(00-1) Concrete 2009

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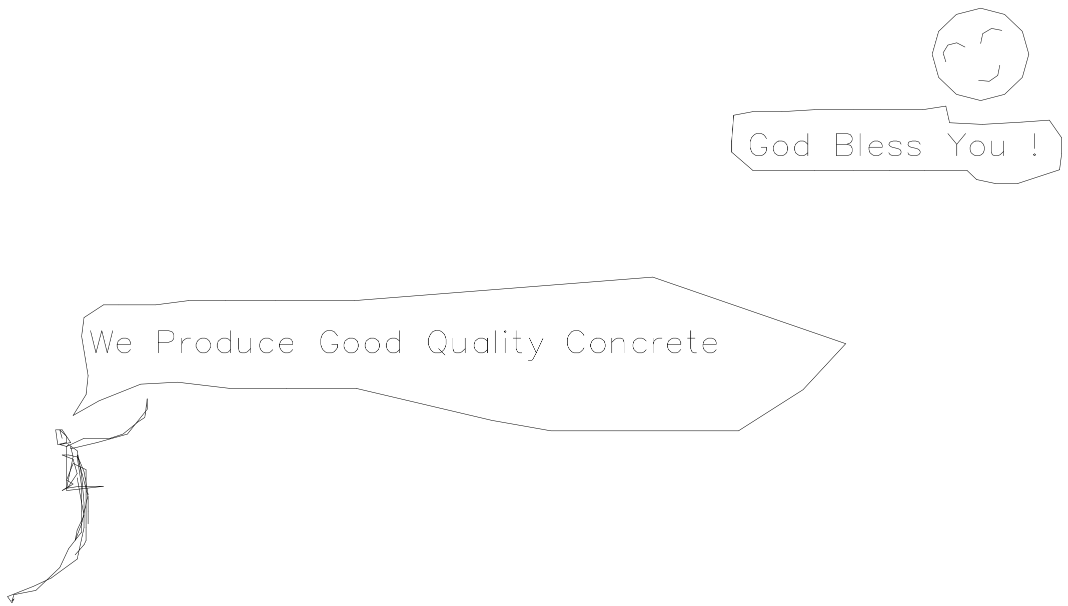

只野敏夫
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Unit symbols and unit conversion figures

conversion	conversion table		conversion standard		
N = kgf * 9.8	N	kgf	1N	≒	0.1kgf
	1	0.102	10N	≒	1kgf
	9.8	1	100N	≒	10kgf
			1kN = 1000N	≒	100kgf
			10kN = 10000N	≒	1000kgf = 1tf

formula

conversion	conversion table					conversion standard		
N/m2 = kgf/cm2 * 98000	N/m2	N/cm2	N/mm2	kgf/cm2	kgf/mm2	1N/mm2	≒	10kgf/cm2
N/m2 = kgf/mm2 * 980000	1	0.0001	0.000001	0.0000102	0.000000102	10N/mm2	≒	100kgf/cm2
N/mm2 = kgf/cm2 * 0.098	10000	1	0.01	0.102	0.00102	100N/mm2	≒	1000kgf/cm2 = 1tf/cm2
N/mm2 = kgf/mm2 * 9.8	1000000	100	1	10.2	0.102	1kN/mm2 = 1000N/mm2	≒	10000kgf/cm2 = 10tf/cm2
	98000	9.8	0.098	1	0.01	1N/cm2	≒	0.1kgf/cm2
	9800000	980	9.8	100	1	10N/cm2	≒	1kgf/cm2
						100N/cm2	≒	10kgf/cm2
						1kN/cm2 = 1000N/cm2	≒	100kgf/cm2

	Concrete 2009	test	slump	concrete	concreting or construction	batching plant	superplasticizer or Superplasticized Con	admixture	cement	aggregate and Sand	water and material	strength	mix design	mix calculation	W/C	example	prestressed	quality control	etc
1	(1) Slump of Concrete ASTM C 143	0	0																
2	(2) Flow Chart of Trial Mix												0						
3	(3) Water Cement Ratio and Compressive Strength ASTM C 31 ACI 211.1 and ACI													0	0				
4	(4) Required Average Compressive Strength											0	0						
5	(5) Bulk Volume of Coarse Aggregate per Unit Volume of Concrete (ACI 211.1-12)									0			0						
6	(6) Recommended Slumps for various types of Construction(ACI 211.1-21)		0										0						
7	(7) Approximate Mixing Water (ACI 211.1-22)										0		0						
8	(8) Concrete Delivery Slip					0													
9	(9) Batching Plant					0													
10	(10) Sieve Analysis of Coarse Aggregate (ASTM C 33)									0									
11	(11) Sieve Analysis of Coarse Aggregate (ASTM C 33)									0									
12	(12)Specific Gravity and Absorption Test of Fine Aggregate (JISA A 1109)	0								0									
13	(13)Specific Gravity and Absorption Test of Fine Aggregate (ASTM C-128)	0								0									
14	(14)Specific Gravity and Absorption Test of Coarse Aggregate (JISA A 1110)	0								0									
15	(15)Specific Gravity and Absorption Test of Coarse Aggregate (ASTM C-127)	0								0									
16	(16)Moisture Condition of Aggregate									0									
17	(17)Fire Concrete ACI 216R-10 Table 2.4.1(a)									0									
18	(18)Batching Plant Percentage of Accuracy					0													
19	(19)Material Finer than 75um(No.200) Sieve 2 ASTM C33 Table-1									0									
20	(20)Material Finer than 75um(No.200) Sieve 2 ASTM C33 Table-1									0									
21	(21)Compressive Strength Test-1											0							
22	(22)Compressive Strength Test-2											0							
23	(23)Fluidized Concrete						0												
24	(24)Compressive Strength Test											0							
25	(25)Calibration					0													
26	(26)Mixing Water										0								
27	(27) Concrete Component			0						0	0								
28	(28) Concrete Volume			0															
29	(29) Concrete Volume(1)			0															
30	(30) Cross Section of Harden Concrete			0															
31	(31) Cylinders with Water Cement Ratios from 0.4 to 0.6																		
32	(32) Effect of Casting Temperature on The Slump		0																
33	(33) Workable Concrete			0															
34	(34) Bleeding Water			0															
35	(35) Good Consolidation and Bad Consolidation			0															
36	(36) Effect of Void in Concrete and Compressive Strength											0							
37	(37) Hardened Concrete Curing																		
38	(38) Concrete Strength											0			0				

39	(39) Effect of Casting and Curing Temperature on Strength Development																		
40	(40) Water Cement Ratio and Compressive Strength												0		0				
41	(41) Water Cement Ratio and Hydraulic Permeability												0		0				
42	(42) Types of Portland Cement								0										
43	(43) Type I								0										
44	(44) Masonry Cement and Mortar Cement								0										
45	(45) Cement Stored								0										
46	(46) Fly Ash								0										
47	(47) Fly Ash Workability								0										
48	(48)Silica Fume Pump Ability								0										
49	(49) Effect of a Slag on Heat of Hydration								0										
50	(50) Mixing Water for Concrete			0							0								
51	(51) Chloride		0																
52	(52) Water Content, Slump and Cement Content		0												0				
53	(53) Relation between Strength and Water Cement Ratio											0			0				
54	(54) Method and Equipment for Transporting Concrete				0														
55	(55) Concrete												0						
56	(56) Concrete Mix Proportion												0						
57	(57) Concrete Technology												0		0				
58	(58) Concrete Trial Mix												0		0				
59	(59) Concrete Mix Proportion			0									0						
60	(60) Consistency						0						0						
61	(61) Consistency-Water												0						
62	(62) Strength												0						
63	(63) Durability			0									0						
64	(64) Concrete Mix Proportion												0						
65	(65) Mix Proportion of Concrete												0						
66	(66) Mix Proportion Step													0					
67	(67) Mix Proportion Step-Slump													0					
68	(68) Mix Proportion Step-Maximum Size of Aggregate													0					
69	(69) ACI 211.1 Mix Proportion Step(1)-Water and Air Content													0					
70	(70) ACI 211.1 Mix Proportion Step(2)-Water and Air Content													0					
71	(71) ACI 211.1 Mix Proportion Step(3)													0	0				
72	(72) ACI 211.1 Mix Proportion Step(4-1) Water Cement Ratio													0	0				
73	(73) ACI 211.1 Mix Proportion Step(4-2) Strength with Cubic Specimen													0					
74	(74) ACI 211.1 Mix Proportion Step(5) Calculate Cement Content													0					
75	(75) ACI 211.1 Mix Proportion Step(6) Calculate Coarse Aggregate Content													0					
76	(76) ACI 211.1 Mix Proportion Step(7) Calculate Fine Aggregate Content													0					
77	(77) ACI 211.1 Mix Proportion Step(8-1) Calculate Fine Aggregate Content													0					
78	(78) ACI 211.1 Mix Proportion Step(8-2) Calculate Unit Weight of Fresh Concrete													0					
79	(79) ACI 211.1Mix Proportion Step(8-3) Calculate Fine Aggregate Content													0					
80	(80) ACI 211.1 Mix Proportion Step(8-4) Adjustment of Aggregate Moisture Content													0					
81	(81) ACI 211.1 Mix Proportion Step(9) Adjustment Trial Batch													0					
82	(82) ACI 211.1 Mix Proportion Step(9-1) Adjustment Trial Batch -Slump -Water Content						0							0					
83	(83) ACI 211.1 Mix Proportion Step(9-2) Adjustment Trial Batch -Slump -Water Content													0					
84	(84) ACI 211.1 Mix Proportion Step Calculation(1)													0					
85	(85) ACI 211.1 Mix Proportion Step Calculation(2)													0	0				
86	(86) ACI 211.1 Mix Proportion Step Calculation(3)													0					

87	(87) ACI 211.1 Mix Proportion Step Calculation(4)													0					
88	(88) ACI 211.1 Mix Proportion Step Calculation(5)													0					
89	(89) ACI 211.1 Mix Proportion Step Calculation(6)													0					
90	(90) ACI 211.1 Mix Proportion Step Calculation(7)													0					
91	(91) ACI 211.1 Mix Proportion Step Calculation(8)													0					
92	(92) ACI 211.1 Mix Proportion -Heavy Weight Structure Concrete Calculation(1)													0					
93	(93) ACI 211.1 Mix Proportion -Heavy Weight Structure Concrete Calculation(2)													0					
94	(94) ACI 211.1 Mix Proportion -Heavy Weight Structure Concrete Calculation(3)													0					
95	(95) ACI 211.1 Mix Proportion -Heavy Weight Structure Concrete Calculation(4)													0					
96	(96) ACI 211.1 Mix Proportion -Heavy Weight Structure Concrete Calculation(5)													0					
97	(97) ACI 211.1 Mix Proportion -Heavy Weight Structure Concrete Calculation(6)													0					
98	(98) ACI 211.1 Mix Proportion -Heavy Weight Structure Concrete Calculation(7)													0					
99	(99) ACI 211.1 Mix Proportion -Heavy Weight Structure Concrete Calculation(8)													0					
100	(100) ACI 211.1 Mix Proportion -Heavy Weight Structure Concrete Calculation(9)													0					
101	(101) ACI 211.1 Design of Concrete Mixes (1)													0					
102	(102) ACI 211.1 Design of Concrete Mixes (2)			0										0					
103	(103) ACI 211.1 Design of Concrete Mixes (3)			0										0					
104	(104) ACI 211.1 Design of Concrete Mixes (4)			0										0					
105	(105) ACI 211.1 Design of Concrete Mixes (5)			0										0					
106	(106) ACI 211.1 Design of Concrete Mixes (6)			0										0					
107	(107) ACI 211.1 Design of Concrete Mixes (7)			0										0					
108	(108) ACI 211.1 Design of Concrete Mixes (8)													0					
109	(109) ACI 211.1 Design of Concrete Mixes (9)													0					
110	(110) ACI 211.1 Design of Concrete Mixes (10)													0					
111	(111) ACI 211.1 Design of Concrete Mixes (11)													0					
112	(112) ACI 211.1 Design of Concrete Mixes (12)													0	0				
113	(113) ACI 211.1 Design of Concrete Mixes (13)													0					
114	(114) ACI 211.1 Design of Concrete Mixes (14)													0					
115	(115) ACI 211.1 Design of Concrete Mixes (15)													0					
116	(116) ACI 211.1 Design of Concrete Mixes (16)													0					
117	(117) ACI 211.1 Design of Concrete Mixes (17)													0					
118	(118) ACI 211.1 Mix Design of Small Size Construction													0					
119	(119) Concrete Material (1)									0									
120	(120) Concrete Material (2)									0									
121	(121) Concrete Material (3)									0									
122	(122) Concrete Material (4)									0									
123	(123) Cement								0										
124	(124) Ordinary Portland Cement								0										
125	(125) High Early Strength Portland Cement								0										
126	(126) Ultra High Early Strength Portland Cement								0										
127	(127) Modulate Heat Portland Cement								0										
128	(128) Sulfate Resisting Portland Cement								0										
129	(129) Blast Furnace Slag Cement								0										
130	(130) Silica Cement (I)								0										
131	(131) Fly Ash Cement								0										
132	(132) Almina Cement								0										
133	(133) Ultra High Strength Portland Cement								0										
134	(134) Cement Ingredient (I)								0										

135	(135) Cement Ingredient (II)								0										
136	(136)Cement Weight								0										
137	(137) Cement Specific Gravity								0										
138	(138) Cement Fineness								0										
139	(139) Cement Setting								0										
140	(140) Cement Soundness								0										
141	(141) Cement Strength								0										
142	(142) Heat of Hydration								0										
143	(143) Cement Choice								0										
144	(144) Cement Storage								0										
145	(145) Kind of Aggregate									0									
146	(146)Required Aggregate									0									
147	(147) Size of Aggregate									0									
148	(148) Grading and Fineness Modulus of Aggregate (1)									0									
149	(149) Grading and Fineness Modulus of Aggregate (2)									0									
150	(150) Grading and Fineness Modulus of Aggregate (3)									0									
151	(151) Water Content of Aggregate									0									
152	(152) Specific Gravity of Aggregate(1)									0									
153	(153) Specific Gravity of Aggregate(2)									0									
154	(154) Specific Gravity of Aggregate(3)									0									
155	(155) Specific Gravity of Aggregate(4)									0									
156	(156) Specific Gravity of Aggregate(5)									0									
157	(157) Surface Moisture Content (1)									0									
158	(158) Absolute Volume			0						0									
159	(159) Unit Weight (1)			0						0									
160	(160) Unit Weight (2)									0									
161	(161) Percentage of Void Ratio of Aggregate			0						0									
162	(162) Harmful Material of Aggregate									0									
163	(163) Decantation Test									0									
164	(164) Durability of Aggregate									0									
165	(165) Abrasion									0									
166	(166) Crushed Stone									0									
167	(167) Lightweight Aggregate									0									
168	(168) Storage of Aggregate									0									
169	(169) Water-1										0								
170	(170) Cement Aggregate Water								0	0	0								
171	(171) Admixture							0											
172	(172) Pozzolan								0										
173	(173) AE Agent							0											
174	(174) Water Reducing Agent							0											
175	(175) Accelerator							0											
176	(176) Retarder							0											
177	(177)Water Proofing Agent			0				0											
178	(178) Concrete			0															
179	(179)Good Point of Concrete			0															
180	(180) Bad Point of Concrete			0															
181	(181) Uses of Concrete			0															
182	(182) Fresh Concrete			0															

183	(183)Good Concrete			0															
184	(184) Workability			0															
185	(185)Consistency																		
186	(186) Plasticity																		
187	(187) Finish Ability			0															
188	(188) Segregation			0															
189	(189) Air Content			0															
190	(190) Slump of Concrete (ACI 143)	0	0	0															
191	(191) Compressive Strength of Concrete (I)											0							
192	(192) Compressive Strength of Concrete (II)											0							
193	(193) Tensile Strength											0							
194	(194) Bending Strength of Concrete (I)											0							
195	(195) Compressive Strength											0							
196	(196) Concrete Strength (Material)											0							
197	(197) Mix Proportion and Compressive Strength											0			0				
198	(198) Mixing and Strength											0							
199	(199) Curing and Strength											0							
200	(200) Ages and Strength											0							
201	(201) Test Piece and strength (I)											0							
202	(202) Test Piece and strength (II)											0							
203	(203)Unit Weight			0															
204	(204) Durability			0															
205	(205) Water tightness			0															
206	(206)Volumetric Change			0															
207	(207)Modulus of Elasticity			0															
208	(208) Mix Proportion of Concrete												0						
209	(209) Mix Proportion (1)												0						
210	(210) Mix Proportion (2)												0						
211	(211) Specified Field Mix Proportion (1)												0						
212	(212) Specified Field Mix Proportion (2)												0						
213	(213) Specified Field Mix Proportion (3)												0						
214	(214) Mix Proportion of Concrete												0						
215	(215) Required Average Strength												0						
216	(216) Water Cement Ratio												0		0				
217	(217) Water Cement Ratio and Strength												0						
218	(218) Water Cement Ratio and Durability												0		0				
219	(219) Water Cement Ratio and Water tightness												0		0				
220	(220) Water Cement Ratio and Durability												0		0				
221	(221) Unit Water and Sand Percentage												0						
222	(222) Correction												0						
223	(223) Unit Water and Unit Cement												0						
224	(224) Unit Fine Aggregate and Coarse Aggregate			0									0						
225	(225) Correction (1)												0						
226	(226) Correction (2)												0						
227	(227) Correction (3)												0						
228	(228) Order of Mix Proportion Design												0						
229	(229) Maximum Size of Aggregate												0						
230	(230) Standard of Air Content												0						

231	(231) Mix Proportion Calculation (1)												0						
232	(232) Mix Proportion Calculation (2)												0						
233	(233) Mix Proportion Calculation (3)												0						
234	(234) Mix Proportion Calculation (4)												0						
235	(235) Mix Proportion Calculation (5)												0						
236	(236) Mix Proportion Calculation (6)												0						
237	(237) Mix Proportion Calculation (7)												0						
238	(238) Advantage of Fresh Concrete																		
239	(239) Attention of Fresh Concrete																		
240	(240) Batching Plant					0													
241	(241) Concrete Delivery Control					0													
242	(242) Quality Control																		
243	(243) Rule of Constant Unit Water Content			0															
244	(244) Mix Proportion of Concrete												0						
245	(245) Water Cement Ratio												0		0				
246	(246) Water Cement Ratio and Strength											0	0		0				
247	(247) Required Average Strength and Extra Co-efficient											0	0						
248	(248) Fluctuation Co-efficient (V)			0															
249	(249) Water Cement Ratio and Durability			0															
250	(250) Water tightness			0															
251	(251) Water Cement Ratio and Mix Proportion Design											0	0		0				
252	(252) Concrete Mix Proportion Design (1)													0					
253	(253) Concrete Mix Proportion Design (2)													0					
254	(254) Concrete Mix Proportion Design (3)													0					
255	(255) Concrete Mix Proportion Design (4)													0					
256	(256) Concrete Mix Proportion Design (5)													0					
257	(257) Concrete Mix Proportion Design (6)													0					
258	(258) Concrete Mix Proportion Design (7)													0					
259	(259) Minimum Content of Cement													0					
260	(260) Slump (Standard Value)			0															
261	(261) Maximum Size of Aggregate										0								
262	(262) Maximum Size of Aggregate										0								
263	(263) Adjustment													0					
264	(264) Unit Coarse Aggregate Volume ,Sand Percentage and Unit Water Content													0					
265	(265) Correction													0					
266	(266) AE Concrete Mix Proportion Design (1)													0					
267	(267) AE Concrete Mix Proportion Design (2)													0					
268	(268) AE Concrete Mix Proportion Design (3)													0					
269	(269) AE Concrete Mix Proportion Design (4)													0					
270	(270) AE Concrete Mix Proportion Design (5)													0					
271	(271) AE Concrete Mix Proportion Design (6)													0					
272	(272) AE Concrete Mix Proportion Design (7)													0					
273	(273) AE Concrete Mix Proportion Design (8)													0					
274	(274) AE Concrete Mix Proportion Design (9)													0					
275	(275) Air Content of AE Concrete													0					
276	(276) Grading of Fine Aggregate													0					
277	(277) Grading of Coarse Aggregate													0					
278	(278) Mix Proportion (1)													0					

279	(279) Mix Proportion (2)													0					
280	(280) Mix Proportion (3)													0					
281	(281) Mix Proportion (4)													0					
282	(282) Mix Proportion (5)													0					
283	(283) Mix Proportion (6)													0					
284	(284) Mix Proportion (7)													0					
285	(285) Mix Proportion (8)													0					
286	(286) Mix Proportion (9)													0					
287	(287) Mix Proportion (10)													0					
288	(288) ACI 318 Water Cement Ratio and Compressive Strength											0		0					
289	(289) ACI 318 Requirements for Concrete Exposed to Sulfates in Soil or Water													0					
290	(290) ACI 211.1 and ACI 211.3 Relationship between Water Cement Ratio and Compressive Strength of Concrete													0					
291	(291) ACI 211 Bulk Volume of Coarse Aggregate per Unit Volume of Concrete									0				0					
292	(292) ACI211.1 and ACI 318 (Metric) Approximate Mixing Water and Target Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate													0					
293	(293) ACI211.1 and ACI 318 (Inch-Pound Units) Approximate Mixing Water and Target Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate													0					
294	(294) ACI 211.Recomended Slumps for Various Types of Construction													0					
295	(295) ACI 302 Minimum Requirements of Cementing Materials for Concrete Used in													0					
296	(296) ACI 318 Cementitious Materials Requirements for Concrete Exposed to Deicing Chemicals													0					
297	(297) ACI 318 Maximum Chloride-Ion Content for Corrosion Protection													0					
298	(298) ACI 318 Modification Factor for Standard Deviation when less than 30 Tests are Available													0					
299	(299) ACI 318 (Metric) Required Average Compressive Strength when Data are not Available to Establish a Standard Maximum Factor for Standard Deviation													0					
300	(300) ACI 318 (Inch-Pound Units) Required Average Compressive Strength when Data are not Available to Establish a Standard Maximum Factor for Standard Deviation													0					
301	(301) Density of Water Versus Temperature													0					
302	(302) ACI 211.1 Mix Proportion (1)													0					
303	(303) ACI 211.1 Mix Proportion (2)													0					
304	(304) ACI 211.1 Mix Proportion (3)													0					
305	(305) ACI 211.1 Mix Proportion (4)													0					
306	(306) ACI 211.1 Mix Proportion (5)													0					
307	(307) ACI 211.1 Mix Proportion (6)													0					
308	(308) ACI 211.1 Mix Proportion (7)													0					
309	(309) ACI 211.1 Mix Proportion (8)													0					
310	(310) ACI 211.1 Mix Proportion (9)													0					
311	(311) ACI 211.1 Table A1.1-Conversion Factors In-lb to SI Units													0					
312	(312) ACI 211.1 Table A1.5.3.1-Recommended Slumps for Various Types of Construction (SI)		0											0					
313	(313) ACI211.1 Table A1.5.3.3 Approximate Mixing Water and Air Content requirements for Difficult Slumps and Nominal Maximum Sizes of Aggregates (SI)													0					
314	(314) ACI 211.1 Table A1.5.3.4(a) Relationship between Water Cement Ratio and Compressive Strength of Concrete (SI)													0					
315	(315) ACI 211.1 Table A1.5.3.4(b) Maximum Permissible Water-Cement Ratios for Concrete Severe Exposures (SI)													0					
316	(316) ACI 211.1 Table A1.5.3.6 Volume of Coarse Aggregate per Unit of Volume of Concrete (SI)									0				0					
317	(317) ACI 211.1 Table A1.5.3.7.1 First Estimate of Mass of Fresh Concrete(SI)													0					
318	(318) ACI 211.1 Mix Proportion (1)													0					

319	(319) ACI 211.1 Mix Proportion (2)													0					
320	(320) ACI 211.1 Mix Proportion (3)													0					
321	(321) ACI 211.1 Mix Proportion (4)													0					
322	(322) ACI 211.1 Mix Proportion (5)													0					
323	(323) ACI 211.1 Mix Proportion (6)													0					
324	(324) ACI 211.1 Mix Proportion (7)													0					
325	(325) Concreting				0														
326	(326) Transporting of Concrete				0														
327	(327) Methods of Concrete Transporting				0														
328	(328) Concrete Pump				0														
329	(329) Concreting				0														
330	(330) Attention of Concreting				0														
331	(331) Compaction of Concrete				0														
332	(332) Joints of Concrete				0														
333	(333) Concrete Surface Finishing				0														
334	(334) Concrete Curing				0														
335	(335) Taking off Forms				0														
336	(336) Cold Weather Concrete			0															
337	(337) Hot Weather Concrete			0															
338	(338) Mass Concrete			0															
339	(339) Concrete under Water			0															
340	(340) Prepacked Concrete			0															
341	(341) Fluidized Concrete			0															
342	(342) Consistency-Water			0															
343	(343) Segregation			0															
344	(344) Workability			0															
345	(345) Compressive Strength(1)											0							
346	(346) Compressive Strength(2)											0							
347	(347) Compressive Strength(3)											0							
348	(348) Compressive Strength(4)											0							
349	(349) Water tightness			0															
350	(350) Durability			0															
351	(351) Alkali-Aggregate Reaction			0															
352	(352) Air Content and Durability			0															
353	(353) Chloride Content			0															
354	(354) Slump of Concrete after using Superplastilizer		0	0			0												
355	(355) Slump of Concrete after adding Water		0	0			0												
356	(356) C/W and Compressive Strength											0			0				
357	(357) Concrete Test I	0																	
358	(358) Concrete Test II	0																	
359	(359)(1) Slump of Concrete	0	0																
360	(360)(190) Slump of Concrete	0	0																
361	(361)(23)Fluidized Concrete						0												
362	(362) Slump of Concrete		0				0												
363	(363) Slump of Concrete (II)		0				0												
364	(364)Mix Proportion												0						
365	(365)Superplasticizer (Additive)						0												
366	(366) Attention of Fresh Concrete			0			0												

367	(367)(60)(82) Slump		0																
368	(368)(243)Slump		0																
369	(369)(8) Concrete Delivery Slip		0			0													
370	(370) Slump Loss		0				0												
371	(371) Slump after Pouring Superplasticizer		0				0												
372	(372)(355) Slump of Concrete after adding Water		0				0												
373	(373) Slump at Batching Plant and Site (Superplasticizer)		0				0												
374	(374) Fluidized Concrete by Superplasticizer or High-range Water Reducing Agent		0				0												
375	(375) Slump and Flow of Fluidized Concrete		0				0												
376	(376) Fluidized Concrete or Superplasticized Concrete by Superplasticizer or High-range Water Reducing Agent or Superplasticizing Admixture		0				0												
377	377-(151) Water Content of Aggregate		0							0									
378	(378) Purpose of Superplasticized Concrete		0				0												
379	(379) Purpose of Superplasticized Concrete II		0				0												
380	(380) Specification of Superplasticized Concrete I		0				0												
381	(381) Specification of Superplasticized Concrete II		0				0												
382	(382) Examples of Superplasticized Concrete(Base Concrete-AE Concrete)						0												
383	(383) Water Content Case of Japan												0						
384	(384) 252 Concrete Mix Proportion Design Case of Japan												0						
385	(385)266 Mix Proportion Design of AE Concrete Case of Japan												0						
386	(386)231 Example of Mix proportion Case of Japan												0						
387	(387)225 Correction Mix Proportion Case of Japan												0						
388	(388)278 Mix Proportion Case of Japan												0						
389	(389)(69) ACI 211.1 Mix Proportion Case of ACI												0						
390	(390) Superplasticizer						0												
391	(391) High-range Water Reducing Agent-Superplasticizer						0												
392	(392-377)-151 Water Content of Aggregate						0			0									
393	(393) Causes of Slump Difference of Superplasticized Concrete		0				0												
394	(394) Dosage Content of Superplasticizer and Slump or Flow		0				0												
395	(395) Classification of High-range Water Reducing Agent-Superplasticizer						0												
396	(396) Total Dosage of Superplasticizer or High Range Water Reducing Agent						0												
397	(397) Effect of Superplasticizer or High Range Water Reducing Agent						0												
398	(398) Effect of Superplasticizer (II)		0				0												
399	(399) Bleeding of Superplasticized Concrete		0	0			0												
400	(400) SI Units																0		
401	(401) Pumpability of Superplasticized Concrete				0														
402	(402) (4) Eart Drilling-Concreting-Chock II				0														
403	(403) Strength Comparison of Concrete(Cement Content=300kg/m3)											0							
404	(404) Compressive Strength											0							
405	(405) Cement-1								0										
406	(406) Cement-2								0										
407	(407) Cement-3								0										
408	(408) Cement-4								0										
409	(409) Cement-5								0										
410	410-171 Admixture							0											
411	411-241 Batching Plant					0													
412	(412) Aggregate and Sand -1									0									
413	(413) Aggregate and Sand-2									0									

414	414-Aggregate and Sand-3									0									
415	(415) Aggregate and Sand-4									0									
416	(416) Concreting-1				0														
417	(417) Concreting -2				0														
418	(418) Concreting-3				0														
419	(419) Aggregate and Sand-5									0									
420	(420) Compressive Strength-1											0							
421	(421) Compressive Strength-2											0							
422	(422) Compressive Strength-3											0							
423	(423) Compressive Strength-4											0							
424	(424) Compressive Strength-5											0							
425	(425) Concrete Strength-6											0							
426	(426) Sump-1		0																
427	(427) Slump-2		0																
428	(428) Slump-3		0																
429	(429) Slump-4		0																
430	(430) Superplasticizer-1						0												
431	(431) Superplasticizer-2						0												
432	(432) Superplasticizer-3						0												
433	(433) Superplasticizer-4						0												
434	(434) Superplasticizer-5						0												
435	(435) Superplasticizer-6						0												
436	(436) Superplasticizer-7						0												
437	(437) Concrete-1			0															
438	(438) Concrete-2			0															
439	(439) Concrete-3			0															
440	(440) Concrete-4			0															
441	(441) Concrete-5			0															
442	(442) Concrete-6			0															
443	(443) Concrete-7			0															
444	(444) Concrete-8			0															
445	(445) Concrete-9			0															
446	(446) Concrete-10			0															
447	(447) Concrete-11			0															
448	(448) W/C-1														0				
449	(449) W/C-2														0				
450	(450) W/C-3														0				
451	(451) W/C-4																		
452	(452) s/a-1																		
451	(451) W/C-4																		
452	(452) s/a-1																		
453	(453) s/a-2																		
454	(454) Air Content-1																		
455	(455) Cement in Superplasticized Concrete-1						0		0										
456	(456) Aggregate in Superplasticized Concrete -2						0			0									
457	(457) Admixture for Base Concrete in Superplasticized Concrete-3						0	0											
458	(458) Superplasticizer in Superplasticized Concrete-4						0												
459	(459) Mix Proportion in Superplasticizer Concrete-5						0						0			0			

460	(460) Cautions of Fresh Concrete						0												
461	(461) Slump in Superplasticized Concrete-6		0				0												
462	(462) Sand Percentage(s/a) in Superplasticized Concrete-7						0			0									
463	(463) Air Content (a) in Superplasticized Concrete-8						0												
464	(464) Water Content (w) in Superplasticized Concrete-9						0												
465	(465) Cement Content© and W/C in Superplasticized Concrete-10						0												
466	(466) Sand Percentage (s/a) in Superplasticized Concrete-11						0												
467	(467) Mix Proportion of Base Concrete in Superplasticized Concrete-12						0												
468	(468) Trial Mix of Base Concrete in Superplasticized Concrete-13						0												
469	(469) Superplasticized Test in Superplasticized Concrete-14						0												
470	(470) Judgement Workability of Superplasticized Concrete-15						0												
471	(471) Production of Superplasticized Concrete-16						0												
472	(472) Adjustment Dosage of Superplasticized Concrete-17						0												
473	(473) Slump Test of Base Concrete and Superplasticized Concrete-18						0												
474	(474) Redosage Superplasticizer of Superplasticized Concrete-19						0	0											
475	(475) Check Points of Design and Specification of Superplasticized Concrete-20						0												0
476	(476) Check Points of Superplasticized Concrete-21						0												0
477	(477) Flow Chart of Superplasticized Concrete-22						0						0						0
478	(478) Order of Base Concrete and Superplasticized Concrete-23				0	0	0	0											0
479	(479) Pumping of Superplasticized Concrete-24				0		0	0											
480	(480) Pumping of Superplasticized Concrete-25				0		0	0											
481	(481) Compaction of Superplasticized Concrete-26				0		0												
482	(482) Finishing of Superplasticized Concrete-27				0		0												
483	(483) Curing of Superplasticized Concrete-28				0		0												
484	(484) Concreting of Superplasticized Concrete-29						0												
485	(485) Production Control of Superplasticized Concrete-30					0	0												
486	(486) Base Concrete Control of Superplasticized Concrete-31						0												
487	(487) Quality Control of Superplasticized Concrete-32						0											0	
488	(488) Purposeof Superplasticized Concrete-33						0												
489	(489) High Compressive Strength Concrete by Superplasticized Concrete-34						0					0							
490	(490) Mass Concrete by Superplasticized Concrete-35						0												0
491	(491) Prestressed Concrete by Superplasticized Concrete-36						0										0		
492	(492) Examples of Superplasticized Concrete(Base Concrete-AE Concrete)															0			
493	(493) Examples of Superplasticized Concrete(Base Concrete-AE Concrete)															0			
494	(494) Cement in Superplasticized Cpncrete																		
495	(495) Judgement of Concrete Condition by Slump Shape (1)		0																
496	(496) Judgement of Concrete Condition by Slump Shape (2)		0																
497	(497) Judgement of Concrete Condition by Slump Test (3)		0																
498	(498) Judgement of Concrete Condition by Slump Test (4)		0																
499	(499) Judgement of Concrete Condition by Slump Test (5)		0																
500	(500) Judgement of Concrete Condition by Slump Test (6)		0																

(01)References

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Otani Noboru
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Kondou Yasuo
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Sankaidou

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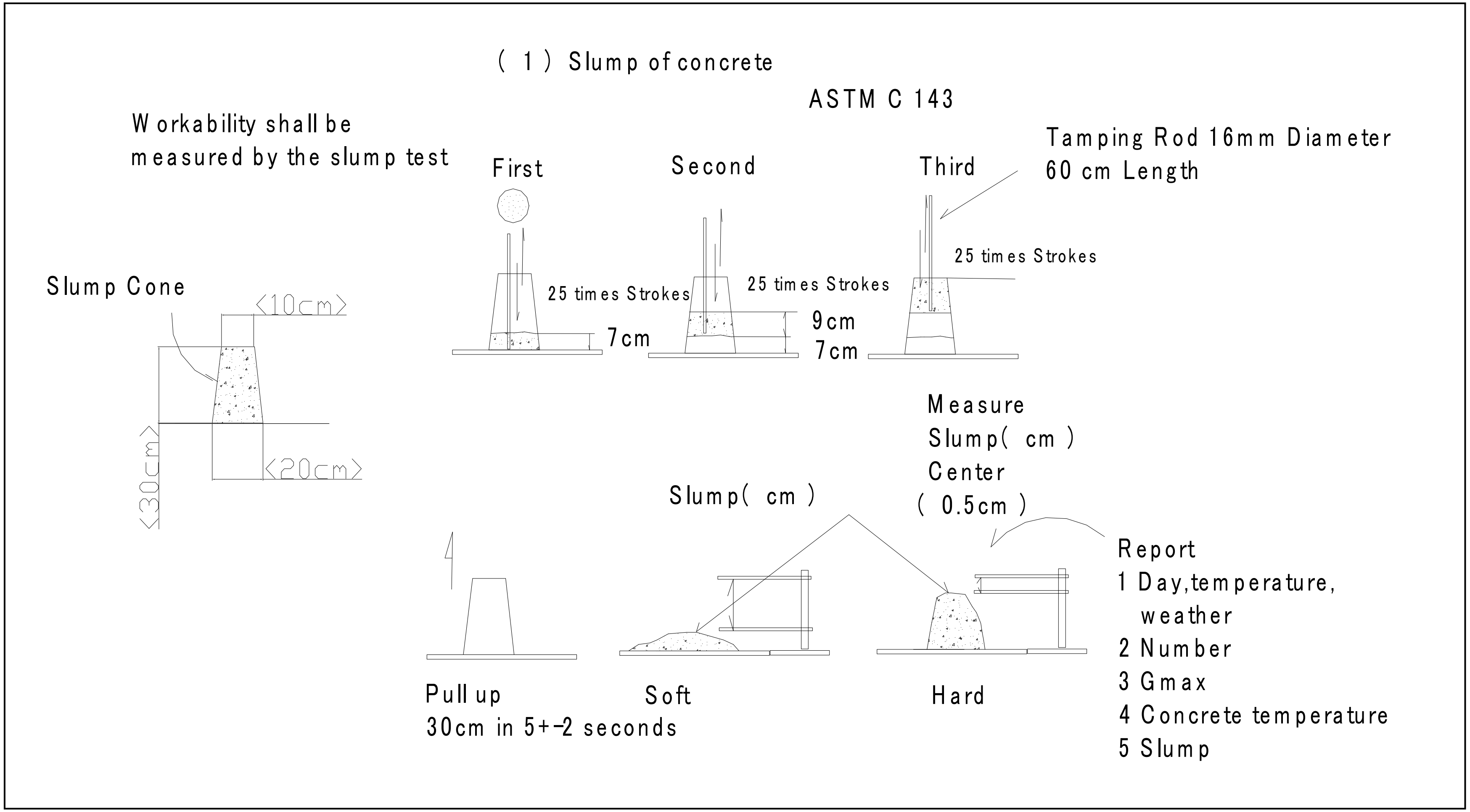
5 Superplasticized Concrete Method
Ogawa Akira
Rikou Tosho

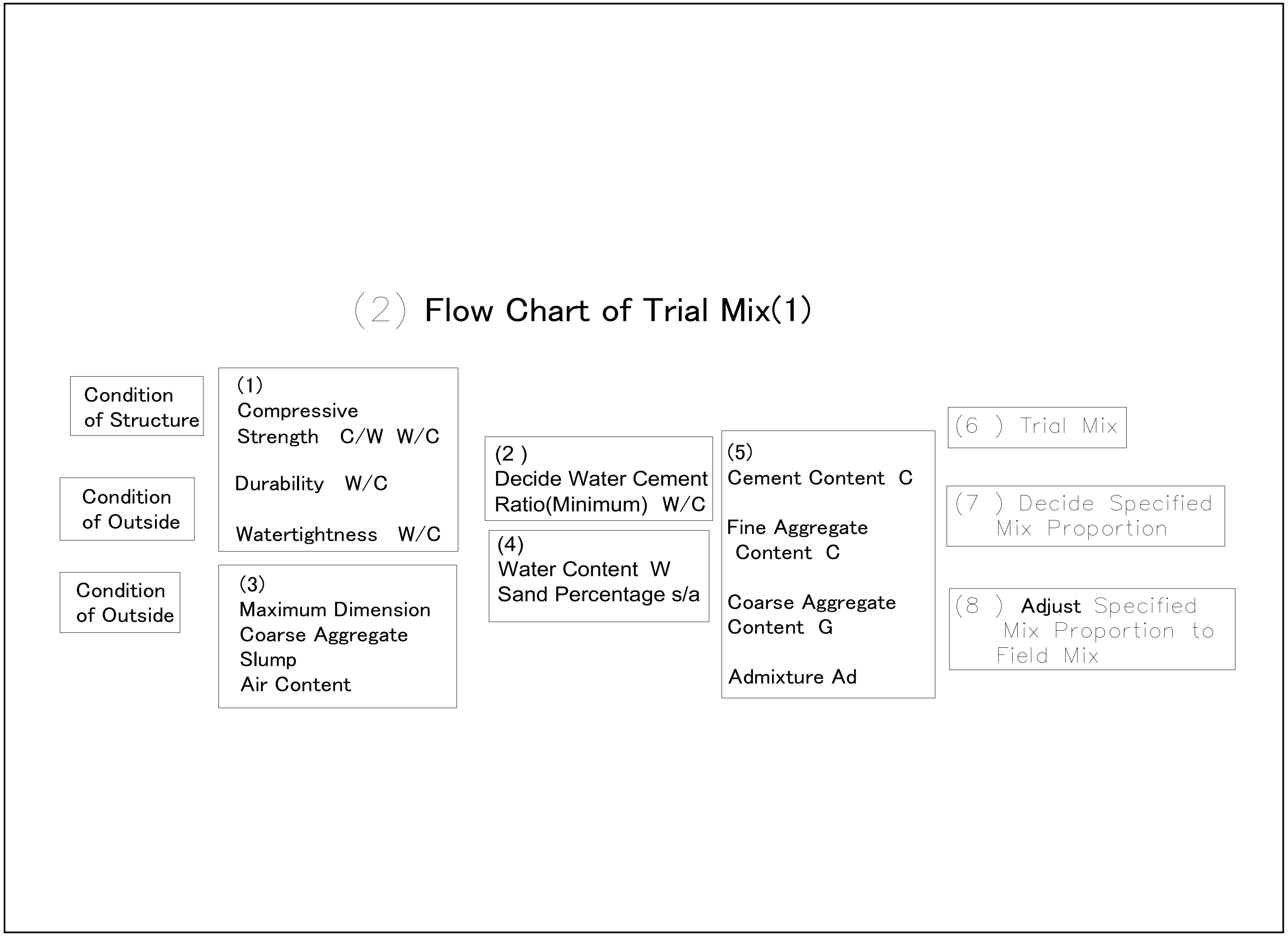
6 Good Concrete
Yoshikane Touru
Cement Journal

只野敏夫
TADANO TOSHIO

(1) Slump of Concrete ASTM C 143



(2) Flow Chart of Trial Mix

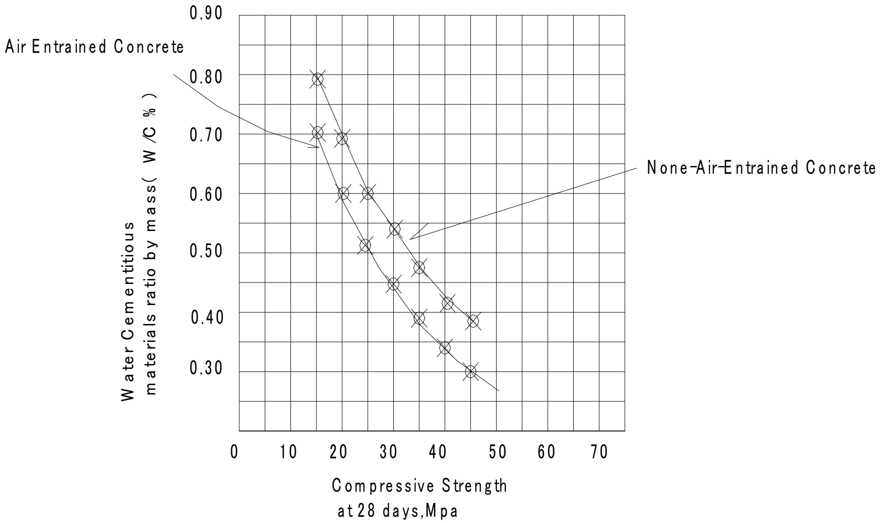


(3) Water Cement Ratio and Compressive Strength ASTM C 31 ACI 211.1 and ACI 211.3

(3) Water Cement Ratio and Compressive Strength

ASTM C 31,
ACI 211.1
and ACI 211.3.

Compressive Strength at 28 days, Mpa	Water Cementitious materials ratio by mass	
	None-air-entrained concrete	Air Entrained Concrete
45	0.38	0.30
40	0.42	0.34
35	0.47	0.39
30	0.54	0.45
25	0.61	0.52
20	0.69	0.60
15	0.79	0.70



(4) Required Average Compressive strength When Data Are Not Available to Establish a Standard Deviation

ACI 318

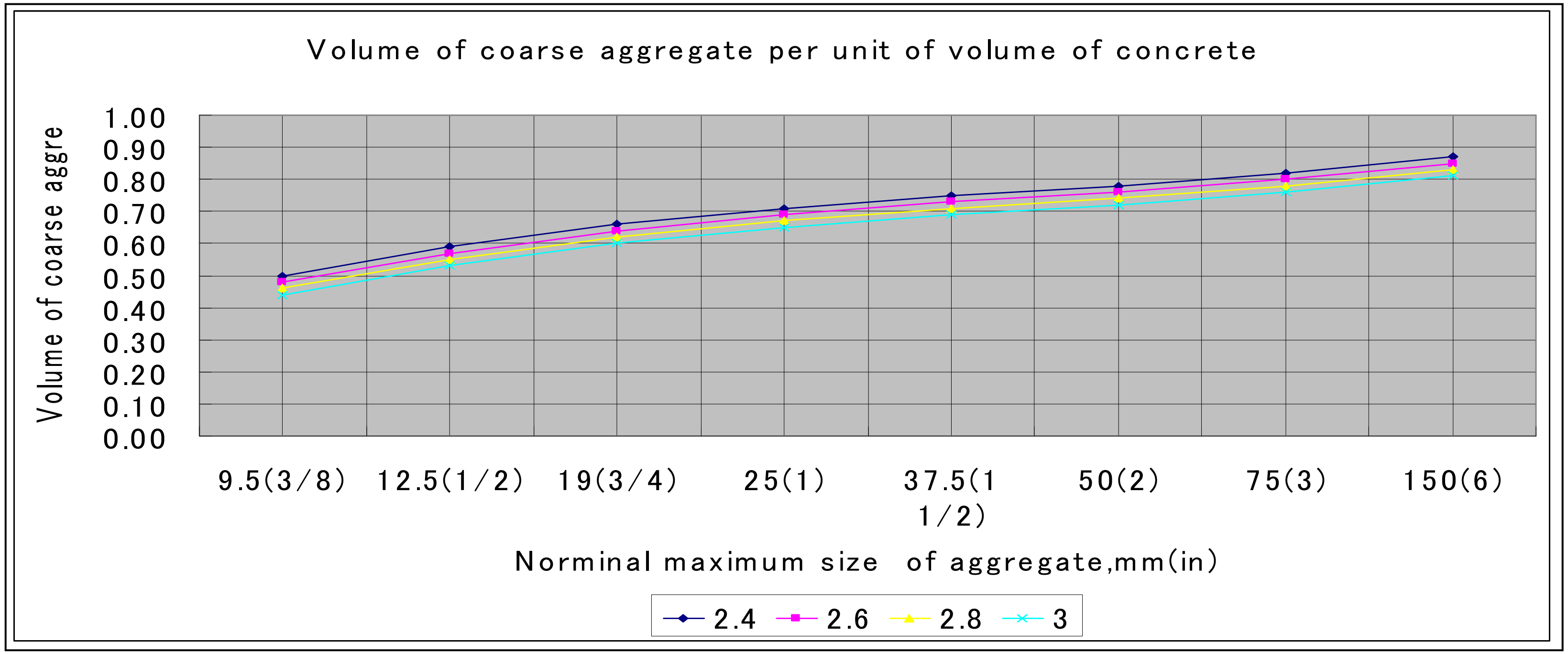
Specified Compressive Strength ,f'c,Mpa	Required Average Compressive Strength ,f'cr,Mpa
Less than 21	f'c+7.0
21 to 35	f'c+8.5
Over 35	1.1*f'c+5.0

(5) Bulk Volume of Coarse Aggregate per Unit Volume of Concrete (ACI 211.1-12)

(5) Table 6.3.6-Bulk Volume of Coarse aggregate per Unit Volume of Concrete

ACI 211.1-12

Nominal maximum size of aggregate, mm (in.)	Bulk volume of dry-rodded coarse aggregate per unit volume of concrete for different fitness moduli of fine aggregate			
	2.4	2.6	2.8	3
9.5 (3/8)	0.50	0.48	0.46	0.44
12.5 (1/2)	0.59	0.57	0.55	0.53
19 (3/4)	0.66	0.64	0.62	0.60
25 (1)	0.71	0.69	0.67	0.65
37.5 (1 1/2)	0.75	0.73	0.71	0.69
50 (2)	0.78	0.76	0.74	0.72
75 (3)	0.82	0.80	0.78	0.76
150 (6)	0.87	0.85	0.83	0.81



(6) Recommended Slumps for various types of Construction(ACI 211.1-21)

(6) Table A1.5.3.1 Recommended slumps for various types of construction (SI)

ACI 211.1-21

Types of construction		Slump, mm	
		Maximum	Minimum
A	Reinforced foundation walls and footings	75	25
B	Plain footings, caissons, and substructure walls	75	25
C	Beam and reinforced walls	100	25
D	Building columns	100	25
E	Pavements and slabs	75	25
F	Mass concrete	75	25

(7) Approximate Mixing Water (ACI 211.1-22)

(7) Table A1.5.3.3 AAproximate mixing water and air content requirements for different slumps and nominal maximum sizes of aggregates (SI)

ACI 211.1-22

	Water,Kg/m3 of concrete for indicated nominal maximum sizes of aggregate							
Slump,mm	9.5	12.5	19	25	37.5	50	75	150
Non-air-entrained concrete								
25 to 50	207	199	190	179	166	154	130	113
75 to 100	228	216	205	193	181	169	145	124
150 to 175	243	228	216	202	190	178	160	-
Approximate amount of entrapped air in non-air-entrained concrete,percent	3	2.5	2	1.5	1	0.5	0.3	0.2

ACI 211.1-22

	Water,Kg/m3 of concrete for indicated nominal maximum sizes of aggregate							
Slump,mm	9.5	12.5	19	25	37.5	50	75	150
Air-entrained concrete								
25 to 50	181	175	168	160	150	142	122	107
75 to 100	202	193	184	175	165	157	133	119
150 to 175	216	205	197	184	174	166	154	-
REcomended average total air content,percent for level of exposure:								
Mild exposure	181	175	168	160	150	142	122	107
Moderate exposure	202	193	184	175	165	157	133	119
Extreme exposure	216	205	197	184	174	166	154	

(8) Concrete Delivery Slip

(8) Concrete Delivery Slip

SLIP NO

DATE

REQUESTER:

(NO 1,NO 2) BATCHING PLANT

MANUFACTURE COMPANY:KJP/BCS

ORDER SHEET NO:

PC.W.B.S

TRUCK NO:

STRUCURE:

CONCRETE MIXING TYPE	DESIGN STRENGTH	MAX SIZE AGGREGATE	W/C	AIR CONTENT	TOTAL ORDER
	(Mpa)	(mm)	(%)	(%)	(m3)

Slump (at Site)	CONCRETE TEMPERATURE (at SITE)	QUANTITY THIS LOAD	QUANTITY CUMULATIVE	TIME RECORD		
				Delivery	POURING	
(mm)	(degree)	(m3)	(m3)	BATCH TIVE	START	FINISH

REMARKS

REMARKS

REMARKS

REMARKS

BATCHING PLANT

NAME: SUBCONTRACTOR

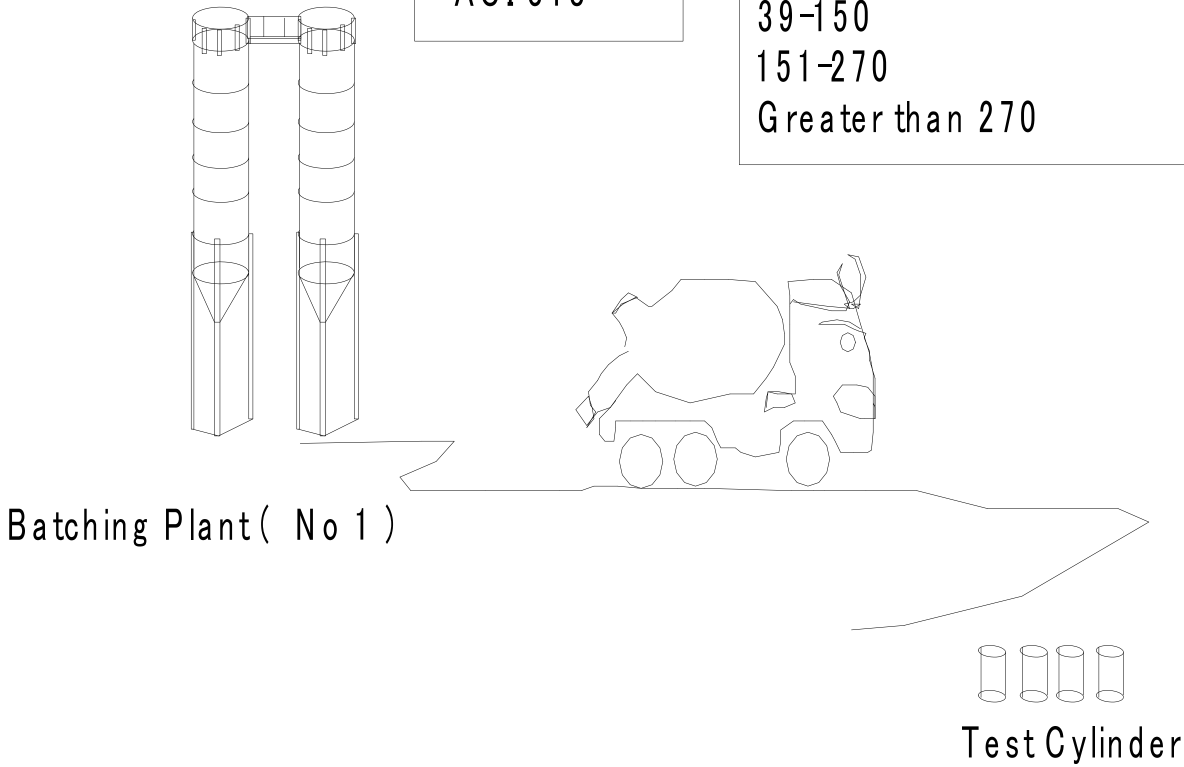
INSPECTOR/KJP

(9) Batching Plant

(9) Batching Plant

ASTM C 172
ASTM C 31
ACI 318

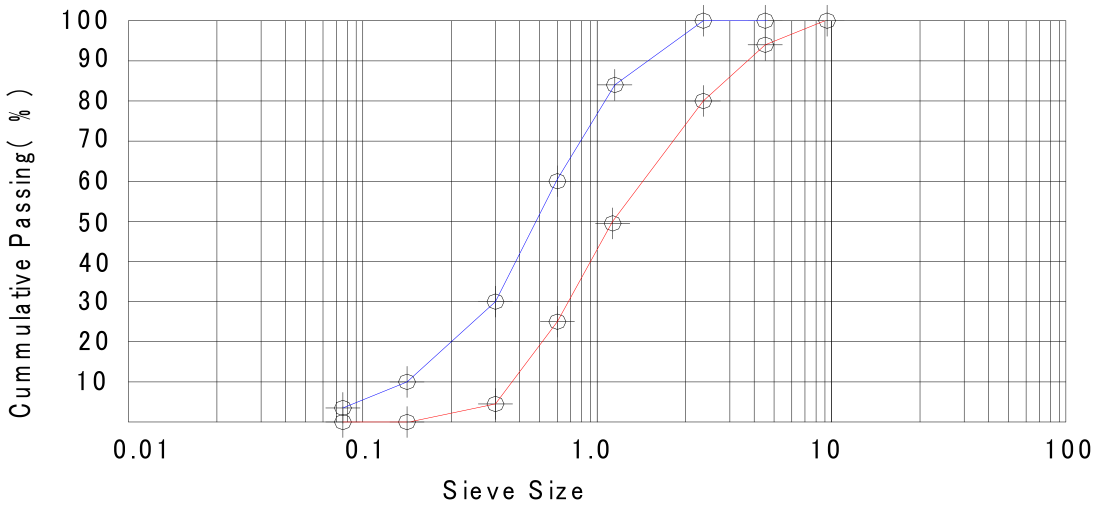
No of Cubic Maters in Any	No of Cubic Maters in Any
0-38	One for each 20 cubic meters
39-150	One for each 40 cubic meters
151-270	One for each 60 cubic meters
Greater than 270	One for each 75 cubic meters



(10) Sieve Analysis of Coarse Aggregate (ASTM C 33)

(10) Sieve Analysis of Fine Aggregate

ASTM C 33



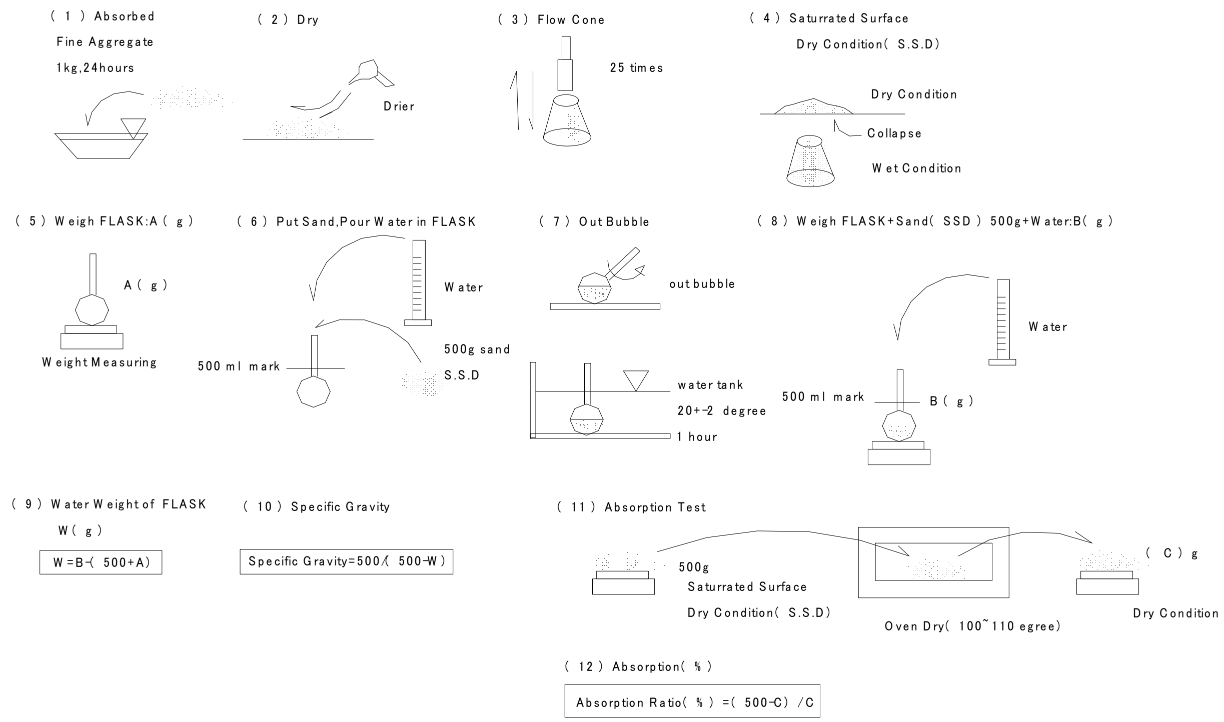
Sieve Size		Percent passing by mass
9.5mm	(3/8 in.)	100
4.75mm	(No.4)	95 to 100
2.36mm	(No.8)	80 to 100
1.18mm	(No.16)	50 to 85
600um	(No.30)	25 to 60
300um	(No.50)	5 to 30
150um	(No.100)	0 to 10

(11) Sieve Analysis of Coarse Aggregate (ASTM C 33)

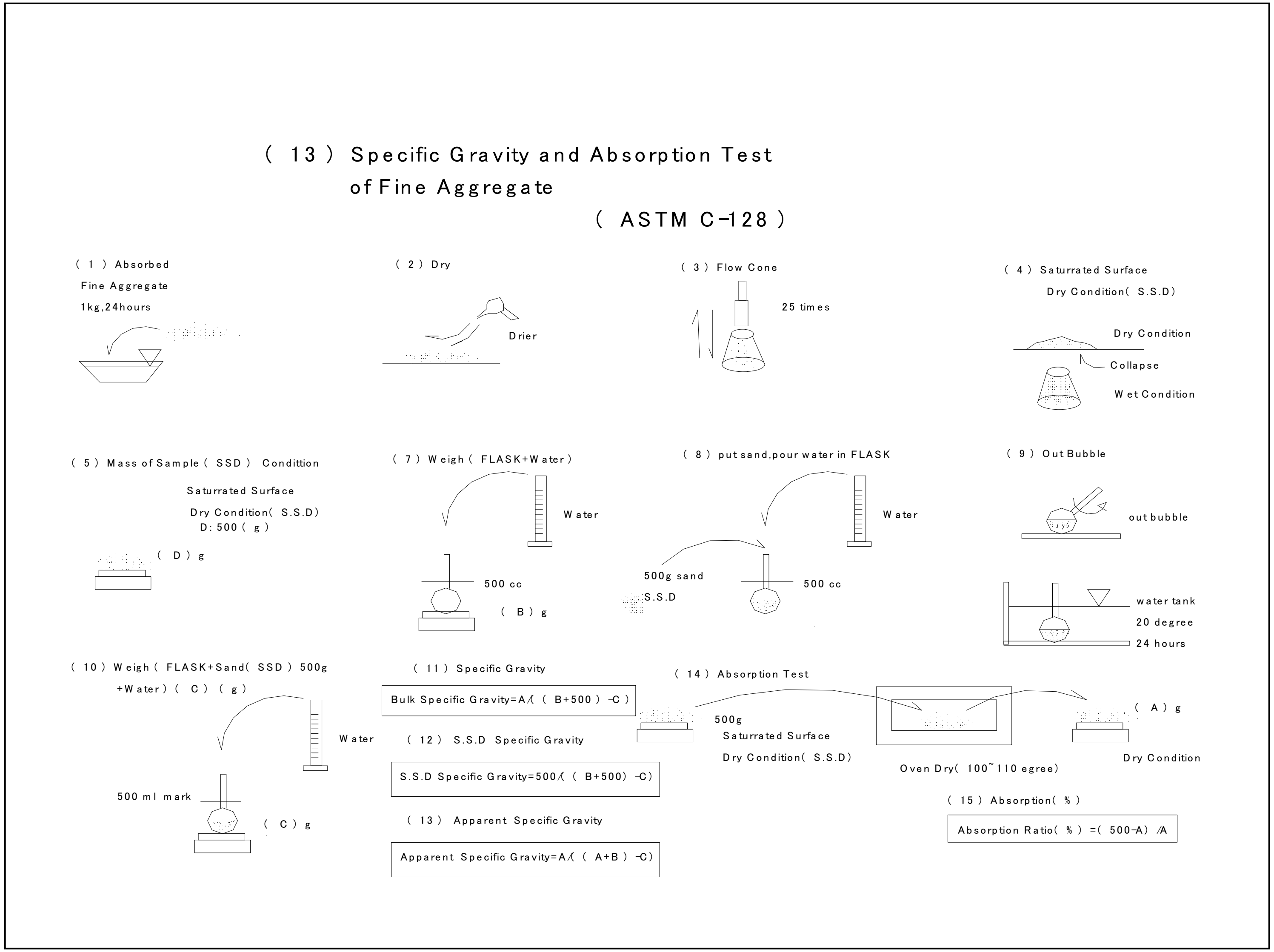
Size Number	Nominal Size (Sieve with Square Openings	100mm (4 in.)	90mm (3 1/2	75mm (3 in.)	63mm (2 1/2	50mm (2 in.)	37.5mm (1 1/2	25.0mm (1 in.)	19.0mm (3/4 in.	12.5mm (1/2 in.	9.5mm (3/8 in.	4.75mm (No.4)	2.36m (No.8)	1.18mm (No.16)	300um (No.50)
1	90 to 37.5 mm(3 1/2 to 1 1/2	100	90 to 10	···	25 to 60	···	0 to 15	···	0 to 5	···	···	···	···	···	···
2	63 to 37.5 mm(2 1/2 to 1 1/2	···	···	100	90 to 10	35 to 70	0 to 15	···	0 to 5	···	···	···	···	···	···
3	50 to 25.0 mm(2 to 1 in.)	···	···	···	100	90 to 10	35 to 70	0 to 15	···	0 to 5	···	···	···	···	···
357	50 to 4.75 mm(2 in.to No.4)	···	···	···	100	95 to 10	···	35 to 70	···	10 to 30		0 to 5	···	···	···
4	37.5 to 19 mm(1 1/2 to 3/4 in.)	···	···	···	···	100	90 to 10	20 to 55	0 to 15	···	0 to 5	···	···	···	···
467	37.5 to 4.75 mm(1 1/2 to No.	···	···	···	···	100	95 to 10	···	35 to 70	···	10 to 30	0 to 5	···	···	···
5	25.0 to 12.5 mm(1 in. to 1/2	···	···	···	···	···	100	90 to 10	20 to 55	0 to 10	0 to 5	···	···	···	···
56	25.0 to 9.5 mm(1 in. to 3/8 in.)	···	···	···	···	···	100	90 to 10	40 to 85	10 to 40	0 to 15	0 to 5	···	···	···
57	25.0 to 4.75 mm(1 in. to	···	···	···	···	···	100	95 to 10	···	25 to 60	···	0 to 10	0 to 5	···	···
6	19.0 to 9.5 mm(3/4 in. to	···	···	···	···	···	···	100	90 to 10	20 to 55	0 to 15	0 to 5	···	···	···
67	19.0 to 4.75 mm(3/4 in. to	···	···	···	···	···	···	100	90 to 10	···	20 to 55	0 to 10	0 to 5	···	···
7	12.5 to 4.75 mm(1/2 in. to	···	···	···	···	···	···	···	100	90 to 10	40 to 70	0 to 15	0 to 5	···	···
8	9.5 to 2.36 mm(3/8 in. to	···	···	···	···	···	···	···	···	100	85 to 10	10 to 30	0 to 10	0 to 5	···
89	9.5 to 1.18 mm(3/8 in. to	···	···	···	···	···	···	···	···	100	90 to 10	20 to 55	5 to 30	0 to 10	0 to 5
9A	4.75 to 1.18 mm(No.4 to	···	···	···	···	···	···	···	···	···	100	85 to 10	10 to 40	0 to 10	0 to 5

(12)Specific Gravity and Absorption Test of Fine Aggregate (JISA A 1109)

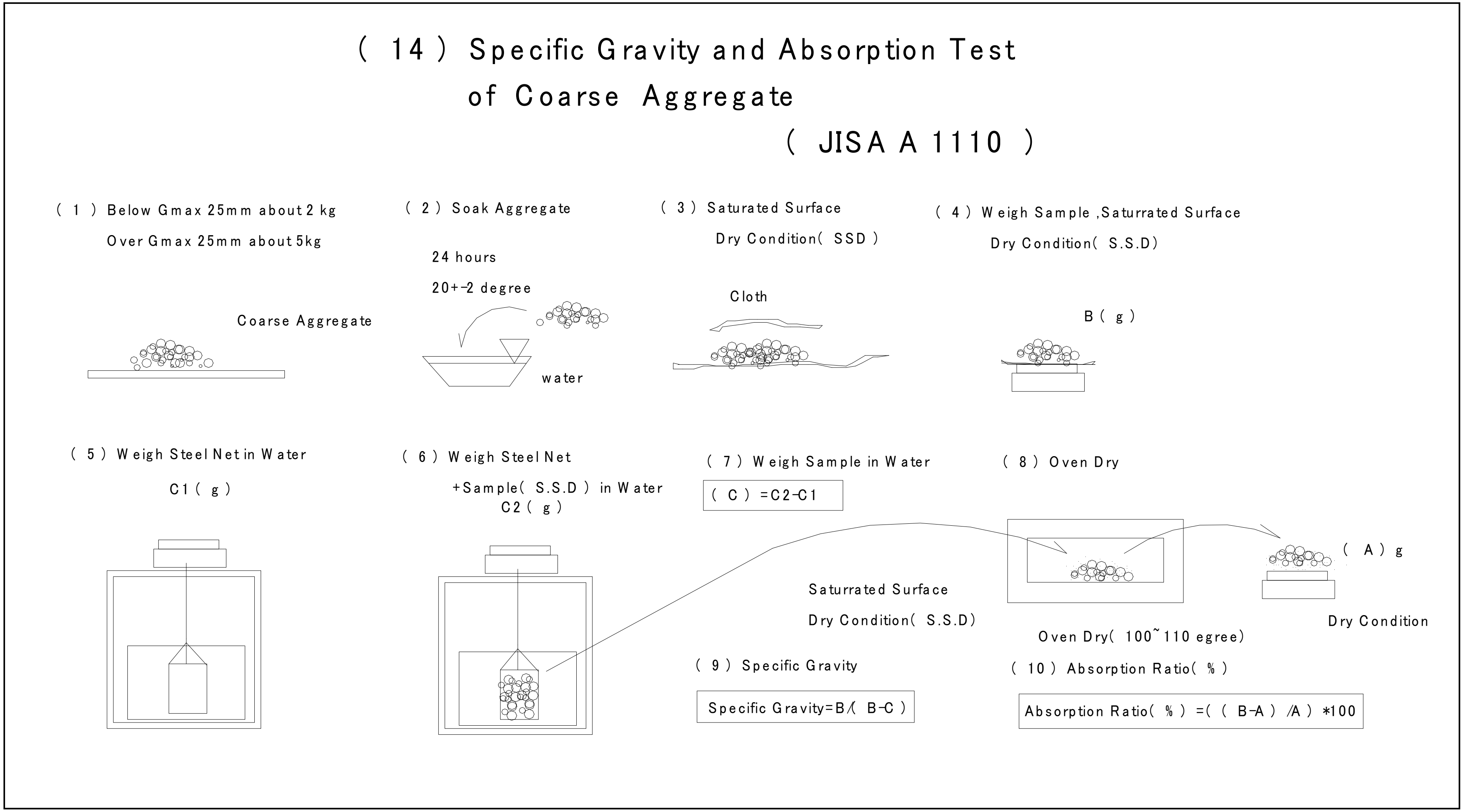
（ 12 ） Specific Gravity and Absorption Test of Fine Aggregate （ JISA A 1109 ）



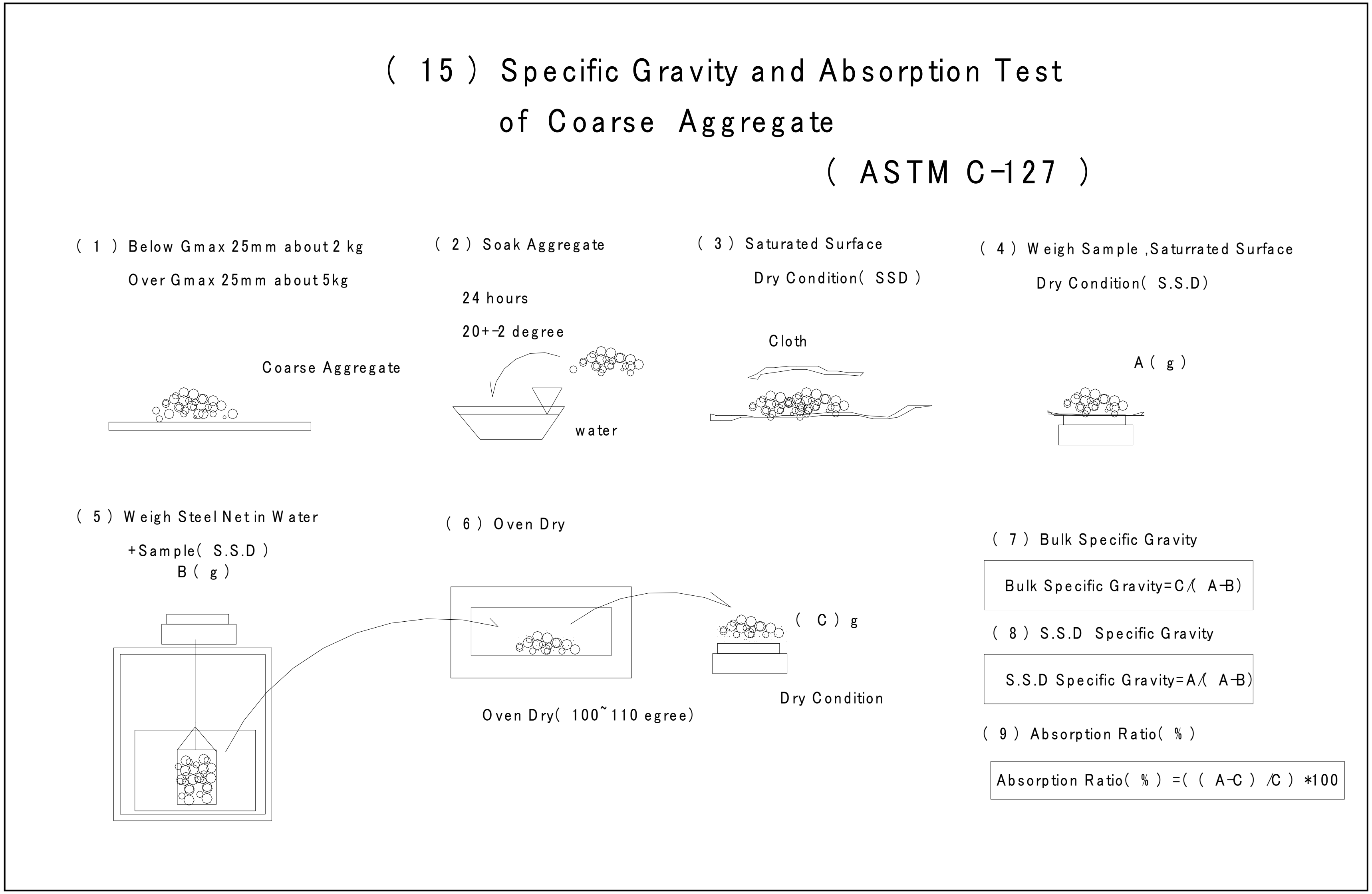
(13)Specific Gravity and Absorption Test of Fine Aggregate (ASTM C-128)



(14)Specific Gravity and Absorption Test of Coarse Aggregate (JISA A 1110)



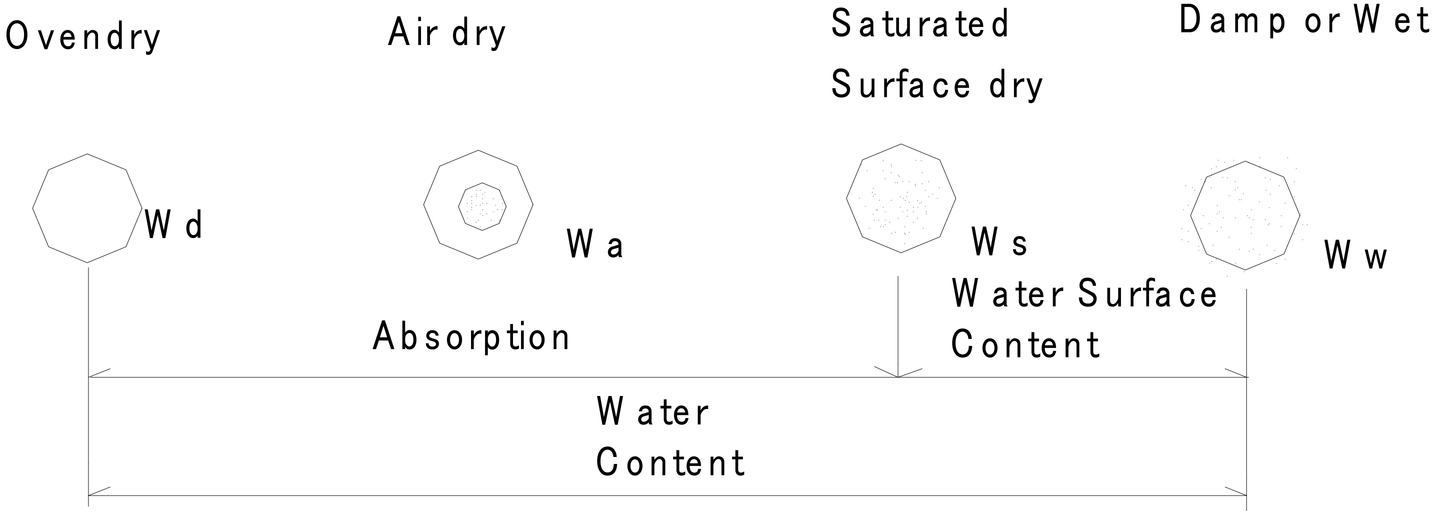
(15)Specific Gravity and Absorption Test of Coarse Aggregate (ASTM C-127)



(16)Moisture Condition of Aggregate

(16) Moisture Condition of Aggregate

ASTM C 31,
ACI 211.1
and ACI 211.3.



Water Surface Content Ratio $=((Ww-Ws)/Ws)*100$

Specific Gravity (S.S.D) $=Ws/Wd$

Absorption Ratio $=((Ws-Wd)/Wd)*100$

Moisture Content Ratio $=((Ww-Wd)/Wd)*100$

(17)Fire Concrete ACI 216R-10 Table 2.4.1(a)

(17) Fire Proofing Concrete

ACI 216R-10

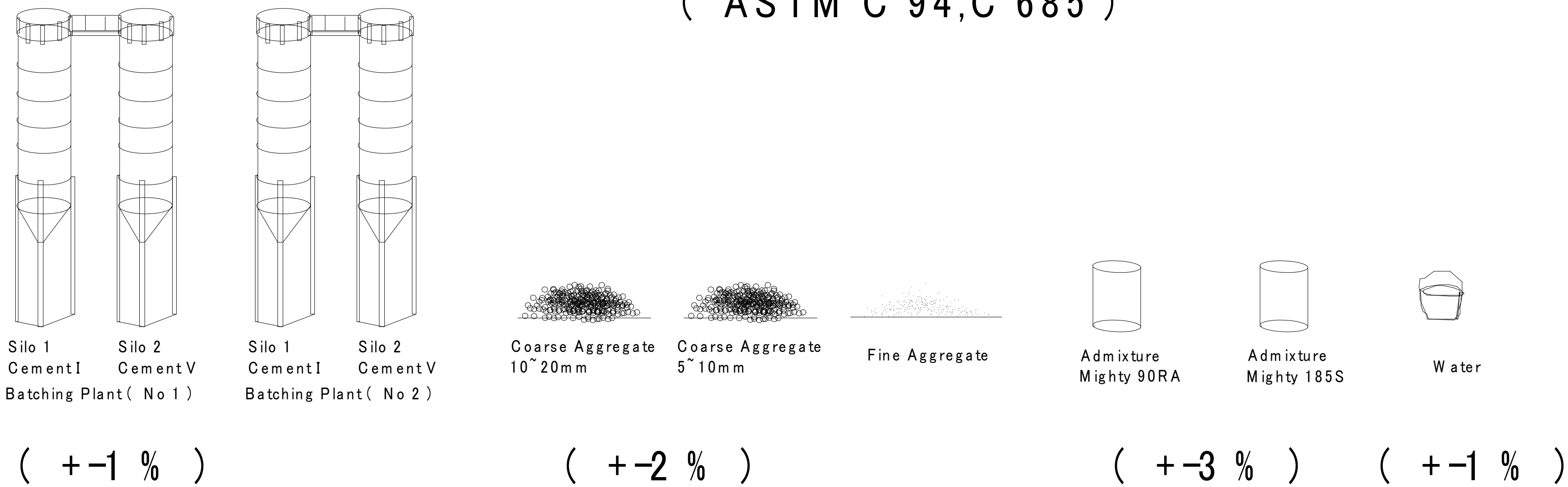
Table 2.4.2.1(a) -Data on Mixes

Symbol	unit	Carb
Type of mix		Carbonate aggregate Concrete
Cement Type I	kg/m3	222
Coarse Aggregate	kg/m3	1059(9mm maximum sizegravel)
Sand	kg/m3	815
Water	kg/m3	141
Average Air Content	%	6.2
Average Unit Weight		2240
psi(Mpa)		4000(28)

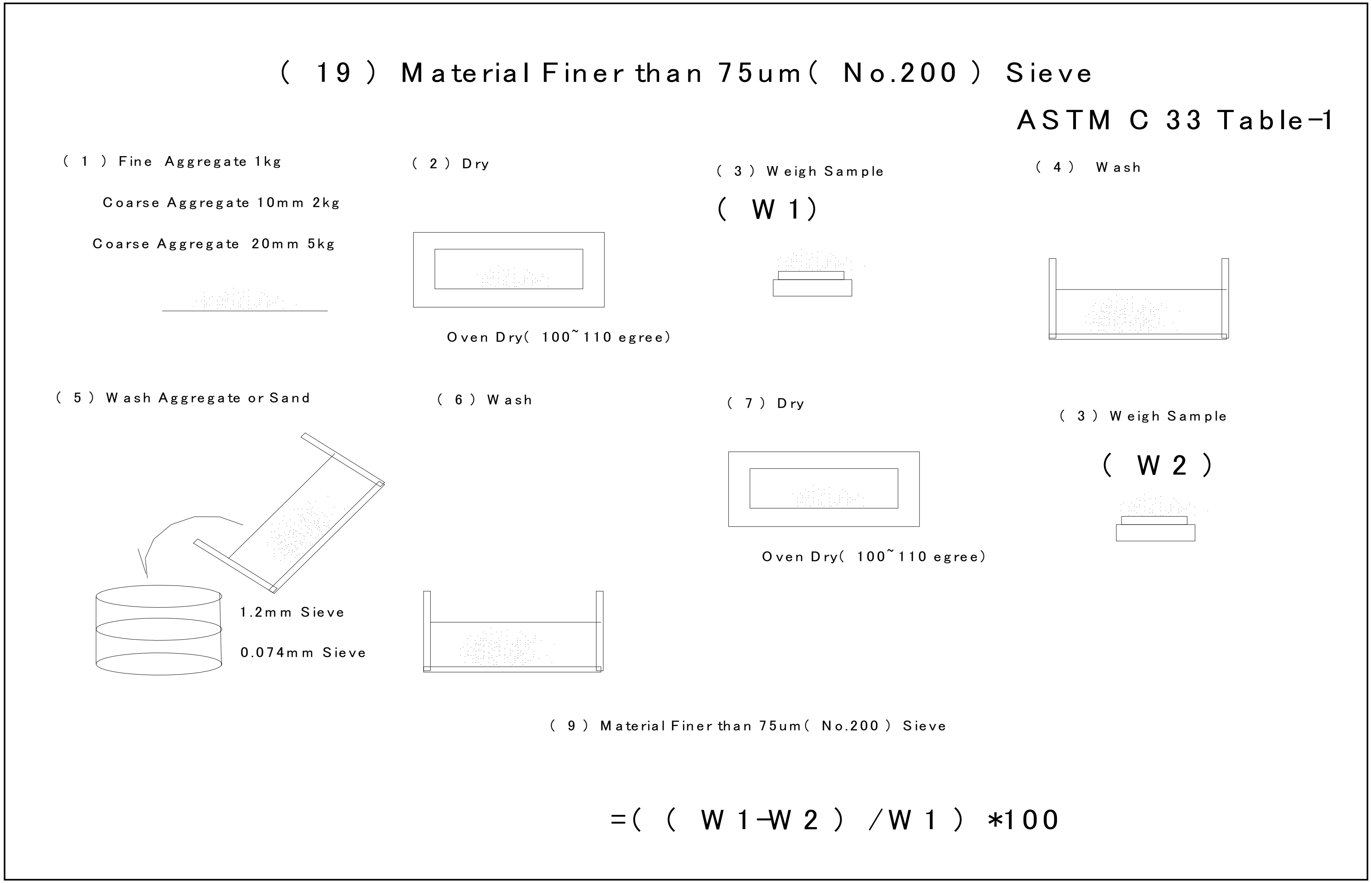
(18)Batching Plant Percentage of Accuracy

(18) Batching Plant Percentage of Accuracy

(ASTM C 94,C 685)



(19)Material Finer than 75um(No.200) Sieve 2 ASTM C33 Table-1



(20)Material Finer than 75um(No.200) Sieve 2 ASTM C33 Table-1

Limits for Deleterious Substances In Fine Aggregate For Concrete

ASTM C 33 Table-1

	Mass percent of total sample(%)
Date	
Clay Lumps and friable Particles	3(%)
Material Finer than 75um(No.200)Sieve All other Concrete	5(%)

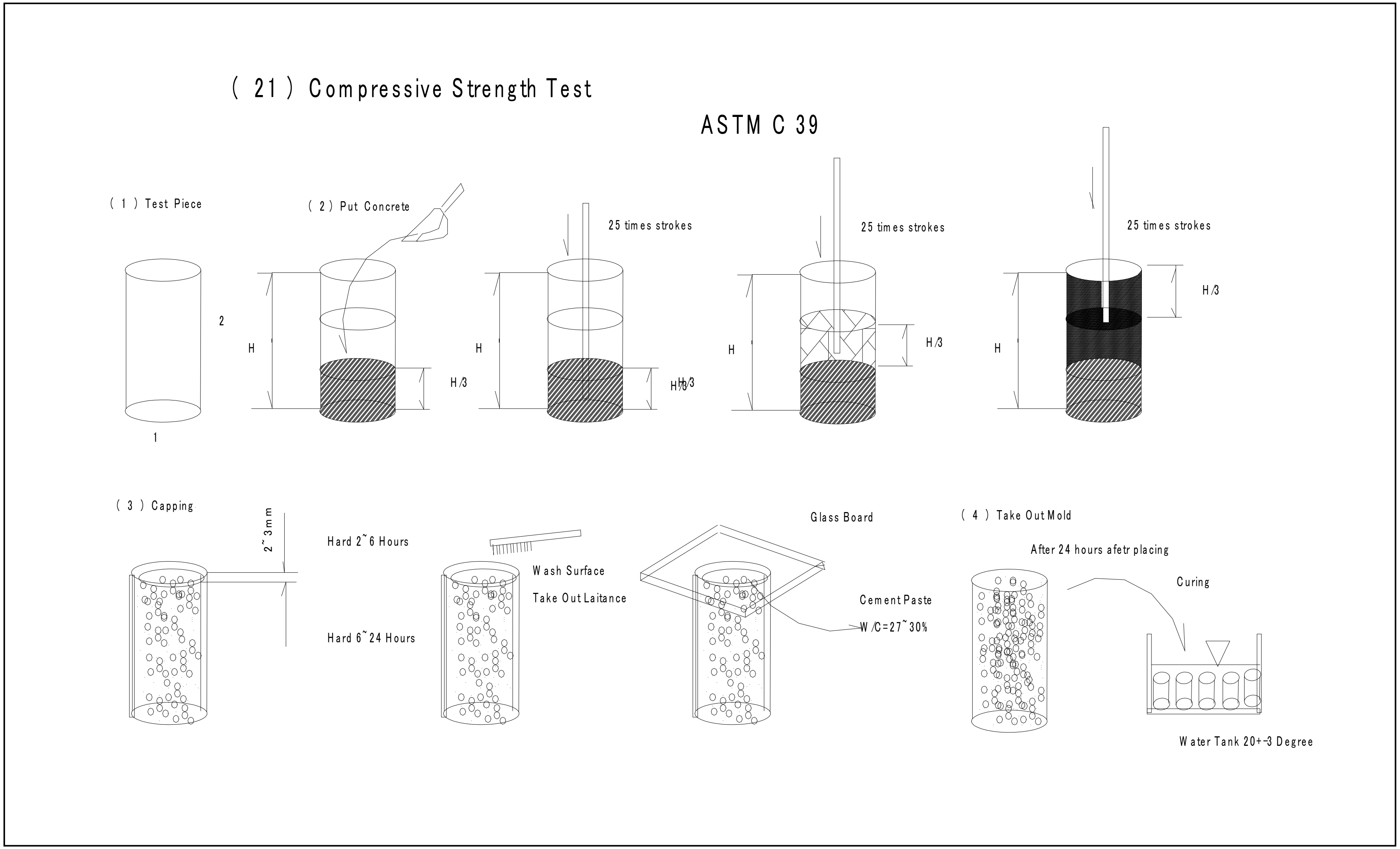
Calculation

B:Bowl
S;Sand
W;Water

Remarks

(1)	S+W				Before Dry
(2)	S			W1	After Dry
(3)	S(1.20mm)Retained	(g)			1.2mm Sieve Retained in dry after
(4)	S(1.20~0.075mm)Retained	(g)			1.2~.075mm Sive Retained in dry after washing
(5)	(0.075mm +1.20mm) Retained Percent	(g)		W2=(3+4)	
(6)	0.075mm passing Percentage	(%)		=((W1-W2)/W1)*100	<5%

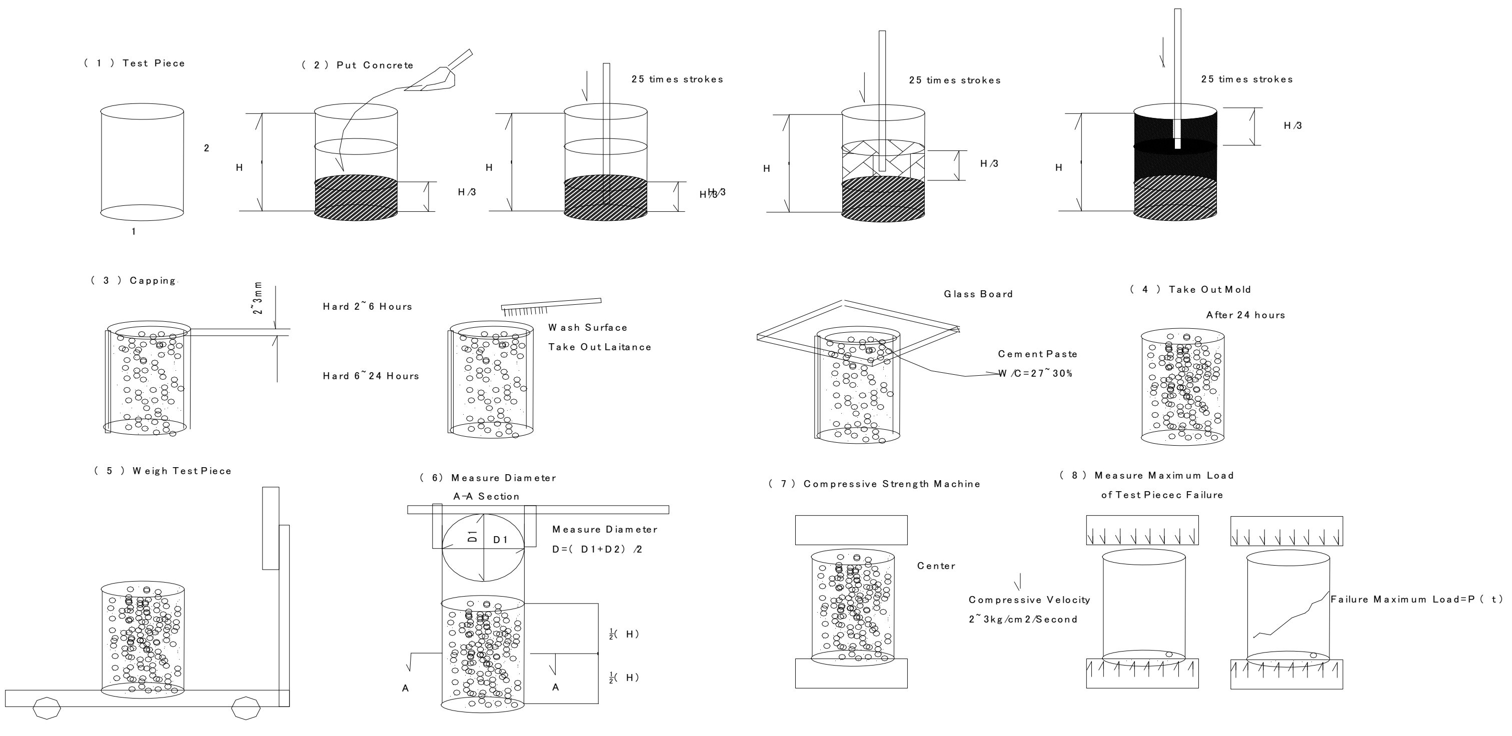
(21)Compressive Strength Test-1



(22)Compressive Strength Test-2

（ 22 ） Compressive Strength Test–2

ASTM C 39–96



（ 9 ） Calculation of Compressive Strength（ kg/cm2）

Compressive Strength（ kg/cm2） =P/A

P:Maximum Load

A:Area

（ 10 ） Report

1 Test Piece No
2 Ages
3 Diameter of Test Piece
4 Maximum Load
5 Compressive Strength
6 Curing Method and Compressive Strength
7 Failure Condition of Test Piece

(23)Fluidized Concrete

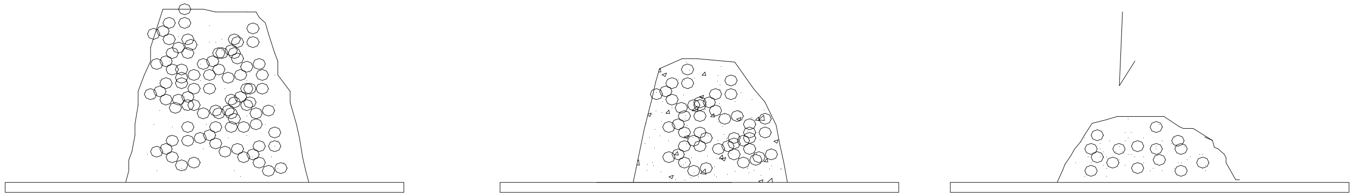
(23) Fluidized Concrete

Pumping Concrete

ACI-304R-36

High Range Water Reducing Agent

C*(x) %



A	B	C
Slump 75+-25	Slump 100+-25	Slump 125+-25

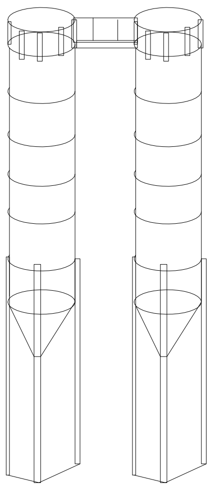
Base Concrete (A, B) — Pumping Concrete (C)

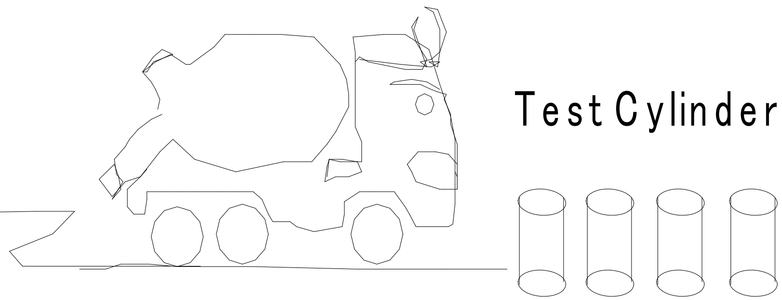
(24)Compressive Strength Test

(24) Compressive Strength Test

ASTM C 172
ASTM C 31
ACI 318

No of Cubic Maters in Any	No of Cubic Maters in Any
0-38	One for each 20 cubic meters
39-150	One for each 40 cubic meters
151-270	One for each 60 cubic meters
Greater Than 270	One for each 75 cubic meters



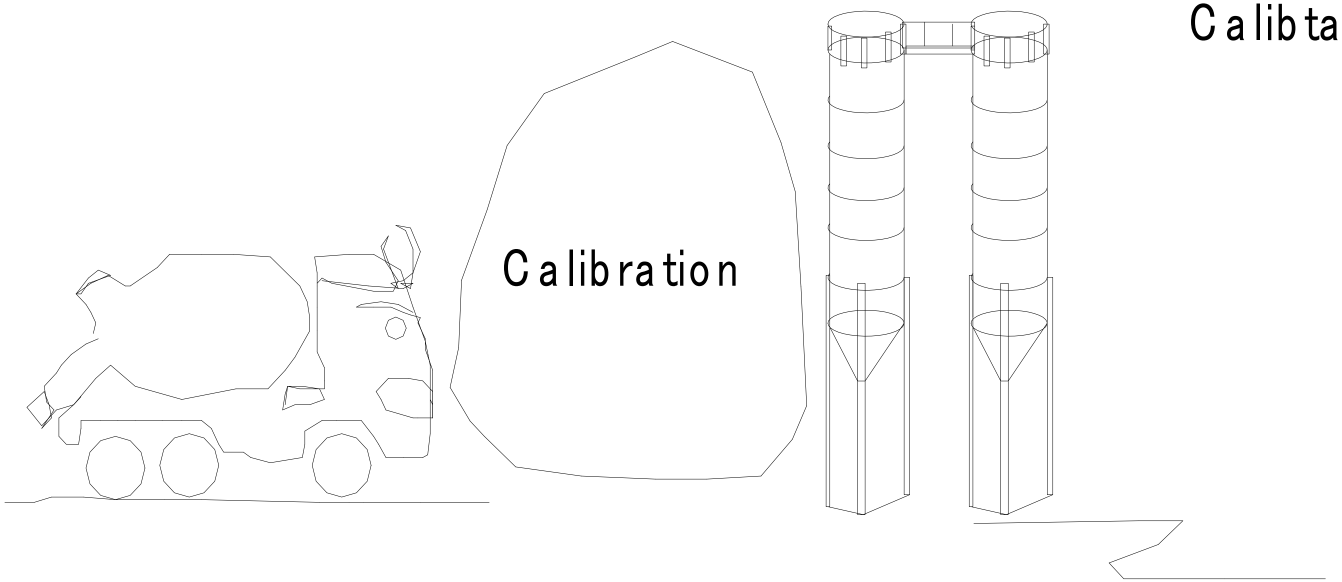


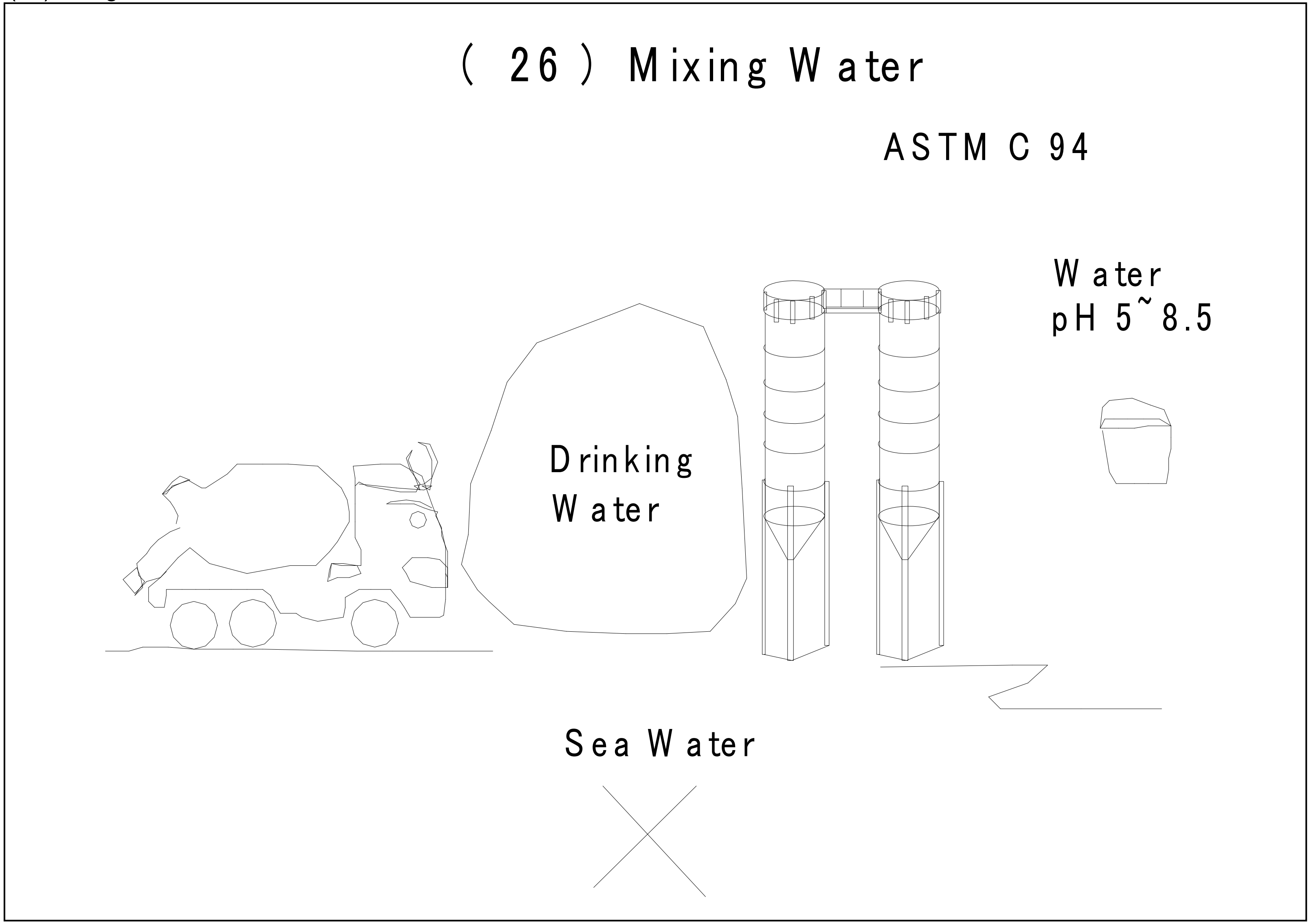
(25)Calibration

（ 25 ） Calibration

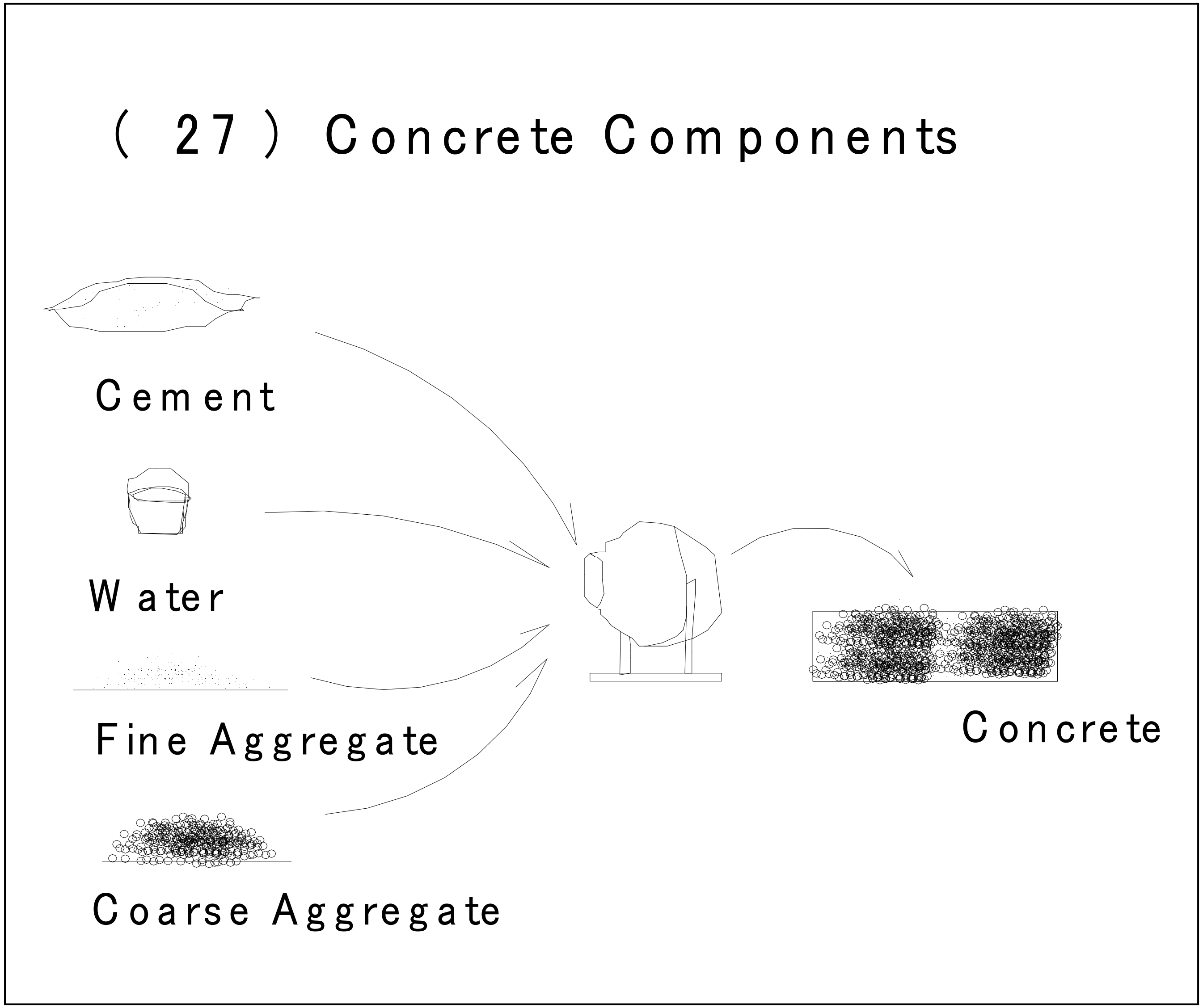
ACI 304 R

Batching Plant Equipment
Calibtared



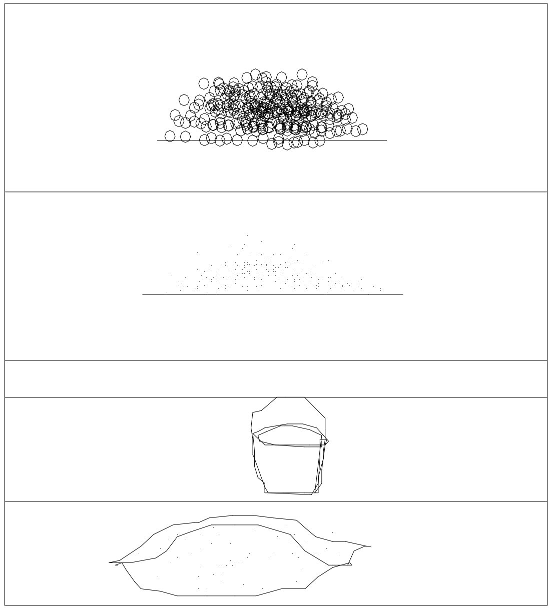

(26) Mixing Water
ASTM C 94
Water
pH 5~8.5
Drinking
Water
Sea Water

(27) Concrete Component



(28) Concrete Volume

(28) Concrete Volume



Coarse Aggregate(30~50%)

Fine Aggregate(25~30%)

Air (1~8%)

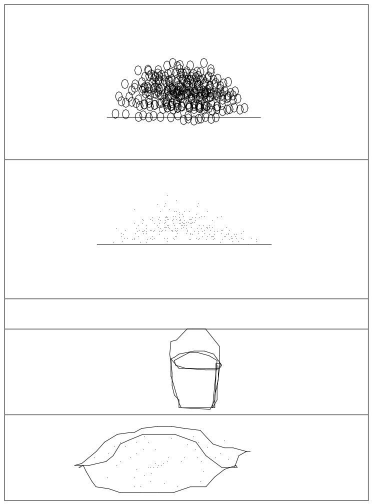
Water (14~24%)

Cement(7~15%)

Concrete 1m3

(29) Concrete Volume(1)

(29) Concrete Volume-1



Coarse Aggregate(30~50%)

Fine Aggregate(25~30%)

Air (1~8%) → Air Entrained Concrete(Air 4~8%)
Non-air-entrained Concrete(Air 1~3%)

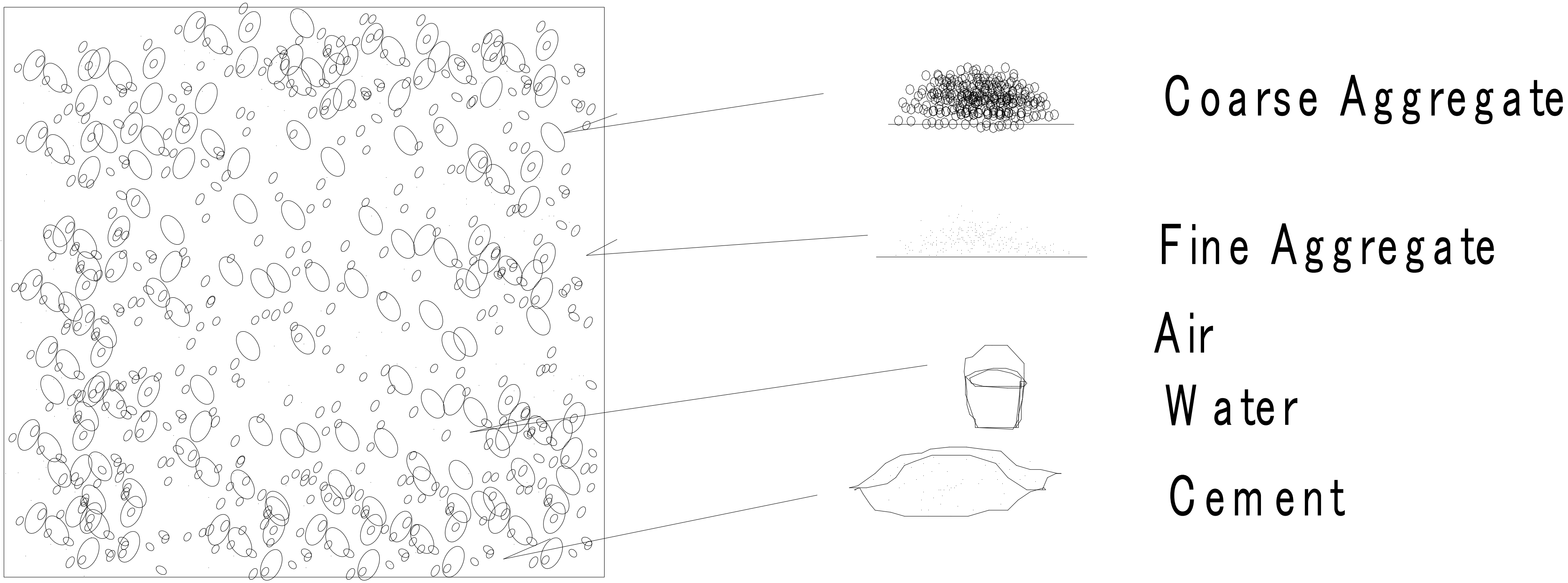
Water (14~24%)

Cement(7~15%) → Rich Mix (Cement Content 15%)
Lean Mix (Cement Content 7%)

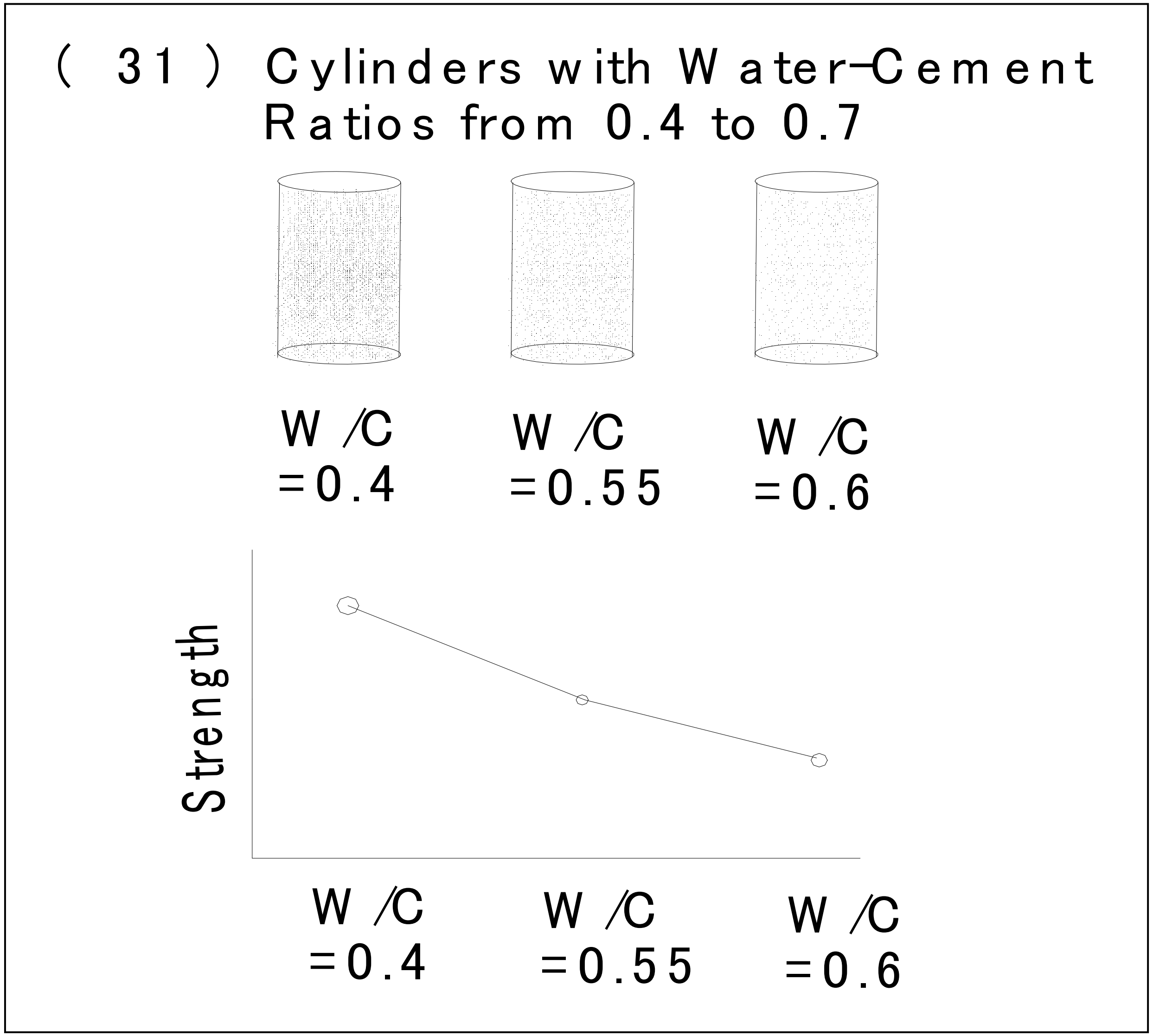
Concrete Volume 1m3

(30) Cross Section of Harden Concrete

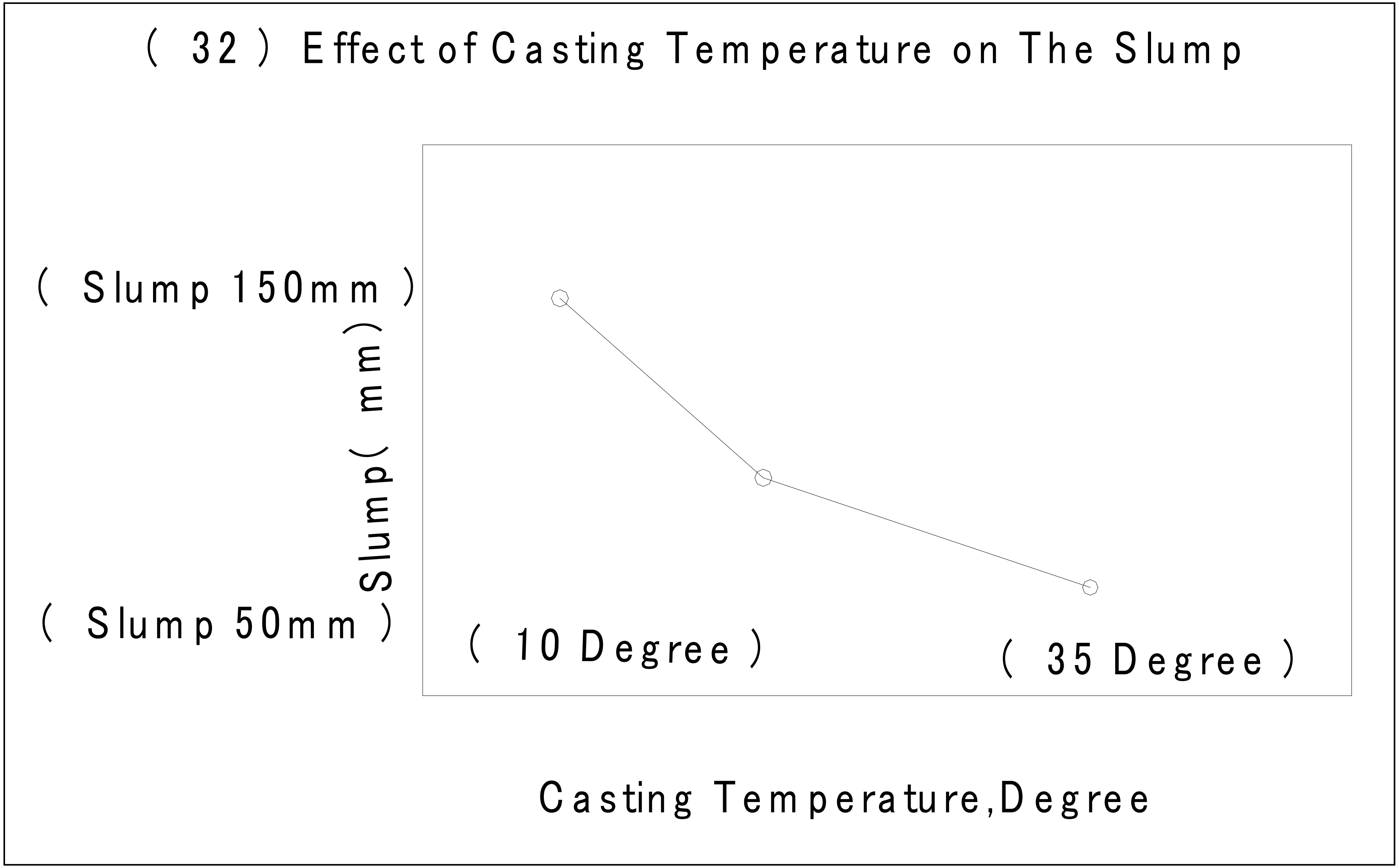
(30) Cross Section of Hardened Concrete



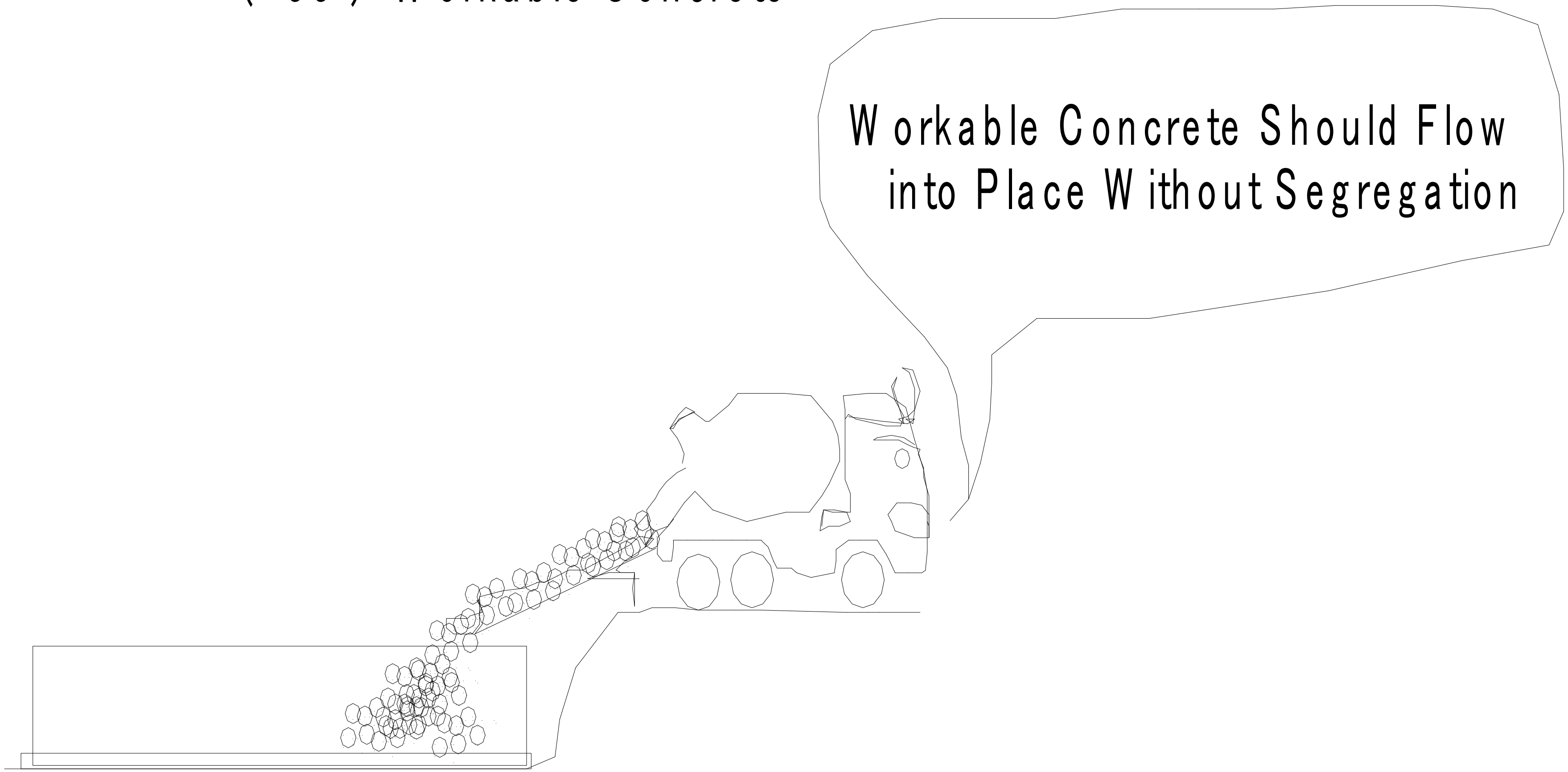
(31) Cylinders with Water Cement Ratios from 0.4 to 0.6



(32) Effect of Casting Temperature on The Slump

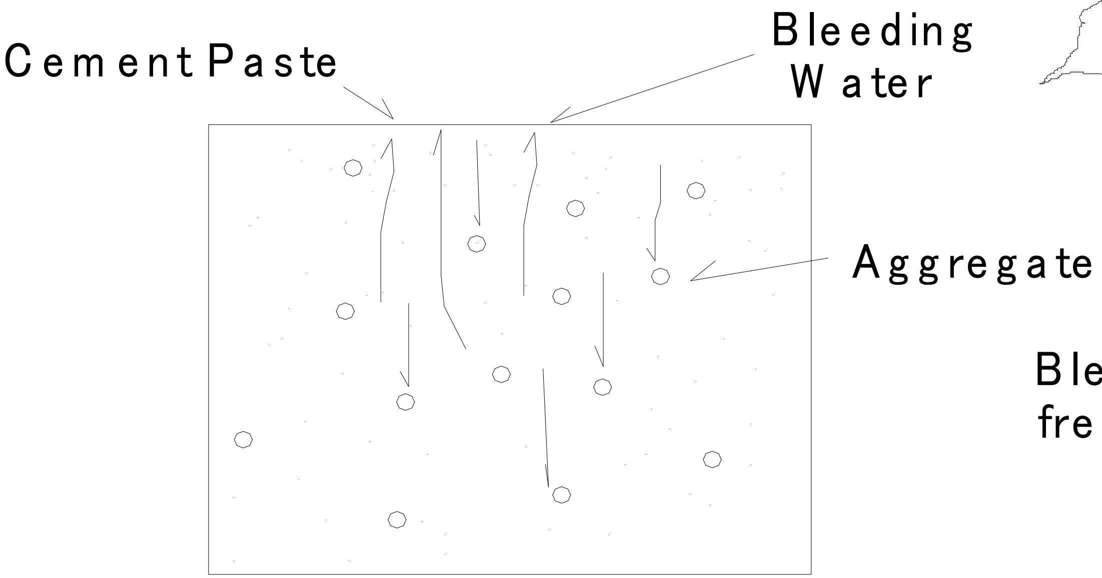


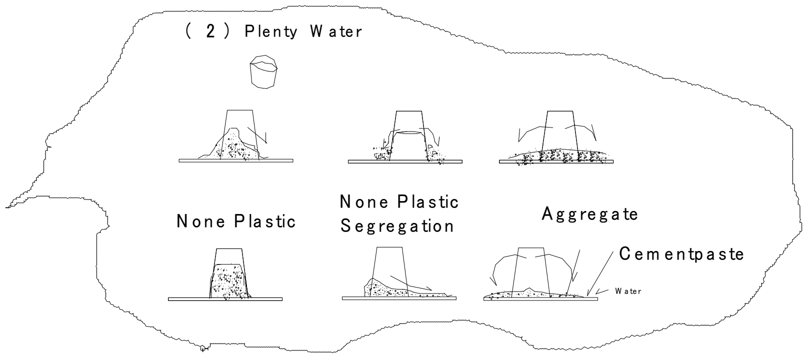
(33) Workable Concrete



(34) Bleeding Water

(34) Bleeding Water



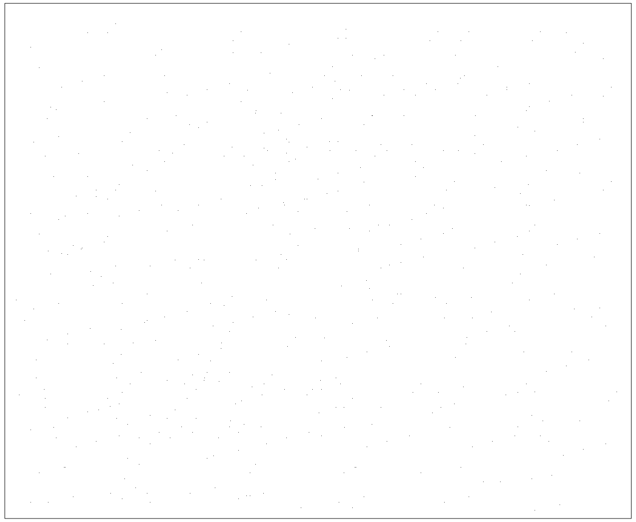


Segregation

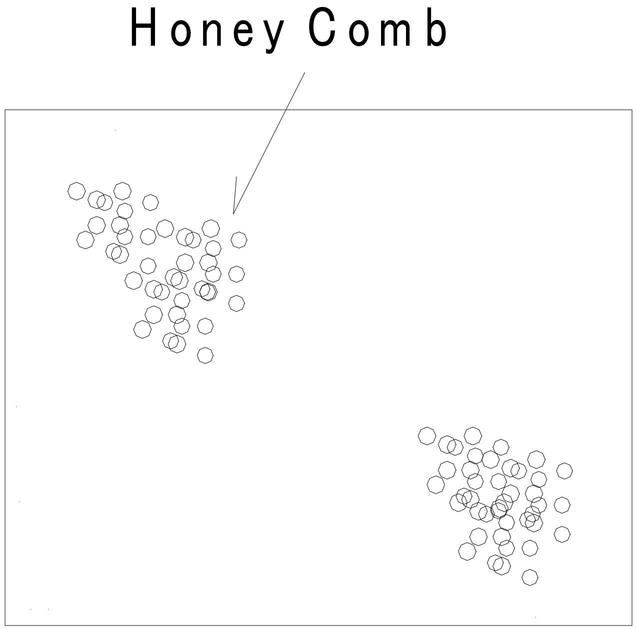
Bleed Water on the surface of a freshly placed concrete slab

(35) Good Consolidation and Bad Consolidation

(35) Good Consolidation and Poor Consolidation

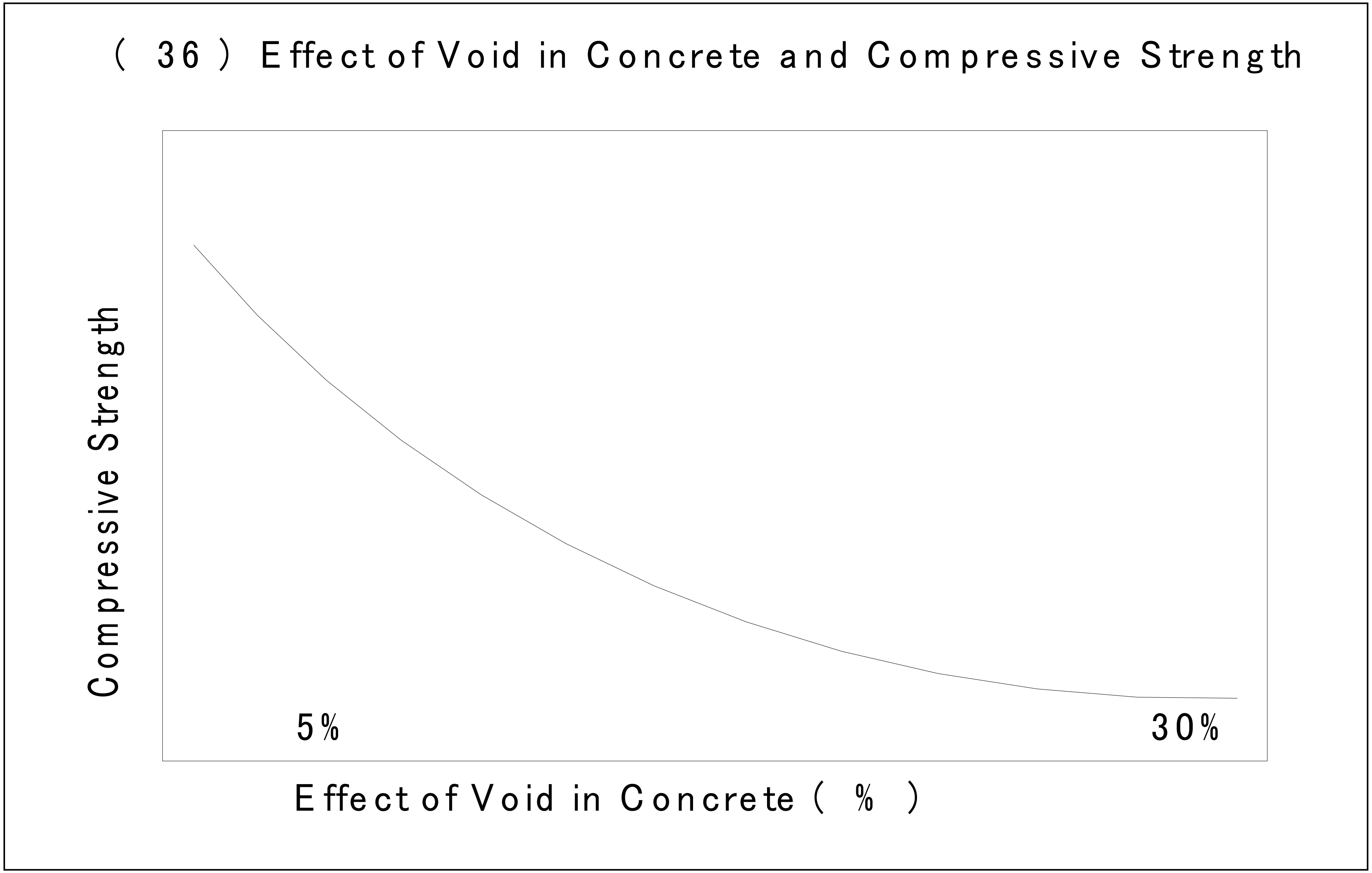


Good Consolidation



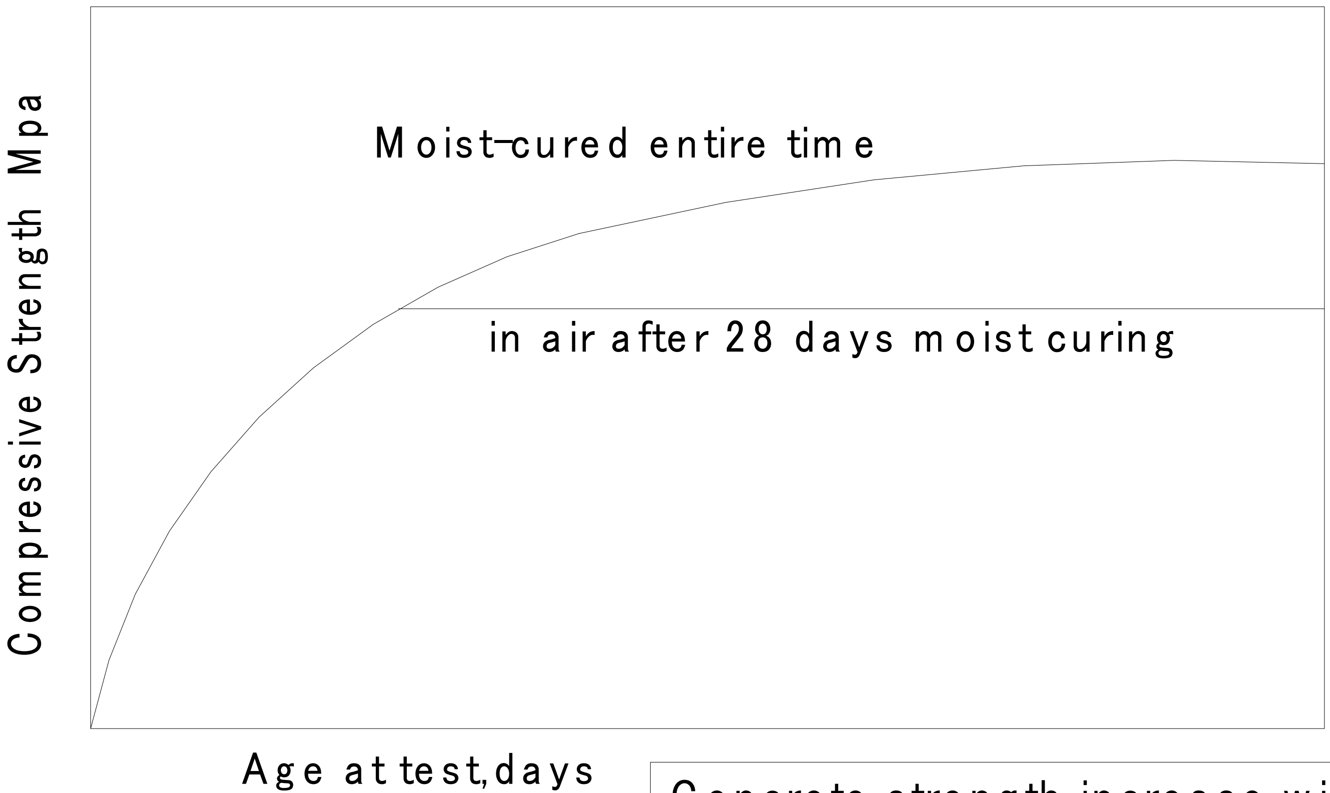
Poor Consolidation

(36) Effect of Void in Concrete and Compressive Strength



(37) Hardened Concrete Curing

(37) Hardened Concrete Curing

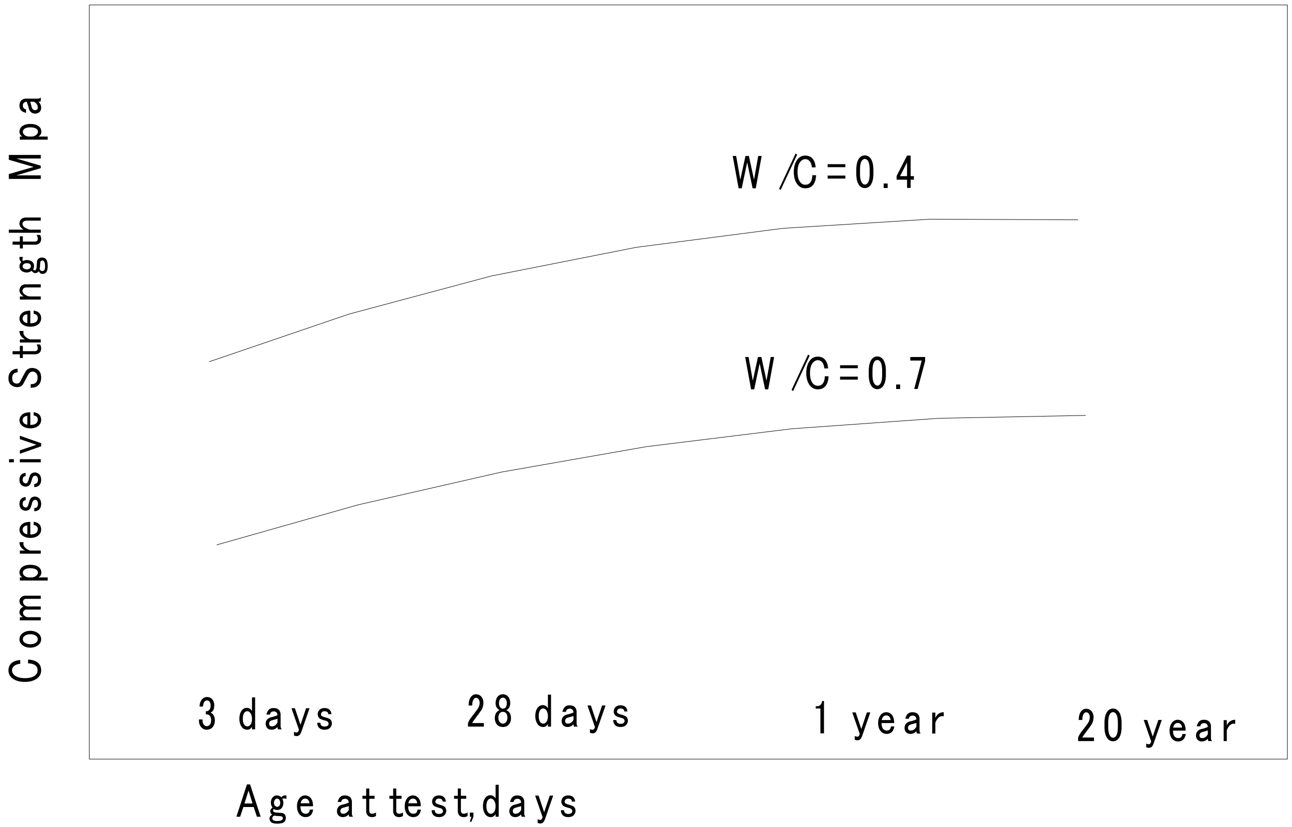


Concrete strength increase with ages
as long as moisture and a favorable temperature

(38) Concrete Strength

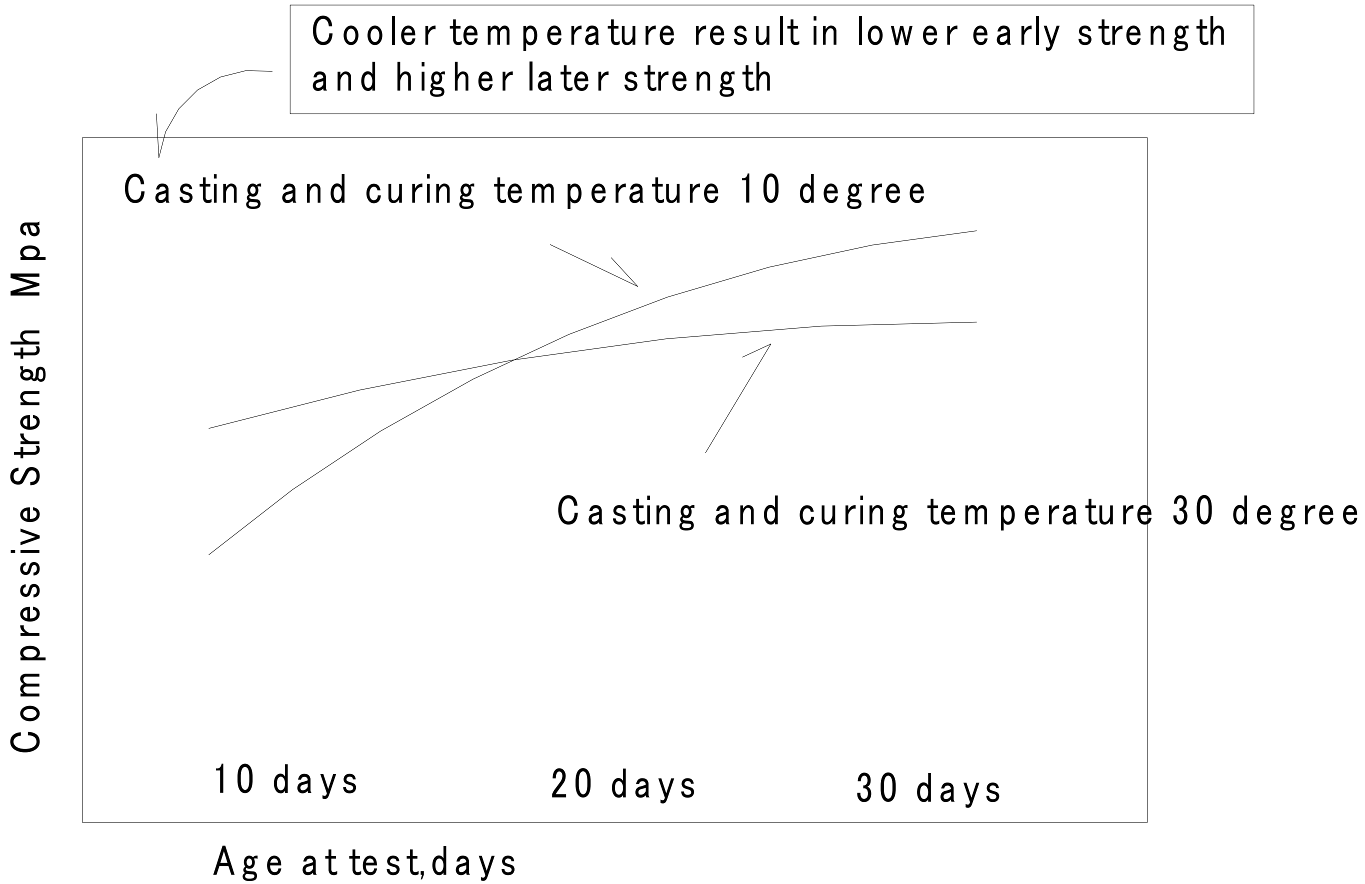
(38) Concrete Strength

Concrete continues to gain strength for many years when moisture is provided by rainfall

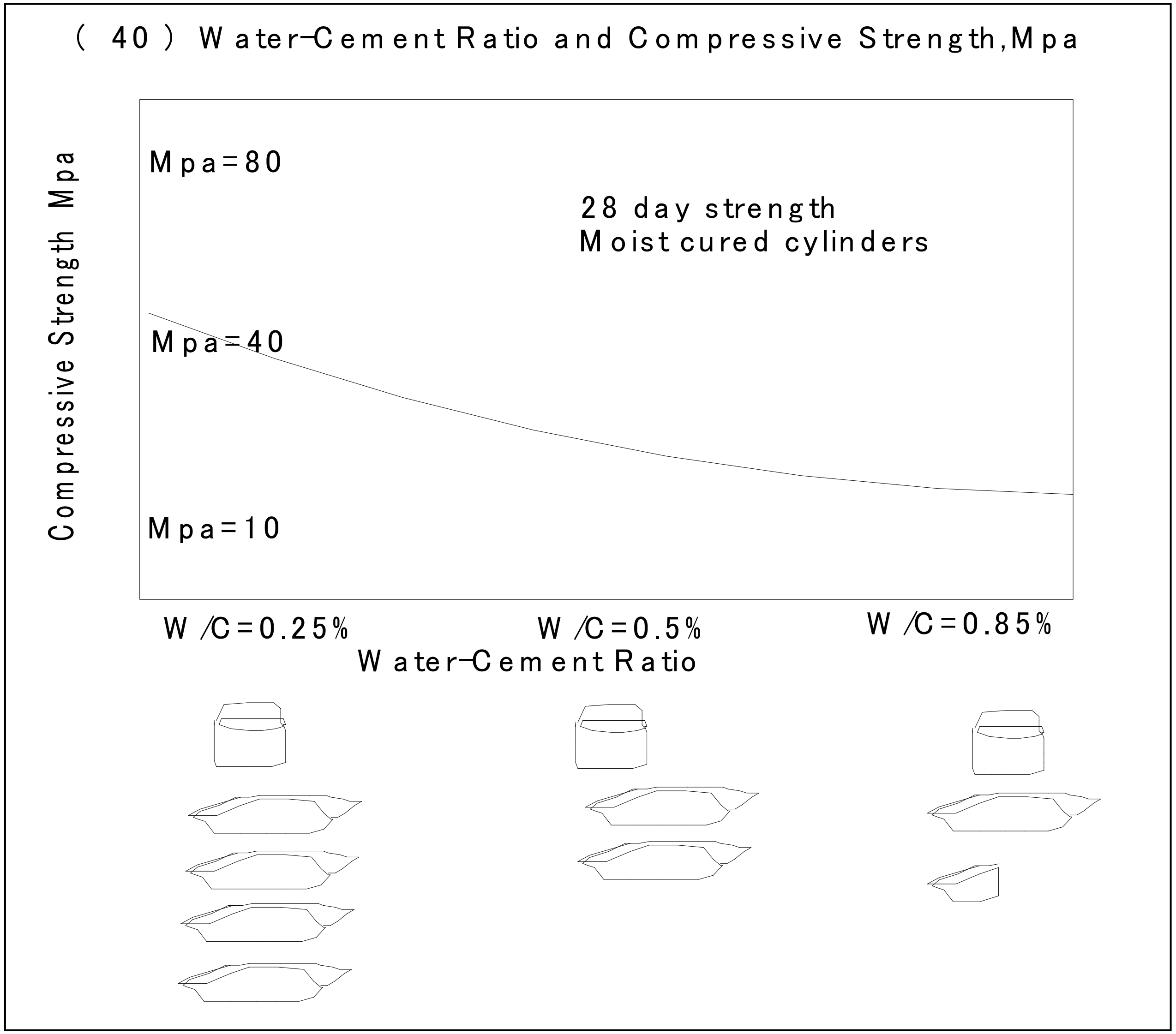


(39) Effect of Casting and Curing Temperature on Strength Development

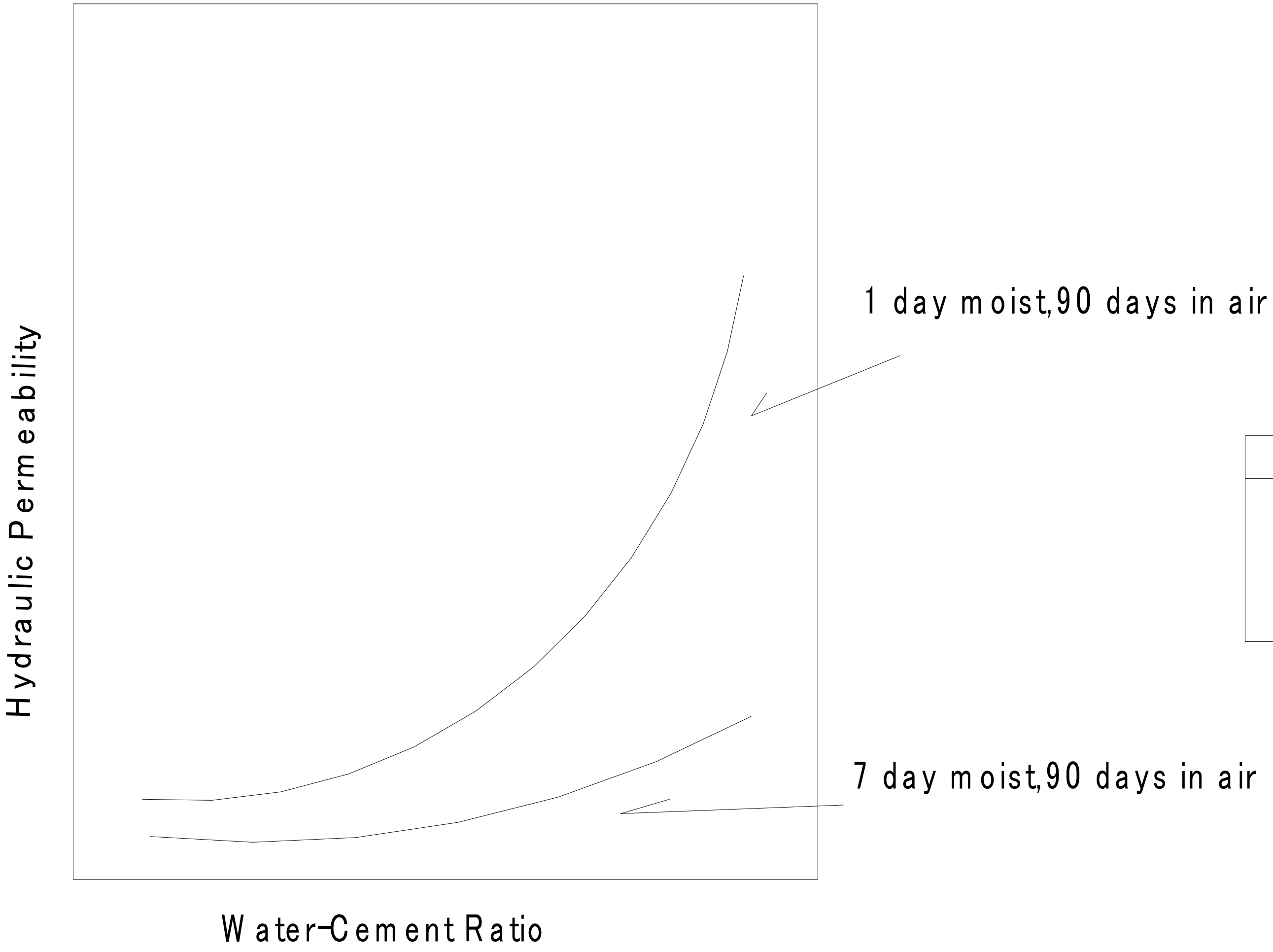
(39) Effect of casting and curing temperature on strength development



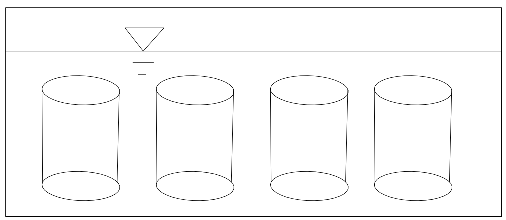
(40) Water Cement Ratio and Compressive Strength



(41) Water-Cement Ratio and Hydraulic Permeability



Curing is important



(42) Types of Portland Cement

ASTM C 150

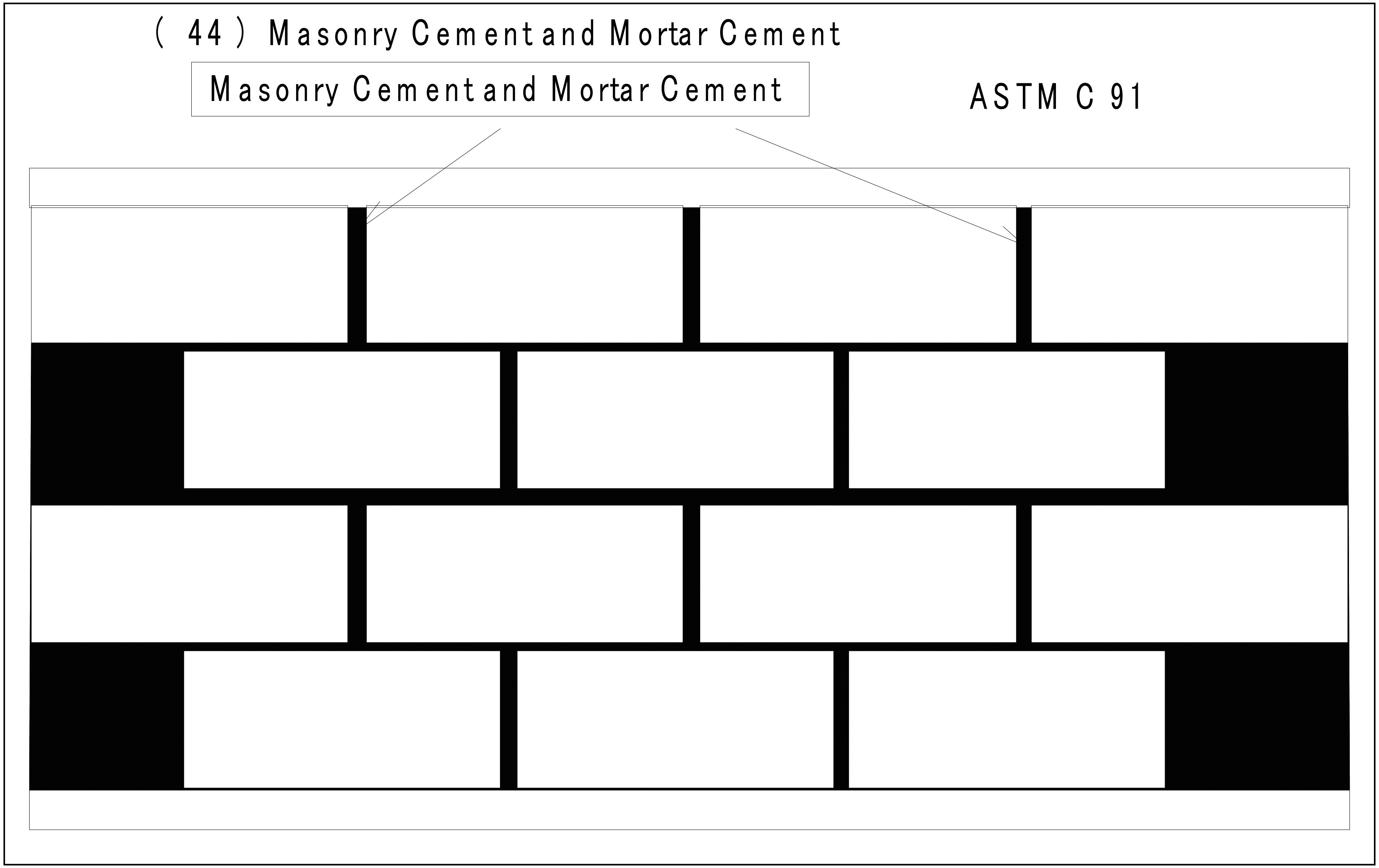
Type I	Normal
Type II	Normal, air-entraining
Type III	High Early Strength
Type IV	Low heat of hydration
Type V	High Sulfate Resistance

(43) Type I

ASTM C 150

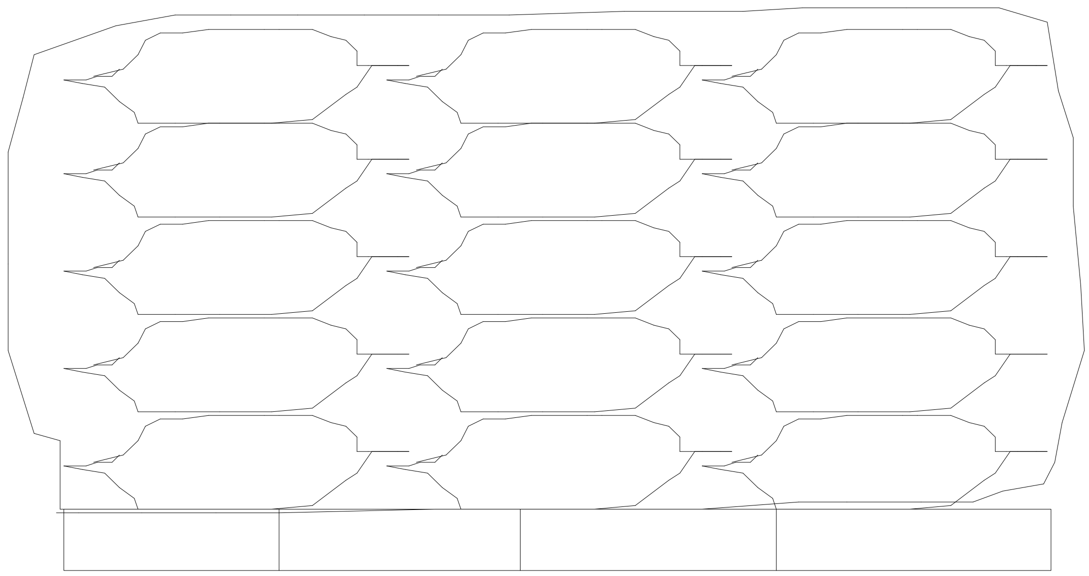
Type I Normal or general use cements include highway pavements, floors, bridges, and buildings.

(44) Masonry Cement and Mortar Cement



(45) Cement Stored

When stored on the job, Cement should be protected from moisture.

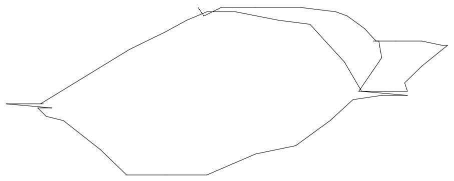


(46) Fly ash

ASTM C 618

Fly ash ,a powder resembling cement,has been used in concrete since the 1930S.

the mostly widely used supplementary cementitious material in concrete ,is a by product of the combustion of pulverized coal in electric power generation plants.



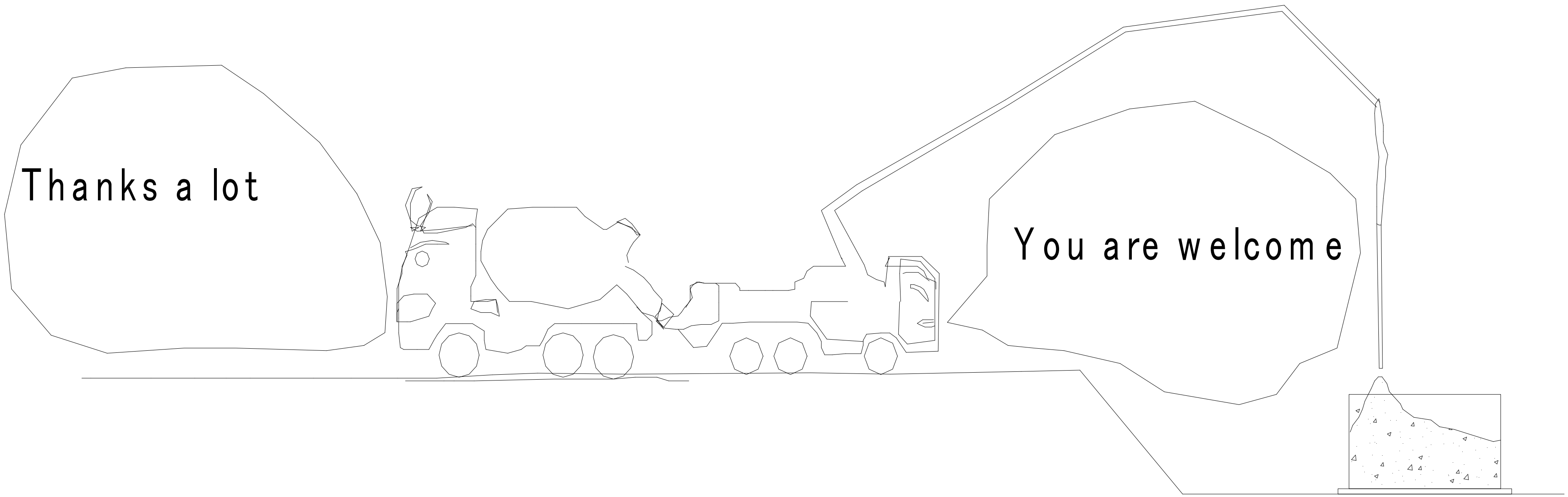
（47） Fly ash:Workability

Fly ash improve workabilityof concrete of equal cement.

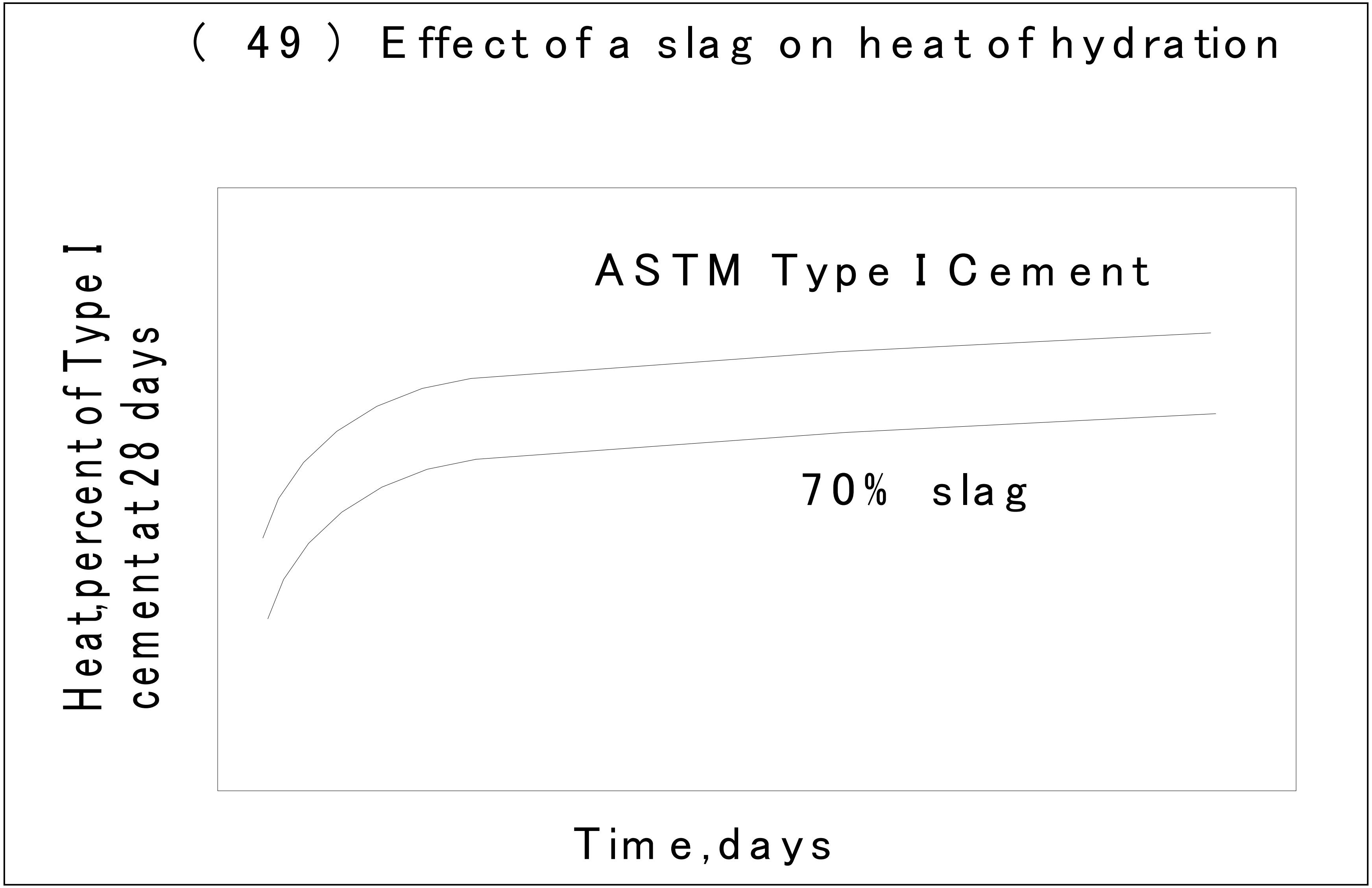
Silica fume may contribute to stickiness of a concrete mixture ;adjustments;including the use of high range water reducers,may be required to maintain workability and compaction and finishing.

（ 48 ） Silica fume:Pumpability

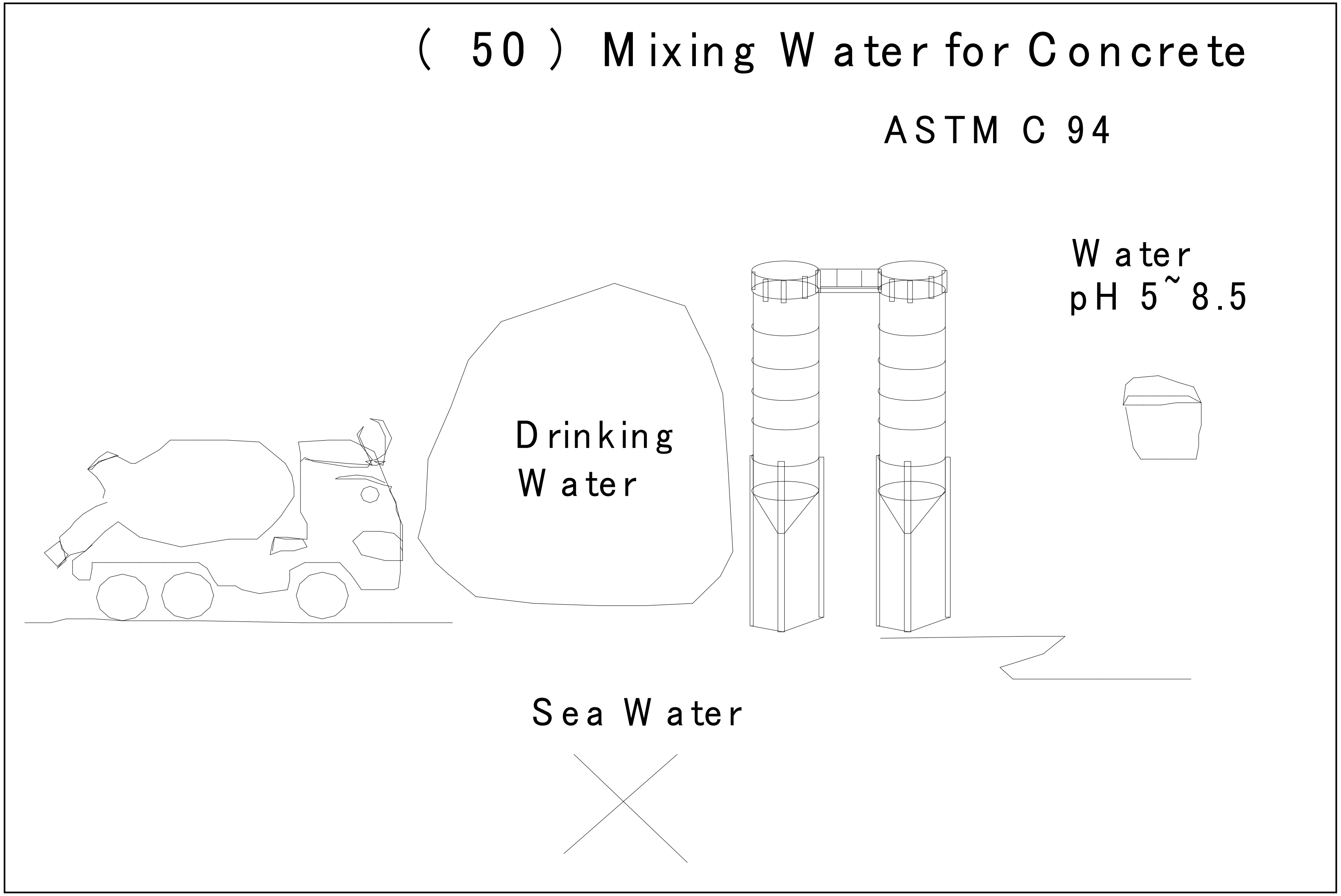
Silica fume is the most effective pumpability,especially in lean mixtures.



(49) Effect of a Slag on Heat of Hydration



(50) Mixing Water for Concrete



(51) Chloride

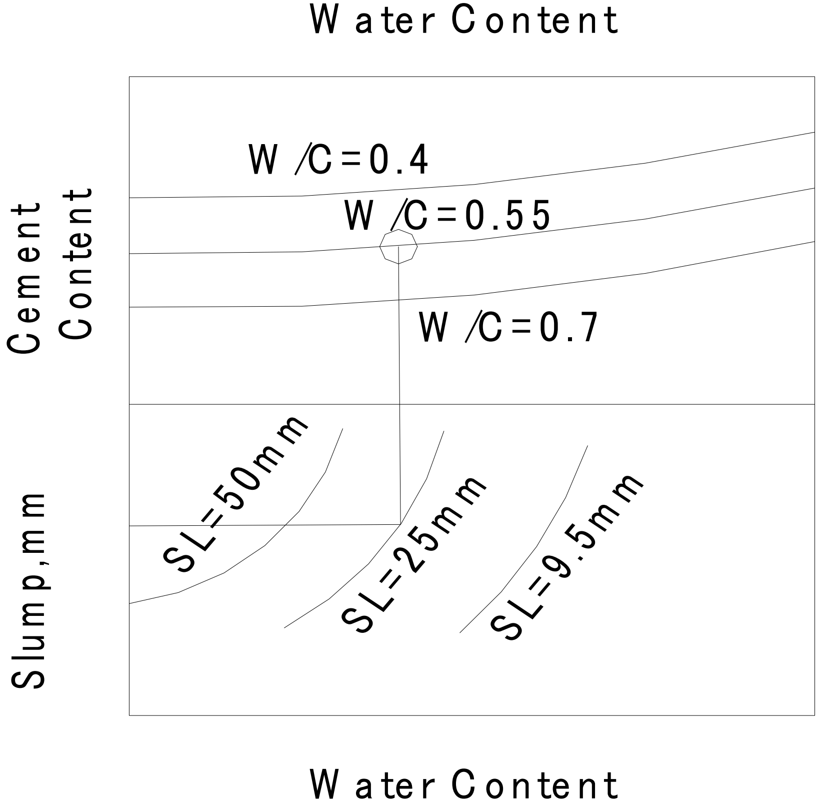
ACI 318

Percentages by mas of cement

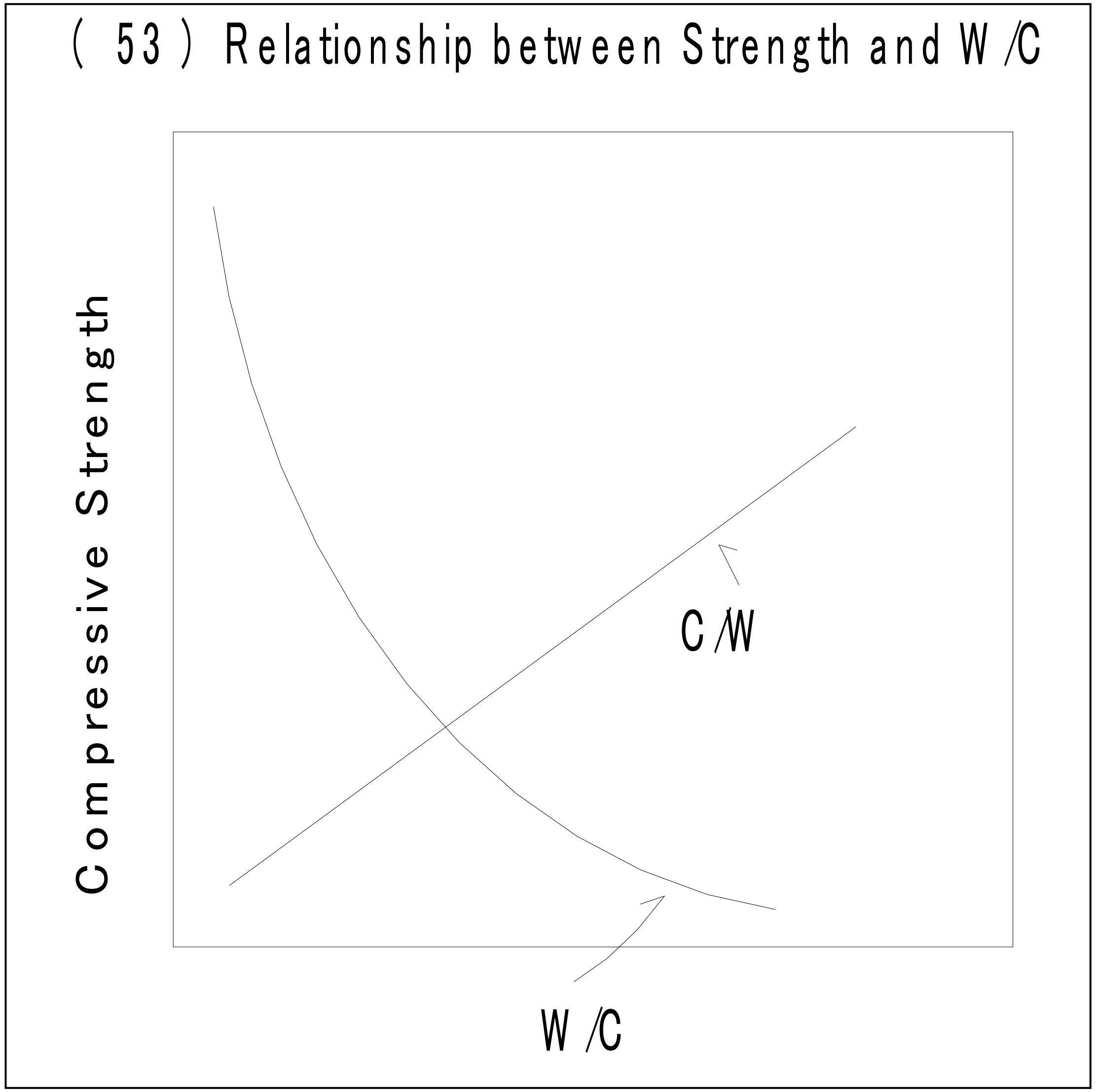
Prestressed Concrete	0.06%
Reinforced concrete exposed to chloride in service	0.15%
Reinforced concrete that will be dry or protected from moisture in service	1.00%
Other reinforced concrete construction	0.30%

(52) Water Content, Slump and Cement Content

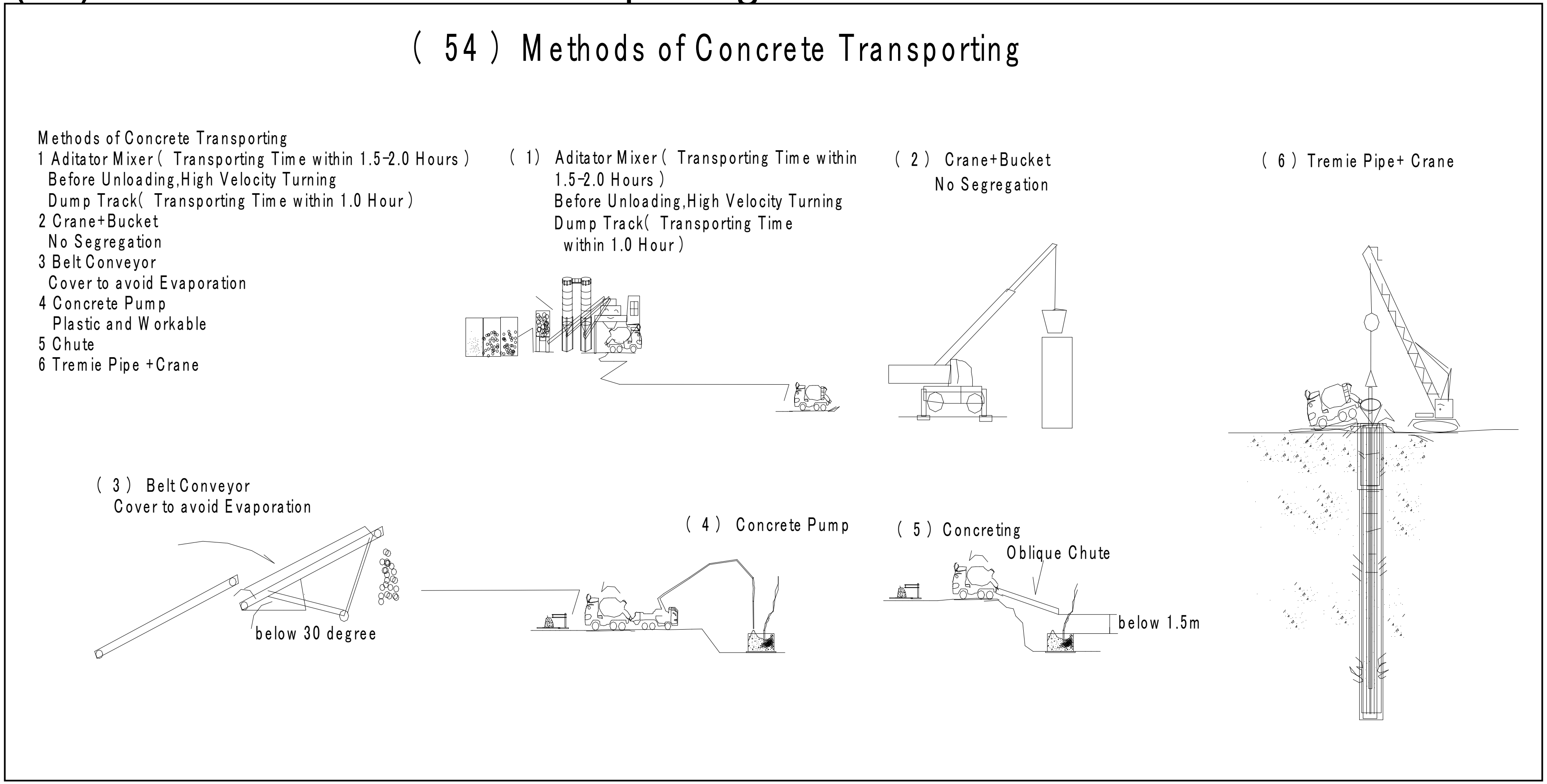
(52) Water Content, Slump and Cement Content



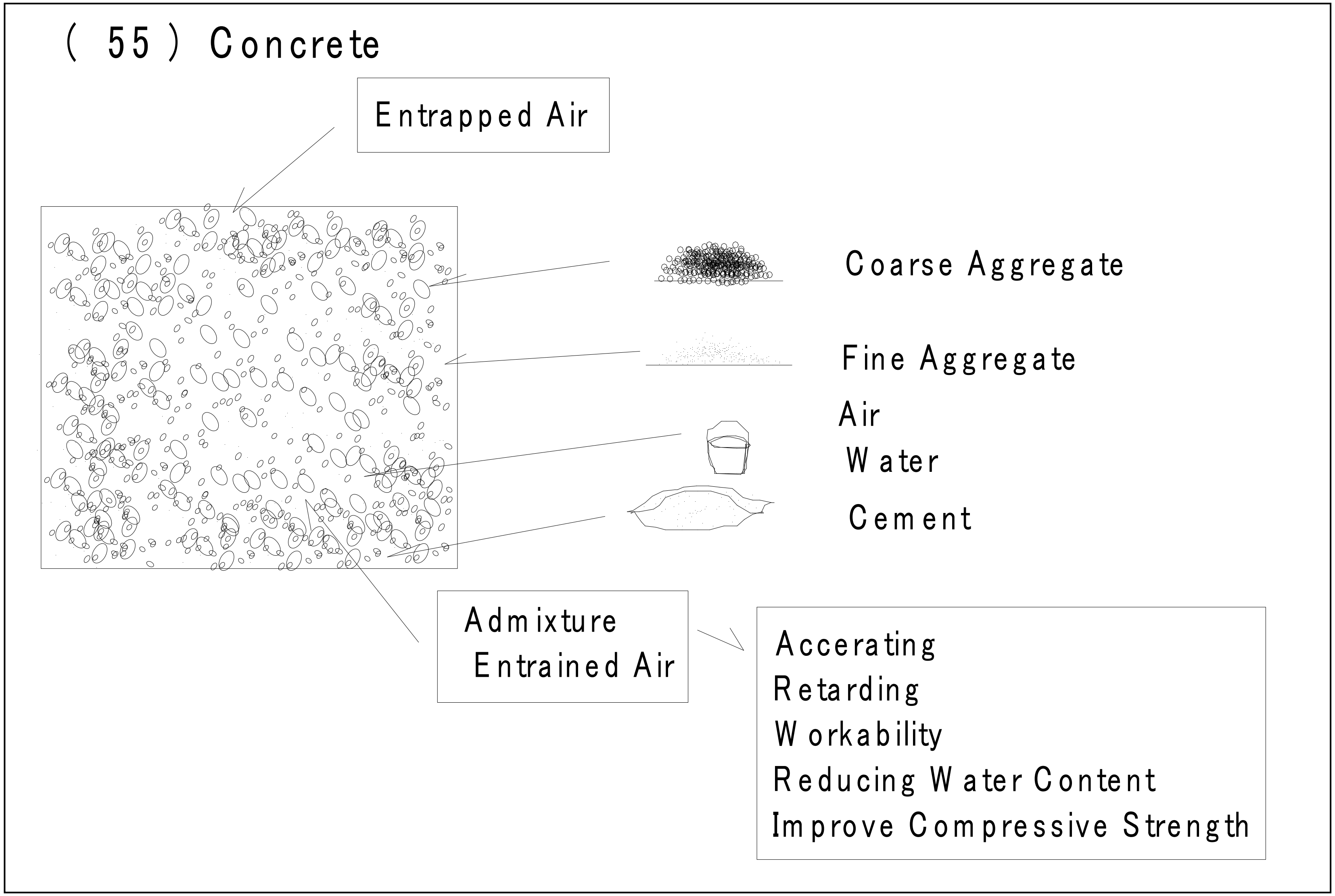
(53) Relation between Strength and Water Cement Ratio



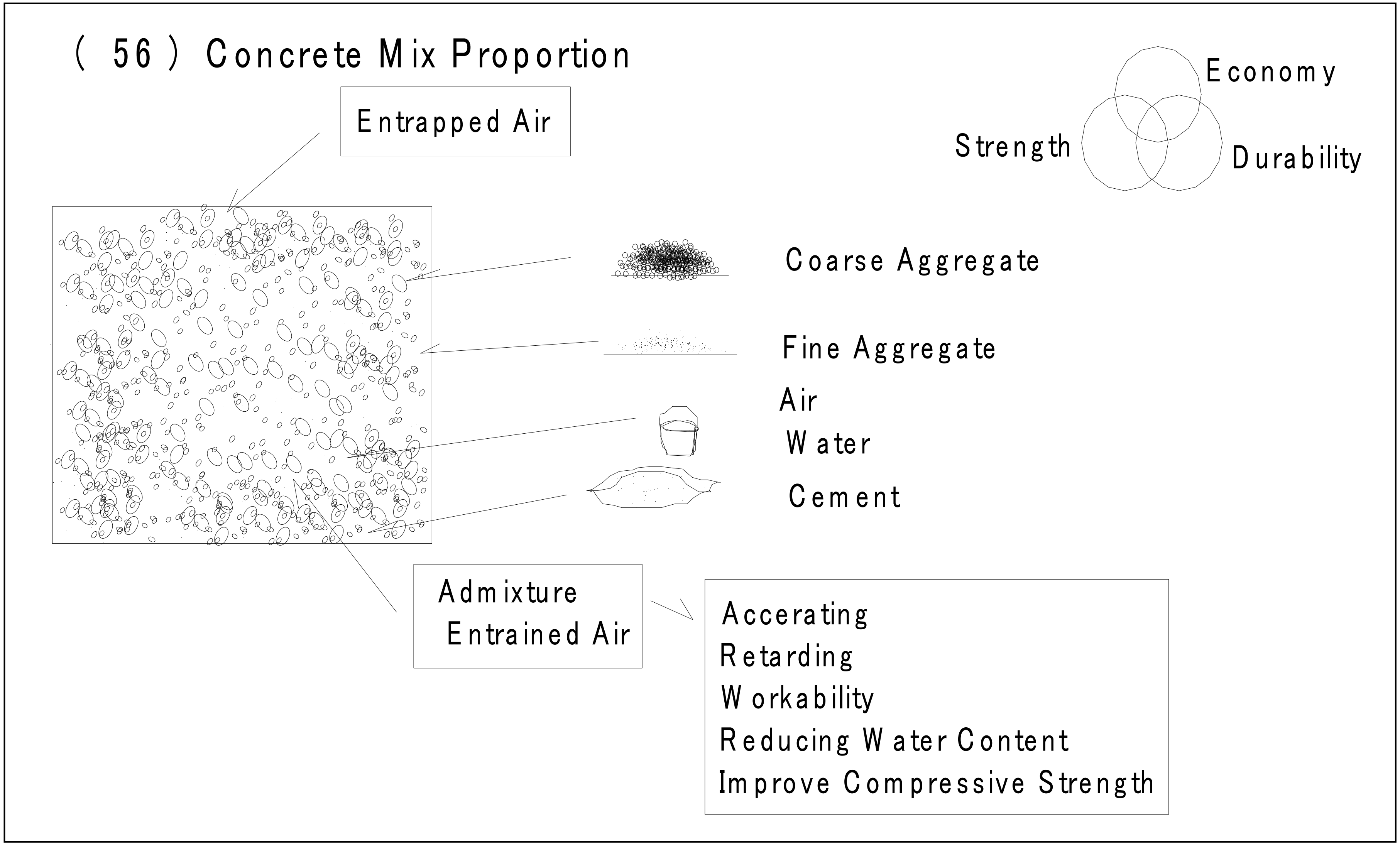
(54) Method of Concrete Transporting



(55) Concrete


(55) Concrete
Entrapped Air
Coarse Aggregate
Fine Aggregate
Air
Water
Cement
Admixture
Entrained Air
Accerating
Retarding
Workability
Reducing Water Content
Improve Compressive Strength

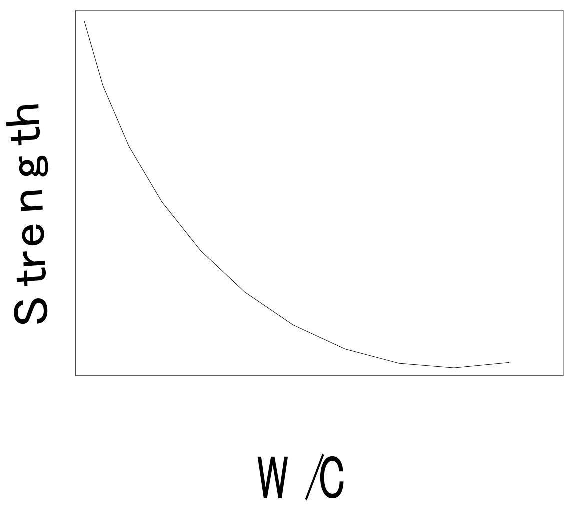
(56) Concrete Mix Proportion



(57) Concrete Technology

Mix Proportion

(1) Concrete Compressive Strength
-Water Cement Ratio



(2) Air (Entrained Air) -Durability

(3) Economy-Adimixture

（58） Concrete Trial Mix

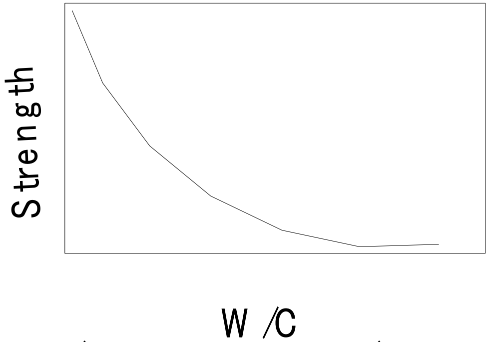
Trial Mix（ Laboratory）

Trial Batch（ Batching Plant）

↓

Mix Proportion

（1） Concrete Compressive Strength
−Water Cement Ratio

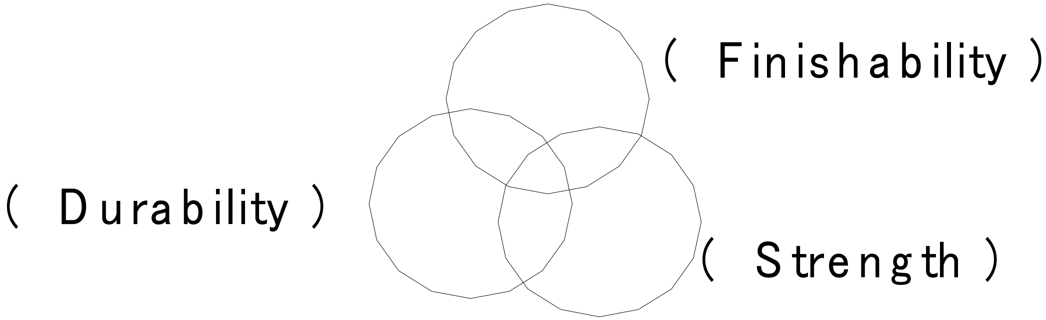


（2） Air（ Entrained Air）−Durability

（3） Economy−Adimixture

(59) Concrete Mix Proportion

(59) Concrete Mix Proportion



(Finish)

Grading of Aggregate, Shape
Cement Content , Entrained Air
Admixture

(60) Consistency

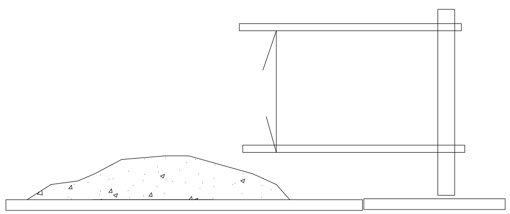
(60) Consistency

ASTM C 143

Consistency Measured by Slump

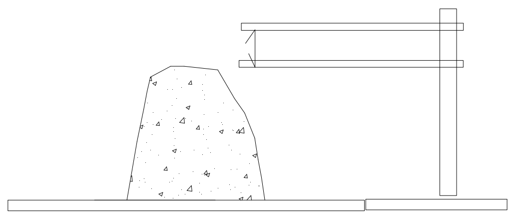
Consistency – Workability

Slump(cm) -High



Soft

Slump(cm) -Low

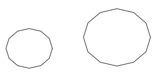
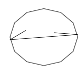
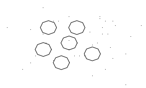


Hard

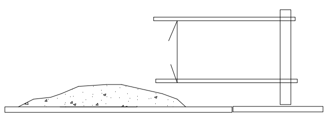
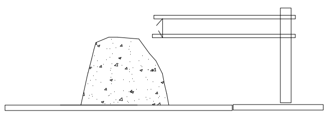
(61) Consistency-Water

(61) Consistency

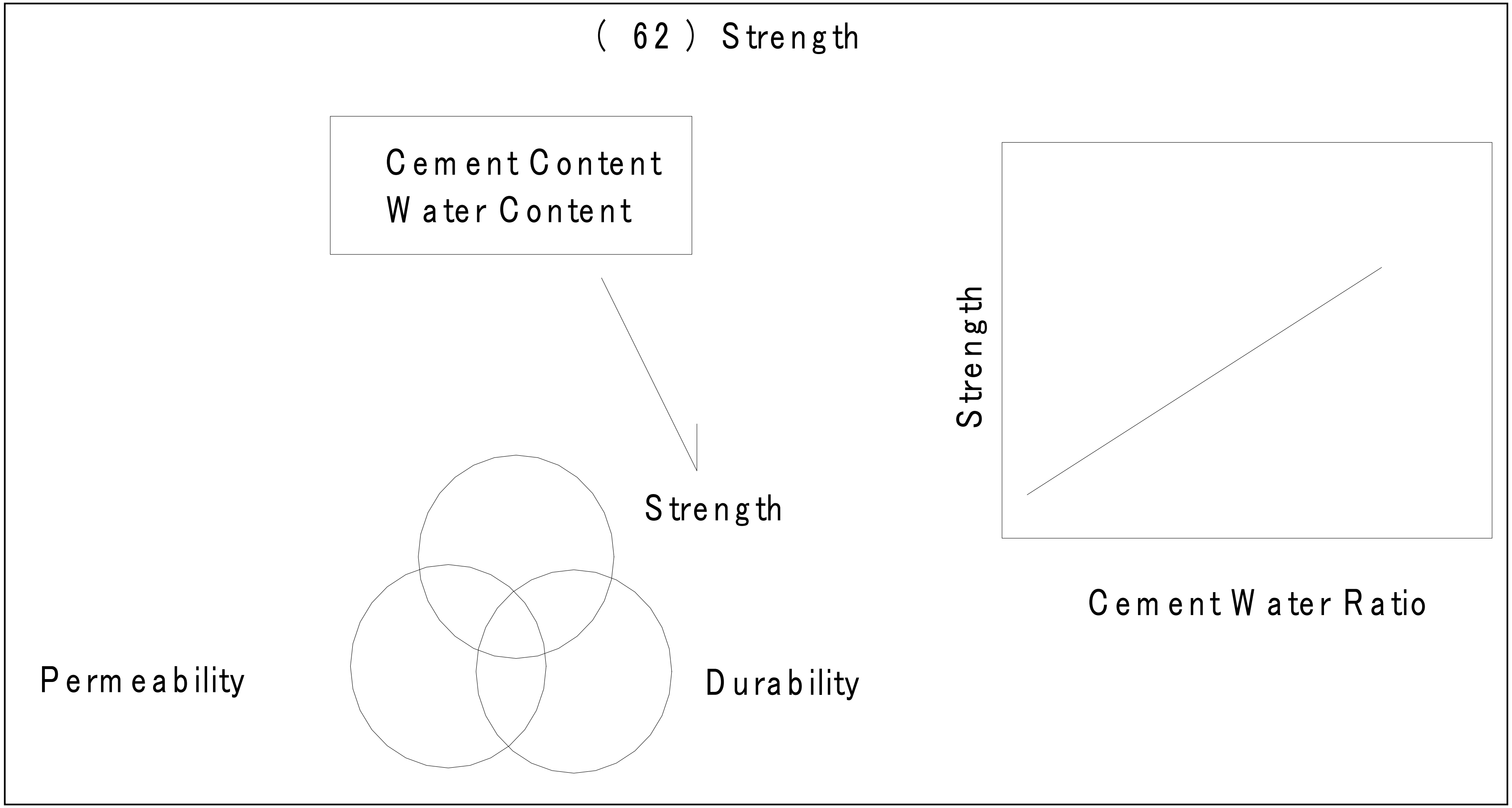
Consistency – Required Water Content

Aggregate Round	Aggregate Maximum Size	Entrained Air
Water–Little	Water–Little	Water–Little
		

Consistency – Workability

Slump(cm) – High	Slump(cm) – Low
	
Soft	Hard

(62) Strength


(62) Strength
Cement Content
Water Content
Strength
Permeability
Durability
Strength
Cement Water Ratio

(63) Durability

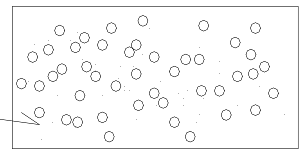
(63) Durability

Freezing
Wet
Heat
Chemical Medicine
Ice

Alkali-Aggregate reaction
Alkali Cement

Sea Water
Sulfate Resisting Portland Cement

Freezing and Thawing Action
AE Concrete-Etrained Air



(64) Concrete Mix Proportion

Data

1 Sieve Analysis Test
2 Unit Weight Test
3 Specific Gravity ,Absorption of Coarse Aggregate
4 Water Content
5 Strength and W/C

(65) Mix Proportion of Concrete

(65) Mix Proportion of Concrete

Type	Grade	Aggregate Max Dimen	Slump	Water Cement Ratio	Sand Percentage	Cement	Water	Fine Aggregate	Coarse Aggregate (G1)	Coarse Aggregate (G2)	Admixture	Admixture	Compressive Strength			Remarks
													3 days	7 days	28 days	
		(mm)	(cm)	(%)	(%)	(kg/m3)	(kg/m3)	(kg/m3)	(kg/m3)	(kg/m3)	(l/m3)	(l/m3)	(Mpa)	(Mpa)	(Mpa)	
		GMax	(SL)	(W/C)	(s/a)	(C)	(W)	(s)	(G1)	(G2)						
																Weight
																Specific Gravity
																Volume

(66) Mix Proportion Step

(66) First Step–Slump

Type	Grade	Aggregate Max Dimen	Slump	Water Cement Ratio	Sand Percentage	Cement	Water	Fine Aggregate	Coarse Aggregate (G1)	Coarse Aggregate (G2)	Admixture	Admixture	CompressiveStrength 3 days	CompressiveStrength 7 days	CompressiveStrength 28 days	Remarks
		(mm)	(cm)	(%)	(%)	(kg/m3)	(kg/m3)	(kg/m3)	(kg/m3)	(kg/m3)	(l/m3)	(l/m3)	(Mpa)	(Mpa)	(Mpa)	
		GMax	(SL)	(W/C)	(s/a)	(C)	(W)	(s)	(G1)	(G2)						
																Weight
																Specific Gravity
																Volume

(67) Mix Proportion Step-Slump

(67) Mix Proportion Step

Type	Grade	Aggregate Max Dimen	Slump	Water Cement Ratio	Sand Percentage	Cement	Water	Fine Aggregate	Coarse Aggregate (G1)	Coarse Aggregate (G2)	Admixture	Admixture	CompressiveStrength			Remarks
													3 days	7 days	28 days	
		(mm)	(cm)	(%)	(%)	(kg/m3)	(kg/m3)	(kg/m3)	(kg/m3)	(kg/m3)	(l/m3)	(l/m3)	(Mpa)	(Mpa)	(Mpa)	
		GMax	(SL)	(W/C)	(s/a)	(C)	(W)	(s)	(G1)	(G2)						
																Weight
																Specific Gravity
																Volume

(1) Slump
(2) Maximum Dimension of Aggregate
(3) Water and Air Content
(4) Water Cement Ratio
(5) Calculate Cement Content
(6) Calculate Aggregate Content
(7) Calculate Fine Aggregate
(8) Adjust Aggregate Moisture Content
(9) Adjust Trial Batch

(68) Mix Proportion Step-Maximum Size of Aggregate

(68) Mix Proportion Step-

(3) Water and Air Content

Type	Grade	Aggregate Max Dimen	Slump	Water Cement Ratio	Sand Percentage	Cement	Water	Fine Aggregate	Coarse Aggregate (G1)	Coarse Aggregate (G2)	Admixture	Admixture	CompressiveStrength			Remarks
													3 days	7 days	28 days	
		(mm)	(cm)	(%)	(%)	(kg/m3)	(kg/m3)	(kg/m3)	(kg/m3)	(kg/m3)	(l/m3)	(l/m3)	(Mpa)	(Mpa)	(Mpa)	
		GMax	(SL)	(W/C)	(s/a)	(C)	(W)	(s)	(G1)	(G2)						
																Weight
																Specific Gravity
																Volume

(69) ACI 211.1 Mix Proportion Step(1)-Water and Air Content

84 Mix Proportion Calculation

1 Cement		Type I		Specific Grav	3.15		
2 Grading of Coarse or Fine Aggregate							
3 Coarse Aggregate				Specific Gravity	2.68	Absorptio	0.50%
4 Fine Aggregate				Specific Gravity	2.64	Absorptio	0.70%
	Fineness Modules				2.8		
5 Compressive Strength (Ages 28 days)						250kg/cm2	
6 Slump						8-10cm	
7 Coarse Aggregate			Grading			5-40mm	
8 Compacted Weight of Coarse Aggregate						1600kg/m3	

1 Step		Slump		8-10cm
2 Step	Coarse Aggregate		Grading	5-40mm
3 Step	Plain Concrete			
	Aggregate	Gmax		40mm

69 70 ACI 211.1 Table 5.3.3 -Approximate Mixing Water and Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate (SI)

Slump(cm)	Aggregate Maximum Dimension (mm)							
	10	12.5	20	25	40	50	70	150
Plain Concrete								
3-5	205	200	185	180	160	155	145	125
8-10	225	215	200	195	175	170	160	140
15-18	240	230	210	205	185	180	170	-
Entrapped	3	2.5	2	1.5	1	0.5	0.3	0.2
AE Concrete								
3-5	180	175	165	160	145	140	135	120
8-10	200	190	180	175	160	155	150	135
15-18	215	205	190	185	170	165	160	-
Air Cont	8	7	6	5	4.5	4	3.5	3

Estimated Water 175kg/m3

Entrapped Air 1%

4 Step	Strength-W/C	Plain Concrete
	Strength	250kg/cm2
	W/C	0.62

71 ACI 211.1 Table A1.5.3.4(a)

Relationships between Water-Cement Ratio and Compressive Strength of Concrete (SI)

Compressive Strength Ages 28 Days(kg/cm2)	Water Cement Ratio W/C	
	Plain Concrete	AE Concrete
450	0.38	
400	0.43	
350	0.48	0.4
300	0.55	0.46
250	0.62	0.53
200	0.7	0.61
150	0.8	0.71

Compressive Strength,Wet Curing in 28 days,23+-1.7 degree

5 Step Cement Content C=175/0.62=282kg/m3

Concrete Mix Proportion

Adjustment Moisture Content

	specifiv gravity(%)	absorption(%)	moisture content(	Water surface content(	Content (kg/m3)	Correction(kg/m3)	Corrected(kg/m3)
		(1)	(2)	(3)=(2)-(	(4)	(5)=(3)*(4)*0.01	(6)=(4)+(5)
Water							
Fine Aggregate							
G1:Aggregate(5							
G2:Aggregate(1							

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregat		Admixture	Admixtu	Comprssive Strength(kgf/c			Remarks	density kg/m3
		(SL)	air	W/C	s/a	C	W	s	CA(5~10mm)	CA(10~20mm)	(% of weight of cement	(% of weight of cement)	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
250	40	10	1	62		282	175									Weight	
						3.15	1									Specific Gravity	
			10			90	175									Volume	

6 Step	Coarse Aggregate Content	
	Fineness Modules	2.8
	Coarse Aggregate Maximum Dimension	40mm
	Dry Compacted Volume of Coarse Aggregate	0.72m3
	Compacted Weight of Coarse Aggregate	1600kg/m3
	Dry Compacted Weight of Coarse Aggregate	0.72*1600=1152kg

75-ACI 211.1 Table A1.5.3.6 Volume of Coarse Aggregate per Unit Volume of Concrete (SI)

Maximum Size of Coarse	Fineness Modules of Fine Aggregate			
	2.4	2.6	2.8	3
10	0.5	0.48	0.46	0.44
12.5	0.59	0.57	0.55	0.53
20	0.66	0.64	0.62	0.6
25	0.71	0.69	0.67	0.65
40	0.76	0.74	0.72	0.7
50	0.78	0.76	0.74	0.72
70	0.81	0.79	0.77	0.75
150	0.87	0.85	0.83	0.81

ASTM C29 Unit Weight of Concrete

(2) Volumetric Method

7-1 Step (1) Gravimetric Method

Maximum Dimension of Coarse Aggregate 40mm Plain Concrete

Plain Concrete Unit Weight of Fresh Con 2420kg

78-ACI 211.1 Table A1.5.3.7.1 First Estimate of Mass of Fresh Concrete (SI)

Aggregate Maximum	resh Concret	AE Concrete
10	2285	2190
12.5	2315	2235
20	2355	2280
25	2375	2315
40	2420	2355
50	2445	2375
70	2465	2400
150	2505	2435

2420-(175+282+1152)=811kg

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cement ratio	sand percent age	Cement	Water	Fine Aggreg ate	Coarse Aggregat		Admixtu re	Admixtu	Comprssive Strength(kgf/cm2)			Remarks
		(SL)	air	W/C	s/a	C	W	s	CA(5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d	
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)						
250	40	10	1	62		282	175	811	1152							Weight
						3.15	1									Specific Gravity
			10			90	175									Volume

7-2 Step (2) Volumetric Method

69 70 ACI 211.1 Table 5.3.3 -Approximate Mixing Water and Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate (SI)

Slump(cm)	Aggregate Maximum Dimension (mm)							
	10	12.5	20	25	40	50	70	150
Plain Concrete								
3-5	205	200	185	180	160	155	145	125
8-10	225	215	200	195	175	170	160	140
15-18	240	230	210	205	185	180	170	-
Entrapped	3	2.5	2	1.5	1	0.5	0.3	0.2
AE Concrete								
3-5	180	175	165	160	145	140	135	120
8-10	200	190	180	175	160	155	150	135
15-18	215	205	190	185	170	165	160	-
Air Cont	8	7	6	5	4.5	4	3.5	3

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregat		Admixture	Admixtur	Comprssive Strength(kgf/cm2)			Remarks
		(SL)	air	W/C	s/a	C	W	s	CA(5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d	
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)						
250	40	10	1	62		282	175	779	1152							Weight
						3.15	1	2.64	2.68							Specific Gravity
			10			90	175	295	430							Volume(cc)

1000cc

=1000-(10+90+175+430)=295

8 Step		Water Content(%)	Absorption(%)
	Coarse Aggregate	2%	0.5
	Fine Aggregate	6%	0.7

Concrete Mix Proportion

Adjustment Moisture Content

	specifiv gravity(%)	absorption(%)	moisture content(	Water surface content(	Content (kg/m3)	Correction(kg/m3)	Corrected(kg/m3)	
		(1)	(2)	(3)=(2)-(	(4)	(5)=(3)*(4)*0.01	(6)=(4)+(5)	
Water					175	-60	115	
Fine Aggregate	2.64	0.7	6.0	5.3	811	43	854	(Wet)
G1:Aggregate(5~10mm) G2:Aggregate(10~20mm)	2.68	0.5	2.0	1.5	1152	17	1169	(Wet)

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixtu	Comprssive Strength(kgf/cm2)			Remarks	
		(SL)	air	W/C	s/a	C	W	s	CA(5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
250	40	10	1	62		282	175	779	1152							Weight	2388
						3.15	1	2.64	2.68							Specific Gravity	
			10			90	175	295	430							Volume(cc)	1000

9 Step Trial Batch

1000cc			282	115	854	1169
20cc			5.64	2.30	####	23.38

→ Trial Batch

Slump =5cm → Slump =9cm

mp 1cm Increase=Water 2kg/m3 Increa

Water | 8kg/m3 Increase

=175+8=183 kg/m3

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cement ratio	sand percent age	Cement	Water	Fine Aggreg ate	Coarse Aggregate		Admixtu re	Admixtu	Comprssive Strength(kgf/cm2)			Remarks	
		(SL)	air	W/C	s/a	C	W	s	CA(5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
250	40	10	1	62		295	183	748	1152							Weight	2378
						3.15	1	2.64	2.68							Specific G	2.378
			10			94	183	283	430							Volume(cc)	1000

(70) ACI 211.1 Mix Proportion Step(2)-Water and Air Content

69 70 ACI 211.1 Table 5.3.3 -Approximate Mixing Water and Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate (SI)

Slump(cm)	Aggregate Maximum Dimension (mm)							
	10	12.5	20	25	40	50	70	150
Plain Concrete								
3-5	205	200	185	180	160	155	145	125
8-10	225	215	200	195	175	170	160	140
15-18	240	230	210	205	185	180	170	–
Entrapped Air(%)	3	2.5	2	1.5	1	0.5	0.3	0.2
AE Concrete								
3-5	180	175	165	160	145	140	135	120
8-10	200	190	180	175	160	155	150	135
15-18	215	205	190	185	170	165	160	–
Air Content(	8	7	6	5	4.5	4	3.5	3

(71) ACI 211.1 Mix Proportion Step(3)

71 ACI 211.1 Table A1.5.3.4(a) Relationships between Water-Cement Ratio and Compressive Strength of Concrete (SI)

Compressive Strength Ages 28 Days(kg/cm2)	Water Cement Ratio W/C	
	Plain Concrete	AE Concrete
450	0.38	
400	0.43	
350	0.48	0.4
300	0.55	0.46
250	0.62	0.53
200	0.7	0.61
150	0.8	0.71

Compressive Strength,Wet Curing in 28 days,23+-1.7 degree

(72) ACI 211.1 Mix Proportion Step(4-1) Water Cement Ratio
71 ACI

Compressive Strength Ages 28 Days(kg/cm2)			Water Cement Ratio W/C			
			Plain Concrete		AE	
450			0.38			
400			0.43			
350			0.48		0.4	
300			0.55		0.46	
250			0.62		0.53	
200			0.7		0.61	
150			0.8		0.71	

Compressive Strength,Wet Curing in 28 days,23+-1.7 degree

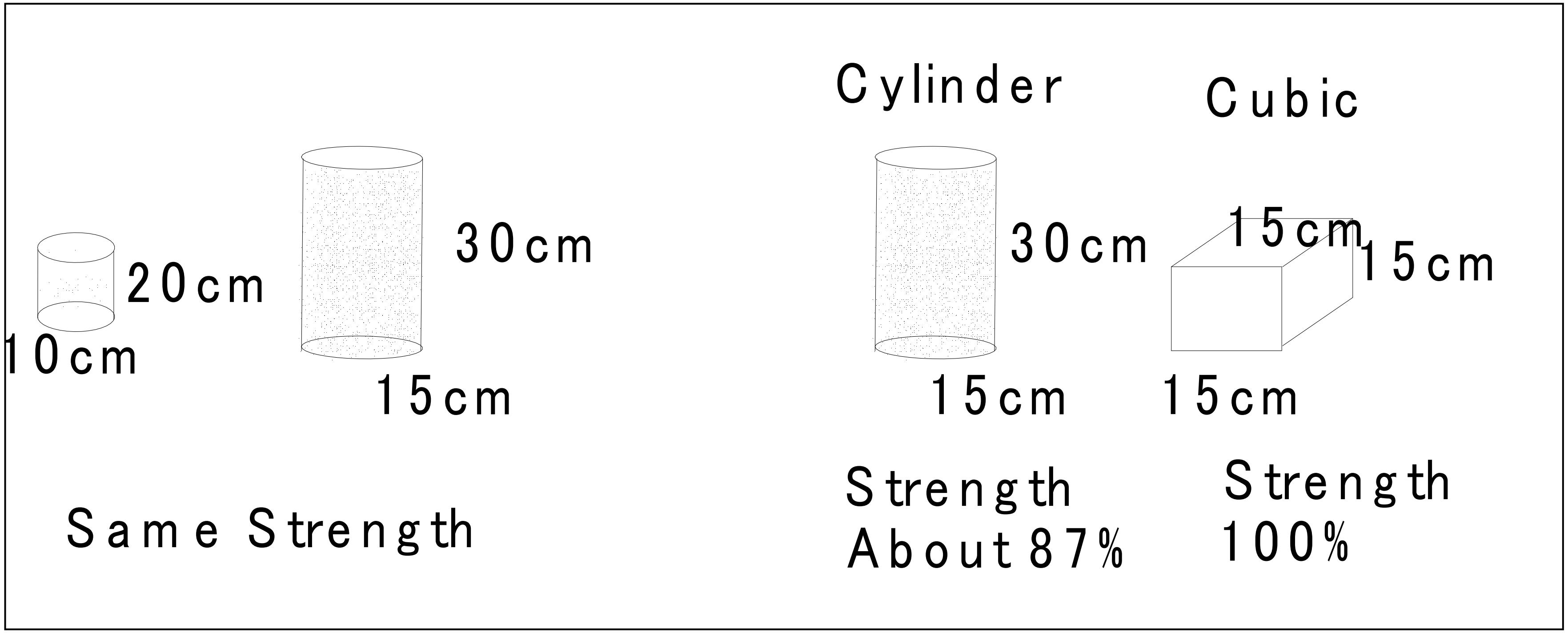
72-ACI 211.1 Table A1.5.3.4(b) Maximum Permissible Water-Cement Ratios for Concrete in Severe Exposures (SI)

Type of Structure	Wet Condition or Freezing and Thawing Action	Sea Water or Sodium Sulfate Chloride
Thin Section(Hand Rail,Beam,below Covering 3 cm)	0.45	0.4
Other Structure	0.5	0.45

ACI Committee 201(Durability of Concrete in Service)

(73) ACI 211.1 Mix Proportion Step(4-2) Strength with Cubic Specimen

Strength with Cubic Specimen
100 % Compressive Strength



(74) ACI 211.1 Mix Proportion Step(5) Calculate Cement Content

(74) ACI 211.1 Mix Proportion Step

(5) Calculate Cement Content

W/C=0.38
W=180
C=474

Type Grade	Aggregate Max Dimen	Air	Slump	Water Cement Ratio	Sand Percentage	Cement	Water	Fine Aggregate	Coarse Aggregate (G1)	Coarse Aggregate (G2)	Admixture	Admixture	Compressive Strength 3 days	7 days	28 days	Remarks
	(mm)	(%)	(cm)	(%)	(%)	(kg/m3)	(kg/m3)	(kg/m3)	(kg/m3)	(kg/m3)	(l/m3)	(l/m3)	(Mpa)	(Mpa)	(Mpa)	
	GMax		(SL)	(W/C)	(s/a)	(C)	(W)	(s)	(G1)	(G2)						
	20		8	0.38		474	180									Weight
																Specific Gravity
																Volume

(75) ACI 211.1 Mix Proportion Step(6) Calculate Coarse Aggregate Content

（ 75 ） ACI 211.1 Mix Proportion Step

（ 6 ） Calculate Coarse Aggregate Content

Type Grade	Aggregate Max Dimen	Air	Slump	Water Cement Ratio	Sand Percentage	Cement	Water	Fine Aggregate	Coarse Aggregate (G1)	Coarse Aggregate (G2)	Admixture	Admixture	CompressiveStrength			Remarks
													3 days	7 days	28 days	
	(mm)	(%)	(cm)	(%)	(%)	(kg/m3)	(kg/m3)	(kg/m3)	(kg/m3)	(kg/m3)	(l/m3)	(l/m3)	(Mpa)	(Mpa)	(Mpa)	
	GMax		(SL)	(W/C)	(s/a)	(C)	(W)	(s)	(G1)	(G2)						
																Weight
																Specific Gravity
																Volume

75-ACI 211.1 Table A1.5.3.6 Volume of Coarse Aggregate per Unit Volume of Concrete (SI)

Maximum Size of Coarse Aggregate	Fineness Modules of Fine Aggregate			
	2.4	2.6	2.8	3
10	0.5	0.48	0.46	0.44
12.5	0.59	0.57	0.55	0.53
20	0.66	0.64	0.62	0.6
25	0.71	0.69	0.67	0.65
40	0.76	0.74	0.72	0.7
50	0.78	0.76	0.74	0.72
70	0.81	0.79	0.77	0.75
150	0.87	0.85	0.83	0.81

ASTM C29 Unit Weight of Concrete

(76) ACI 211.1 Mix Proportion Step(7) Calculate Fine Aggregate Content

（ 76 ） ACI 211.1 Mix Proportion Step

（ 7 ） Calculate Fine Aggregate Content

W/C=0.38
W=180
C=474

Type Grade	Aggregate Max Dimen	Air	Slump	Water Cement Ratio	Sand Percentage	Cement	Water	Fine Aggregate	Coarse Aggregate (G1)	Coarse Aggregate (G2)	Admixture	Admixture	Compressive Strength 3 days	7 days	28 days	Remarks
	(mm)	(%)	(cm)	(%)	(%)	(kg/m3)	(kg/m3)	(kg/m3)	(kg/m3)	(kg/m3)	(l/m3)	(l/m3)	(Mpa)	(Mpa)	(Mpa)	
	GMax		(SL)	(W/C)	(s/a)	(C)	(W)	(s)	(G1)	(G2)						
	20		8	0.38		474	180									Weight
																Specific Gravity
																Volume

Volume of Coarse Aggregate per Unit Volume of Concrete

Maximum Size of Coarse Aggregate	Fineness Modules of Fine Aggregate 2.4	2.6	2.8	3
10	0.5	0.48	0.46	0.44
12.5	0.59	0.57	0.55	0.53
20	0.66	0.64	0.62	0.6
25	0.71	0.69	0.67	0.65
40	0.76	0.74	0.72	0.7
50	0.78	0.76	0.74	0.72
70	0.81	0.79	0.77	0.75
150	0.87	0.85	0.83	0.81

ASTM C29 Unit Weight of Concrete

(77) ACI 211.1 Mix Proportion Step(8-1) Calculate Fine Aggregate Content

75-ACI 211.1 Table A1.5.3.6 Volume of Coarse Aggregate per Unit Volume of Concrete (SI)				
Maximum Size of Coarse Aggregate	Fineness Modules of Fine Aggregate			
	2.4	2.6	2.8	3
10	0.5	0.48	0.46	0.44
12.5	0.59	0.57	0.55	0.53
20	0.66	0.64	0.62	0.6
25	0.71	0.69	0.67	0.65
40	0.76	0.74	0.72	0.7
50	0.78	0.76	0.74	0.72
70	0.81	0.79	0.77	0.75
150	0.87	0.85	0.83	0.81
				ASTM C29 Unit Weight of Concrete

(78) ACI 211.1 Mix Proportion Step(8-2) Calculate Unit Weight of Fresh Concrete

78-ACI211.1 Table A1.5.3.7.1 First Estimate of Mass of Fresh Concrete (SI)

Aggregate Maximum Dimension (mm)	Fresh Concrete	AE Concrete
10	2285	2190
12.5	2315	2235
20	2355	2280
25	2375	2315
40	2420	2355
50	2445	2375
70	2465	2400
150	2505	2435

Unit Weight of Fresh Concrete

$U=10G_a(100-A)+C(1-G_a/G_c)$

U	Unit Weight of Fresh Concrete
Ga	Specific Gravity of Fine Coarse Aggregate Saturated Surface-Dry State of Aggregate)
Go	Specific Gravity of Cement
A	Air Content(%)
W	Water Content(kg/m3)
C	Cement Content(kg/m3)

(79) ACI 211.1Mix Proportion Step(8-3) Calculate Fine Aggregate Content

(79) ACI 211.1 Mix Proportion Step

(8-3) Calculate Fine Aggregate Content

Gravimetric Method
Volumetric Method

Type Grade	Aggregate Max Dimen	Air	Slump	Water Cement Ratio	Sand Percentage	Cement	Water	Fine Aggregate	Coarse Aggregate (G1)	Coarse Aggregate (G2)	Admixture	Admixture	CompressiveStrength 3 days	7 days	28 days	Remarks
	(mm)	(%)	(cm)	(%)	(%)	(kg/m3)	(kg/m3)	(kg/m3)	(kg/m3)	(kg/m3)	(l/m3)	(l/m3)	(Mpa)	(Mpa)	(Mpa)	
	GMax		(SL)	(W/C)	(s/a)	(C)	(W)	(s)	(G1)	(G2)						
																Weight
																Specific Gravity
																Volume

(80) ACI 211.1 Mix Proportion Step(8-4) Adjustment of Aggregate Moisture Content

Concrete Mix Proportion

Adjustment Moisture Content

	specifiv gravity(%)	absorption(%)	moisture content(%)	Water surface content(%)	Content (kg/m3)	Correction (kg/m3)	Corrected (kg/m3)
		(1)	(2)	(3)=(2)-(1)	(4)	(5)=(3)×(4)×0.01	(6)=(4)+(5)
Water							
Fine Aggregate	2.61	1.66					
G1 Aggregate(5~10mm)	2.71	0.89					
G2 Aggregate(10~20mm)	2.7	0.93					

(A)35-100-I

Mix Ratio 0.25 0.75

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks	density kg/m3
		(SL)	air	W/C	s/a	C	W	s	CA(5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d		
	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	Mighty	Mighty					
35	20	100+-25	2	38	46	487	185	769	234	700	1.46	1.46				Weight	2375
						3.15	1	2.61	2.71	2.7						Specific Gravity	2.38
			20			155	185	295	86	259						Volume	1000

(81) ACI 211.1 Mix Proportion Step
(9) Adjustment of Trial Batch

ASTM C 192 Making and Curing Concrete Compression and Flexure Test Specimens in The Laboratory

ASTM C 138 Unit Weight of Concrete

ASTM C 138,C173 or C231 Air Content

Check Workability

Segregation

Finishability

(82) ACI 211.1 Mix Proportion Step

(9-1) Adjustment of Trial Batch
Slump-Water Content

Slump 1cm Increase or Decrease

Water 2kg/m3 per Concrete Volume 1m3

Decrese or Increse

Slump(cm)

Soft Hard

（ 83 ） ACI 211.1 Mix Proportion Step

（ 9-2 ） Adjustment of Trial Batch

Air Content-Water Content

Air Content 1% Increase or Decrease

Water 3kg/m3 per Concrete Volume 1m3

Decrese or Increse

(84) ACI 211.1 Mix Proportion Step Calculation(1)

84 Mix Proportion Calculation

1 Cement	Type I	Specific Grav	3.15		
2 Grading of Coarse or Fine Aggregate					
3 Coarse Aggregate		Specific Gravity	2.68	Absorption	0.50%
4 Fine Aggregate		Specific Gravity	2.64	Absorption	0.70%
Fineness Modules			2.8		
5 Compressive Strength (Ages 28 days)				250kg/cm2	
6 Slump				8-10cm	
7 Coarse Aggregate	Grading			5-40mm	
8 Compacted Weight of Coarse Aggregate				1600kg/m3	

1 Step Slump 8-10cm

2 Step Coarse Aggregate Grading 5-40mm

3 Step Plain Concrete

Aggregate Gmax 40mm

69 70 ACI211.1 Table 5.3.3 -Approximate Mixing Water and Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate (SI)

Slump (cm)	Aggregate Maximum Dimension (mm)							
	10	12.5	20	25	40	50	70	150
Plain Concrete								
3-5	205	200	185	180	160	155	145	125
8-10	225	215	200	195	175	170	160	140
15-18	240	230	210	205	185	180	170	–
Entrapped	3	2.5	2	1.5	1	0.5	0.3	0.2
AE Concrete								
3-5	180	175	165	160	145	140	135	120
8-10	200	190	180	175	160	155	150	135
15-18	215	205	190	185	170	165	160	–
Air Conten	8	7	6	5	4.5	4	3.5	3

Estimated Water 175kg/m3

Entrapped Air 1%

84 Mix Proportion Calculation

1 Cement	Type I	Specific Gravity	3.15		
2 Grading of Coarse or Fine Aggregate					
3 Coarse Aggregate		Specific Gravity	2.68	Absorption	0.50%
4 Fine Aggregate		Specific Gravity	2.64	Absorption	0.70%
Fineness Modules			2.8		
5 Compressive Strength (Ages 28 days)				250kg/cm2	
6 Slump				8-10cm	
7 Coarse Aggregate	Grading			5-40mm	
8 Compacted Weight of Coarse Aggregate				1600kg/m3	

1 Step	Slump		8-10cm
2 Step	Coarse Aggregate	Grading	5-40mm
3 Step	Plain Concrete		
	Aggregate	Gmax	40mm

69 70 ACI 211.1 Table 5.3.3 -Approximate Mixing Water and Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate (SI)

Slump (cm)	Aggregate Maximum Dimension (mm)							
	10	12.5	20	25	40	50	70	150
Plain Concrete								
3-5	205	200	185	180	160	155	145	125
8-10	225	215	200	195	175	170	160	140
15-18	240	230	210	205	185	180	170	-
Entrapped Air(%)	3	2.5	2	1.5	1	0.5	0.3	0.2
AE Concrete								
3-5	180	175	165	160	145	140	135	120
8-10	200	190	180	175	160	155	150	135
15-18	215	205	190	185	170	165	160	-
Air Content(	8	7	6	5	4.5	4	3.5	3

Estimated Water 175kg/m3
Entrapped Air 1%

4 Step Strength-W/C Plain Concrete Strength 250kg/cm2 W/C 0.62%

71 ACI 211.1 Table A1.5.3.4(a) Relationships between Water-Cement Ratio and Compressive Strength of Concrete (SI)

Compressive Strength Ages 28 Days(kg/cm2)	Water Cement Ratio W/C	
	Plain Concrete	AE Concrete
450	0.38	
400	0.43	
350	0.48	0.4
300	0.55	0.46
250	0.62	0.53
200	0.7	0.61
150	0.8	0.71

Compressive Strength,Wet Curing in 28 days,23+-1.7 degree

5 Step Cement Content C=175/0.62=282kg/m3

Concrete Mix Proportion

Adjustment Moisture Content

	specifiv gravity(%)	absorption(%)	moisture content(%)	Water surface	Content(kg/m3)	Correction(kg/m3)	Corrected(kg/m3)
		(1)	(2)	(3)=(2)-(1)	(4)	(5)=(3)*(4)*0.01	(6)=(4)+(5)
Water							
Fine Aggregate							
G1:Aggregate(5~10mm)							
G2:Aggregate(10~20mm)							

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks	density kg/m3
		(SL)	air	W/C	s/a	C	W	s	CA(5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
250	40	10	1	62		282	175									Weight	
						3.15	1									Specific Gravity	
			10			90	175									Volume	

6 Step Coarse Aggregate Content

Fineness Modules	2.8
Coarse Aggregate Maximum Dimension	40mm
Dry Compacted Volume of Coarse Aggregate	0.72m3
Compacted Weight of Coarse Aggregate	1600kg/m3
Dry Compacted Weight of Coarse Aggregate	0.72*1600=1152kg

75-ACI 211.1 Table A1.5.3.6 Volume of Coarse Aggregate per Unit Volume of Concrete (SI)

Maximum Size of Coarse Aggregate	Fineness Modules of Fine Aggregate			
	2.4	2.6	2.8	3
10	0.5	0.48	0.46	0.44
12.5	0.59	0.57	0.55	0.53
20	0.66	0.64	0.62	0.6
25	0.71	0.69	0.67	0.65
40	0.76	0.74	0.72	0.7
50	0.78	0.76	0.74	0.72
70	0.81	0.79	0.77	0.75
150	0.87	0.85	0.83	0.81

ASTM C29 Unit Weight of Concrete

7 Step Fine Aggregate Content
(1) Gravimetric Method
(2) Volumetric Method

7-1 Step (1) Gravimetric Method
Maximum Dimension of Coarse Aggregate 40mm Plain Concrete
Plain Concrete Unit Weight of Fresh Concrete 2420kg

78-ACI 211.1 Table A1.5.3.7.1 First Estimate of Mass of Fresh Concrete (SI)

Aggregate Maximum Dimension(mm)	Fresh Concrete	AE Concrete
10	2285	2190
12.5	2315	2235
20	2355	2280
25	2375	2315
40	2420	2355
50	2445	2375
70	2465	2400
150	2505	2435

2420-(175+282+1152)=811kg

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks
		(SL)	air	W/C	s/a	C	W	s	CA(5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d	
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)						
250	40	10	1	62		282	175	811	1152							Weight
						3.15	1									Specific Gravity
			10			90	175									Volume

7-2 Step (2) Volumetric Method

69 70 ACI 211.1 Table 5.3.3 -Approximate Mixing Water and Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate (SI)

Slump (cm)	Aggregate Maximum Dimension (mm)							
	10	12.5	20	25	40	50	70	150
Plain Concrete								
3-5	205	200	185	180	160	155	145	125
8-10	225	215	200	195	175	170	160	140
15-18	240	230	210	205	185	180	170	-
Entrapped Air(%)	3	2.5	2	1.5	1	0.5	0.3	0.2
AE Concrete								
3-5	180	175	165	160	145	140	135	120
8-10	200	190	180	175	160	155	150	135
15-18	215	205	190	185	170	165	160	-
Air Content(	8	7	6	5	4.5	4	3.5	3

=295*2.64=779

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks	
		(SL)	air	W/C	s/a	C	W	s	CA(5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
250	40	10	1	62		282	175	779	1152							Weight	
						3.15	1	2.64	2.68							Specific Gravity	
			10			90	175	295	430							Volume(cc)	1000cc

=1000-(10+90+175+430)=295

8 Step

	Water Content(%)	Absorption(%)
Coarse Aggregate	2%	0.5
Fine Aggregate	6%	0.7

Concrete Mix Proportion

Adjustment Moisture Content

	specifiv gravity(%)	absorption(%)	moisture content(%)	Water surface (%)	Content(kg/m3)	Correction(kg/m3)	Corrected(kg/m3)	
		(1)	(2)	(3)=(2)-(1)	(4)	(5)=(3)*(4)*0.01	(6)=(4)+(5)	
Water					175	-60	115	
Fine Aggregate	2.64	0.7	6.0	5.3	811	43	854	(Wet)
G1:Aggregate(5~10mm) G2:Aggregate(10~20mm)	2.68	0.5	2.0	1.5	1152	17	1169	(Wet)

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks	
		(SL)	air	W/C	s/a	C	W	s	CA(5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
250	40	10	1	62		282	175	779	1152							Weight	2388
						3.15	1	2.64	2.68							Specific Gravity	
			10			90	175	295	430							Volume(cc)	1000

9 Step

Trial Batch

1000cc			282	115	854	1169
20cc			5.64	2.30	17.08	23.38

→ Trial Batch

Slump =5cm → Slump =9cm

Slump 1cm Increase=Water 2kg/m3 Increase

Water | 8kg/m3 Increase

=175+8=183 kg/m3

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks	
		(SL)	air	W/C	s/a	C	W	s	CA(5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
250	40	10	1	62		295	183	748	1152							Weight	2378
						3.15	1	2.64	2.68							Specific Gravity	2.378
			10			94	183	283	430							Volume(cc)	1000

(85) ACI 211.1 Mix Proportion Step Calculation(2)

4 Step	Strength-W/C	Plain Concrete
	Strength	250kg/cm 2
	W/C	0.62

71 ACI 211.1 Table A1.5.3.4(a) Relationships between Water-Cement Ratio and Compressive Strength of Concrete (SI)

Compressive Strength Ages 28 Days(kg/cm2)	Water Cement Ratio W/C	
	Plain Concrete	AE Concrete
450	0.38	
400	0.43	
350	0.48	0.4
300	0.55	0.46
250	0.62	0.53
200	0.7	0.61
150	0.8	0.71

Compressive Strength,Wet Curing in 28 days,23+−1.7 degree

(86) ACI 211.1 Mix Proportion Step Calculation(3)

5 Step   Cement Content   C=175/0.62=282kg/m3

Concrete Mix Proportion

Adjustment Moisture Content

	specify gravity(%	absorption(%)	moisture content(%)	Water surface	Content(kg/m3)	Correction(kg/	Corrected(kg/m3)
		(1)	(2)	(3)=(2)-(1)	(4)	(5)=(3)*(4)*0.01	(6)=(4)+(5)
Water							
Fine Aggregate							
G1:Aggregate(5~10mm)							
G2:Aggregate(10~20mm							

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water	sand	Cement	Water	Fine	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/			Remarks	density kg/m3
		(SL)	air	W/C	s/a	C	W	s	CA(5~10	CA(10~2	% of	% of	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
250	40	10	1	62		282	175									Weight	
						3.15	1									Specific Gravity	
			10			90	175									Volume	

(87) ACI 211.1 Mix Proportion Step Calculation(4)

6 Step	Coarse Aggregate Content	
	Fineness Modules	2.8
	Coarse Aggregate Maximum Dimension	40mm
	Dry Compacted Volume of Coarse Aggregate	0.72m3
	Compacted Weight of Coarse Aggregate	1600kg/m3
	Dry Compacted Weight of Coarse Aggregate	0.72*1600=1152kg

75-ACI 211.1 Table A1.5.3.6 Volume of Coarse Aggregate per Unit Volume of Concrete (SI)

Maximum Size of Coarse Aggregate	Fineness Modules of Fine Aggregate			
	2.4	2.6	2.8	3
10	0.5	0.48	0.46	0.44
12.5	0.59	0.57	0.55	0.53
20	0.66	0.64	0.62	0.6
25	0.71	0.69	0.67	0.65
40	0.76	0.74	0.72	0.7
50	0.78	0.76	0.74	0.72
70	0.81	0.79	0.77	0.75
150	0.87	0.85	0.83	0.81

ASTM C29 Unit Weight of Concrete

(88) ACI 211.1 Mix Proportion Step Calculation(5)

7 Step — Fine Aggregate Content

(1) Gravimetric Method

(2) Volumetric Method

7-1 Step — (1) Gravimetric Method

Maximum Dimension of Coarse Aggregate — 40mm — Plain Concrete

Plain Concrete — Unit Weight of Fresh Concrete — 2420kg

78-ACI 211.1 Table A1.5.3.7.1 First Estimate of Mass of Fresh Concrete (SI)

Aggregate Maximum	Fresh Concrete	AE Concrete
10	2285	2190
12.5	2315	2235
20	2355	2280
25	2375	2315
40	2420	2355
50	2445	2375
70	2465	2400
150	2505	2435

2420-(175+282+1152)=811kg

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water	sand	Cement	Water	Fine	Coarse Aggregate		Admixture	Admixture	Comprssive			Remarks
		(SL)	air	W/C	s/a	C	W	s	CA(5~10	CA(10~2	% of	% of	3d	7d	28d	
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)						
250	40	10	1	62		282	175	811	1152							Weight
						3.15	1									Specific Gravity
			10			90	175									Volume

(89) ACI 211.1 Mix Proportion Step Calculation(6)

7-2 Step (2) Volumetric Method

69 70 ACI 211.1 Table 5.3.3 -Approximate Mixing Water and Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate (SI)

Slump (cm)	Aggregate Maximum Dimension (mm)							
	10	12.5	20	25	40	50	70	150
Plain Concrete								
3-5	205	200	185	180	160	155	145	125
8-10	225	215	200	195	175	170	160	140
15-18	240	230	210	205	185	180	170	–
Entrapped Air(%)	3	2.5	2	1.5	1	0.5	0.3	0.2
AE Concrete								
3-5	180	175	165	160	145	140	135	120
8-10	200	190	180	175	160	155	150	135
15-18	215	205	190	185	170	165	160	–
Air Content(	8	7	6	5	4.5	4	3.5	3

=295*2.64=779

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water	sand	Cement	Water	Fine	Coarse Aggregate		Admixture	Admixture	Comprssive			Remarks
		(SL)	air	W/C	s/a	C	W	s	CA(5~10	CA(10~2	% of	% of	3d	7d	28d	
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)						
250	40	10	1	62		282	175	779	1152							Weight
						3.15	1	2.64	2.68							Specific Gravity
			10			90	175	295	430							Volume(cc)

1000cc

=1000-(10+90+175+430)=295

(90) ACI 211.1 Mix Proportion Step Calculation(7)

8 Step

	Water Content(%)	Absorpton(%)
Coarse Aggregate	2%	0.5
Fine Aggregate	6%	0.7

Concrete Mix Proportion

Adjustment Moisture Content

	specifv gravity(%	absorpton(%)	moisture content(%)	Water surface	Content(kg/m3)	Correction(kg/	Corrected(kg/m3)	
		(1)	(2)	(3)=(2)-(1)	(4)	(5)=(3)*(4)*0.01	(6)=(4)+(5)	
Water					175	-60	115	
Fine Aggregate	2.64	0.7	6.0	5.3	811	43	854	(Wet)
G1:Aggregate(5~10mm) G2:Aggregate(10~20mm	2.68	0.5	2.0	1.5	1152	17	1169	(Wet)

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water	sand	Cement	Water	Fine	Coarse Aggregate		Admixture	Admixture	Comprssive			Remarks	
		(SL)	air	W/C	s/a	C	W	s	CA(5~10	CA(10~2	% of	% of	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	Mighty	Mighty					
250	40	10	1	62		282	175	779	1152							Weight	2388
						3.15	1	2.64	2.68							Specific Gravity	
			10			90	175	295	430							Volume(cc)	1000

(91) ACI 211.1 Mix Proportion Step Calculation(8)

9 Step

Trial Batch

1000cc			282	115	854	1169
20cc			5.64	2.30	17.08	23.38

→ Trial Batch

Slump =5cm → Slump =9cm

Slump 1cm Increase=Water 2kg/m3 Increase

Water | 8kg/m3 Increase

=175+8=183 kg/m3

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water	sand	Cement	Water	Fine	Coarse Aggregate		Admixture	Admixture	Comprssive			Remarks	
		(SL)	air	W/C	s/a	C	W	s	CA(5~10	CA(10~2	% of	% of	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	Mighty	Mighty					
250	40	10	1	62		295	183	748	1152							Weight	2378
						3.15	1	2.64	2.68							Specific Gravity	2.378
			10			94	183	283	430							Volume(cc)	1000

(92) ACI 211.1 Mix Proportion -Heavy Weight Structure Concrete Calculation(1)

(92) ACI 211.1 Heavy Weight Structure Concrete

Condition

1 Heavy Weight Structure Concrete
2 Under Water
3 Compressive Strength (Ages 28 days) 210kg/cm 2
4 Slump 3-5cm
5 Shape of Aggregate 5-20mm
6 Dry Compacted Weight of Coarse Aggregate 1522kg/m 3

8 Cement Type I Specific Grav 3.15
Grading of Coarse or Fine Aggregate
Coarse Aggregate Specific Grav 2.68 Absorpt 0.50%
Fine Aggregate Specific Grav 2.64 Absorpt 0.70% Fineness Modules 2.8

1 Step Slump 3-5cm
2 Step Coarse Aggregate Grading 5-25mm
3 Step AE Concrete Under Aeration
Aggregate Gmax 25mm

69 70 ACI 211.1 Table 5.3.3 -Approximate Mixing Water and Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate (SI)

Slump(cm)	Aggregate Maximum Dimension (mm)							
	10	12.5	20	25	40	50	70	150
Plain Concrete								
3-5	205	200	185	180	160	155	145	125
8-10	225	215	200	195	175	170	160	140
15-18	240	230	210	205	185	180	170	–
Entrapped	3	2.5	2	1.5	1	0.5	0.3	0.2
AE Concrete								
3-5	180	175	165	160	145	140	135	120
8-10	200	190	180	175	160	155	150	135
15-18	215	205	190	185	170	165	160	–
Air Conten	8	7	6	5	4.5	4	3.5	3

Estimated Water 160kg/m 3
Entrapped Air 5%

(92) ACI 211.1 Heavy Weight Structure Concrete
Condition

1 Heavy Weight Structure Concrete
2 Under Water
3 Compressive Strength (Ages 28 days) 210kg/cm2
4 Slump 3-5cm
5 Shape of Aggregate 5-20mm
6 Dry Compacted Weight of Coarse Aggregate 1522kg/m3

8 Cement Type I Specific Gravity 3.15
Grading of Coarse or Fine Aggregate
Coarse Aggregate Specific Gravity 2.68 Absorptio 0.50%
Fine Aggregate Specific Gravity 2.64 Absorptio 0.70%
Fineness Modules 2.8

1 Step Slump 3-5cm
2 Step Coarse Aggregate Grading 5-25mm
3 Step AE Concrete Under Aeration
Aggregate Gmax 25mm

69 70 ACI 211.1 Table 5.3.3 -Approximate Mixing Water and Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate (SI)

Slump (cm)	Aggregate Maximum Dimension (mm)							
	10	12.5	20	25	40	50	70	150
Plain Concrete								
3-5	205	200	185	180	160	155	145	125
8-10	225	215	200	195	175	170	160	140
15-18	240	230	210	205	185	180	170	-
Entrapped Air(%)	3	2.5	2	1.5	1	0.5	0.3	0.2
AE Concrete								
3-5	180	175	165	160	145	140	135	120
8-10	200	190	180	175	160	155	150	135
15-18	215	205	190	185	170	165	160	-
Air Content(	8	7	6	5	4.5	4	3.5	3

Estimated Water 160kg/m3
Entrapped Air 5%

4 Step Strength-W/C

Strength	AE Concrete 210kg/cm2	Adapt Smaller	
W/C	0.59	W/C	0.5

71 ACI 211.1 Table A1.5.3.4(a) Relationships between Water-Cement Ratio and Compressive Strength of Concrete (SI)

W/C and Compressive Strength		
Compressive Strength Ages 28 Days(kg/cm2)	Water Cement Ratio W/C	
	Plain Concrete	AE Concrete
450	0.38	
400	0.43	
350	0.48	0.4
300	0.55	0.46
250	0.62	0.53
200	0.7	0.61
150	0.8	0.71

Compressive Strength,Wet Curing in 28 days,23+-1.7 degree
ASTM C 31

72-ACI 211.1 Table A1.5.3.4(b) Maximum Permissible Water-Cement Ratios for Concrete in Severe Exposures (SI)

Allowable Water Cement Ratio		
Type of Strucutre	Wet Condition or Freezing and Thawing Action	Sea Water or Sodium Sulfate Chloride
Thin Section(Hand Rail,Beam,below Covering 3 cm)	0.45	0.4
Other Strucure	0.5	0.45
ACI Committee 201(Durability of Concrete in Service)		

5 Step　　　　　Cement Content　　　　　C=160/0.5=320kg/m3

Concrete Mix Proportion

Adjustment Moisture Content

	specifiv gravity(%)	absorption(%)	moisture content(%)	Water surface	Content(kg/m3)	Correction(kg/m3)	Corrected(kg/m3)
		(1)	(2)	(3)=(2)-(1)	(4)	(5)=(3)*(4)*0.01	(6)=(4)+(5)
Water							
Fine Aggregate							
G1:Aggregate(5~10mm)							
G2:Aggregate(10~20mm)							

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks	density kg/m3
		(SL)	air	W/C	s/a	C	W	s	CA(5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
250	40	5	5	0.5		320	160									Weight	
						3.15	1									Specific Gravity	
			50			102	160									Volume	

6 Step Coarse Aggregate Content

Fineness Modules	2.8
Coarse Aggregate Maximum Dimension	25mm
Dry Compacted Volume of Coarse Aggregate	0.67m3
Compacted Weight of Coarse Aggregate	1522kg/m3
Dry Compacted Weight of Coarse Aggregate	0.67*1522=1020kg

75-ACI 211.1 Table A1.5.3.6 Volume of Coarse Aggregate per Unit Volume of Concrete (SI)

Maximum Size of Coarse Aggregate	Fineness Modules of Fine Aggregate			
	2.4	2.6	2.8	3
10	0.5	0.48	0.46	0.44
12.5	0.59	0.57	0.55	0.53
20	0.66	0.64	0.62	0.6
25	0.71	0.69	0.67	0.65
40	0.76	0.74	0.72	0.7
50	0.78	0.76	0.74	0.72
70	0.81	0.79	0.77	0.75
150	0.87	0.85	0.83	0.81

ASTM C29 Unit Weight of Concrete

(93) ACI 211.1 Mix Proportion -Heavy Weight Structure Concrete Calculation(2)

4 Step	Strength-W/C	AE Concrete		Adapt Smaller
	Strength	210kg/cm2		
	W/C	0.59	W/C	0.5

71-ACI211.1 Table A1.5.3.4(a) Relationships between Water-Cement Ratio and Compressive Strength of Concrete (SI)

W/C and Compressive Strength		
Compressive Strength Ages 28 Days (kg/cm2)	Water Cement Ratio W/C	
	Plain Concrete	AE Concrete
450	0.38	
400	0.43	
350	0.48	0.4
300	0.55	0.46
250	0.62	0.53
200	0.7	0.61
150	0.8	0.71

Compressive Strength, Wet Curing in 28 days, 23+-1.7 degree
ASTM C 31

72-ACI211.1 Table A1.5.3.4(b) Maximum Permissible Water-Cement Ratios for Concrete in Severe Exposures (SI)

Allowable Water Cement Ratio		
Type of Strucutre	Wet Condition or Freezing and Thawing Action	Sea Water or Sodium Sulfate Chloride
Thin Section (Hand Rail, Beam, below Covering 3 cm)	0.45	0.4
Other Strucure	0.5	0.45
ACI Committee 201 (Durability of Concrete in Service)		

(94) ACI 211.1 Mix Proportion -Heavy Weight Structure Concrete Calculation(3)

5 Step Cement Content C=160/0.5=320kg/m 3

Concrete Mix Proportion

Adjustment Moisture Content

	specifiv gravity(%	absorption(%)	moisture content(%)	Water surface	Content(kg/m3)	Correction(kg/	Corrected(kg/m3)
		(1)	(2)	(3)=(2)-(1)	(4)	(5)=(3)*(4)*0.01	(6)=(4)+(5)
Water							
Fine Aggregate							
G1:Aggregate(5~10mm)							
G2:Aggregate(10~20mm							

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water	sand	Cement	Water	Fine	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/			Remarks
		(SL)	air	W/C	s/a	C	W	s	CA(5~10	CA(10~2	% of	% of	3d	7d	28d	
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)						
250	40	5	5	0.5		320	160									Weight
						3.15	1									Specific Gravity
			50			102	160									Volume

(95) ACI 211.1 Mix Proportion -Heavy Weight Structure Concrete Calculation(4)

6 Step

Coarse Aggregate Content

Fineness Modules	2.8
Coarse Aggregate Maximum Dimension	25mm
Dry Compacted Volume of Coarse Aggregate	0.67m3
Compacted Weight of Coarse Aggregate	1522kg/m3
Dry Compacted Weight of Coarse Aggregate	0.67*1522=1020kg

75-ACI 211.1 Table A1.5.3.6 Volume of Coarse Aggregate per Unit Volume of Concrete (SI)

Maximum Size of Coarse Aggregate	Fineness Modules of Fine Aggregate			
	2.4	2.6	2.8	3
10	0.5	0.48	0.46	0.44
12.5	0.59	0.57	0.55	0.53
20	0.66	0.64	0.62	0.6
25	0.71	0.69	0.67	0.65
40	0.76	0.74	0.72	0.7
50	0.78	0.76	0.74	0.72
70	0.81	0.79	0.77	0.75
150	0.87	0.85	0.83	0.81

ASTM C29 Unit Weight of Concrete

(96) ACI 211.1 Mix Proportion -Heavy Weight Structure Concrete Calculation(5)

7 Step　Fine Aggregate Content
(1) Gravimetric Method
(2) Volumetric Method

7-1 Step　(1) Gravimetric Method
Maximum Dimension of Coarse Aggregate　25mm　AE Concrete
AE Concrete　Unit Weight of Fresh Concrete　2315kg

78-ACI211.1 Table A1.5.3.7.1 First Estimate of Mass of Fresh Concrete (SI)

Aggregate Maximum	Fresh Concrete	AE Concrete
10	2285	2190
12.5	2315	2235
20	2355	2280
25	2375	2315
40	2420	2355
50	2445	2375
70	2465	2400
150	2505	2435

2315-(320+160+1020)=815kg (Dry)

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water	sand	Cement	Water	Fine	Coarse Aggregate		Admixture	Admixture	Comprssive			Remarks	
		(SL)	air	W/C	s/a	C	W	s	CA(5~10	CA(10~2	% of	% of	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
250	40	5	5	0.5		320	160	815	1020							Weight	
						3.15	1	2.64	2.68							Specific Gravity	
			50			102	160	309	381							Volume	1001

(97) ACI 211.1 Mix Proportion -Heavy Weight Structure Concrete Calculation(6)

7-2 Step (2) Volumetric Method

69 70 ACI211.1 Table 5.3.3 -Approximate Mixing Water and Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate (SI)

Slump(cm)	Aggregate Maximum Dimension (mm)							
	10	12.5	20	25	40	50	70	150
Plain Concrete								
3-5	205	200	185	180	160	155	145	125
8-10	225	215	200	195	175	170	160	140
15-18	240	230	210	205	185	180	170	−
Entrapped Air(%)	3	2.5	2	1.5	1	0.5	0.3	0.2
AE Concrete								
3-5	180	175	165	160	145	140	135	120
8-10	200	190	180	175	160	155	150	135
15-18	215	205	190	185	170	165	160	−
Air Content(	8	7	6	5	4.5	4	3.5	3

=295*2.64=779

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water	sand	Cement	Water	Fine	Coarse Aggregate		Admixture	Admixture	Comprssive			Remarks
		(SL)	air	W/C	s/a	C	W	s	CA(5~10	CA(10~2	% of	% of	3d	7d	28d	
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)						
250	40	5	5	50		320	160	810	1020							Weight
						3.15	1	2.64	2.68							Specific Gravity
			50			102	160	307	381							Volume(cc)

1000

=1000-(50+102+160+381)=307

(98) ACI 211.1 Mix Proportion -Heavy Weight Structure Concrete Calculation(7)

8 Step

	Water Content(%)	Absorption(%)
Coarse Aggregate	3%	0.5
Fine Aggregate	5%	0.7

Concrete Mix Proportion

Adjustment Moisture Content

	specifiv gravity(%	absorption(%)	moisture content(%)	Water surface	Content(kg/m3)	Correction(kg/	Corrected(kg/m3)
		(1)	(2)	(3)=(2)-(1)	(4)	(5)=(3)x(4)x0.01	(6)=(4)+(5)
Water					160	-60	100
Fine Aggregate	2.64	0.7	5.0	4.3	810	35	845
G1 Aggregate(5~10mm) / G2 Aggregate(10~20mm	2.68	0.5	3.0	2.5	1020	26	1046

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water	sand	Cement	Water	Fine	Coarse Aggregate		Admixture	Admixture	Comprssive			Remarks	
		(SL)	air	W/C	s/a	C	W	s	CA(5~10	CA(10~2	% of	% of	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
250	40	5	5	62		320	160	810	1020							Weight	2310
						3.15	1	2.64	2.68							Specific Gravity	
			50			102	160	307	381							Volume(cc)	999

(99) ACI 211.1 Mix Proportion -Heavy Weight Structure Concrete Calculation(8)

9 Step Trial Batch

1000cc			320	160	810	1020
20cc			6.40	3.20	16.20	20.40

→ Trial Batch

Slump=5cm → OK

Air Content 5.00% OK

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water	sand	Cement	Water	Fine	Coarse Aggregate		Admixture	Admixture	Comprssive			Remarks	
		(SL)	air	W/C	s/a	C	W	s	CA(5~10	CA(10~2	(% of	(% of	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
250	40	5	5	62		320	160	810	1020							Weight	2310
						3.15	1	2.64	2.68							Specific Gravity	
			50			102	160	307	381							Volume(cc)	999

(100) ACI 211.1 Mix Proportion -Heavy Weight Structure Concrete Calculation(9)

9 Step TrialBatch

1000cc			320	160	810	1020
20cc			6.40	3.20	16.20	20.40

→ TrialBatch

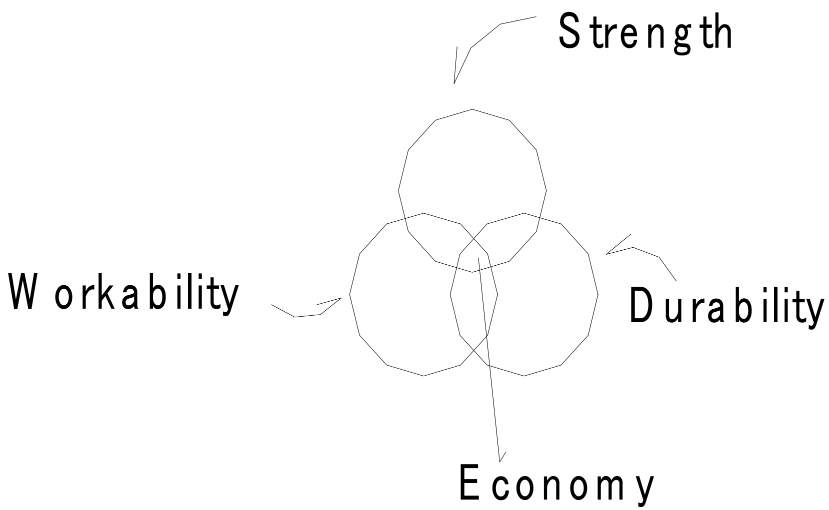
Slump=5cm → OK

Air Content 5.00% OK

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water	sand	Cement	Water	Fine	Coarse Aggregate		Admixture	Admixture	Comprssive			Remarks	
		(SL)	air	W/C	s/a	C	W	s	CA(5~10	CA(10~2	% of	% of	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
250	40	5	5	62		320	160	810	1020							Weight	2310
						3.15	1	2.64	2.68							Specific Gravity	
			50			102	160	307	381							Volume(cc)	999

(101) ACI 211.1 Design of Concrete Mixes



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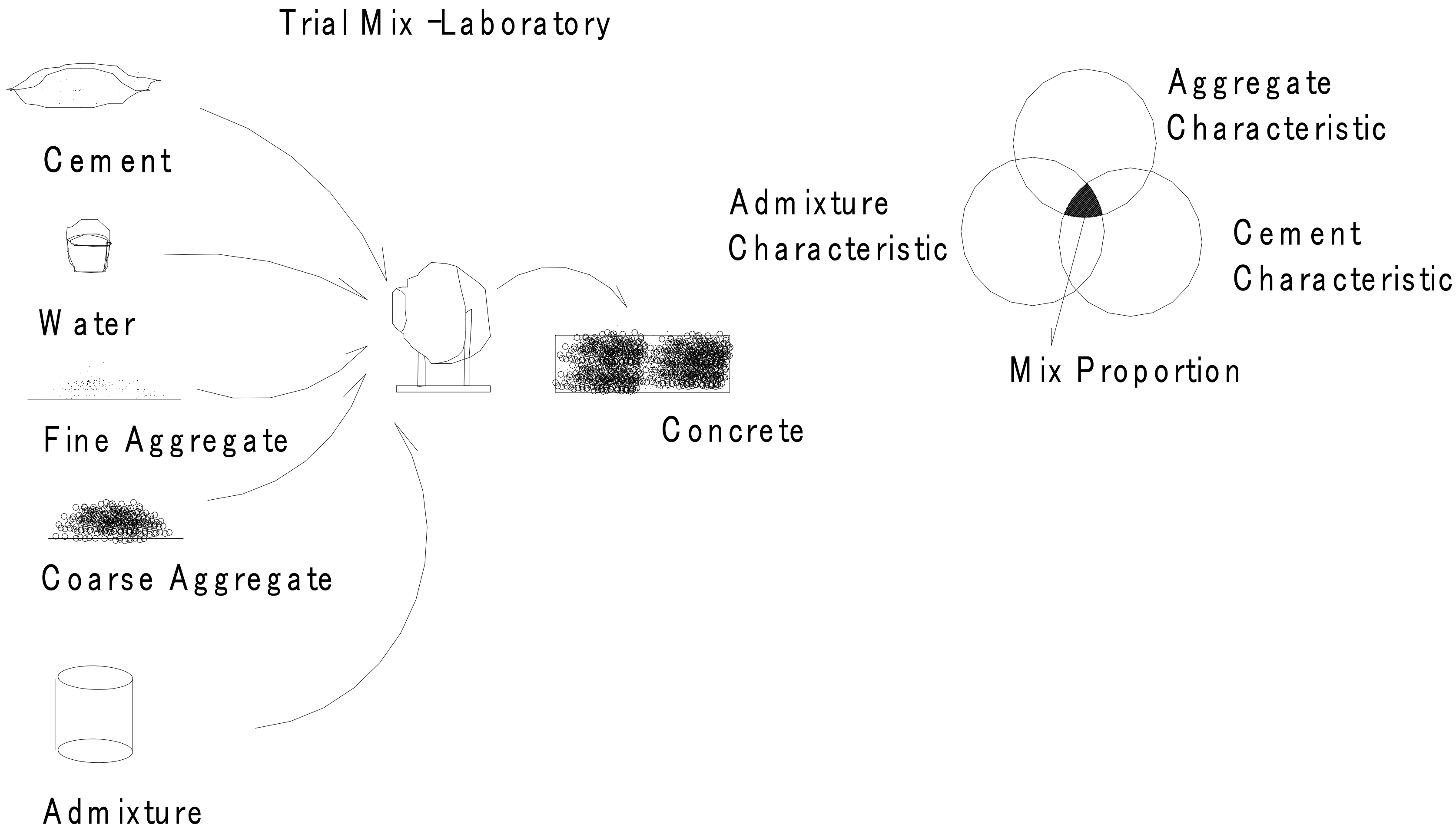
Recommended Practice for selecting Proportions for Concrete

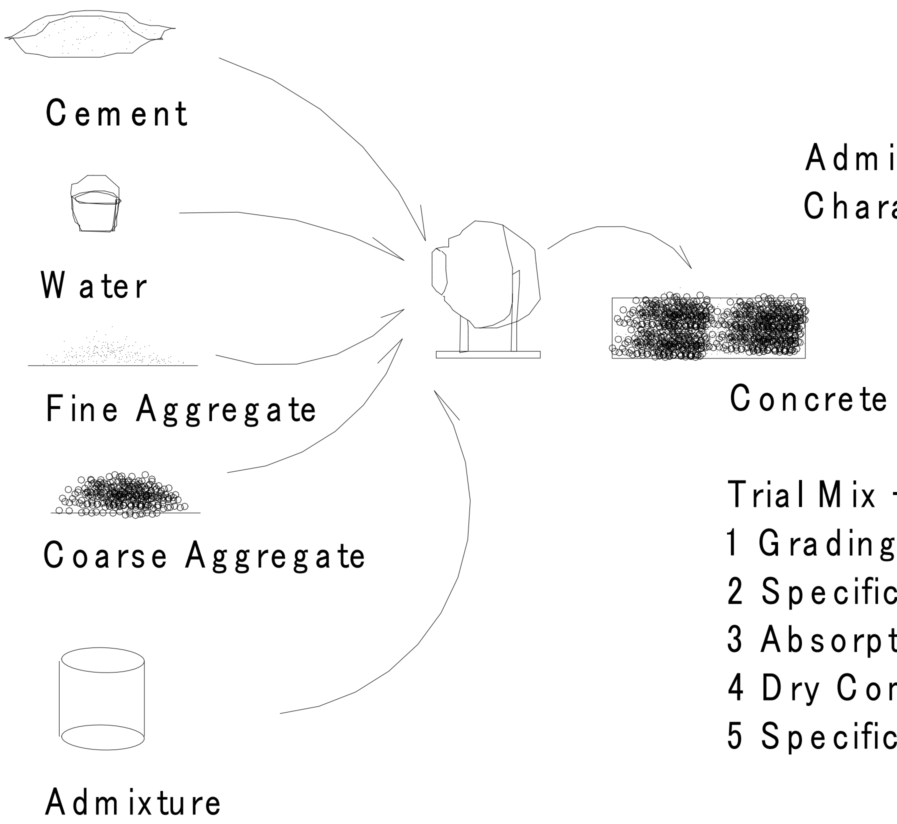
(102) ACI 211.1 Design of Concrete Mixes (2)

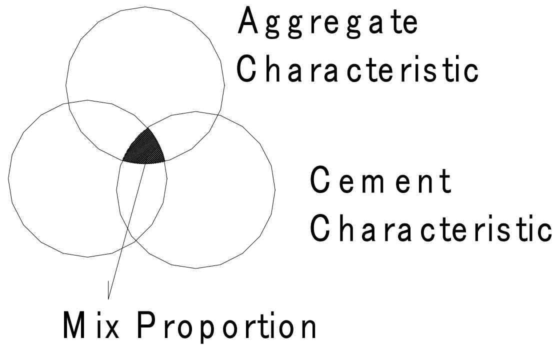


(103) ACI 211.1 Design of Concrete Mixes (3)

(103) ACI 211.1 Design of Concrete Mixes(3)

Trial Mix -Laboratory





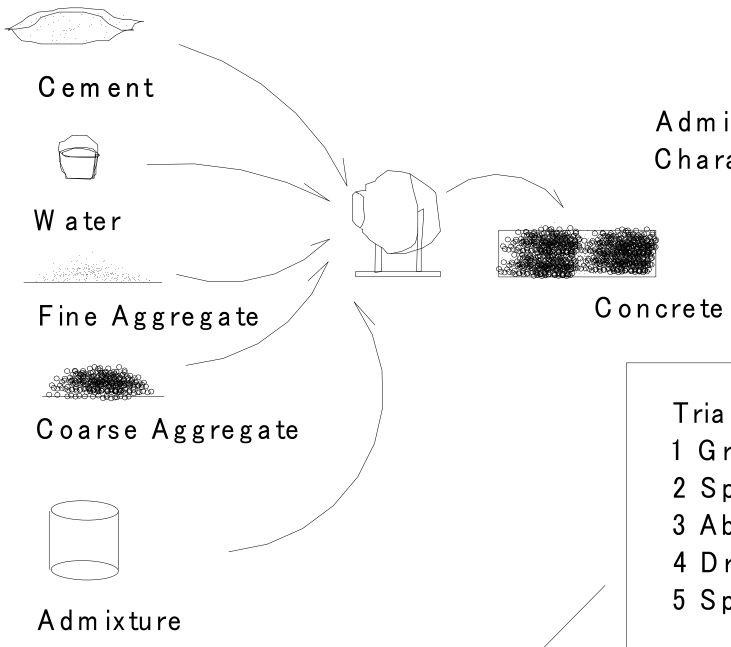
Trial Mix -Laboratory data

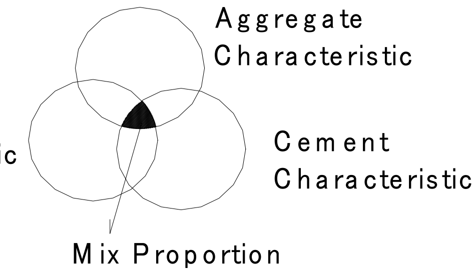
1 Grading of Fine or Coarse Aggregate
2 Specific Gravity
3 Absorption
4 Dry Compacting Unit Weight of Coarse Aggregate
5 Specific Gravity of Cement

(104) ACI 211.1 Design of Concrete Mixes (4)

(104) ACI 211.1 Design of Concrete Mixes (4)

Trial Mix - Laboratory





Trial Mix - Laboratory data

1 Grading of Fine or Coarse Aggregate
2 Specific Gravity
3 Absorption
4 Dry Compacting Unit Weight of Coarse Aggregate
5 Specific Gravity of Cement

Entrapped Air (Admixture)

Improve

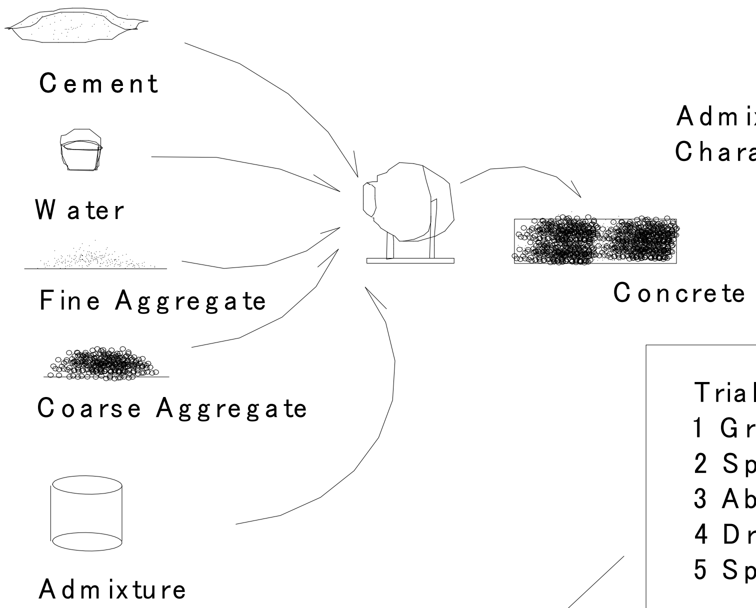
Workability and Durability of Concrete

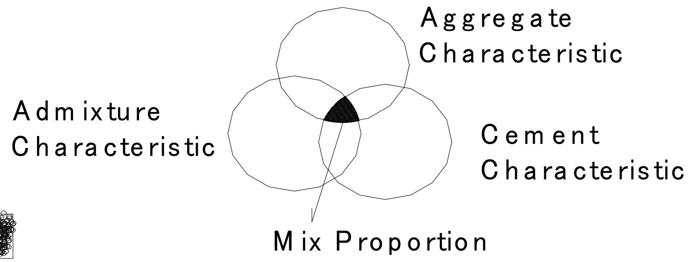
W/C-same
>Cement Content 335kg/m3
Strength-Decrease
<Cement Content 250kg/m3
Strength-Increase

(105) ACI 211.1 Design of Concrete Mixes (5)

(105) ACI 211.1 Design of Concrete Mixes (5)

Trial Mix -Laboratory





Trial Mix -Laboratory data

1 Grading of Fine or Coarse Aggregate
2 Specific Gravity
3 Absorption
4 Dry Compacting Unit Weight of Coarse Aggregate
5 Specific Gravity of Cement

Entrapped Air (Admixture)

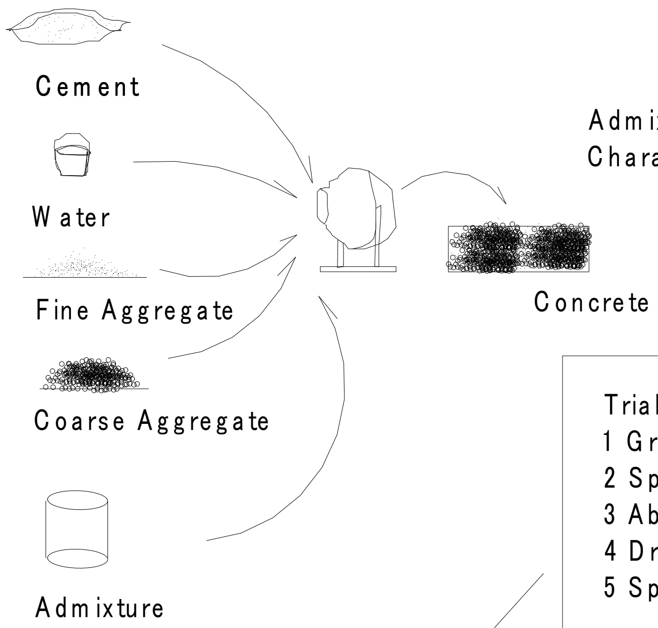
Improve

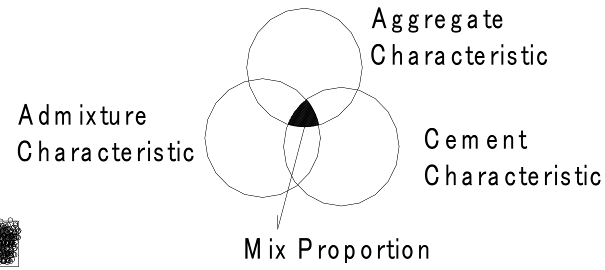
Workability and Durability of Concrete

W/C-same
>Cement Content 335kg/m3
Strength-Decrease
<Cement Content 250kg/m3
Strength -Increase

(106) ACI 211.1 Design of Concrete Mixes (6)

(106) ACI 211.1 Design of Concrete Mixes(6)





Trial Mix –Laboratory data
1 Grading of Fine or Coarse Aggregate
2 Specific Gravity
3 Absorption
4 Dry Compacting Unit Weight of Coarse Aggregate
5 Specific Gravity of Cement

Entrapped Air (Admixture)

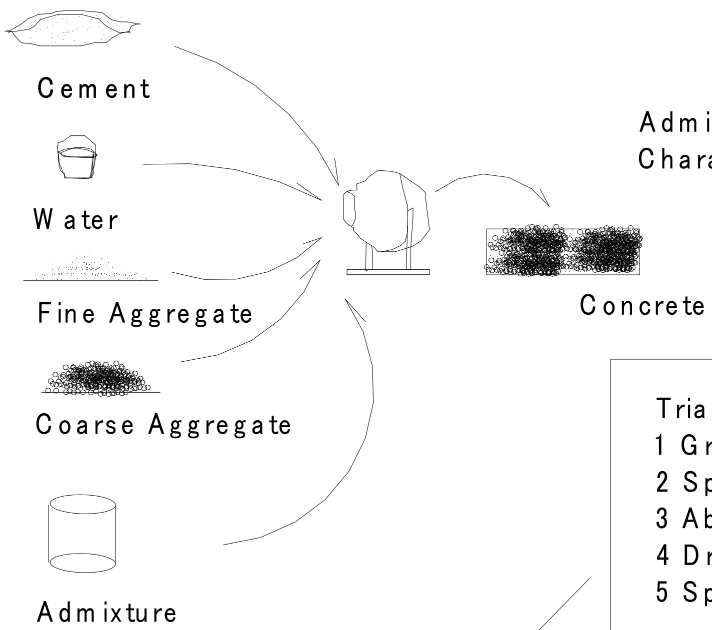
Improve

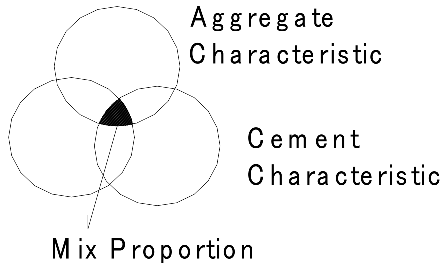
Workability and Durability of Concrete

W/C–same
>Cement Content 335kg/m3
Strength–Decrease
<Cement Content 250kg/m3
Strength –Increase

(107) ACI 211.1 Design of Concrete Mixes (7)

(106) ACI 211.1 Design of Concrete Mixes(6)





Trial Mix –Laboratory data

1 Grading of Fine or Coarse Aggregate
2 Specific Gravity
3 Absorption
4 Dry Compacting Unit Weight of Coarse Aggregate
5 Specific Gravity of Cement

Entrapped Air (Admixture)

Improve

Workability and Durability of Concrete

W/C–same
>Cement Content 335kg/m3
Strength–Decrease
<Cement Content 250kg/m3
Strength –Increase

(108) ACI 211.1 Design of Concrete Mixes (8)

Maximum Slump	
Types of Structure	Maximum Slump
Mass Concrete	5
Channel	7.5
Slab and Invert of Tunnel	5
Wall Top, Pier, Parapet	5
Tunnel, Arch	10
Other Structure	7.5

	Sand Fineness Module						2.75
	Slump						7.5–10cm

Proportion of Air Contend, Water Content, Fine Aggregate and Coarse Aggregate

Gmax	Dry Compacting Coarse Aggregate Weight per Unit	AE Concrete			Plan Concrete		
		Air Content	Average Water Content	Sand Percentage (Absolute Volume) to Aggregate	Entrapped Air	Average Water Content	Sand Percentage (Absolute Volume) to
(mm)	(%)	(%)	(kg/m3)	(%)	(%)	(kg/m3)	(%)
10	41	8	191	59	3	209	61
15	52	7	182	50	2.5	199	53
20	62	6	168	42	2	187	45
25	67	5	158	37	1.5	178	41
40	73	4.5	145	33	1	166	36
50	76	4	136	30	0.5	158	33
80	81	3.5	121	28	0.3	144	31
150	87	3	97	24	0.2	125	28

Adjusting Value

	Adjustment of Value		
	Water Content	Sand Percentage	Dry Compacting Coarse Aggregate
Fineness of Sand 0.1 Increase /Decrease	–	+-0.5%	-+1.0%
Slump 1 cm Increase /Decrease	1.2%	–	–
Air Content 1 % Increase /Decrease	-+3.0%	-+ (0.5-1.0)%	–
Water Cement Ratio 0.05 Increase / Decrease	–	+-1.0%	–
Sand Percentage 1 % Increase / Decrease	+-1.0%	–	-+2.0%
Angular Aggregate	+ (7-10)%	+ (3-5)%	–
Low Slump (Paving Concrete)	-3.0%	-3.0%	6.0%

Water Content 1000kg/m 3, Water Degree over 15 Degree-998kg/m 3

(111) ACI 211.1 Design of Concrete Mixes (11)

111-Water Cement Ratio of Concrete

No	Types of Concrete	Water Cement Ratio	
		Hard Weather	Mild Weather
A	Hard Weather (I)	0.45+-0.02	0.55+-0.02
B	Hard Weather (II)	0.50+-0.02	0.55+-0.02
C	Hard Weather (III)	0.59+-0.02	0.58+-0.02
D	Sodium Sulfate Alkali	–	0.50+-0.02
E	Sodium Sulfate Alkali	0.45+-0.02	–
F	Concreting By Tremie	0.45+-0.02	0.45+-0.02
G	Channel	0.53+-0.02	0.58+-0.02
H	Inner Concrete of Dam	W/C-Strength-Heat Characteristic and Volume Changing	

111-Water Cement Ratio of Concrete

No	Types of Concrete	Water Cement Ratio	
		Hard Weather	Mild Weather
A	Hard Weather(I)	0.45+-0.02	0.55+-0.02
B	Hard Weather (II)	0.50+-0.02	0.55+-0.02
C	Hard Weather (III)	0.59+-0.02	0.58+-0.02
D	Sodium Sulfate Alkali	-	0.50+-0.02
E	Sodium Sulfate Alkali	0.45+-0.02	-
F	Concreting By Tremie	0.45+-0.02	0.45+-0.02
G	Channel	0.53+-0.02	0.58+-0.02
H	Inner Concrete of Dam	W/C-Strength-Heat Characteristic and Volume Changing	

112-Compressive Strength to W/C

Water Cement Ratio	Compressive Strength (kg/cm2) at Ages 28 Days	
	AE Concrete	Plain Concrete
0.4	300	380
0.45	275	345
0.5	245	300
0.55	218	265
0.6	190	240
0.65	170	210
0.7	155	190

113-Aggregate Maximum Dimension of Structure

Minimum Dimension of Section (cm)	Aggregate Maximum Dimension (mm)		
	Reinforcement Wall and Pier	Reinforcement Slab	Plain Concrete Slab
Below 13	……..	20-40	20-40
15-28	20-40	40	40-75
30-73	40-75	75	75-150
Over 75	40-75	75	150

Aggregate Maximum Dimension of Structure<(2/3)*Minimum Pitch of Reinforcement

(112) ACI 211.1 Design of Concrete Mixes (12)

Compressive Strength to W/C

Water Cement Ratio	Compressive Strength (kg/cm 2) at Ages 28 Days	
	AE Concrete	Plain Concrete
0.4	300	380
0.45	275	345
0.5	245	300
0.55	218	265
0.6	190	240
0.65	170	210
0.7	155	190

(113) ACI 211.1 Design of Concrete Mixes (13)

113-Aggregate Maximum Dimension of Structure

Minimum Dimension of Section (cm)	Aggregate Maximum Dimension (mm)		
	Reinforcement Wall and Pier	Reinforcement Slab	Plain Concrete Slab
Below 13	······..	20-40	20-40
15-28	20-40	40	40-75
30-73	40-75	75	75-150
Over 75	40-75	75	150

Aggregate Maximum Dimension of Structure<(2/3)*Minimum Pitch of Reinforcement

(114) ACI 211.1 Design of Concrete Mixes (14)

alculation of Concrete Mix
xample-1

1 II Type Cement, Specific Gravity 3.15 Pozzolan Specific Gravity 2.5
2 Coarse Aggregate Specific Gravity 2.68
3 Fine Aggrgate Specific Gravity 2.63 Fineness Modules 2.75
4 Dry Compacted Weight of Coarse Aggregate 1680kg/m3
5 AE Agent

6 Reinforcement Concrete Wall, Minimum Thickness 28cm Maximum Slump 7.5cm
Aggregate Maximum Dimension 40mm

107-Maximum Slump

Types of Structure	Maximum Slump
Mass Concrete	5
Channel	7.5
Slab and Invert of Tunnel	5
Wall Top, Pier, Parapet	5
Tunnel, Arch	10
Other Structure	7.5

113-Aggregate Maximum Dimension of Structure

Minimum Dimension of Section (cm)	Aggregate Maximum Dimension (mm)		
	Reinforcement Wall and Pier	Reinforcement Slab	Plain Concrete Slab
Below 13	……..	20-40	20-40
15-28	20-40	40	40-75
30-73	40-75	75	75-150
Over 75	40-75	75	150

Aggregate Maximum Dimension of Structure<(2/3)*Minimum Pitch of Reinforcement

Calculation of Concrete Mix

Example-1

1	II Type Cement, Specific Gravity	3.15	Pozzolan Specific Gravity	2.5
2	Coarse Aggregate		Specific Gravity	2.68
3	Fine Aggrgate		Specific Gravity	2.63
4	Dry Compacted Weight of Coarse Aggregate		1680kg/m3	
5	AE Agent		Fineness Modules	2.75

6 Reinforcement Concrete Wall,Minimum Thickness 28cm Maximum Slump 7.5cm
Aggregate Maximum Dimension 40mm

107-Maximum Slump

Types of Structure	Maximum Slump
Mass Concrete	5
Channel	7.5
Slab and Invert of Tunnel	5
Wall Top,Pier,Parapet	5
Tunnel, Arch	10
Other Structure	7.5

113-Aggregate Maximum Dimension of Structure

Minimum	Aggregate Maximum Dimension (mm)										
			Reinforcement Wall and Pier			Reinforcement Slab			Plain Concrete Slab		
Below 13			……..			20-40			20-40		
15-28			20-40			40			40-75		
30-73			40-75			75			75-150		
Over 75			40-75			75			150		

Aggregate Maximum Dimension of Structure<(2/3)*Minimum Pitch of Reinforcement

111-Water Cement Ratio of Concrete

No	Types of Concrete	Water Cement Ratio	
		Hard Weather	Mild Weather
A	Hard Weather(I)	0.45+-0.02	0.55+-0.02
B	Hard Weather (II)	0.50+-0.02	0.55+-0.02
C	Hard Weather (III)	0.59+-0.02	0.58+-0.02
D	Sodium Sulfate Alkali	–	0.50+-0.02
E	Sodium Sulfate Alkali	0.45+-0.02	–
F	Concreting By Tremie	0.45+-0.02	0.45+-0.02
G	Channel	0.53+-0.02	0.58+-0.02
H	Inner Concrete of Dam	W/C-Strength-Heat Characteristic and Volume Changing	

210kg/cm2

Fluctuation Coefficient	15%
Required Compressive Strength	210*1.15=242kg/cm2
Dry Compacted Weight of Coarse Aggregate	1680kg/m3
Coarse Aggregate Content	73%
Dry Compacted Weight of Coarse Aggregate	=1680*0.73=1226

145/0.5=290

Concrete Test Mix Cement Content

Coarse Aggregate Content

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks
		(SL)	air	W/C	s/a	C	W	s	CA(5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d	
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	Mighty 900RA=( )%*cement	Mighty 185S=( )%				
242	40	7.5	4.5	0.5		290	145	686	1226							Weight
						3.15	1	2.63	2.68							Specific Gravity
			45		36	92	145	261	457							Volume

Concrete Mix Proportion

=1226/2.68=457

Adjustment Moisture Content

=1000-(45+145+457+92)=261

	specifiv gravity(%)	absorption(%)	moisture content(%)	Water surface	Content(kg/m3)	Correction(kg/m3)	Corrected(kg/m3)
		(1)	(2)	(3)=(2)-(1)	(4)	(5)=(3)*(4)*0.01	(6)=(4)+(5)
Water	1				145	-47	98
Fine Aggregate	2.63			5.000	686	34	720
Aggregate	2.68			1.000	1226	12	1238

Sand Fineness Module	2.75
Slump	7.5-10cm

109-Proportion of Air Contend ,Water Content , Fine Aggregate and Coarse Aggregate

Gmax	Dry Compacting Coarse Aggregate Weight	AE Concrete			Plain Concrete		
		Air Content	Average Water Content	Sand Percentage(Absolute Volume)	Entrapped Air	Average Water Content	Sand Percentage(Absolute Volume)
(mm)	(%)	(%)	(kg/m3)	(%)	(%)	(kg/m3)	(%)
10	41	8	191	59	3	209	61
15	52	7	182	50	2.5	199	53
20	62	6	168	42	2	187	45
25	67	5	158	37	1.5	178	41
40	73	4.5	145	33	1	166	36
50	76	4	136	30	0.5	158	33
80	81	3.5	121	28	0.3	144	31
150	87	3	97	24	0.2	125	28

110-Adjusting Value

	Adjustment of Value		
	Water Content	Sand Percentage	Dry Compacting Coarse Aggregate
neness of Sand 0.1 Increase / Decrea	-	+-0.5%	-+1.0%
Slump 1 cm Increase / Decrease	1.2%	-	-
Air Content 1 % Increase / Decrease	-+3.0%	-+(0.5-1.0)%	-
Water Cement Ratio 0.05 Increase / Decrease	-	+-1.0%	-
Sand Percentage 1 % Increase / Decrease	+-1.0%	-	-+2.0%
Angular Aggregate	+(7-10)%	+(3-5)%	-
Low Slump (Paving Concrete)	-3.0%	-3.0%	6.0%

Water Content 1000kg/m3,Water Degree over 15 Degree-998kg/m3

Example-2

Not Freezing and Thawing Action

Power Station Type C

111-Water Cement Ratio of Concrete

No	Types of Concrete	Water Cement Ratio	
		Hard Weather	Mild Weather
A	Hard Weather(I)	0.45+-0.02	0.55+-0.02
B	Hard Weather (II)	0.50+-0.02	0.55+-0.02
C	Hard Weather (III)	0.59+-0.02	0.58+-0.02
D	Sodium Sulfate Alkali	-	0.50+-0.02
E	Sodium Sulfate Alkali	0.45+-0.02	-
F	Concreting By Tremie	0.45+-0.02	0.45+-0.02
G	Channel	0.53+-0.02	0.58+-0.02
H	Inner Concrete of Dam	W/C-Strength-Heat Characteristic and Volume Changing	

Ages 28 Days 175kg/cm2 (80%) Compressive Strength 200kg/cm2

107-Maximum Slump

Types of Structure	Maximum Slump
Mass Concrete	5
Channel	7.5
Slab and Invert of Tunnel	5
Wall Top,Pier,Parapet	5
Tunnel, Arch	10
Other Structure	7.5

113-Aggregate Maximum Dimension of Structure

Minimum	Aggregate Maximum Dimension (mm)										
			Reinforc			Reinforcement Slab			Plain Concrete Slab		
Below 13			……‥			20-40			20-40		
15-28			20-40			40			40-75		
30-73			40-75			75			75-150		
Over 75			40-75			75			150		

Aggregate Maximum Dimension of Structure<(2/3)*Minimum Pitch of Reinforcement

Aggregate Maximum Dimension　　80mm
Alkali -aggregate reaction　　Pozzolan Cement (30 %)
Portland Cement　　Portland Cement (70%)

145/0.5=290

Concrete Test Mix Cement Content　　Coarse Aggregate Content

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks
		(SL)	air	W/C	s/a	C	W	s	CA(5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d	
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)						
250	40	5	4.5	0.5		290	145									Weight
							1									Specific Gravity
			45				145									Volume

Concrete Mix Proportion

Adjustment Moisture Content

	specifiv gravity(%)	absorption(%)	moisture content(%)	Water surface	Content(kg/m3)	Correction(kg/m3)	Corrected(kg/m3)
		(1)	(2)	(3)=(2)-(1)	(4)	(5)=(3)*(4)*0.01	(6)=(4)+(5)
Water							
Fine Aggregate							
G1:Aggregate(5~10mm)							
G2:Aggregate(10~20mm)							

111-Water Cement Ratio of Concrete

No	Types of Concrete	Water Cement Ratio	
		Hard Weather	Mild Weather
A	Hard Weather (I)	0.45+-0.02	0.55+-0.02
B	Hard Weather (II)	0.50+-0.02	0.55+-0.02
C	Hard Weather (III)	0.59+-0.02	0.58+-0.02
D	Sodium Sulfate Alkali	–	0.50+-0.02
E	Sodium Sulfate Alkali	0.45+-0.02	–
F	Concreting By Tremie	0.45+-0.02	0.45+-0.02
G	Channel	0.53+-0.02	0.58+-0.02
H	Inner Concrete of Dam	W/C-Strength-Heat Characteristic and Volume Changing	

(116) ACI 211.1 Design of Concrete Mixes (16)

Wall,Ages 28 Days 15*30cm TestCylinder 210kg/cm2

Fluctuation Coefficient 15%

Required Compressive Strength 210*1.15=242kg/cm2

Dry Compacted WeightofCoarse Aggregate 1680kg/m3

Coarse Aggregate Content 73%

Dry Compacted WeightofCoarse Aggregate =1680*0.73=1226

145/0.5=290

Concrete TestMix CementContent

Coarse Aggregate Content

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water	sand	Cement	Water	Fine	Coarse Aggregate		Admixt	Admixt	Comprssive Strength (kgf/cm2)			Remarks
		(SL)	air	W/C	s/a	C	W	s	CA(5~10m	CA(10~2	% of	% of	3d	7d	28d	
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	Mighty	Mighty				
242	40	7.5	4.5	0.5		290	145	686	1226							Weight
						3.15	1	2.63	2.68							Specific Gravity
			45		36	92	145	261	457							Volume

Concrete Mix Proportion

=1226/2.68=457

Adjustment Moisture Content

=1000-(45+145+457+92)=261

	specifiv gravity (%)	absorption (%)	moisture	Water surface	Content(kg/m3)	Correction (kg/m3)	Corrected (kg/m3)
		(1)	(2)	(3)=(2)-(1)	(4)	(5)=(3)*(4)*0.01	(6)=(4)+(5)
Water	1				145	-47	98
Fine Aggregate	2.63			5.000	686	34	720
Aggregate	2.68			1.000	1226	12	1238

(117) ACI 211.1 Design of Concrete Mixes (17)

Sand Fineness Module	2.75
Slump	7.5–10cm

109-Proportion of Air Contend ,Water Content, Fine Aggregate and Coarse Aggregate

Gmax	Dry Compacting Coarse Aggregate	AE Concrete			Plain Concrete		
		Air Content	Average Water Content	Sand Percentage (Absolute	Entrapped Air	Average Water Content	Sand Percentage (Absolute
(mm)	(%)	(%)	(kg/m3)	(%)	(%)	(kg/m3)	(%)
10	41	8	191	59	3	209	61
15	52	7	182	50	2.5	199	53
20	62	6	168	42	2	187	45
25	67	5	158	37	1.5	178	41
40	73	4.5	145	33	1	166	36
50	76	4	136	30	0.5	158	33
80	81	3.5	121	28	0.3	144	31
150	87	3	97	24	0.2	125	28

110-Adjusting Value

	Adjustment of Value		
	Water Conten	Sand Percentage	Dry Compacting
ieness of Sand 0.1 Increase /Decrea	–	+-0.5%	-+1.0%
Slump 1 cm Increase /Decrease	1.2%	–	–
Air Content 1 % Increase /Decrease	-+3.0%	-+ (0.5-1.0)%	–
Water Cement Ratio 0.05 Increase /Decrease	–	+-1.0%	–
Sand Percentage 1 % Increase / Decrease	+-1.0%	–	-+2.0%
Angular Aggregate	+ (7-10)%	+ (3-5)%	–
Low Slump (Paving Concrete)	-3.0%	-3.0%	6.0%

Water Content 1000kg/m3,Water Degree over 15 Degree-998kg/m3

(118) ACI 211.1 Mix Design of Small Size Construction

118 Mix proportion of Small Size Construction
(It is possible to use without adjusting)

Coarse Aggregate Maximum Dimension (mm)	Mix Proportion	Cement Content One Bag (50kg)/m3	Aggregate Content(kg) per Cement One Bag (50kg)		
			Sand		Gravel or Crusher
			AE Concrete	Plain Concrete	
13	A	7.8	125	130	90
	B	7.7	120	125	100
	C	7.6	120	125	110
20	A	7.4	120	125	120
	B	7.1	120	125	130
	C	7	115	120	140
25	A	7.1	120	125	130
	B	6.9	115	120	145
	C	6.8	110	115	155
40	A	6.7	120	125	155
	B	6.5	115	120	170
	C	6.4	110	115	185
50	A	6.4	120	125	175
	B	6.2	115	120	180
	C	6	110	115	205

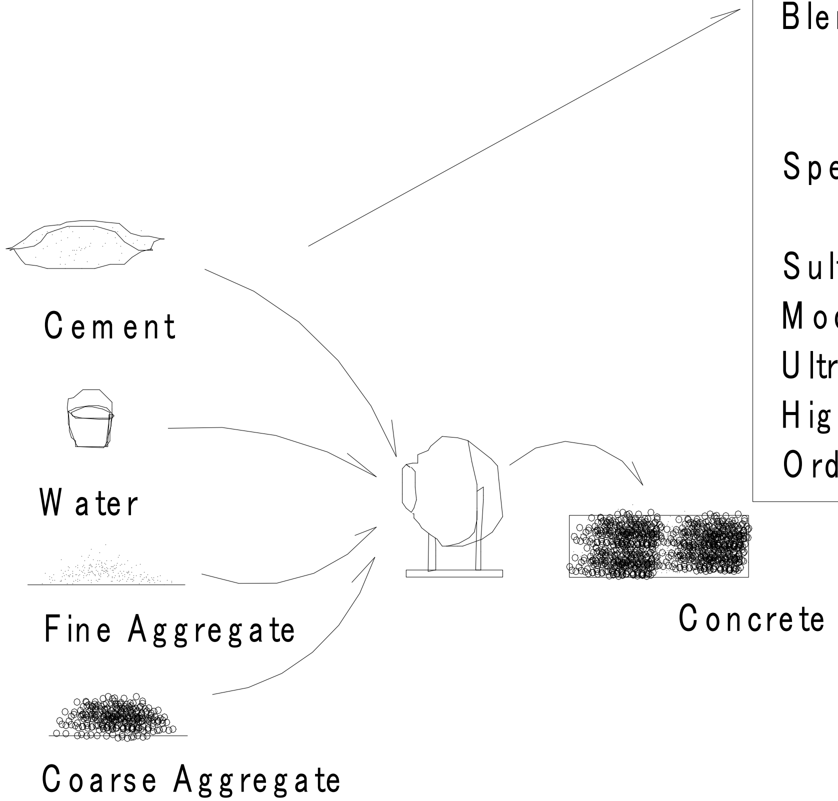
1 Select Aggregate Maximum Dimension
Use Mix B
Pour Water-Workable
If Sand Shortage — Mix Proportion A
If Sand Plenty — Mix Proportion C

2 Sand Weight
If Wet Sand — Increase 5kg per one Bag Batch
If Much Wet Sand — Increase 10kg per one Bag Batch

3 AE Concrete — Freezing and Thawing Action

(119) Concrete Material (1)

(119) Concrete Material(1)



Cement

Blended Cement－(Blast-Furnance Slag Cement, Portland Pozzolan Cement,Silica Cement,Fly Ash Cement)

Special Cement－(Alumina Cement,Ultra Rapid Harding Cement)

Sulfate Resisting Portland Cement

Moderate Heat Portland Cement

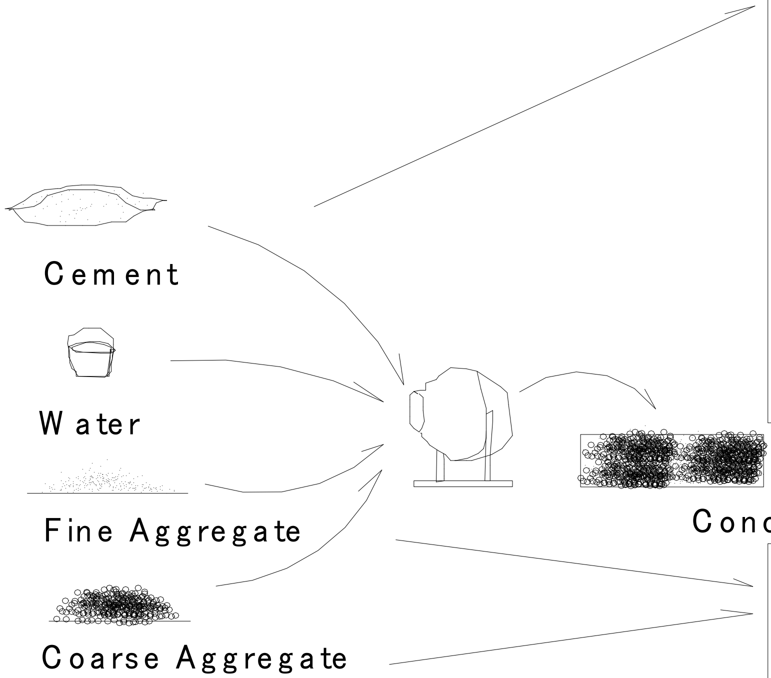
Ultra High Early Strength Portland Cement

High Early Strength Portland Cement

Ordinary Portland Cement

(120) Concrete Material (2)

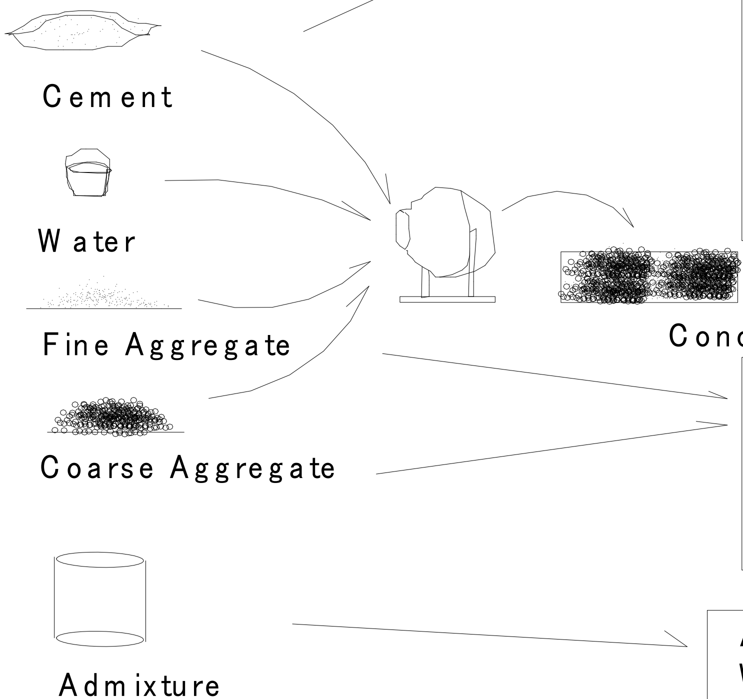
(120) Concrete Material(2)



Cement
- Blended Cement (Blast-Furnance Slag Cement, Portland Pozzolan Cement, Silica Cement, Fly Ash Cement)
- Special Cement (Alumina Cement, Ultra Rapid Harding Cement)
- Sulfate Resisting Portland Cement
- Moderate Heat Portland Cement
- Ultra High Early Strength Portland Cement
- High Early Strength Portland Cement
- Ordinary Portland Cement

Aggregate
- Sand
- Crushed Sand
- Gravel
- Crushed Stone

(121) Concrete Material(3)

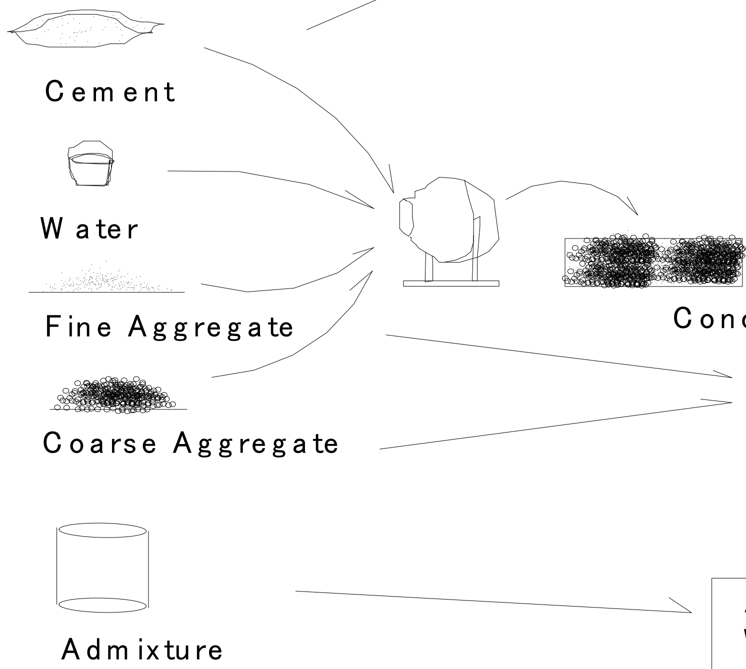


Cement
- Blended Cement-(Blast-Furnance Slag Cement, Portland Pozzolan Cement,Silica Cement,Fly Ash Cement)
- Special Cement-(Alumina Cement,Ultra Rapid Harding Cement)
- Sulfate Resisting Portland Cement
- Moderate Heat Portland Cement
- Ultra High Early Strength Portland Cement
- High Early Strength Portland Cement
- Ordinary Portland Cement

Aggregate
- Sand
- Crushed Sand
- Gravel
- Crushed Stone

Admixture
- Water Reducing Agent
- Accelerator
- Retarder
- Water Proof Agent

(122) Concrete Material (4)



Cement
Blended Cement (Blast-Furnance Slag Cement, Portland Pozzolan Cement, Silica Cement, Fly Ash Cement)
Special Cement (Alumina Cement, Ultra Rapid Harding Cement)
Sulfate Resisting Portland Cement
Moderate Heat Portland Cement
Ultra High Early Strength Portland Cement
High Early Strength Portland Cement
Ordinary Portland Cement

Aggregate
Sand
Crushed Sand
Gravel
Crushed Stone

Admixture
Water Reducing Agent
Accelerator
Retarder
Water Proof Agent

Cement

Blended Cement -(Blast-Furnance Slag Cement, Portland Pozzolan Cement, Silica Cement, Fly Ash Cement)

Special Cement -(Alumina Cement, Ultra Rapid Harding Cement)

Sulfate Resisting Portland Cement

Moderate Heat Portland Cement

Ultra High Early Strength Portland Cement

High Early Strength Portland Cement

Ordinary Portland Cement

(124) Ordinary Portland Cement

1 90 %

2 Popular

3 Improve by Admixture

4 Block,Pipe,Building,Pavement,Port Construction
Wall,Drainage,Tunnel,Dam,River Construction,Bridge

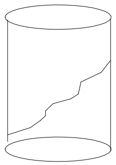
(125) High Early Strength Portland Cement

(125) High Early Strength Portland Cement

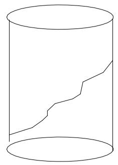
Compressive Strength of
High Early Strength Portland Cement
at Ages 7 Days

=

Compressive Strength of
Ordinary Portland Cement
at Ages 28 Days



Compressive Strength at 7 Days



Compressive Strength at 28 Days

1 Heat of Hydration
2 Cold Weather Concreting
3 Early Compressive Strength
4 Long-term Compressive Strength

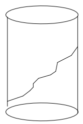
Attention

1 Not Fit for Mass Concrete
2 Cracks
3 Curing

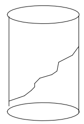
(126) Ultra High Early Strength Portland Cement

(126) Ultra High Early Strength Portland Cement

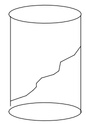
Compressive Strength of Ultra High Early Strength Portland Cement at Ages 1 Day ＝ Compressive Strength of Ordinary Portland Cement at Ages 7 Days ＝ Compressive Strength of High Early Strength Portland Cement at Ages 3 Day



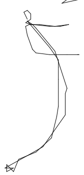
Compressive Strength at 1 Days



Compressive Strength at 7 Days



Compressive Strength at 3 Days



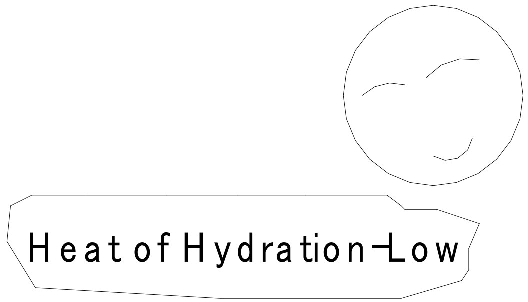
For Urgent Works

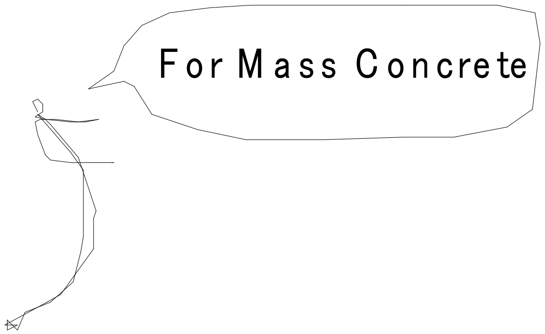
1 Early Compressive Strength －High
2 Good Workability
3 Heat of Hydration－high
4 Drying shrinkage －A Little
5 Good Durability

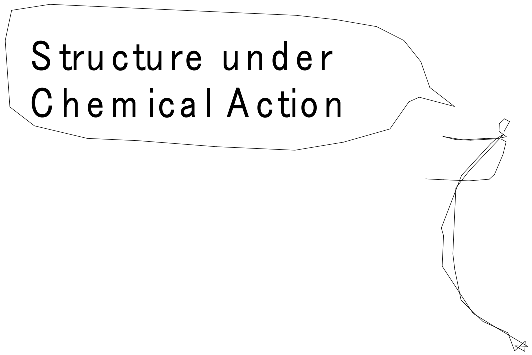
(127) Modulate Heat Portland Cement

(127) Modelate Heat Portland Cement

1 Early Compressive Strength - Low
  Long Term Compressive Strength - High
2 Heat of Hydration - Low
3 Volume change - A Little
4 Chemical Resisting - Big

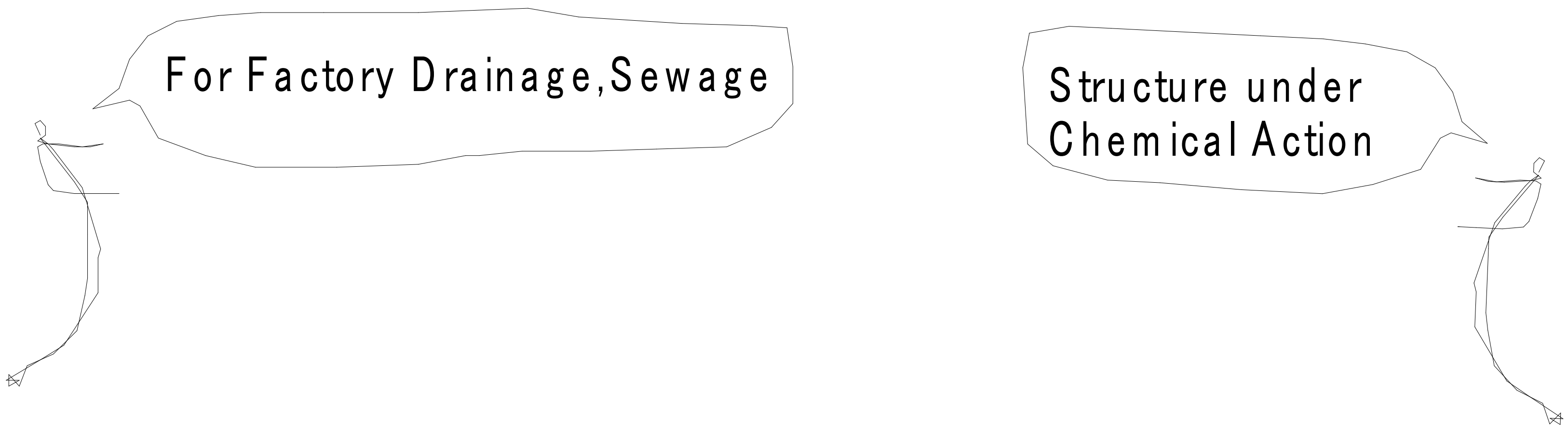






(128) Sulfate Resisting Portland Cement

（128）Sulfate Resisting Portland Cement



(129) Blast-Furnance Slag Cement

1. Early Compressive Strength-Low
   Long-term Compressive Strength-High
2. Chemical Erosion Resistance-High
   (Acid,Sea Water,Sewage)
3. Watertightness-High
4. Heat of Hydration-Low
5. Dry Shrinkage,Craks-Much

Uses

1. Tunnel
2. Sewage Construction
3. Structure under Sea Water

(130) Silica Cement

1 Early Compressive Strength-Low
Long-term Compressive Strength-High
2 Chemical Resistance-High
(Sea Water)
3 Watertightness-High
4 Heat of Hydration-Low
5 Dry Shrinkage,Craks-Much
6 Fluidity-Big

Uses
1 River,Port Structure
2 Factory Sewage,Sewage Construction
3 Structure under Sea Water

(131) Fly-Ash Cement

1 Early Compressive Strength-Low
Long-term Compressive Strength-High
2 Chemical Erosion Resistance-High
(Acid,Sea Water,Sewage)
3 Watertightness-High
4 Heat of Hydration-Low
5 Dry Shrinkage,Cracks-Low
6 Fluidity-High

Uses
1 Dam
2 Structure under Water

A Fly Ash Content 5-10%
B Fly Ash Content 10-20%
C Fly Ash Content 20-30%

(132) Almina Cement

1 Early Compressive Strength–High

2 Chemical Resistance–High
(Acid,Sea Water,Sewage)
3 Durability to Heat–High
4 Heat of Hydration–High
5 Reinforcement–Rust

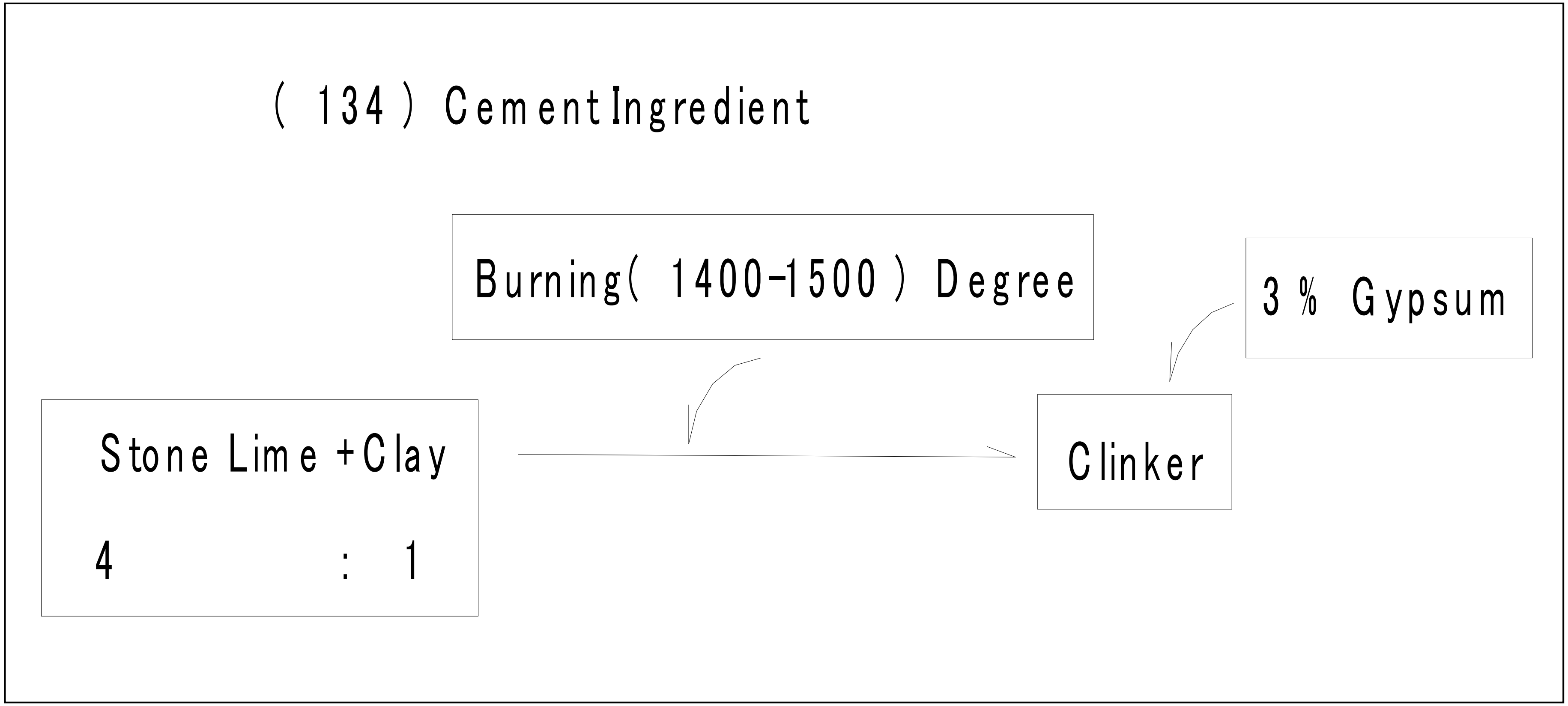
Uses
1 Urgent Construction

Attention
1 W/C Below 40–45%
2 Curing Temperature below 20–25 degree

(133) Ultra High Early Strength Portland Cement

1 Early Compressive Strength-High
2 Long Term Compressive Strength-High
3 Setting Time -Short
About 100kg/cm2 after 3 Hours
Concrete Finish within 30 Minute's

(134) Cement Ingredient (I)

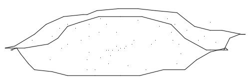


(135) Cement Ingredient (II)

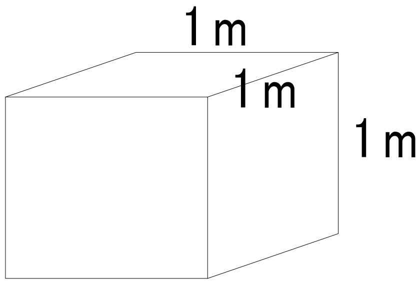
Cement Type	Compound (Weight %)			
	C3S	C2S	C3A	C4AF
Ordinary Portland Cement	50	26	9	90
Moderate Portland Cement	48	30	5	11
High Early Strength Portland Cement	67	9	8	8
Ultra High Early Strength Portland Cement	68	6	8	8
Sulfate Resisting Portland Cement	57	23	2	13
	C3S	C2S	C3A	C4AF
	Early Strength-High	Long Term Strength-High	Hydration Velocity-Quick	Strength-Low
	Hydration Heat-High	Hydration Heat-Low	Hydration Heat-High	Hydration Heat-Low
			Shrinkage-Much	Shrinkage-Low

(136) Cement Weight

Burning Temperature,Fineness,Burning Temperature, Weathering(Aeration)



Cement

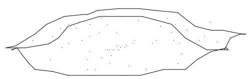


1m3=1500kg

(137) Cement Specific Gravity

(137) Cement Specific Gravity

Burning Temperature,Fineness,Burning Temperature, Weathering(Aeration)



Cement

Cement Specific Gravity→High
→Burning Temperature→High

Cement Specific Gravity→Low
→Burning Temperature→Low

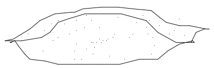
(138) Cement Fineness

(138) Cement Fineness

Cement Specific Gravity

Effect

Weathering (Aeration)



Cement

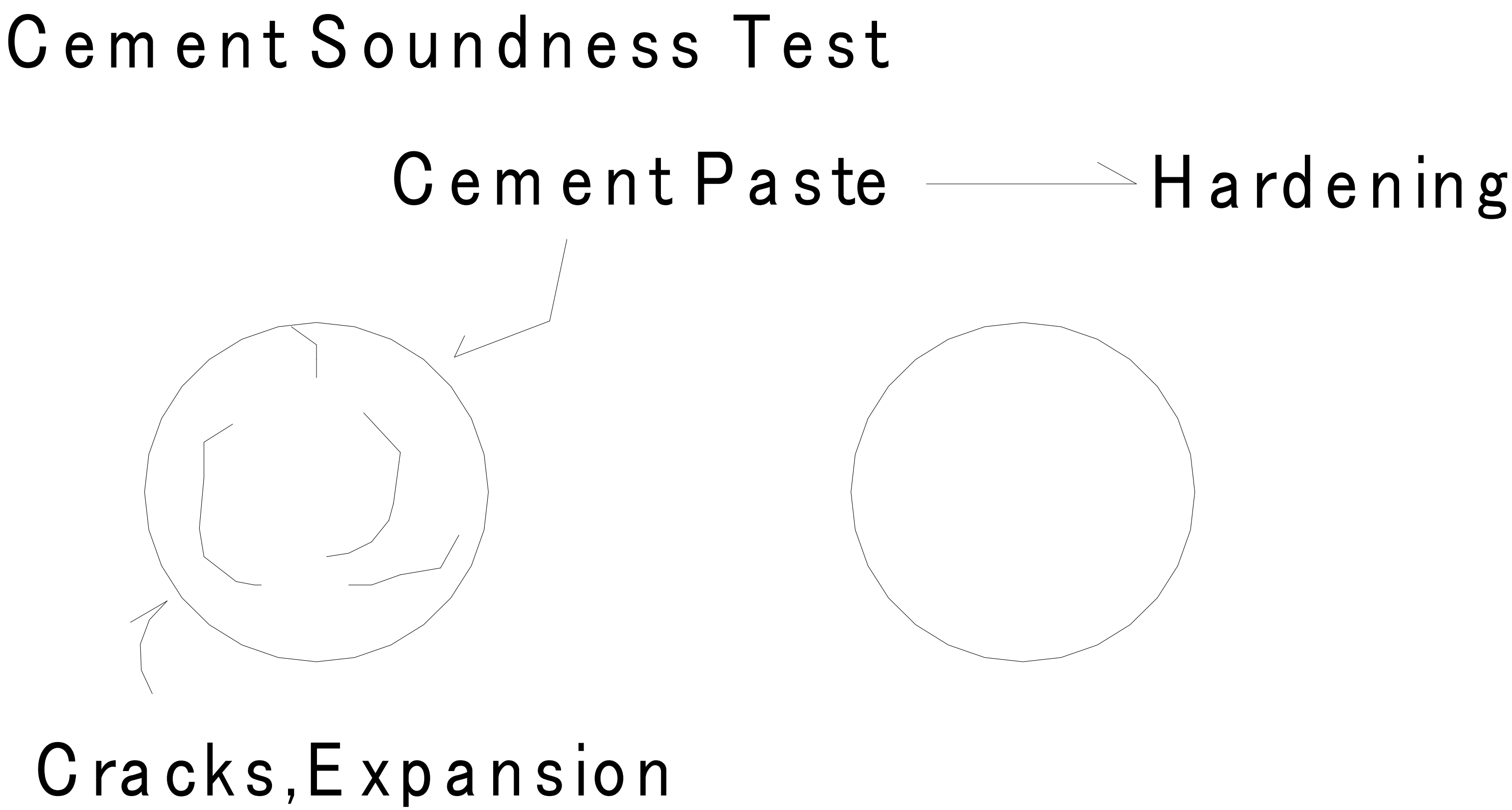
Burning Temperature	Cement Specific Gravity
High	Big
Low	Small

(139) Cement Setting

(139) Cement Setting

Fineness	Quick
Water Temperature	Quick
Temperature	Quick
Gypsum Content	Slow
Aeration	Slow

(140) Cement Soundness



(141) Cement Strength

Mortar Strength Test

(142) Heat of Hydration

(142) Heat of Hydration

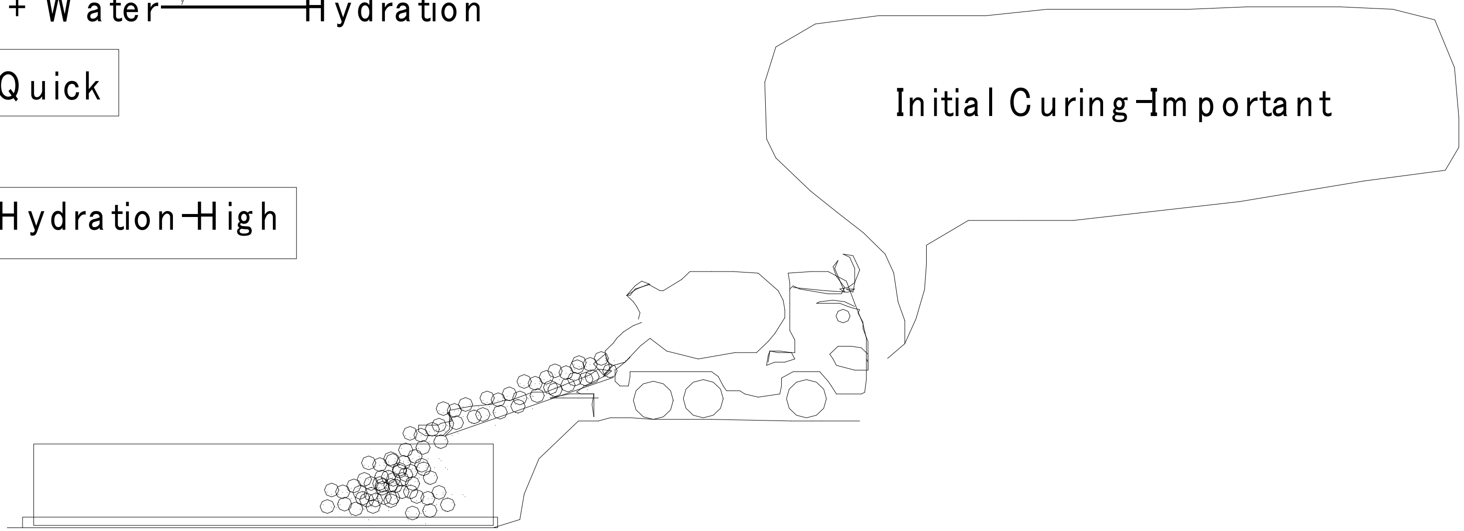
Heat

Cement + Water ——— Hydration

Setting–Quick

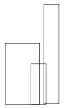
↕

Heat of Hydration–High



(143) Cement Choice

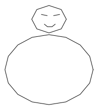
(143) Cement Choice



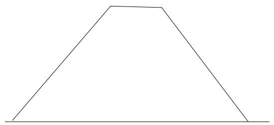
Building -11

Emergency Construction-11,5,6,9,10

Port Construction-11,1,3,4,7



Cold-Weather Concreting-11,6,9,10



Dam-8,4,11

Cement
Blended Cement-

1 Blast-Furnance Slag Cement,

2 Portland Pozzolan Cement,

3 Silica Cement,

4 Fly Ash Cement

Special Cement -

5 Alumina Cement,

6 Ultra Rapid Harding Cement

7 Sulfate Resisting Portland Cement

8 Moderate Heat Portland Cement

9 Ultra High Early Strength Portland Cement

10 High Early Strength Portland Cement

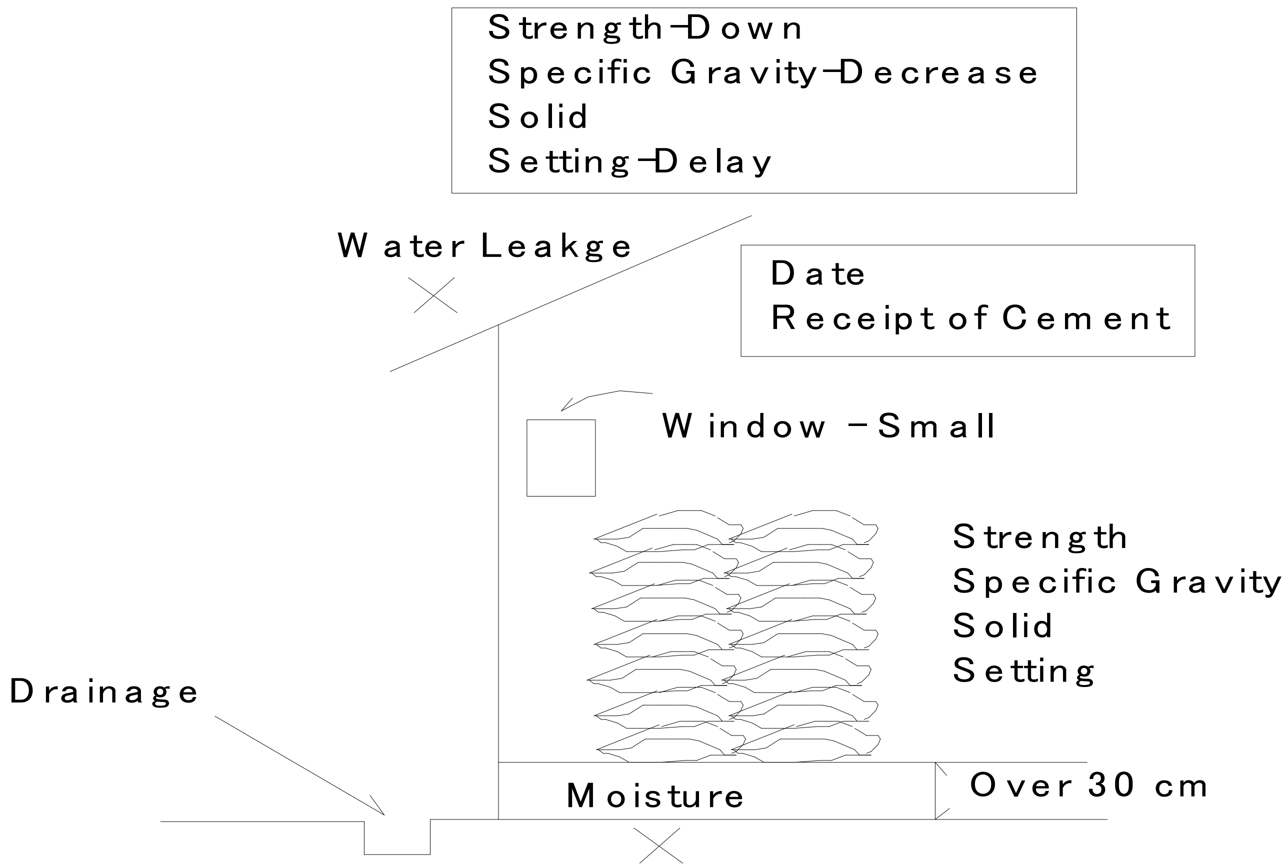
11 Ordinary Portland Cement

(144) Cement Storage

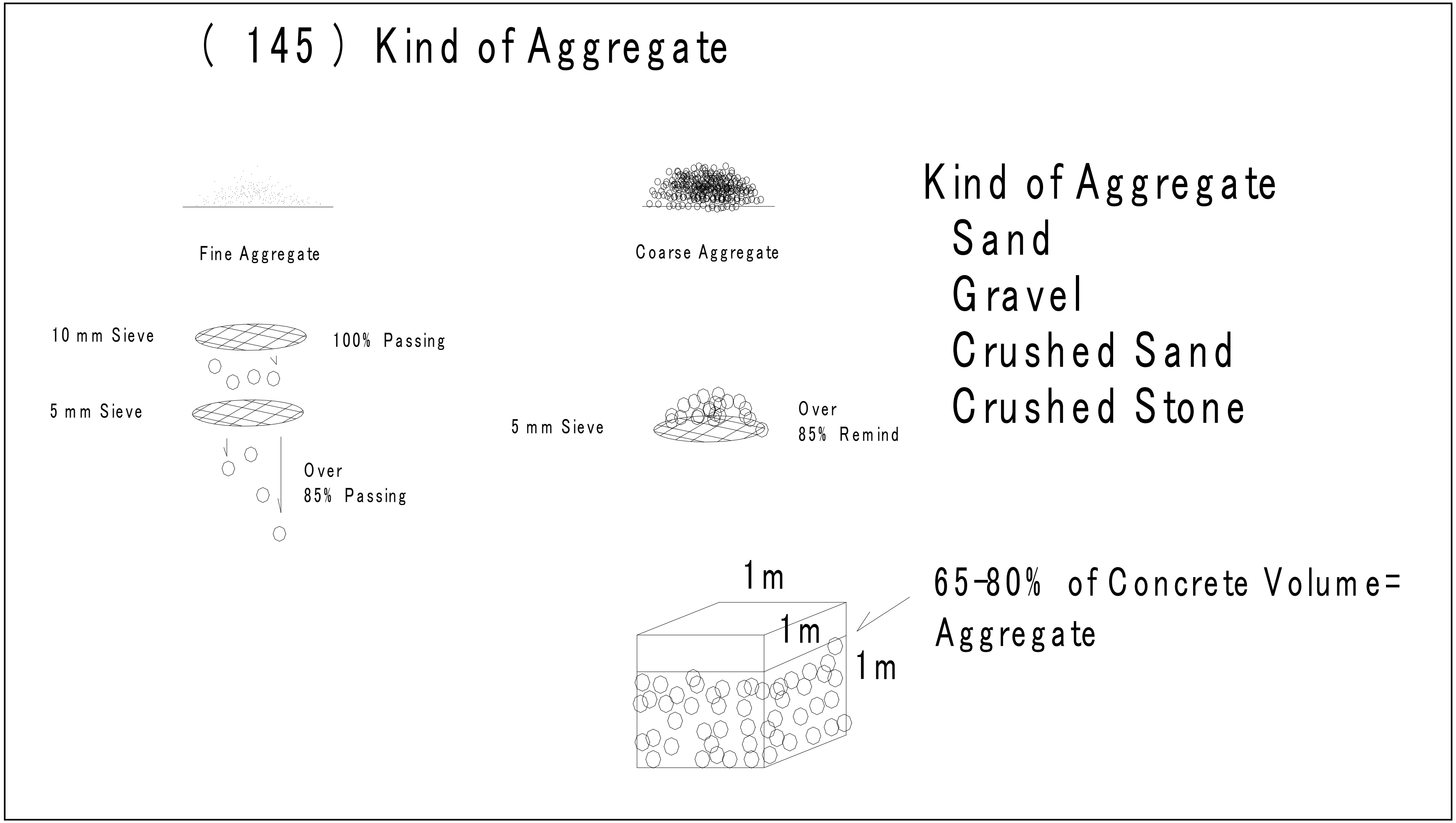
(144) Cement Storage

Carbon Dioxide+Moisture——Carbonate

Weathering

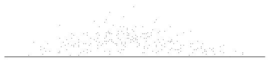


(145) Kind of Aggregate

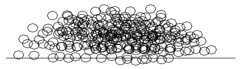


(146)Required Aggregate

（146） Required Aggregate



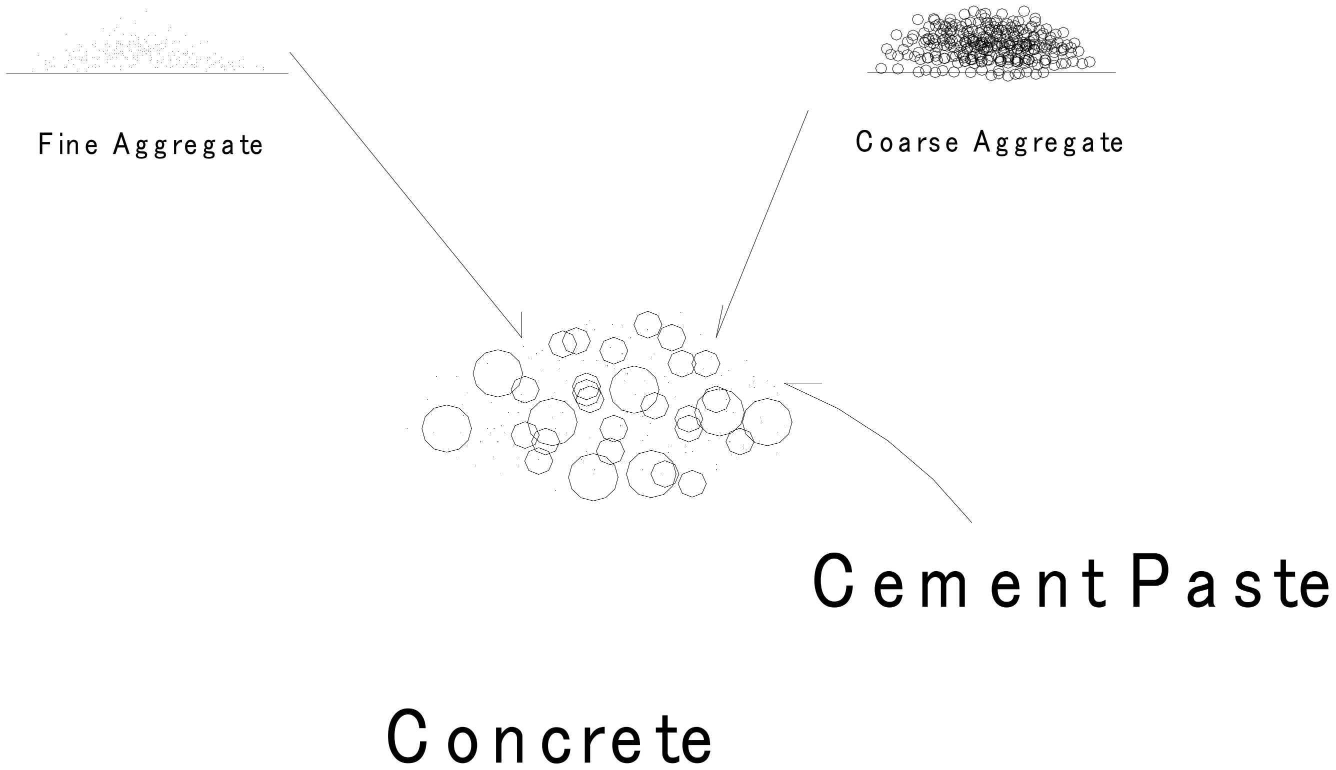
Fine Aggregate



Coarse Aggregate

1 Hard
2 No Clay,No Timber
3 Durability
4 Specific Gravity-Big
5 Unit Weight-Big
6 No Abrasion
7 Small Absorption
8 Good Shape
9 Good Grading

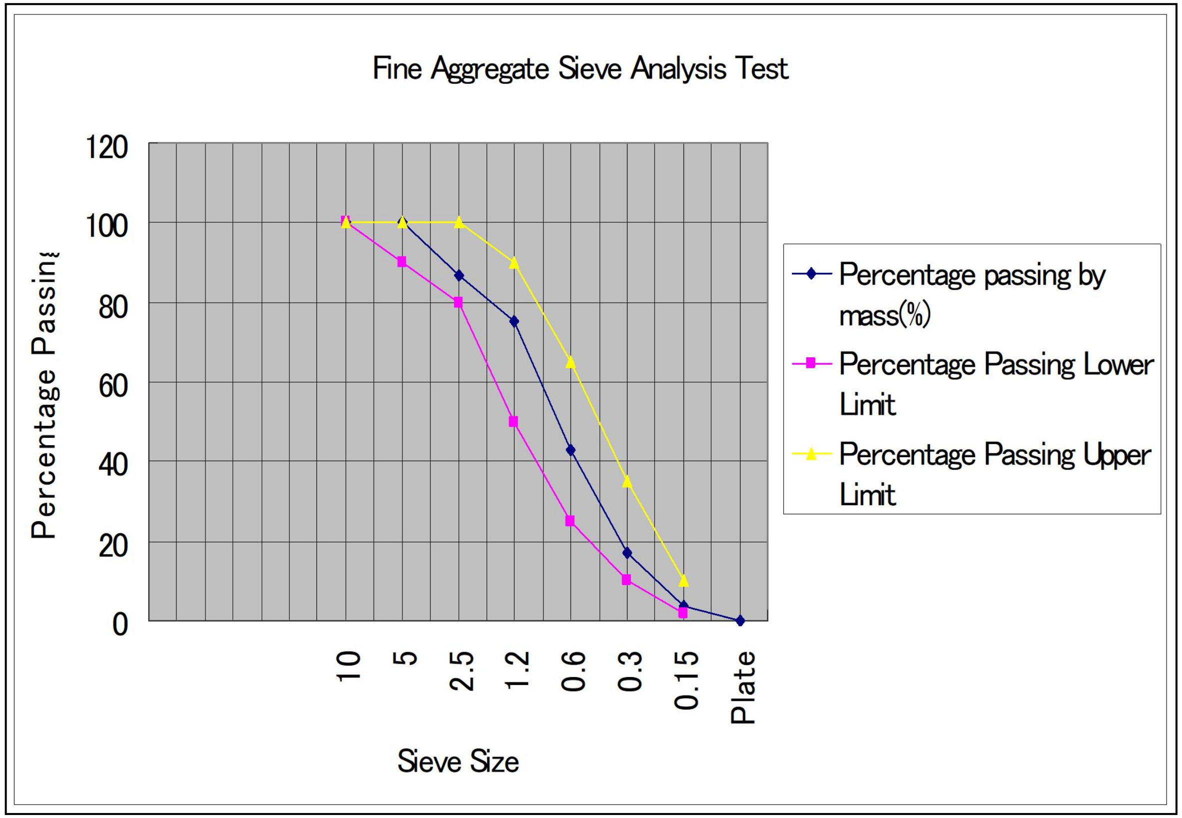
(147) Size and Grading of Aggregate (1)



(148) Grading and Fineness Modulus of Aggregate (1)

148 Sieve Analysis Test

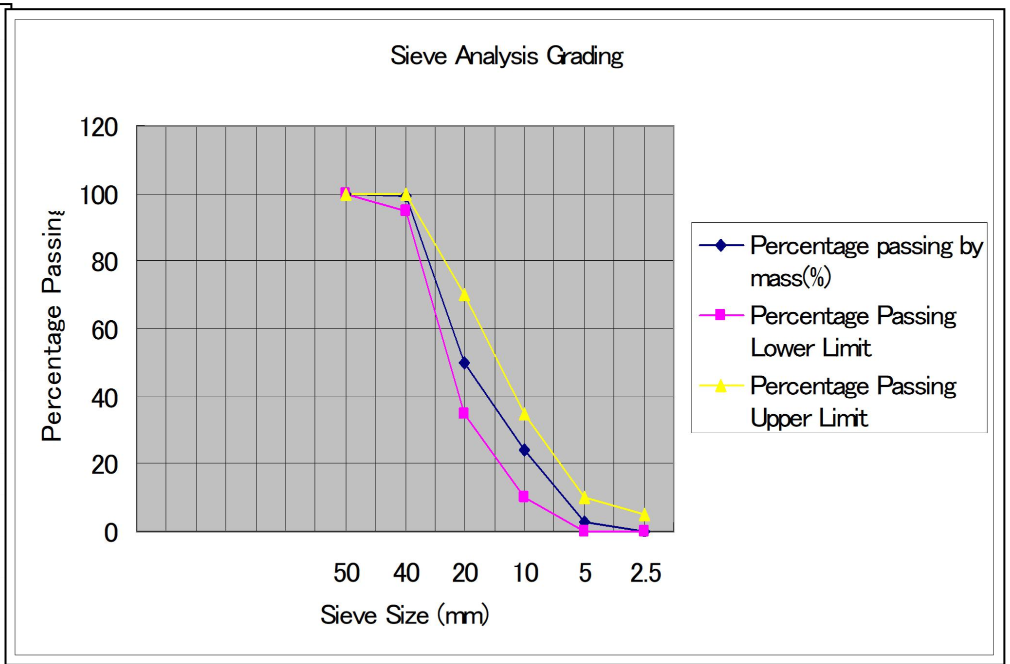
Sieve Size (mm)	Cumulative Percentage retained by mass (g)	Cumulative Percentage retained by mass (%)	Percentage of individual fraction retained by mass (g)	Percentage of individual fraction retained by mass (%)	Percentage passing by mass (%)
10	0	0	0	0	100
5	0	0	0	0	100
2.5	65	13	65	13	87
1.2	124	25	59	12	75
0.6	286	57	162	32	43
0.3	415	83	129	26	17
0.15	481	96	66	13	4
Plate	500	100	19	4	0
Total			500	100	
Fineness Modulus	=(13+25+57+83+96)/100=2.74				



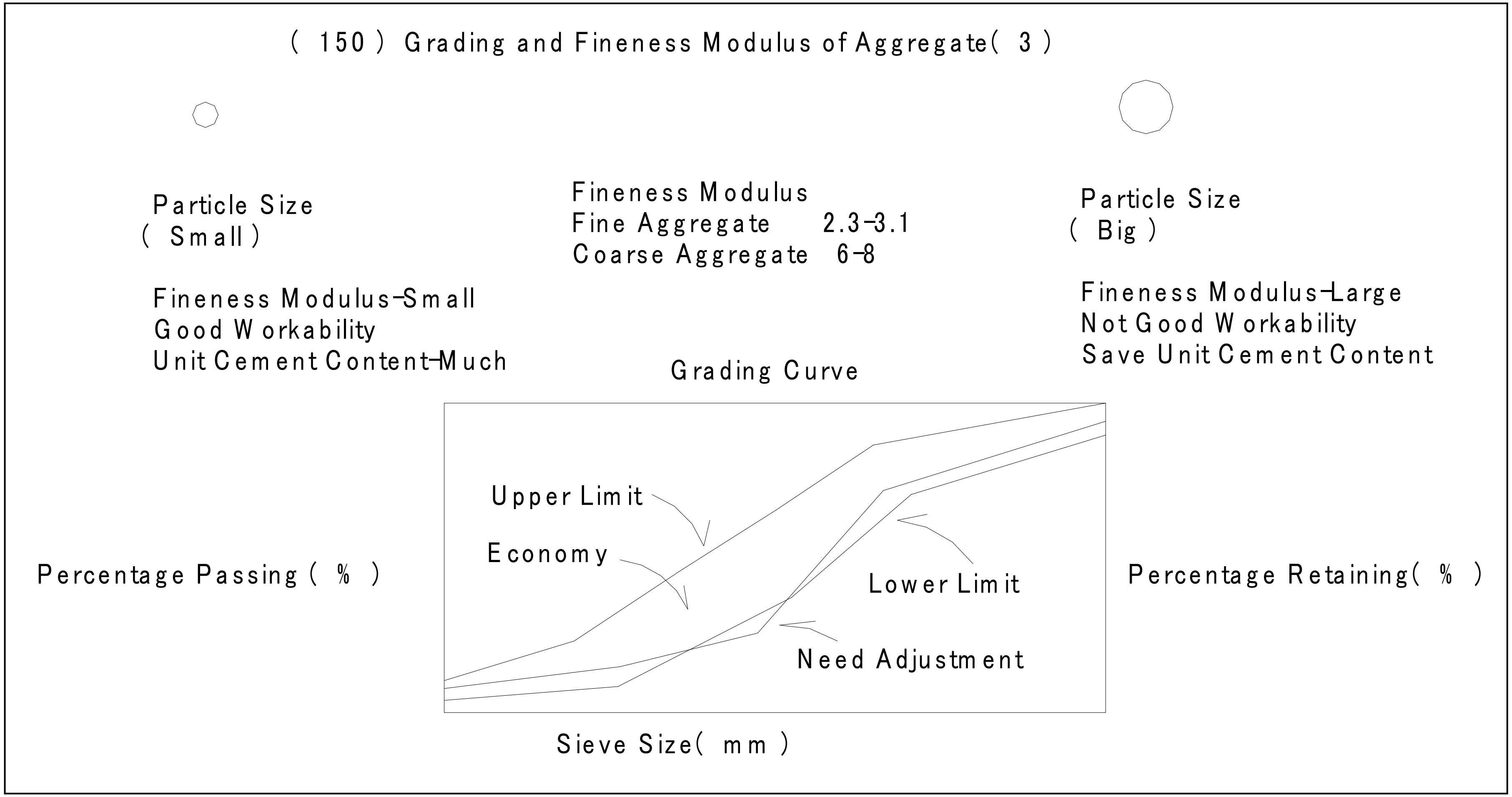
(149) Grading and Fineness Modulus of Aggregate (2)

149 Sieve Analysis Test, Coarse Aggregate

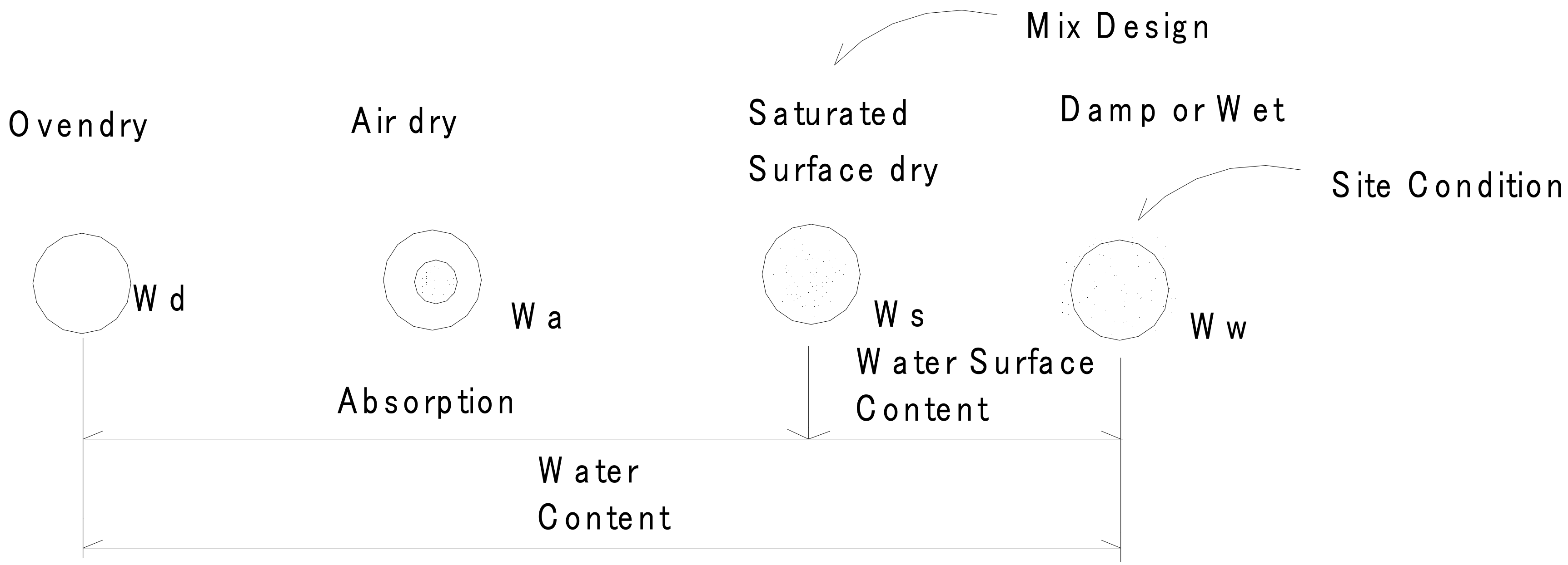
Sieve Size (mm)	Cumulative Percentage retained by mass		Percentage of individual fraction retained by mass		Percentage passing by mass
	(g)	(%)	(g)	(%)	(%)
50	0	0	0	0	100
40	148	1	148	1	99
30	2540	17	2392	16	83
25	4787	32	2247	15	68
20	7492	50	2705	18	50
15	9745	65	2253	15	35
10	11401	76	1656	11	24
5	14556	97	3155	21	3
2.5	15000	100	444	3	0
1.2					
0.6					
0.3					
0.15					
Plate					
Total			15000	100	
Fineness Modulus	=(1+50+76+97+100+400)/100=7.24		Maximum Size of Coarse Aggregate (mm)=40mm		



(150) Grading and Fineness Modulus of Aggregate (3)



(151) Water Content of Aggregate



Water Surface Content Ratio $=((Ww-Ws)/Ws)*100$

Specific Gravity (S.S.D) $=Ws/Wd$

Absorption Ratio $=((Ws-Wd)/Wd)*100$

(152) Specific Gravity of Aggregate

Fine Aggregate 2.5–2.65
Coarse Aggregate 2.55–2.70

Weathering
Specific Gravity–Small

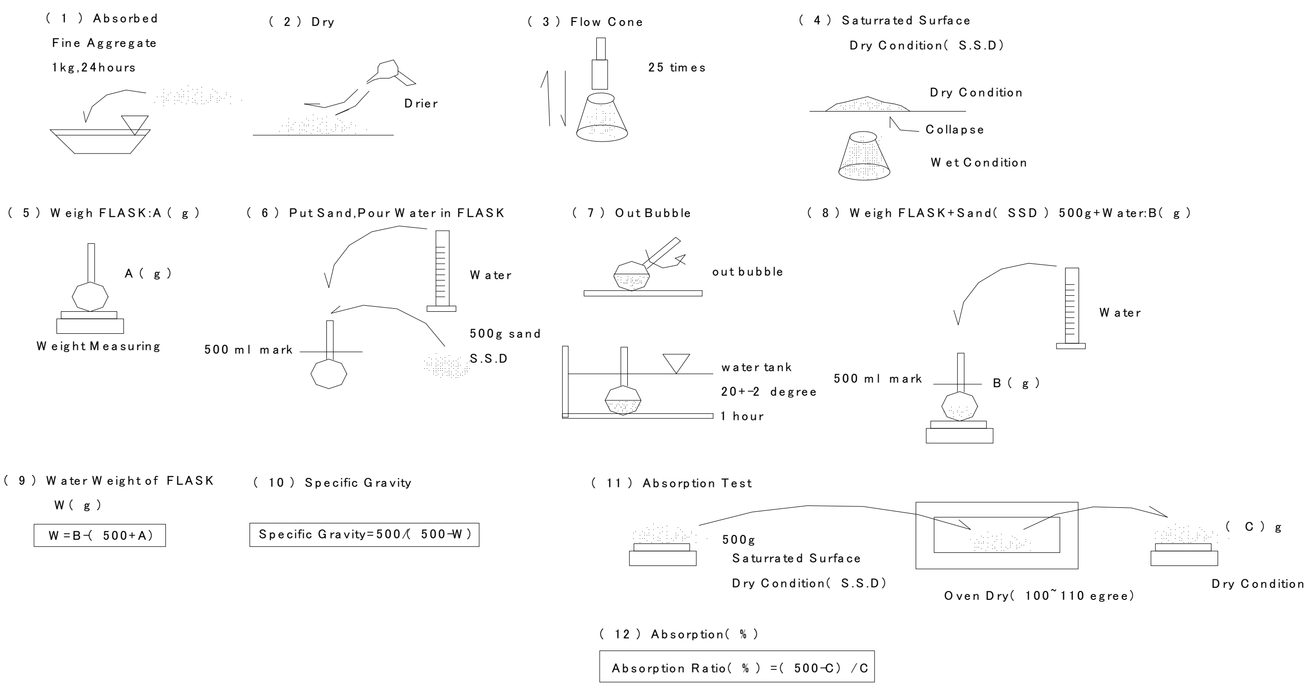
Use for Mix Design

(153) Specific Gravity of Aggregate(2)

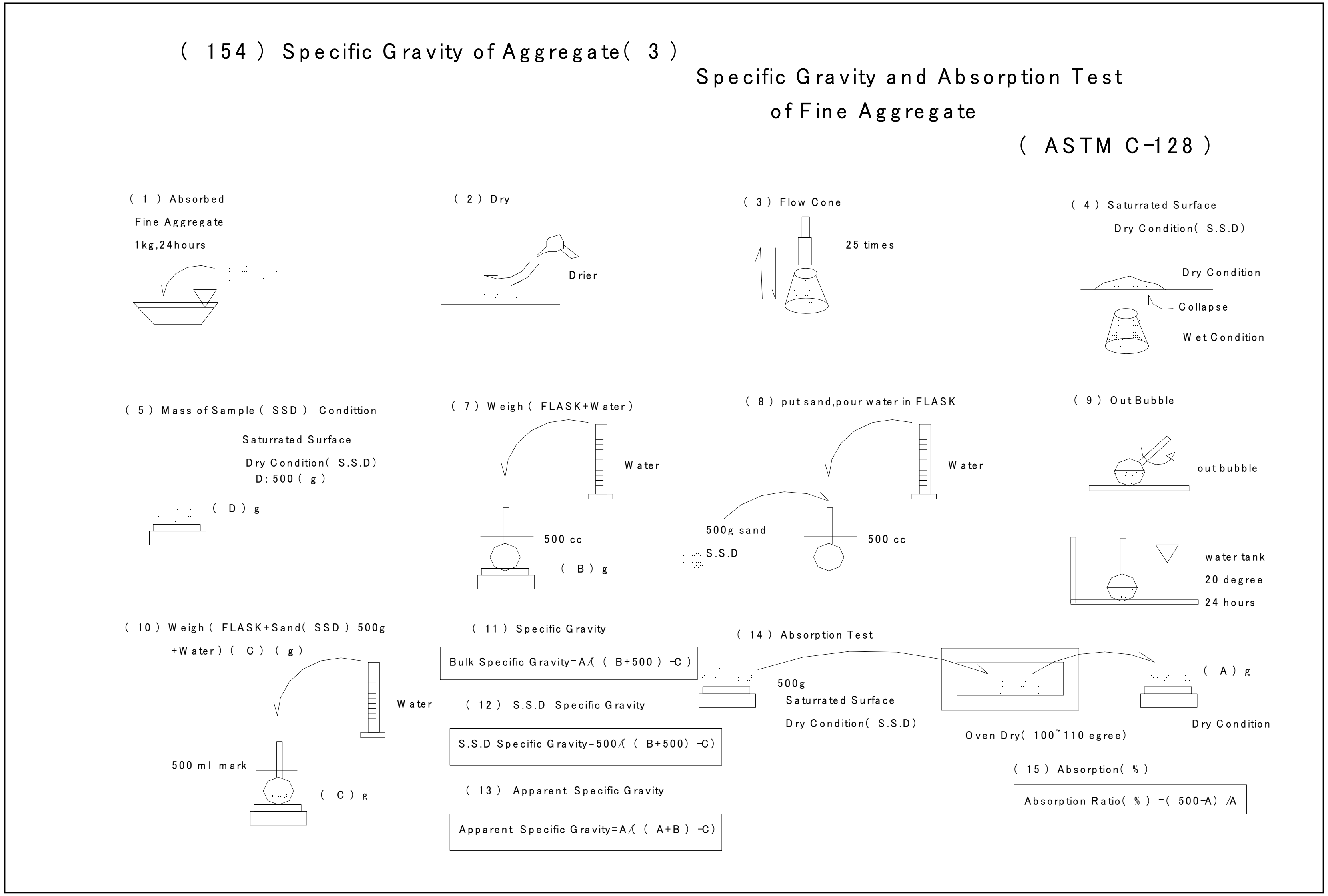
（153）Specific Gravity of Aggregate（2）

Fine Aggregate 2.5–2.65
Coarse Aggregate 2.55–2.70

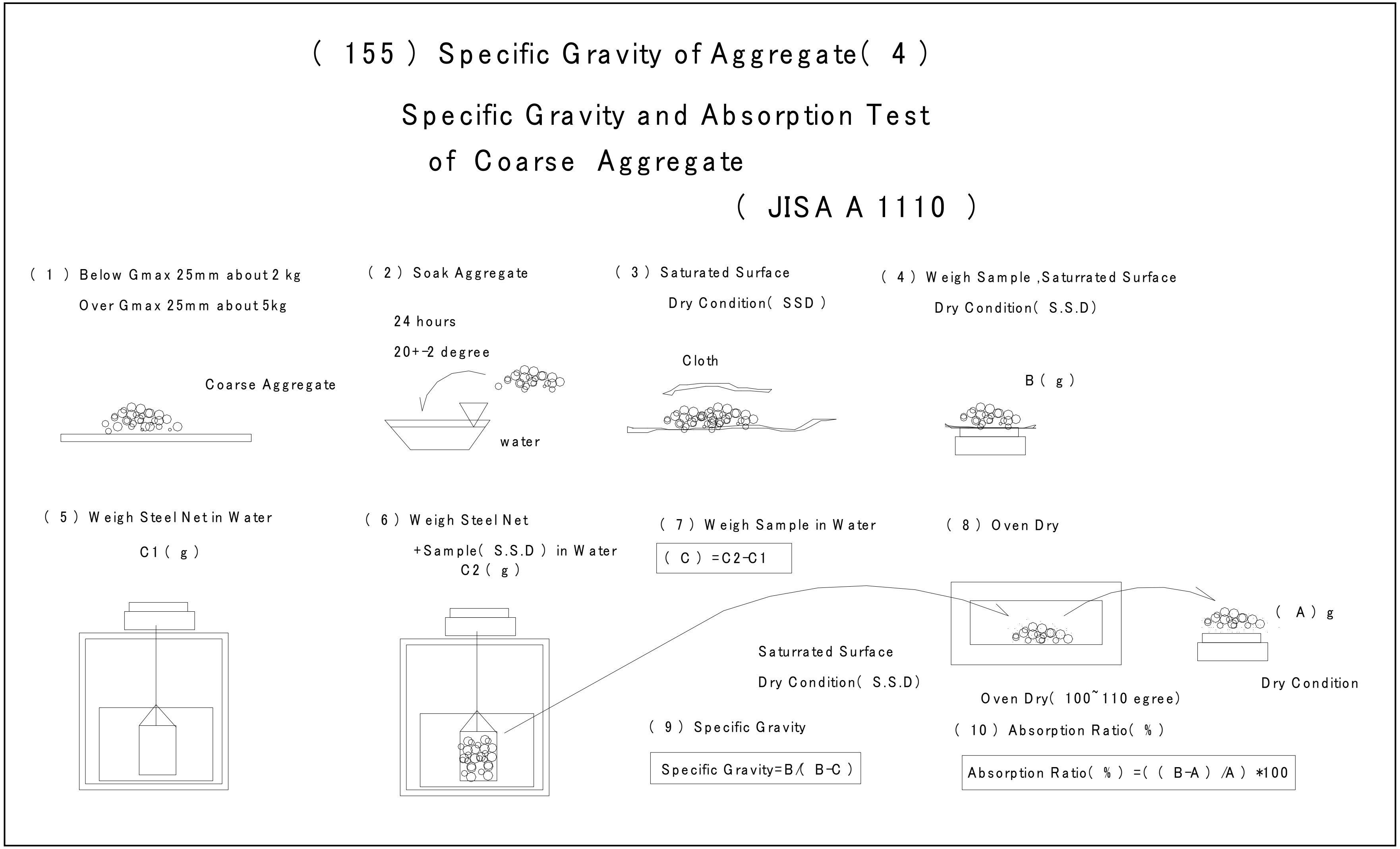
Specific Gravity and Absorption Test
of Fine Aggregate
（JISA A 1109）



(154) Specific Gravity of Aggregate(3)



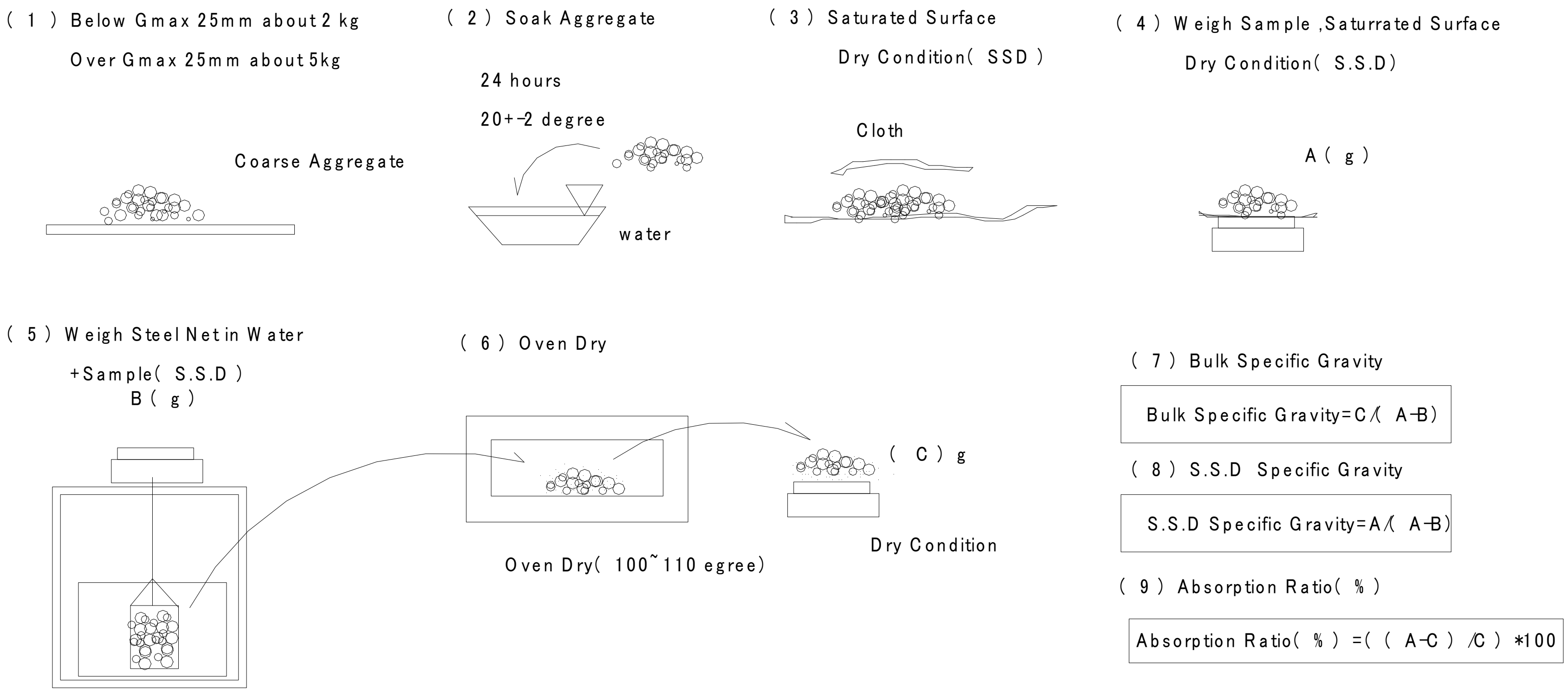
(155) Specific Gravity of Aggregate(4)



(156) Specific Gravity of Aggregate(5)

Specific Gravity and Absorption Test of Coarse Aggregate

(ASTM C-127)



(157) Surface Moisture Content (1)

Moisture Content Ratio of Aggregate	
Condition of Aggregate	Surface Moisture Ratio (%)
Wet Gravel or Wet Crushed Stone	1.5-2
Much Wet Sand	5-8
Normal Wet Sand	2-4
Wet Sand	0.5-2

(158) Absolute Volume

(158) Absolute Volume

Absolute Volume(m3)=Weight(kg)/(Specific Gravity*1000(kg/m3))

(159) Unit Weight

Unit Weight

Air Dried State

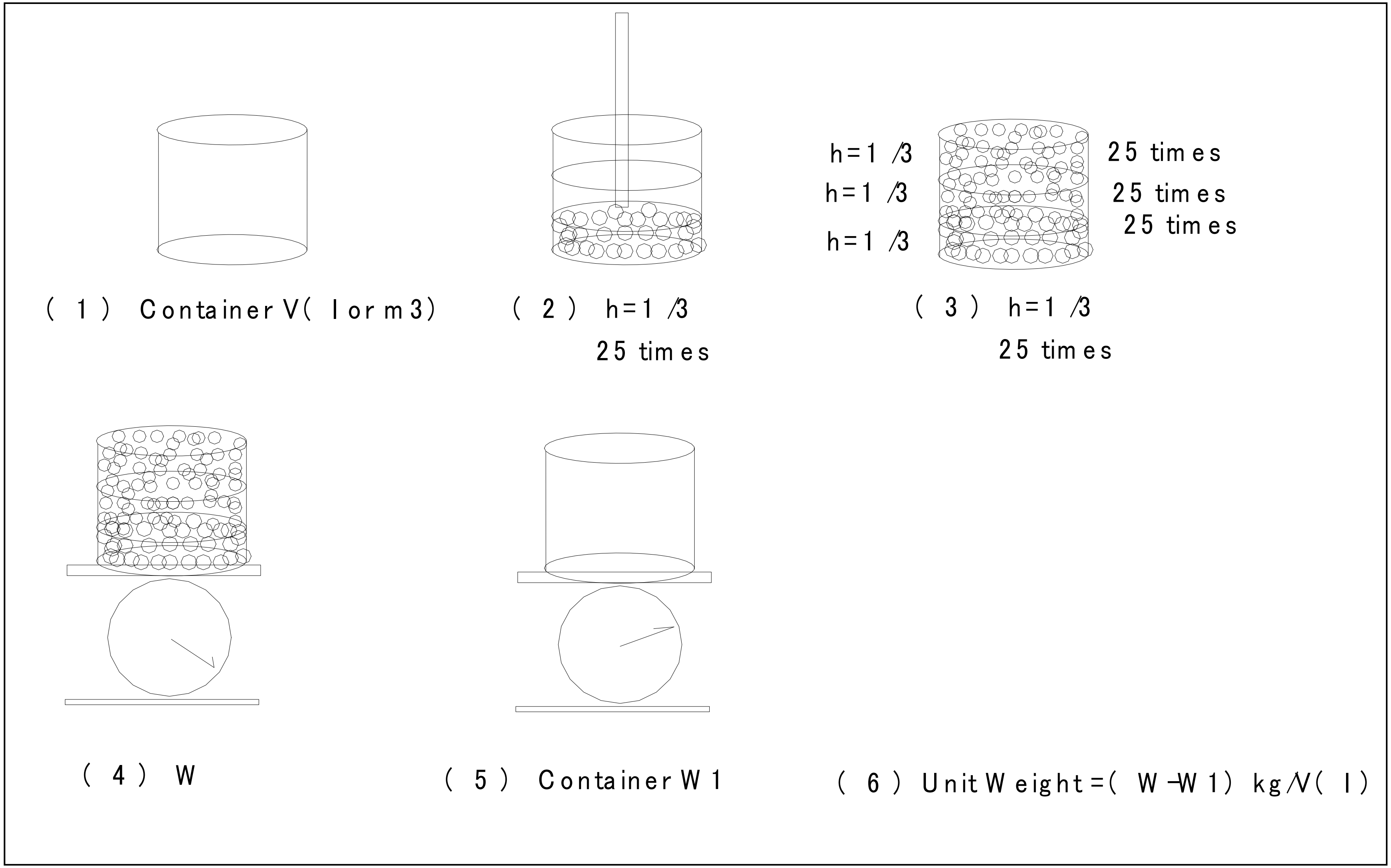
Unit Weight ← Specific Gravity, Grading, Degree of Compaction, Water Content

↑

Effect

Unit Weight	
Fine Aggregate	1450-1700 kg/m3
Coarse Aggregate	1550-1850kg/m3
Combined Aggregate	1750-2000kg/m3

(160) Unit Weight (2)

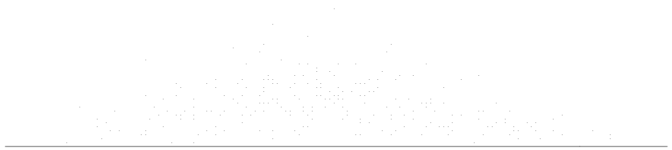


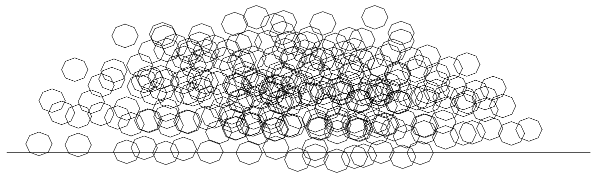
(161) Percentage of Void Ratio of Aggregate

(161) Percentage of Void Ratio of Aggregate

Fine Aggregate	30–45 %
Coarse Aggregate	30–40 %

(162) Harmful Material of Aggregate





Fine Aggregate

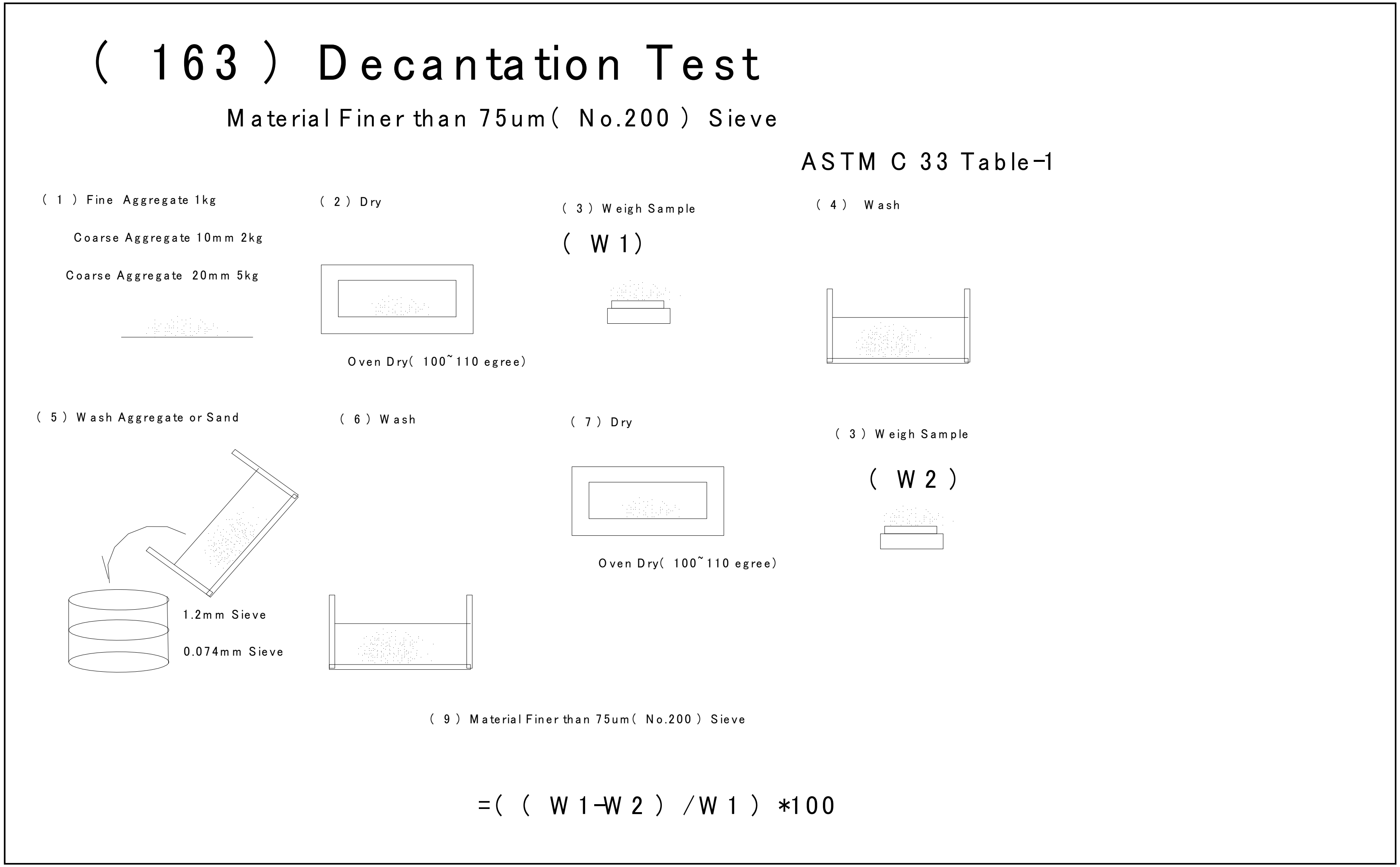
Coarse Aggregate

Aggregate

1 Clean

2 Not Include Clay, Silt and Harmful Material

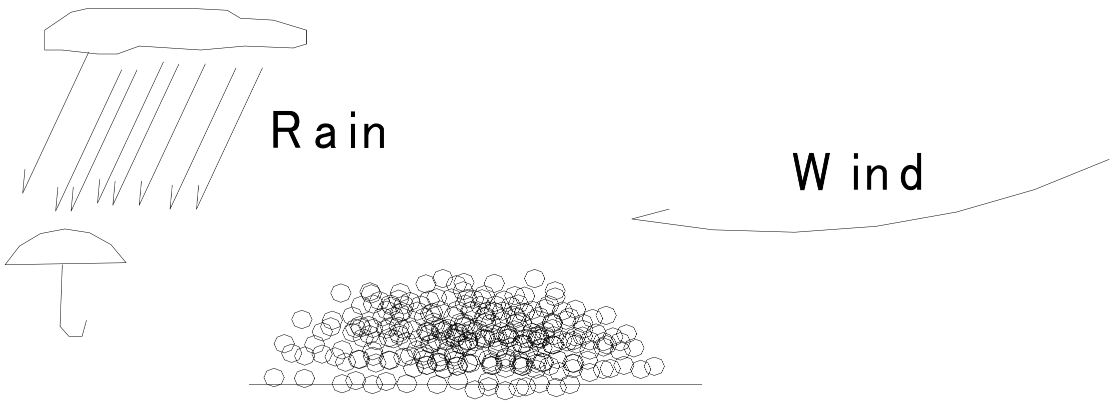
(163) Decantation Test



（ 164 ） Durability of Aggregate

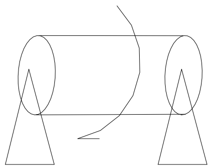
Specific Gravity → Big
Absorption Ratio → Small

→ Good Durability



(165) Abrasion

Los-Angels Abrasion Test
Road Pavement
Heavy Traffic



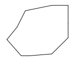
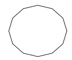
1000 Times

1000 Times
1.7mm Sieve
Retained Weight
Percentage of Abrasio
=((Abrasion Loss Weight/Sample Weight Before Test)) *100

Road Pavement-35%
Dam Concrete-40%

(166) Crushed Stone

(166) Crushed Stone

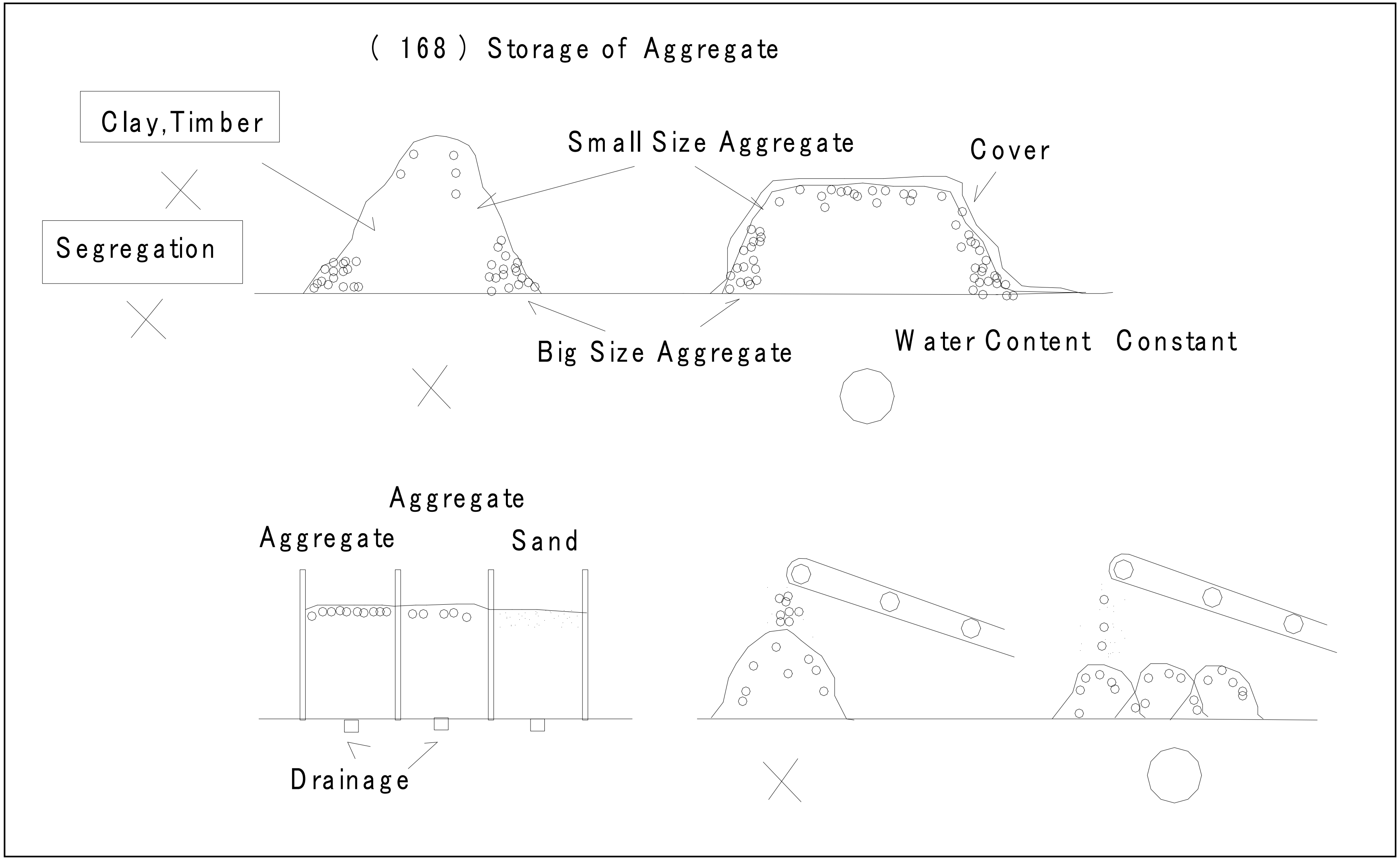
	 Crushed Stone	 River Gravel
Shape	Square	Round
Void Ratio	Big	Small
Fluidity	Bad	Good
Fine Aggregate Content Water Cement	Much	Not Much

(167) Lightweight Aggregate

(167) Lightweight Aggregate

Below 1.9t/m3

(168) Storage of Aggregate



(169) Water

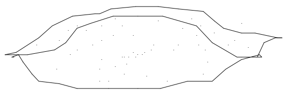
Drinking Water Rain River Water Underground Water	Oil Acid Chloride Organic Impurities in Water
○	×

(170) Cement Aggregate Water

(170) Cement Aggregate Water

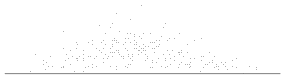
Cement

1 No Weathering
2 Specific Gravity→Big

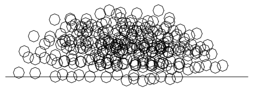


Cement

Aggregate



Fine Aggregate



Coarse Aggregate

1 Hard
2 No Clay,No Timber
3 Durability
4 Specific Gravity→Big
5 Unit Weight→Big
6 No Abrasion
7 Small Absorption
8 Good Shape
9 Good Grading

Water

Drinking Water
Rain
River Water
Underground Water

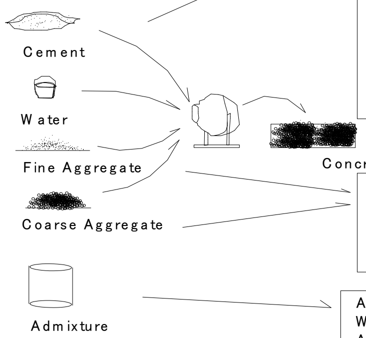
○

Oil
Acid
Chloride
Organic Impurities in Water

×

(171) Admixture

(171) Admixture



Cement
Blended Cement (Blast-Furnance Slag Cement, Portland Pozzolan Cement, Silica Cement, Fly Ash Cement)
Special Cement (Alumina Cement, Ultra Rapid Harding Cement)
Sulfate Resisting Portland Cement
Moderate Heat Portland Cement
Ultra High Early Strength Portland Cement
High Early Strength Portland Cement
Ordinary Portland Cement

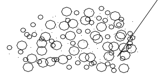
Aggregate
Sand
Crushed Sand
Gravel
Crushed Stone

Admixture
Water Reducing Agent
Accelerator
Retarder
Water Proof Agent

AE Agent——AE Concrete

(173) AE Agent

AE Agent



Ball Bearing

Entrained Air
1 Improve Workability
2 Decrease Bleeding
3 Improve Resisting to Freezing and thawing Action
4 Decrease Water Content
5 Cold -Weather Concreting
6 Decrease Segregation

(174) Water Reducing Agent

Water Reducing Agent
1 Spread Cement Particles
2 Improve Hydration
3 Improve Strength
4 Decrease Water Content
5 Save Cement Content
6 Improve Workability

1 High Strength Concrete——800-1000kg/cm2
2 Fluidized Concrete——Slump 7cm Base Concrete
3 High Slump Concrete——Slump 14cm

(177) Water Proofing Agent

1 Decrease Absorption and Permeability
2 AE Agent Reducing Agent

(176) Retarder

1 Delay Cement Setting
2 Cold-Weather Concreting
3 Transport for Long Time
4 Mass Concrete

1 Improve Early Age Strength
2 Increase Hydration Heat

(175) Accelerator

1 Remve Form Quickly
2 Shorten Curing Period
3 Improve Hardening in Cold Weather Concrete

Calcium Chloride=1-2% of Cement Weight

1 Improve Early Age Strength
2 Increase Hydration Heat

(172) Pozzolan

(172) Pozzolan

Fly Ash
1 Early Compressive Strength-Low
Long-term Compressive Strength-High
2 Chemical Erosion Resistance-High
(Acid,Sea Water,Sewage)
3 Watertightness-High
4 Heat of Hydration-Low
5 Dry Shrinkage,Cracks-Low
6 Fluidity-High

Uses
1 Dam
2 Structure under Water

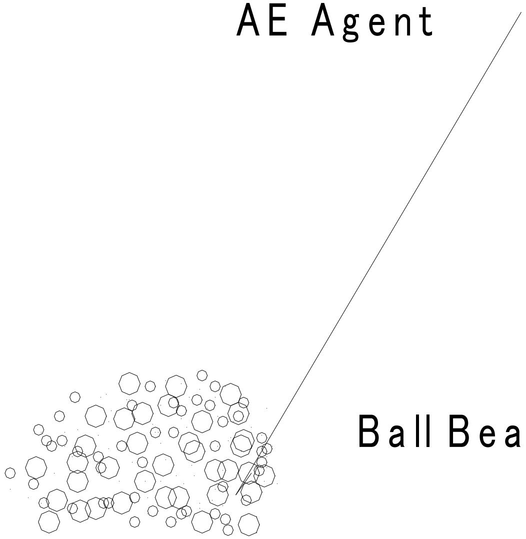
A Fly Ash Content 5-10%
B Fly Ash Content 10-20%
C Fly Ash Content 20-30%

Fly Ash
1 Improve Workability
2 Decrease Bleeding
3 Decrease Heat of Hydration
4 Improve Strength and Water Tightness under Wet Curing
5 Improve Chemical Erosion Resistance
6 Dry Shrinkage,Cracks-Low
7 Improve Consistency
8 Decrease Unit Water Content

(173) AE Agent

(173) AE Agent

AE Agent



Ball Bearing

Entrained Air

1 Improve Workability
2 Decrease Bleeding
3 Improve Resisting to Freezing and thawing Action
4 Decrease Water Content
5 Cold -Weather Concreting
6 Decrease Segregation

(174) Water Reducing Agent

Water Reducing Agent
1 Spread Cement Particles
2 Improve Hydration
3 Improve Strength
4 Decrease Water Content
5 Save Cement Content
6 Improve Workability

1 High Strength Concrete——800-1000kg/cm2
2 Fluidized Concrete——Slump 7cm Base Concrete
3 High Slump Concrete——Slump 14cm

(175) Accelerator

1 Remve Form Quickly
2 Shorten Curing Period
3 Improve Hardening in Cold Weather Concrete

Calcium Chloride=1–2% of Cement Weight

1 Improve Early Age Strength
2 Increase Hydration Heat

(176) Retarder

1 Delay Cement Setting
2 Cold-Weather Concreting
3 Transport for Long Time
4 Mass Concrete

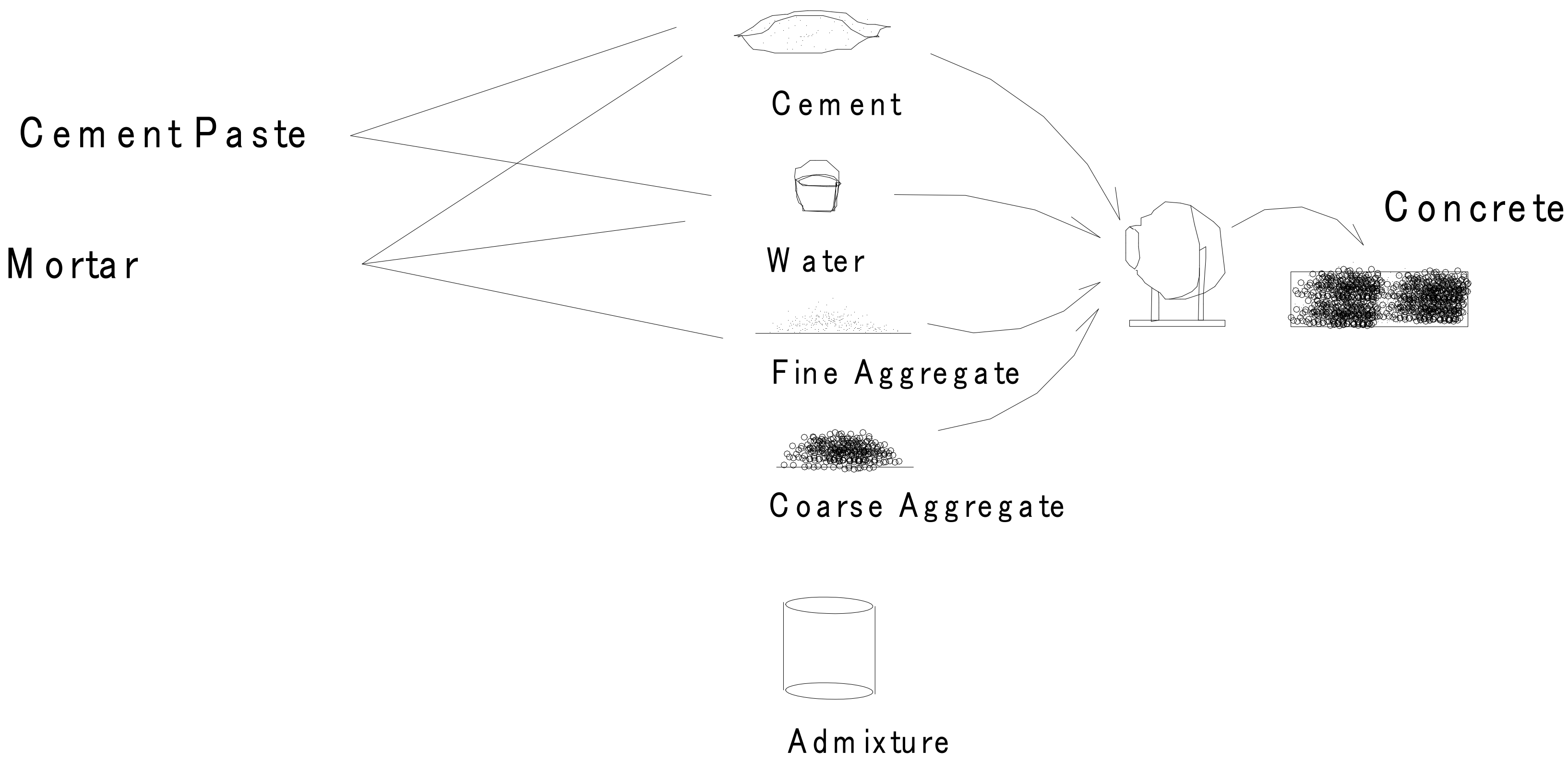
1 Improve Early Age Strength
2 Increase Hydration Heat

(177) Water Proofing Agent

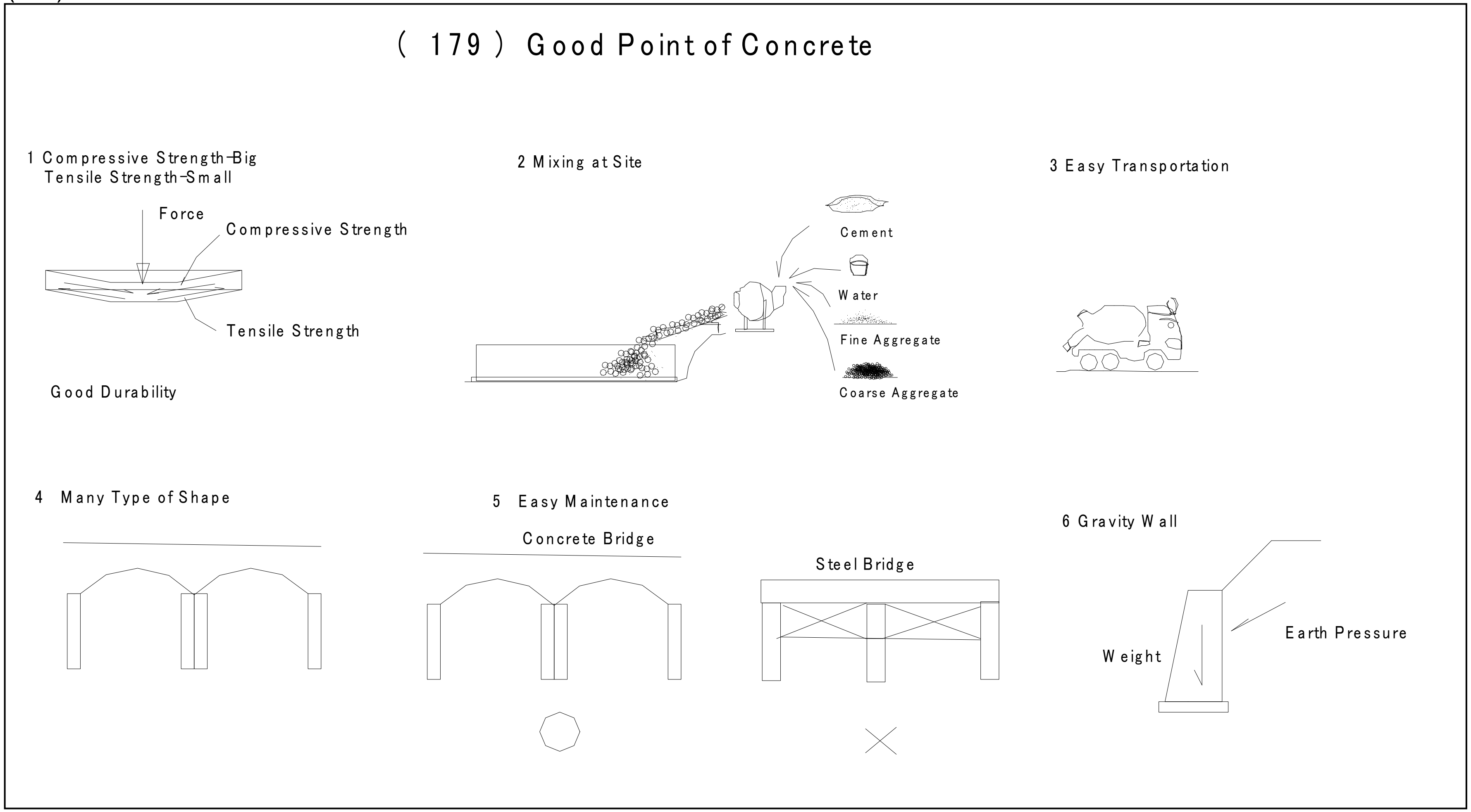
1 Decrease Absorption and Permeability
2 AE Agent Reducing Agent

(178) Concrete

(178) Concrete



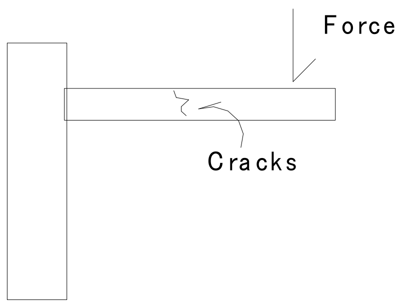
(179)Good Point of Concrete



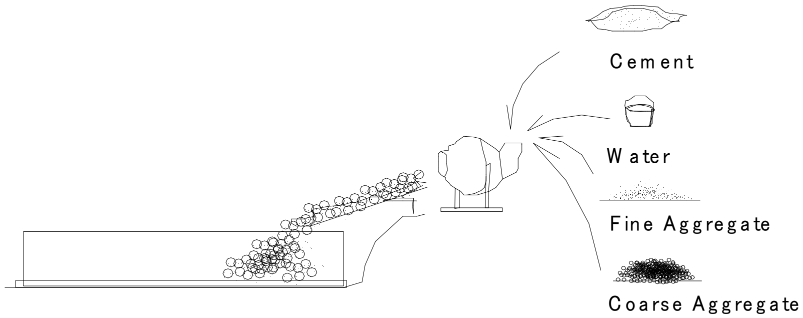
(180) Bad Point of Concrete

(180) Bad Point of Concrete

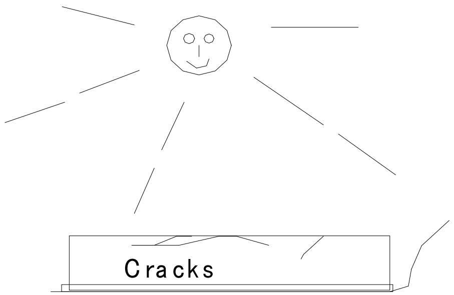
1 Tensile Strength Small



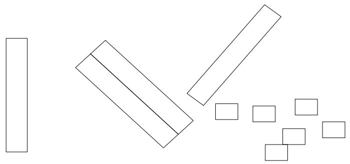
2 Long Curing Day until Hardening



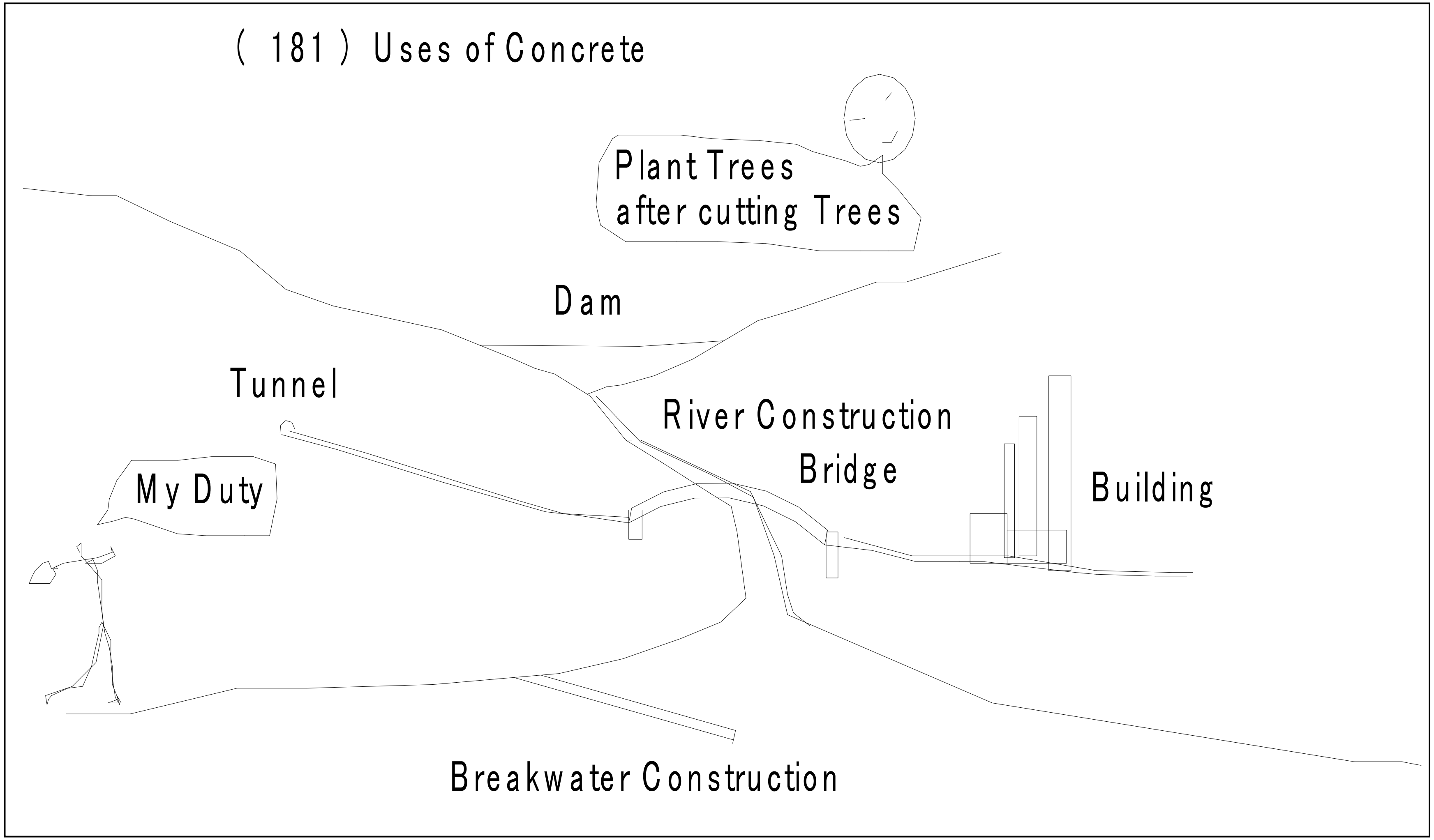
3 Cracks by Dry Shrinkage



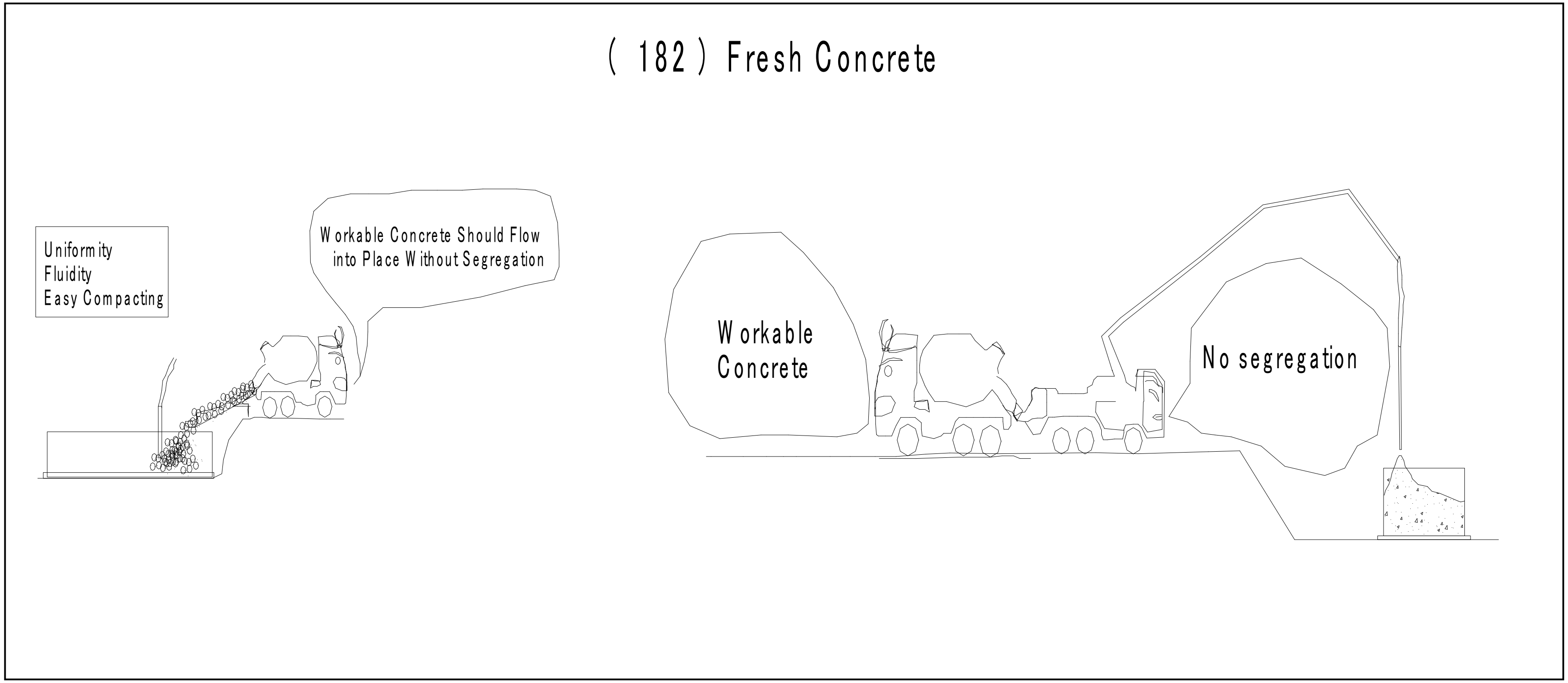
4 Difficult Disposal Concrete



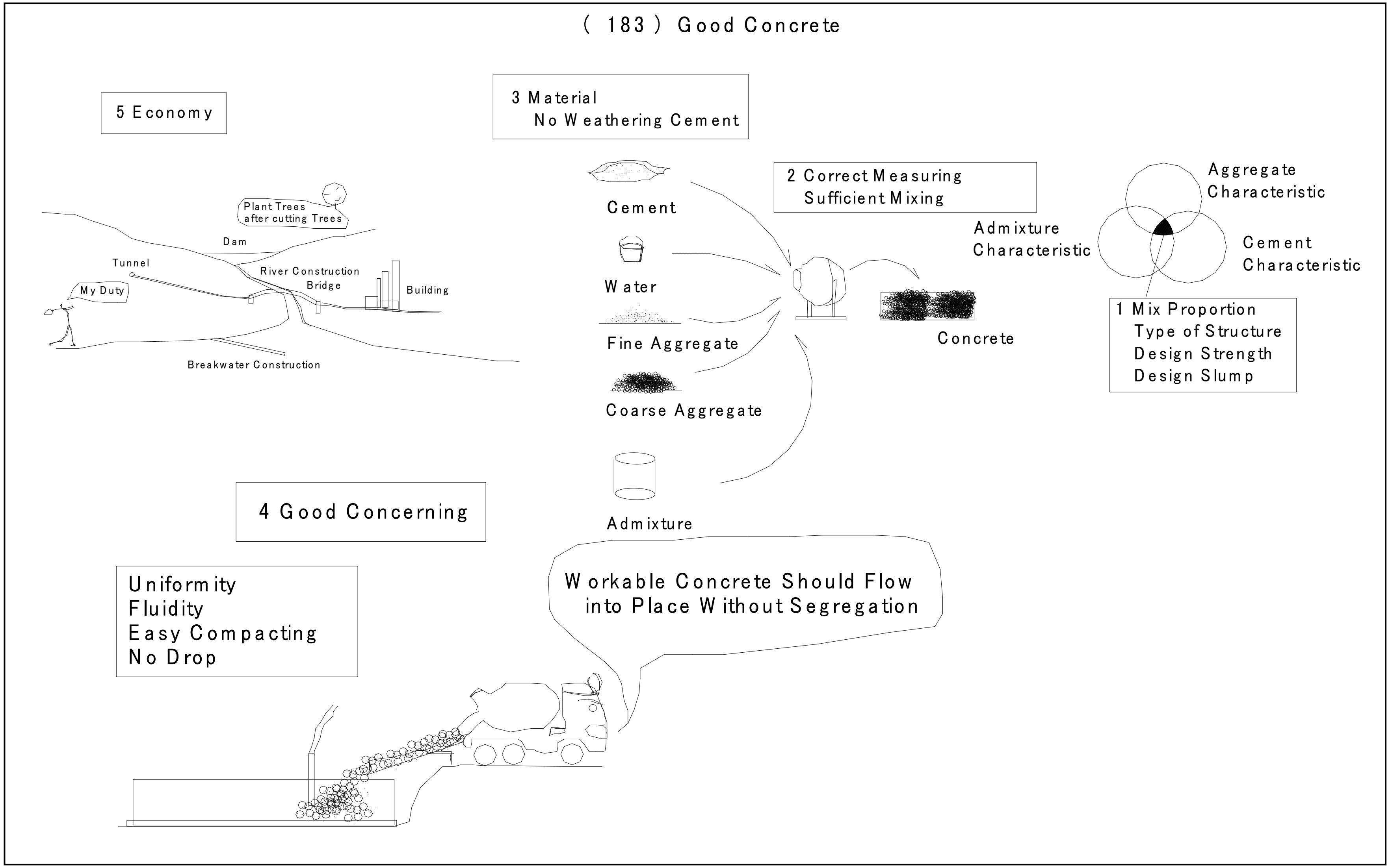
(181) Uses of Concrete



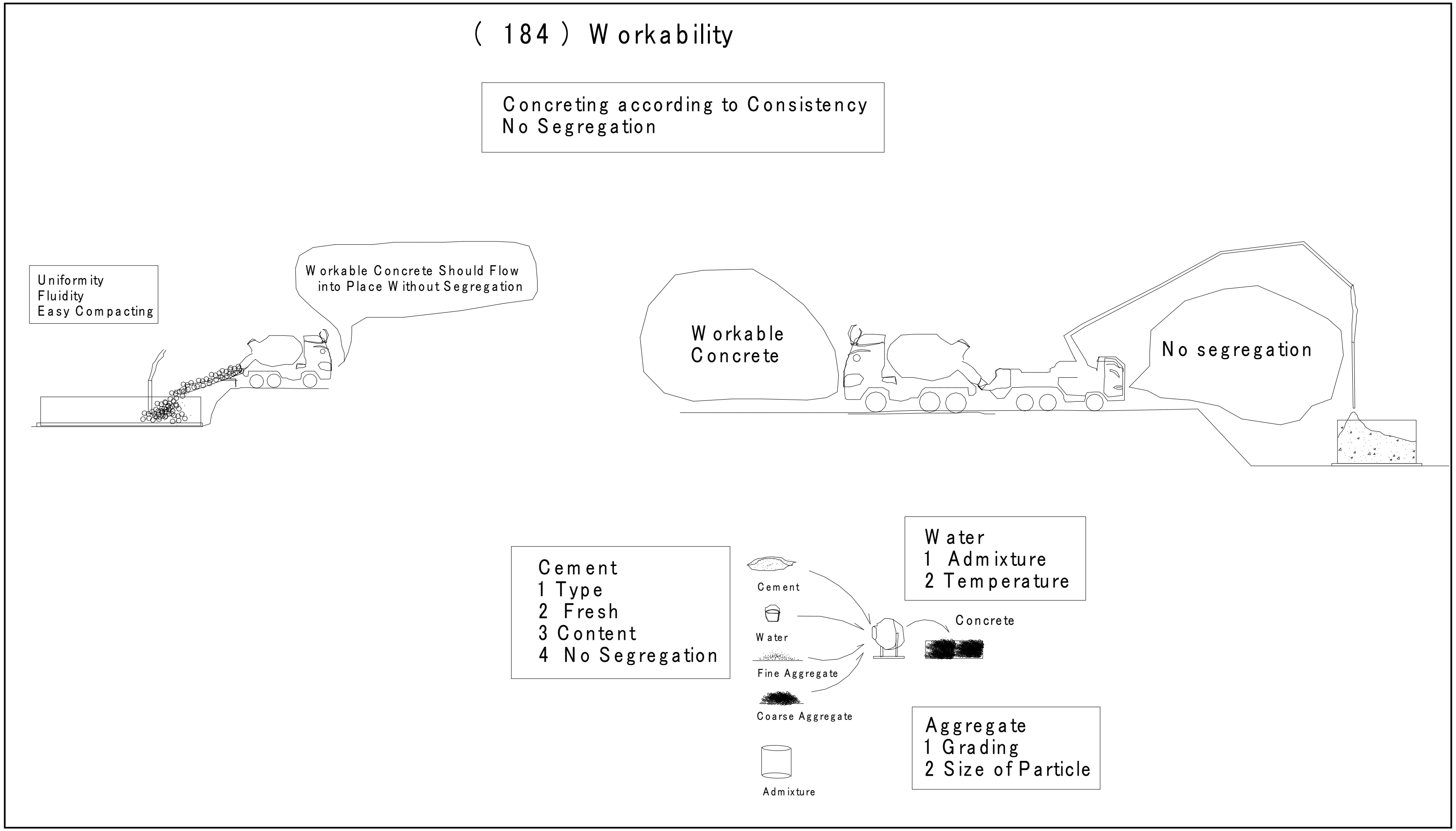
(182) Fresh Concrete



(183)Good Concrete



(184) Workability



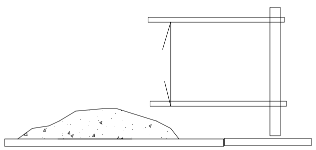
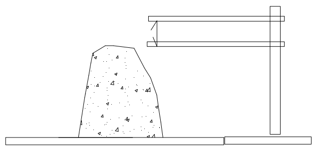
(185)Consistency

(185) Consistency

ASTM C 143

Consistency Measured by Slump

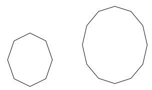
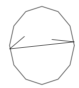
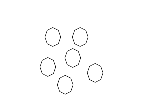
Consistency –Workability

Slump(cm) -High	Slump(cm) -Low
	
Soft	Hard

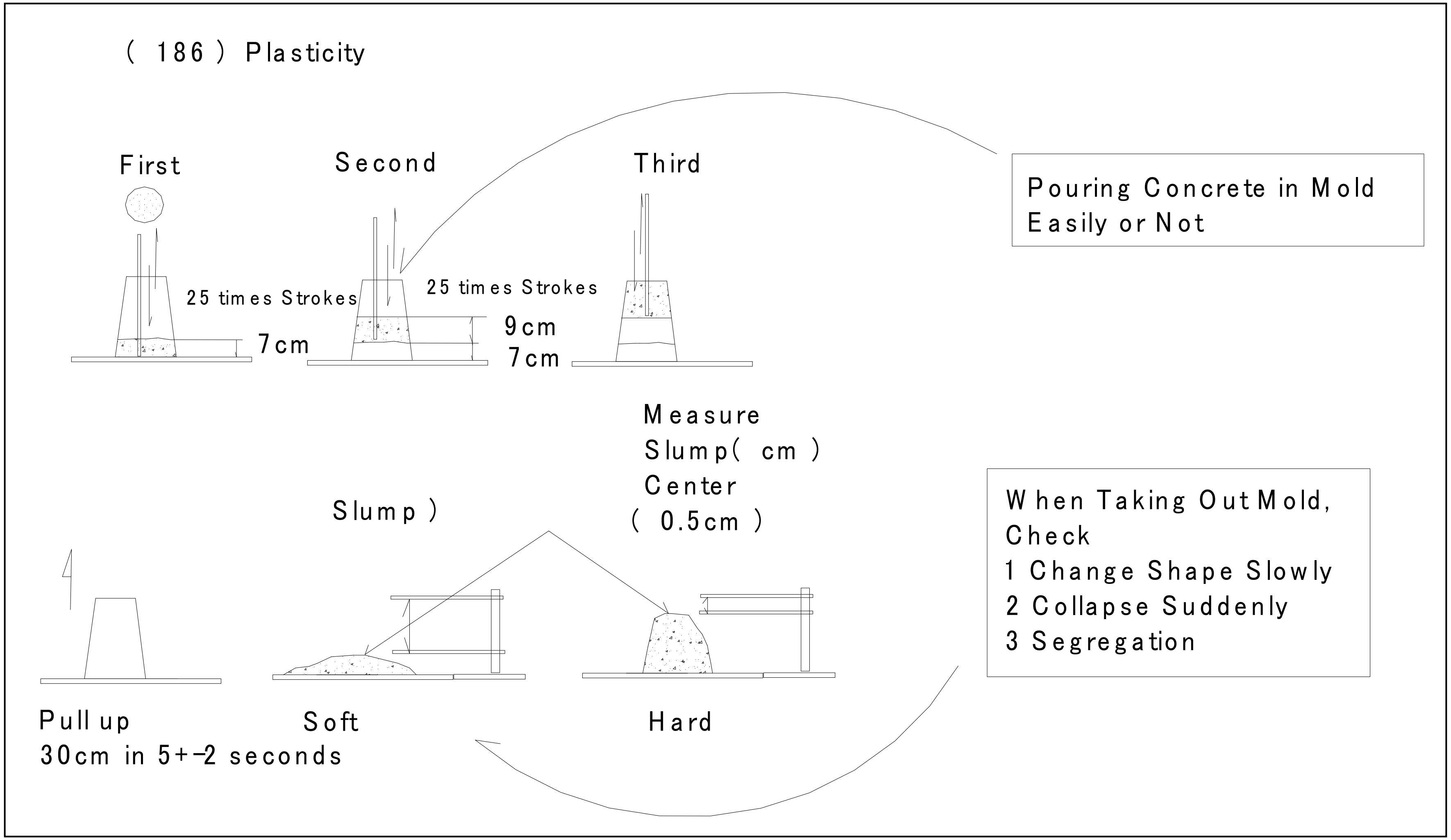
Plenty Water

Not Plenty Water

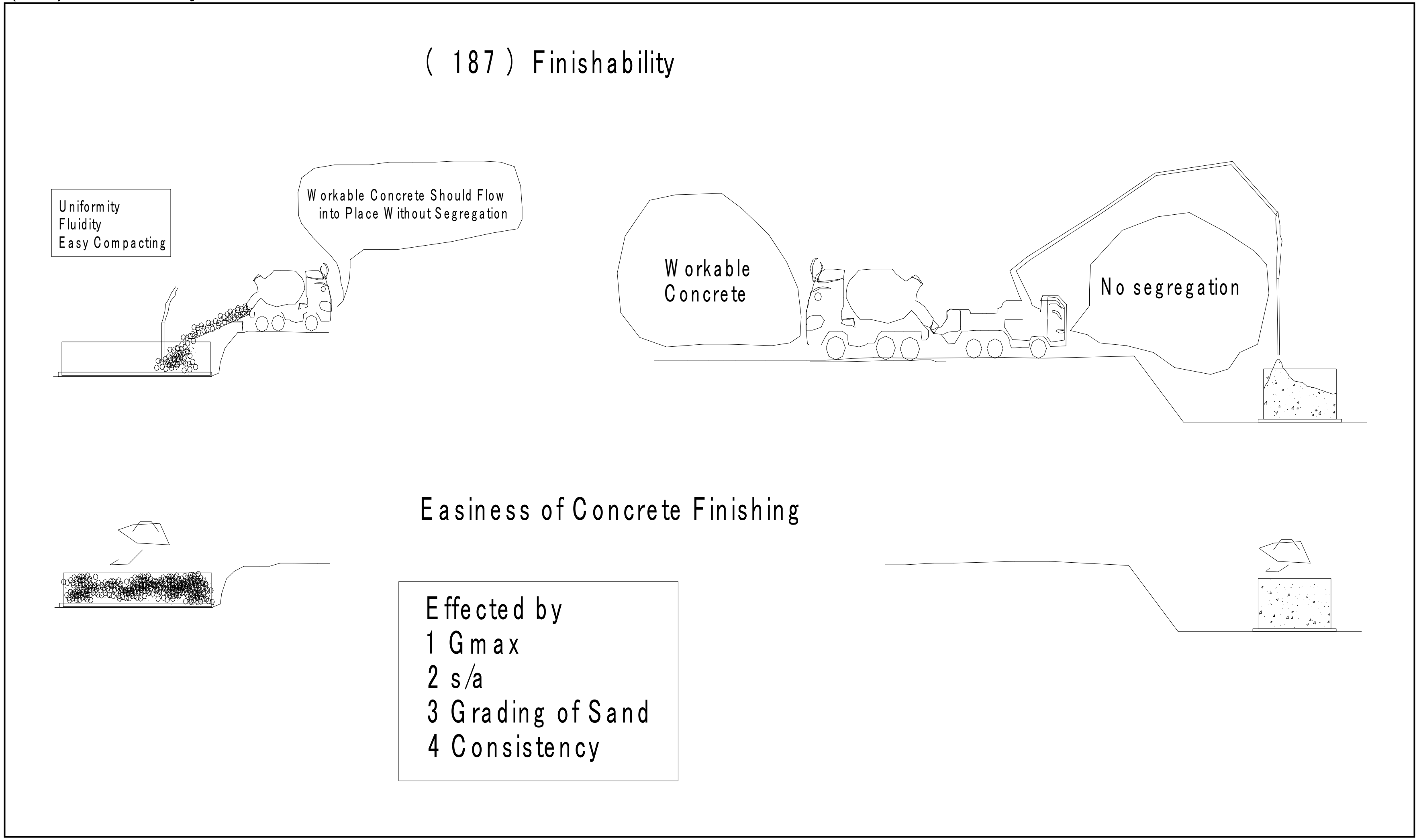
Consistency –Required Water Content

Aggregate Round	Aggregate Maximum Size	Entrained Air
Water–A Little	Water–A Little	Water–A Little
		

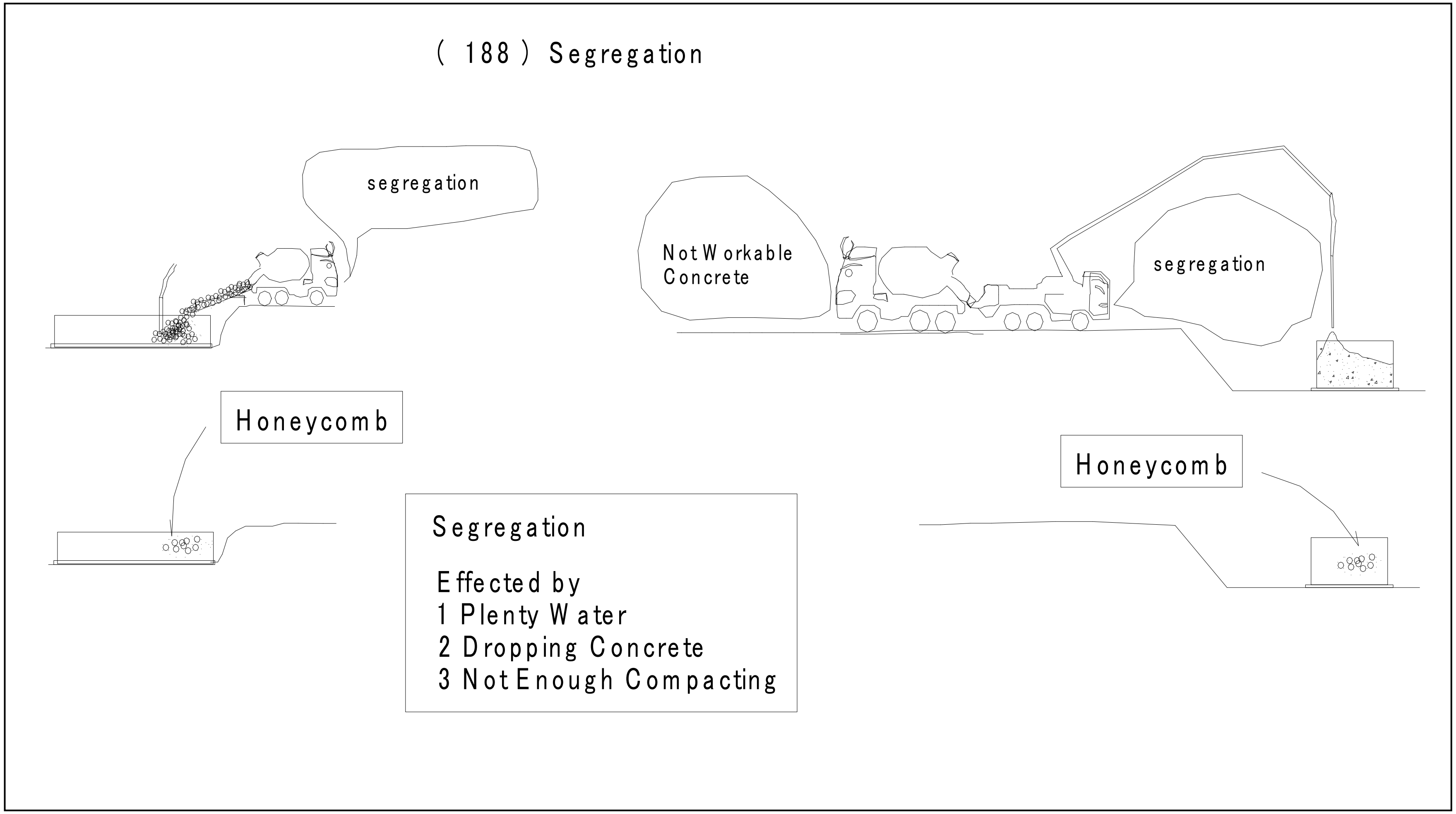
(186) Plasticity



(187) Finish Ability



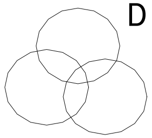
(188) Segregation



(189) Air Content

(189) Air Content

Good Point

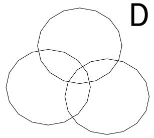


Durability

Workability

Strength

Bad Point



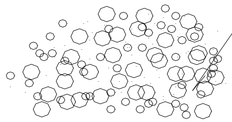
Decrease Bond Strength

Decrease Unit Weight

Decrease Strength a little

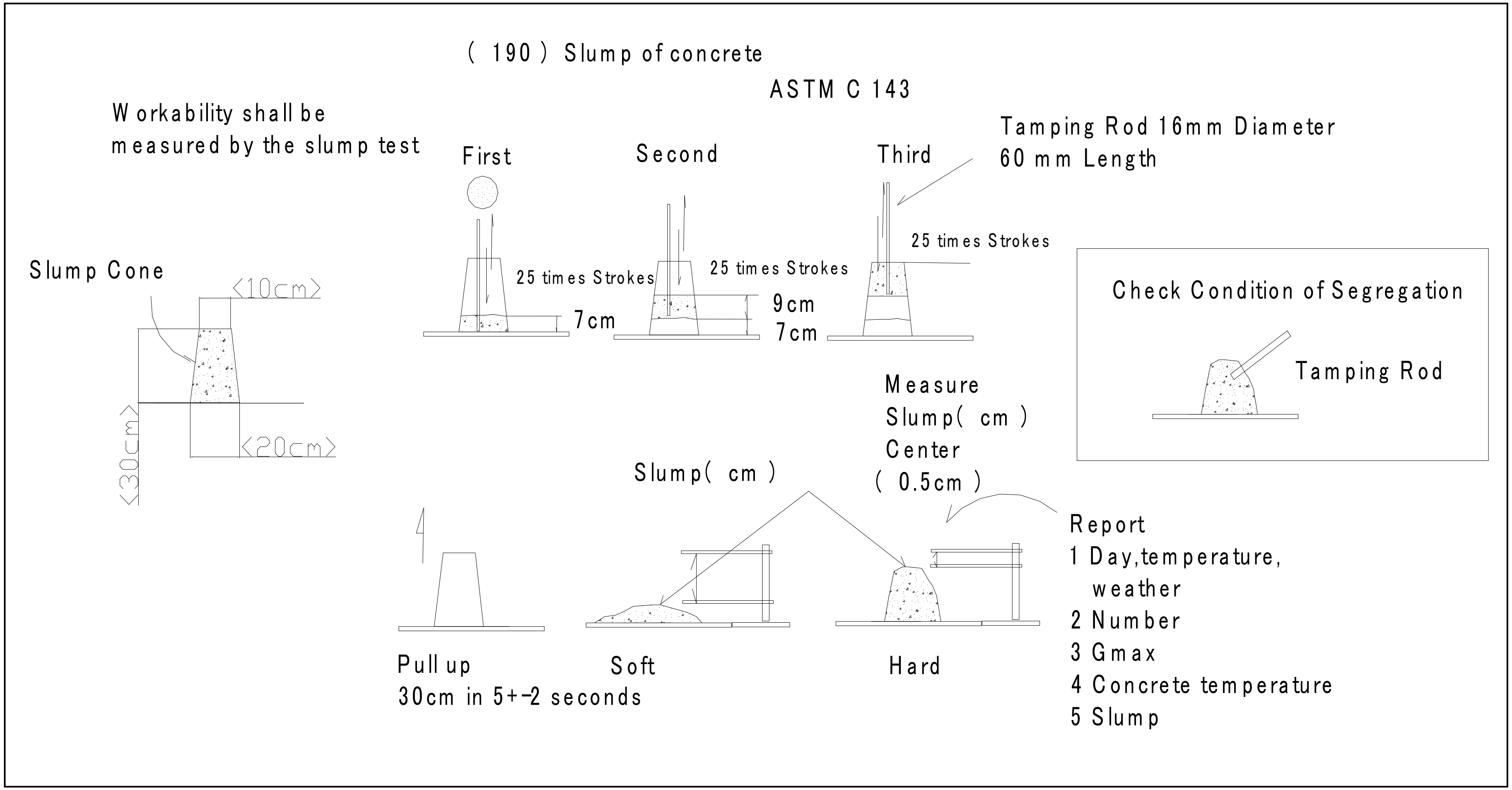
AE Agent

Entrained Air
1 Improve Workability
2 Decrease Bleeding
3 Improve Resisting to Freezing and thawing Action
4 Decrease Water Content
5 Cold -Weather Concreting
6 Decrease Segregation

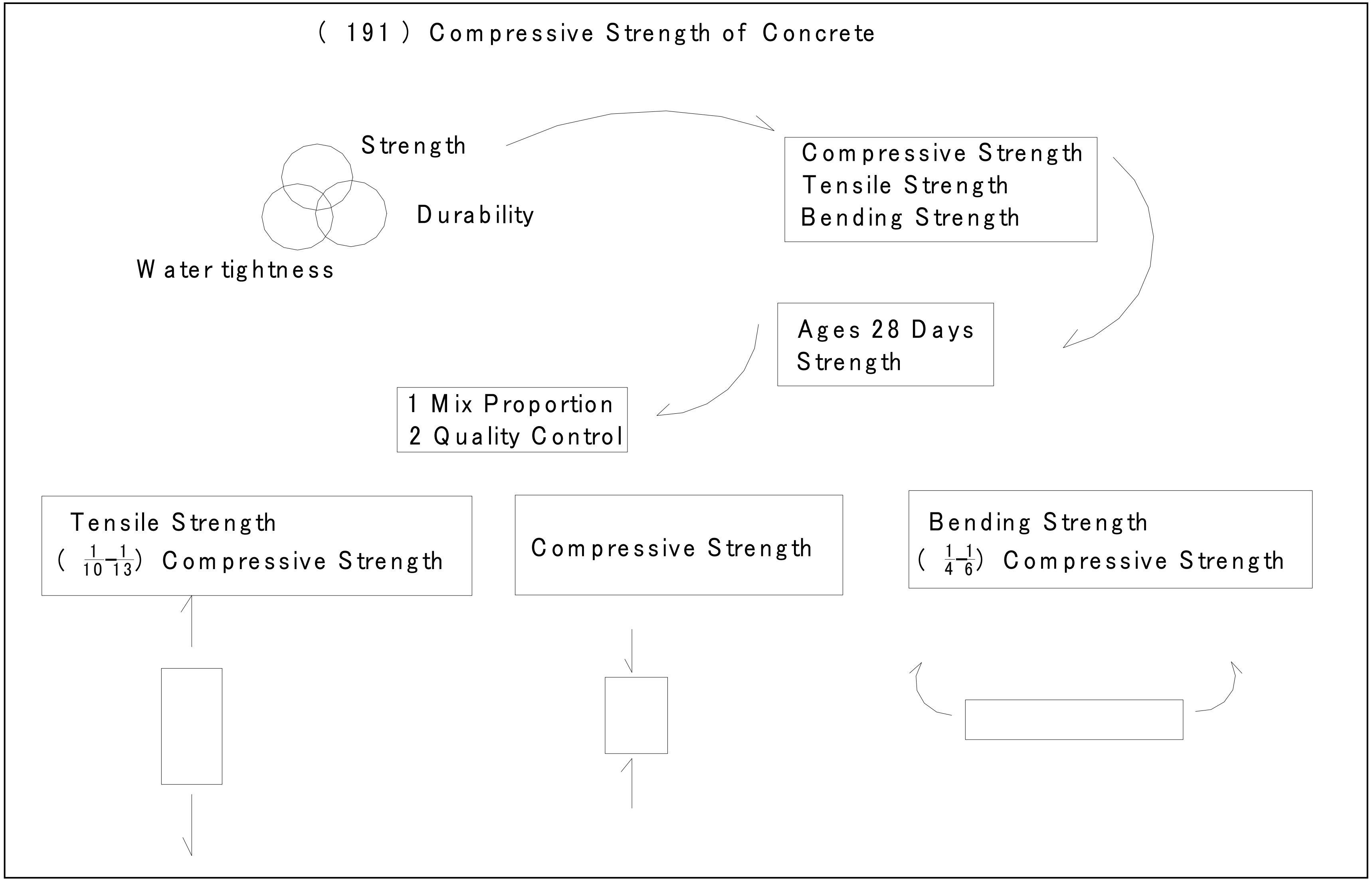


Ball Bearing

(190) Slump of Concrete (ACI 143)



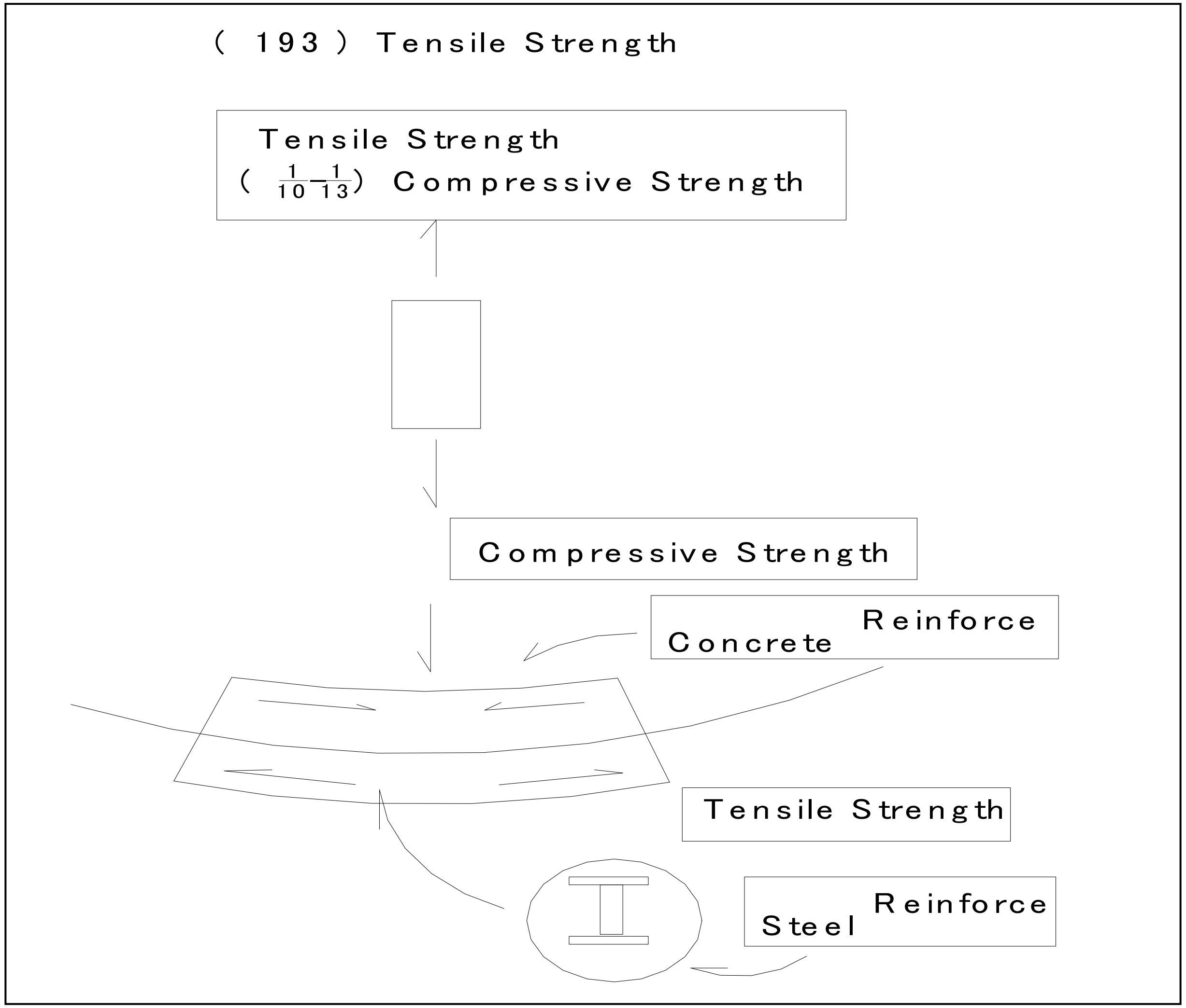
(191) Compressive Strength of Concrete (I)



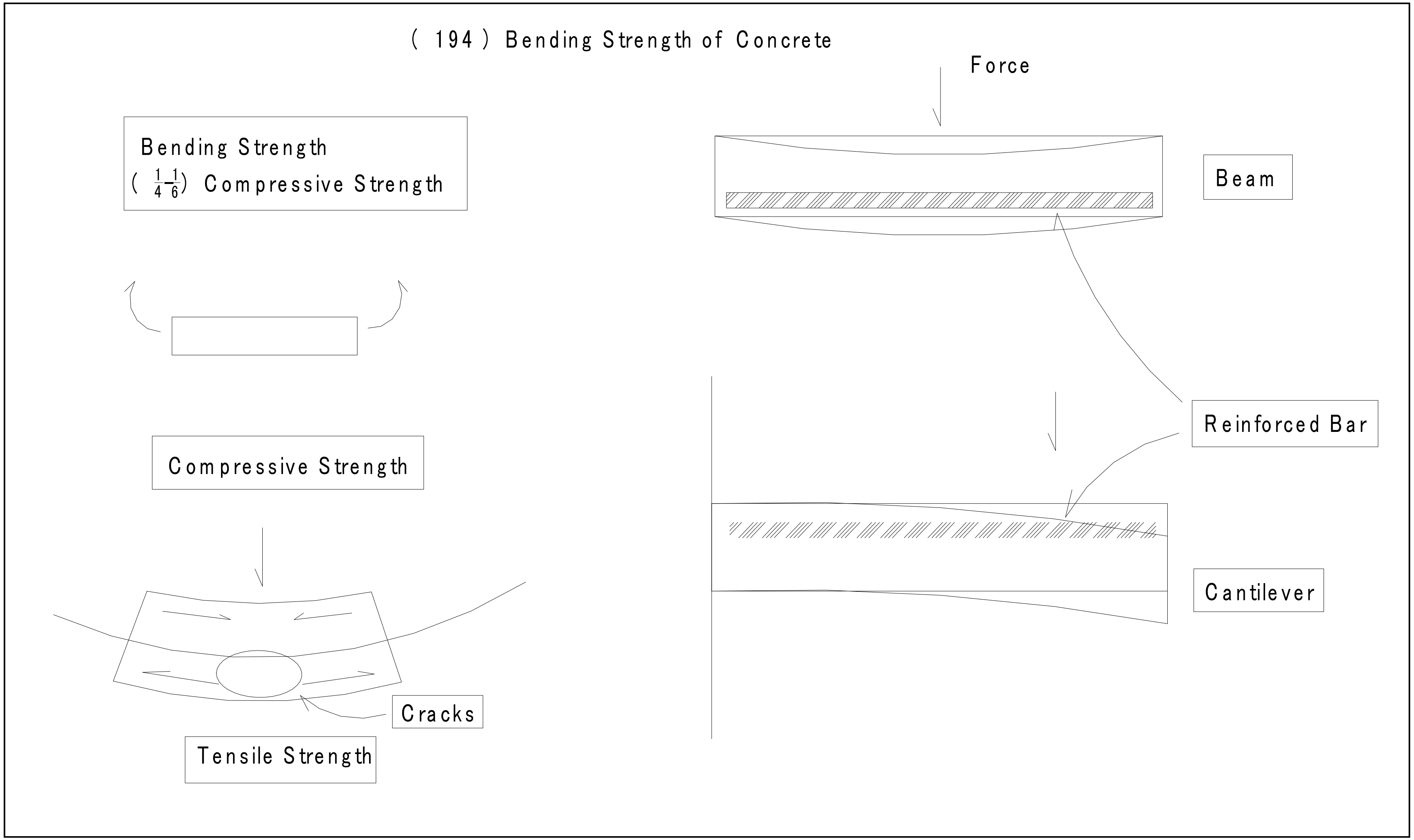
(192) Compressive Strength of Concrete (2)

1 Type of Concrete
2 Material Quality
3 Construction Method
4 Weather Condition

(193) Tensile Strength

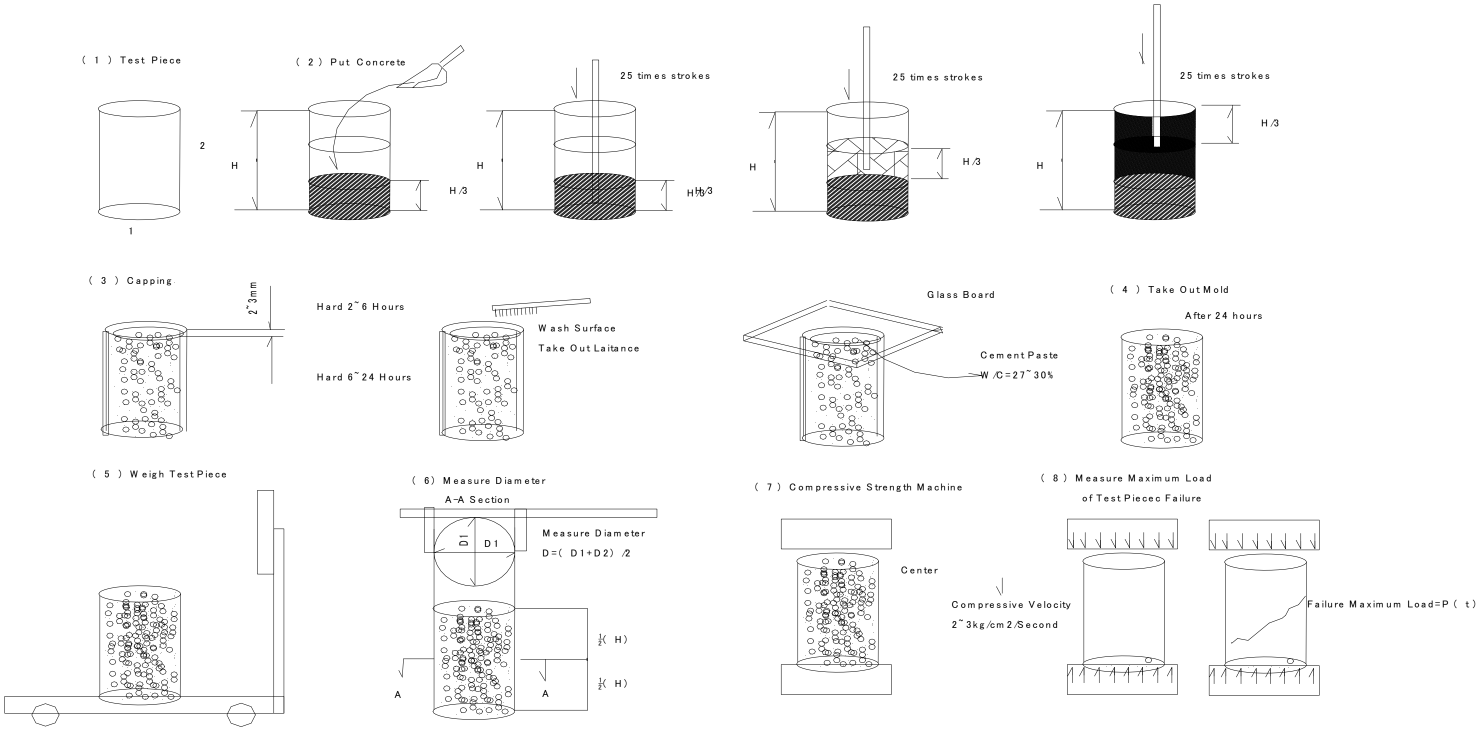


(194) Bending Strength of Concrete (I)



(195) Compressive Strength Test-2

ASTM C 39-96



(9) Calculation of Compressive Strength(kg/cm2)

Compressive Strength(kg/cm2) =P/A

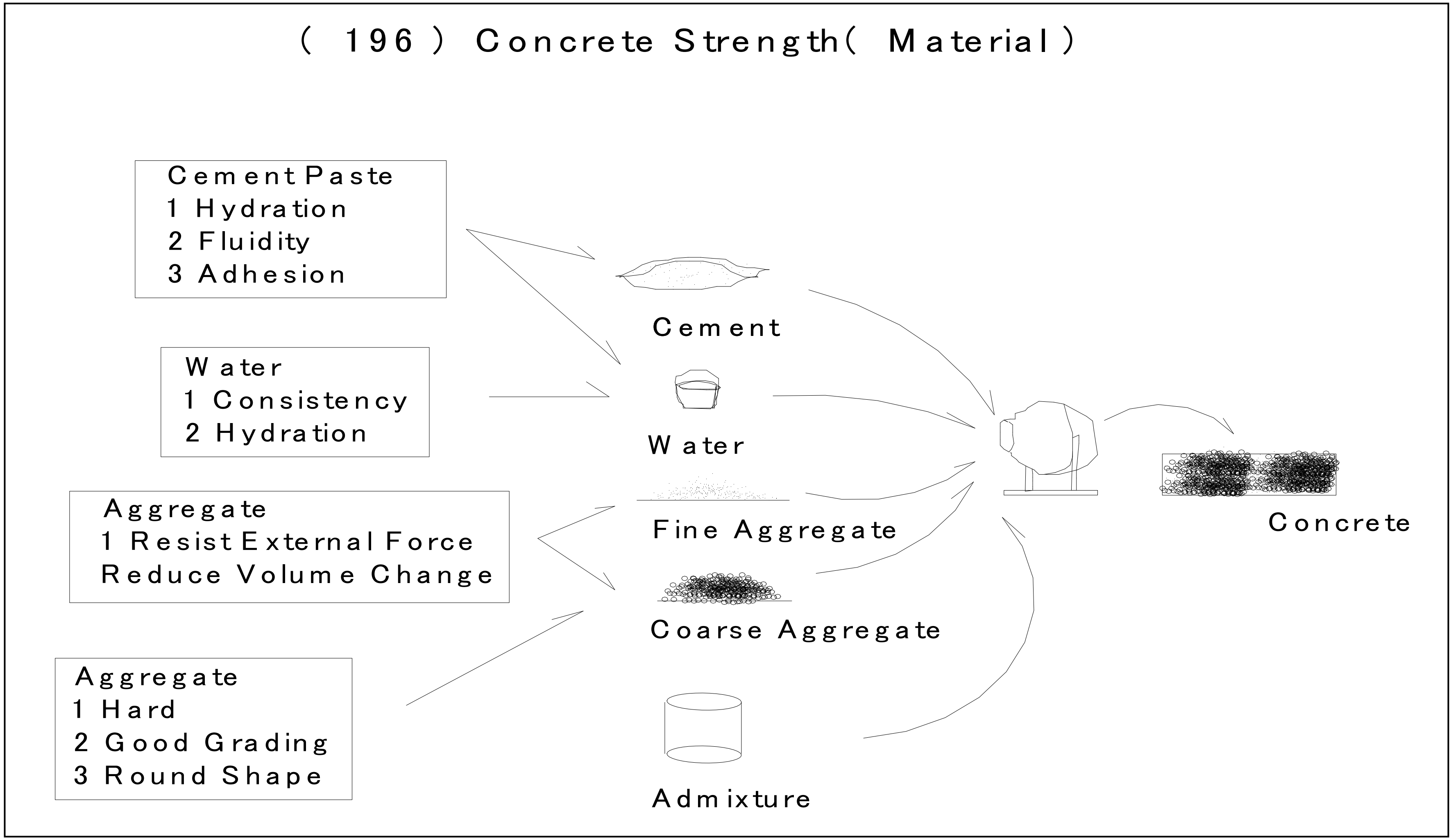
P:Maximum Load

A:Area

(10) Report

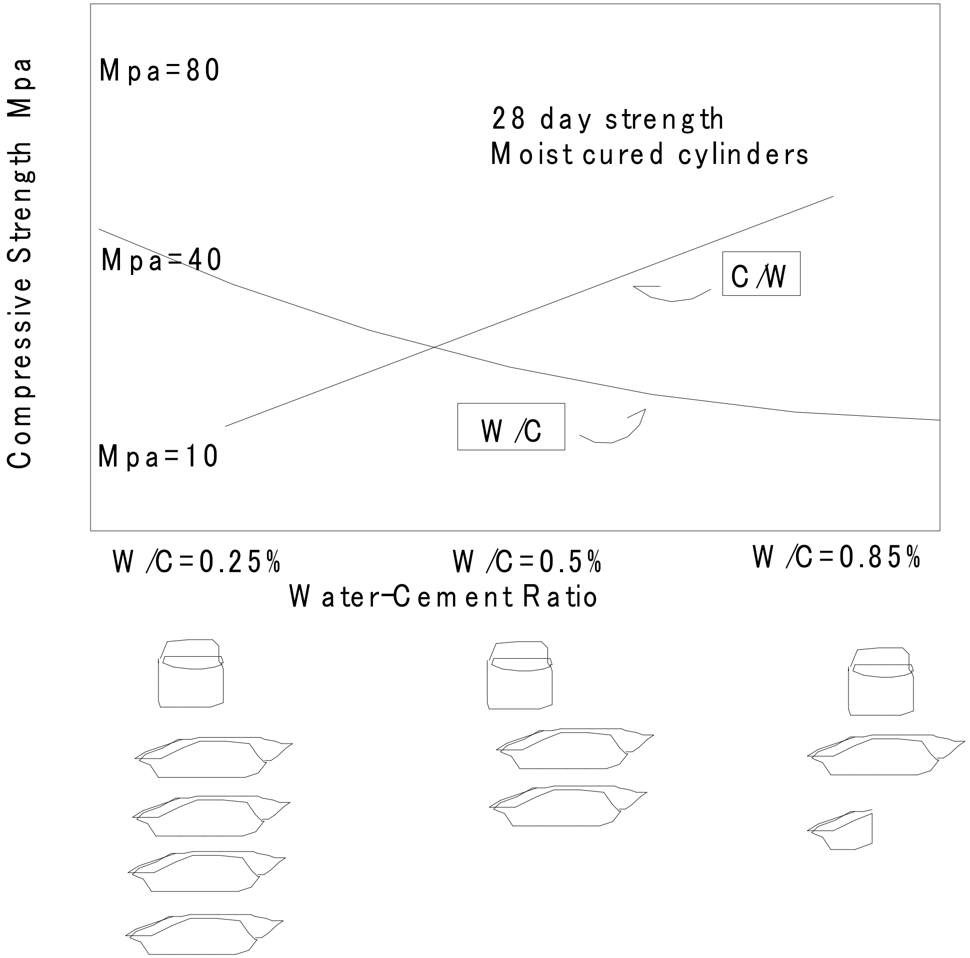
1 Test Piece No
2 Ages
3 Diameter of Test Piece
4 Maximum Load
5 Compressive Strength
6 Curing Method and Compressive Strength
7 Failure Condition of Test Piece

(196) Concrete Strength (Material)



(197) Mix Proportion and Compressive Strength

(197) Mix Proportion and Compressive Strength

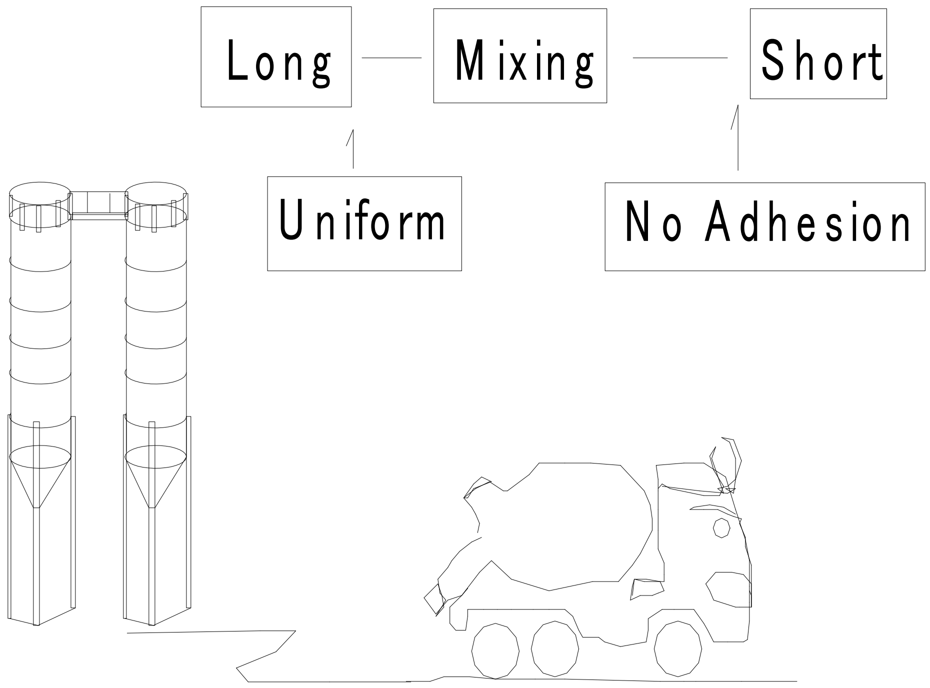


1 W/C is unproportional to Strength
2 C/W is proportional to Strength
3 Durability and Watertightness are proportion to Unit Cement
4 Durability and Watertightness are unproportion to Unit Water

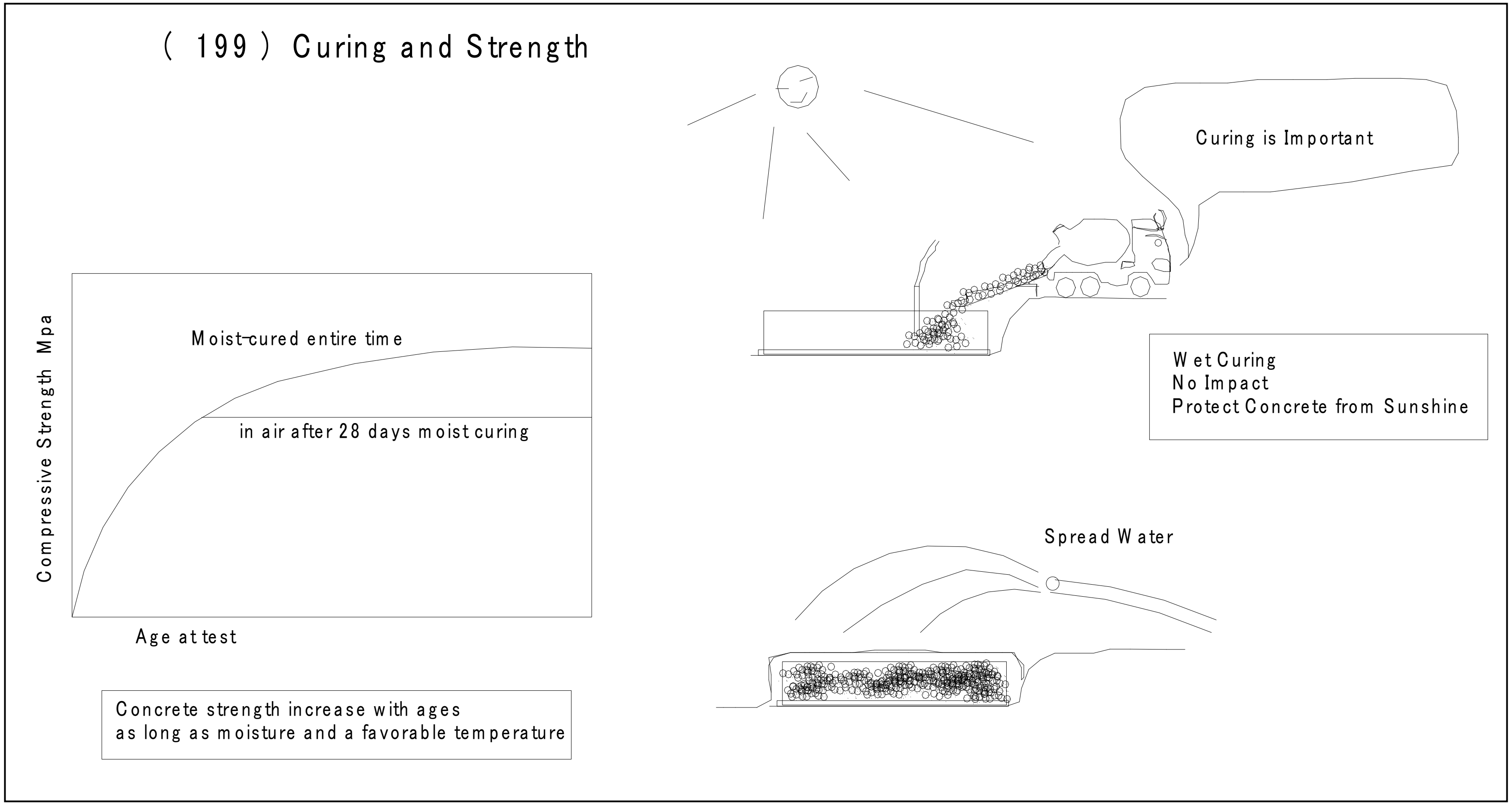
(198) Mixing and Strength

Sufficient Mixing

1 Good Quality
  Uniformity
2 High Strength
3 A Little Segregation
4 Good Workability



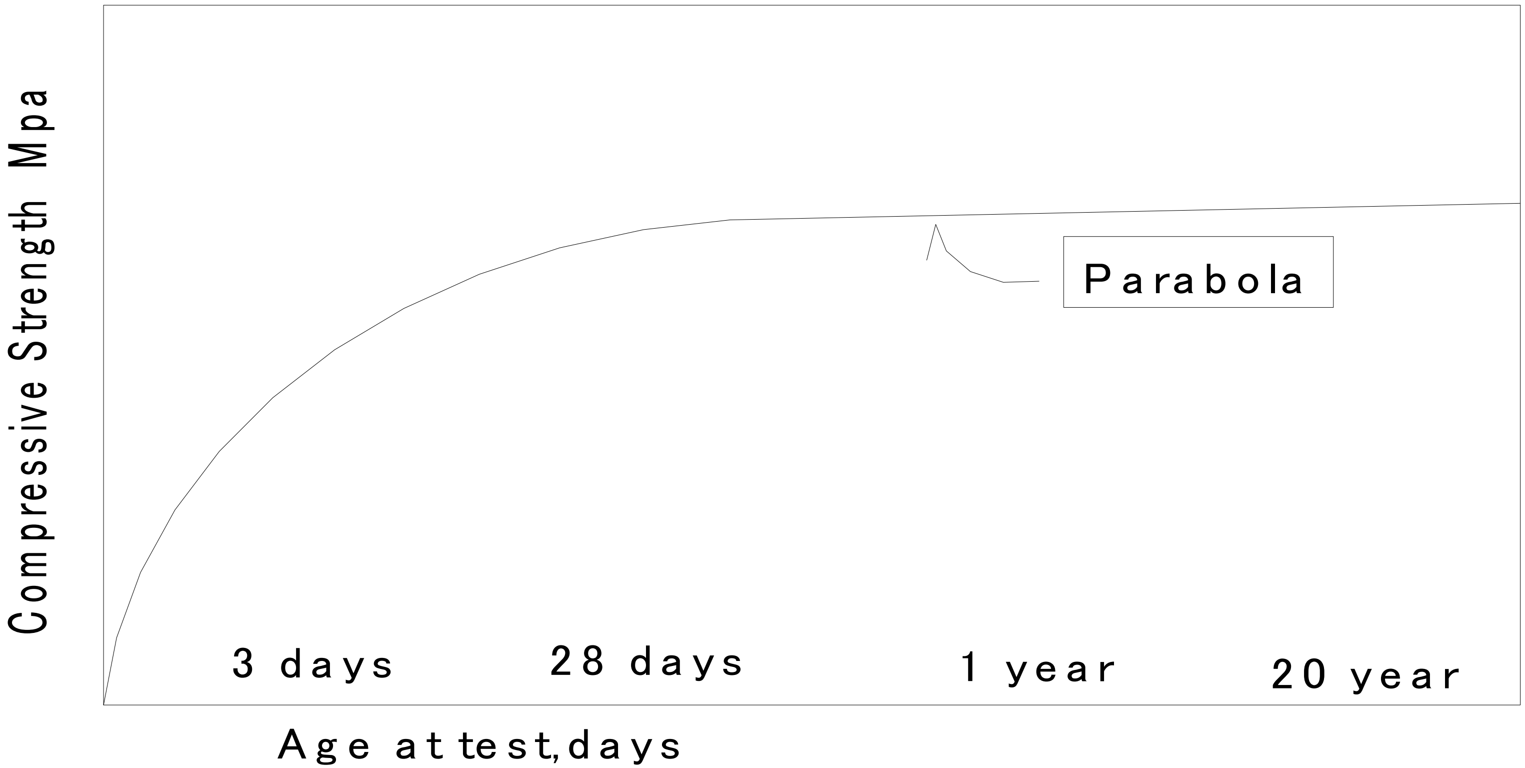
(199) Curing and Strength



(200) Ages and Strength

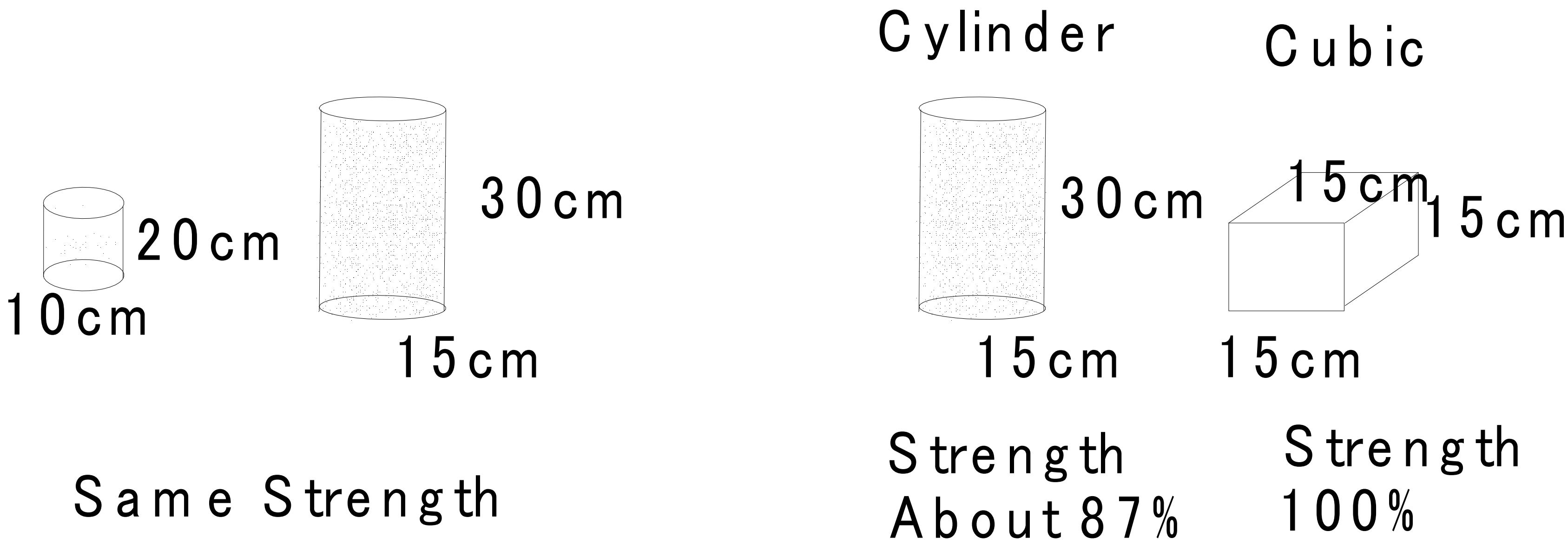
(200) Ages and Strength

Concrete continues to gain strength for many years when moisture is provided by rainfall



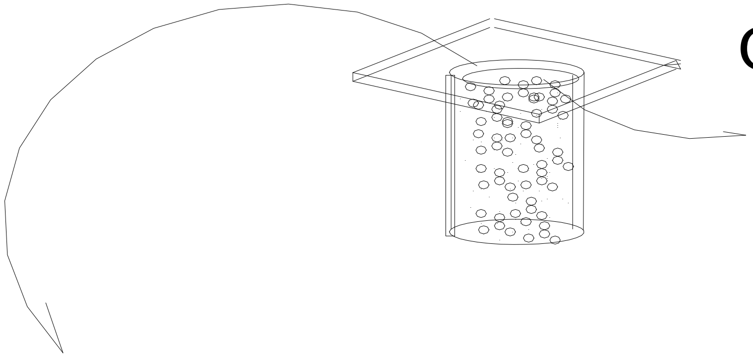
(201) Test Piece and strength (I)

(201) Test Piece and Strength (I)



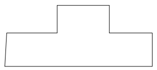
(202) Test Piece and strength (II)

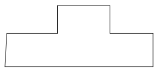
(202) Test Piece and Strength (II)



Capping
Glass Board
Cement Paste
W/C=27~30%

Capping Surface

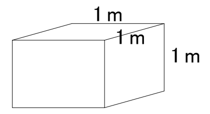
 0.1mm , Strength 6–10% Down

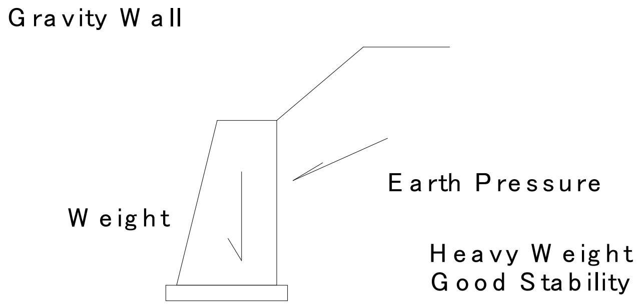
 0.25mm , Strength 35% Down

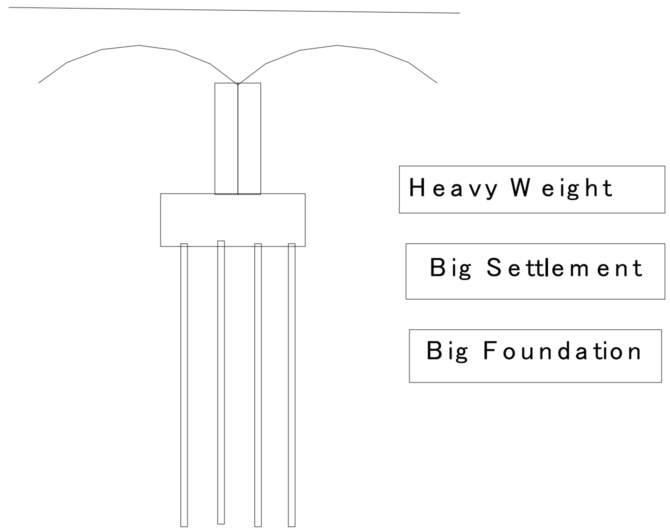
(203)Unit Weight

（ 203 ） Unit Weight

Plain Concrete 2300–2350 kg/m3
Reinforced Concrete 2400–2500kg/m3
Light Weight Concrete 1500–2000kg/m3



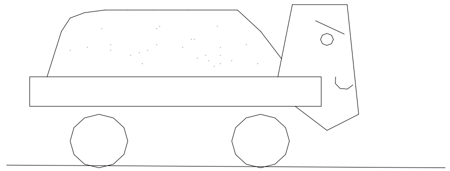




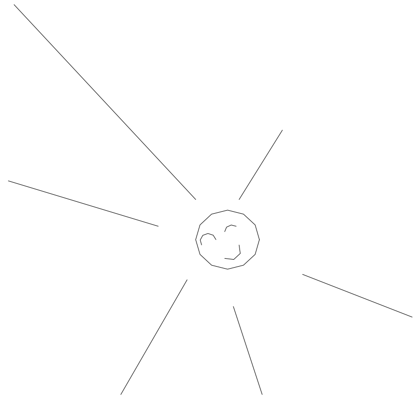
(204) Durability

(204) Durability

Freezing
Wet
Heat
Chemical Medicine
Ice
Abrasion

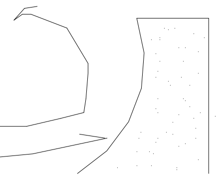


Abrasion

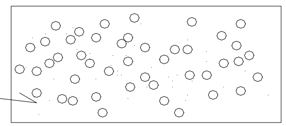


Alkali-Aggregate reaction
Alkali Cement

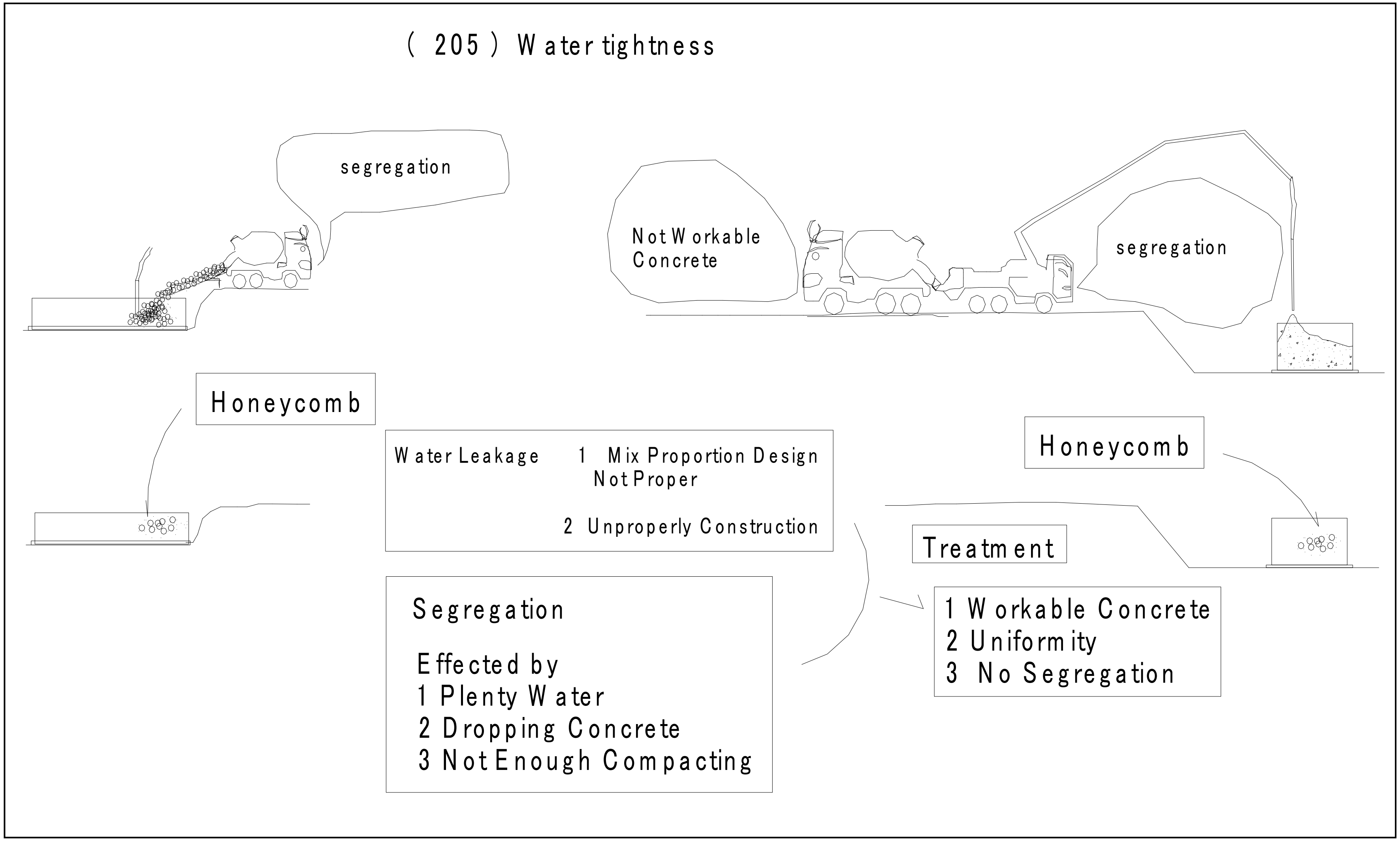
Sea Water
Sulfate Resisting Portland Cement



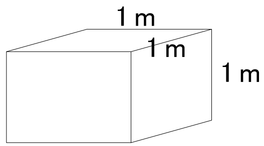
Freezing and Thawing Action
AE Concrete-Etrained Air



(205) Water tightness



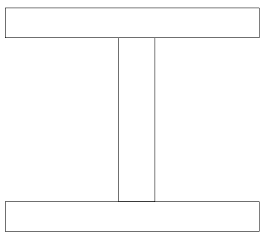
（ 206 ） Volumetric Change



Rate of Expansion of Concrete
7−13*0.000001/Degree

Concrete

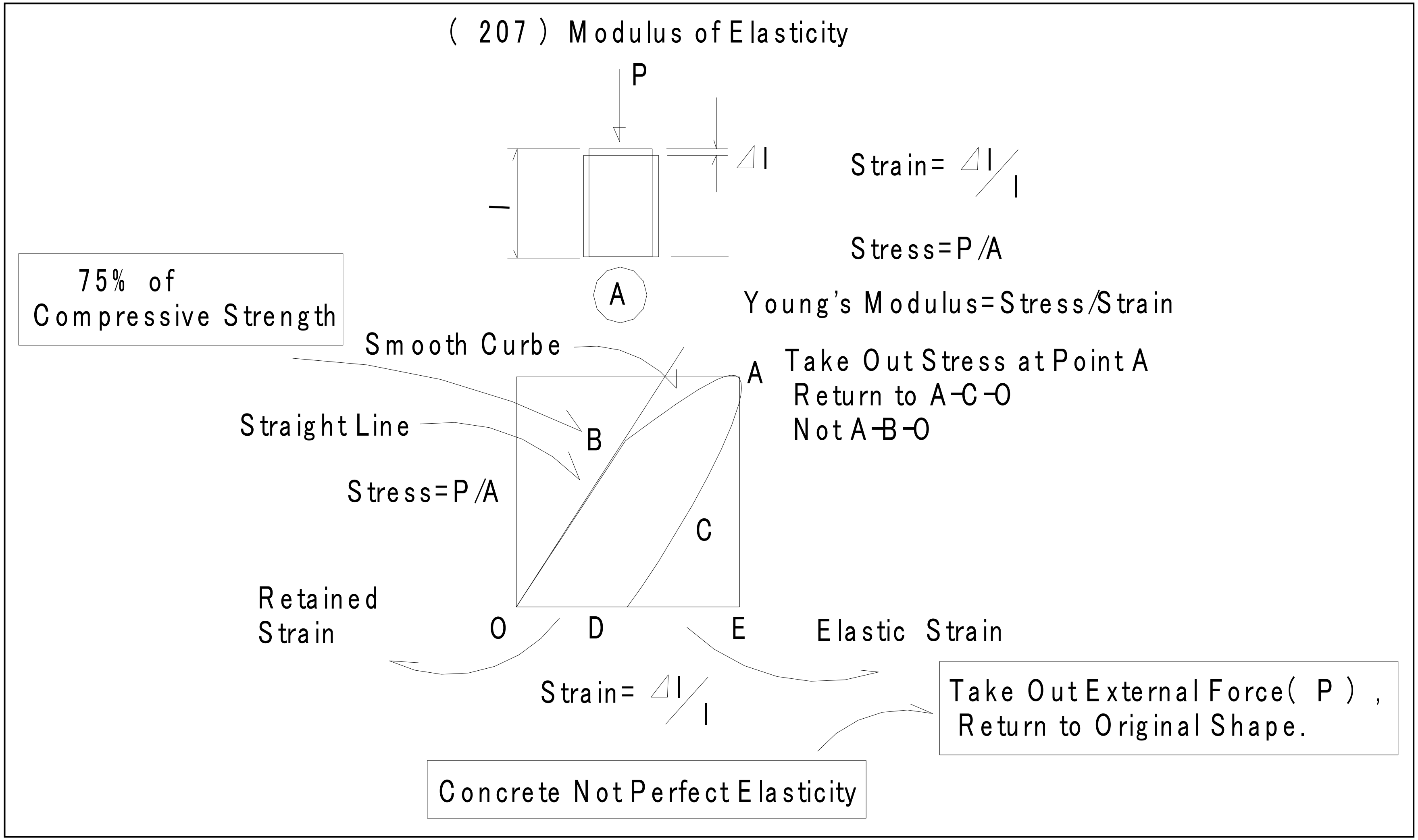
Almost Same



Rate of Expansion of Steel
7−13*0.000001/Degree

Steel

(207)Modulus of Elasticity

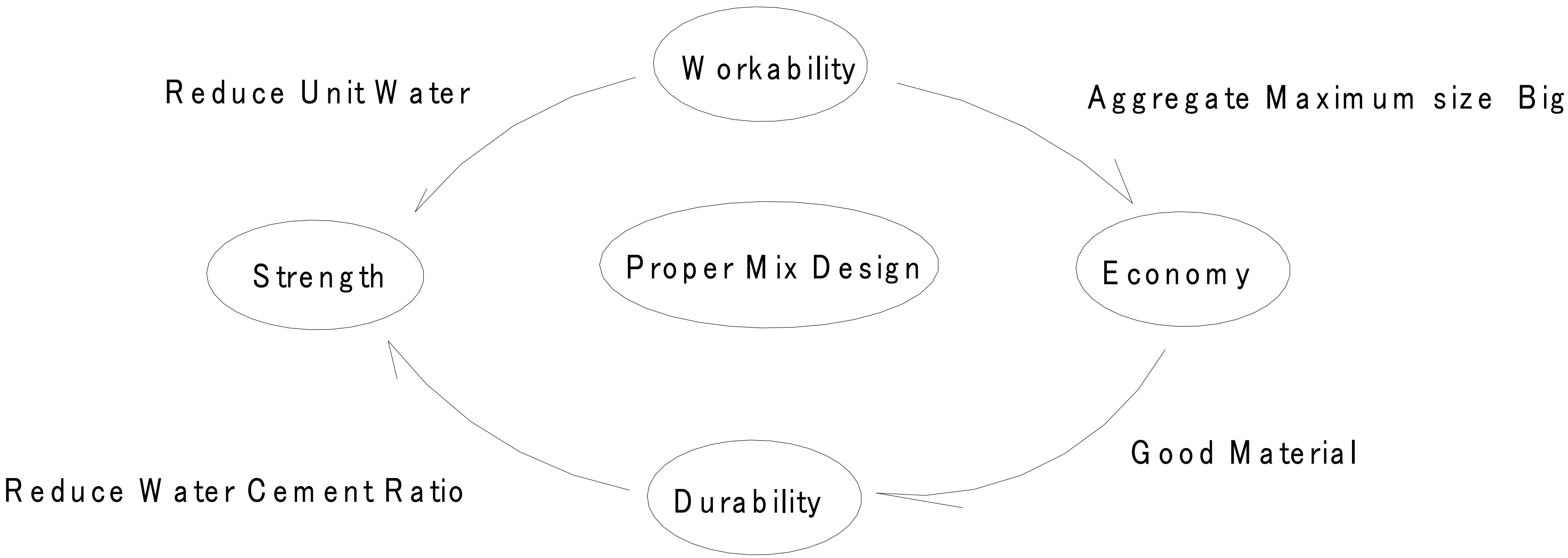


(208) Mix Proportion of Concrete

(208) Mix Proportion of Concrete

Mix Proportion Design

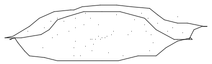
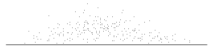
1 Material Test
2 Mix Proportion Test
3 Trial Mix
4 Decision of Mix Proportion



(209) Mix Proportion (1)

(209) Mix Proportion

Mix Proportion Volume

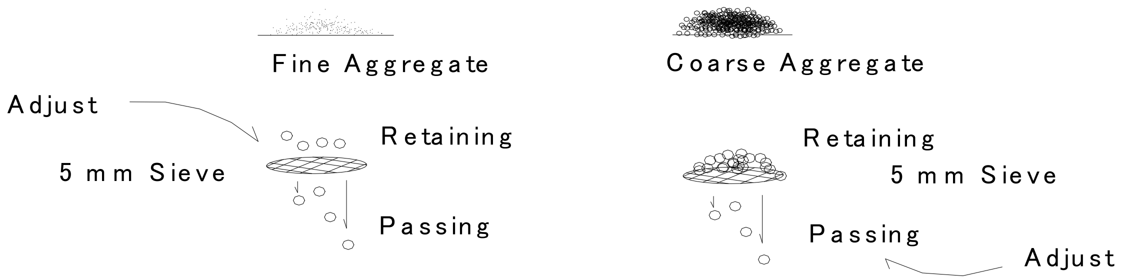
	Cement	Fine Aggregate	Coarse Aggregate
Compressive Strength $\sigma_{28} = 240\ kg/cm^2$	1	2	4
Compressive Strength $\sigma_{28} = 180\ kg/cm^2$	1	3	6

(210) Mix Proportion (2)

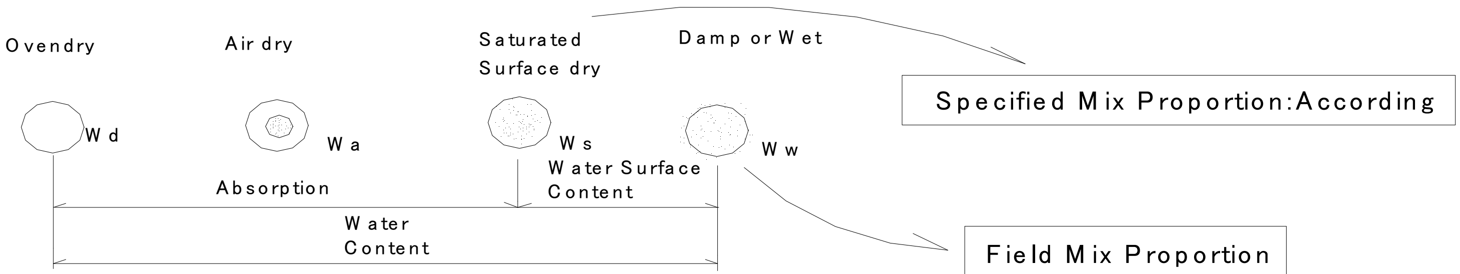
(210) Mix Proportion (2)

Specified Mix Proportion:According to Specification
Field Mix Proportion:Adjust 5mm Sieve Passing or Retaining Amount
Adjust Water Surface Content and Absorption of Aggregate

(1) Adjust Grading



(2) Adjust Moisture Condition of Aggregate



Water Surface Content Ratio =((Ww-Ws) /Ws) *100

Specific Gravity (S.S.D) =Ws/Wd

Absorption Ratio =((Ws-Wd) /Wd) *100

211 Specified Mix proportion-Field Mix Proportion

Specified Mix Proportion

Water	Cement	Fine Aggreg	Coarse
(kg)	(kg)	(kg)	(kg)
178	369	720	1090

Aggregate Condition of Field

Actual Fine Aggregate

Water Surf	Passing 5 mm	Retaining 5 mm	Total
(%)	(%)	(%)	(%)
2	95	5	100

Actual Coarse Aggregate

Water Surf	Passing 5 mm	Retaining 5 mm	Total
(%)	(%)	(%)	(%)
1	2	98	100

(1) Grading Adjustment Saturated Surface Dry State of Aggregate

x	Unit Fine Aggregate
y	Unit Coarse Aggregate

$x+y=1810$

$0.05x+(1-0.02)y=1090$

x 735

y 1075

(212) Specified Field Mix Proportion (2)

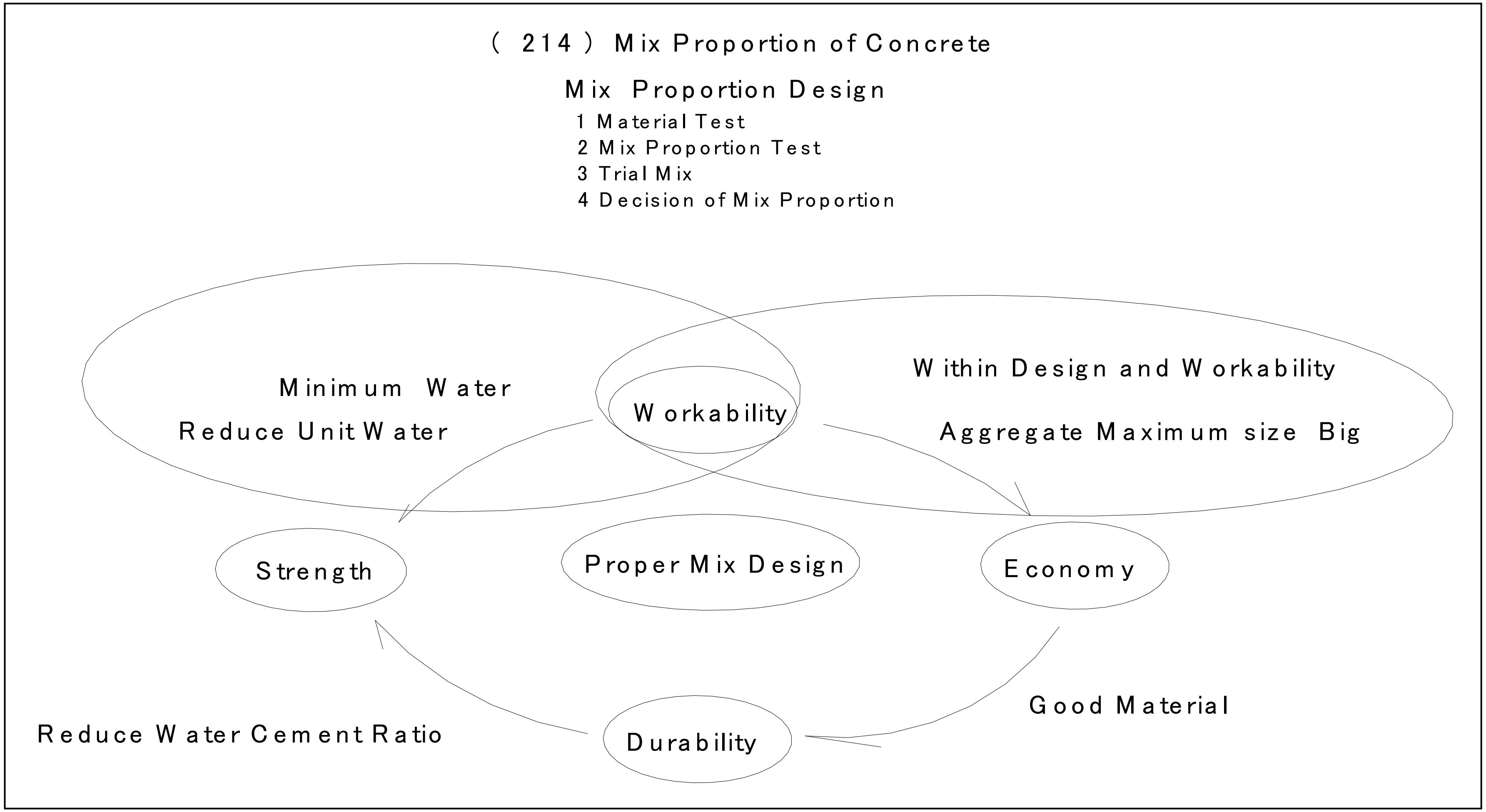
Adjustment Moisture Content

	specify gravity (%)	absorption (%)	moisture content(%)	Water surface content(%)	Content (kg/m3)	Correction by Grading	Correction (kg/m3)	Corrected (kg/m3)
		(1)	(2)	(3)=(2)−(1)	(4)	(5)	5)=(3)*5)*0.01	(6)=(4)+(5)
Water					178		-26	152
Cement					369			369
Fine Aggregate				2	720	735	15	745
Aggregate				1	1090	1075	11	1086

(213) Specified Field Mix Proportion (3)

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks
		(SL)	air	W/C	s/a	C	W	s	CA(5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d	
	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	Mighty 900RA=( )%*cement	Mighty 185S=( )%				
						369	152	745	1086							Weight
																Specific Gravity
																Volume

(214) Mix Proportion of Concrete



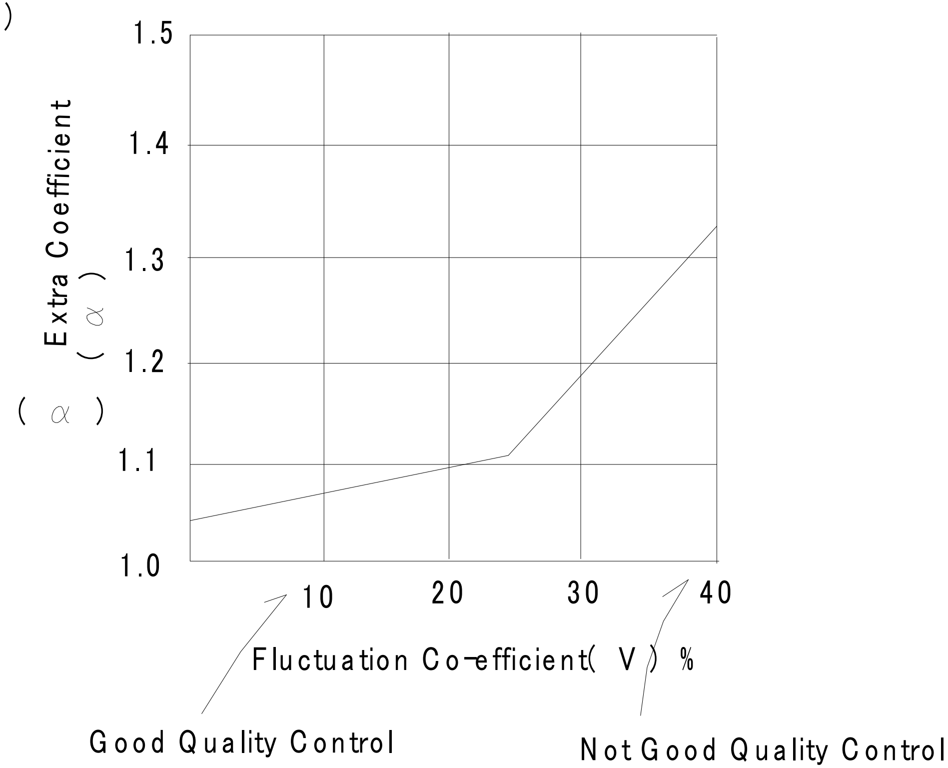
(215) Required Average Strength

(215) Required Average Strength

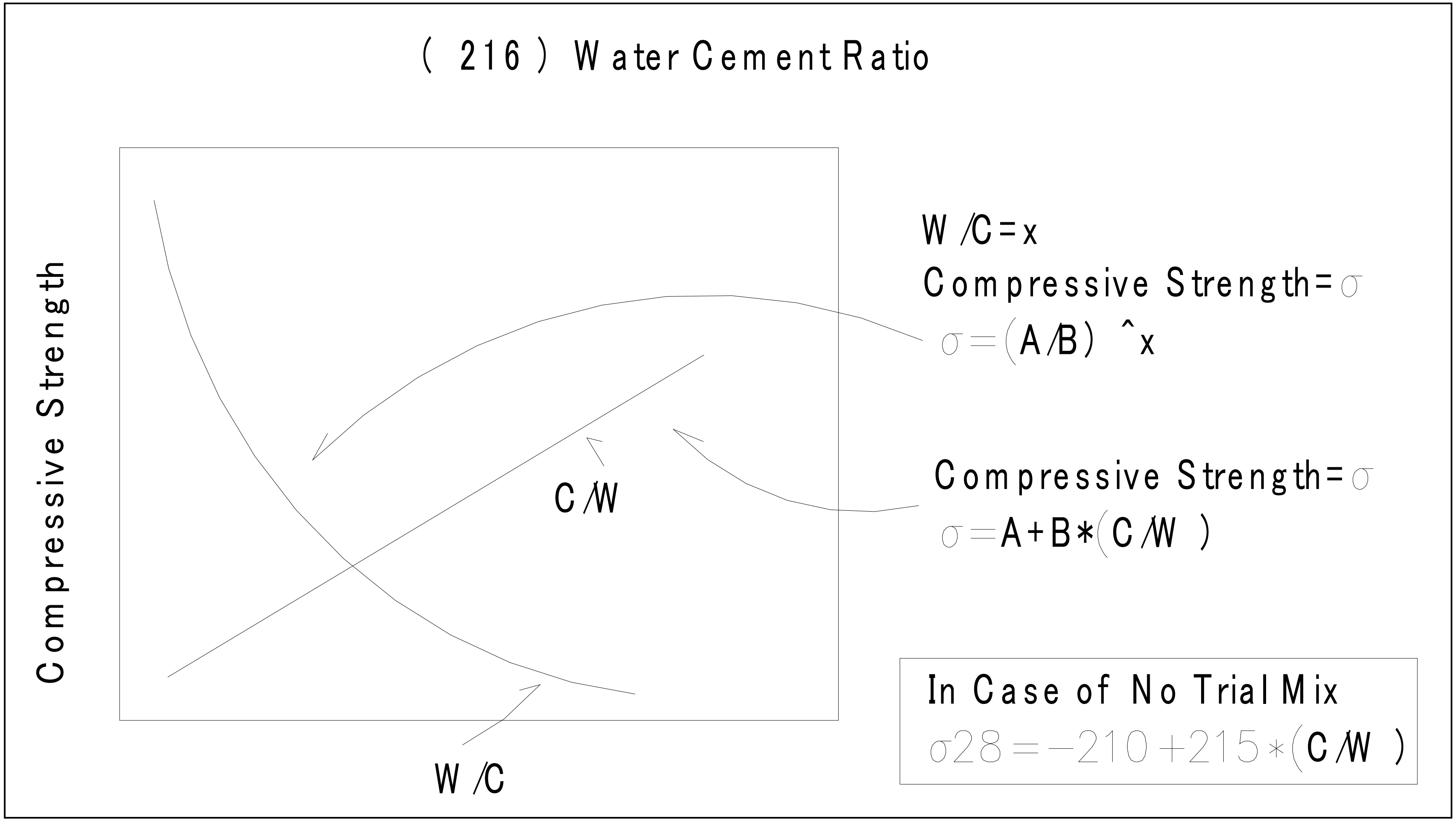
Required Average Strength(σr) =(σck) *Extra Coefficient (α)

(σck) =Design Strength

Fluctuation Co-efficient(V) %



(216) Water Cement Ratio



(217) Water Cement Ratio and Strength

217 W/C and Strength

y=ax+b

(x*x)a+(x)b=(x*y)

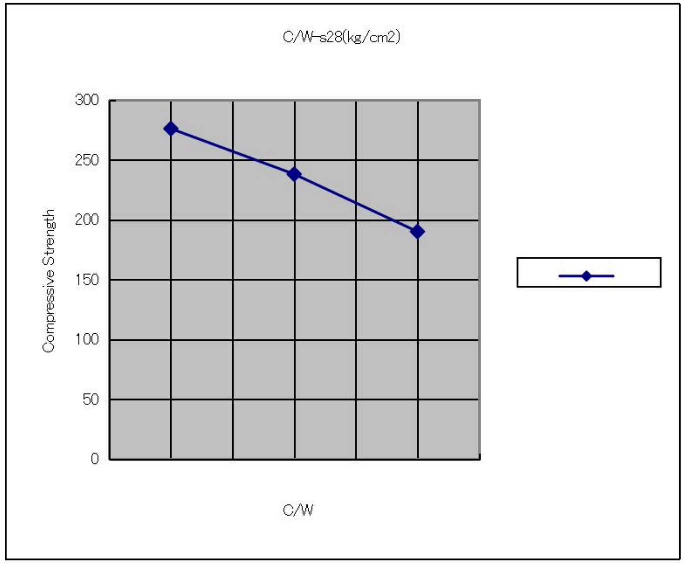
(x)a+nb=(y)

n=Measuring Number

C/W-s

y=259*x-239

W/C(%)	50	55	60
(C/W)	2	1.82	1.67
s28(kg/cm2)	276	238	190



C/W=x

s28(kg/cm2)=y

	x	y	x*x	x*y
	2	276	4	552
	1.82	238	3.3124	433.16
	1.67	190	2.7889	317.3
Total	5.49	704	10.1013	1302.46

y=ax+b

(x*x)a+(x)b=(x*y) =(10.1013)*a+(5.49)*b=1302.46

(x)a+nb=(y) =(5.49)*a+3b=704

a=259

b=-239

y=259*x-239

(218) W/C and Durability

Compressive Strength	W/C=50%
Durability	W/C=65%
Water Tightness	W/C=55%

Minimum Value 50%

(219) Water Cement Ratio and Water tightness

(219) W/C and Water Tightness

Plain Concrete Below W/C=55%

External Concrete of Dam Below W/C=60%

(220) Water Cement Ratio and Durability

220 W/C and Durability

Weather Condition	Strict Weather			Not Strict Weather		
Section	Thin	Normal	Thick	Thin	Normal	Thick
Under Water	55 (50)	60 (55)	60 (55)	55 (50)	65 (60)	65 (60)
Normal	60 (55)	65 (60)	65 (60)	60 (55)	70 (65)	70 (65)
Dam Concrete	60			65		
Weather Condition	Strict Weather, A Lot of Freezing and Thawing Action			A Few of Freezing and Thawing Action		
Paving Concrete	45			50		

220 W/C and Durability

Weather Condition	Strict Weather			Not Strict Weather		
Section	Thin	Normal	Thick	Thin	Normal	Thick
Under Water	55(50)	60(55)	60(55)	55(50)	65(60)	65(60)
Normal	60(55)	65(60)	65(60)	60(55)	70(65)	70(65)
Dam Concrete	60			65		
Weather Condition	Strict Weather,A Lot of Freezing and Thawing Action			A Fewoof Freezing and Thawing Action		
Paving Concrete	45			50		

221 Unit Water and Sand Percentage of Concrete

River Sand,River Gravel,W/C=55%,Slump=5cm,FM=2.75

Maximum Size of Aggregate	No Admixture			AE Concrete				
					Good Quality AE Agent		Good Quality Water Reducing Agent	
	Entrapped Air	Sand Percentage	Unit Water of Concrete	Air Content(Strict Weather)	Sand Percentage	Unit Water of Concrete	Sand Percentage	Unit Water of Concrete
(mm)	(%)	(%)	(kg)	(%)	(%)	(kg)	(%)	(kg)
15	2.5	49	187	7	46	169	47	156
20	2	45	181	6	42	162	43	150
25	1.5	41	172	5	37	153	38	143
40	1.2	36	160	4.5	33	141	34	131

50	1	33	152	4	30	131	31	122
80	0.5	31	139	3.5	28	117	28.5	109
150	0.3	28	120	3	24	100	24	93

222 Correction

Section	Correction of (s/a)%	Correction of (W)kg
FM of Sand(0.1 Bigger)	Increase 0.5	No Correction
W/C(0.05 Bigger)	Increase 1	No Correction
Slump(2.5cm Bigger)	No Correction	Increase 3%
Air Content(1% Bigger)	Decrease(0.5-1)	Decrease(3)%
Crushed Stone	Increase 3-5	Increase 7-10%
Concrete Pavement	Decrease(3)	Decrease(3%)

223 Unit Water and Unit Cement

Type of Concrete	Unit Water	Unit Cement
Plain Concrete	Decrease as much as posible	Decide W and W/C
Reinforced Concrete	Decrease as much as posible	Decide W and W/C(Over 300kg
Pavement Concrete	Below 150kg	280-340kg
Dam Concrete	Below 120kg	Internal Minimum 140kg External W and W/C

(221) Unit Water and Sand Percentage

221 Unit Water and Sand Percentage of Concrete

River Sand, River Gravel, W/C=55%, Slump=5cm, FM=2.75

Maximum Size of Aggregate	No Admixture			AE Concrete				
					Good Quality AE Agent		Good Quality Water Reducing Agent	
	Entrapped Air	Sand Percentage	Unit Water of Concrete	Air Content(Strict Weather)	Sand Percentage	Unit Water of Concrete	Sand Percentage	Unit Water of Concrete
(mm)	(%)	(%)	(kg)	(%)	(%)	(kg)	(%)	(kg)
15	2.5	49	187	7	46	169	47	156
20	2	45	181	6	42	162	43	150
25	1.5	41	172	5	37	153	38	143
40	1.2	36	160	4.5	33	141	34	131
50	1	33	152	4	30	131	31	122
80	0.5	31	139	3.5	28	117	28.5	109
150	0.3	28	120	3	24	100	24	93

(222) Correction

222 Correction

Section	Correction of (s/a)%	Correction of (W)kg
FM of Sand (0.1 Bigger)	Increase 0.5	No Correction
W/C (0.05 Bigger)	Increase 1	No Correction
Slump (2.5cm Bigger)	No Correction	Increase 3%
Air Content (1% Bigger)	Decrease (0.5-1)	Decrease (3)%
Crushed Stone	Increase 3-5	Increase 7-10%
Concrete Pavement	Decrease (3)	Decrease (3%)

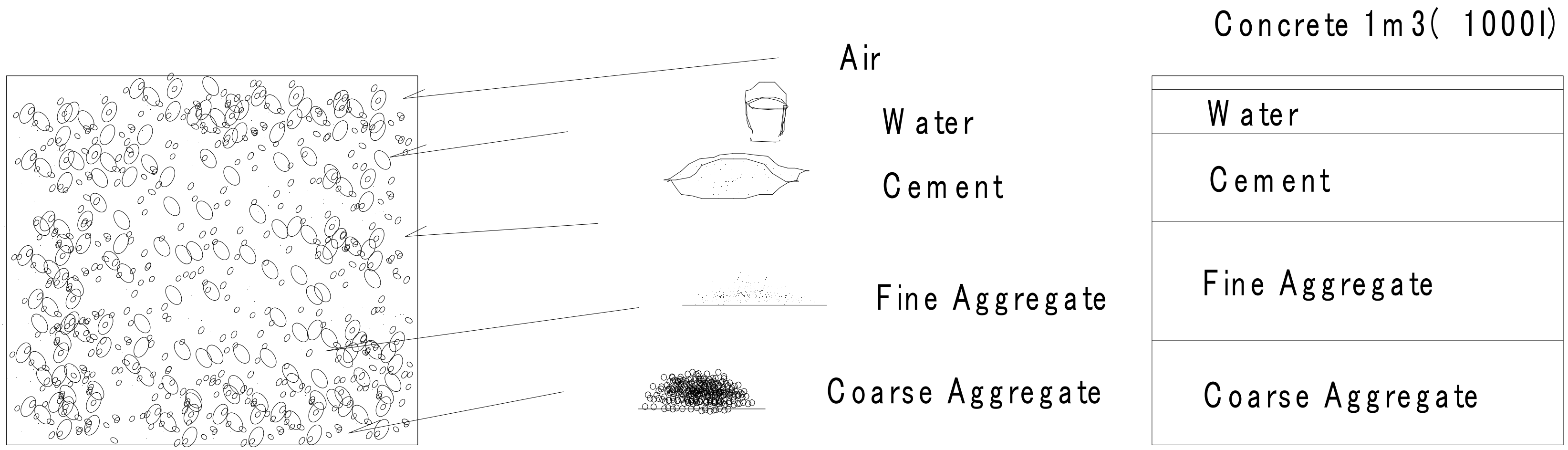
(223) Unit Water and Unit Cement

223 Unit Water and Unit Cement

Type of Concrete	Unit Water	Unit Cement
Plain Concrete	Decrease as much as possible	Decide W and W/C
Reinforced Concrete	Decrease as much as possible	Decide W and W/C (Over 300kg)
Pavement Concrete	Below 150kg	280-340kg
Dam Concrete	Below 120kg	Internal Minimum 140kg External W and W/C

(224) Unit Fine Aggregate and Coarse Aggregate

(224) Unit Fine Aggregate and Unit Coarse Aggregate



s/a=Sand Percentage
=Fine Aggregate(Volume) /(Fine Aggregate Volume+Coarse Aggregate Volume)

(225) Correction (1)

225 Correction	
Gmax:Aggregate Maximum Size(mm)	40
Slump(cm)	10
Water Cement Ratio(%)	51.5
Calculate Unit Weight?	
Cement Specific Gravity	3.15
Fineness Modulus(FM)	2.8
Fine Aggregate Specific Gravity	2.57
Coarse Aggregate Specific Gravity	2.61

221 Unit Water and Sand Percentage of Concrete

River Sand, River Gravel, W/C=55%, Slump=5cm, FM=2.75

Maximum Size of Aggregate	No Admixture			AE Concrete				
					Good Quality AE Agent		Good Quality Water Reducing Agent	
	Entrapped Air	Sand Percentage	Unit Water of Concrete	Air Content(Strict Weather)	Sand Percentage	Unit Water of Concrete	Sand Percentage	Unit Water of Concrete
(mm)	(%)	(%)	(kg)	(%)	(%)	(kg)	(%)	(kg)
15	2.5	49	187	7	46	169	47	156
20	2	45	181	6	42	162	43	150
25	1.5	41	172	5	37	153	38	143
40	1.2	36	160	4.5	33	141	34	131
50	1	33	152	4	30	131	31	122
80	0.5	31	139	3.5	28	117	28.5	109
150	0.3	28	120	3	24	100	24	93

225 Correction

Gmax:Aggregate Maximum Size(mm)	40
Slump(cm)	10
Water Cement Ratio(%)	51.5
Calculate Unit Weight ?	
Cement Specific Gravity	3.15
Fineness Modulus(FM)	2.8
Fine Aggregate Specific Gravity	2.57
Coarse Aggregate Specific Gravity	2.61

221 Unit Water and Sand Percentage of Concrete

River Sand,River Gravel,W/C=55%,Slump=5cm,FM=2.75

Maximum Size of Aggregate	No Admixture			AE Concrete				
					Good Quality AE Agent		Good Quality Water Reducing Agent	
	Entrapped Air	Sand Percentage	Unit Water of Concrete	Air Content(Strict Weather)	Sand Percentage	Unit Water of Concrete	Sand Percentage	Unit Water of Concrete
(mm)	(%)	(%)	(kg)	(%)	(%)	(kg)	(%)	(kg)
15	2.5	49	187	7	46	169	47	156
20	2	45	181	6	42	162	43	150
25	1.5	41	172	5	37	153	38	143
40	1.2	36	160	4.5	33	141	34	131
50	1	33	152	4	30	131	31	122
80	0.5	31	139	3.5	28	117	28.5	109
150	0.3	28	120	3	24	100	24	93

	Condition		Correction	s/a	W
	Reference	Example		(%)	(kg)
	40	40		36	160
F.M	2.75	2.8	36+(2.8-2.75)*0.5/0.1=36.3	36.3	160
W/C	55	51.5	36.3-(0.55-0.515)*1/0.05=36.3	35.6	160
Slump	5	10	160+(1+(10-5)*0.03/2.5)=170	35.6	170

222 Correction

Section	Correction of (s/a)%	Correction of (W)kg
FM of Sand(0.1 Bigger)	Increase 0.5	No Correction
W/C(0.05 Bigger)	Increase 1	No Correction
Slump(2.5cm Bigger)	No Correction	Increase 3%
Air Content(1% Bigger)	Decrease(0.5-1)	Decrease(3)%

Crushed Stone	Increase 3-5	Increase 7-10%
Concrete Pavement	Decrease(3)	Decrease(3%)

(1) W/C=51.5% W=170 C=170/(51.5*0.01)=330

(4)254*2.57=653

(6)=459*2.61=1199

Saturated Surface-Dry State of Aggregate

237

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks	density kg/m3
		(SL)	air	W/C	s/a	C	W	s	CA (5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
	40	10	1.2	51.5	35.6	330	170	653	1199							Weight	
						3.15	1	2.57	2.61							Specific Gravity	
			12			105	170	254	459							Volume	

(2)=330/3.15=105

(5)=1000-(12+105+170+254)=459

(3)=(1000-(12+105+170))*35.6*0.01=254

(226) Correction (2)

	Condition		Correction	s/a	W
	Reference	Example		(%)	(kg)
	40	40		36	160
F.M	2.75	2.8	36+(2.8-2.75)*0.5/0.1=36.3	36.3	160
W/C	55	51.5	36.3-(0.55-0.515)*1/0.05=36.3	35.6	160
Slump	5	10	160+(1+(10-5)*0.03/2.5)=170	35.6	170

222 Correction

Section	Correction of (s/a)%	Correction of (W)kg
FM of Sand (0.1 Bigger)	Increase 0.5	No Correction
W/C (0.05 Bigger)	Increase 1	No Correction
Slump (2.5cm Bigger)	No Correction	Increase 3%
Air Content (1% Bigger)	Decrease (0.5-1)	Decrease (3)%
Crushed Stone	Increase 3-5	Increase 7-10%
Concrete Pavement	Decrease (3)	Decrease (3%)

(227) Correction (3)

(1) W/C=51.5%   W=170   C=170/(51.5*0.01)=330

(4)254*2.57=653

(6)=459*2.61=1199

Saturated Surface-Dry State of Aggregate

237

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks	density kg/m3
		(SL)	air	W/C	s/a	C	W	s	CA(5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
	40	10	1.2	51.5	35.6	330	170	653	1199							Weight	
						3.15	1	2.57	2.61							Specific Gravity	
			12			105	170	254	459							Volume	

(2)=330/3.15=105

(5)=1000-(12+105+170+254)=459

(3)= (1000-(12+105+170))*35.6*0.01=254

(228) Order of Mix Proportion Design

(1) Calculate Mix Proportion Strength
(2) Decide Water Cement Ratio
(3) Decide Maximum Size of Aggregate, Slump and Air Content
(4) Select Unit Water and Sand Percentage
(5) Calculate Unit Cement, Unit Fine Aggregate, Unit Coarse Aggregate and Admixture
(6) Trial Mix
(7) Decide Specified Mix Proportion
(8) Correct Specified Mix Proportion to Field Mix

(229) Maximum Size of Aggregate

229 Maximum Size of Aggregate and Slump

Type of Concrete	Type of Structure	Maximum Size of Aggregate (mm)		Slump (cm)
Plain Concrete			Standard: Below 100mm. Not Over (1/4) Minimum Size of Structure, Water Tightness Concrete: Not Over 1/5	2.5-8
Reinforcement Concrete	Normal	25	Below 50mm. Not Over (1/5) Minimum Size of Structure, Not Over 3/4 Reinforced Bar Interval	5-12
	Big Section	40		2.5-10
	Water tightness			Below 8
Concrete Pavement		Below 40		2.5
Dam Concrete		Below 150		3-5

(230) Standard of Air Content

230 Standard of Air Content

Type		Air Content(%)
Plain. Reinforcement Concrete		3-6
Concrete Pavement		4
Dam Concrete	Maximum Size 40mm	4.0+-1
	Maximum Size 80mm	3.5+-1
	Maximum Size 150mm	3.0+-1

(231) Mix Proportion Calculation (1)

231 Example of Mix proportion

a	Reinforced Concrete Retaining Wall	
b	Required Strength	s28(kg/cm2)=210kg/cm2
c	Slump(cm)	8cm
d	Co-efficient	15%
e	Weather	Mild
f	No Need Water Tightness	
g	Cement Specific Gravity	3.16
h	Fine Aggregate Specific Gravity	2.6
i	Fine Modulus of Fine Aggregate	2.85
j	Coarse Aggregate Specific Gravity	2.64
k	Maximum Size of Aggregate(mm)	25

(1) Required Strength

d Co-efficient 15%

Extra Co-efficient 1.12

Required Strengt σr

σr=210*1.12=235(kg/cm2)

(2) Water Cement Ratio (W/C)

According to Required Strength and Durability or

s28=-210+215*(C/W) 235=-210+215*(C/W)

W/C=48.3% ← Adapt Smaller 48.3%

220 W/C and Durability

Weather Condition	Strict Weather			Not Strict Weather		
Section	Thin	Normal	Thick	Thin	Normal	Thick
Under Water	55(50)	60(55)	60(55)	55(50)	65(60)	65(60)
Normal	60(55)	65(60)	65(60)	60(55)	70(65)	70(65)
Dam Concrete	60			65		
Weather Condition	Strict Weather,A Lot of Freezing and Thawing			A Few of Freezing and Thawing Action		
Paving Concrete	45			50		

(3) Slump

c Slump(cm) 8cm

(4) Maximum Size of Coarse Aggregate

k Maximum Size of Aggregate(mm) 25

(5) Unit Water and Sand Percentage

221 Unit Water and Sand Percentage of Concrete

River Sand,River Gravel,W/C=55%,Slump=5cm,FM=2.75

Maximum Size of Aggregate	No Admixture			AE Concrete				
	Entrapped Air	Sand Percentage	Unit Water of Concrete	Air Content (Strict Weather)	Good Quality AE Agent		Good Quality Water Reducing	
					Sand Percentage	Unit Water of Concrete	Sand Percentage	Unit Water of Concrete
(mm)	(%)	(%)	(kg)	(%)	(%)	(kg)	(%)	(kg)
15	2.5	49	187	7	46	169	47	156
20	2	45	181	6	42	162	43	150
25	1.5	41	172	5	37	153	38	143
40	1.2	36	160	4.5	33	141	34	131
50	1	33	152	4	30	131	31	122
80	0.5	31	139	3.5	28	117	28.5	109
150	0.3	28	120	3	24	100	24	93

222 Correction River Sand,River Gravel,W/C=55%,Slump=5cm,FM=2.75

Section	Correction of (s/a)%	Correction of (W)kg
FM of Sand(0.1 Bigger)	Increase 0.5	No Correction
W/C(0.05 Bigger)	Increase 1	No Correction
Slump(2.5cm Bigger)	No Correction	Increase 3%
Air Content(1% Bigger)	Decrease(0.5-1)	Decrease(3)%
Crushed Stone	Increase 3-5	Increase 7-10%
Concrete Pavement	Decrease(3)	Decrease(3%)

Section	Correction of (s/a)%	Correction of (W)kg	s/a(%)	W(kg)
			41	172
Sand (F.M)=2.85	(s/a)=41+((2.85-2.75)/(0.1))*0.5=0.5	No Correction	41.5	172
W/C=(48.3%)	(s/a)=41.5+((0.48.3-0.55)/0.05)*1=40.2	No Correction	40.2	172
Slump(8cm)	No Correction	72*(1+((8-5)/2.5)*0.03)=17	40.2	172

s/a(%)	40.2
W(kg)	172

C=172/0.483=356kg

(6) Unit Cement =178/(48.3*0.01)=369
(7) Unit Aggregate
(7-2)Fine Aggregate Weight=277*2.6=720

(8) Required Mix Proportion

(7-4)Coarse Aggregate Weight=413*2.64=1090

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks
		(SL)	air	W/C	s/a	C	W	s	CA(5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d	
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)						
235	25	8	1.5	48.3	40.2	369	178	720	1090							Weight
						3.16	1	2.6	2.64							Specific Gravity
			15			117	178	277	413							Volume

=369/3.16=117

(7-3)Coarse Aggregate Volume=(1000-(15+117+178+277))=413

(7-1)Fine Aggregate Volume=(1000-(15+117+178))*40.2*0.01=277

231 Example of Mix proportion

a	Reinforced Concrete Retaining Wall	
b	Required Strength	s28(kg/cm2)=210kg/cm2
c	Slump(cm)	8cm
d	Co-efficient	15%
e	Weather	Mild
f	No Need Water Tightness	
g	Cement Specific Gravity	3.16
h	Fine Aggregate Specific Gravity	2.6
i	Fine Modulus of Fine Aggregate	2.85
j	Coarse Aggregate Specific Gravity	2.64
k	Maximum Size of Aggregate(mm)	25

Trial Mix

Trial Mix After Mix Proportion Calculation

1 Adjust Slump and Air Content

2 Adjust Sand Percentage(s/a)

Section	W/C	s/a	W	C	Slump	Remarks
	(%)	(%)	(kg)	(kg)	(cm)	
1-1 Batch	52	45	177	340	8.5	Required Slump(5-6cm)
1-2 Batch	52	45	171	329	5	Adjust Slump
2 Batch	52	44	169.5	326	5.5	
3 Batch	52	43	167	321	5.5	
4 Batch	52	42	165.5	318	5	
5 Batch	52	41	164	315	5.5	Decided
6 Batch	52	40	162.5	313	5	Segregation

1 Adjust Slump and Air Content

2 Adjust Sand Percentage(s/a)

Change (s/a) 1%

Confirm Concrete Condition

(2) Water Cement Ratio (W/C)

According to Required Strength and Durability or

$\sigma_{28}=-210+215*(C/W)$ $235=-210+215*(C/W)$

W/C=48.3% Adapt Smaller 48.3%

220 W/C and Durability

Weather Condition	Strict Weather			Not Strict Weather		
Section	Thin	Normal	Thick	Thin	Normal	Thick
Under Water	55 (50)	60 (55)	60 (55)	55 (50)	65 (60)	65 (60)
Normal	60 (55)	65 (60)	65 (60)	60 (55)	70 (65)	70 (65)
Dam Concrete	60			65		
Weather Condition	Strict Weather, A Lot of Freezing and Thawing Action			A Few of Freezing and Thawing Action		
Paving Concrete	45			50		

(3) Slump

c Slump (cm) 8cm

(4) Maximum Size of Coarse Aggregate

k Maximum Size of Aggregate (mm) 25

(5) Unit Water and Sand Percentage

221 Unit Water and Sand Percentage of Concrete

River Sand, River Gravel, W/C=55%, Slump=5cm, FM=2.75

Maximum Size of Aggregate	No Admixture			AE Concrete				
					Good Quality AE Agent		Good Quality Water Reducing Agent	
	Entrapped Air	Sand Percentage	Unit Water of Concrete	Air Content (Strict Weather)	Sand Percentage	Unit Water of Concrete	Sand Percentage	Unit Water of Concrete
(mm)	(%)	(%)	(kg)	(%)	(%)	(kg)	(%)	(kg)
15	2.5	49	187	7	46	169	47	156
20	2	45	181	6	42	162	43	150
25	1.5	41	172	5	37	153	38	143
40	1.2	36	160	4.5	33	141	34	131
50	1	33	152	4	30	131	31	122
80	0.5	31	139	3.5	28	117	28.5	109
150	0.3	28	120	3	24	100	24	93

(234) Mix Proportion Calculation (4)

222 Correction   River Sand, River Gravel, W/C=55%, Slump=5cm, FM=2.75

Section	Correction of (s/a)%	Correction of (W)kg
FM of Sand (0.1 Bigger)	Increase 0.5	No Correction
W/C (0.05 Bigger)	Increase 1	No Correction
Slump (2.5cm Bigger)	No Correction	Increase 3%
Air Content (1% Bigger)	Decrease (0.5-1)	Decrease (3)%
Crushed Stone	Increase 3-5	Increase 7-10%
Concrete Pavement	Decrease (3)	Decrease (3%)

(235) Mix Proportion Calculation (5)

Section	Correction of (s/a)%	Correction of (W)kg	s/a(%)	W (kg)
			41	172
Sand (F.M)=2.85	(s/a)=41+((2.85-2.75)/(0.1))*0.5=0.5	No Correction	41.5	172
W/C=(48.3%)	(s/a)=41.5+((0.48.3-0.55)/0.05)*1=40.2	No Correction	40.2	172
SLump(8cm)	No Correction	172*(1+((8-5)/2.5)*0.03)=178	40.2	172

s/a(%)	40.2
W (kg)	172

C=172/0.483=356kg

6) Unit Cement=178/(48.3*0.01)=369

(7) Unit Aggregate

(7-2) Fine Aggregate Weight=277*2.6=720

(8) Required Mix Proportion

(7-4) Coarse Aggregate Weight=413*2.64=1090

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Compressive Strength (kgf/cm2)			Remarks	density kg/m3
		(SL)	air	W/C	s/a	C	W	s	CA 5~10mm)	CA (10~20mm)	% of weight of cement)	% of weight of cement)	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
235	25	8	1.5	48.3	40.2	369	178	720	1090							Weight	
						3.16	1	2.6	2.64							Specific Gravity	
			15			117	178	277	413							Volume	

231 Example of Mix proportion

=369/3.16=117

(7-3) Coarse Aggregate Volume= (1000-(15+117+178+277))=413

(7-1) Fine Aggregate Volume= (1000-(15+117+178))*40.2*0.01=277

a	Reinforced Concrete Retaining Wall	
b	Required Strength	s28 (kg/cm2)=210kg/cm2
c	Slump (cm)	8cm
d	Co-efficient	15%
e	Weather	Mild
f	No Need Water Tightness	
g	Cement Specific Gravity	3.16
h	Fine Aggregate Specific Gravity	2.6
i	Fine Modulus of Fine Aggregate	2.85
j	Coarse Aggregate Specific Gravity	2.64
k	Maximum Size of Aggregate (mm)	25

(237) Mix Proportion Calculation (7)

Trial Mix

Trial Mix After Mix Proportion Calculation

1 Adjust Slump and Air Content

2 Adjust Sand Percentage (s/a)

Section	W/C (%)	s/a (%)	W (kg)	C (kg)	Slump (cm)	Remarks
1-1 Batch	52	45	177	340	8.5	Required Slump (5-6cm)
1-2 Batch	52	45	171	329	5	Adjust Slump
2 Batch	52	44	169.5	326	5.5	
3 Batch	52	43	167	321	5.5	
4 Batch	52	42	165.5	318	5	
5 Batch	52	41	164	315	5.5	Decided
6 Batch	52	40	162.5	313	5	Segregation

1 Adjust Slump and Air Content

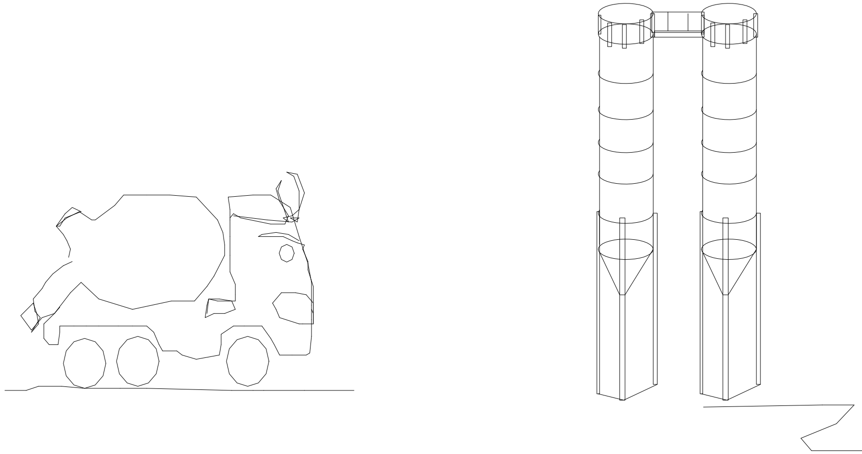
2 Adjust Sand Percentage (s/a)

Change (s/a) 1%

Confirm Concrete Condition

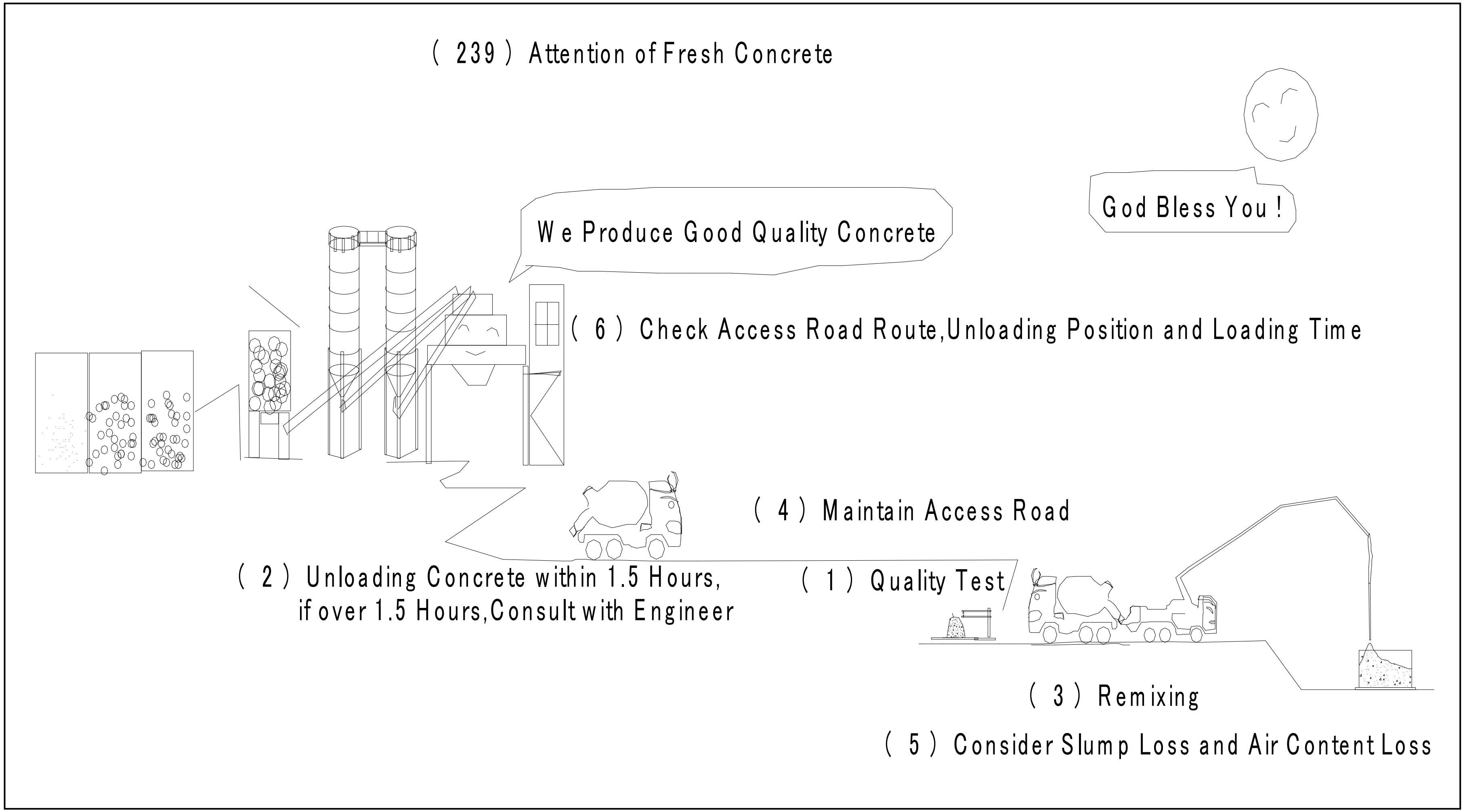
(238) Advantage of Fresh Concrete

(238) Advantages of Fresh Concrete

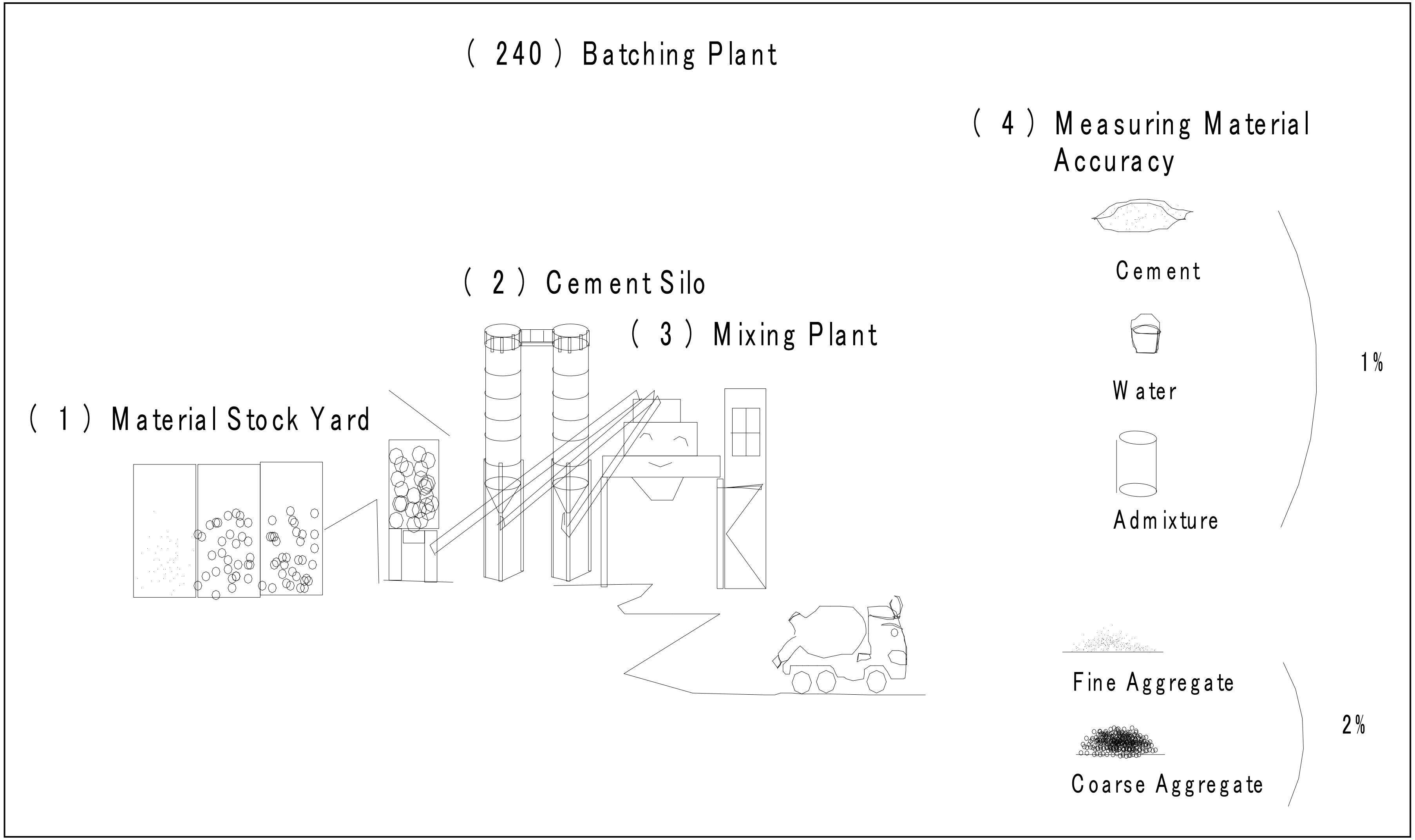


(1) Product Plenty Concrete
(2) Good Quality Control
(3) Advance Construction Progress
(4) Economy
(5) Easy Cost Estimation

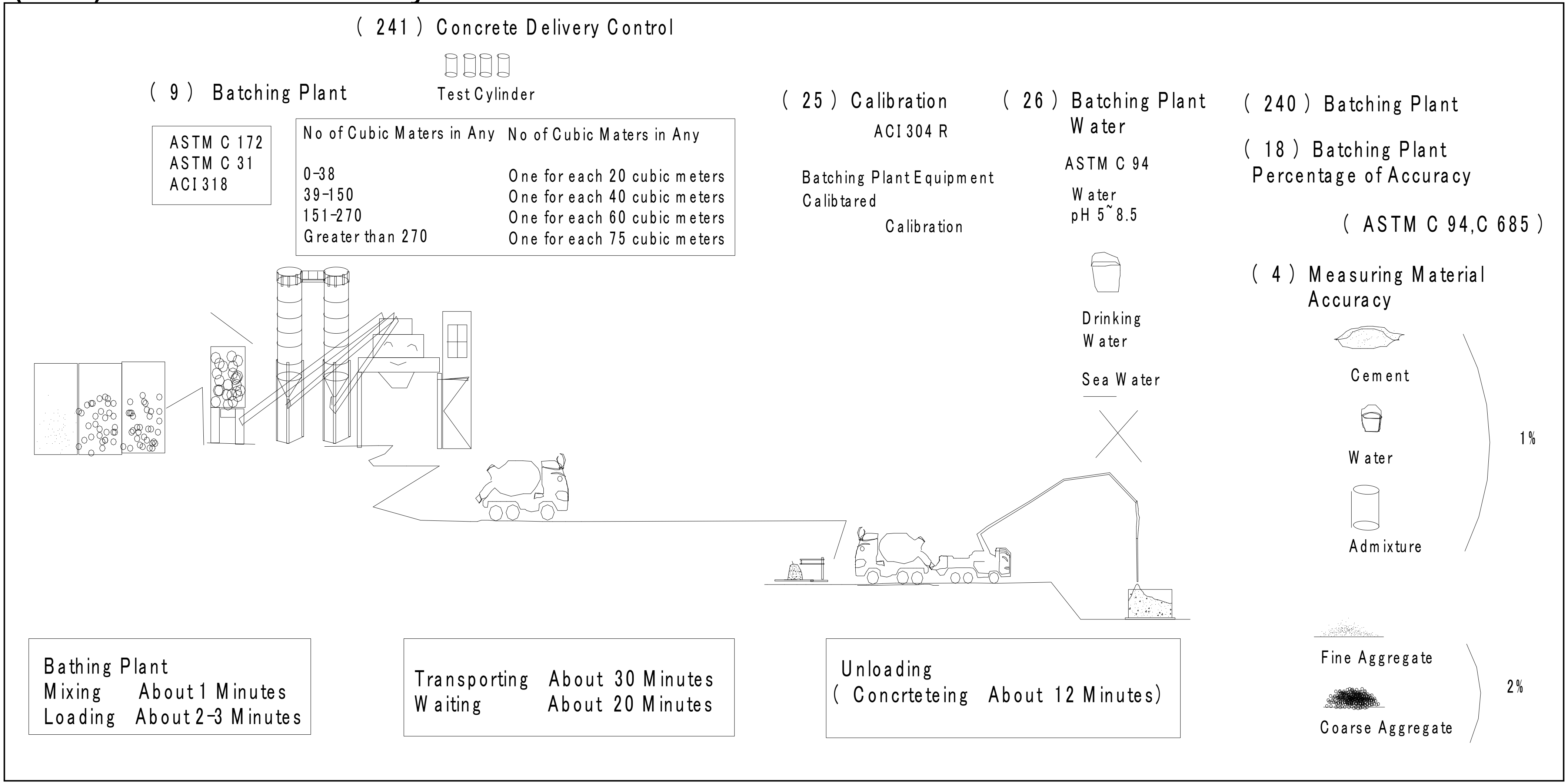
(239) Attention of Fresh Concrete



(240) Batching Plant



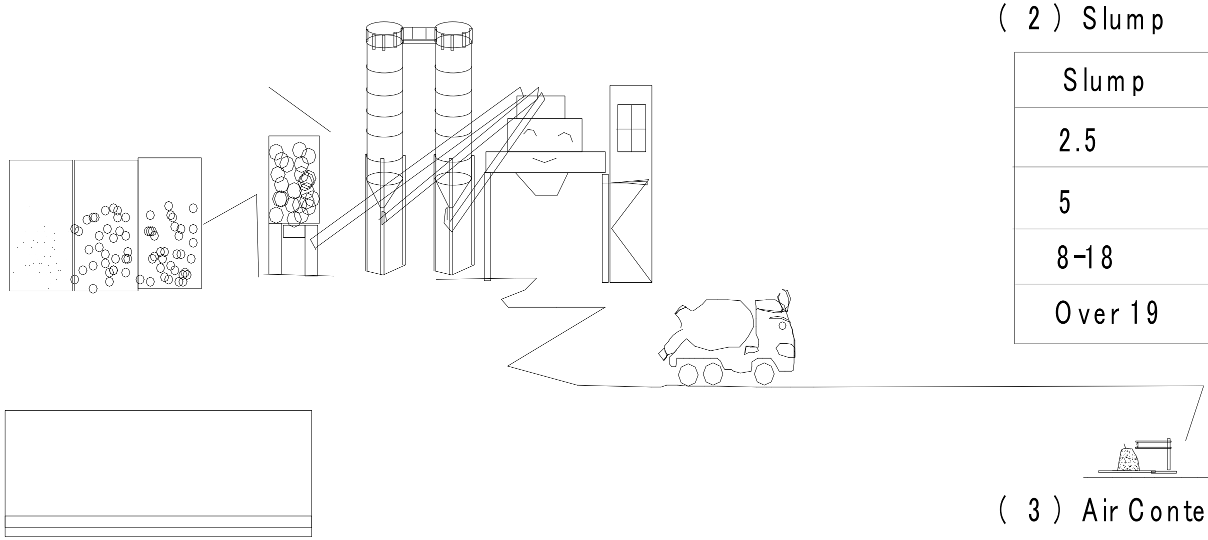
(241) Concrete Delivery Control



No of Cubic Maters in Any	No of Cubic Maters in Any
0-38	One for each 20 cubic meters
39-150	One for each 40 cubic meters
151-270	One for each 60 cubic meters
Greater than 270	One for each 75 cubic meters

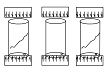
(242) Quality Control

(242) Quality Control



Laboratory

(1) Compressive Strength

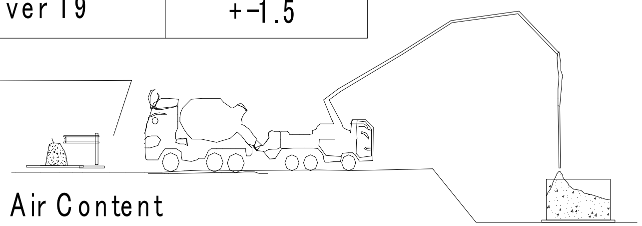


a) Compressive Strength Required Strength

b) Average Compressive Strength Strength

(2) Slump

Slump	Allowance
2.5	+-1
5	+-1.5
8-18	+-2.5
Over 19	+-1.5



(3) Air Content

Type of Concrete	Allowance
Normal Concrete	+-1
Light Weight	+-1.5

(243) Rule of Constant Unit Water Content

(243) Rule of Constant Unit Water Content

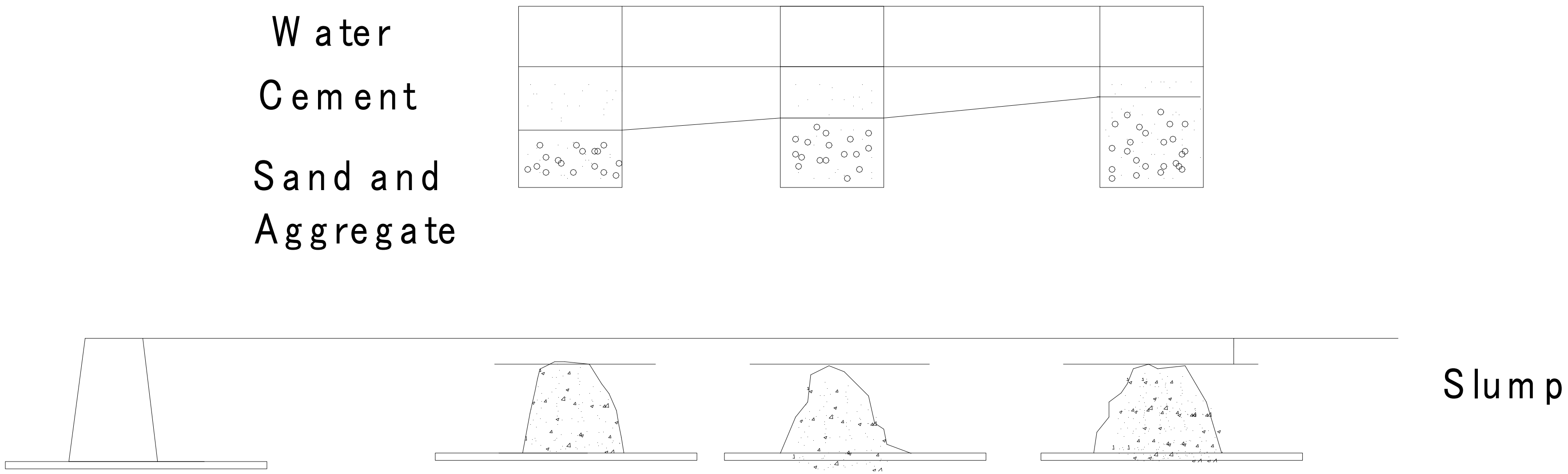
Slump is effected by Water

1 Water Content = Constant

2 s/a = Constant

3 Cement Content, Sand and Aggregate Content are Changed

Slump = Constant



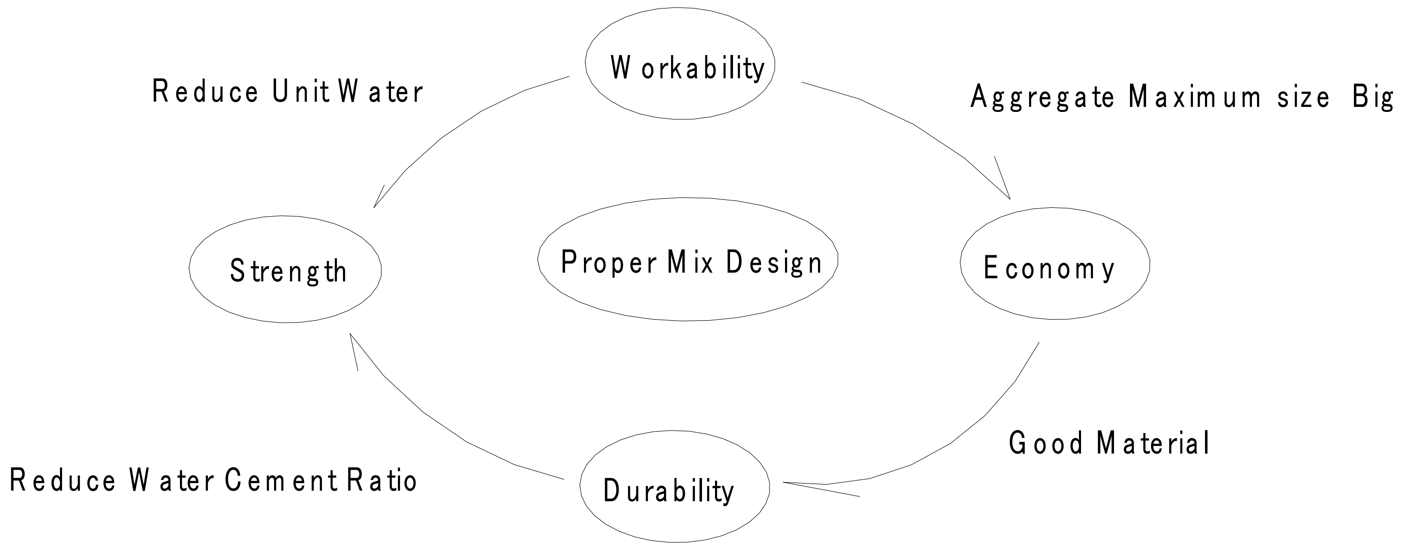
(244) Mix Proportion of Concrete

(244) Mix Proportion of Concrete

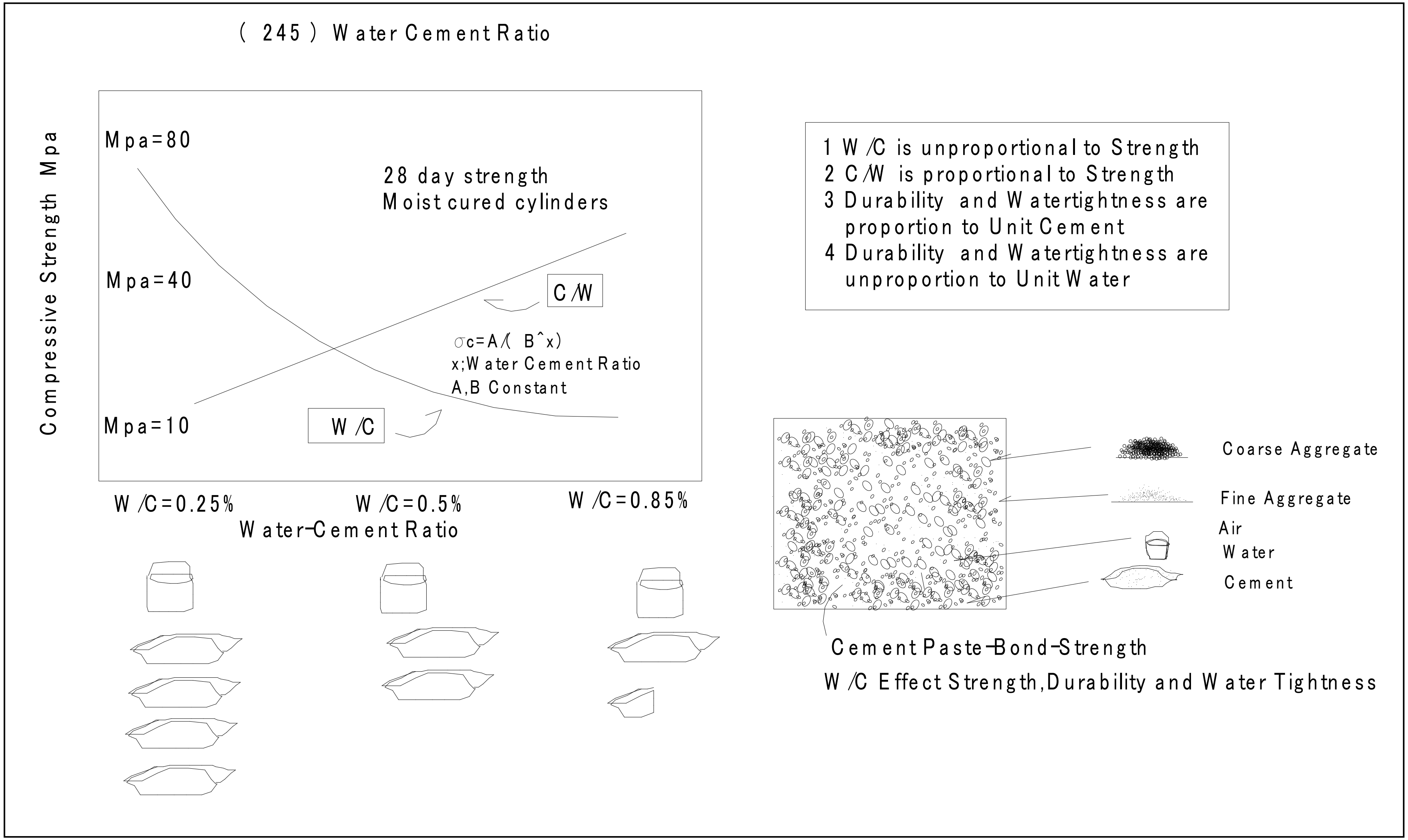
Mix Proportion Design

1 Material Test
2 Mix Proportion Test
3 Trial Mix
4 Decision of Mix Proportion

1 Slump,Water Content and Consistency
2 W/C–Strength and Durability
3 W/C–Water Tightness
4 Workability,s/a and Minimum Water Content
5 Maximum Size of Coarse Aggregate due to Structure
6 Unit Cement Content,Unit Fine Aggregate and Unit Coarse Aggregate
7 Air Content and AE Agent

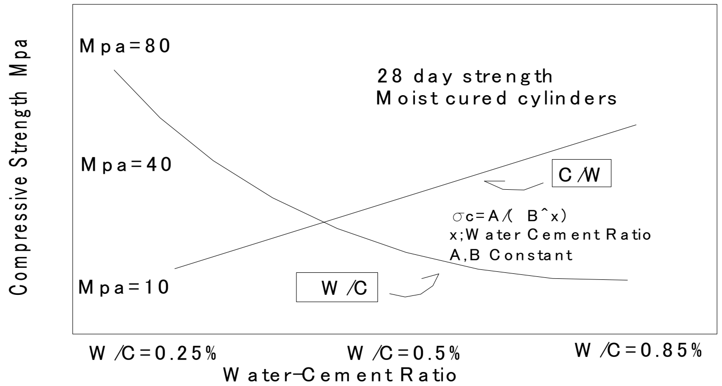


(245) Water Cement Ratio

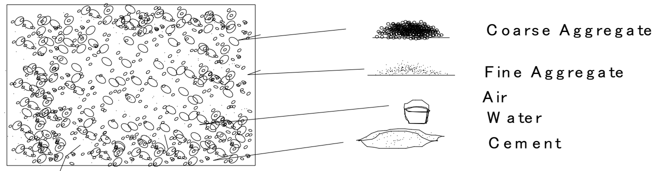


(246) Water Cement Ratio and Strength

(246) Water Cement Ratio and Strength

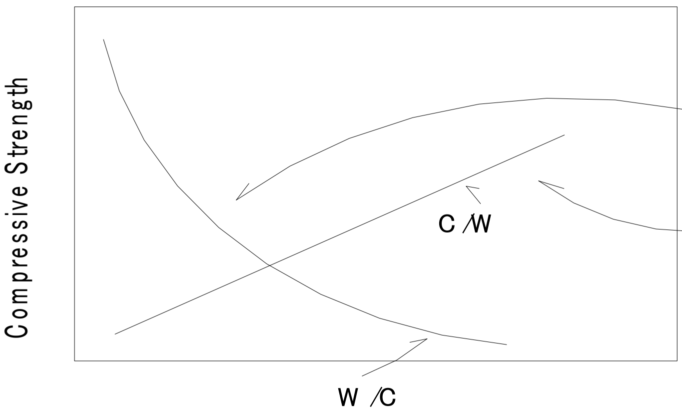


1 W/C is unproportional to Strength
2 C/W is proportional to Strength
3 Durability and Watertightness are proportion to Unit Cement
4 Durability and Watertightness are unproportion to Unit Water



Cement Paste-Bond-Strength

W/C Effect Strength,Durability and Water Tightness



W/C=x

Compressive Strength=σ

$\sigma = (A/B)$ ^x

Compressive Strength=σ

$\sigma = A + B * (C/W)$

Small Construction

In Case of No Trial Mix

$\sigma 28 = -210 + 215 * (C/W)$

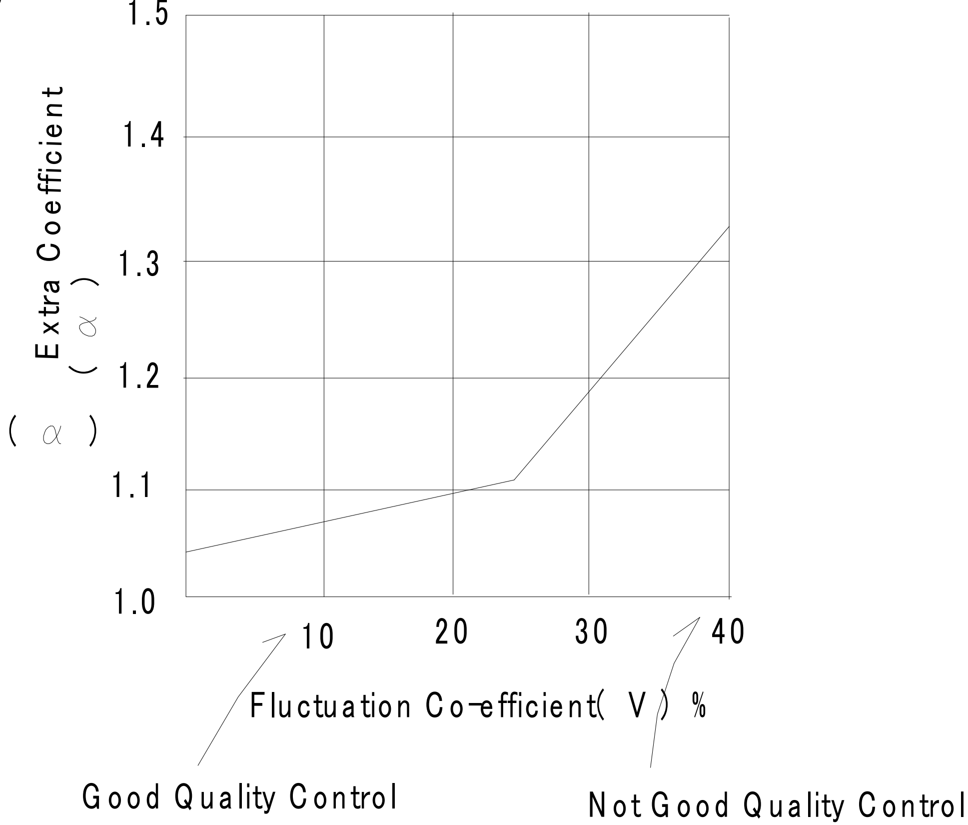
(247) Required Average Strength and Extra Co-efficient

(247) Required Average Strength and Extra Co-efficient

Required Average Strength(σr) =(σck) *Extra Coefficient (α)

(σck)=Design Strength

Fluctuation Co-efficient(V) %	Control Level
7-10	Super
10-15	Good
15-20	Normal
Over 20	Bad



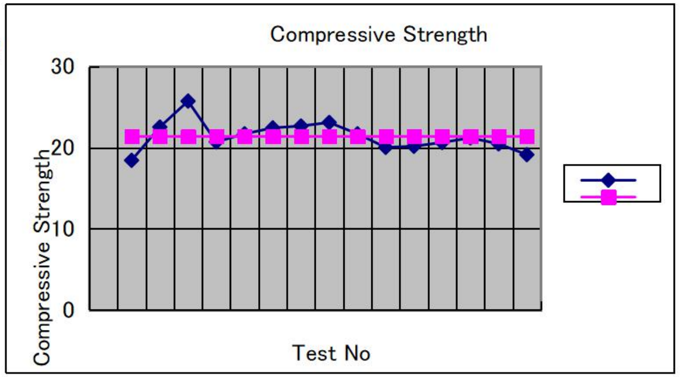
(248) Fluctuation Co-efficient (V)

248 Calculation of Fluctuation Modulus

Test No	Measuring Value,Concrete Compressive Strength(N/mm2					x^2
	x1	x2	x3	Total	Averae;x	(N/mm2)
1	17.7	18.8	18.8	55.3	18.4	339.79
2	23.6	22	22	67.6	22.5	507.75
3	25.3	26.1	25.8	77.2	25.7	662.20
4	20.8	19.5	21.8	62.1	20.7	428.49
5	21.7	22.8	20.6	65.1	21.7	470.89
6	22.4	21.7	23.2	67.3	22.4	503.25
7	23	21.6	23.4	68	22.7	513.78
8	23.3	23	23	69.3	23.1	533.61
9	21.7	22.8	20.6	65.1	21.7	470.89
10	20.8	18.8	20.5	60.1	20.0	401.33
11	19	19.2	22.3	60.5	20.2	406.69
12	19.8	20.8	21.3	61.9	20.6	425.73
13	18.2	23.8	21.6	63.6	21.2	449.44
14	20.3	20.8	20.3	61.4	20.5	418.88
15	15.7	18.4	23.3	57.4	19.1	366.08
Total					320.6	6898.8
Average					21.38	459.92

Standard Deviation: s=(459.92-21.38^2)^0.5 1.68 N/mm2

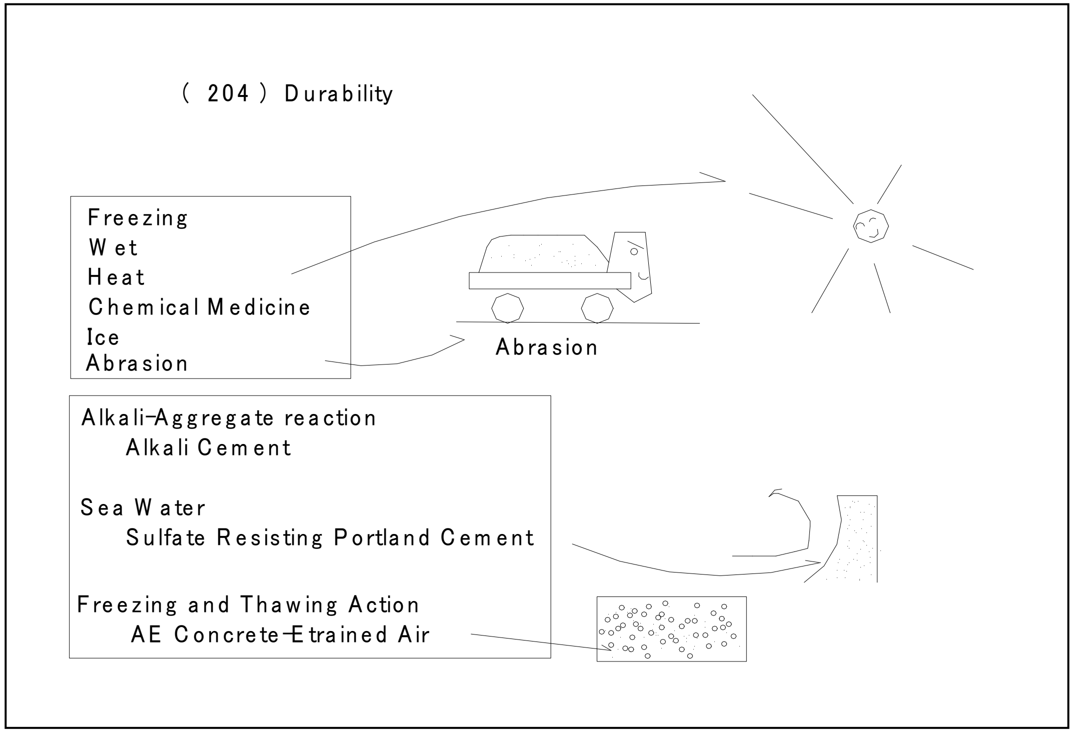
Test No	Averae;x	Averae
1	18.4	21.38
2	22.5	21.38
3	25.7	21.38
4	20.7	21.38
5	21.7	21.38
6	22.4	21.38
7	22.7	21.38
8	23.1	21.38
9	21.7	21.38
10	20.0	21.38
11	20.2	21.38
12	20.6	21.38
13	21.2	21.38
14	20.5	21.38
15	19.1	21.38

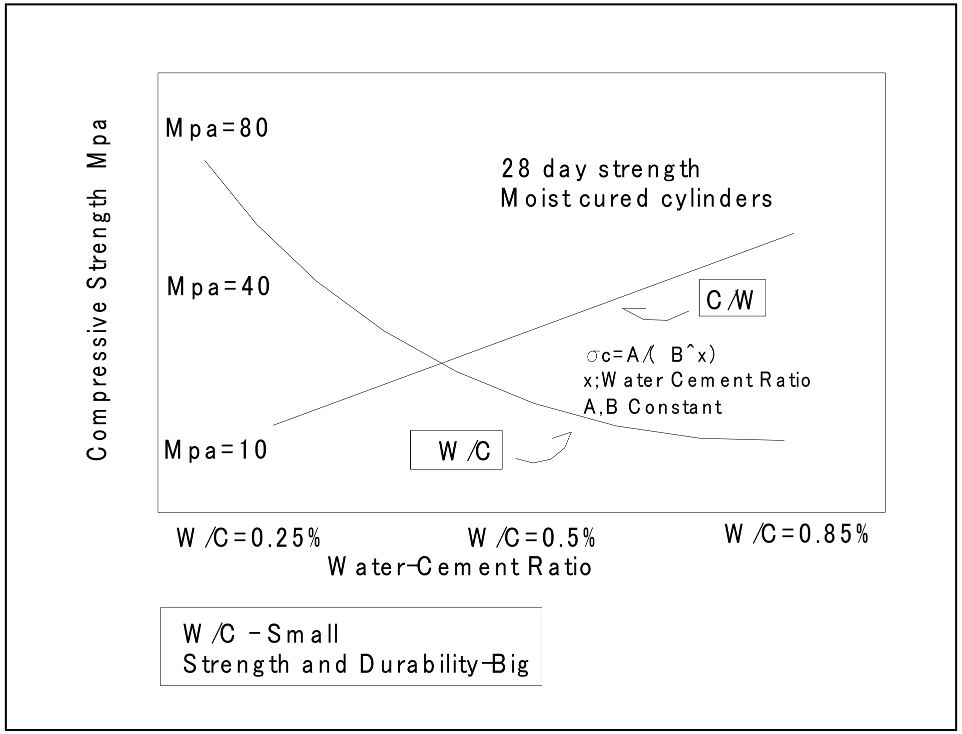


(249) Water Cement Ratio and Durability

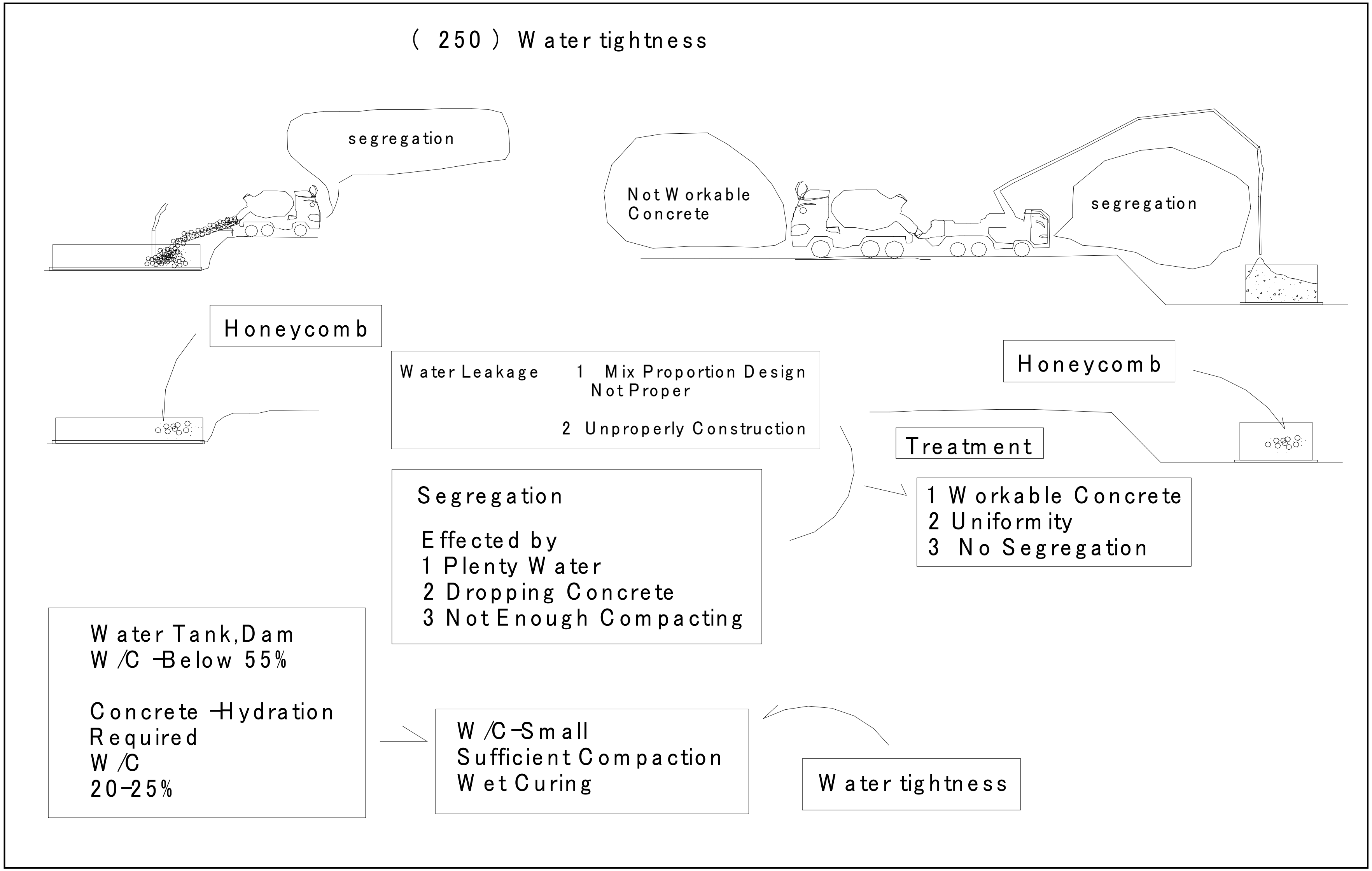
220 W/C and Durability

Weather Condition	Strict Weather			Not Strict Weather		
Section	Thin	Normal	Thick	Thin	Normal	Thick
Under Water	55 (50)	60 (55)	60 (55)	55 (50)	65 (60)	65 (60)
Normal	60 (55)	65 (60)	65 (60)	60 (55)	70 (65)	70 (65)
Dam Concrete	60			65		
Weather Condition	Strict Weather, A Lot of Freezing and Thawing Action			A Few of Freezing and Thawing Action		
Paving Concrete	45			50		





(250) Water tightness



(251) Water Cement Ratio and Mix Proportion Design

(251) W/C and Mix Proportion Design

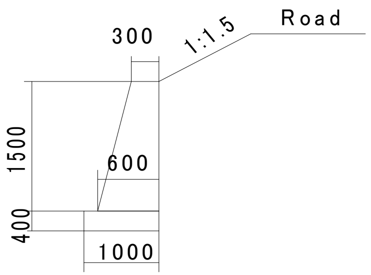
Compressive Strength	W/C=50%
Durability	W/C=65%
Water Tightness	W/C=55%
Concreting Under Water	Below W/C=55%

Minimum Value 50%

(252) Concrete Mix Proportion Design (1)

(1) $\sigma ck=16.0N/mm2$
(2) C/W−σ
$\sigma 28=21+21.5*(C/W)$

(253) Concrete Mix Proprtion Design(2)



252 Concrete Mix Proportion Design

(1) s ck=16N/mm2

(2) C/W−s   s 28=21+21.5*(C/W)

(3) Structure Section

(4) Material

(5) Construction Control   Field Mix

(6) s/a and W

Cement	Normal Portland Cement
Sand	Fineness Modulus (F.M)=2.75
	Specific Gravity=2.62
Gravel	Maximum Size of Aggregate 50mm
	Specific Gravity=2.65

Mix Proportion Calculation

(1) W/C

a) W/C-Compressive Strength

1) Extra Co-efficient(a)   (a)=1.18

Fluctuation Modulus (V)=15-20%   (V)=20%

2) Required Strength(s r)

(s r) = 16*1.18=-21+21.5(C/W)

(W/C)=54%

252 Concrete Nix Proportion Design
(1) sck=16N/mm2
(2) C/W-s s28=21+21.5*(C/W)
(3) Structure Section
(4) Material
(5) Construction Control Field Mix
(6) s/a and W

Cement	Normal Portland Cement
Sand	Fineness Modulus(F.M)=2.75
	Specific Gravity=2.62
Gravel	Maximum Size of Aggregate 50mm
	Specific Gravity=2.65

Mix Proportion Calculation
(1) W/C
a) W/C-Compressive Strength
1) Extra Co-efficient(a) (a)=1.18
Fluctuation Modulus (V)=15-20% (V)=20%
2) Required Strength(sr)
(sr)=16*1.18=-21+21.5(C/W)
(W/C)=54%
b) Durability
220 W/C and Durability

Weather Condition	Strict Weather			Not Strict Weather		
Section	Thin	Normal	Thick	Thin	Normal	Thick
Under Water	55(50)	60(55)	60(55)	55(50)	65(60)	65(60)
Normal	60(55)	65(60)	65(60)	60(55)	70(65)	70(65)
Dam Concrete	60			65		
Weather Condition	Strict Weather,A Lot of Freezing and Thawing Action			A Fewoof Freezing and Thawing Action		
Paving Concrete	45			50		

(W/C)=65%
c) Selection of W/C
(W/C)=54% Adapt Smaller (W/C)

(2) Decide Slump and Maximum Size of Aggregate

a) Slump

229 Maximum Size of Aggregate and Slump

Type of Concrete	Type of Structure	Maximum Size of Aggregate(mm)		Slump(cm)
Plain Concrete			Standard :Below 100mm.Not Over (1/4) Minimum Size of Structure,Water Tightness Concrete :Not Over 1/5	2.5-8
Reinforcement Concrete	Normal	25	Below 50mm.Not Over (1/5) Minimum Size of Structure,Not Over 3/4 Reinforced Bar Interval	5-12
	Big Section	40		2.5-10
	Water tightness			Below 8
Concrete Pavement		Below 40		2.5
Dam Concrete		Below 150		3-5

230 Standard of Air Content

Type		Air Content(%)
Plain. Reinforcement Concrete		3-6
Concrete Pavement		4
Dam Concrete	Maximum Size 40mm	4.0+-1
	Maximum Size 80mm	3.5+-1
	Maximum Size 150mm	3.0+-1

Slump 6.5cm

Maximu Size of Aggregate 50mm

(3) Calculate Unit Water Content(W)

221 Unit Water and Sand Percentage of Concrete

River Sand,River Gravel,W/C=55%,Slump=5cm,FM=2.75

Maximum Size of Aggregate	No Admixture			AE Concrete				
				Air Content(Strict Weather)	Good Quality AE Agent		Good Quality Water Reducing Agent	
	Entrapped Air	Sand Percentage	Unit Water of Concrete		Sand Percentage	Unit Water of Concrete	Sand Percentage	Unit Water of Concrete
(mm)	(%)	(%)	(kg)	(%)	(%)	(kg)	(%)	(kg)
15	2.5	49	187	7	46	169	47	156
20	2	45	181	6	42	162	43	150
25	1.5	41	172	5	37	153	38	143
40	1.2	36	160	4.5	33	141	34	131
50	1	33	152	4	30	131	31	122
80	0.5	31	139	3.5	28	117	28.5	109
150	0.3	28	120	3	24	100	24	93

(4) Calculate s/a

222 Correction River Sand,River Gravel,W/C=55%,Slump=5cm,FM=2.75

Section	Correction of (s/a)%	Correction of (W)kg
FM of Sand(0.1 Bigger)	Increase 0.5	No Correction
W/C(0.05 Bigger)	Increase 1	No Correction
Slump(2.5cm Bigger)	No Correction	Increase 3%
Air Content(1% Bigger)	Decrease(0.5-1)	Decrease(3)%
Crushed Stone	Increase 3-5	Increase 7-10%
Concrete Pavement	Decrease(3)	Decrease(3%)

Condition		Calculation	s/a	W
Reference	Example		(%)	(kg)
50	50		33	152
2.75	2.75		33	152
55	54	s/a=(33+(0.54-0.55)/0.05)*1)=32.8	32.8	152
5	6.5	W=152*(1+((6.5-5)/2.5)*0.03)=155	32.8	155

(5) (6) Unit Water Content and Fine Aggregate and Coarse Aggregate

(1) W/C=54% W=155 C=155/(54*0.01)=287

(4)234*2.62=613

(6)=496*2.65=1314

Specified Mix Proportion

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks	density kg/m3
		(SL)	air	W/C	s/a	C	W	s	CA (5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	Mighty 900RA=( )%*cement	Mighty 185S=( )%					
	50	6.5	1	54.0	32.0	287	155	612	1315							Weight	
						3.15	1	2.62	2.65							Specific Gravity	
			10			105	155	234	496							Volume	1000

(2)=287/3.15=105

(5)=1000-(10+105+155+234)=496

(3)=(1000-(10+105+155))*32*0.01=234

b) Durability

220 W/C and Durability

Weather Condition	Strict Weather			Not Strict Weather		
Section	Thin	Normal	Thick	Thin	Normal	Thick
Under Water	55 (50)	60 (55)	60 (55)	55 (50)	65 (60)	65 (60)
Normal	60 (55)	65 (60)	65 (60)	60 (55)	70 (65)	70 (65)
Dam Concrete	60			65		
Weather Condition	Strict Weather, A Lot of Freezing and Thawing Action			A Few of Freezing and Thawing Action		
Paving Concrete	45			50		

(W/C)=65%

c) Selection of W/C

(W/C)=54% Adapt Smaller (W/C)

(2) Decide Slump and Maximum Size of Aggregate

a) Slump

229 Maximum Size of Aggregate and Slump

Type of Concrete	Type of Structure	Maximum Size of Aggregate (mm)		Slump (cm)
Plain Concrete			Standard :Below 100mm .Not Over (1/4) Minimum Size of Structure, Water Tightness Concrete :Not Over 1/5	2.5-8
Reinforcement Concrete	Normal	25	Below 50mm .Not Over (1/5) Minimum Size of Structure, Not Over 3/4 Reinforced Bar Interval	5-12
	Big Section	40		2.5-10
	Water tightness			Below 8
Concrete Pavement		Below 40		2.5
Dam Concrete		Below 150		3-5

(255) Concrete Mix Proportion Design (4)

230 Standard of Air Content

Type		Air Content(%)
Plain. Reinforcement Concrete		3-6
Concrete Pavement		4
Dam Concrete	Maximum Size 40mm	4.0+-1
	Maximum Size 80mm	3.5+-1
	Maximum Size 150mm	3.0+-1

Slump 6.5cm

Maximu Size of Aggregate 50mm

(3) Calculate Unit Water Content(W)

221 Unit Water and Sand Percentage of Concrete

River Sand, River Gravel, W/C=55%, Slump=5cm, FM=2.75

Maximum Size of Aggregate	No Admixture			AE Concrete				
	Entrapped Air	Sand Percentage	Unit Water of Concrete	Air Content(Strict Weather)	Good Quality AE Agent: Sand Percentage	Good Quality AE Agent: Unit Water of Concrete	Good Quality Water Reducing Agent: Sand Percentage	Good Quality Water Reducing Agent: Unit Water of Concrete
(mm)	(%)	(%)	(kg)	(%)	(%)	(kg)	(%)	(kg)
15	2.5	49	187	7	46	169	47	156
20	2	45	181	6	42	162	43	150
25	1.5	41	172	5	37	153	38	143
40	1.2	36	160	4.5	33	141	34	131
50	1	33	152	4	30	131	31	122
80	0.5	31	139	3.5	28	117	28.5	109
150	0.3	28	120	3	24	100	24	93

(3) Calculate Unit Water Content(W)

221 Unit Water and Sand Percentage of Concrete

River Sand, River Gravel, W/C=55%, Slump=5cm, FM=2.75

Maximum Size of Aggregate	No Admixture			AE Concrete				
					Good Quality AE Agent		Good Quality Water Reducing Agent	
	Entrapped Air	Sand Percentage	Unit Water of Concrete	Air Content(Strict Weather)	Sand Percentage	Unit Water of Concrete	Sand Percentage	Unit Water of Concrete
(mm)	(%)	(%)	(kg)	(%)	(%)	(kg)	(%)	(kg)
15	2.5	49	187	7	46	169	47	156
20	2	45	181	6	42	162	43	150
25	1.5	41	172	5	37	153	38	143
40	1.2	36	160	4.5	33	141	34	131
50	1	33	152	4	30	131	31	122
80	0.5	31	139	3.5	28	117	28.5	109
150	0.3	28	120	3	24	100	24	93

(4) Calculate s/a

222 Correction River Sand, River Gravel, W/C=55%, Slump=5cm, FM=2.75

Section	Correction of (s/a)%	Correction of (W)kg
FM of Sand (0.1 Bigger)	Increase 0.5	No Correction
W/C (0.05 Bigger)	Increase 1	No Correction
Slump (2.5cm Bigger)	No Correction	Increase 3%
Air Content (1% Bigger)	Decrease (0.5-1)	Decrease (3)%
Crushed Stone	Increase 3-5	Increase 7-10%
Concrete Pavement	Decrease (3)	Decrease (3%)

Condition		Calculation	s/a	W
Reference	Example		(%)	(kg)
50	50		33	152
2.75	2.75		33	152
55	54	s/a=(33+(0.54-0.55)/0.05)*1)=32.8	32.8	152
5	6.5	W=152*(1+((6.5-5)/2.5)*0.03)=155	32.8	155

Specified Mix Proportion

(1) W/C=46% W=160 C=160/(46*0.01)=348

(4)245*2.63=643

(6)=435*2.65=1153

Specified Mix Proportion

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength (kgf/cm2)			Remarks	density kg/m3
		(SL)	air	W/C	s/a	C	W	s	CA(5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
320	25	12	5	46.0	36	348	160	643	1153							Weight	
						3.15	1	2.63	2.65							Specific Gravity	
			50			110	160	245	435							Volume	1000

(2)=348/3.15=110

(5)=1000-(50+110+160+245)=435

(3)=(1000-(50+110+160))*36*0.01=245

(259) Minimum Content of Cement

259 Cement Minimum Content	
Type of Structure	Unit Cement Content
	(kg)
Reinforcement Concrete	Over 300
Concrete Under Water	Over 370
Pavement Concrete	280-340
Dam Concrete (Internal)	About 140
Dam Concrete (External)	

(260) Slump (Standard Value)

260 Slump

1) Reinforcement Concrete(Slump)(cm)	
Normal	5–12
Big Structure	2.5–10
2) Plain Concrete	2.5–8
Concrete under Water	
Tremie,Pump	13–18
Sacked Concrete	7–12
Pavement Concrete	2.5
Dam Concrete	3–5

(261) Maximum Size of Aggregate

261 Maximum Size of Coarse Aggregate									
Plain Concrete				Below 100mm,Below (1/4)of Minimum Size of Aggregate					
Reinforcement Concrete(Slump)(cm)				Below 50mm,Below (1/5) of Minimum Size of Structure,Below (3/4)of Reinforcement Minimum Interval					
Type of Structure				Maximum Size of Aggregate (mm)					
Normal ,Beam Wall Pier Slab				25					
Big Section,Fooching Caison				40					
Maximum Size of Coarse Aggregate									
Pavement Concrete				Below 40					

(262) Maximum Size of Aggregate

262 Sand Percentage and Water Content			
Maximum Size of Aggregate(mm)	Sand Percentage(s/a) (%)	Water Content W (N)	
20	46	184	1 Good Grading 2 W/C=0.55 3 Fine Aggregate F.M=2.75
25	41	178	
40	37	166	
50	34	157	
80	31	148	
150	26	131	

(263) Adjustment

263 Adjustment			
Condition Changing	Correction		
	s/a(%)	W(N)	W(kg)
1,W/C 0.05 Increase or Decrease	+−1	0	0
2,Fine Aggregate F.M 0.1 Increase Decrease	+−0.5	0	0
3,Slump 2.5cm Increase Decrease	0	+−3	+−3
4,s/a 1% Increase Decrease	−	+−15N	+−1.5kg
5,Coarse Aggregate −Crushed Stone	+3−5	+90−150kg	(+9−15kg)
6,Fine Aggregate −Crushed Sand	+2−3	+60−90kg	(+6−9kg)
7,Pavement Concrete	−3	−50N	(−5kg)

(264) Unit Coarse Aggregate Volume ,Sand Percentage and Unit Water Content

264UnitCoarse Aggregate Volume,UnitWater and Sand Percentage ofConcrete

Maximum Size of Aggregate	Unit Coarse Aggregate Volume(%)	No Admixture			AE Concrete				
		Entrapped Air	Sand Percentage	Unit Water of Concrete	Air Content(Strict Weather)	Good Quality AE Agent		Good Quality Water Reducing Agent	
						Sand Percentage	Unit Water of Concrete	Sand Percentage	Unit Water of Concrete
(mm)	(%)	(%)	(%)	(kg)	(%)	(%)	(kg)	(%)	(kg)
15	53	2.5	49	190	7	46	170	47	160
20	61	2	45	185	6	42	165	43	155
25	66	1.5	41	175	5	37	155	38	145
40	72	1.2	36	165	4.5	33	145	34	135
50	75	1	33	155	4	30	135	31	125
80	81	0.5	31	140	3.5	28	120	29	110
1,Normal Sand (F.M) Fineness Modulus 2.8 Slump 8cm									

(265) Correction

265 Correction		
Section	Correction of (s/a)%	Correction of (W)kg
FM of Sand (0.1 Bigger)	Increase 0.5	No Correction
Slump (1cm Bigger)	No Correction	Increase 1.2%
Air Content (1% Bigger)	Decrease (0.5-1)	Decrease (3)%
Crushed Stone	Increase 3-5	Increase 9-15
Crushed Sand	Increase 2-3	Increase 6-9

(266) AE Concrete Mix Proportion Design (1)

266 Mix Proportion Design of AE Concrete

(1) Area Location	Cold Area		
(2) Type of Structure	Reinforcement Concrete Girder Bridge		
(3) Structure Section	Minimum Dimension		350mm
(4) Interval Length of Reinforcements			35mm
(5) Design Strength			28N/mm2
(6) Material			
	Fine Aggregate	Fineness Modulus	2.85
		Specific Gravity	2.63
	Coarse Aggregate	Specific Gravity	2.65

262 Sand Percentage and Water Content

Maximum Size of Aggregate(mm)	Sand Percentage(s/a) (%)	Water Content W (N)	
20	46	184	1 Good Grading 2 W/C=0.55 3 Fine Aggregate F.M=2.75
25	41	178	
40	37	166	
50	34	157	
80	31	148	
150	26	131	

1 Normal Grading Sand and Gravel, W/C=0.55 Slump 7.5cm, Fine Aggregate (F.M)=2.75

(267) AE Concrete Mix Proportion Design (2)

Cem ent:Norm al Portland Cem ent
Sand:Good Grading F.M =2.85 Specific Gravity 2 .63
Geavel:Specific Gravity =2.65
AE Agent

263 Adjustment

Condition Changing	Correction		
	s/a(%)	W(N)	W(kg)
1,W/C 0.05 Increase or Decrease	+-1	0	0
2,Fine Aggregate F.M 0.1 Increase Decrease	+-0.5	0	0
3,Slump 2.5cm Increase Decrease	0	+-3	+-3
4,s/a 1% Increase Decrease	–	+-15N	+-1.5kg
5,Coarse Aggregate -Crushed Stone	+3-5	+90-150kg	(+9-15kg)
6,Fine Aggregate -Crushed Sand	+2-3	+60-90kg	(+6-9kg)
7,Pavement Concrete	-3	-50N	(-5kg)

(268) AE Concrete Mix Proportion Design (3)

Mix Proportion Design

(1) Coarse Aggregate Maximum Size

Minimum Size of Aggregate =350*(1/5)=70mm

Minimum Interval Pitch of Reinforcement =35*(3/4)=25mm

(2) Air Content

From Maximum Size of Aggregate

264 Unit Coarse Aggregate Volume, Unit Water and Sand Percentage of Concrete

Maximum Size of Aggregate	Unit Coarse Aggregate Volume (%)	No Admixture			AE Concrete				
		Entrapped Air	Sand Percentage	Unit Water of Concrete	Air Content(Strict Weather)	Good Quality AE Agent		Good Quality Water Reducing Agent	
						Sand Percentage	Unit Water of Concrete	Sand Percentage	Unit Water of Concrete
(mm)	(%)	(%)	(%)	(kg)	(%)	(%)	(kg)	(%)	(kg)
15	53	2.5	49	190	7	46	170	47	160
20	61	2	45	185	6	42	165	43	155
25	66	1.5	41	175	5	37	155	38	145
40	72	1.2	36	165	4.5	33	145	34	135
50	75	1	33	155	4	30	135	31	125
80	81	0.5	31	140	3.5	28	120	29	110
1,Normal Sand (F.M) Fineness Modulus 2.8 Slump 8cm									

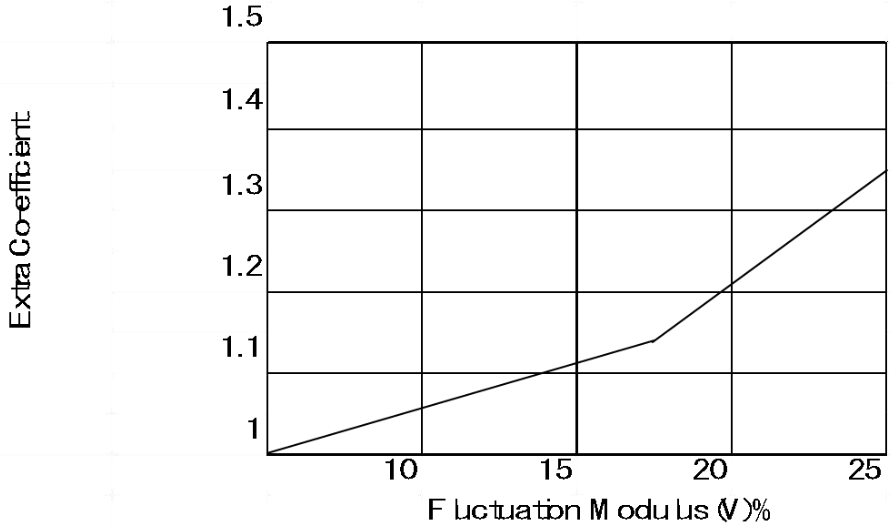
Air Content=5+-1.0%

(269) AE Concrete Mix Proportion Design (4)

(3) Water Cement Ratio

a) Compressive Strength W/C

) Extra Co-efficient(a)



Fluctuation Modulus (V)%	Control Degree
7-10	Super
10-15	Good
15-20	Normal
Over 20	Not Normal

Fluctuation Modulus (V) 15%

Extra Co-efficient(a) 1.14

(270) AE Concrete Mix Proportion Design (5)

i) W/C-Compressive Strength

s r=1.14*28=32　　32 (N/mm 2)　　320kg/cm 2

s 28=32=-16+21.7*(C/W)　　W/C=45%

b)Durability

220 W/C and Durability

Weather Condition	Strict Weather			Not Strict Weather		
Section	Thin	Normal	Thick	Thin	Normal	Thick
Under Water	55 (50)	60 (55)	60 (55)	55 (50)	65 (60)	65 (60)
Normal	60 (55)	65 (60)	65 (60)	60 (55)	70 (65)	70 (65)
Dam Concrete	60			65		
Weather Condition	Strict Weather, A Lot of Freezing and Thawing Action			A Fewoof Freezing and Thawing Action		
Paving Concrete	45			50		

Adapt　　W/C=45%

(271) AE Concrete Mix Proportion Design (6)

⑷ Slump

259 Cement Minimum Content

Type of Structure	Unit Cement Content (kg)
Reinforcement Concrete	Over 300
Concrete Under Water	Over 370
Pavement Concrete	280-340
Dam Concrete (Internal)	About 140
Dam Concrete (External)	

260 Slump

1) Reinforcement Concrete(Slump)(cm)	
Normal	5–12
Big Structure	2.5–10
2) Plain Concrete	2.5–8
Concrete under Water	
Tremie,Pump	13–18
Sacked Concrete	7–12
Pavement Concrete	2.5
Dam Concrete	3–5

Adapt Slump 12cm

(272) AE Concrete Mix Proportion Design (7)

264 Unit Coarse Aggregate Volume, Unit Water and Sand Percentage of Concrete

Maximum Size of Aggregate	Unit Coarse Aggregate Volume (%)	No Admixture			AE Concrete				
		Entrapped Air	Sand Percentage	Unit Water of Concrete	Air Content (Strict Weather)	Good Quality AE Agent		Good Quality Water Reducing Agent	
						Sand Percentage	Unit Water of Concrete	Sand Percentage	Unit Water of Concrete
(mm)	(%)	(%)	(%)	(kg)	(%)	(%)	(kg)	(%)	(kg)
15	53	2.5	49	190	7	46	170	47	160
20	61	2	45	185	6	42	165	43	155
25	66	1.5	41	175	5	37	155	38	145
40	72	1.2	36	165	4.5	33	145	34	135
50	75	1	33	155	4	30	135	31	125
80	81	0.5	31	140	3.5	28	120	29	110

1, Normal Sand (F.M) Fineness Modulus 2.8 Slump 8cm

262 Sand Percentage and Water Content

Maximum Size of Aggregate(mm)	Sand Percentage(s/a) (%)	Water Content W (N)	
20	46	184	1 Good Grading 2 W/C=0.55 3 Slump 7.5cm 4, Fine Aggregate F.M=2.75
25	41	178	
40	37	166	
50	34	157	
80	31	148	
150	26	131	

(273) AE Concrete Mix Proportion Design (8)

263 Adjustment

Condition Changing	Correction			Condition		Calculation	s/a	W
	s/a(%)	W(N)	W(kg)	Reference	Example		(%)	(kg)
							37	155
1,W/C 0.05 Increase or Decrease	+-1	0	0	0.55	0.45	s/a= (0.45-0.55)/0.05)*1+37	35.0	155
2,Fine Aggregate F.M 0.1 Increase Decrease	+-0.5	0	0	2.75	2.85	s/a= (2.85-2.75)/0.1)*0.5+35	35.5	155
3,Slump 2.5cm Increase Decrease	0	+-3	+-3	7.5	12	W = ((12-7.5)/2.5)*3+155	35.5	160.4
4,s/a 1% Increase Decrease	-	+-15N	+-1.5kg	37				
5,Coarse Aggregate -Crushed Stone	+3-5	+90-150kg	(+9-15kg)					
6,Fine Aggregate -Crushed Sand	+2-3	+60-90kg	(+6-9kg)					
7,Pavement Concrete	-3	-50N	(-5kg)					

(274) AE Concrete Mix Proportion Design (9)

Specified Mix Proportion

(1) W /C=46%　　W =160　C=160/(46*0.01)=348

(4)245*2.63=643

(6)=435*2.65=1153

Specified Mix Proportion

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength (kgf/cm2)			Remarks	density kg/m3
		(SL)	air	W/C	s/a	C	W	s	CA(5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
320	25	12	5	46.0	36	348	160	643	1153							Weight	
						3.15	1	2.63	2.65							Specific Gravity	
			50			110	160	245	435							Volume	1000

(2)=348/3.15=110

(5)=1000-(50+110+160+245)=435

(3)=(1000-(50+110+160))*36*0.01=245

(275) Air Content of AE Concrete

275 Air Content of AE Concrete	
Maximum Size of Coarse Aggregate (mm)	Air Content (%)
15	6
20	5
25	4.5
40	4
50	3.5
80	3

275 Air Content of AE Concrete

Maximum Size of Coarse Aggregate (mm)	Air Content (%)
15	6
20	5
25	4.5
40	4
50	3.5
80	3

276 Grading of Fine Aggregate

Sieve Size	Sieve Passing Percentage
10	100
5	90-100
2.5	80-100
1.2	50-90
0.6	25-65
0.3	10-35
0.15	2-10

277 Grading of Coarse Aggregate

Sieve Size(mm)	Sieve Passing Percentage											
Coarse Aggregate	100	80	60	50	40	30	25	20	15	10	5	3
50-5	-	-	100	95-100	-	-	35-70		10-35		0-5	-
40-5	-	-	-	100	95-100	-	-	35-70	-	10-30	0-5	-
30-5	-	-	-	-	100	95-100	-	40-75	-	10-35	0-10	0-5
25-5	-	-	-	-	-	100	95-100	-	30-70	-	0-10	0-5
20-5	-	-	-	-	-	-	100	90-100	-	-	0-10	0-5
15-5	-	-	-	-	-	-	-	100	90-100	20-55	0-15	0-5
10-5	-	-	-	-	-	-	-	-	100	40-70	0-40	0-10
80-40	100	90-100	45-70	-	0-15	-	-	0-5	-	85-100	-	-
60-40	-	100	90-100	35-70	0-15	-	-	0-5	-	-	-	-
50-25	-	-	100	90-100	35-70	-	0-15	-	0-5	-	-	-
40-20	-	-	-	100	90-100	-	20-55	0-15	-	0-5	-	-
30-15	-	-	-	-	100	90-100		20-55	0-5	0-10	-	-

278 Mix Proportion

(1) Design Condition

1. Location:

2. Type of Structur

3. Design Strength: sck=21N/mm2

4. Material

Cement	Normal Portland Cement	Specific Gravity	3.15
Fine Aggregate		Specific Gravity(S.S.D)	2.65
Coarse Aggregate			
AE Agent	C*0.03%		

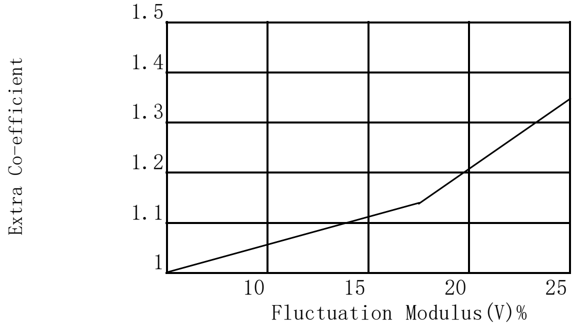
5. Sulmp:(10+-1) (10+-1)%

6. Air Content: 4-5%

275 Air Content of AE Concrete

Maximum Size of Coarse Aggregate (mm)	Air Content (%)
15	6
20	5
25	4.5
40	4
50	3.5
80	3

7.Fluctuation Co-efficient(V)
i) Extra Co-efficient(a)



Fluctuation Modulus(V)%	Control Degree
7-10	Super
10-15	Good
15-20	Normal
Over 20	Not Normal

Fluctuation Modulus(V) 15%
Extra Co-efficient(a) 1.14

(2) Specified Mix Proportion Design
(1) Maximum Size of Coarse Aggregate
261 Maximum Size of Coarse Aggregate

Plain Concrete	Below 100mm,Below (1/4)of Minimum Size of Aggregate
Reinforcement Concrete(Slump)(cm)	Below 50mm,Below (1/5) of Minimum Size of Structure,Below (3/4)of Reinforcement Minimum
Type of Structure	Maximum Size of Aggregate (mm)
Normal ,Beam Wall Pier Slab	25
Big Section,Fooching Caison	40
Maximum Size of Coarse Aggregate	
Pavement Concrete	Below 40

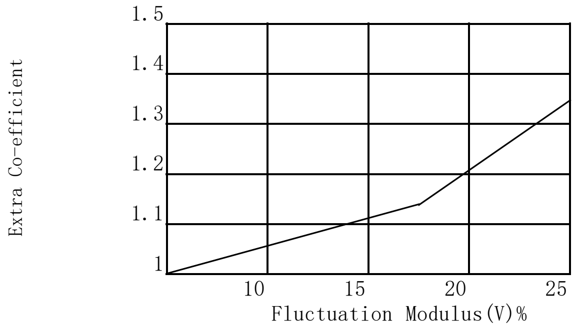
a)Maximum Size of Structure=500*(1/5)=100mm
b) Minimum Size Reinforcement Pitch =109*(3/4)=82mm
Maximum Size of Coarse Aggregate =25mm
(2) Air Content

275 Air Content of AE Concrete

Maximum Size of Coarse Aggregate (mm)	Air Content (%)
15	6
20	5
25	4.5
40	4
50	3.5
80	3

Air Content=4.5%

(3) Water Cement Ratio
a) Compressive Strength W/C
i) Extra Co-efficient(a)



Fluctuation Modulus(V)%	Control Degree
7-10	Super
10-15	Good
15-20	Normal
Over 20	Not Normal

Fluctuation Modulus(V) 15%
Extra Co-efficient(a) 1.12

ii) W/C-Compressive Strength

sr=1.12*21=23.5N/mm2 23.5N/mm2

s(28)=24=-16+21.7*(C/W) W/C=54%

s(28)=24=-21+21.5*(C/W) W/C=47%

b)Durability

220 W/C and Durability

Weather Condition	Strict Weather			Not Strict Weather		
Section	Thin	Normal	Thick	Thin	Normal	Thick
Under Water	55(50)	60(55)	60(55)	55(50)	65(60)	65(60)
Normal	60(55)	65(60)	65(60)	60(55)	70(65)	70(65)
Dam Concrete	60			65		
Weather Condition	Strict Weather,A Lot of Freezing and Thawing			A Fewoof Freezing and Thawing Action		
Paving Concrete	45			50		

c) Adapt W/C=47% (Select Smallest)

(4)Unit Water

264Unit Coarse Aggregate Volume,Unit Water and Sand Percentage of Concrete

Maximum Size of Aggregate	Unit Coarse Aggregate Volume (%)	No Admixture			AE Concrete				
		Entrapped Air	Sand Percentage(s/a)	Unit Water of Concrete	Air Content(Strict Weather)	Good Quality AE Agent		Good Quality Water Reducing	
						Sand Percentage	Unit Water of Concrete	Sand Percentage	Unit Water of Concrete
(mm)	(%)	(%)	(%)	(kg)	(%)	(%)	(kg)	(%)	(kg)
15	53	2.5	49	190	7	46	170	47	160
20	61	2	45	185	6	42	165	43	155
25	66	1.5	41	175	5	37	155	38	145
40	72	1.2	36	165	4.5	33	145	34	135
50	75	1	33	155	4	30	135	31	125
80	81	0.5	31	140	3.5	28	120	29	110
1,Normal Sand (F.M) Fineness Modulus 2.8 Slump 8cm									

265 Correction

Section	Correction of (s/a)%	Correction of (W)kg	Condition Reference	Condition Example	Calculation	s/a (%)	W (kg)
						37	155
FM of Sand(0.1 Bigger)	Increase 0.5	No Correction	2.8	2.8		37	155
Slump(1cm Bigger)	No Correction	Increase 1.2%	8	10	=(1+((10-8)/1)*1.2*0.01)*155=159	37	159
Air Content(1% Bigger)	Decrease(0.5-1)	Decrease(3)%					
Crushed Stone	Increase 3-5	Increase 9-15					
Crushed Sand	Increase 2-3	Increase 6-9					

(5) s/a s/a=37%

(6)Specified Mix Proportion

(1) W/C=47% W=159 C=159/(47*0.01)=338

(4)254*2.6=660

(6)=432*2.65=1145

(7) 338*0.03*0.01=1.014

Specified Mix Proportion

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks	density kg/m3
		(SL)	air	W/C	s/a	C	W	s	CA(5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
240	25	10	4.5	47.0	37	338	159	660	1145		1.01					Weight	
						3.15	1	2.6	2.65							Specific Gravity	
			45			110	159	254	432							Volume	1000

(2)=338/3.15=110

(5)=1000-(45+110+159+254)=432

(3)=(1000-(45+110+159))*37*0.01=254

(3) To Field Mix Proportion from Specified Mix Proportion

Specified Mix Proportion

W(kg)	C(kg)	Sand(kg)	Aggregate(kg)
159	338	660	1145

Field Condition

	Adjustment by Grading		Water Surface(%)	5mm Passing(%)	5mm Retained (%)		
Sand	x	Wet Condition	3	92	8	655	=x+y=660+1145=1805
Aggregate	y	Wet Condition	3	5	95	1150	=0.08*x+0.95*y=1145

Concrete Mix Proportion

Adjustment Moisture Content

	specifiv gravity(%)	absorption(%)	moisture content(%)	Water surface content(%)	Content(kg/m3)	Correction(kg/m3)	Corrected(kg/m3)
		(1)	(2)	(3)=(2)-(1)	(4)	(5)=(3)*(4)*0.01	(6)=(4)+(5)
Water					159	-55	104
Fine Aggregate	2.6	1.66		3	655	20	675
Coarse Aggregate	2.65	0.89		3	1150	35	1185

(276) Grading of Fine Aggregate

276 Grading of Fine Aggregate	
Sieve Size	Sieve Passing Percentage
10	100
5	90–100
2.5	80–100
1.2	50–90
0.6	25–65
0.3	10–35
0.15	2–10

(277) Grading of Coarse Aggregate

277 Grading of Coarse Aggregate												
Sieve Size (mm)	Sieve Passing Percentage											
Coarse Aggregate size (mm)	100	80	60	50	40	30	25	20	15	10	5	3
50-5	-	-	100	95-100	-	-	35-70		10-35		0-5	-
40-5	-	-	-	100	95-100	-	-	35-70	-	10-30	0-5	-
30-5	-	-	-	-	100	95-100	-	40-75	-	10-35	0-10	0-5
25-5	-	-	-	-	-	100	95-100	-	30-70	-	0-10	0-5
20-5	-	-	-	-	-	-	100	90-100	-	-	0-10	0-5
15-5	-	-	-	-	-	-	-	100	90-100	20-55	0-15	0-5
10-5	-	-	-	-	-	-	-	-	100	40-70	0-40	0-10
80-40	100	90-100	45-70	-	0-15	-	-	0-5	-	85-100	-	-
60-40	-	100	90-100	35-70	0-15	-	-	0-5	-	-	-	-
50-25	-	-	100	90-100	35-70	-	0-15	-	0-5	-	-	-
40-20	-	-	-	100	90-100	-	20-55	0-15	-	0-5	-	-
30-15	-	-	-	-	100	90-100		20-55	0-5	0-10	-	-

(278) Mix Proportion (1)

278 Mix Proportion

(1) Design Condition

1. Location:

2. Type of Structure:

3. Design Strength: σck=21N/mm2

4. Material

Cement	Normal Portland Cement	Specific Gravity	3.15
Fine Aggregate		Specific Gravity (S.S.D)	2.65
Coarse Aggregate			
AE Agent	C×0.03%		

5. Sulmp: (10+-1) (10+-1)%

6. Air Content: 4-5%

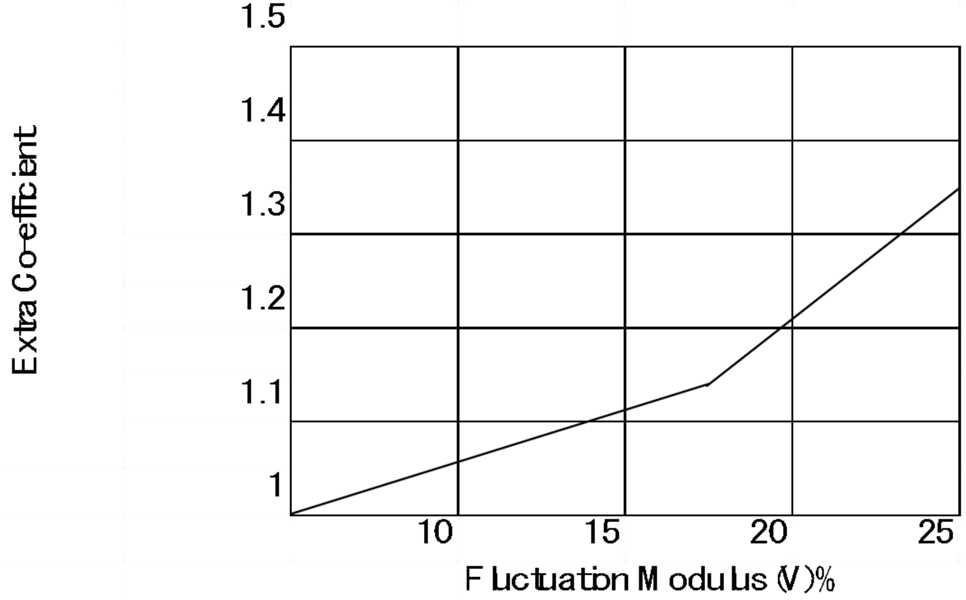
275 Air Content of AE Concrete

Maximum Size of Coarse Aggregate (mm)	Air Content (%)
15	6
20	5
25	4.5
40	4
50	3.5
80	3

(279) Mix Proportion (2)

7.Fluctuation Co-efficient(V)

i) Extra Co-efficient(a)



Fluctuation Modulus (V)%	Control Degree
7-10	Super
10-15	Good
15-20	Normal
Over 20	Not Normal

Fluctuation Modulus (V) 15%

Extra Co-efficient(a) 1.14

(280) Mix Proportion (3)

(2) Specified Mix Proportion Design

(1) Maximum Size of Coarse Aggregate

261 Maximum Size of Coarse Aggregate

Plain Concrete	Below 100mm,Below (1/4)of Minimum Size of Aggregate
Reinforcement Concrete(Slump)(cm)	Below 50mm,Below (1/5) of Minimum Size of Structure,Below (3/4)of Reinforcement Minimum Interval
Type of Structure	Maximum Size of Aggregate (mm)
Normal ,Beam Wall Pier Slab	25
Big Section,Fooching Caison	40
Maximum Size of Coarse Aggregate	
Pavement Concrete	Below 40

a)Maximum Size of Structure: =500*(1/5)=100mm

b) Minimum Size Reinforcement Pitch =109*(3/4)=82mm

Maximum Size of Coarse Aggregate =25mm

(281) Mix Proportion (4)

(2) Air Content

275 Air Content of AE Concrete

Maximum Size of Coarse Aggregate (mm)	Air Content (%)
15	6
20	5
25	4.5
40	4
50	3.5
80	3

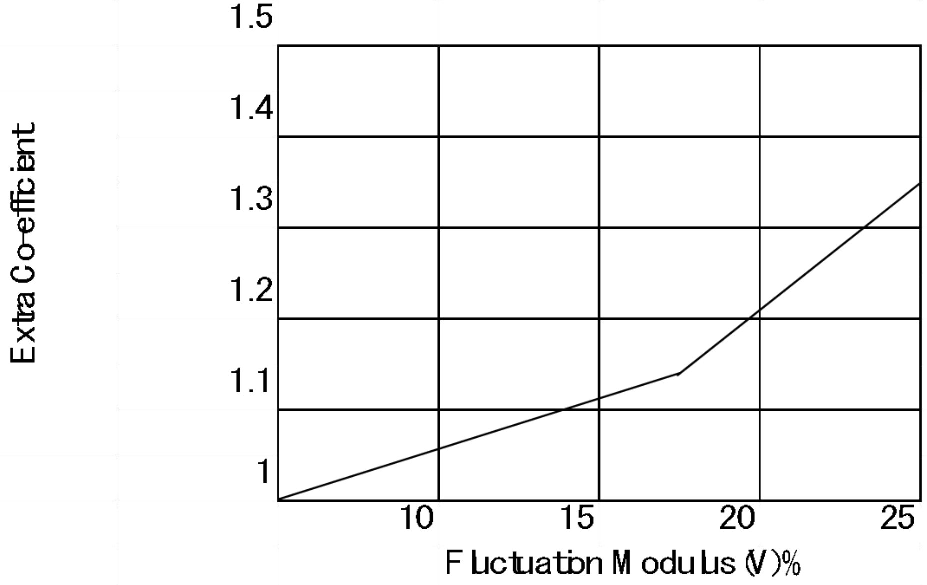
Air Content=4.5%

(282) Mix Proportion (5)

(3) Water Cement Ratio

a) Compressive Strength　　W/C

i) Extra Co-efficient(a)



Fluctuation Modulus (V)%	Control Degree
7-10	Super
10-15	Good
15-20	Normal
Over 20	Not Normal

Fluctuation Modulus (V)　　15%

Extra Co-efficient(a)　　1.12

ii) W/C-Compressive Strength

$s_r = 1.12*21 = 23.5 N/mm^2$　　$23.5 N/mm^2$

$s(28) = 24 = -16 + 21.7*(C/W)$　　W/C=54%

$s(28) = 24 = -21 + 21.5*(C/W)$　　W/C=47%

(283) Mix Proportion (6)

b) Durability

220 W/C and Durability

Weather Condition	Strict Weather			Not Strict Weather		
Section	Thin	Normal	Thick	Thin	Normal	Thick
Under Water	55 (50)	60 (55)	60 (55)	55 (50)	65 (60)	65 (60)
Normal	60 (55)	65 (60)	65 (60)	60 (55)	70 (65)	70 (65)
Dam Concrete	60			65		
Weather Condition	Strict Weather, A Lot of Freezing and Thawing Action			A Fewo of Freezing and Thawing Action		
Paving Concrete	45			50		

c) Adapt W/C=47% (Select Smallest)

(284) Mix Proportion (7)

(4)Unit Water

264Unit Coarse Aggregate Volume, Unit Water and Sand Percentage of Concrete

Maximum Size of Aggregate	Unit Coarse Aggregate Volume (%)	No Admixture			AE Concrete				
		Entrapped Air	Sand Percentage (s/a)	Unit Water of Concrete	Air Content (Strict Weather)	Good Quality AE Agent		Good Quality Water Reducing Agent	
						Sand Percentage	Unit Water of Concrete	Sand Percentage	Unit Water of Concrete
(mm)	(%)	(%)	(%)	(kg)	(%)	(%)	(kg)	(%)	(kg)
15	53	2.5	49	190	7	46	170	47	160
20	61	2	45	185	6	42	165	43	155
25	66	1.5	41	175	5	37	155	38	145
40	72	1.2	36	165	4.5	33	145	34	135
50	75	1	33	155	4	30	135	31	125
80	81	0.5	31	140	3.5	28	120	29	110

1,Normal Sand (F.M) Fineness Modulus 2.8 Slump 8cm

(285) Mix Proportion (8)

265 Correction

Section	Correction of (s/a)%	Correction of (W)kg	Condition		Calculation	s/a	W
			Reference	Example		(%)	(kg)
						37	155
FM of Sand (0.1 Bigger)	Increase 0.5	No Correction	2.8	2.8		37	155
Slump (1cm Bigger)	No Correction	Increase 1.2%	8	10	=(1+((10-8)/1)*1.2*0.01)*155=159	37	159
Air Content (1% Bigger)	Decrease (0.5-1)	Decrease (3)%					
Crushed Stone	Increase 3-5	Increase 9-15					
Crushed Sand	Increase 2-3	Increase 6-9					

(5) s/a s/a=37%

(286) Mix Proportion (9)

(6)Specified Mix Proportion

(1) W/C=47%　　W=159　C=159/(47*0.01)=338

(4)254*2.6=660

(7) 338*0.03*0.01=1.014

(6)=432*2.65=1145

Saturated Surface-Dry State of Aggregate

Specified Mix Proportion

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength (kgf/cm2)			Remarks	density kg/m3
		(SL)	air	W/C	s/a	C	W	s	CA(5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
240	25	10	4.5	47.0	37	338	159	660	1145		1.01					Weight	
						3.15	1	2.6	2.65							Specific Gravity	
			45			110	159	254	432							Volume	1000

(2)=338/3.15=110

(5)=1000-(45+110+159+254)=432

(3)= (1000-(45+110+159))*37*0.01=254

(287) Mix Proportion (10)

(3) To Field Mix Proportion from Specified Mix Proportion

Specified Mix Proportion

W(kg)	C(kg)	Sand(kg)	Aggregate (kg)
159	338	660	1145

Field Condition

	Adjustment by Grading		Water Surface(%)	5mm Passing(%)	5mm Retained(%)		
Sand	x	Wet Condition	3	92	8	655	=x+y=660+1145=1805
Aggregate	y	Wet Condition	3	5	95	1150	=0.08*x+0.95*y=1145

Concrete Mix Proportion

Adjustment Moisture Content

	specific gravity(%)	absorption(%)	moisture content(%)	Water surface content(%)	Content(kg/m3)	Correction(kg/m3)	Corrected(kg/m3)
		(1)	(2)	(3)=(2)-(1)	(4)	(5)=(3)*(4)*0.01	(6)=(4)+(5)
Water					159	-55	104
Fine Aggregate	2.6	1.66		3	655	20	675
Coarse Aggregate	2.65	0.89		3	1150	35	1185

Specified Mix Proportion

W(kg)	C(kg)	Sand(kg)	Aggregate (kg)
159	338	660	1145

Field Mix Proportion(1m3)

W(kg)	C(kg)	Sand(kg)	Aggregate (kg)
104	338	675	1185

(288) ACI 318 Water Cement Ratio and Compressive Strength

288 ACI318 W/C and Compressive Strength

Maximum Water-Cementitious Material Ratios and Minimum Design Strengths for Various Exposure Conditions

Exposure Condition	Maximum Water-Cementitious Material Ratios by Mass Concrete	Minimum Design Compressive Strength fc, Mpa (psi)
Concrete Protected from Exposure to Freezing and Thawing, Application of Deicing Chemicals, or Aggressive Substances	Select Water-Cementitious Material Ratio on Basis of Strength, Workability, and Finishing Needs.	Select Strength Based on Structural Requirements
Concrete intended to have low permeability when exposed to water.	0.5	28 (4000)
Concrete exposed to freezing and thawing in a moist condition or deicers	0.45	31 (4500)
For corrosion protection for reinforced concrete exposed to chlorides from deicing salts, salt water, brackish water, seawater, or spray from these sources.	0.4	35 (5000)

Adapted from ACI318

288 ACI 318 W/C and Compressive Strength

Maximum Water-Cementitious Material Ratios and Minimum Design Strengths for Various Exposure Conditions

Exposure Condition	Maximum Water-Cementitious Material Ratios by Mass Concrete	Minimum Design Compressive Strength f'c,Mpa(psi)
Concrete Protected from Exposure to Freezing and Thawing,Applicationof Deicing Chemicals, or Aggressive Substances	Select Water-Cementitious Material Ratio on Basis of Strength,Workability,and Finishing Needs.	Select Strength Based on Structural Requirements
Concrete intended to have low permeability when exposed to water.	0.5	28(4000)
Concrete exposed to freezing and thawing in a moist condition or deicers	0.45	31(4500)
For corrosion protection for reinforced concrete exposed to chlorides from deicing salts, salt water, brackish water,seawater,or spray from these sources.	0.4	35(5000)

Adapted from ACI 318

289 ACI 318 Requirements for concrete exposed to sulfates in soil or water

Sulfate Exposure	Water-soluble sulfate(S04) in soil,percent by mass.	Sulfate(SO4) in Water,ppm	Cement Type	Maximum water-cementitious material ratio,by mass	Minimum design compressive strength f"c,Mpa(psi)
Negligible	Less than 0.10	Less than 150	No special type required	-	-
Moderate	0.10 to 0.20	150 to 1500	II,MS,IP(MS),IS (MS),P(MS),I(PM)(MS),I(SM)(MS)	0.5	28(4000)
Severe	0.20 to 2.00	1500 to 10,000	V,HS	0.45	31(4500)
Very Severe	Over 2.00	Over 10,000	V,HS	0.4	35(5000)

290 ACI 211.1 and ACI 211.3 Relationship(Metric) between water cement ratio and compressive strength of concrete

Compressive Strength at 28 days,Mpa	Water-cementitious materials ratio by mass	
	Non-air-entrained concrete	Air-entrained concrete
45	0.38	0.3
40	0.42	0.34
35	0.47	0.39
30	0.54	0.45
25	0.61	0.52
20	0.69	0.6
15	0.79	0.7

Strength is based on cylinders moist-cured 28 days in accordance with ASTM C31(AASHTO T 23).Relationship assumes nominal maximum size aggregate of about 19 to 25 mm. Adapted from ACI 211.1 and ACI 211.3

290 ACI 211.1 and ACI 211.3 Relationship(Inch-Pound Units) between water cement ratio and compressive strength of

Compressive Strength at 28 days,psi	Water-cementitious materials ratio by mass	
	Non-air-entrained concrete	Air-entrained concrete
7000	0.33	-
6000	0.41	0.32
5000	0.48	0.4
4000	0.57	0.48
3000	0.68	0.59
2000	0.82	0.74

Strength is based on cylinders moist-cured 28 days in accordance with ASTM C31(AASHTO T 23).Relationship assumes nominal maximum size aggregate of about 3/4in.to 1 in. Adapted from ACI 211.1 and ACI 211.3

291 ACI 211 Bulk Volume of Coarse Aggregate per Unit Volume of Concrete

Maximum Size of Coarse Aggregate	Fineness Modules of Fine Aggregate			
	2.4	2.6	2.8	3
10	0.5	0.48	0.46	0.44
12.5	0.59	0.57	0.55	0.53
20	0.66	0.64	0.62	0.6
25	0.71	0.69	0.67	0.65
40	0.76	0.74	0.72	0.7
50	0.78	0.76	0.74	0.72
70	0.81	0.79	0.77	0.75
150	0.87	0.85	0.83	0.81

Bulk volume are based on aggregates in a dry-rodded condition described in ASTM C 29 (AASHTO T 19).Adapted from ACI 211

292 ACI 211.1 and ACI 318(Metric) Approximate Mixing Water and Target Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate

Slump(mm)	Water,kilograms per cubic meter of concrete,for indicated sizes of aggregate*							
	9.5	12.5	19	25	37.5	50**	75**	150**
Non-Air-entrained concrete								
25-50	207	199	190	179	166	154	130	113
75-100	228	216	205	193	181	169	145	124
150-175	243	228	216	202	190	178	160	-
Approximate amount of entrapped air in non-air-entrained concrete, percent	3	2.5	2	1.5	1	0.5	0.3	0.2
Air-entrained concrete								
25-50	181	175	168	160	150	142	122	107
75-100	202	193	184	175	165	157	133	119
150-175	216	205	197	184	174	166	154	-
Recommended average total air content,percent,for level of exposure(&)								
Mild exposure	4.5	4	3.5	3	2.5	2	1.5	1
Moderate Exposure	6	5.5	5	4.5	4.5	4	3.5	3
Severe exposure	7.5	7	6	6	5.5	5	4.5	4

* These quantities of mixing water are for use in computing cementitious material contents for trial batches. They are maximums for reasonably well-shaped angular coarse aggregates graded within limits of accepted specifications.

** The slump values for concrete containing aggregates larger than 37.5mm are based on slump tests made after removal of particles larger than 37.5mm by wet screening.

(&) The air content in job specifications should be specified to be delivered within -1 to +2 percentage points of the table target value for moderated and severe exposures. Adapted from ACI 211.1 and ACI 318.However(1995) presents this information in graphical form.

293 ACI 211.1 and ACI 318(Inch-Pound Units) Approximate Mixing Water and Target Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate

Slump(in)	Water,pounds per cubic yard of concrete,for indicated sizes of aggregate*							
	(3/8) In	(1/2) In	(3/4) In	(1) In	(1 1/2) In	(2) In	(3) In	(6) In
Non-Air-entrained concrete								
1-2	350	335	315	300	275	260	220	190
3-4	385	365	340	325	300	285	245	210
6-7	410	385	360	340	315	300	270	-
Approximate amount of entrapped air in non-air-entrained concrete, percent	3	2.5	2	1.5	1	0.5	0.3	0.2
Air-entrained concrete								
1-2	305	295	280	270	250	240	205	180
3-4	340	325	305	295	275	265	225	200
6-7	365	345	325	310	290	280	260	-
Recommended average total air content,percent,for level of exposure(&)								
Mild exposure	4.5	4	3.5	3	2.5	2	1.5	1
Moderate Exposure	6	5.5	5	4.5	4.5	3.5	3.5	3
Severe exposure	7.5	7	6	6	5.5	5	4.5	4

* These quantities of mixing water are for use in computing cementitious material contents for trial batches. They are maximums for reasonably well-shaped angular coarse aggregates graded within limits of accepted specifications.

** The slump values for concrete containing aggregates larger than 37.5mm are based on slump tests made after removal of particles larger than 37.5mm by wet screening.

(&) The air content in job specifications should be specified to be delivered within -1 to +2 percentage points of the table target value for moderated and severe exposures. Adapted from ACI 211.1 and ACI 318.However(1995) presents this information in graphical form.

294 ACI 211.1 Recommended Slumps for various types of construction

Concrete construction	Slump,mm(in)	
	Maximum*	Minimum
Reinforced foundation walls and footings	75(3)	25(1)
Plain footings,caisons,and substructure walls	75(3)	25(1)
Beams and reinforced walls	100(4)	25(1)
Building columns	100(4)	25(1)
Pavements and slabs	75(3)	25(1)
Mass concrete	75(3)	25(1)

* May be increased 25mm(1in.) for consolidation by hand methods, such as rodding and spading.. Plasticizers can safely provide higher slumps. Adapted from ACI 211.1.

295 ACI 302 Minimum requirements of cementing materials for concrete used in flatwork

Nominal maximum size of aggregate,mm(in.)	Cementing materials,kg/m3(lb/yd^3)*
37.5(1*1/2)	280(470)
25	310(520)
19(3/4)	320(540)
12.5(1/2)	350(590)
9.5(3/8)	360(610)

* Cementing materials quantities may need to be greater for severe exposure.For example, for deicer exposures, concrete should contain at least 335kg/m3(564yd3) of cementing materials. Adapted from ACI 302.

296 ACI 318 Cementitious materials requirements for concrete exposed to deicing chemicals

Cementitious materials *	Maximum percent of total cementitious materials by mass**
Fly ash and natural pozzolans	25
Slag	50
Silica fume	10
Total of fly ash,slag,silica fume and natural pozzolans	50&
Total of natural pozzolans and silica fume	35&

* Includes portion of supplementary cementing materials in blended cements.

** Total cementitious materials include the summation of Portland cements, blended cements, fly ash,slag,silica fume and other pozzolans.

& Silica fume should not constitute more than 10% of total cementitious materials and fly ash or other pozzolans shall not constitute more than 25% of cementitious materials. Adapted from ACI 318

297 ASTM C 1218 ACI 318 Maximum chloride-ion(Cl-) in concrete,percent by mass of cement*

Type of member	Maximum water-soluble chloride ion(CL-) in concrete,percent by mass of cement*
Prestressed concrete	0.06
Reinforced concrete exposed to chloride in service	0.15
Reinforced concrete that will be dry or protected from moisture in service	1
Other reinforced concrete construction	0.3

ASTM C 1218

Adapted from ACI 318

298 ACI 318 Modification Factor for standard deviation when less than 30 tests are available

Number of tests*	Modification Factor for standard deviation**
Less than 15	Use table 299
15	1.16
20	1.08
25	1.03
30 or more	1

* Interpolate for intermediate numbers of tests.

**Modification Factor for standard deviation to be used to determine required average strength ,f'cr.

Adapted from ACI 318

299 ACI 318 (Metric) Required average compressive strength when data are not available to establish

Specified compressive strength,f'c,MPa	Required average compressive strength,f'cr,MPa
Less than 21	f'c+7.0
21 to 35	f'c+8.5
Over 35	1.10f'c+5

Adapted from ACI 318

300 ACI 318 (Inch-Pound Units).Required average compressive strength when data are not available to establish a standard deviation

Specified compressive strength,f'c,psi	Required average compressive strength,f'cr,psi
Less than 3000	f'c+1000
3000 to 5000	f'c+1200
Over 5000	1.10f'c+700

Adapted from ACI 318

298 ACI 318 Modification Factor for standard deviation when less than 30 tests are available

Eq.9-1	f'cr=f'c+1.34*S	(f'c<35MPa)	(f'c>35MPa)
Eq.9-2	f'cr=f'c+2.33*S-3.45(Mpa)	(f'c<35MPa)	
Eq.9-2	f'cr=f'c+2.33*S-500(psi)	(f'c<35MPa)	(f'c>35MPa)
Eq.9-3	f'cr=0.9*f'c+2.33*S		(f'c>35MPa)

f'cr=required average compressive strength of concrete used as the basis for selection of

f'c=specified compressive strength of concrete,Mpa(psi)

S=standard deviation,MPa(psi)

301 Density of water versus temperature

Temperature,degree	Density,kg/m3
16	998.93
18	998.58
20	998.19
22	997.75
24	997.27
26	996.75
28	996.2
30	995.61

302 Mixture proportioning

1 Absolute volume method Metric)

Conditions and specifications

Structure	Pavement
Weather	Severe freeze-thaw
Specified compressive strength	f'c 35MPa 28days
Slump	25mm-75mm
Nominal maximum size aggregate	25mm
Cement	Type GU(ASTM C 1157)
	Relative Density 3.0
Coarse Aggregate	Well graded,25mm nominal maximum-size rounded gravel(ASTM C 33 or AASHTO M80)
	Saturated Surface Specific Gravity 2.68
	Absorption of 0.5%(Moisture content at SSD condition)
	Bulk density (Unit Weight) of 1600 kg/m3 .
	Moisture Content 2%
Fine Aggregate	
	Natural Sand(ASTM C 33 or AASHTO M6)
	Saturated Surface Specific Gravity 2.64
	Absorption of 0.7%(Moisture content at SSD condition)
	Moisture Content 6%
	Fineness Modulus 2.8
Air-entrained admixture	
	ASTM C 260 or AASHTO M154
Water-reducer	
	ASTM C 494(AASHTO M 194)
	reducing water by 10% when used at a dosage rate of 3g per kg of cement

Strength

Design strength 35MPa

Required strength f'cr f'c+8.5=35+8.5=43.5Mpa

299 ACI 318 Required average compressive strength when data are not available to establish a

Specified compressive strength,f'c,MPa	Required average compressive strength,f'cr,MPa
Less than 21	f'c+7.0
21 to 35	f'c+8.5
Over 35	1.10f'c+5

Adapted from ACI 318

Water cement ratio

Weather Freezing and thawing

288 ACI 318 W/C and Compressive Strength

Maximum Water-Cementitious Material Ratios and Minimum Design Strengths for Various Exposure Conditions

Exposure Condition	Maximum Water-Cementitious Material Ratios by Mass Concrete	Minimum Design Compressive Strength f'c,Mpa(psi)
Concrete Protected from Exposure to Freezing and Thawing,Applicationof Deicing Chemicals, or Aggressive Substances	Select Water-Cementitious Material Ratio on Basis of Strength,Workability,and Finishing Needs.	Select Strength Based on Structural Requirements
Concrete intended to have low permeability when exposed to water.	0.5	28(4000)
Concrete exposed to freezing and thawing in a moist condition or deicers	0.45	31(4500)
For corrosion protection for reinforced concrete exposed to chlorides from deicing salts, salt water, brackish water,seawater,or spray from these sources.	0.4	35(5000)

Adapted from ACI 318

Required strength f'cr f'c+8.5=35+8.5=43.5Mpa

W/C=0.34-((43.5-40)/(45-40))*(0.34-0.3)=0.31

W/C=0.31

Adapt Lower w/C W/C=0.31

290 ACI 211.1 and ACI 211.3 Relationship(Metric) between water cement ratio and compressive strength of concrete

Compressive Strength at 28 days,Mpa	Water-cementitious materials ratio by mass	
	Non-air-entrained concrete	Air-entrained concrete
45	0.38	0.3
40	0.42	0.34
35	0.47	0.39
30	0.54	0.45
25	0.61	0.52
20	0.69	0.6
15	0.79	0.7

Strength is based on cylinders moist-cured 28 days in accordance with ASTM C31(AASHTO T 23).Relationship assumes nominal maximum size aggregate of about 19 to 25 mm. Adapted from ACI 211.1 and ACI 211.3

Air Content

Severe freeze thaw exposure
Target air content 5-8% Adapt 8% within +-0.5% percentage
Maximum size of aggregate 25mm

292 ACI 211.1 and ACI 318(Metric) Approximate Mixing Water and Target Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate

Slump(mm)	Water,kilograms per cubic meter of concrete,for indicated sizes of aggregate*							
	9.5	12.5	19	25	37.5	50**	75**	150**
Non-Air-entrained concrete								
25-50	207	199	190	179	166	154	130	113
75-100	228	216	205	193	181	169	145	124
150-175	243	228	216	202	190	178	160	-
Approximate amount of entrapped air in non-air-entrained concrete, percent	3	2.5	2	1.5	1	0.5	0.3	0.2
Air-entrained concrete								
25-50	181	175	168	160	150	142	122	107
75-100	202	193	184	175	165	157	133	119
150-175	216	205	197	184	174	166	154	-
Recommended average total air content,percent,for level of exposure(&)								
Mild exposure	4.5	4	3.5	3	2.5	2	1.5	1
Moderate Exposure	6	5.5	5	4.5	4.5	4	3.5	3
Severe exposure	7.5	7	6	6	5.5	5	4.5	4

* These quantities of mixing water are for use in computing cementitious material contents for trial batches. They are maximums for reasonably well-shaped angular coarse aggregates graded within limits of accepted specifications.

** The slump values for concrete containing aggregates larger than 37.5mm are based on slump tests made after removal of particles larger than 37.5mm by wet screening.

(&) The air content in job specifications should be specified to be delivered within -1 to +2 percentage points of the table target value for moderated and severe exposures. Adapted from ACI 211.1 and ACI 318.However(1995) presents this information in graphical form.

Slump

Slump is specified at 25mm to 75mm
Use 75mm+-20mm

Water content

75mm-Slump
25mm Maximum size of Aggregate
Water content 175kg/m3 → (175-25kg/m3)=150kg/m3 due to round gravel
Water Reducer reduce 10% → (150-15kg/m3)=135kg/m3

Cement Content

greater than 310kg/m3
W/C=0.31 W=135kg/m3 C=435kg/m3

295 ACI 302 Minimum requirements of cementing materials for concrete used in flatwork

Nominal maximum size of aggregate,mm(in.)	Cementing materials,kg/m3(lb/yd^3)*
37.5(1*1/2)	280(470)
25	310(520)
19(3/4)	320(540)
12.5(1/2)	350(590)
9.5(3/8)	360(610)

* Cementing materials quantities may need to be greater for severe exposure.For example, for deicer exposures, concrete should contain at least 335kg/m3(564yd3) of cementing materials. Adapted from ACI 302.

Coarse Aggregate Content

Bulk volume of coarse aggregate

Maximum size coarse aggregate 25mm

Sand :Fineness Modulus 2.8

Bulk density 0.67

Bulk density 1600kg/m3

Ovendry mass of coarse aggregate =1600*0.67=1072kg

291 ACI 211 Bulk Volume of Coarse Aggregate per Unit Volume of Concrete

Maximum Size of Coarse Aggregate	Fineness Modules of Fine Aggregate			
	2.4	2.6	2.8	3
10	0.5	0.48	0.46	0.44
12.5	0.59	0.57	0.55	0.53
20	0.66	0.64	0.62	0.6
25	0.71	0.69	0.67	0.65
40	0.76	0.74	0.72	0.7
50	0.78	0.76	0.74	0.72
70	0.81	0.79	0.77	0.75
150	0.87	0.85	0.83	0.81

Bulk volume are based on aggregates in a dry-rodded condition described in ASTM C 29 (AASHTO T 19).Adapted from ACI 211

Admixture content

Air content 8%

Dosage rate

Air entraining admixture 0.5g per kg of cement 0.5*435=218g/m3

Water reducer 3g per kg of cement 3*435=1305g/m3

Specified Mix Proportion

(1) W/C=31% W=135 C=135/(31*0.01)=435

(6)240*2.64=634

(3)=1600*0.67=1072kg

Saturated Surface-Dry State of Aggregate

Specified Mix Proportion

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Air entrained	Water reducer	Comprssive Strength(kgf/cm2)			Remarks	
		(SL)	air	W/C	s/a	C	W	s	CA (5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d		
Mpa	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
43.5	25	7.5	8	31.0		435	135	634	1072		0.22	1.31				Weight	2278
						3	1	2.64	2.68							Specific Gravity	
			80			145	135	240	400							Volume	1000

(2)=435/3=145

(4)=1072/2.68=400

(5)=(1000-(80+145+135+400))=240

To Field Mix Proportion from Specified Mix Proportion

Specified Mix Proportion

W(kg)	C(kg)	Sand(kg)	Aggregate(kg)
135	435	634	1072

Concrete Mix Proportion

Adjustment Moisture Content

	specifiv gravity(%)	absorption (%)	moisture content(%)	Water surface content(%)	Content(kg/m3)	Correction(kg/m3)	Corrected(kg/m3)
		(1)	(2)	(3)=(2)-(1)	(4)	(5)=(3)*(4)*0.01	(6)=(4)+(5)
Water					135	-50	85
Fine Aggregate	2.64	0.7	6.0	5.3	634	34	668
Coarse Aggregate	2.68	0.5	2.0	1.5	1072	16	1088

Field Mix Proportion(1m3)

W(kg)	C(kg)	Sand(kg)	Aggregate(kg)
85	435	668	1088

(289) ACI 318 Requirements for Concrete Exposed to Sulfates in Soil or Water

289 ACI 318 Requirements for concrete exposed to sulfates in soil or water					
Sulfate Exposure	Water-soluble sulfate (SO4) in soil, percent by mass.	Sulfate (SO4) in Water, ppm	Cement Type	Maximum water-cementitious material ratio, by mass	Minimum design compressive strength f'c, Mpa (psi)
Negligible	Less than 0.10	Less than 150	No special type required	–	–
Moderate	0.10 to 0.20	150 to 1500	II, MS, P(MS), IS(MS), P(MS), I(PM)(MS), I(SM)(MS)	0.5	28 (4000)
Severe	0.20 to 2.00	1500 to 10,000	V, HS	0.45	31 (4500)
Very Severe	Over 2.00	Over 10,000	V, HS	0.4	35 (5000)

(290) ACI 211.1 and ACI 211.3 Relationship between Water Cement Ratio and Compressive Strength of Concrete

290 ACI 211.1 and ACI 211.3 Relationship (Metric) between water cement ratio and compressive strength of concrete		
Compressive Strength at 28 days, Mpa	Water-cementitious materials ratio by mass	
	Non-air-entrained concrete	Air-entrained concrete
45	0.38	0.3
40	0.42	0.34
35	0.47	0.39
30	0.54	0.45
25	0.61	0.52
20	0.69	0.6
15	0.79	0.7
Strength is based on cylinders moist-cured 28 days in accordance with ASTM C31 (AASHTO T 23). Relationship assumes nominal maximum size aggregate of about 19 to 25 mm. Adapted from ACI 211.1 and ACI 211.3		

(291) ACI 211 Bulk Volume of Coarse Aggregate per Unit Volume of Concrete

291 ACI211 Bulk Volume of Coarse Aggregate per Unit Volume of Concrete

Maximum Size of Coarse Aggregate	Fineness Modules of Fine Aggregate			
	2.4	2.6	2.8	3
10	0.5	0.48	0.46	0.44
12.5	0.59	0.57	0.55	0.53
20	0.66	0.64	0.62	0.6
25	0.71	0.69	0.67	0.65
40	0.76	0.74	0.72	0.7
50	0.78	0.76	0.74	0.72
70	0.81	0.79	0.77	0.75
150	0.87	0.85	0.83	0.81

Bulk volume are based on aggregates in a dry-rodded condition described in ASTM C 29 (AASHTO T 19).Adapted from ACI211

(292) ACI211.1 and ACI 318 (Metric) Approximate Mixing Water and Target Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate

292 ACI211.1 and ACI318 (Metric) Approximate Mixing Water and Target Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate								
Slump (mm)	Water, kilograms per cubic meter of concrete, for indicated sizes of aggregate*							
	9.5	12.5	19	25	37.5	50**	75**	150**
Non-Air-entrained concrete								
25-50	207	199	190	179	166	154	130	113
75-100	228	216	205	193	181	169	145	124
150-175	243	228	216	202	190	178	160	–
Approximate amount of entrapped air in non-air-entrained concrete, percent	3	2.5	2	1.5	1	0.5	0.3	0.2
Air-entrained concrete								
25-50	181	175	168	160	150	142	122	107
75-100	202	193	184	175	165	157	133	119
150-175	216	205	197	184	174	166	154	–
Recommended average total air content, percent, for level of exposure (&)								
Mild exposure	4.5	4	3.5	3	2.5	2	1.5	1
Moderate Exposure	6	5.5	5	4.5	4.5	4	3.5	3
Severe exposure	7.5	7	6	6	5.5	5	4.5	4

*These quantities of mixing water are for use in computing cementitious material contents for trial batches. They are maximums for reasonably well-shaped angular coarse aggregates graded within limits of accepted specifications.

**The slump values for concrete containing aggregates larger than 37.5mm are based on slump tests made after removal of particles larger than 37.5mm by wet screening.

&) The air content in job specifications should be specified to be delivered within -1 to +2 percentage points of the table target value for moderated and severe exposures. Adapted from ACI211.1 and ACI 318.However(1995) presents this information i

(293) ACI211.1 and ACI 318 (Inch-Pound Units) Approximate Mixing Water and Target Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate

293 ACI211.1 and ACI318 (Inch-Pound Units) Approximate Mixing Water and Target Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate

Slump (in)	Water, pounds per cubic yard of concrete, for indicated sizes of aggregate*							
	(3/8) in	(1/2) in	(3/4) in	(1) in	(1 1/2) in	(2) in	(3) in	(6) in
Non-Air-entrained concrete								
1-2	350	335	315	300	275	260	220	190
3-4	385	365	340	325	300	285	245	210
6-7	410	385	360	340	315	300	270	–
Approximate amount of entrapped air in non-air-entrained concrete, percent	3	2.5	2	1.5	1	0.5	0.3	0.2
Air-entrained concrete								
1-2	305	295	280	270	250	240	205	180
3-4	340	325	305	295	275	265	225	200
6-7	365	345	325	310	290	280	260	–
Recommended average total air content, percent, for level of exposure (&)								
Mild exposure	4.5	4	3.5	3	2.5	2	1.5	1
Moderate Exposure	6	5.5	5	4.5	4.5	3.5	3.5	3
Severe exposure	7.5	7	6	6	5.5	5	4.5	4

*These quantities of mixing water are for use in computing cementitious material contents for trial batches. They are maximums for reasonably well-shaped angular coarse aggregates graded within limits of accepted specifications.

**The slump values for concrete containing aggregates larger than 37.5mm are based on slump tests made after removal of particles larger than 37.5mm by wet screening.

(&) The air content in job specifications should be specified to be delivered within -1 to +2 percentage points of the table target value for moderated and severe exposures. Adapted from ACI211.1 and ACI 318. However (1995) presents this information i

(294) ACI 211.Recomended Slumps for Various Types of Construction

294 ACI 211.1 Recommended Slumps for various types of construction

Concrete construction	Slump, mm (in)	
	Maximum*	Minimum
Reinforced foundation walls and footings	75 (3)	25 (1)
Plain footings, caisons, and substructure walls	75 (3)	25 (1)
Beams and reinforced walls	100 (4)	25 (1)
Building columns	100 (4)	25 (1)
Pavements and slabs	75 (3)	25 (1)
Mass concrete	75 (3)	25 (1)

*May be increased 25mm (1 in.) for consolidation by hand methods, such as rodding and spading..
Plasticizers can safely provide higher slumps. Adapted from ACI 211.1.

(295) ACI 302 Minimum Requirements of Cementing Materials for Concrete Used in Flatwork

295 ACI 302 Minimum requirements of cementing materials for concrete used in flatwork	
Nominal maximum size of aggregate, mm (in.)	Cementing materials, kg/m3 (lb/yd^3)*
37.5 (1*1/2)	280 (470)
25	310 (520)
19 (3/4)	320 (540)
12.5 (1/2)	350 (590)
9.5 (3/8)	360 (610)

*Cementing materials quantities may need to be greater for severe exposure. For example, for deicer exposures, concrete should contain at least 335kg/m3 (564yd3) of cementing materials. Adapted from ACI 302.

(296) ACI 318 Cementitious Materials Requirements for Concrete Exposed to Deicing Chemicals

296 ACI 318 Cementitious materials requirements for concrete exposed to deicing chemicals	
Cementitious materials *	Maximum percent of total cementitious materials by mass**
Fly ash and natural pozzolans	25
Slag	50
Silica fume	10
Total of fly ash, slag, silica fume and natural pozzolans	50&
Total of natural pozzolans and silica fume	35&

* Includes portion of supplementary cementing materials in blended cements.

** Total cementitious materials include the summation of Portland cements, blended cements, fly ash, slag, silica fume and other pozzolans.

& Silica fume should not constitute more than 10% of total cementitious materials and fly ash or other pozzolans shall not constitute more than 25% of cementitious materials. Adapted from ACI 318

(297) ACI 318 Maximum Chloride-Ion Content for Corrosion Protection

297 ASTM C 1218 ACI318 Maximum chloride-ion (Cl-) in concrete, percent by mass of cement*	
Type of member	Maximum water-soluble chloride ion (CL-) in concrete, percent by mass of cement*
Prestressed concrete	0.06
Reinforced concrete exposed to chloride in service	0.15
Reinforced concrete that will be dry or protected from moisture in service	1
Other reinforced concrete construction	0.3
ASTM C 1218	
Adapted from ACI318	

(298) ACI 318 Modification Factor for Standard Deviation when less than 30 Tests are Available

298 ACI318 Modification Factor for standard deviation when less than 30 tests are available	
Number of tests*	Modification Factor for standard deviation**
Less than 15	Use table 299
15	1.16
20	1.08
25	1.03
30 or more	1

* Interpolate for intermediate numbers of tests.

**Modification Factor for standard deviation to be used to determine the required average strength, fcr.

Adapted from ACI318

(299) ACI 318 (Metric) Required Average Compressive Strength when Data are not Available to Establish a Standard Maximum Factor for Standard Deviation

299 ACI 318 (Metric) Required average compressive strength when data are not available to establish a	
Specified compressive strength, fc, MPa	Required average compressive strength, fcr, MPa
Less than 21	fc+7.0
21 to 35	fc+8.5
Over 35	1.10fc+5
Adapted from ACI 318	

(300) ACI 318 (Inch-Pound Units) Required Average Compressive Strength when Data are not Available to Establish a Standard Maximum Factor for Standard Deviation

300 ACI318 (Inch-Pound Units).Required average compressive strength when data are not available to establish a standard deviation	
Specified compressive strength,fc,psi	Required average compressive strength,fcr,psi
Less than 3000	fc+1000
3000 to 5000	fc+1200
0ver 5000	1.10fc+700
Adapted from ACI318	

(301) Density of Water Versus Temperature

301 Density of water versus temperature

Temperature,degree	Density,kg/m3
16	998.93
18	998.58
20	998.19
22	997.75
24	997.27
26	996.75
28	996.2
30	995.61

(302) ACI 211.1 Mix Proportion (1)

302 Mixture proportioning

1 Absolute volume method Metric)

Conditions and specifications

Structure	Pavement:
Weather	Severe freeze-thaw
Specified compressive strength	fc 35MPa 28days
Slump	25mm -75mm
Nominal maximum size aggregate	25mm
Cement	Type GU (ASTM C 1157)
	Relative Density 3.0
Coarse Aggregate	Well graded, 25mm nominal maximum-size rounded gravel (ASTM C 33 or AASHTO M 80)
	Saturated Surface Specific Gravity 2.68
	Absorption of 0.5% (Moisture content at SSD condition)
	Bulk density (Unit Weight) of 1600 kg/m 3 .
	Moisture Content 2%
Fine Aggregate	
	Natural Sand (ASTM C 33 or AASHTO M 6)
	Saturated Surface Specific Gravity 2.64
	Absorption of 0.7% (Moisture content at SSD condition)
	Moisture Content 6%
	Fineness Modulus 2.8
Air-entrained admixture	
	ASTM C 260 or AASHTO M 154
Water-reducer	
	ASTM C 494 (AASHTO M 194)
	reducing water by 10% when used at a dosage rate of 3g per kg of cement

(303) ACI 211.1 Mix Proportion (2)

Strength

Design strength 35MPa

Required strength fcr fc+8.5=35+8.5=43.5Mpa

299 ACI318 Required average compressive strength when data are not available to establish a standard

Specified compressive strength, fc, MPa	Required average compressive strength, fcr, MPa
Less than 21	fc+7.0
21 to 35	fc+8.5
Over 35	1.10fc+5

Adapted from ACI318

(304) ACI 211.1 Mix Proportion (3)

Water cement ratio

Weather Freezing and thawing

288 ACI318 W/C and Compressive Strength

Maximum Water-Cementitious Material Ratios and Minimum Design Strengths for Various Exposure Conditions

Exposure Condition	Maximum Water-Cementitious Material Ratios by Mass Concrete	Minimum Design Compressive Strength fc,Mpa (psi)
Concrete Protected from Exposure to Freezing and Thawing, Application of Deicing Chemicals, or Aggressive Substances	Select Water-Cementitious Material Ratio on Basis of Strength, Workability, and Finishing Needs.	Select Strength Based on Structural Requirements
Concrete intended to have low permeability when exposed to water.	0.5	28 (4000)
Concrete exposed to freezing and thawing in a moist condition or deicers	0.45	31 (4500)
For corrosion protection for reinforced concrete exposed to chlorides from deicing salts, salt water, brackish water, seawater, or spray from these sources.	0.4	35 (5000)

Adapted from ACI318

Required strength fcr fc+8.5=35+8.5=43.5Mpa

W/C=0.34−((43.5-40)/(45-40))∗(0.34-0.3)=0.31

W/C=0.31

Adapt Lower w/C W/C=0.31

(305) ACI 211.1 Mix Proportion (4)

290 ACI211.1 and ACI211.3 Relationship (Metric) between water cementratio and compressive strength of concrete

Compressive Strength at 28 days, Mpa	Water-cementitious materials ratio by mass	
	Non-air-entrained concrete	Air-entrained concrete
45	0.38	0.3
40	0.42	0.34
35	0.47	0.39
30	0.54	0.45
25	0.61	0.52
20	0.69	0.6
15	0.79	0.7

Strength is based on cylinders moist-cured 28 days in accordance with ASTM C31 (AASHTO T 23). Relationship assumes nominal maximum size aggregate of about 19 to 25 mm. Adapted from ACI211.1 and ACI211.3

(306) ACI 211.1 Mix Proportion (5)

Air Content

Severe freeze thaw exposure

Target air content 5-8% Adapt 8% within +-0.5% percentage

Maximum size of aggregate 25mm

292 ACI 211.1 and ACI 318 (Metric) Approximate Mixing Water and Target Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate

Slump (mm)	Water, kilograms per cubic meter of concrete, for indicated sizes of aggregate*							
	9.5	12.5	19	25	37.5	50**	75**	150**
Non-Air-entrained concrete								
25-50	207	199	190	179	166	154	130	113
75-100	228	216	205	193	181	169	145	124
150-175	243	228	216	202	190	178	160	–
Approximate amount of entrapped air in non-air-entrained concrete, percent	3	2.5	2	1.5	1	0.5	0.3	0.2
Air-entrained concrete								
25-50	181	175	168	160	150	142	122	107
75-100	202	193	184	175	165	157	133	119
150-175	216	205	197	184	174	166	154	–
Recommended average total air content, percent, for level of exposure (&)								
Mild exposure	4.5	4	3.5	3	2.5	2	1.5	1
Moderate Exposure	6	5.5	5	4.5	4.5	4	3.5	3
Severe exposure	7.5	7	6	6	5.5	5	4.5	4

*These quantities of mixing water are for use in computing cementitious material contents for trial batches. They are maximums for reasonably well-shaped angular coarse aggregates graded within limits of accepted specifications.

**The slump values for concrete containing aggregates larger than 37.5mm are based on slump tests made after removal of particles larger than 37.5mm by wet screening.

&) The air content in job specifications should be specified to be delivered within -1 to +2 percentage points of the table target value for moderated and severe exposures. Adapted from ACI 211.1 and ACI 318. However (1995) presents this information i

(307) ACI 211.1 Mix Proportion (6)

Slump

Slump is specified at 25mm to 75mm

Use 75mm +-20mm

Water content

75mm-Slump

25mm Maximum size of Aggregate

Water content 175kg/m3 ⟶ (175-25kg/m3)=150kg/m3 due to round gravel

Water Reducer reduce 10% ⟶ (150-15kg/m3)=135kg/m3

Cement Content greater than 310kg/m3

W/C=0.31 W=135kg/m3 C=435kg/m3

295 ACI 302 Minimum requirements of cementing materials for concrete used in flatwork

Nominal maximum size of aggregate, mm (in.)	Cementing materials, kg/m3 (b/yd^3)*
37.5 (1*1/2)	280 (470)
25	310 (520)
19 (3/4)	320 (540)
12.5 (1/2)	350 (590)
9.5 (3/8)	360 (610)

*Cementing materials quantities may need to be greater for severe exposure. For example, for deicer exposures, concrete should contain at least 335kg/m3 (564yd3) of cementing materials. Adapted from ACI 302.

(308) ACI 211.1 Mix Proportion (7)

Coarse Aggregate Content

Bulk volume of coarse aggregate

Maximum size coarse aggregate	25mm
Sand Fineness Modulus	2.8
Bulk density	0.67
Bulk density	1600kg/m3
Ovendry mass of coarse aggregate	=1600*0.67=1072kg

291 ACI211 Bulk Volume of Coarse Aggregate per Unit Volume of Concrete

Maximum Size of Coarse Aggregate	Fineness Modules of Fine Aggregate			
	2.4	2.6	2.8	3
10	0.5	0.48	0.46	0.44
12.5	0.59	0.57	0.55	0.53
20	0.66	0.64	0.62	0.6
25	0.71	0.69	0.67	0.65
40	0.76	0.74	0.72	0.7
50	0.78	0.76	0.74	0.72
70	0.81	0.79	0.77	0.75
150	0.87	0.85	0.83	0.81

Bulk volume are based on aggregates in a dry-rodded condition described in ASTM C 29 (AASHTO T 19).Adapted from ACI211

(309) ACI 211.1 Mix Proportion (8)

Admixture content

Air content 8%

Dosage rate

Air entraining admixture 0.5g per kg of cement 0.5*435=218g/m3

Water reducer 3g per kg of cement 3*435=1305g/m3

Specified Mix Proportion

(1) W/C=31% W=135 C=135/(31*0.01)=435

(6)240*2.64=634

(3)=1600*0.67=1072kg

Specified Mix Proportion

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Air entrained	Water reducer	Comprssive Strength (kgf/cm2)			Remarks	
		(SL)	air	W/C	s/a	C	W	s	CA(5~10mm)	CA(10~20mm)	% of weight of cement	% of weight of cement	3d	7d	28d		
Mpa	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
43.5	25	7.5	8	31.0		435	135	634	1072		0.22	1.31				Weight	2278
						3	1	2.64	2.68							Specific Gravity	
			80			145	135	240	400							Volume	1000

(2)=435/3=145

(4)=1072/2.68=400

(5)=(1000-(80+145+135+400))=240

(310) ACI 211.1 Mix Proportion (9)

To Field Mix Proportion from Specified Mix Proportion

Specified Mix Proportion

W (kg)	C (kg)	Sand (kg)	Aggregate (kg)
135	435	634	1072

Concrete Mix Proportion

Adjustment Moisture Content

	specifiv gravity (%)	absorption (%)	moisture content(%)	Water surface content(%)	Content(kg/m3)	Correction (kg/m3)	Corrected (kg/m3)
		(1)	(2)	(3)=(2)−(1)	(4)	(5)=(3)*(4)*0.01	(6)=(4)+(5)
Water					135	-50	85
Fine Aggregate	2.64	0.7	6.0	5.3	634	34	668
Coarse Aggregate	2.68	0.5	2.0	1.5	1072	16	1088

Field Mix Proportion (1m3)

W (kg)	C (kg)	Sand (kg)	Aggregate (kg)
85	435	668	1088

(311) ACI 211.1 Table A1.1-Conversion Factors In-lb to SI Units

311 ACI 211.1 Table A1.1-Conversion Factors, in.-lb to SI Units*

Quantity	in-lb unit	SI- unit	Conversion factor(Ratio:in.lb/SI)
Length	inch (in.)	millimeter(mm)	25.4
Volume	cubic foot(ft^3)	cubic meter(m^3)	0.02832
	cubic yard (yd^3)	cubic meter(m^3)	0.7646
Mass	pound (lb)	kilogram (kg)	0.4536
Stress	pounds per square inch (psi)	megapascal(MPa)	6.895*10^-2
Density	pounds per cubic foot (lb/ft^3)	kilograms per cubic meter (kg/m^3)	16.02
	pounds per cubic yard (lb/yd^3)	kilograms per cubic meter (kg/m^3)	0.5933
Temperature	degrees Fahrenheit (F)	degrees Celsius-C	**

*Gives names (and abbreviations) of measurement units in the inch-pound system as used in the body of this report and in the SI(metric) system, along with multipliers for converting the former to the latter. From ASTM E 380. *System e International

311 ACI 211.1 Table A1.1-Conversion Factors, in.-lb to SI Units*

Quantity	in-lb unit	SI+ unit	Conversion factor(Ratio:in.l
Length	inch(in.)	millimeter(mm)	25.4
Volume	cubic foot(ft^3)	cubic meter(m^3)	0.02832
	cubic yard(yd^3)	cubic meter(m^3)	0.7646
Mass	pound(lb)	kilogram(kg)	0.4536
Stress	pounds per square inch (psi)	megapascal(MPa)	6.895*10^-2
Density	pounds per cubic foot (lb/ft^3)	kilograms per cubic meter	16.02
	pounds per cubic yard (lb/yd^3)	kilograms per cubic meter	0.5933
Temperature	degrees Fahrenheit (F)	egrees Celsius	**

*Gives names(and abbreviations) of measurement units in the inch-pound system as used in the body of this report and in the SI(metric) system, along with multipliers for converting the former to the latter. From ASTM E 380 *Systeme International d'Unites **C=(F-

312 ACI 211.1 Table A1.5.3.1-Recommended Slumps for Various Types of Construction(SI)

Types of construction	Slump,mm(in)	
	Maximum*	Minimum
Reinforced foundation walls and footings	75(3)	25(1)
Plain footings,caisons,and substructure walls	75(3)	25(1)
Beams and reinforced walls	100(4)	25(1)
Building columns	100(4)	25(1)
Pavements and slabs	75(3)	25(1)
Mass concrete	75(3)	25(1)

*May be increased 1 in.for methods of consolidation other than vibration.

313 ACI 211.1 Table A1.5.3.3(Metric) Approximate Mixing Water and Target Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate(SI)

Slump(mm)	ter,kilograms per cubic meter of concrete,for indicated sizes of aggrega							
	9.5	12.5	19	25	37.5	50**	75**	150**
Non-Air-entrained concrete								
25-50	207	199	190	179	166	154	130	113
75-100	228	216	205	193	181	169	145	124
150-175	243	228	216	202	190	178	160	-
Approximate amount of entrapped air in non-air-entrained concrete, percent	3	2.5	2	1.5	1	0.5	0.3	0.2
Air-entrained concrete								
25-50	181	175	168	160	150	142	122	107
75-100	202	193	184	175	165	157	133	119
150-175	216	205	197	184	174	166	154	-
Recommended average total air content,percent,for level of exposure(&)								
Mild exposure	4.5	4	3.5	3	2.5	2	1.5	1
Moderate Exposure	6	5.5	5	4.5	4.5	4	3.5	3
Severe exposure	7.5	7	6	6	5.5	5	4.5	4

* These quantities of mixing water are for use in computing cementitious material contents for trial batches. They are maximums for reasonably well-shaped angular coarse aggregates graded within limits of accepted specifications.

** The slump values for concrete containing aggregates larger than 37.5mm are based on slump tests made after removal of particles larger than 37.5mm by wet screening.

(&) The air content in job specifications should be specified to be delivered within -1 to +2 percentage points of the table target value for moderated and severe exposures.

Adapted from ACI 211.1 and ACI 318.However(1995) presents this information in graphical form

314 ACI 211.1 Table A1.5.3.4(a). Relationship(Metric) between water cement ratio and compressive strength of concrete (SI)

Compressive Strength at 28 days,Mpa	Water-cementitious materials ratio by mass	
	Non-air-entrained concrete	Air-entrained concrete
45	0.38	0.3
40	0.42	0.34
35	0.47	0.39
30	0.54	0.45
25	0.61	0.52
20	0.69	0.6
15	0.79	0.7

Strength is based on cylinders moist-cured 28 days in accordance with ASTM C31(AASHTO T 23).Relationship assumes nominal maximum size aggregate of about 19 to 25 mm. Adapted from ACI 211.1 and ACI 211.3

315-Table A1.5.3.4(b) -Relationship between water-cement ratio and compressive strength of concrete (SI)

Type of Structure	Wet Condition or Freezing and Thawing Action	Sea Water or Sodium Sulfate Chloride
Thin Sections(railings,curbs,sills,ledges,omamental work) and exposed to freezing and thawing*	0.45	0.4++
All other structures	0.5	0.45++

* Based on ACI 201.2R. * Concrete should also be air-entrained. ++ If sulfate resisting cement (Type II or Type V of ASTM C 150) is used, permissible water-cement ratio may be increased by 0.05.

316 ACI 211.1 Table A1.5.3.6- Volume of coarse aggregate per unit of volume of concrete (SI)

Maximum Size of Coarse Aggregate	Fineness Modules of Fine Aggregate			
	2.4	2.6	2.8	3
9.5	0.5	0.48	0.46	0.44
12.5	0.59	0.57	0.55	0.53
19	0.66	0.64	0.62	0.6
25	0.71	0.69	0.67	0.65
37.5	0.75	0.73	0.71	0.69
50	0.78	0.76	0.74	0.72
75	0.82	0.8	0.78	0.76
150	0.87	0.85	0.83	0.81

Volume are based on aggregates in a dry-rodded condition described in ASTM C 29 (AASHTO T 19).Adapted from ACI 211

317 ACI 211.1 Table A1.5.3.7.1 -First estimate of mass of fresh concrete (SI)

Aggregate Maximum Dimension(mm)	Fresh Concrete	AE Concrete
9.5	2285	2200
12.5	2310	2230
19	2345	2275
25	2380	2290
37.5	2410	2350
50	2445	2345
75	2490	2405
150	2530	2435

318 ACI 211.1 Mix Proportion

A2.1 Example 1		Required Average Strength	24 Mpa
		Slump	75 to 100mm
		Maximum Size of Coarse Aggregate	37.5mm
		Dry-rodded mass of coarse aggregate	1600 kg/m3
		Cement Type	Type I
		Cement Specific Gravity	3.15
		lk Specific Gravity of Coarse Aggrega	2.68
		Absorption of Coarse Aggregate	0.50%
		ılk Specific Gravity of Fine Aggregat	2.64
		Absorption of Fine Aggregate	0.70%
		Fineness Modulus of Fine Aggregate	2.8
A2.2			
A2.2.1	Step-1	Slump	75 to 100mm
A2.2.2	Step-2	Maximum Size of Coarse Aggregate	37.5mm
A2.2.3	Step-3	Non-air-entrained concrete	

(313) Table-A1.5.3.3
Water Content

181kg/m3

313 ACI 211.1 Table A1.5.3.3(Metric) Approximate Mixing Water and Target Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate(SI)

Slump(mm)	ter,kilograms per cubic meter of concrete,for indicated sizes of aggrega							
	9.5	12.5	19	25	37.5	50**	75**	150**
Non-Air-entrained concrete								
25-50	207	199	190	179	166	154	130	113
75-100	228	216	205	193	181	169	145	124
150-175	243	228	216	202	190	178	160	-
Approximate amount of entrapped air in non-air-entrained	3	2.5	2	1.5	1	0.5	0.3	0.2
Air-entrained concrete								
25-50	181	175	168	160	150	142	122	107
75-100	202	193	184	175	165	157	133	119
150-175	216	205	197	184	174	166	154	-
Recommended average total air content,percent,for level of exposure(&)								
Mild exposure	4.5	4	3.5	3	2.5	2	1.5	1
Moderate Exposure	6	5.5	5	4.5	4.5	4	3.5	3
Severe exposure	7.5	7	6	6	5.5	5	4.5	4

* These quantities of mixing water are for use in computing cementitious material contents for trial batches. They are maximums for reasonably well-shaped angular coarse aggregates graded within limits of accepted specifications.

** The slump values for concrete containing aggregates larger than 37.5mm are based on slump tests made after removal of particles larger than 37.5mm by wet screening.

(&) The air content in job specifications should be specified to be delivered within -1 to +2 percentage points of the table target value for moderated and severe exposures. Adapted from ACI 211.1 and ACI 318.However(1995) presents this information in graphical form

A2.2.4 Step-4 Water-Cement Ratio

(314) Table A1.5.3.4(a) 24MPa

Required Average Strength 24 Mpa

W/C=0.69-((0.69-0.61)/(25-20))*(24-20)=0.62 W/C=0.62

314 ACI 211.1 Table A1.5.3.4(a). Relationship(Metric) between water cement ratio and compressive strength

Compressive Strength at 28 days,Mpa	Water-cementitious materials ratio by mass	
	Non-air-entrained concrete	Air-entrained concrete
45	0.38	0.3
40	0.42	0.34
35	0.47	0.39
30	0.54	0.45
25	0.61	0.52
20	0.69	0.6
15	0.79	0.7

Strength is based on cylinders moist-cured 28 days in accordance with ASTM C31(AASHTO T 23).Relationship assumes nominal maximum size aggregate of about 19 to 25 mm. Adapted from ACI 211.1 and ACI 211.3

A2.2.5 Step-5 Required Cement Content W=181kg/m3 W/C=0.62

C=181/0.62=292kg/m3

A2.2.6 Step-6 Quantity of Aggregate

(316) Table A1.5.3.6 Fineness Modulus 2.8

Required Dry Mass =0.71*1600=1136kg

316 ACI 211.1 Table A1.5.3.6- Volume of coarse aggregate per unit of volume of concrete (SI)

Maximum Size of Coarse Aggregate	Fineness Modules of Fine Aggregate			
	2.4	2.6	2.8	3
9.5	0.5	0.48	0.46	0.44
12.5	0.59	0.57	0.55	0.53
19	0.66	0.64	0.62	0.6
25	0.71	0.69	0.67	0.65
37.5	0.75	0.73	0.71	0.69
50	0.78	0.76	0.74	0.72
75	0.82	0.8	0.78	0.76
150	0.87	0.85	0.83	0.81

Volume are based on aggregates in a dry-rodded condition described in ASTM C 29 (AASHTO T 19).Adapted from ACI 211

A2.2.7 Step-7 Mass or Absolute Volume
A2.2.7.1 Mass basis

First estimate of mass of Fresh conc
2410kg

Water	181 kg
Cement	292 kg
Coarse Aggregate	1136 kg
Total	1609 kg

Mass of fine aggregate
2410-1609=801kg

(317) Table A1.5.3.7.1
317 ACI 211.1 Table A1.5.3.7.1 -First estimate of mass of fresh concrete (SI)

Aggregate Maximum Dimension(mm)	Fresh Concrete	AE Concrete
9.5	2285	2200
12.5	2310	2230
19	2345	2275
25	2380	2290
37.5	2410	2350
50	2445	2345
75	2490	2405
150	2530	2435

A2.2.7.2 Absolute Volume Basis
Specified Mix Proportion

(1) W/C=62% W=181 C=181/(62*0.01)=292

(6) 293*2.64=774

(3)=0.71*1600=1136kg

Saturated Surface-Dry State of Aggregate

Specified Mix Proportion

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks	density kg/m3
		(SL)	air	W/C	s/a	C	W	s	CA(5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d		
Mpa	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
24	37.5	7.5-10.0	1	62.0		292	181	774	1136							Weight	
						3.15	1	2.64	2.68							Specific Gravity	
			10			93	181	293	423							Volume	1000

(2)=392/3.15=93

(4)=1136/2.68=423

(5)=1000-(10+93+181+423)=293

A2.2.7.3 Step-8 Adjusted aggregate masses

Concrete Mix Proportion

Adjustment Moisture Content
Specified Mix Proportion
Saturated Surface-Dry State of Aggregate

W(kg)	C(kg)	Sand(kg)	Aggregate(kg)
181	292	774	1136

Field Condition

			Moisture Content(
Sand		Wet Conditio	6
Aggregate		Wet Conditio	2

	specifiv gravity(%)	absorption(%)	moisture content(%)	Water surface content(%)	Content(kg/m3)	Correction(kg/m3)	Corrected(kg/m3)
		(1)	(2)	(3)=(2)-(1)	(4)	(5)=(3)*(4)*0.01	(6)=(4)+(5)
Water					181	-58	123
Fine Aggregate	2.64	0.7	6.0	5.3	774	41	815
Coarse Aggregate	2.68	0.5	2.0	1.5	1136	17	1153

Field Mix Proportion(1m3)

W(kg)	C(kg)	Sand(kg)	Aggregate(kg)
123	292	815	1153

318 ACI 211.1 Mix Proportion

A2.1 Example 1	Required Average Strength	24 Mpa
	Slump	75 to 100mm
	Maximum Size of Coarse Aggregate	37.5mm
	Dry-rodded mass of coarse aggregate	1600 kg/m3
	Cement Type	Type I
	Cement Specific Gravity	3.15
	lk Specific Gravity of Coarse Aggrega	2.68
	Absorption of Coarse Aggregate	0.50%
	ılk Specific Gravity of Fine Aggregat	2.64
	Absorption of Fine Aggregate	0.70%
	Fineness Modulus of Fine Aggregate	2.8

(312) ACI 211.1 Table A1.5.3.1-Recommended Slumps for Various Types of Construction (SI)

312 ACI 211.1 Table A1.5.3.1-Recommended Slumps for Various Types of Construction (SI)

Types of construction	Slump, mm (in)	
	Maximum*	Minimum
Reinforced foundation walls and footings	75 (3)	25 (1)
Plain footings, caissons, and substructure walls	75 (3)	25 (1)
Beams and reinforced walls	100 (4)	25 (1)
Building columns	100 (4)	25 (1)
Pavements and slabs	75 (3)	25 (1)
Mass concrete	75 (3)	25 (1)

*May be increased 1 in. for methods of consolidation other than vibration.

(313) ACI211.1 Table A1.5.3.3 Approximate Mixing Water and Air Content requirements for Difficult Slumps and Nominal Maximum Sizes of Aggregates (SI)

313 ACI211.1 Table A1.5.3.3 (Metric) Approximate Mixing Water and Target Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate (SI)

Slump (mm)	Water, kilograms per cubic meter of concrete, for indicated sizes of aggregate*							
	9.5	12.5	19	25	37.5	50**	75**	150**
Non-Air-entrained concrete								
25-50	207	199	190	179	166	154	130	113
75-100	228	216	205	193	181	169	145	124
150-175	243	228	216	202	190	178	160	–
Approximate amount of entrapped air in non-air-entrained concrete, percent	3	2.5	2	1.5	1	0.5	0.3	0.2
Air-entrained concrete								
25-50	181	175	168	160	150	142	122	107
75-100	202	193	184	175	165	157	133	119
150-175	216	205	197	184	174	166	154	–
Recommended average total air content, percent, for level of exposure (&)								
Mild exposure	4.5	4	3.5	3	2.5	2	1.5	1
Moderate Exposure	6	5.5	5	4.5	4.5	4	3.5	3
Severe exposure	7.5	7	6	6	5.5	5	4.5	4

*These quantities of mixing water are for use in computing cementitious material contents for trial batches. They are maximums for reasonably well-shaped angular coarse aggregates graded within limits of accepted specifications.

**The slump values for concrete containing aggregates larger than 37.5mm are based on slump tests made after removal of particles larger than 37.5mm by wet screening.

(&) The air content in job specifications should be specified to be delivered within -1 to +2 percentage points of the table target value for moderated and severe exposures. Adapted from ACI211.1 and ACI 318. However (1995) presents this information i

(314) ACI 211.1 Table A1.5.3.4(a) Relationship between Water Cement Ratio and Compressive Strength of Concrete (SI)

314 ACI 211.1 Table A1.5.3.4(a). Relationship (Metric) between water cement ratio and compressive strength of concrete (SI)

Compressive Strength at 28 days, Mpa	Water-cementitious materials ratio by mass	
	Non-air-entrained concrete	Air-entrained concrete
45	0.38	0.3
40	0.42	0.34
35	0.47	0.39
30	0.54	0.45
25	0.61	0.52
20	0.69	0.6
15	0.79	0.7

Strength is based on cylinders moist-cured 28 days in accordance with ASTM C31 (AASHTO T 23). Relationship assumes nominal maximum size aggregate of about 19 to 25 mm. Adapted from ACI 211.1 and ACI 211.3

(315) ACI 211.1 Table A1.5.3.4(b) Maximum Permissible Water-Cement Ratios for Concrete Severe Exposures (SI)

315-Table A1.5.3.4(b) -Relationship between water-cement ratio and compressive strength of concrete (SI)		
Type of Structure	Wet Condition or Freezing and Thawing Action	Sea Water or Sodium Sulfate Chloride
Thin Sections (railings, curbs, sills, ledges, ornamental work) and exposed to freezing and thawing+	0.45	0.4++
All other structures	0.5	0.45++

*Based on ACI 201.2R. *Concrete should also be air-entrained. ++ If sulfate resisting cement (Type II or Type V of ASTM C 150) is used, permissible water-cement ratio may be increased by 0.05.

(316) ACI 211.1 Table A1.5.3.6 Volume of Coarse Aggregate per Unit of Volume of

316 ACI211.1 Table A1.5.3.6-Volume of coarse aggregate per unit of volume of concrete (SI)				
Maximum Size of Coarse Aggregate	Fineness Modules of Fine Aggregate			
	2.4	2.6	2.8	3
9.5	0.5	0.48	0.46	0.44
12.5	0.59	0.57	0.55	0.53
19	0.66	0.64	0.62	0.6
25	0.71	0.69	0.67	0.65
37.5	0.75	0.73	0.71	0.69
50	0.78	0.76	0.74	0.72
75	0.82	0.8	0.78	0.76
150	0.87	0.85	0.83	0.81
Volume are based on aggregates in a dry-rodded condition described in ASTM C 29 (AASHTO T 19). Adapted from ACI211				

(317) ACI 211.1 Table A1.5.3.7.1 First Estimate of Mass of Fresh Concrete(SI)

317 ACI 211.1 Table A1.5.3.7.1 -First estimate of mass of fresh concrete (SI)		
Aggregate Maximum Dimension (mm)	Fresh Concrete	AE Concrete
9.5	2285	2200
12.5	2310	2230
19	2345	2275
25	2380	2290
37.5	2410	2350
50	2445	2345
75	2490	2405
150	2530	2435

(318) ACI 211.1 Mix Proportion (1)

318 ACI 211.1 Mix Proportion

A2.1 Example 1	Required Average Strength	24 Mpa
	Slump	75 to 100mm
	Maximum Size of Coarse Aggregate	37.5mm
	Dry-rodded mass of coarse aggregate	1600 kg/m3
	Cement Type	Type I
	Cement Specific Gravity	3.15
	Bulk Specific Gravity of Coarse Aggregate	2.68
	Absorption of Coarse Aggregate	0.50%
	Bulk Specific Gravity of Fine Aggregate	2.64
	Absorption of Fine Aggregate	0.70%
	Fineness Modulus of Fine Aggregate	2.8

(319) ACI 211.1 Mix Proportion (2)

A2.2			
A2.2.1	Step-1	Slump	75 to 100mm
A2.2.2	Step-2	Maximum Size of Coarse Aggregate	37.5mm
A2.2.3	Step-3	Non-air-entrained concrete	
		(313) Table-A1.5.3.3	
		Water Content	181kg/m3

313 ACI211.1 Table A1.5.3.3 (Metric) Approximate Mixing Water and Target Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate (SI)

Slump (mm)	Water, kilograms per cubic meter of concrete, for indicated sizes of aggregate*							
	9.5	12.5	19	25	37.5	50**	75**	150**
Non-Air-entrained concrete								
25-50	207	199	190	179	166	154	130	113
75-100	228	216	205	193	181	169	145	124
150-175	243	228	216	202	190	178	160	–
Approximate amount of entrapped air in non-air-entrained concrete, percent	3	2.5	2	1.5	1	0.5	0.3	0.2
Air-entrained concrete								
25-50	181	175	168	160	150	142	122	107
75-100	202	193	184	175	165	157	133	119
150-175	216	205	197	184	174	166	154	–
Recommended average total air content, percent, for level of exposure (&)								
Mild exposure	4.5	4	3.5	3	2.5	2	1.5	1
Moderate Exposure	6	5.5	5	4.5	4.5	4	3.5	3
Severe exposure	7.5	7	6	6	5.5	5	4.5	4

*These quantities of mixing water are for use in computing cementitious material contents for trial batches. They are maximums for reasonably well-shaped angular coarse aggregates graded within limits of accepted specifications.

**The slump values for concrete containing aggregates larger than 37.5mm are based on slump tests made after removal of particles larger than 37.5mm by wet screening.

(&) The air content in job specifications should be specified to be delivered within -1 to +2 percentage points of the table target value for moderated and severe exposures. Adapted from ACI211.1 and ACI 318.However(1995) presents this information i

(320) ACI 211.1 Mix Proportion (3)

A2.2.4 Step-4 Water-Cement Ratio

(314) Table A1.5.3.4 (a) 24MPa

Required Average Strength 24 Mpa

W/C=0.69-((0.69-0.61)/(25-20))*(24-20)=0.62 W/C=0.62

314 ACI 211.1 Table A1.5.3.4 (a). Relationship (Metric) between water cement ratio and compressive strength of concrete (SI)

Compressive Strength at 28 days, Mpa	Water-cementitious materials ratio by mass	
	Non-air-entrained concrete	Air-entrained concrete
45	0.38	0.3
40	0.42	0.34
35	0.47	0.39
30	0.54	0.45
25	0.61	0.52
20	0.69	0.6
15	0.79	0.7

Strength is based on cylinders moist-cured 28 days in accordance with ASTM C31 (AASHTO T 23). Relationship assumes nominal maximum size aggregate of about 19 to 25 mm. Adapted from ACI 211.1 and ACI 211.3

(321) ACI 211.1 Mix Proportion (4)

A2.2.5 Step-5 Required Cement Content W=181kg/m3 W/C=0.62

C=181/0.62=292kg/m3

A2.2.6 Step-6 Quantity of Aggregate

(316) Table A1.5.3.6 Fineness Modulus 2.8

Required Dry Mass =0.71*1600=1136kg

316 ACI 211.1 Table A1.5.3.6 – Volume of coarse aggregate per unit of volume of concrete (SI)

Maximum Size of Coarse Aggregate	Fineness Modules of Fine Aggregate			
	2.4	2.6	2.8	3
9.5	0.5	0.48	0.46	0.44
12.5	0.59	0.57	0.55	0.53
19	0.66	0.64	0.62	0.6
25	0.71	0.69	0.67	0.65
37.5	0.75	0.73	0.71	0.69
50	0.78	0.76	0.74	0.72
75	0.82	0.8	0.78	0.76
150	0.87	0.85	0.83	0.81

Volume are based on aggregates in a dry-rodded condition described in ASTM C 29 (AASHTO T 19). Adapted from ACI 211

(322) ACI 211.1 Mix Proportion (5)

A2.2.7 Step-7 Mass or Absolute Volume

A2.2.7.1 Mass basis

First estimate of mass of Fresh concrete
2410kg

Water	181 kg
Cement	292 kg
Coarse Aggregate	1136 kg
Total	1609 kg

Mass of fine aggregate
2410-1609=801kg

(317) Table A1.5.3.7.1

317 ACI 211.1 Table A1.5.3.7.1 -First estimate of mass of fresh concrete (SI)

Aggregate Maximum Dimension (mm)	Fresh Concrete	AE Concrete
9.5	2285	2200
12.5	2310	2230
19	2345	2275
25	2380	2290
37.5	2410	2350
50	2445	2345
75	2490	2405
150	2530	2435

(323) ACI 211.1 Mix Proportion (6)

A2.2.7.2 Absolute Volume Basis

Specified Mix Proportion

(1) W/C=62% W=181 C=181/(62*0.01)=292

(6) 293*2.64=774

(3)=0.71*1600=1136kg

Specified Mix Proportion

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength (kgf/cm2)			Remarks	density kg/m3
		(SL)	air	W/C	s/a	C	W	s	CA(5~10mm)	CA(10~20mm)	% of weight of cement)	% of weight of cement)	3d	7d	28d		
Mpa	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
24	37.5	7.5-10.0	1	62.0		292	181	774	1136							Weight	
						3.15	1	2.64	2.68							Specific Gravity	
			10			93	181	293	423							Volume	1000

(2)=392/3.15=93

(4)=1136/2.68=423

(5)=1000-(10+93+181+423)=293

(324) ACI 211.1 Mix Proportion (7)

A2.2.7.3 Step-8 Adjusted aggregate masses

Concrete Mix Proportion

Adjustment Moisture Content

Specified Mix Proportion

Saturated Surface-Dry State of Aggregate

W (kg)	C (kg)	Sand (kg)	Aggregate (kg)
181	292	774	1136

Field Condition

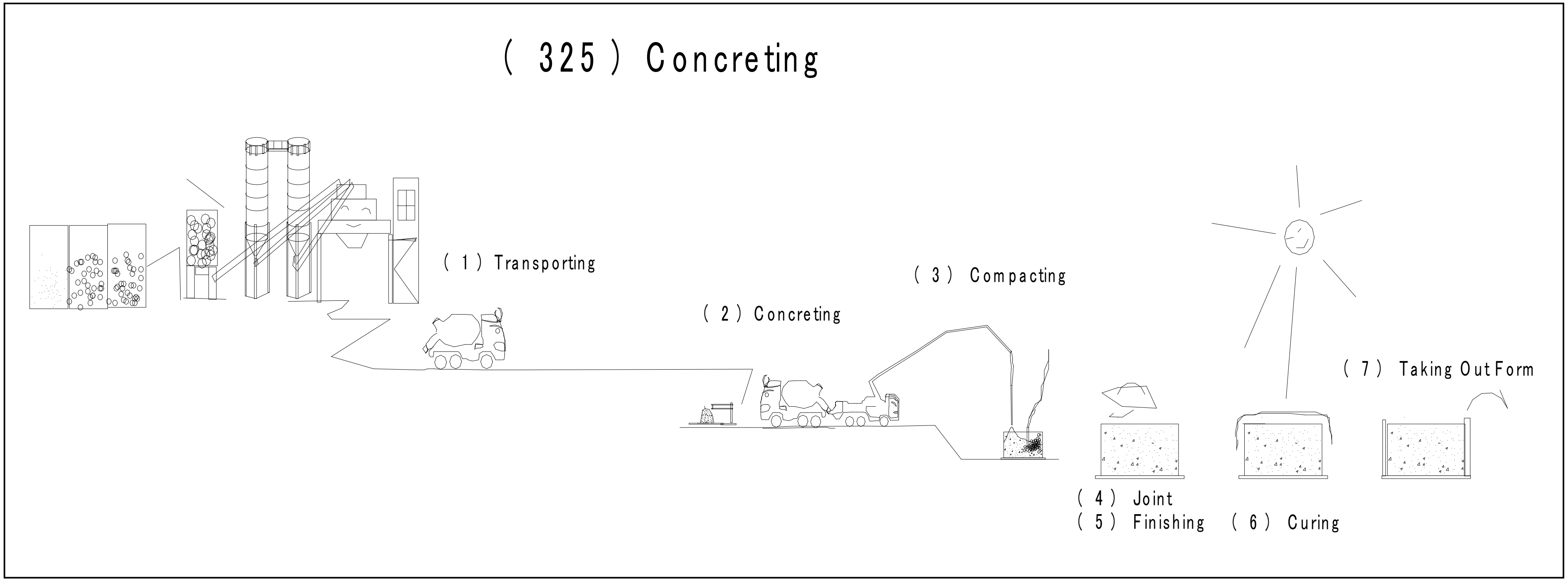
			Moisture Content(%)
Sand		Wet Condition	6
Aggregate		Wet Condition	2

	specifiv gravity (%)	absorption (%)	moisture content(%)	Water surface content(%)	Content(kg/m3)	Correction (kg/m3)	Corrected (kg/m3)
		(1)	(2)	(3)=(2)−(1)	(4)	(5)=(3)*(4)*0.01	(6)=(4)+(5)
Water					181	-58	123
Fine Aggregate	2.64	0.7	6.0	5.3	774	41	815
Coarse Aggregate	2.68	0.5	2.0	1.5	1136	17	1153

Field Mix Proportion (1m3)

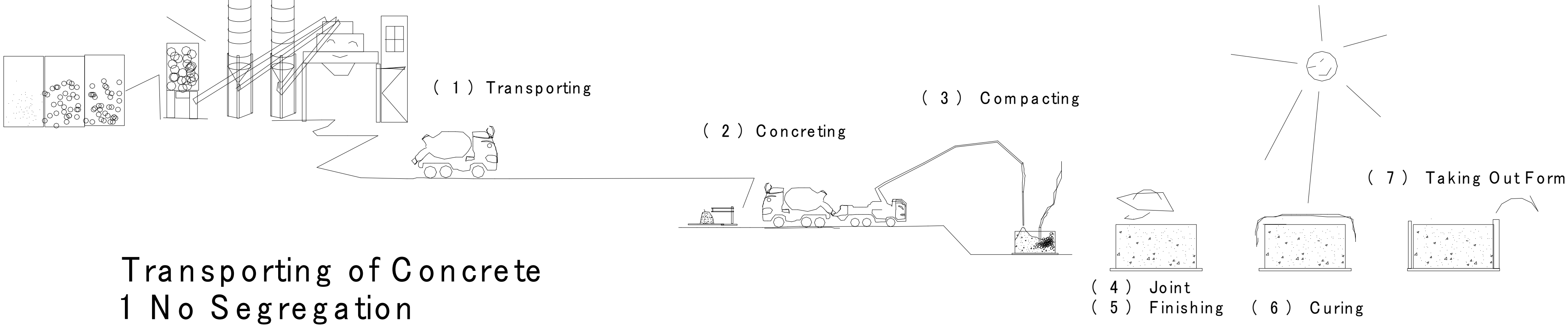
W (kg)	C (kg)	Sand (kg)	Aggregate (kg)
123	292	815	1153

(325) Concreting



(326) Transporting of Concrete

(326) Transporting of Concrete



Transporting of Concrete
1 No Segregation
2 No Slump Loss
3 No Air Content Loss
4 Within 90 Minute's (Temperature Over 25 Degree)
Within 180 Minute's (Temperature Below 25 Degree)
5 Transporting by Dump Track,Slump 2.5cm Pavement Concrete

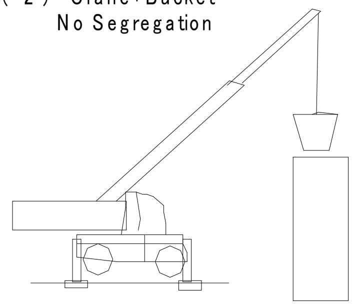
(327) Methods of Concrete Transporting

(327) Methods of Concrete Transporting

Methods of Concrete Transporting

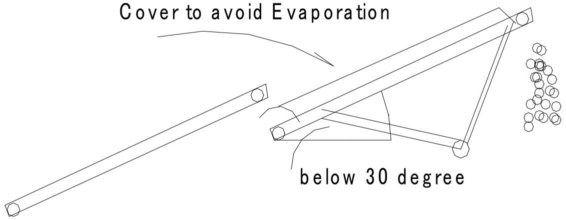
1 Aditator Mixer (Transporting Time within 1.5–2.0 Hours)
  Before Unloading,High Velocity Turning
  Dump Track(Transporting Time within 1.0 Hour)
2 Crane+Bucket
  No Segregation
3 Belt Conveyor
  Cover to avoid Evaporation
4 Concrete Pump
  Plastic and Workable
5 Chute

(2) Crane+Bucket
No Segregation

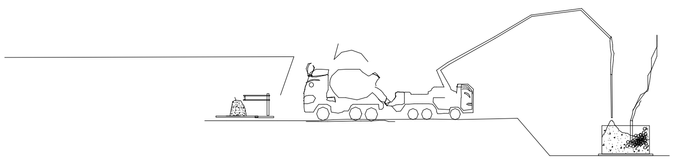


(1) Aditator Mixer (Transporting Time within 1.5–2.0 Hours)
Before Unloading,High Velocity Turning
Dump Track(Transporting Time within 1.0 Hour)

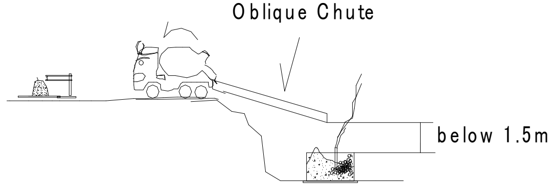
(3) Belt Conveyor
Cover to avoid Evaporation



(4) Concrete Pump

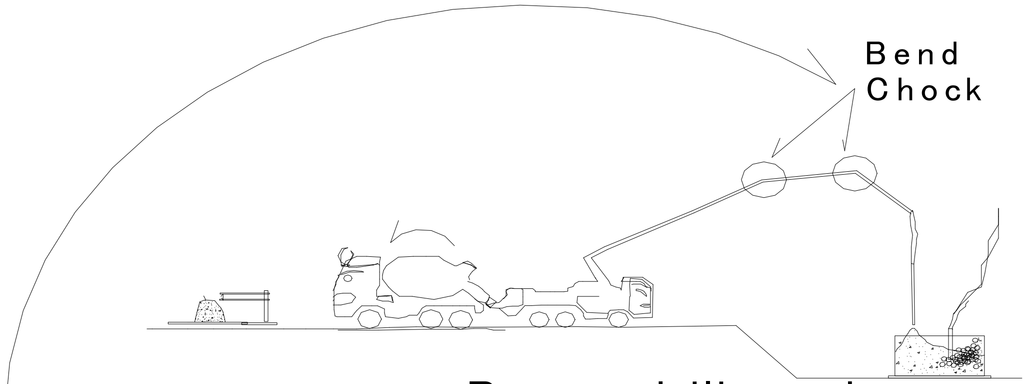


(5) Concreting



(328) Concrete Pump

(328) Concrete Pump



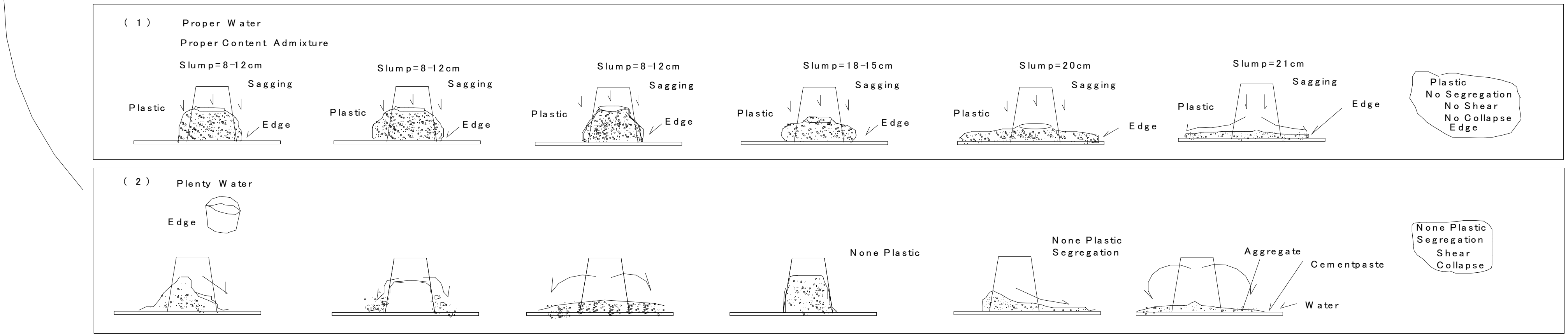
(a) Slump, 8-18cm.

(b) Maximum Size of Coarse Aggregate, below 40mm.

(c) Reduce Pumping Pipe Bend as much as possible. Horizontal or Down Direction.

(d) Before Pumping, Send Mortar.

Pumpability -ok



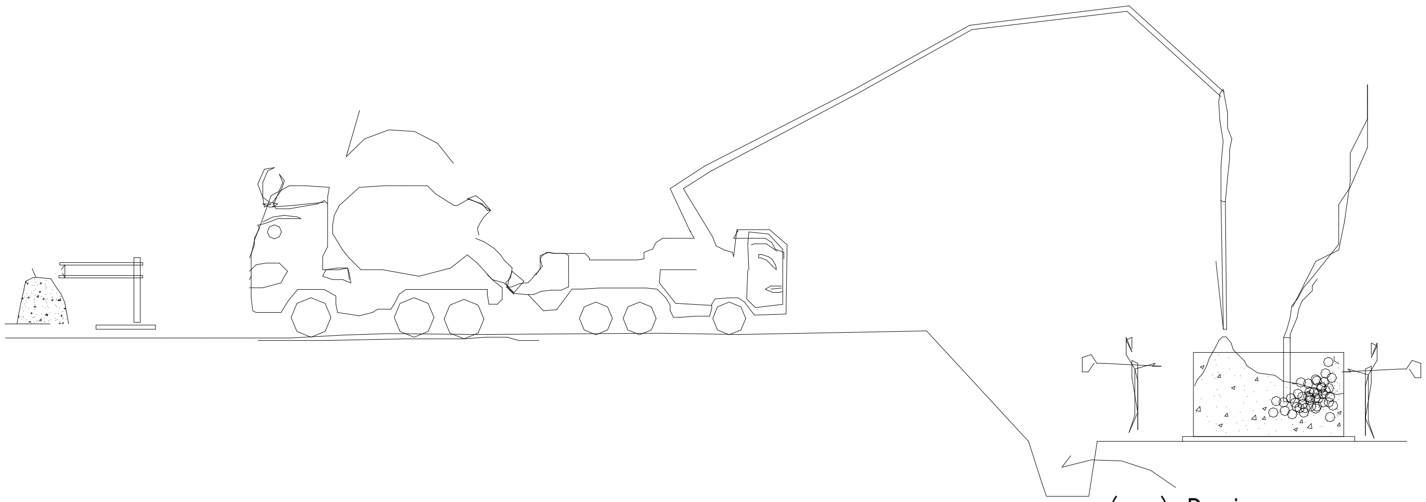
Pumpability -No Good

(329) Concreting

(a) Check Reinforcement and Form

(b) Keep Members of Transporting,Concreting,Compacting and Curing.

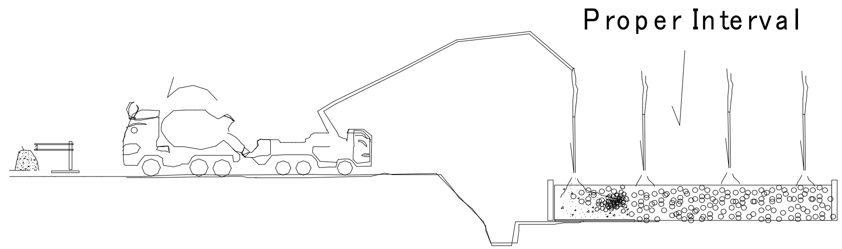
(c) Drainage

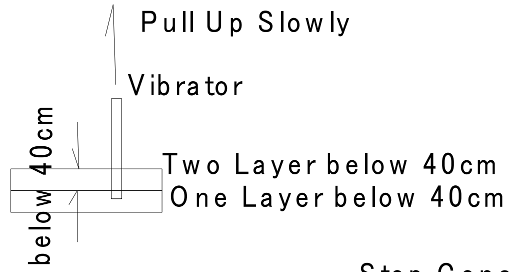


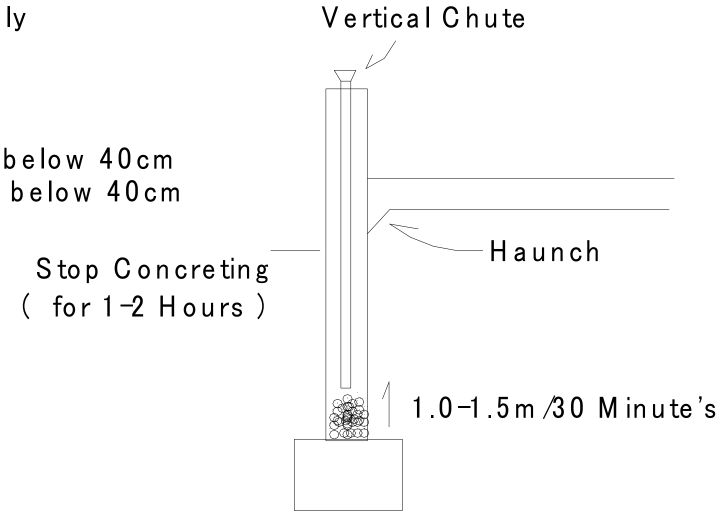
(330) Attention of Concreting

(330) Attention of Concreting

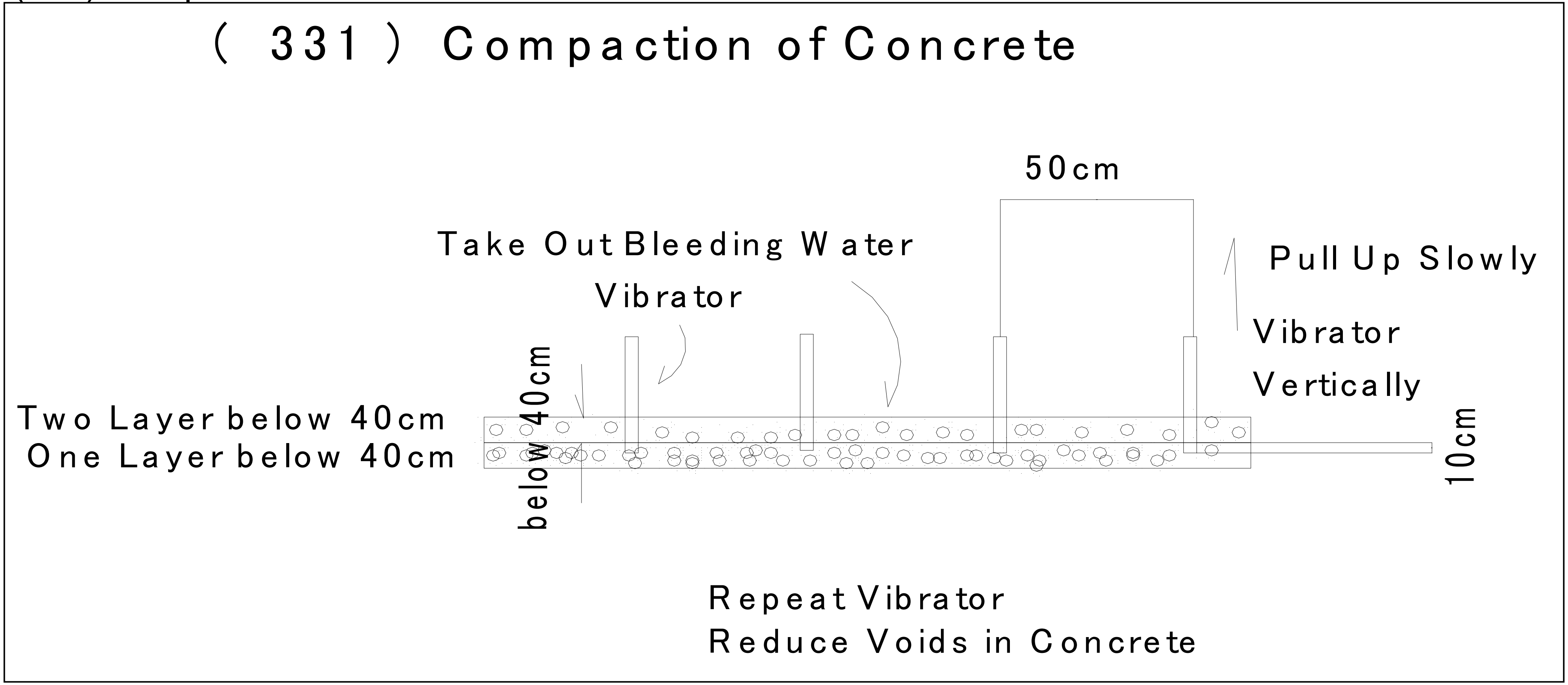
(a) Distribute Concrete Propoerly
(b) Concreting Continiouly
(c) Concreting Velocity Verticaly
1.0–1.5m/30 Minute's
(d) Concreting One Layer
below 40cm
(e) High Structure,Use Vertical Chute
(f) Take Out Bleedind Water
(g) Concreting Temperature
Cold Weather Concrete ,5–20 degree
Hot Weather Concrete,below 30 degree
Mass Concrete ,Low Temperature
(h) Pier,Wall,and Slab
Stop Concreting below Haunch



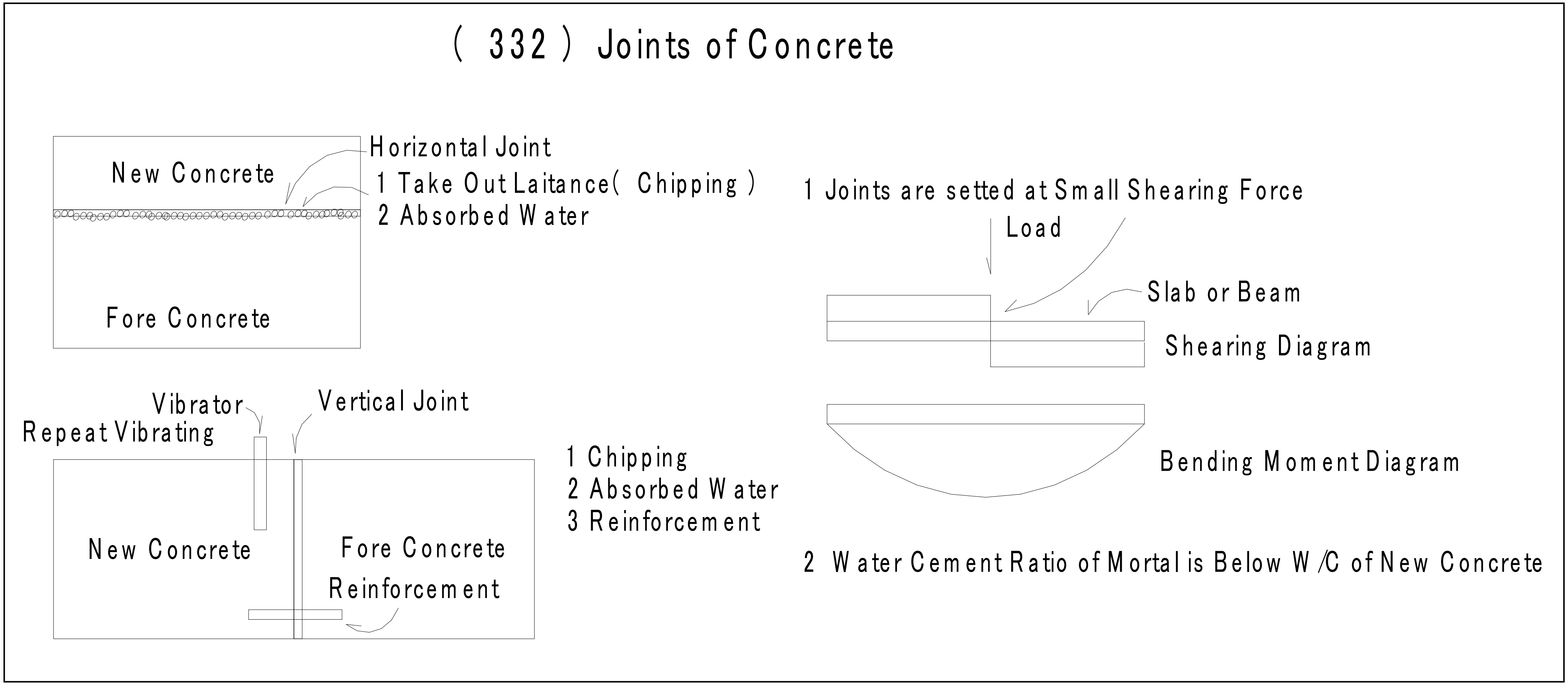




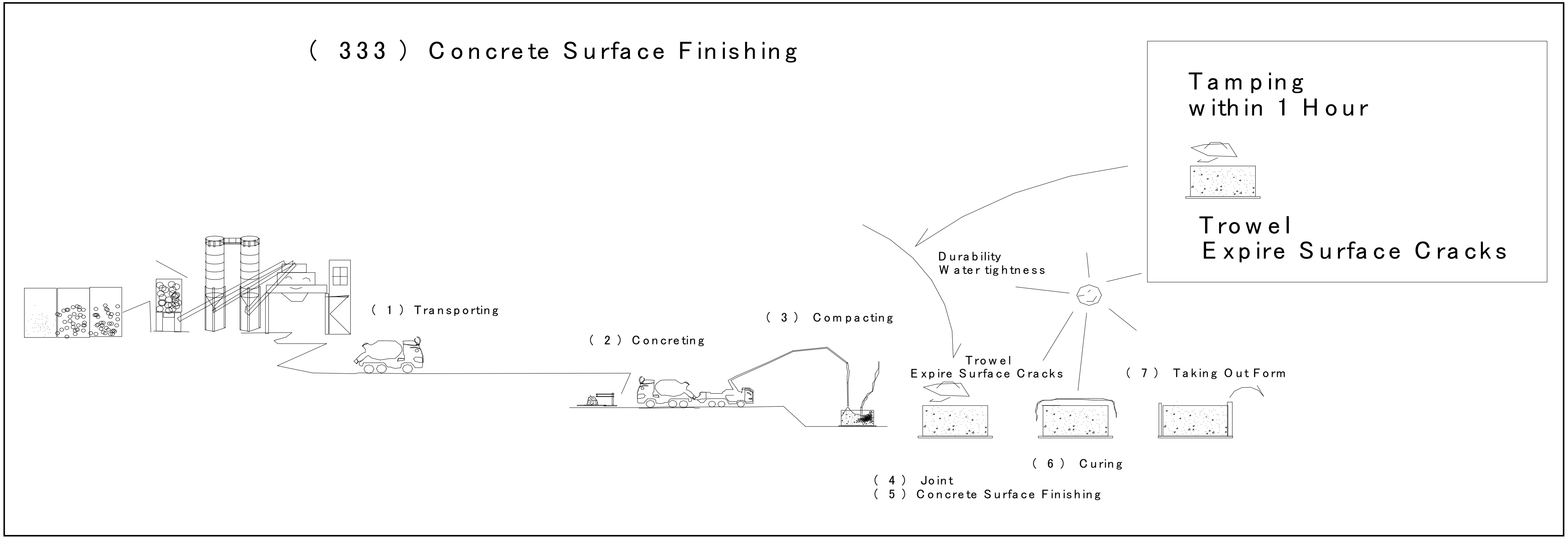
(331) Compaction of Concrete



(332) Joints of Concrete

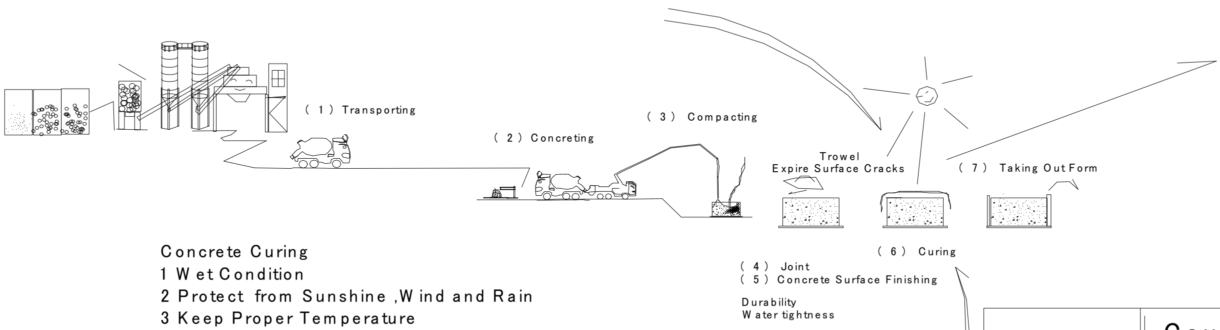


(333) Concrete Surface Finishing

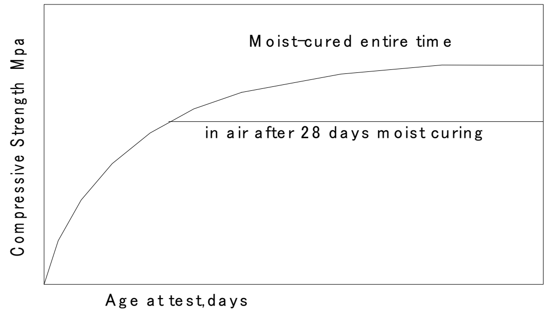


(334) Concrete Curing

(334) Concrete Curing



(37) Hardened Concrete Curing



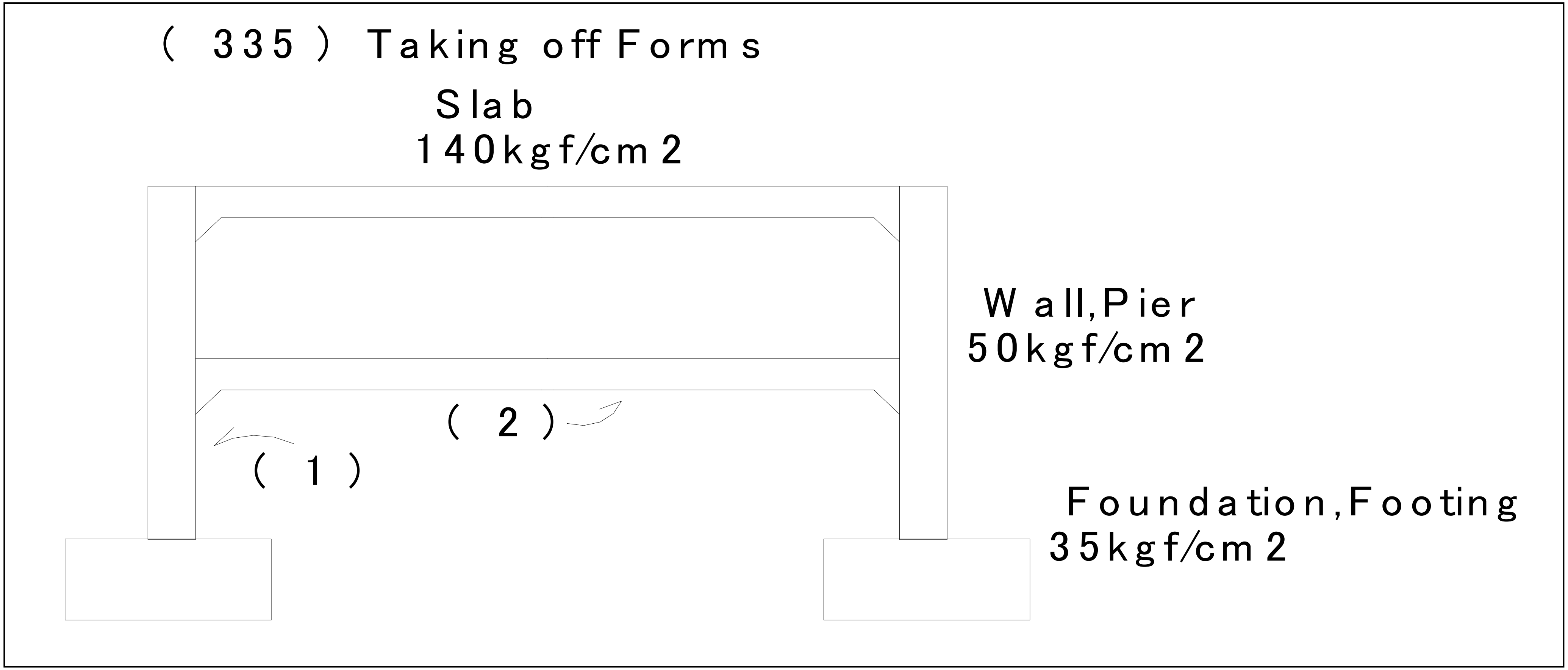
Concrete strength increase with ages
as long as moisture and a favorable temperature

Concrete Curing
1 Wet Condition
2 Protect from Sunshine ,Wind and Rain
3 Keep Proper Temperature
4 Protect From Impact

Curing Day
1 Normal Portland Cement 5 days
2 High Early Strength Portland Cement 3 days
3 Cold Weather Concrete Over 5 degree
f'c=50kgf/cm2
4 Hot Weather Concrete 24 hours ,Wet Condition,5days
5 Pavement Concrete
Normal Portland Cement 14 days
High Early Strength Cement 7 days
Moderate Heat Portland Cement 21 days
6 Dam Concrete
Normal,Moderate Portland Cement 14 days
Blended Cement 21 days11

	Causes	Curing Method	Remarks
Normal	1 Sunshine- 2 Freezing 3 Loading 4 Vibration and Impaction	1 Water Spray 2 Seat Curing (Avoid Sunshine ,Cold Wind and Wind)	Curing Day 2-3 Days
Cold	Freezing		Initial Curing Strength: 35-50kg/cm2
Hot	Dry	1 Wet Curing 2 Seat Curing :Membrane Curing	Keep Wet Curing

(335) Taking off Forms



(336) Cold Weather Concrete

(336) Cold Weather Concrete

Average Temperature 4 degree

a Material
1 Cement:Normal or High Early Strength Portland Cement
Not proper Blast-furnance Slag Cement and Fly-Ash Cement
2 Aggregate:
3 Admixture: AE Agent,AE Water Reducing Agent
4 Not Heat Cement

b Mix Proportion
1 AE Concrete
2 Unit Water:Minimum Water Content within Required Workability

c Transportation.Concreting
1 Avoid Wind
2 Concreting Temperature 5-20 degree
3 Concreting:Taking out Snow or Ice
4 Joint:Warm Fore Concrete

d Curing
1 Curing until Required Strength
2 Concrete Curing Temperature:5 degree
3 Avoid Dry

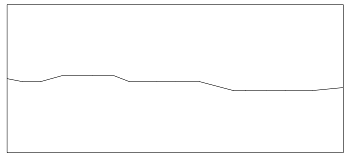
(337) Hot Weather Concrete

(337) Hot Weather Concrete

Over Average Temperature 25 degree

a Material
1 Aggregate:Protect from Sunshine,Spread Water
2 Admixture
3 Unit Water and Unit Cement Water Content within Required Workability
4 Cooling:Aggregate: 2 degree
Water Temperature:4 degree
Cement:8 degree
→ Down Concrete Temperature 1 degree

b Excution
1 Transportation:Not Slump Loss
2 Forms Reinforcement:Spread Water
3 Concreting Time : 1–1.5 hours from Mixing
4 Concreting Temperature:below 35 degree
5 Cold Joint:Early Setting Time
Mass Concrete:Retarder



6 Curing:Avoid Sunshine,Protect Concrete from Wind
24 hours Wet Curing
5 days Curing

(338) Mass Concrete

(338) Mass Concrete

Foundation
Cement Cracks

1 Controlling of Temperature Cracks
  1 Reinforcement
  2 Crack Joint
  3 Pre-Cooling
  4 Pipe-Cooling

2 Concrete Mixing
    Minimum Cement Content Within Required Workability
    and Designed Compressive Strength
    Reduce Hydration Heat
  1 Cement Heat Portland Cement
              Blast Cement
              Silica Cement
              Flyash Cement
  2 Designed Compressive Strength 91 days

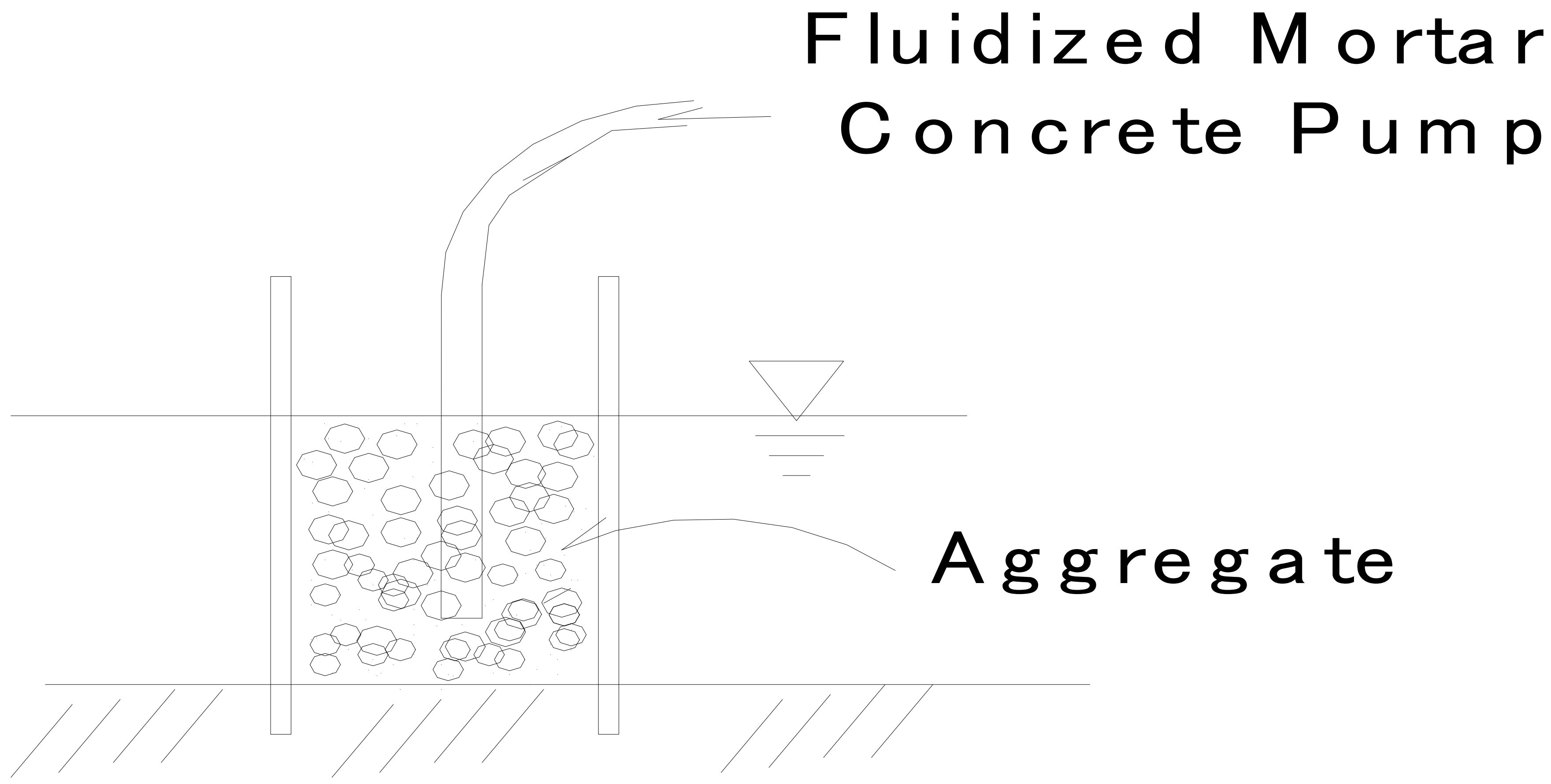
(339) Concrete under Water

1 60% Compressive Strength
2 Not Fit for Dam Concrete and Reinforced Concrete

Methods
1 Tremie
2 Concrete Pump
3 Velocity of Flow : 3m/minute

(340) Prepacked Concrete

(340) Prepacked Concrete



(341) Fluidized Concrete

(1) Super Plasticizer
Standard Type and Retarder Type

(2) Mix Proportion
Base Concrete+Super Plasticizer
Base Concrete:AE Concrete

(3) Slump
1 below 18cm
2 increase in 10cm by Super Plasticizer
3 Base Concrete Slump:over 5-6 cm
Fuidized Concrete Slump:8-12 cm

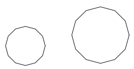
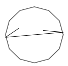
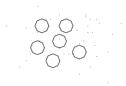
(4) Mix Proportion
1 Super Plasticizer(Additive Content)
below 0.5% of Cement
Ignore Volume of Super Plasticizer
2 Mix Proportion Table
Type,Transportation Time and Pump

(5) Fluidized Concrete
1 Add Super Plasticizer to Base Concrete at Site
2 Add Super Plasticizer to Base Concrete at Batch Plant

(342) Consistency-Water

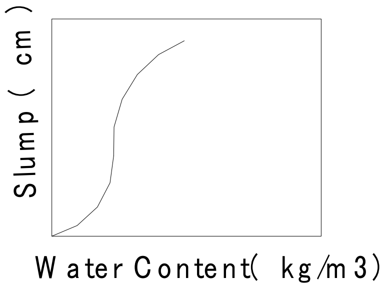
(342) Consistency

Consistency –Required Water Content

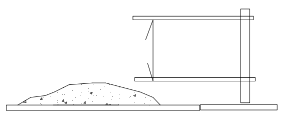
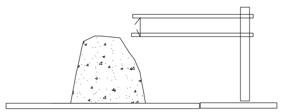
Aggregate Round	Aggregate Maximum Size	Entrained Air
Water–Little	Water–Little	Water–Little
		

Slump Test–(5–18cm)
Concrete of Dry Consistency–V.B.Test
Causes

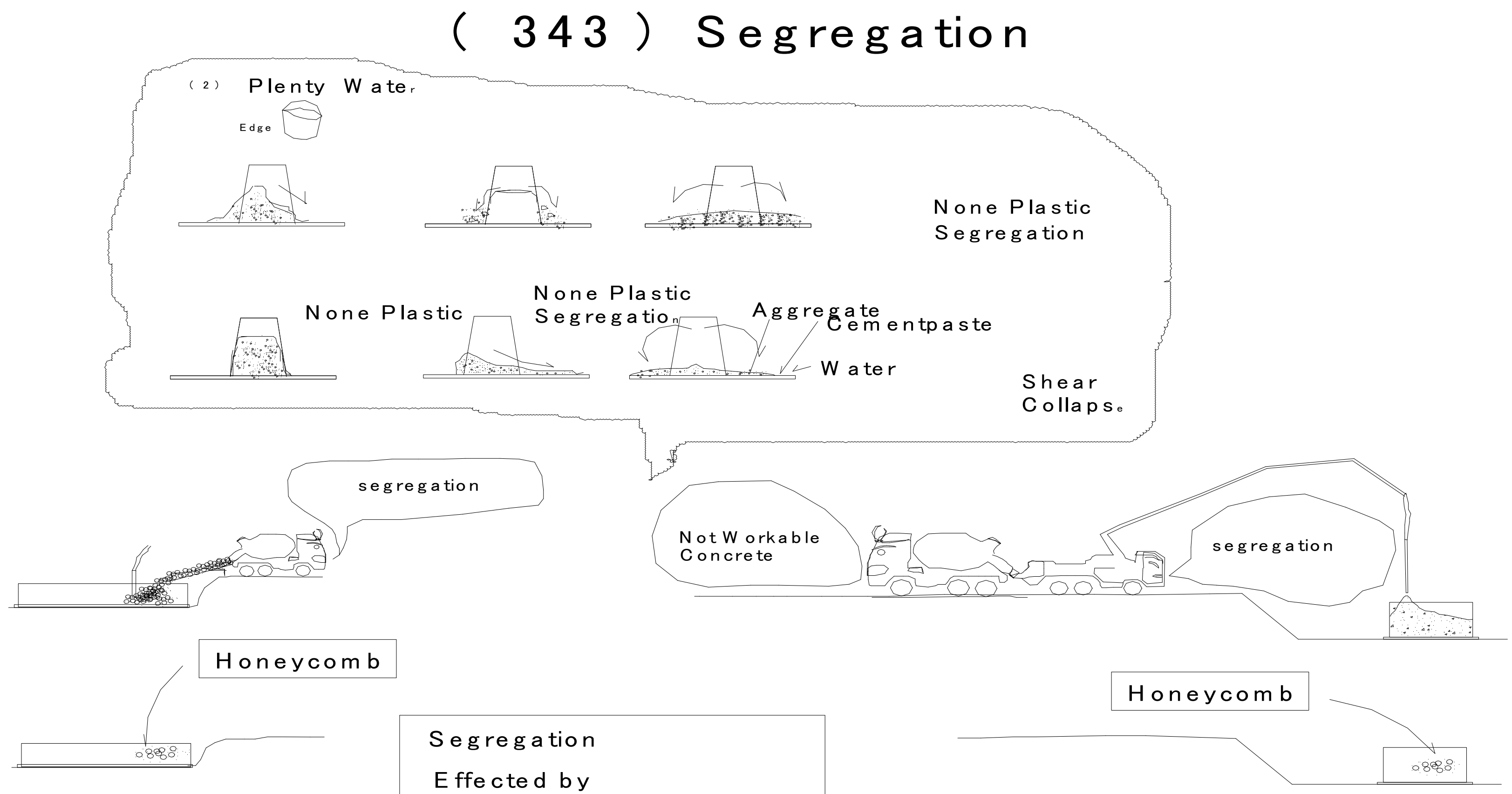
1 Water Content
  1.2% of Water Increase–Slump 1 cm increase
2 Air Content
  Air Content 1 % Increase–Slump 2.5 cm Increase
3 Maximum Size of Aggregate
  G Max Bigger–Water Content and Cement Content Decrease
4 Grading
5 Sand Percentage Bigger–Slump Smaller
6 AE Agent,AE Water Reducing Agent–Spread Cement Particles
  Entrained Air–Ball Bearing Action
7 Fly Ash Cement:Ball Bearing Action
8 Temperatute:Concrete Temperture 10 Degree Up–Slump 2–3 cm Smaller



Consistency –Workability

Slump(cm) –High	Slump(cm) –Low
	
Soft	Hard

(343) Segregation

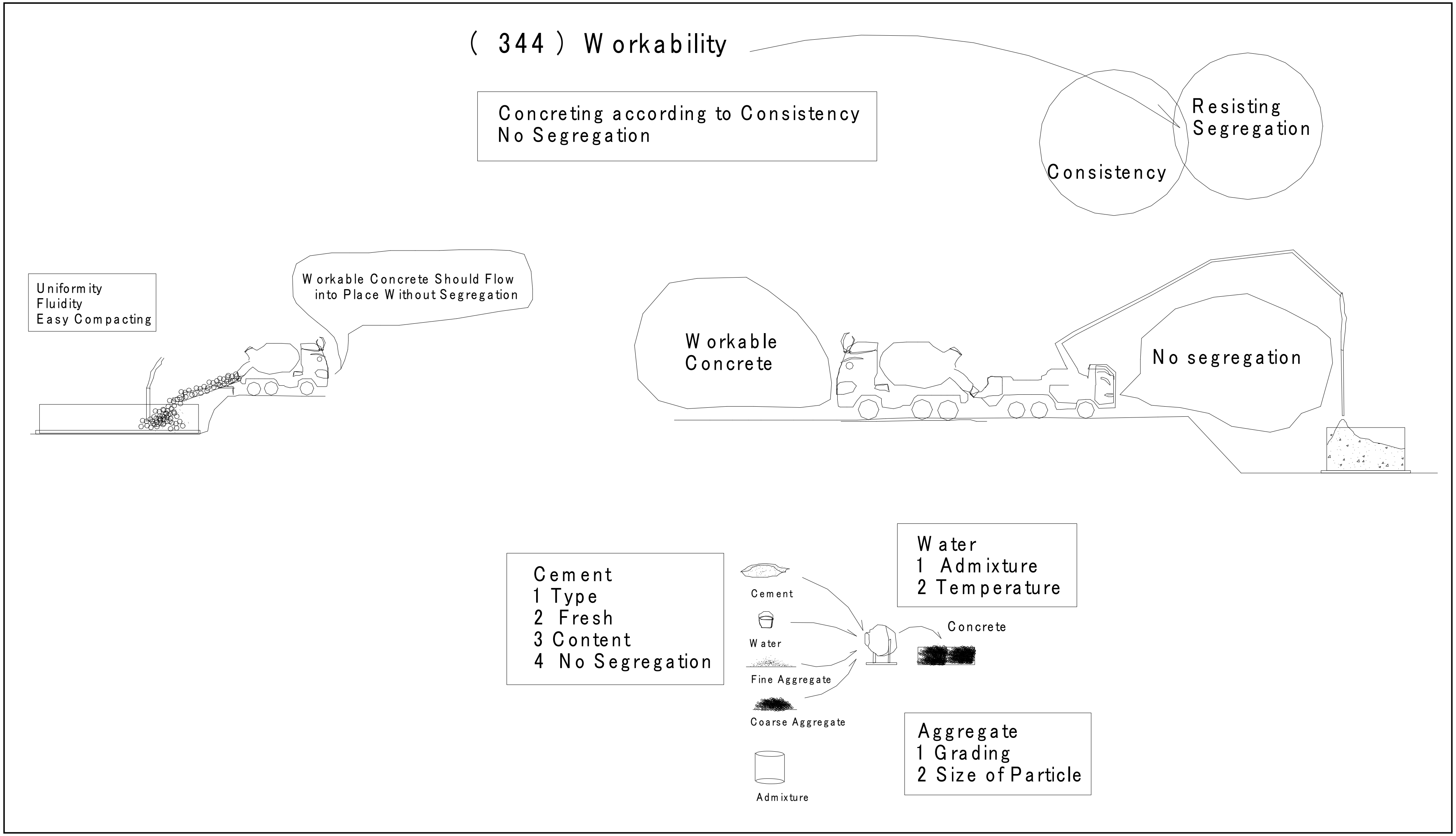


Segregation

Effected by
1 Plenty Water
2 Dropping Concrete
3 Not Enough Compacting

Not Proper Mix Proportion
1 Transportation
2 Unproper Construction ,Over Compacting
→Segregation
3 Bleeding→Bond Strength between Reinforcement and Forms →Decrease
Watertightness→Decrease
4 G Max→Bigger→Segregation Increase
5 AE Agent,AE Water Reducing Agent→Ressist Segregation

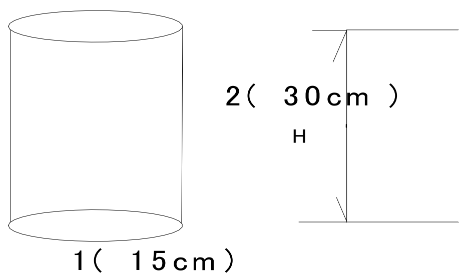
(344) Workability



(345) Compressive Strength(1)

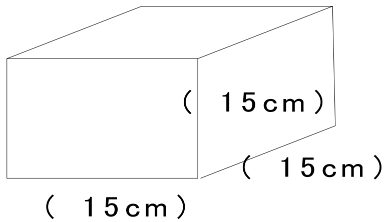
(345) Compressive Strength

Test Piece (Cylinde)



USA

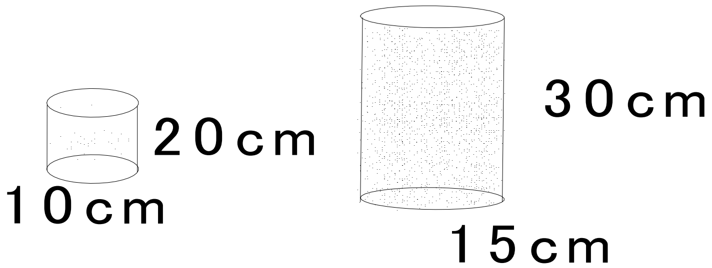
Test Piece (Cubic)



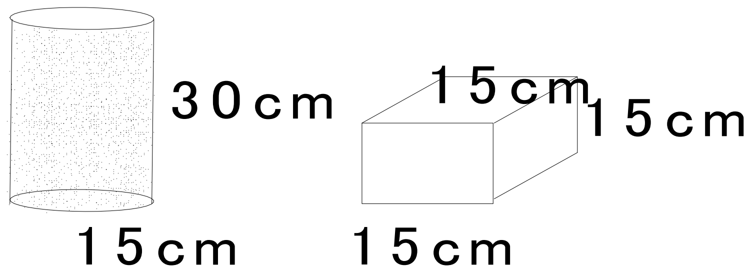
Europe

Compressive Strength

1 Cement
2 Maximum Size of Coarse Aggregate
3 Crushed Stone or River Stone
4 Type of Admixture
5 Mix Proportion
6 Air Content
7 Curing Method
8 Dry or Wet
9 Test Method(Test Piece or Loading Velocity)



Same Strength



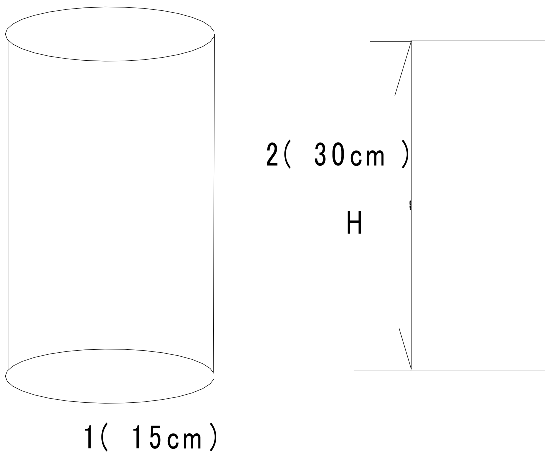
Strength About 87%

Strength 100%

(346) Compressive Strength(2)

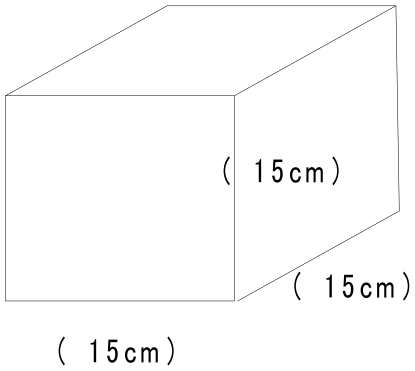
(345) Compressive Strength

Test Piece (Cylinde)



USA

Test Piece (Cubic)



Europe

Compressive Strength

1 Cement

2 Maximum Size of Coarse Aggregate

3 Crushed Stone or River Stone

4 Type of Admixture

5 Mix Proportion

6 Air Content

7 Curing Method

8 Dry or Wet

9 Test Method(Test Piece or Loading Velocity)

(347) Compressive Strength(3)

(347) Compressive Strength(3)

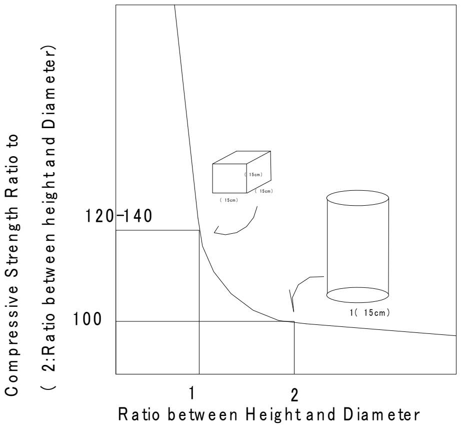


fig-1 Test Piece Shape effect Compressive Strength

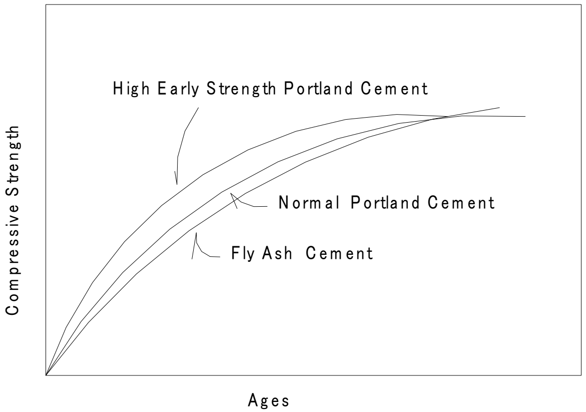


fig-2 Cement Type effect Compressive Strength

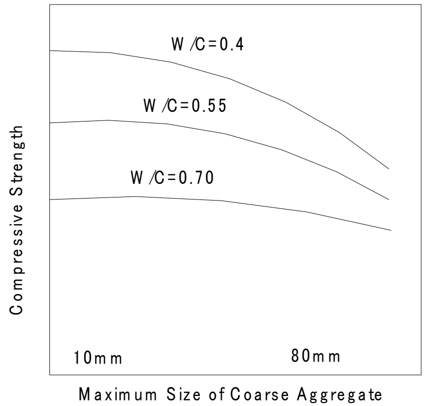


fig-3 Maximum Size of Coarse Aggregate effect Compressive Strength

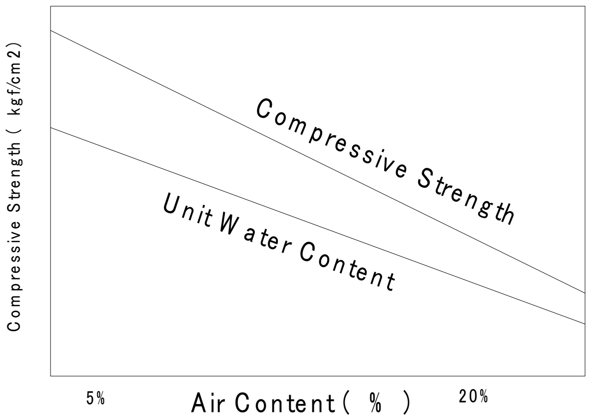


fig-4 W /C and Slump are Constant

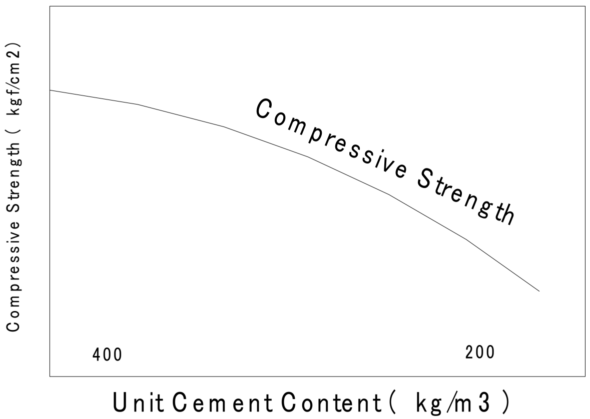


fig-5 Unit Cement and Slump are Constant

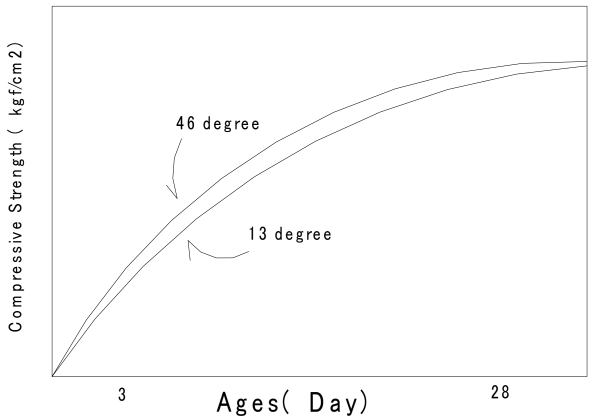


fig-6 Curing Temperature Effect Compressive Strength

(348) Compressive Strength(4)

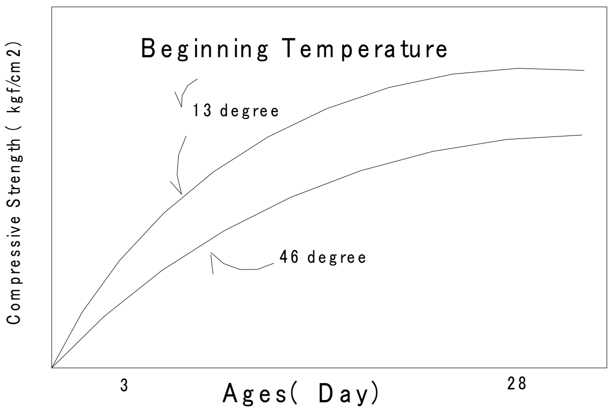


fig-7 Beginning Temperature Effect
Compressive Strength

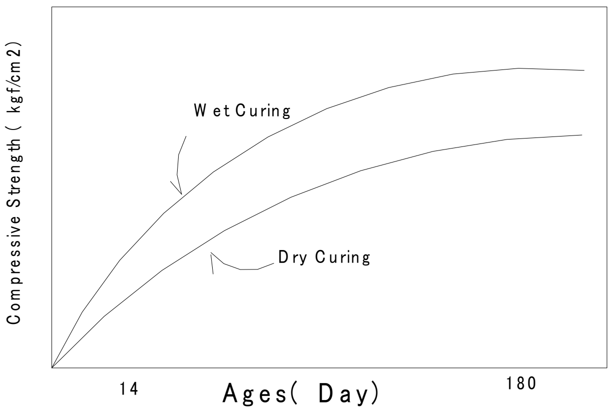


fig-8 Wet or Dry effect
Compressive Strength

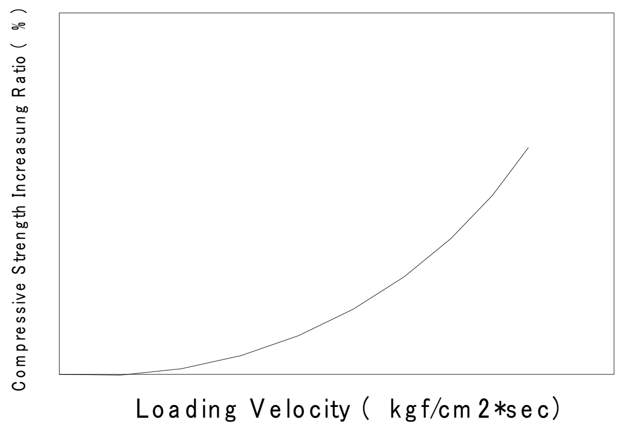


fig-9 Loading Velocity effect
Compressive Strength

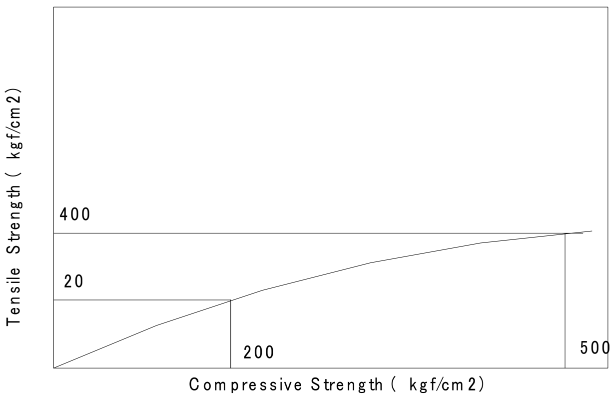


fig-10 Tensile Strength and
Compressive Strength

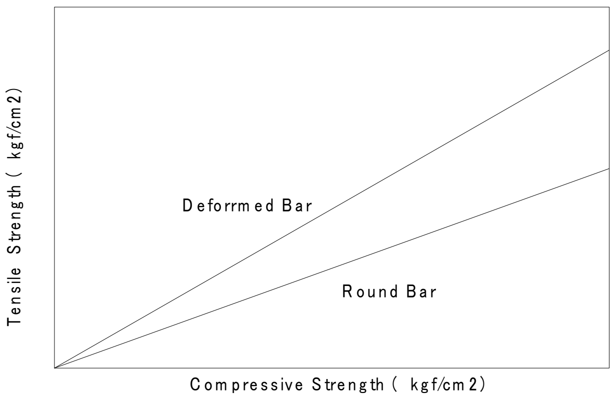


fig-11 Bond Strength and
Compressive Strength

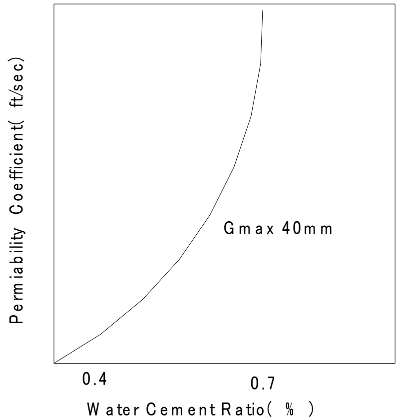


fig-12 W/C and Watertightness

(349) Water tightness

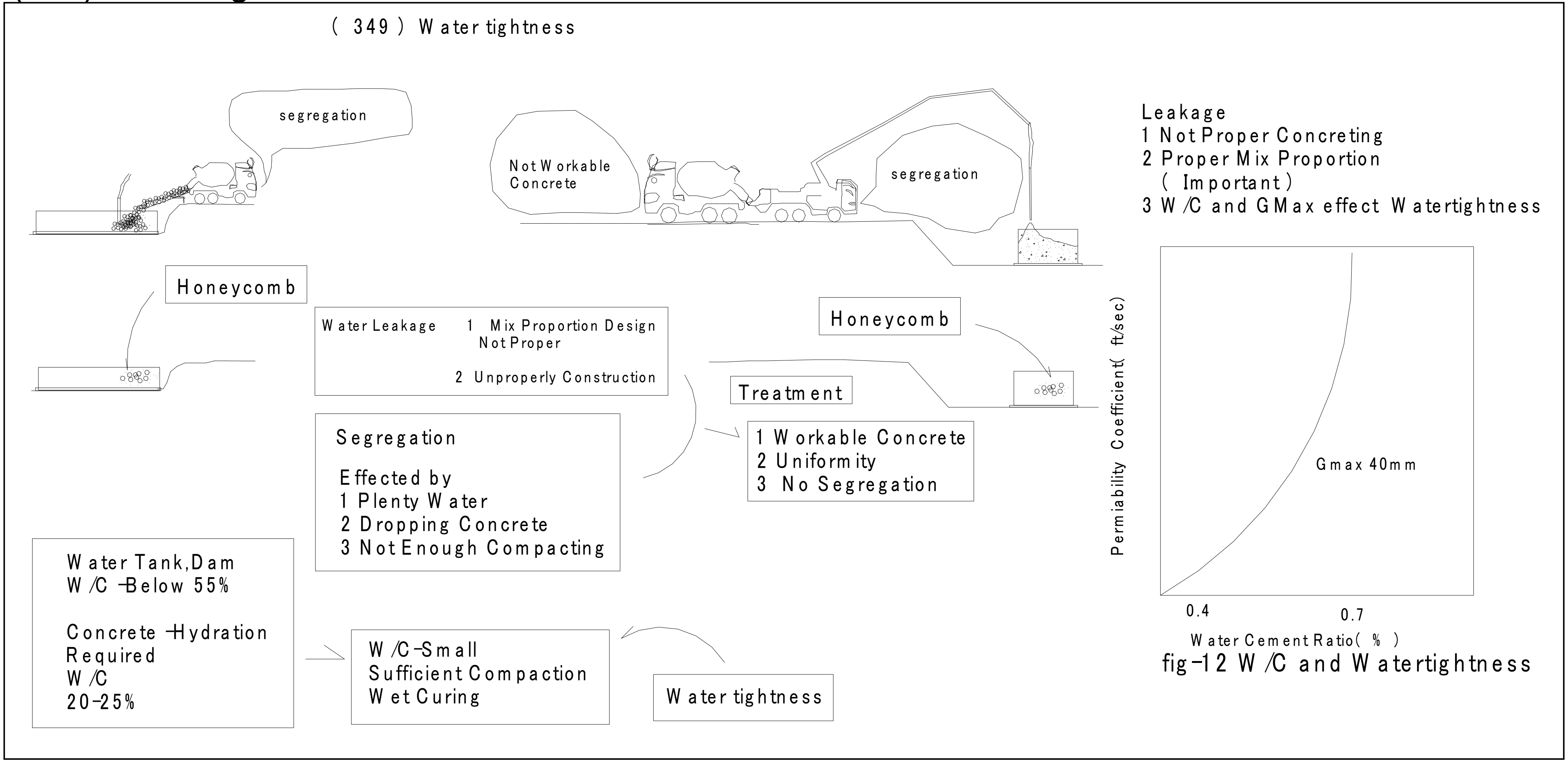
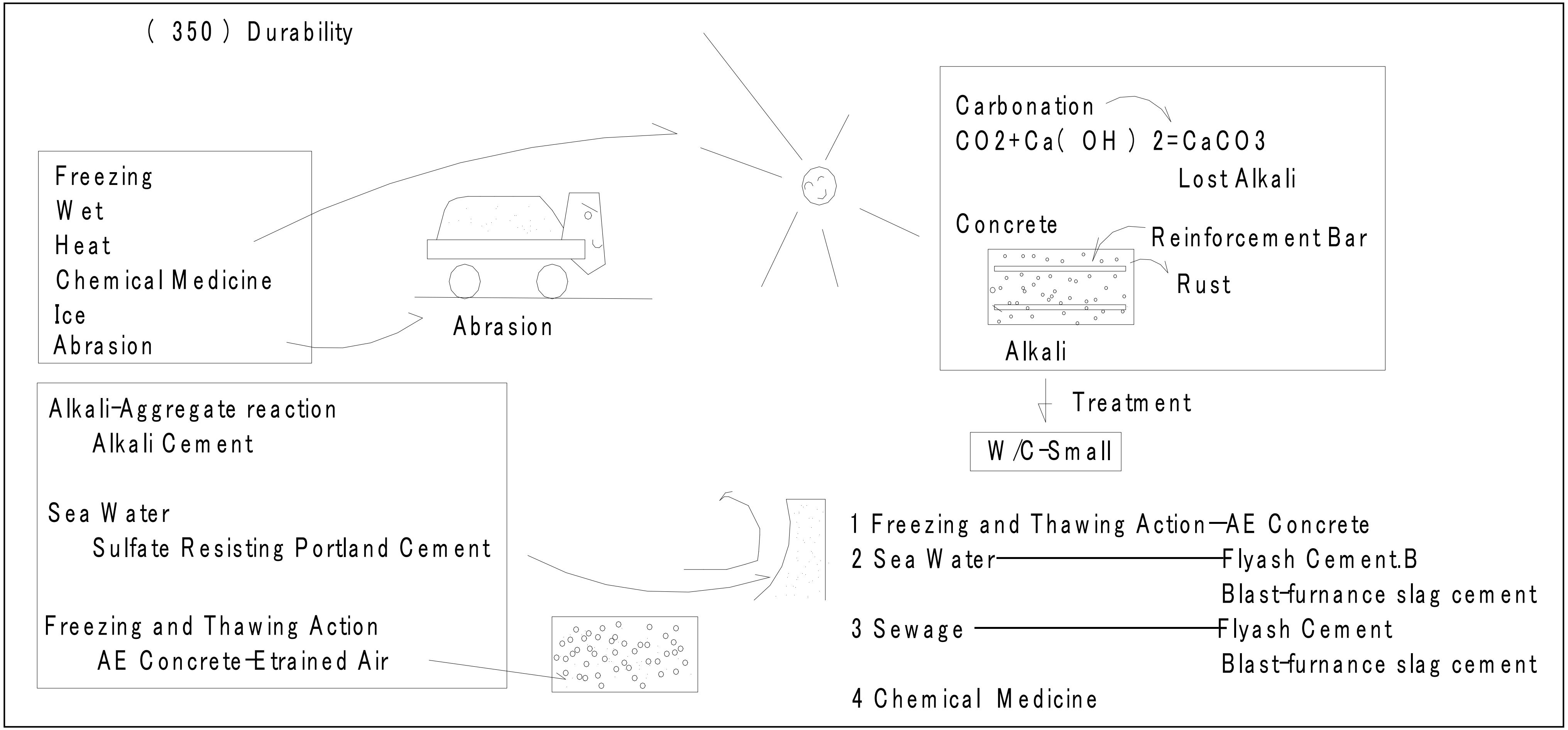
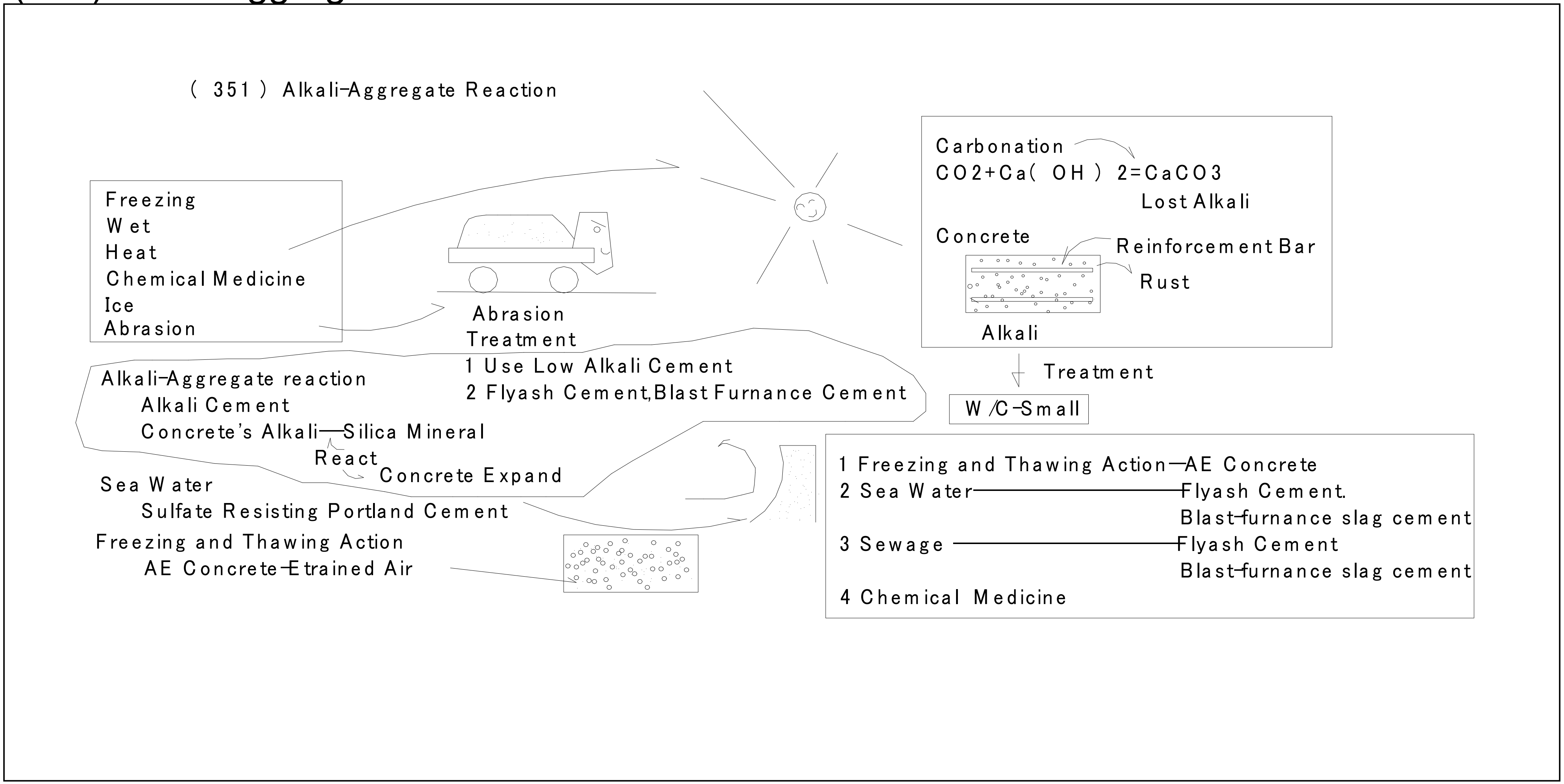


fig-12 W/C and Watertightness

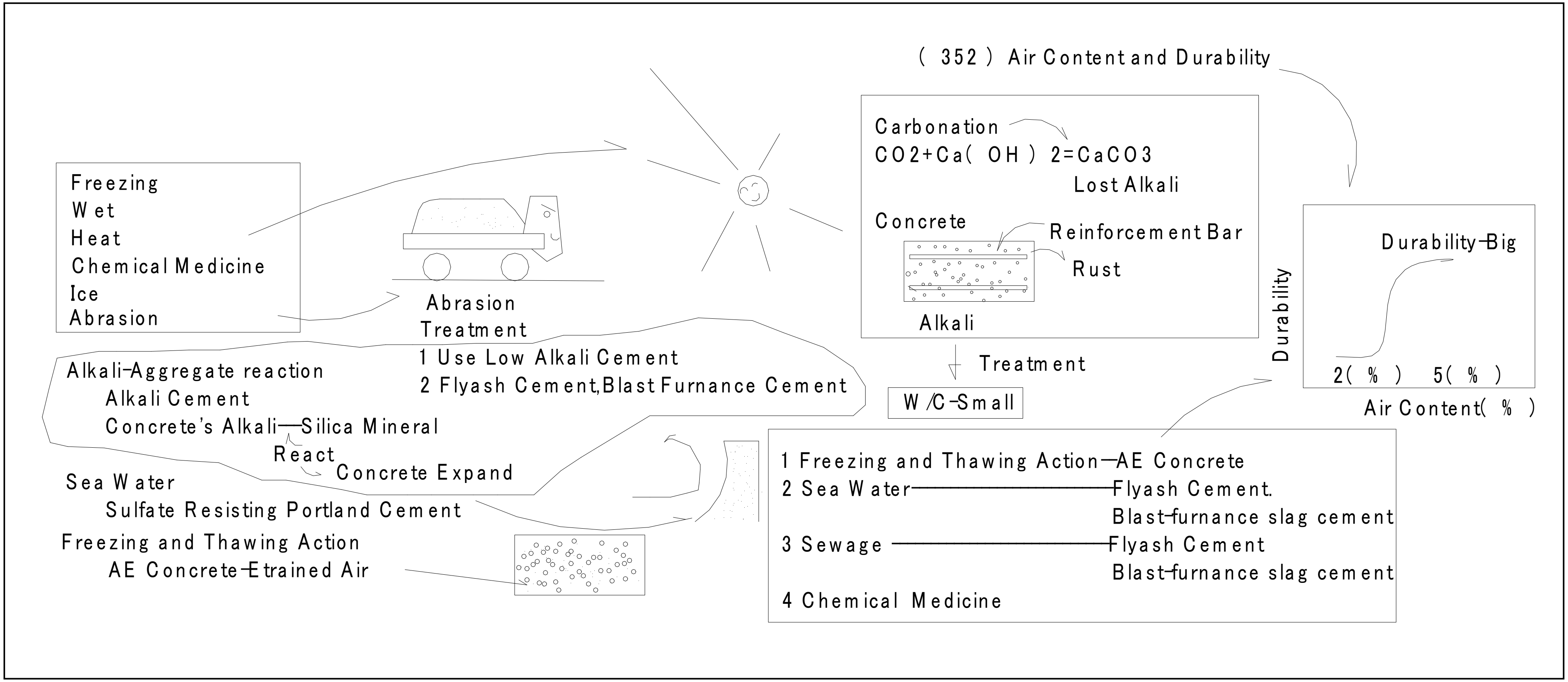
(350) Durability



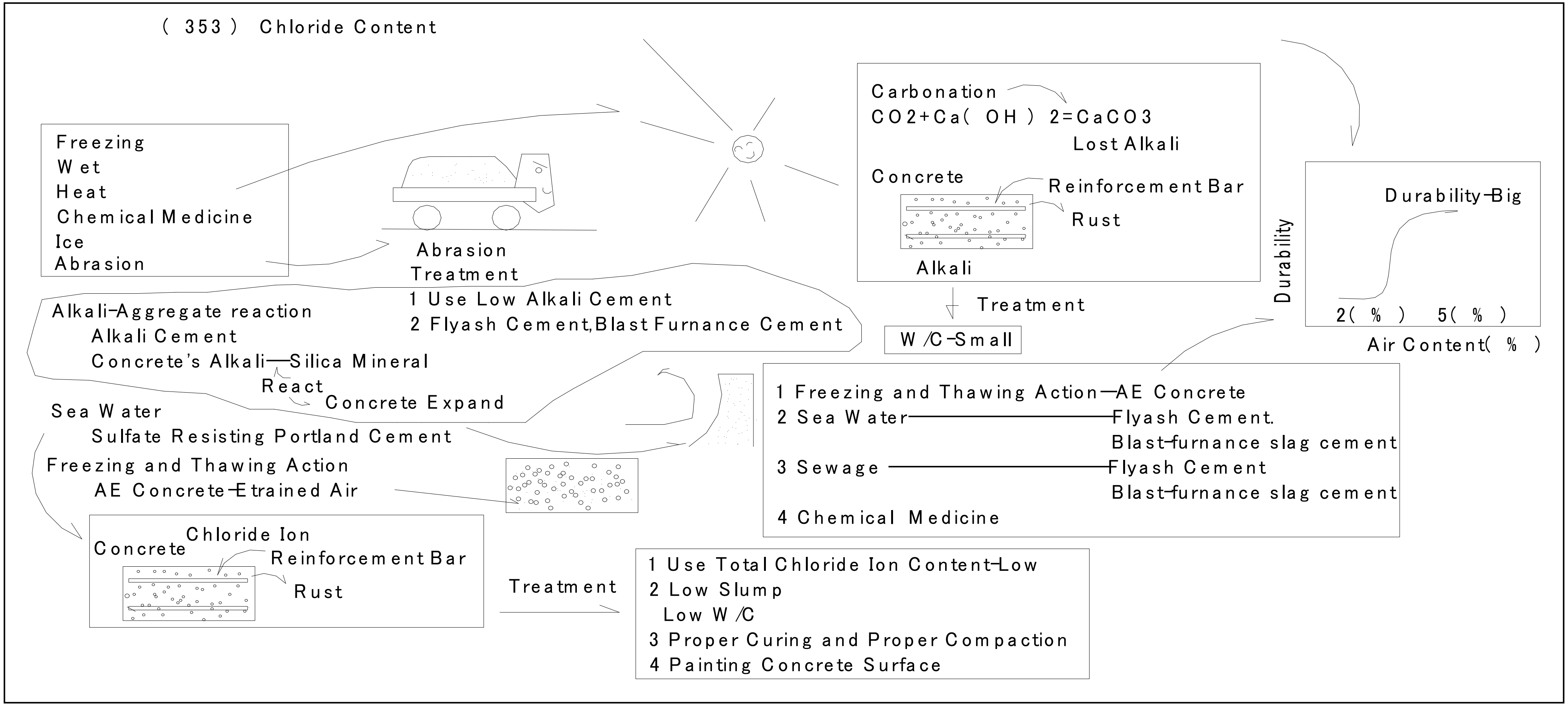
(351) Alkali-Aggregate Reaction



(352) Air Content and Durability

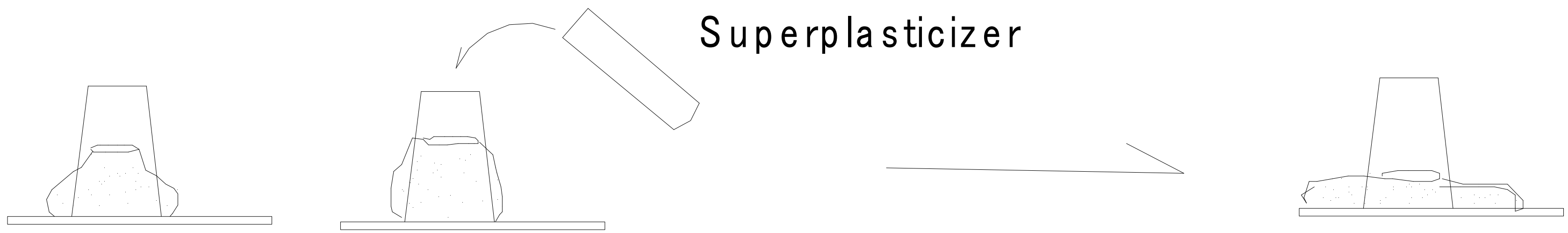


(353) Chloride Content



(354) Slump of Concrete after using Superplastilizer

(354) Slump of concrete after using Superplastilizer

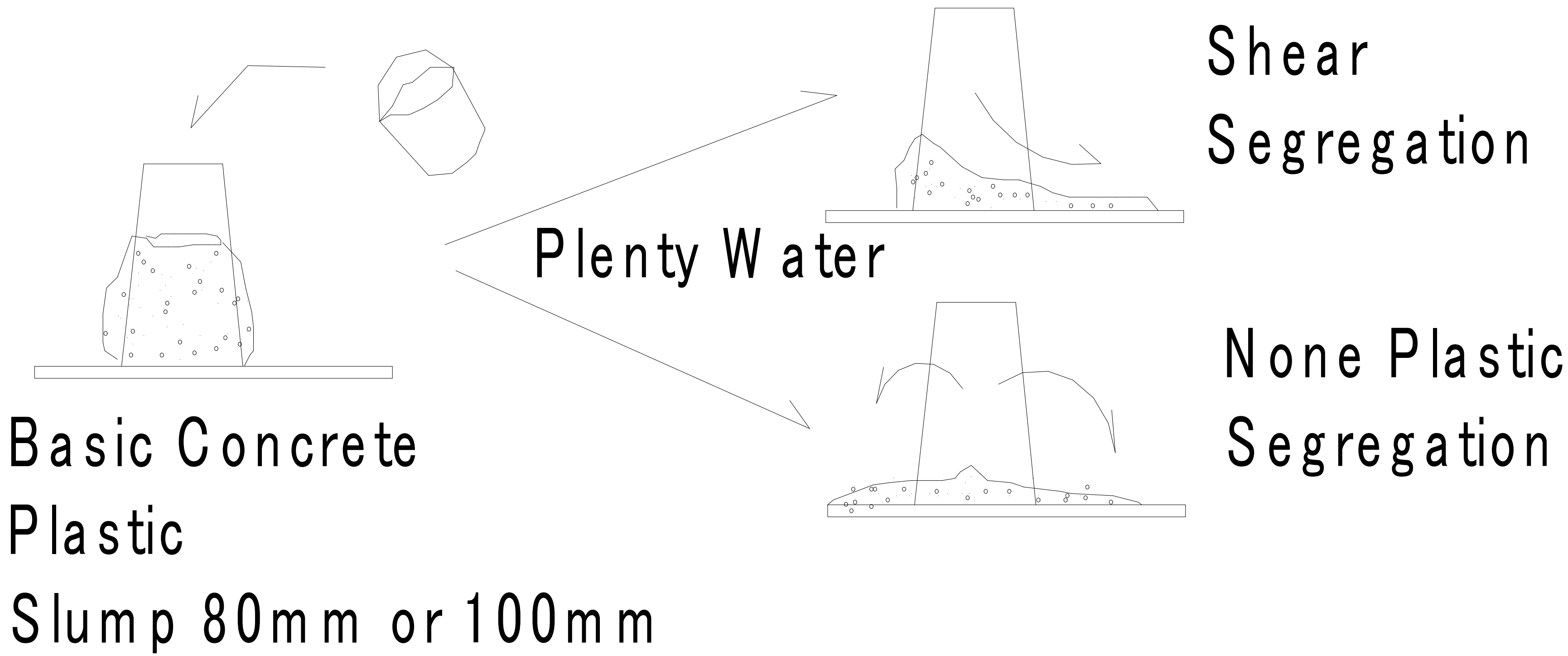


Basic Concrete
AE Concrete
Slump 80t-25mm
Admixture :AE Agent

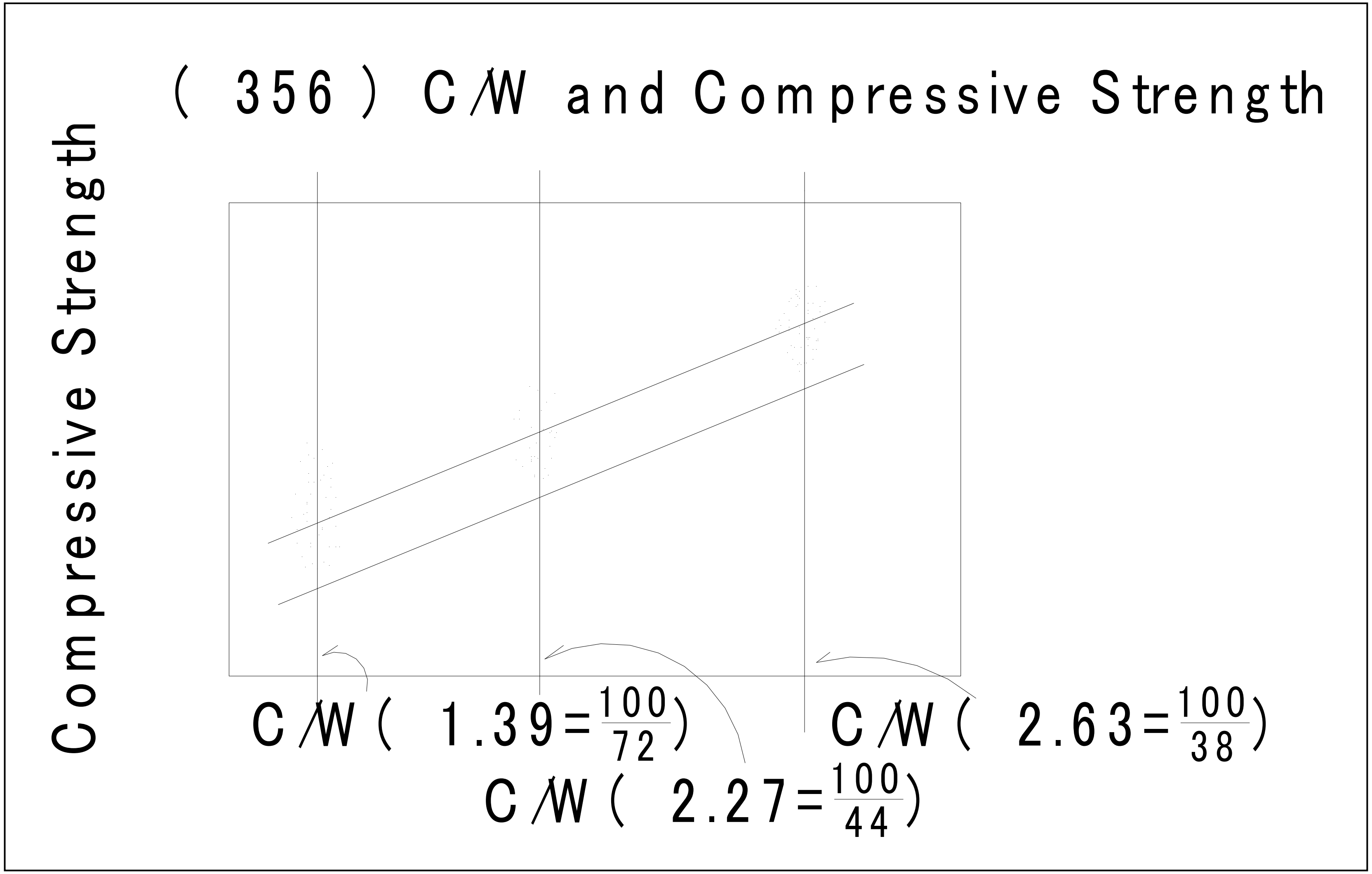
Slump 180+-25mm
Superplasticized Concrete

(355) Slump of Concrete after adding Water

(355) Slump of concrete after adding Water

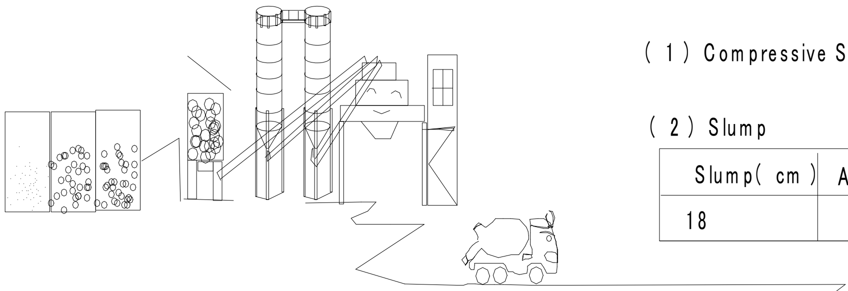


(356) C/W and Compressive Strength



(357) Concrete Test I

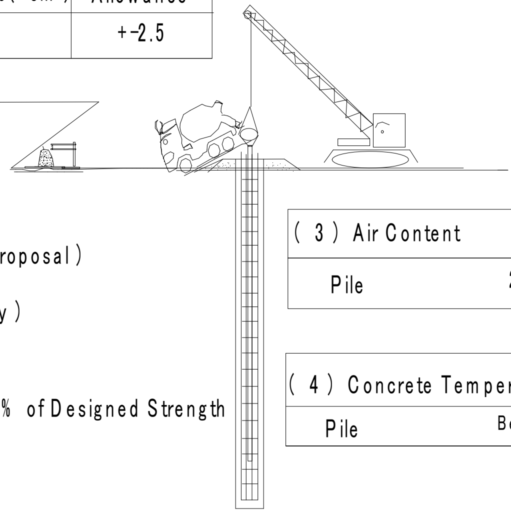
(357) Concrete Test I



(1) Compressive Strength M40 –(N/mm2)

(2) Slump

Slump(cm)	Allowance
18	+-2.5



(Sampling of Concrete – Concrete Volume per 50m3)

a) Sampling Test Pieces
Trial Pile–9 Pieces
σ7–3 Pieces
σ14–3 Pieces
σ28–3 Pieces

b) Sampling Test Pieces (Proposal)
Main Pile–9 Pieces (Before Concrete Stability)
σ7–3 Pieces
σ14–3 Pieces
σ28–3 Pieces

c) Sampling Test Pieces (Proposal)
Main Pile–6 Pieces (After Concrete Stability)
σ7–3 Pieces
If Compressive Strength >60% of Designed Strength
σ28–3 Pieces

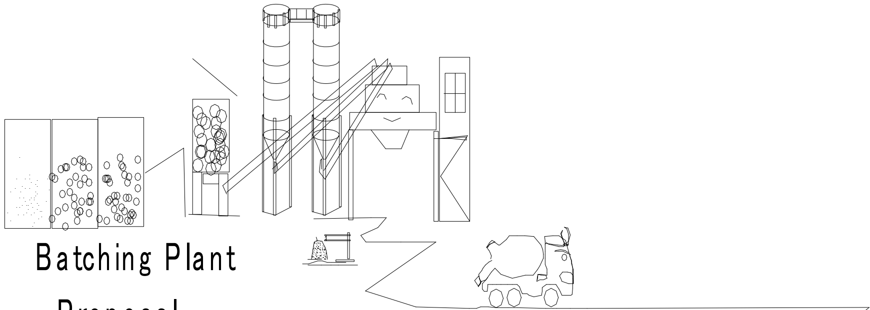
σ7–3 Pieces
If Compressive Strength <60% of Designed Strength
σ28–1 Piece
If Compressive Strength >Designed Strength
σ28–2 Pieces
σ28–1 Piece
If Compressive Strength <Designed Strength
σ56–2 Pieces

(3) Air Content	
Pile	2.0 %

(4) Concrete Temperature	
Pile	Below 32 Degree

(358) Concrete Test II

(358) Concrete Test II



Proposal

(a) Sampling 1 per 1 Pile

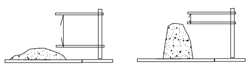
(Sampling of Concrete - Concrete Volume per 50m3)

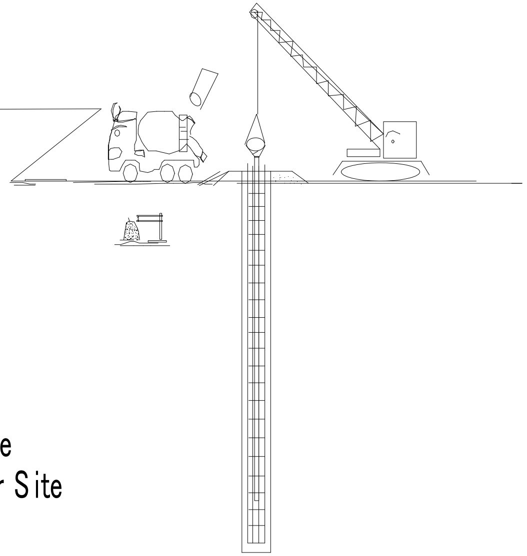
(b) Slump Test every Mixer Truck

(c) Slump Test at Batching Plant and Site

(d) Unloading within 60-90 minute's

(e) High Slump-Wait Low Slump-Add Admixture at Batching Plant or Site





(1) Compressive Strength M40 -(N/mm2)

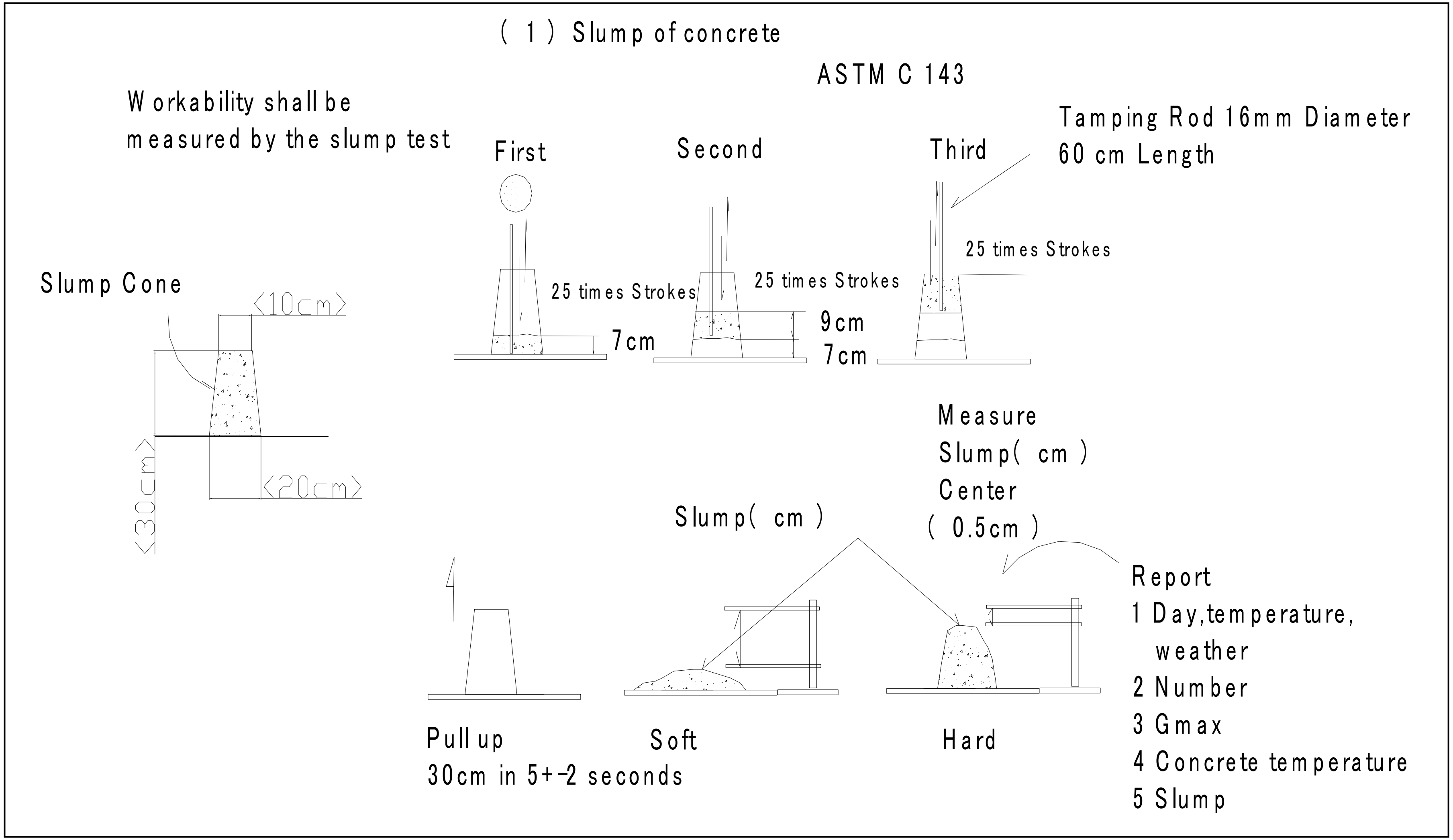
(2) Slump

Slump(cm)	Allowance
18	+-2.5

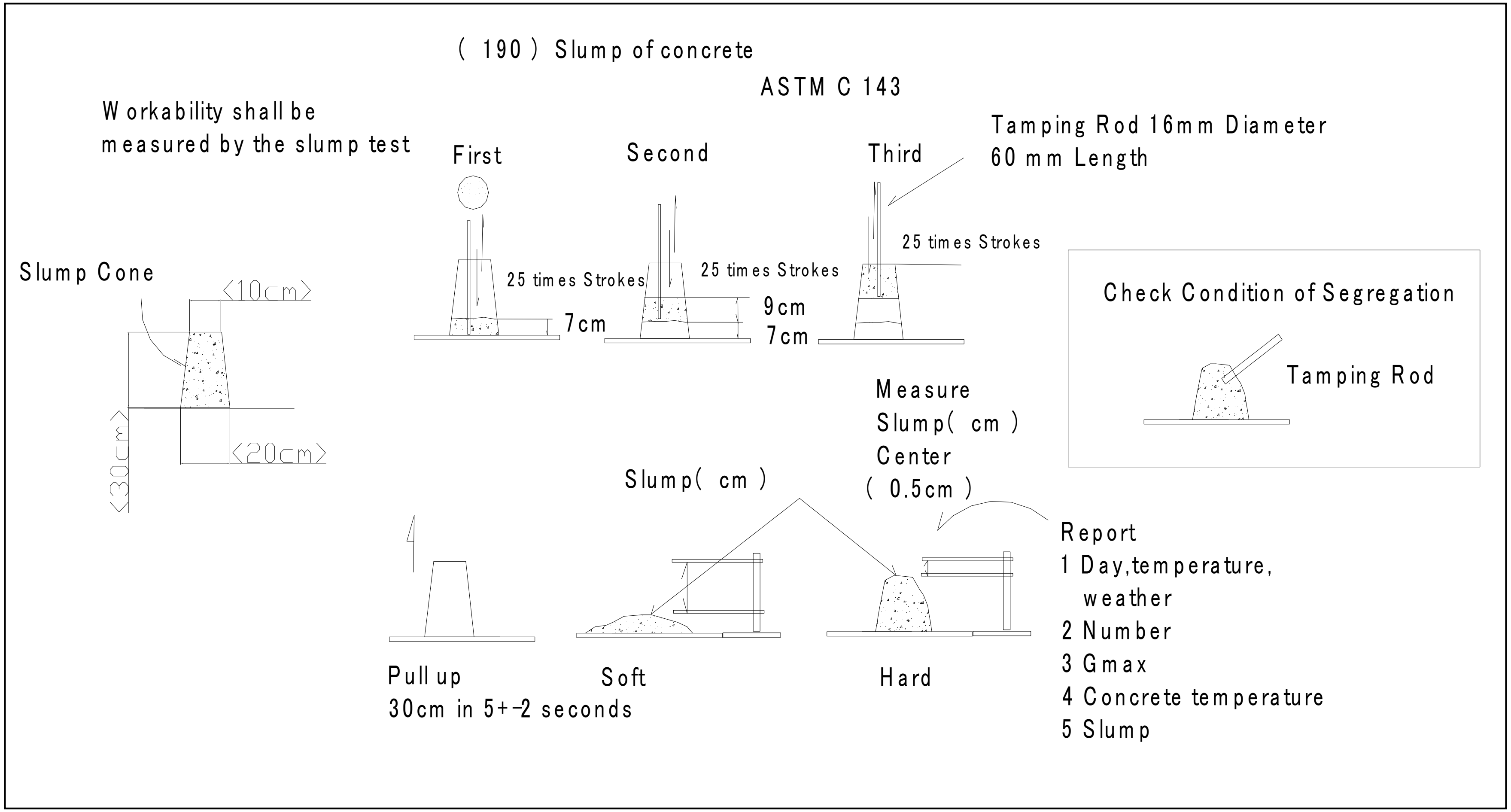
(3) Air Content
2.0 %

(4) Concrete Temperature
Below 32 Degree

(359)(1) Slump of Concrete



(360)(190) Slump of Concrete

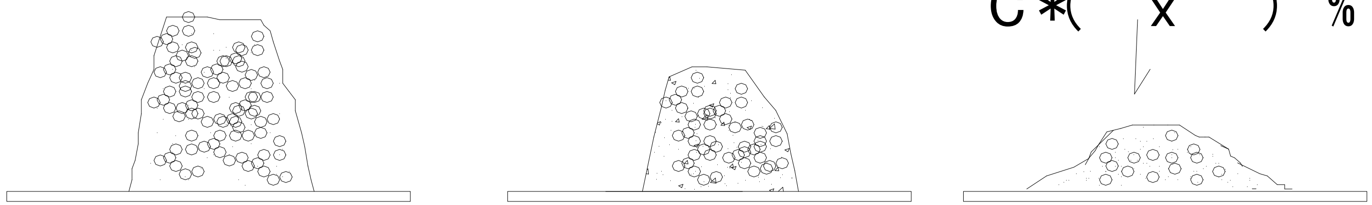


(361)(23)Fluidized Concrete

(23) Fluidized Concrete

Pumping Concrete   ACI-304R-36

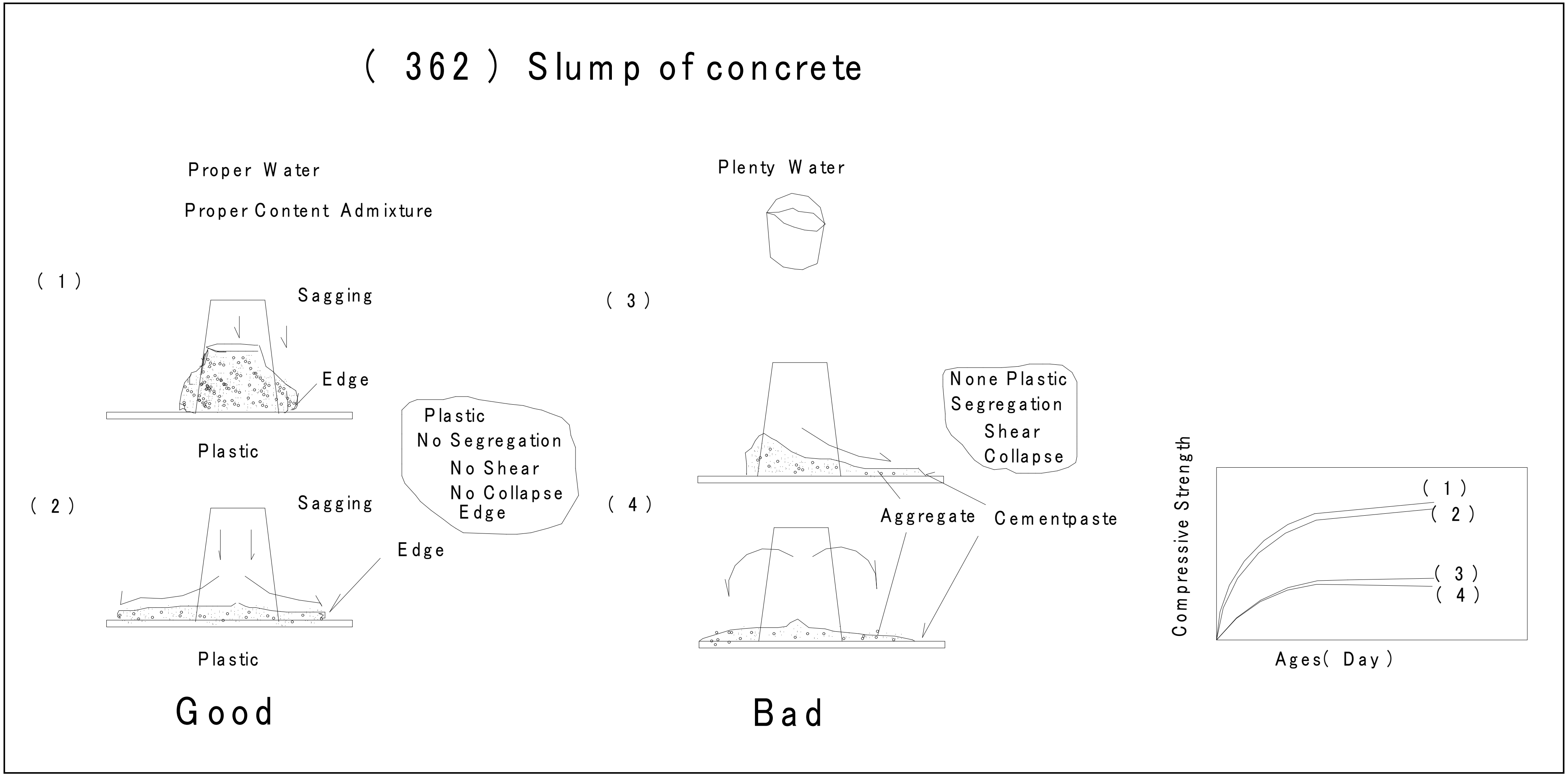
High Range Water
Reducing Agent:
Superplastilizer
C*(x) %



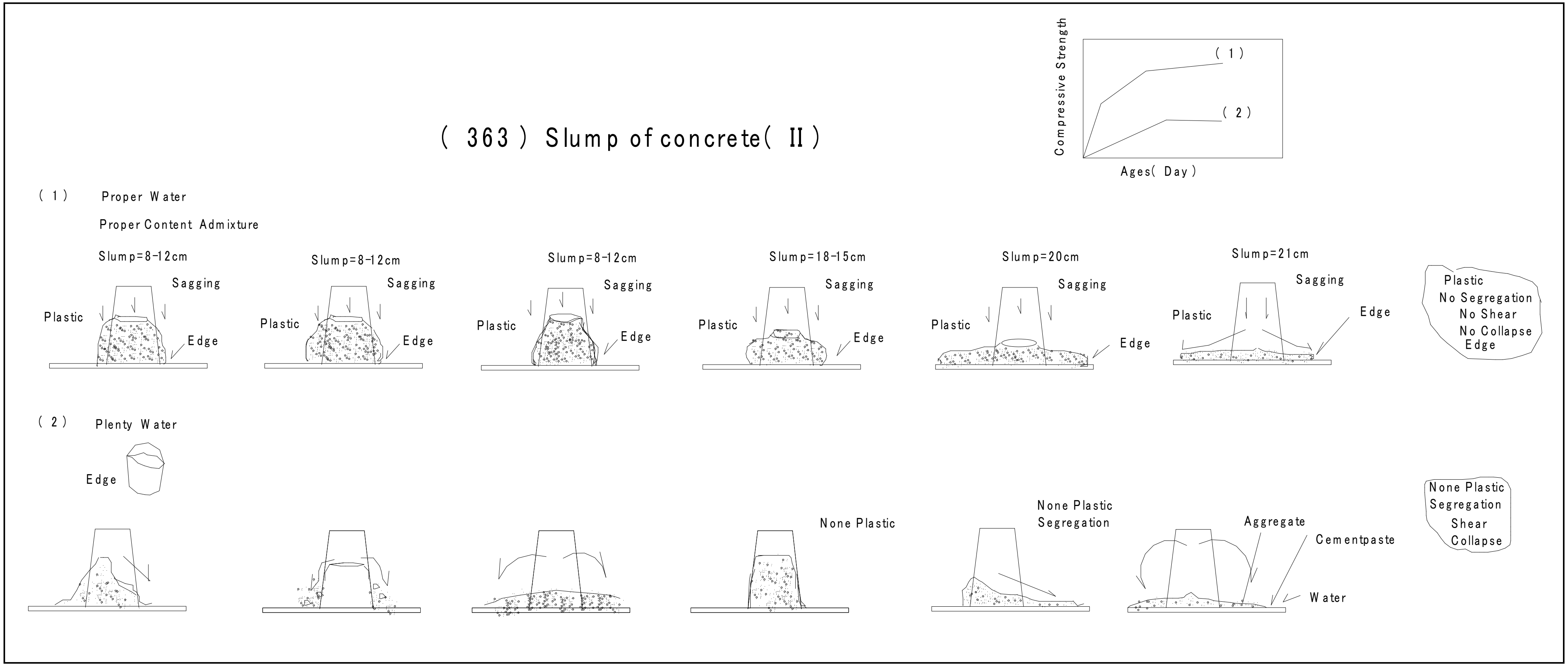
A	B	C
Slump 75+-25	Slump 100+-25	Slump 180+-25

Base Concrete (A, B)   Pumping Concrete (C)

(362) Slump of Concrete



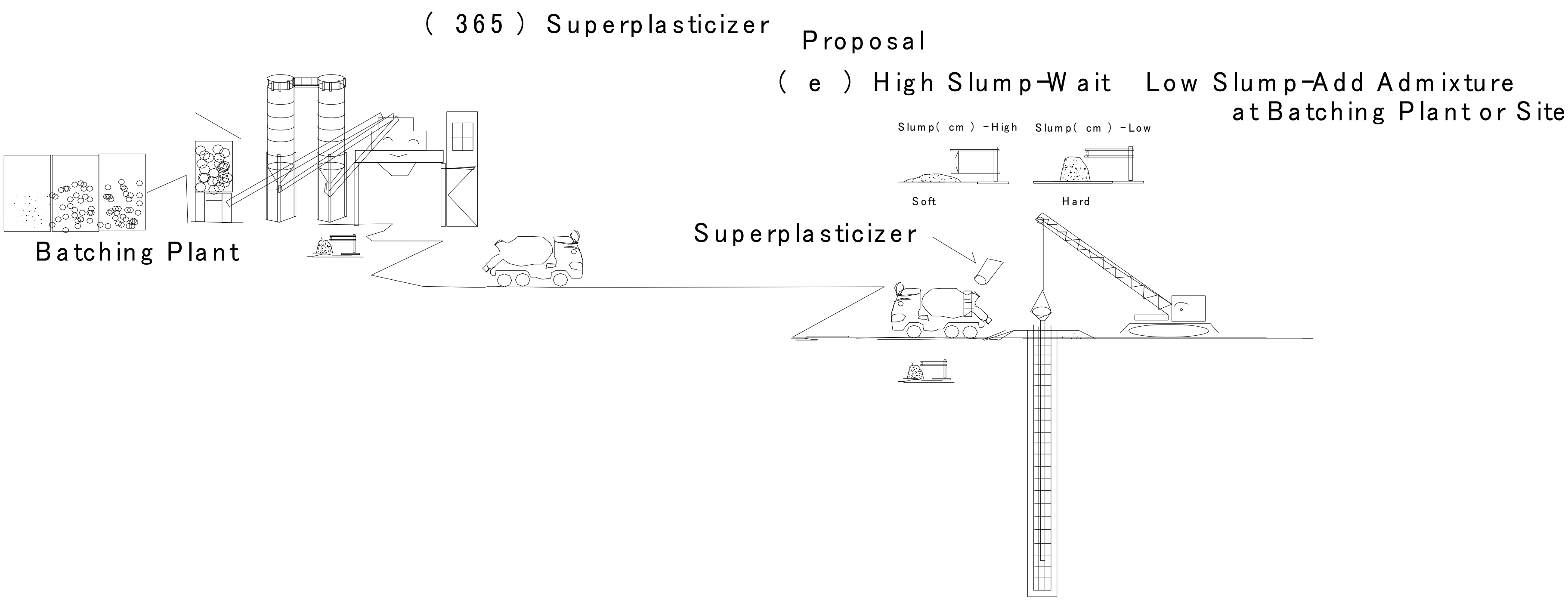
(363) Slump of Concrete (II)



(364)(382) Examples of Superplasticized Concrete(Base Concrete-/ Case of Japan

No	Purpose of Superplasticizer	Design Strength	Slump(Base Concrete)	Slump by Superplasticizer	sand percentage	Water	Cement	water cement ratio	Base Concrete Admixture	Superplasticizer	Remarks
			(SL)	(SL)	s/a	W	OPC	W/C			
		(N/mm2)	cm	cm	(%)	(Kg/m3)	(Kg/m3)	(%)	C*(%)		
1	W/c-decrease, workability-improve	21	12	22	49	179	320	56	AE Ajent	Superplasti	Base concrete -AE Concrete
2	Pumpability-Improve	23	19	23	50	191	398	48	AE Ajent	Superplasticizer	
3	Dry shrinkage, Cracks-Decrease	21	12	21	45	178	307	58	AE Ajent	Superplasticizer	
4	W/c-decrease, workability-improve	21	13	22	42	147	283	52	AE Ajent	Superplasticizer	
5	Dry shrinkage, Cracks-Decrease	21	12	21	45	156	285	55	AE Ajent	Superplasticizer	
6	Pumpability-Improve	30	8	16	40	153	340	45	AE Ajent	Superplasticizer	
7	Dry shrinkage, Cracks-Decrease	24	12	21	45	155	300	52	AE Ajent	Superplasticizer	
8	Dry shrinkage, Cracks-Decrease	21	12	18	47	160	276	58	AE Ajent	Superplasticizer	
9	Recovery Slump Loss	21	16	18	43	169	311	54	AE Ajent	Superplasticizer	
10	Workability-improve	21	15	18	46	174	348	50	AE Ajent	Superplasticizer	
11	Hyration Heat-Decrease,Protection Crack	24	8	18	48	166	281	59	AE Ajent	Superplasticizer	
12	Bleeding-Decrease,Protect Cracks	21	12	21	47	168	307	55	AE Ajent	Superplasticizer	
13	Bleeding-Decrease,Protect Cracks	21	12	21	46	163	304	54	AE Ajent	Superplasticizer	
14	Protect Cracks	21	15	21	48	188	355	53	AE Ajent	Superplasticizer	
15	Bleeding-Decrease	26	15	21	44	172	380	45	AE Water Re	Superplasticizer	
16	Protect Cracks,Workability-Improve	21	12	21	44	162	304	53	AE Water Re	Superplasticizer	
17	Hyration Heat-Decrease,Protection Crack	24	12	21	44	161	326	49	AE Ajent	Superplasticizer	
18	Protect Cracks,Workability-Improve	30	12	21	46	187	390	48	AE Water Re	Superplasticizer	
19	Protect Cracks,Workability-Improve	27	15	19	44	183	359	51	AE Water Re	Superplasticizer	
20	Protect Cracks,Workability-Improve	27	12	19	43	170	340	50	AE Water Re	Superplasticizer	
21	Pumpability-Improve,W-Decrease	21	18	21	52	178	349	51	AE Ajent	Superplasticizer	
22	Protect Cracks,Workability-Improve	23	15	21	45	166	335	50	AE Water Re	Superplasticizer	
23	Protect Cracks,Workability-Improve	27	12	20	46	180	328	55	AE Ajent	Superplasticizer	

(365)Superplasticizer (Additive)

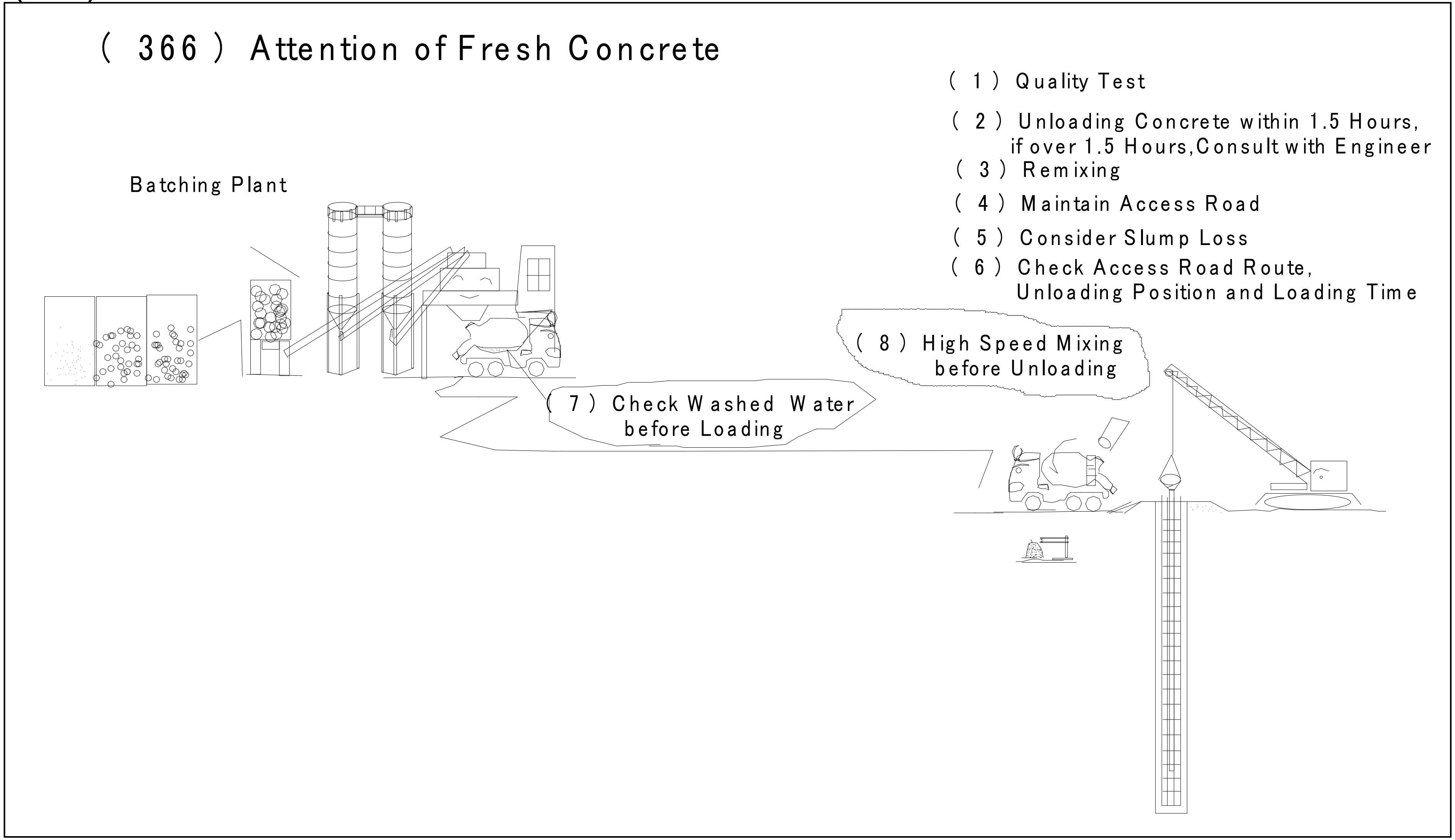


Mixer Truck

Slump (cm)	+3	+6	+9	+12	+15	+18
Volume(m3)	0.10%	0.20%	0.30%	0.40%	0.50%	0.60%
6	2.8	5.6	8.5	11.3	14.1	16.9
5	2.4	4.7	7.1	9.4	11.8	14.1
4	1.9	3.8	5.6	7.5	9.4	11.3
3	1.4	2.8	4.2	5.6	7.1	8.5
2	0.9	1.9	2.8	3.8	4.7	5.6
1	0.5	0.9	1.4	1.9	2.4	2.8

(Unit:L)

(366) Attention of Fresh Concrete



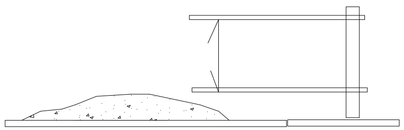
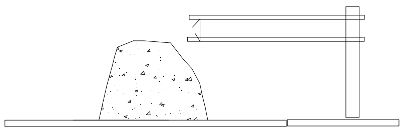
(367)(60)(82) Slump

(60) Consistency

ASTM C 143

Consistency Measured by Slump

Consistency-Workability

Slump(cm) -High	Slump(cm) -Low
	
Soft	Hard

(82) ACI 211.1 Mix Proportion Step

(9-1) Adjustment of Trial Batch

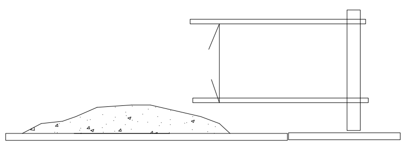
Slump-Water Content

Slump 1cm Increase or Decrease

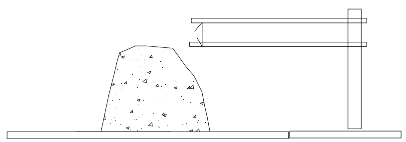
Water 2kg/m3 per Concrete Volume 1m3

Decrese or Increse

Slump(cm)

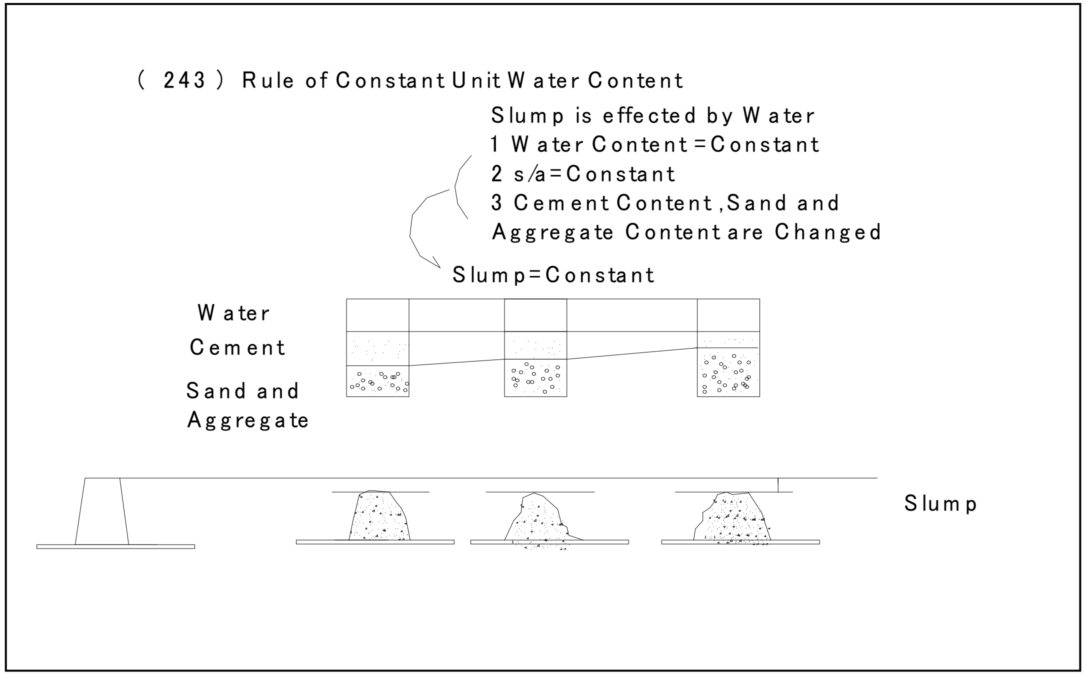


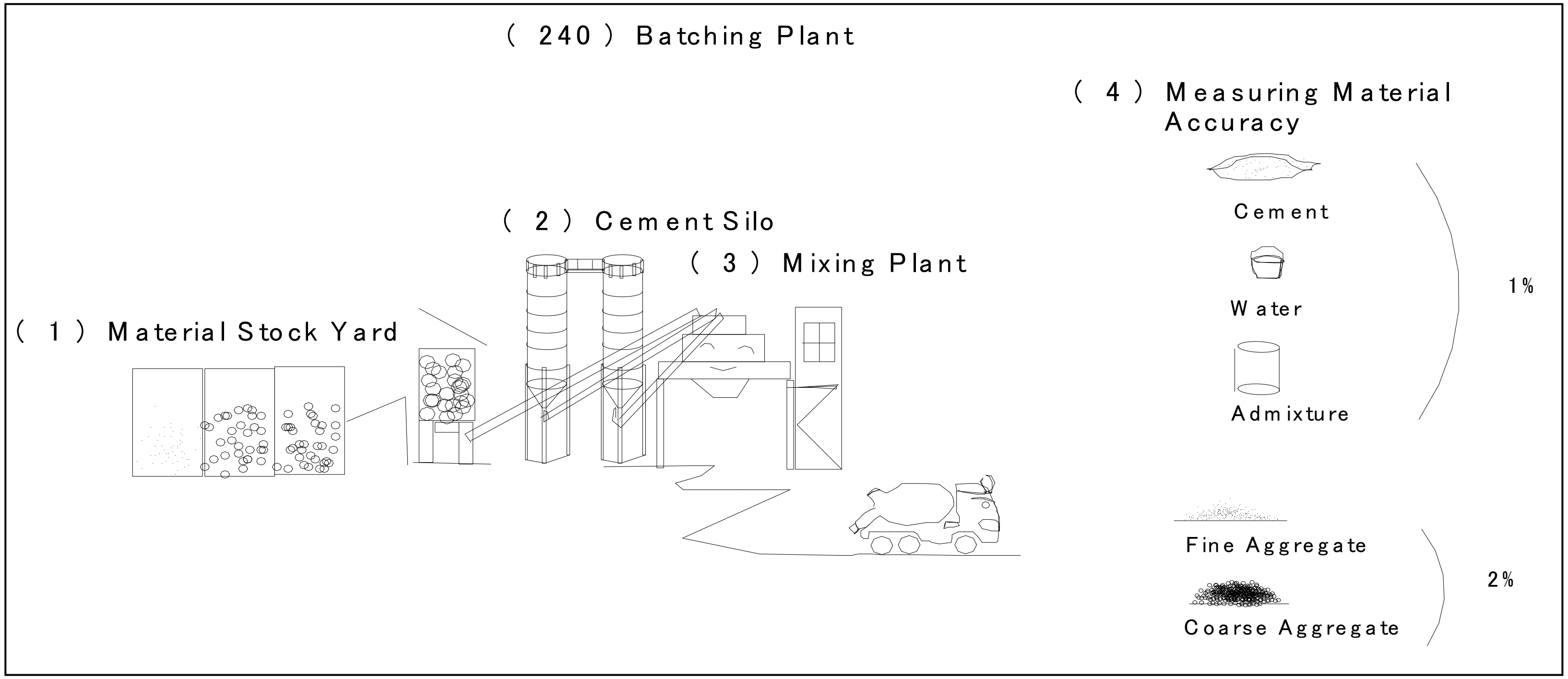
Soft



Hard

(368)(243)Slump





(369)(8) Concrete Delivery Slip

(369) (8) Concrete Delivery Slip

Company

SLIP NO

DATE

REQUESTER:

(NO 1,NO 2) BATCHING PLANT

ORDER SHEET NO:

TRUCK NO:

MANUFACTURE COMPANY:

LOCATION

STRUCURE:

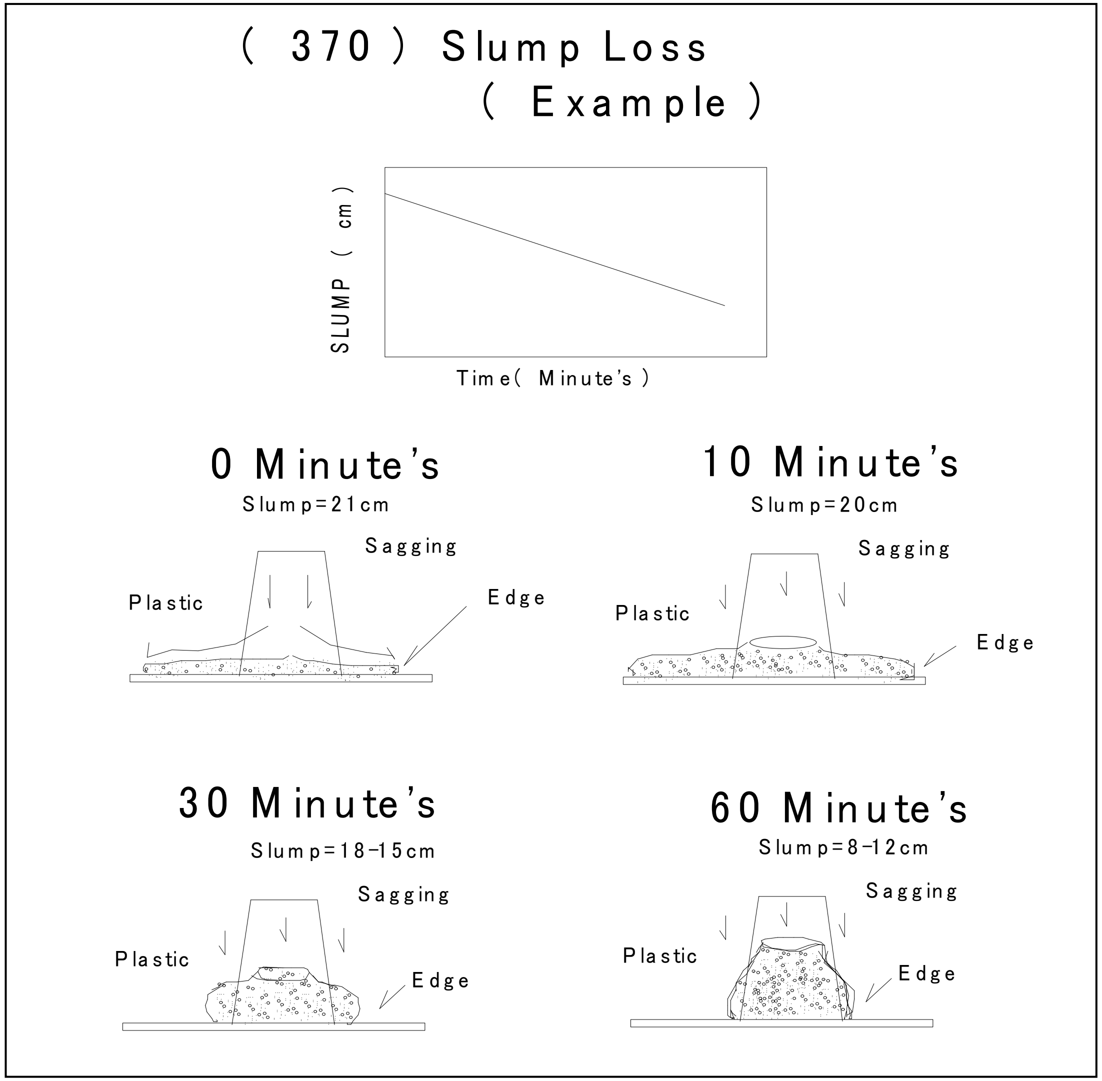
CONCRETE MIXING TYPE	DESIGN STRENGTH	MAX SIZE AGGREGATE	W /C	AIR CONTENT	TOTAL ORDER
	(M)	(mm)	(%)	(%)	(m3)

Slump (at BP)	CONCRETE TEMPERA TURE (at BP)	QUANTITY THIS LOAD	QUANTITY CUMULA TIVE	TIME RECORD		
				Delivery BATCH TIVE	POURING	
					START	FINISH
(mm)	(degree)	(m3)	(m3)			

Slump (at Site)	CONCRETE TEMPERA TURE (at Site)	REMARKS
(mm)	(degree)	

REMARKS	REMARKS	REMARKS
BATCHING PLANT	NAME: SUBCONTRACTOR	INSPECTOR/KJP

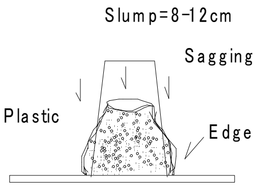
(370) Slump Loss



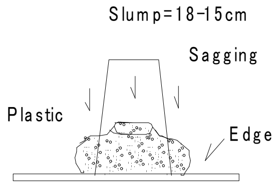
(371) Slump after Pouring Superplasticizer

(371) Slump after Pouring Superplasticizer
(Example)

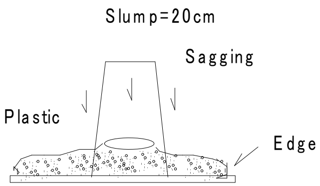
(1) Base Concrete
No Superplasticizer



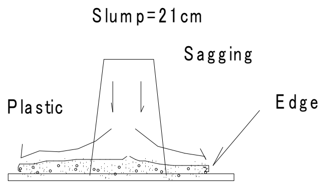
(2) Superplasticizer
C*0.3%



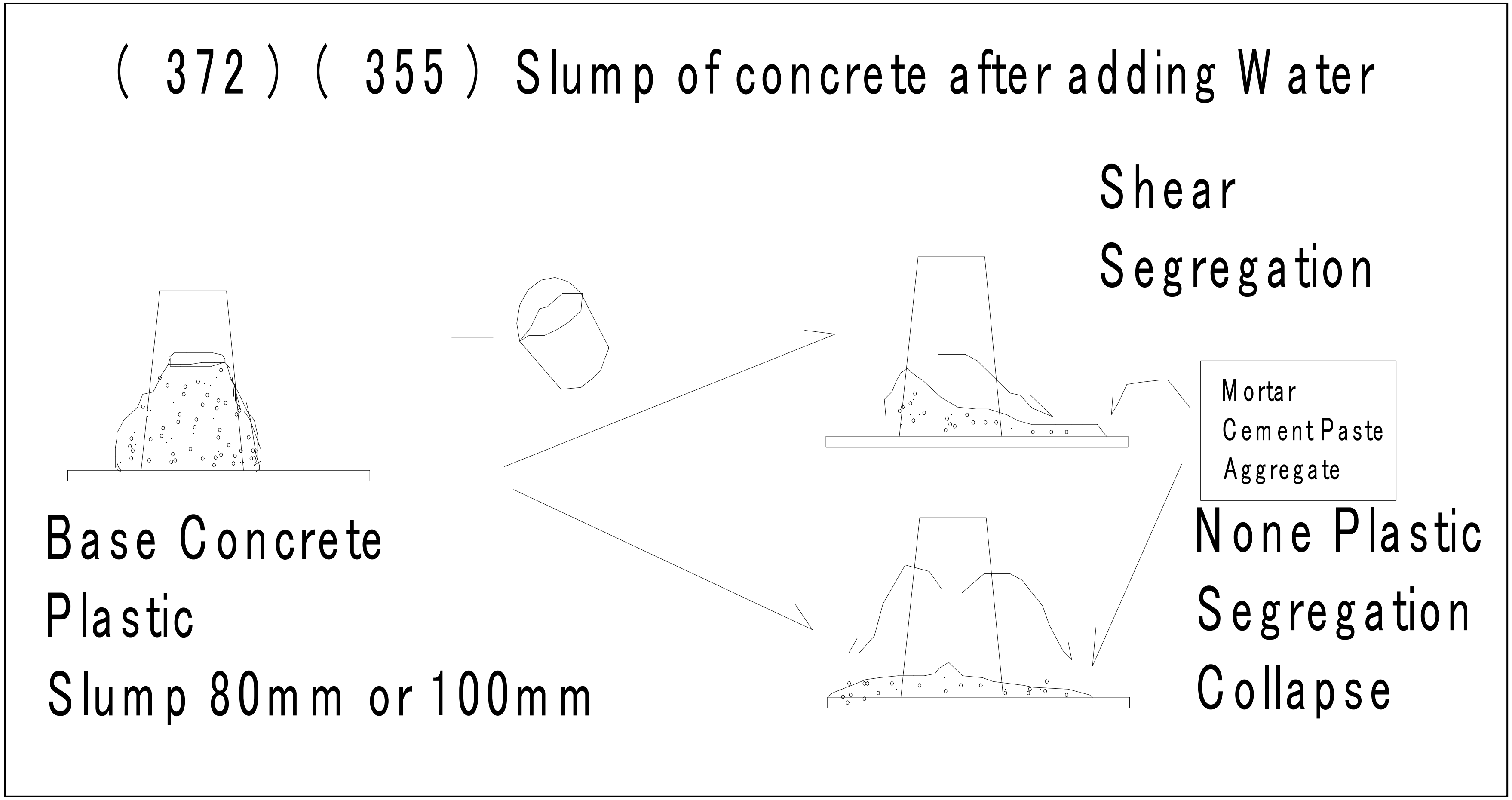
(3) Superplasticizer
C*0.6%



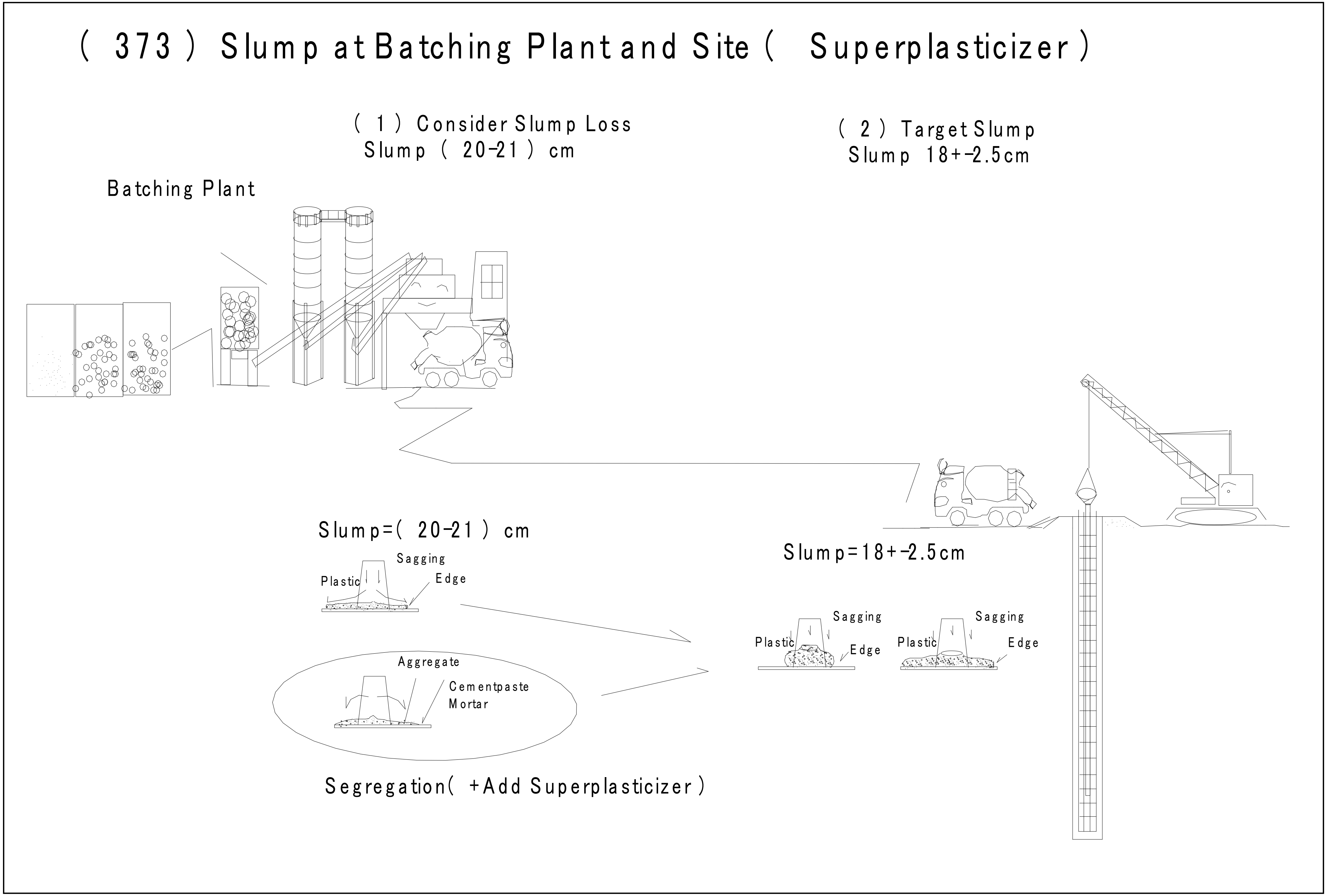
(4) Superplasticizer
C*0.8%



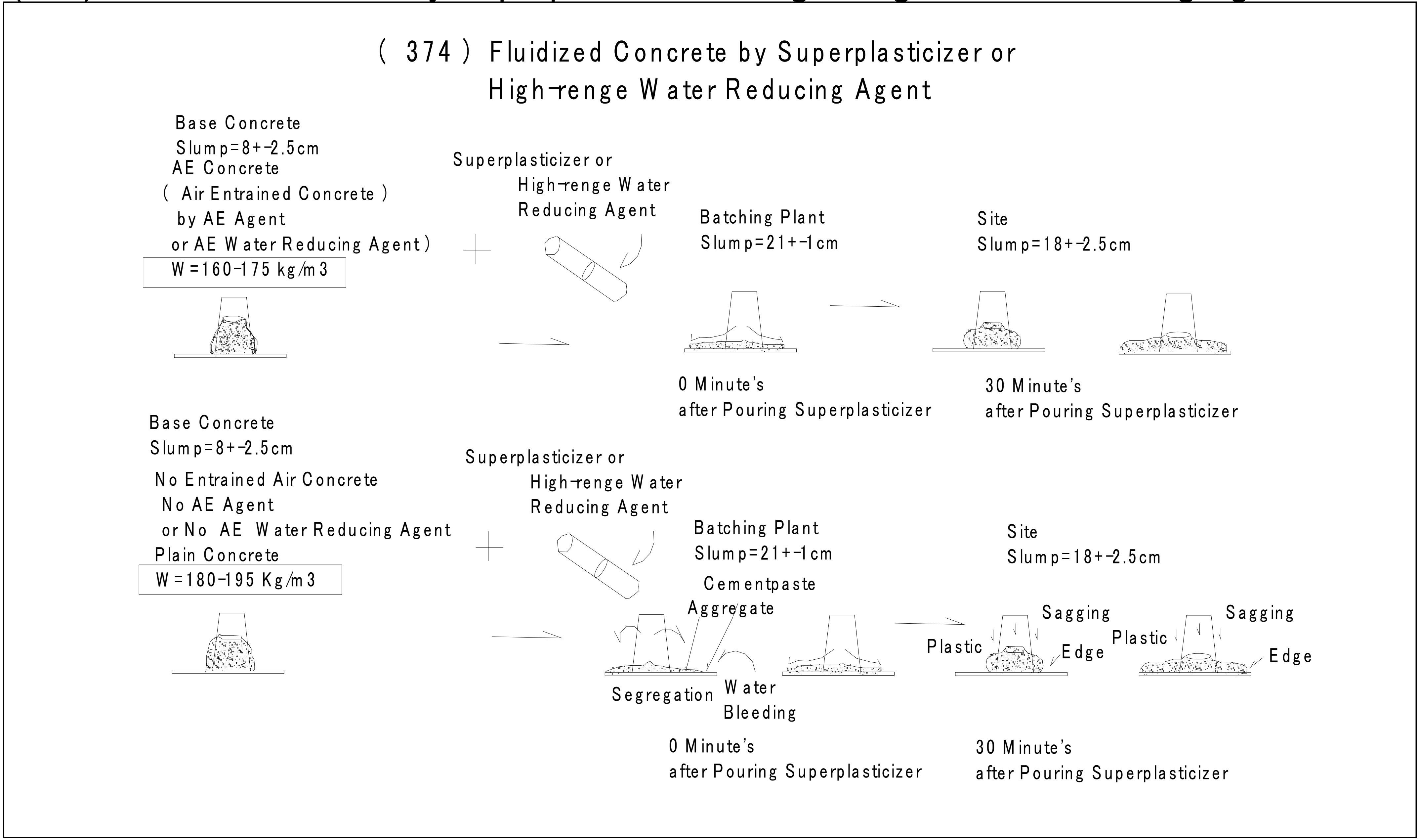
(372)(355) Slump of Concrete after adding Water



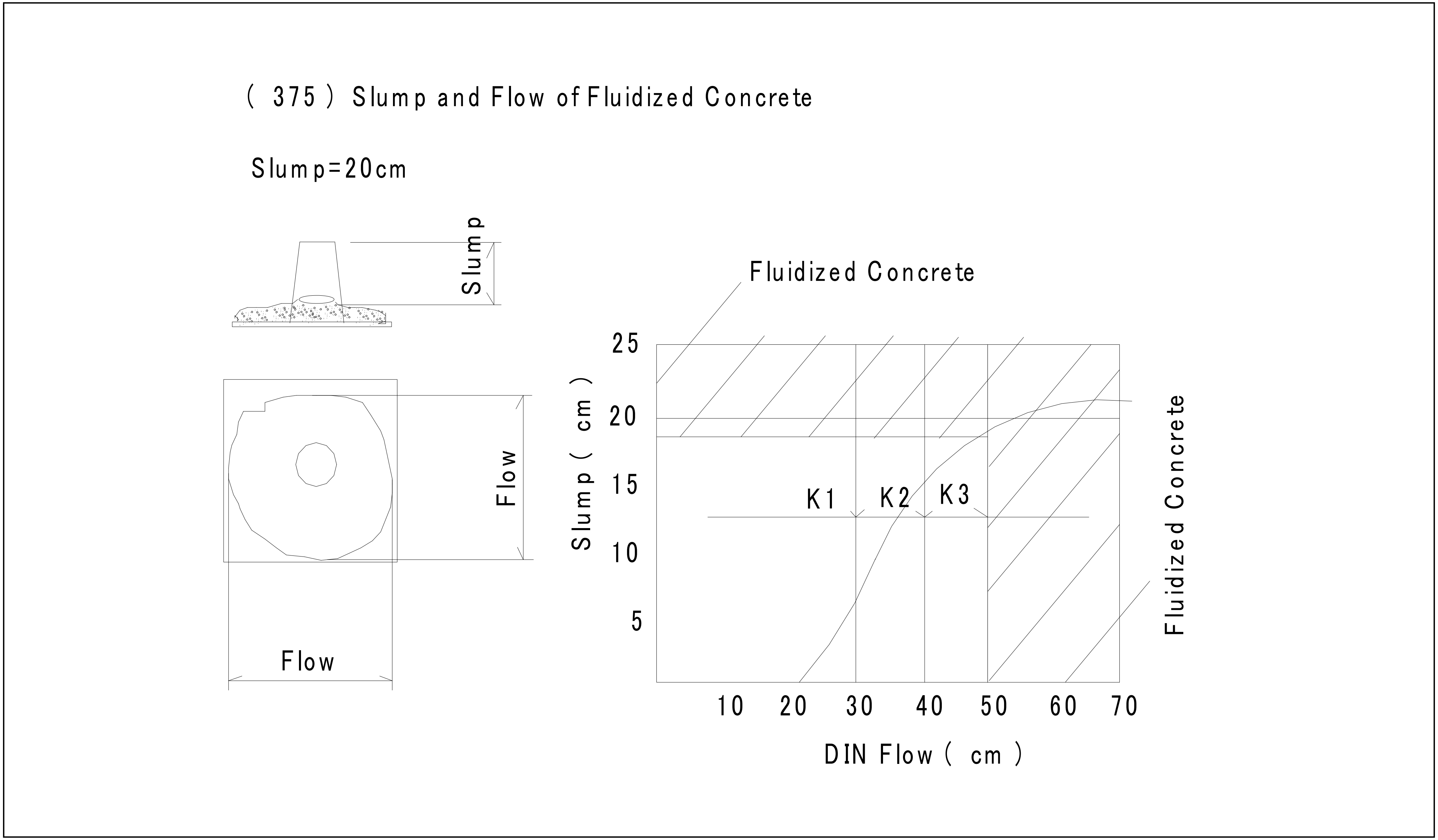
(373) Slump at Batching Plant and Site (Superplasticizer)



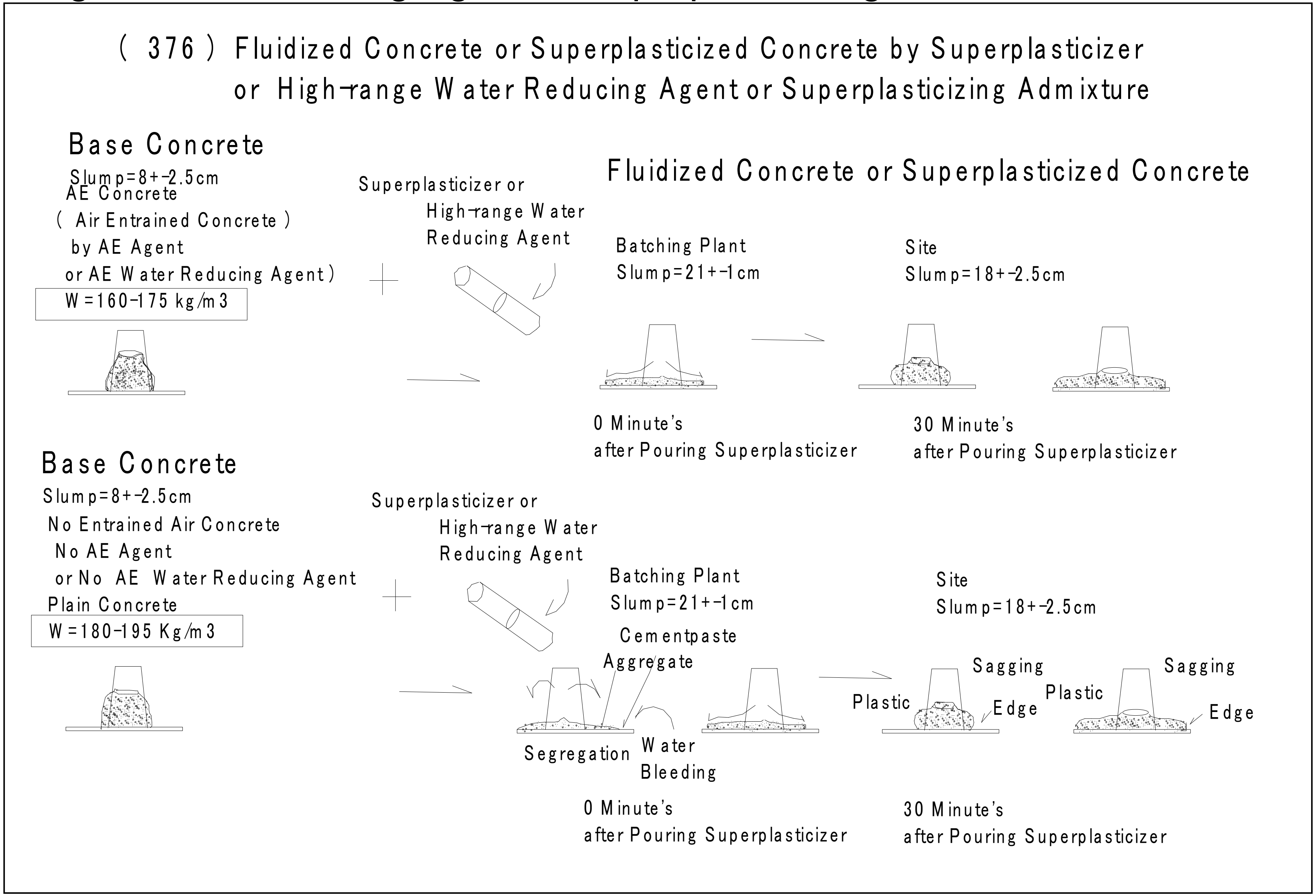
(374) Fluidized Concrete by Superplasticizer or High-range Water Reducing Agent



(375) Slump and Flow of Fluidized Concrete

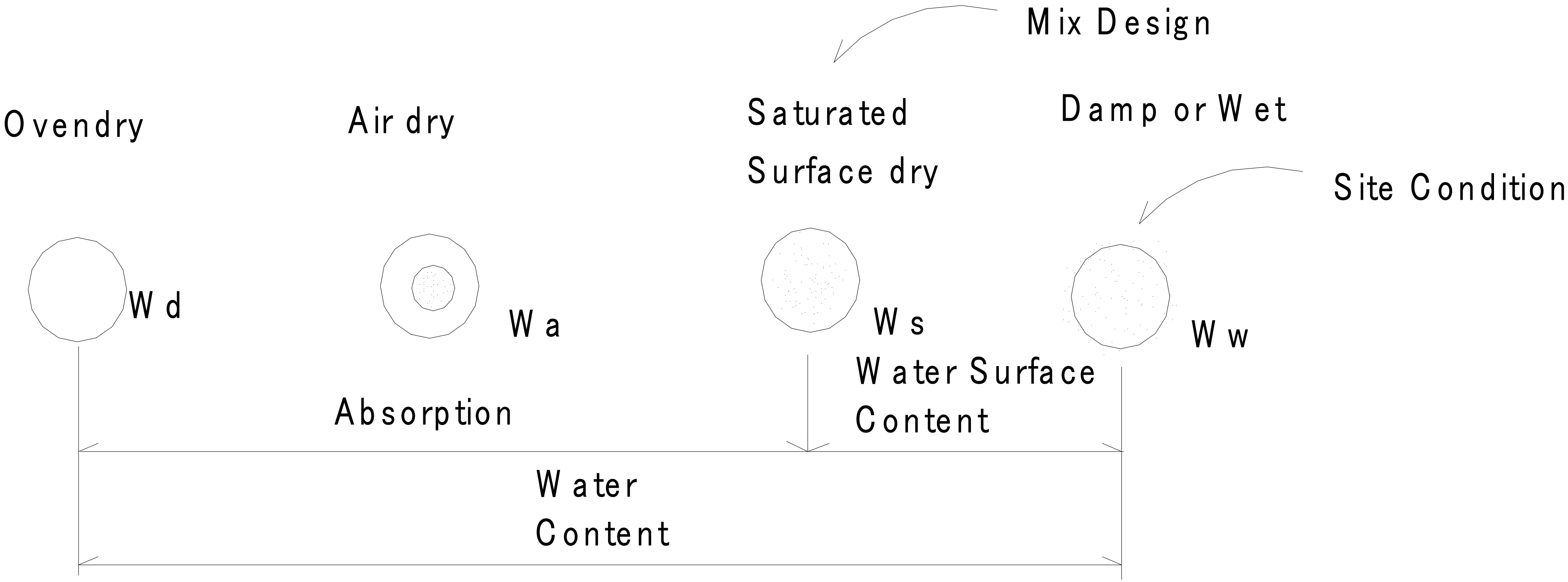


(376) Fluidized Concrete or Superplasticized Concrete by Superplasticizer or High-range Water Reducing Agent or Superplasticizing Admixture



377-(151) Water Content of Aggregate

377-(151) Water Content of Aggregate



Water Surface Content Ratio =((Ww-Ws)/Ws)*100

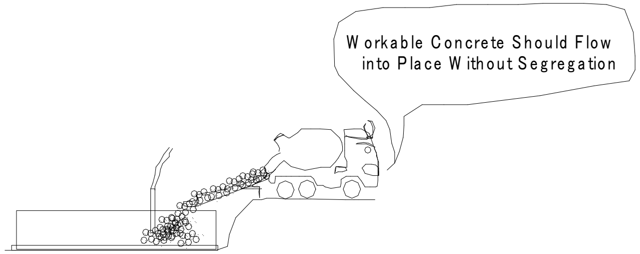
Specific Gravity (S.S.D) =Ws/Wd

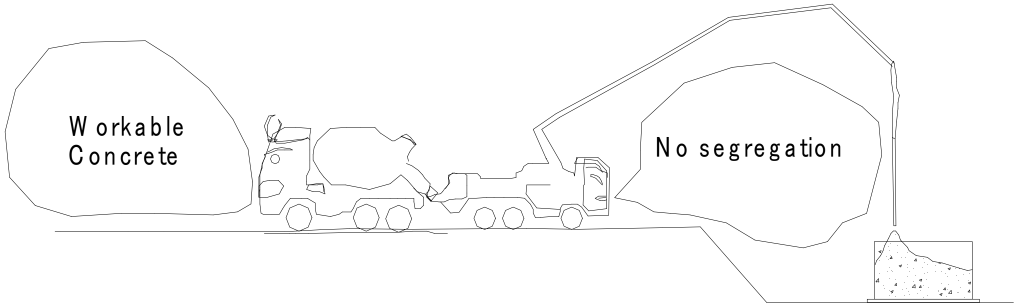
Absorption Ratio =((Ws-Wd)/Wd)*100

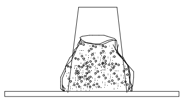
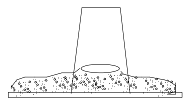
Moisture Content Ratio =((Ww-Wd)/Wd)*100

(378) Purpose of Superplasticized Concrete

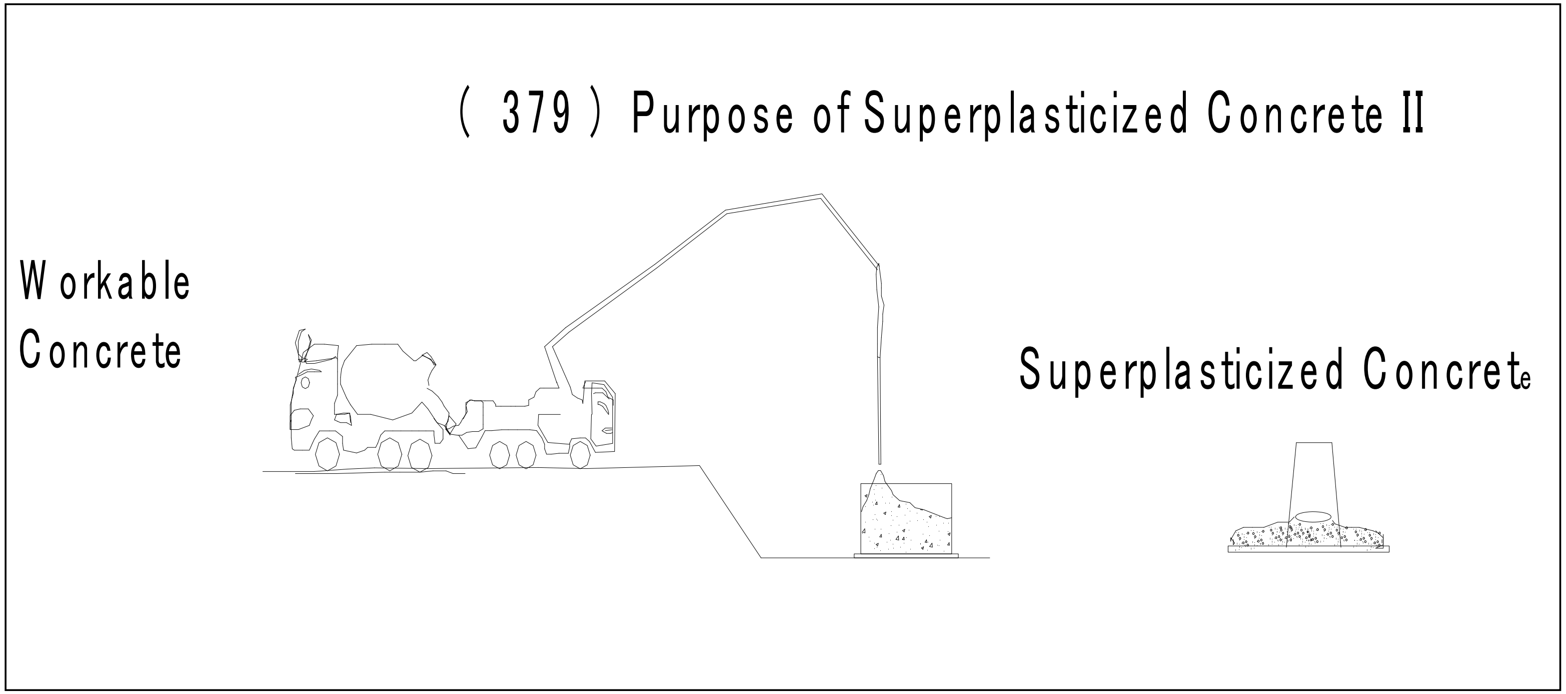
(378) Purpose of Superplasticized Concrete





Concrete of Dry Consistency		Superplasticized Concrete
		
16m3/h	Concreting Velocity	35m3/h
6 Persons	Concreting Worker	4 Persons

(379) Purpose of Superplasticized Concrete II

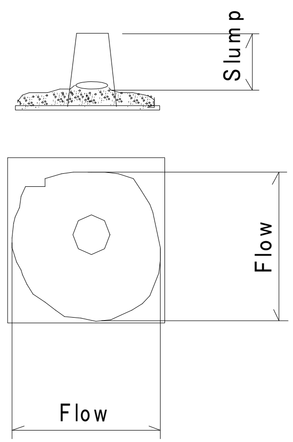


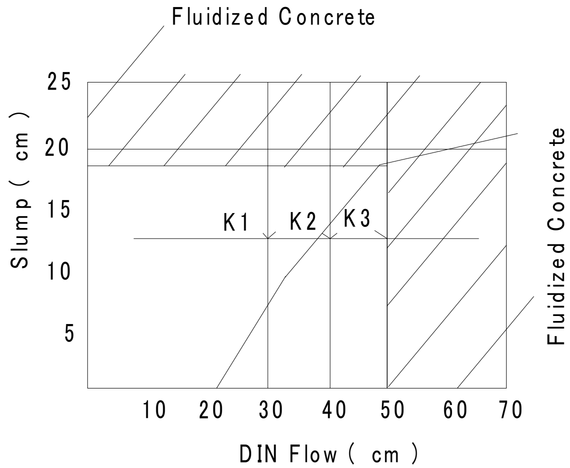
1 Water Content	Decrease	
2 Cement Content	Decrease	
3 Dry Shrinkage	Decrease	Protection Cracks
4 Initial Strength	Increase	Shorten period Formwork Removal
5 Strength of Concrete	High	
6 Hydration Heat	Decrease	
7 Bleeding	Decrease	Protection Setting
8 Watertightness	Improve	
9 Durability	Improve	
10 Bond Strength of Reinforcement Bar	Improve	
11 Pumpability	Improve	
12 Workability (Concreting Compaction)	Improve	
13 Finishability	Improve	

(380) Specification of Superplasticized Concrete I

(380) Specification of Superplasticized Concrete I

Case of German





K1(Hard) :Flow Value (DIN) below 30cm

K2(Plastic) :Flow Value (DIN) 31-40cm

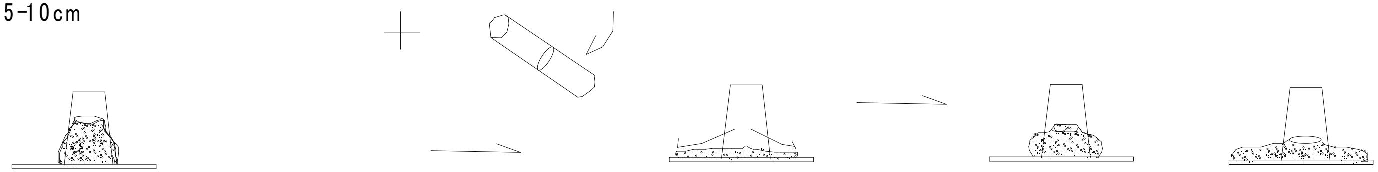
K3(Soft) :Flow Value (DIN) 41-50cm

Plastic
Workabilty
No Segregation

Case of German
Base Concrete
Flow Value(DIN) 38-42cm
Slump 5-10cm

Superplasticizer or
High-range Water
Reducing Agent

Superplasticized Concrete
Flow Value(DIN) 56-60cm
Slump 20+-2cm



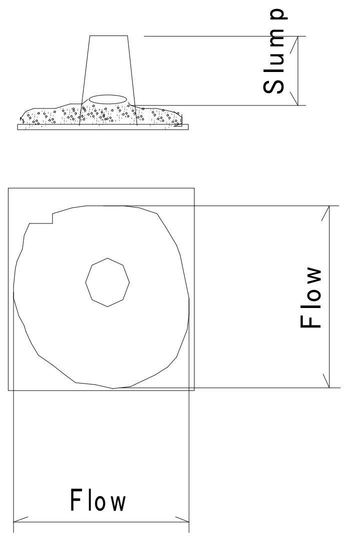
0 Minute's
after Pouring Superplasticizer

30 Minute's
after Pouring Superplasticizer

(381) Specification of Superplasticized Concrete II

(381) Specification of Superplasticized Concrete II

Case of British

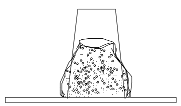


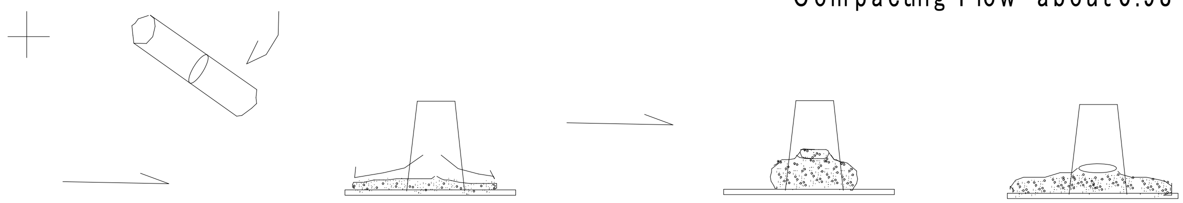
Plastic
Workabilty
No Segregation
No Bleeding
No Abnormal Setting
No Abnormal Air Coontent

Case of British
Base Concrete
Flow Value(DIN) 38-42cm
Slump 5-10cm

Superplasticizer or
High-range Water
Reducing Agent

Superplasticized Concrete
Flow Value(DIN) 51-62cm
Slump Over 20cm
Compacting Flow about 0.98





0 Minute's
after Pouring Superplasticizer

30 Minute's
after Pouring Superplasticizer

(382) Examples of Superplasticized Concrete(Base Concrete-AE C Case of Japan

No	Purpose of Superplasticizer	Design Strength	Slump(Base Concrete)	Slump by Superplasticizer	sand percentage	Water	Cement	water cement ratio	Base Concrete Admixture	Superplasticizer	Remarks
			(SL)	(SL)	s/a	W	OPC	W/C			
		(N/mm2)	cm	cm	(%)	(Kg/m3)	(Kg/m3)	(%)	C*(%)		
1	W/c-decrease, workability-improve	21	12	22	49	179	320	56	AE Ajent	Superplasticizer	Base concrete-AE Concrete
2	Pumpability-Improve	23	19	23	50	191	398	48	AE Ajent	Superplasticizer	
3	Dry shrinkage, Cracks-Decrease	21	12	21	45	178	307	58	AE Ajent	Superplasticizer	
4	W/c-decrease, workability-improve	21	13	22	42	147	283	52	AE Ajent	Superplasticizer	
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7	Dry shrinkage, Cracks-Decrease	24	12	21	45	155	300	52	AE Ajent	Superplasticizer	
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9	Recovery Slump Loss	21	16	18	43	169	311	54	AE Ajent	Superplasticizer	
10	Workability-improve	21	15	18	46	174	348	50	AE Ajent	Superplasticizer	
11	Hyration Heat-Decrease,Protection Cra	24	8	18	48	166	281	59	AE Ajent	Superplasticizer	
12	Bleeding-Decrease,Protect Cracks	21	12	21	47	168	307	55	AE Ajent	Superplasticizer	
13	Bleeding-Decrease,Protect Cracks	21	12	21	46	163	304	54	AE Ajent	Superplasticizer	
14	Protect Cracks	21	15	21	48	188	355	53	AE Ajent	Superplasticizer	
15	Bleeding-Decrease	26	15	21	44	172	380	45	AE Water Reducing	Superplasticizer	
16	Protect Cracks,Workability-Improve	21	12	21	44	162	304	53	AE Water Reducing	Superplasticizer	
17	Hyration Heat-Decrease,Protection Cra	24	12	21	44	161	326	49	AE Ajent	Superplasticizer	
18	Protect Cracks,Workability-Improve	30	12	21	46	187	390	48	AE Water Reducing	Superplasticizer	
19	Protect Cracks,Workability-Improve	27	15	19	44	183	359	51	AE Water Reducing	Superplasticizer	
20	Protect Cracks,Workability-Improve	27	12	19	43	170	340	50	AE Water Reducing	Superplasticizer	
21	Pumpability-Improve,W-Decrease	21	18	21	52	178	349	51	AE Ajent	Superplasticizer	
22	Protect Cracks,Workability-Improve	23	15	21	45	166	335	50	AE Water Reducing	Superplasticizer	
23	Protect Cracks,Workability-Improve	27	12	20	46	180	328	55	AE Ajent	Superplasticizer	
24	Workability-Improve	21	15	18	45	190	333	57	AE Ajent	Superplasticizer	
25	Workability-Improve	21	15	21	47	161	275	59	AE Water Reducing	Superplasticizer	
26	Workability-Improve	27	14	21	48	181	348	52	AE Water Reducing	Superplasticizer	
27	Protect Cracks,Workability-Improve	21	15	21	46	163	281	58	AE Water Reducing	Superplasticizer	
28	Protect Cracks,Workability-Improve	35	12	18	39	178	434	41	AE Water Reducing	Superplasticizer	
29	Workability-Improve	35	15	21	48	185	456	41	AE Ajent	Superplasticizer	
30	Protect Cracks,Workability-Improve	21	15	21	47	161	284	57	AE Water Reducing	Superplasticizer	
31	Water Content-Decrease	21	18	21	46	173	298	58	AE Water Reducing	Superplasticizer	
32	Protect Cracks,Workability-Improve	26	15	20	46	185	370	50	AE Ajent	Superplasticizer	
33	Protect Cracks,Workability-Improve	21	15	18	49	185	300	62	AE Ajent	Superplasticizer	
34	Protect Cracks,Workability-Improve	37	12	21	46	180	383	47	AE Ajent	Superplasticizer	

(383) Water Content Case of Japan

(3) Calculate Unit Water Content(W)

221 Unit Water and Sand Percentage of Concrete

River Sand,River Gravel,W/C=55%,Slump=5cm,FM=2.75

Maximum Size of Aggregat	No Admixture			AE Concrete				
					Good Quality AE Agent		Good Quality Water Reducing Agent	
	Entrapped Air	Sand Percentage	Unit Water of Concrete	Air Content(Strict Weather)	Sand Percentage	Unit Water of Concrete	Sand Percentage	Unit Water of Concrete
(mm)	(%)	(%)	(kg)	(%)	(%)	(kg)	(%)	(kg)
15	2.5	49	187	7	46	169	47	156
20	2	45	181	6	42	162	43	150
25	1.5	41	172	5	37	153	38	143
40	1.2	36	160	4.5	33	141	34	131
50	1	33	152	4	30	131	31	122
80	0.5	31	139	3.5	28	117	28.5	109
150	0.3	28	120	3	24	100	24	93

(4) Calculate s/a

222 Correction River Sand,River Gravel,W/C=55%,Slump=5cm,FM=2.75

Section	Correction of (s/a)%	Correction of (W)kg
FM of Sand(0.1 Bigger)	Increase 0.5	No Correction
W/C(0.05 Bigger)	Increase 1	No Correction
Slump(2.5cm Bigger)	No Correction	Increase 3%
Air Content(1% Bigger)	Decrease(0.5-1)	Decrease(3)%
Crushed Stone	Increase 3-5	Increase 7-10%
Concrete Pavement	Decrease(3)	Decrease(3%)

(384) 252 Concrete Mix Proportion Design Case of Japan

252 Concrete Mix Proportion Design
(1) σck=16N/mm2
(2) C/W-σ σ28=21+21.5*(C/W)
(3) Structure Section
(4) Material
(5) Construction Control Field Mix
(6) s/a and W

Cement	Normal Portland Cement
Sand	Fineness Modulus(F.M)=2.75
	Specific Gravity=2.62
Gravel	Maximum Size of Aggregate 50mm
	Specific Gravity=2.65

Mix Proportion Calculation
(1) W/C
a) W/C-Compressive Strength
1) Extra Co-efficient(a) (a)=1.18
Fluctuation Modulus (V)=15-20% (V)=20%
2) Required Strength(σr)
(σr)=16*1.18=-21+21.5(C/W)
(W/C)=54%
b) Durability
220 W/C and Durability

Weather Condition	Strict Weather			Not Strict Weather		
Section	Thin	Normal	Thick	Thin	Normal	Thick
Under Water	55(50)	60(55)	60(55)	55(50)	65(60)	65(60)
Normal	60(55)	65(60)	65(60)	60(55)	70(65)	70(65)
Dam Concrete	60			65		

Weather Condition	Strict Weather,A Lot of Freezin	A Fewoof Freezing and Thawing Action
Paving Concrete	45	50

(W/C)=65%
c) Selection of W/C
(W/C)=54% Adapt Smaller (W/C)

(2) Decide Slump and Maximum Size of Aggregate

a) Slump

229 Maximum Size of Aggregate and Slump

Type of Concrete	Type of Structure	Maximum Size of Aggregate(mm)	Slump(cm)
Plain Concrete		Standard :Below 100mm.Not Over (1/4) Min	2.5-8
Reinforcement Conc	Normal	25 Below 50mm.Not Over (1/5) Minimum Size c	39580
	Big Section	40	2.5-10
	Water tightness		Below 8
Concrete Pavement		Below 40	2.5
Dam Concrete		Below 150	39512

230 Standard of Air Content

Type		Air Content(%)
Plain. Reinforcement Concrete		39513
Concrete Pavement		4
Dam Conc	Maximum Size 40mr	4.0+-1
	Maximum Size 80mr	3.5+-1
	Maximum Size 150n	3.0+-1

Slump	6.5cm
Maximu Size of Aggregate	50mm

(3) Calculate Unit Water Content(W)

221 Unit Water and Sand Percentage of Concrete

River Sand,River Gravel,W/C=55%,Slump=5cm,FM=2.75

Maximum Size of Aggregate	No Admixture			AE Concrete				
					Good Quality AE Agent		Good Quality Water Reducing Agent	
	Entrapped Air	Sand Percentage	Unit Water of Concrete	Air Content(Strict Weather)	Sand Percentage	Unit Water of Concrete	Sand Percentage	Unit Water of Concrete
(mm)	(%)	(%)	(kg)	(%)	(%)	(kg)	(%)	(kg)
15	2.5	49	187	7	46	169	47	156
20	2	45	181	6	42	162	43	150
25	1.5	41	172	5	37	153	38	143
40	1.2	36	160	4.5	33	141	34	131
50	1	33	152	4	30	131	31	122
80	0.5	31	139	3.5	28	117	28.5	109
150	0.3	28	120	3	24	100	24	93

(4) Calculate s/a

222 Correction River Sand,River Gravel,W/C=55%,Slump=5cm,FM=2.75

Section	Correction of (s/a)%	Correction of (W)kg	Condition Reference	Example	Calculation	s/a (%)	W (kg)
			50	50		33	152
FM of Sand(0.1 Bigger)	Increase 0.5	No Correction	2.75	2.75		33	152
W/C(0.05 Bigger)	Increase 1	No Correction	55	54	s/a=(33+(0.54-0.55)/0.05)*1)=32.8	32.8	152
Slump(2.5cm Bigger)	No Correction	Increase 3%	5	6.5	W=152*(1+((6.5-5)/2.5)*0.03)=155	32.8	154.736
Air Content(1% Bigger)	Decrease(0.5-1)	Decrease(3)%					
Crushed Stone	Increase 3-5	Increase 7-10%					
Concrete Pavement	Decrease(3)	Decrease(3%)					

(5) (6) Unit Water Content and Fine Aggregate and Coarse Aggregate

(1) W/C=54% W=155 C=155/(54*0.01)=287

(4)234*2.62=613

(6)=496*2.65=1314

Specified Mix Proportion / Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cem	sand perc	Cement	Water	Fine Aggr	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks	density kg/m3
		(SL)	air	W/C	s/a	C	W	s	CA(5~10n	CA(10~20	(% of weig	(% of weig	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	Mighty 90	Mighty 185	S=( )%				
	50	6.5	1	54	32	287.037037	155	612.032	1315.46	0						Weight	
						3.15	1	2.62	2.65							Specific Gravity	
			10			105	155	233.6	496.4							Volume	1000

(2)=287/3.15=105

(5)=1000-(10+105+155+234)=496

(3)=(1000-(10+105+155))*32*0.01=234

(385)266 Mix Proportion Design of AE Concrete Case of Japan

266 Mix Proportion Design of AE Concrete
(1) Area:Location Cold Area
(2) Type of Structure Reinforcement Concrete Girder Bridge
(3) Structure Section Minimum Dimension 350mm
(4) Interval Length of Reinforcements 35mm
(5) Design Strength 28N/mm2
(6) Material

Fine Aggregate	Fineness Modulus	2.85
	Specific Gravity	2.63
Coarse Aggregate	Specific Gravity	2.65

262 Sand Percentage and Water Content

Maximum Size of Aggregate(mm)		Sand Percentage(s/a) (%)		Water Content W (N)					
20		46		184		1 Good Grading 2 W/C=0.55 3 Fine Aggregate F.M=2.75			
25		41		178					
40		37		166					
50		34		157					
80		31		148					
150		26		131					

1 Normal Grading Sand and Gravel , W/C=0.55 Slump 7.5cm,Fine Aggregate (F.M)=2.75

Cement:Normal Portland Cement
Sand:Good Grading F.M=2.85 Specific Gravity 2 .63
Geavel :Specific Gravity =2.65
AE Agent

263 Adjustment

Condition Changing	Correction		
	s/a(%)	W(N)	W(kg)
1,W/C 0.05 Increase or Decrease	+-1	0	0
2,Fine Aggregate F.M 0.1 Increase Decre	+-0.5	0	0
3,Slump 2.5cm Increase Decrease	0	+-3	+-3
4,s/a 1% Increase Decrease	-	+-15N	+-1.5kg
5,Coarse Aggregate -Crushed Stone	+3-5	+90-150kg	(+9-15kg)
6,Fine Aggregate -Crushed Sand	+2-3	+60-90kg	(+6-9kg)
7,Pavement Concrete	-3	-50N	(-5kg)

Mix Proportion Design

(1) Coarse Aggregate Maximum Size

Minimum Size of Aggregate =350*(1/5)=70mm

Minimum Interval Pitch of Reinforcement =35*(3/4)=25mm

(2) Air Content

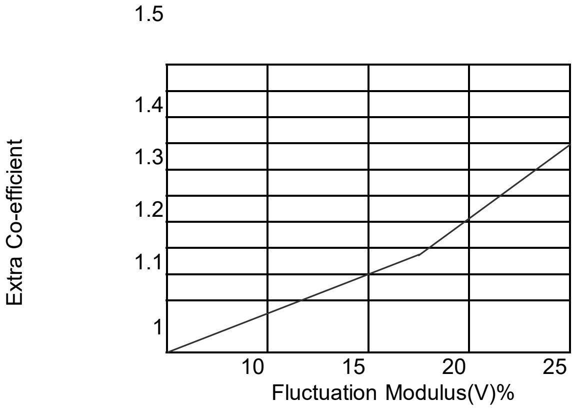
From Maximum Size of Aggregate

264Unit Coarse Aggregate Volume,Unit Water and Sand Percentage of Concrete

Maximum Size of Aggregate	Unit Coarse Aggregate Volume(%)	No Admixture			AE Concrete				
		Entrapped Air	Sand Percentage	Unit Water of Concrete	Air Content(Strict Weather)	Good Quality AE Agent		Good Quality Water Reducing Agent	
Gmax		a	s/a	w	a	Sand Percentage	Unit Water of Concrete	Sand Percentage	Unit Water of Concrete
(mm)	(%)	(%)	(%)	(kg)	(%)	(%)	(kg)	(%)	(kg)
15	53	2.5	49	190	7	46	170	47	160
20	61	2	45	185	6	42	165	43	155
25	66	1.5	41	175	5	37	155	38	145
40	72	1.2	36	165	4.5	33	145	34	135
50	75	1	33	155	4	30	135	31	125
80	81	0.5	31	140	3.5	28	120	29	110
1,Normal Sand (F.M) Fineness Modulus 2.8 Slump 8cm									

Air Content=5+-1.0%

(3) Water Cement Ratio
a) Compressive Strength W/C
i) Extra Co-efficient(a)



Fluctuation Modulus(V)%	Control Degree
7-10	Super
10-15	Good
15-20	Normal
Over 20	Not Normal

Fluctuation Modulus(V) 15%
Extra Co-efficient(a) 1.14

ii) W/C-Compressive Strength
sr=1.14*28=32 32(N/mm2) 320kg/cm2
s28=32=-16+21.7*(C/W) W/C=45%
b)Durability
220 W/C and Durability

Weather Condition		Strict Weather			Not Strict Weather		
Section		Thin	Normal	Thick	Thin	Normal	Thick
Under Water		55(50)	60(55)	60(55)	55(50)	65(60)	65(60)
Normal		60(55)	65(60)	65(60)	60(55)	70(65)	70(65)
Dam Concrete		60			65		
Weather Condition		Strict Weather, A Lot of Freezing and Thawing Action			A Fewoof Freezing and Thawing Action		
Paving Concrete		45			50		

Adapt W/C=45%

(4) Slump

259 Cement Minimum Content

Type of Structure		Unit Cement Content			
		(kg)			
Reinforcement		Over 300			
Concrete Under		Over 370			
Pavement		280-340			
Dam		About 140			
Dam					

260 Slump

1) Reinforcement Concrete(Slump)(cm)	
Normal	5-12
Big Structure	2.5-10
2) Plain Concrete	2.5-8
Concrete under	
Tremie,Pump	13-18
Sacked Concrete	7-12
Pavement	2.5
Dam Concrete	3-5

Adapt Slump 12cm

264Unit Coarse Aggregate Volume,Unit Water and Sand Percentage of Concrete

Maximum Size of Aggregate	Unit Coarse Aggregate Volume(	No Admixture		AE Concrete					
		Entrapped Air	Sand Percentage	Unit Water of Concrete	Air Content(Strict Weather)	Good Quality AE Agent		Good Quality Water Reducing Agent	
Gmax						Sand Percentage	Unit Water of Concrete	Sand Percentage	Unit Water of Concrete
		a	s/a	w	a	s/a	w	s/a	w
(mm)	(%)	(%)	(%)	(kg)	(%)	(%)	(kg)	(%)	(kg)
15	53	2.5	49	190	7	46	170	47	160
20	61	2	45	185	6	42	165	43	155
25	66	1.5	41	175	5	37	155	38	145
40	72	1.2	36	165	4.5	33	145	34	135
50	75	1	33	155	4	30	135	31	125
80	81	0.5	31	140	3.5	28	120	29	110

1,Normal Sand (F.M) Fineness Modulus 2.8 Slump 8cm

262 Sand Percentage and Water Content

Maximum Size of Aggregate(mm)	Sand Percentage(s/a) (%)	Water Content W (N)
20	46	184
25	41	178
40	37	166
50	34	157
80	31	148
150	26	131

1 Good Grading   2 W/C=0.55 3 Slump 7.5cm   4,Fine Aggregate F.M=2.75

263 Adjustment

Condition Changing	Correction s/a(%)	W(N)	W(kg)	Condition Reference	Example	Calculation	s/a (%)	W (kg)
							37	155
1,W/C 0.05 Increase or Decrease	+-1	0	0	0.55	0.45	s/a=((0.45-0.55)/0.05)*1+37	35.0	155
2,Fine Aggregate F.M 0.1 Increase	+-0.5	0	0	2.75	2.85	s/a=((2.85-2.75)/0.1)*0.5+35	35.5	155
3,Slump 2.5cm Increase Decrease	0	+-3	+-3	7.5	12	W=((12-7.5)/2.5)*3+155	35.5	160.4
4,s/a 1% Increase Decrease	-	+-15N	+-1.5kg	37				
5,Coarse Aggregate -Crushed Stone	+3-5	+90-150kg	(+9-15kg)					
6,Fine Aggregate -Crushed Sand	+2-3	+60-90kg	(+6-9kg)					
7,Pavement Concrete	-3	-50N	(-5kg)					

Specified Mix Proportion

(1) W/C=46%   W=160   C=160/(46*0.01)=348

(4)245*2.63=643

(6)=435*2.65=1153

Saturated Surface-Dry State of Aggregate

Specified Mix Proportion

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks	density kg/m3
		(SL)	air	W/C	s/a	C	W	s	CA (5~10mm)	CA(10~20m m)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
320	25	12	5	46.0	36	348	160	643	1153	0						Weight	
						3.15	1	2.63	2.65							Specific Gravity	
			50			110	160	245	435							Volume	1000

(2)=348/3.15=110

(5)=1000-(50+110+160+245)=435

(3)=(1000-(50+110+160))*36*0.01=245

261 Maximum Size of Coarse Aggregate

Plain Concrete	Below 100mm,Below (1/4)of Minimum Size of Aggregate	
Reinforcement Concrete(Slump)(cm)		Below 50mm,Below (1/5) of Minimum Size of Structure ,Below (3/4)of Reinforcement Minimum
Type of Structure	Maximum Size of Aggregate (mm)	
Normal ,Beam Wall Pier Slab		25
Big Section,Fooching Caison		40
Maximum Size of Coarse Aggregate		
Pavement Concrete		Below 40

262 Sand Percentage and Water Content

Maximum Size of Aggregate(mm)		Sand Percentage(s/a) (%)		Water Content W (N)					
20		46		184		1 Good Grading 2 W/C=0.55 3 Slump 7.5cm 4,Fine Aggregat			
25		41		178					
40		37		166					
50		34		157					
80		31		148					
150		26		131					

263 Adjustment

Condition Changing	Correction s/a(%)	W(N)	W(kg)
1,W/C 0.05 Increase or Decrease	+-1	0	0
2,Fine Aggregate F.M 0.1 Increase Decre	+-0.5	0	0
3,Slump 2.5cm Increase Decrease	0	+-3	+-3
4,s/a 1% Increase Decrease	-	+-15N	+-1.5kg
5,Coarse Aggregate -Crushed Stone	+3-5	+90-150kg	(+9-15kg)
6,Fine Aggregate -Crushed Sand	+2-3	+60-90kg	(+6-9kg)
7,Pavement Concrete	-3	-50N	(-5kg)

264Unit Coarse Aggregate Volume,Unit Water and Sand Percentage of Concrete

Maximum Size of Aggregate	Unit Coarse Aggregate Volume(	o Admixture		AE Concrete					
		Entrapped Air	Sand Percentage	Unit Water of Concrete	Air Content(Strict Weather)	Good Quality AE Agent		Good Quality Water Reducing Agent	
						Sand Percentage	Unit Water of Concrete	Sand Percentage	Unit Water of Concrete
(mm)	(%)	(%)	(%)	(kg)	(%)	(%)	(kg)	(%)	(kg)
15	53	2.5	49	190	7	46	170	47	160
20	61	2	45	185	6	42	165	43	155
25	66	1.5	41	175	5	37	155	38	145
40	72	1.2	36	165	4.5	33	145	34	135
50	75	1	33	155	4	30	135	31	125
80	81	0.5	31	140	3.5	28	120	29	110

ineness Modulus 2.8 Slump 8cm

265 Correction

Section	Correction of (s/a)%	Correction of (W)kg	
Sand(0.1 Bigger)	Increase 0.5	No Correction	
np(1cm Bigger)	No Correction	Increase 1.2%	
ntent(1% Bigger)	Decrease(0.5-1)	Decrease(3)%	
ushed Stone	Increase 3-5	Increase 9-15	
rushed Sand	Increase 2-3	Increase 6-9	

(386)231 Example of Mix proportion   Case of Japan

231 Example of Mix proportion

a	Reinforced Concrete Retaining Wall	
b	Required Strength	s28(kg/cm2)=210kg/cm2
c	Slump(cm)	8cm
d	Co-efficient	15%
e	Weather	Mild
f	No Need Water Tightness	
g	Cement Specific Gravity	3.16
h	Fine Aggregate Specific Gravity	2.6
i	Fine Modulus of Fine Aggregate	2.85
j	Coarse Aggregate Specific Gravity	2.64
k	Maximum Size of Aggregate(mm)	25

(1) Required Strength

(a) Co-efficient 15%

Extra Co-efficient(a) 1.12

Required Strength sr

σ=210*1.12=235(kg/cm2)

(2) Water Cement Ratio (W/C)

According to Required Strength and Durability or

σ28=-210+215*(C/W)   235=-210+215*(C/W)

W/C=48.3%   Adapt Smaller 48.3%

220 W/C and Durability

Weather Condition	Strict Weather			Not Strict Weather		
Section	Thin	Normal	Thick	Thin	Normal	Thick
Under Water	55(50)	60(55)	60(55)	55(50)	65(60)	65(60)
Normal	60(55)	65(60)	65(60)	60(55)	70(65)	70(65)
Dam Concrete	60			65		
Weather Condition	Strict Weather,A Lot of Freezing and Thawing Action			A Few of Freezing and Thawing Action		
Paving Concrete	45			50		

(3) Slump

c Slump(cm) 8cm

(4) Maximum Size of Coarse Aggregate
k Maximum Size of Aggregate(mm) 25

(5) Unit Water and Sand Percentage

221 Unit Water and Sand Percentage of Concrete
River Sand,River Gravel,W/C=55%,Slump=5cm,FM=2.75

Maximum Size of Aggregate	No Admixture			AE Concrete				
	Entrapped Air	Sand Percentage	Unit Water of Concrete	Air Content(Strict Weather)	Good Quality AE Agent		Good Quality Water Reducing Agent	
					Sand Percentage	Unit Water of Concrete	Sand Percentage	Unit Water of Concrete
(mm)	(%)	(%)	(kg)	(%)	(%)	(kg)	(%)	(kg)
15	2.5	49	187	7	46	169	47	156
20	2	45	181	6	42	162	43	150
25	1.5	41	172	5	37	153	38	143
40	1.2	36	160	4.5	33	141	34	131
50	1	33	152	4	30	131	31	122
80	0.5	31	139	3.5	28	117	28.5	109
150	0.3	28	120	3	24	100	24	93

222 Correction River Sand,River Gravel,W/C=55%,Slump=5cm,FM=2.75

Section	Correction of (s/a)%	Correction of (W)kg
FM of Sand(0.1 Bigger)	Increase 0.5	No Correction
W/C(0.05 Bigger)	Increase 1	No Correction
Slump(2.5cm Bigger)	No Correction	Increase 3%
Air Content(1% Bigger)	Decrease(0.5-1)	Decrease(3)%
Crushed Stone	Increase 3-5	Increase 7-10%
Concrete Pavement	Decrease(3)	Decrease(3%)

Section	Correction of (s/a)%	Correction of (W)kg	s/a(%)	W(kg)
			41	172
Sand (F.M)=2.85	(s/a)=41+((2.85-2.75)/(0.1))*0.5=0.5	No Correction	41.5	172
W/C=(48.3%)	(s/a)=41.5+((0.48.3-0.55)/0.05)*1=40.2	No Correction	40.2	172
Slump(8cm)	No Correction	172*(1+((8-5)/2.5)*0.03)=178	40.2	172

s/a(%)	40.2
W(kg)	172

C=172/0.483=356kg

(6) Unit Cement =178/(48.3*0.01)=369
(7) Unit Aggregate
(7-2)Fine Aggregate Weight=277*2.6=720

(8) Required Mix Proportion

(7-4)Coarse Aggregate Weight=413*2.64=1090

Saturated Surface-Dry State of Aggregate

density kg/m3

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks
		(SL)	air	W/C	s/a	C	W	s	CA (5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d	
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)						
235	25	8	1.5	48.3	40.2	369	178	720	1090							Weight
						3.16	1	2.6	2.64							Specific Gravity
			15			117	178	277	413							Volume

231 Example of Mix proportion

=369/3.16=117

(7-3)Coarse Aggregate Volume=(1000-(15+117+178+277))=413

(387)225 Correction Mix Proportion　　Case of Japan

225 Correction

Gmax:Aggregate Maximum Size(mm)	40
Slump(cm)	10
Water Cement Ratio(%)	51.5
Calculate Unit Weight ?	
Cement Specific Gravity	3.15
Fineness Modulus(FM)	2.8
Fine Aggregate Specific Gravity	2.57
Coarse Aggregate Specific Gravity	2.61

221 Unit Water and Sand Percentage of Concrete

River Sand,River Gravel,W/C=55%,Slump=5cm,FM=2.75

Maximum Size of Aggregate	No Admixture			AE Concrete				
					Good Quality AE Agent		Good Quality Water Reducing Agent	
	Entrapped Air	Sand Percentage	Unit Water of Concrete	Air Content(Strict Weather)	Sand Percentage	Unit Water of Concrete	Sand Percentage	Unit Water of Concrete
(mm)	(%)	(%)	(kg)	(%)	(%)	(kg)	(%)	(kg)
15	2.5	49	187	7	46	169	47	156
20	2	45	181	6	42	162	43	150
25	1.5	41	172	5	37	153	38	143
40	1.2	36	160	4.5	33	141	34	131
50	1	33	152	4	30	131	31	122
80	0.5	31	139	3.5	28	117	28.5	109
150	0.3	28	120	3	24	100	24	93

	Condition		Correction	s/a	W
	Reference	Example		(%)	(kg)
	40	40		36	160
F.M	2.75	2.8	36+(2.8-2.75)*0.5/0.1=36.3	36.3	160
W/C	55	51.5	36.3-(0.55-0.515)*1/0.05=36.3	35.6	160
Slump	5	10	160+(1+(10-5)*0.03/2.5)=170	35.6	170

222 Correction

Section	Correction of (s/a)%	Correction of (W)kg
FM of Sand(0.1 Bigger)	Increase 0.5	No Correction
W/C(0.05 Bigger)	Increase 1	No Correction
Slump(2.5cm Bigger)	No Correction	Increase 3%
Air Content(1% Bigger)	Decrease(0.5-1)	Decrease(3)%
Crushed Stone	Increase 3-5	Increase 7-10%
Concrete Pavement	Decrease(3)	Decrease(3%)

(1) W/C=51.5% W=170 C=170/(51.5*0.01)=330

(4)254*2.57=653

(6)=459*2.61=1199

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Saturated Surface-Dry State of Aggregate

density kg/m3

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks
		(SL)	air	W/C	s/a	C	W	s	CA (5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d	
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)						
	40	10	1.2	51.5	35.6	330	170	653	1199							Weight
						3.15	1	2.57	2.61							Specific Gravity
			12			105	170	254	459							Volume

(2)=330/3.15=105

(5)=1000-(12+105+170+254)=459

(3)=(1000-(12+105+170))*35.6*0.01=254

(388)278 Mix Proportion   Case of Japan

(1) Design Condition

1.Location:

2.Type of Structure:

3.Design Strength: σck=21N/mm2

4.Material

Cement	Normal Portland Cement	Specific Gravity	3.15
Fine Aggregate		Specific Gravity(S.S.D)	2.65
Coarse Aggregate			
AE Agent	C*0.03%		

5.Sulmp:(10+-1)   (10+-1)%

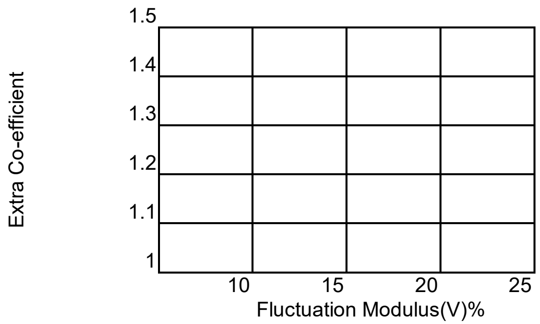
6.Air Content: 4-5%

275 Air Content of AE Concrete

Maximum Size of Coarse Aggregate (mm	Air Content (%)
15	6
20	5
25	4.5
40	4
50	3.5
80	3

7.Fluctuation Co-efficient(V)

i) Extra Co-efficient(a)



Fluctuation Modulus(V)%	Control Degree
7-10	Super
10-15	Good
15-20	Normal
Over 20	Not Normal

Fluctuation Modulus(V)   15%

Extra Co-efficient(a)   1.14

(2) Specified Mix Proportion Design

(1) Maximum Size of Coarse Aggregate

261 Maximum Size of Coarse Aggregate

Plain Concrete	Below 100mm,Below (1/4)of Minimum Size of Aggregate
Reinforcement Concrete(Slump)(cm)	Below 50mm,Below (1/5) of Minimum Size of Structure,Below (3/4)of Reinforcement Minimum Interval
Type of Structure	Maximum Size of Aggregate (mm)
Normal ,Beam Wall Pier Slab	25
Big Section,Fooching Caison	40
Maximum Size of Coarse Aggregate	
Pavement Concrete	Below 40

a)Maximum Size of Structure: =500*(1/5)=100mm

b) Minimum Size Reinforcement Pitch =109*(3/4)=82mm

Maximum Size of Coarse Aggregate =25mm

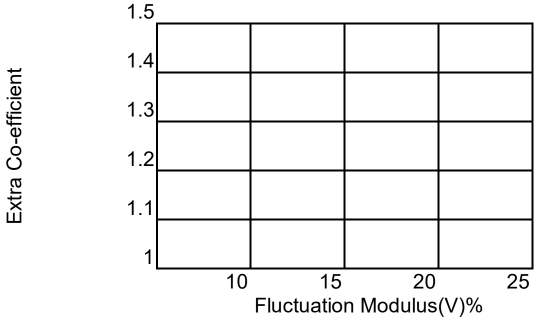
(2) Air Content

275 Air Content of AE Concrete

Maximum Size of Coarse Aggregate (mm	Air Content (%)
15	6
20	5
25	4.5
40	4
50	3.5
80	3

Air Content=4.5%

(3) Water Cement Ratio
a) Compressive Strength W/C
i) Extra Co-efficient(a)



Fluctuation Modulus(V)%	Control Degree
7-10	Super
10-15	Good
15-20	Normal
Over 20	Not Normal

Fluctuation Modulus(V) 15%
Co-efficient(a) 1.12

ii) W/C-Compressive Strength

σr=1.12*21=23.5N/mm2 23.5N/mm2

σ(28)=24=-16+21.7*(C/W) W/C=54%

σ(28)=24=-21+21.5*(C/W) W/C=47%

b)Durability

220 W/C and Durability

Weather Condition	Strict Weather			Not Strict Weather		
Section	Thin	Normal	Thick	Thin	Normal	Thick
Under Water	55(50)	60(55)	60(55)	55(50)	65(60)	65(60)
Normal	60(55)	65(60)	65(60)	60(55)	70(65)	70(65)
Dam Concrete	60			65		
Weather Condition	Strict Weather,A Lot of Freezing and Thawing Action			A Fewoof Freezing and Thawing Action		
Paving Concrete	45			50		

c) Adapt W/C=47%(Select Smallest)

(4)Unit Water

264Unit Coarse Aggregate Volume,Unit Water and Sand Percentage of Concrete

Maximum Size of Aggregate	Unit Coarse Aggregate Volume(%)	No Admixture			AE Concrete				
		Entrapped Air	Sand Percentage(s/a)	Unit Water of Concrete	Air Content(Strict Weather)	Good Quality AE Agent		Good Quality Water Reducing Agent	
						Sand Percentage	Unit Water of Concrete	Sand Percentage	Unit Water of Concrete
(mm)	(%)	(%)	(%)	(kg)	(%)	(%)	(kg)	(%)	(kg)
15	53	2.5	49	190	7	46	170	47	160
20	61	2	45	185	6	42	165	43	155
25	66	1.5	41	175	5	37	155	38	145
40	72	1.2	36	165	4.5	33	145	34	135
50	75	1	33	155	4	30	135	31	125
80	81	0.5	31	140	3.5	28	120	29	110
1,Normal Sand (F.M) Fineness Modulus 2.8 Slump 8cm									

265 Correction

Section	Correction of (s/a)%	Correction of (W)kg	Condition		Calculation	s/a	W
			Reference	Example		(%)	(kg)
						37	155
FM of Sand(0.1 Bigger)	Increase 0.5	No Correction	2.8	2.8		37	155
Slump(1cm Bigger)	No Correction	Increase 1.2%	8	10	=(1+((10-8)/1)*1.2*0.01)*155=159	37	159
Air Content(1% Bigger)	Decrease(0.5-1)	Decrease(3)%					
Crushed Stone	Increase 3-5	Increase 9-15					
Crushed Sand	Increase 2-3	Increase 6-9					

(5) s/a s/a=37%

(6)Specified Mix Proportion

(1) W/C=47%   W=159   C=159/(47*0.01)=338

(4)254*2.6=660   (7) 338*0.03*0.01=1.014

(6)=432*2.65=1145

Specified Mix Proportion

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks	density kg/m3
		(SL)	air	W/C	s/a	C	W	s	CA (5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
240	25	10	4.5	47.0	37	338	159	660	1145		1.01					Weight	
						3.15	1	2.6	2.65							Specific Gravity	
			45			110	159	254	432							Volume	1000

(2)=338/3.15=110   (5)=1000-(45+110+159+254)=432

(3)=(1000-(45+110+159))*37*0.01=254

(3) To Field Mix Proportion from Specified Mix Proportion

Specified Mix Proportion

W(kg)	C(kg)	Sand(kg)	Aggregate(kg)
159	338	660	1145

Field Condition

	Adjustment by Grading		**Water Surface(%)**	5mm Passing(%)	5mm Retained(%)		
Sand	**x**	**Wet Conditio**	**3**	92	8	655	x+y=660+1145=180
Aggregate	**y**	**Wet Conditio**	**3**	5	95	1150	=0.08*x+0.95*y=114

Concrete Mix Proportion

Adjustment Moisture Content

	specifiv gravity(%)	absorption (%)	moisture content(%)	Water surface content(%)	Content(kg/m3)	Correction(kg/m3)	Corrected(kg/m3)
		(1)	(2)	(3)=(2)-(1)	(4)	(5)=(3)*(4)*0.01	(6)=(4)+(5)
Water					159	-55	104
Fine Aggregate	2.6	1.66		3	655	20	675
Coarse Aggregate	2.65	0.89		3	1150	35	1185

Specified Mix Proportion

W(kg)	C(kg)	Sand(kg)	Aggregate(kg)
159	338	660	1145

Field Mix Proportion(1m3)

W(kg)	C(kg)	Sand(kg)	Aggregate(kg)
104	338	675	1185

(389) (69) ACI 211.1 Mix Proportion Case of ACI

(69) ACI 211.1 Mix Proportion Step(1)-Water and Air Content

84 Mix Proportion Calculation

1 Cement Type I Specific Gravity 3.15

2 Grading of Coarse or Fine Aggregate

3 Coarse Aggregate Specific Gravity 2.68 Absorption 0.50%

4 Fine Aggregate Specific Gravity 2.64 Absorption 0.70%

Fineness Modules 2.8

5 Compressive Strength (Ages 28 days) 250kg/cm2

6 Slump 8-10cm

7 Coarse Aggregate Grading 5-40mm

8 Compacted Weight of Coarse Aggregate 1600kg/m3

1 Step Slump 8-10cm

2 Step Coarse Aggregate Grading 5-40mm

3 Step Plain Concrete

Aggregate Gmax 40mm

69 70 ACI 211.1 Table 5.3.3 -Approximate Mixing Water and Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate (SI)

Slump(cm)	Aggregate Maximum Dimension (mm)							
	10	12.5	20	25	40	50	70	150
Plain Concrete								
3-5	205	200	185	180	160	155	145	125
8-10	225	215	200	195	175	170	160	140
15-18	240	230	210	205	185	180	170	-
Entrapped Air(%)	3	2.5	2	1.5	1	0.5	0.3	0.2
AE Concrete								
3-5	180	175	165	160	145	140	135	120
8-10	200	190	180	175	160	155	150	135
15-18	215	205	190	185	170	165	160	-
Air Content(	8	7	6	5	4.5	4	3.5	3

Estimated Water 175kg/m3

Entrapped Air 1%

4 Step	Strength-W/C	Plain Concrete
	Strength	250kg/cm2
	W/C	0.62

71 ACI 211.1 Table A1.5.3.4(a) Relationships between Water-Cement Ratio and Compressive Strength of Concrete (SI)

Compressive Strength Ages 28 Days(kg/cm2)	Water Cement Ratio W/C	
	Plain Concrete	AE Concrete
450	0.38	
400	0.43	
350	0.48	0.4
300	0.55	0.46
250	0.62	0.53
200	0.7	0.61
150	0.8	0.71

Compressive Strength,Wet Curing in 28 days,23+-1.7 degree

5 Step	Cement Content	C=175/0.62=282kg/m3

Concrete Mix Proportion

Adjustment Moisture Content

	specifiv gravity(%)	absorption (%)	moisture content(%)	Water surface content(%)	Content(kg/m3)	Correction(kg/m3)	Corrected(kg/m3)
		(1)	(2)	(3)=(2)-(1)	(4)	(5)=(3)*(4)*0.01	(6)=(4)+(5)
Water							
Fine Aggregate							
G1:Aggregate(5~10mm)							
G2:Aggregate(10~20mm)							

Saturated Surface-Dry State of Aggregate

density kg/m3

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks
		(SL)	air	W/C	s/a	C	W	s	CA (5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d	
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)						
250	40	10	1	62		282	175									Weight
						3.15	1									Specific Gravity
			10			90	175									Volume

6 Step Coarse Aggregate Content

Fineness Modules	2.8
Coarse Aggregate Maximum Dimension	40mm
Dry Compacted Volume of Coarse Aggregate	0.72m3
Compacted Weight of Coarse Aggregate	1600kg/m3
Dry Compacted Weight of Coarse Aggregate	0.72*1600=1152kg

75-ACI 211.1 Table A1.5.3.6 Volume of Coarse Aggregate per Unit Volume of Concrete (SI)

Maximum Size of Coarse Aggregate	Fineness Modules of Fine Aggregate			
	2.4	2.6	2.8	3
10	0.5	0.48	0.46	0.44
12.5	0.59	0.57	0.55	0.53
20	0.66	0.64	0.62	0.6
25	0.71	0.69	0.67	0.65
40	0.76	0.74	0.72	0.7
50	0.78	0.76	0.74	0.72
70	0.81	0.79	0.77	0.75
150	0.87	0.85	0.83	0.81

ASTM C29 Unit Weight of Concrete

7 Step Fine Aggregate Content

(1) Gravimetric Method
(2) Volumetric Method

7-1 Step (1) Gravimetric Method

Maximum Dimension of Coarse Aggregate 40mm Plain Concrete

Plain Concrete Unit Weight of Fresh Concrete 2420kg

78-ACI 211.1 Table A1.5.3.7.1 First Estimate of Mass of Fresh Concrete (SI)

Aggregate Maximum	Fresh Concrete	AE Concrete
10	2285	2190
12.5	2315	2235
20	2355	2280
25	2375	2315
40	2420	2355
50	2445	2375
70	2465	2400
150	2505	2435

2420-(175+282+1152)=811kg

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks
		(SL)	air	W/C	s/a	C	W	s	CA (5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d	
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)						
250	40	10	1	62		282	175	811	1152							Weight
						3.15	1									Specific Gravity
			10			90	175									Volume

7-2 Step (2) Volumetric Method

69 70 ACI 211.1 Table 5.3.3 -Approximate Mixing Water and Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate (SI)

Slump(cm)	Aggregate Maximum Dimension (mm)							
	10	12.5	20	25	40	50	70	150
Plain Concrete								
3-5	205	200	185	180	160	155	145	125
8-10	225	215	200	195	175	170	160	140
15-18	240	230	210	205	185	180	170	-
Entrapped Air(%)	3	2.5	2	1.5	1	0.5	0.3	0.2
AE Concrete								
3-5	180	175	165	160	145	140	135	120
8-10	200	190	180	175	160	155	150	135
15-18	215	205	190	185	170	165	160	-
Air Content(	8	7	6	5	4.5	4	3.5	3

=295*2.64=779

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks	
		(SL)	air	W/C	s/a	C	W	s	CA (5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
250	40	10	1	62		282	175	779	1152							Weight	
						3.15	1	2.64	2.68							Specific Gravity	
			10			90	175	295	430							Volume(cc)	1000cc

=1000-(10+90+175+430)=295

8 Step

	Water Content(%)	Absorption(%)
Coarse Aggregate	2%	0.5
Fine Aggregate	6%	0.7

Concrete Mix Proportion

Adjustment Moisture Content

	specifiv gravity(%)	absorption (%)	moisture content(%)	Water surface content(%)	Content(kg/m3)	Correction(kg/m3)	Corrected(kg/m3)	
		(1)	(2)	(3)=(2)-(1)	(4)	(5)=(3)*(4)*0.01	(6)=(4)+(5)	
Water					175	-60	115	
Fine Aggregate	2.64	0.7	6.0	5.3	811	43	854	(Wet)
G1:Aggregate(5~10mm) G2:Aggregate(10~20mm)	2.68	0.5	2.0	1.5	1152	17	1169	(Wet)

Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks	
		(SL)	air	W/C	s/a	C	W	s	CA (5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
250	40	10	1	62		282	175	779	1152							Weight	2388
						3.15	1	2.64	2.68							Specific Gravity	
			10			90	175	295	430							Volume(cc)	1000

9 Step

Trial Batch

1000cc			282	115	854	1169
20cc			5.64	2.30	17.08	23.38

→ Trial Batch

Slump =5cm → Slump =9cm

Slump 1cm Increase=Water 2kg/m3 Increase

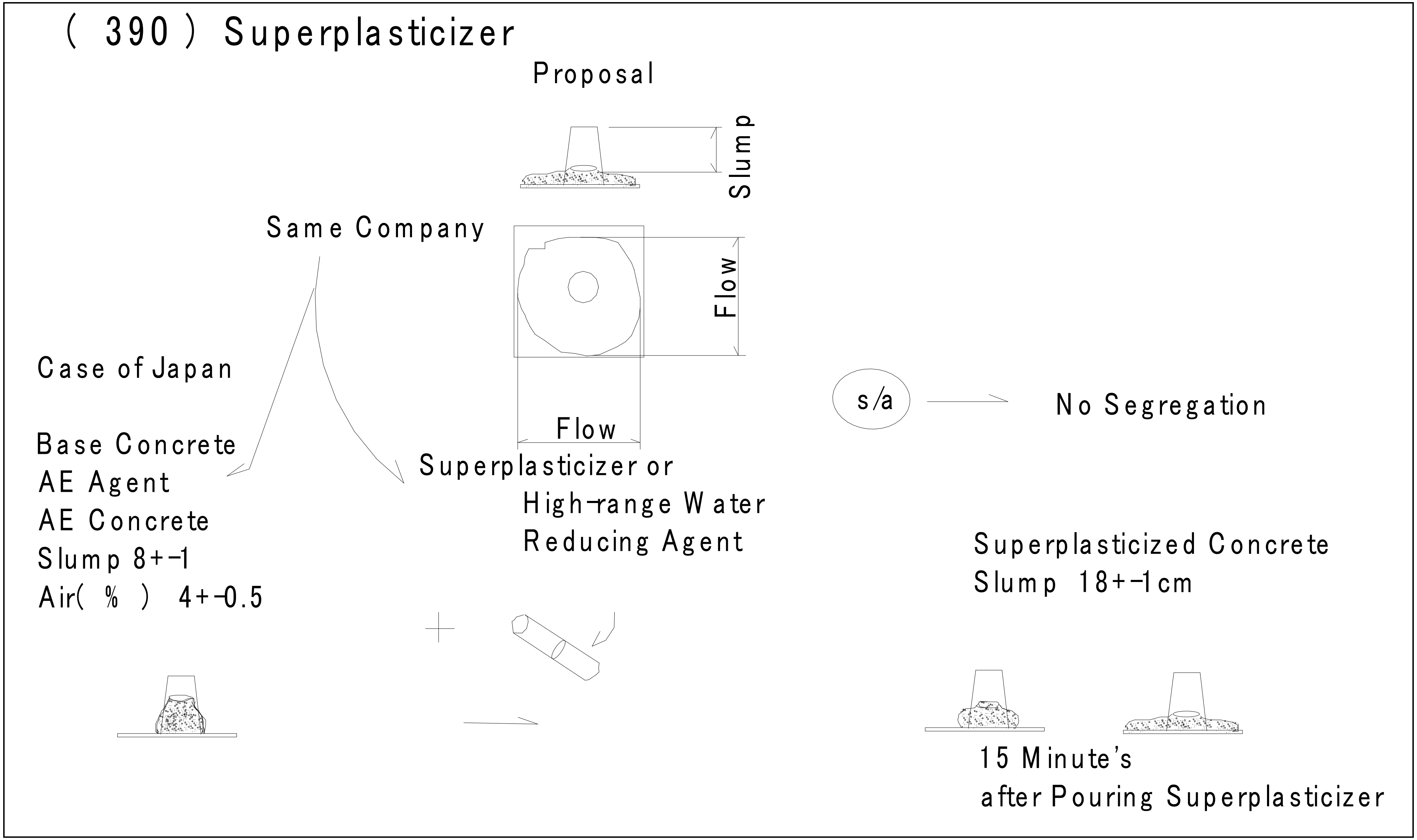
Water | 8kg/m3 Increase

=175+8=183 kg/m3

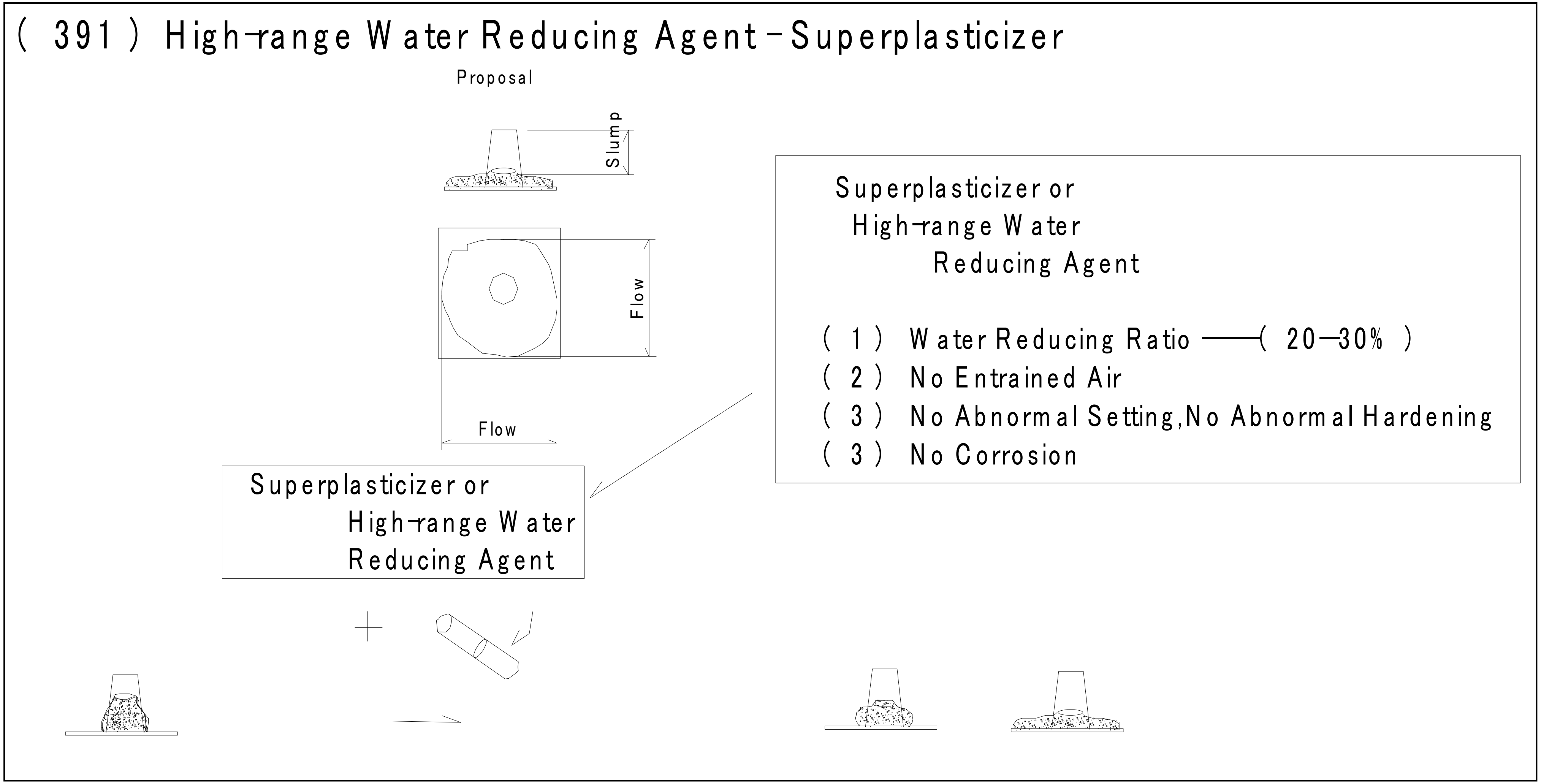
Saturated Surface-Dry State of Aggregate

Grade	Gmax	Slump	air	water cement ratio	sand percentage	Cement	Water	Fine Aggregate	Coarse Aggregate		Admixture	Admixture	Comprssive Strength(kgf/cm2)			Remarks	
		(SL)	air	W/C	s/a	C	W	s	CA (5~10mm)	CA(10~20mm)	(% of weight of cement)	(% of weight of cement)	3d	7d	28d		
kg/cm2	(mm)	cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)							
250	40	10	1	62		295	183	748	1152							Weight	2378
						3.15	1	2.64	2.68							Specific Gravity	2.378
			10			94	183	283	430							Volume(cc)	1000

(390) Superplasticizer

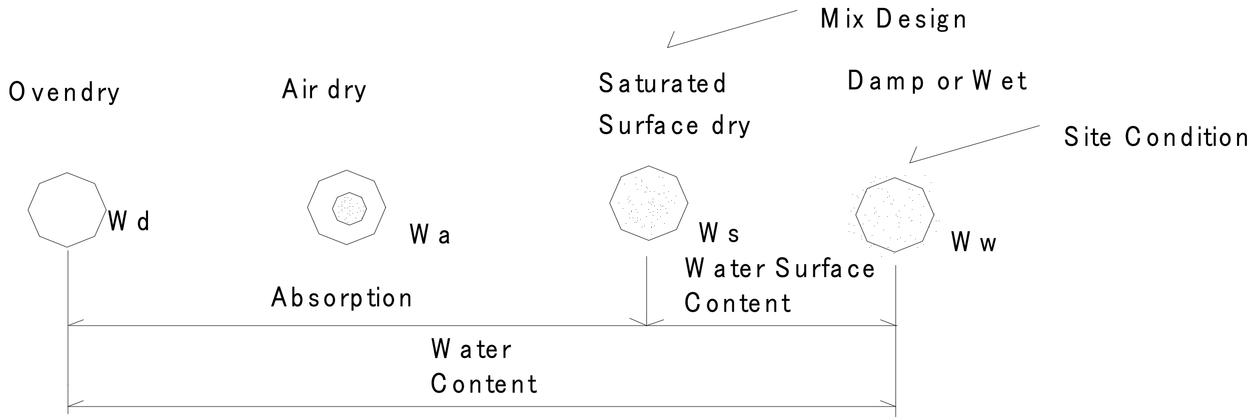


(391) High-range Water Reducing Agent-Superplasticizer



(392-377)-151 Water Content of Aggregate

392-377-(151) Water Content of Aggregate



Water Surface Content Ratio =((Ww-Ws) /Ws) *100

Specific Gravity (S.S.D) =Ws/Wd

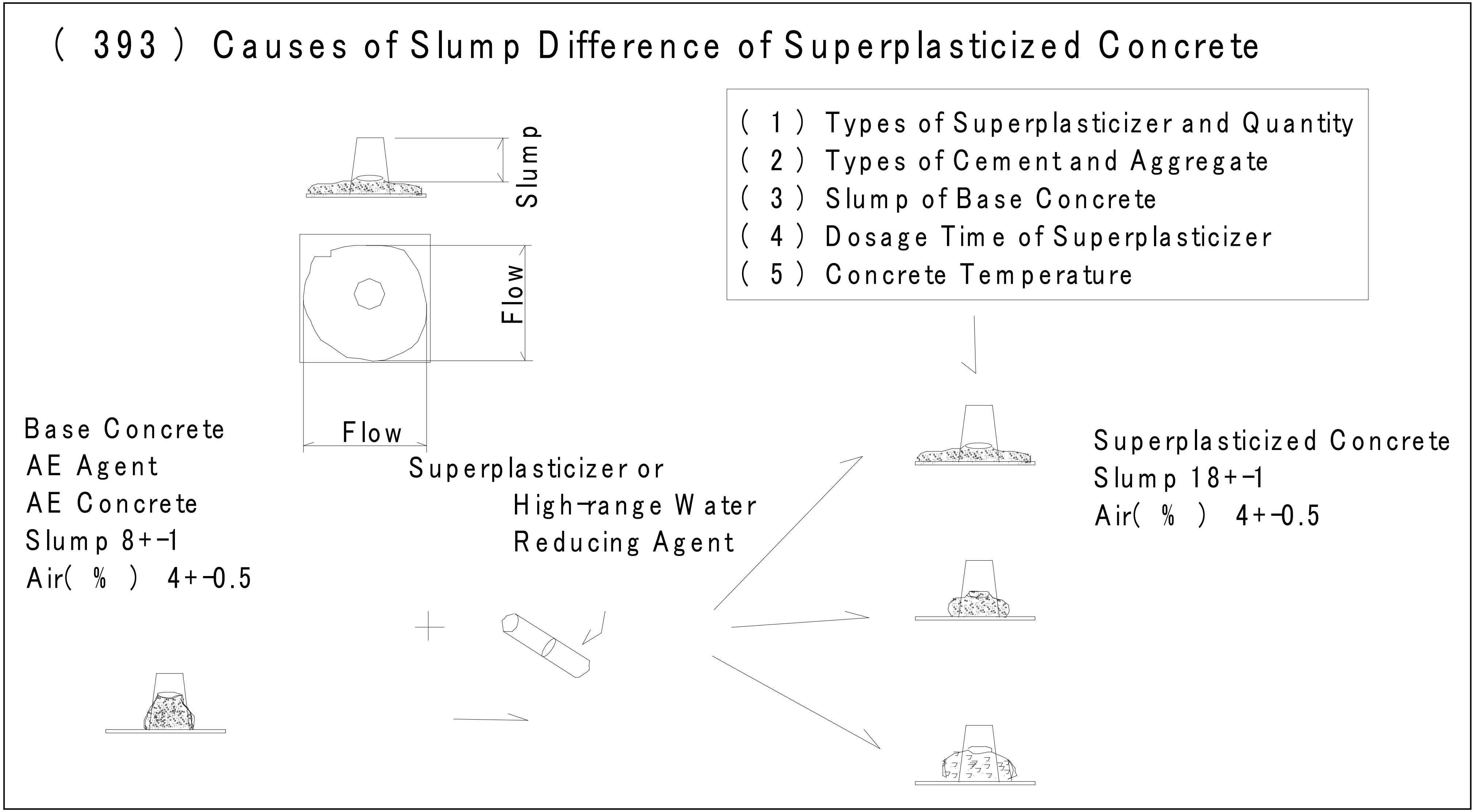
Absorption Ratio =((Ws-Wd) /Wd) *100

Moisture Content Ratio =((Ww-Wd) /Wd) *100

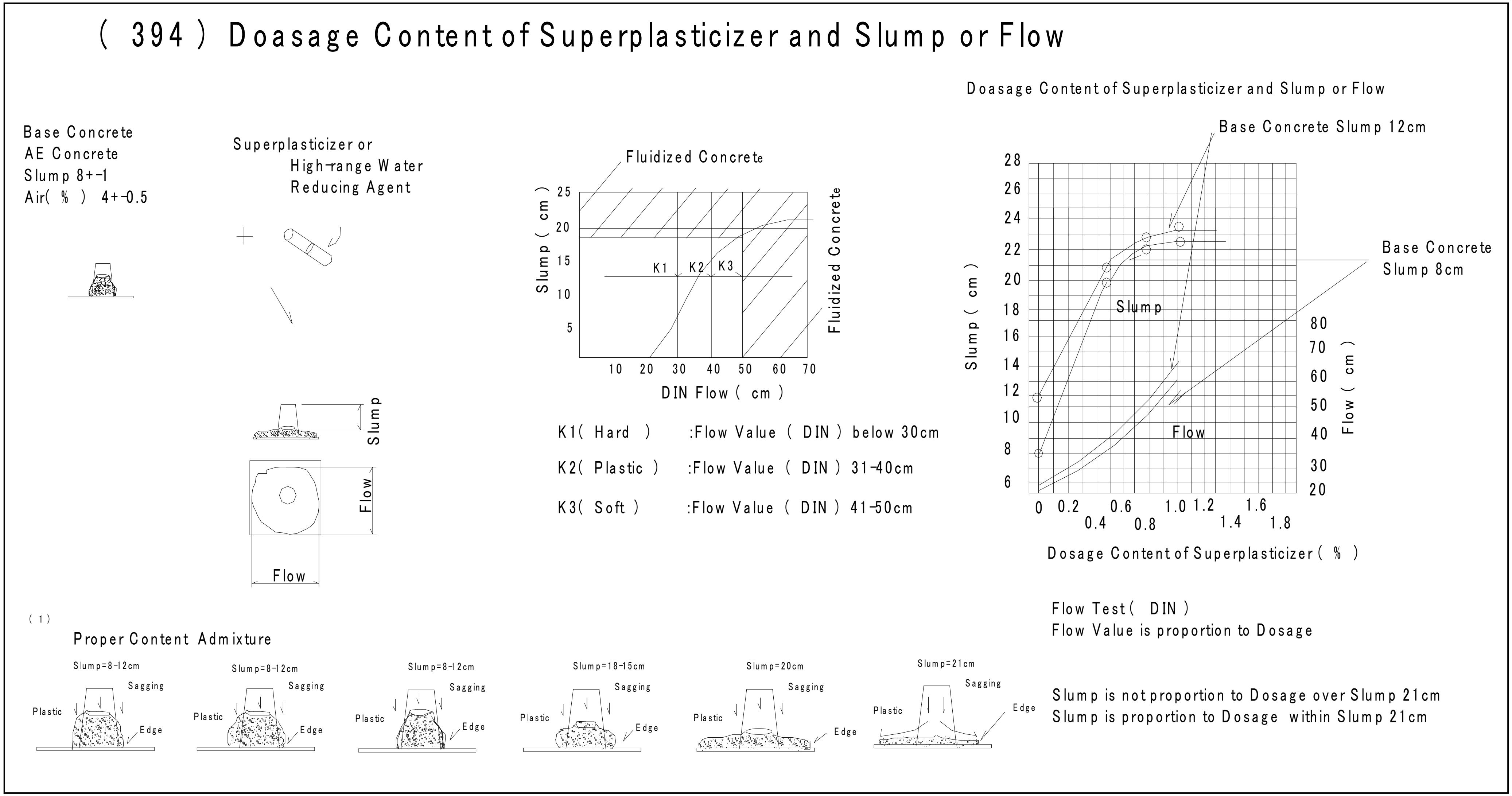
Moisture Content

Ww(g)	Wd(g)	Wc(%)	Ww(g)	Wd(g)	Wc(%)	Ww(g)	Wd(g)	Wc(%)	Ww(g)	Wd(g)	Wc(%)
500	499	0.200	500	485	3.093	500	471	6.157	500	457	9.409
500	498	0.402	500	484	3.306	500	470	6.383	500	456	9.649
500	497	0.604	500	483	3.520	500	469	6.610	500	455	9.890
500	496	0.806	500	482	3.734	500	468	6.838	500	454	10.132
500	495	1.010	500	481	3.950	500	467	7.066	500	453	10.375
500	494	1.215	500	480	4.167	500	466	7.296	500	452	10.619
500	493	1.420	500	479	4.384	500	465	7.527	500	451	10.865
500	492	1.626	500	478	4.603	500	464	7.759	500	450	11.111
500	491	1.833	500	477	4.822	500	463	7.991	500	449	11.359
500	490	2.041	500	476	5.042	500	462	8.225	500	448	11.607
500	489	2.249	500	475	5.263	500	461	8.460	500	447	11.857
500	488	2.459	500	474	5.485	500	460	8.696	500	446	12.108
500	487	2.669	500	473	5.708	500	459	8.932	500	445	12.360
500	486	2.881	500	472	5.932	500	458	9.170	500	444	12.613

(393) Causes of Slump Difference of Superplasticized Concrete

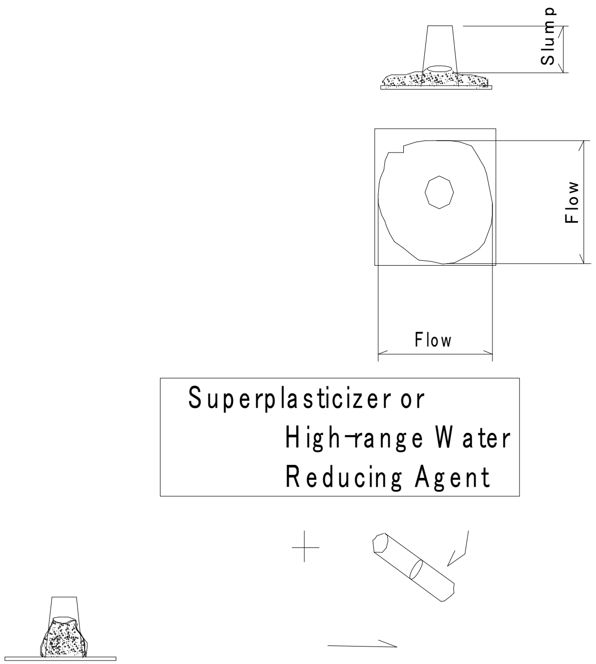


(394) Dosage Content of Superplasticizer and Slump or Flow



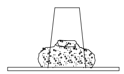
(395) Classification of High-range Water Reducing Agent-Superplasticizer

(395) Classification of High-range Water Reducing Agent－Superplasticizer

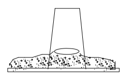


Effection (Same Dosage)

(A) Sulphonated malanie－formaldehyde condensates (SMF) — 0.5



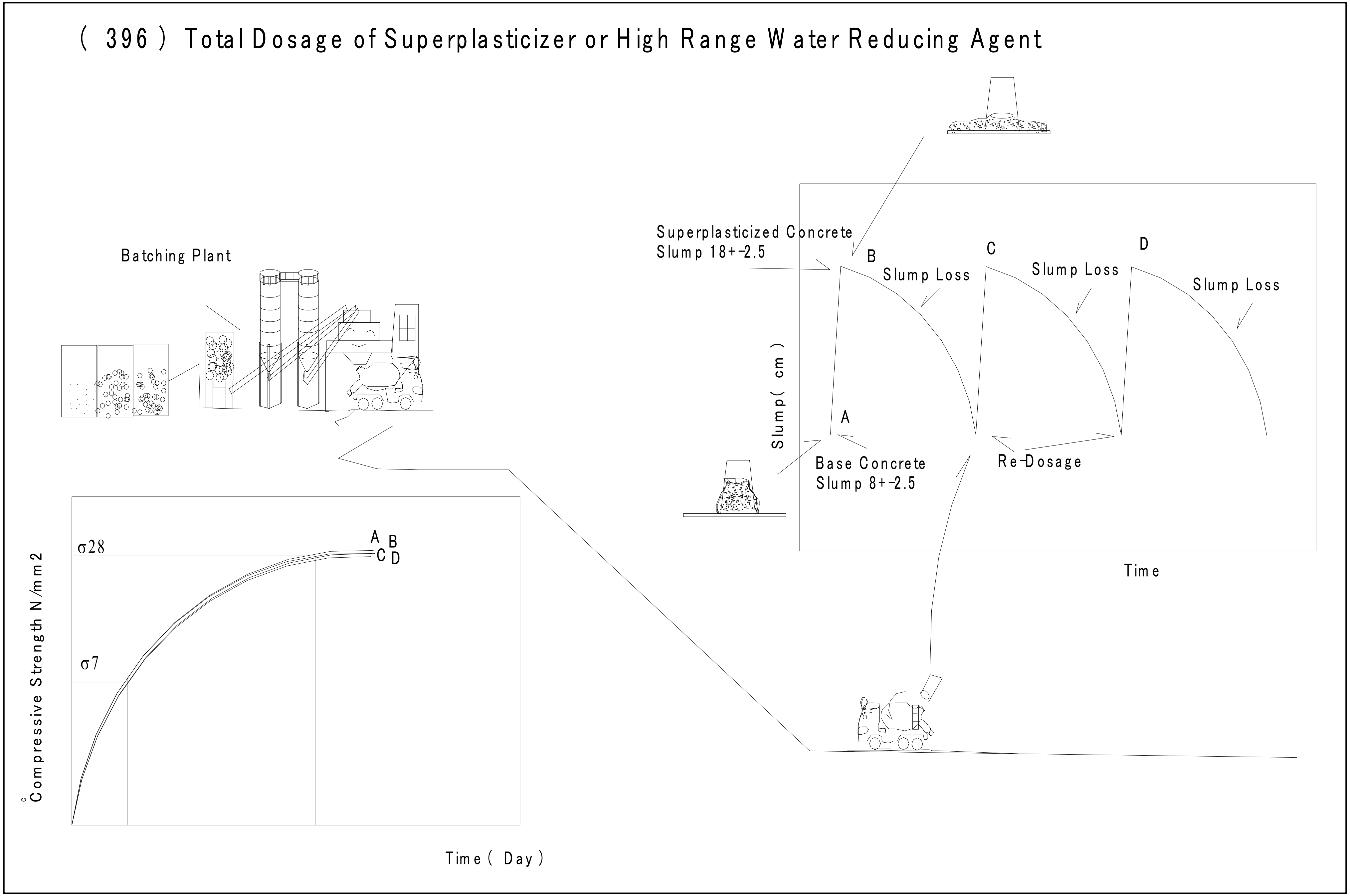
(B) Sulphonated naphthalene－formaldehyde condensates (SNF) — 1



(C) Modified lignosulphonates (MLS)

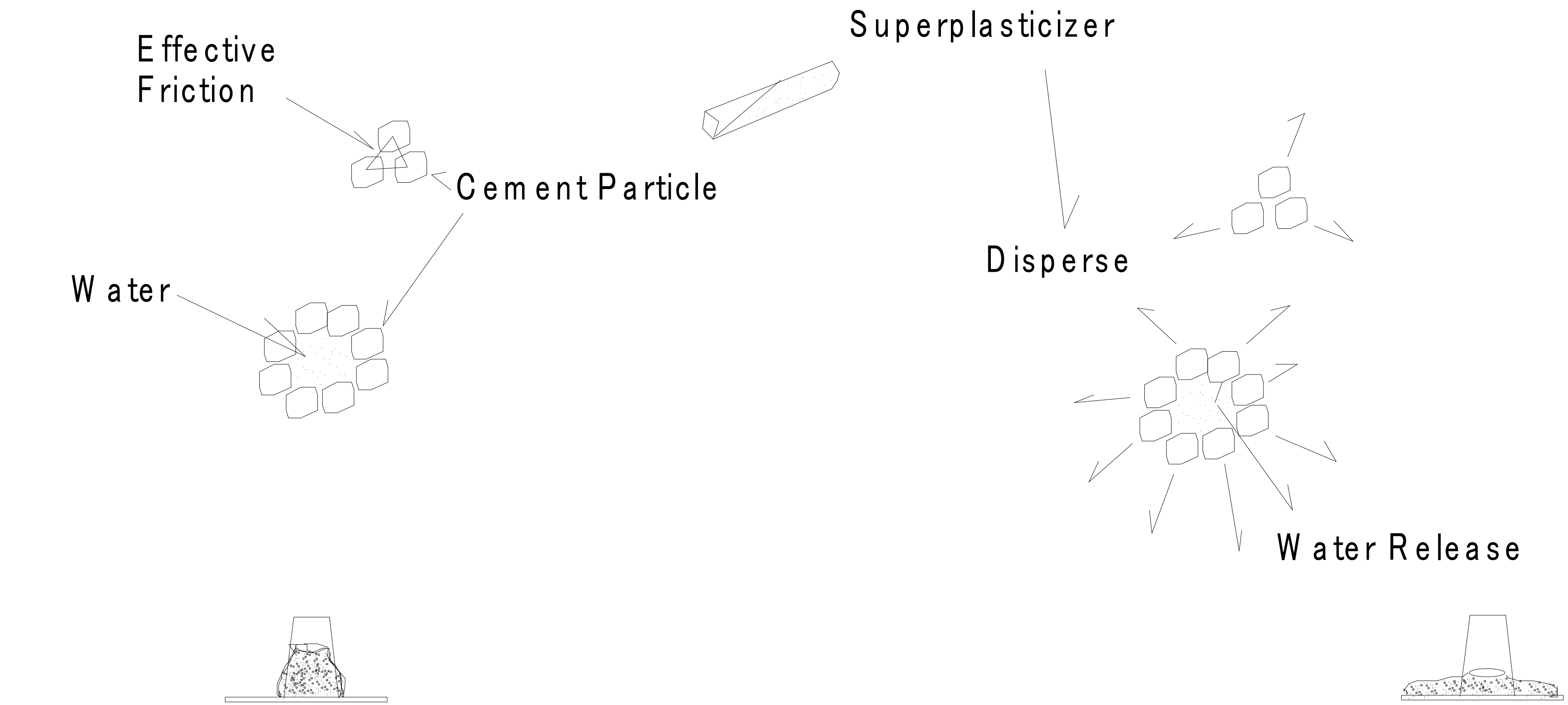
(D) Others types

(396) Total Dosage of Superplasticizer or High Range Water Reducing Agent

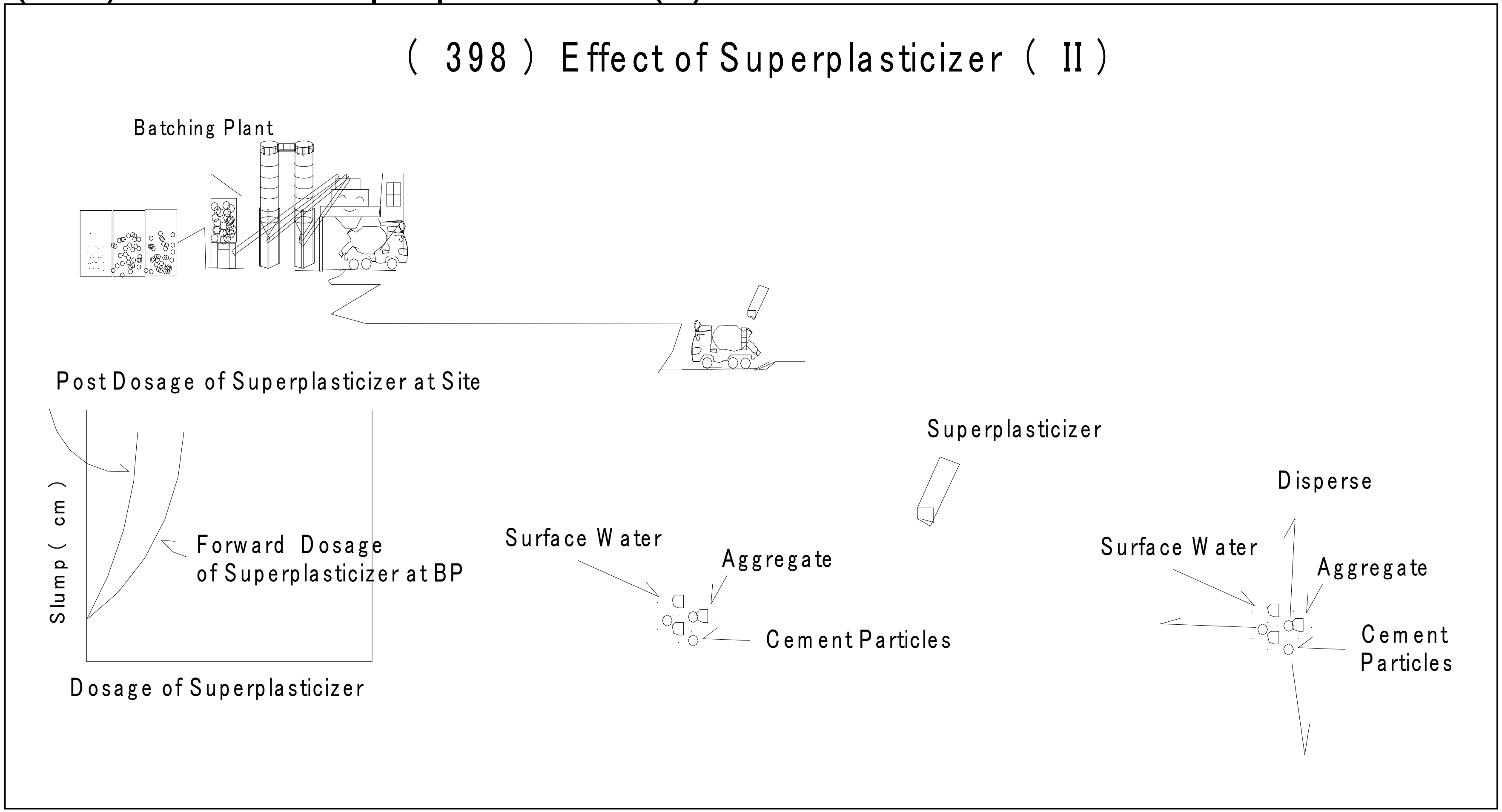


(397) Effect of Superplasticizer or High Range Water Reducing Agent

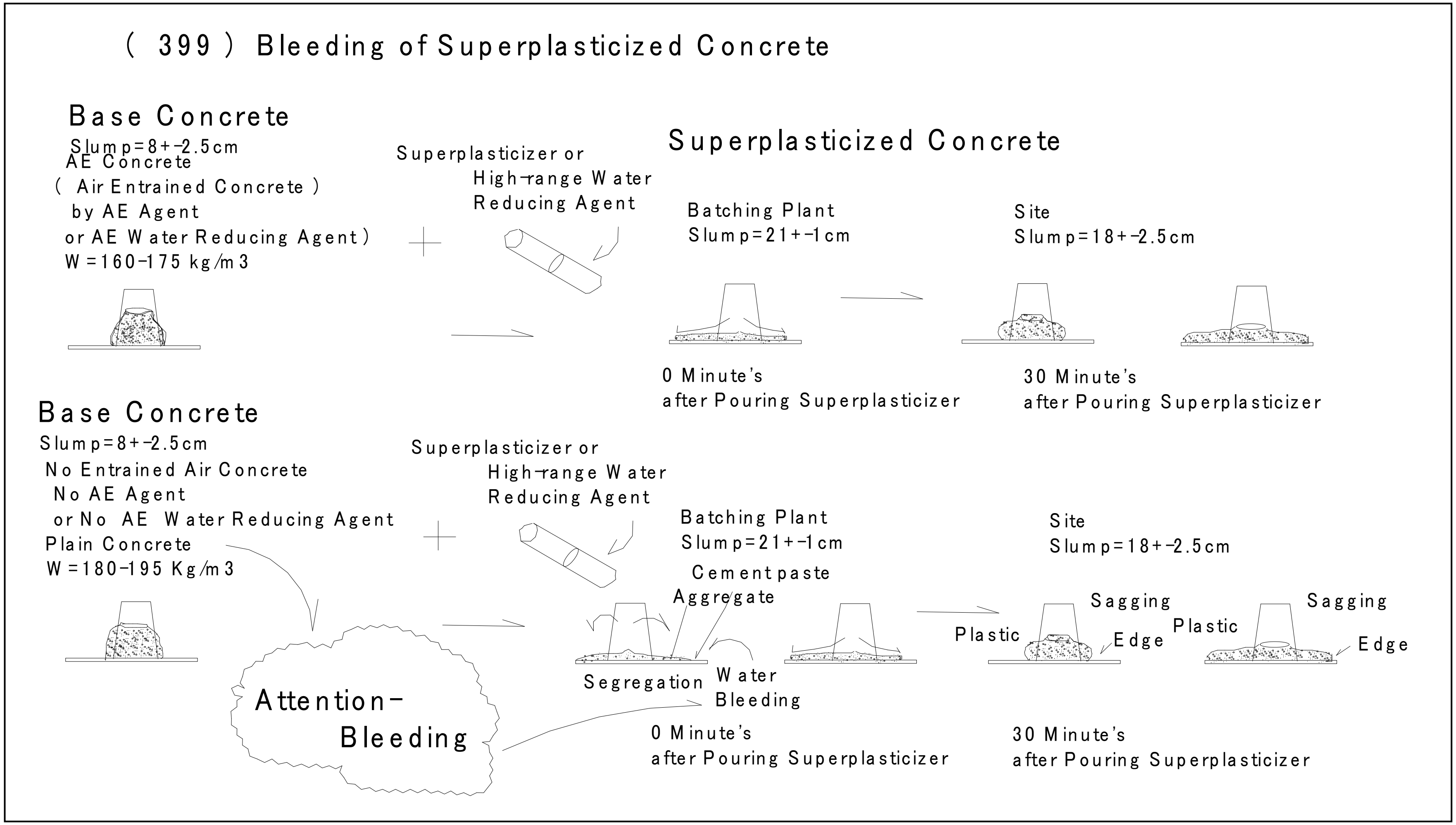
(397) Effect of Superplasticizer or High Range Water Reducing Agent



(398) Effect of Superplasticizer (II)



(399) Bleeding of Superplasticized Concrete



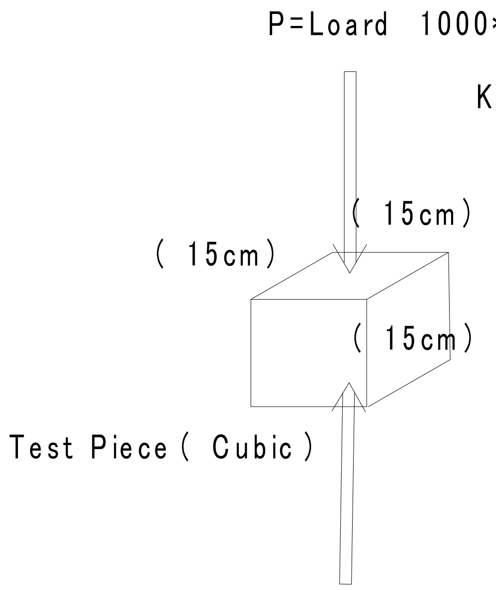
(400) SI Units

(400) SI Units

1 kg/cm2 ——— 0.1N/mm2
2 1kg*cm ——— 100N-mm
3 1kg(f) ——— 10N
4 1t/m ——— 10kN/m
5 1Mpa ——— 1N/mm2=0.1020kg/mm2

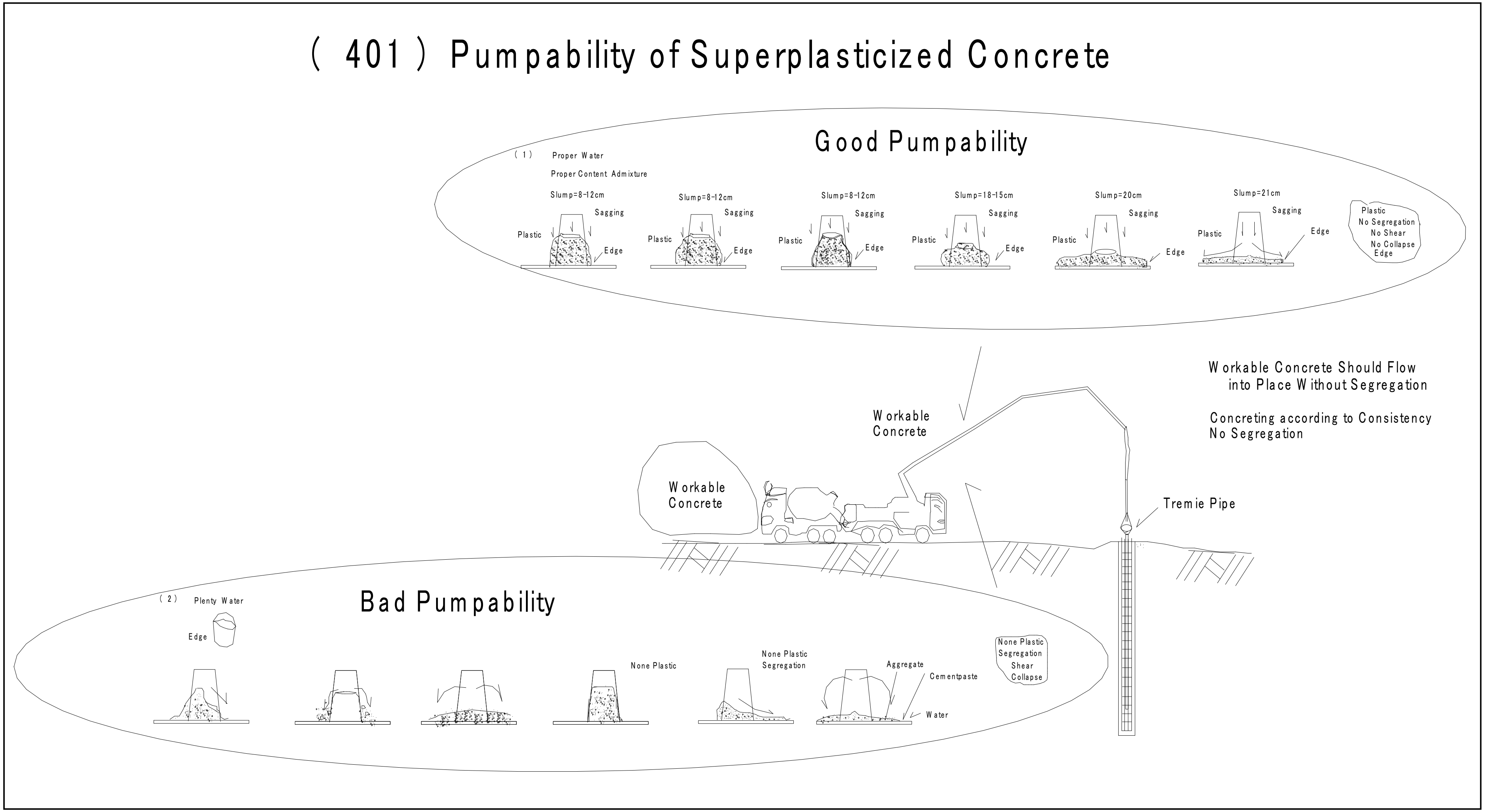
1 1inch ——— 25.4 millimeters=2.54cm
2 1metre ——— 39.37inches=1.09yards

1 12inches ——— 1 foot
2 3 feet ——— 1 yard
3 1 foot ——— 30.48 centimetres=0.3048 metres
4 1 yard ——— 0.9144 metres=91.44 centimetres

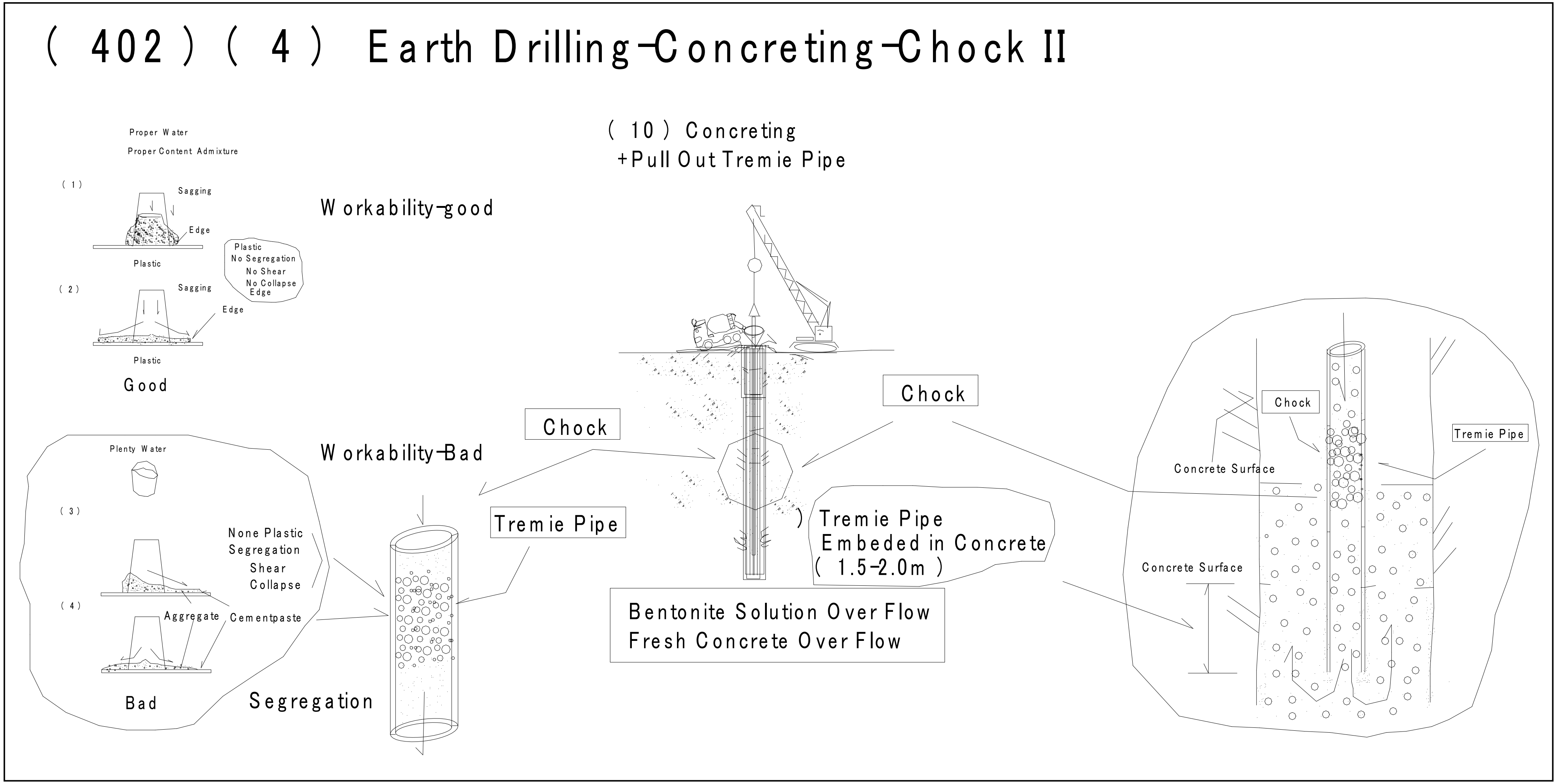


Compressive Strength=P/(area;mm2)
=1000*1000N /(150*150) mm2
=44.4N/mm2=44N/mm2

(401) Pumpability of Superplasticized Concrete

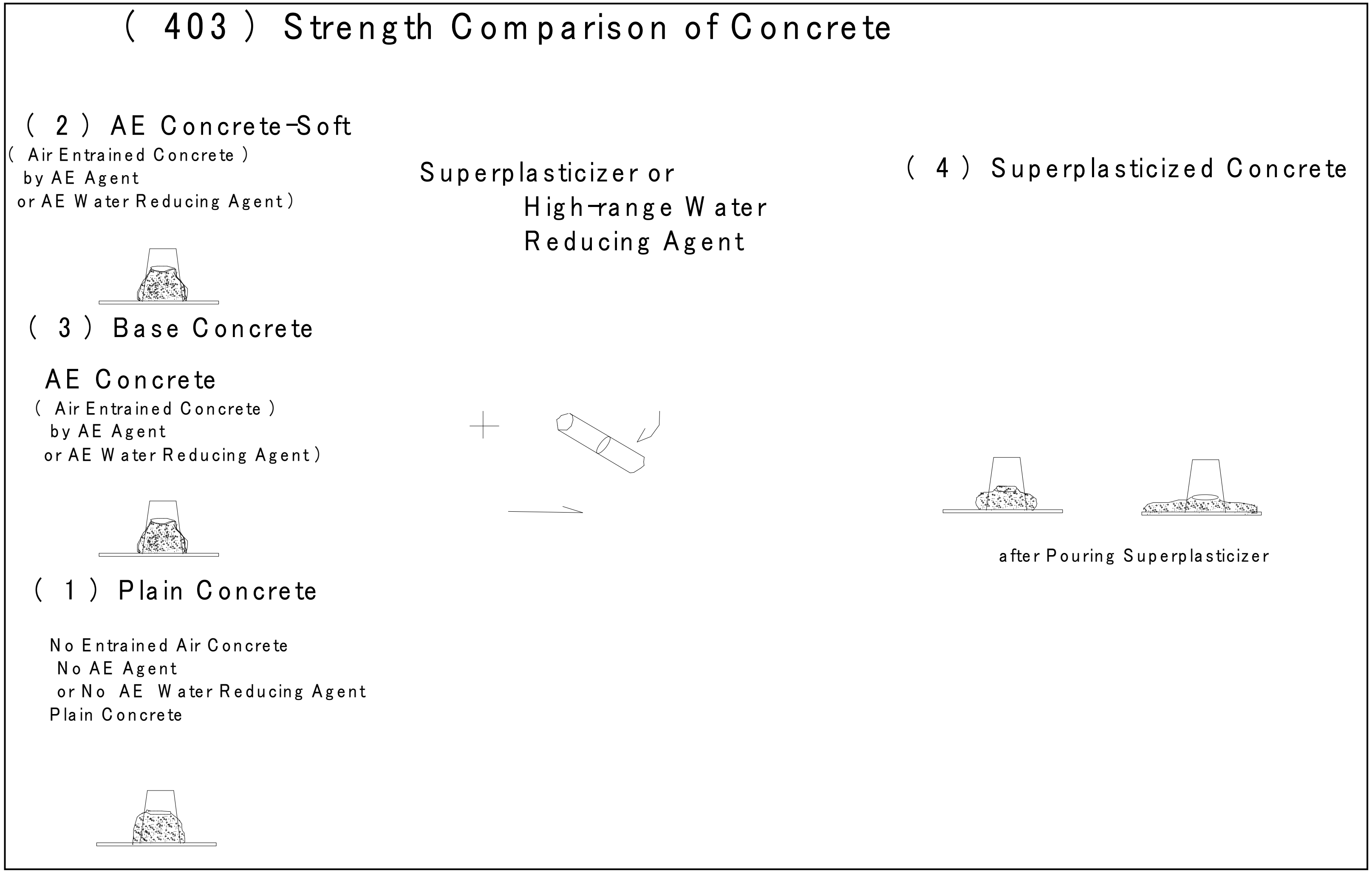


(402) (4) Earth Drilling-Concreting-Chock II



(403) Strength Comparison of Concrete(Cement Content=300kg/m3)

No	Types of Concrete	Slump(Base Concrete)	Air	water cement ratio	sand percentage	Water	Cement	Design Strength 28days	Base Concrete Admixture	Superplasticizer	Remarks
		(SL)		W/C	s/a	W					
		cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(N/mm2)	C*(%)		
1	Plain Concrete	21	1	70	48	210	300	21			
2	AE Concrete(Soft	21	4	61	46	183	300	23	AE Water Reducing Ajent		soft
3	Base Concrete	15	4	55	46	165	300	28	AE Water Reducing Ajent		
4	Superplasticized Concrete	21	4	55	46	165	300	28	AE Ajent	Superplasticizer	



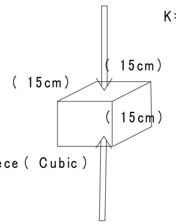
(404) Compressive Strength

(404) Compressive Strength

1 kg/cm2 —— 0.1N/mm2
2 1kg*cm —— 100N-mm
3 1kg(f) —— 10N
4 1t/m —— 10kN/m
5 1Mpa —— 1N/mm2=0.1020kg/mm2

P=Loard 1000*K*N

K=1000



Compressive Strength=P/(area;mm2)
=1000*1000N /(150*150) mm2
=44.4N/mm2=44N/mm2

Test Piece (Cubic)

(KN)	N/mm2												
670	29.8	700	31.1	730	32.4	760	33.8	790	35.1	820	36.4	850	37.8
671	29.8	701	31.2	731	32.5	761	33.8	791	35.2	821	36.5	851	37.8
672	29.9	702	31.2	732	32.5	762	33.9	792	35.2	822	36.5	852	37.9
673	29.9	703	31.2	733	32.6	763	33.9	793	35.2	823	36.6	853	37.9
674	30.0	704	31.3	734	32.6	764	34.0	794	35.3	824	36.6	854	38.0
675	30.0	705	31.3	735	32.7	765	34.0	795	35.3	825	36.7	855	38.0
676	30.0	706	31.4	736	32.7	766	34.0	796	35.4	826	36.7	856	38.0
677	30.1	707	31.4	737	32.8	767	34.1	797	35.4	827	36.8	857	38.1
678	30.1	708	31.5	738	32.8	768	34.1	798	35.5	828	36.8	858	38.1
679	30.2	709	31.5	739	32.8	769	34.2	799	35.5	829	36.8	859	38.2
680	30.2	710	31.6	740	32.9	770	34.2	800	35.6	830	36.9	860	38.2
681	30.3	711	31.6	741	32.9	771	34.3	801	35.6	831	36.9	861	38.3
682	30.3	712	31.6	742	33.0	772	34.3	802	35.6	832	37.0	862	38.3
683	30.4	713	31.7	743	33.0	773	34.4	803	35.7	833	37.0	863	38.4
684	30.4	714	31.7	744	33.1	774	34.4	804	35.7	834	37.1	864	38.4
685	30.4	715	31.8	745	33.1	775	34.4	805	35.8	835	37.1	865	38.4
686	30.5	716	31.8	746	33.2	776	34.5	806	35.8	836	37.2	866	38.5
687	30.5	717	31.9	747	33.2	777	34.5	807	35.9	837	37.2	867	38.5
688	30.6	718	31.9	748	33.2	778	34.6	808	35.9	838	37.2	868	38.6
689	30.6	719	32.0	749	33.3	779	34.6	809	36.0	839	37.3	869	38.6
690	30.7	720	32.0	750	33.3	780	34.7	810	36.0	840	37.3	870	38.7
691	30.7	721	32.0	751	33.4	781	34.7	811	36.0	841	37.4	871	38.7
692	30.8	722	32.1	752	33.4	782	34.8	812	36.1	842	37.4	872	38.8
693	30.8	723	32.1	753	33.5	783	34.8	813	36.1	843	37.5	873	38.8
694	30.8	724	32.2	754	33.5	784	34.8	814	36.2	844	37.5	874	38.8
695	30.9	725	32.2	755	33.6	785	34.9	815	36.2	845	37.6	875	38.9
696	30.9	726	32.3	756	33.6	786	34.9	816	36.3	846	37.6	876	38.9
697	31.0	727	32.3	757	33.6	787	35.0	817	36.3	847	37.6	877	39.0
698	31.0	728	32.4	758	33.7	788	35.0	818	36.4	848	37.7	878	39.0
699	31.1	729	32.4	759	33.7	789	35.1	819	36.4	849	37.7	879	39.1

880	39.1	930	41.3	980	43.6	1030	45.8	1080	48.0	1130	50.2	1180	52.4	1230	54.7
881	39.2	931	41.4	981	43.6	1031	45.8	1081	48.0	1131	50.3	1181	52.5	1231	54.7
882	39.2	932	41.4	982	43.6	1032	45.9	1082	48.1	1132	50.3	1182	52.5	1232	54.8
883	39.2	933	41.5	983	43.7	1033	45.9	1083	48.1	1133	50.4	1183	52.6	1233	54.8
884	39.3	934	41.5	984	43.7	1034	46.0	1084	48.2	1134	50.4	1184	52.6	1234	54.8
885	39.3	935	41.6	985	43.8	1035	46.0	1085	48.2	1135	50.4	1185	52.7	1235	54.9
886	39.4	936	41.6	986	43.8	1036	46.0	1086	48.3	1136	50.5	1186	52.7	1236	54.9
887	39.4	937	41.6	987	43.9	1037	46.1	1087	48.3	1137	50.5	1187	52.8	1237	55.0
888	39.5	938	41.7	988	43.9	1038	46.1	1088	48.4	1138	50.6	1188	52.8	1238	55.0
889	39.5	939	41.7	989	44.0	1039	46.2	1089	48.4	1139	50.6	1189	52.8	1239	55.1
890	39.6	940	41.8	990	44.0	1040	46.2	1090	48.4	1140	50.7	1190	52.9	1240	55.1
891	39.6	941	41.8	991	44.0	1041	46.3	1091	48.5	1141	50.7	1191	52.9	1241	55.2
892	39.6	942	41.9	992	44.1	1042	46.3	1092	48.5	1142	50.8	1192	53.0	1242	55.2
893	39.7	943	41.9	993	44.1	1043	46.4	1093	48.6	1143	50.8	1193	53.0	1243	55.2
894	39.7	944	42.0	994	44.2	1044	46.4	1094	48.6	1144	50.8	1194	53.1	1244	55.3
895	39.8	945	42.0	995	44.2	1045	46.4	1095	48.7	1145	50.9	1195	53.1	1245	55.3
896	39.8	946	42.0	996	44.3	1046	46.5	1096	48.7	1146	50.9	1196	53.2	1246	55.4
897	39.9	947	42.1	997	44.3	1047	46.5	1097	48.8	1147	51.0	1197	53.2	1247	55.4
898	39.9	948	42.1	998	44.4	1048	46.6	1098	48.8	1148	51.0	1198	53.2	1248	55.5
899	40.0	949	42.2	999	44.4	1049	46.6	1099	48.8	1149	51.1	1199	53.3	1249	55.5
900	40.0	950	42.2	1000	44.4	1050	46.7	1100	48.9	1150	51.1	1200	53.3	1250	55.6
901	40.0	951	42.3	1001	44.5	1051	46.7	1101	48.9	1151	51.2	1201	53.4	1251	55.6
902	40.1	952	42.3	1002	44.5	1052	46.8	1102	49.0	1152	51.2	1202	53.4	1252	55.6
903	40.1	953	42.4	1003	44.6	1053	46.8	1103	49.0	1153	51.2	1203	53.5	1253	55.7
904	40.2	954	42.4	1004	44.6	1054	46.8	1104	49.1	1154	51.3	1204	53.5	1254	55.7
905	40.2	955	42.4	1005	44.7	1055	46.9	1105	49.1	1155	51.3	1205	53.6	1255	55.8
906	40.3	956	42.5	1006	44.7	1056	46.9	1106	49.2	1156	51.4	1206	53.6	1256	55.8
907	40.3	957	42.5	1007	44.8	1057	47.0	1107	49.2	1157	51.4	1207	53.6	1257	55.9
908	40.4	958	42.6	1008	44.8	1058	47.0	1108	49.2	1158	51.5	1208	53.7	1258	55.9
909	40.4	959	42.6	1009	44.8	1059	47.1	1109	49.3	1159	51.5	1209	53.7	1259	56.0
910	40.4	960	42.7	1010	44.9	1060	47.1	1110	49.3	1160	51.6	1210	53.8	1260	56.0
911	40.5	961	42.7	1011	44.9	1061	47.2	1111	49.4	1161	51.6	1211	53.8	1261	56.0
912	40.5	962	42.8	1012	45.0	1062	47.2	1112	49.4	1162	51.6	1212	53.9	1262	56.1
913	40.6	963	42.8	1013	45.0	1063	47.2	1113	49.5	1163	51.7	1213	53.9	1263	56.1
914	40.6	964	42.8	1014	45.1	1064	47.3	1114	49.5	1164	51.7	1214	54.0	1264	56.2
915	40.7	965	42.9	1015	45.1	1065	47.3	1115	49.6	1165	51.8	1215	54.0	1265	56.2
916	40.7	966	42.9	1016	45.2	1066	47.4	1116	49.6	1166	51.8	1216	54.0	1266	56.3
917	40.8	967	43.0	1017	45.2	1067	47.4	1117	49.6	1167	51.9	1217	54.1	1267	56.3
918	40.8	968	43.0	1018	45.2	1068	47.5	1118	49.7	1168	51.9	1218	54.1	1268	56.4
919	40.8	969	43.1	1019	45.3	1069	47.5	1119	49.7	1169	52.0	1219	54.2	1269	56.4
920	40.9	970	43.1	1020	45.3	1070	47.6	1120	49.8	1170	52.0	1220	54.2	1270	56.4
921	40.9	971	43.2	1021	45.4	1071	47.6	1121	49.8	1171	52.0	1221	54.3	1271	56.5
922	41.0	972	43.2	1022	45.4	1072	47.6	1122	49.9	1172	52.1	1222	54.3	1272	56.5
923	41.0	973	43.2	1023	45.5	1073	47.7	1123	49.9	1173	52.1	1223	54.4	1273	56.6
924	41.1	974	43.3	1024	45.5	1074	47.7	1124	50.0	1174	52.2	1224	54.4	1274	56.6
925	41.1	975	43.3	1025	45.6	1075	47.8	1125	50.0	1175	52.2	1225	54.4	1275	56.7
926	41.2	976	43.4	1026	45.6	1076	47.8	1126	50.0	1176	52.3	1226	54.5	1276	56.7
927	41.2	977	43.4	1027	45.6	1077	47.9	1127	50.1	1177	52.3	1227	54.5	1277	56.8
928	41.2	978	43.5	1028	45.7	1078	47.9	1128	50.1	1178	52.4	1228	54.6	1278	56.8
929	41.3	979	43.5	1029	45.7	1079	48.0	1129	50.2	1179	52.4	1229	54.6	1279	56.8

(405) Cement-1

(405) Cement-1

(42) Types of Portland Cement

ASTM C 150

Type I	Normal
Type II	Normal,air-entraining
Type III	High Early Strength
Type IV	Low heat of hydration
Type V	High Sulfate Resistance

(43) Type I

ASTM C 150

Type I

Normal or general use cements include highway pavements,floors,bridges, and buildings.

(47) Fly ash:Workability

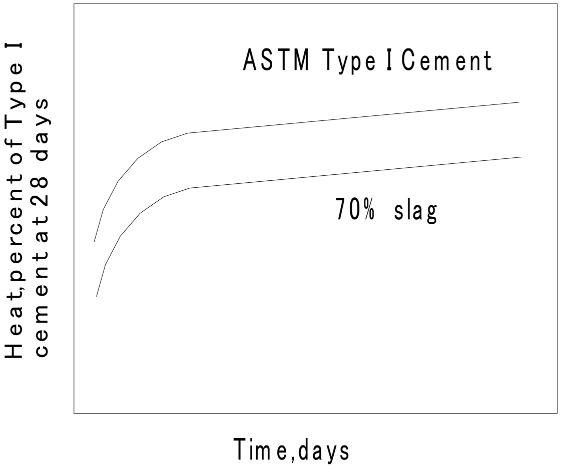
Fly ash improve workabilityof concrete of equal cement.

Silica fume may contribute to stickiness of a concrete mixture ;adjustments;including the use of high range water reducers,may be required to maintain workability and compaction and finishing.

(48) Silica fume:Pumpability

Silica fume is the most effective pumpability, especially in lean mixtures.

(49) Effect of a slag on heat of hydration



(119) Concrete Material(1)

Cement

Blended Cement-(Blast-Furnance Slag Cement, Portland Pozzolan Cement,Silica Cement,Fly Ash Cement)

Special Cement-(Alumina Cement,Ultra Rapid Harding Cement)

Sulfate Resisting Portland Cement

Moderate Heat Portland Cement

Ultra High Early Strength Portland Cement

High Early Strength Portland Cement

Ordinary Portland Cement

(124) Ordinary Portland Cement

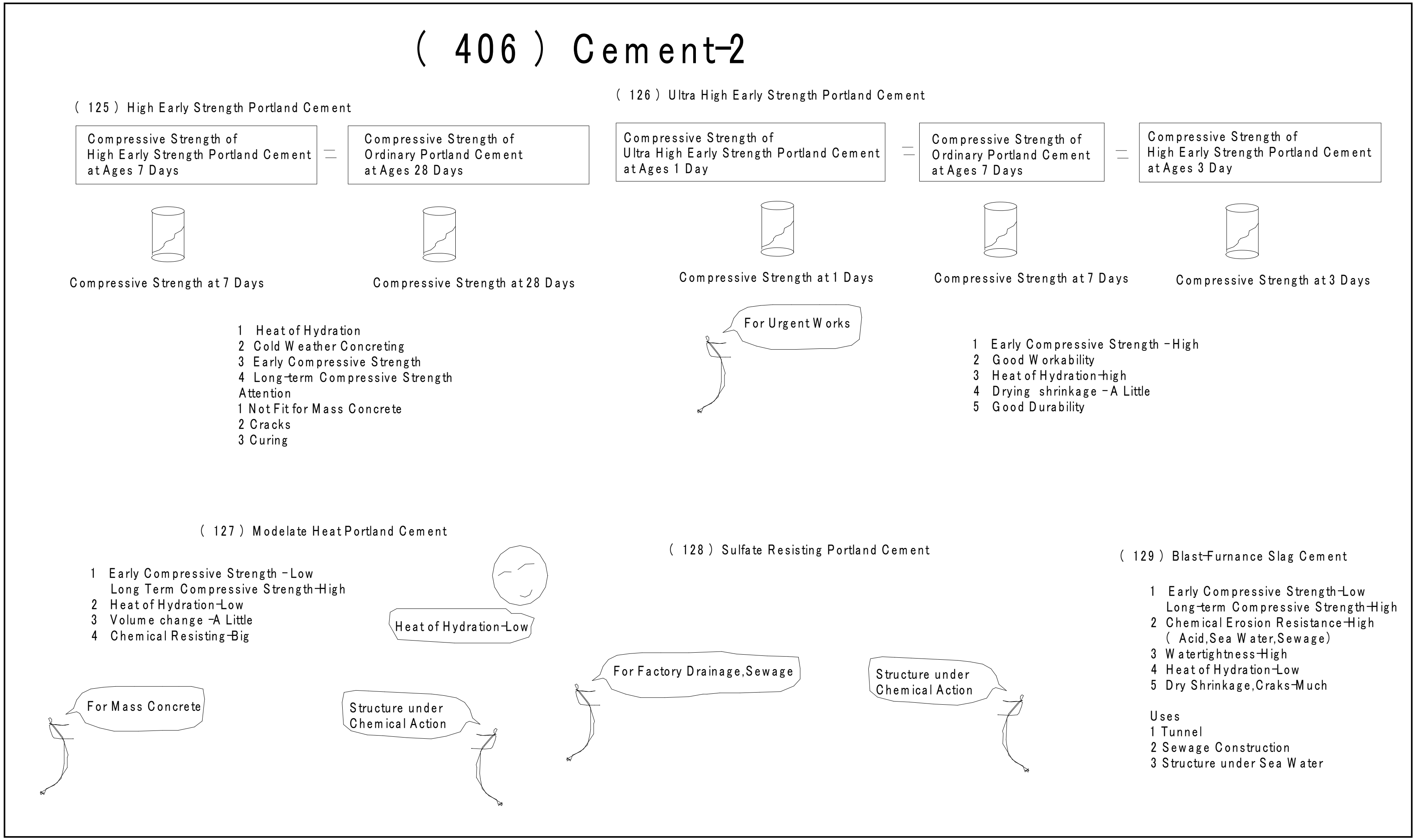
1 90 %

2 Popular

3 Improve by Admixture

4 Block,Pipe,Building,Pavement,Port Construction Wall,Drainage,Tunnel,Dam,River Construction,Bridge

(406) Cement-2



(406) Cement-2
(125) High Early Strength Portland Cement
Compressive Strength of High Early Strength Portland Cement at Ages 7 Days = Compressive Strength of Ordinary Portland Cement at Ages 28 Days
Compressive Strength at 7 Days
Compressive Strength at 28 Days
1 Heat of Hydration
2 Cold Weather Concreting
3 Early Compressive Strength
4 Long-term Compressive Strength
Attention
1 Not Fit for Mass Concrete
2 Cracks
3 Curing
(126) Ultra High Early Strength Portland Cement
Compressive Strength of Ultra High Early Strength Portland Cement at Ages 1 Day = Compressive Strength of Ordinary Portland Cement at Ages 7 Days = Compressive Strength of High Early Strength Portland Cement at Ages 3 Day
Compressive Strength at 1 Days
Compressive Strength at 7 Days
Compressive Strength at 3 Days
For Urgent Works
1 Early Compressive Strength -High
2 Good Workability
3 Heat of Hydration-high
4 Drying shrinkage -A Little
5 Good Durability
(127) Modelate Heat Portland Cement
1 Early Compressive Strength -Low
Long Term Compressive Strength-High
2 Heat of Hydration-Low
3 Volume change -A Little
4 Chemical Resisting-Big
Heat of Hydration-Low
For Mass Concrete
Structure under Chemical Action
(128) Sulfate Resisting Portland Cement
For Factory Drainage,Sewage
Structure under Chemical Action
(129) Blast-Furnance Slag Cement
1 Early Compressive Strength-Low
Long-term Compressive Strength-High
2 Chemical Erosion Resistance-High
(Acid,Sea Water,Sewage)
3 Watertightness-High
4 Heat of Hydration-Low
5 Dry Shrinkage,Craks-Much
Uses
1 Tunnel
2 Sewage Construction
3 Structure under Sea Water

(407) Cement-3

(407) Cement-3

(130) Silica Cement

1 Early Compressive Strength-Low
Long-term Compressive Strength-High
2 Chemical Resistance-High
(Sea Water)
3 Watertightness-High
4 Heat of Hydration-Low
5 Dry Shrinkage,Craks-Much
6 Fluidity-Big

Uses
1 River,Port Structure
2 Factory Sewage,Sewage Construction
3 Structure under Sea Water

(131) Fly-Ash Cement

1 Early Compressive Strength-Low
Long-term Compressive Strength-High
2 Chemical Erosion Resistance-High
(Acid,Sea Water,Sewage)
3 Watertightness-High
4 Heat of Hydration-Low
5 Dry Shrinkage,Cracks-Low
6 Fluidity-High

Uses
1 Dam
2 Structure under Water

A Fly Ash Content 5-10%
B Fly Ash Content 10-20%
C Fly Ash Content 20-30%

(132) Almina Cement

1 Early Compressive Strength-High

2 Chemical Resistance-High
(Acid,Sea Water,Sewage)
3 Durability to Heat-High
4 Heat of Hydration-High
5 Reinforcement-Rust

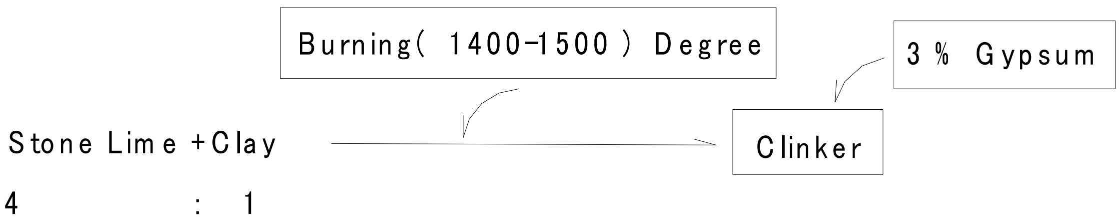
Uses
1 Urgent Construction

Attention
1 W/C Below 40-45%
2 Curing Temperature below 20-25 degree

(133) Ultra High Early Strength Portland Cement

1 Early Compressive Strength-High
2 Long Term Compressive Strength-High
3 Setting Time -Short
About 100kg/cm2 after 3 Hours
Concrete Finish within 30 Minute's

(134) Cement Ingredient



(408) Cement-4

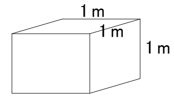
(408) Cement-4

Cement Type	Compound (Weight %)			
	C3S	C2S	C3A	C4AF
Ordinary Portland Cement	50	26	9	90
Moderate Portland Cement	48	30	5	11
High Early Strength Portland Cement	67	9	8	8
Ultra High Early Strength Portland Cement	68	6	8	8
Sulfate Resisting Portland Cement	57	23	2	13
	C3S	C2S	C3A	C4AF
	Early Strength-High	Long Term Strength-High	Hydration Velocity-Quick	Strength-Low
	Hydration Heat-High	Hydration Heat-Low	Hydration Heat-High	Hydration Heat-Low
			Shrinkage-Much	Shrinkage-Low

(135) Cement Ingredient(2)

(136) Cement Weight

Burning Temperature,Fineness,Burning Temperature,
Weathering(Aeration)



1m3=1500kg

(137) Cement Specific Gravity

Burning Temperature,Fineness,Burning Temperature,
Weathering(Aeration)

Cement Specific Gravity-High
-Burning Temperature-High

Cement Specific Gravity-Low
-Burning Temperature-Low

(138) Cement Fineness

Cement Specific Gravity ← Effect ← Weathering(Aeration)

Burning Temperature	Cement Specific Gravity
High	Big
Low	Small

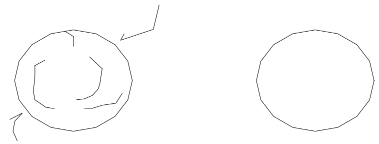
(139) Cement Setting

Fineness	Quick
Water Temperature	Quick
Temperature	Quick
Gypsum Content	Slow
Aeration	Slow

(140) Cement Soundness

Cement Soundness Test

Cement Paste → Hardening



Cracks,Expansion

(409) Cement-5

(409) Cement-5

(141) Cement Strength

Mortar Strength Test

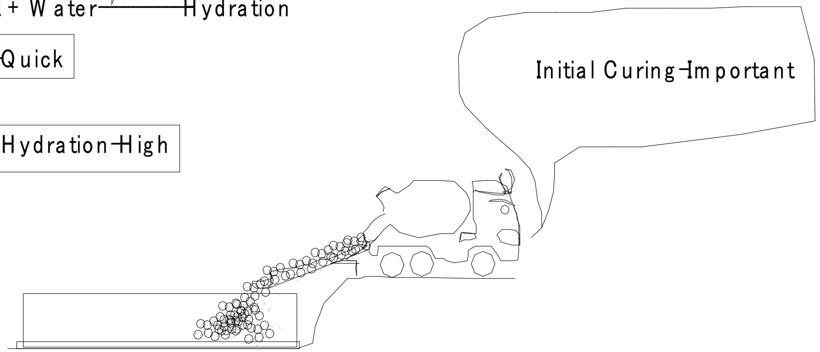
(142) Heat of Hydration

Heat

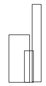
Cement + Water — Hydration

Setting-Quick

Heat of Hydration-High



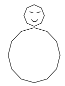
(143) Cement Choice



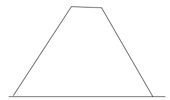
Building -11

Emergency Construction-11,5,6,9,10

Port Construction-11,1,3,4,7



Cold-Weather Concreting-11,6,9,10



Dam-8,4,11

Cement

Blended Cement-

1 Blast-Furnance Slag Cement,

2 Portland Pozzolan Cement,

3 Silica Cement,

4 Fly Ash Cement

Special Cement -

5 Alumina Cement,

6 Ultra Rapid Harding Cement

7 Sulfate Resisting Portland Cement

8 Moderate Heat Portland Cement

9 Ultra High Early Strength Portland Cement

10 High Early Strength Portland Cement

11 Ordinary Portland Cement

(172) Pozzolan

Fly Ash

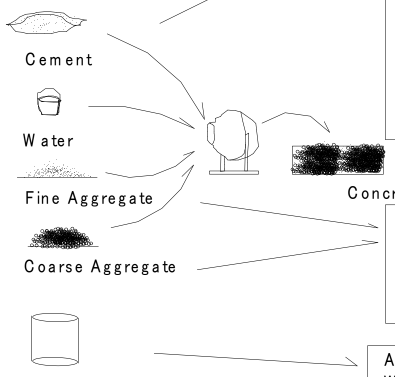
1 Early Compressive Strength-Low
  Long-term Compressive Strength-High
2 Chemical Erosion Resistance-High
  (Acid,Sea Water,Sewage)
3 Watertightness-High
4 Heat of Hydration-Low
5 Dry Shrinkage,Cracks-Low
6 Fluidity-High

Uses
1 Dam
2 Structure under Water

A Fly Ash Content 5-10%
B Fly Ash Content 10-20%
C Fly Ash Content 20-30%

Fly Ash
1 Improve Workability
2 Decrease Bleeding
3 Decrease Heat of Hydration
4 Improve Strength and Water Tightness under Wet Curing
5 Improve Chemical Erosion Resistance
6 Dry Shrinkage,Cracks-Low
7 Improve Consistency
8 Decrease Unit Water Content

410-171 Admixture



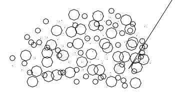
Cement
Blended Cement－(Blast-Furnance Slag Cement, Portland Pozzolan Cement,Silica Cement,Fly Ash Cement)
Special Cement－(Alumina Cement,Ultra Rapid Harding Cement)
Sulfate Resisting Portland Cement
Moderate Heat Portland Cement
Ultra High Early Strength Portland Cement
High Early Strength Portland Cement
Ordinary Portland Cement

Aggregate
Sand
Crushed Sand
Gravel
Crushed Stone

Admixture
Water Reducing Agent
Accelerator
Retarder
Water Proof Agent

AE Agent——AE Concrete

AE Agent



Ball Bearing

(173) AE Agent

Entrained Air
1 Improve Workability
2 Decrease Bleeding
3 Improve Resisting to Freezing and thawing Action
4 Decrease Water Content
5 Cold -Weather Concreting
6 Decrease Segregation

(174) Water Reducing Agent

Water Reducing Agent
1 Spread Cement Particles
2 Improve Hydration
3 Improve Strength
4 Decrease Water Content
5 Save Cement Content
6 Improve Workability

1 High Strength Concrete——800-1000kg/cm2
2 Fluidized Concrete——Slump 7cm Base Concrete
3 High Slump Concrete——Slump 14cm

(177) Water Proofing Agent

1 Decrease Absorption and Permeability
2 AE Agent Reducing Agent

(176) Retarder

1 Delay Cement Setting
2 Cold-Weather Concreting
3 Transport for Long Time
4 Mass Concrete

1 Improve Early Age Strength
2 Increase Hydration Heat

(175) Accelerator

1 Remve Form Quickly
2 Shorten Curing Period
3 Improve Hardening in Cold Weather Concrete

Calcium Chloride=1-2% of Cement Weight

1 Improve Early Age Strength
2 Increase Hydration Heat

411-241 Batching Plant

411-241 Batching Plant

(9) Batching Plant

Test Cylinder

ASTM C 172
ASTM C 31
ACI 318

No of Cubic Maters in Any	No of Cubic Maters in Any
0-38	One for each 20 cubic meters
39-150	One for each 40 cubic meters
151-270	One for each 60 cubic meters
Greater than 270	One for each 75 cubic meters

(25) Calibration

ACI 304 R

Batching Plant Equipment
Calibtared

Calibration

(26) Batching Plant
Water

ASTM C 94

Water
pH 5~8.5

Drinking
Water

Sea Water

(240) Batching Plant

(18) Batching Plant
Percentage of Accuracy

(ASTM C 94,C 685)

(4) Measuring Material
Accuracy

Cement

Water

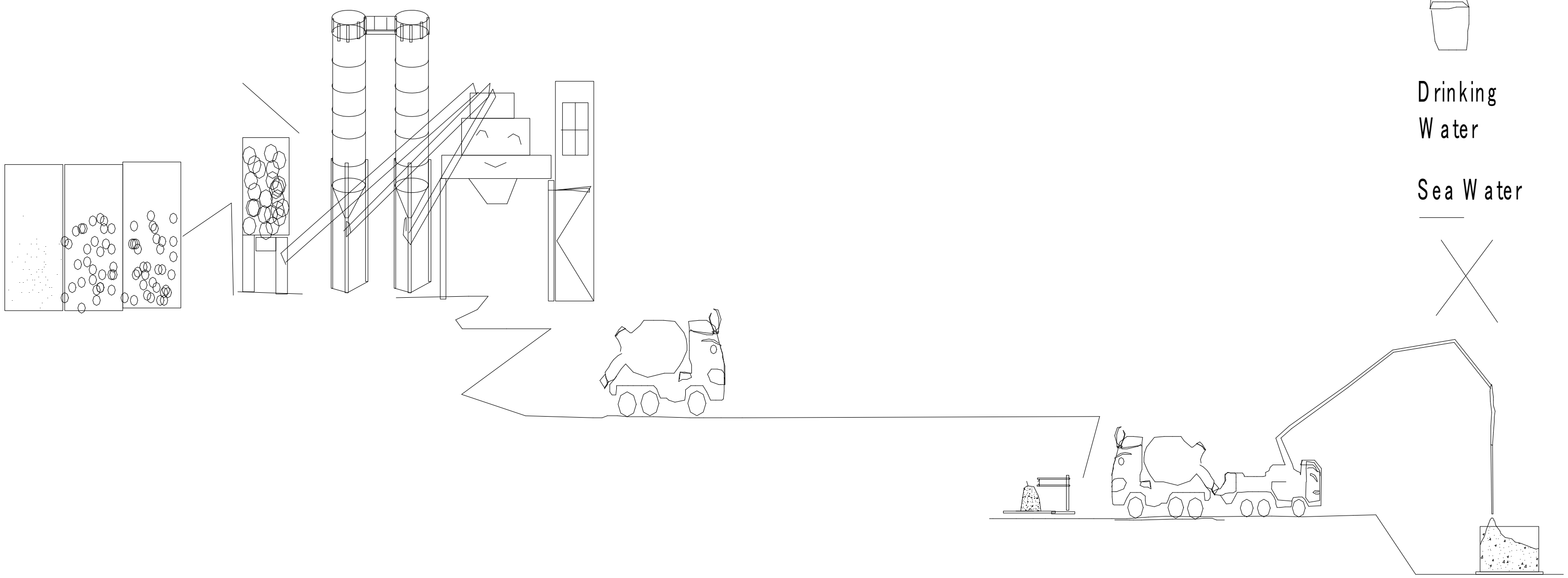
Admixture

1%

Fine Aggregate

Coarse Aggregate

2%



Bathing Plant
Mixing About 1 Minutes
Loading About 2-3 Minutes

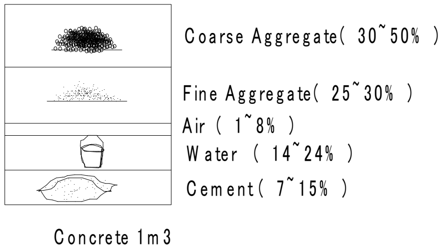
Transporting About 30 Minutes
Waiting About 20 Minutes

Unloading
(Concrteteing About 12 Minutes)

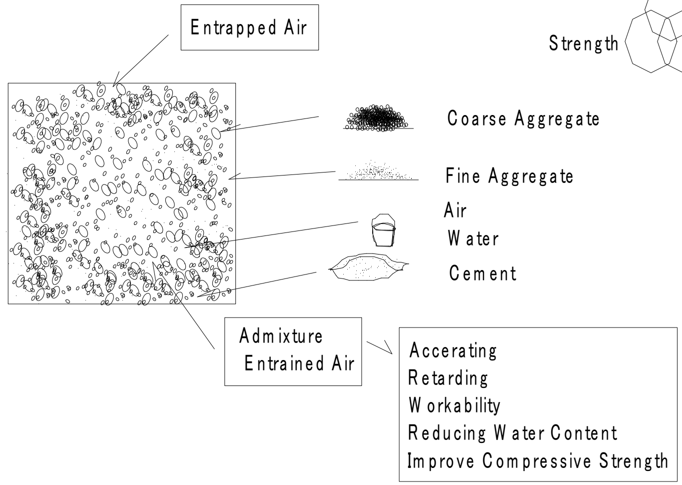
(412) Aggregate and Sand -1

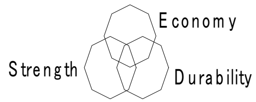
412-Aggregate and Sand

(28) Concrete Volume

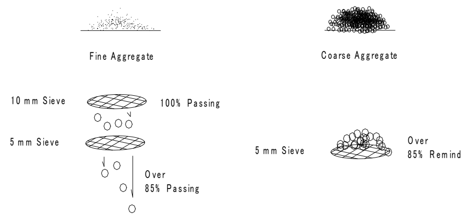


(56) Concrete Mix Proportion

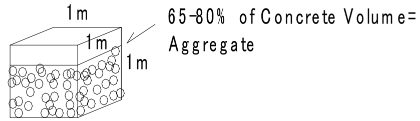




(145) Kind of Aggregate



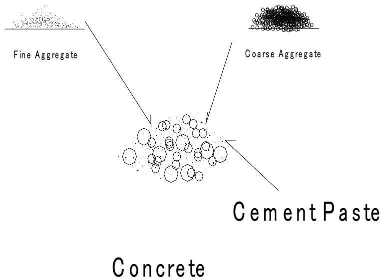
Kind of Aggregate
- Sand
- Gravel
- Crushed Sand
- Crushed Stone



(146) Required Aggregate

1 Hard
2 No Clay,No Timber
3 Durability
4 Specific Gravity-Big
5 Unit Weight-Big
6 No Abrasion
7 Small Absorption
8 Good Shape
9 Good Grading

(147) Size and Grading of Aggregate(1)



(152) Specific Gravity of Aggregate

Fine Aggregate	2.5-2.65
Coarse Aggregate	2.55-2.70

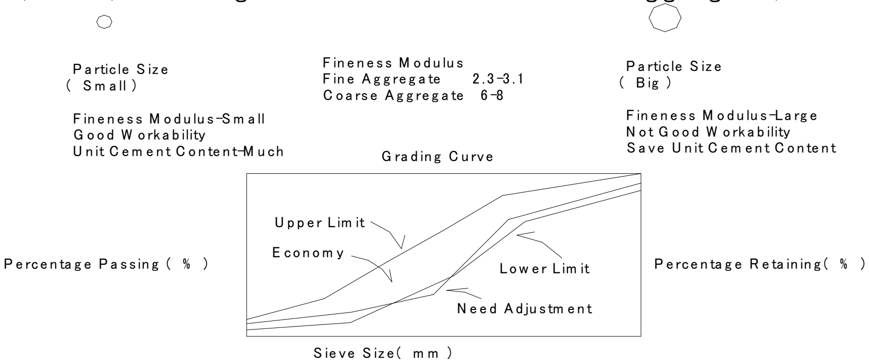
Weathering
Specific Gravity-Small

Use for Mix Design

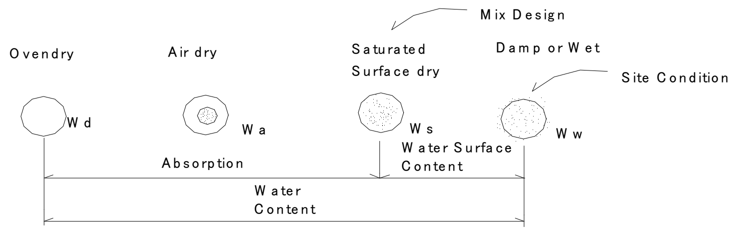
(413) Aggregate and Sand-2

413 aggregate and Sand-2

(150) Grading and Fineness Modulus of Aggregate (3)



(151) Water Content of Aggregate



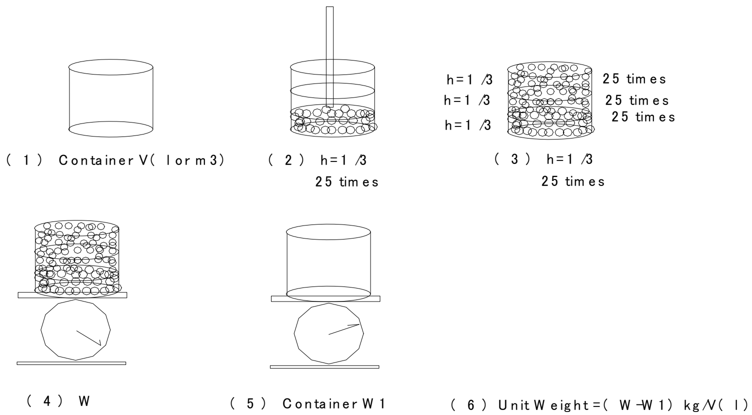
Water Surface Content Ratio =((Ww-Ws)/Ws)*100

Specific Gravity (S.S.D) =Ws/Wd

Absorption Ratio =((Ws-Wd)/Wd)*100

Moisture Content Ratio =((Ww-Wd)/Wd)*100

(160) Unit Weight (2)



(158) Absolute Volume

Absolute Volume (m3) =Weight (kg) /(Specific Gravity*1000 (kg/m3))

(159) Unit Weight

Unit Weight

Air Dried State

Unit Weight ← Specific Gravity, Grading, Degree of Compaction, Water Content

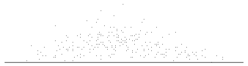
Effect

Unit Weight	
Fine Aggregate	1450-1700 kg/m3
Coarse Aggregate	1550-1850kg/m3
Combined Aggregate	1750-2000kg/m3

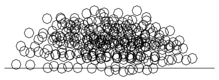
414-Aggregate and Sand-3

414 -Aggregate and Sand-3

(162) Harmful Material of Aggregate



Fine Aggregate



Coarse Aggregate

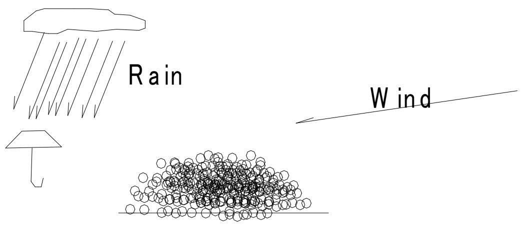
Aggregate

1 Clean

2 Not Include Clay,Silt and Harmful Material

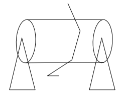
(164) Durability of Aggregate

Specific Gravity → Big
Absorption Ratio → Small
→ Good Durability



(165) Abrasion

Los-Angels Abrasion Test
Road Pavement
Heavy Traffic



1000 Times

1000 Times
1.7mm Sieve
Retained Weight
Percentage of Abrasio
=((Abrasion Loss Weight/Sample Weight Before Test)) *100

Road Pavement-35%
Dam Concrete-40%

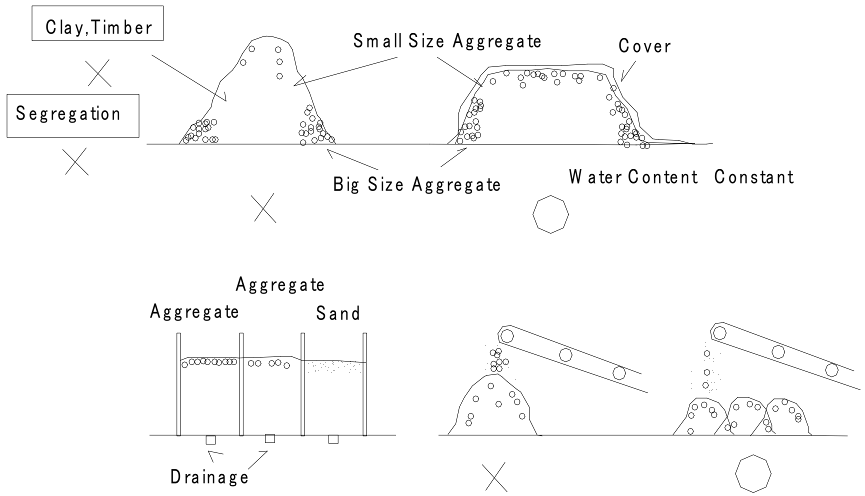
(167) Lightweight Aggregate

Below 1.9t/m3

(166) Crushed Stone

	Crushed Stone	River Gravel
Shape	Square	Round
Void Ratio	Big	Small
Fluidity	Bad	Good
Fine Aggregate Content, Water, Cement	Much	Not Much

(168) Storage of Aggregate



415-Aggregate and Sand-4

221 Unit Water and Sand Percentage of Concrete

River Sand, River Gravel, W/C=55%, Slump=5cm, FM=2.75

Maximum Size of Aggregate	No Admixture			AE Concrete				
	Entrapped Air	Sand Percentage	Unit Water of Concrete	Air Content (Strict Weather)	Good Quality AE Agent		Good Quality Water Reducing Agent	
					Sand Percentage	Unit Water of Concrete	Sand Percentage	Unit Water of Concrete
(mm)	(%)	(%)	(kg)	(%)	(%)	(kg)	(%)	(kg)
15	2.5	49	187	7	46	169	47	156
20	2	45	181	6	42	162	43	150
25	1.5	41	172	5	37	153	38	143
40	1.2	36	160	4.5	33	141	34	131
50	1	33	152	4	30	131	31	122
80	0.5	31	139	3.5	28	117	28.5	109
150	0.3	28	120	3	24	100	24	93

229 Maximum Size of Aggregate and Slump

Type of Concrete	Type of Structure	Maximum Size of Aggregate (mm)		Slump (cm)
Plain Concrete			Standard Below 100mm. Not Over (1/4) Minimum Size of Structure, Water Tightness Concrete Not Over 1/5	2.5-8
Reinforcement Concrete	Normal	25	Below 50mm. Not Over (1/5) Minimum Size of Structure, Not Over 3/4 Reinforced Bar Interval	5-12
	Big Section	40		2.5-10
	Water tightness			Below 8
Concrete Pavement		Below 40		2.5
Dam Concrete		Below 150		3-5

75-ACI 211.1 Table A1.5.3.6 Volume of Coarse Aggregate per Unit Volume of Concrete (SI)

Maximum Size of Coarse Aggregate	Fineness Modules of Fine Aggregate			
	2.4	2.6	2.8	3
10	0.5	0.48	0.46	0.44
12.5	0.59	0.57	0.55	0.53
20	0.66	0.64	0.62	0.6
25	0.71	0.69	0.67	0.65
40	0.76	0.74	0.72	0.7
50	0.78	0.76	0.74	0.72
70	0.81	0.79	0.77	0.75
150	0.87	0.85	0.83	0.81

ASTM C29 Unit Weight of Concrete

69 70 ACI 211.1 Table 5.3.3 -Approximate Mixing Water and Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate (SI)

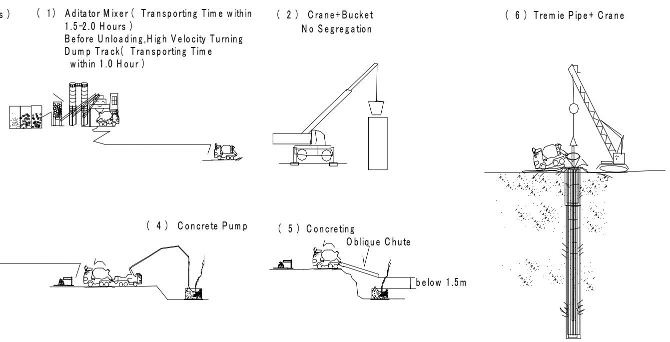
Slump (cm)	Aggregate Maximum Dimension (mm)							
	10	12.5	20	25	40	50	70	150
Plain Concrete								
3-5	205	200	185	180	160	155	145	125
8-10	225	215	200	195	175	170	160	140
15-18	240	230	210	205	185	180	170	–
Entrapped Air (%)	3	2.5	2	1.5	1	0.5	0.3	0.2
AE Concrete								
3-5	180	175	165	160	145	140	135	120
8-10	200	190	180	175	160	155	150	135
15-18	215	205	190	185	170	165	160	–
Air Content(	8	7	6	5	4.5	4	3.5	3

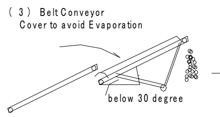
(416) Concreting-1

416 Concreting-1

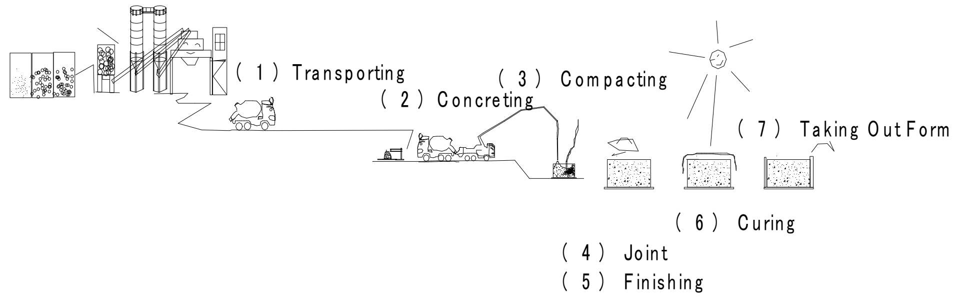
(54) Methods of Concrete Transporting

Methods of Concrete Transporting
1 Aditator Mixer (Transporting Time within 1.5-2.0 Hours)
Before Unloading,High Velocity Turning
Dump Track(Transporting Time within 1.0 Hour)
2 Crane+Bucket
No Segregation
3 Belt Conveyor
Cover to avoid Evaporation
4 Concrete Pump
Plastic and Workable
5 Chute
6 Tremie Pipe +Crane

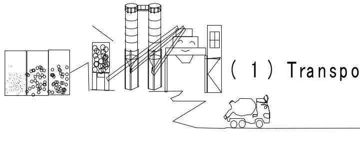


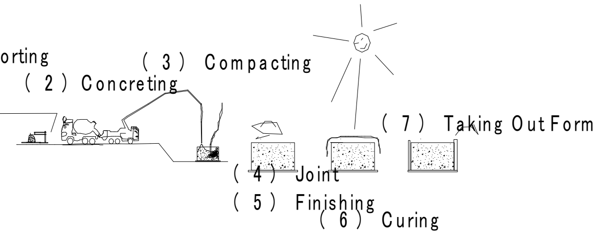


(325) Concreting



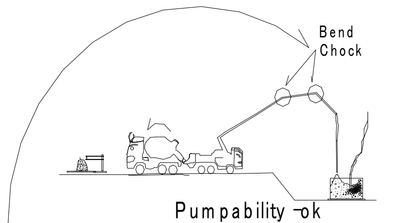
(326) Transporting of Concrete





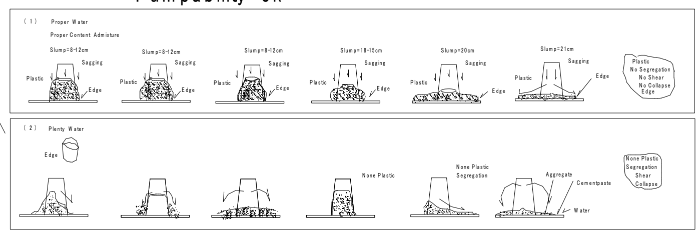
Transporting of Concrete
1 No Segregation
2 No Slump Loss
3 No Air Content Loss
4 Within 90 Minute's (Temperature Over 25 Degree)
Within 180 Minute's (Temperature Below 25 Degree)
5 Transporting by Dump Track,Slump 2.5cm Pavement Concrete

(328) Concrete Pump



(a) Slump, 8-18cm.
(b) Maximum Size of Coarse Aggregate , below 40mm.
(c) Reduce Pumping Pipe Bend as much as possible. Horizontal or Down Direction.
(d) Before Pumping ,Send Mortar.

Pumpability -ok



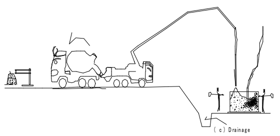
Pumpability -No Good

(417) Concreting -2

417 Concreting-2

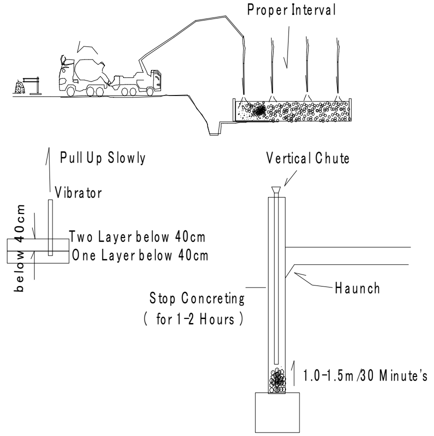
(329) Concreting

(a) Check Reinforcement and Form
(b) Keep Members of Transporting,Concreting,Compacting
and Curing.
(c) Drainage

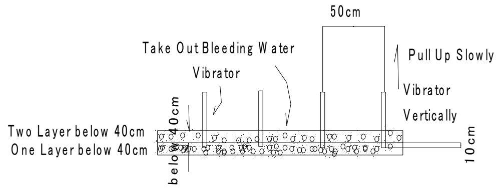


(330) Attention of Concreting

(a) Distribute Concrete Propoerly
(b) Concreting Continiouly
(c) Concreting Velocity Verticaly
1.0-1.5m /30 Minute's
(d) Concreting One Layer
below 40cm
(e) High Structure,Use Vertical Chute
(f) Take Out Bleedind Water
(g) Concreting Temperature
Cold Weather Concrete ,5-20 degree
Hot Weather Concrete,below 30 degree
Mass Concrete ,Low Temperature
(h) Pier,Wall,and Slab
Stop Concreting below Haunch

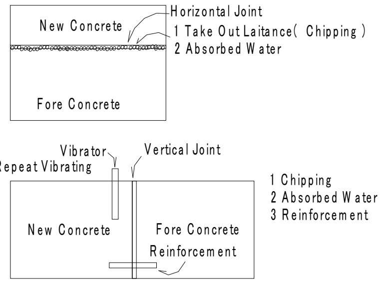


(331) Compaction of Concrete



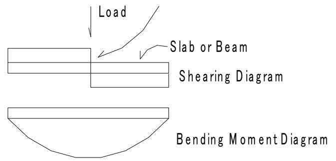
Repeat Vibrator
Reduce Voids in Concrete

(332) Joints of Concrete



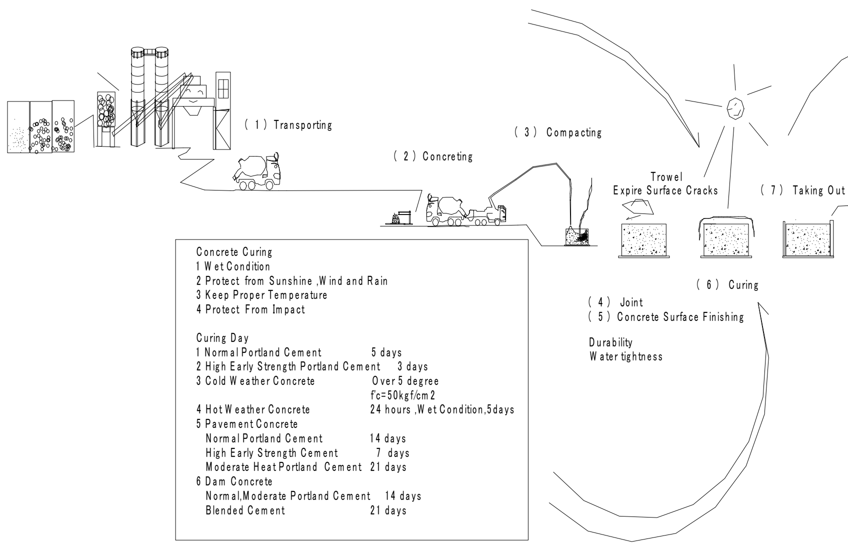
1 Chipping
2 Absorbed Water
3 Reinforcement

1 Joints are setted at Small Shearing Force



2 Water Cement Ratio of Mortal is Below W/C of New Concrete

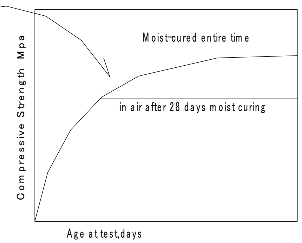
(334) Concrete Curing



Concrete Curing
1 Wet Condition
2 Protect from Sunshine ,Wind and Rain
3 Keep Proper Temperature
4 Protect From Impact

Curing Day
1 Normal Portland Cement 5 days
2 High Early Strength Portland Cement 3 days
3 Cold Weather Concrete Over 5 degree
f'c=50kgf/cm2
4 Hot Weather Concrete 24 hours ,Wet Condition,5days
5 Pavement Concrete
Normal Portland Cement 14 days
High Early Strength Cement 7 days
Moderate Heat Portland Cement 21 days
6 Dam Concrete
Normal,Moderate Portland Cement 14 days
Blended Cement 21 days

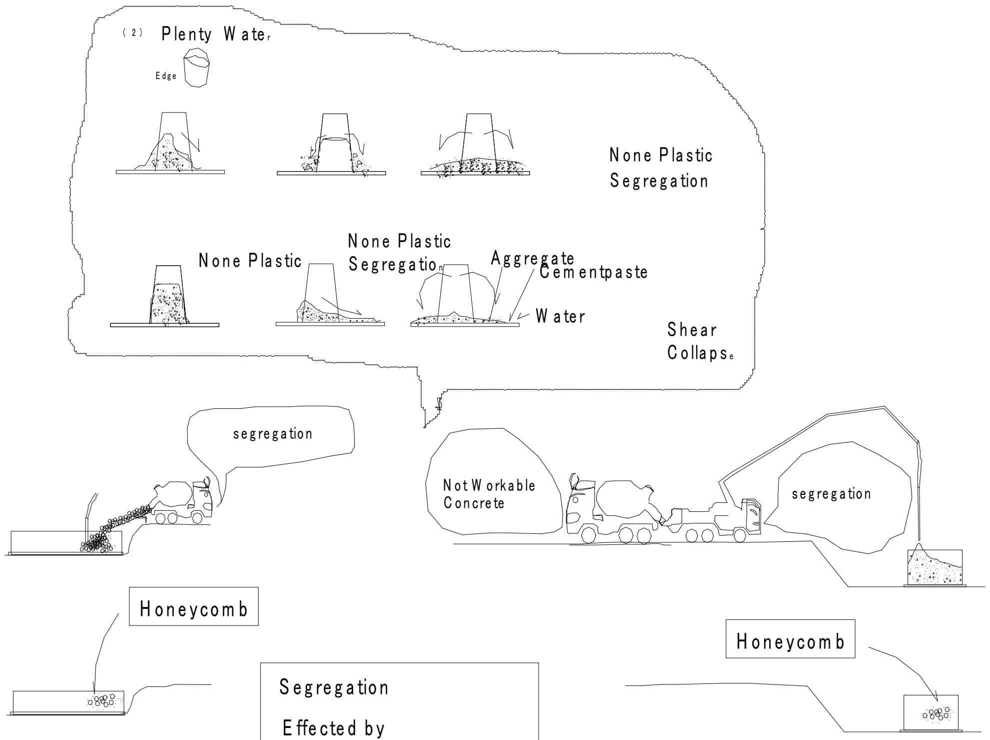
(37) Hardened Concrete Curing



Concrete strength increase with ages
as long as moisture and a favorable temperature

(418) Concreting-3

(343) Segregation

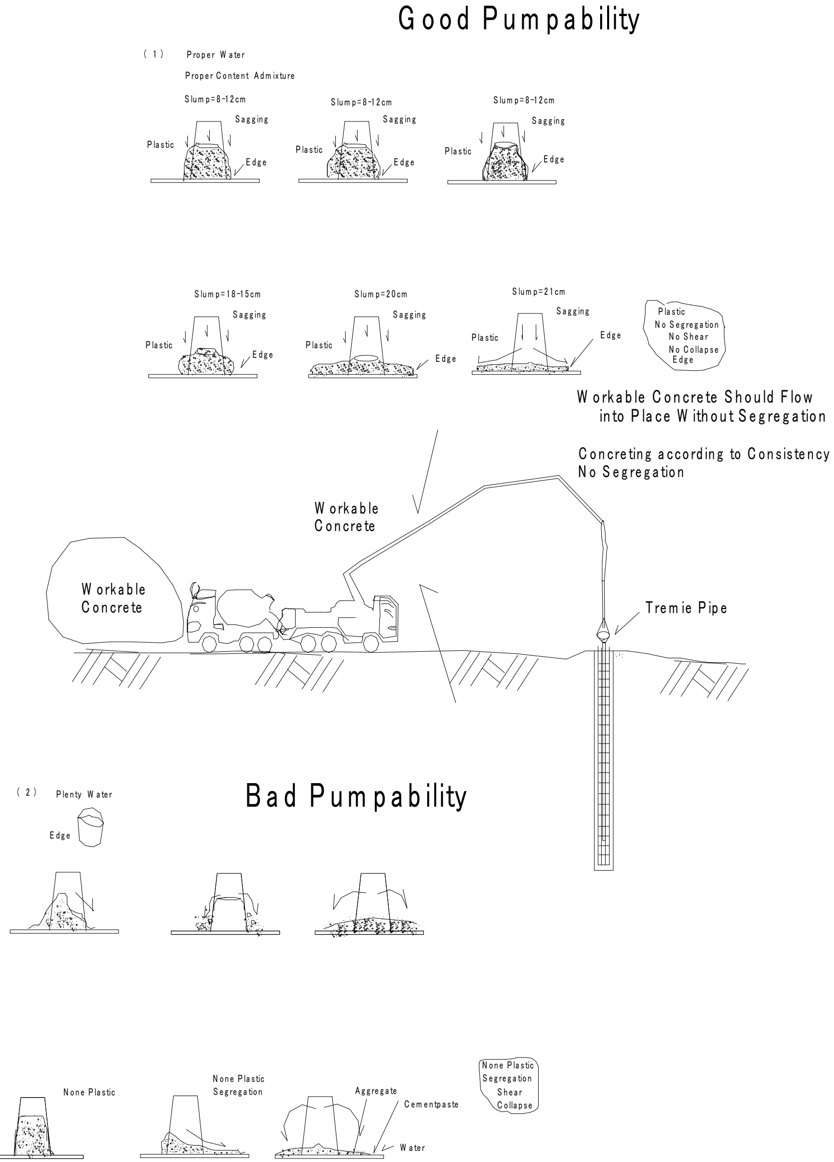


Segregation

Effected by
1 Plenty Water
2 Dropping Concrete
3 Not Enough Compacting

Not Proper Mix Proportion
1 Transportation
2 Unproper Construction, Over Compacting
-Segregation
3 Bleeding-Bond Strength between Reinforcement and Forms -Decrease
Watertightness-Decrease
4 G Max-Bigger-Segregation Increase
5 AE Agent, AE Water Reducing Agent-Ressist Segregation

(401) Pumpability of Superplasticized Concrete



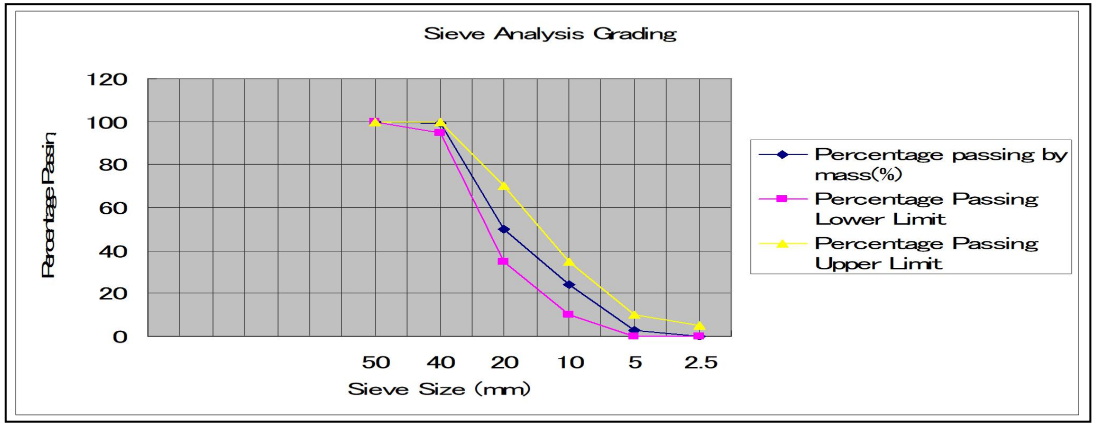
(419) Aggregate and Sand-5

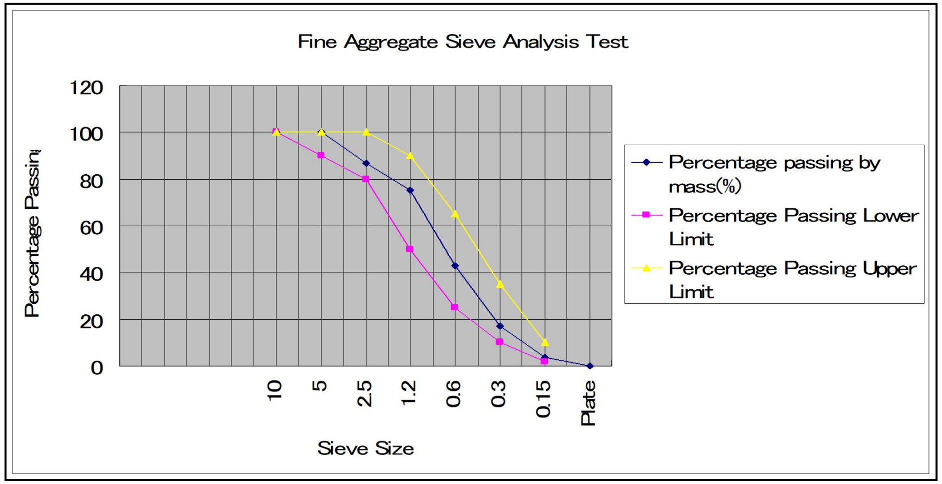
149 Sieve Analysis Test,Coarse Aggregate

Sieve Size (mm)	Cumulative Percentage retained by mass		Percentage of individual fraction retained by mass		Percentage passing by mass
	(g)	(%)	(g)	(%)	(%)
50	0	0	0	0	100
40	148	1	148	1	99
30	2540	17	2392	16	83
25	4787	32	2247	15	68
20	7492	50	2705	18	50
15	9745	65	2253	15	35
10	11401	76	1656	11	24
5	14556	97	3155	21	3
2.5	15000	100	444	3	0
1.2					
0.6					
0.3					
0.15					
Plate					
Total			15000	100	
Fineness Modulus	=(1+50+76+97+100+400)/100=7.24		Maximum Size of Coarse Aggregate (mm)=40mm		

148 Sieve Analysis Test

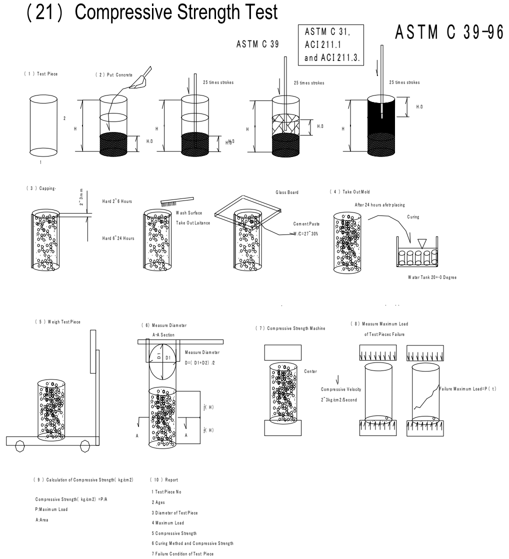
Sieve Size (mm)	Cumulative Percentage retained by mass		Percentage of individual fraction retained by mass		Percentage passing by mass
	(g)	(%)	(g)	(%)	(%)
10	0	0	0	0	100
5	0	0	0	0	100
2.5	65	13	65	13	87
1.2	124	25	59	12	75
0.6	286	57	162	32	43
0.3	415	83	129	26	17
0.15	481	96	66	13	4
Plate	500	100	19	4	0
Total			500	100	
Fineness Modulus	=(13+25+57+83+96)/100=2.74				





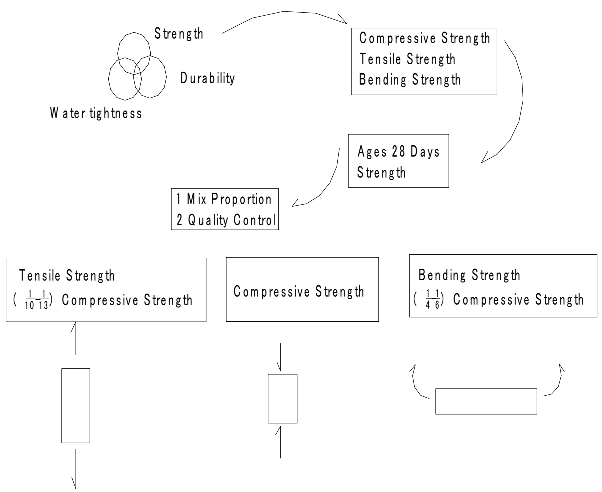
(420) Compressive Strength-1

(21) Compressive Strength Test

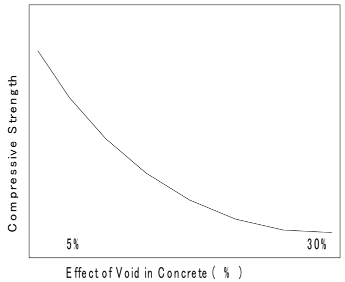


Concrete continues to gain strength for many years when moisture is provided by rainfall

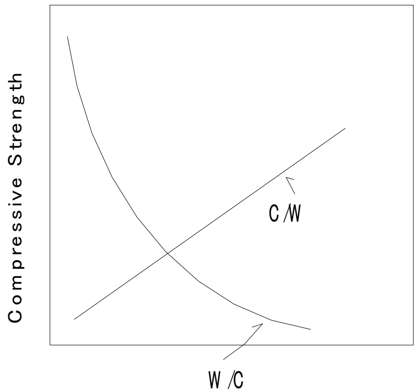
(191) Compressive Strength of Concrete



(36) Effect of Void in Concrete and Compressive Strength



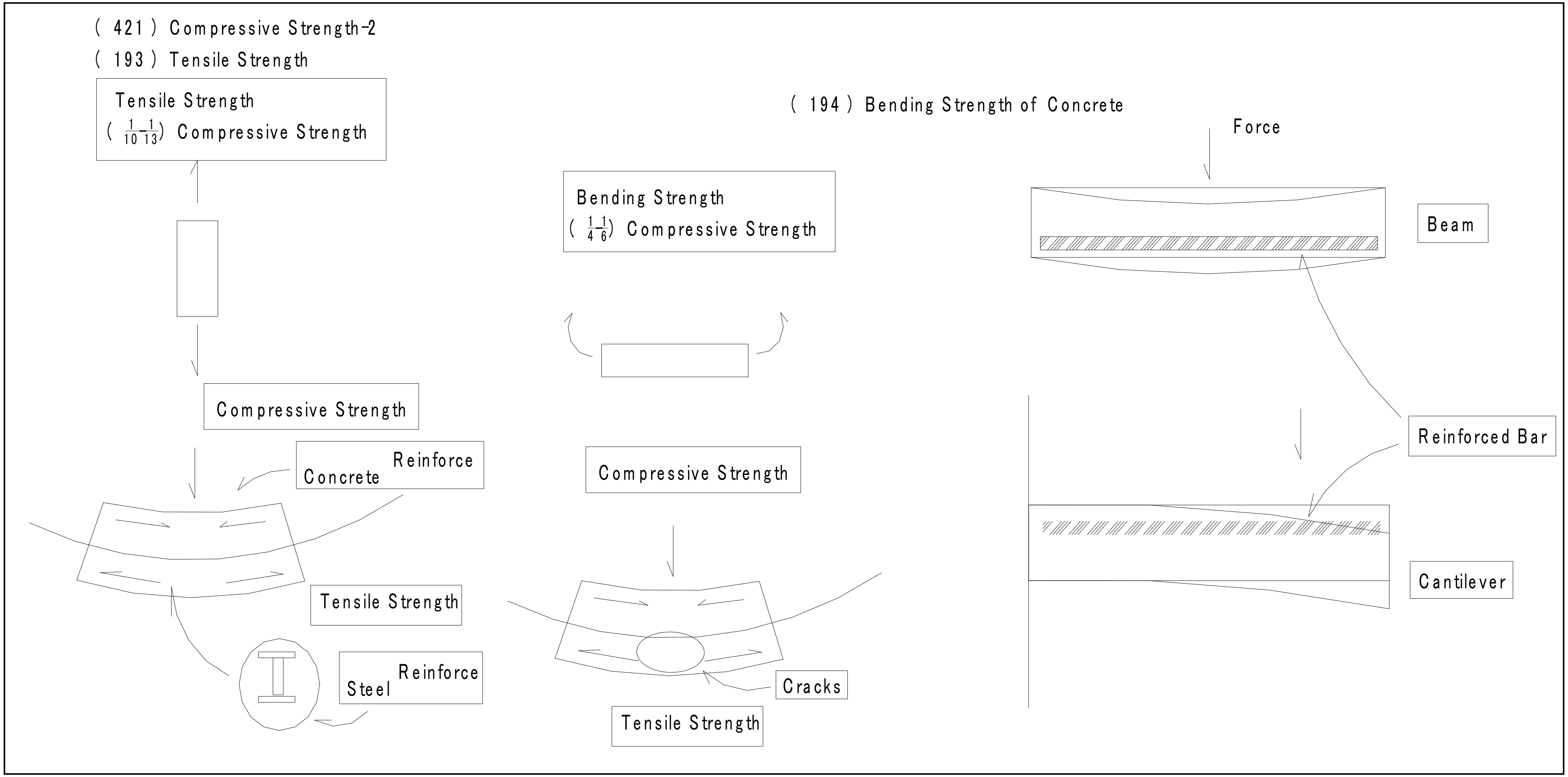
(53) Relationship between Strength and W/C



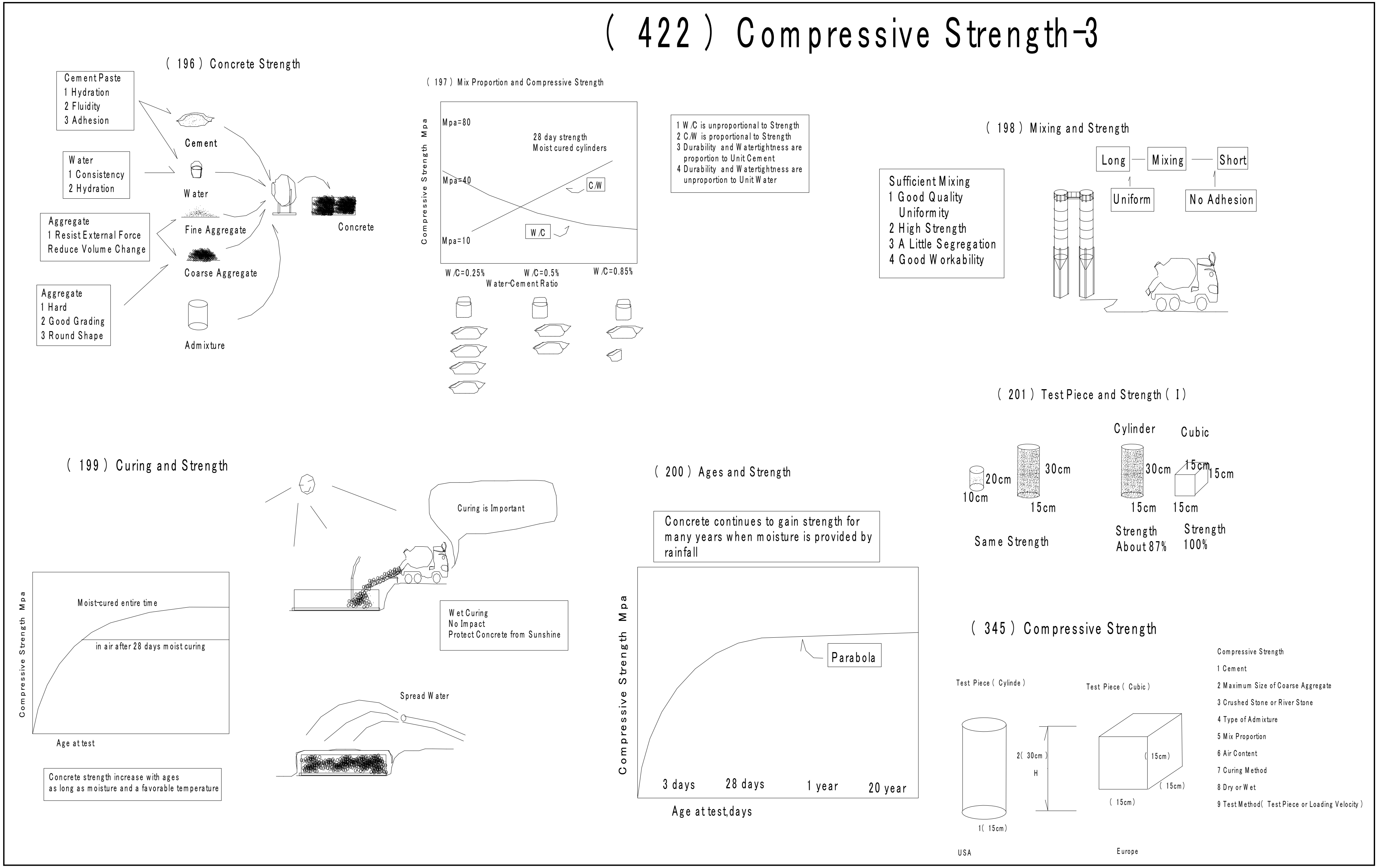
(192) Compressive Strength of Concrete (2)

1 Type of Concrete
2 Material Quality
3 Construction Method
4 Weather Condition

(421) Compressive Strength-2



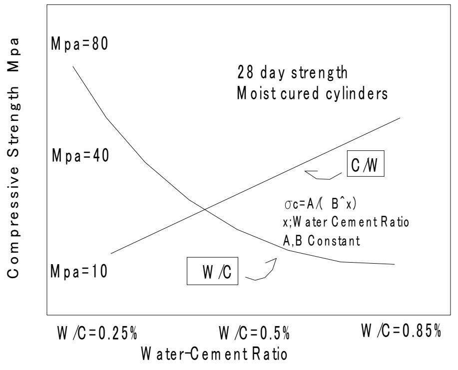
(422) Compressive Strength-3



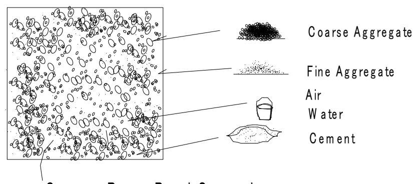
(423) Compressive Strength-4

(423) Compressive Strength-4

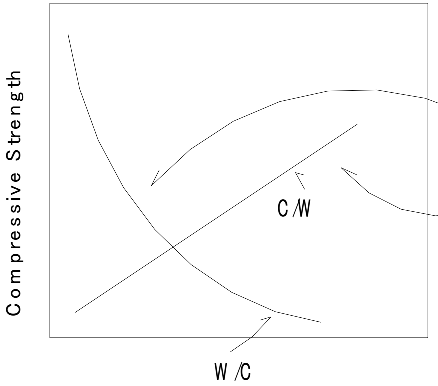
(246) Water Cement Ratio and Strength



1 W/C is unproportional to Strength
2 C/W is proportional to Strength
3 Durability and Watertightness are proportion to Unit Cement
4 Durability and Watertightness are unproportion to Unit Water



Cement Paste-Bond-Strength
W/C Effect Strength,Durability and Water Tightness



W/C=x
Compressive Strength=σ
$\sigma=(A/B)$ ^x

Compressive Strength=σ
$\sigma=A+B*(C/W)$

Small Construction

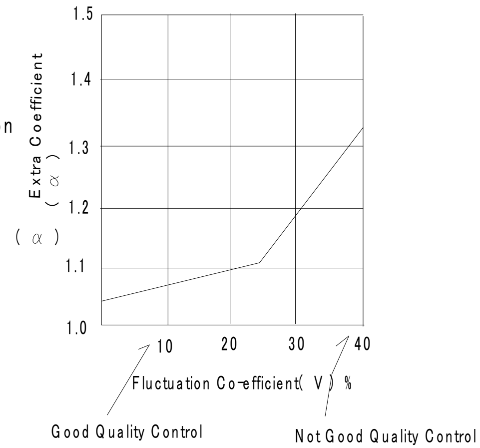
In Case of No Trial Mix
$\sigma 28=-210+215*(C/W)$

(247) Required Average Strength and Extra Co-efficient

Required Average Strength(σr) =(σck) *Extra Coefficient (α)

(σck) =Design Strength

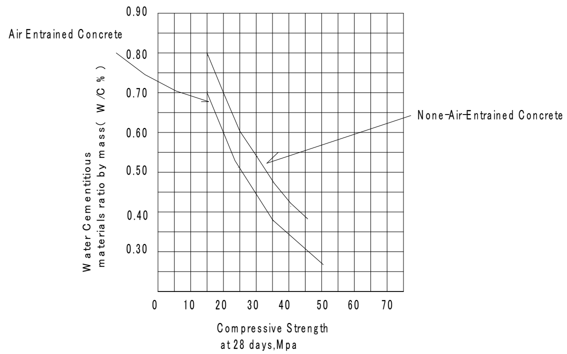
Fluctuation Co-efficient(V) %	Control Level
7-10	Super
10-15	Good
15-20	Normal
Over 20	Bad



(3) Water Cement Ratio and Compressive Strength

ASTM C 31, ACI 211.1 and ACI 211.3.

Compressive Strength at 28 days,Mpa	Water Cementitious materials ratio by mass	
	None-air-entrained concrete	Air Entrained Concrete
45	0.38	0.30
40	0.42	0.34
35	0.47	0.39
30	0.54	0.45
25	0.61	0.52
20	0.69	0.60
15	0.79	0.70



(424) Compressive Strength-5

(424) Compressive Strength-5

(347) Compressive Strength(3)

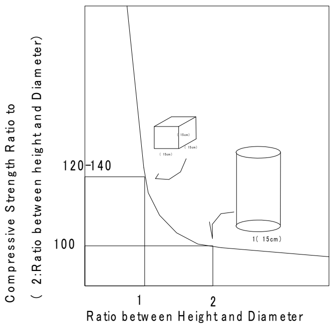


fig-1 Test Piece Shape effect Compressive Strength

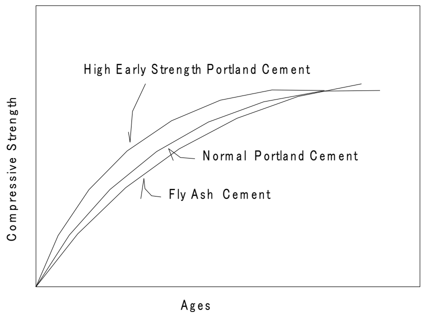


fig-2 Cement Type effect Compressive Strength

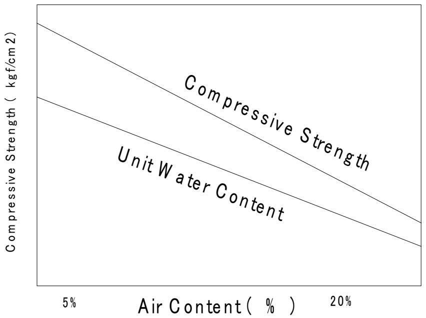


fig-4 W/C and Slump are Constant

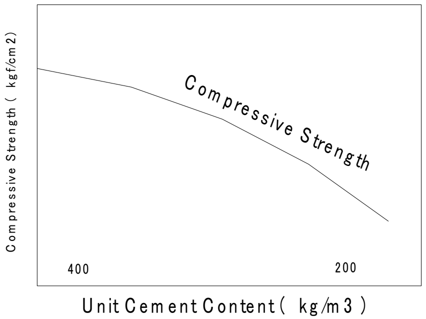


fig-5 Unit Cement and Slump are Constant

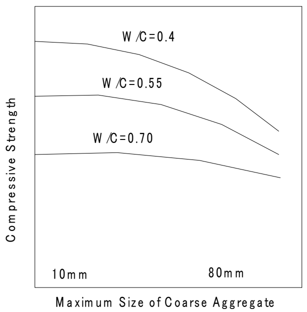


fig-3 Maximum Size of Coarse Aggregate effect Compressive Strength

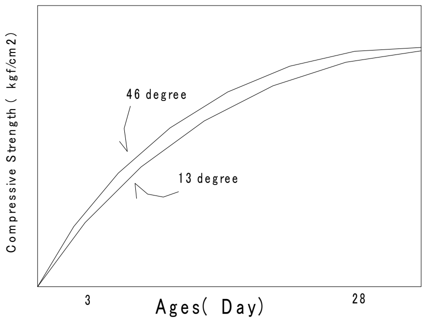


fig-6 Curing Temperature Effect Compressive Strength

(348) Compressive Strength(4)

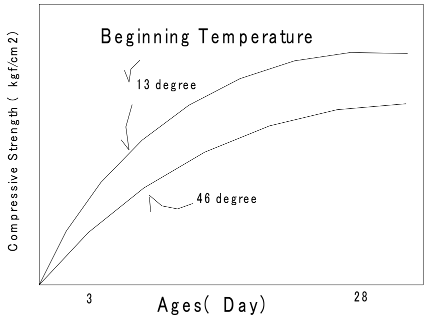


fig-7 Beginning Temperature Effect Compressive Strength

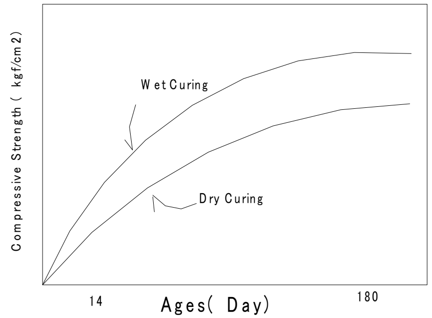


fig-8 Wet or Dry effect Compressive Strength

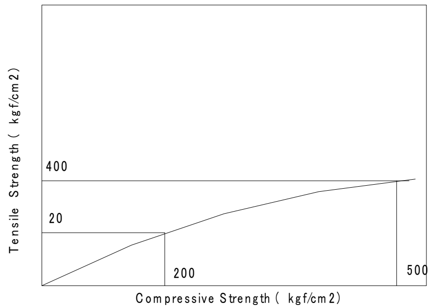


fig-10 Tensile Strength and Compressive Strength

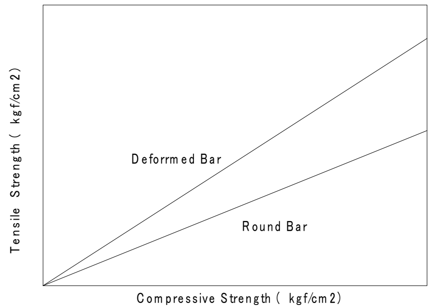


fig-11 Bond Strength and Compressive Strength

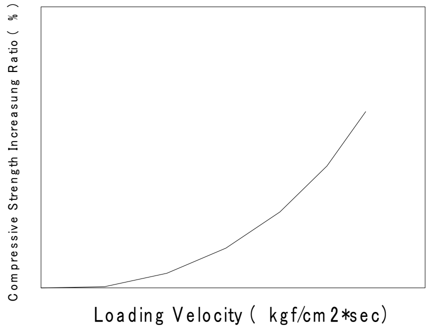


fig-9 Loading Velocity effect Compressive Strength

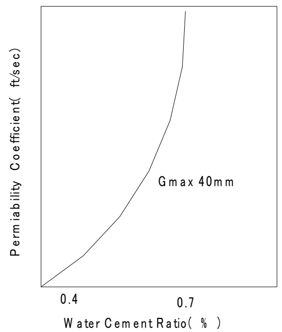


fig-12 W/C and Watertightness

(425) Concrete Strength-6

290 ACI 211.1 and ACI 211.3 Relationship(Metric) between water cement ratio and compressive strength of concrete

Compressive Strength at 28 days,Mpa	Water-cementitious materials ratio by mass	
	Non-air-entrained concrete	Air-entrained concrete
45	0.38	0.3
40	0.42	0.34
35	0.47	0.39
30	0.54	0.45
25	0.61	0.52
20	0.69	0.6
15	0.79	0.7

Strength is based on cylinders moist-cured 28 days in accordance with ASTM C31(AASHTO T 23).Relationship assumes nominal maximum size aggregate of about 19 to 25 mm. Adapted from ACI 211.1 and ACI 211.3

288 ACI318 W/C and Compressive Strength

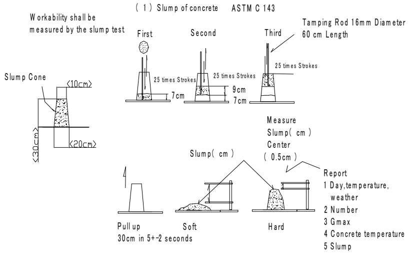
Maximum Water-Cementitious Material Ratios and Minimum Design Strengths for Various Exposure Conditions

Exposure Condition	Maximum Water-Cementitious Material Ratios by Mass Concrete	Minimum Design Compressive Strength fc,Mpa (psi)
Concrete Protected from Exposure to Freezing and Thawing,Application of Deicing Chemicals, or Aggressive Substances	Select Water-Cementitious Material Ratio on Basis of Strength,Workability,and Finishing Needs.	Select Strength Based on Structural Requirements
Concrete intended to have low permeability when exposed to water.	0.5	28 (4000)
Concrete exposed to freezing and thawing in a moist condition or deicers	0.45	31 (4500)
For corrosion protection for reinforced concrete exposed to chlorides from deicing salts, salt water, brackish water,seawater,or spray from these sources.	0.4	35 (5000)

Adapted from ACI318

(426) Sump-1

(426) Slump -1

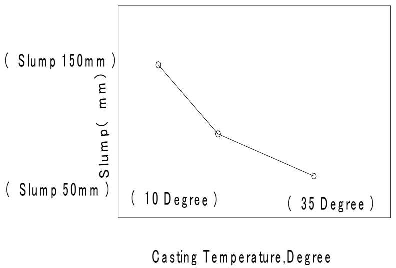


(6) Table A1.5.3.1 Recommended slumps for various types of construction (SI)

ACI 211.1-21

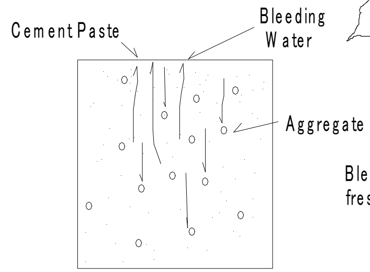
Types of construction		Slump,mm Maximum	Slump,mm Minimum
A	Reinforced foundation walls and footings	75	25
B	Plain footings,caissons,and substructure walls	75	25
C	Beam and reinforced walls	100	25
D	Building columns	100	25
E	Pavements and slabs	75	25
F	Mass concrete	75	25

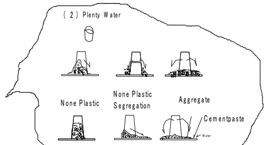
(32) Slump and Casting Temperature



(32) Effect of Casting Temperature on The Slump

(34) Bleeding Water

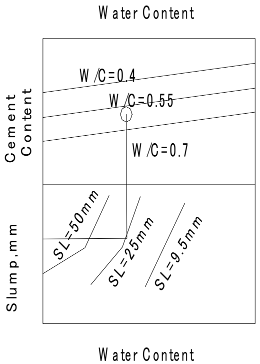




Segregation

Bleed Water on the surface of a freshly placed concrete slab

(52) Water Content,Slump and Cement Content

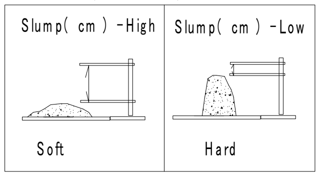


(60) Consistency

ASTM C 143

Consistency Measured by Slump

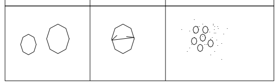
Consistency -Workability



(61) Consistency

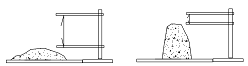
Consistency -Required Water Content

Aggregate Round	Aggregate Maximum Size	Entrained Air
Water-Little	Water-Little	Water-Little



Consistency -Workability

Slump(cm) -High Slump(cm) -Low



(82) ACI 211.1 Mix Proportion Step

(9-1) Adjustment of Trial Batch

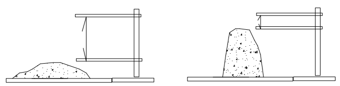
Slump-Water Content

Slump 1cm Increase or Decrease

Water 2kg/m3 per Concrete Volume 1m3

Decrese or Increse

Slump(cm)



Soft Hard

(108) ACI 211.1 Design of Concrete Mixes(8)

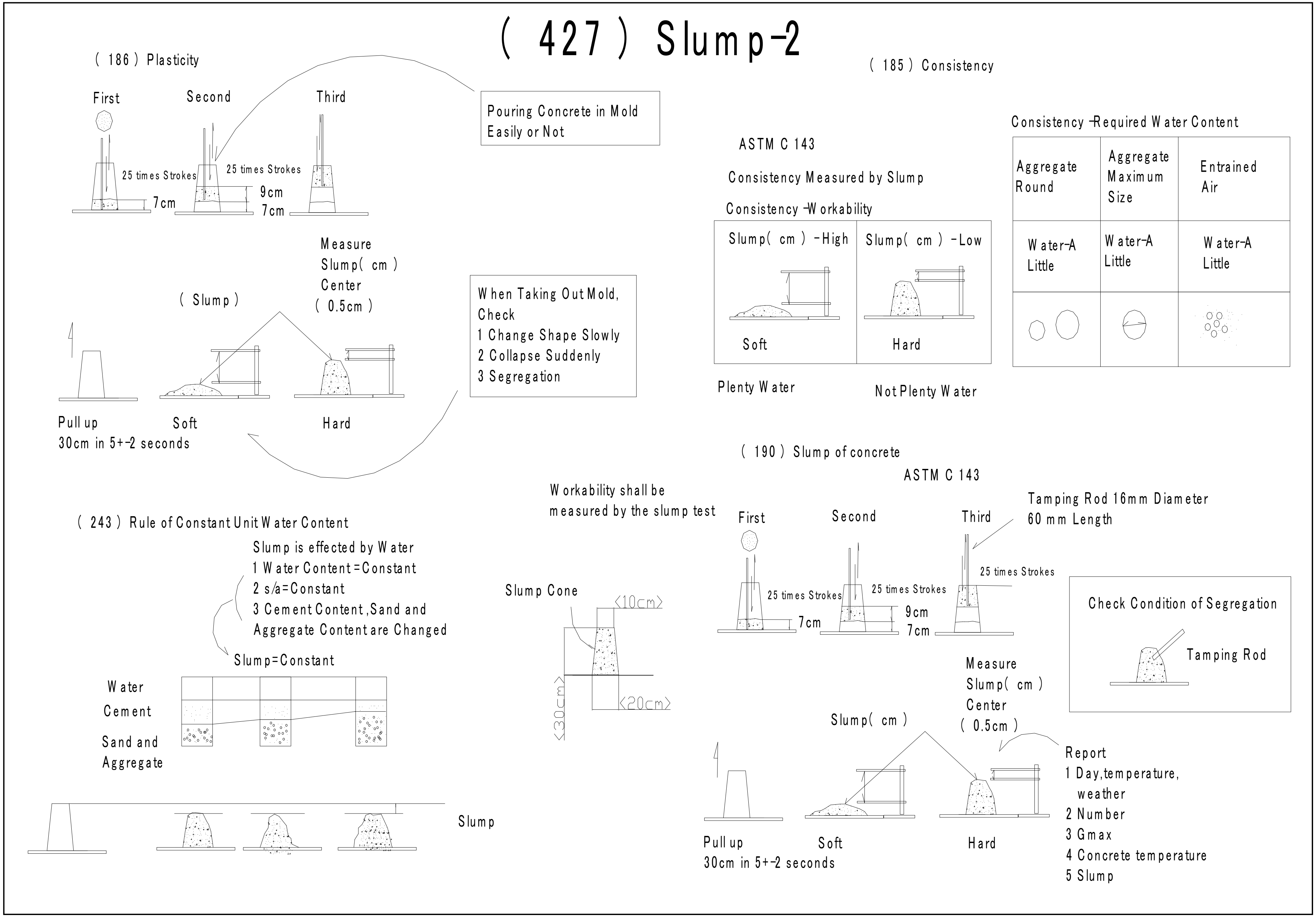
Water Content-Maximum Slump

Maximum Slump

Types of Structure	Maximum Slump
Mass Concrete	5
Channel	7.5
Slab and Invert of Tunnel	5
Wall pier parapet	5
Tunnel,Arch	10
Other Structure	7.5

Soft Concrete-Segregation
Strength -Low
Durability-Low

(427) Slump-2


(427) Slump-2
(186) Plasticity
First
Second
Third
25 times Strokes
25 times Strokes
7cm
9cm
7cm
Pouring Concrete in Mold
Easily or Not
Measure
Slump(cm)
Center
(0.5cm)
(Slump)
When Taking Out Mold,
Check
1 Change Shape Slowly
2 Collapse Suddenly
3 Segregation
Pull up
30cm in 5+-2 seconds
Soft
Hard
(185) Consistency
ASTM C 143
Consistency Measured by Slump
Consistency -Workability
Slump(cm) -High
Slump(cm) -Low
Soft
Hard
Plenty Water
Not Plenty Water
Consistency -Required Water Content
Aggregate
Round
Aggregate
Maximum
Size
Entrained
Air
Water-A
Little
Water-A
Little
Water-A
Little
(190) Slump of concrete
ASTM C 143
Workability shall be
measured by the slump test
First
Second
Third
Tamping Rod 16mm Diameter
60 mm Length
25 times Strokes
25 times Strokes
25 times Strokes
7cm
9cm
7cm
Check Condition of Segregation
Tamping Rod
Measure
Slump(cm)
Center
(0.5cm)
Slump(cm)
Report
1 Day,temperature,
weather
2 Number
3 Gmax
4 Concrete temperature
5 Slump
Pull up
30cm in 5+-2 seconds
Soft
Hard
(243) Rule of Constant Unit Water Content
Slump is effected by Water
1 Water Content=Constant
2 s/a=Constant
3 Cement Content ,Sand and
Aggregate Content are Changed
Slump=Constant
Water
Cement
Sand and
Aggregate
Slump
Slump Cone
<10cm>
<20cm>
<30cm>

(428) Slump-3

293 ACI 211.1 and ACI 318 (Inch-Pound Units) Approximate Mixing Water and Target Air Content Requirements for Different Slumps and Nominal Maximum Sizes of Aggregate

Slump (in)	Water, pounds per cubic yard of concrete, for indicated sizes of aggregate*							
	(3/8) in	(1/2) in	(3/4) in	(1) in	(1 1/2) in	(2) in	(3) in	(6) in
Non-Air-entrained concrete								
1-2	350	335	315	300	275	260	220	190
3-4	385	365	340	325	300	285	245	210
6-7	410	385	360	340	315	300	270	–
Approximate amount of entrapped air in non-air-entrained concrete, percent	3	2.5	2	1.5	1	0.5	0.3	0.2
Air-entrained concrete								
1-2	305	295	280	270	250	240	205	180
3-4	340	325	305	295	275	265	225	200
6-7	365	345	325	310	290	280	260	–
Recommended average total air content, percent, for level of exposure (&)								
Mild exposure	4.5	4	3.5	3	2.5	2	1.5	1
Moderate Exposure	6	5.5	5	4.5	4.5	3.5	3.5	3
Severe exposure	7.5	7	6	6	5.5	5	4.5	4

*These quantities of mixing water are for use in computing cementitious material contents for trial batches. They are maximums for reasonably well-shaped angular coarse aggregates graded within limits of accepted specifications.

**The slump values for concrete containing aggregates larger than 37.5mm are based on slump tests made after removal of particles larger than 37.5mm by wet screening.

(&) The air content in job specifications should be specified to be delivered within -1 to +2 percentage points of the table target value for moderated and severe exposures. Adapted from ACI 211.1 and ACI 318. However (1995) presents this information i

294 ACI 211.1 Recommended Slumps for various types of construction

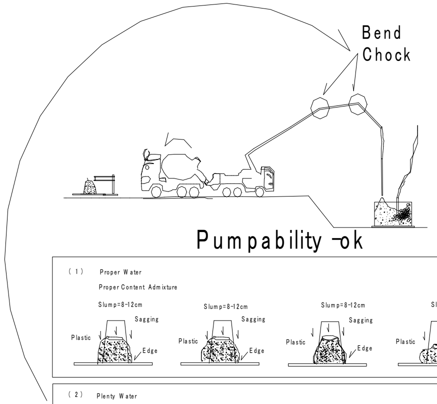
Concrete construction	Slump, mm (in)	
	Maximum*	Minimum
Reinforced foundation walls and footings	75 (3)	25 (1)
Plain footings, caissons, and substructure walls	75 (3)	25 (1)
Beams and reinforced walls	100 (4)	25 (1)
Building columns	100 (4)	25 (1)
Pavements and slabs	75 (3)	25 (1)
Mass concrete	75 (3)	25 (1)

*May be increased 25mm (1 in.) for consolidation by hand methods, such as rodding and spading.. Plasticizers can safely provide higher slumps. Adapted from ACI 211.1.

(429) Slump-4

(429) Slump-4

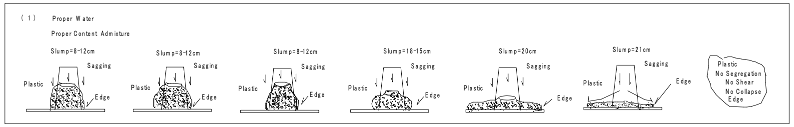
(328) Concrete Pump

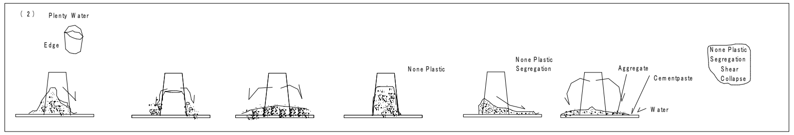


(a) Slump, 8-18cm.
(b) Maximum Size of Coarse Aggregate , below 40mm.
(c) Reduce Pumping Pipe Bend as much as possible. Horizontal or Down Direction.

(d) Before Pumping ,Send Mortar.

Pumpability -ok



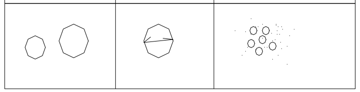


Pumpability -No Good

(342) Consistency

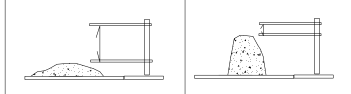
Consistency -Required Water Content

Aggregate Round	Aggregate Maximum Size	Entrained Air
Water-Little	Water-Little	Water-Little

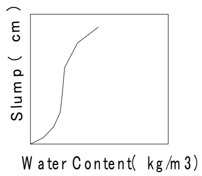


Consistency -Workability

Slump(cm) -High	Slump(cm) -Low
Soft	Hard

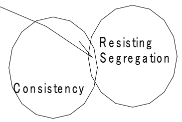


Slump Test-(5-18cm)
Concrete of Dry Consistency-V.B.Test
Causes
1 Water Content
1.2% of Water Increase-Slump 1 cm increase
2 Air Content
Air Content 1 % Increase-Slump 2.5 cm Increase
3 Maximum Size of Aggregate
G Max Bigger-Water Content and Cement Content Decrease
4 Grading
5 Sand Percentage Bigger-Slump Smaller
6 AE Agent,AE Water Reducing Agent-Spread Cement Particles
Entrained Air-Ball Bearing Action
7 Fly Ash Cement:Ball Bearing Action
8 Temperatute:Concrete Temperture 10 Degree Up-Slump 2-3 cm Smaller

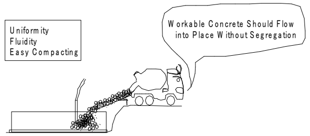


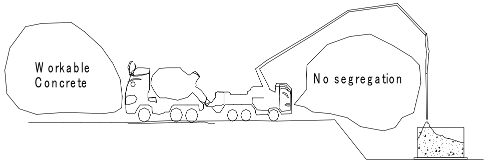
(344) Workability

Concreting according to Consistency
No Segregation

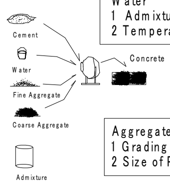


Uniformity
Fluidity
Easy Compacting





Cement
1 Type
2 Fresh
3 Content
4 No Segregation



Water
1 Admixture
2 Temperature

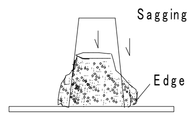
Aggregate
1 Grading
2 Size of Particle

(362) Slump of concrete

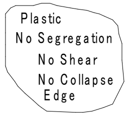
Proper Water

Proper Content Admixture

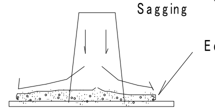
(1)



Plastic



(2)

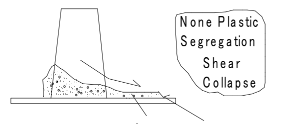


Plastic

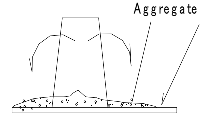
Good

Plenty Water

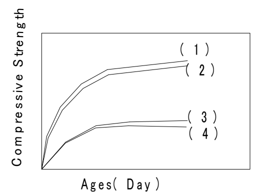
(3)



(4)



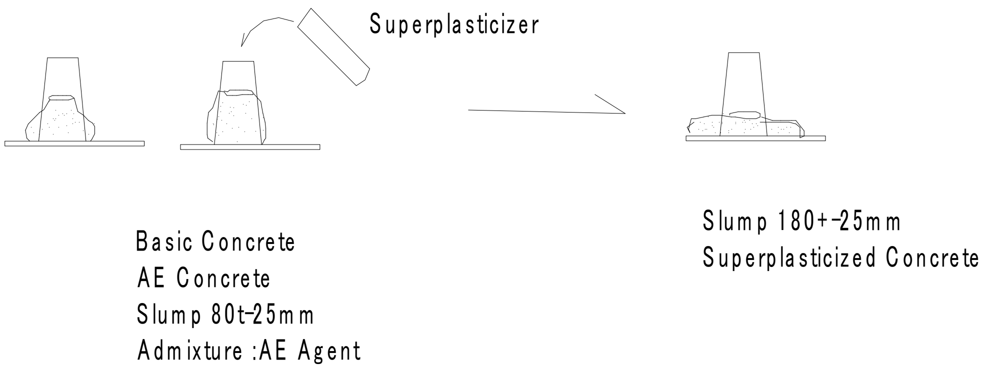
Bad



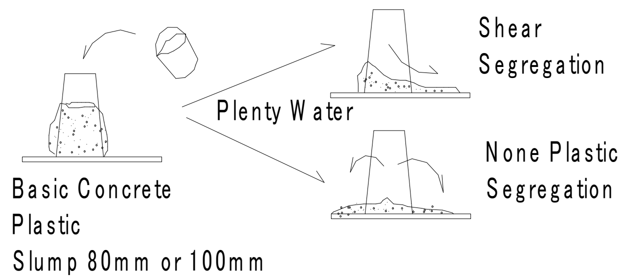
(430) Superplasticizer-1

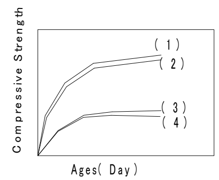
(430) Superplastilizer-1

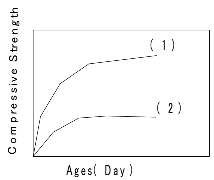
(354) Slump of concrete after using Superplastilizer



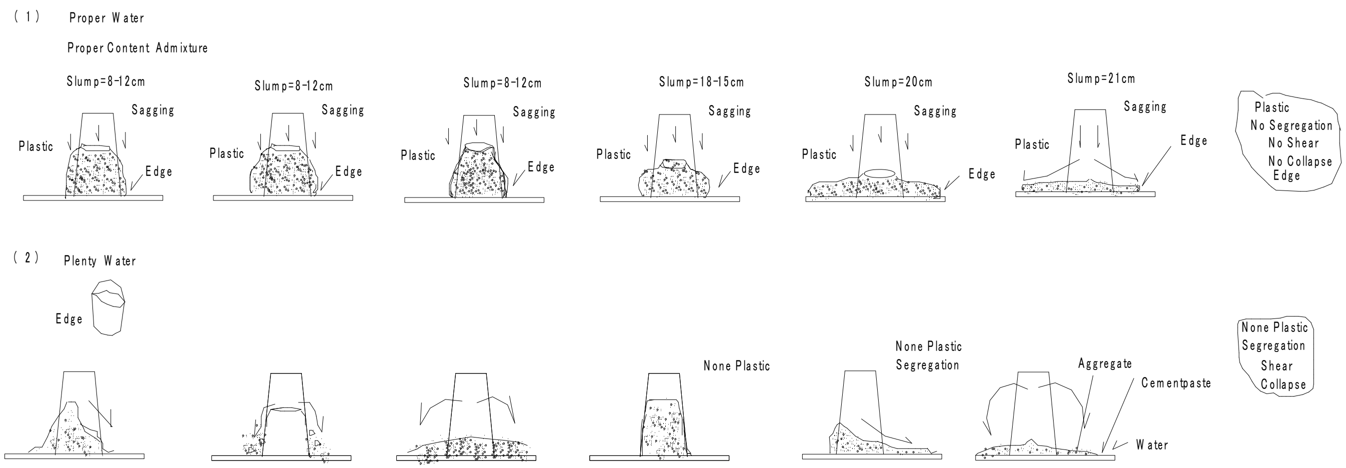
(355) Slump of concrete after adding Water



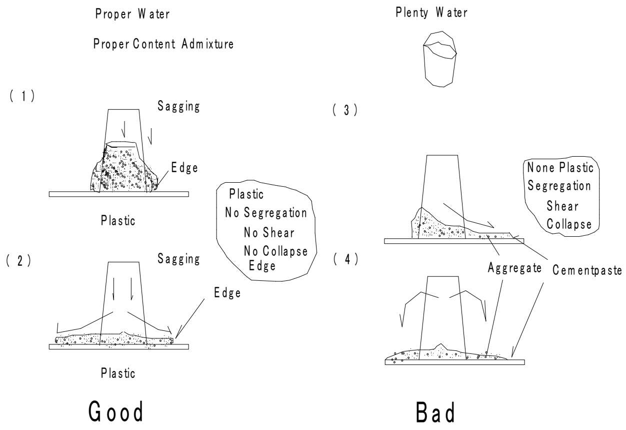




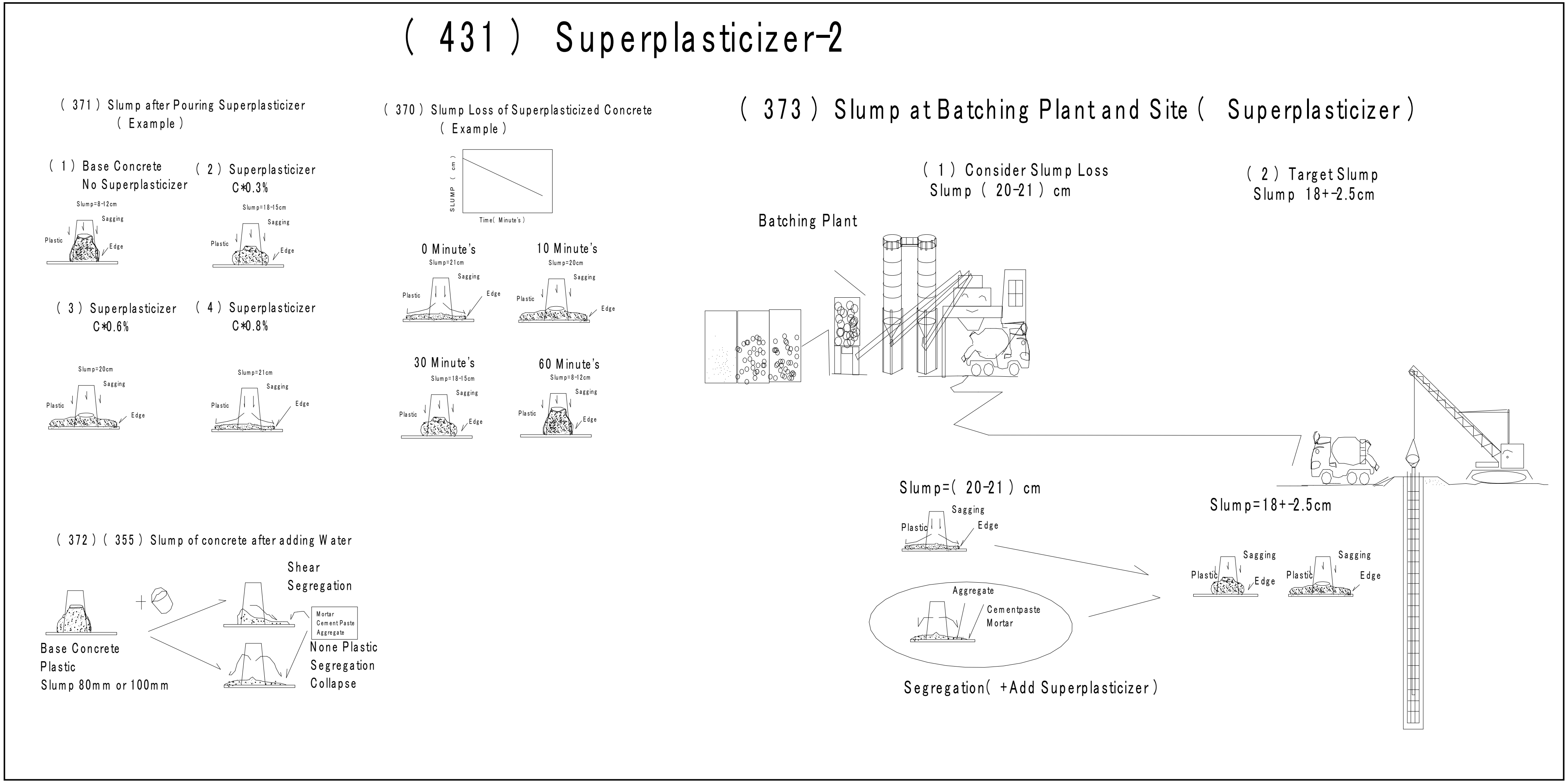
(363) Slump of concrete(II)



(362) Slump of concrete



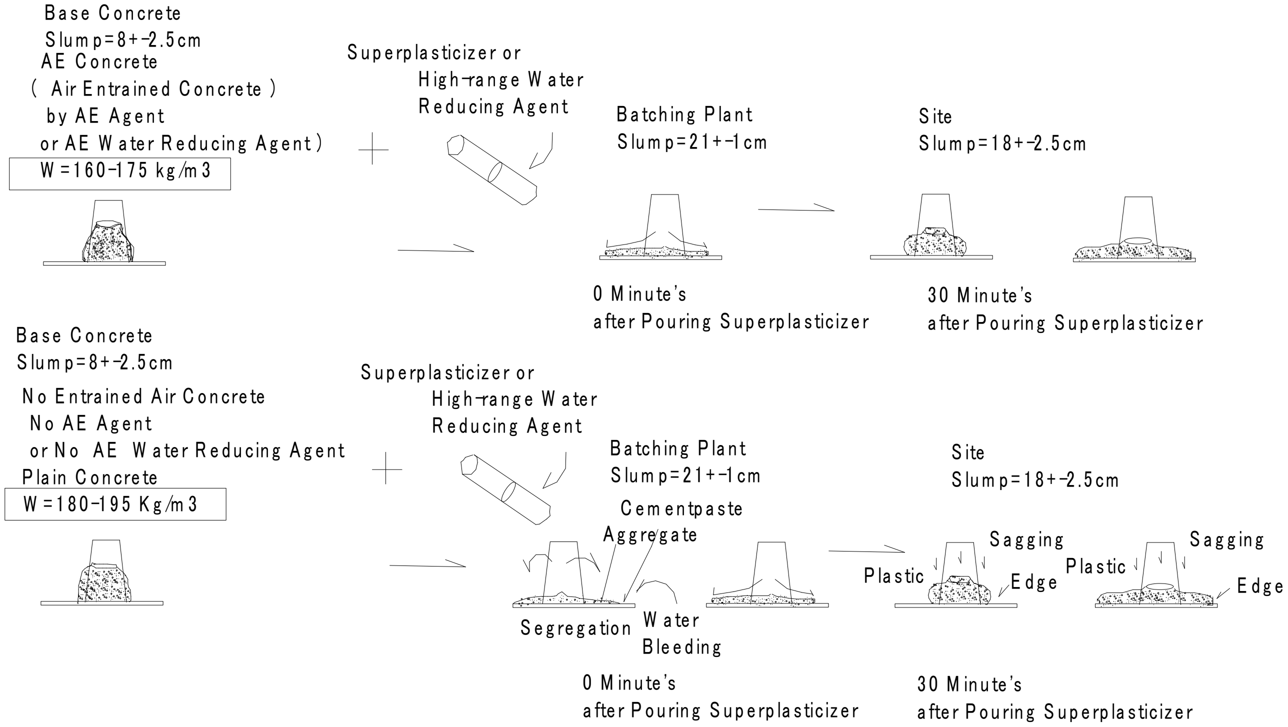
(431) Superplasticizer-2



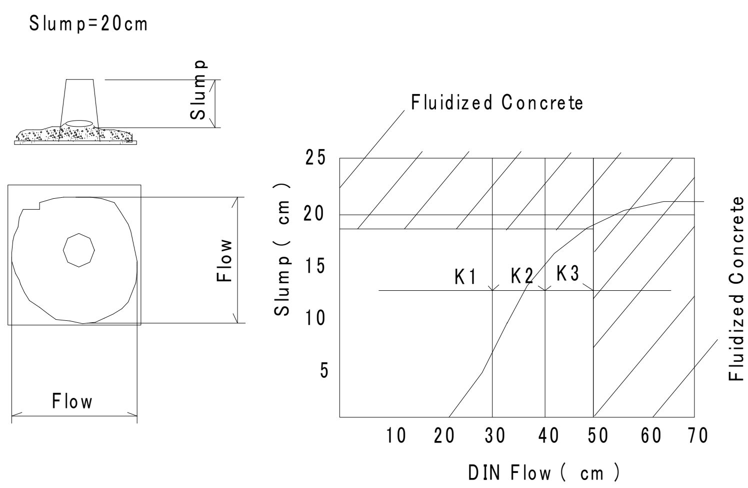
(432) Superplasticizer-3

(432) Superplasticizer-3

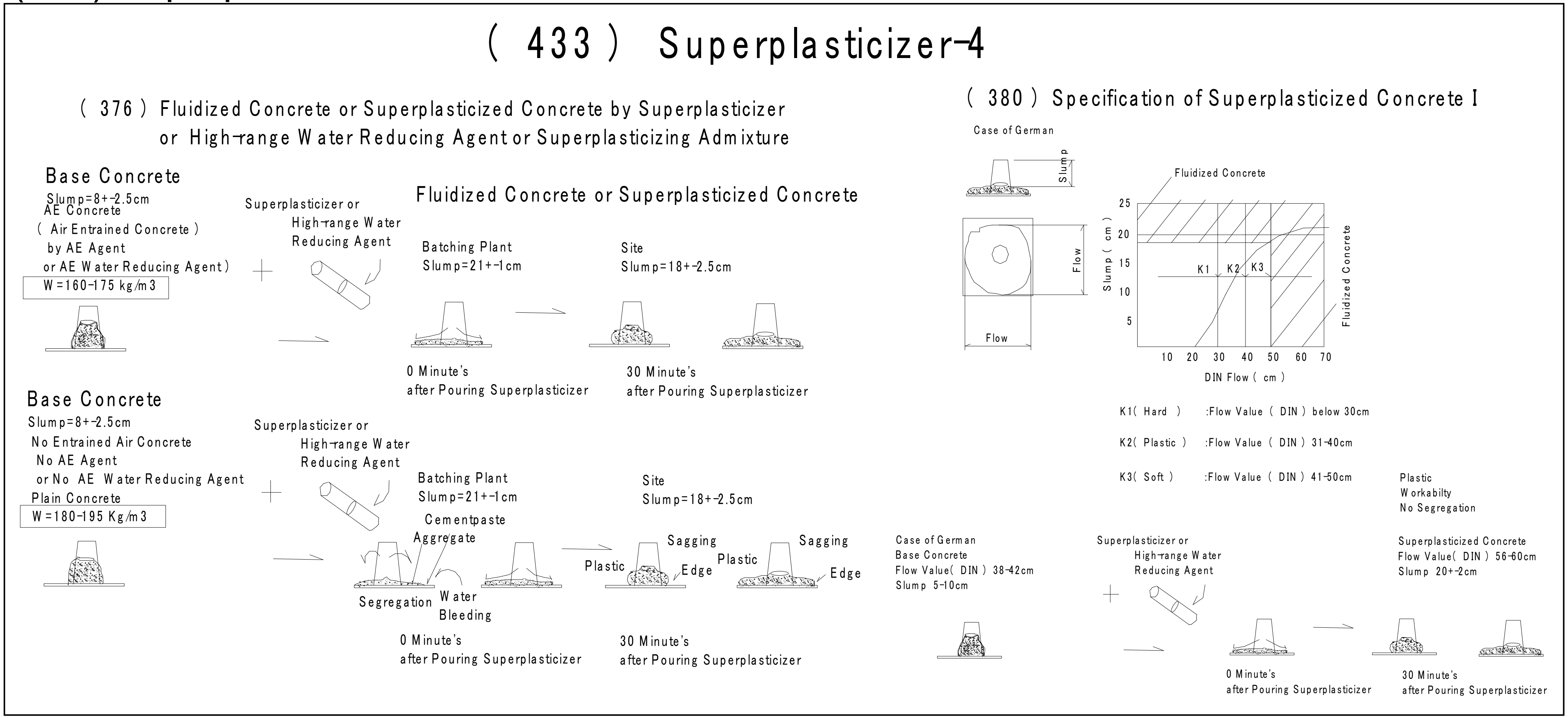
(374) Fluidized Concrete by Superplasticizer or High-range Water Reducing Agent



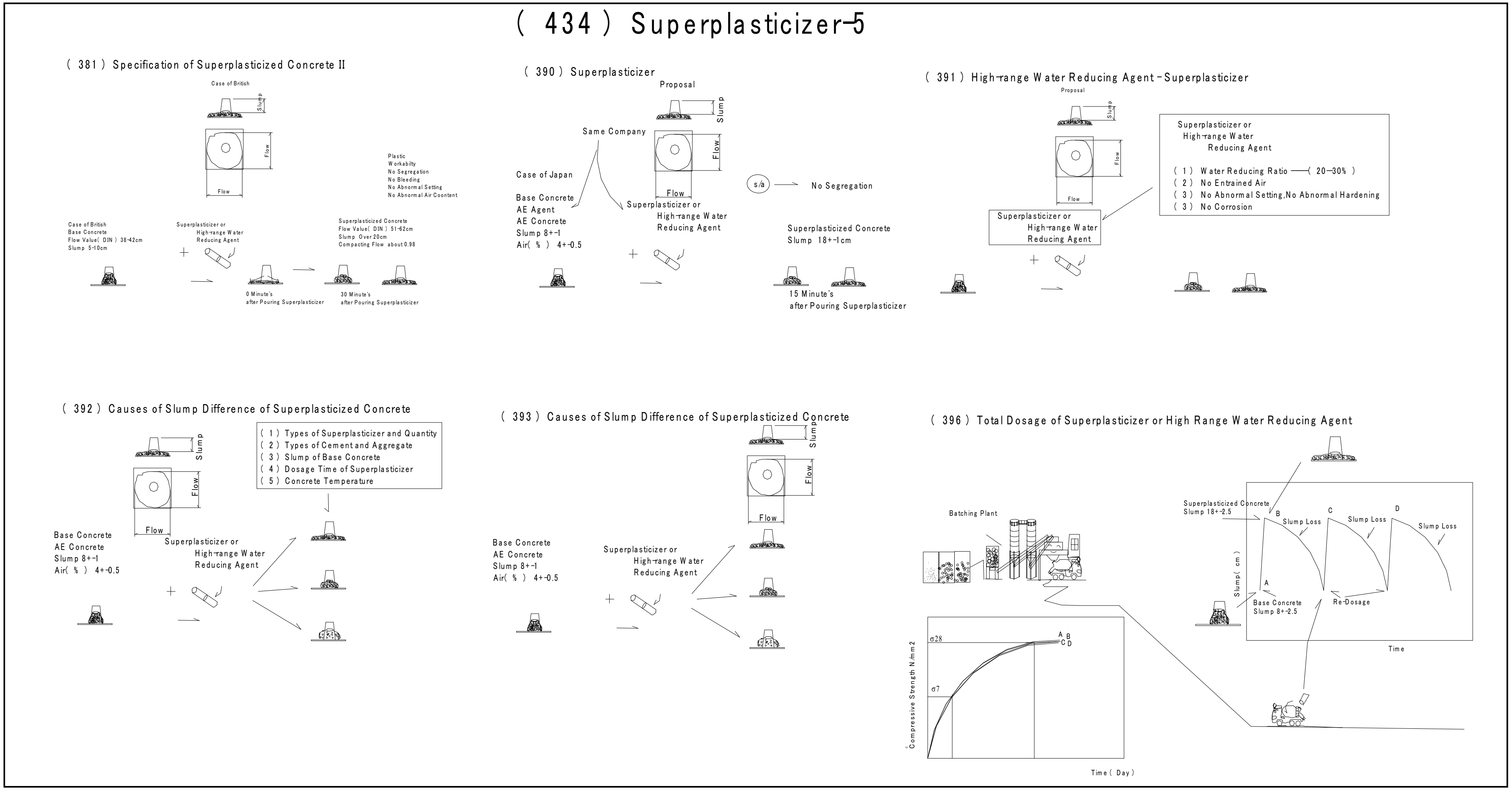
(375) Slump and Flow of Fluidized Concrete



(433) Superplasticizer-4



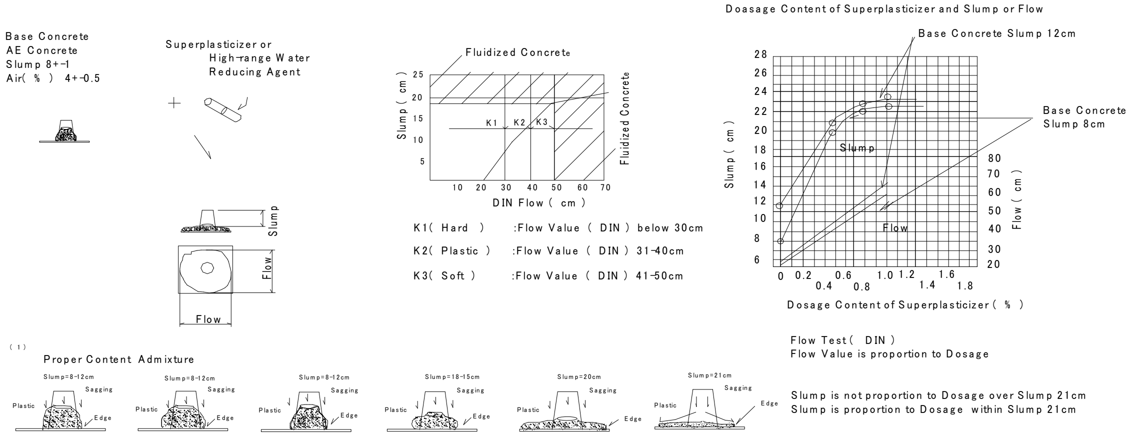
(434) Superplasticizer-5



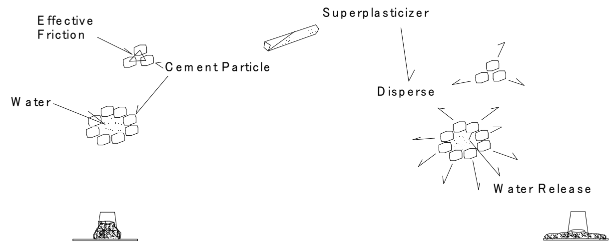
(435) Superplasticizer-6

(435) Superplasticizer -6

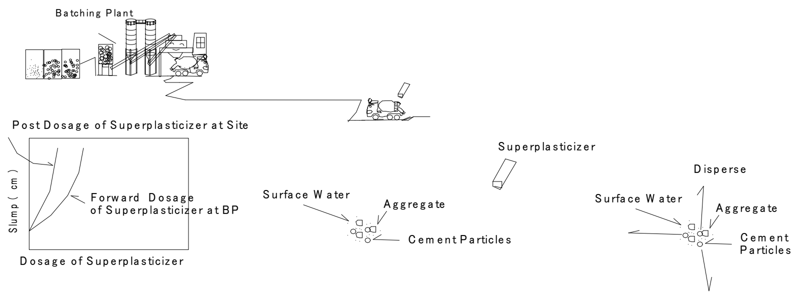
(394) Doasage Content of Superplasticizer and Slump or Flow



(397) Effect of Superplasticizer or High Range Water Reducing Agent

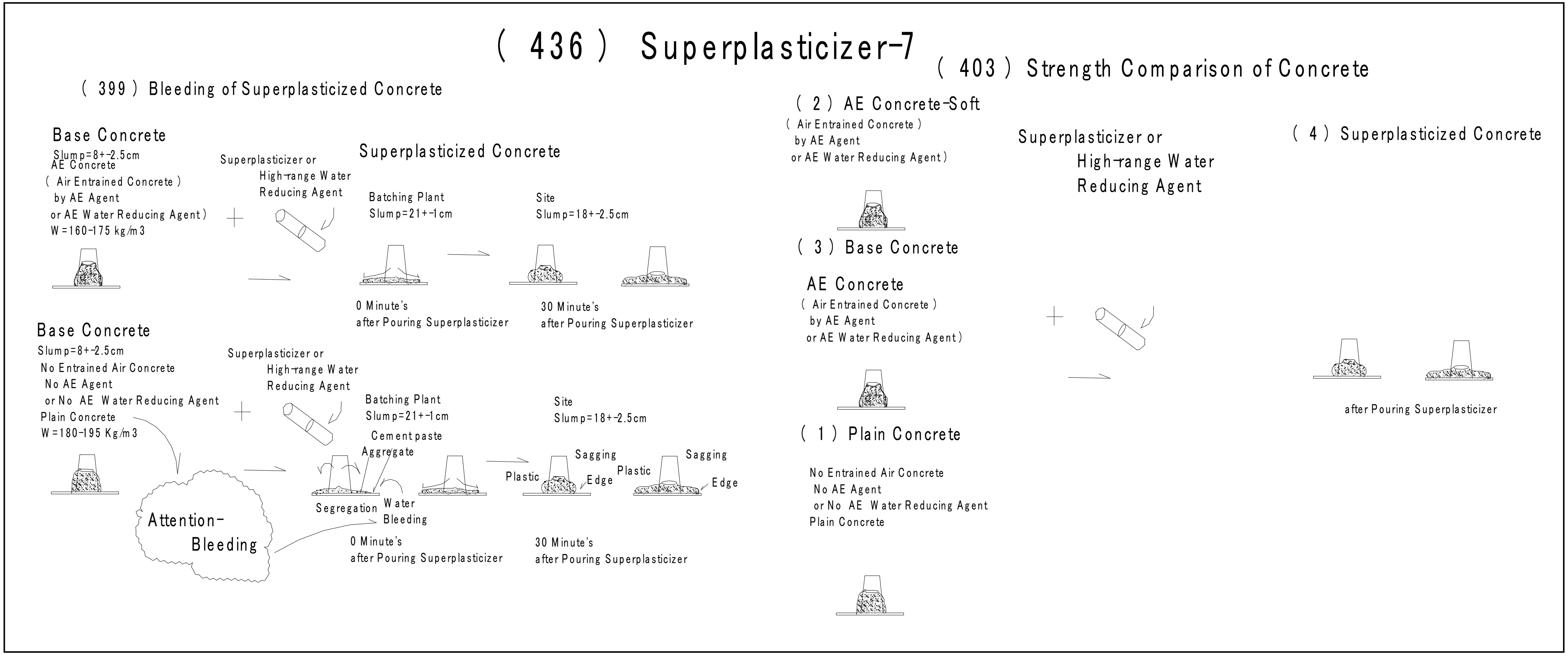


(398) Effect of Superplasticizer (II)



(436) Superplasticizer-7

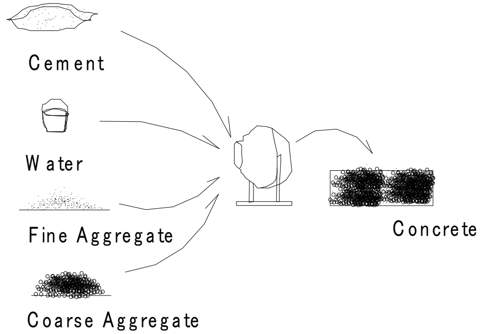
No	Types of Concrete	Slump(Base Concrete)	Air	water cement ratio	sand percentage	Water	Cement	Design Strength 28days	Base Concrete Admixture	Superplasticizer	Remarks
		(SL)		W/C	s/a	W					
		cm	(%)	(%)	(%)	(Kg/m3)	(Kg/m3)	(N/mm2)	C*(%)		
1	Plain Con	21	1	70	48	210	300	21			
2	AE Concr	21	4	61	46	183	300	23	AE Water Reducing		soft
3	Base Con	15	4	55	46	165	300	28	AE Water Reducing Ajent		
4	Superplasticized Concrete	21	4	55	46	165	300	28	AE Ajent	Superplasticizer	



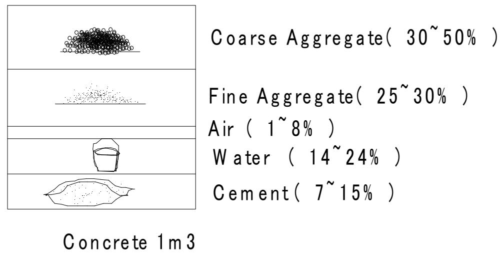
(437) Concrete-1

(437) Concrete-1

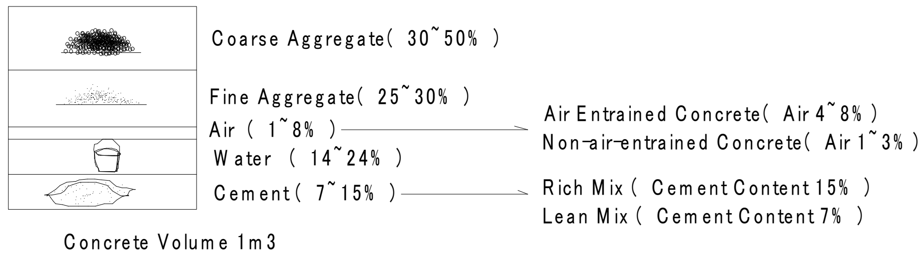
(27) Concrete Components



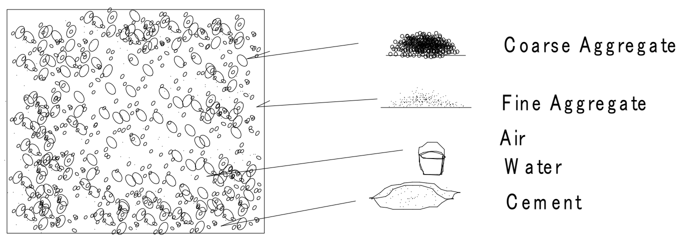
(28) Concrete Volume



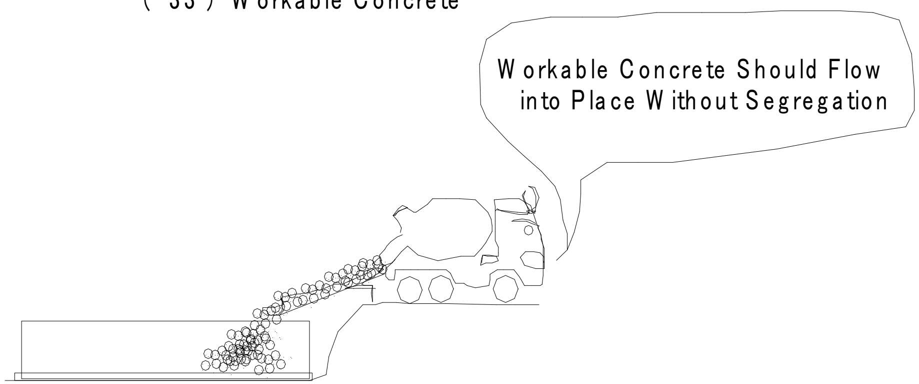
(29) Concrete Volume-1



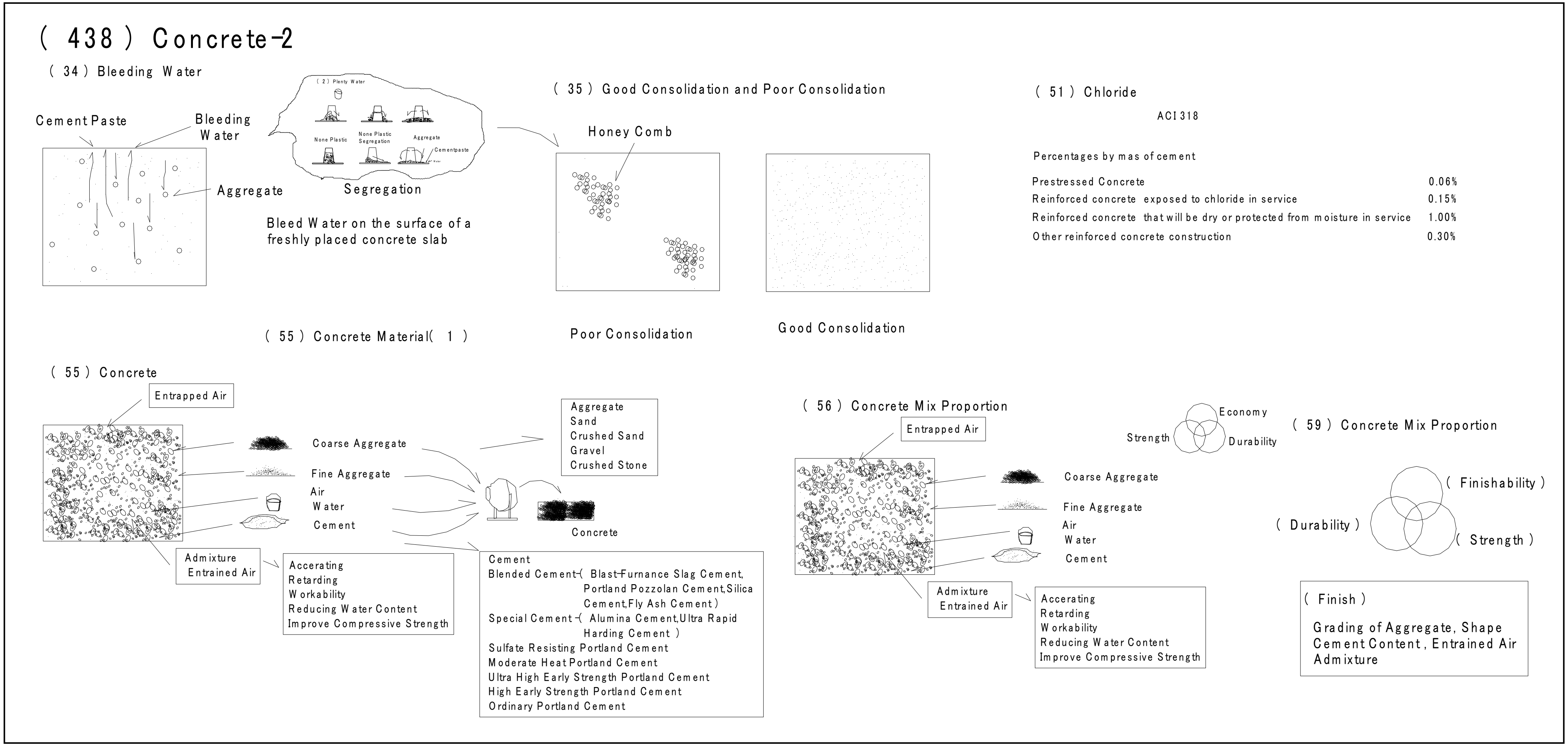
(30) Cross Section of Hardened Concrete



(33) Workable Concrete



(438) Concrete-2



(439) Concrete-3

(439) Concrete-3

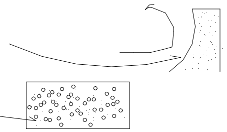
(63) Durability

Freezing
Wet
Heat
Chemical Medicine
Ice

Alkali-Aggregate reaction
Alkali Cement

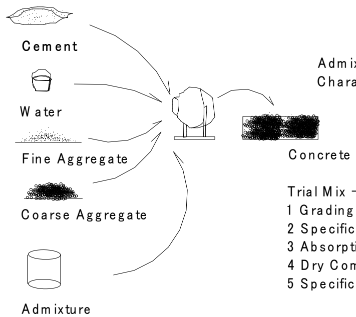
Sea Water
Sulfate Resisting Portland Cement

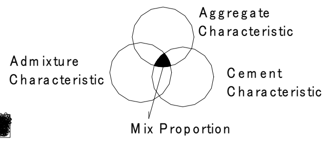
Freezing and Thawing Action
AE Concrete-Etrained Air



(103) ACI 211.1 Design of Concrete Mixes(3)

Trial Mix -Laboratory

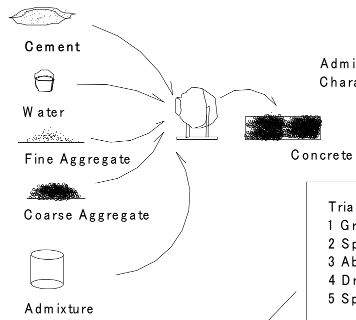


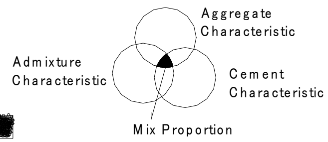


Trial Mix -Laboratory data
1 Grading of Fine or Coarse Aggregate
2 Specific Gravity
3 Absorption
4 Dry Compacting Unit Weight of Coarse Aggregate
5 Specific Gravity of Cement

(104) ACI 211.1 Design of Concrete Mixes(4)

Trial Mix -Laboratory





Trial Mix -Laboratory data
1 Grading of Fine or Coarse Aggregate
2 Specific Gravity
3 Absorption
4 Dry Compacting Unit Weight of Coarse Aggregate
5 Specific Gravity of Cement

Entrapped Air (Admixture)

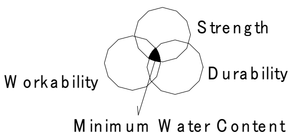
Improve

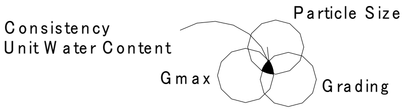
Workability and Durability of Concrete

W/C-same
>Cement Content 335kg/m3
Strength-Decrease
<Cement Content 250kg/m3
Strength -Increase

(107) ACI 211.1 Design of Concrete Mixes(7)

Water Content





(159) Unit Weight

Unit Weight
Air Dried State

Unit Weight ← Specific Gravity, Grading, Degree of Compaction, Water Content

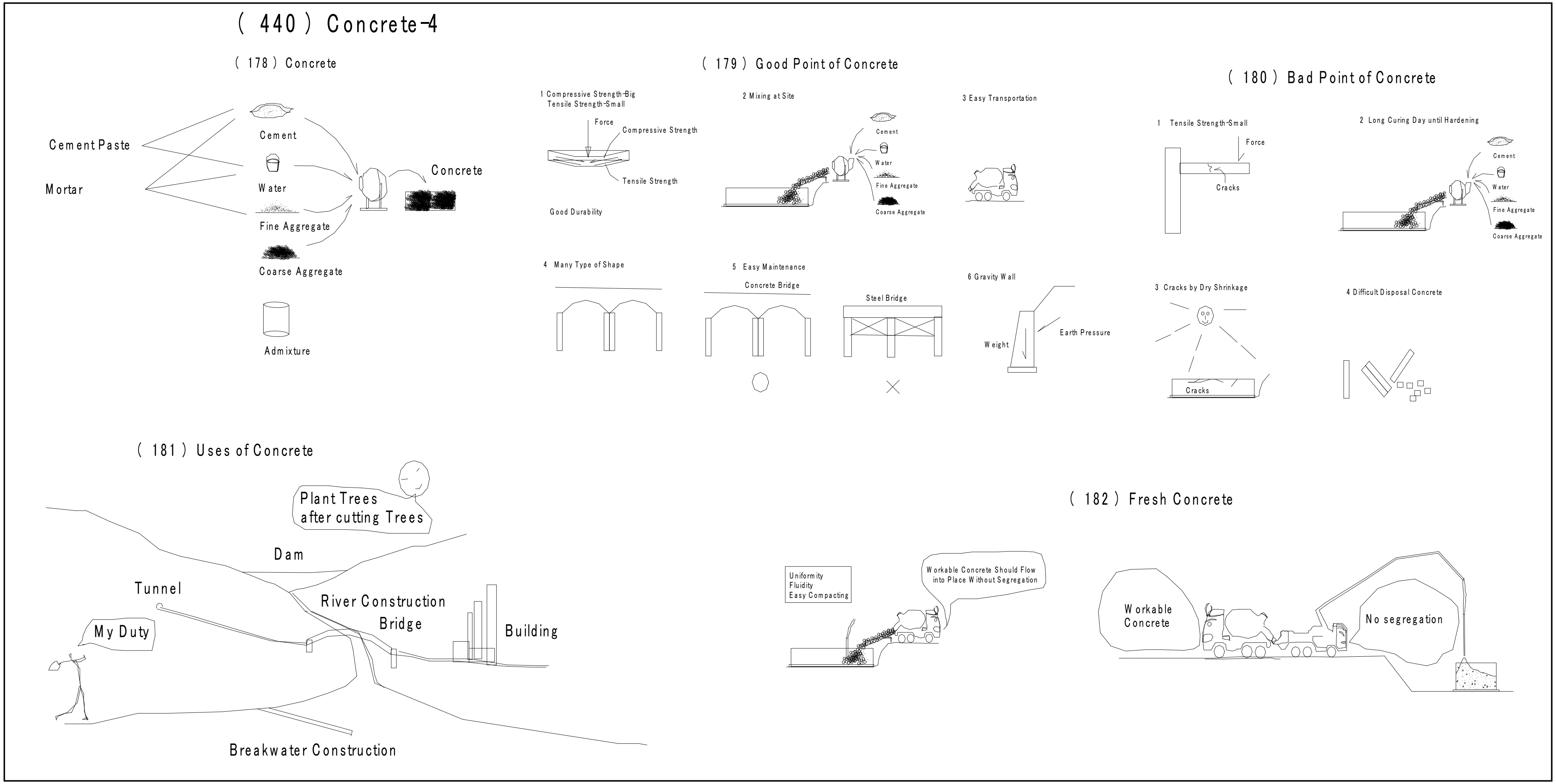
↑ Effect

Unit Weight	
Fine Aggregate	1450-1700 kg/m3
Coarse Aggregate	1550-1850kg/m3
Combined Aggregate	1750-2000kg/m3

(161) Percentage of Void Ratio of Aggregate

Fine Aggregate	30-45 %
Coarse Aggregate	30-40 %

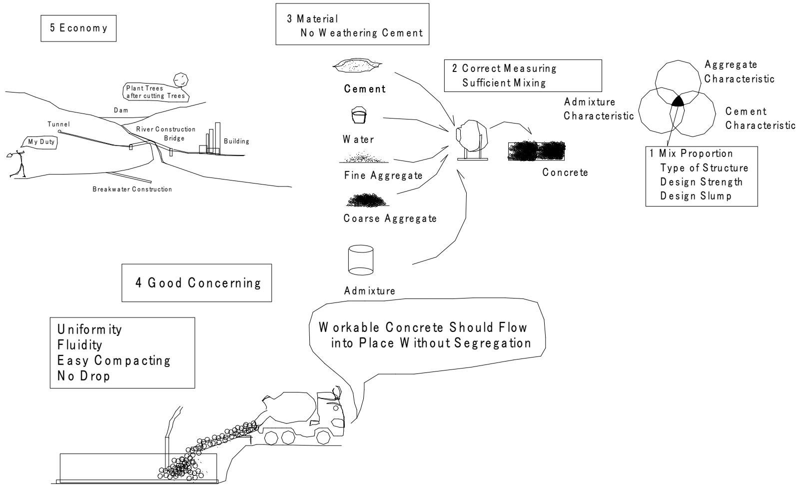
(440) Concrete-4



(441) Concrete-5

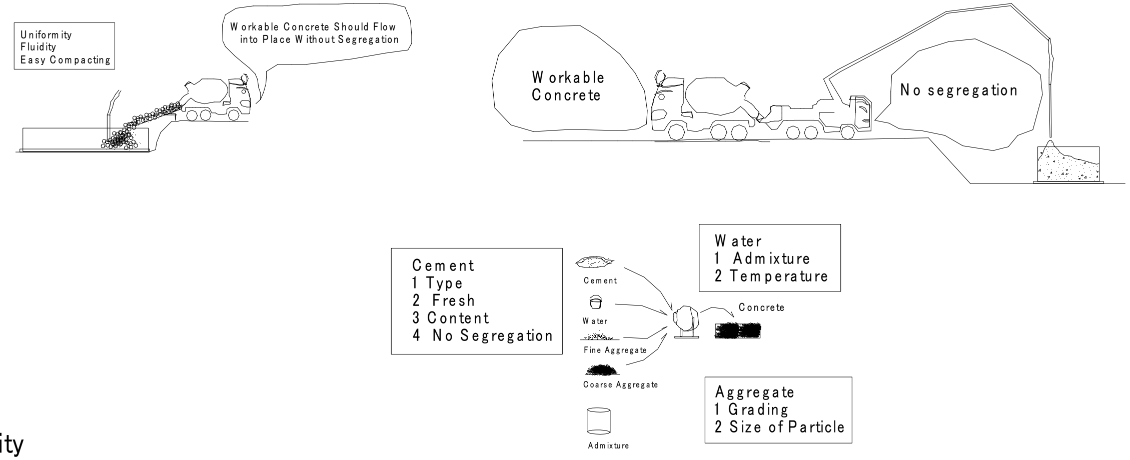
(441) Concrete -5

(183) Good Concrete

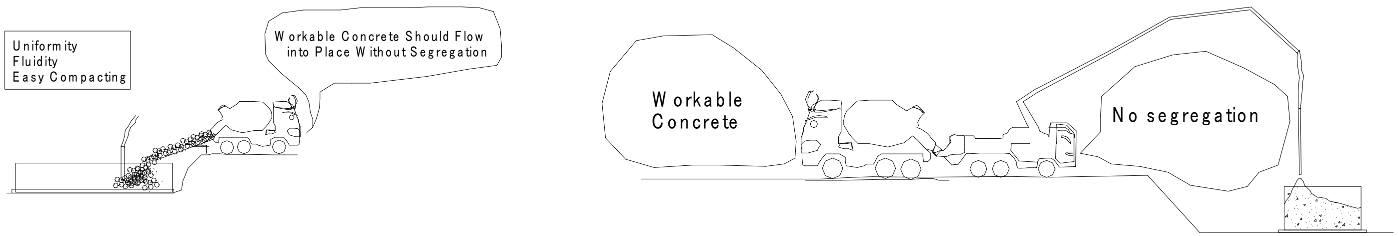


(184) Workability

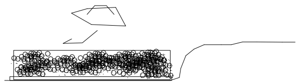
Concreting according to Consistency
No Segregation



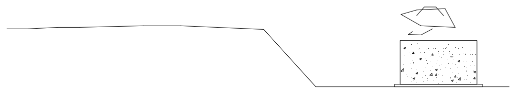
(187) Finishability



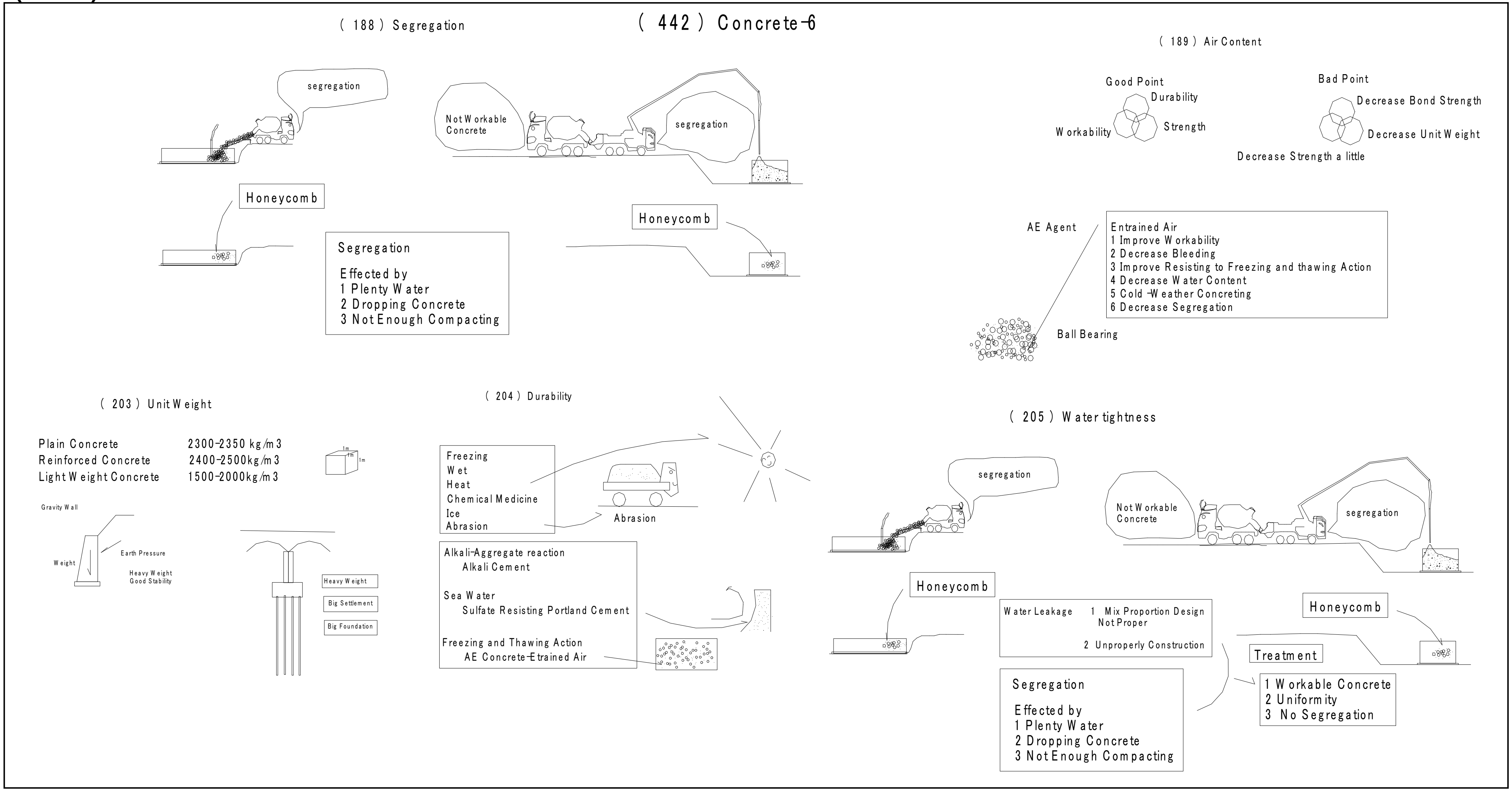
Easiness of Concrete Finishing



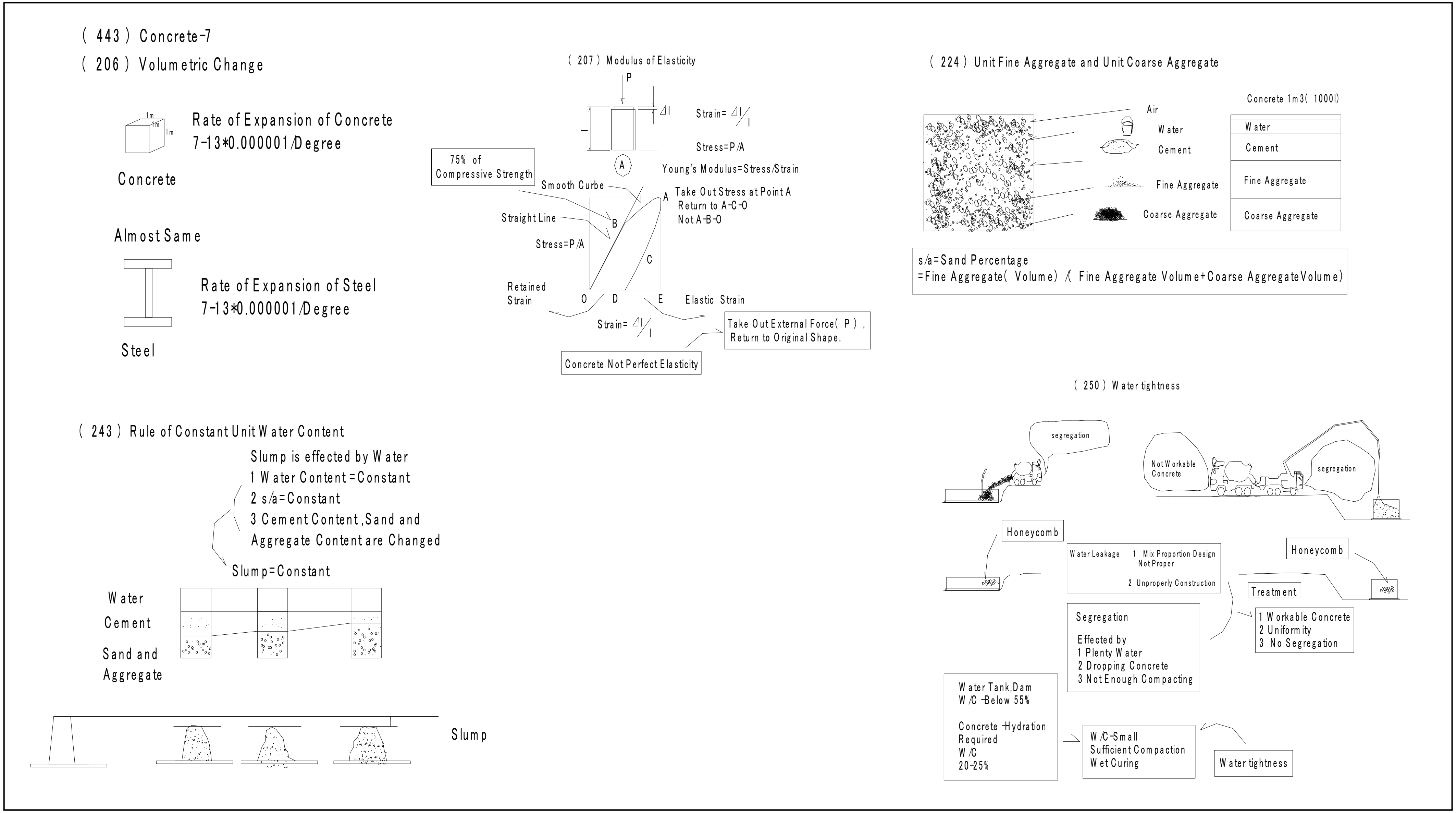
Effected by
1 Gmax
2 s/a
3 Grading of Sand
4 Consistency



(442) Concrete-6



(443) Concrete-7



(444) Concrete-8

(444) Concrete-8

(338) Mass Concrete

Foundation
Cement Cracks

1 Controlling of Temperature Cracks
  1 Reinforcement
  2 Crack Joint
  3 Pre-Cooling
  4 Pipe-Cooling

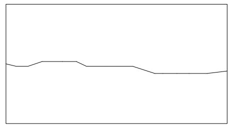
2 Concrete Mixing
  Minimum Cement Content Within Required Workability and Designed Compressive Strength
  Reduce Hydration Heat
  1 Cement Heat Portland Cement
    Blast Cement
    Silica Cement
    Flyash Cement
  2 Designed Compressive Strength 91 days

(337) Hot Weather Concrete

Over Average Temperature 25 degree

a Material
1 Aggregate:Protect from Sunshine,Spread Water
2 Admixture
3 Unit Water and Unit Cement Water Content within Required Workability
4 Cooling:Aggregate: 2 degree
  Water Temperature:4 degree
  Cement:8 degree
  → Down Concrete Temperature 1 degree

b Excution
1 Transportation:Not Slump Loss
2 Forms Reinforcement:Spread Water
3 Concreting Time : 1-1.5 hours from Mixing
4 Concreting Temperature:below 35 degree
5 Cold Joint:Early Setting Time
  Mass Concrete:Retarder



6 Curing:Avoid Sunshine,Protect Concrete from Wind
  24 hours Wet Curing
  5 days Curing

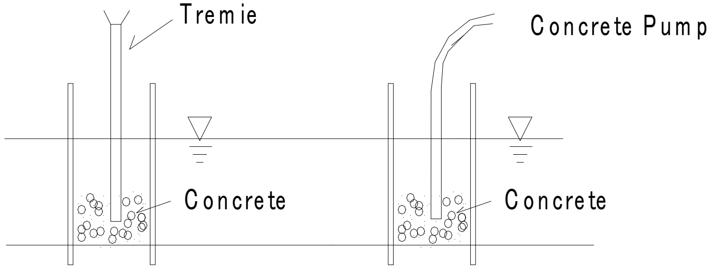
(445) Concrete-9

(445) Concrete -9

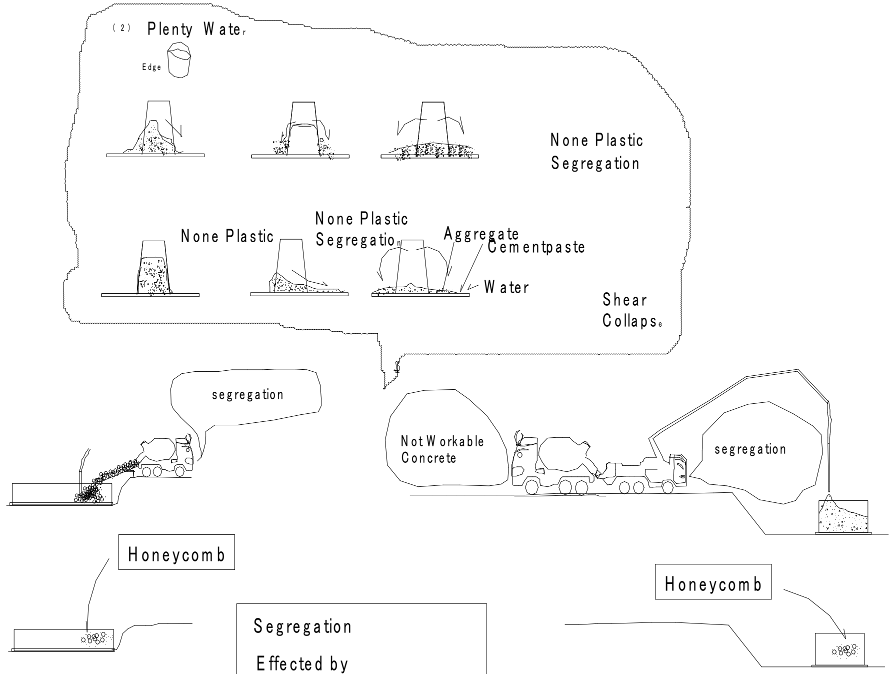
(339) Concrete under Water

1 60% Compressive Strength
2 Not Fit for Dam Concrete and Reinforced Concrete

Methods
1 Tremie
2 Concrete Pump
3 Velocity of Flow : 3m/minute



(343) Segregation



Segregation

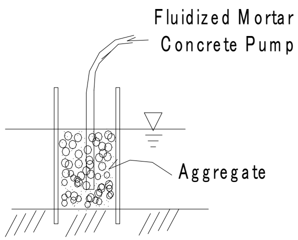
Effected by
1 Plenty Water
2 Dropping Concrete
3 Not Enough Compacting

Not Proper Mix Proportion
1 Transportation
2 Unproper Construction ,Over Compacting
-Segregation
3 Bleeding-Bond Strength between Reinforcement and Forms -Decrease
Watertightness-Decrease
4 G Max-Bigger-Segregation Increase
5 AE Agent,AE Water Reducing Agent-Ressist Segregation

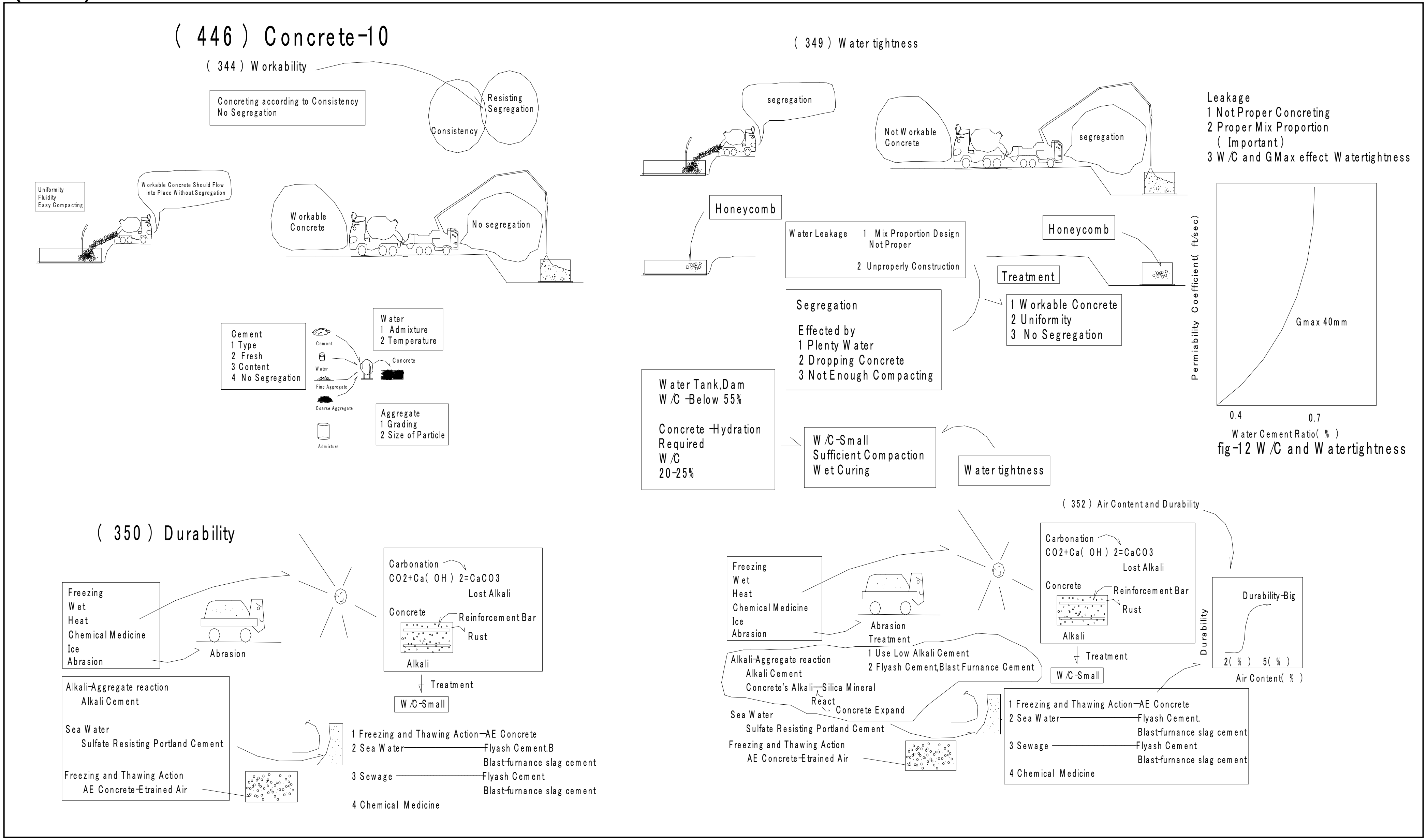
(341) Fluidized Concrete

(1) Super Plasticizer
Standard Type and Retarder Type
(2) Mix Proportion
Base Concrete+Super Plasticizer
Base Concrete:AE Concrete
(3) Slump
1 below 18cm
2 increase in 10cm by Super Plasticizer
3 Base Concrete Slump:over 5-6 cm
Fuidized Concrete Slump:8-12 cm
(4) Mix Proportion
1 Super Plasticizer (Additive Content)
below 0.5% of Cement
Ignore Volume of Super Plasticizer
2 Mix Proportion Table
Type,Transportation Time and Pump
(5) Fluidized Concrete
1 Add Super Plasticizer to Base Concrete at Site
2 Add Super Plasticizer to Base Concrete at Batch Plant

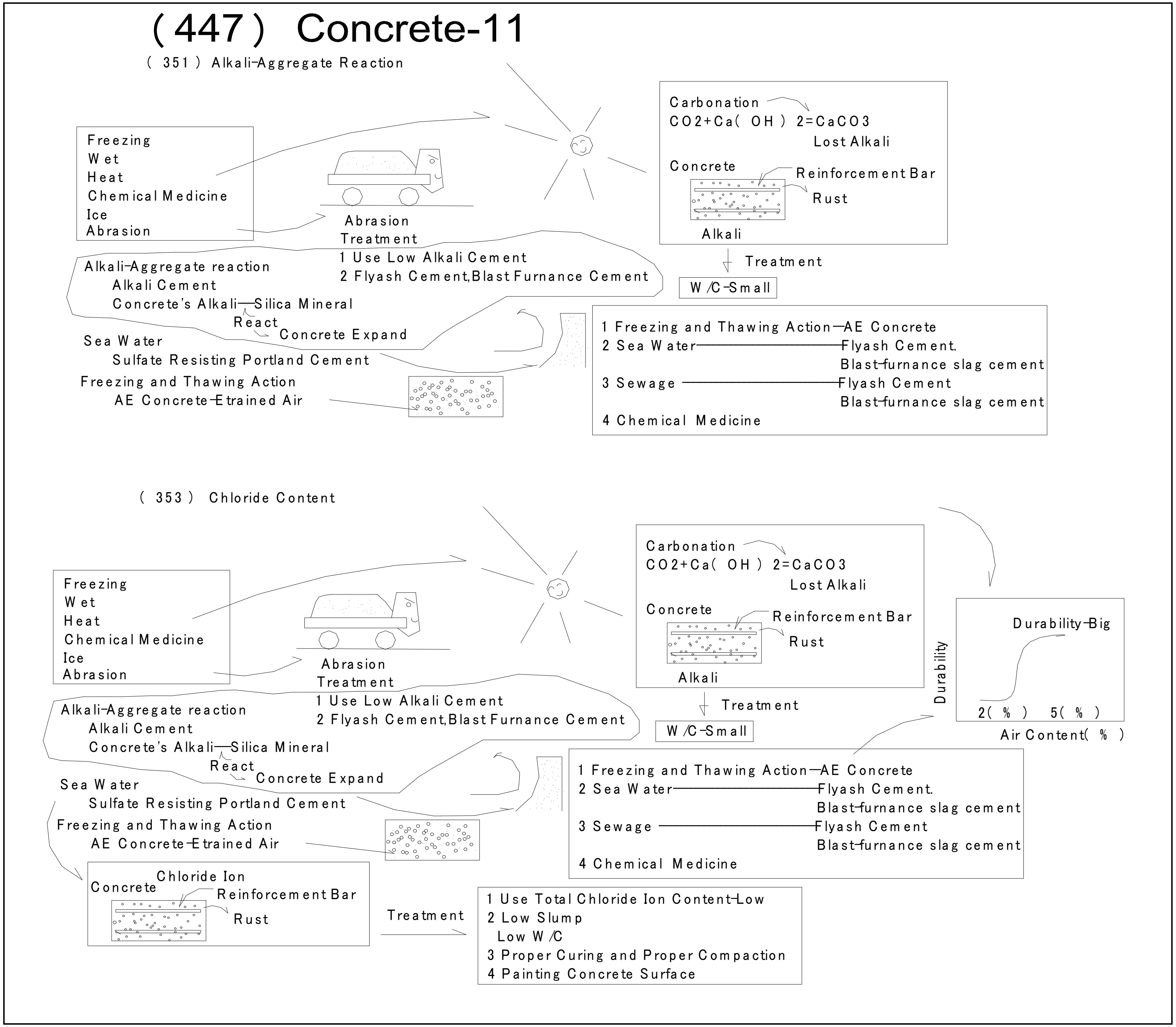
(340) Prepacked Concrete



(446) Concrete-10



(447) Concrete-11

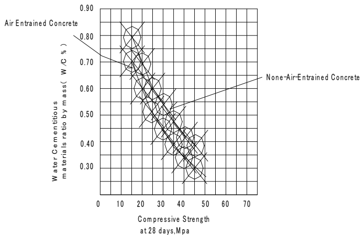


(448) W /C-1

(3) Water Cement Ratio and Compressive Strength

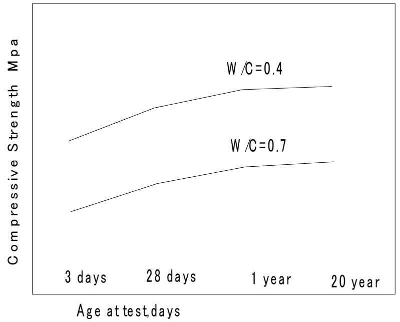
ASTM C 31, ACI 211.1 and ACI 211.3.

Compressive Strength at 28 days,Mpa	Water Cementitious materials ratio by mass	
	None-air-entrained concrete	Air Entrained Concrete
45	0.38	0.30
40	0.42	0.34
35	0.47	0.39
30	0.54	0.45
25	0.61	0.52
20	0.69	0.60
15	0.79	0.70

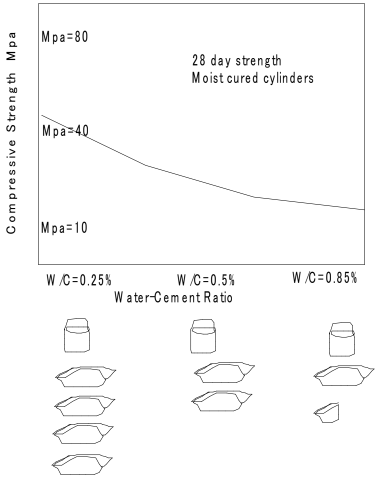


(38) Concrete Strength

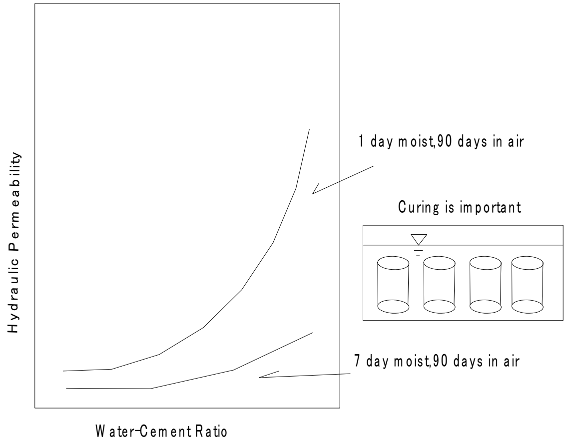
Concrete continues to gain strength for many years when moisture is provided by rainfall



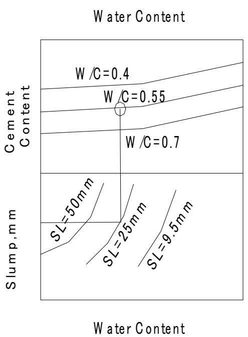
(40) Water-Cement Ratio and Compressive Strength,Mpa



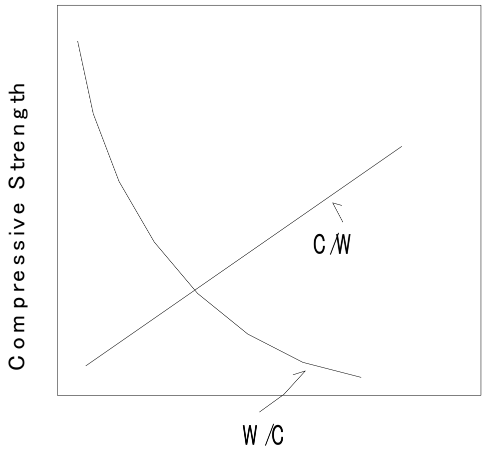
(41) Water-Cement Ratio and Hydraulic Permeability



(52) Water Content,Slump and Cement Content



(53) Relationship between Strength and W /C



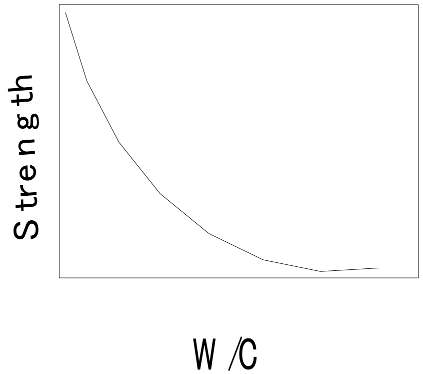
(57) Concrete Technology

Mix Proportion

(1) Concrete Compressive Strength -Water Cement Ratio

(2) Air (Entrained Air) -Durability

(3) Economy-Adimixture



(449) W/C-2

(449) W /C -2

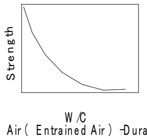
(58) Concrete Trial Mix

Trial Mix (Laboratory)

Trial Batch (Batching Plant)

Mix Proportion

(1) Concrete Compressive Strength -Water Cement Ratio

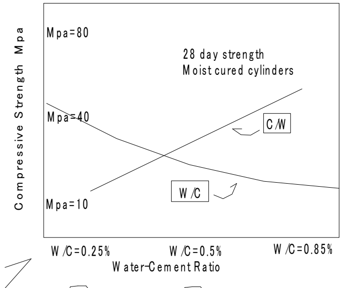


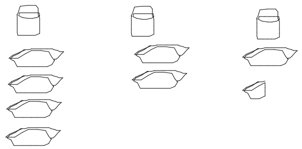
(2) Air (Entrained Air) -Durability

(3) Economy-Adimixture

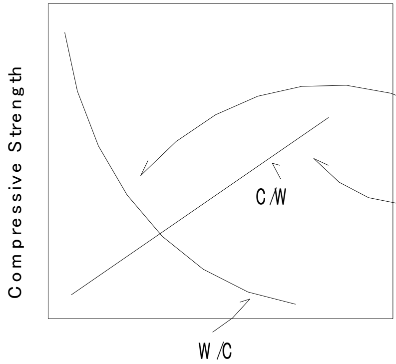
1 W /C is unproportional to Strength
2 C /W is proportional to Strength
3 Durability and Watertightness are proportion to Unit Cement
4 Durability and Watertightness are unproportion to Unit Water

(197) Mix Proportion and Compressive Strength





(216) Water Cement Ratio



W /C=x

Compressive Strength=σ

$\sigma=(A/B)$ ^x

Compressive Strength=σ

$\sigma=A+B*(C/W)$

In Case of No Trial Mix

$\sigma 28=-210+215*(C/W)$

(218) W /C and Durability

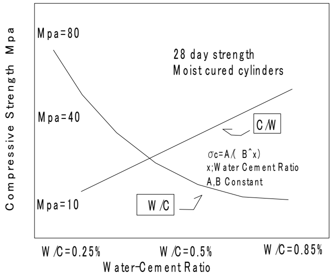
Compressive Strength	W /C=50%
Durability	W /C=65%
Water Tightness	W /C=55%

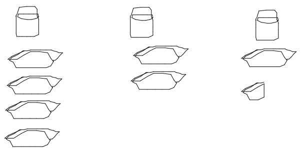
Minimum Value 50%

(219) W /C and Water Tightness

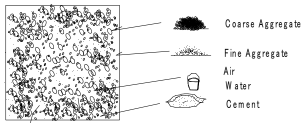
Plain Concrete	Below W/C=55%
External Concrete of Dam	Below W/C=60%

(245) Water Cement Ratio





1 W /C is unproportional to Strength
2 C /W is proportional to Strength
3 Durability and Watertightness are proportion to Unit Cement
4 Durability and Watertightness are unproportion to Unit Water



Cement Paste-Bond-Strength

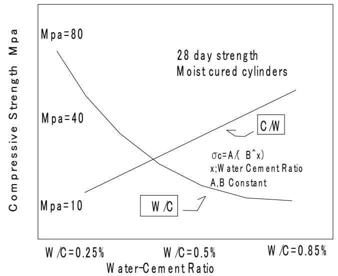
W /C Effect Strength,Durability and Water Tightness

(251) W /C and Mix Proportion Design

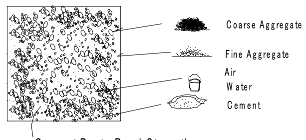
Compressive Strength	W/C=50%
Durability	W/C=65%
Water Tightness	W/C=55%
Concreting Under Water	Below W/C=55%

Minimum Value 50%

(246) Water Cement Ratio and Strength

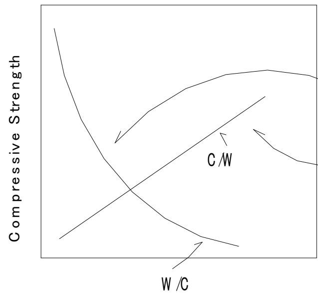


1 W /C is unproportional to Strength
2 C /W is proportional to Strength
3 Durability and Watertightness are proportion to Unit Cement
4 Durability and Watertightness are unproportion to Unit Water



Cement Paste-Bond-Strength

W /C Effect Strength,Durability and Water Tightness



W /C=x

Compressive Strength=σ

$\sigma=(A/B)$ ^x

Compressive Strength=σ

$\sigma=A+B*(C/W)$

Small Construction

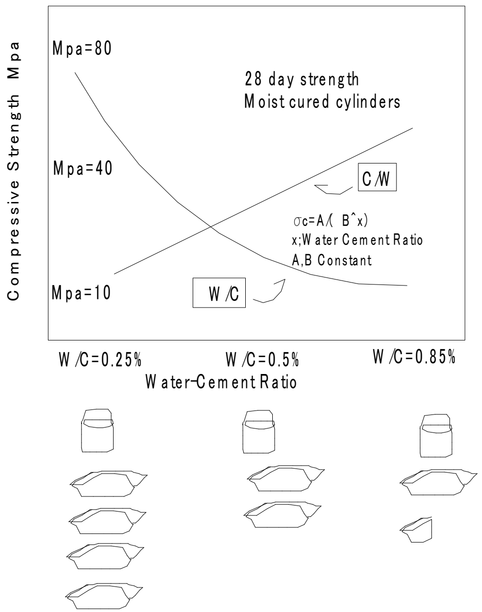
In Case of No Trial Mix

$\sigma 28=-210+215*(C/W)$

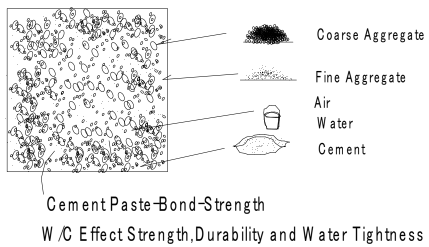
(450) W/C-3

(450) Water Cement Ratio-3

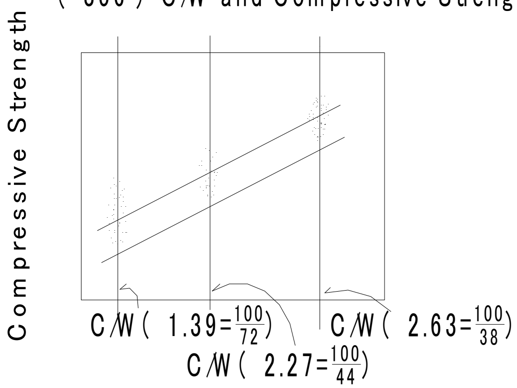
(245) Water Cement Ratio



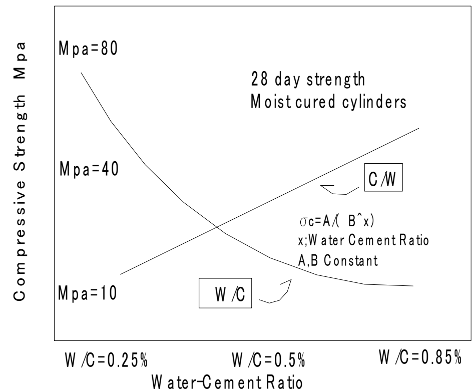
1 W/C is unproportional to Strength
2 C/W is proportional to Strength
3 Durability and Watertightness are proportion to Unit Cement
4 Durability and Watertightness are unproportion to Unit Water



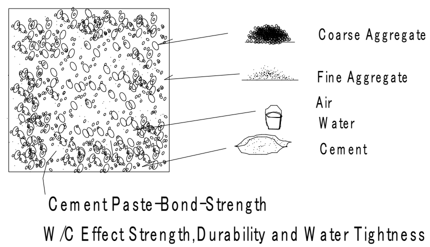
(356) C/W and Compressive Strength

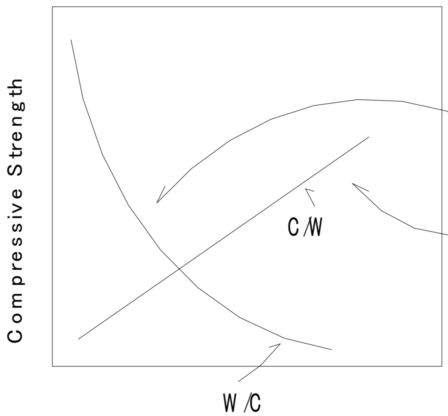


(246) Water Cement Ratio and Strength



1 W/C is unproportional to Strength
2 C/W is proportional to Strength
3 Durability and Watertightness are proportion to Unit Cement
4 Durability and Watertightness are unproportion to Unit Water





W/C=x
Compressive Strength=σ
$\sigma=(A/B)$ ^x

Compressive Strength=σ
$\sigma=A+B*(C/W)$

Small Construction

In Case of No Trial Mix
$\sigma 28=-210+215*(C/W)$

(451) W/C-4

71 ACI 211.1 Table A1.5.3.4(a) Relationships between Water-Cement Ratio and Compressive Strength of Concrete (SI)

Compressive Strength Ages 28 Days(kg/cm2)	Water Cement Ratio W/C	
	Plain Concrete	AE Concrete
450	0.38	
400	0.43	
350	0.48	0.4
300	0.55	0.46
250	0.62	0.53
200	0.7	0.61
150	0.8	0.71

Compressive Strength,Wet Curing in 28 days,23+−1.7 degree

72-ACI211.1 Table A1.5.3.4(b) Maximum Permissible Water-Cement Ratios for Concrete in Severe Exposures (SI)

Type of Structure	Wet Condition or Freezing and Thawing Action	Sea Water or Sodium Sulfate Chloride
Thin Section (Hand Rail,Beam ,below Covering 3 cm)	0.45	0.4
Other Structure	0.5	0.45

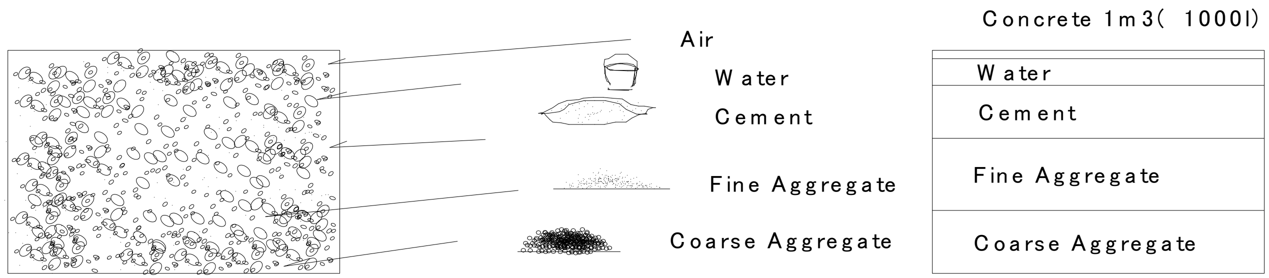
ACI Committee 201 (Durability of Concrete in Service)

Compressive Strength to W/C

Water Cement Ratio	Compressive Strength (kg/cm 2) at Ages 28 Days	
	AE Concrete	Plain Concrete
0.4	300	380
0.45	275	345
0.5	245	300
0.55	218	265
0.6	190	240
0.65	170	210
0.7	155	190

(452) s/a-1

(224) Unit Fine Aggregate and Unit Coarse Aggregate



s/a=Sand Percentage
=Fine Aggregate(Volume) /(Fine Aggregate Volume+Coarse Aggregate Volume)

(3) Slump
c Slump(cm) 8cm

(4) Maximum Size of Coarse Aggregate
k Maximum Size of Aggregate(mm) 25

(5) Unit Water and Sand Percentage

221 Unit Water and Sand Percentage of Concrete
River Sand,River Gravel,W/C=55% ,Slump=5cm ,FM=2.75

Maximum Size of Aggregate	No Admixture			AE Concrete				
					Good Quality AE Agent		Good Quality Water Reducing Agent	
	Entrapped Air	Sand Percentage	Unit Water of Concrete	Air Content(Strict Weather)	Sand Percentage	Unit Water of Concrete	Sand Percentage	Unit Water of Concrete
(mm)	(%)	(%)	(kg)	(%)	(%)	(kg)	(%)	(kg)
15	2.5	49	187	7	46	169	47	156
20	2	45	181	6	42	162	43	150
25	1.5	41	172	5	37	153	38	143
40	1.2	36	160	4.5	33	141	34	131
50	1	33	152	4	30	131	31	122
80	0.5	31	139	3.5	28	117	28.5	109
150	0.3	28	120	3	24	100	24	93

(453) s/a-2

262 Sand Percentage and Water Content			
Maximum Size of Aggregate(mm)	Sand Percentage(s/a) (%)	Water Content W (N)	
20	46	184	1 Good Grading 2 W/C=0.55 3 Fine Aggregate F.M=2.75
25	41	178	
40	37	166	
50	34	157	
80	31	148	
150	26	131	

265 Correction		
Section	Correction of (s/a)%	Correction of (W)kg
FM of Sand (0.1 Bigger)	Increase 0.5	No Correction
Slump (1cm Bigger)	No Correction	Increase 1.2%
Air Content(1% Bigger)	Decrease (0.5–1)	Decrease (3)%
Crushed Stone	Increase 3–5	Increase 9–15
Crushed Sand	Increase 2–3	Increase 6–9

(454) Air Content-1

230 Standard of Air Content

Type		Air Content(%)
Plain. Reinforcement Concrete		3-6
Concrete Pavement		4
Dam Concrete	Maximum Size 40mm	4.0+-1
	Maximum Size 80mm	3.5+-1
	Maximum Size 150mm	3.0+-1

275 Air Content of AE Concrete

Maximum Size of Coarse Aggregate (mm)	Air Content (%)
15	6
20	5
25	4.5
40	4
50	3.5
80	3

(455) Cement in Superplasticized Concrete-1

(455) Cement in Superplasticized Concrete-1

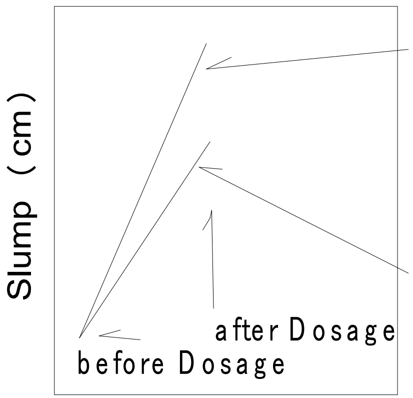
(119) Concrete Material(1)

Cement
Blended Cement-(Blast-Furnance Slag Cement, Portland Pozzolan Cement,Silica Cement,Fly Ash Cement)
Special Cement -(Alumina Cement,Ultra Rapid Harding Cement)
Sulfate Resisting Portland Cement
Moderate Heat Portland Cement
Ultra High Early Strength Portland Cement
High Early Strength Portland Cement
Ordinary Portland Cement

Air Content
Ordinary Portland Cement → Air Content No Change

Other Concrete → Air Content in 1 % Decrease

Effect of Superplasticizer

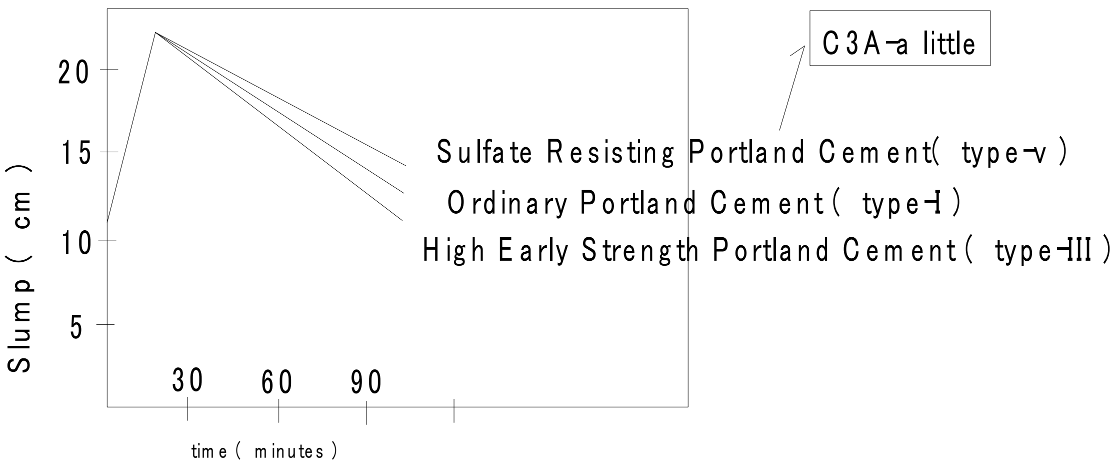


Cement
Blended Cement-(Blast-Furnance Slag Cement, Portland Pozzolan Cement,Silica Cement,Fly Ash Cement)

Moderate Heat Portland Cement
High Early Strength Portland Cement
Ordinary Portland Cement

Ultra High Early Strength Portland Cement

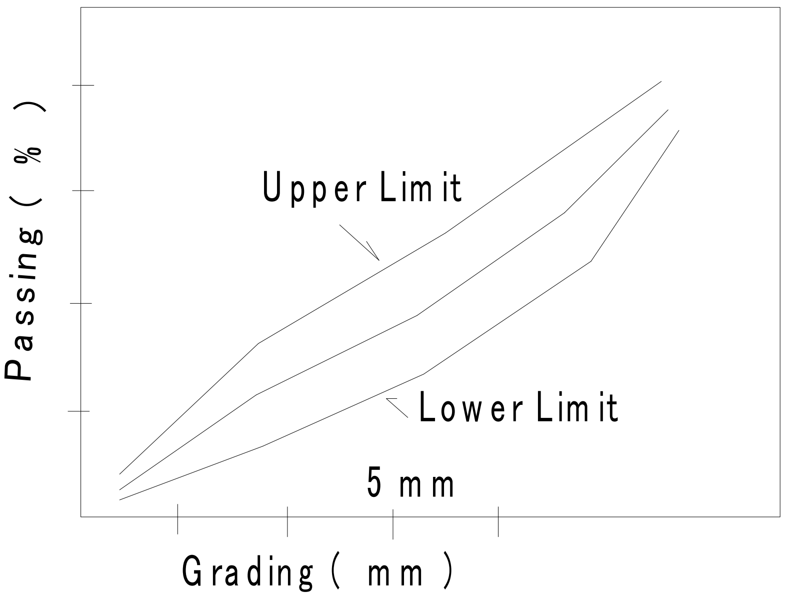
Effect of Superplasticizer



(456) Aggregate in Superplasticized Concrete -2

(456) Aggregate in Superplasticized Concrete-2

(1) Grading of Different Combination of Fine and Coarse Aggregate



Grading Curve in Compound Aggregates

(2) Small Particles

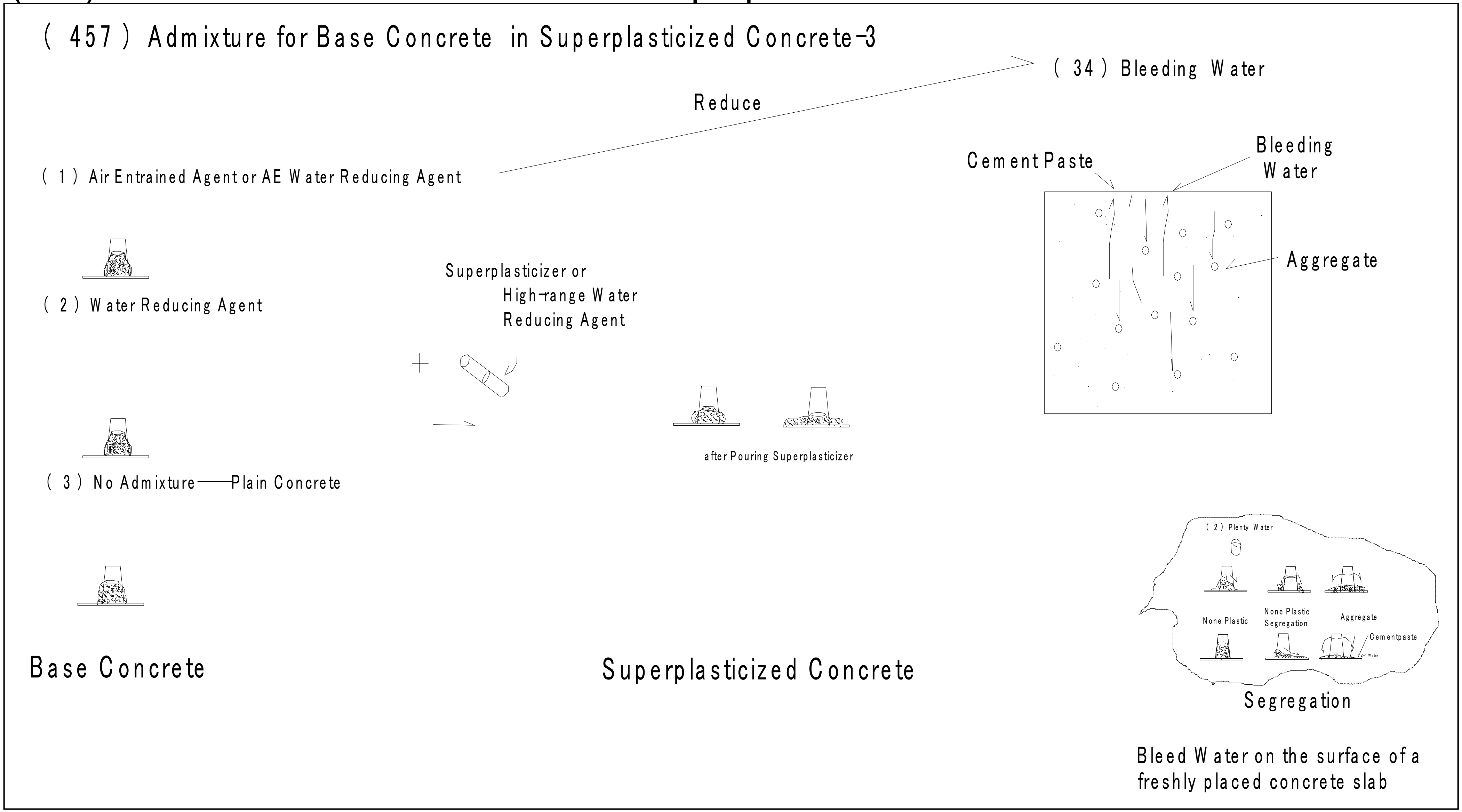
(1) Maximum Aggregate Size over 40mm
Passing Amount in 0.3mm Sieve—over 400kg/m3

Maximum Aggregate Size over 20mm
Passing Amount in 0.3mm Sieve—over 450kg/m3

(2) Amount of Passing in 1.2mm Sieve
Cement Content over 270kg/m3——24-35%
Cement Content below 270 kg/m3—over 35%

(3) Case -Shortage of Small Particles in Sand
Use Pozollan

(457) Admixture for Base Concrete in Superplasticized Concrete-3

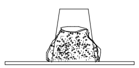


(458) Superplasticizer in Superplasticized Concrete-4

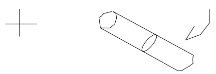
(458) Superplasticizer in Superplasticized Concrete-4

Combination between Superplasticizer and Admixture in Base Concrete

Admixture in Base Concrete	Superplasticizer
Air Entrained Agent or	Standard Type
AE Water Reducing Agent	Standard Type
AE Water Reducing Retarder Type	Standard Type
Air Entrained Agent	Retarder Type
Air Entrained Water Reducing Retarder Type	Retarder Type



Superplasticizer or
High-range Water
Reducing Agent



after Pouring Superplasticizer

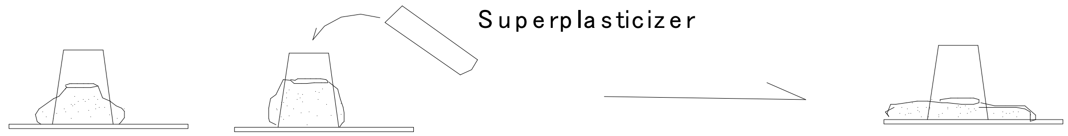
(459) Mix Proportion in Superplasticizer Concrete-5

(459) Mix Proportion in Superplasticized Concrete-5

Decide

(1) Base Concrete
Mix Proportion

(2) Dosage in
Superplasticizer

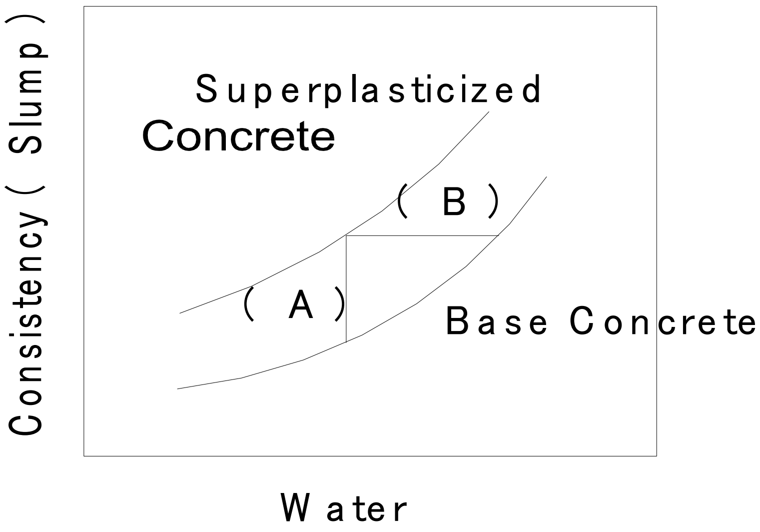


AE Concrete
Slump 80t-25mm
Admixture :AE Agent

Base Concrete

Slump 180+-25mm

Superplasticized Concrete



(A) Improve Workability
Water—Constant

(B) Reduce Water Content
Keep Workability

(460)Cautions of Fresh Concrete

Cautions of Batching Plant and Concreting

(A) Batching Plant

(1)Prepare Delivery Slip

(2) Check Autographic Record

(3) When Making Test Pieces(Cylinders),Check Water Content Cement Cntent and Superplasticizer especially.

(4)Wait Unloading when Concrete Condition is Soft,

(5) Target Slump of Batching Plant is 20cm or 21cm,Adjust Slump in 1cm by Adding Water (2-3kg/m3) Increasing or Decreasing

(6) Confirm Washed Water in Mixer before Loading Concrete

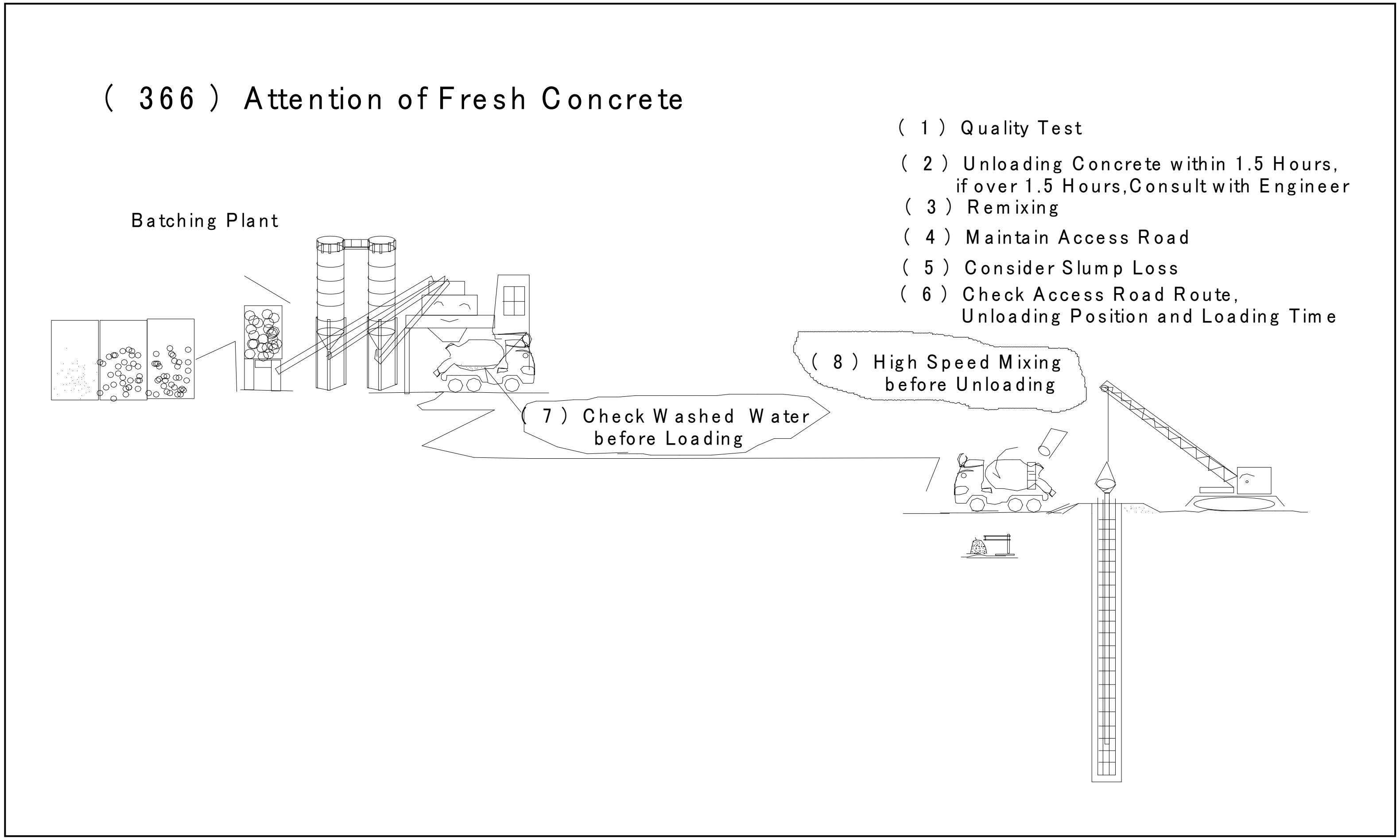
(B) Concreting at Site

(1) High Speed Turning Mixer before Unloading

(2) Wait Unloading When Slump over 20.5cm,then Check Condition of Concrete

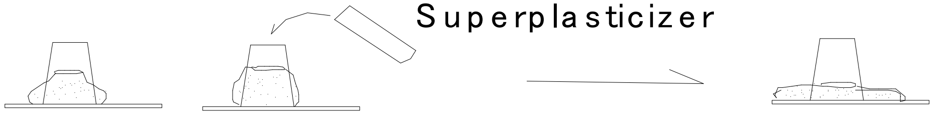
(3) Adjust Slump(Concrete Condition) if Concrete Condition Hard (Slump below 15.5cm) by using Superplasticizer

(4) Transportation Time over 90 Minutes', Check Condition of Concrete.



(461) Slump in Superplasticized Concrete-6

(461) Slump in Superplasticized Concrete-6

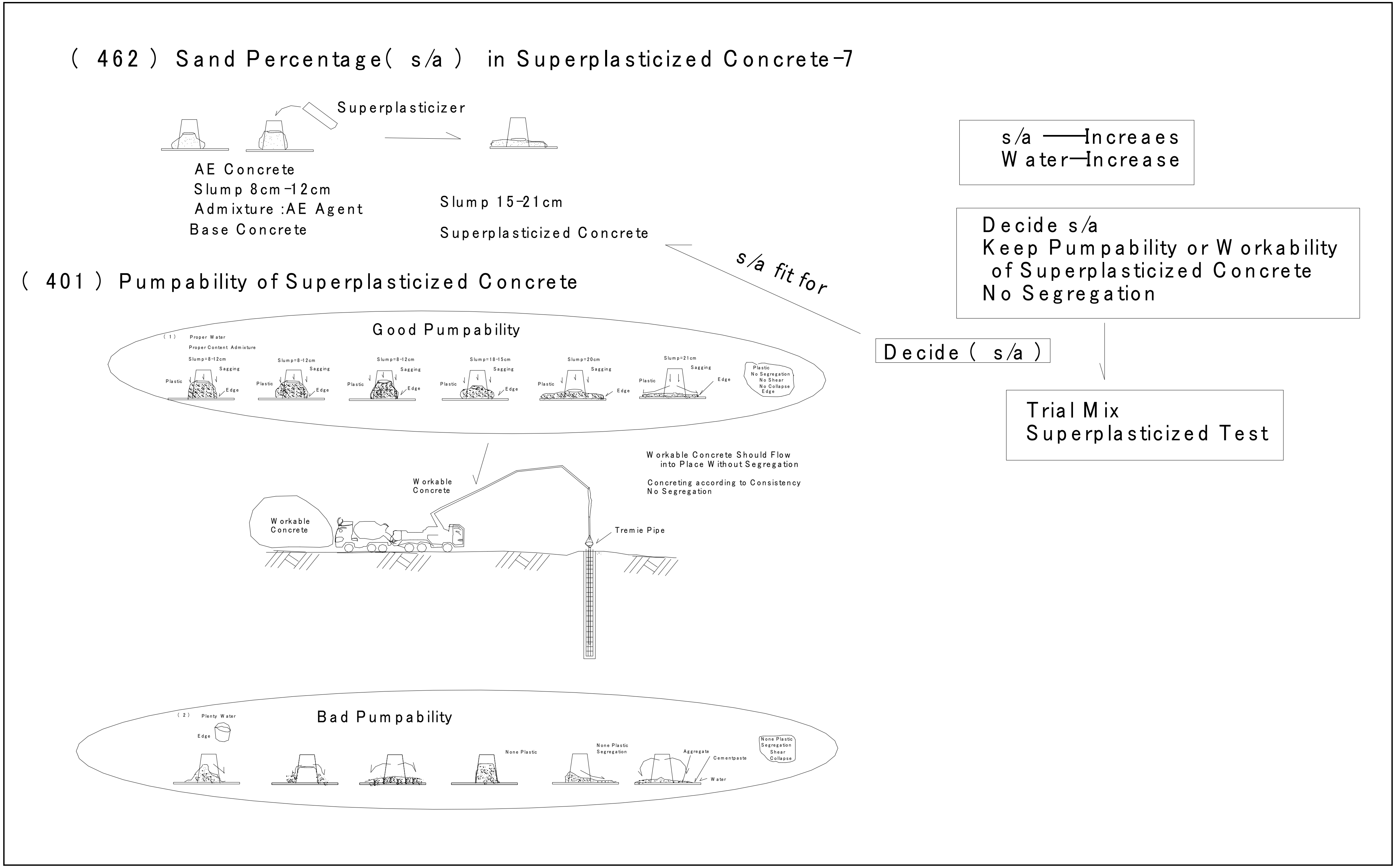


AE Concrete
Slump 8cm-12cm
Admixture :AE Agent
Base Concrete

Slump 15-21cm
Superplasticized Concrete

	Slump of Base Concrete	Slump of Superplasticized Concrete
Normal Concrete	8	15
	8	18
	12	21
	15	21
Light Concrete	15	21,22
	18	

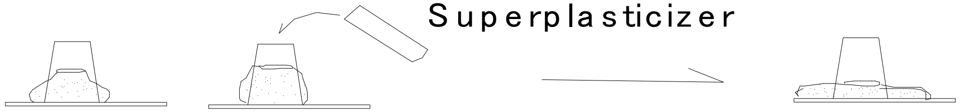
(462) Sand Percentage(s/a) in Superplasticized Concrete-7



(463) Air Content (a) in Superplasticized Concrete-8

(463) Air Content (a) in Superplasticized Concrete-8

Superplasticizer



AE Concrete
Slump 8cm-12cm
Admixture :AE Agent
Base Concrete

Slump 15-21cm

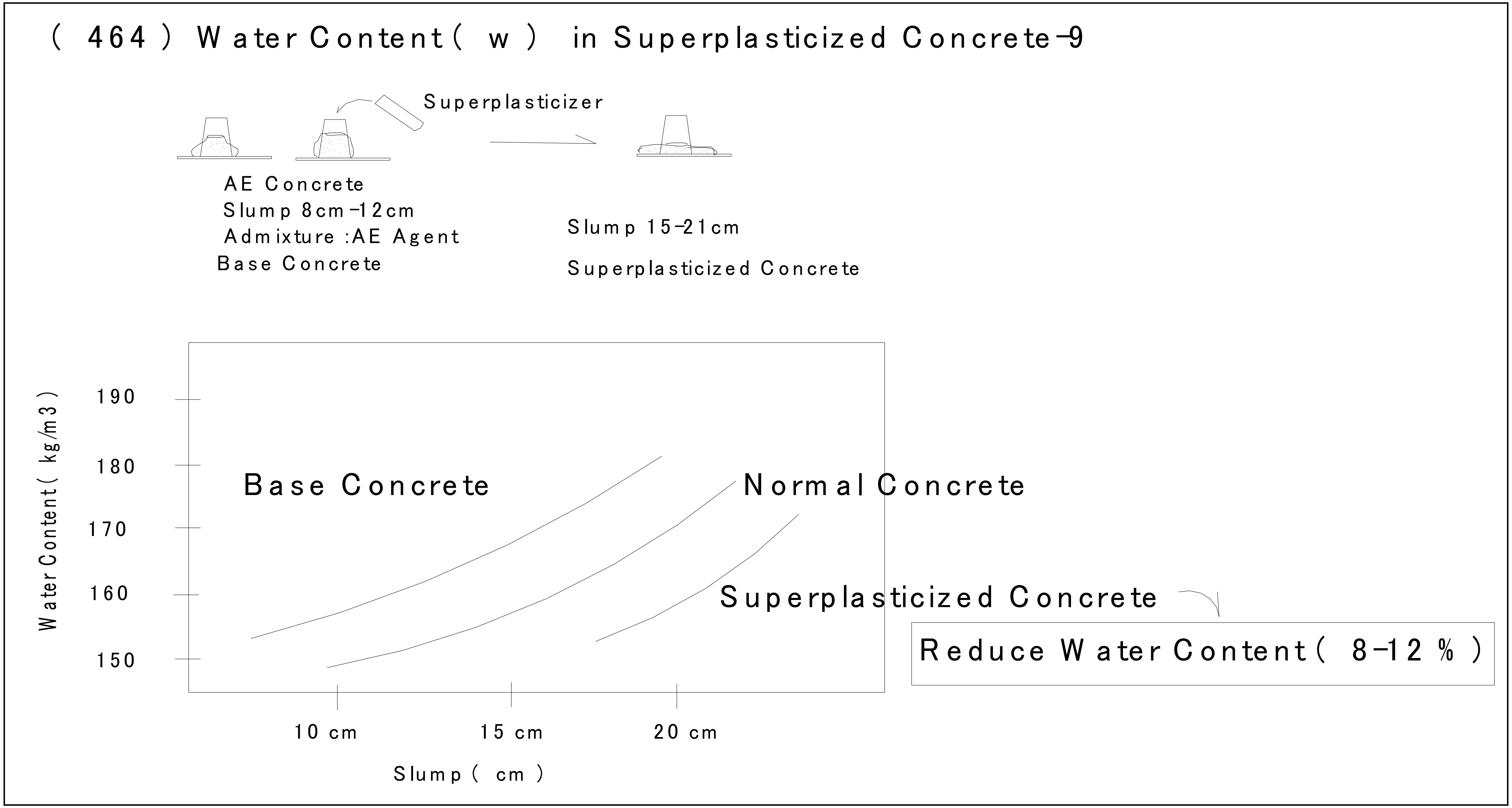
Superplasticized Concrete

Air Content

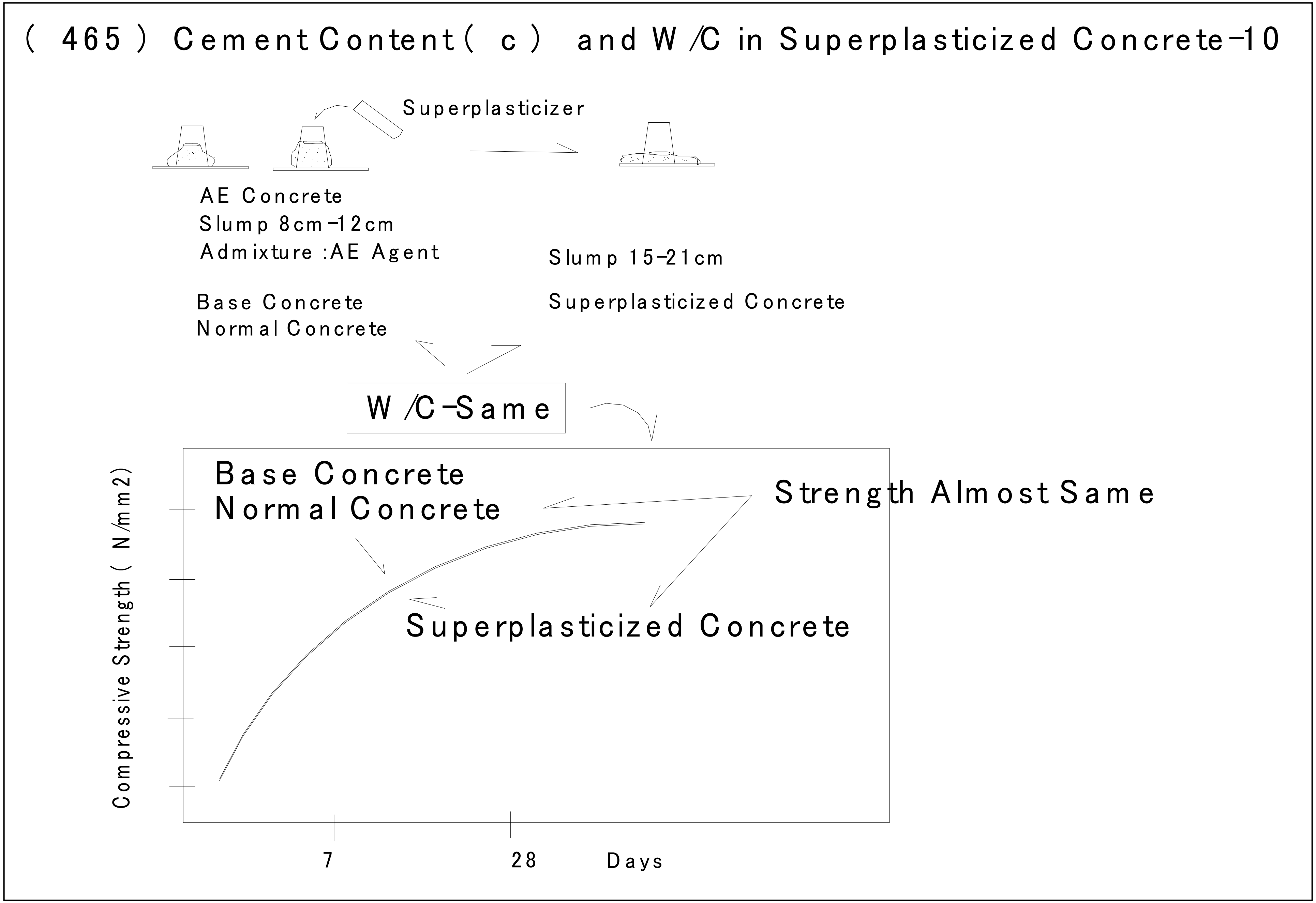
Decide

Reduce Bleeding
Improve Workability and Pumpability
No Segregation
Base Concrete——AE Concrete
Normal Concrete——4%
Light Concrete——5%

(464) Water Content (w) in Superplasticized Concrete-9

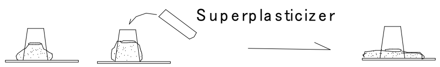


(465) Cement Content© and W/C in Superplasticized Concrete-10



(466) Sand Percentage (s/a) in Superplasticized Concrete-11

(466) Sand Percentage (s/a) in Superplasticized Concrete-11



AE Concrete
Slump 8cm-12cm
Admixture :AE Agent

Base Concrete

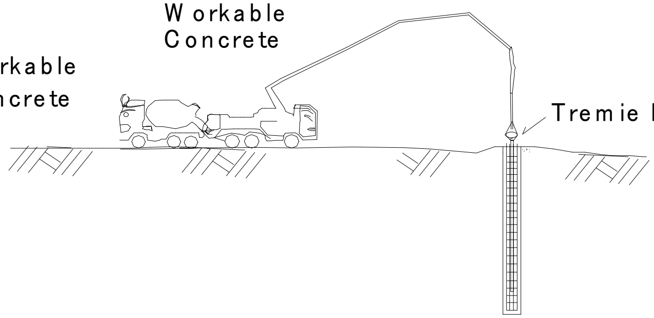
Slump 15-21cm

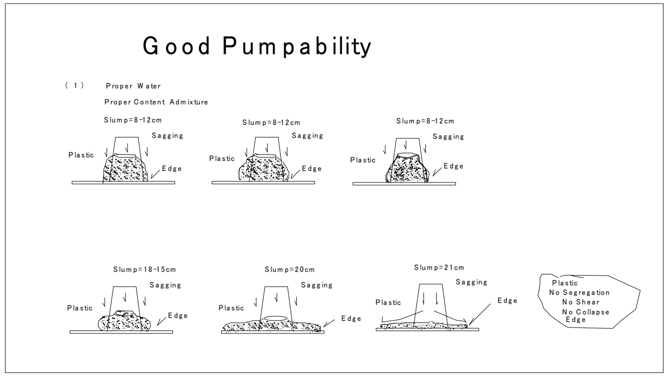
Superplasticized Concrete

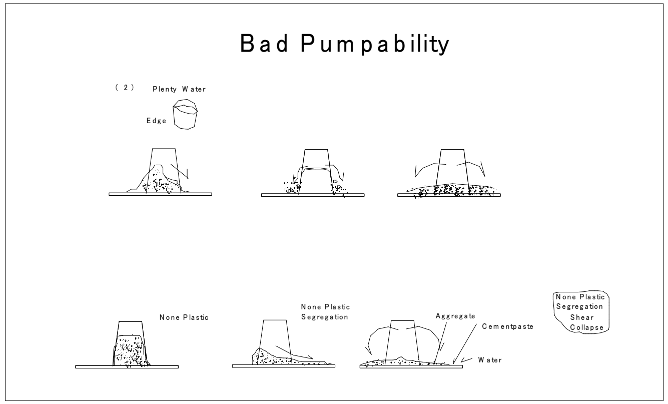
Deside s/a by Trial Mix

Pumping
s/a bigger in 2-3 %

Workable Concrete Should Flow
into Place Without Segregation
Concreting according to Consistency
No Segregation

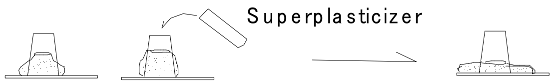






(467) Mix Proportion of Base Concrete in Superplasticized Concrete-12

(467) Mix Propotion of Base Concrete in Superplasticized Concrete-12



AE Concrete
Slump 8cm-12cm
Admixture :AE Agent

Base Concrete

Slump 15-21cm

Superplasticized Concrete

(1) W/C-Constant

Example=Ready Mixed Concrete Factory

	Slump (cm)	W/C (%)	s/a (%)	W (kg/m3)	C (kg/m3)	Remarks
Normal Concrete	15	58	43	162	280	
	21	58	47	180	310	(soft)
Base Concrete	15	58	47	168	290	

W=162+1.5(47-43) =168

C=C/(W/C) =(168/(0.58))
=290 (kg/m3)

Superplasticized Test
Workability Test
Trial Test

(2) C-Constant

Example=Ready Mixed Concrete Factory

	Slump (cm)	W/C (%)	s/a (%)	W (kg/m3)	C (kg/m3)	Remarks
Normal Concrete	15	58	43	162	280	
	21	58	47	180	310	(soft)
Base Concrete	15	54	47	168	310	

W/C=168/310=54

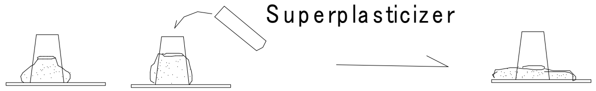
W=162+1.5(47-43)
=168

C=310(kg/m3)

Superplasticized Test
Workability Test
Trial Test

(468) Trial Mix of Base Concrete in Superplasticized Concrete-13

(468) Trial Mix of Base Concrete in Superplasticized Concrete-13



AE Concrete
Slump 8cm-12cm
Admixture :AE Agent

Base Concrete

Slump 15-21cm

Superplasticized Concrete

Example=Ready Mixed Concrete Factory

	Slump (cm)	W/C (%)	s/a (%)	W (kg/m3)	C (kg/m3)	Remarks
Normal Concrete	15	58	43	162	280	
	21	58	47	180	310	(soft)

W=162+1.5(47-43)=168

C=C/(W/C)=(168/(0.58))
=290(kg/m3)

Base Concrete	15	58	47	168	290	

Superplasticized Test
Workability Test
Trial Test

Superplasticized Test
Judge Workability

Decide Dosage Superplasticizer

Slump of Base Concrete
—(1-2cm increase)

Check Slump Loss for 30 minutes'

Test Item
(1) Concrete Temperature
(2) Slump Test and Flow Test
(3) Setting Test (Proctor Penetration Resistance Test)
(4) Compressive Strength Test
(5) Density Test

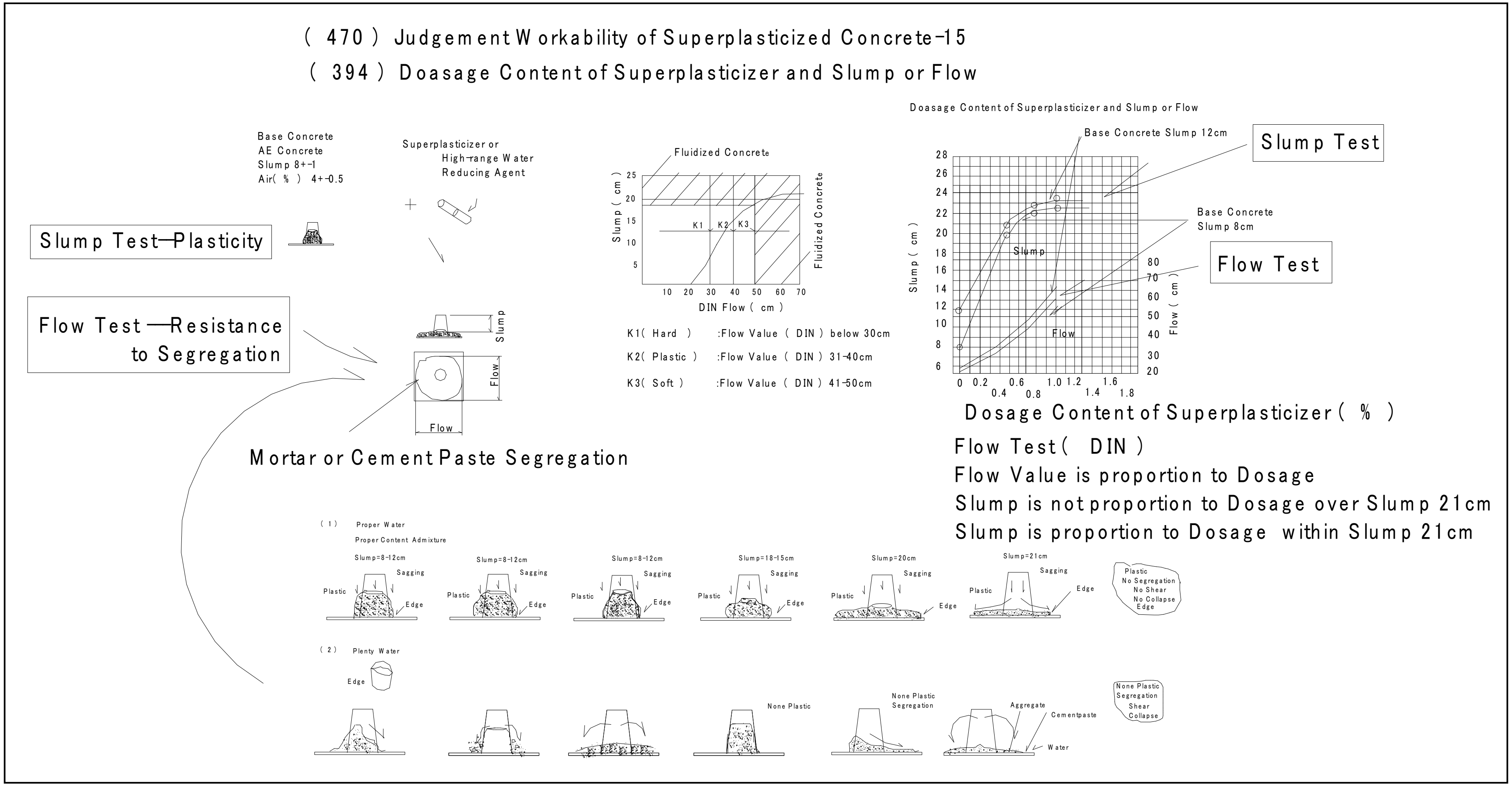
(469) Superplasticized Test in Superplasticized Concrete-14

(469) Superplasticized Test in Superplasticized Concrete-14

Condition	Correction	
	S/A	W
W/C 0.05 Increase Decrease	+-1	–
Fineness Modules FM 0.1(Sand) Increas Decrease	+-0.5	–
Slump 1.0cm Increas Decrease	–	+-1.2%
Air Content 1.0% Increas Decrease	+-0.5-1.0	-+3%
S/A 1% Increas Decrease	–	+-1.5kg
Crushed Stone	+3-5	+9-15kg
Crushed Sand	+2-3	+6-9kg

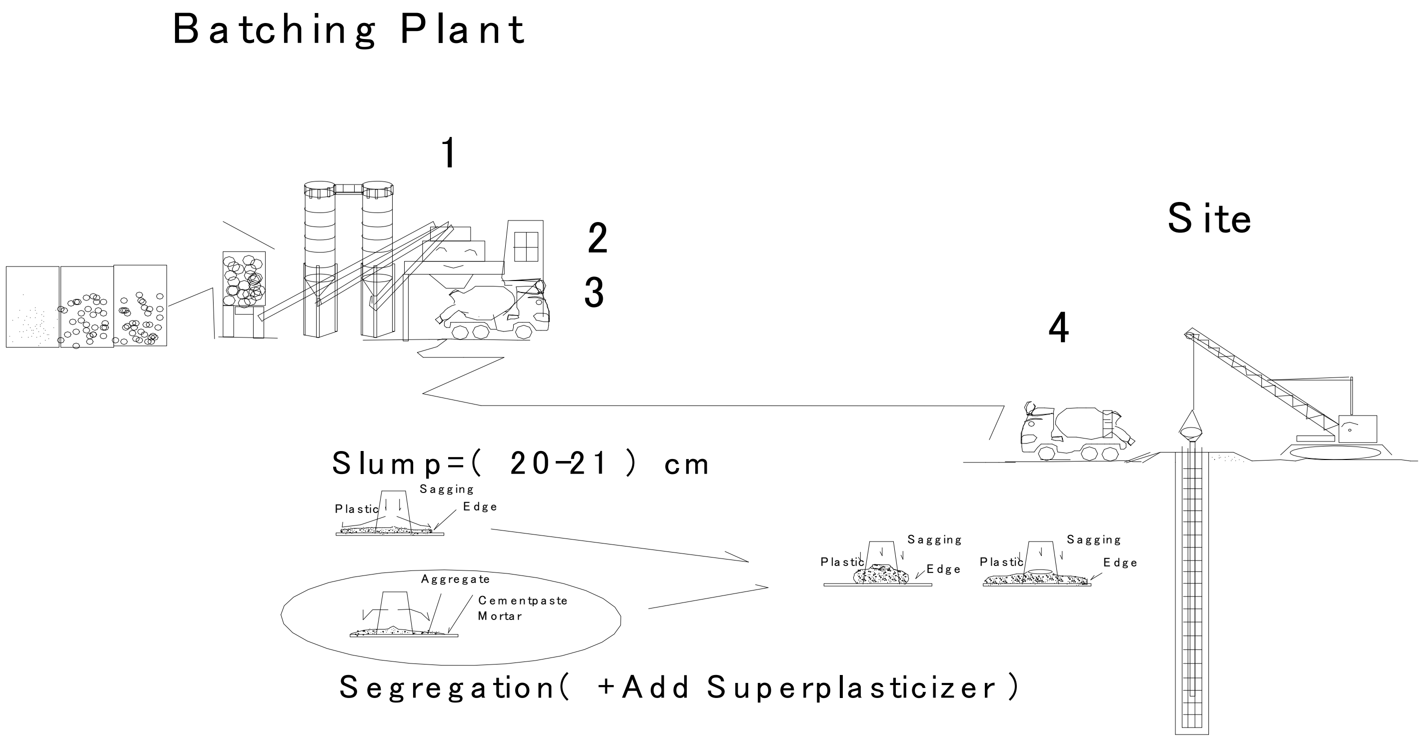
Adjust :Slump1cm ── Superplasticizer :(0.1-0.2%)

(470) Judgement Workability of Superplasticized Concrete-15



(471) Production of Superplasticized Concrete-16

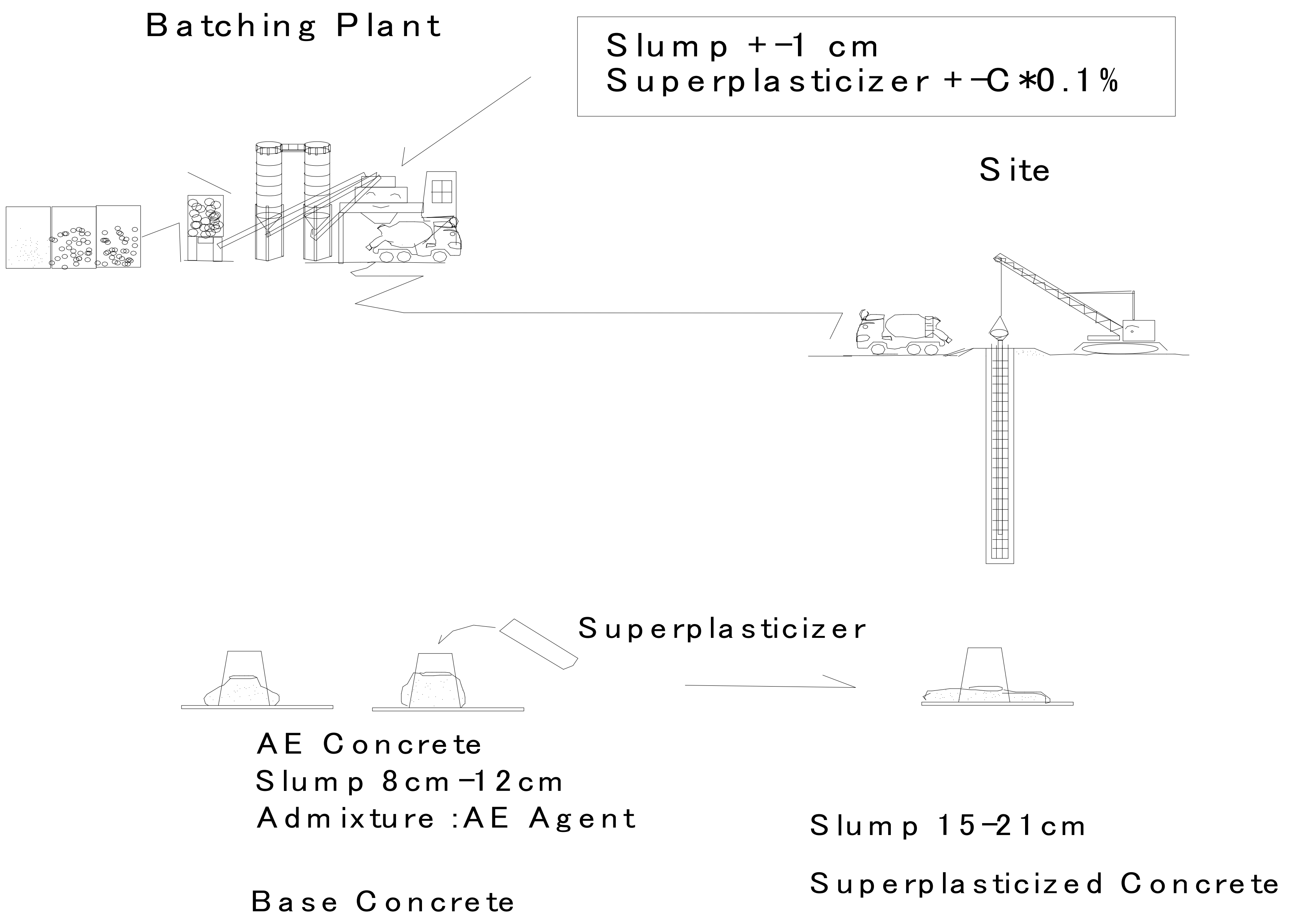
(471) Production of Superplasticized Concrete-16



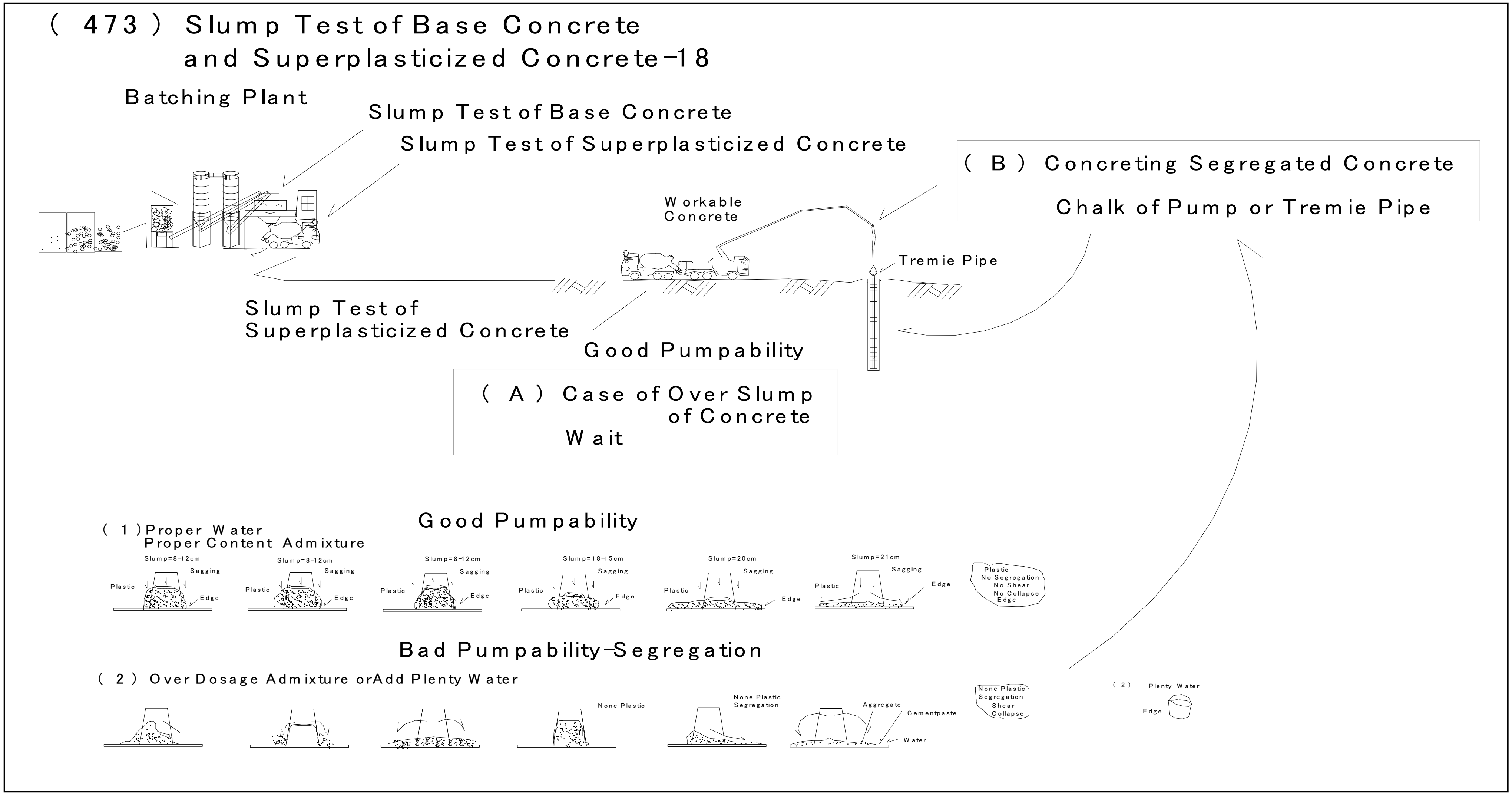
	Situation of Superplasticicizer Dosage
1	Batching Plant
2	Mixer Truck at Batching Plant
3	Dosage into Mixer Truck at Batching Plant,then Remixing at Site
4	Mixer Truck at Site
5	

(472) Adjustment Dosage of Superplasticized Concrete-17

(472) Adjustment Dosage of Superplasticized Concrete-17

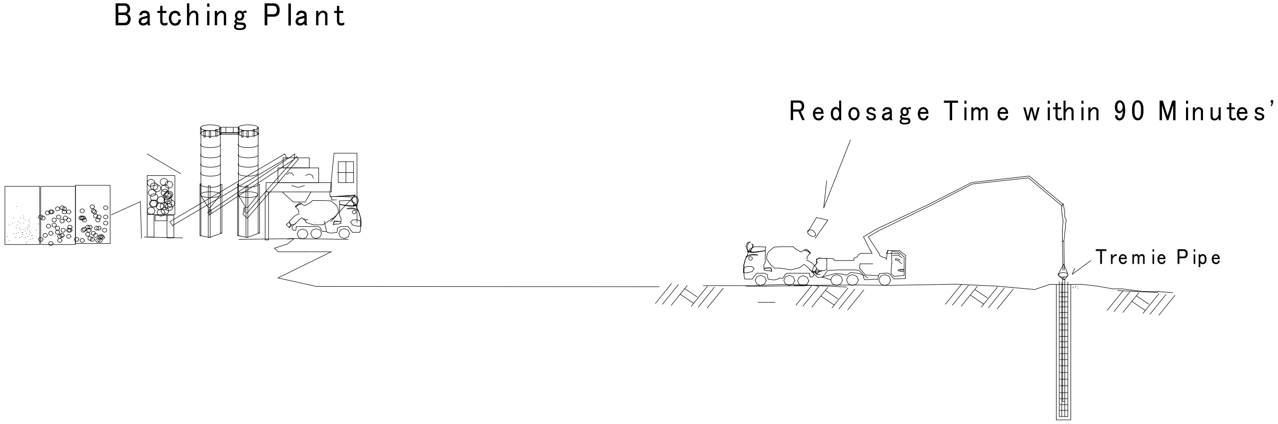


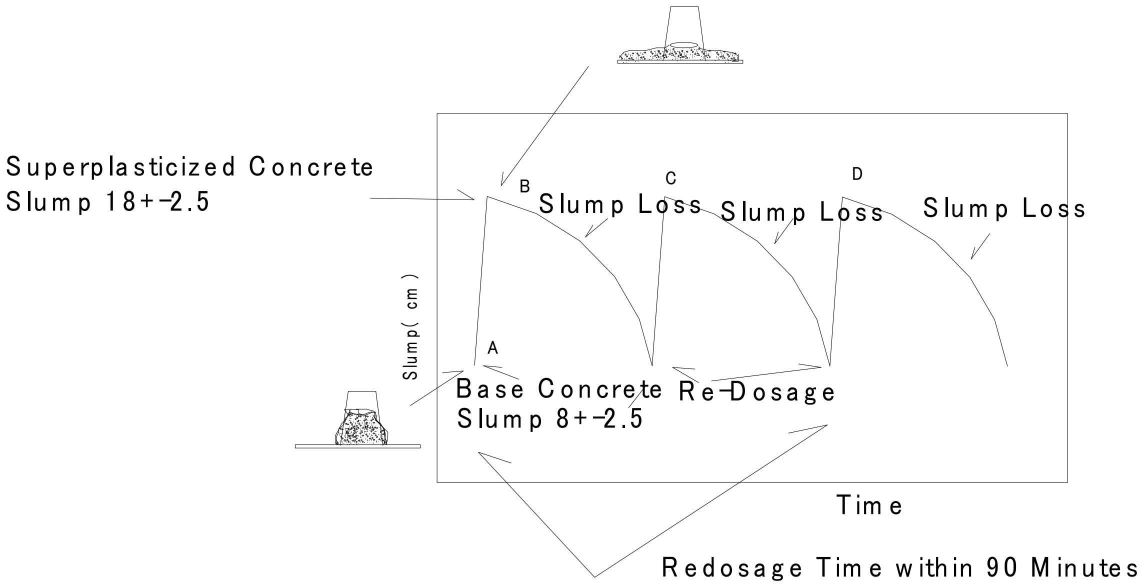
(473) Slump Test of Base Concrete and Superplasticized Concrete-18

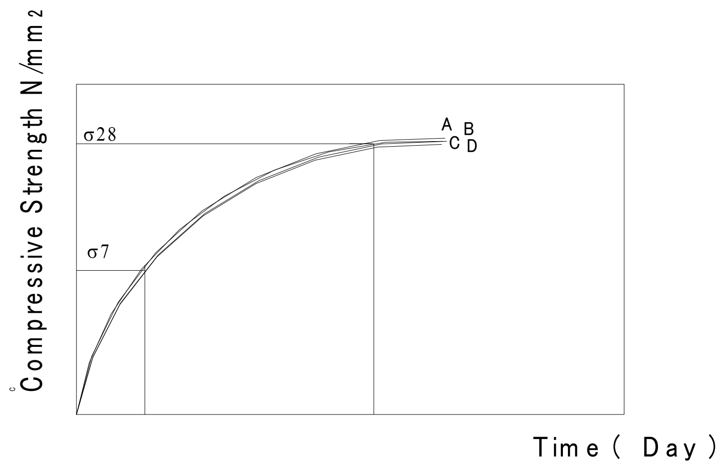


(474) Redosage Superplasticizer of Superplasticized Concrete-19

(474) Redosage Superplasticizer
of Superplasticized Concrete-19



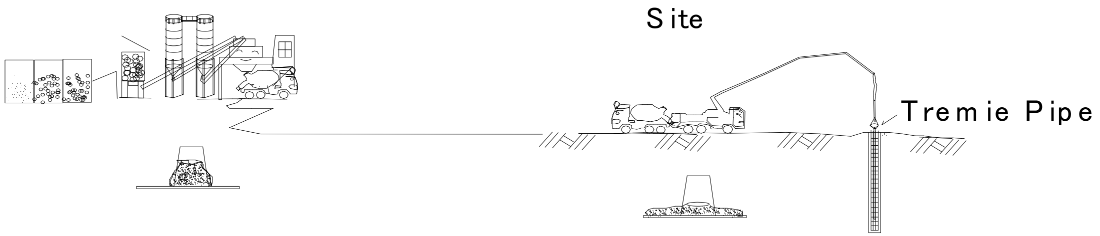




(475) Check Points of Design and Specification of Superplasticized Concrete-20

（475）Check Points of Design and Specification of Superplasticized Concrete-20

Batching Plant

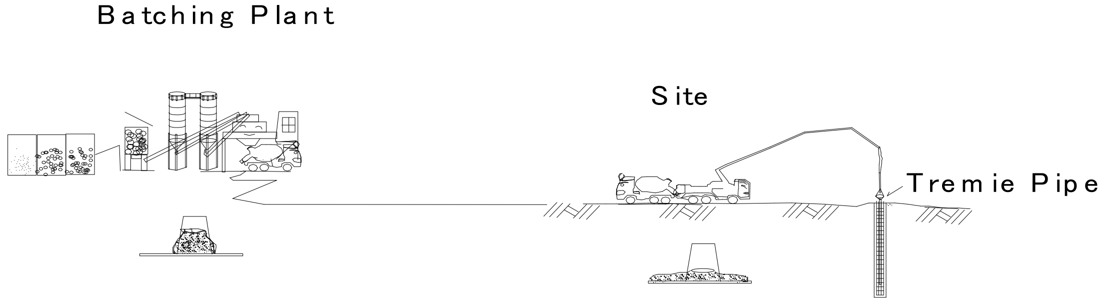


Check points of Design and Specification

（1）Construction Summary: 1-Type 2-Size 3-Situation 4-Volume 5-Access Road
（2）Period: 1-Seas ion and Period 2-Curing.
（3）Design and Specifications of Building : 1-Dimension Situation 2-Rebar Situation 3-Finishing 4-Cracks
（4）Quality and Grade of Concrete 1 Quality and Grade 2-Type 3-Specification
（5）Material Quality: 1-Aggregate 2-Cement 3-Water 4-Admixture
（6）Concrete Production : 1-Mix Proportion 2-Plant 3-Order for Concrete 4-Quality Control of Fresh Concrete 5-Test at Unloading 6-ConcreteCompressive Strength
（7）Concrete Transportation and Concreting : 1-Method between Mixing Start and Concrete Finishing 2-Time Limit from Mixing Start to Finishing 3-Quality Change from Transportation to Concreting 4-Test at Site 5-Test after Concreting 6-Limit of Joint Concrete
（8）Removal of Formworks : 1-Scaffolding and Board
（9）Concrete Finishing : 1-Finishability
（10）Concrete Curing : 1-Curing Method
（11）Test and Inspection : 1-Material 2-Concrete

(476) Check Points of Superplasticized Concrete-21

（476） Check Points of Superplasticized Concrete−21



Check points of Concreting

（1） Basic Policy Decision of Construction
- 1 Total Planning of Construction
- 2 Climate and Enviroment at Site
- 3 Slump of Base Concrete and Superplasticized Concrete
- 4 Type of High Range Water Reducing Agent
- 5 Construction Managing System

（2） Mix Proportion Planning
- 1 Kind and Quality of Material
- 2 Mix Proportion of Base Concrete
- 3 Trila Mix and Superplasticized Test
- 4 s/a
- 5 Concrete Temperature

（3） Superplasticized Concrete
- 1 Batching Plant
- 2 Planning of Mixer Truck
- 3 Mixer Truck Capacity
- 4 Proper Amount of Superplasticizer
- 5 Quality Test

（4） Pump Planning
- 1 Type and Number of Pump
- 2 Pipes of Pump
- 3 Quality Control of Pump

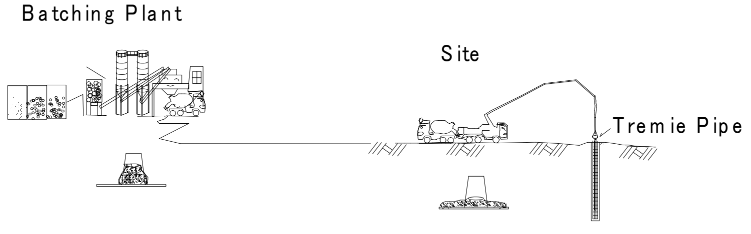
（5） Concreteing Planning
- 1 Meeting before Concreting
- 2 Concreting Planning and Concreting Order
- 3 Concreting Method
- 4 Control System and Number of Worker
- 5 Compaction Planning
- 6 Finishing Planning

（6） Concrete Curing Planning
- 1 Curing Method
- 2 Curing Period
- 3 Removal Time Forms and Scaffoldings

（7） Quality Control and Inspection Planning
- 1 Quality Test

(477) Flow Chart of Superplasticized Concrete-22

(477) Flow Chart of Superplasticized Concrete-22



Check points of Concreting

(1) Basic Policy Decision of Construction
1 Total Planning of Construction
2 Climate and Enviroment at Site
3 Slump of Base Concrete and Superplasticized Concrete
4 Type of High Range Water Reducing Agent
5 Construction Managing System

(2) Mix Proportion Planning
1 Kind and Quality of Material
2 Mix Proportion of Base Concrete
3 Trila Mix and Superplasticized Test
4 s/a
5 Concrete Temperature

(3) Superplasticized Concrete
1 Batching Plant
2 Planning of Mixer Truck
3 Mixer Truck Capacity
4 Proper Amount of Superplasticizer
5 Quality Test

(4) Pump Planning
1 Type and Number of Pump
2 Pipes of Pump
3 Quality Control of Pump

(5) Concreteing Planning
1 Meeting before Concreting
2 Concreting Planning and Concreting Order
3 Concreting Method
4 Control System and Number of Worker
5 Compaction Planning
6 Finishing Planning

(6) Concrete Curing Planning
1 Curing Method
2 Curing Period
3 Removal Time Forms and Scaffoldings

(7) Quality Control and Inspection Planning
1 Quality Test

(Flow Chart of Superplasticized Concrete)

Concreting Order

Check Design and Specification (1)

Mix Proportion of Base Concrete
and Superplasticized Concrete (2)

Trial Mix at Laboratory (2)

Trial Mix at Batching Plant (2)

Order Superplasticized Concrete

Quality Test at Batching Plant (2)

Transportation

Slump Test at Site (4)

Unloading (4)

Pump (4)

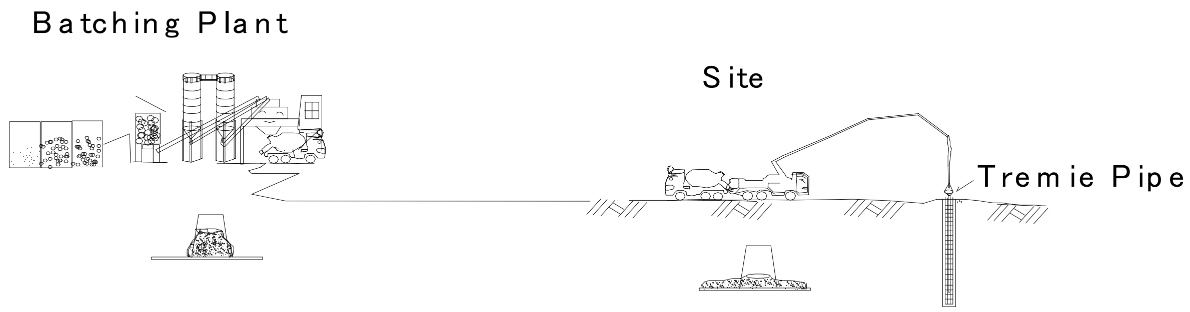
Concreting and Compaction (5)

Finishing (5)

Curing (6)

(478) Order of Base Concrete and Superplasticized Concrete-23

(478) Order of Base Concrete and Superplasticized Concrete-23



(1) Summary

1 Construction Name , Location
2 Quantity,Concreting Date
3 Report (Material Quality Test,Mix Proportion Document)

(2) Concrete Condition

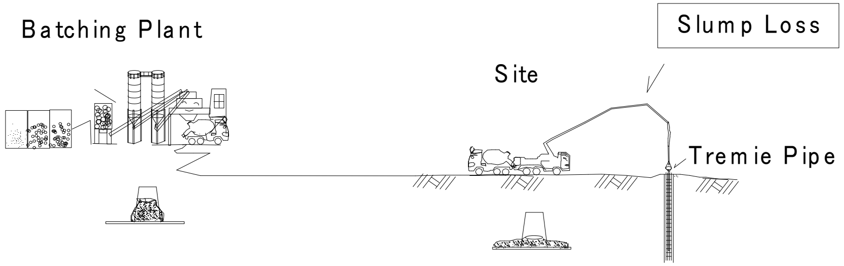
1 Cement Type
2 Aggregate Type
3 Aggregate Maximum Dimension
4 Required Slump
5 Required Air Content
6 Target Slump
7 Admixture Type
8 s/a
9 Pozzolan
10 Density
11 Maximum of W/C
12 Minimum of Cement Content
13 Concrete Temperature

(3) Etic

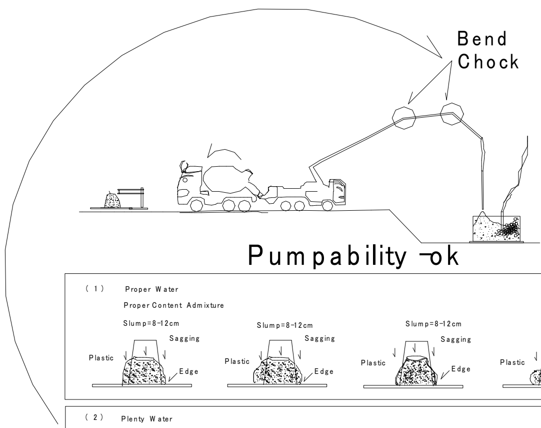
1 Allowable Value of Slump
2 Loading Amount of Truck Agitator
3 Quality Test
4 Planning of Mixer Truck Delivery

(479) Pumping of Superplasticized Concrete-24

(479) Pumping of Superplasticized Concrete–24



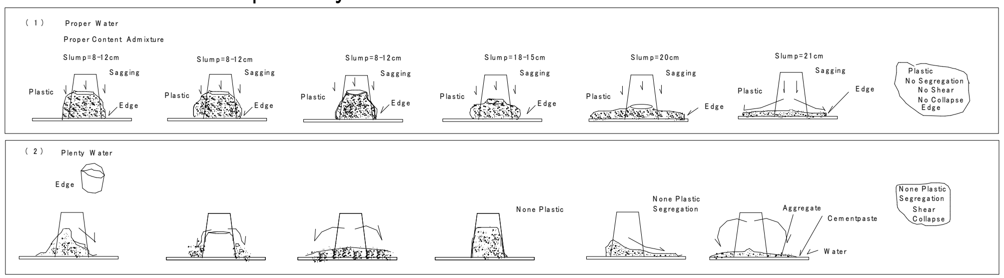
(328) Concrete Pump



(a) Slump, 8–18cm.
(b) Maximum Size of Coarse Aggregate , below 40mm.
(c) Reduce Pumping Pipe Bend as much as possible. Horizontal or Down Direction.

(d) Before Pumping ,Send Mortar.

Pumpability –ok



Pumpability –No Good

(1) Attention of Pumping
1 No Add Water
2 Soft Concrete (Over Slump) –Wait
Segregated Concrete by Water –Reject
3 Slump Loss–Redosage Superplasticizer
4 Pumping Velocity–Proper Pumpability
5 Pumping–Continuous
6 Chock–Prepare Cement
–Down Pumping Velocity

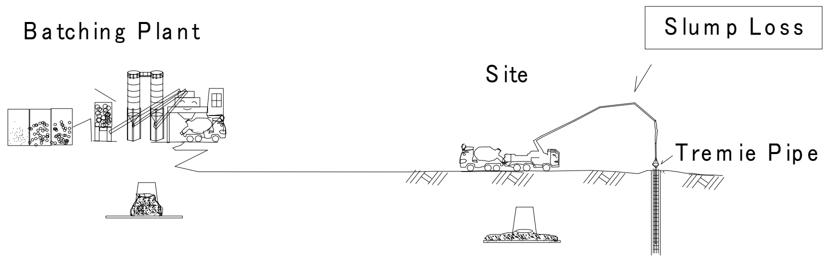
(2) Quality Change by Pumping
1 Pumping Length >100m —Slump Loss in 2cm

(3) Pumping and Pipeline Arrangement
1 Shortest Pipeline
2 Superplasticized Concrete–Pipe Diameter —over 5 in

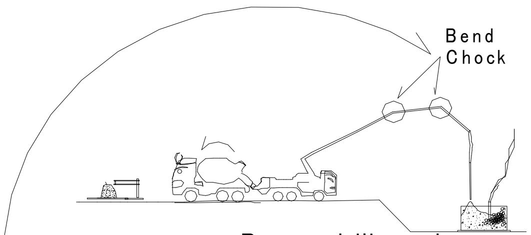
(4) Position of Pump
1 Near Concreting Site
2 Two Pumping Trucks

(480) Pumping of Superplasticized Concrete-25

(480) Pumping of Superplasticized Concrete-25



(328) Concrete Pump



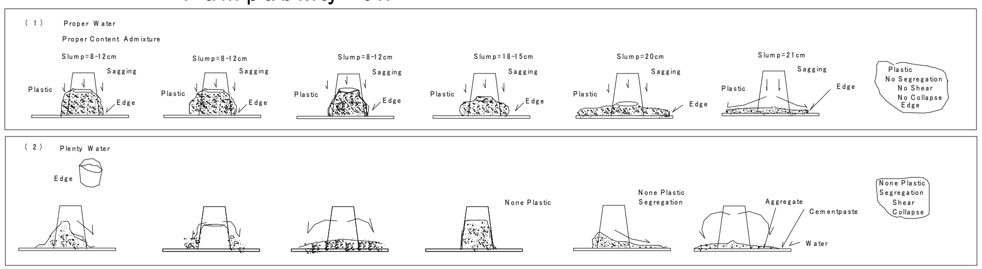
(a) Slump, 8-18cm.

(b) Maximum Size of Coarse Aggregate , below 40mm.

(c) Reduce Pumping Pipe Bend as much as possible. Horizontal or Down Direction.

(d) Before Pumping ,Send Mortar.

Pumpability -ok



Pumpability -No Good

(1) Attention of Pumping

1 No Add Water
2 Soft Concrete (Over Slump) -Wait
Segregated Concrete by Water -Reject
3 Slump Loss-Redosage Superplasticizer
4 Pumping Velocity-Proper Pumpability
5 Pumping-Continuous
6 Chock-Prepare Cement
-Down Pumping Velocity

(2) Quality Change by Pumping

1 Pumping Length >100m —Slump Loss in 2cm

(3) Pumping and Pipeline Arrangement

1 Shortest Pipeline
2 Superplasticized Concrete-Pipe Diameter —over 5 in

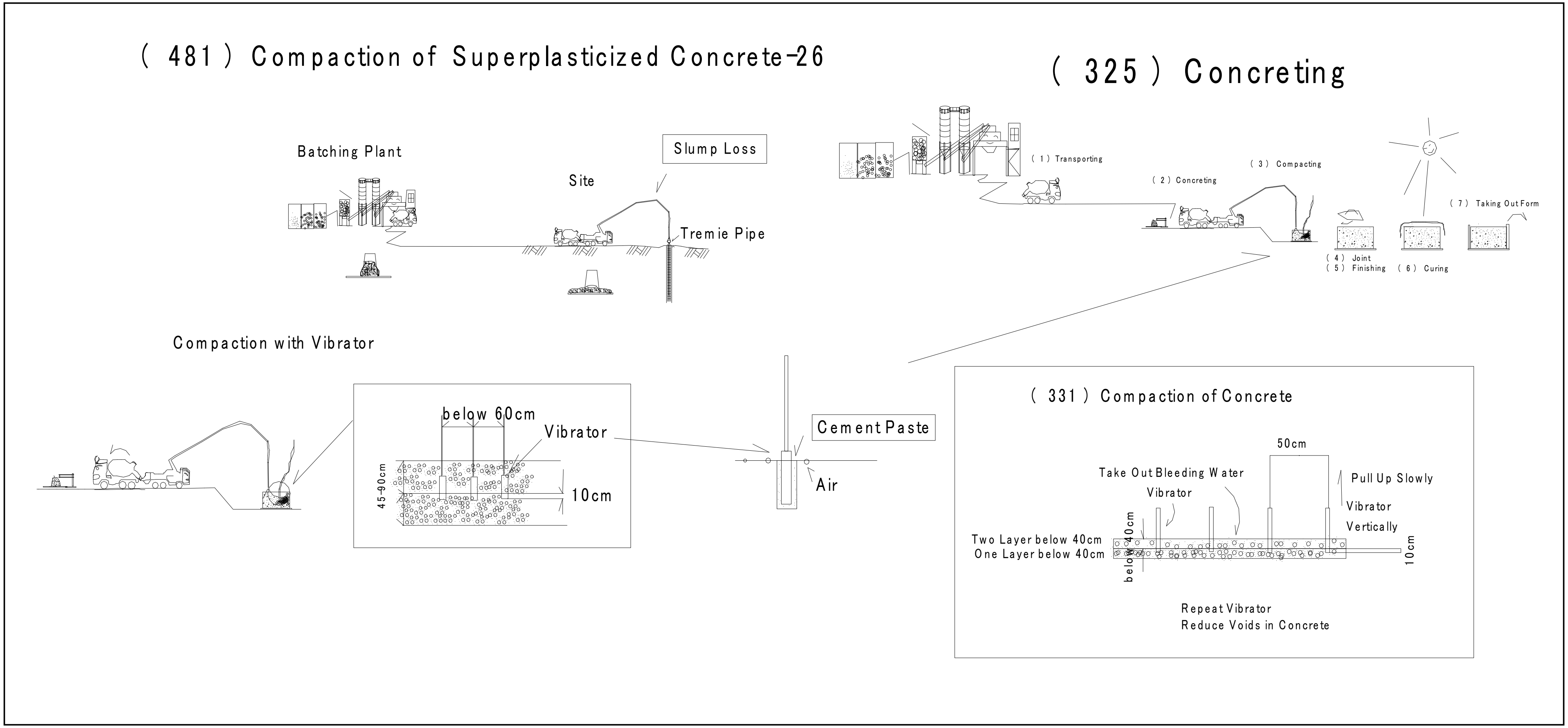
(4) Position of Pump

1 Near Concreting Site
2 Two Pumping Trucks

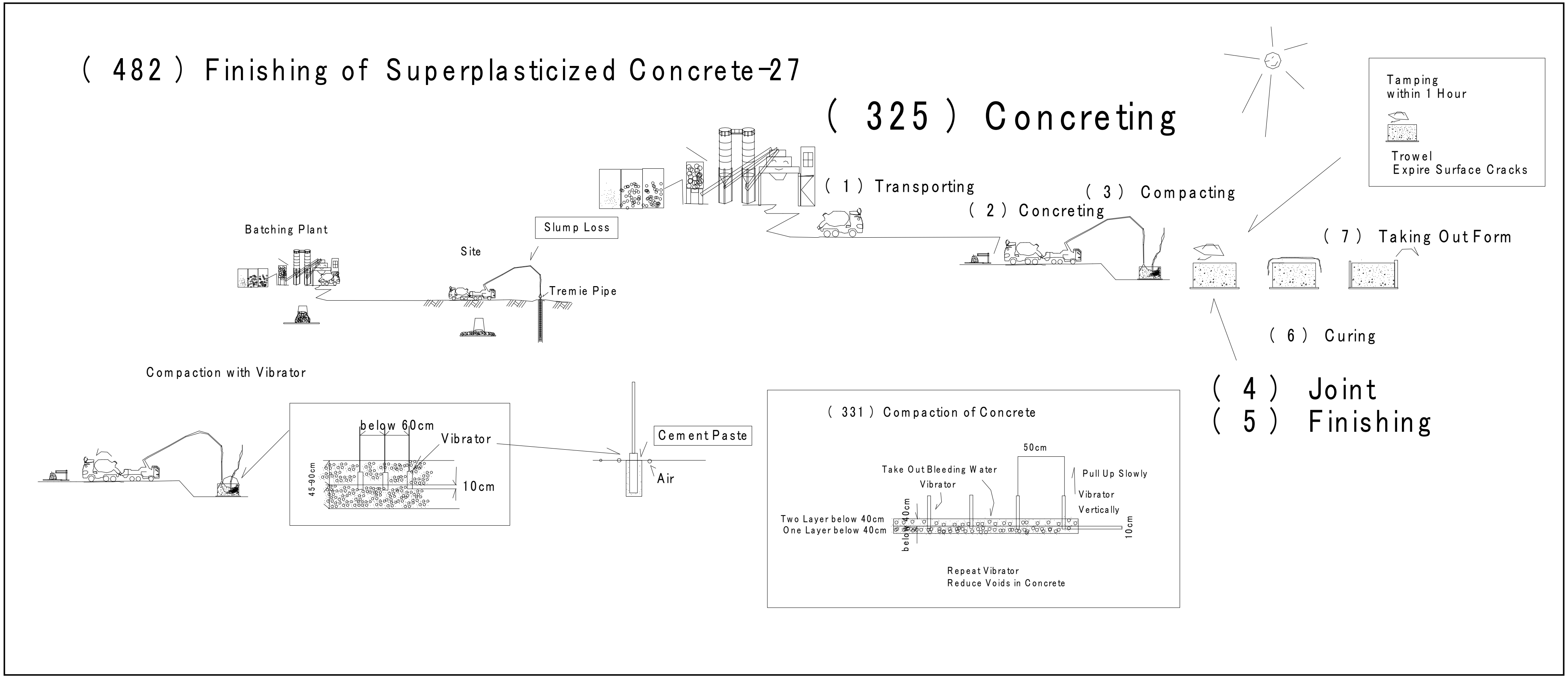
(1) Caution of Pumping

1 Concreting Start from Longest Location
2 Enough Compaction and Concreting Continuously
3 Dropping Height —No Segregation,Use Vertical Chute
4 Joint Concrete Carefully
5 Avoid Concreting Horizontally
6 Concrete Interval within 60-90 Minutes
7 Careful Concreting at narrow Location
8 Not Disturb Reinforced Bar

(481) Compaction of Superplasticized Concrete-26

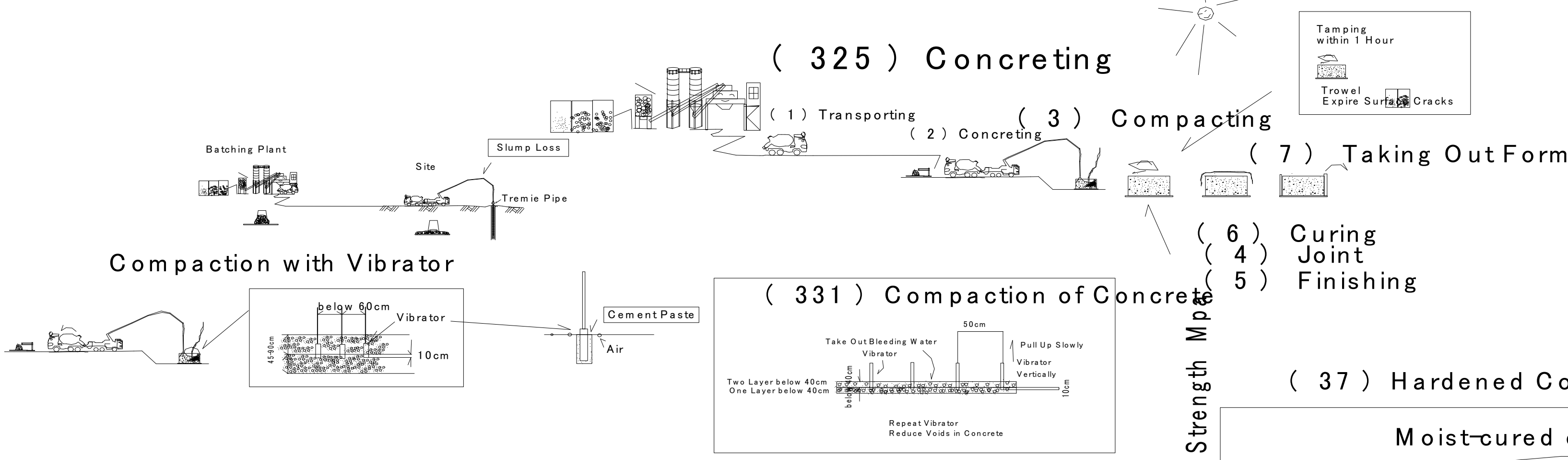


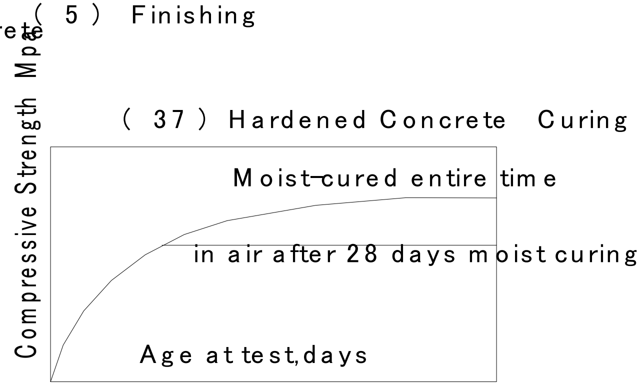
(482) Finishing of Superplasticized Concrete-27



(483) Curing of Superplasticized Concrete-28

(483) Curing of Superplasticized Concrete-28





Concrete strength increase with ages
as long as moisture and a favorable temperature

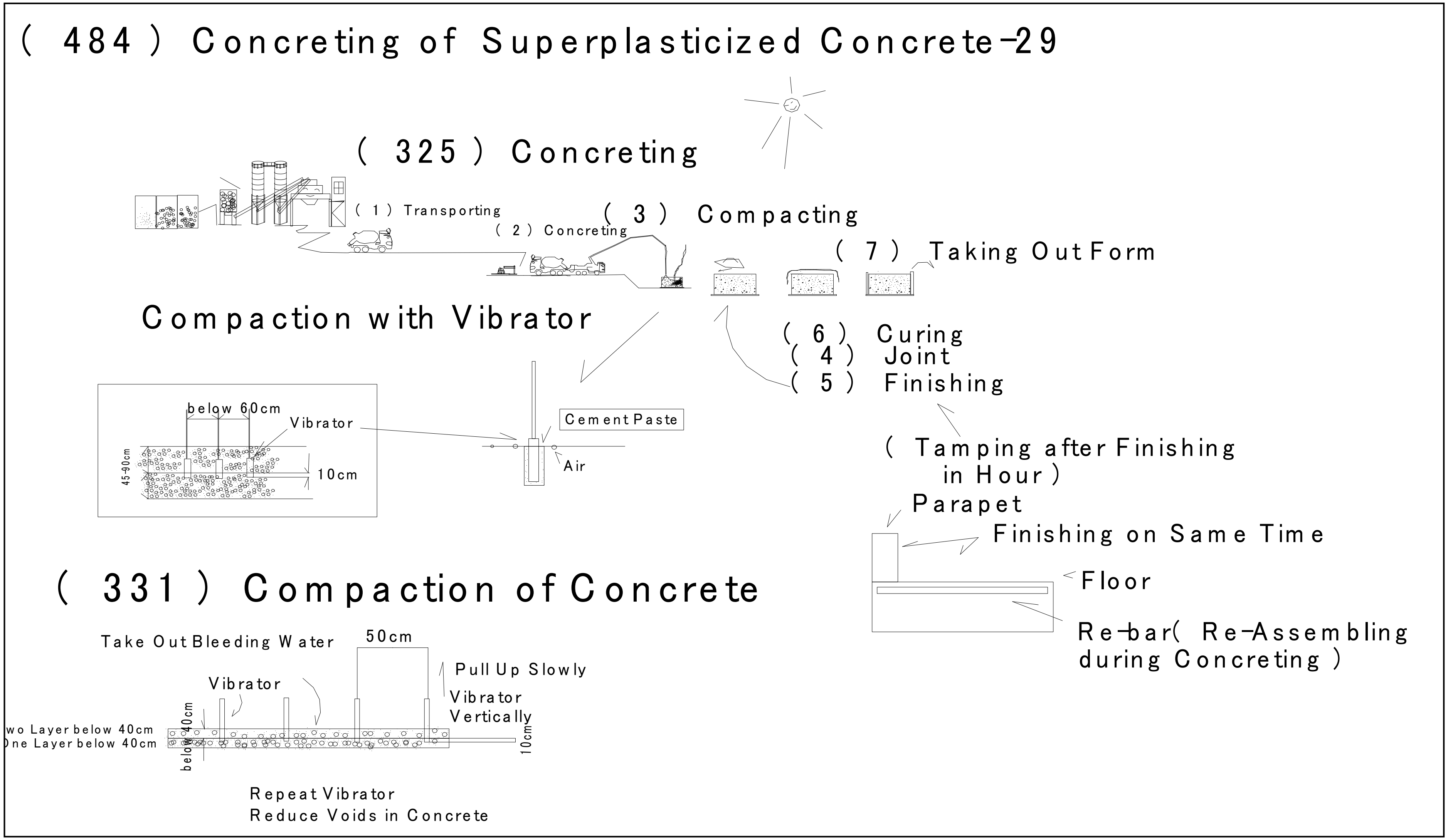
(334) Concrete Curing

Concrete Curing
1 Wet Condition
2 Protect from Sunshine ,Wind and Rain
3 Keep Proper Temperature
4 Protect From Impact

Curing Day
1 Normal Portland Cement 5 days
2 High Early Strength Portland Cement 3 days
3 Cold Weather Concrete Over 5 degree
f'c=50kgf/cm2
4 Hot Weather Concrete 24 hours ,Wet Condition,5days
5 Pavement Concrete
Normal Portland Cement 14 days
High Early Strength Cement 7 days
Moderate Heat Portland Cement 21 days
6 Dam Concrete
Normal,Moderate Portland Cement 14 days
Blended Cement 21 days11

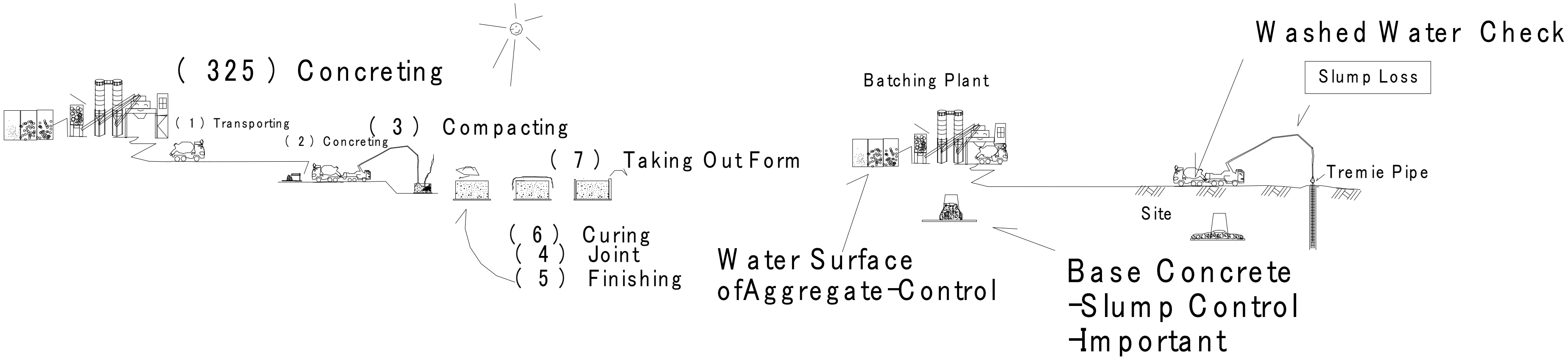
	Causes	Curing Method	Remarks
Normal	1 Sunshine- 2 Freezing 3 Loading 4 Vibration and Impaction	1 Water Spray 2 Seat Curing (Avoid Sunshine ,Cold Wind and Wind)	Curing Day 2-3 Days
Cold	Freezing		Initial Curing Strength: 35-50kg/cm2
Hot	Dry	1 Wet Curing 2 Seat Curing :Membrane Curing	Keep Wet Curing

(484) Concreting of Superplasticized Concrete-29

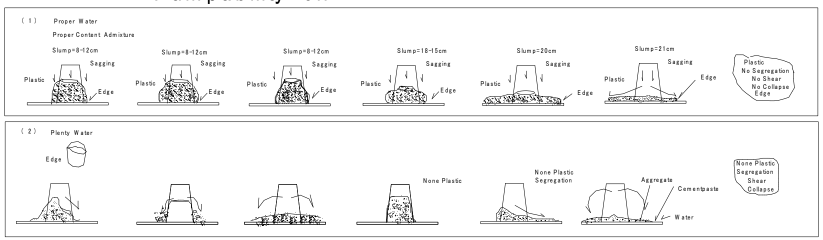


(485) Production Control of Superplasticized Concrete−30

(485) Production Control of Superplasticized Concrete−30



Pumpability −ok



Pumpability −No Good

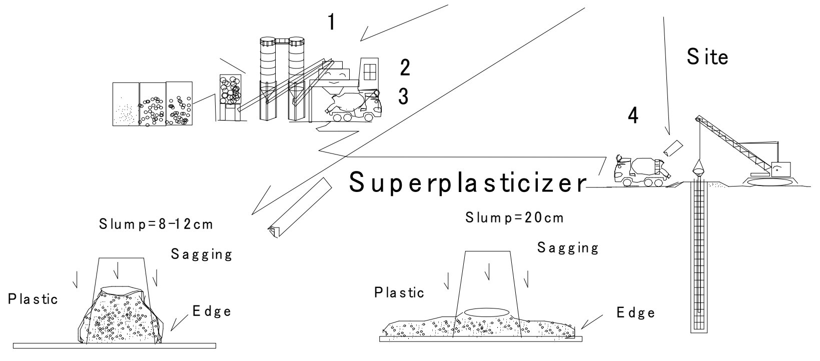
Difference		
Water Surface ofAggregate	Slump	Strength
Fine Aggregate(+−1%)	+−(3−4) %	−+(6−8) %
Coarse Aggregate(+−1%)	+−(1−2) %	−+(2−4) %

(486) Base Concrete Control of Superplasticized Concrete-31

(486) Base Concrete Control of Superplasticized Concrete-31

(471) Production of Superplasticized Concrete-16

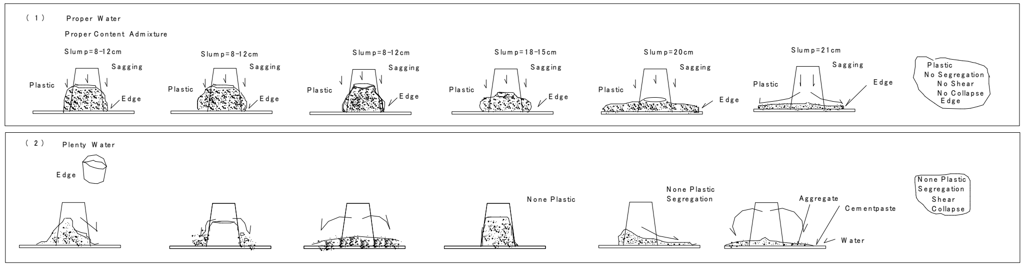
Slump Test or Check
Consistency of Base Concrete
before Dosage Superplasiticizer



Base Concrete

Superplasticized Concrete

Pumpability -ok

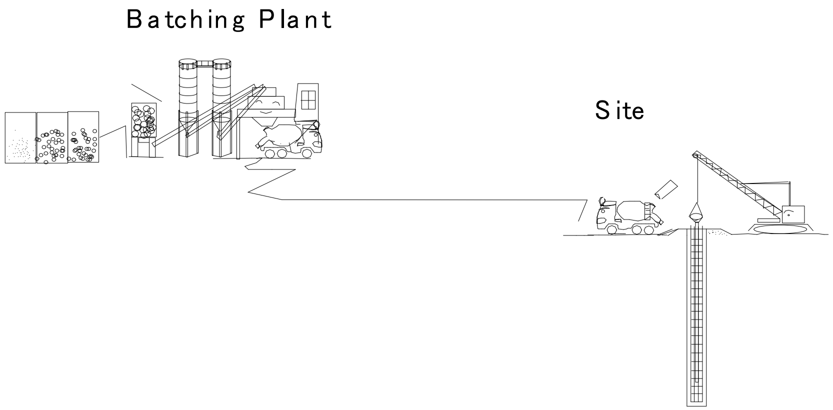


Pumpability -No Good

	Situation of Superplasticicizer Dosage
1	Batching Plant
2	Mixer Truck at Batching Plant
3	Dosage into Mixer Truck at Batching Plant,then Remixing at Site
4	Mixer Truck at Site

(487) Quality Control of Superplasticized Concrete-32

(487) Quality Control of Superplasticized Concrete-32



After Dosage Superplasicizer

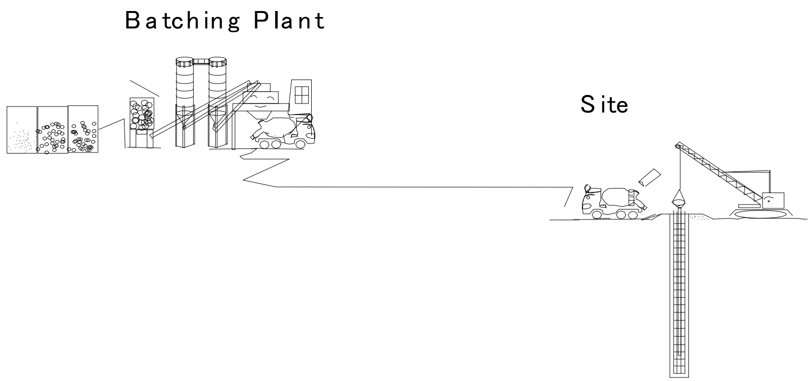
	Frequency	Allowance
Workability		
Slump		
Flow		
Air		
Compressive Strength		

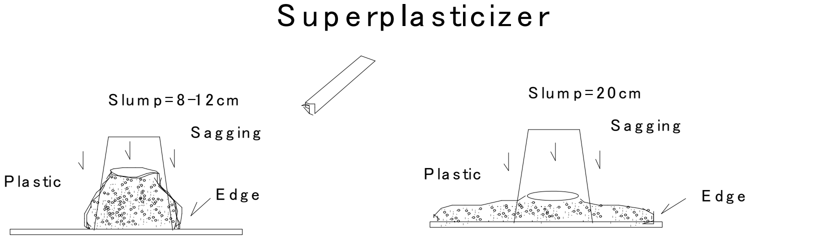
Before Concreting

	Frequency	Allowance
Workability		
Slump		
Flow		
Air		
Compressive Strength		

(488) Purpose of Superplasticized Concrete-33

（488） Quality Control of Superplasticized Concrete-33





Base Concrete

Superplasticized Concrete

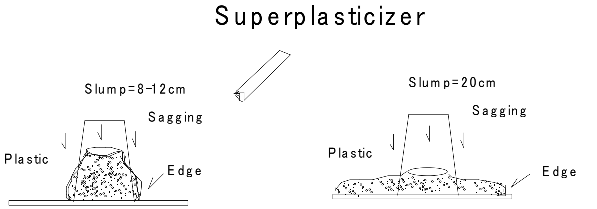
Quality — No Change
Compressive Strength — Same
Workability, Pumpability — Improve

Purpose

1 Water — Reduce
2 W/C — Reduce
3 Cement — Reduce
4 Workability Pumpability — Improve
5 Watertightness Durability — Improve
6 Compressive Strength — Improve

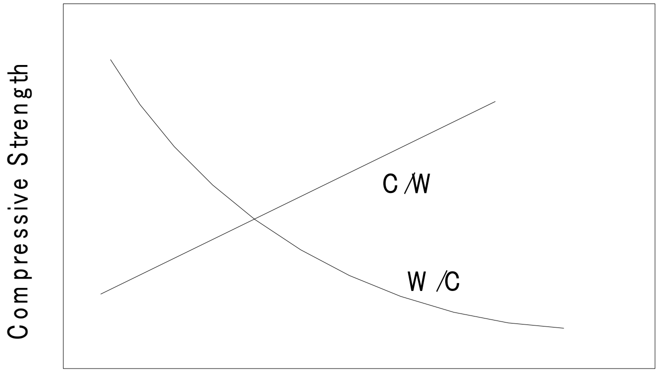
(489) High Compressive Strength Concrete by Superplasticized Concrete-34

(489) High Compressive Strength Concrete by Superplasticized Concrete-34



Base Concrete   Superplasticized Concrete

Quality — No Change
Compressive Strength — Same
Workability, Pumpability — Improve



1 Slump — below 15 cm
2 W/C — below 55%
3 Cement Content
Normal Concrete
270-450kg/m3
Light Weight Concrete
300-450kg/m3
JASS 5

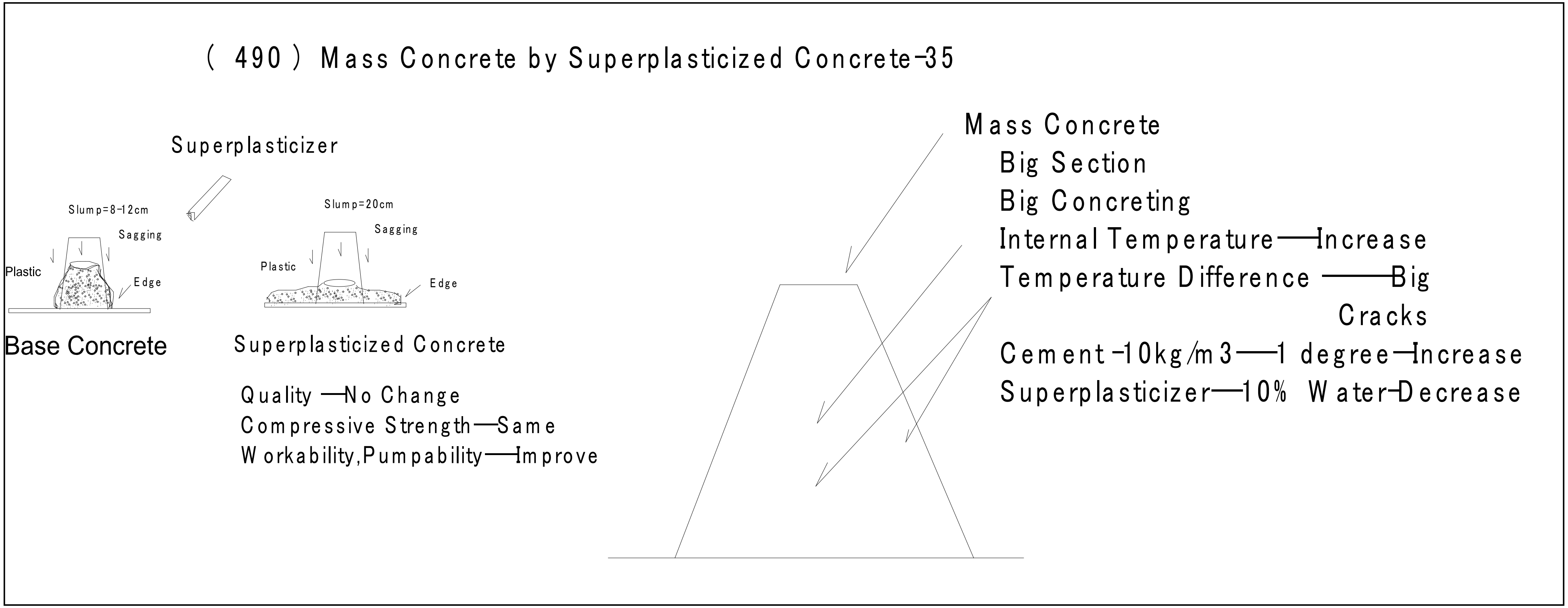
High Compressive Strength Concrete

W/C — Reduce
Cement — Increase
→ Drying Shrinkage, Hydraulic Heat
→ Cracks

Superplasticized Concrete

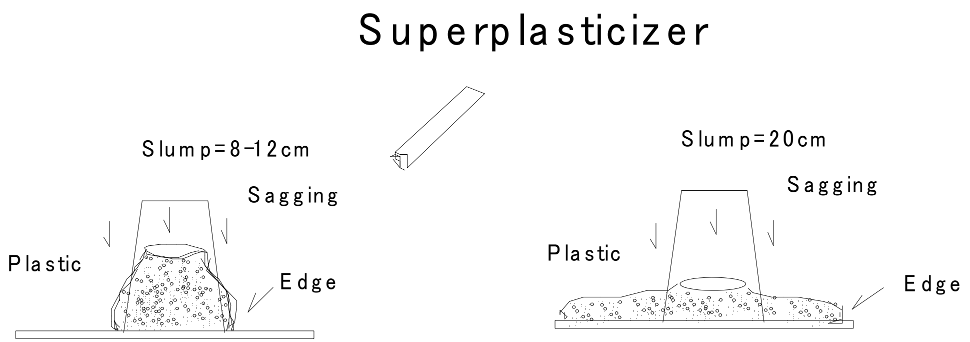
Water — Reduce
Cement — Decrease
→ Drying Shrinkage, Hydraulic Heat
→ Down
→ Cracks
→ Little

(490) Mass Concrete by Superplasticized Concrete-35



(491) Prestressed Concrete by Superplasticized Concrete-36

(491) Prestressed Concrete by Superplasticized Concrete-36



Base Concrete   Superplasticized Concrete

Quality — No Change
Compressive Strength — Same
Workability, Pumpability — Improve

Designed Strength — Pretensioning — over 350kg/cm2
Post-tensioning — over 300kg/cm2

(492) Examples of Superplasticized Concrete(Base Concrete-AE C Case of Japan

No	Purpose of Superplasticizer	Design Strength	Slump(Base Concrete)	Slump by Superplasticizer	sand percentage	Water	Cement	water cement ratio	Base Concrete Admixtur	Superplasticizer	Remarks
			(SL)	(SL)	s/a	W	OPC	W/C			
		(N/mm2)	cm	cm	(%)	(Kg/m3)	(Kg/m3)	(%)	C*(%)		
1	W/c-decrease, workability-improve	21	12	22	49	179	320	56	AE Ajent	Superplasticizer	Base concrete-AE Concrete
2	Pumpability-Improve	23	19	23	50	191	398	48	AE Ajent	Superplasticizer	
3	Dry shrinkage, Cracks-Decrease	21	12	21	45	178	307	58	AE Ajent	Superplasticizer	
4	W/c-decrease, workability-improve	21	13	22	42	147	283	52	AE Ajent	Superplasticizer	
5	Dry shrinkage, Cracks-Decrease	21	12	21	45	156	285	55	AE Ajent	Superplasticizer	
6	Pumpability-Improve	30	8	16	40	153	340	45	AE Ajent	Superplasticizer	
7	Dry shrinkage, Cracks-Decrease	24	12	21	45	155	300	52	AE Ajent	Superplasticizer	
8	Dry shrinkage, Cracks-Decrease	21	12	18	47	160	276	58	AE Ajent	Superplasticizer	
9	Recovery Slump Loss	21	16	18	43	169	311	54	AE Ajent	Superplasticizer	
10	Workability-improve	21	15	18	46	174	348	50	AE Ajent	Superplasticizer	
11	Hyration Heat-Decrease,Protection Crac	24	8	18	48	166	281	59	AE Ajent	Superplasticizer	
12	Bleeding-Decrease,Protect Cracks	21	12	21	47	168	307	55	AE Ajent	Superplasticizer	
13	Bleeding-Decrease,Protect Cracks	21	12	21	46	163	304	54	AE Ajent	Superplasticizer	
14	Protect Cracks	21	15	21	48	188	355	53	AE Ajent	Superplasticizer	
15	Bleeding-Decrease	26	15	21	44	172	380	45	AE Water Re	Superplasticizer	
16	Protect Cracks,Workability-Improve	21	12	21	44	162	304	53	AE Water Re	Superplasticizer	
17	Hyration Heat-Decrease,Protection Crac	24	12	21	44	161	326	49	AE Ajent	Superplasticizer	
18	Protect Cracks,Workability-Improve	30	12	21	46	187	390	48	AE Water Re	Superplasticizer	
19	Protect Cracks,Workability-Improve	27	15	19	44	183	359	51	AE Water Re	Superplasticizer	
20	Protect Cracks,Workability-Improve	27	12	19	43	170	340	50	AE Water Re	Superplasticizer	
21	Pumpability-Improve,W-Decrease	21	18	21	52	178	349	51	AE Ajent	Superplasticizer	
22	Protect Cracks,Workability-Improve	23	15	21	45	166	335	50	AE Water Re	Superplasticizer	
23	Protect Cracks,Workability-Improve	27	12	20	46	180	328	55	AE Ajent	Superplasticizer	
24	Workability-Improve	21	15	18	45	190	333	57	AE Ajent	Superplasticizer	
25	Workability-Improve	21	15	21	47	161	275	59	AE Water Re	Superplasticizer	
26	Workability-Improve	27	14	21	48	181	348	52	AE Water Re	Superplasticizer	
27	Protect Cracks,Workability-Improve	21	15	21	46	163	281	58	AE Water Re	Superplasticizer	
28	Protect Cracks,Workability-Improve	35	12	18	39	178	434	41	AE Water Re	Superplasticizer	
29	Workability-Improve	35	15	21	48	185	456	41	AE Ajent	Superplasticizer	
30	Protect Cracks,Workability-Improve	21	15	21	47	161	284	57	AE Water Re	Superplasticizer	
31	Water Content-Decrease	21	18	21	46	173	298	58	AE Water Re	Superplasticizer	
32	Pumpability-Improve,W-Decrease	40	6	12	36	148	436	34	AE Water Re	Superplasticizer	
33	Workability-Improve	41	12	18	38	157	443	35	AE Water Re	Superplasticizer	
34	Protect Cracks,Workability-Improve	26	15	20	46	185	370	50	AE Ajent	Superplasticizer	
35	Protect Cracks,Workability-Improve	21	15	18	49	185	300	62	AE Ajent	Superplasticizer	
36	Protect Cracks,Workability-Improve	37	12	21	46	180	383	47	AE Ajent	Superplasticizer	

(493) Examples of Superplasticized Concrete(Base Concrete-AE Concrete)

No	Purpose of Superplasticizer	Design Strength	Slump(Base Concrete)	Slump by Superplasticizer	sand percentage	Water	Cement	Air Content (%)	water cement ratio	Sand	Aggregate	Base Concrete Admixture	Superplasticizer	Remarks
			(SL)	(SL)	s/a	W	OPC	a	W/C	s	G			
		(N/mm2)	cm	cm	(%)	(Kg/m3)	(Kg/m3)	(%)	(%)	(Kg/m3)	(Kg/m3)	C*(%)		
37	Protect Cracks,Workability-Impro	23	18	22	46	171	294	4	59			C*(0.25%	C*(0.4%)	
38	Protect Cracks,Workability-Impro	23	18	22	46	174	308	4	57			C*(0.25%	C*(0.4%)	
39	Workability-Improve	21	12		49	179	320	4	56			C*(0.2%)		
40	Mass Concrete	21	12	18	46	151	256		58	892	1057	C*(1.0%)	C*(1.0%)	Base concrete -AE Concrete
41	Workability-Improve	21	12	21	49	179	320	4	56	866	939	C*(0.36%	C*(0.6%)	
42	Workability-Improve,Water Tightness		15	21	47	166	335	4	50	864	988	C*(0.25%)		

(494) Cement in Superplasticized Cpncrete

(494) Cement in Superplasticized Concrete

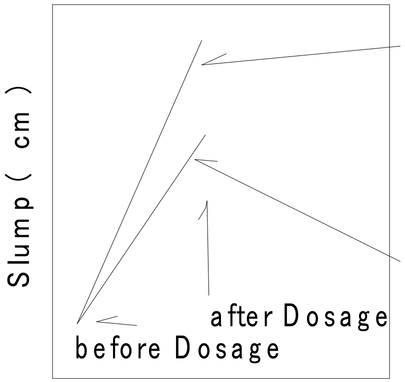
(455) Cement in Superplasticized Concrete-1

(119) Concrete Material(1)

Cement
Blended Cement-(Blast-Furnance Slag Cement, Portland Pozzolan Cement,Silica Cement,Fly Ash Cement)
Special Cement -(Alumina Cement,Ultra Rapid Harding Cement)
Sulfate Resisting Portland Cement
Moderate Heat Portland Cement
Ultra High Early Strength Portland Cement
High Early Strength Portland Cement
Ordinary Portland Cement

Air Content
Ordinary Portland Cement → Air Content No Change
Other Concrete → Air Content in 1 % Decrease

Effect of Superplasticizer

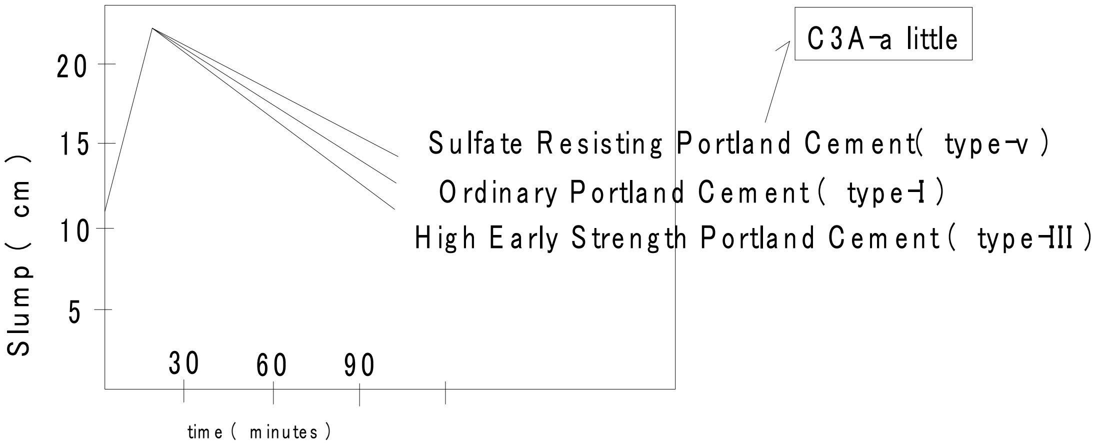


Cement
Blended Cement-(Blast-Furnance Slag Cement, Portland Pozzolan Cement,Silica Cement,Fly Ash Cement)

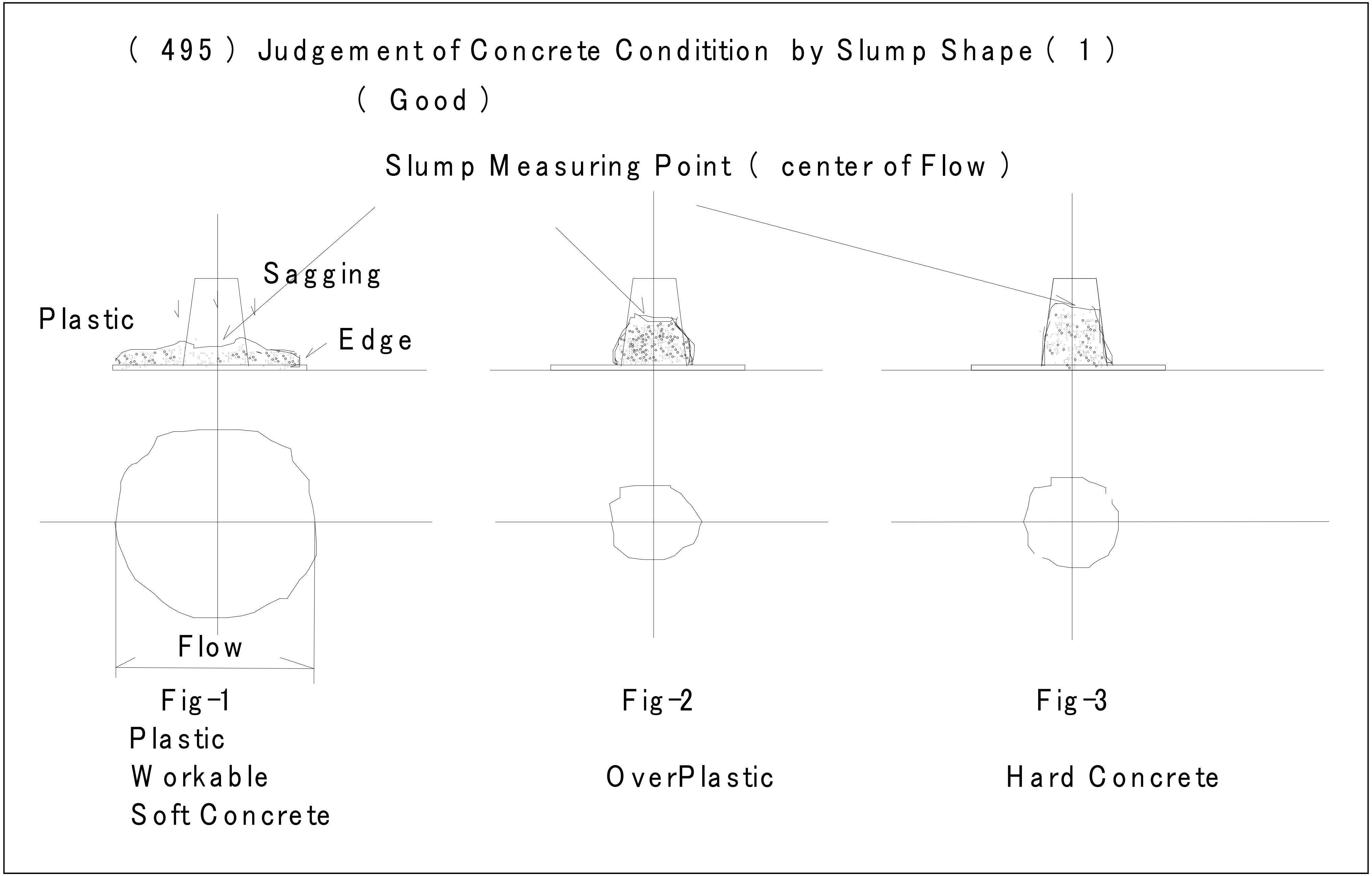
Moderate Heat Portland Cement
High Early Strength Portland Cement
Ordinary Portland Cement

Ultra High Early Strength Portland Cement

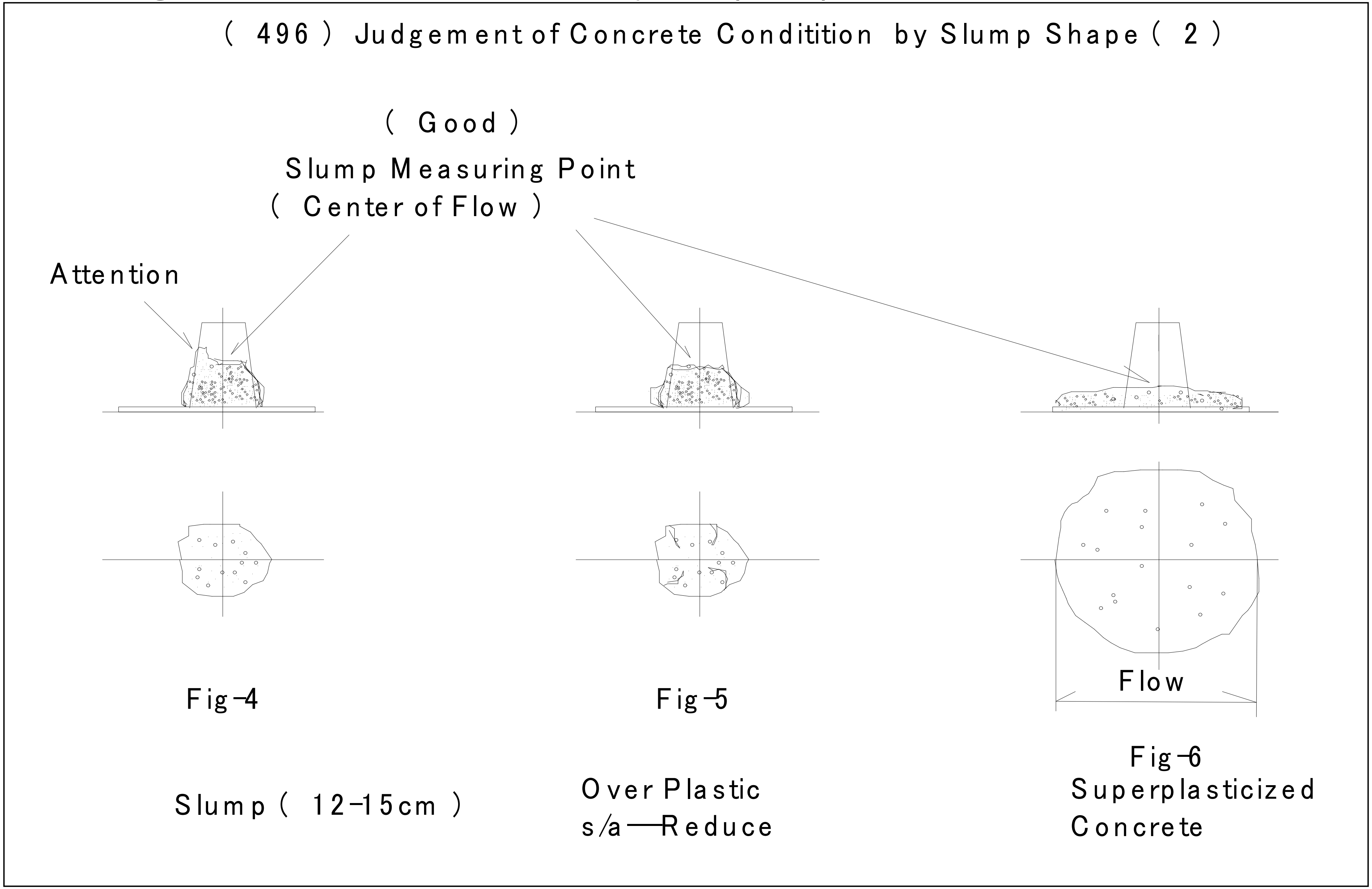
Effect of Superplasticizer



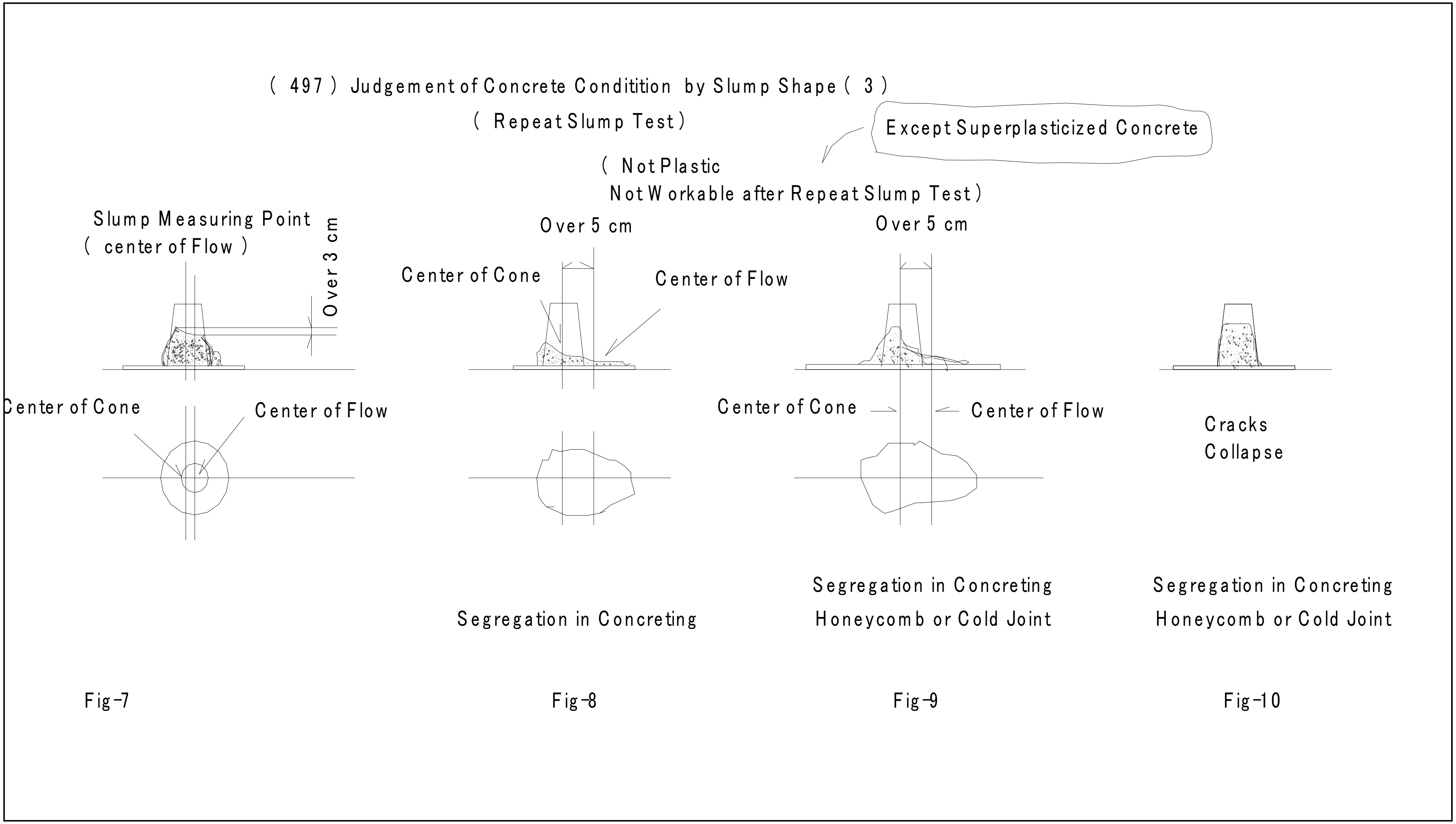
(495) Judgement of Concrete Condition by Slump Shape (1)



(496) Judgement of Concrete Condition by Slump Shape (2)



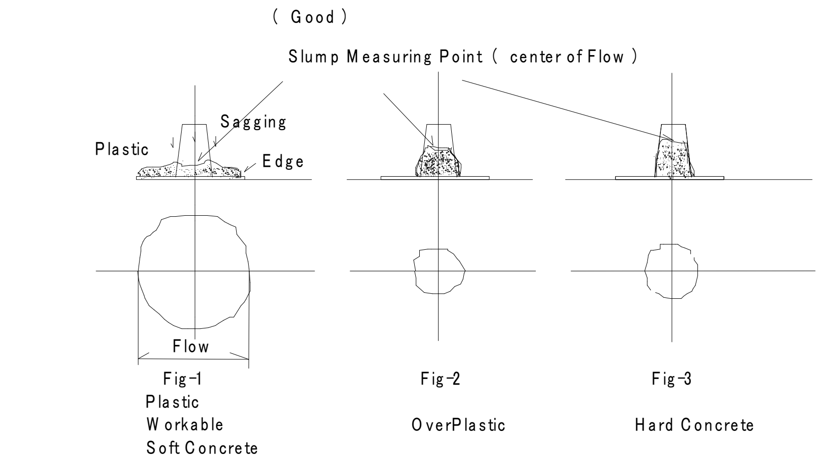
(497) Judgement of Concrete Condition by Slump Test (3)



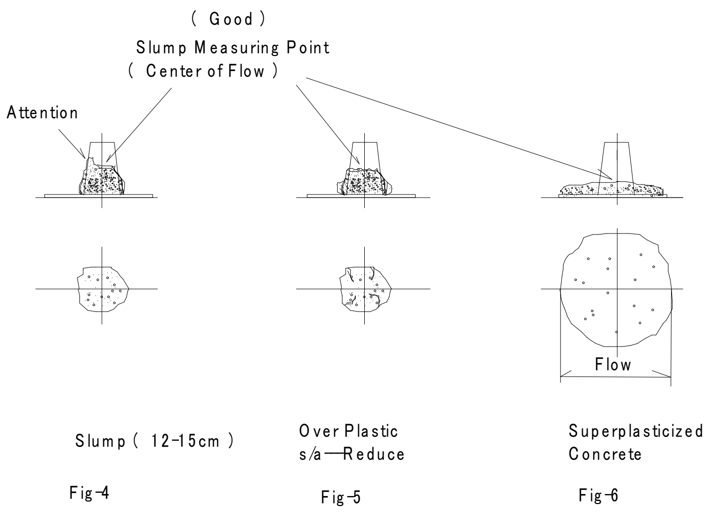
(498) Judgement of Concrete Condition by Slump Test (4)

(498) Judgement of Concrete Conditition by Slump Shape (4)

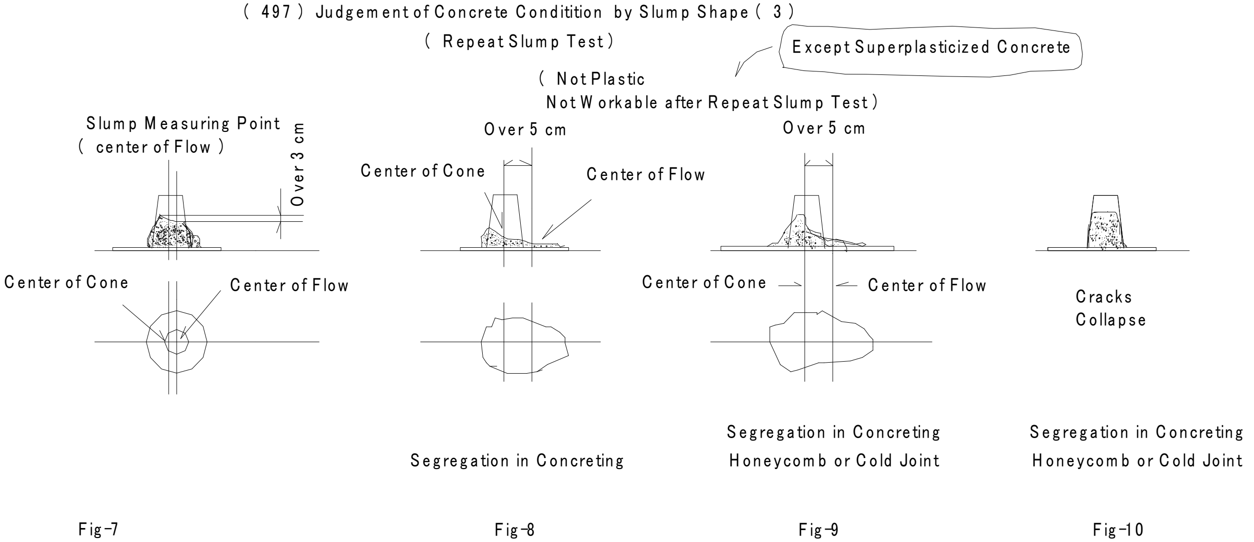
(495) Judgement of Concrete Conditition by Slump Shape (1)



(496) Judgement of Concrete Conditition by Slump Shape (2)

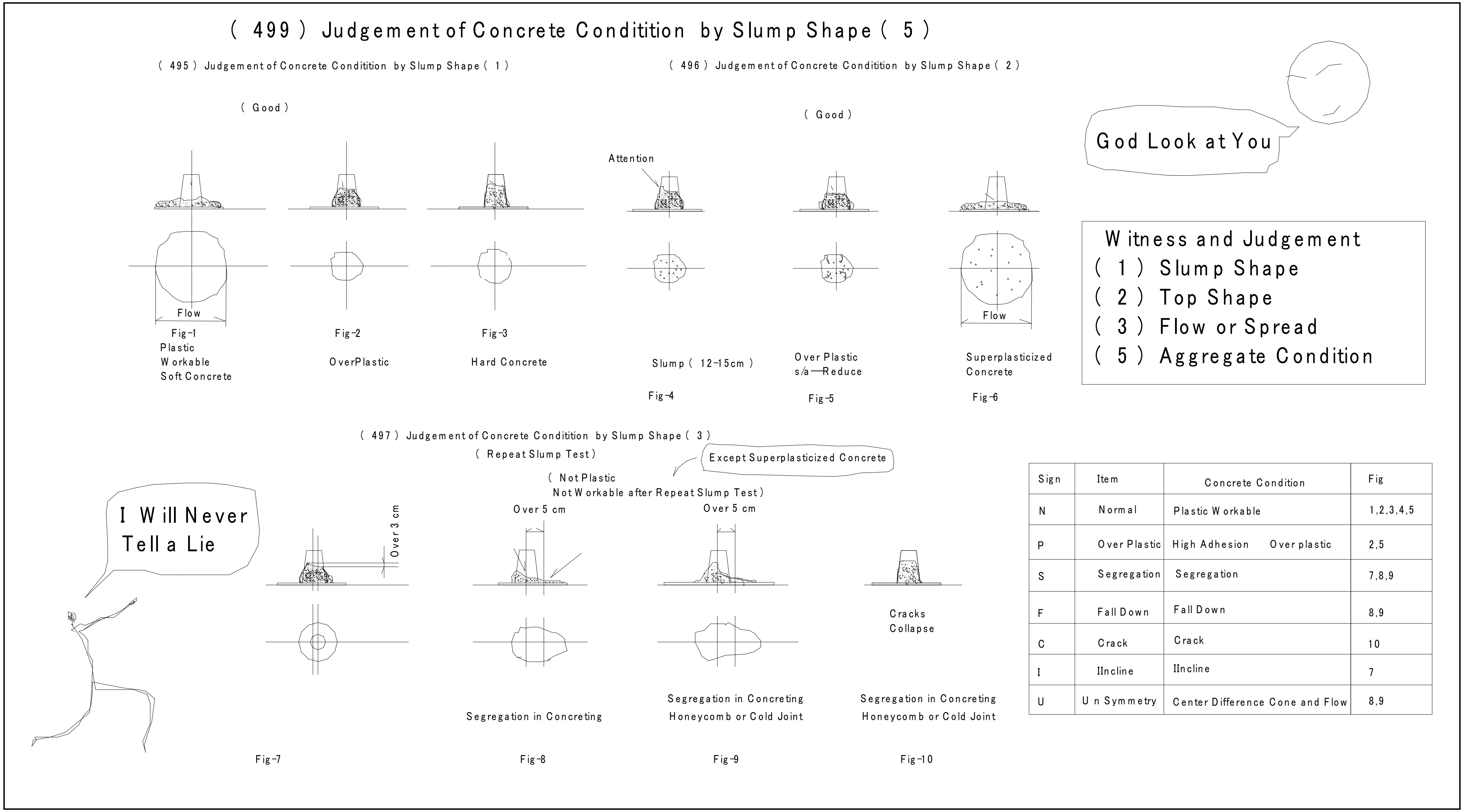


(497) Judgement of Concrete Conditition by Slump Shape (3)



Sign	Item	Concrete Condition	Fig
N	Normal	Plastic Workable	1,2,3,4,5
P	Over Plastic	High Adhesion Over plastic	2,5
S	Segregation	Segregation	7,8,9
F	Fall Down	Fall Down	8,9
C	Crack	Crack	10
I	IIncline	IIncline	7
U	Un Symmetry	Center Difference Cone and Flow	8,9

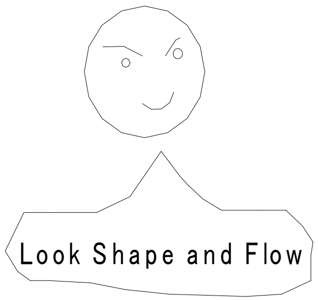
(499) Judgement of Concrete Condition by Slump Test (5)



Sign	Item	Concrete Condition	Fig
N	Normal	Plastic Workable	1,2,3,4,5
P	Over Plastic	High Adhesion Over plastic	2,5
S	Segregation	Segregation	7,8,9
F	Fall Down	Fall Down	8,9
C	Crack	Crack	10
I	IIncline	IIncline	7
U	Un Symmetry	Center Difference Cone and Flow	8,9

(500) Judgement of Concrete Condition by Slump Test (6)

(500) Judgement of Concrete Condition by Slump Shape (6)



(495) Judgement of Concrete Condition by Slump Shape (1)

(496) Judgement of Concrete Condition by Slump Shape (2)

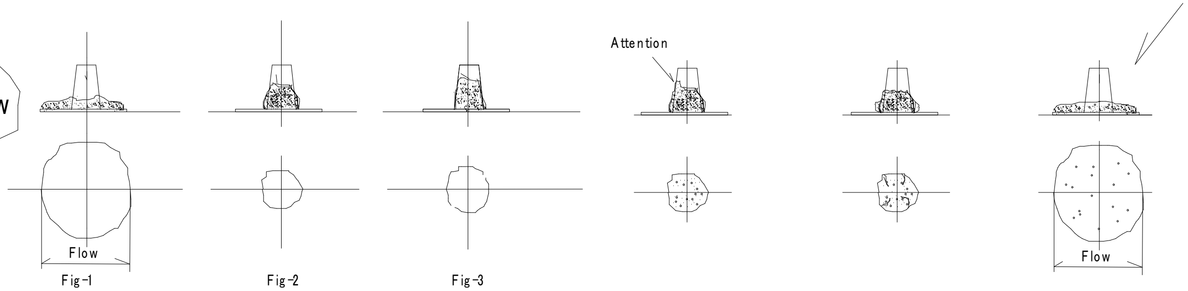


Fig-1 Plastic Workable Soft Concrete

Fig-2 OverPlastic

Fig-3 Hard Concrete

Fig-4 Slump (12-15cm)

Fig-5 Over Plastic s/a—Reduce

Fig-6 Superplasticized Concrete

Grading of Aggregate
s/a——Increase——Large Flow——
——Water Increase

Not Good Concrete

Witness and Judgement
(1) Slump Shape
(2) Top Shape
(3) Flow or Spread
(5) Aggregate Condition

(497) Judgement of Concrete Condition by Slump Shape (3)
(Repeat Slump Test)

Except Superplasticized Concrete

(Not Plastic
Not Workable after Repeat Slump Test)

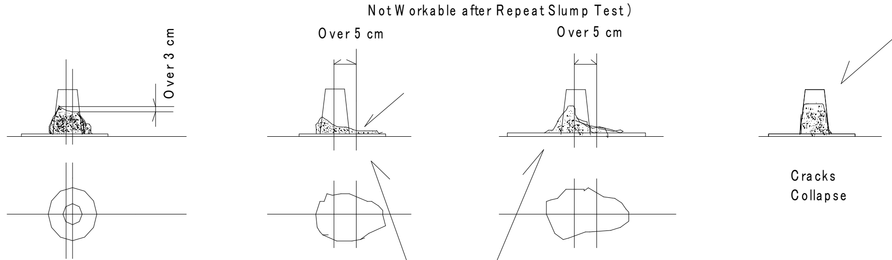


Fig-7

Fig-8 Segregation in Concreting

Fig-9 Segregation in Concreting Honeycomb or Cold Joint

Fig-10 Segregation in Concreting Honeycomb or Cold Joint

Grading of Aggregate
5-2.5mm—Too Much

Water—Increase——Improve Slump——Not Get Workability

Grading of Aggregate
-Segregation
10-5mm—a Little

Sign	Item	Concrete Condition	Fig
N	Normal	Plastic Workable	1,2,3,4,5
P	Over Plastic	High Adhesion Over plastic	2,5
S	Segregation	Segregation	7,8,9
F	Fall Down	Fall Down	8,9
C	Crack	Crack	10
I	IIncline	IIncline	7
U	Un Symmetry	Center Difference Cone and Flow	8,9