
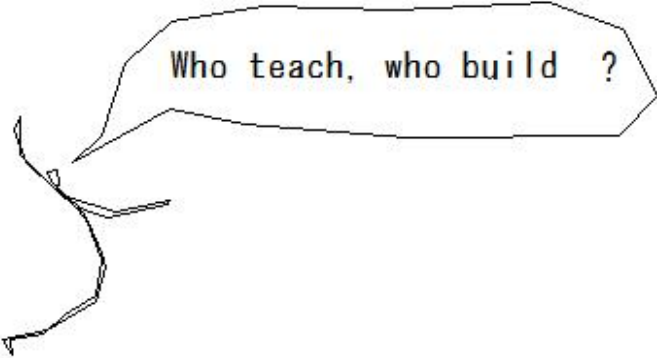


(01)Bridge works(illustration) in Africa(1-530)

(01)Bridge works(illustration) in Africa(1-530)



You !



Who teach, who build ?

只野敏夫
TADANO TOSHIO

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Continuous slab
truss
steel structure
steel structure
Design load
joining
member splice
High strength bolt friction joining
High strength bolt friction joining
High strength bolt friction joining
high-strength bolt friction joint
high-strength bolt friction joint
welding
welding

477 (B477)Arc welding	welding
478 (B478)Arc welding	welding
479 (B479)group welding	welding
480 (B480)Fillet welding	welding
481 (B481)Fillet weld cross section	welding
482 (B482)welded joint Fillet welding(Throat thickness)	welding
483 (B483)welded joint	welded joint
484 (B484)welded joint	welded joint
485 (B485)welded joint	welded joint
486 (B486)welded joint	welded joint
487 (B487)rahmen bridge	rahmen bridge
488 (B488)rahmen bridge	rahmen bridge
489 (B489)simple plate girder bridge	simple plate girder bridge
490 (B490)grid girder bridge	grid girder bridge
491 (B491)cable-stayed bridge	cable-stayed bridge
492 (B492)suspension bridge	suspension bridge
493 (B493)suspension bridge	suspension bridge
494 (B494)Formwork and Support	suspension bridge
495 (B495)Concrete structures and loads	Formwork and Support
496 (B496)Concrete bridge-Truss bridge	Concrete structures and loads
497 (B497)Concrete bridge-Concrete girder bridge	Concrete bridge
498 (B498)Concrete bridge-Arch bridge	Concrete bridge
499 (B499)Concrete bridge-Rahmen Bridge	Concrete bridge
500 (B500)Concrete bridge-Cable stayed bridge	Concrete bridge
501 (B501)Concrete bridge-Outer cable PC bridge	Concrete bridge
502 (B502)Bridge general drawing	Concrete bridge
503 (B503)Prestressed concrete	Bridge general drawing
504 (B504)Pretension method	Prestressed concrete
505 (B505)Post tension method	Pretension method
506 (B506)Bridge girder expansion joint	Post tension method
507 (B507)Parapet	Bridge girder expansion joint
508 (B508)Box girder bridge	Parapet
509 (B509)Prestressed concrete pavement-movable method	Box girder bridge
510 (B510)Prestressed concrete pavement-Fixed abutment method	Prestressed concrete pavement

511 (B511) Prestressed concrete pavement-Elastic abutment method
512 (B512) Edging-trowel
513 (B513) Edging
514 (B514) Continuous girder
515 (B515) Concrete strength
516 (B516) Bending strength
517 (B517) Pier crown
518 (B518) Bridge seat
519 (B519) Erection bar-Rebar for assembly
520 (B520) Creep
521 (B521) Floor slab
522 (B522) Distribution rebar
523 (B523) Drying Shrinkage -Settlement - Different - Cracks
524 (B524) Crack-causes-Concrete drying shrinkage
525 (B525) Crack-causes- joint - bad
526 (B526) Crack-causes-Incomplete expansion joint
527 (B527) Crack-Curing to prevent cracks-Poor design
528 (B528) Concrete Placing
529 (B529) Formwork seam-Crevice - Cement outflow
530 (B530) Concrete surface - full of holes

Prestressed concrete pavement
Prestressed concrete pavement
Edging-trowel
Edging
Continuous girder
Concrete strength
Bending strength
Pier crown
Bridge seat
Erection bar-Rebar for assembly
Creep
Floor slab
Distribution rebar
Drying Shrinkage
Crack-causes
Crack-causes
Crack-causes
Crack-Curing
Concrete Placing
Formwork seam

137 (B137)Bridge type	abutment
239 (B239)abutment	abutment
442 (B442)Additional bar	Additional bar
299 (B299)aqueduct	aqueduct
296 (B296)arc welding(core wire)	arc welding
202 (B202)arch	arch
314 (B314)solid rib arch	arch
369 (B369)arch(two hinged arch bridge)	arch
317 (B317)tied arch bridge	arch
65 (B65)Bridge(Arch bridge)	Arch bridge
66 (B66)Bridge(Arch bridge)	Arch bridge
67 (B67)Bridge(Arch bridge)	Arch bridge
68 (B68)Bridge(Arch bridge)	Arch bridge
69 (B69)Bridge(Arch bridge)	Arch bridge
70 (B70)Bridge(Arch bridge)	Arch bridge
203 (B203)arch bridge(Arch bridge without hinges (deck bridge))	arch bridge
204 (B204)arch bridge(Arch bridge without hinges (deck bridge))	arch bridge
205 (B205)arch bridge(Two-hinge arch bridge(half-through bridge))	arch bridge
206 (B206)arch bridge(Two-hinge arch bridge (half-through bridge))	arch bridge
207 (B207)arch bridge(Three hinge arch bridge (deck bridge))	arch bridge
208 (B208)arch bridge(Three hinge arch bridge (deck bridge))	arch bridge
209 (B209)arch bridge(Tide arch bridge)	arch bridge
210 (B210)arch bridge(Tide arch bridge)	arch bridge
211 (B211)arch bridge(Langer girder bridge)	arch bridge
212 (B212)arch bridge(Langer Truss Bridge)	arch bridge
302 (B302)spandrel braced arch bridge	arch bridge
381 (B381)avoid bridge from overflow	avoid bridge from overflow
422 (B422)axial force of bolt	axial force of bolt
358 (B358)base drawing	base drawing
377 (B377)beam	beam
257 (B257)beam bridge with steel plate floor	beam bridge with steel plate floor
415 (B415)bed plate	bed plate
427 (B427)bending compressive stress	bending compressive stress
429 (B429)bending moment	bending moment

430 (B430)bending moment diagram
431 (B431)bending moment influence line
517 (B517)Pier crown
428 (B428)bending tensile stress
423 (B423)bolt edge distance
 9 (B9)joining(Bolt joint)
371 (B371)Bolt joint (double friction joint)
395 (B395)bolt joint(full strength of member)
 37 (B37)Bolted joint
 38 (B38)Bolted joint
 39 (B39)Bolted joint
 40 (B40)Bolted joint
 41 (B41)Bolted joint
 42 (B42)Bolted joint
461 (B461)both end overhanging beam
175 (B175)Box girder bridge
195 (B195)Drip-box girder bridge
509 (B509)Prestressed concrete pavement-movable method
376 (B376)box section
408 (B408)braced arch bridge
400 (B400)bracket
311 (B311)braking load
 1 (B1)Bridge
 57 (B57)Bridge
343 (B343)halfthrough bridge
344 (B344)basculer bridge
347 (B347)longcolumn-form pier
368 (B368)double-deck bridge
374 (B374)howe truss
375 (B375)box girder bridge
378 (B378)overhanging pier
151 (B151)Bridge composition
152 (B152)Bridge composition(floor beam and lateral bracing)
153 (B153)Bridge composition(Bridge width)

bending moment diagram
bending moment influence line
Bending strength
bending tensile stress
bolt edge distance
Bolt joint
Bolt joint
bolt joint
Bolted joint
Bolted joint
Bolted joint
Bolted joint
Bolted joint
Bolted joint
both end overhanging beam
Box girder bridge
box girder bridge
Box girder bridge
box section
braced arch bridge
bracket
braking load
Bridge
Bridge
bridge
bridge
bridge
bridge
bridge
bridge
Bridge composition
Bridge composition
Bridge composition

154 (B154)Bridge composition(Bridge width)	Bridge composition
155 (B155)Bridge composition(Bridge length)	Bridge composition
157 (B157)Bridge erection(travelling form)	Bridge erection
162 (B162)prestressed concrete bridge(Erection method)	Bridge erection
163 (B163)prestressed concrete bridge(Erection method)	Bridge erection
164 (B164)prestressed concrete bridge(Erection method)	Bridge erection
165 (B165)prestressed concrete bridge(Erection method)	Bridge erection
167 (B167)Bridge erection(cantilever erection)	Bridge erection
168 (B168)Bridge erection(cantilever slab)	Bridge erection
170 (B170)Bridge erection(Movable shoring)	Bridge erection
174 (B174)cable-stayed bridge	Bridge erection
185 (B185)Bridge erection(Movable shoring-P&Z method)	Bridge erection
186 (B186)mushroom-shaped slab bridge(piltz bridge)	Bridge erection
187 (B187)form traveler /travelling form(Vorbauwagen)	Bridge erection
190 (B190)precast concrete block method	Bridge erection
201 (B201)staging goliath erection	Bridge erection
221 (B221)erection truss method	Bridge erection
225 (B225)Cantilever erection method	Bridge erection
226 (B226)Cantilever erection method	Bridge erection
123 (B123)Bridge erection(bearing /support)	Bridge erection(bearing /support)
124 (B124)Bridge erection(bearing /support)	Bridge erection(bearing /support)
125 (B125)Bridge erection(bearing /support)	Bridge erection(bearing /support)
126 (B126)Bridge erection(bearing /support)	Bridge erection(bearing /support)
127 (B127)Bridge erection(bearing /support)	Bridge erection(bearing /support)
128 (B128)Bridge erection(bearing /support)	Bridge erection(bearing /support)
129 (B129)Bridge erection(bearing /support)	Bridge erection(bearing /support)
130 (B130)Bridge erection(bearing /support)	Bridge erection(bearing /support)
131 (B131)Bridge erection(expansion joint)	Bridge erection(expansion joint)
132 (B132)Bridge erection(expansion joint)	Bridge erection(expansion joint)
503 (B503)Prestressed concrete	Bridge general drawing
507 (B507)Parapet	Bridge girder expansion joint
240 (B240)bridge length	bridge length
237 (B237)bridge seat	bridge seat
519 (B519)Erection bar-Rebar for assembly	Bridge seat

133 (B133)Bridge type	Bridge type
134 (B134)Bridge type	Bridge type
135 (B135)Bridge type	Bridge type
136 (B136)Bridge type	Bridge type
138 (B138)Bridge type(girder beam)	Bridge type
139 (B139)Bridge type(plate girder bridge)	Bridge type
140 (B140)Bridge type(composite girder)	Bridge type
141 (B141)simple bridge	Bridge type
142 (B142)Bridge type(box girder)	Bridge type
143 (B143)Bridge type(truss)	Bridge type
144 (B144)Bridge type	Bridge type
145 (B145)Bridge type(continuous girder truss)	Bridge type
146 (B146)Bridge type(gerber bridge/cantilever bridge)	Bridge type
147 (B147)Bridge type(arch bridge)	Bridge type
148 (B148)Bridge type(Rahmen/rigid-frame bridge)	Bridge type
149 (B149)Bridge type(cable stayed bridge)	Bridge type
150 (B150)Bridge type(suspension bridge)	Bridge type
313 (B313)butt joint(gross sectional area)	butt joint
491 (B491)cable-stayed bridge	cable-stayed bridge
309 (B309)camber	camber
434 (B434)camber	camber
227 (B227)Cantilever	Cantilever
228 (B228)Cantilever slab	Cantilever slab
171 (B171)cantilever-bridge girder bridge(gerber bridge)	cantilever-bridge girder bridge
340 (B340)center line	center line
336 (B336)chipping	chipping
337 (B337)finish of chipping	chipping
284 (B284)clear span	clear span
288 (B288)collision load	collision load
455 (B455)Column with spiral rebar	Column with spiral rebar
414 (B414)combined bridge	combined bridge
260 (B260)composite column	composite column
172 (B172)composite girder(Steel/concrete composite girder)	composite girder
173 (B173)composite girder(Prestressed concrete composite girder)	composite girder

214 (B214)compression member	compression member
497 (B497)Concrete bridge-Concrete girder bridge	Concrete bridge
498 (B498)Concrete bridge-Arch bridge	Concrete bridge
499 (B499)Concrete bridge-Rahmen Bridge	Concrete bridge
500 (B500)Concrete bridge-Cable stayed bridge	Concrete bridge
501 (B501)Concrete bridge-Outer cable PC bridge	Concrete bridge
502 (B502)Bridge general drawing	Concrete bridge
110 (B110)Concrete bridge(Erection)	Concrete bridge(Erection)
111 (B111)Concrete bridge(Erection-Precast Erection-Segment method)	Concrete bridge(Erection)
112 (B112)Concrete bridge(Erection-Precast girder erection -Segment method)	Concrete bridge(Erection)
113 (B113)Concrete bridge(Erection-Precast girder erection)	Concrete bridge(Erection)
529 (B529)Formwork seam-Crevice - Cement outflow	Concrete Placing
516 (B516)Bending strength	Concrete strength
496 (B496)Concrete bridge-Truss bridge	Concrete structures and loads
515 (B515)Concrete strength	Continuos girder
198 (B198)continuous girder	continuous girder
463 (B463)Continuous slab	Continuous slab
396 (B396)corrosion	corrosion
169 (B169)Coupler joint	Coupler joint
232 (B232)cover plate	cover plate
525 (B525)Crack-causes- joint - bad	Crack-causes
526 (B526)Crack-causes-Incomplete expansion joint	Crack-causes
527 (B527)Crack-Curing to prevent cracks-Poor design	Crack-causes
528 (B528)Concrete Placing	Crack-Curing
521 (B521)Floor slab	Creep
449 (B449)cross beam	cross beam
234 (B234)deck bridge	deck bridge
293 (B293)deck bridge	deck bridge
181 (B181)Deflection	Deflection
323 (B323)deflection	deflection
324 (B324)deflection angle	deflection
325 (B325)deflection curve	deflection
467 (B467)Design load	Design load
280 (B280)diagonal member	diagonal member

346 (B346)direct load
523 (B523)Drying Shrinkage -Settlement - Different - Cracks
391 (B391)double reinforcement rectangular beam
279 (B279)dowel
452 (B452)drag out installation method
194 (B194)drip
524 (B524)Crack-causes-Concrete drying shrinkage
357 (B357)Dywidag method
416 (B416)eccentric load
514 (B514)Continuos girder
513 (B513)Edging
328 (B328)elastic load
362 (B362)launching erection
520 (B520)Creep
382 (B382)sliding erection method
462 (B462)Interlocking erection method
417 (B417)erection method of bent style
119 (B119)Concrete bridge(Erection-Cast-in-place method)
120 (B120)Concrete bridge(Erection-Cast-in-place method)
121 (B121)Concrete bridge(Erection-Cast-in-place method)
122 (B122)Bridge erection(bearing /support)
295 (B295)expansion equipment
278 (B278)felloe guard
305 (B305)fillet welding
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193 (B193)filling concrete
264 (B264)fixed arch bridge
265 (B265)fixed bearing
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266 (B266)fixed support
403 (B403)flange
406 (B406)flange angle
404 (B404)flange joint
405 (B405)flange plate

direct load
Distribution rebar
double reinforcement rectangular beam
dowel
drag out installation method
drip
Drying Shrinkage
Dywidag method
eccentric load
Edging
Edging-trowel
elastic load
erection
Erection bar-Rebar for assembly
erection method
erection method
erection method of bent style
Erection-Cast-in-place method
Erection-Cast-in-place method
Erection-Cast-in-place method
Erection-Cast-in-place method
expansion equipment
felloe guard
fillet welding
fillet welding
filling concrete
fixed arch bridge
fixed bearing
fixed slab
fixed support
flange
flange angle
flange joint
flange plate

188 (B188)flat slab
401 (B401)flat slab
238 (B238)floor deck
289 (B289)floor slab
290 (B290)floor slab bridge
522 (B522)Distribution rebar
441 (B441)floor system
388 (B388)form-tie
495 (B495)Concrete structures and loads
530 (B530)Concrete surface - full of holes
454 (B454)Four sides simply support slab
281 (B281)free end
407 (B407)freyssinet method
356 (B356)Gerbar(anchor span)
248 (B248)gerber bridge(cantilever bridge)
62 (B62)Bridge(Girder bridge)
245 (B245)girder bridge
246 (B246)Girder height
255 (B255)grating structure
490 (B490)grid girder bridge
14 (B14)groove welding
15 (B15)groove welding
16 (B16)groove welding
17 (B17)groove welding
18 (B18)groove welding
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20 (B20)groove welding
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22 (B22)groove welding
23 (B23)Welding method
224 (B224)gusset plate
235 (B235)halfthrough bridge
262 (B262)handrail
263 (B263)handrail

flat slab
flat slab
floor deck
floor slab
floor slab
Floor slab
floor system
form-tie
Formwork and Support
Formwork seam
Four sides simply support slab
free end
freyssinet method
Gerbar
gerber bridge(cantilever bridge)
Girder bridge
girder bridge
girder bridge
grating structure
grid girder bridge
groove welding
groove welding
groove welding
groove welding
groove welding
groove welding
groove welding
groove welding
groove welding
groove welding
groove welding
gusset plate
halfthrough bridge
handrail
handrail

379 (B379)haunch
470 (B470)High strength bolt friction joining
471 (B471)High strength bolt friction joining
472 (B472)High strength bolt friction joining
473 (B473)Allowable force Pa (N) per high-strength bolt friction joint per friction surface
474 (B474)Allowable force Pa (N) per high-strength bolt friction joint per friction surface
451 (B451)Horizontal girder erection method
298 (B298)horizontal shear stress
166 (B166)hot rolled steel section
156 (B156)I beam bridge
199 (B199)I-beam bridge
286 (B286)impact load
200 (B200)I-steel
468 (B468)Type of joining
350 (B350)joint(butt joint)
351 (B351)joint(butt welding)
363 (B363)bolt splice(splice)
394 (B394)member joint
457 (B457)langer bridge
450 (B450)lateral bracing
413 (B413)law of plane maintenance
285 (B285)lift bridge
184 (B184)load
321 (B321)longitudinal load
223 (B223)lower chord member
274 (B274)lower lateral bracing
282 (B282)main girder
469 (B469)member splice
438 (B438)Mohr's theorem
437 (B437)moment plate
436 (B436)monorail
229 (B229)movable support
230 (B230)movable support
218 (B218)Moving load

haunch
High strength bolt friction joining
High strength bolt friction joining
High strength bolt friction joining
high-strength bolt friction joint
high-strength bolt friction joint
Horizontal girder erection method
horizontal shear stress
hot rolled steel section
I beam bridge
I-beam bridge
impact load
I-steel
joining
joint
joint
joint
joint
langer bridge
lateral bracing
law of plane maintenance
lift bridge
load
longitudinal load
lower chord member
lower lateral bracing
main girder
member splice
Mohr's theorem
moment plate
monorail
movable support
movable support
Moving load

397 (B397)negative reinforcement
341 (B341)neutral axis
342 (B342)neutral plane
424 (B424)nominal diameter of bolt
256 (B256)nominal stress
216 (B216)One way slab
196 (B196)Outside girder
433 (B433)outside girder
46 (B46)Painting
47 (B47)Painting
48 (B48)Painting
49 (B49)Painting
50 (B50)Painting
51 (B51)Painting
52 (B52)Painting
53 (B53)Painting
54 (B54)Painting
55 (B55)Painting
56 (B56)Painting
508 (B508)Box girder bridge
61 (B61)Bridge(PC concrete bridge)
159 (B159)PC steel fixing method(SEEE method)
160 (B160)PC steel fixing method(SM method)
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5 (B5)PC steel material
384 (B384)PC steel wire
92 (B92)prestressed concrete(PC structure)
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236 (B236)pier crown
518 (B518)Bridge seat
412 (B412)plane truss
183 (B183)plate girder(horizontal stiffener)
315 (B315)Plate girder (sole plate)
316 (B316)Plate girder (sway bracing)

negative reinforcement
neutral axis
neutral plane
nominal diameter of bolt
nominal stress
One way slab
Outside girder
outside girder
Painting
Painting
Painting
Painting
Painting
Painting
Painting
Painting
Painting
Painting
Painting
Parapet
PC concrete bridge
PC steel fixing method
PC steel fixing method
PC steel fixing method
PC steel material
PC steel wire
PC structure
PC structure
pier crown
Pier crown
plane truss
plate girder
Plate girder
Plate girder

411 (B411)plate girder bridge	plate girder bridge
300 (B300)scallop	plate girder(scallop)
439 (B439)Portal pier	portal
440 (B440)portal bracing	portal
310 (B310)positive reinforcement	positive reinforcement
273 (B273)post tension(sheath)	post tension
506 (B506)Bridge girder expansion joint	Post tension method
192 (B192)Post-tension method	Post-tension method
421 (B421)Post-tensioning	Post-tensioning
402 (B402)pratt truss	pratt truss
189 (B189)Precast concrete girder	Precast concrete girder
114 (B114)Concrete bridge(Erection-Precast girder erection)	Precast girder erection
115 (B115)Concrete bridge(Erection-Precast girder erection)	Precast girder erection
116 (B116)Concrete bridge(Erection-Precast girder erection)	Precast girder erection
117 (B117)Concrete bridge(Erection-Precast girder erection)	Precast girder erection
118 (B118)Concrete bridge(Erection-Cast-in-place method)	Precast girder erection
44 (B44)pressure welding	pressure welding
45 (B45)pressure welding	pressure welding
94 (B94)prestressed concrete(Pre-tension method (factory production))	prestressed concrete
95 (B95)prestressed concrete(Post-tension method (field production))	prestressed concrete
96 (B96)prestressed concrete(Prestressed concrete construction)	prestressed concrete
97 (B97)prestressed concrete(Prestressed concrete construction)	prestressed concrete
98 (B98)prestressed concrete(Introduction of prestress)	prestressed concrete
99 (B99)prestressed concrete(Introduction of prestress)	prestressed concrete
100 (B100)prestressed concrete(pretension)	prestressed concrete
101 (B101)prestressed concrete(Reduction of prestress)	prestressed concrete
102 (B102)prestressed concrete(Sliding friction loss)	prestressed concrete
103 (B103)prestressed concrete(Variations in pre-stressing)	prestressed concrete
104 (B104)prestressed concrete(Fixing method of PC steel)	prestressed concrete
105 (B105)prestressed concrete(Freycinet method: wedge anchorage)	prestressed concrete
106 (B106)prestressed concrete(Devidark construction method: Screw/nut fixation)	prestressed concrete
107 (B107)prestressed concrete(BBRV method: Heading anchorage)	prestressed concrete
108 (B108)prestressed concrete(Leonhard method: End processing embedding fixation)	prestressed concrete
109 (B109)prestressed concrete(grouting)	prestressed concrete

504 (B504)Pretension method	Prestressed concrete
383 (B383)prestressed concrete beam	prestressed concrete beam
409 (B409)prestressed concrete bridge	prestressed concrete bridge
510 (B510)Prestressed concrete pavement-Fixed abutment method	Prestressed concrete pavement
511 (B511)Prestressed concrete pavement-Elastic abutment method	Prestressed concrete pavement
512 (B512)Edging-trowel	Prestressed concrete pavement
191 (B191)Pretension method	Pretension method
505 (B505)Post tension method	Pretension method
410 (B410)Pretensioning system	Pretensioning system
487 (B487)rahmen bridge	rahmen bridge
488 (B488)rahmen bridge	rahmen bridge
64 (B64)Bridge(Rahmen bridge -rigid frame)	Rahmen bridge -rigid frame
91 (B91)Bridge(RC structure)	RC structure
380 (B380)reaction	reaction
307 (B307)Rebar joint(sleeve nut)	Rebar joint
332 (B332)rectangular beam with single reinforcement	rectangular beam with single reinforcement
360 (B360)reinforced concrete girder bridge	reinforced concrete girder bridge
361 (B361)reinforced concrete slab	reinforced concrete slab
359 (B359)reinforced concrete	reinforced concrete
456 (B456)Rigid frame bridge	Rigid frame bridge
197 (B197)Rigid frame bridge(Rahmen)	Rigid frame bridge(Rahmen)
252 (B252)field rivet	rivet
258 (B258)shop rivet	rivet
319 (B319)stress rivet	rivet
329 (B329)single sheared rivet	rivet
372 (B372)screw rivet	rivet
387 (B387)flat head rivet	rivet
390 (B390) double shear rivet	rivet
458 (B458)rivet	rivet
459 (B459) rivet lateral pitch	rivet
460 (B460)rivet joint	rivet
10 (B10)joining(Rivet joint)	Rivet joint
43 (B43)Rivet joint	Rivet joint
306 (B306)road bridge (slab)	road bridge

89 (B89)Bridge(Steel bridge erection)	Steel bridge erection
90 (B90)Bridge(Steel bridge erection)	Steel bridge erection
71 (B71)Bridge(Steel bridge manufacturing procedure)	Steel bridge manufacturing procedure
72 (B72)Bridge(Steel bridge manufacturing procedure)	Steel bridge manufacturing procedure
73 (B73)Bridge(Steel bridge manufacturing procedure)	Steel bridge manufacturing procedure
74 (B74)Bridge(Steel bridge manufacturing procedure)	Steel bridge manufacturing procedure
75 (B75)Bridge(Steel bridge manufacturing procedure)	Steel bridge manufacturing procedure
76 (B76)Bridge(Steel bridge manufacturing procedure)	Steel bridge manufacturing procedure
77 (B77)Bridge(Steel bridge manufacturing procedure)	Steel bridge manufacturing procedure
259 (B259)steel form	steel form
308 (B308)steel girder(shear connector/Dowel)	steel girder
7 (B7)Steel material symbol	Steel material symbol
261 (B261)steel sheet pile	steel sheet pile
386 (B386)steel strand for prestressed concrete	steel strand for prestressed concrete
465 (B465)Characteristics of steel structure	steel structure
466 (B466)Characteristics of steel structure	steel structure
297 (B297)vertical stiffener	stiffener
420 (B420)stiffener	stiffener
419 (B419)stiffener girder	stiffener girder
59 (B59)Bridge(Stone bridge)	Stone bridge
393 (B393)stress of member	stress of member
322 (B322)stringer	stringer
291 (B291)superstructure work	superstructure
292 (B292)superstructure	superstructure
271 (B271)support	support
272 (B272)support	support
275 (B275)support(movable)	support
276 (B276)support(rotating)	support
277 (B277)support(fixed)	support
215 (B215)suspension bridge(anchor block)	suspension bridge
352 (B352)suspension bridge	suspension bridge
492 (B492)suspension bridge	suspension bridge
493 (B493)suspension bridge	suspension bridge
494 (B494)Formwork and Support	suspension bridge

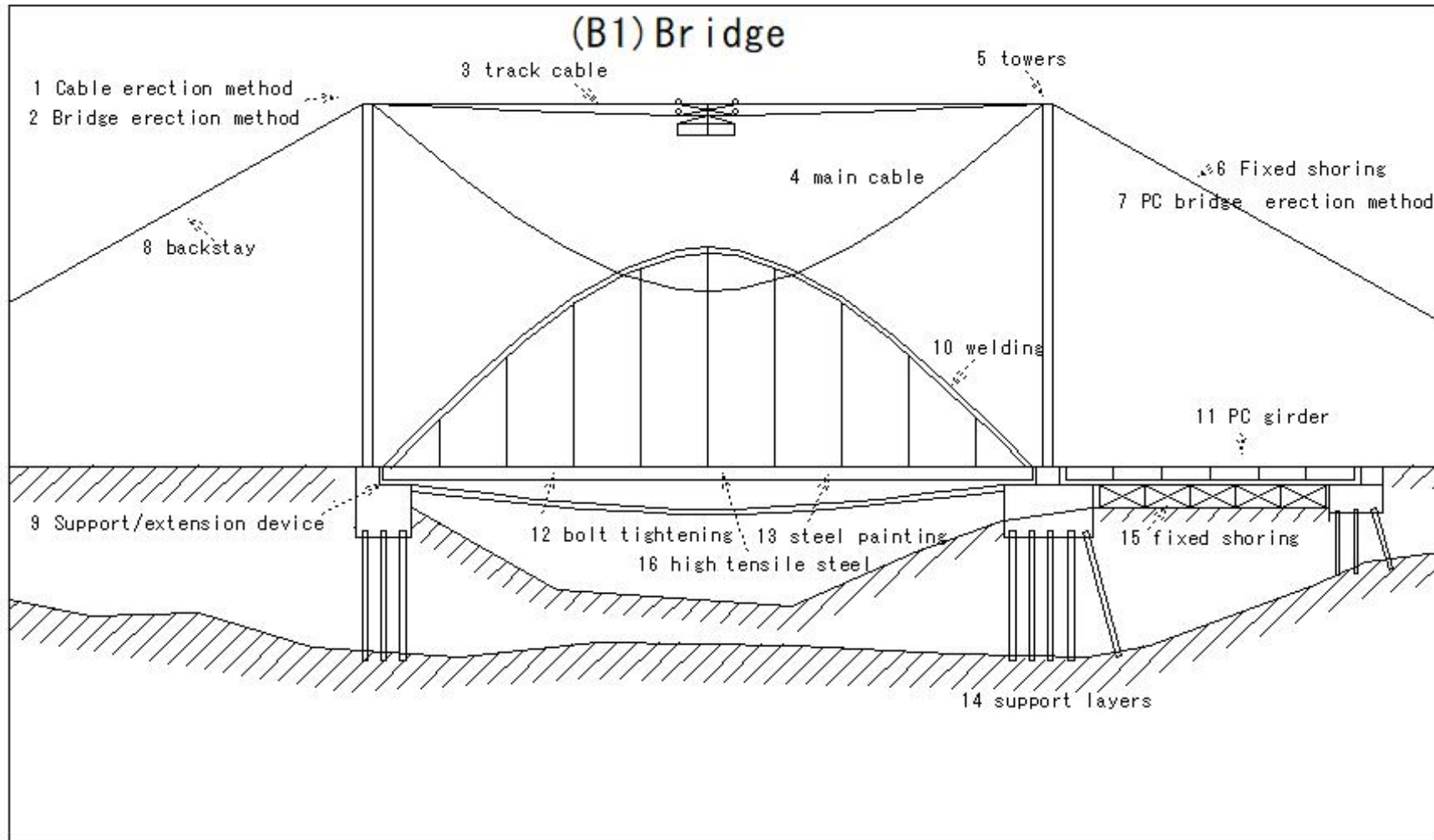
3 (B3)Tape alignment
355 (B355)T-beam
353 (B353)T-beam girder bridge
333 (B333)T-beam with single reinforcement
6 (B6)Tempered high tensile strength steel
78 (B78)Bridge(Temporary assembly inspection of steel bridges)
2 (B2)Tensile strength-stress strain curve
269 (B269)three-hinged arch
373 (B373)throat depth
233 (B233)through bridge
241 (B241)portal bracing
242 (B242)curved-chord truss
243 (B243)bowstring warren truss
247 (B247)K-truss
249 (B249)chord member
250 (B250)chord member joint
283 (B283)main truss(main girder)
287 (B287)truss(upper chord member)
330 (B330)end sway bracing
334 (B334)end stiffener
338 (B338)intermediate sway bracing
339 (B339)intermediate stiffener
345 (B345)parallel-chord truss
348 (B348) truss(counter)
365 (B365)truss
366 (B366)truss(internal stable)
367 (B367)truss(internal determinate)
389 (B389) truss(web member)
464 (B464)warren truss
63 (B63)Bridge(Truss bridge)
222 (B222)truss(panel point)
354 (B354)T-shaped steel
370 (B370)two way slab
364 (B364)uniform load

Tape alignment
T-beam
T-beam girder bridge
T-beam with single reinforcement
Tempered high tensile strength steel
Temporary assembly inspection of steel bridges
Tensile strength
three-hinged arch
throat depth
through bridge
truss
truss
truss
truss
truss
truss
truss
truss
truss
truss
truss
truss
truss
truss
truss
truss
truss
truss
truss
truss
truss
Truss bridge
truss(panel point)
T-shaped steel
two way slab
uniform load

219 (B219)upper lateral bracing	upper lateral bracing
320 (B320)viaduct (highness)	viaduct
158 (B158)web	web
220 (B220)web	web
392 (B392)web plate	web plate
445 (B445)arc welding tool	weld
453 (B453)reinforcement of weld	weld
11 (B11)welded joint	welded joint
12 (B12)welded joint	welded joint
13 (B13)fillet weld	welded joint
483 (B483)welded joint	welded joint
484 (B484)welded joint	welded joint
485 (B485)welded joint	welded joint
486 (B486)welded joint	welded joint
446 (B446)welded joints	welded joints
444 (B444)welded steel truss bridge	welded steel truss bridge
244 (B244)groove welding	welding
251 (B251)field welding	welding
312 (B312)auxiliary mark full field welding	welding
398 (B398)welding(boxing of different length)	welding
399 (B399)welding(plug welding)	welding
475 (B475)welding	welding
476 (B476)welding	welding
477 (B477)Arc welding	welding
478 (B478)Arc welding	welding
479 (B479)group welding	welding
480 (B480)Fillet welding	welding
481 (B481)Fillet weld cross section	welding
482 (B482)welded joint Fillet welding(Throat thickness)	welding
8 (B8)joining(Welding joint)	Welding joint
231 (B231)corner joint(Welding joint)	Welding joint
24 (B24)Welding method(Hand welding)	Welding method
25 (B25)Welding method(Automatic welding)	Welding method
26 (B26)Welding method(Semi-automatic welding)	Welding method

27 (B27)Welding method(Points to note -welding)	Welding method
28 (B28)Welding method(Visual inspection)	Welding method
29 (B29)Welding method(Visual inspection)	Welding method
30 (B30)Welding method(Visual inspection)	Welding method
31 (B31)Welding method(Visual inspection)	Welding method
32 (B32)Welding method(Visual inspection)	Welding method
33 (B33)Welding method(Visual inspection)	Welding method
34 (B34)Welding method(Visual inspection)	Welding method
35 (B35)Welding method(Visual inspection)	Welding method
36 (B36)Welding method(Visual inspection)	Welding method
448 (B448)Welding strength	Welding strength
443 (B443)welding symbol	welding symbol
58 (B58)Bridge(Wooden bridge)	Wooden bridge
268 (B268)wooden bridge	wooden bridge
318 (B318)wooden bridge(bolster)	wooden bridge
349 (B349)wooden bridge	wooden bridge
425 (B425)wooden bridge	wooden bridge
426 (B426)wooden bridge	wooden bridge
432 (B432)wooden bridge(collar brace)	wooden bridge
435 (B435)wooden beam bridge	wooden bridge

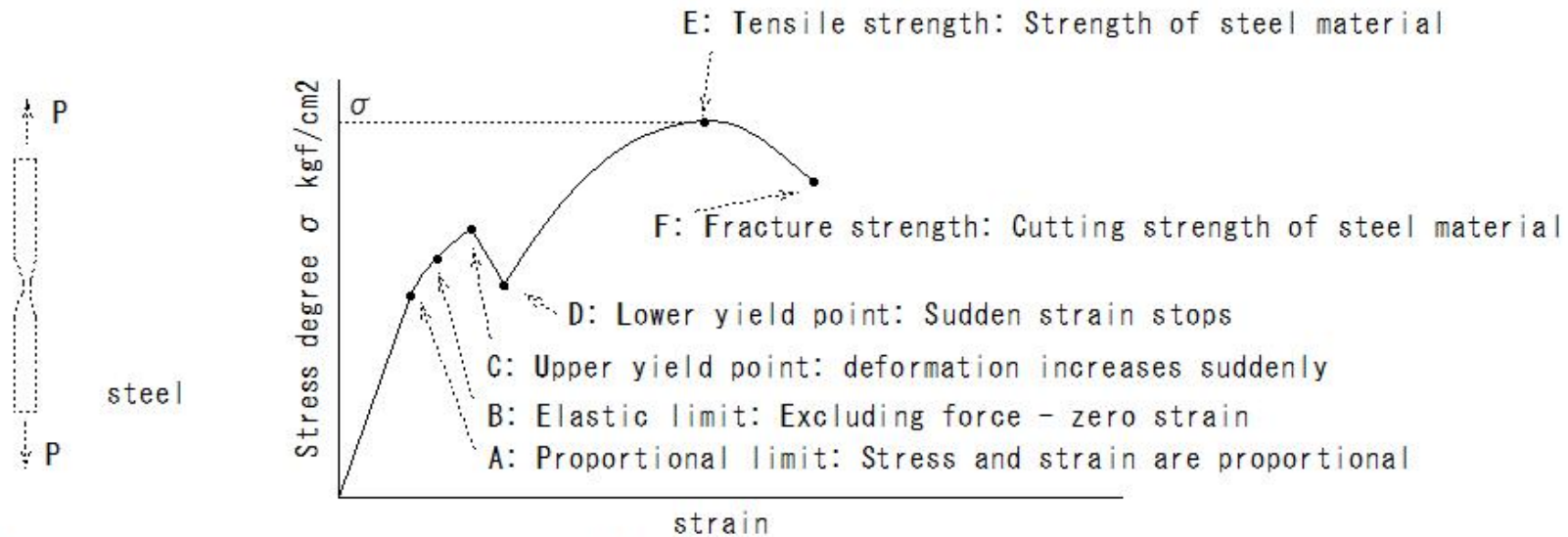
(B1) Bridge



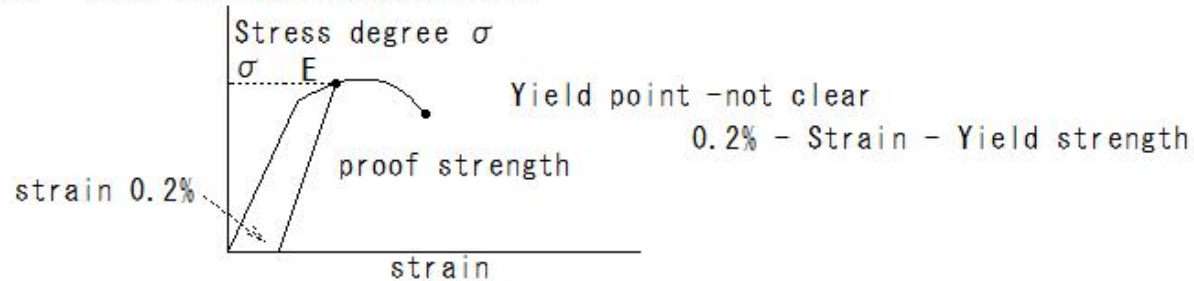
(B2)Tensile strength-stress strain curve

(B2) Tensile strength-stress strain curve

Tensile strength-stress strain curve

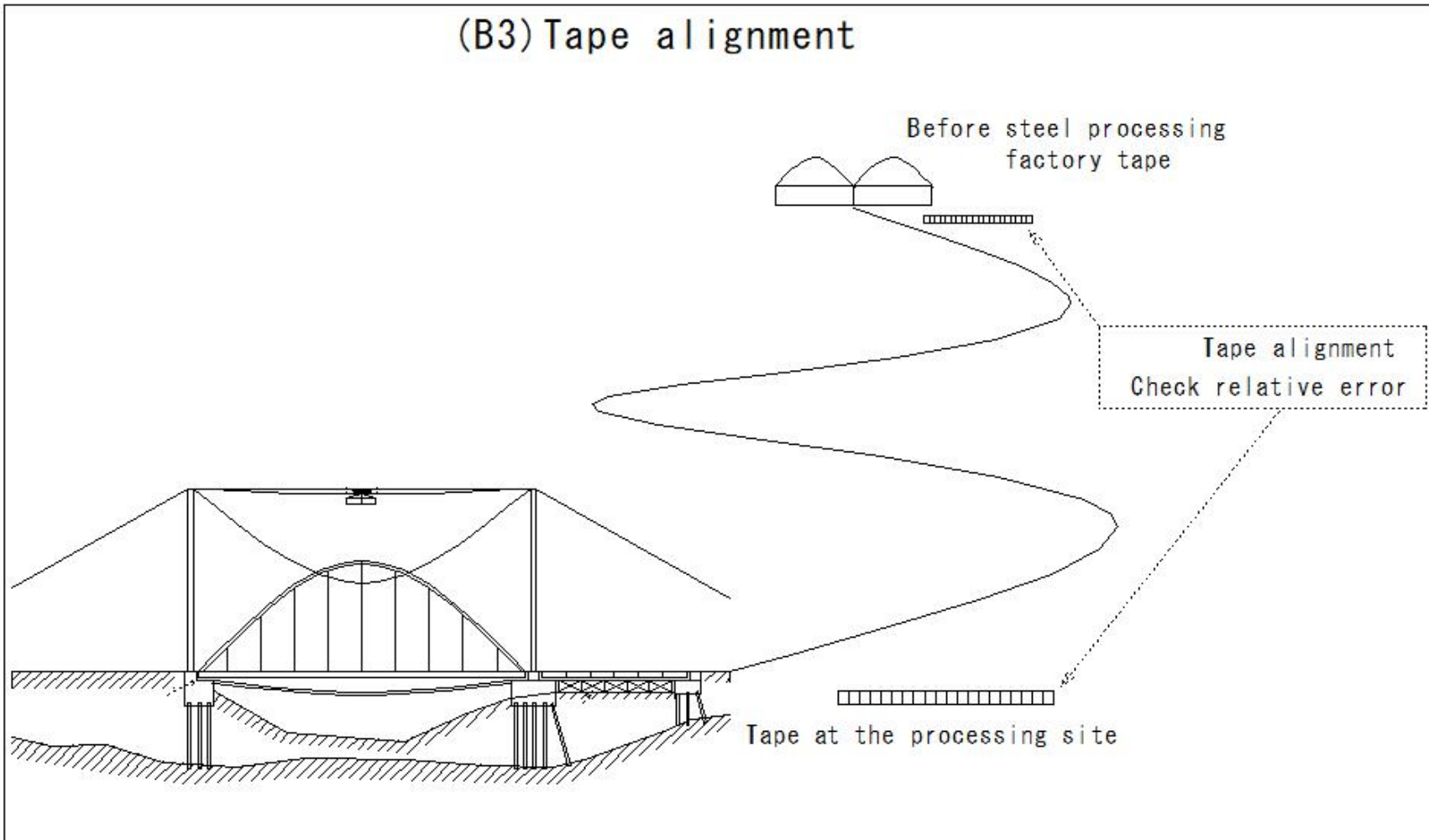


Tensile strength - high tensile strength steel



(B3)Tape alignment

(B3) Tape alignment



(B4)Rolled steel for general structures

(B4)Rolled steel for general structures

Rolled steel for general structures

$$\begin{aligned} &400-41\text{kgf/mm}^2 \times g \text{ (gravitational acceleration)} \\ &41 \times 9.80665 \doteq 400/\text{mm}^2 \end{aligned}$$

S S 400

③Tensile strength of steel material 400N/mm²

②Rolled steel materials for general structures

①Chemical components

① : Steel S Iron F

② : Product name/Application name

③ : Strength

(B5)PC steel material

(B5)PC steel material

PC steel material

S

WPR

7A

③7-stranded A line

②Prestressed round steel wire

①Chemical components

① : Steel

② : Product name

③ : Type/number

(B6)Tempered high tensile strength steel

(B6)Tempered high tensile strength steel

Tempered high tensile strength steel

S M 570 Q

④Q refining: Product/application explanation

③570N/mm²: Tensile strength

②M carbon/weldability: Product name

①S chemical composition: steel

① : Steel

② : Product name

③ : Tensile strength

④ : Explanation of product/use

(B7)Steel material symbol

(B7) Steel material symbol

Steel material symbol

A: Weather resistance

B: Rod-shaped object (PC steel rod)

D: Deformed steel bar

M: Weldability

P: For prestressing

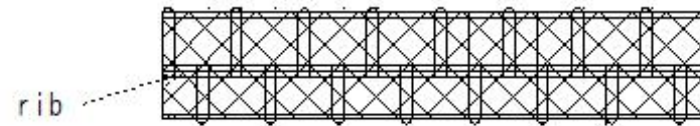
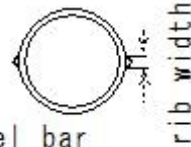
R: Round steel reinforcing bar/Round steel bar

S: Rolled material for general structures

TK: Structural carbon steel pipe

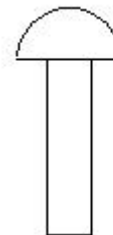
US: Stainless steel

Y: Yield point/steel material for sheet piles



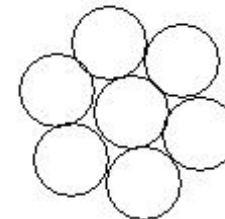
Deformed reinforcing bar

SV330



rivet

SWPR7A



wire

(B8)Welding joint

(B8)joining(Welding joint)

①Welding joint



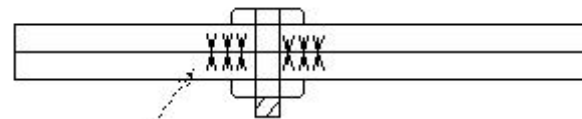
Joining steel materials by melting them with heat
Add welding metal and weld

(B9)joining(Bolt joint)

(B9) joining (Bolt joint)

② Bolt joint

Force is transmitted by friction force by pressing steel materials together with bolts.



Bolt tightening force

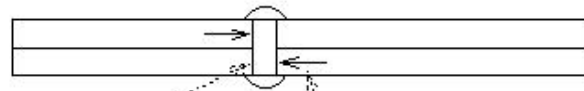
(B10)joining(Rivet joint)

(B10) joining (Rivet joint)

③Rivet joint

Joining steel materials with rivets

Rivet joint



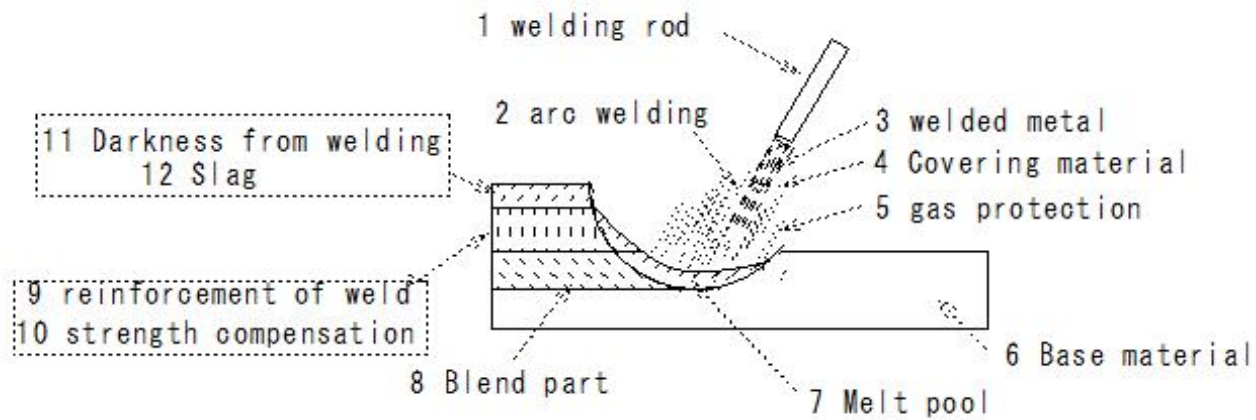
Bearing force
Bearing force of steel material

shear force
Rivet shear force

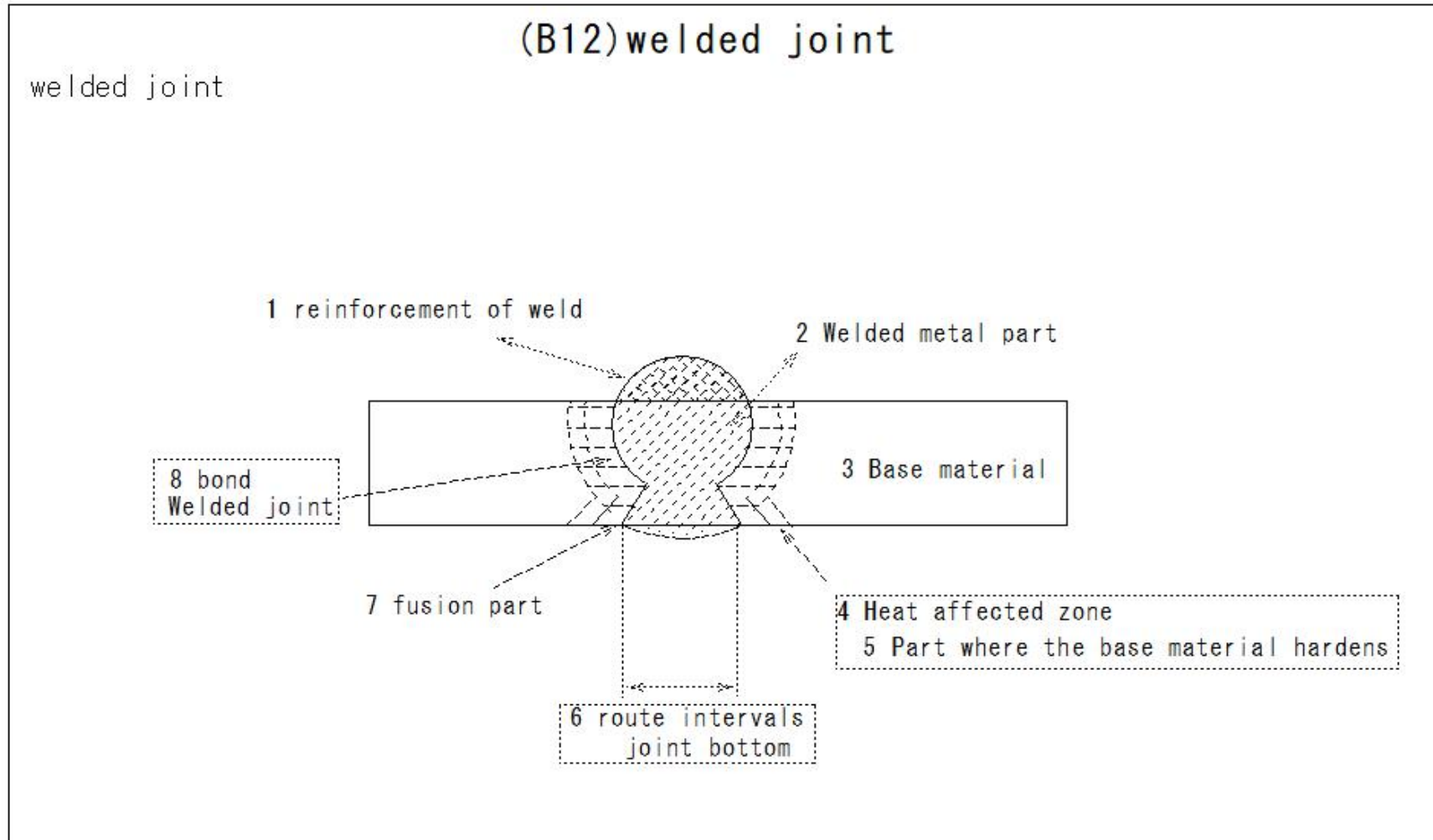
(B11)welded joint

(B11)welded joint

welded joint



(B12)welded joint

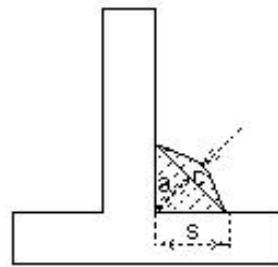
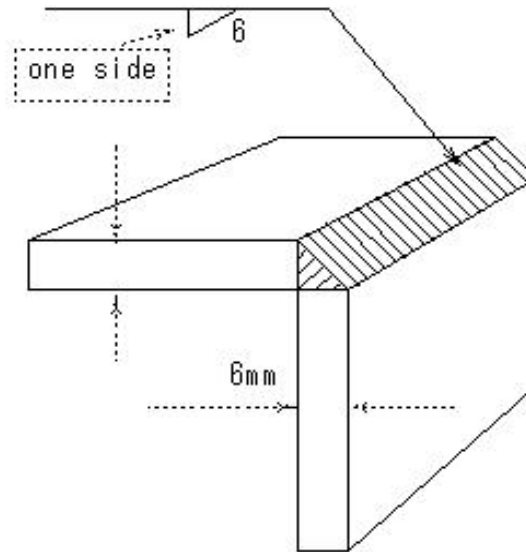
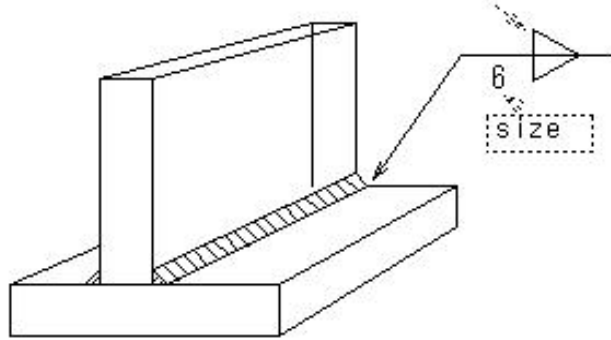


(B13)fillet weld

fillet weld

(B13)fillet weld

Both sides joined



a: Throat thickness
c: Reinforcement filler
s: size

fillet weld

(B14)groove welding

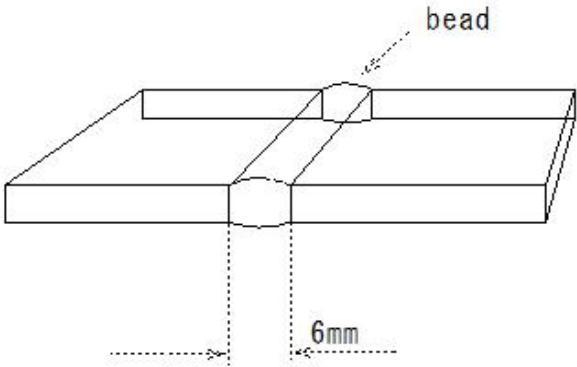
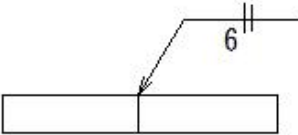
(B14) groove welding

groove welding

Both parts - joining

I type

welding symbol

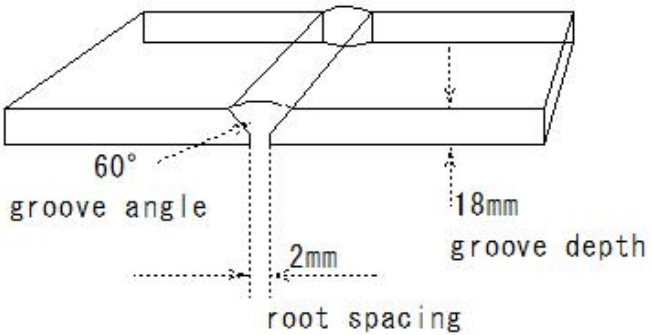

Types of welding	Welding state diagram	illustrations	symbols	Plate thickness limit
I type	 <p>bead</p> <p>6mm</p>	 <p>6</p>		6mm

(B15)groove welding

(B15) groove welding

groove welding
Both parts - joining
V type

welding symbol

Types of welding	Welding state diagram	illustrations	symbols	Plate thickness limit
V type	 <p>60° groove angle 18mm groove depth 2mm root spacing</p>	 <p>18 60°</p>	v	20mm

(B16)groove welding

(B16) groove welding

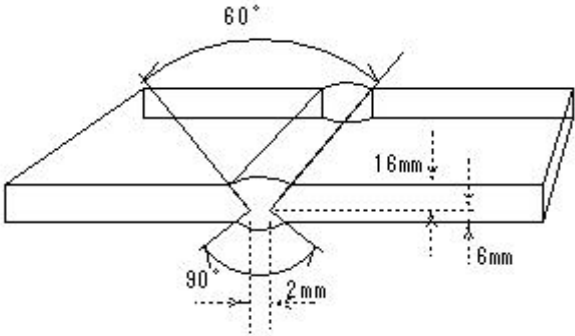
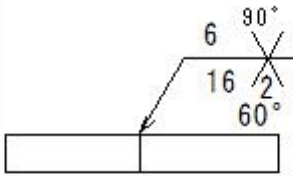
groove welding

Both parts - joining

X type

Double-sided V-shaped

welding symbol

Types of welding	Welding state diagram	illustrations	symbols	Plate thickness limit
X type Double-sided			X	30mm

(B17)groove welding

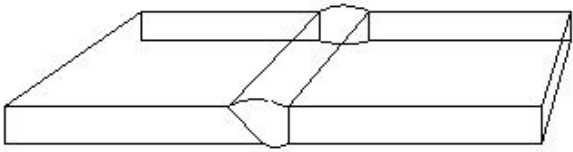

(B17) groove welding

groove welding

Both parts - joining

✓ type

welding symbol

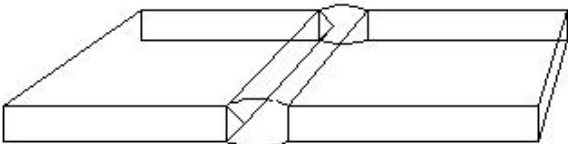
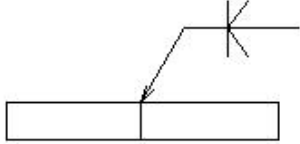
Types of welding	Welding state diagram	illustrations	symbols	Plate thickness limit
✓ type			✓	20mm

(B18)groove welding

(B18) groove welding

groove welding
Both parts - joining
K type
Double-sided V-shaped

welding symbol

Types of welding	Welding state diagram	illustrations	symbols	Plate thickness limit
K type Double-sided V-shaped			K	30mm

(B19)groove welding

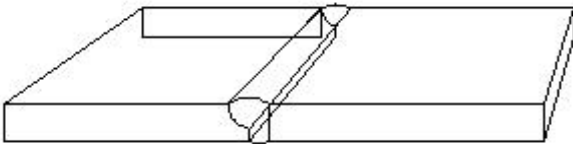
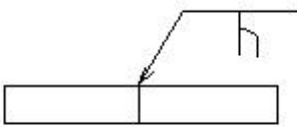
(B19) groove welding

groove welding

Both parts - joining

J type

welding symbol

Types of welding	Welding state diagram	illustrations	symbols	Plate thickness limit
J type			J	20mm

(B20)groove welding

(B20) groove welding

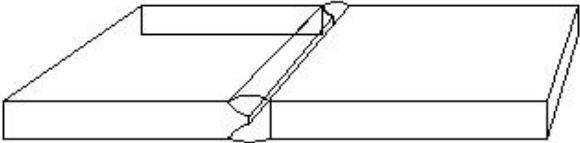
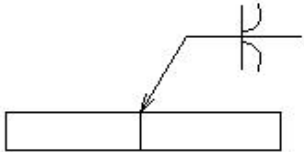

groove welding

Both parts - joining

J type

Double-sided J shape

welding symbol

	Welding state diagram	illustrations	symbols	Plate thickness limit
<p>J type Double-sided J shape</p>				<p>40mm</p>

(B21)groove welding

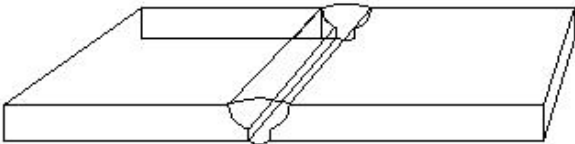
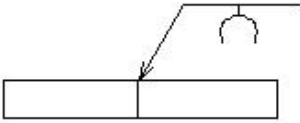

(B21)groove welding

groove welding

Both parts - joining

U type

welding symbol

Types of welding	Welding state diagram	illustrations	symbols	Plate thickness limit
U type				50mm

(B22)groove welding

(B22) groove welding

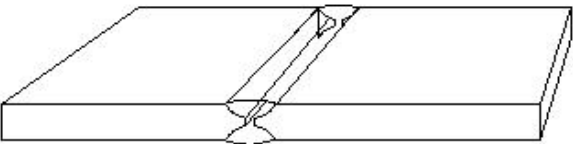
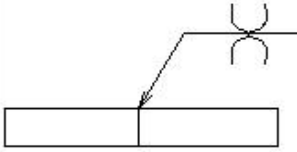

groove welding

Both parts - joining

H type

Double-sided U shape

welding symbol

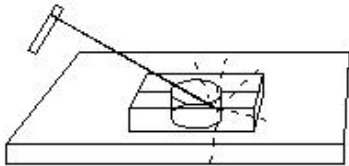
	Welding state diagram	illustrations	symbols	Plate thickness limit
<p>H type Double-sided U shape</p>				<p>60mm</p>

(B23)Welding method

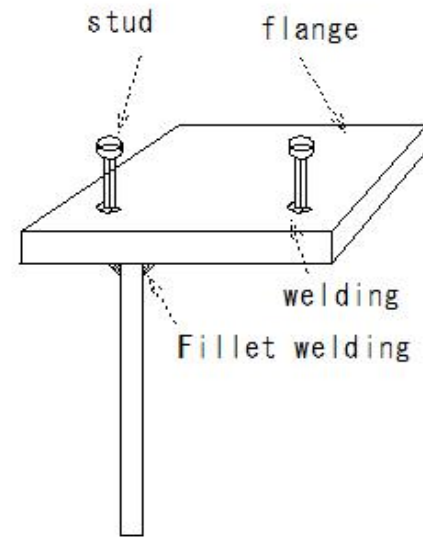
(B23)Welding method

Welding method

- ②Automatic welding
- ③Semi-automatic welding



①Hand welding



④Arc stud welding

(B24)Welding method(Hand welding)

(B24)Welding method(Hand welding)

Welding method

Hand welding

coated arc welding rod

Work efficiency - low

Finish - uneven

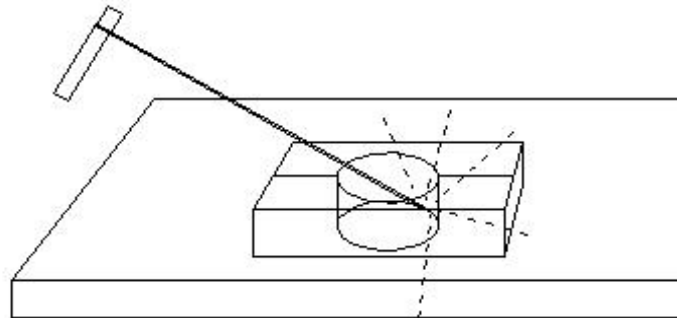
Scope of application - wide

Upward welding- possible

small current

Weld cracking - strong

Shock - strong



①Hand welding

(B25)Welding method(Automatic welding)

(B25) Welding method(Automatic welding)

Welding method

Automatic welding

submerged arc welding

High efficiency

Finish fixed

Downward - limited

high current

Weld cracking occurs

Shock - weak

Dehumidification/cleaning - required

(B26)Welding method(Semi-automatic welding)

(B26) Welding method (Semi-automatic welding)

Welding method

Semi-automatic welding

gas shielded arc welding

Wind speed 1 m/s or less

Wind speed over 2 m/s - countermeasures required

Welding - downward, horizontal possible

efficiency - good

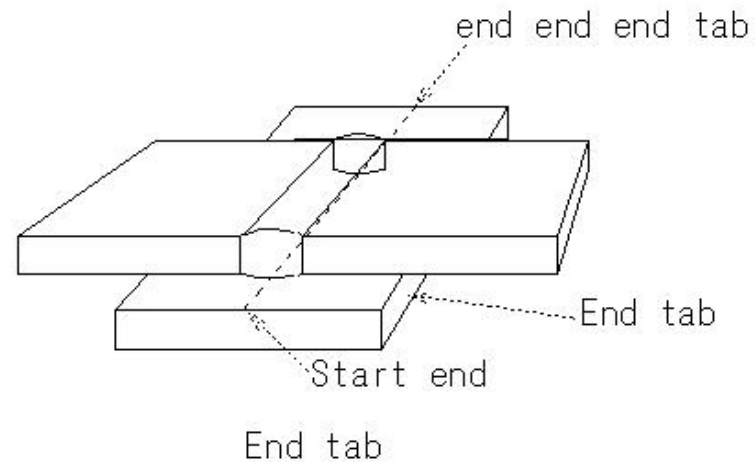
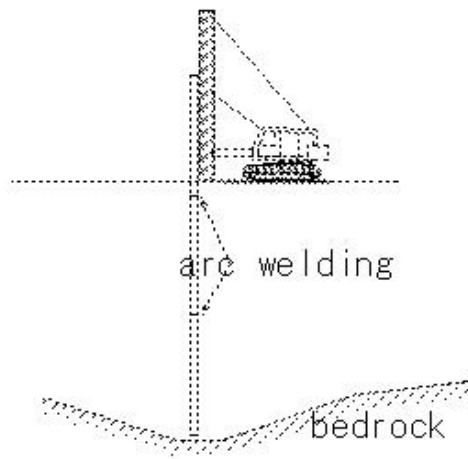
(B27)Welding method(Points to note -welding)

(B27)Welding method(Points to note -welding)

Welding method

Points to note -welding

- ① Welder: Qualified person
- ② Welding material: Dry
- ③ Tack welding: Length 80mm or more
- ④ Trenching: Dimension confirmation Cleaning
- ⑤ Residual heat: 50-100°C
- ⑥ End tab: Start end - end end end tab



(B28)Welding method(Visual inspection)

(B28)Welding method(Visual inspection)

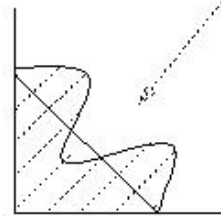
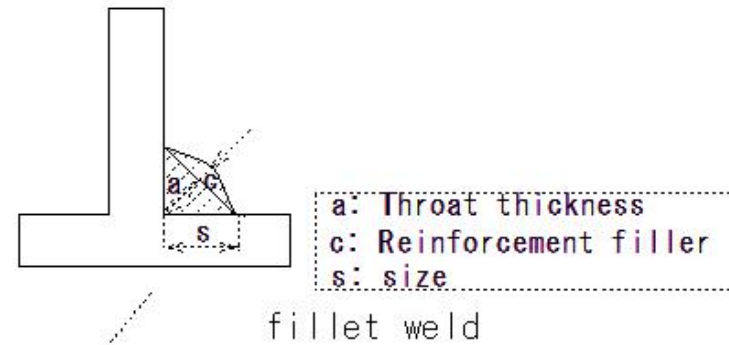
Welding method

Visual inspection

defective condition

① Insufficient throat thickness

fillet weld



① Insufficient throat thickness

fillet weld

(B29)Welding method(Visual inspection)

(B29)Welding method(Visual inspection)

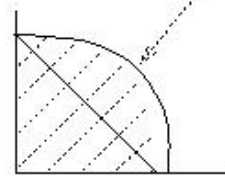
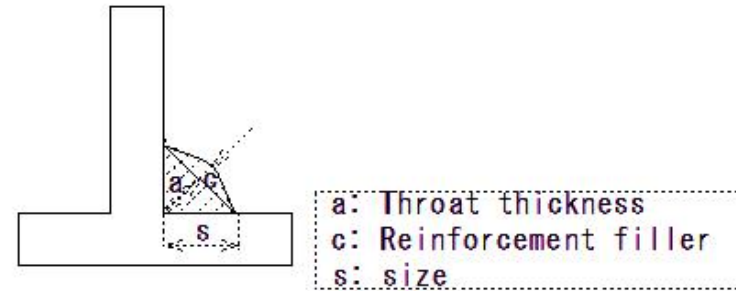
Welding method

Visual inspection

defective condition

② Excessive reinforcement

fillet weld



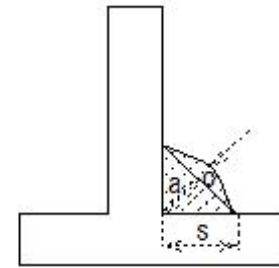
② Excessive reinforcement

fillet weld

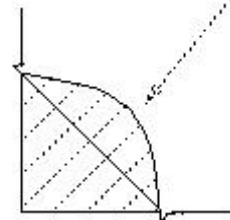
(B30)Welding method(Visual inspection)

(B30)Welding method(Visual inspection)

Welding method
Visual inspection
defective condition
③Undercut
fillet weld



a: Throat thickness
c: Reinforcement filler
s: size

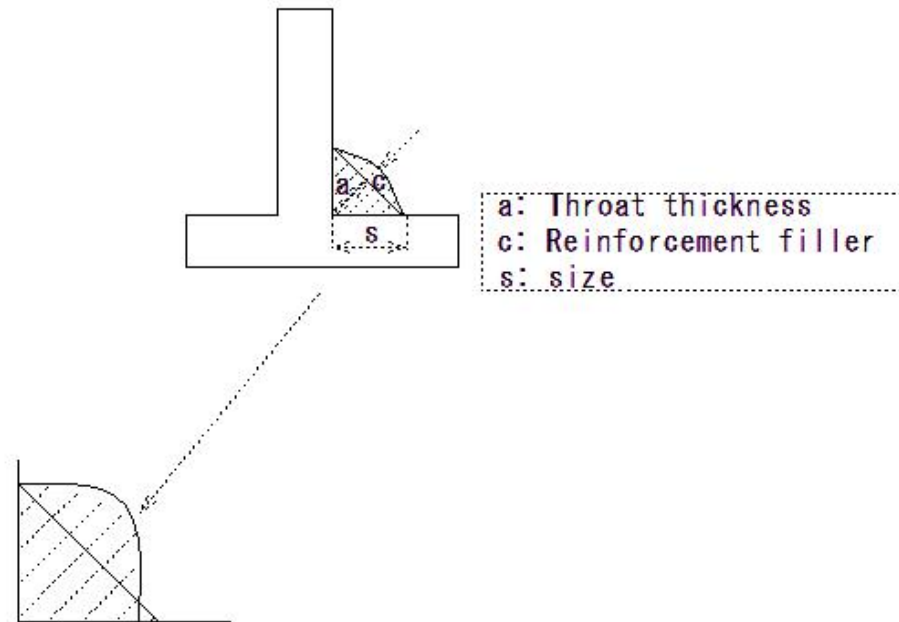


③Undercut

(B31)Welding method(Visual inspection)

(B31)Welding method(Visual inspection)

Welding method
Visual inspection
defective condition
④Overlap
fillet weld



④Overlap

fillet weld

(B32)Welding method(Visual inspection)

(B32)Welding method(Visual inspection)

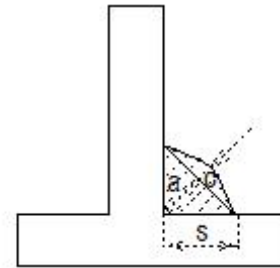
Welding method

Visual inspection

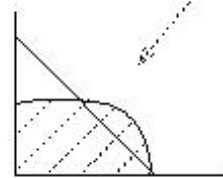
defective condition

⑤ Insufficient leg length (size)

fillet weld



a: Throat thickness
c: Reinforcement filler
s: size



⑤ Insufficient leg length (size)

fillet weld

(B33)Welding method(Visual inspection)

(B33)Welding method(Visual inspection)

Welding method

Visual inspection

defective condition

⑥Insufficient throat thickness

groove welding



⑥Insufficient throat thickness
groove welding

(B34)Welding method(Visual inspection)

(B34)Welding method(Visual inspection)

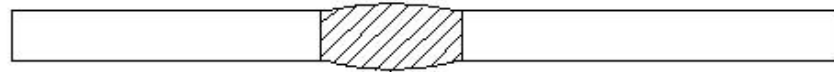
Welding method

Visual inspection

defective condition

⑦Excessive reinforcement

groove welding



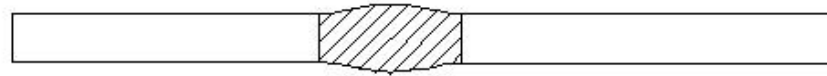
⑦Excessive reinforcement

groove welding

(B35)Welding method(Visual inspection)

(B35)Welding method(Visual inspection)

Welding method
Visual inspection
defective condition
⑧Undercut
groove welding

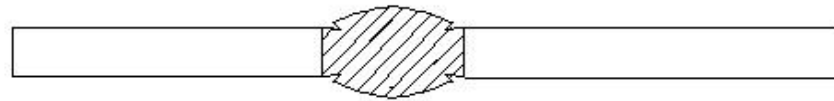


⑧Undercut
groove welding

(B36)Welding method(Visual inspection)

(B36)Welding method(Visual inspection)

Welding method
Visual inspection
defective condition
⑨Overlap
groove welding



⑨Overlap
groove welding

(B37) Bolted joint

(B37) Bolted joint

Bolted joint

Force is transmitted by friction force by pressing steel materials together with bolts.

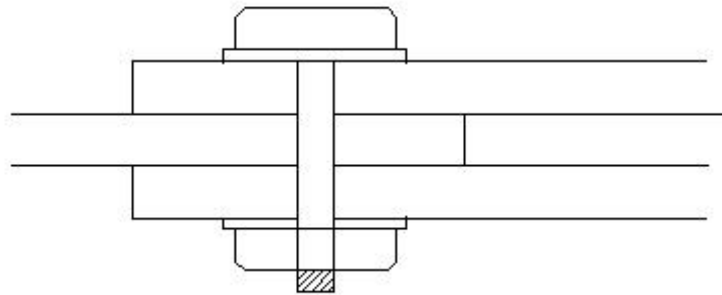
Bolt tightening force

• Processing of joint surfaces

① Oil-removal rough surface

② Painting-removal

③ Removal of rust, oil, and dirt

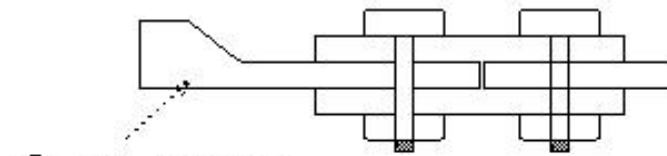


Bolted joint

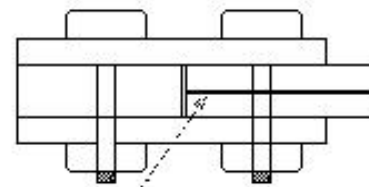
(B38) Bolted joint

(B38) Bolted joint

Bolted joint



① Add a taper



② Add filler

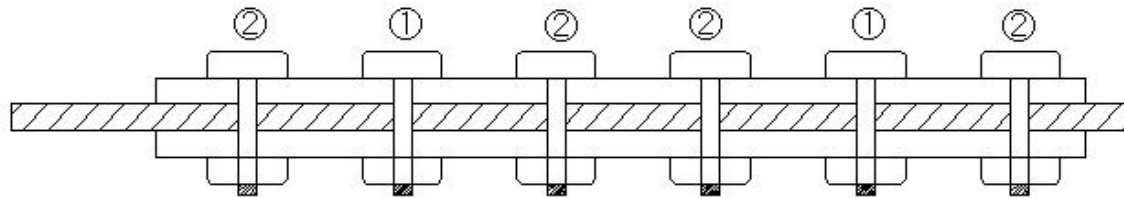
Bolted joint

(B39) Bolted joint

Bolted joint

Bolt tightening order
Center of bolt group
from center to edge

Combining welding and bolting
After welding is complete - Bolt connection



(B40) Bolted joint

(B40) Bolted joint

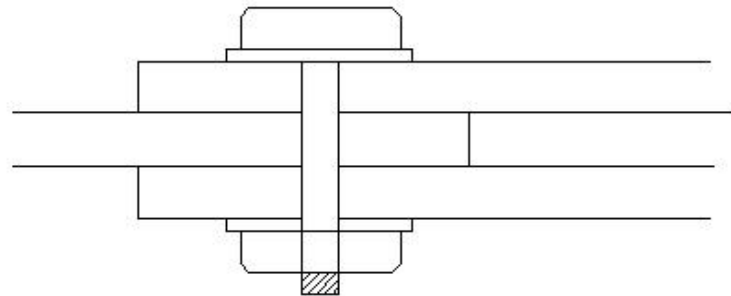
Bolted joint

How to tighten bolts

① Tighten twice

② Torque coefficient method: 10% increase in axial force

F8T F10T F11T



Bolted joint

(B41) Bolted joint

(B41) Bolted joint

Bolted joint

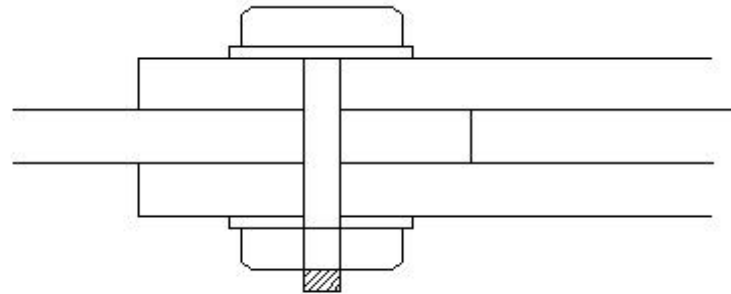
Bolt tightening

① Rotate the nut

② Use torque wrench

Torque and axial force: Verification: Torque method

③ Rotation method: Measuring the rotation angle of the nut



Bolted joint

(B42) Bolted joint

(B42) Bolted joint

Bolted joint

Bolt tightening inspection

① Rotation method: 100% inspection

Mark the starting position

Rotation speed - measurement

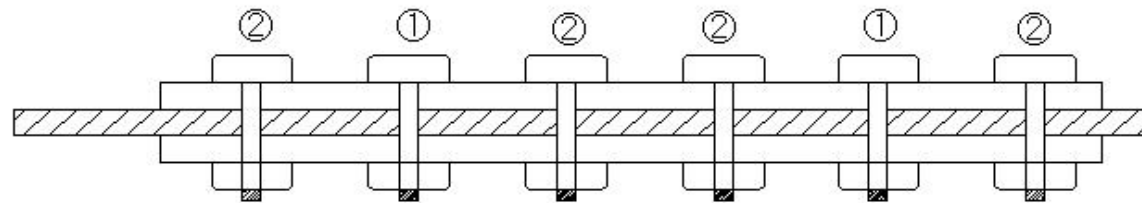
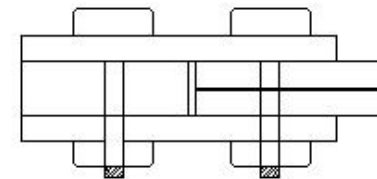
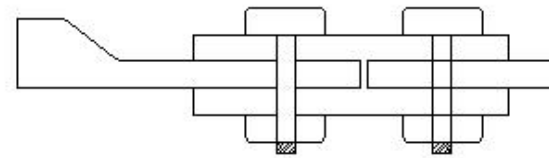
Visual inspection

② Torque method

Torque wrench nut - rotation - torque

③ Tightening inspection: Early on-site inspection

Number of inspection: 10% of each bolt group



Bolted joint

(B43)Rivet joint

(B43)Rivet joint

Rivet joint

19mm 22mm 25mm

Factory finish 10% more strength: Field finish

- ① Rivet material
SS400-SV330 used
Using SM490-SV400A

Rivet joint- points

- ① Uniformly heat the rivet to 900-1100°C
- ② Temporarily tighten bolt drift pin Do not remove it at once
- ③ Rivet length - appropriate
- ④ No cracks, rust, scratches, or peeling
- ⑤ Loose rivets - Re-driving after cooling is not possible
- ⑥ Defective rivet: Removal - gas cutting - tapping and removal



(B44)pressure welding

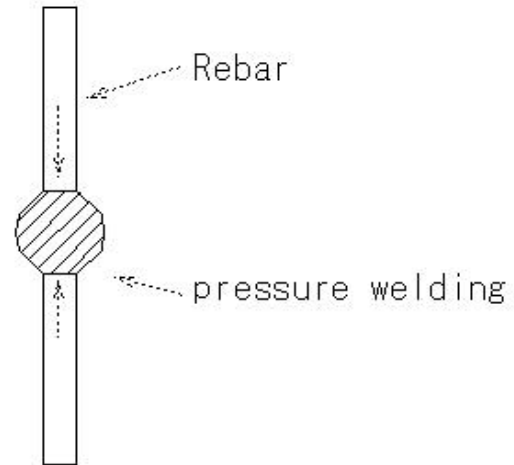
(B44)pressure welding

pressure welding

Rebar - Oxyacetylene flame - Heating

300kgf/cm²

Pressure - pressure welding

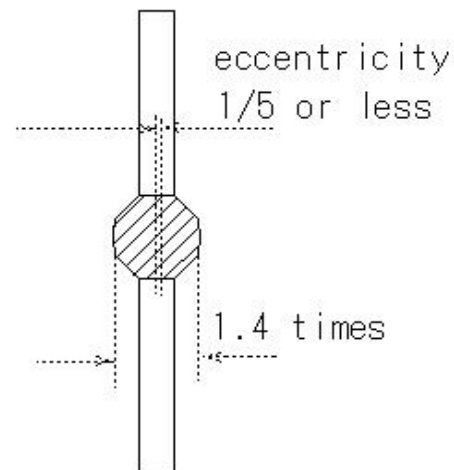


(B45)pressure welding

(B45)pressure welding

Points to note during pressure welding

- ① Amount of shrinkage of reinforcing bars due to pressure welding - Estimated amount
- ② Pressure contact surface - grinder finish
- ③ Pressure contact surface - flat finish
- ④ Pressure welding time: 19 mm - 1 minute, 29 mm - 2 minutes, 32 mm - 3 minutes
- ⑤ Pressure welding - eccentricity: reinforcing bar diameter $1/5$ or less
- ⑥ Pressure welding part bulge: 1.4 times or more the reinforcing bar diameter
- ⑦ Pressure welding part - no bends
- ⑧ 200 pressure welding points, 5 points pulled out - tensile test



(B46)Painting

(B46) Painting

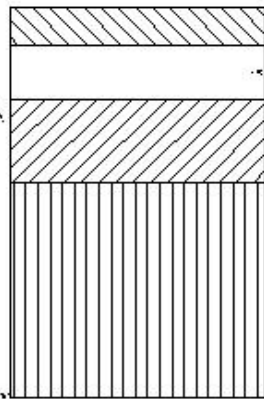
Antirust paint

Solvent Diluent

Pigment: Determines the color of the paint

Additives: Anti-flow agent, hardening agent, accelerator

Color : resin/oil - anti-corrosion material



(B47)Painting

(B47)Painting

Type of paint

- ①Etching primer (for undercoat)
- ②Zinc rich primer (for undercoat)
- ③Lead anti-rust paint (for undercoat)
- ④Lead-based anti-rust paint (for undercoat)
- ⑤Chlorinated rubber paint (for undercoat/topcoat)
- ⑥Epoxy resin paint (for intermediate coating/top coating)
- ⑦Tar epoxy resin paint (for top coating)
- ⑧MIO paint (for intermediate coating/top coating)
- ⑨Synthetic resin blend paint

(B48)Painting

(B48) Painting

Painting

Form of paint

Factory - spray type

On-site -Brush type

Example of painting in urban area
factory

- ①Primer
- ②Lead rust prevention type 1
- ③Lead rust prevention type 2

On-site

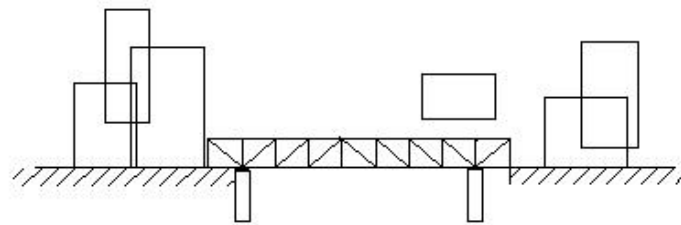
- ①Lead tan rust prevention type 2
- ②Synthetic resin formulation (intermediate coating)
- ③Synthetic resin formulation (top coating)

Painting example in the coastal industrial area
factory

- ①Zinc rich primer
- ②Chlorinated rubber base coat (1)
- ③Chlorinated rubber base coat (2)

On-site

- ①Chlorinated rubber intermediate coating
- ②Chlorinated rubber topcoat



urban area



coastal industrial area

(B49)Painting

(B49) Painting

Surface preparation

Steel structures - oxidation - weakens

Steel surface - Coating - Oxygen binding prevention - Painting

Steel surface - moisture, organic matter, dirt, rust

Before painting - Removal - Surface preparation

1st class, 2nd class, 3rd class, 4th class

Type 1: High degree of cleaning, high quality finish

(B50)Painting

(B50) Painting

Painting

Surface preparation

① Type 1: Newly constructed structure

Blasting method: Spraying fine sand/grains

Surface roughness: about 50S

- Original sheet blasting: Steel sheet before processing - blasting treatment
- Product blasting: Blasting on products
- Washing with phosphoric acid and hydrochloric acid, iron-cleaning

(B51)Painting

(B51)Painting

Painting

Surface preparation (clean)

②Type 2(clean) repainting

Wire wheel disc sander

Iron naked cleaning

③Type 3(clean)repainting

Wire wheel disc sander wire brush

Iron naked cleaning

④Type 4(clean) repainting

Wire brush sandpaper

Dirt removal

⑤Welding part(clean)

Welded area - alkaline

blasting treatment

Neutralizer treatment

grinder finish

(B52)Painting

(B52) Painting

Painting

factory paint

1 Points to note

① Temperature 5°C or more

At high temperatures - Paint film - Foam

② Humidity - 85% or less

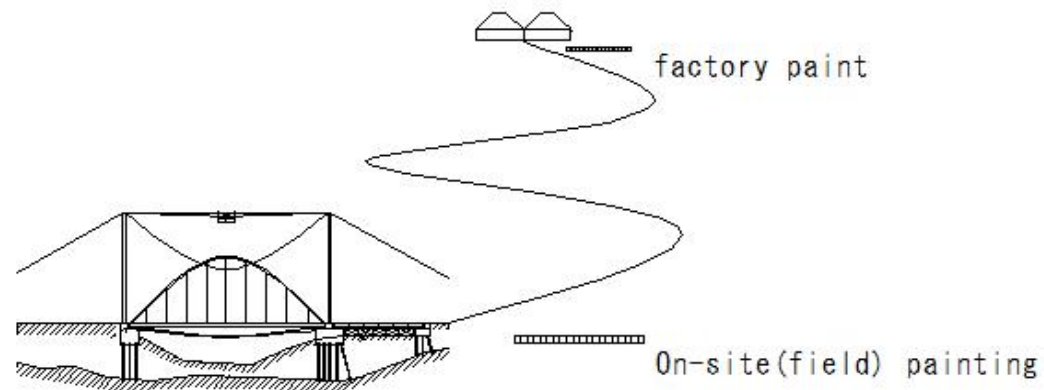
③ When it rains or snows - Canceled

④ Strong winds - canceled

⑤ Scorching sun - canceled

⑥ Lower layer paint - Appropriate drying Upper layer - Application Adhesion - Improve

⑦ Substrate preparation - Finished day - 1st layer - Paint - Application



(B53)Painting

(B53)Painting

Painting

factory paint

Points

2Special coating

Painting inside the box girder (sealed part)

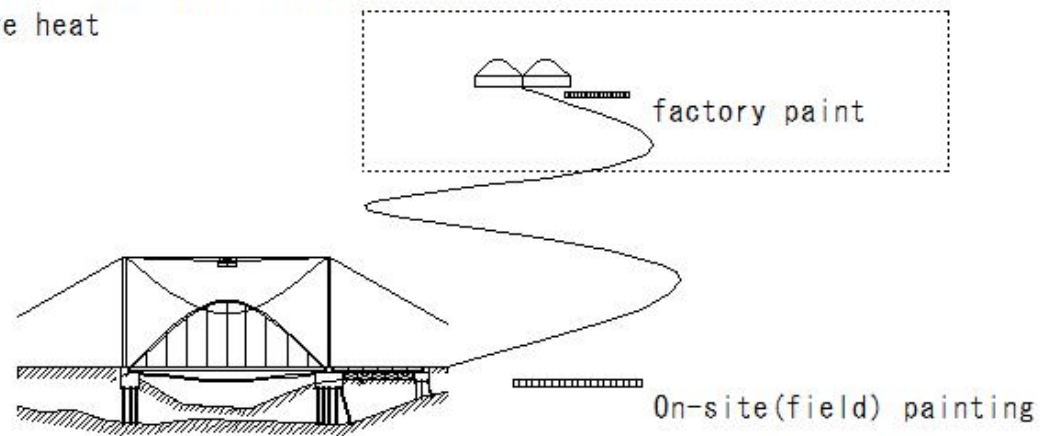
Ventilation/lighting equipment

Top coat

Tar epoxy resin: Rust prevention power - large - use

100°C or more - receive heat

Uses tar epoxy resin



(B54)Painting

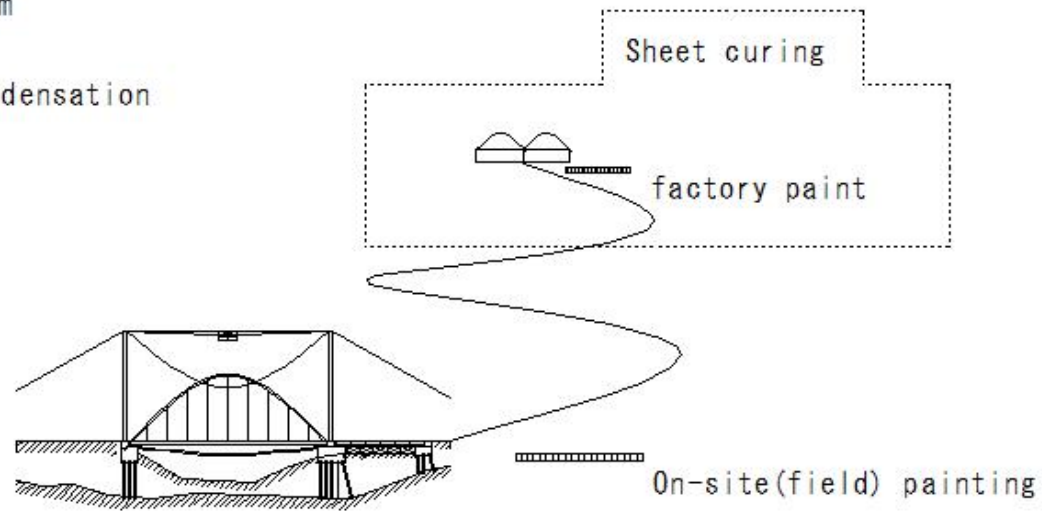
(B54) Painting

Painting

factory paint

3 Protection of paint film

- Sheet curing
- Prevention of dew condensation



(B55)Painting

(B55) Painting

Painting

factory paint

4 Parts not painted

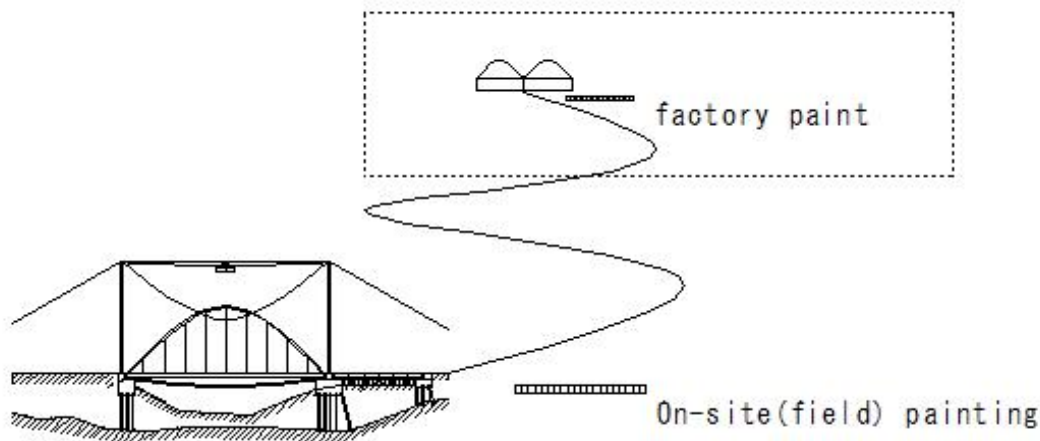
- ① Bonded part between steel and concrete
- ② Finished surface of bearing(Support)
- ③ Joint surface of high strength bolt
- ④ On-site welding surface: within 10cm outside (painted after welding is completed)

5 Surface preparation - Type 1

bearing(Support)



Bolt joint



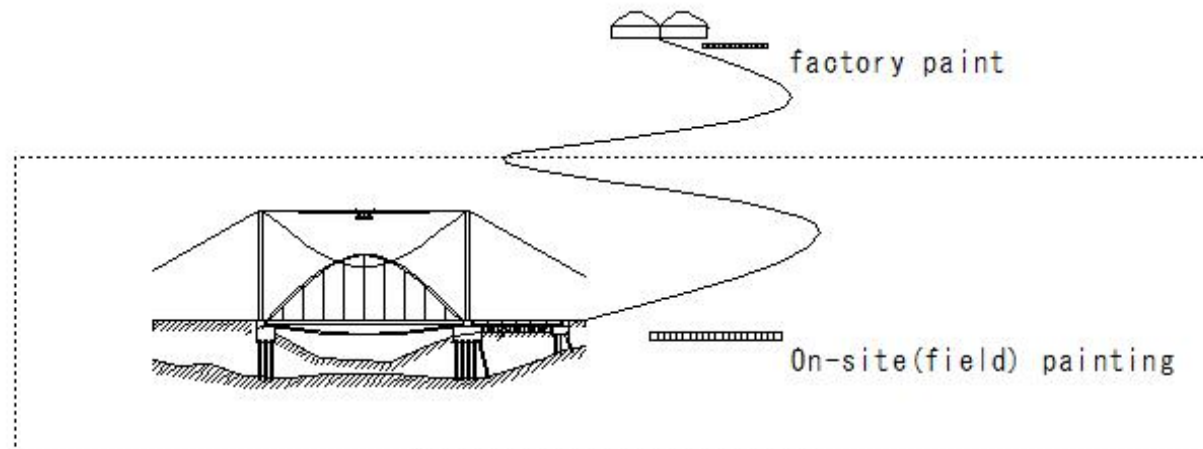
(B56)Painting

(B56) Painting

Painting

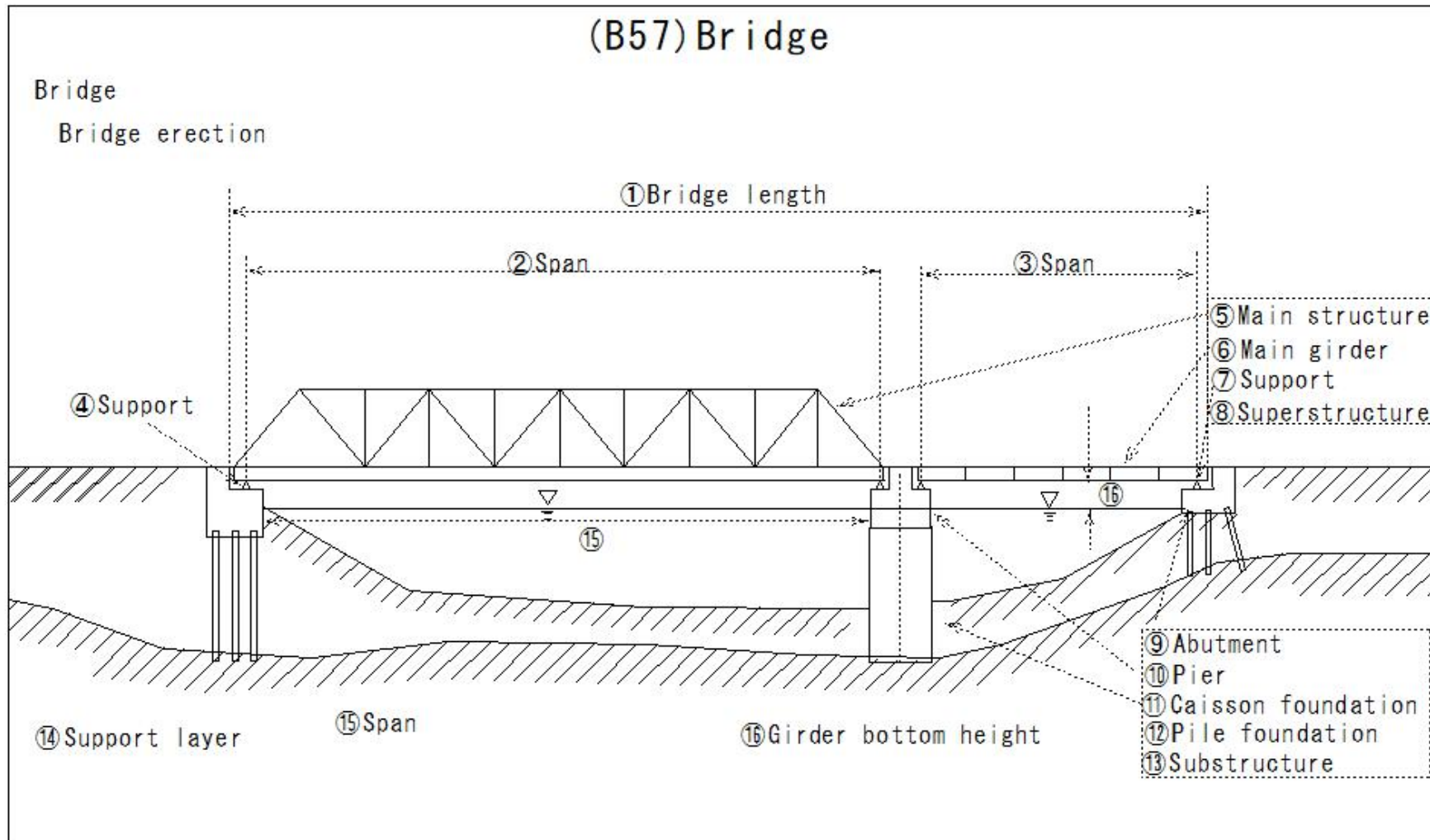
field painting

- ①Factory paint - peeling parts - same paint as factory
- ②On-site painting: Surface preparation - Type 4
- ③On-site: Repair painting - Undercoating - Intermediate coating - Top coating
- ④Paint - Manufacturing factory - On-site: Do not open the package



(B57)Bridge

(B57) Br idge

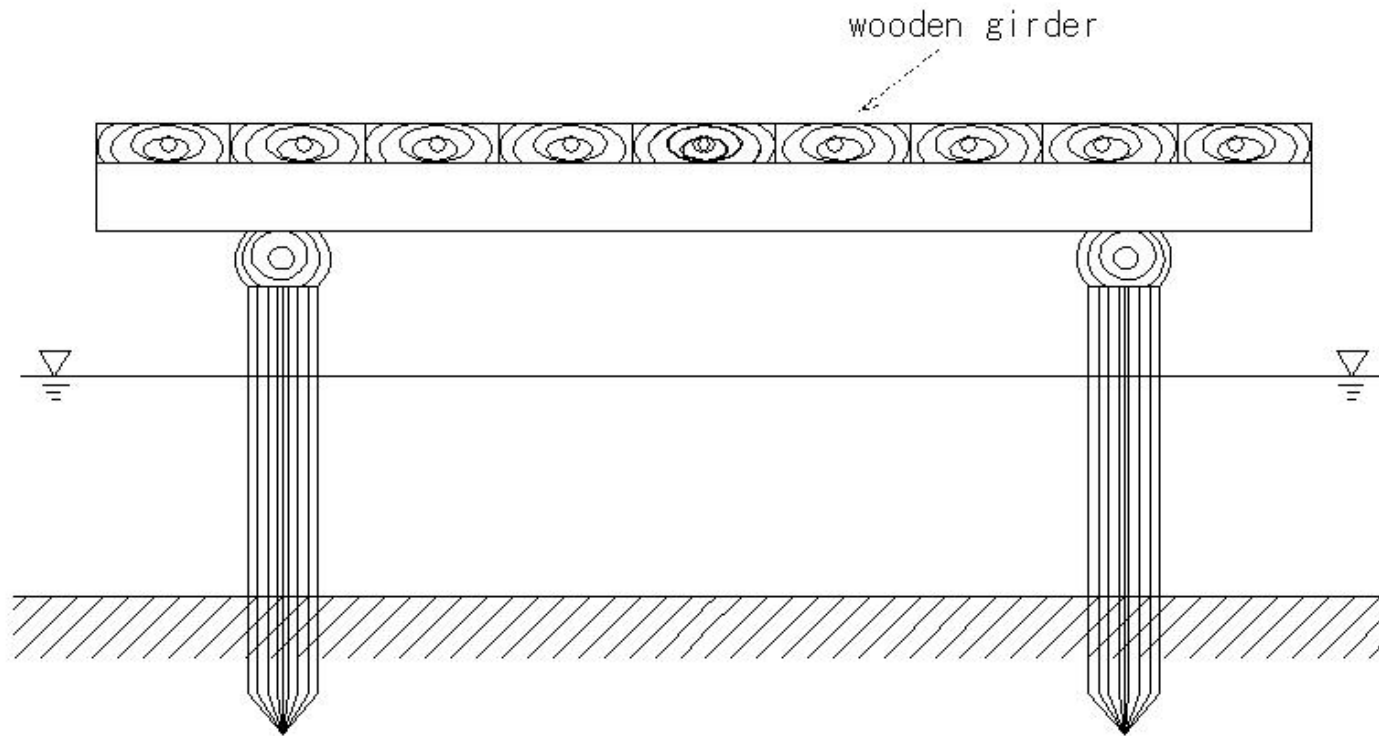


(B58)Bridge(Wooden bridge)

(B58) Bridge (Wooden bridge)

Bridge-Material-Classification

① Wooden bridge

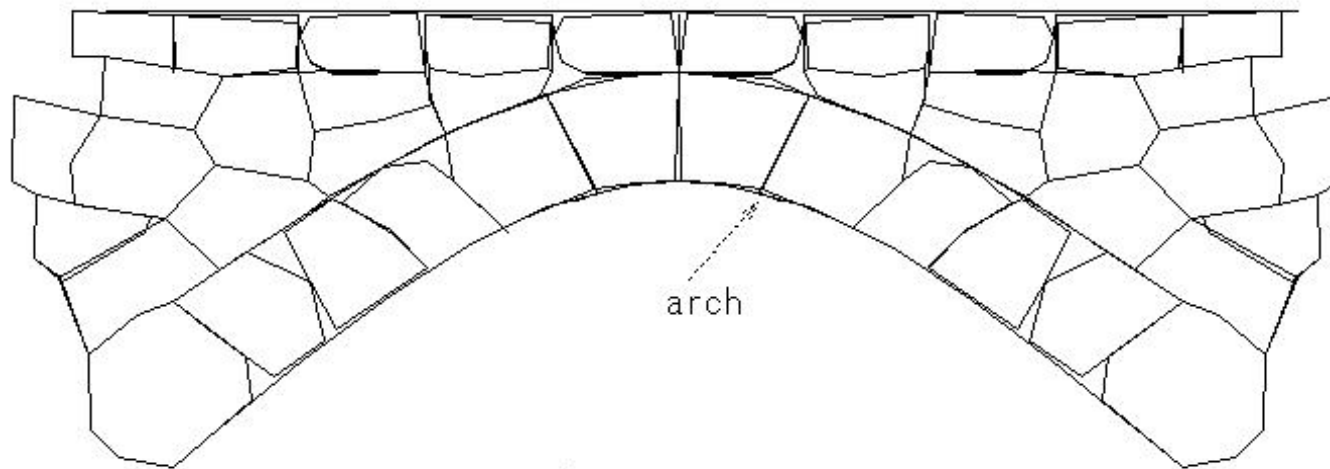


(B59)Bridge(Stone bridge)

(B59) Bridge (Stone bridge)

Bridge

Bridge-Material-Classification



arch

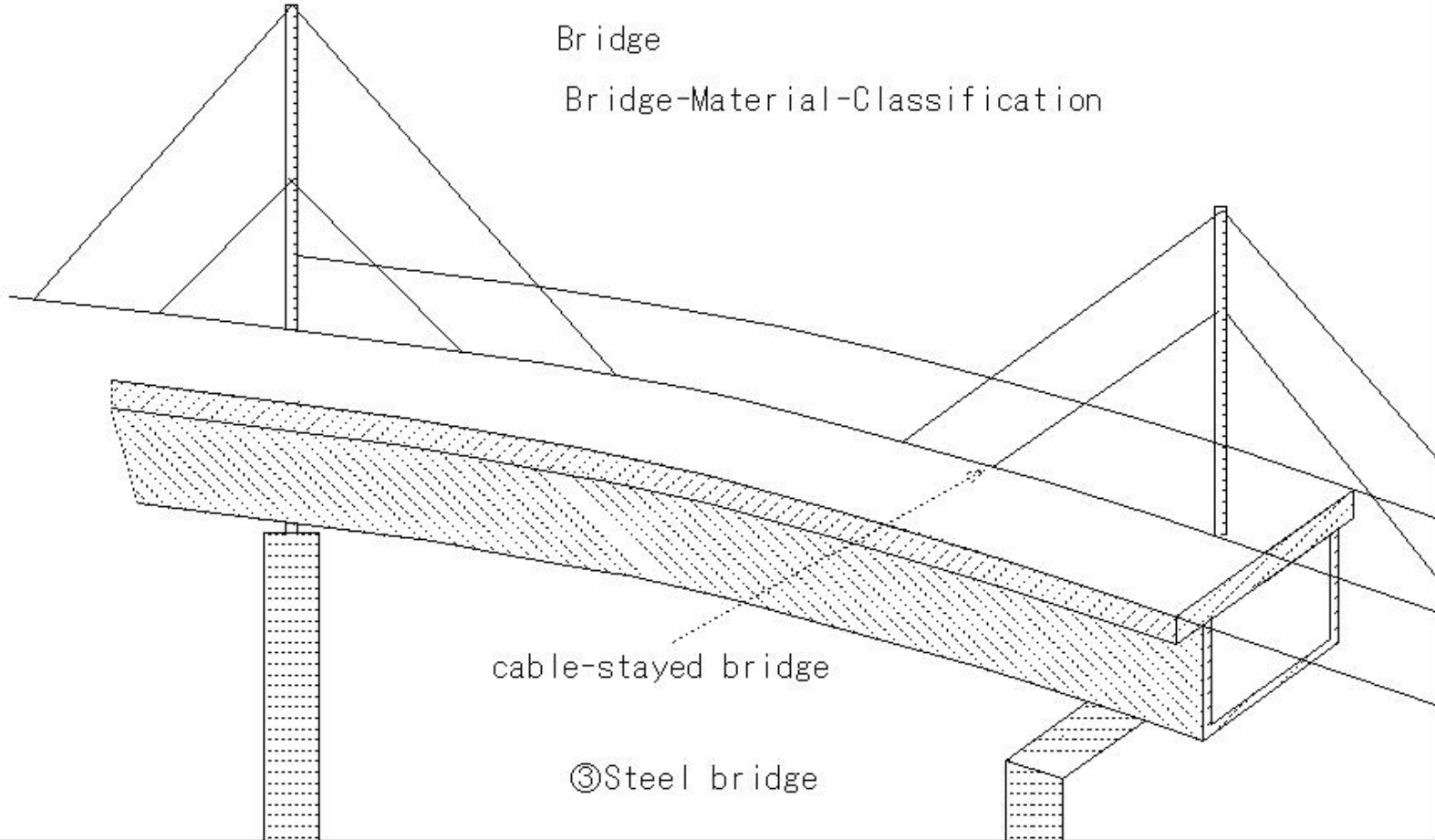
② Stone bridge

(B60)Bridge(Steel bridge)

(B60) Bridge (Steel bridge)

Bridge

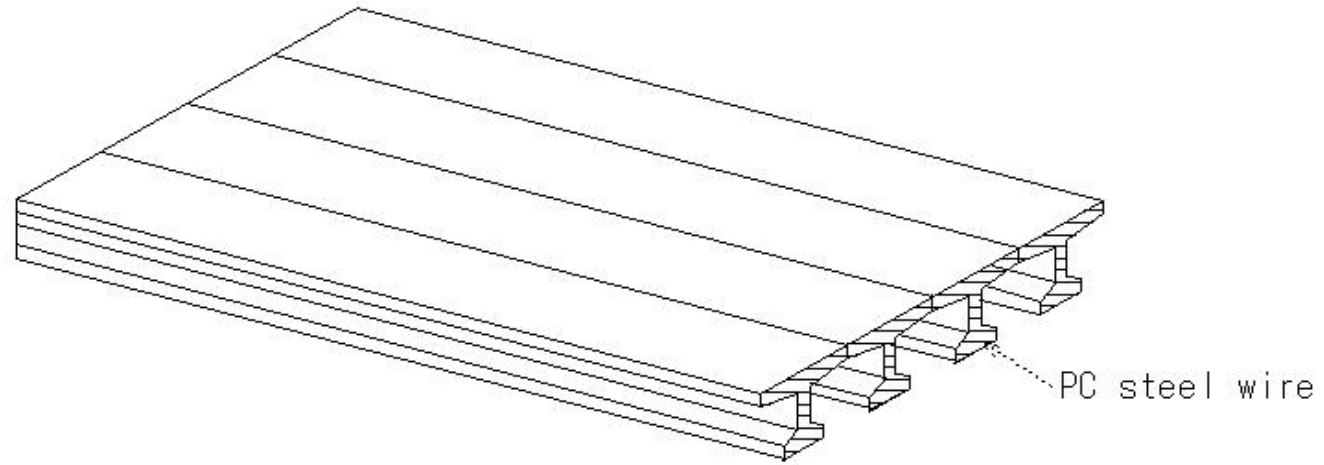
Bridge-Material-Classification



(B61)Bridge(PC concrete bridge)

(B61) Bridge (PC concrete bridge)

Bridge
Bridge-Material-Classification



④PC concrete bridge

(B62)Bridge(Girder bridge)

(B62) Bridge (Girder bridge)

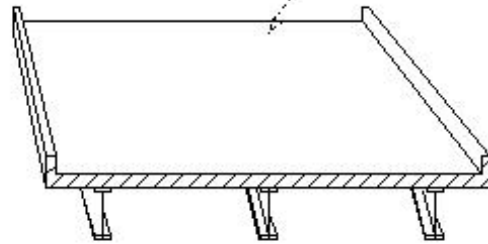
Bridge

Bridge-Structure-Classification

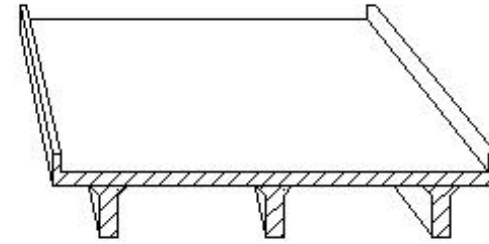
①Girder bridge

Bending moment resisting shear force

concrete floor slab



• Plate girder bridge



• T-shaped beam bridge

(B63)Bridge(Truss bridge)

(B63)Bridge(Truss bridge)

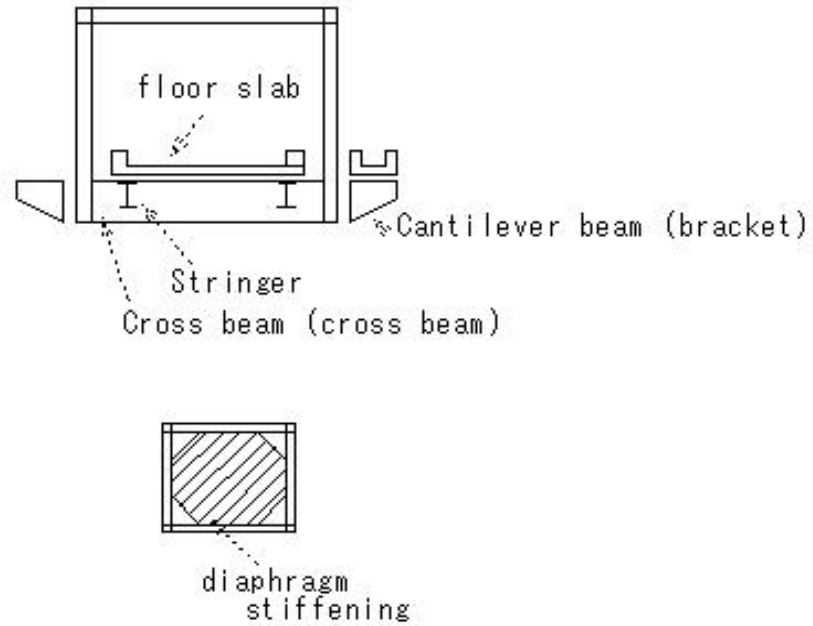
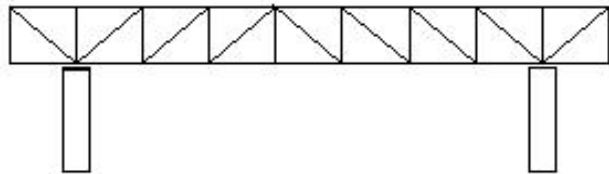
Bridge

Bridge-Structure-Classification

②Truss

resist axially

Truss bridge



(B64)Bridge(Rahmen bridge -rigid frame)

(B64) Bridge (Rahmen bridge -rigid frame)

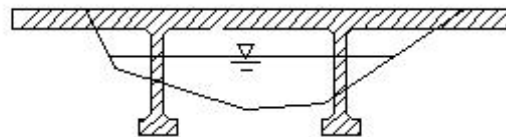
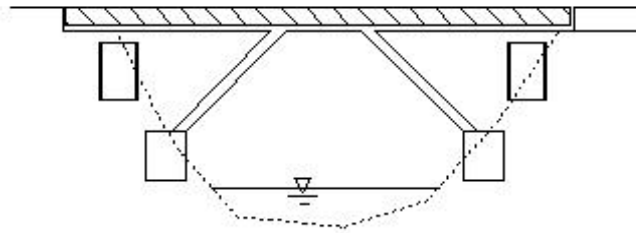
Bridge

Bridge-Structure-Classification

③Rahmen bridge rigid frame

resist bending moments

Rahmen bridge



(B65)Bridge(Arch bridge)

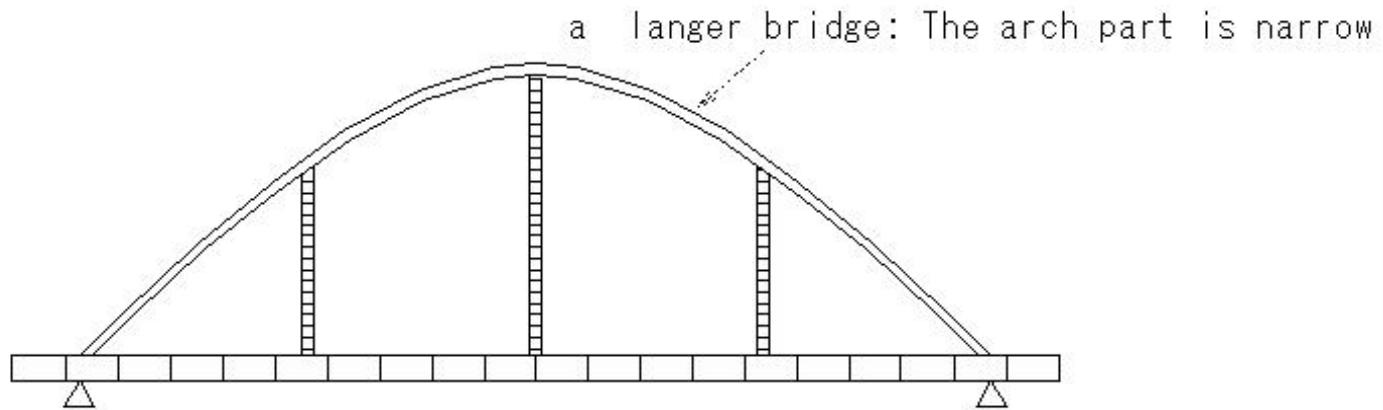
(B65) Bridge (Arch bridge)

Bridge

Bridge-Structure-Classification

④ Arch bridge

Resistance centered on the axial direction



a langer Bridge

(B66)Bridge(Arch bridge)

(B66) Bridge (Arch bridge)

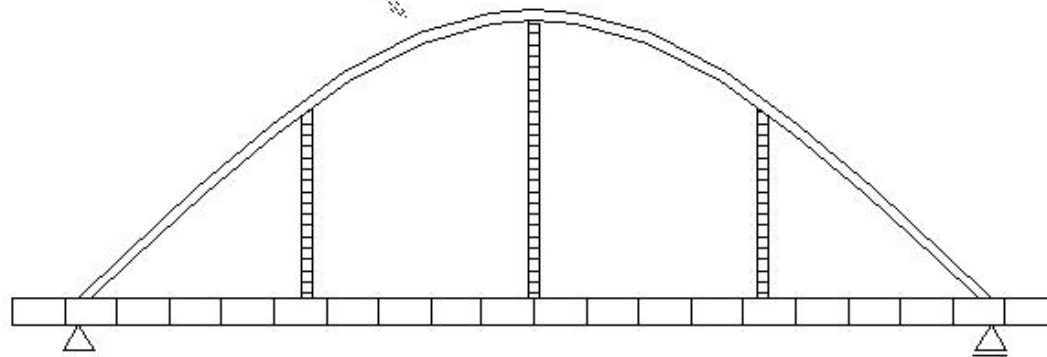
Bridge

Bridge-Structure-Classification

④ Arch bridge

Resistance centered on the axial direction

b Rose Bridge: The arch and beam parts are almost the same



b Rose Bridge

(B67)Bridge(Arch bridge)

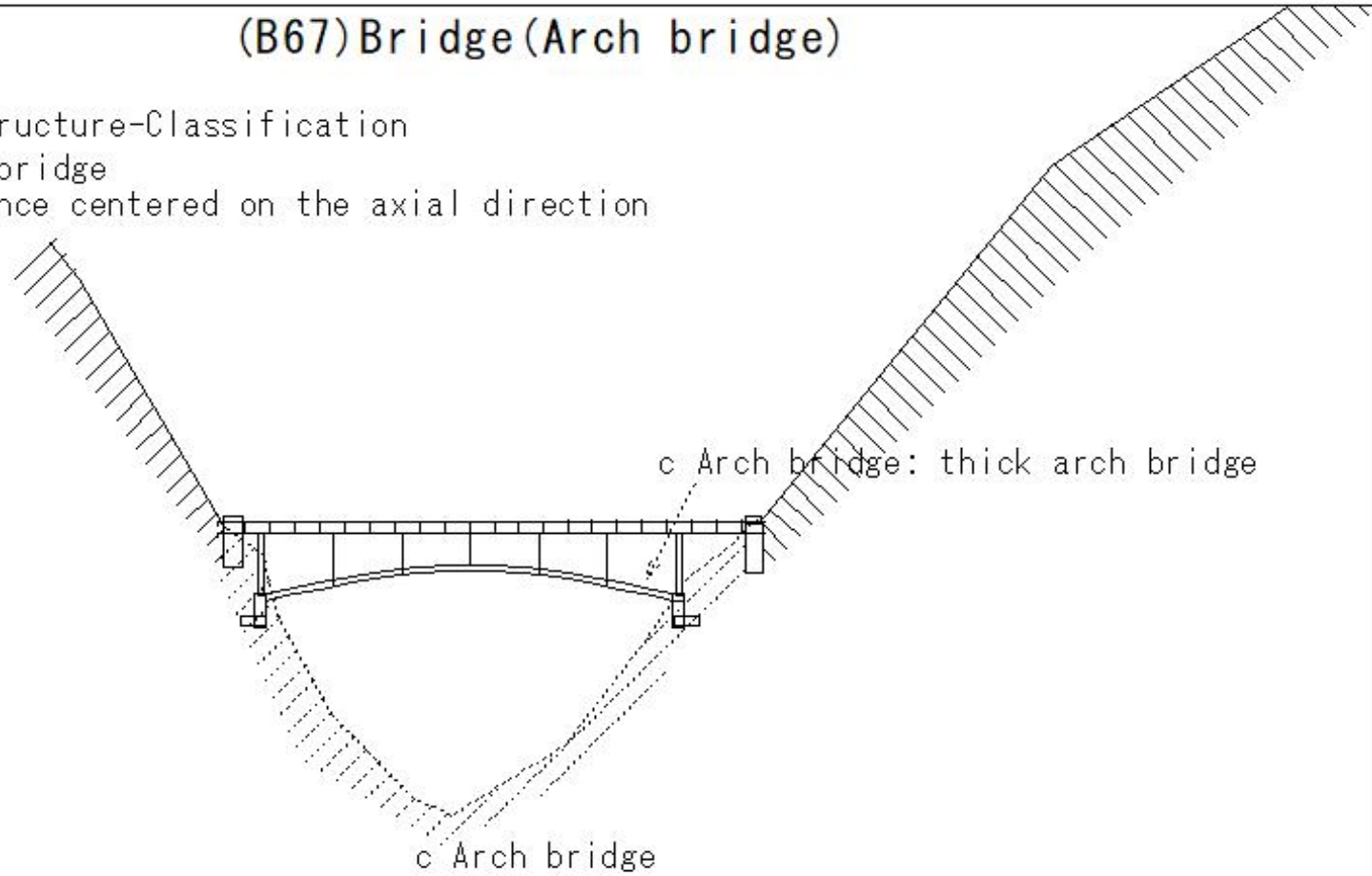
(B67)Bridge(Arch bridge)

Bridge

Bridge-Structure-Classification

④ Arch bridge

Resistance centered on the axial direction



(B68)Bridge(Arch bridge)

(B68) Br idge (Arch br idge)

d 3 hinge arch



(B69)Bridge(Arch bridge)

(B69) Bridge (Arch bridge)

e 2 hinge arch



(B70)Bridge(Arch bridge)

(B70) Br idge (Arch br idge)

f Fixed arch



(B71)Bridge(Steel bridge manufacturing procedure)

(B71)Bridge(Steel bridge manufacturing procedure)

Bridge

Steel bridge manufacturing procedure

①Original drawing/inking

②Processing

③Welding

④Temporary assembly

⑤Painting

⑥Transportation

⑦Erection

①Original drawing/inking

steel plate

steel tape measure on construction site

Tape alignment of steel tape measure

at manufacturing factory

original size scale

Full size drawing on the factory floor

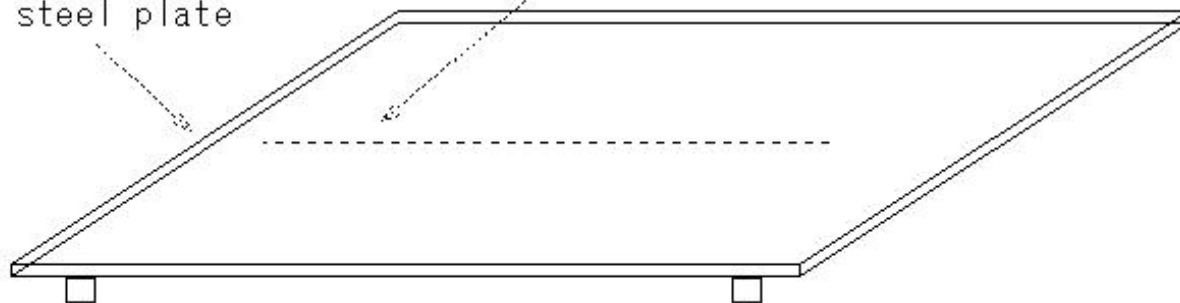
Dimension ruler template production

Move onto the steel plate

processing

①Original drawing/inking

steel plate



(B72)Bridge(Steel bridge manufacturing procedure)

(B72) Bridge (Steel bridge manufacturing procedure)

Bridge

Steel bridge manufacturing procedure

①Original drawing/inking

②Processing

③Welding

④Temporary assembly

⑤Painting

⑥Transportation

⑦Erection

②Processing

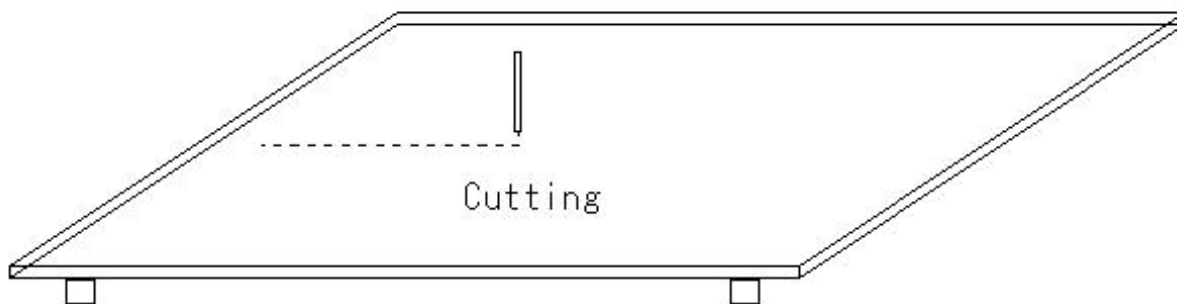
①Cutting

②Drilling

③Cutting

④Bending processing

②Processing



(B73)Bridge(Steel bridge manufacturing procedure)

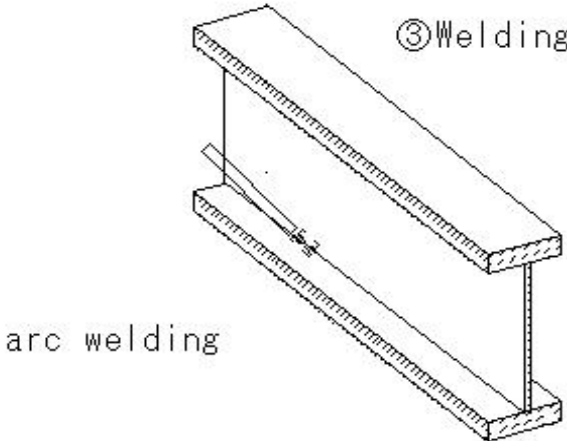
(B73)Bridge(Steel bridge manufacturing procedure)

Bridge

Steel bridge manufacturing procedure

- ①Original drawing/inking
- ②Processing
- ③Welding
- ④Temporary assembly
- ⑤Painting
- ⑥Transportation
- ⑦Erection

③Welding
arc welding



(B74)Bridge(Steel bridge manufacturing procedure)

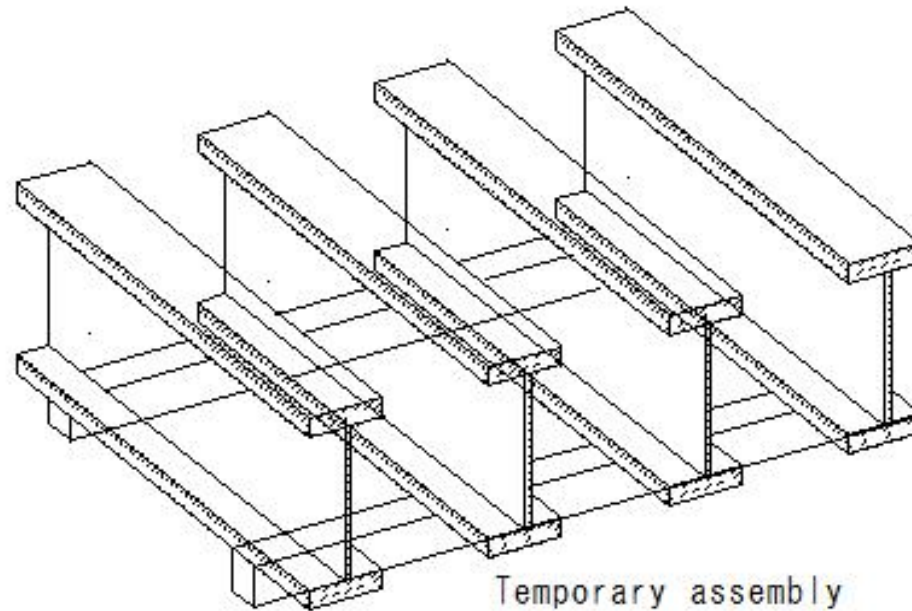
(B74)Bridge(Steel bridge manufacturing procedure)

Bridge

Steel bridge manufacturing procedure

- ① Original drawing/inking
- ② Processing
- ③ Welding
- ④ Temporary assembly
- ⑤ Painting
- ⑥ Transportation
- ⑦ Erection

④ Temporary assembly



(B75)Bridge(Steel bridge manufacturing procedure)

(B75) Bridge (Steel bridge manufacturing procedure)

Bridge

Steel bridge manufacturing procedure

①Original drawing/inking

②Processing

③Welding

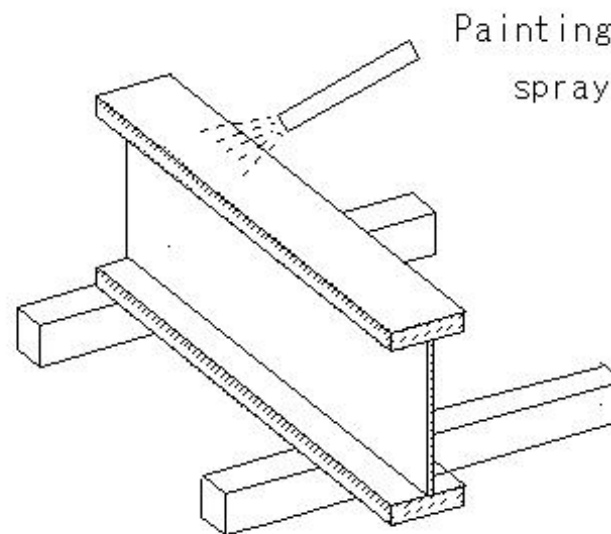
④Temporary assembly

⑤Painting

⑥Transportation

⑦Erection

⑤Painting



(B76)Bridge(Steel bridge manufacturing procedure)

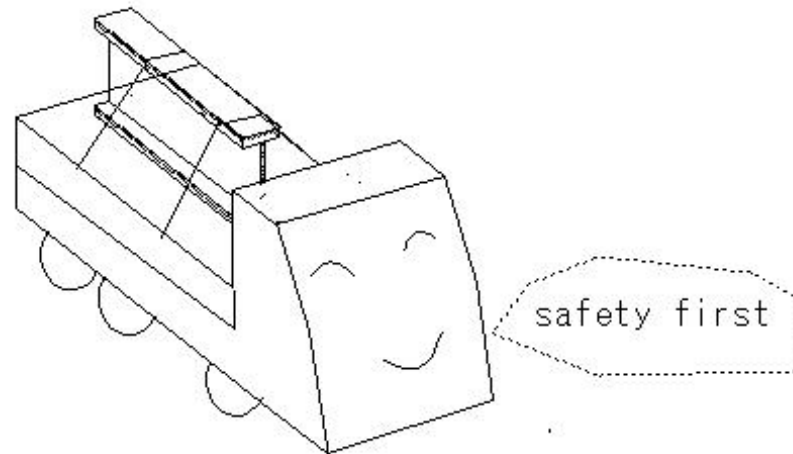
(B76) Bridge (Steel bridge manufacturing procedure)

Bridge

Steel bridge manufacturing procedure

- ①Original drawing/inking
- ②Processing
- ③Welding
- ④Temporary assembly
- ⑤Painting
- ⑥Transportation
- ⑦Erection

⑥Transportation



truck transportation

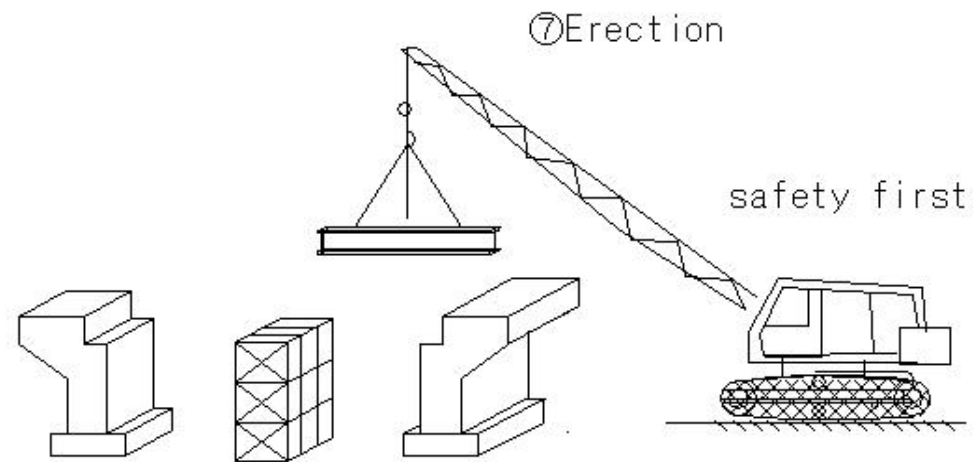
(B77)Bridge(Steel bridge manufacturing procedure)

(B77)Bridge(Steel bridge manufacturing procedure)

Bridge

Steel bridge manufacturing procedure

- ①Original drawing/inking
- ②Processing
- ③Welding
- ④Temporary assembly
- ⑤Painting
- ⑥Transportation
- ⑦Erection

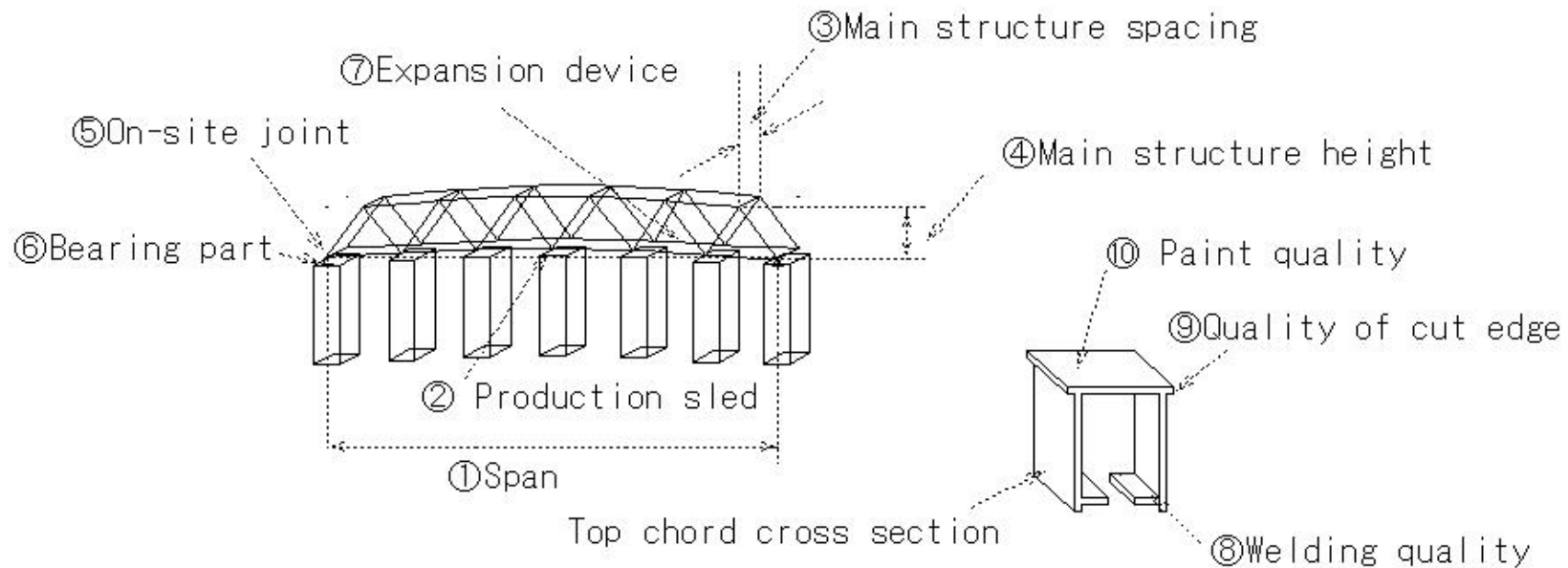


(B78)Bridge(Temporary assembly inspection of steel bridges)

(B78) Bridge (Temporary assembly inspection of steel bridges)

Bridge

Temporary assembly inspection of steel bridges



Temporary assembly: stress-free state

(B79)Bridge(Steel bridge erection)

(B79)Bridge(Steel bridge erection)

Bridge

Steel bridge erection

- ① Truck crane type Used - the span is short
- ② Scaffolding type (staging)
- ③ Cable type - used for long single span bridges
- ④ Cantilever type
- ⑤ Pull-out type
- ⑥ Erection truss type
- ⑦ Large block type erection

(B80)Bridge(Steel bridge erection)

(B80) Bridge (Steel bridge erection)

Bridge

Steel bridge erection

① Truck crane type erection

Used -the span is short

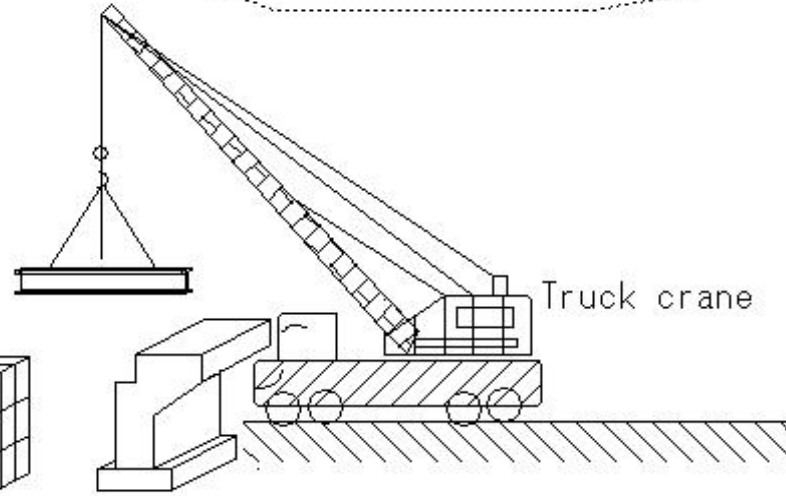
Erection location -no restrictions

Construction period -short

Economic



your family is waiting you



safety first



Erection

Truck crane

(B81)Bridge(Steel bridge erection)

(B81)Bridge(Steel bridge erection)

Bridge

Steel bridge erection

②Scaffolding type (staging)

Abutment Middle part of the pier

Erection location - no restrictions

Self-propelled crane/floating crane (water)

advantage

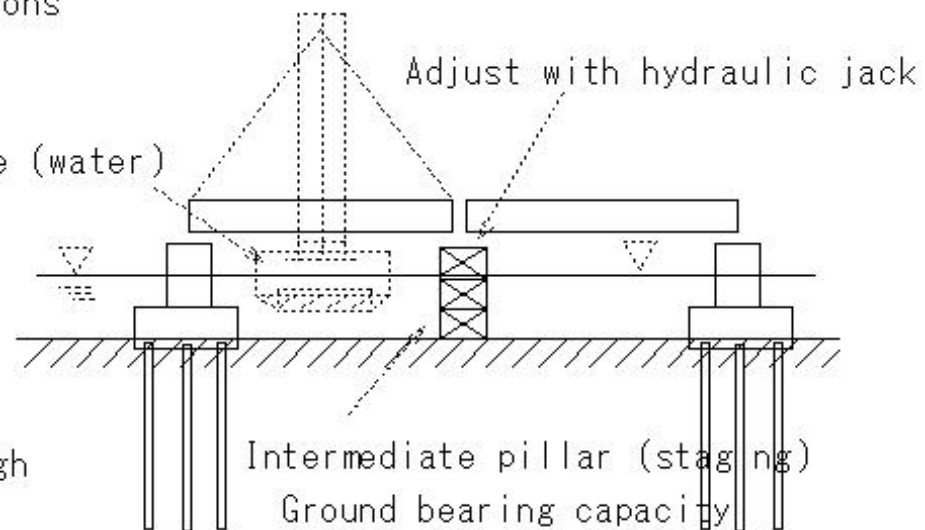
- Easy to manage
- Erection without stress

disadvantage

- Below the digits - Can't get high

Scope of application - wide

- Indeterminate burr
- Curved bridge



②Scaffolding type (staging)

(B82)Bridge(Steel bridge erection)

(B82) Bridge (Steel bridge erection)

Bridge

Steel bridge erection

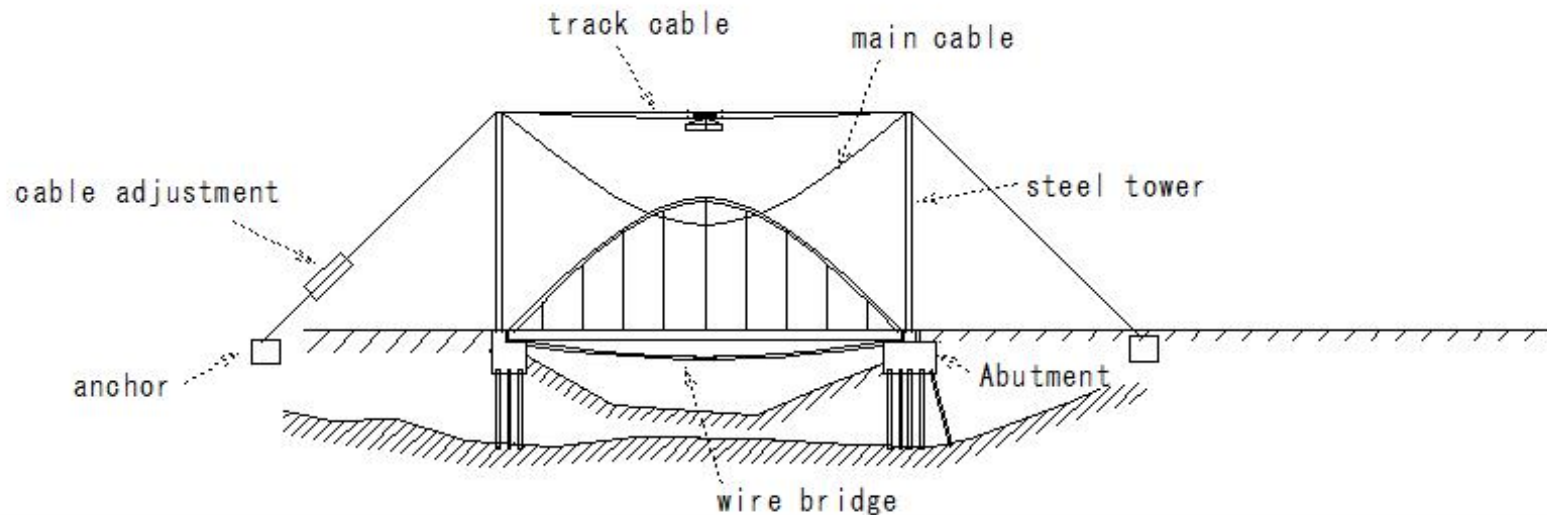
- ③Cable erection construction method
- Hanging cable construction method

Disadvantage

- Difficult to adjust camber
- Temporary equipment - large
- Difficulty in erection
- Construction period - long

Advantage

- Stress-free erection
- Scaffolding - not required



(B83)Bridge(Steel bridge erection)

(B83) Bridge (Steel bridge erection)

③Cable erection construction method

Diagonal hanging cable construction method

Bridge
Steel bridge erection

Scope of application - wide

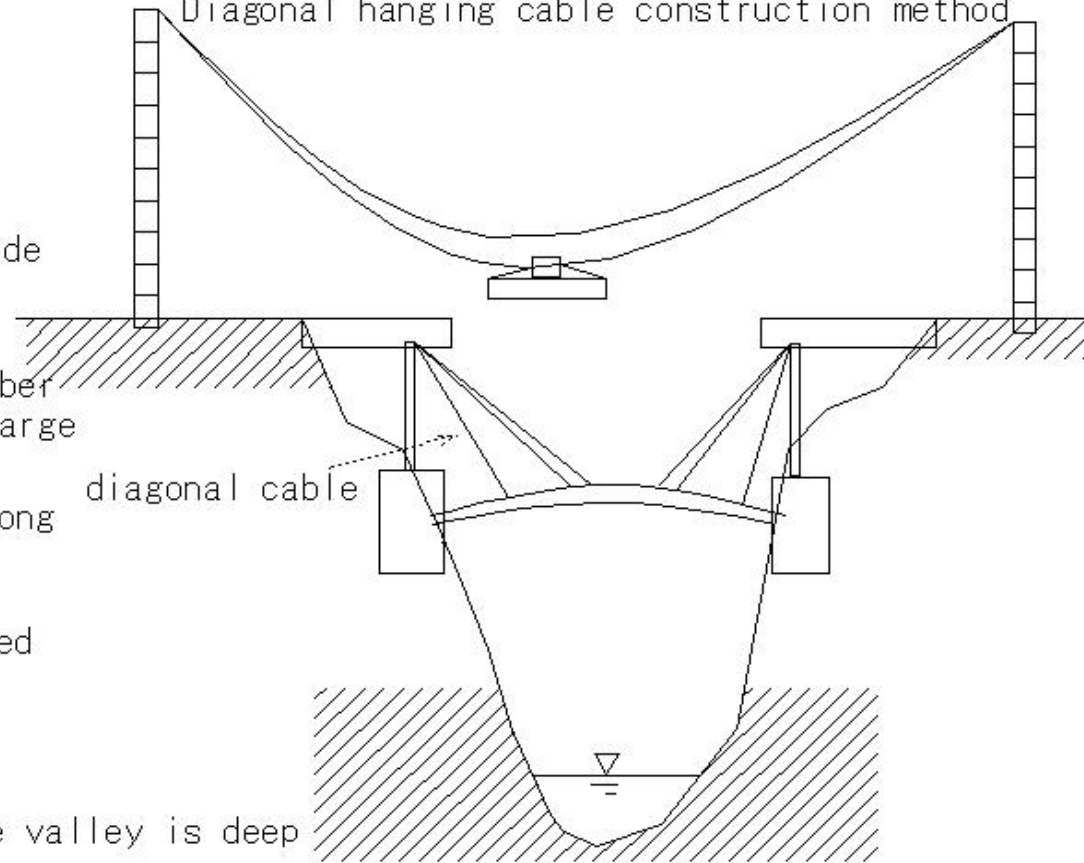
- Long span

Disadvantage

- Difficult to adjust camber
- Temporary equipment - large
- Difficulty in erection
- Construction period - long

advantage

- Stress-free erection
- Scaffolding -not required



Good -the valley is deep

(B84)Bridge(Steel bridge erection)

(B84) Bridge (Steel bridge erection)

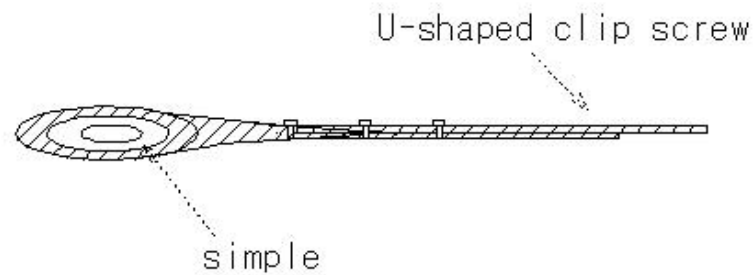
Bridge

Steel bridge erection

Erection cable

Points

- ① Do not use kinked products.
- ② New wire: Apply load to remove stretching
- ③ Wire rope: terminal treatment
the longer rope



(B85)Bridge(Steel bridge erection)

(B85) Bridge (Steel bridge erection)

Bridge

Steel bridge erection

④Cantilever construction method

advantage

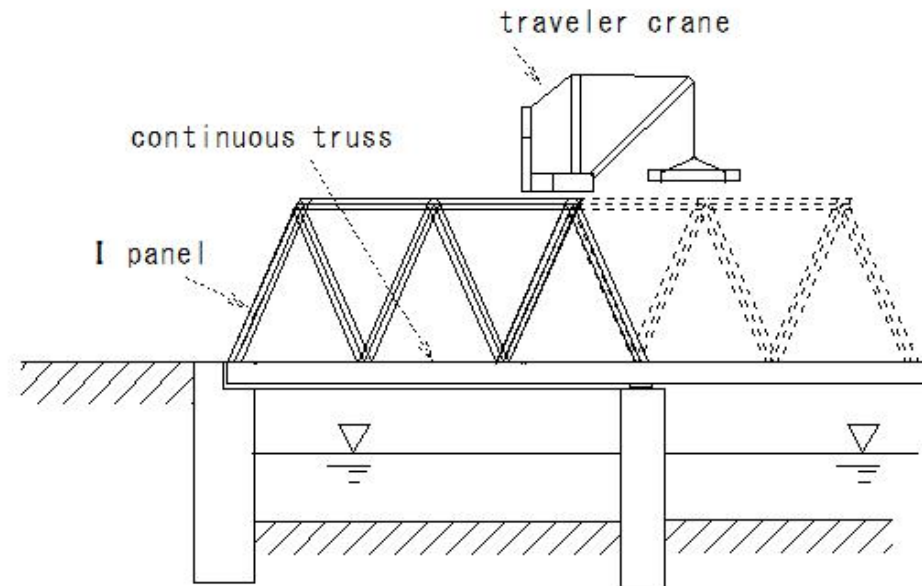
- No scaffolding required
- Temporary equipment - small

disadvantage

- Erection stress - large
- Experience - required

Application

- Continuous truss
- Simple truss
- Continuous boxing



④Cantilever construction method

(B86)Bridge(Steel bridge erection)

(B86)Bridge(Steel bridge erection)

Bridge

Steel bridge erection

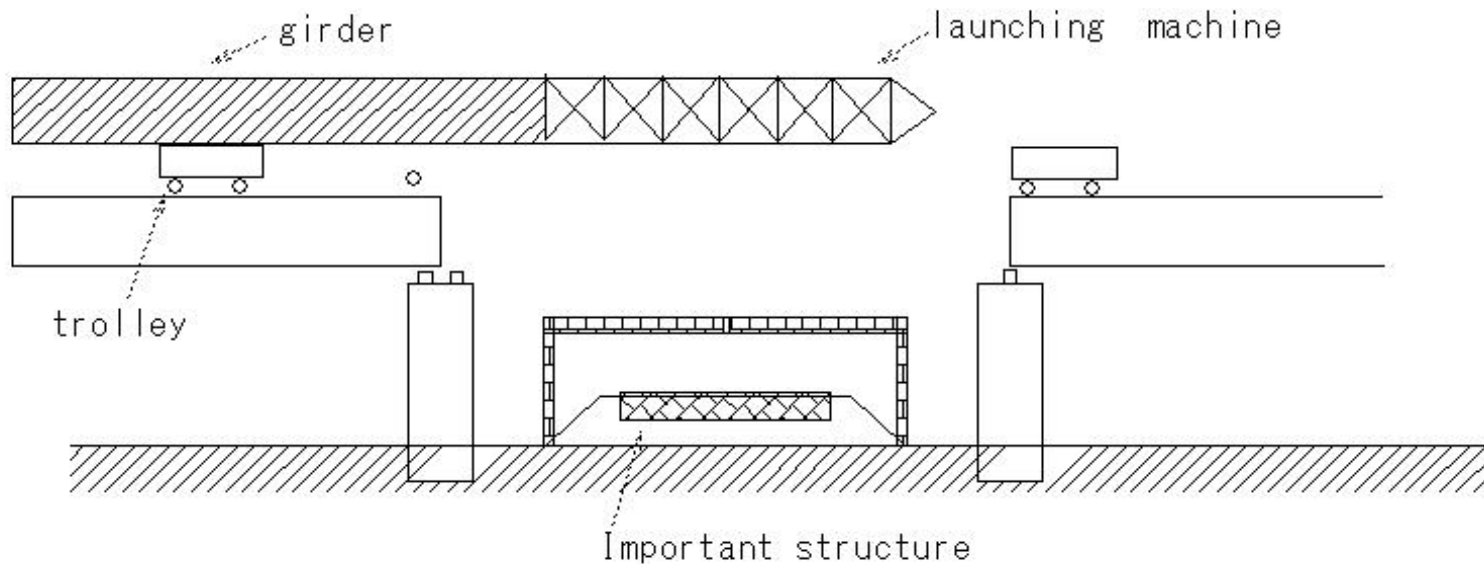
Scaffolding - unnecessary

Erection structure - limitations

straight bridge

⑤ Pull-out construction method

launching erection



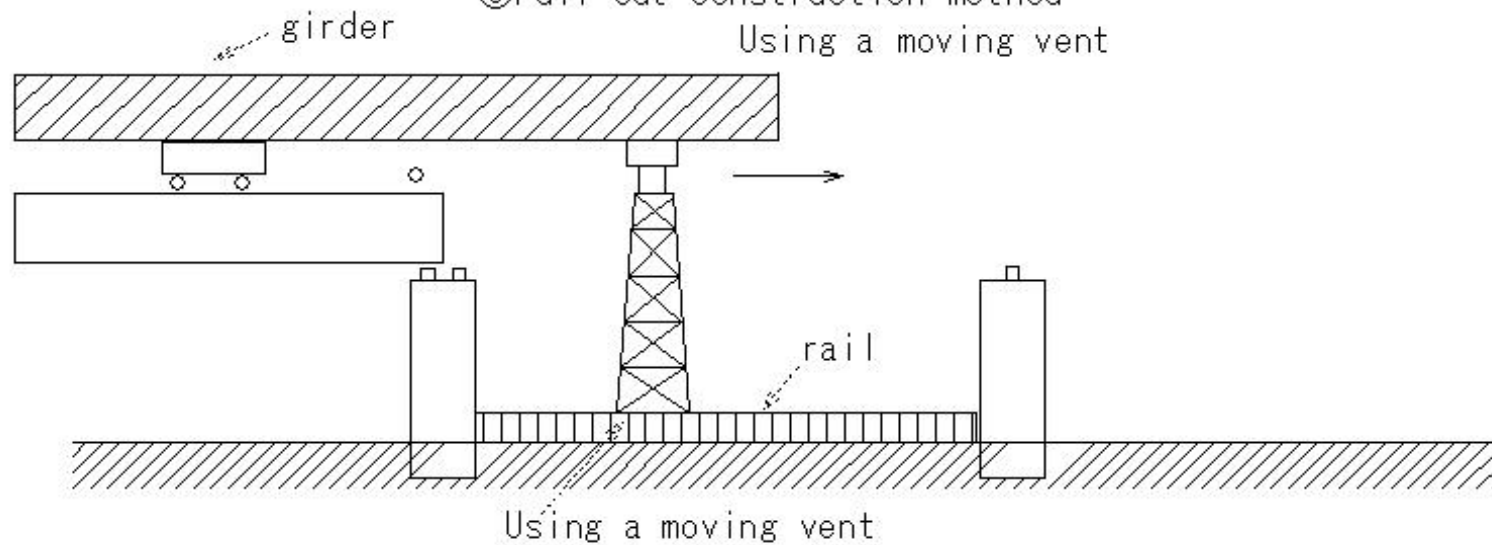
(B87) Bridge (Steel bridge erection)

(B87) Bridge (Steel bridge erection)

Bridge
Steel bridge erection

Construction period - short
Scaffolding - unnecessary
Erection structure - limitations
straight bridge

⑤ Pull-out construction method
Using a moving vent

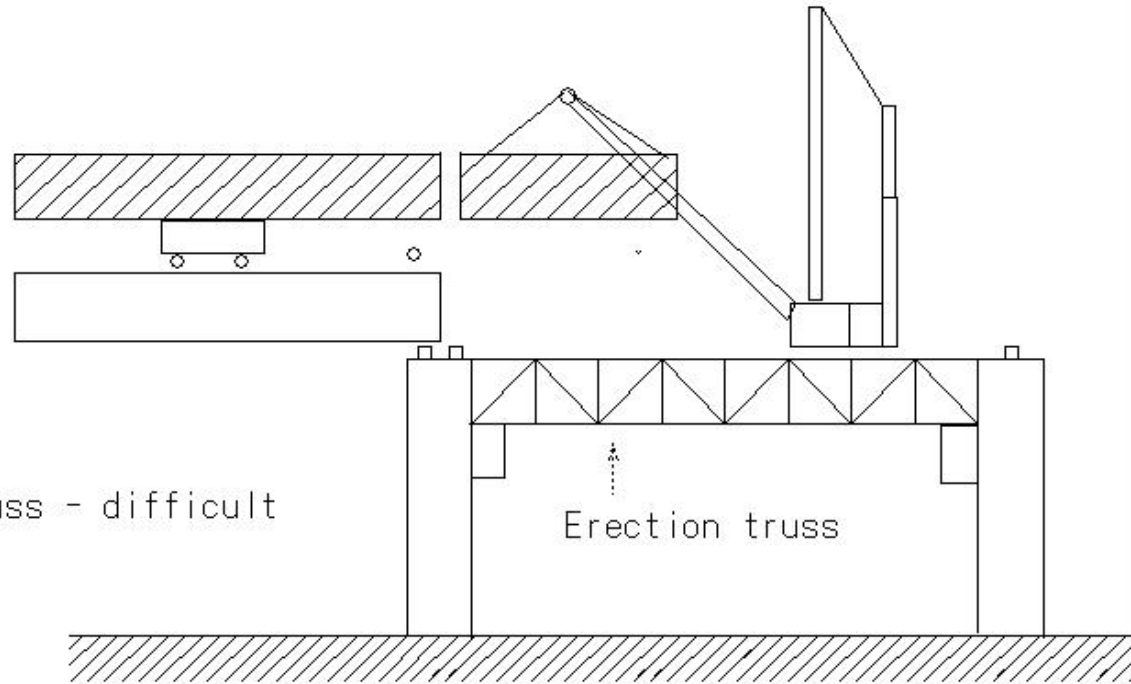


(B88) Bridge (Steel bridge erection)

(B88) Bridge (Steel bridge erection)

Bridge
Steel bridge erection

Ⓒ Erection truss type
Erection truss



- No scaffolding required
- Removal of the erected truss - difficult

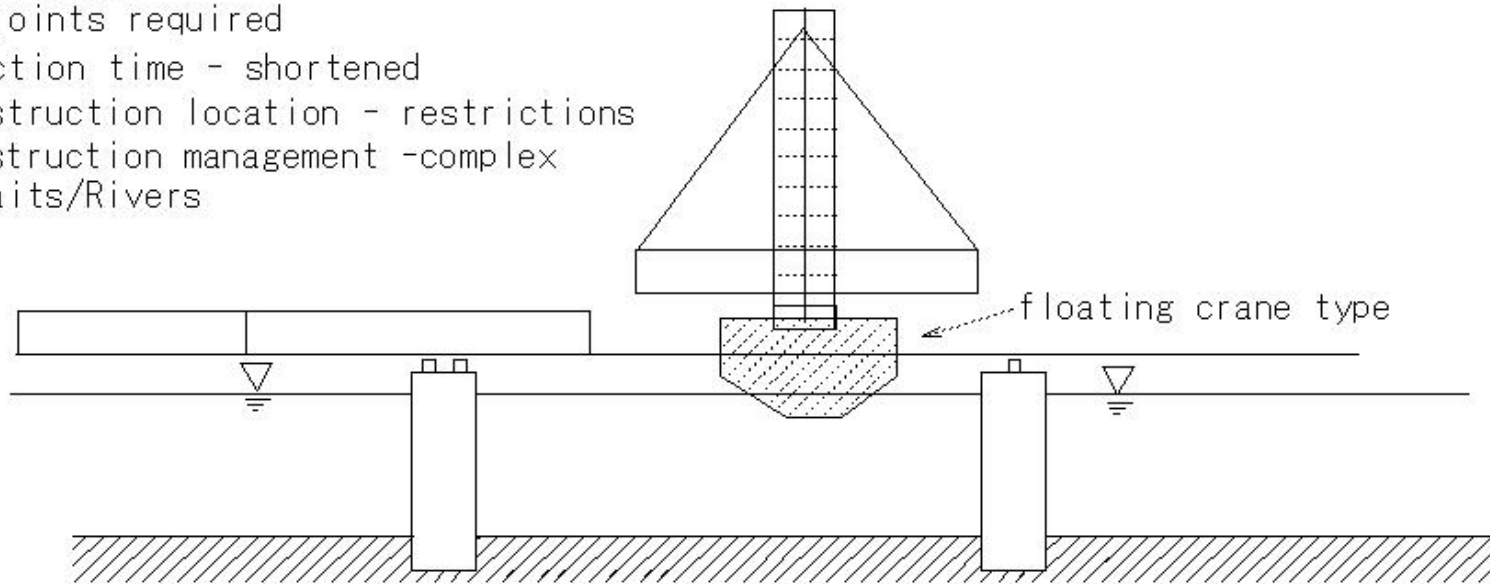
(B89)Bridge(Steel bridge erection)

(B89) Bridge (Steel bridge erection)

Bridge
Steel bridge erection

- long span
bulk lifting
- No joints required
 - Erection time - shortened
 - Construction location - restrictions
 - Construction management -complex
 - Straits/Rivers

⑦ Large block type erection
floating crane type



(B90)Bridge(Steel bridge erection)

(B90)Bridge(Steel bridge erection)

Bridge

Steel bridge erection

⑦Large block type erection

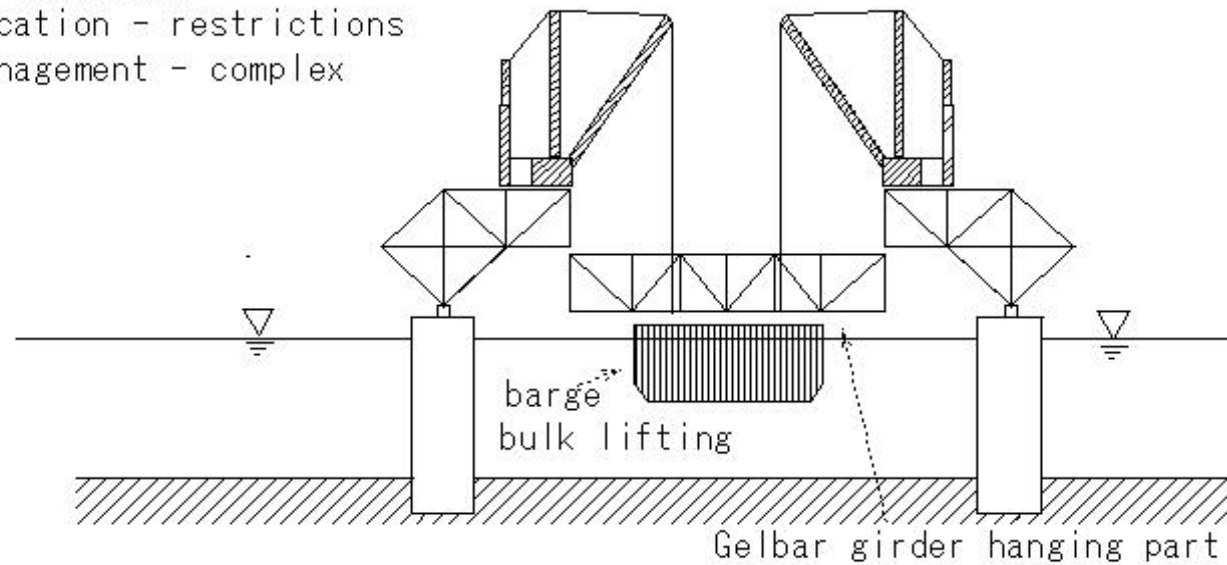
long span

bulk lifting

- No joints required
- Erection time - shortened
- Construction location - restrictions
- Construction management - complex
- Straits/Rivers

⑦Large block type erection

Bulk lifting type

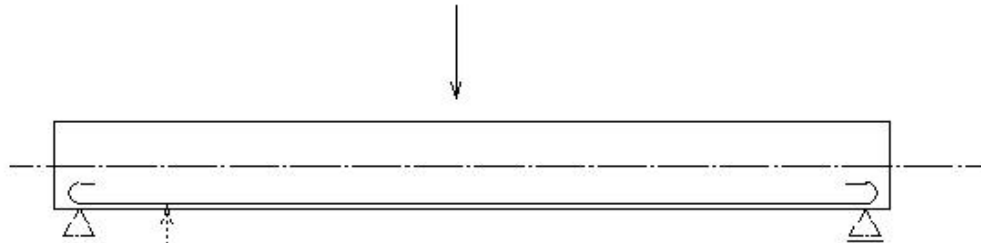


(B91)Bridge(RC structure)

(B91) Bridge (RC structure)

RC structure

- Concrete - cannot resist tensile force



- Tensile force - part receiving - reinforcing bar arrangement

(B92)prestressed concrete(PC structure)

(B92)prestressed concrete(PC structure)

prestressed concrete

Full prestressed concrete

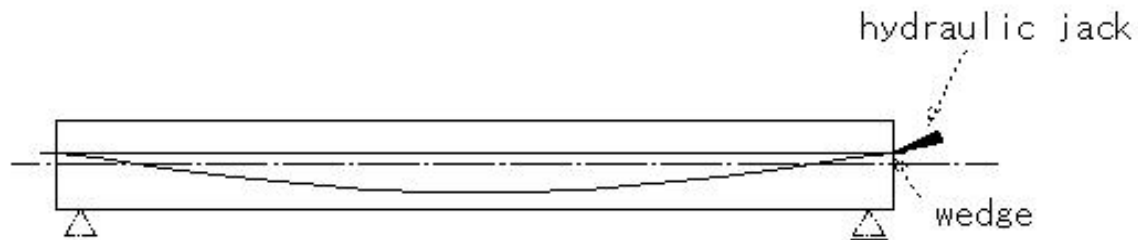
Compressive force is provided by PC steel material

Acting pulling force - cancel out

Prestressed concrete: PC

PC structure

Full prestressed concrete



Put the PC steel wire on the pulling side

Pull - Wedge - Introduce compressive force

Tensile force: All received by prestress

(B93)prestressed concrete(PC structure)

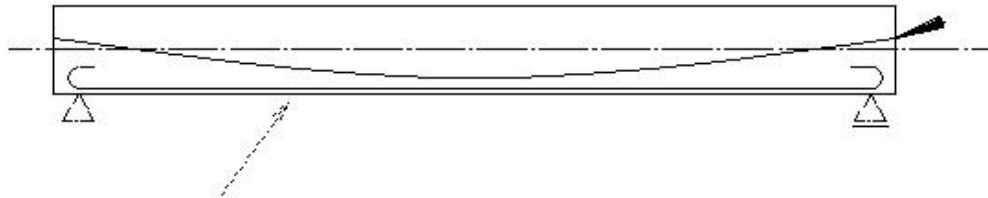
(B93)prestressed concrete(PC structure)

prestressed concrete

PC structure

Part of the tensile force is borne by the reinforcing steel

Partial prestressed concrete



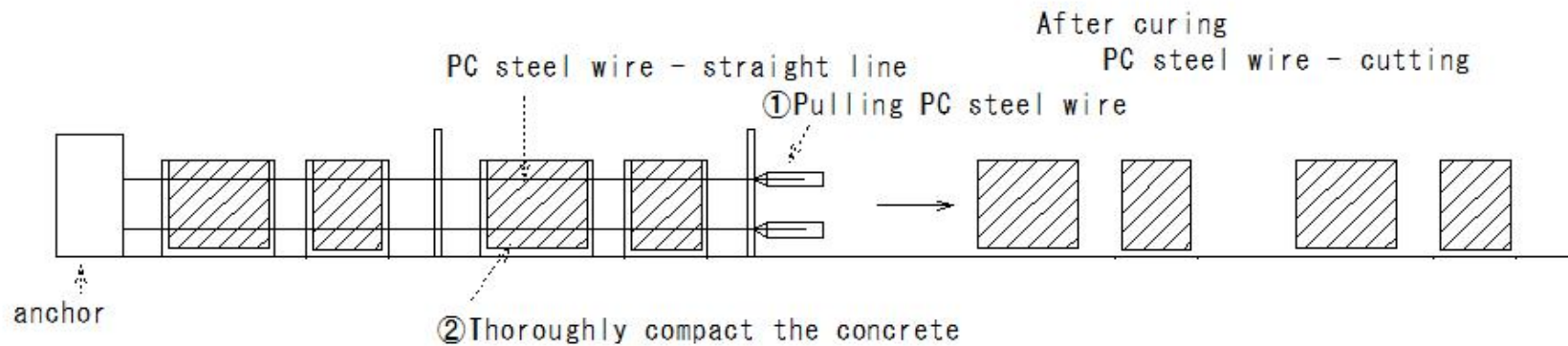
Resisting tensile force with reinforcing bars and PC steel wire

(B94)prestressed concrete(Pre-tension method (factory production))

(B94)prestressed concrete(Pre-tension method (factory production))

prestressed concrete

①Pre-tension method (factory production)



- ①PC steel wire - tension
 - ②Concrete placement
 - ③After curing
 - ④Tension-release
 - ⑤PC steel wire - adhesion of concrete
- Pressure force - introduction
Concrete strength: 350kgf/cm² or more
PC piles, PC sleepers, girder within 20m

(B95)prestressed concrete(Post-tension method (field production))

(B95)prestressed concrete(Post-tension method (field production))

prestressed concrete

②Post-tension method (field production)

PC steel wire - curve

Draw the formwork and determine the position of reinforcing bars and sheathing

After curing

- Grout inside the sheath
- Pull with hydraulic jack

① On-site - formwork construction

② Sheath installation

③ Concrete placement

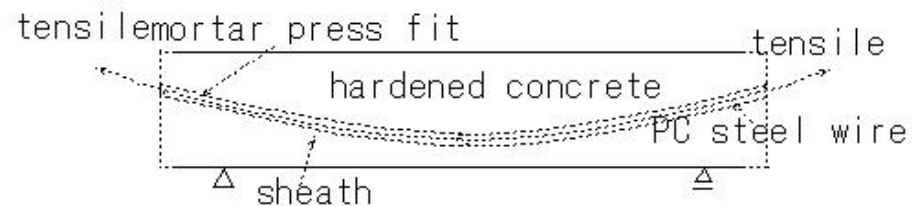
④ After curing

⑤ Insert the PC steel wire into the sheath

⑥ Hydraulic jack pull

⑦ Grout the holes in the sheath

⑧ Integration of PC steel wire and concrete - introduction of compressive force



grout material

Post tension: Concrete strength 300kgf/cm² or more

Cement, water reducing agent, aluminum powder, water

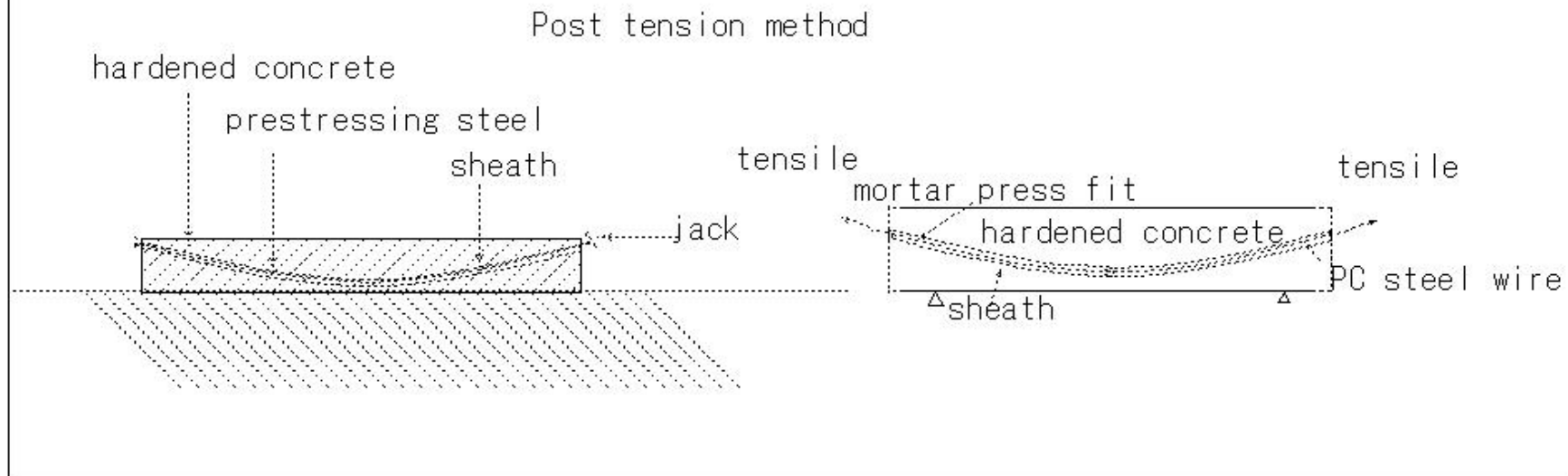
Expandability Breathing I won't allow it W/C: 38-45% Cold region: 40% or less

(B96)prestressed concrete(Prestressed concrete construction)

(B96) prestressed concrete (Prestressed concrete construction)

Prestressed concrete construction

- ① High strength hard mixed concrete, early strength
- ② Compact thoroughly with a vibrator
- ③ The cross section is large and the internal temperature becomes high.
Cool by passing water through the sheath



(B97)prestressed concrete(Prestressed concrete construction)

(B97) prestressed concrete(Prestressed concrete construction)

prestressed concrete

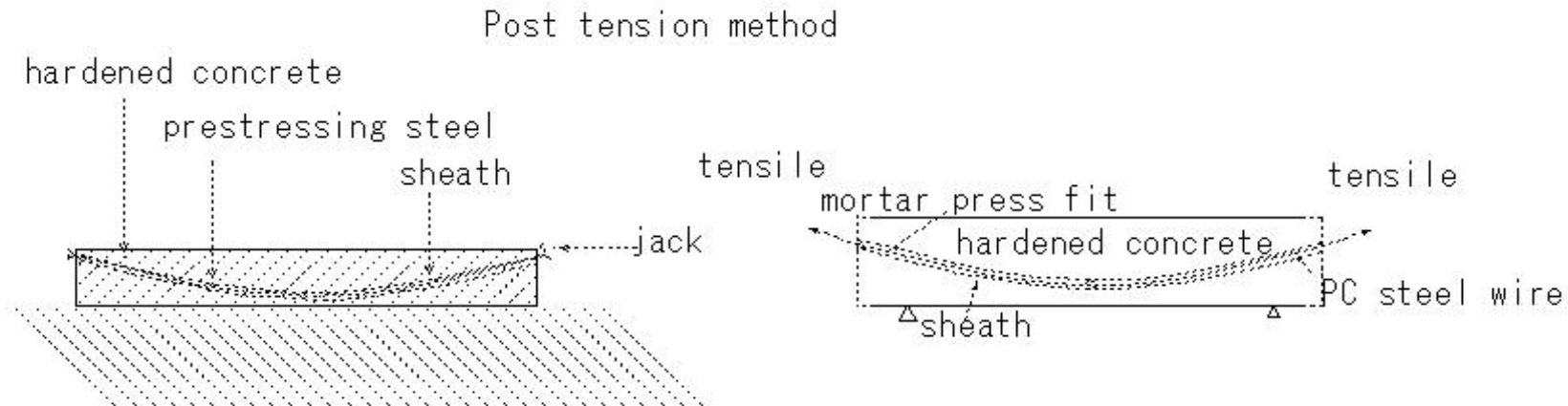
Prestressed concrete construction

②Assembling PC steel materials and reinforcing bars

①Position of prestressed steel material Position of assembled reinforcing bars
Preferably prestressed steel material position

② Floor slab - thin PC steel material position - important

Be careful when pouring concrete



(B98)prestressed concrete(Introduction of prestress)

(B98)prestressed concrete(Introduction of prestress)

prestressed concrete

Prestressed concrete construction

③Introduction of prestress

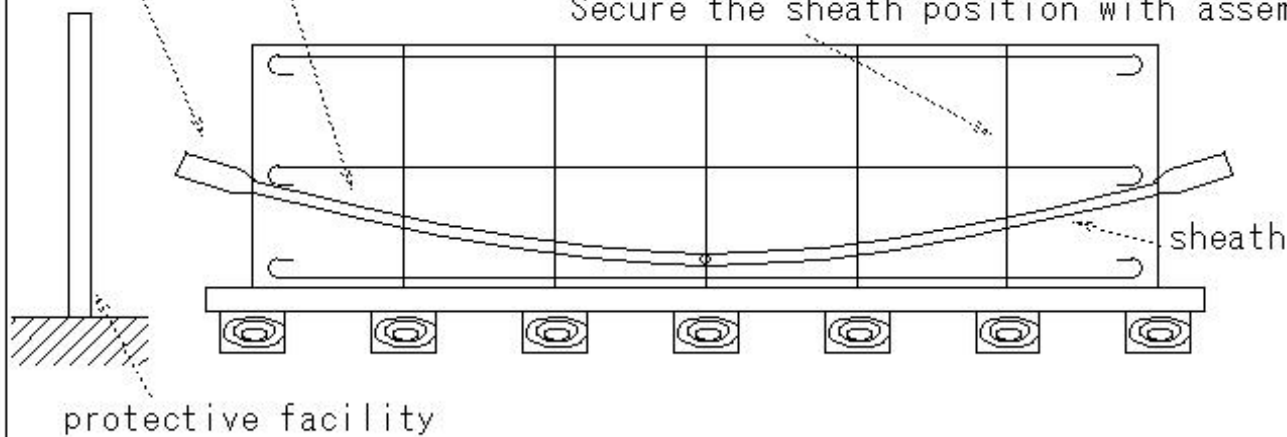
For post tension

Post tension construction

Introducing prestress

Introduced amount - Sliding friction loss amount - Estimated amount

Secure the sheath position with assembled reinforcing bars



(B99)prestressed concrete(Introduction of prestress)

(B99) prestressed concrete(Introduction of prestress)

prestressed concrete

Prestressed concrete construction

③ Introduction of prestress

For post tension

① Prestress introduction: Concrete design strength of 85% or more

② PC tensile force: Increase by the amount of sliding friction loss

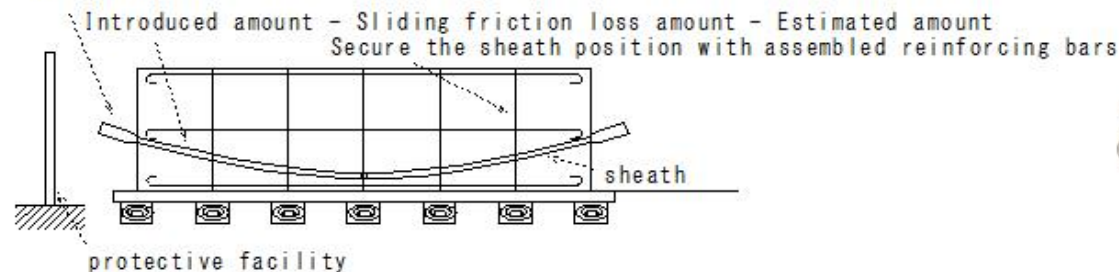
between the sheath and the PC steel wire

③ Protective facilities when introducing PC

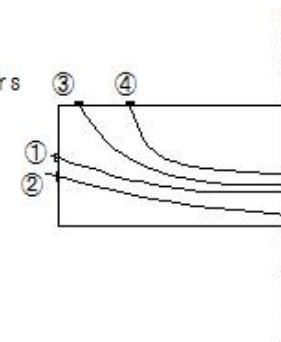
Do not place people behind the pulling device.

④ Prestress introduction: Introduce sequentially from the side closest to the centroid of the cross section

Introducing prestress



For post tension



(B100)prestressed concrete(pretension)

(B100) prestressed concrete (pretension)

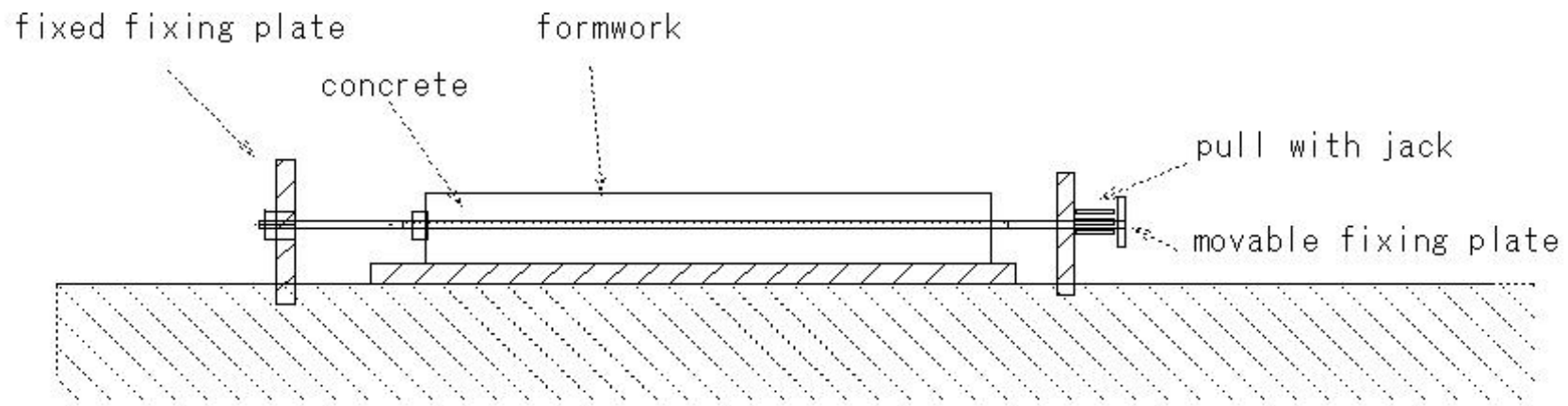
prestressed concrete

Prestressed concrete construction

In case of pretension

①Tension release: Concrete strength 350kgf/cm² or more

②Steam curing: Factory tension released in one day



(B101)prestressed concrete(Reduction of prestress)

(B101)prestressed concrete(Reduction of prestress)

prestressed concrete

Problems with prestressing

①Reduction of prestress

① Relaxation of PC steel materials

②Concrete creep

③Drying shrinkage

countermeasure

①Concrete strength - Sufficient - Prestress introduction

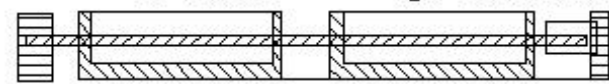
②Pre-tension method: 300kgf/cm² or more

③Post-tension method Design nominal strength 85% or more

Apply compressive force

PC steel

①Pretension method



pull with jack

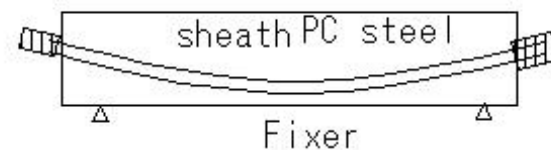
Fixed stand

Cut after curing

factory products

②Post-tension method

pull with jack



Press the mortar into the sheath in a tense state and fix it.

On-site fabrication/Large structures

(B102)prestressed concrete(Sliding friction loss)

(B102) prestressed concrete(Sliding friction loss)

prestressed concrete

Problems with prestressing

②Sliding friction loss

①PC steel wire - pull

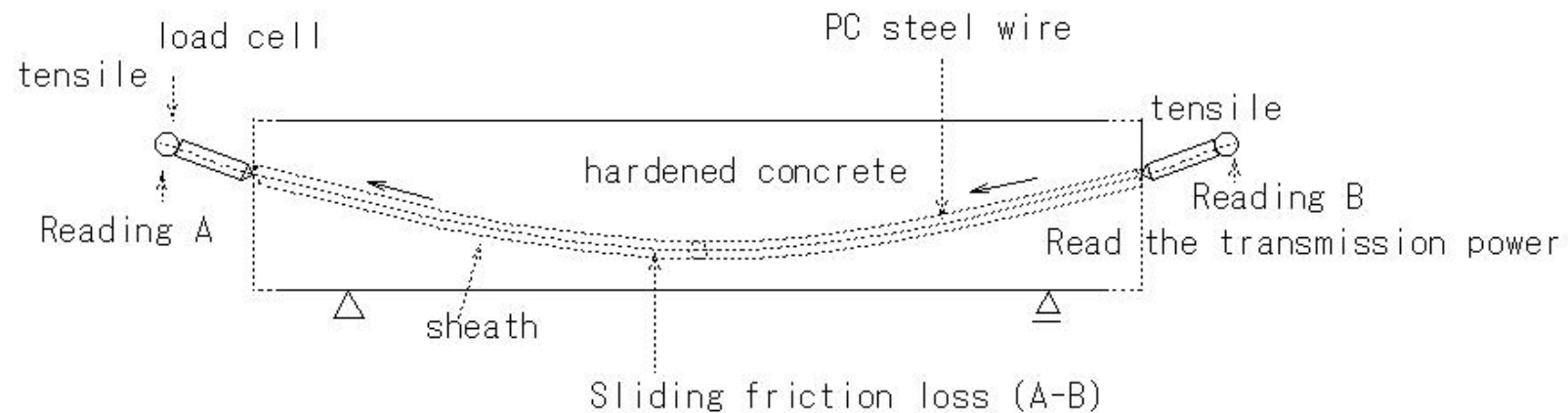
②Friction between the sheath wall and the PC steel wire

③Sliding friction loss

④Indicators on both ends

⑤Sliding loss friction

⑥Prestress introduction



(B103)prestressed concrete(Variations in pre-stressing)

(B103)prestressed concrete(Variations in pre-stressing)

prestressed concrete

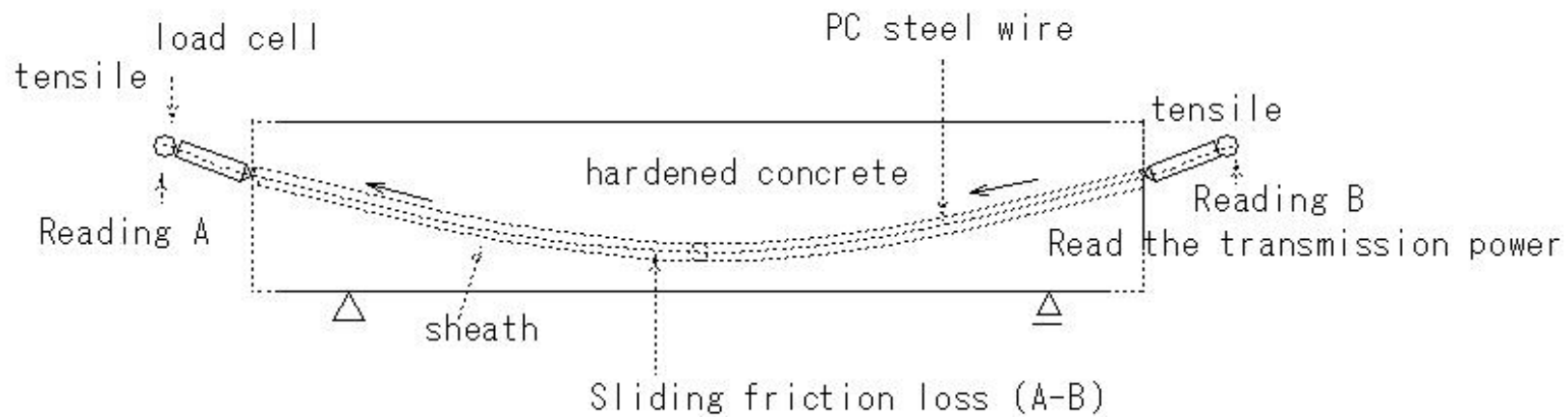
Problems with prestressing

③Variations in pre-stressing

Introduction of prestress

Load cell calibration (adjustment)

Friction loss measurement



(B104)prestressed concrete(Fixing method of PC steel)

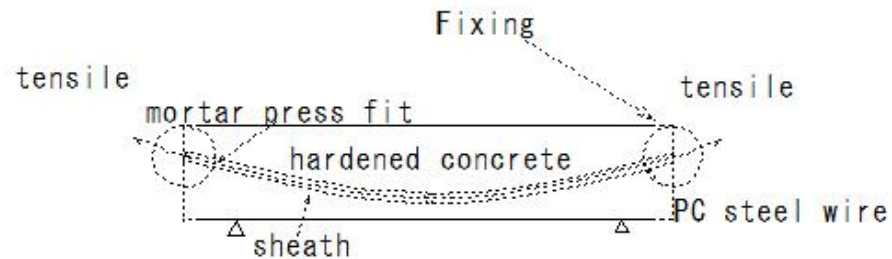
(B104) prestressed concrete (Fixing method of PC steel)

prestressed concrete

Fixing method of PC steel material

- ①Wedge fixation: Freissinet, hoop cone, OBC
- ②Screw/nut fixing: Devidark
- ③Heading fixation: BBRV/OSPA
- ④Socket casting fixation: Strand
- ⑤Edge processing embedding fixing: Leonhard Leopa
- ⑥Torsion fixation: SEEE

Post tension method



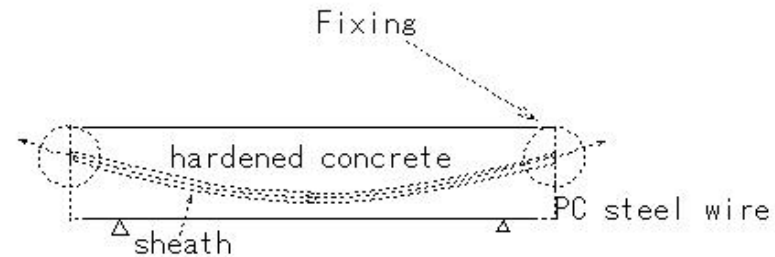
(B105)prestressed concrete(Freycinet method: wedge anchorage)

(B105) prestressed concrete (Freycinet method: wedge anchorage)

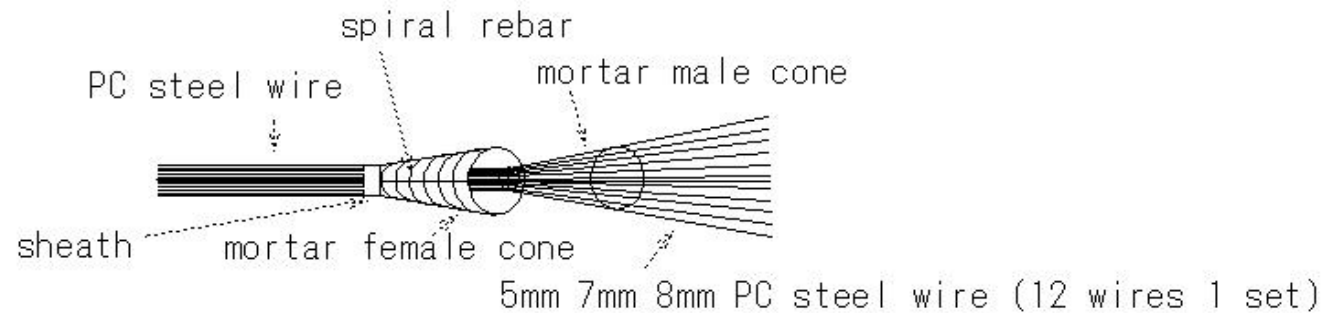
prestressed concrete

method of PC steel material

Fixing method of PC steel material



①Freycinet method: wedge anchorage



①Pull with Freycinet jack/pump

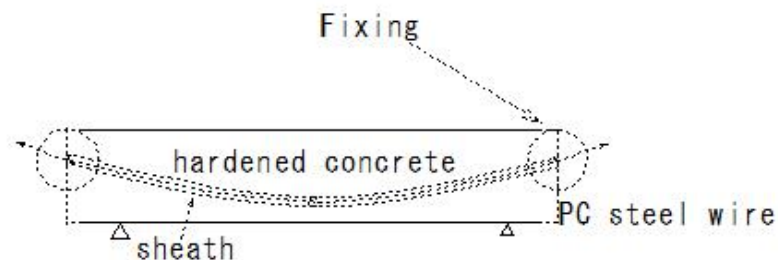
②Fixed with mortar cone

③Tension, fixation, and wedge removal -performed continuously

(B106)prestressed concrete(Devidark construction method: Screw/nut fixation)

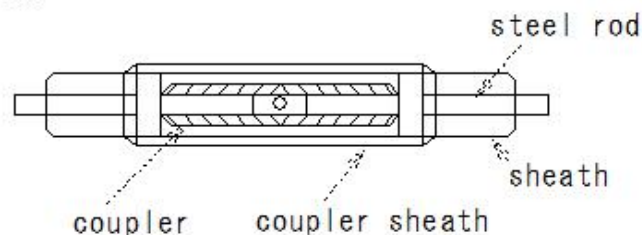
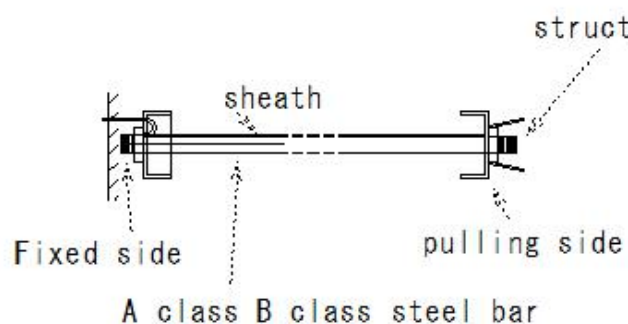
(B106)prestressed concrete(Devidark construction method: Screw/nut fixation)

prestressed concrete



Fixing method of PC steel material

②Devidark construction method: Screw/nut fixation



PC steel rod (Class A, Class B) - Apply tensile force with screws

PC steel bar - cut and transport
case of connected
use a coupler

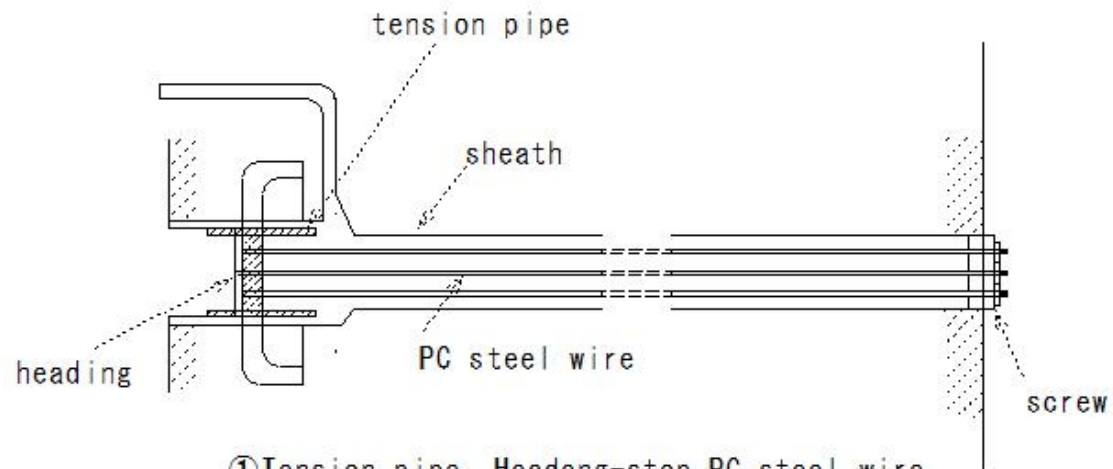
(B107)prestressed concrete(BBRV method: Heading anchorage)

(B107)prestressed concrete(BBRV method: Heading anchorage)

prestressed concrete

Fixing method of PC steel material

③BBRV method: Heading anchorage



①Tension pipe Heading-stop PC steel wire

Tighten the screw at the other end to apply tensile force to the steel wire.

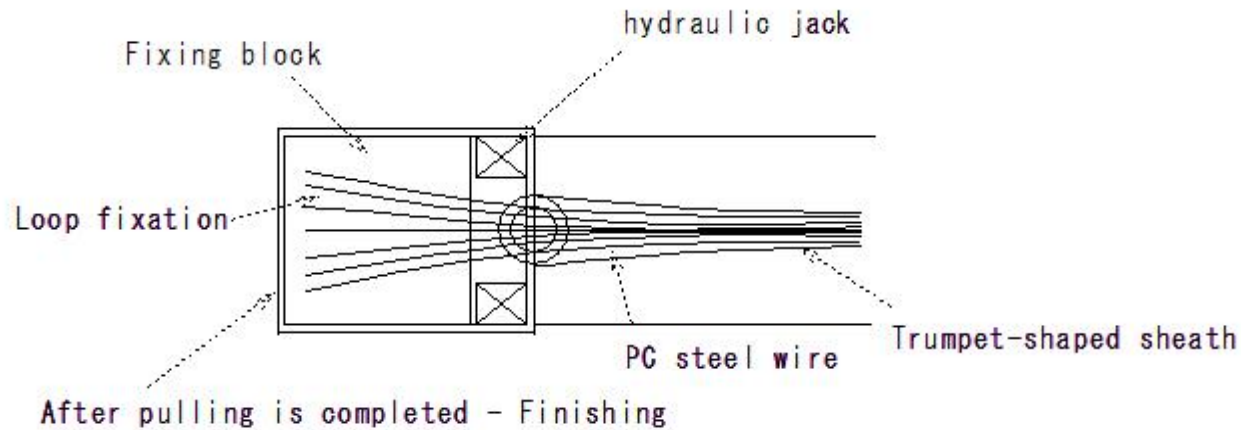
(B108)prestressed concrete(Leonhard method: End processing embedding fixation)

(B108)prestressed concrete(Leonhard method: End processing embedding fixation)

prestressed concrete

Fixing method of PC steel material

④Leonhard method: End processing embedding fixation



- ①End of PC steel wire - Embed in the fixing block
- ②Pass through the trumpet-shaped sheath
- ③Hydraulic jack pull

(B109)prestressed concrete(grouting)

(B109)prestressed concrete(grouting)

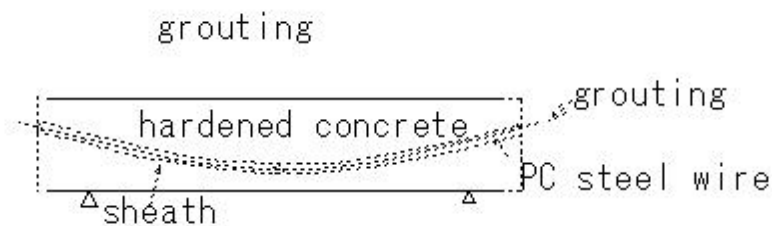
prestressed concrete

grouting

- ①After fixing the PC steel material, integrate the PC and concrete
- ②Fill the inside of the sheath with high-strength grout material

Construction problems

- ①Grout mortar: Cement dispersant aluminum powder - shrinkage prevention
- ②Grout mixer: Mixing time within 5 minutes
- ③Grout: 1.2mm sieve grout pump
- ④Inside the sheath wet with water
- ⑤Grout: Continuously inject from low to high places
Continue until high quality grout comes out from the outlet side.
- ⑥Inject grout immediately after mixing
do it continuously



(B110)Concrete bridge(Erection)

(B110) Concrete bridge(Erection)

Concrete bridge(Erection)

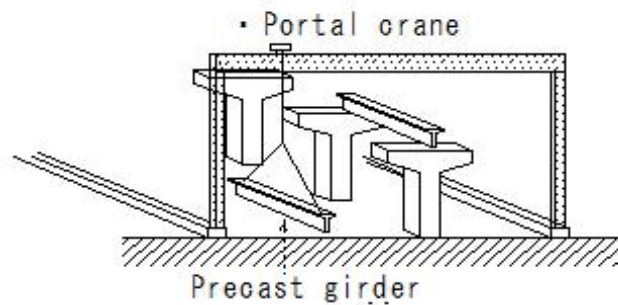
①Precast construction method

- Precast girder
- Precast segment

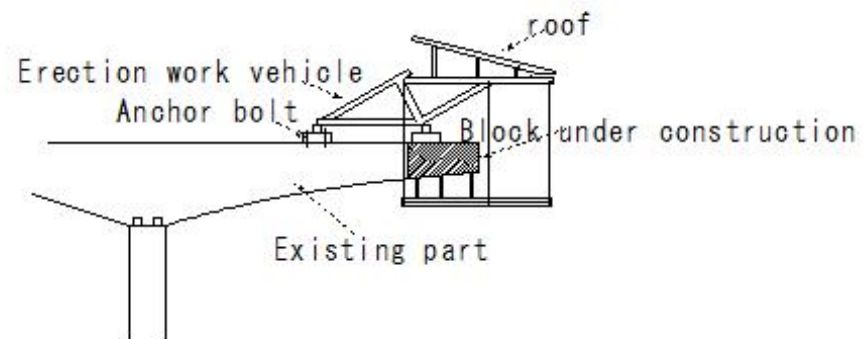
②Cast-in-place method

- Fixed shoring type
- Mobile shoring type
- Extrusion method
- Cantilever construction

• Precast girder Erection method



Cast-in-place method Cast-in-place cantilever construction



(B111)Concrete bridge(Erection-Precast Erection-Segment method)

(B111) Concrete bridge (Erection-Precast Erection-Segment method)

Concrete bridge(Erection)

①Precast erection method

①Produced in the factory yard - precast girders and precast segments

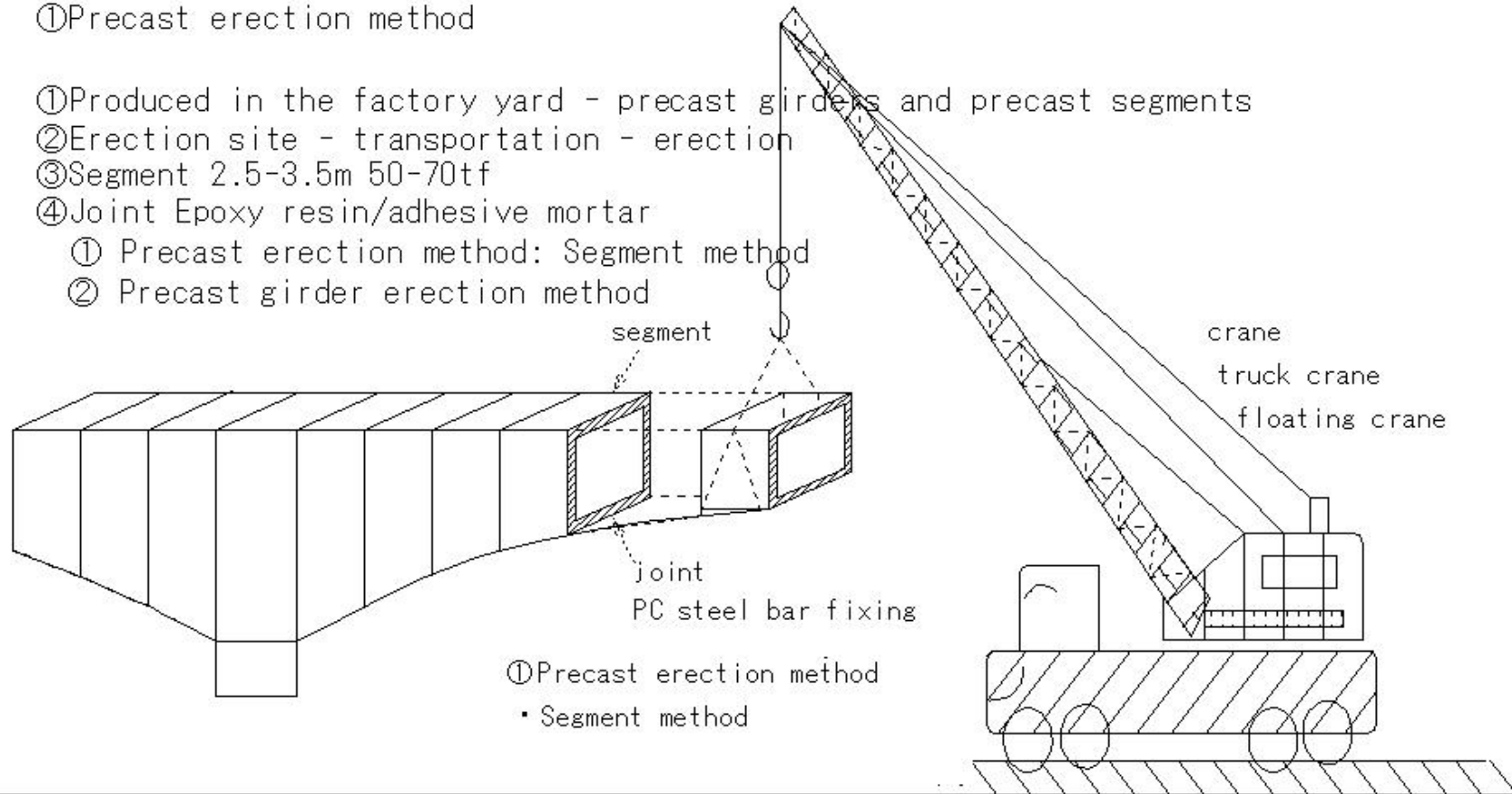
②Erection site - transportation - erection

③Segment 2.5-3.5m 50-70tf

④Joint Epoxy resin/adhesive mortar

① Precast erection method: Segment method

② Precast girder erection method

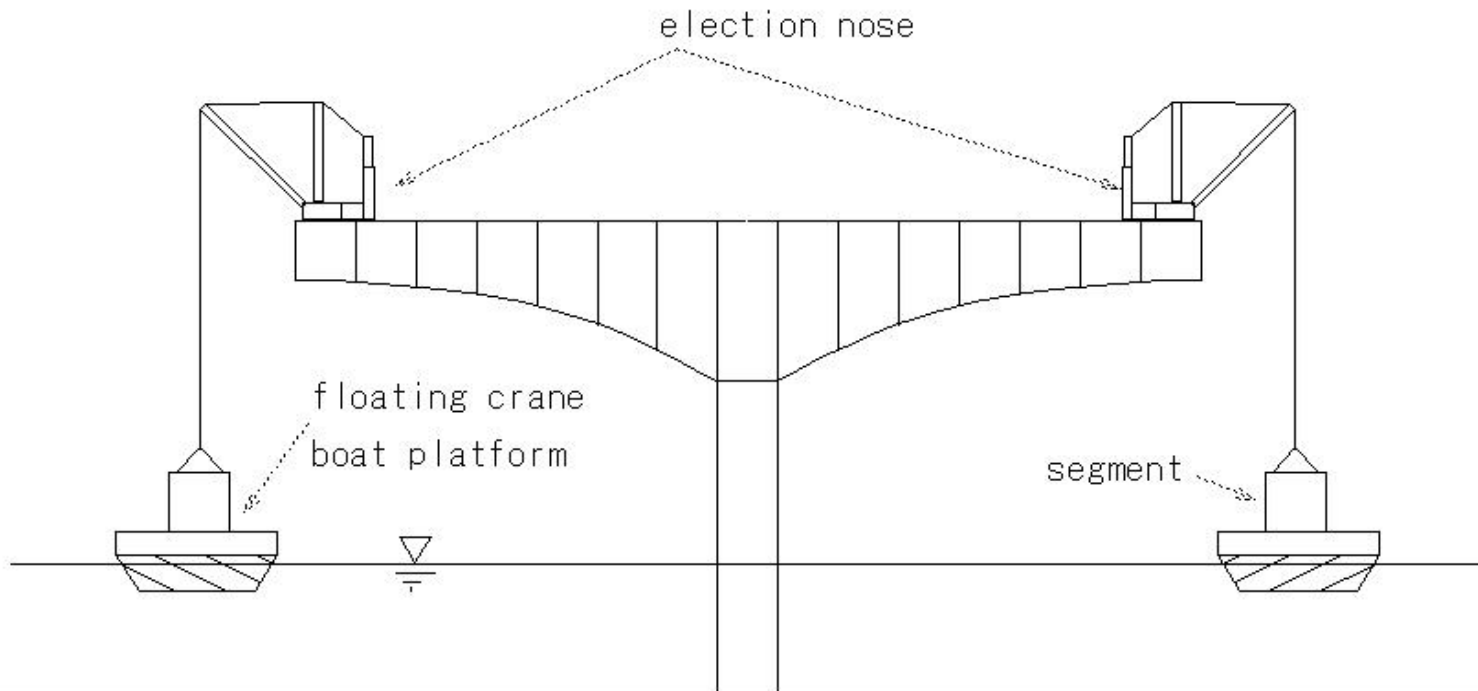


(B112)Concrete bridge(Erection-Precast girder erection -Segment method)

(B112) Concrete bridge(Erection-Precast girder erection -Segment method)

Concrete bridge(Erection)

②Precast girder erection method



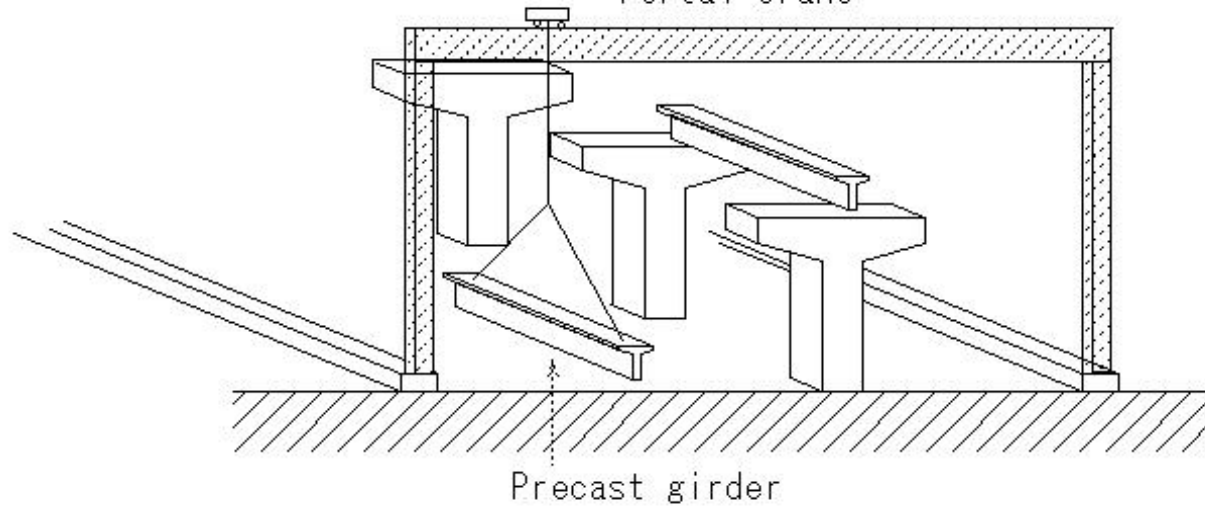
(B113)Concrete bridge(Erection-Precast girder erection)

(B113) Concrete bridge(Erection-Precast girder erection)

Concrete bridge(Erection)

• Precast girder Erection method

• Portal crane



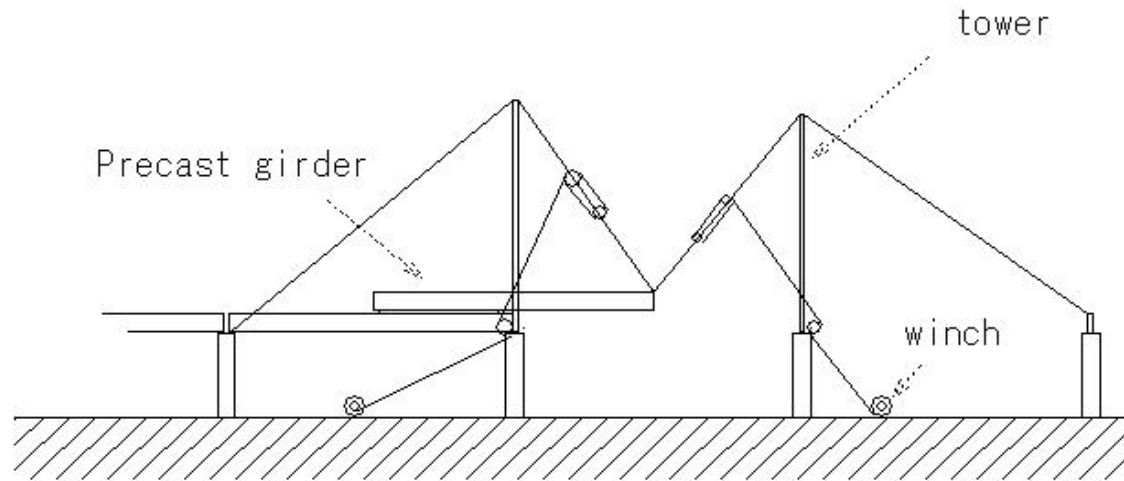
Precast girder

(B114)Concrete bridge(Erection-Precast girder erection)

(B114) Concrete bridge(Erection-Precast girder erection)

Concrete bridge(Erection)

- Precast girder erection

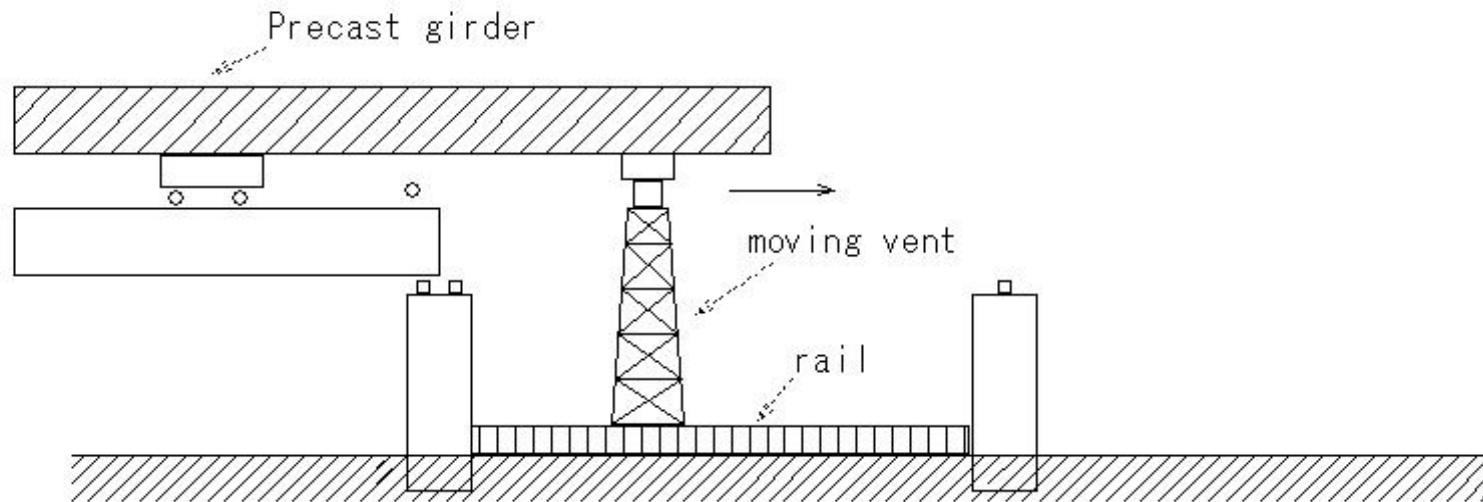


(B115)Concrete bridge(Erection-Precast girder erection)

(B115) Concrete bridge(Erection-Precast girder erection)

Concrete bridge(Erection)

Precast girder erection

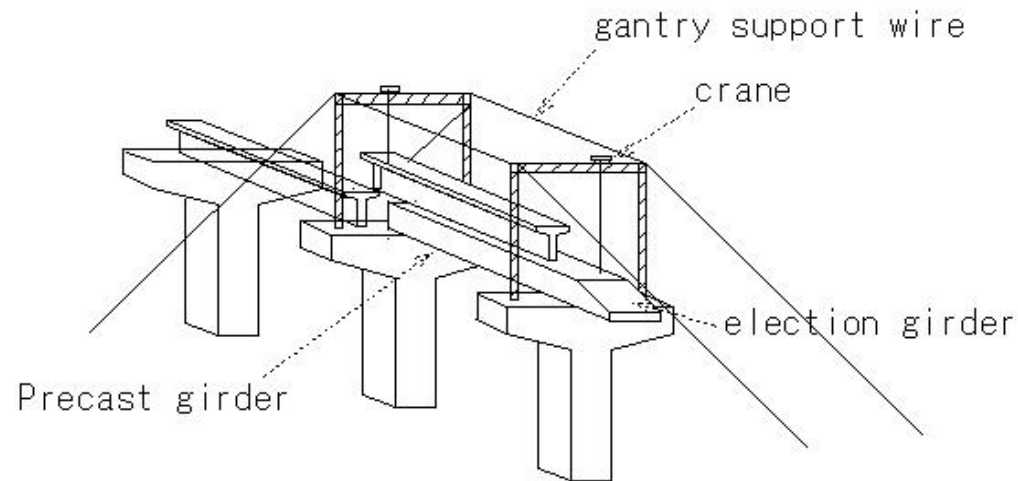


(B116)Concrete bridge(Erection-Precast girder erection)

(B116) Concrete bridge (Erection-Precast girder erection)

Concrete bridge(Erection)

- Precast girder erection
 - Precast girder Erection method
 - Portal crane



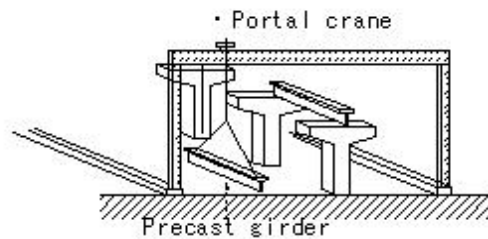
(B117)Concrete bridge(Erection-Precast girder erection)

(B117) Concrete bridge (Erection-Precast girder erection)

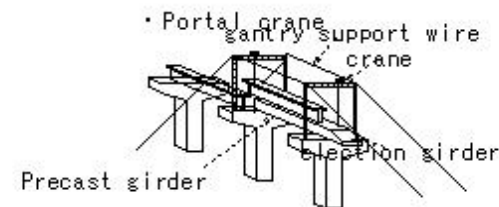
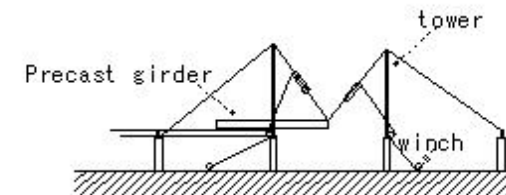
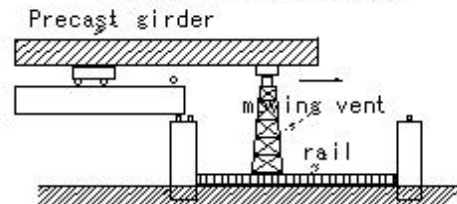
Concrete bridge(Erection)

• Precautions when handling precast parts

- ① During temporary construction, do not support anything other than the specified support points
- ② Weak against buckling in the lateral direction
Do not tilt more than 5 degrees
- ③ Prestress is well balanced
Parts - Torsion - Balance - Collapse
-Destruction of parts-Caution



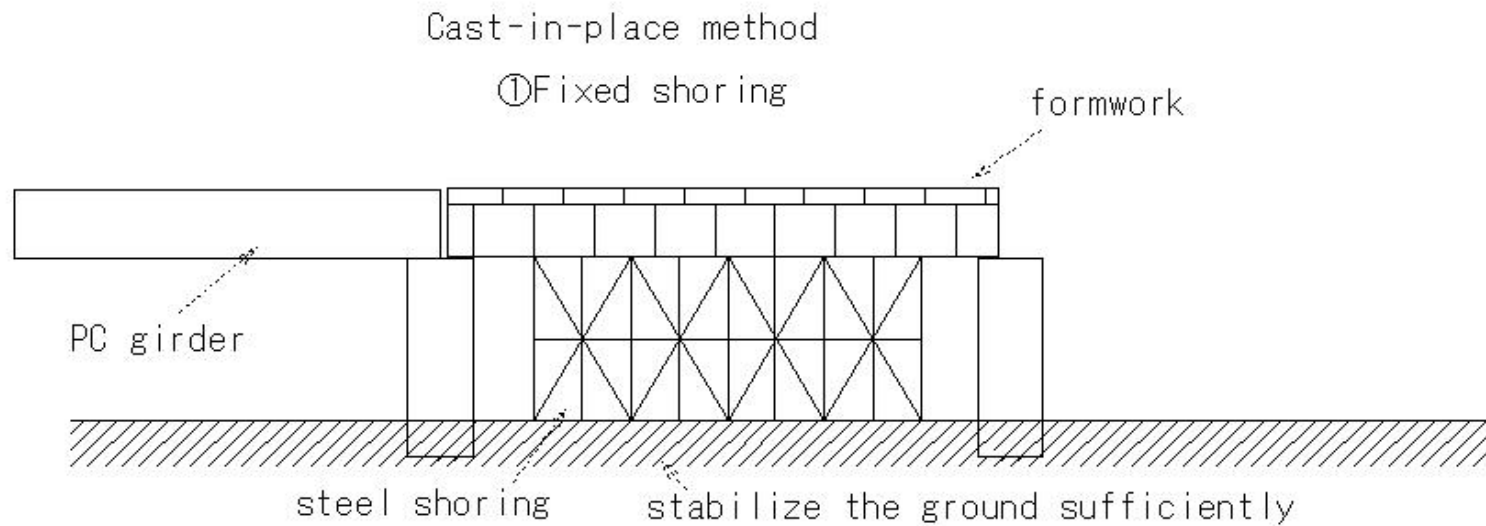
Precast girder erection



(B118)Concrete bridge(Erection-Cast-in-place method)

(B118) Concrete bridge (Erection-Cast-in-place method)

Concrete bridge(Erection)



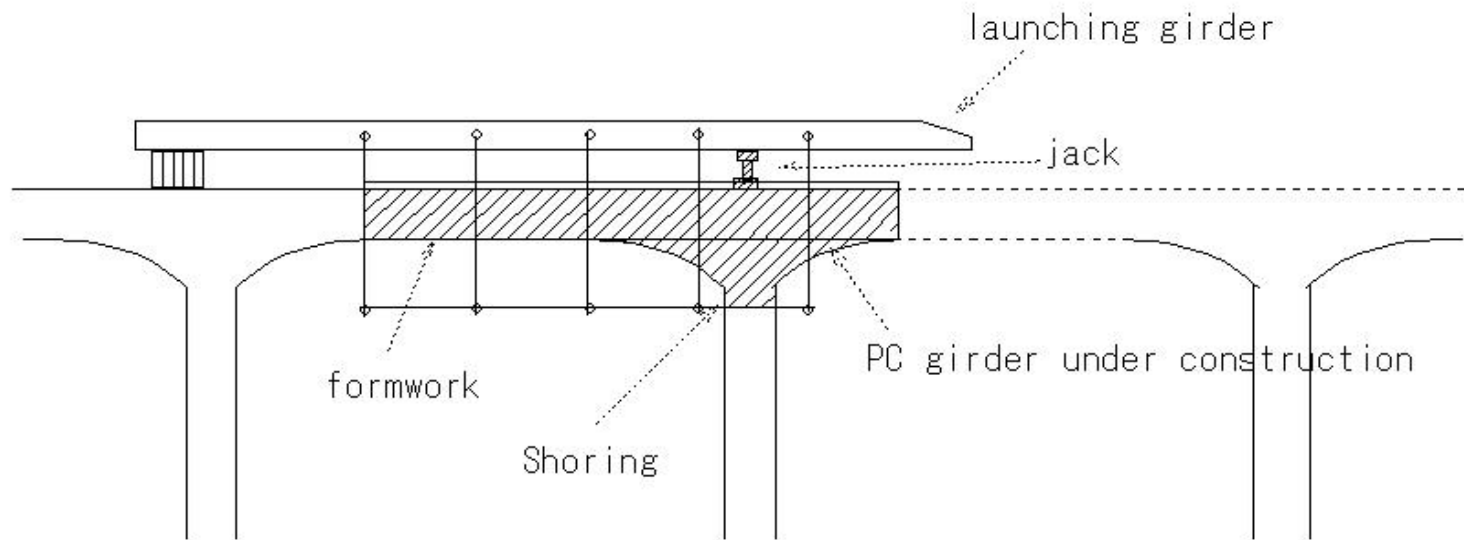
(B119)Concrete bridge(Erection-Cast-in-place method)

(B119) Concrete bridge (Erection-Cast-in-place method)

Concrete bridge(Erection)

Cast-in-place method

② Mobile shoring

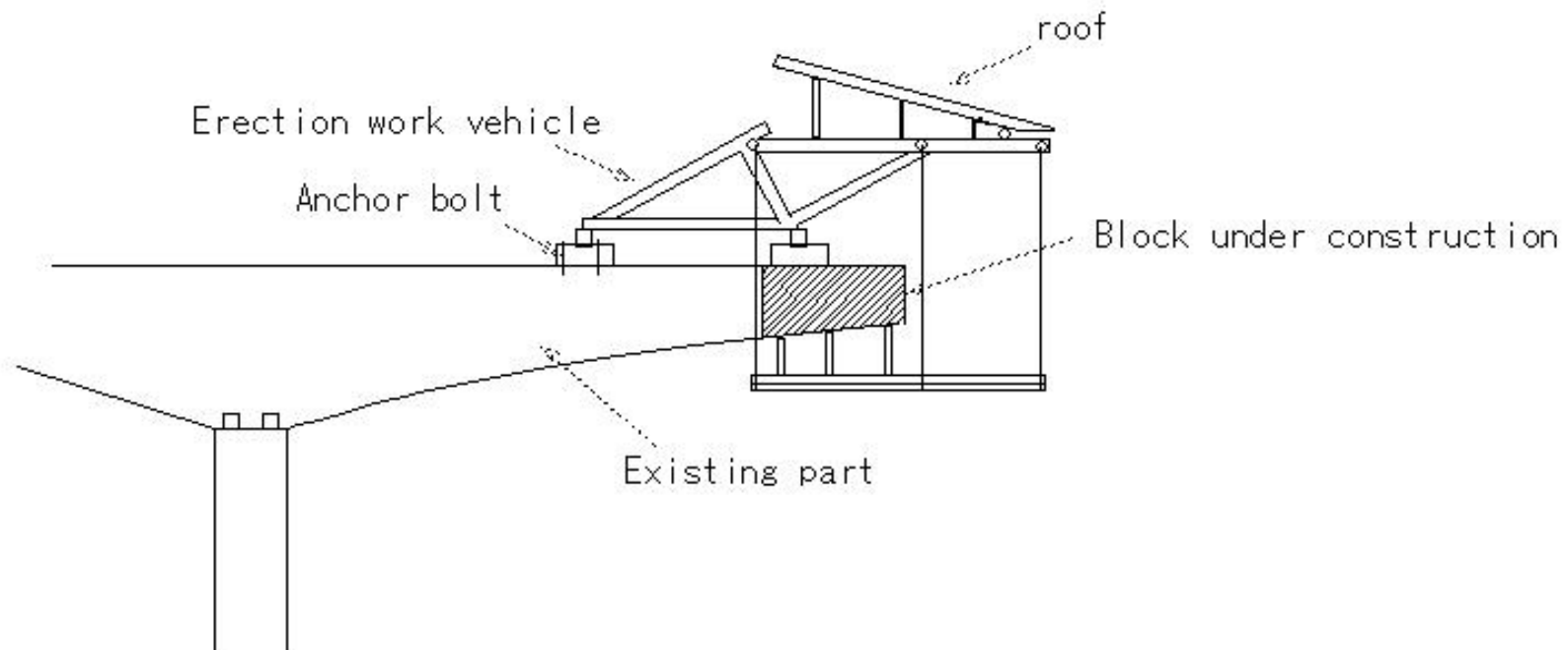


(B120)Concrete bridge(Erection-Cast-in-place method)

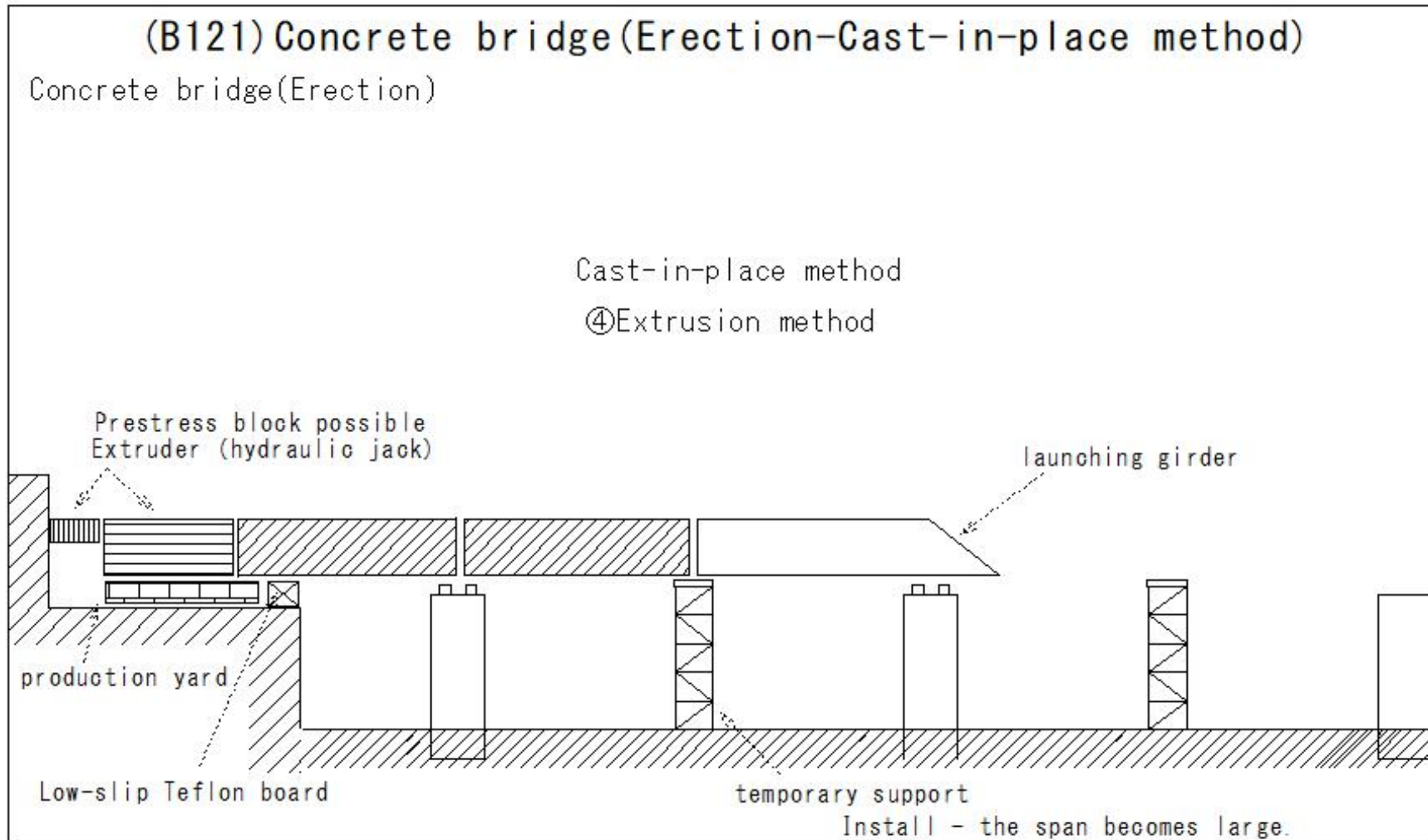
(B120)Concrete bridge(Erection-Cast-in-place method)

Concrete bridge(Erection)

Cast-in-place method
③ Cast-in-place cantilever construction



(B121)Concrete bridge(Erection-Cast-in-place method)

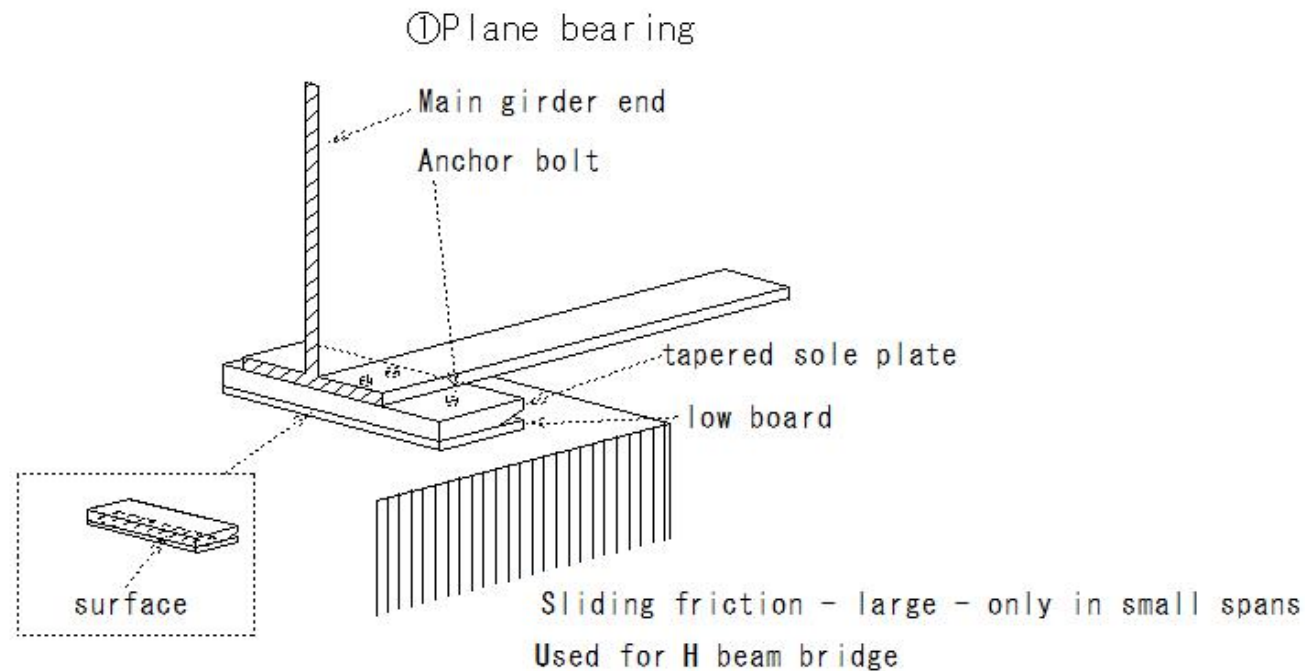


(B122) Bridge erection (bearing / support)

(B122) Bridge erection (bearing / support)

Bridge erection (bearing / support)

- Deformation and load of the upper structure - transmitted to the lower structure
- Deformation of the lower structure - does not affect the upper structure
- Fixing the substructure and bearings and embedding anchor bolts
Use non-shrinking mortar

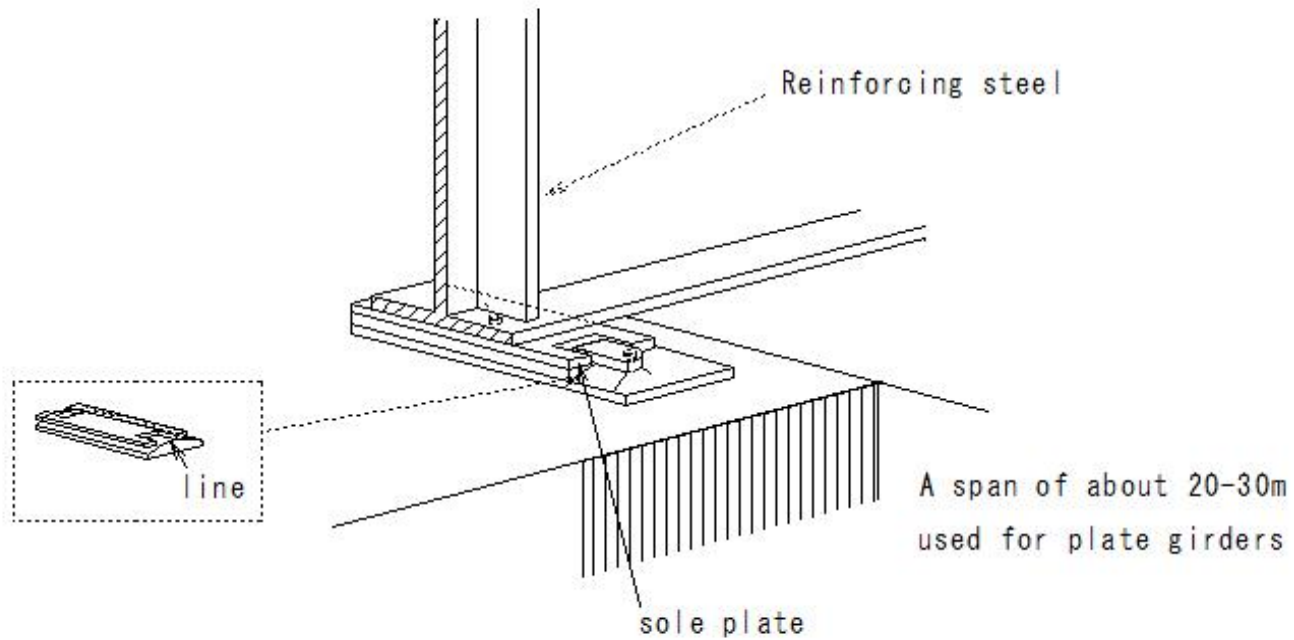


(B123)Bridge erection(bearing /support)

(B123)Bridge erection(bearing /support)

Bridge erection(bearing /support)
bearing(support)

②Line support



(B124) Bridge erection(bearing /support)

(B124) Bridge erection(bearing /support)

Bridge erection(bearing /support)

bearing(support)

③ Pin bearing

pin

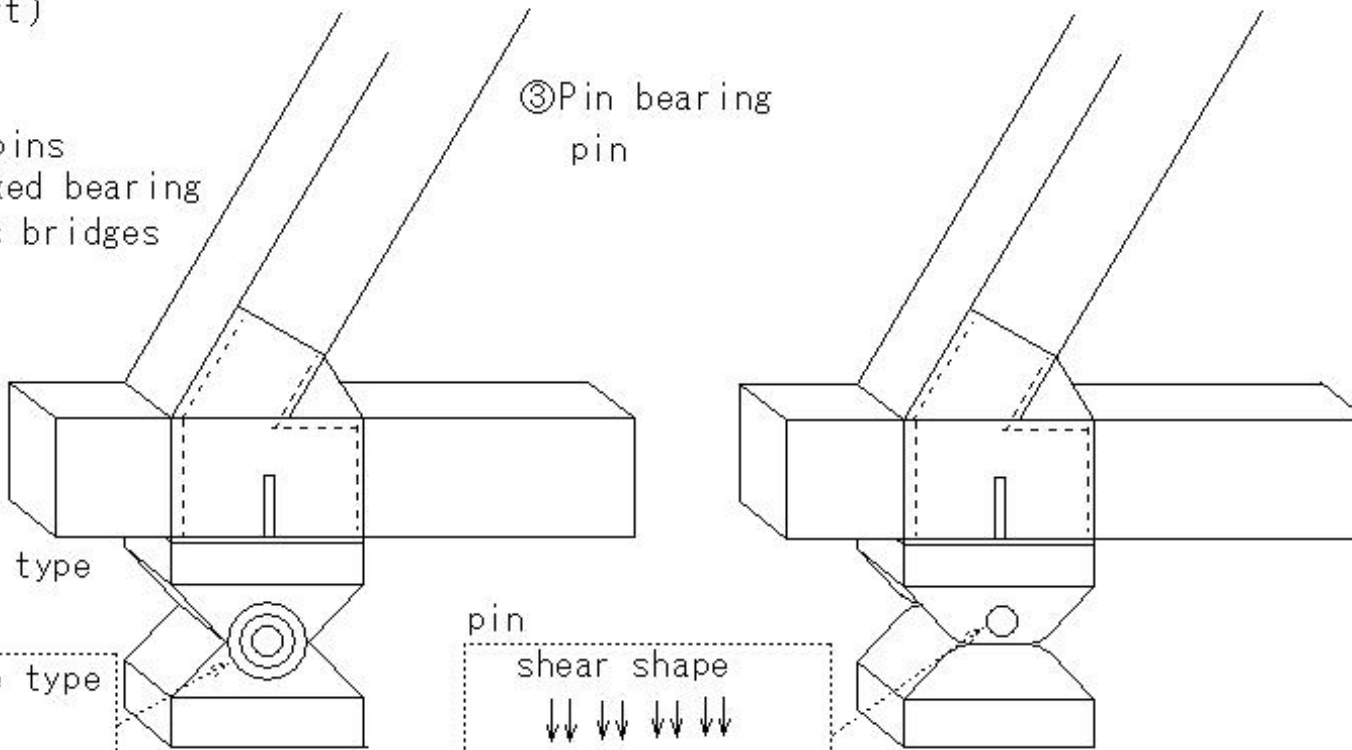
Supported by pins

Large span fixed bearing

Used for truss bridges

③ Pin bearing

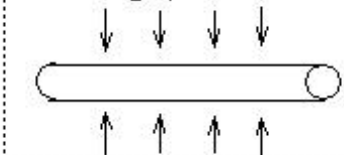
pin



Bearing pressure type

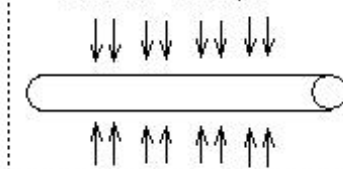
pin

Bearing pressure type



pin

shear shape



(B125)Bridge erection(bearing /support)

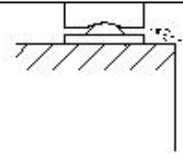
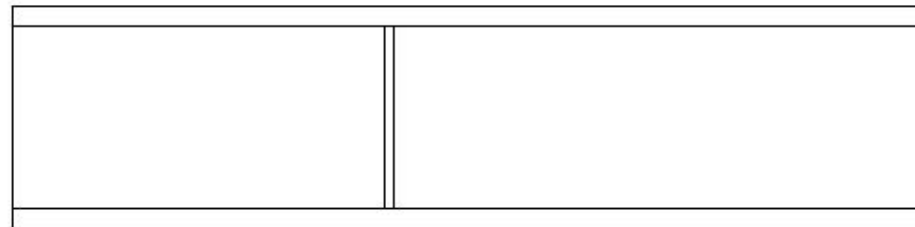
(B125) Bridge erection(bearing /support)

Bridge erection(bearing /support)

bearing(support)

④Bipot bearing

④Bipot bearing



$r_2 > r_1$ - Rolling friction
Spherical rolling friction bearing
Rotatable in all directions

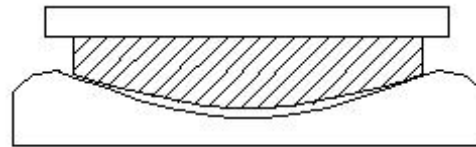
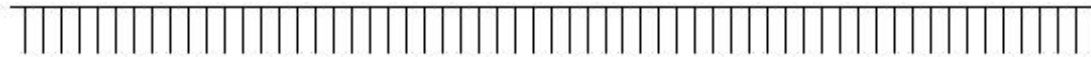
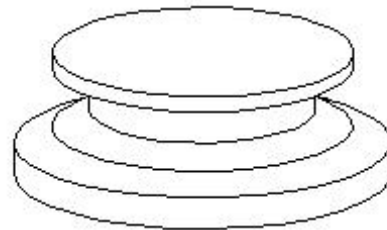
(B126) Bridge erection(bearing /support)

(B126) Bridge erection(bearing /support)

Bridge erection(bearing /support)
bearing(support)

⑤Support plate support

⑤Support plate support



Supported by sliding friction on the curved surface of the supporting slope

Transforms in all directions

Used for diagonal and curved bridges

(B127)Bridge erection(bearing /support)

(B127) Bridge erection(bearing /support)

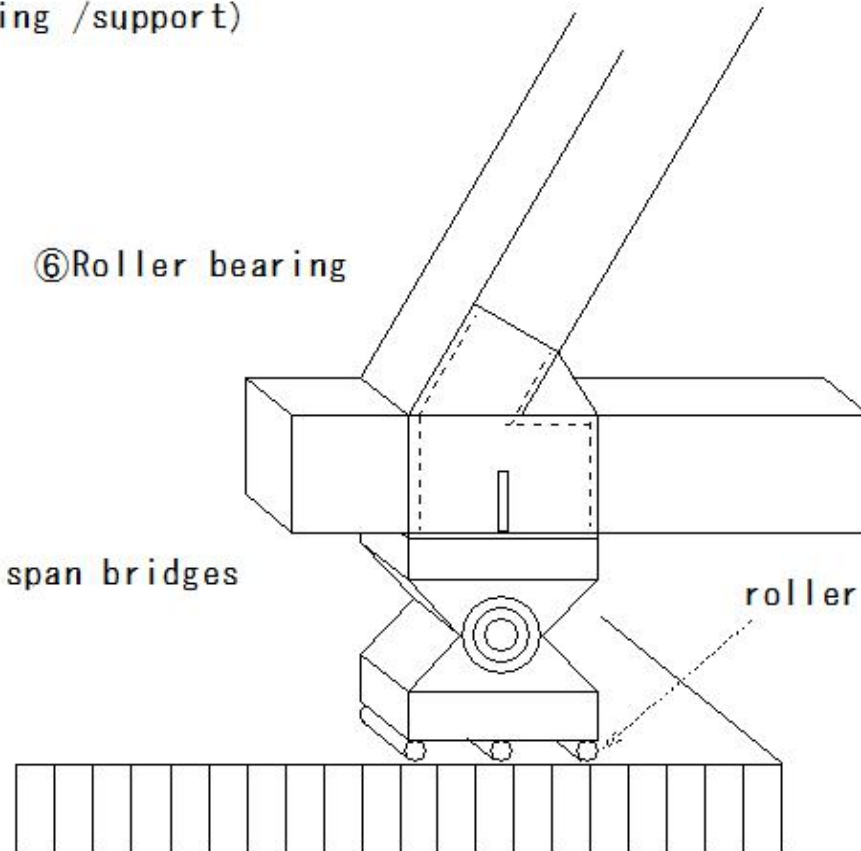
Bridge erection(bearing /support)

bearing(support)

⑥Roller bearing

⑥Roller bearing

Truss bridge
used for large span bridges



roller

(B128) Bridge erection(bearing /support)

(B128) Bridge erection(bearing /support)

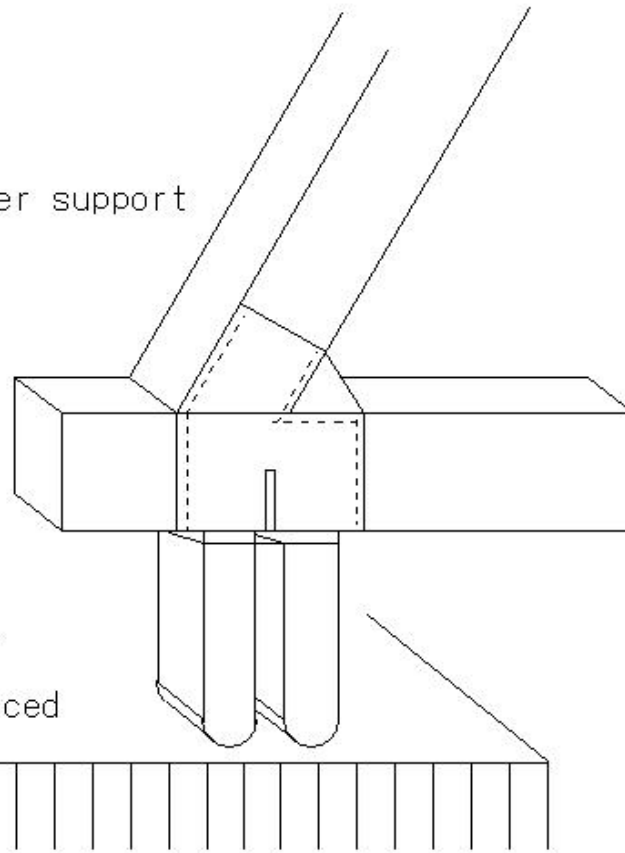
Bridge erection(bearing/support)

bearing(support)

⑦Rocker support

⑦Rocker support

locker
Bottom of roller-reduced

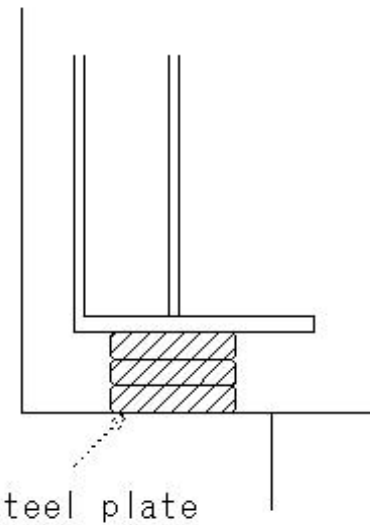
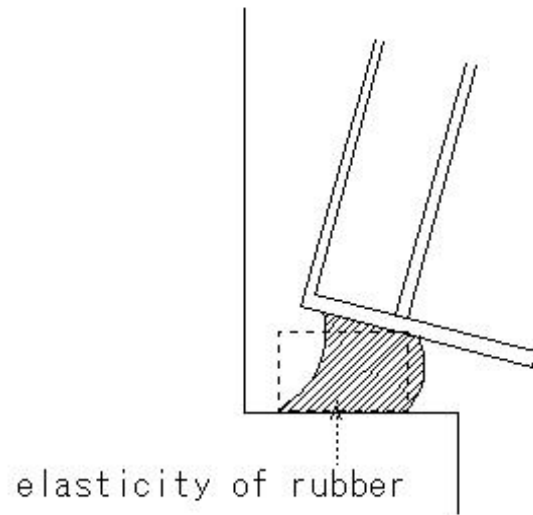


(B129)Bridge erection(bearing /support)

(B129) Bridge erection(bearing /support)

Bridge erection(bearing /support)
bearing(support)

⊗Rubber bearing



Rotation/horizontal force-following
Large structure - reinforced steel plate
Reinforce by layering a rubber plate on top

(B130) Bridge erection(bearing /support)

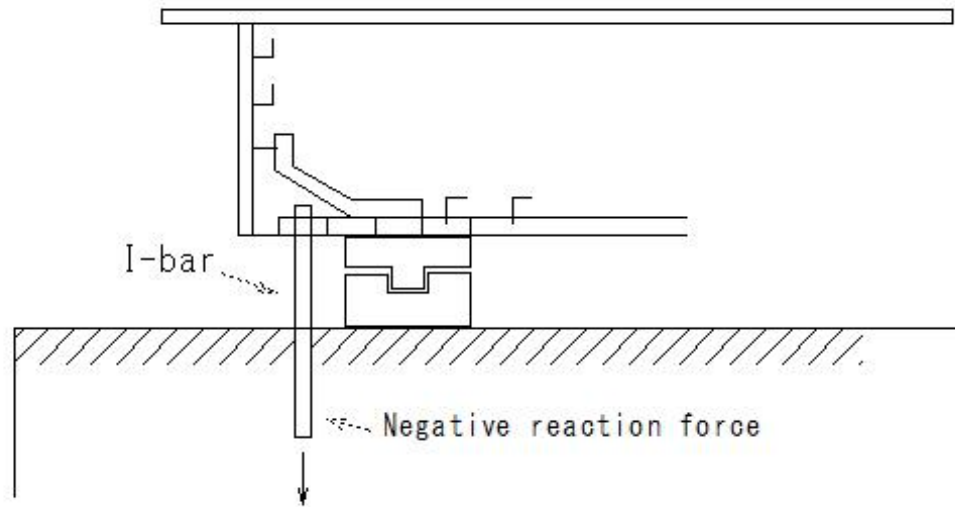
(B130) Bridge erection(bearing /support)

Bridge erection(bearing /support)

bearing(support)

⑨I-bar

⑨I-bar



(B131)Bridge erection(expansion joint)

(B131) Bridge erection(expansion joint)

Bridge erection(expansion joint)

expansion joint

Temperature change Elastic deformation Superstructure - continuum

Superstructure-continuum

- ①Rigidity - Durability
- ②Drivability - less noise
- ③Construction and management - easy

Support type

- ①Finger type (pre-attached type)
- ②Overlap type (pre-attached type)

butt type

- ③Rubber joint type (retrofit type)
- ④Joint type (pre-attached type)

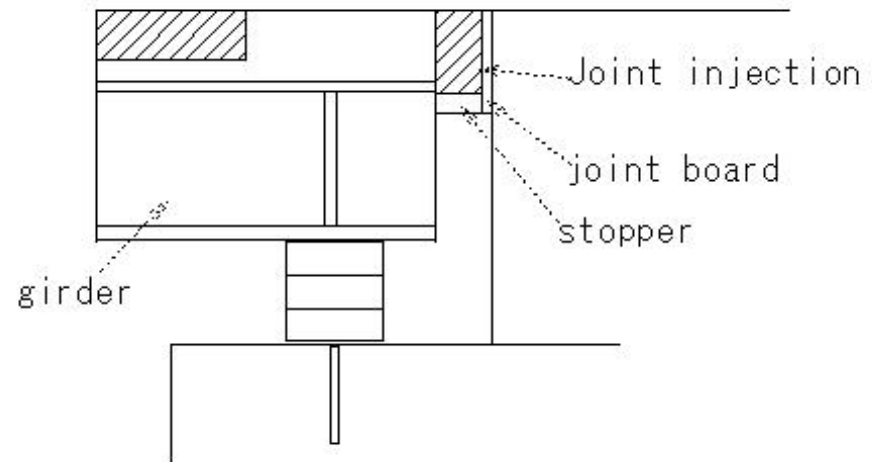
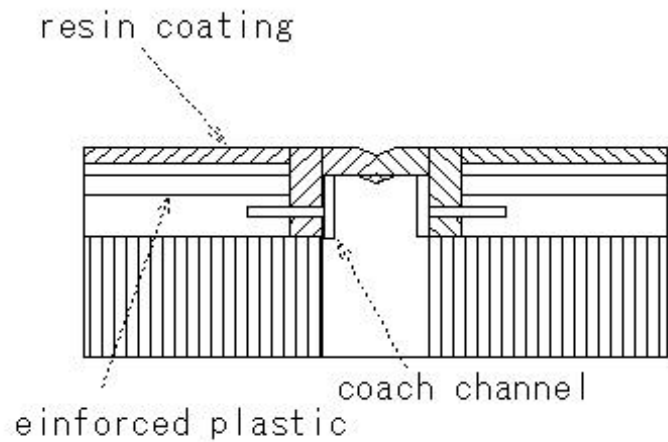
(B132)Bridge erection(expansion joint)

(B132)Bridge erection(expansion joint)

Bridge erection(expansion joint)
expansion joint

Rubber joint type (retrofit type)

Joint type(plate)



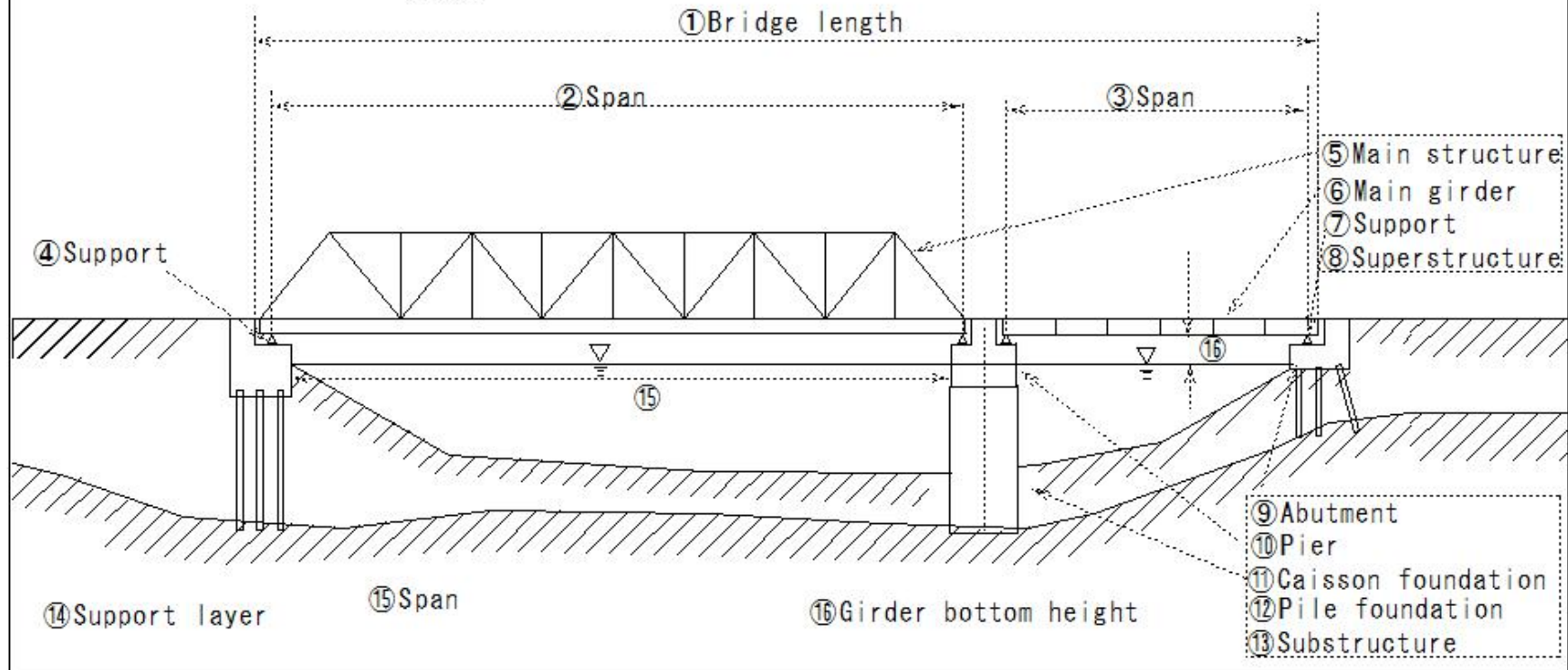
(B133) Bridge type

(B133) Bridge type

Bridge type
superstructure
substructure

superstructure
floor assembly
bridge girder
truss

substructure
supporting superstructure



(B134) Bridge type (Classification by use)

(B134) Bridge type (Classification by use)

Bridge type (Classification by use)

Type of bridge

Classification by use

- ① highway bridge
- ② railway bridge
- ③ combined bridge
- ④ aqueduct bridge
- ⑤ over bridge
- ⑥ movable bridge
- ⑦ fixed bridge
- ⑧ Eternal Bridge
- ⑨ emergency bridge

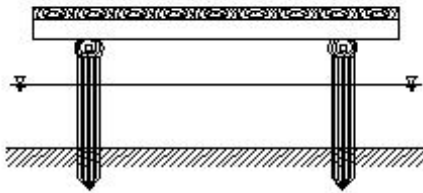
(B135)Bridge type

(B135)Bridge type

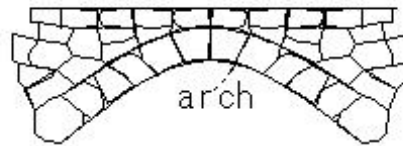
Type of bridge

Classification by materials used

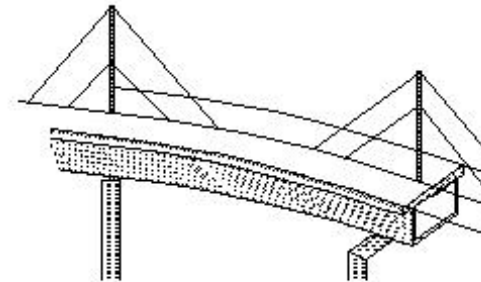
① wooden bridge



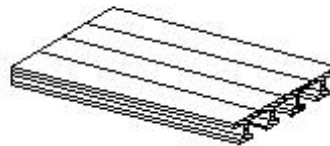
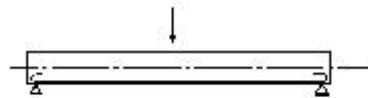
② stone bridge



③ steel bridge



④ reinforced concrete bridge ⑤ prestressed concrete bridge



(B136)Bridge type

(B136)Bridge type

Type of bridge

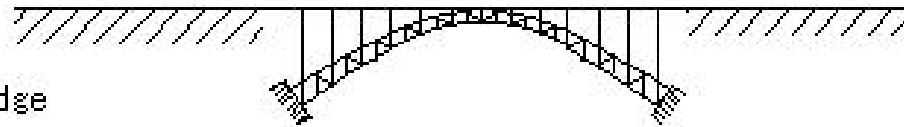
aisle location

deck bridge

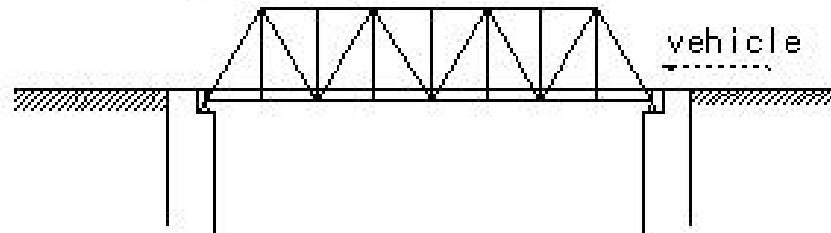
through bridge

half-through bridge

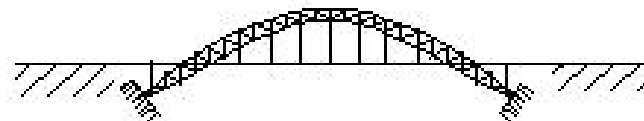
deck bridge



through bridge

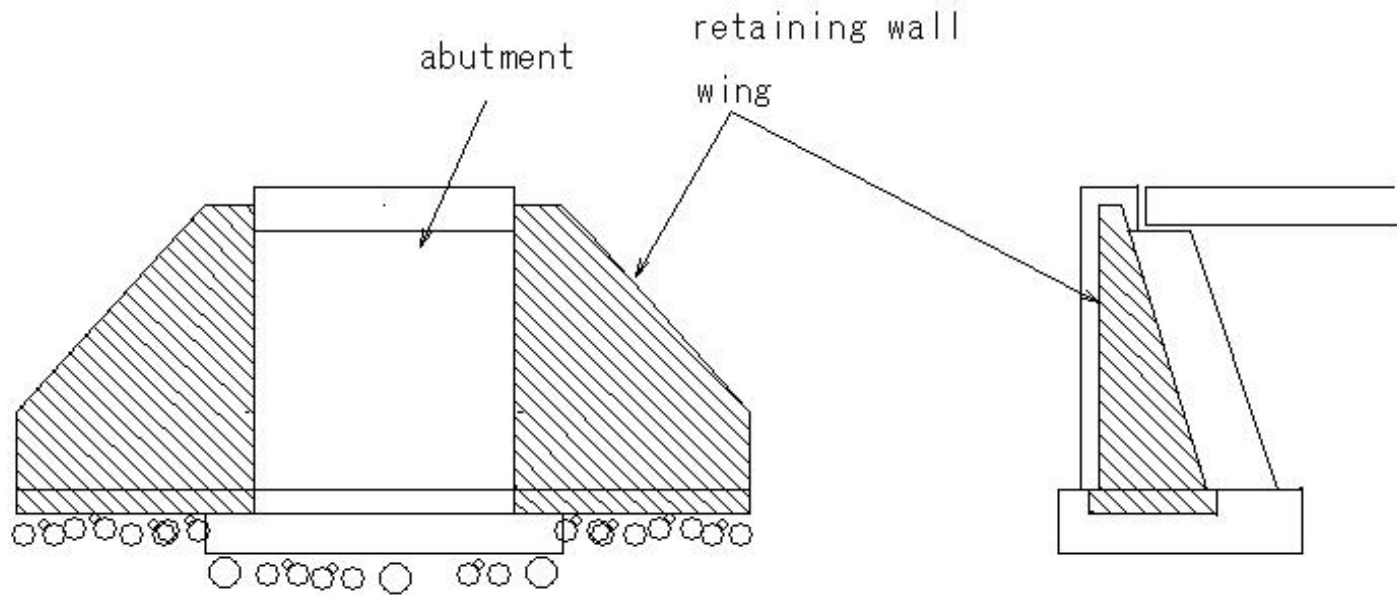


half-through bridge



(B137) Bridge type

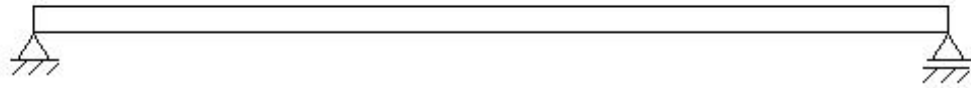
(B137) abutment (wing)



(B138)Bridge type(girder beam)

(B138)Bridge type(girder beam)

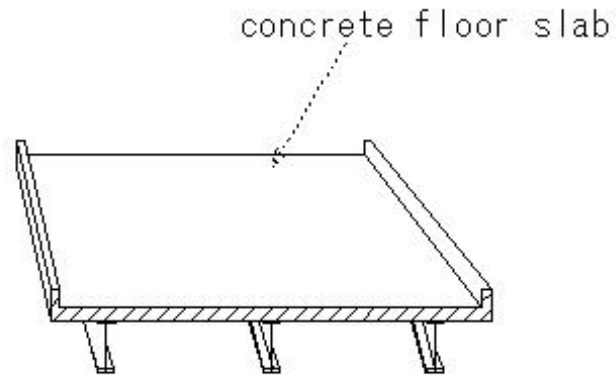
girder bridge



(B139)Bridge type(plate girder bridge)

(B139)Bridge type(plate girder bridge)

plate girder bridge

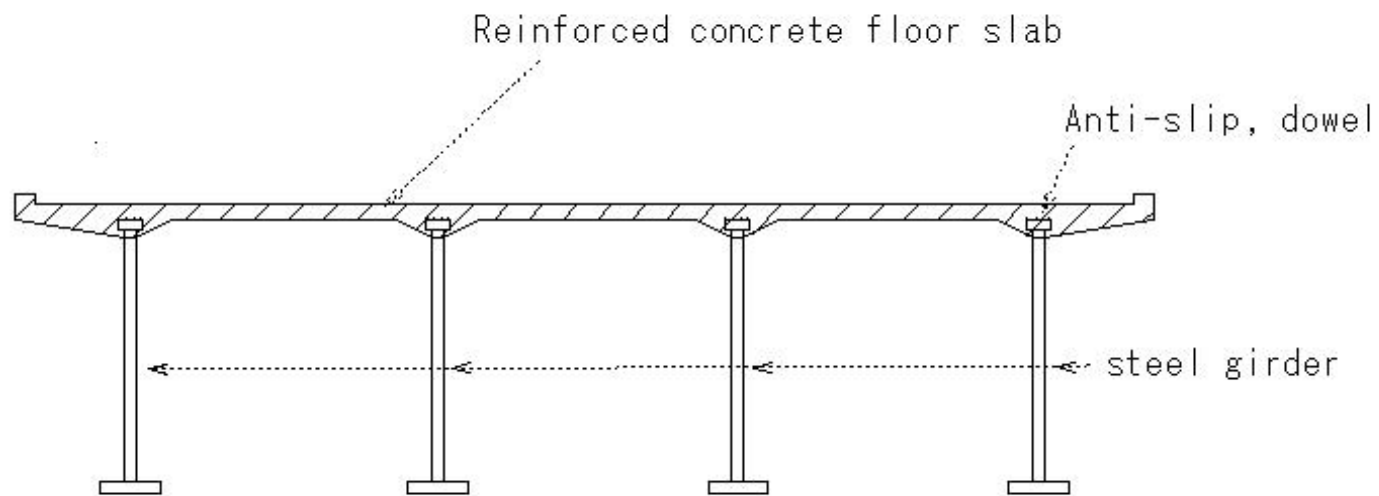


• Plate girder bridge

(B140) Bridge type (composite girder)

(B140) Bridge type (composite girder)

composite girder



Reinforced concrete floor slab

Anti-slip, dowel

steel girder

Steel/concrete composite girder

(B141) simple bridge

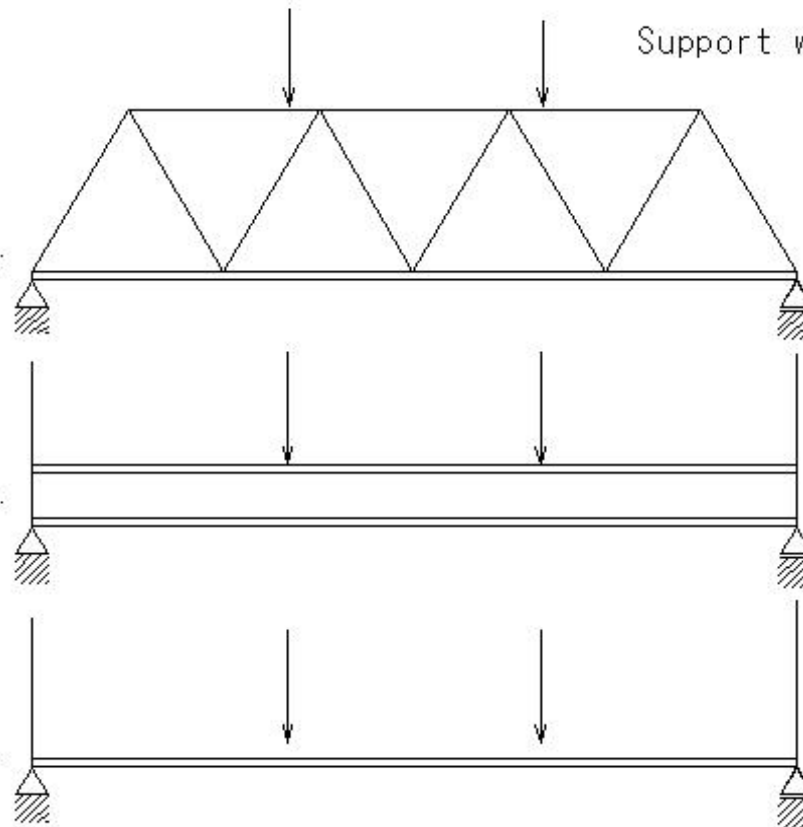
(B 1 41) simple bridge

simple truss bridge

Support with simple support
Main girder

simple girder bridge

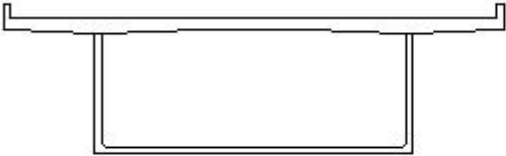
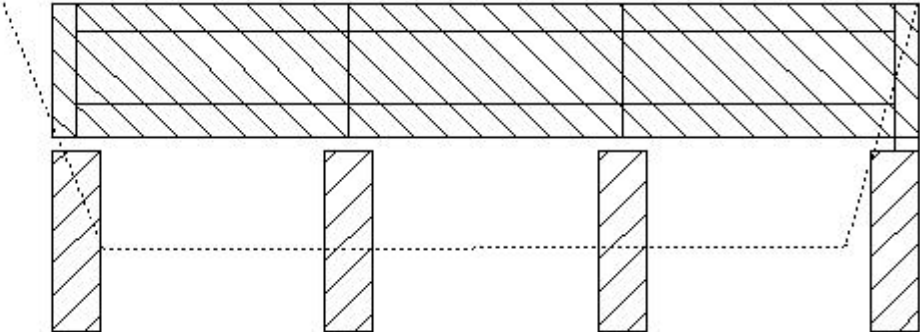
simple bridge



(B142)Bridge type(box girder)

(B142)Bridge type(box girder)

box girder



girder of box section

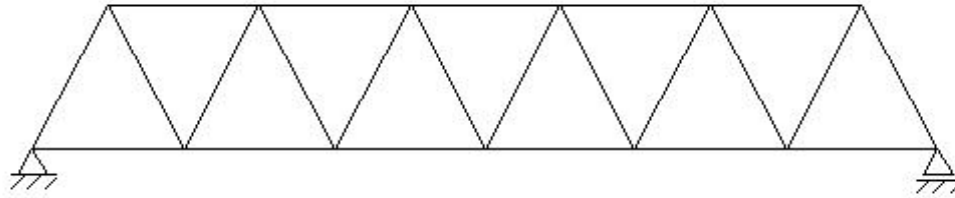
main girder

(B143)Bridge type(truss)

(B143) Bridge type(truss)

truss bridge

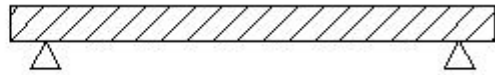
truss bridge



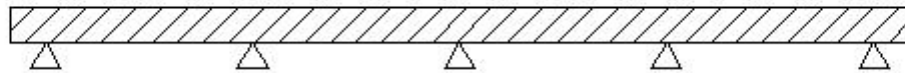
(B144)Bridge type

(B144)Bridge type

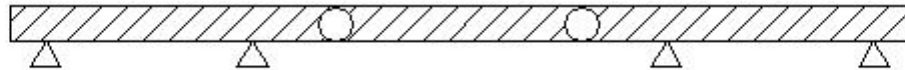
simple girder



continuos girder



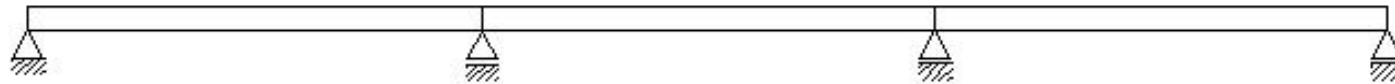
gerber girder



(B145)Bridge type(continuous girder truss)

(B145)Bridge type(continuous girder truss)

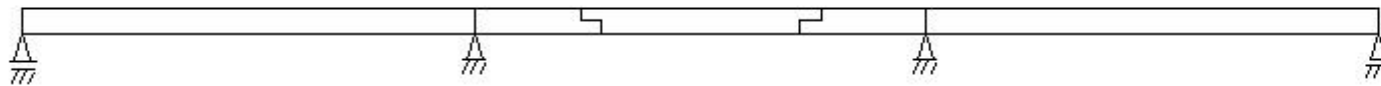
continuous girder truss



(B146) Bridge type (gerber bridge/cantilever bridge)

(B146) Bridge type (gerber bridge/cantilever bridge)

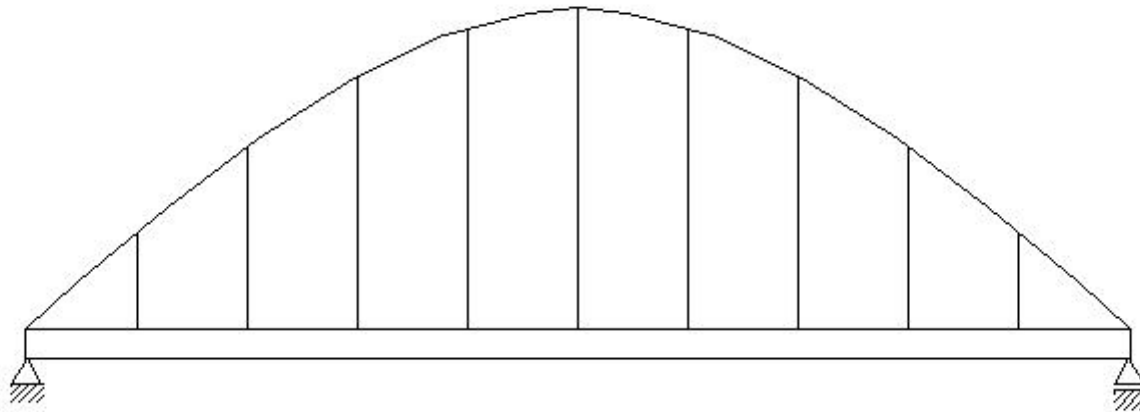
gerber bridge/cantilever bridge



(B147)Bridge type(arch bridge)

(B147) Bridge type(arch bridge)

arch bridge



(B148)Bridge type(Rahmen/rigid-frame bridge)

(B148)Bridge type(Rahmen/rigid-frame bridge)

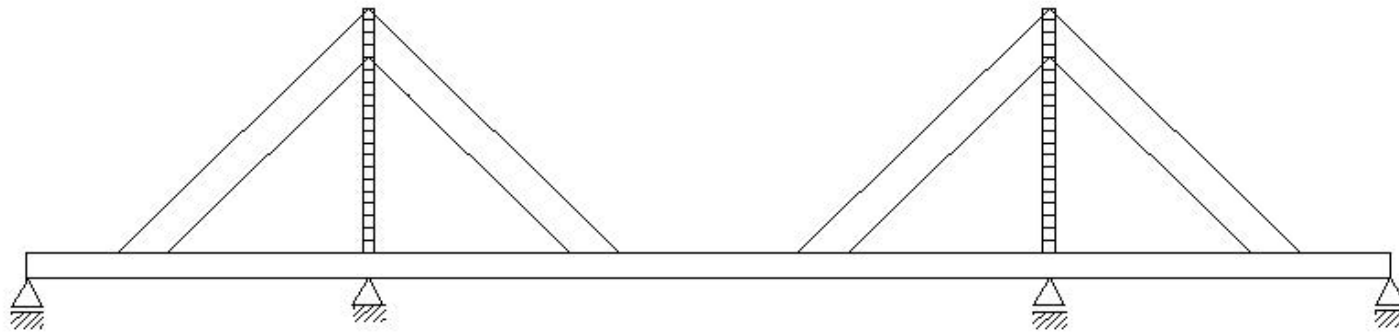
Rahmen/rigid-frame bridge



(B149)Bridge type(cable stayed bridge)

(B149)Bridge type(cable stayed bridge)

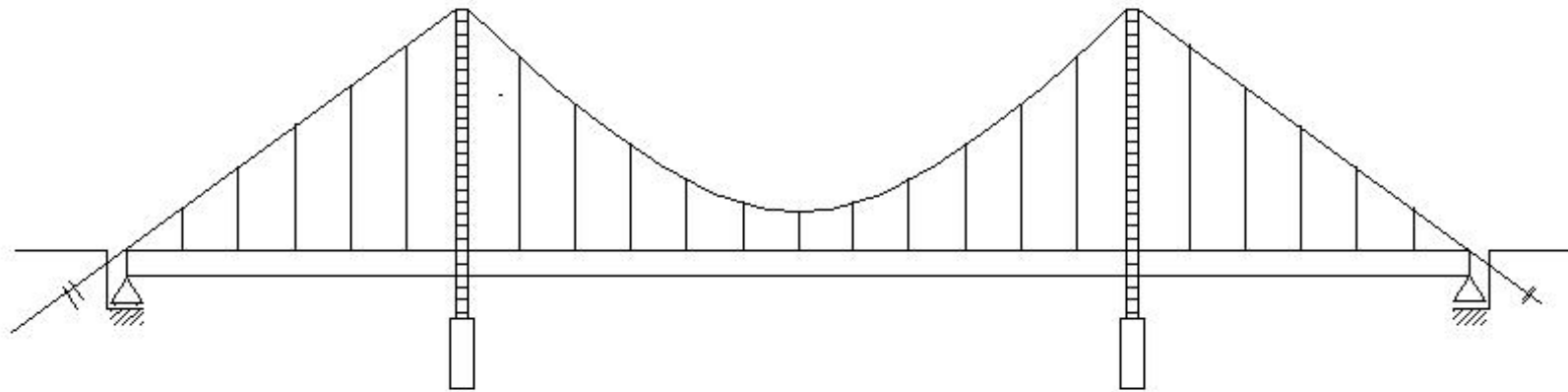
cable stayed bridge



(B150)Bridge type(suspension bridge)

(B150) Bridge type(suspension bridge)

suspension bridge

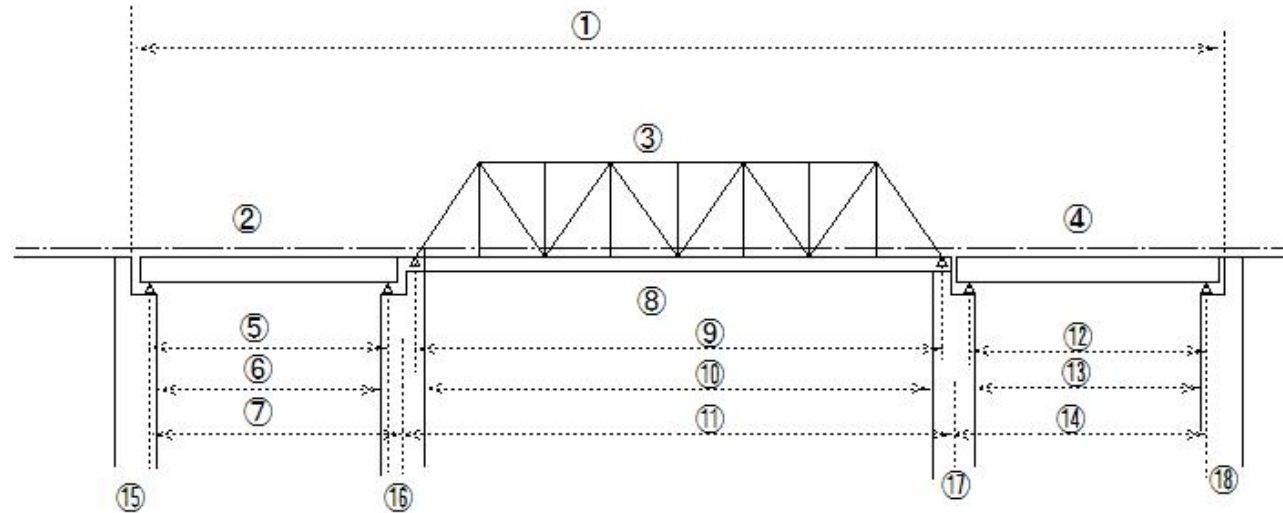


(B151)Bridge composition

(B151)Bridge composition

Bridge composition
superstructure

- ① Bridge length
- ② deck bridge
- ③ through bridge(truss bridge)
- ④ Girder bridge
- ⑤ Span
- ⑥ clear span
- ⑦ Side span
- ⑧ Road location
- ⑨ Span
- ⑩ clear span
- ⑪ Central span
- ⑫ Span
- ⑬ clear span
- ⑭ Central span
- ⑮ Abutment
- ⑯ Pier
- ⑰ Pier
- ⑱ Abutment



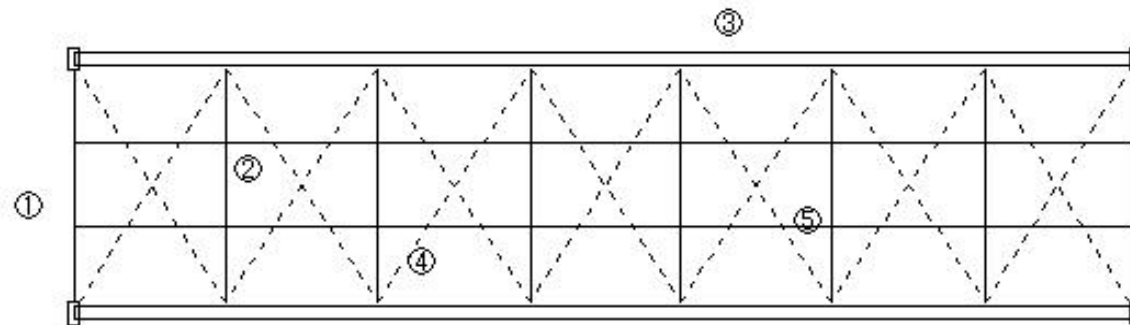
(B152)Bridge composition(floor beam and lateral bracing)

(B152)Bridge composition(floor beam and lateral bracing)

Bridge composition

floor beam and lateral bracing

- ①End crossbeam
- ②Floor girder
- ③main truss /main girder
- ④lateral bracing
- ⑤stringer
- ⑥sway bracing
- ⑦wind bracing
- ⑧Support



(B153)Bridge composition(Bridge width)

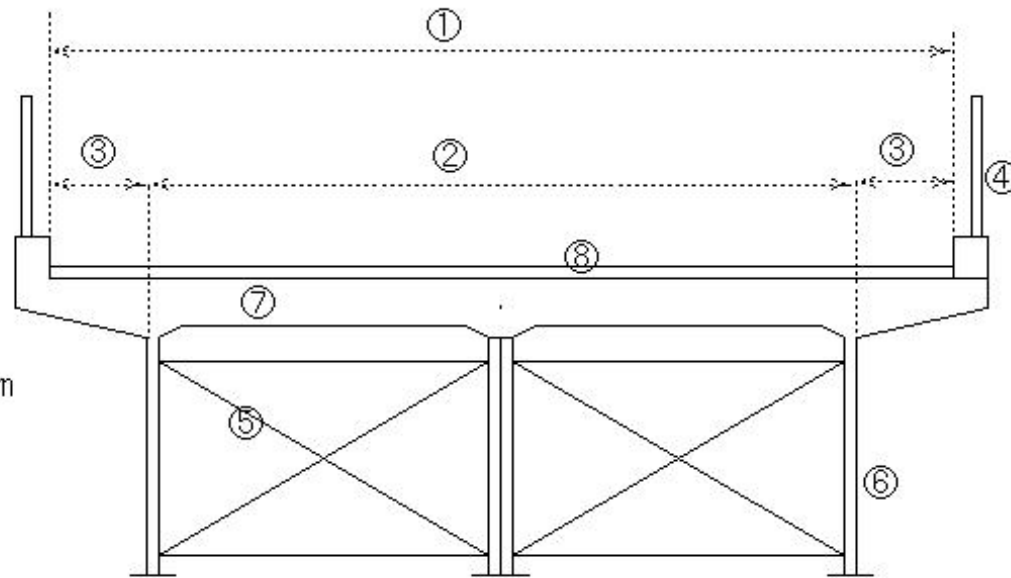
(B153)Bridge composition(Bridge width)

Bridge composition

Bridge width

- ① Bridge width
- ② Roadway width
- ③ S:urban area 0.25m/rural area 0.5m
- ④ handrail
- ⑤ sway bracing
- ⑥ main truss
- ⑦ Floor slab
- ⑧ Paving

1 lane minimum value 2.75m
Expressway maximum 3.75m



(B154) Bridge composition (Bridge width)

(B154) Bridge composition (Bridge width)

Bridge composition

Bridge width

① Bridge width

② Roadway width

③ s

④ handrail

⑤ Stringer

⑥ lateral bracing

⑦ Main girder

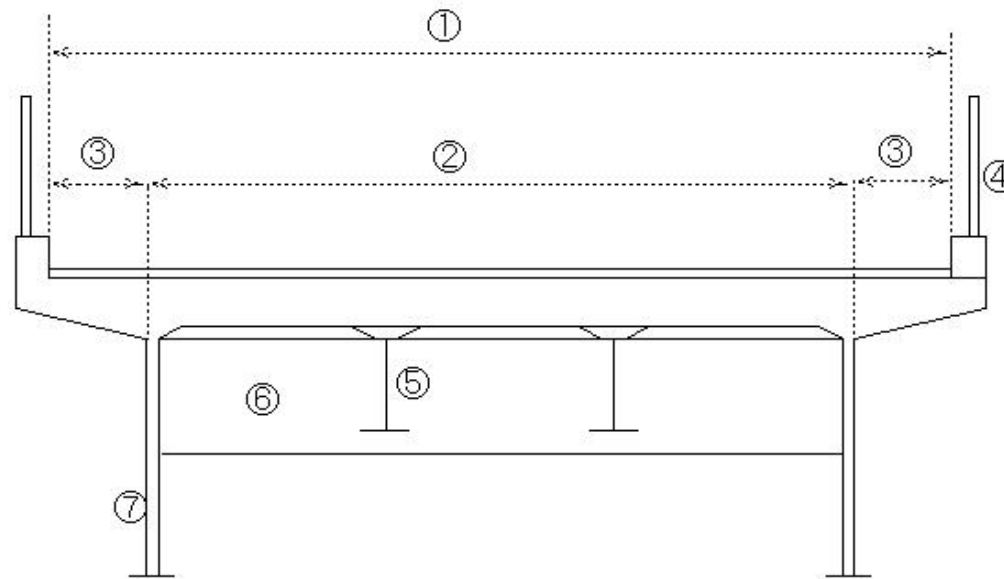
Vertical slope 0.5-2.0%

Cross slope road drainage

Sidewalk 1%

Road 2%

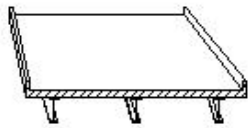
Sidewalk curb 15cm



(B155)Bridge composition(Bridge length)

(B155)Bridge composition(Bridge length)

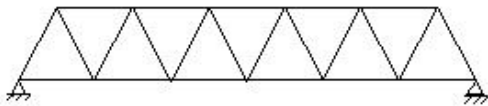
1 plate girder composite girder <40m



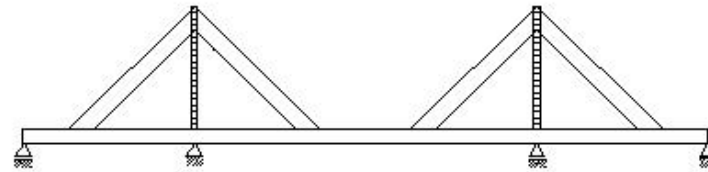
2 continuous girder truss 40-200m



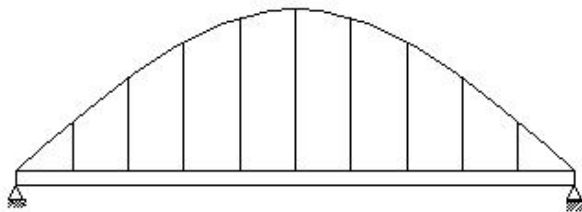
3 truss 50-300m



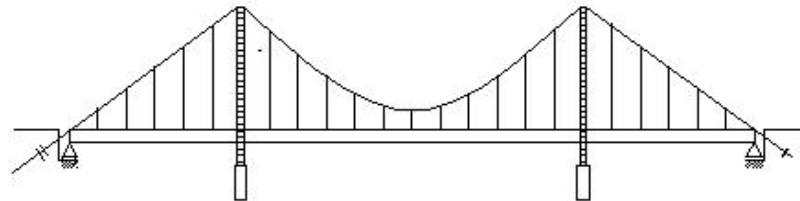
4 Cable-stayed bridge 100-350m



5 arches 80-500m



6 suspension bridge 100-1500m

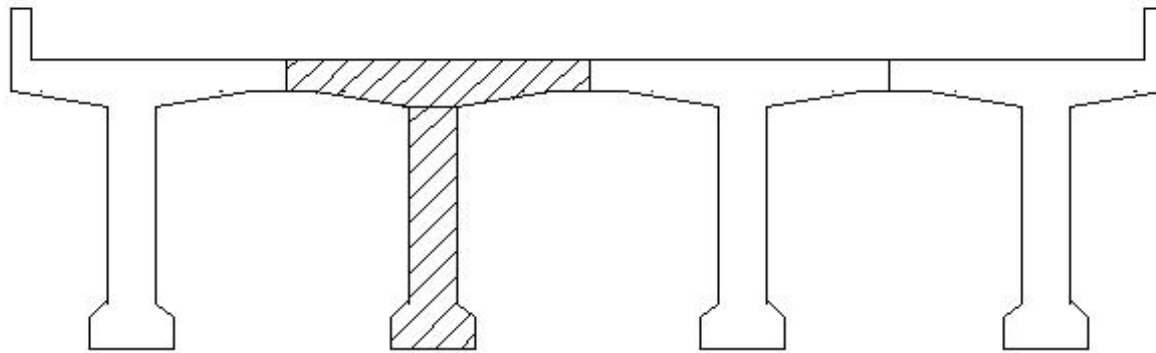


(B156)I beam bridge

(B156) I beam bridge

I girder bridge

Main girder: I-shaped cross-section girder

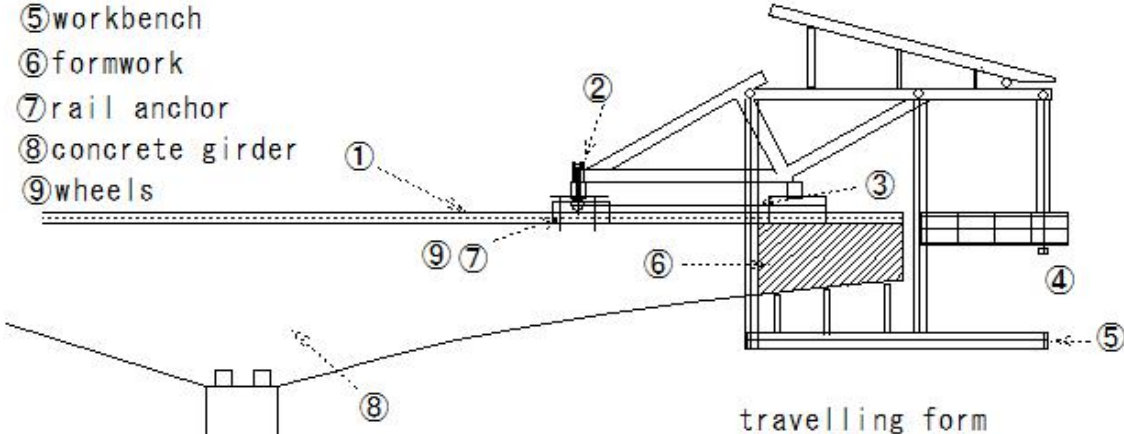


(B157) Bridge erection(travelling form)

(B157) Bridge erection(travelling form)

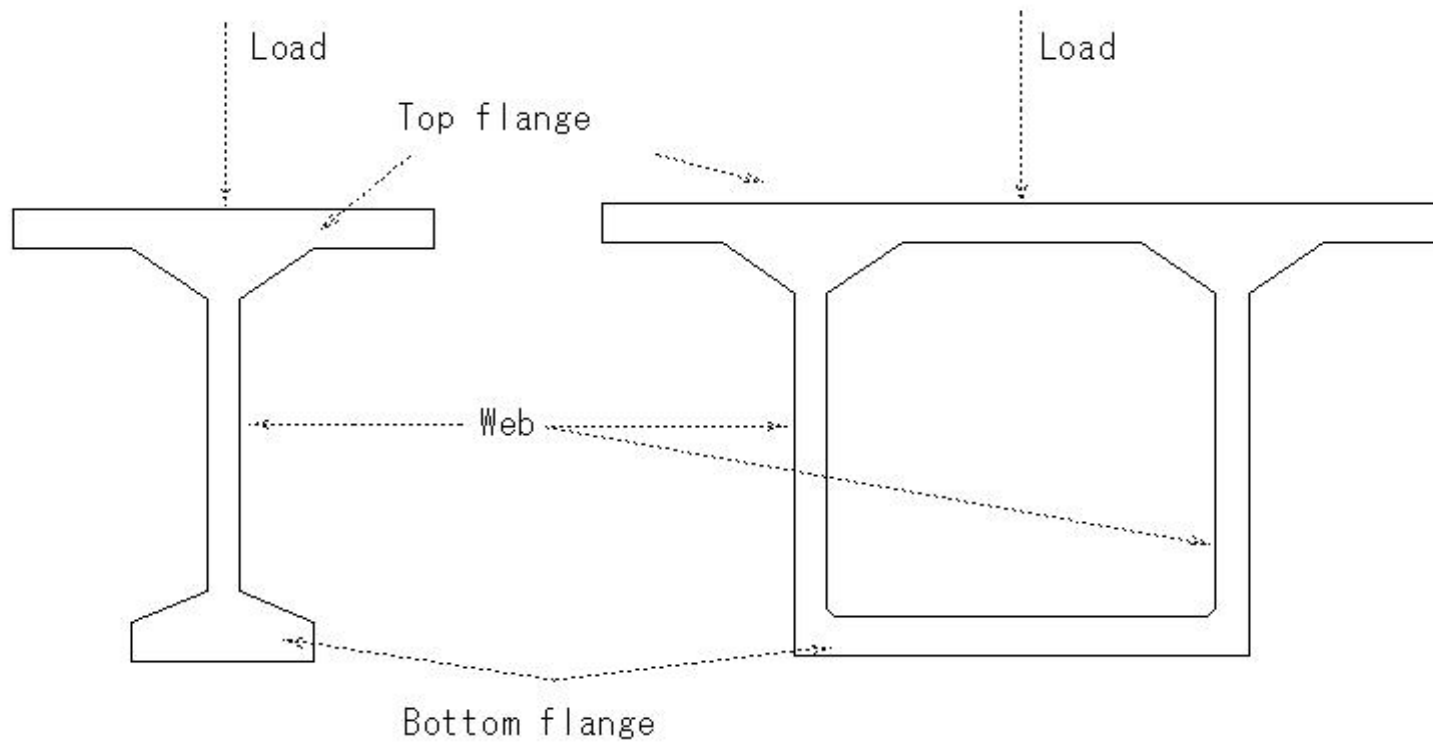
travelling form
moveable form carrier
mobile work vehicle

- ①moving rail
- ②anchors
- ③wheels
- ④workbench
- ⑤workbench
- ⑥formwork
- ⑦rail anchor
- ⑧concrete girder
- ⑨wheels



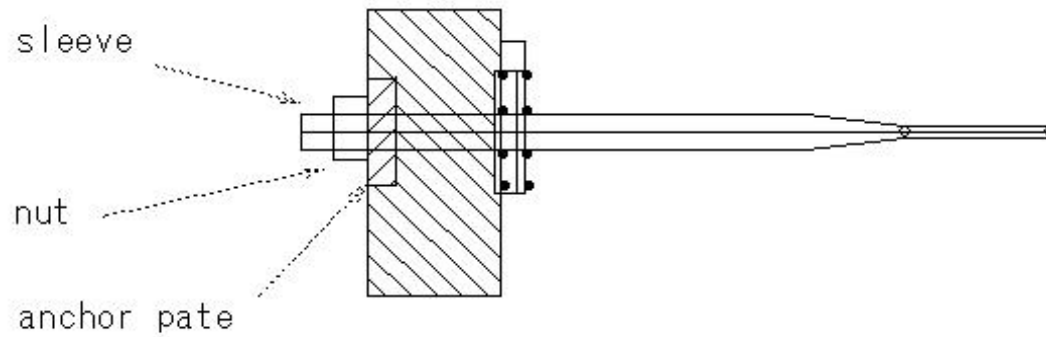
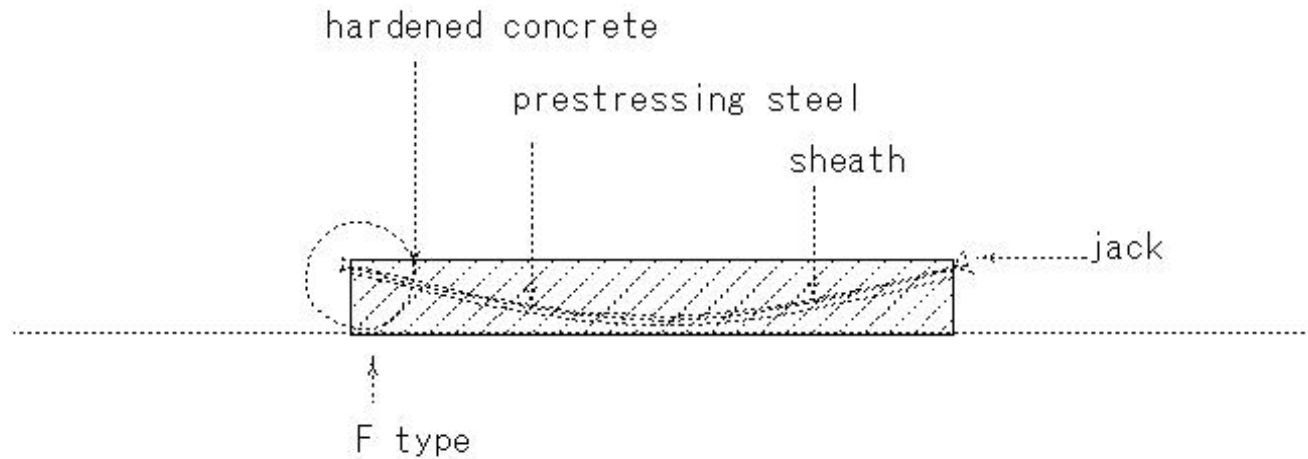
(B158)web

(B158) web



(B159)PC steel fixing method(SEEE method)

(B159)PC steel fixing method(SEEE method)

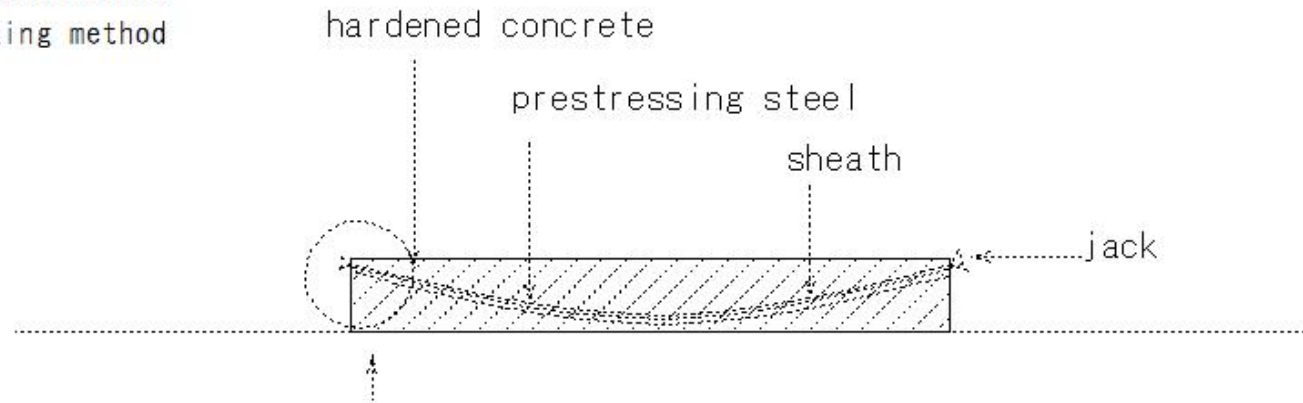


Fixing method of PC steel

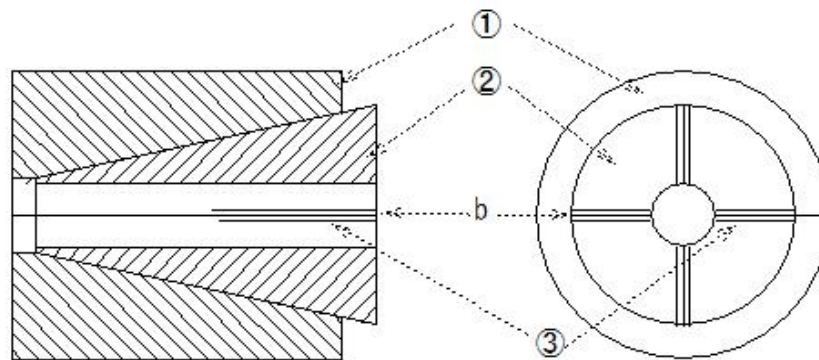
(B160)PC steel fixing method(SM method)

(B160)PC steel fixing method(SM method)

smitomo-monostrad method
PC steel fixing method



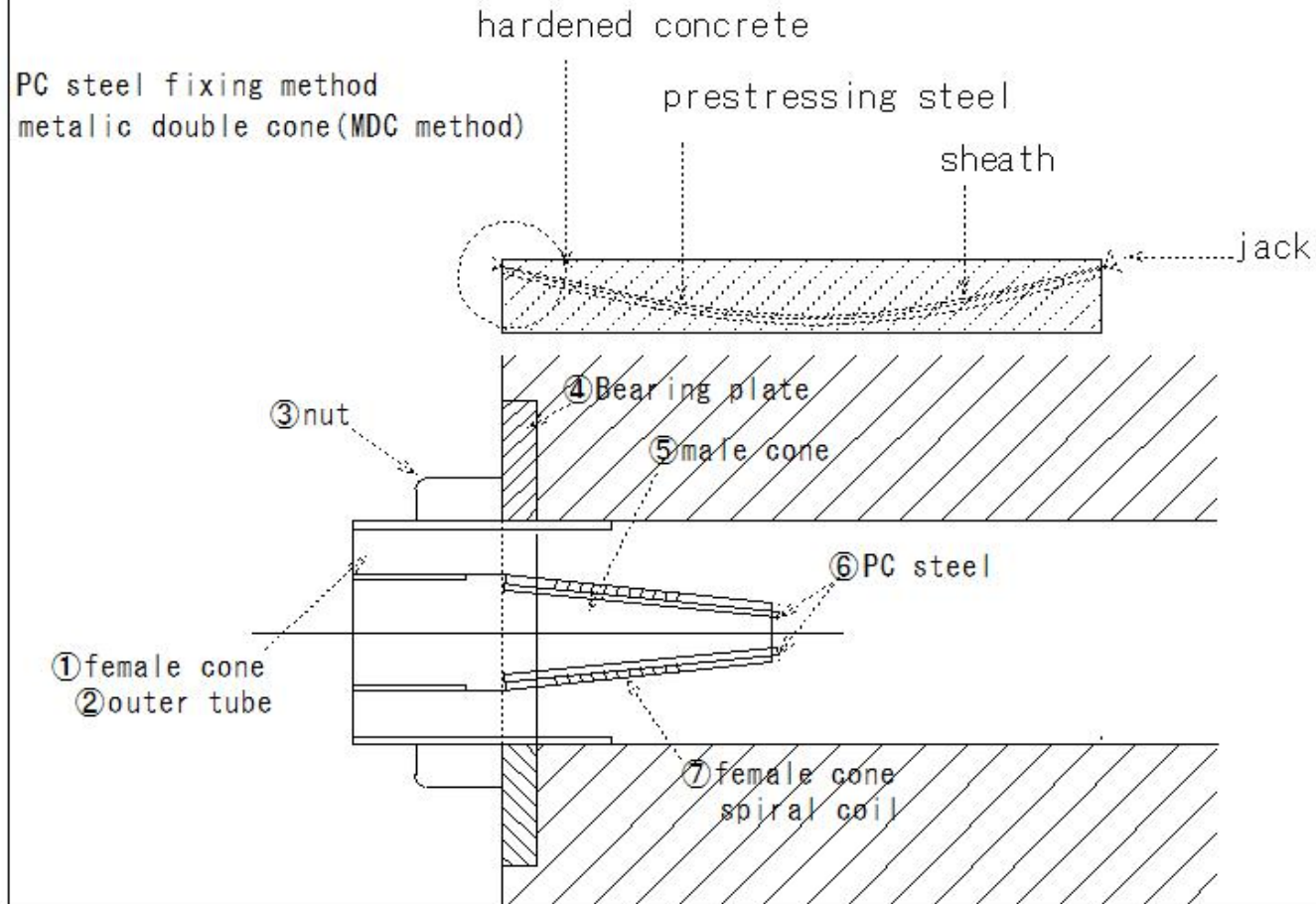
- ① Male cone
- ② Female cone
- ③ Slit



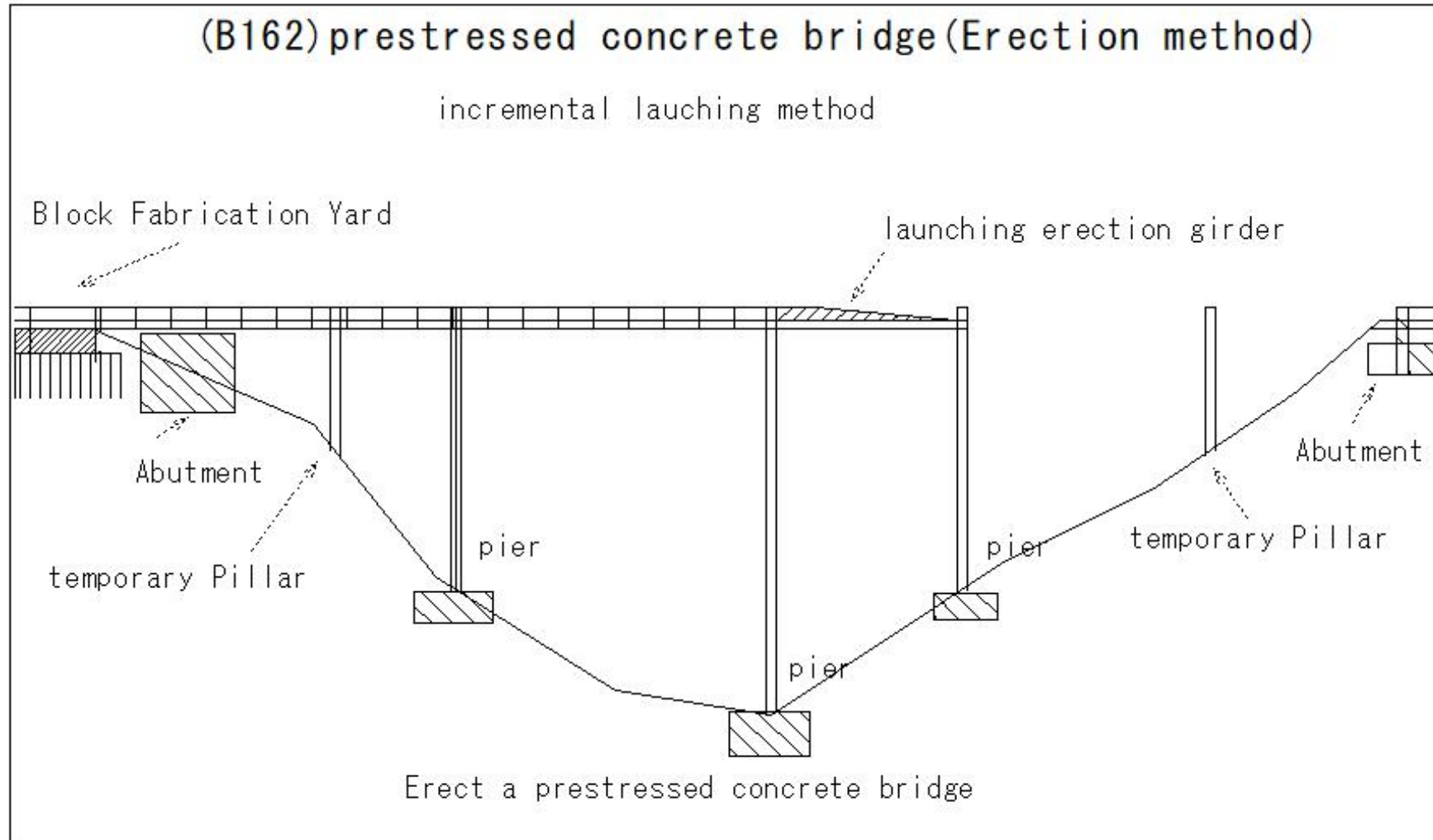
Wedge-shaped clip

(B161)PC steel fixing method(MDC method)

(B161)PC steel fixing method(MDC method)



(B162)prestressed concrete bridge(Erection method)



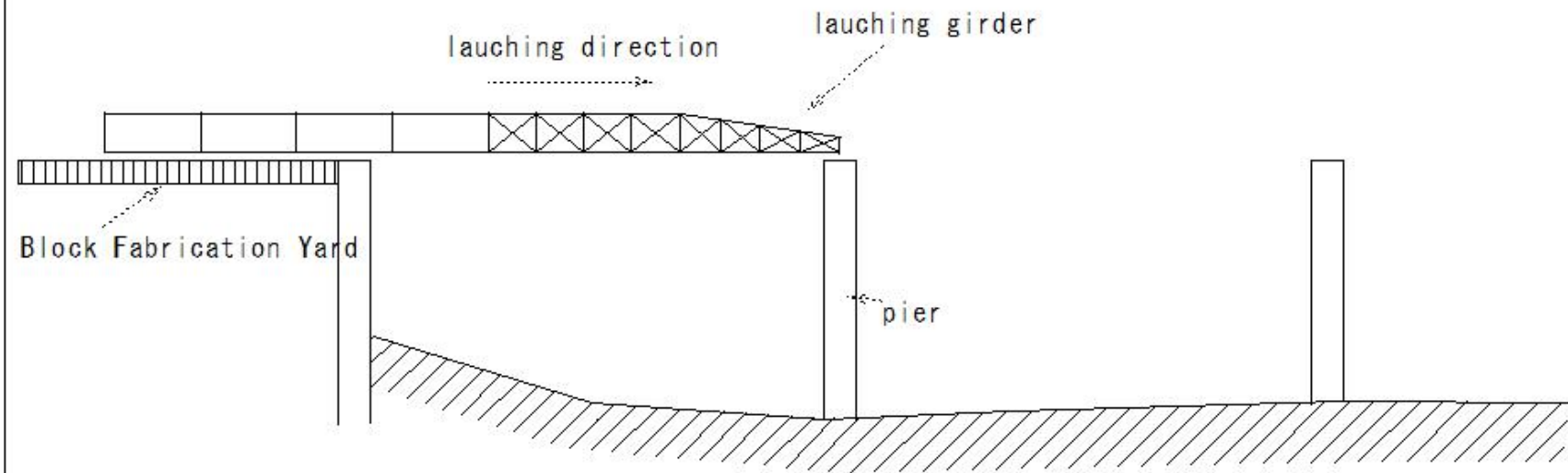
(B163)prestressed concrete bridge(Erection method)

(B163)prestressed concrete bridge(Erection method)

prestressed concrete bridge

Erection method

incremental launching method



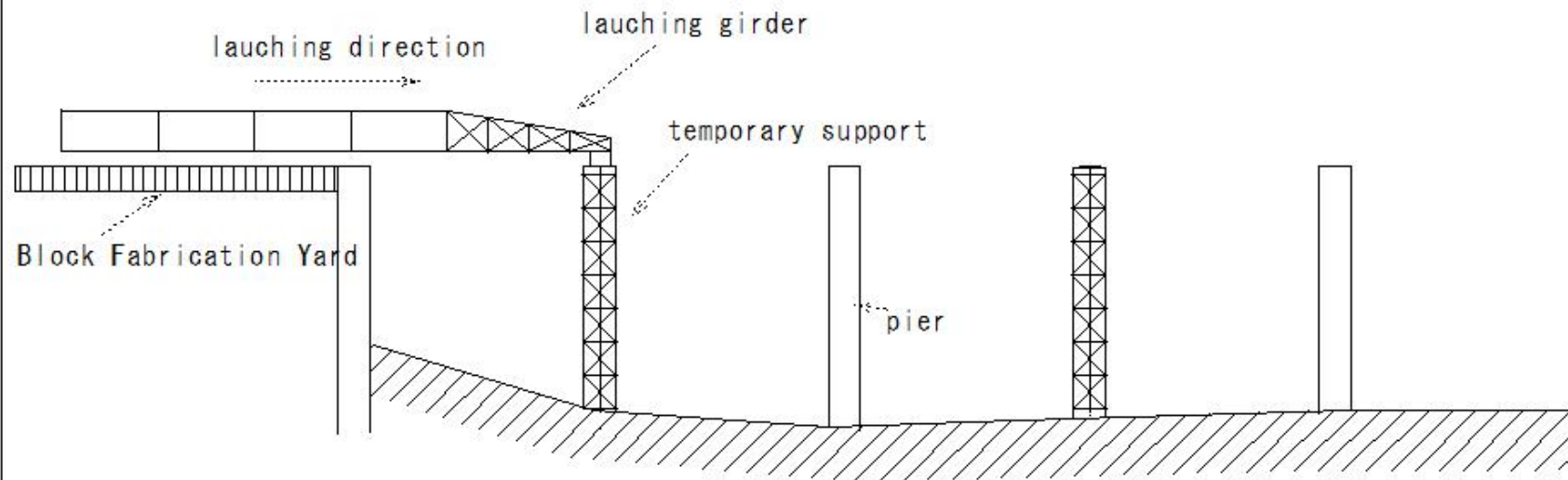
(B164)prestressed concrete bridge(Erection method)

(B164)prestressed concrete bridge(Erection method)

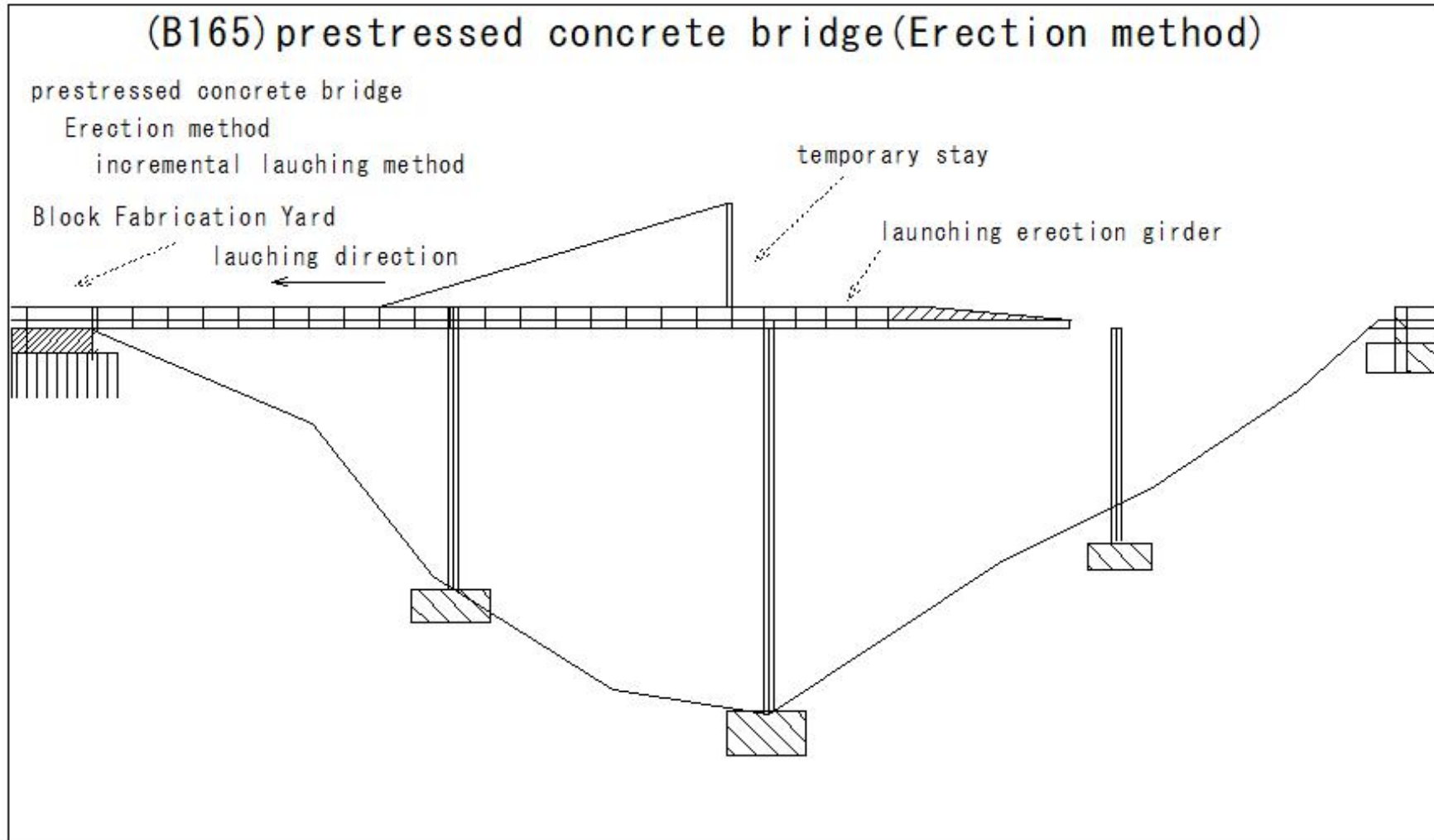
prestressed concrete bridge

Erection method

incremental launching method



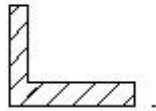
(B165)prestressed concrete bridge(Erection method)



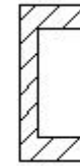
(B166)hot rolled steel section

(B166)hot rolled steel section

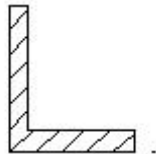
Angle iron



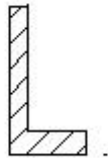
Channel steel



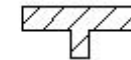
Angle iron



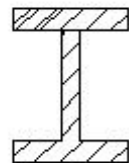
Angle iron



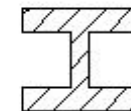
T steel



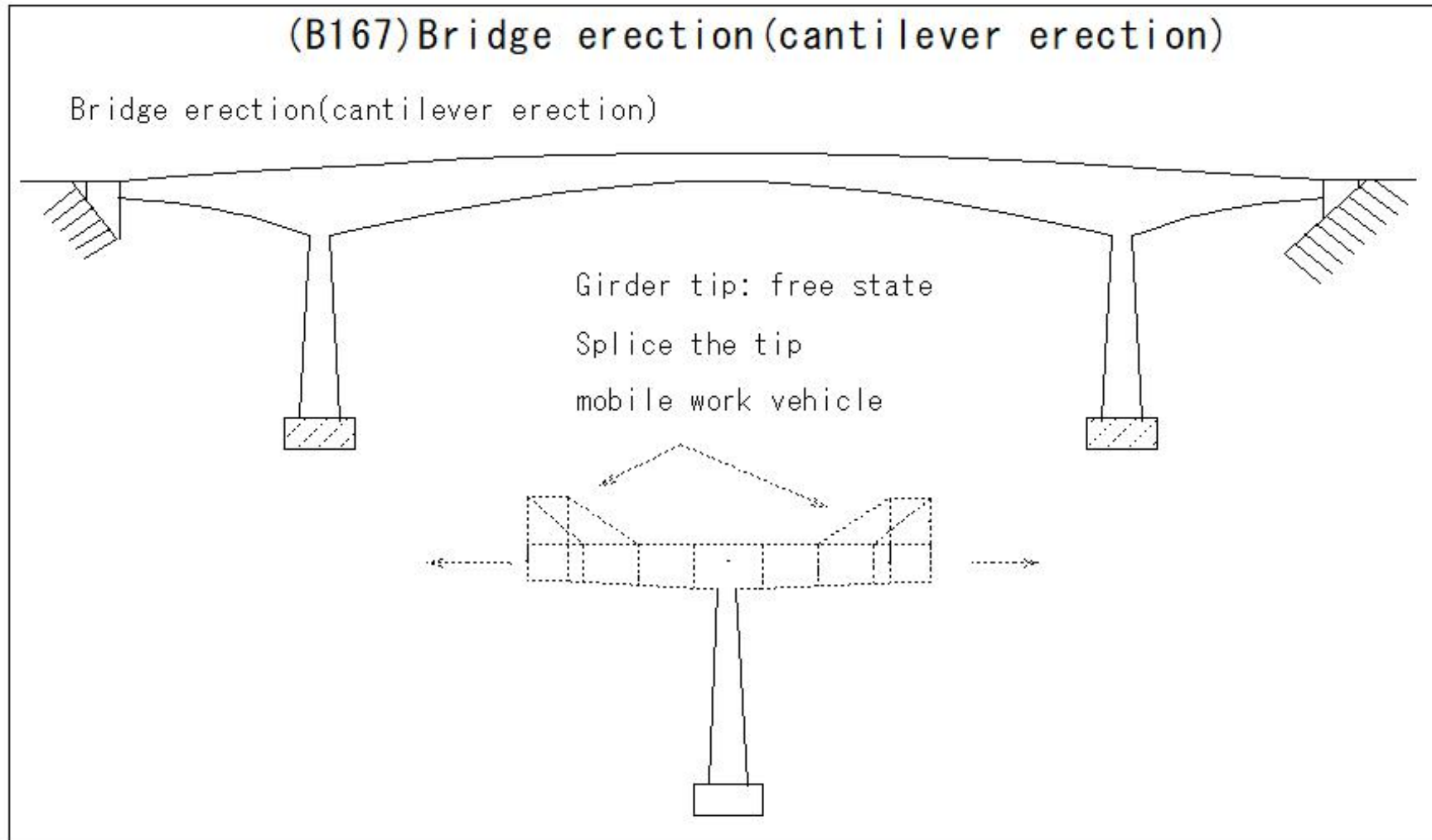
I-type steel



H steel

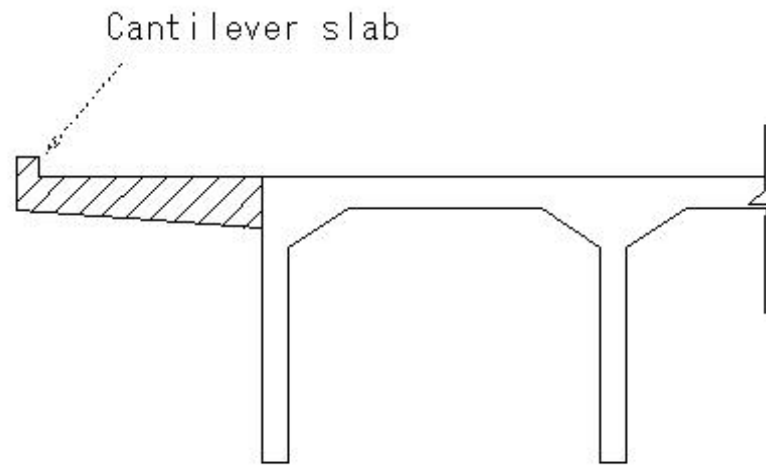
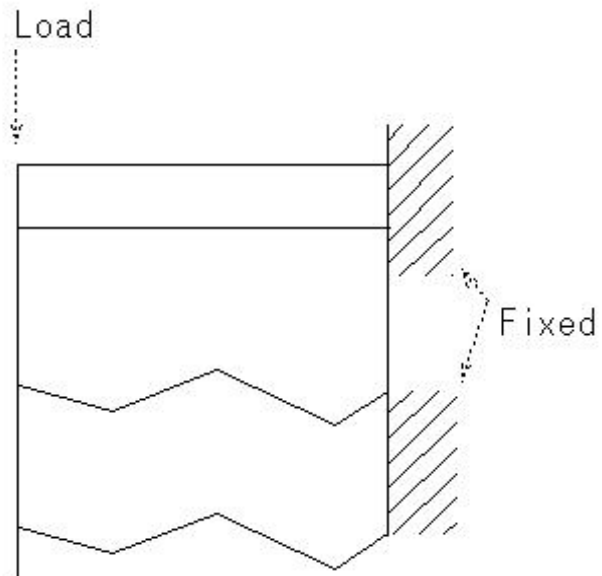


(B167) Bridge erection(cantilever erection)



(B168) Bridge erection (cantilever erection)

(B168) Bridge erection (cantilever slab)



Cantilever slab

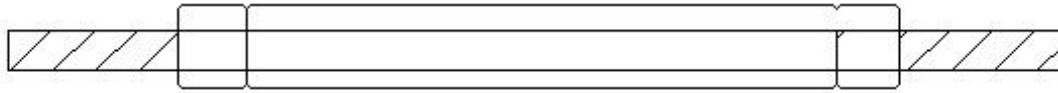
Overhang of road bridge deck

(B169)Coupler joint

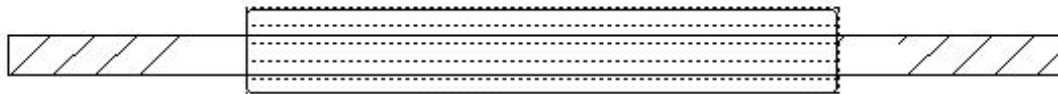
(B169) Coupler joint

Rebar joint for concrete

①Fixed torque



②Resin fixed type



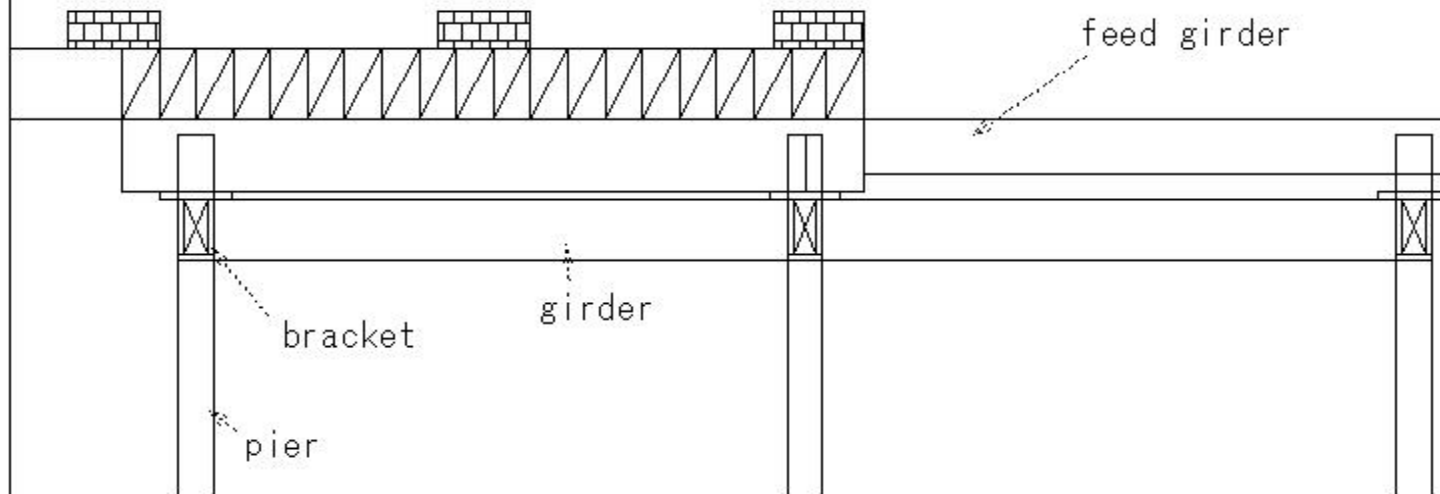
③Crimp fixing method



(B170) Bridge erection (Movable shoring)

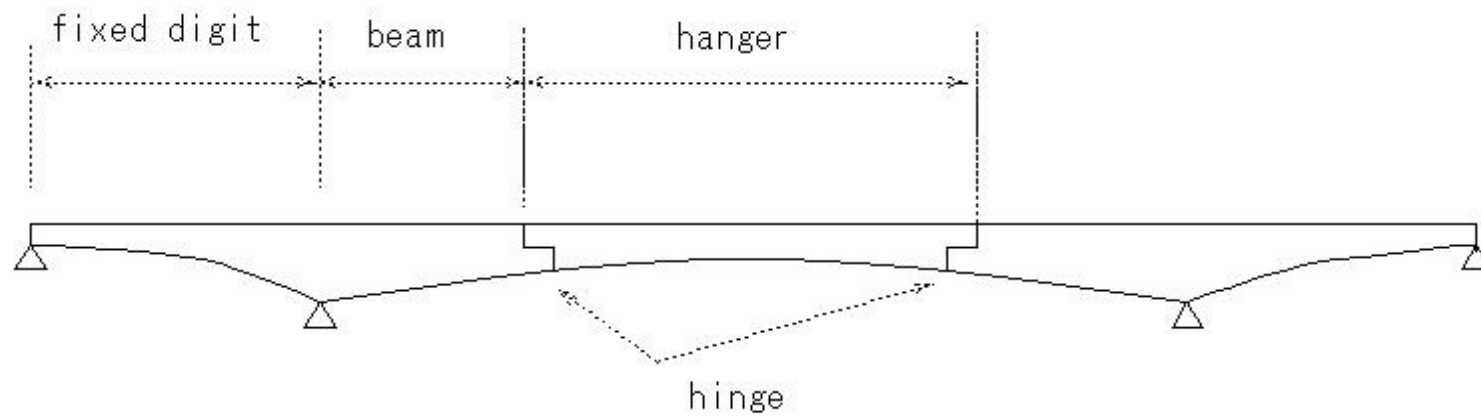
(B170) Bridge erection (Movable shoring)

Bridge erection (Movable shoring)



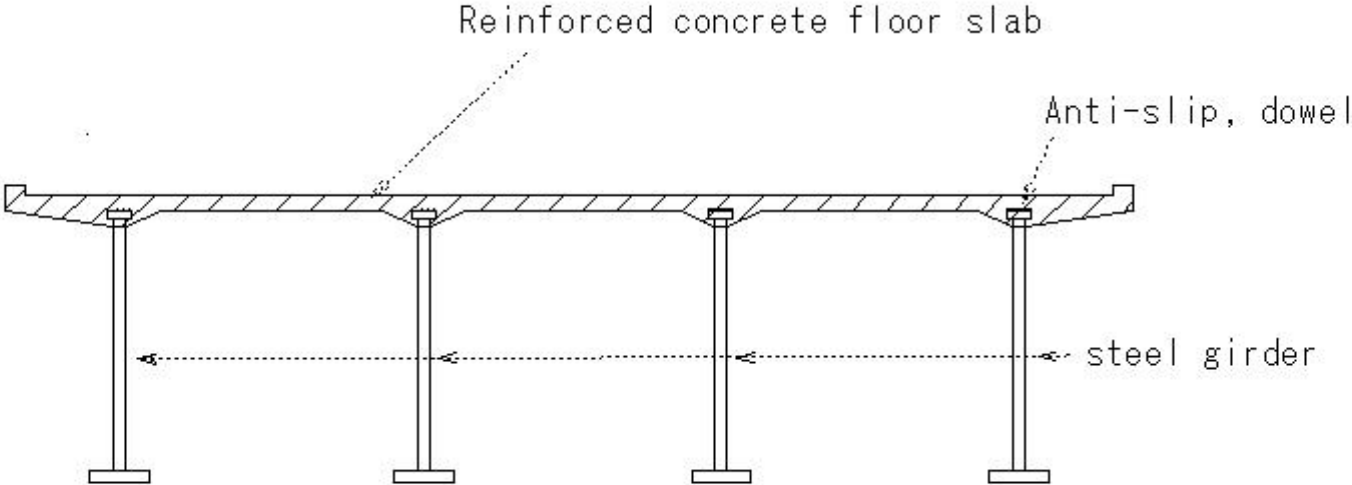
(B171)cantilever-bridge girder bridge(gerber bridge)

(B171)cantilever-bridge girder bridge(gerber bridge)



(B172) composite girder(Steel/concrete composite girder)

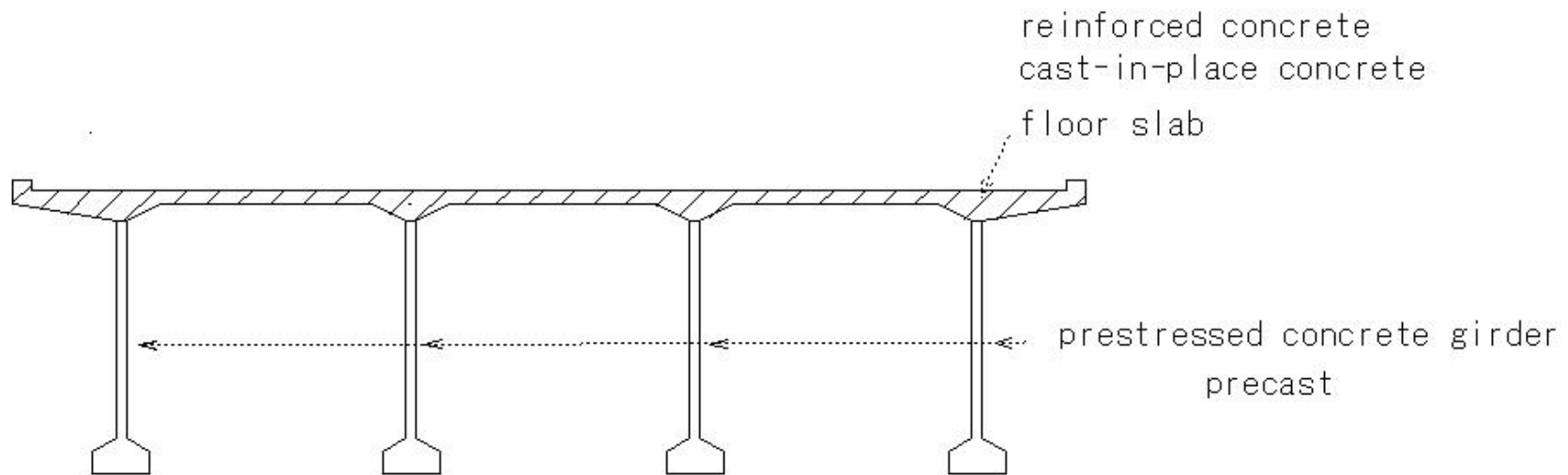
(B172) composite girder (Steel/concrete composite girder)



Steel/concrete composite girder

(B173) composite girder (Prestressed concrete composite girder)

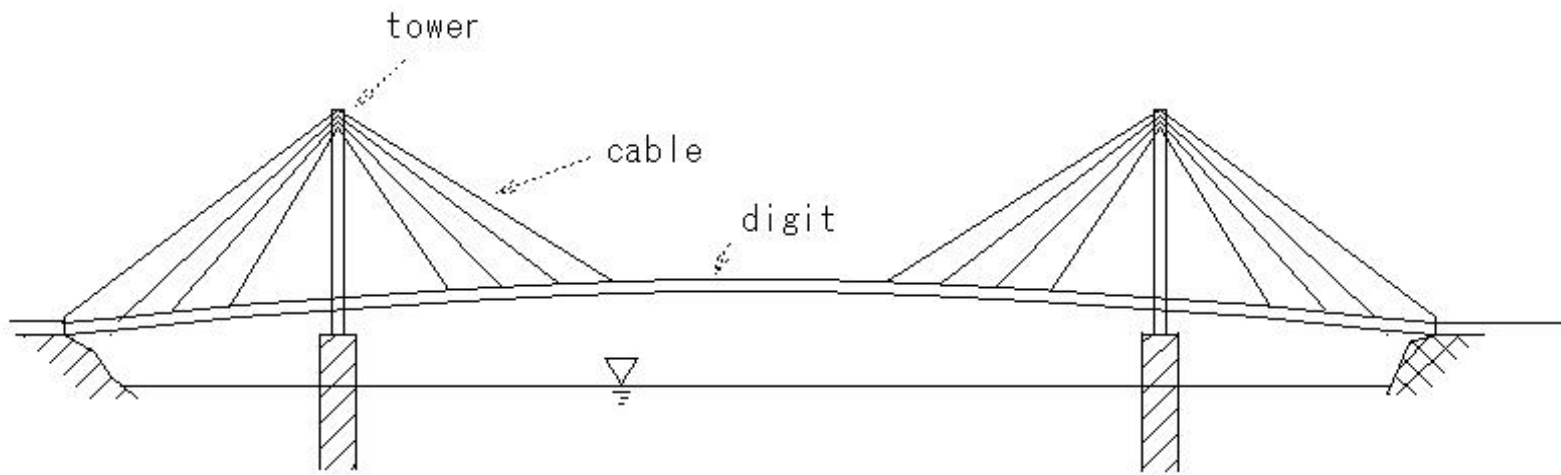
(B173) composite girder (Prestressed concrete composite girder)



Prestressed concrete composite girder

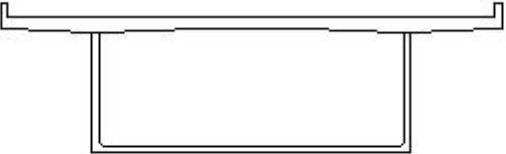
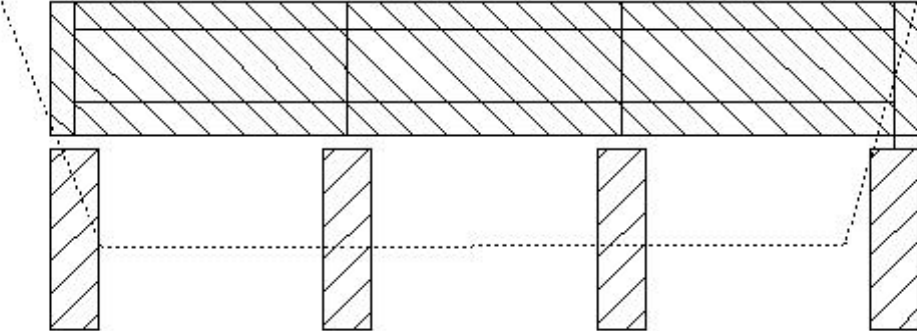
(B174)cable-stayed bridge

(B174) cable-stayed bridge



(B175)Box girder bridge

(B175) Box girder bridge

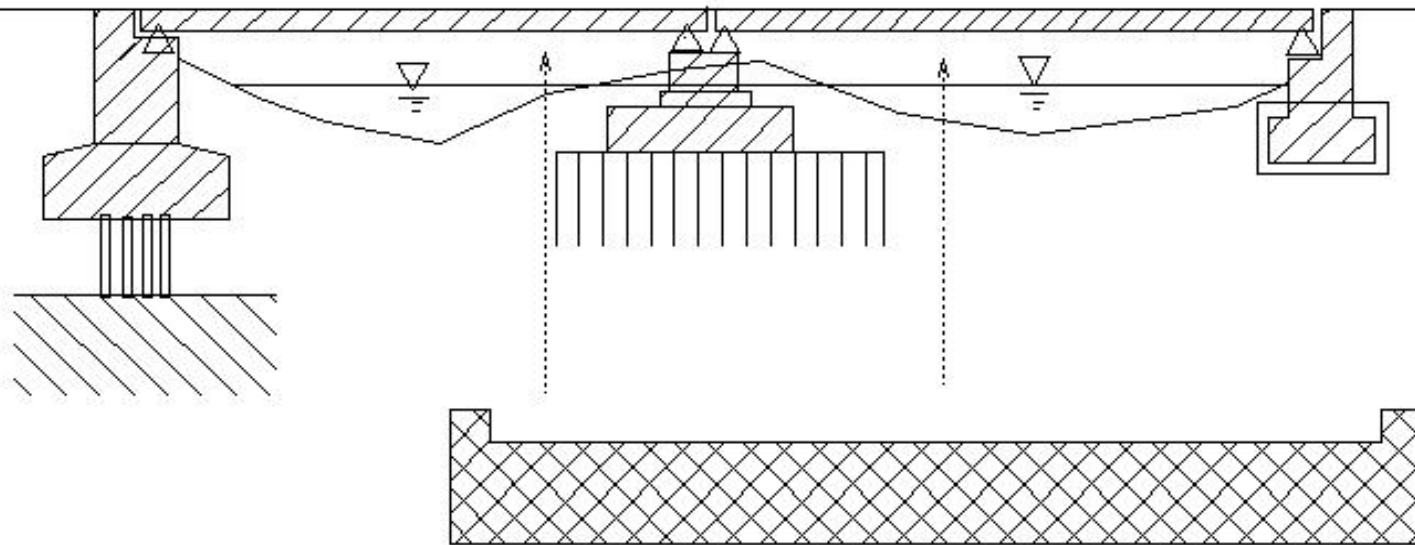


girder of box section

main girder

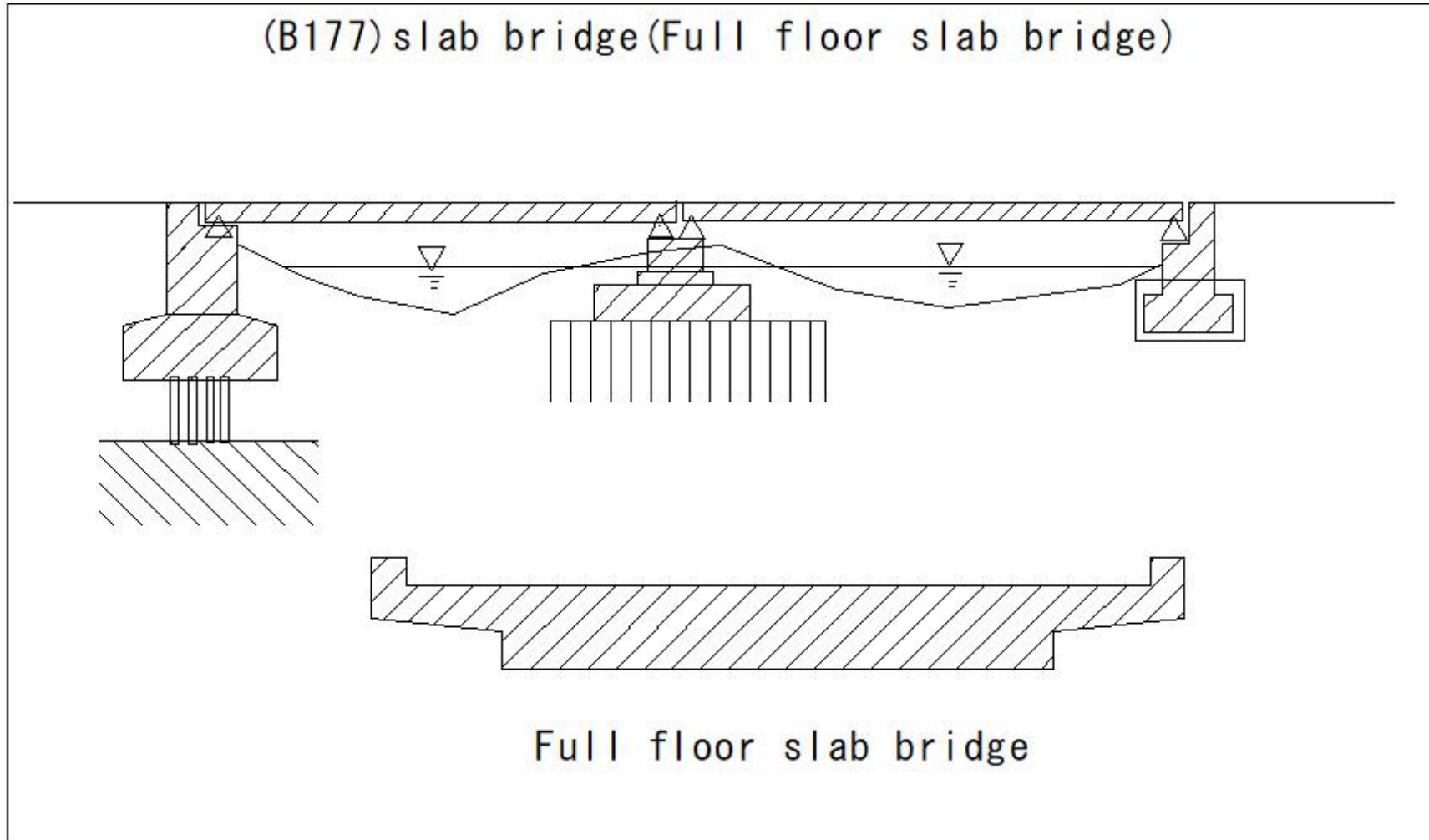
(B176)slab bridge(Reinforced concrete slab bridge)

(B176)slab bridge(Reinforced concrete slab bridge)



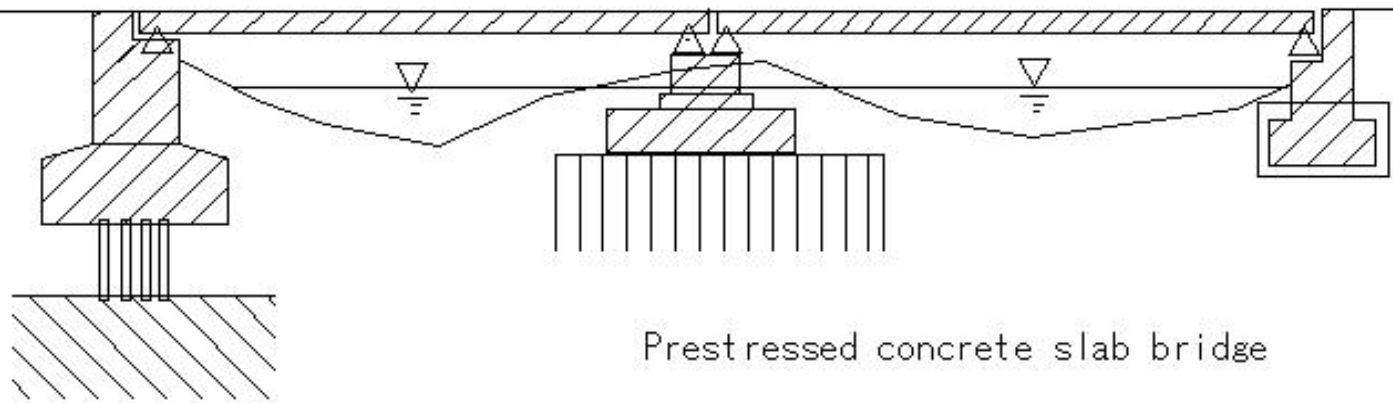
① Reinforced concrete slab bridge
(RC slab bridge)

(B177)slab bridge(Full floor slab bridge)

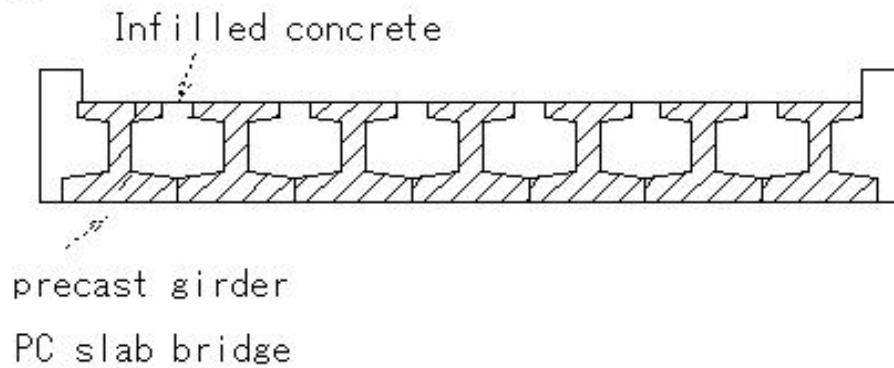


(B178)slab bridge(precast girder)

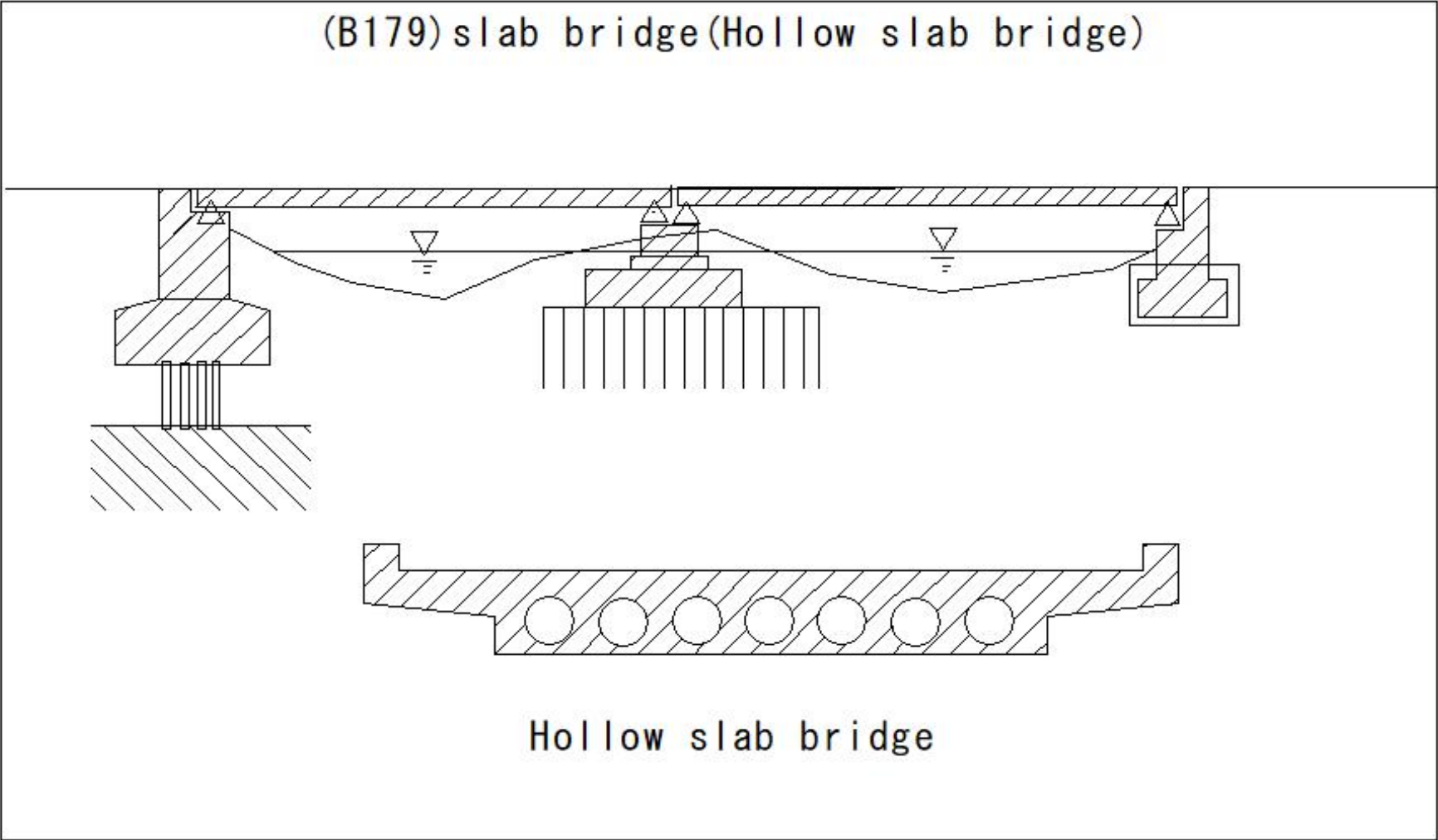
(B178)slab bridge(precast girder)



Prestressed concrete slab bridge

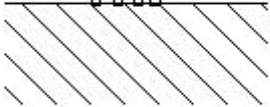
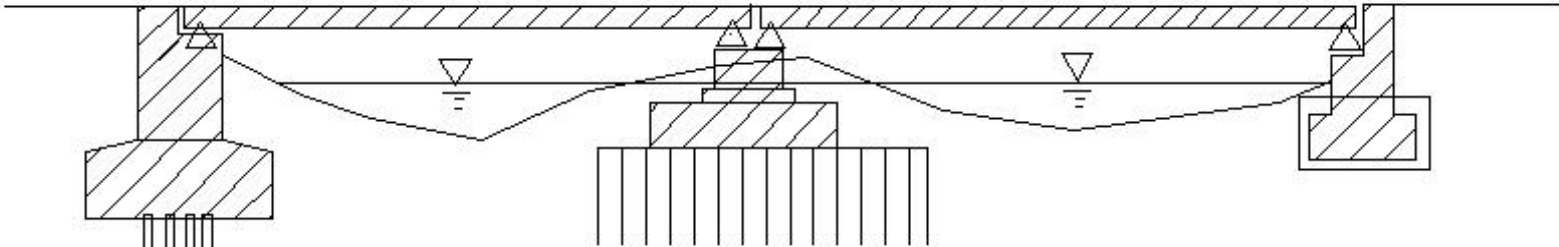


(B179)slab bridge(Hollow slab bridge)



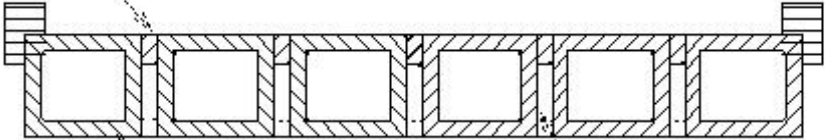
(B180)slab bridge(Precast girder bridge)

(B180) slab bridge (Precast girder bridge)



Precast girder bridge

filling concrete

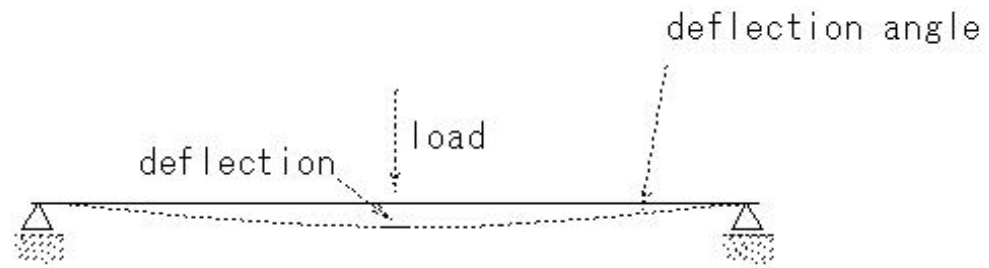


precast girder

crossbeam

(B181)Deflection

(B181) Deflection



amount of deformation due to load

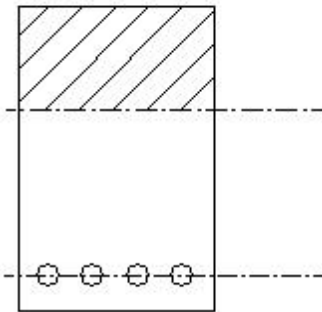
(B182)Single rebar-Abdominal rebar

(B182) Single rebar-Abdominal rebar

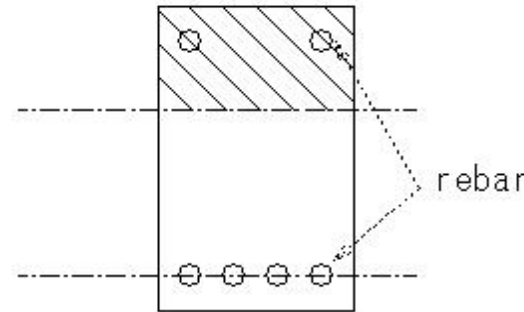
compression side cross section

neutral axis

pulling side



Single rebar-

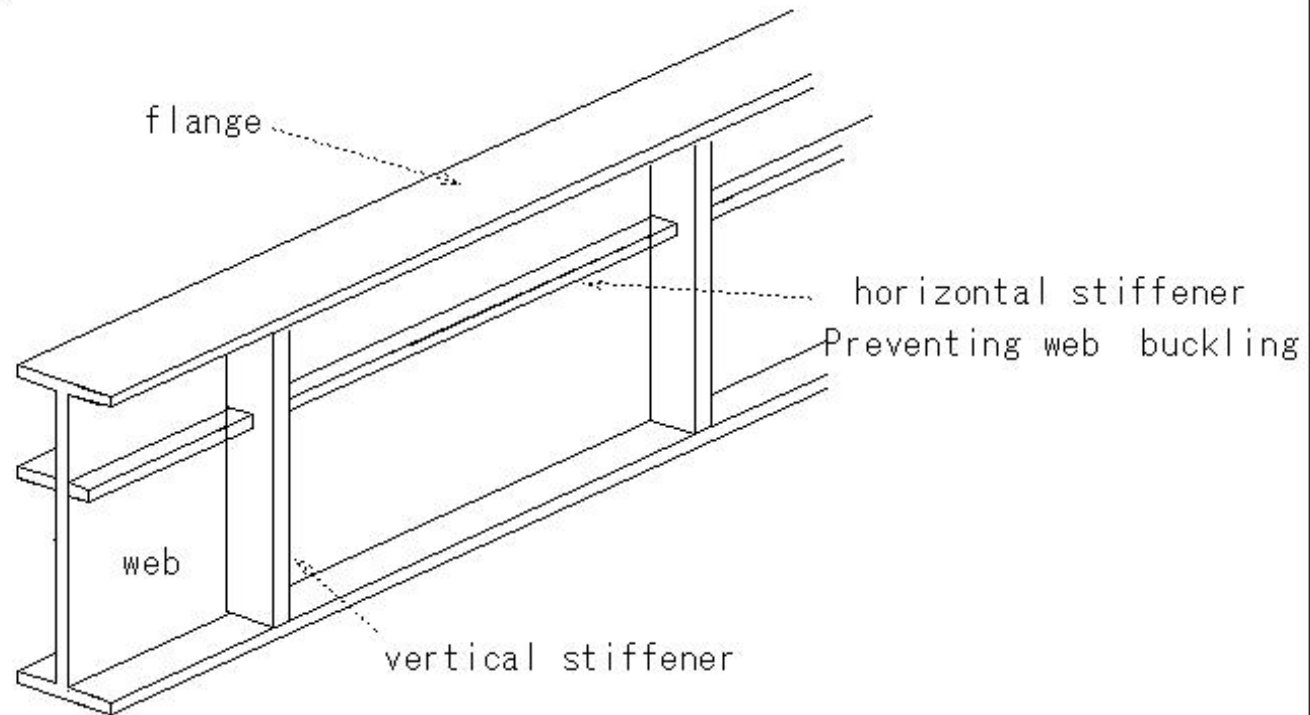


Abdominal rebar

(B183)plate girder(horizontal stiffener)

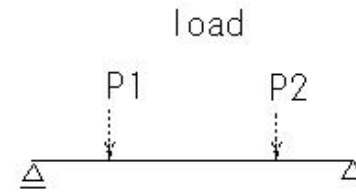
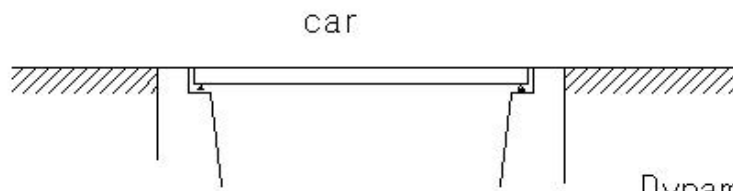
(B183)plate girder(horizontal stiffener)

plate girder

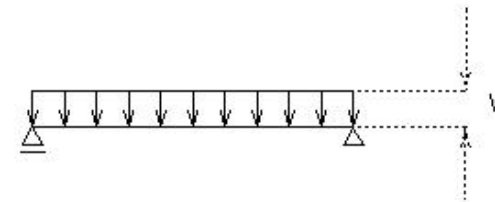
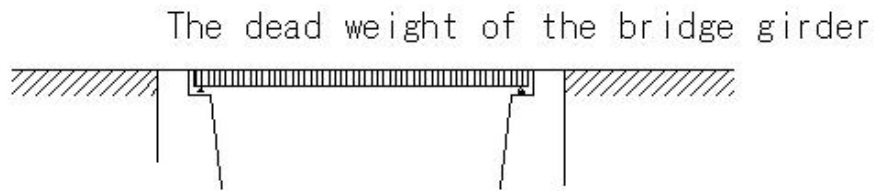


(B184)load

(B184) load

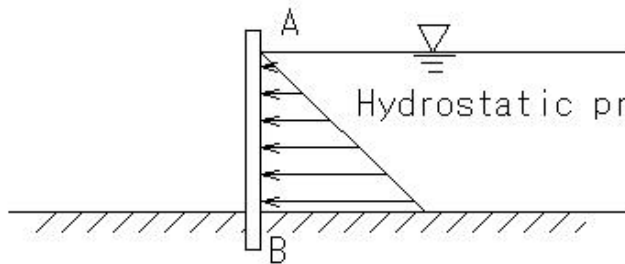


Dynamic load (live load)

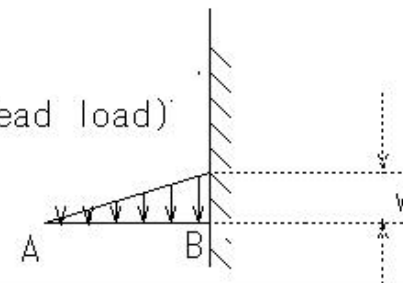


The dead weight of the bridge girder

static load

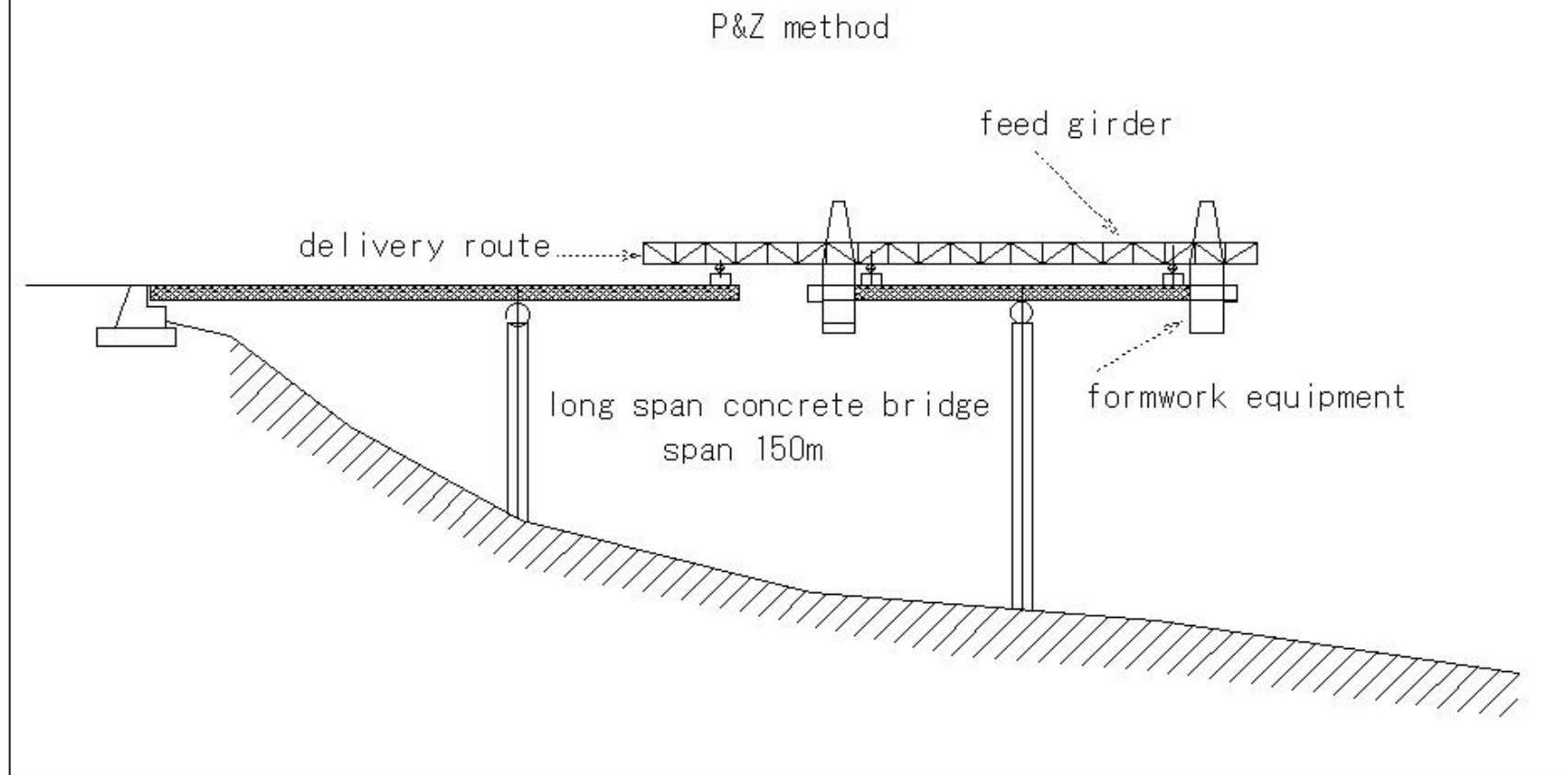


Hydrostatic pressure (static load dead load)

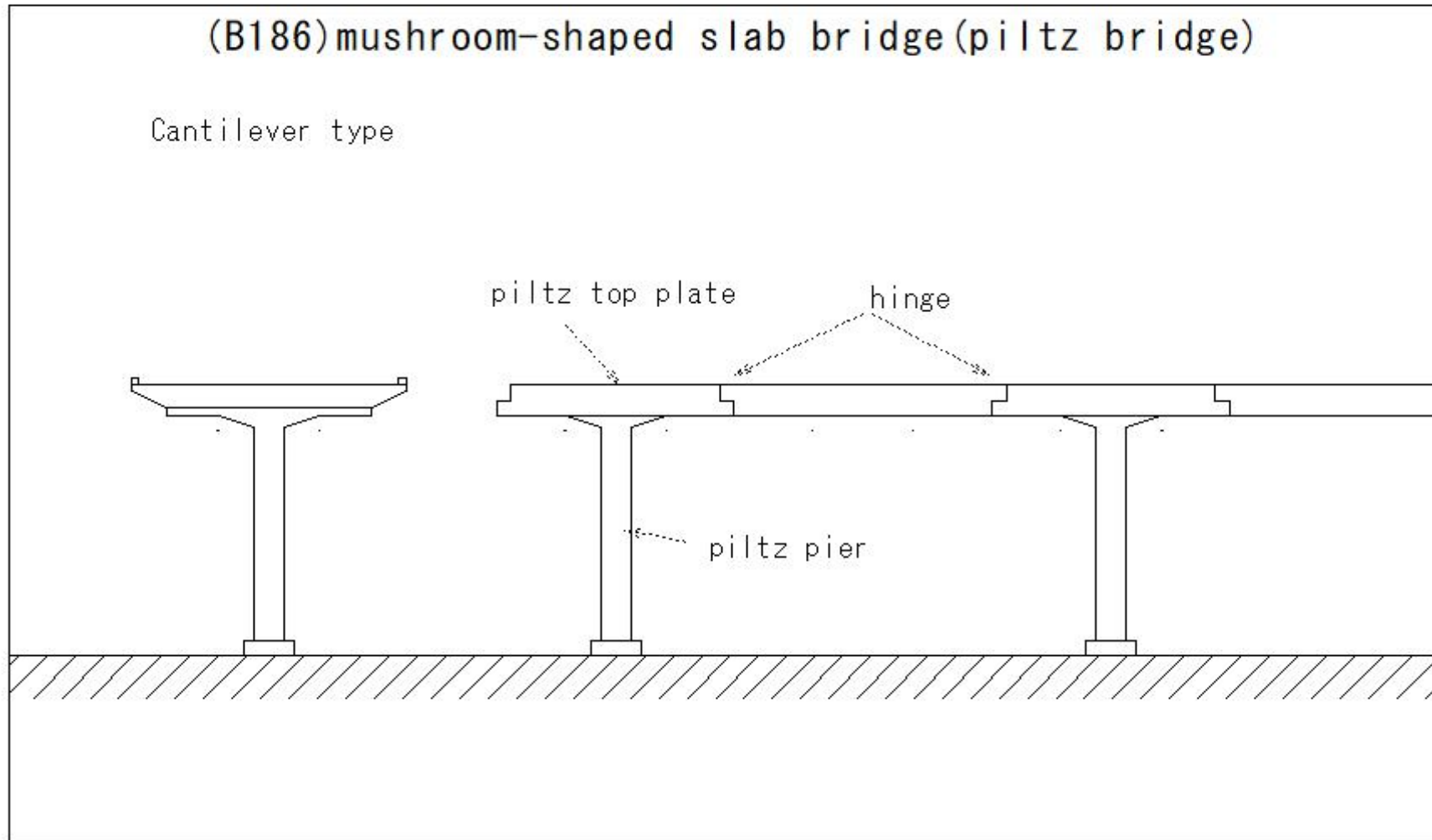


(B185) Bridge erection (Movable shoring-P&Z method)

(B185) Bridge erection (Movable shoring-P&Z method)



(B186)mushroom-shaped slab bridge(piltz bridge)



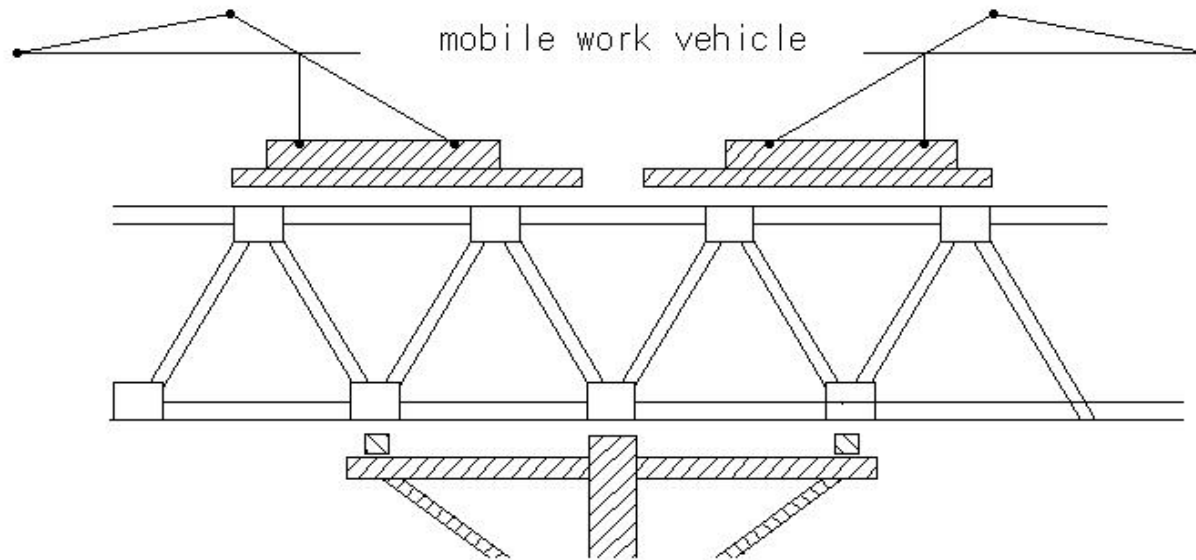
(B187)form traveler /travelling form(Vorbauwagen)

(B187)form traveler /travelling form(Vorbauwagen)

form traveler /travelling form(Vorbauwagen)

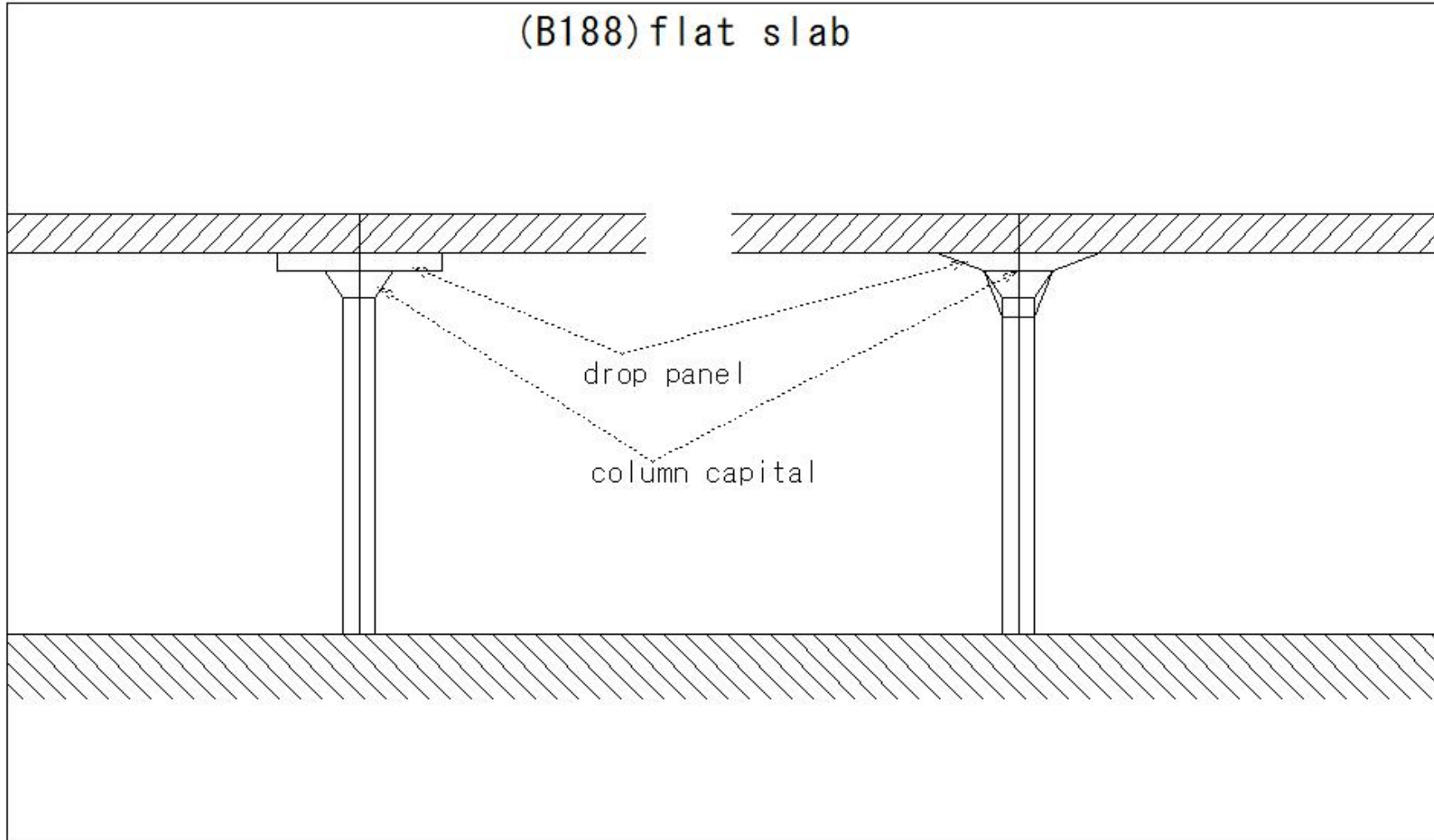
No. 1 Vorbauwagen

No. 2 Vorbauwagen

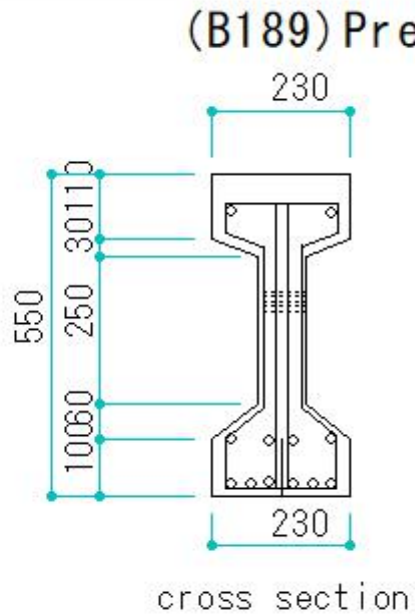


(B188) flat slab

(B188) flat slab



(B189)Precast concrete girder

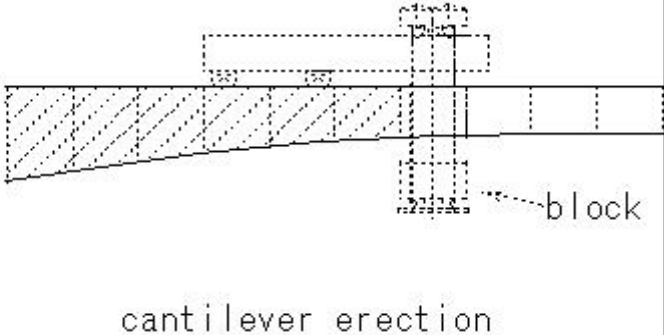
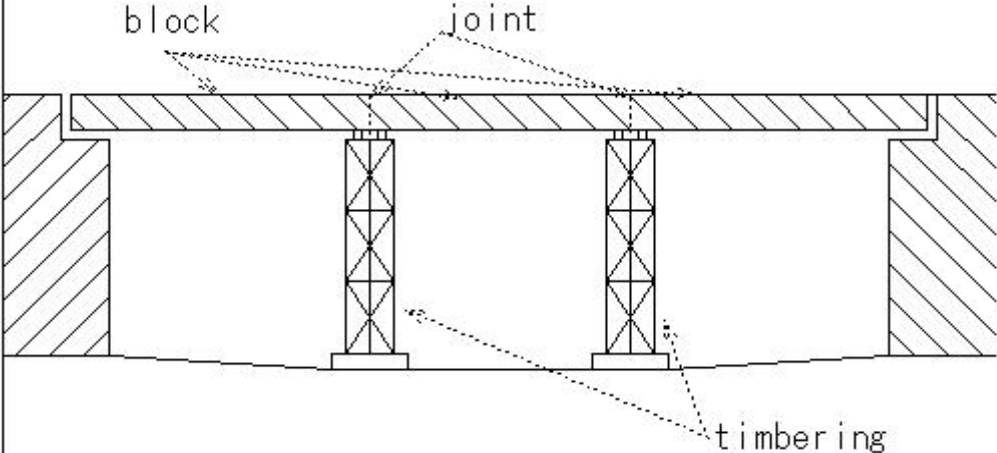


- ①Reduction of on-site work
- ②Shortening construction period
- ③Quality improvement
- ④Less affected by weather conditions

(B190)precast concrete block method

(B190)precast concrete block method

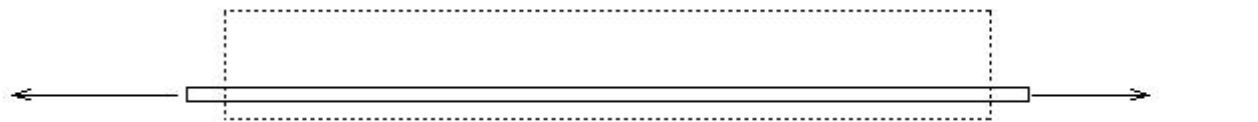
Precast concrete block method



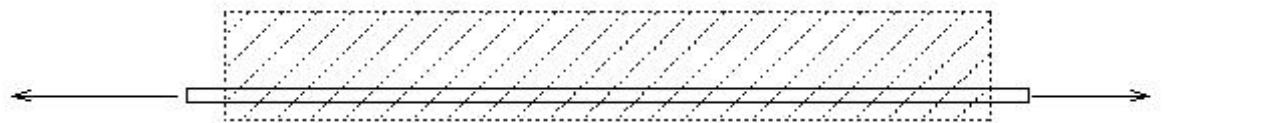
(B191)Pretension method

(B191)Pretension method

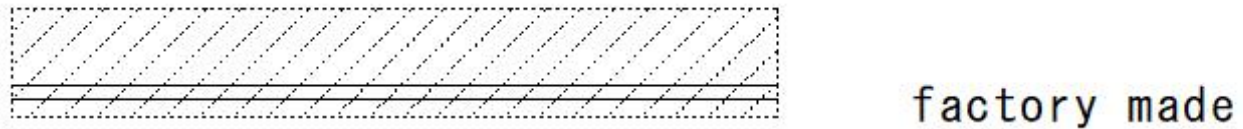
① Tension of pc steel



② Concrete placement



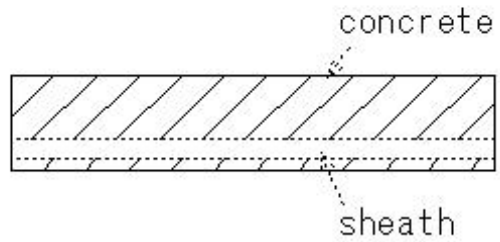
③ Tension release from pc steel material
after concrete hardening



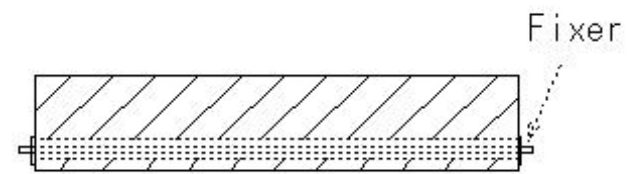
(B192) Post-tension method

(B192) Post-tension method

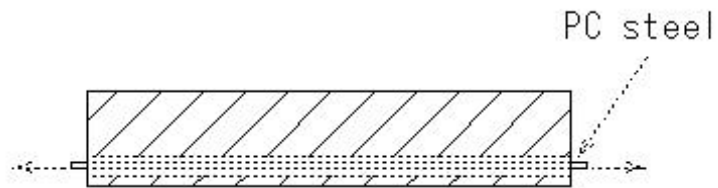
① Concrete placement after sheath placement



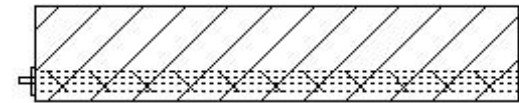
③ Fix PC steel to concrete



② PC material tension after concrete hardening

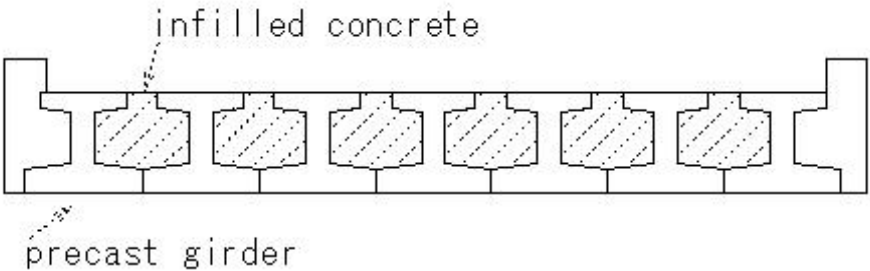
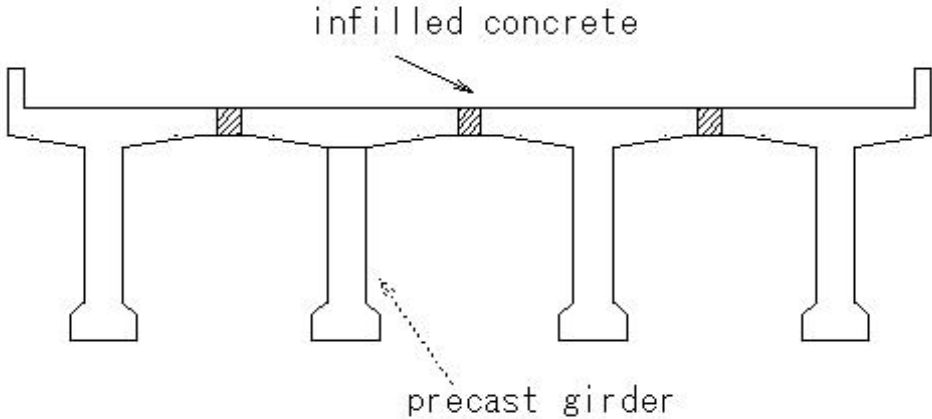


④ Grouting inside the sheath (duct)



(B193)filling concrete

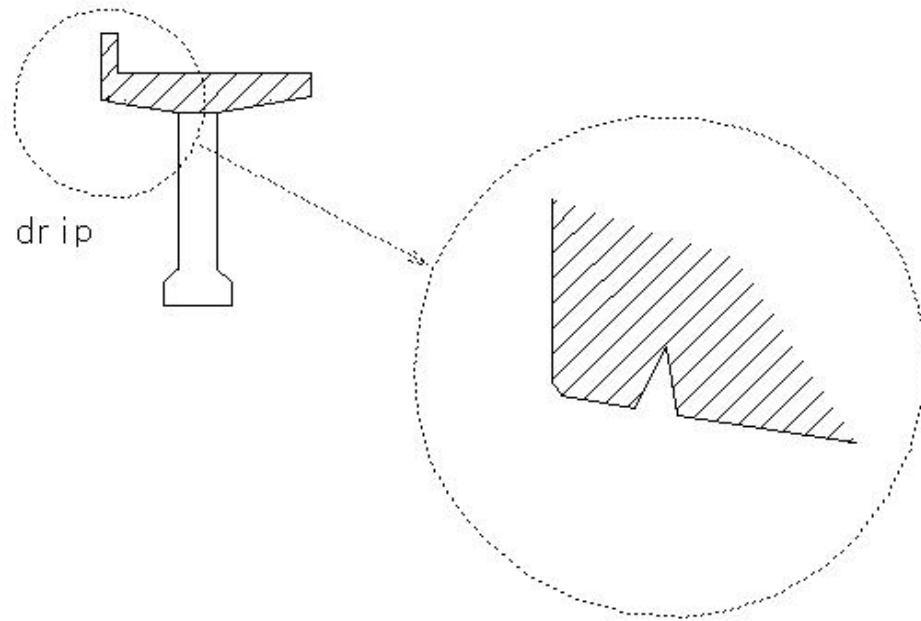
(B193) filling concrete



(B194)drip

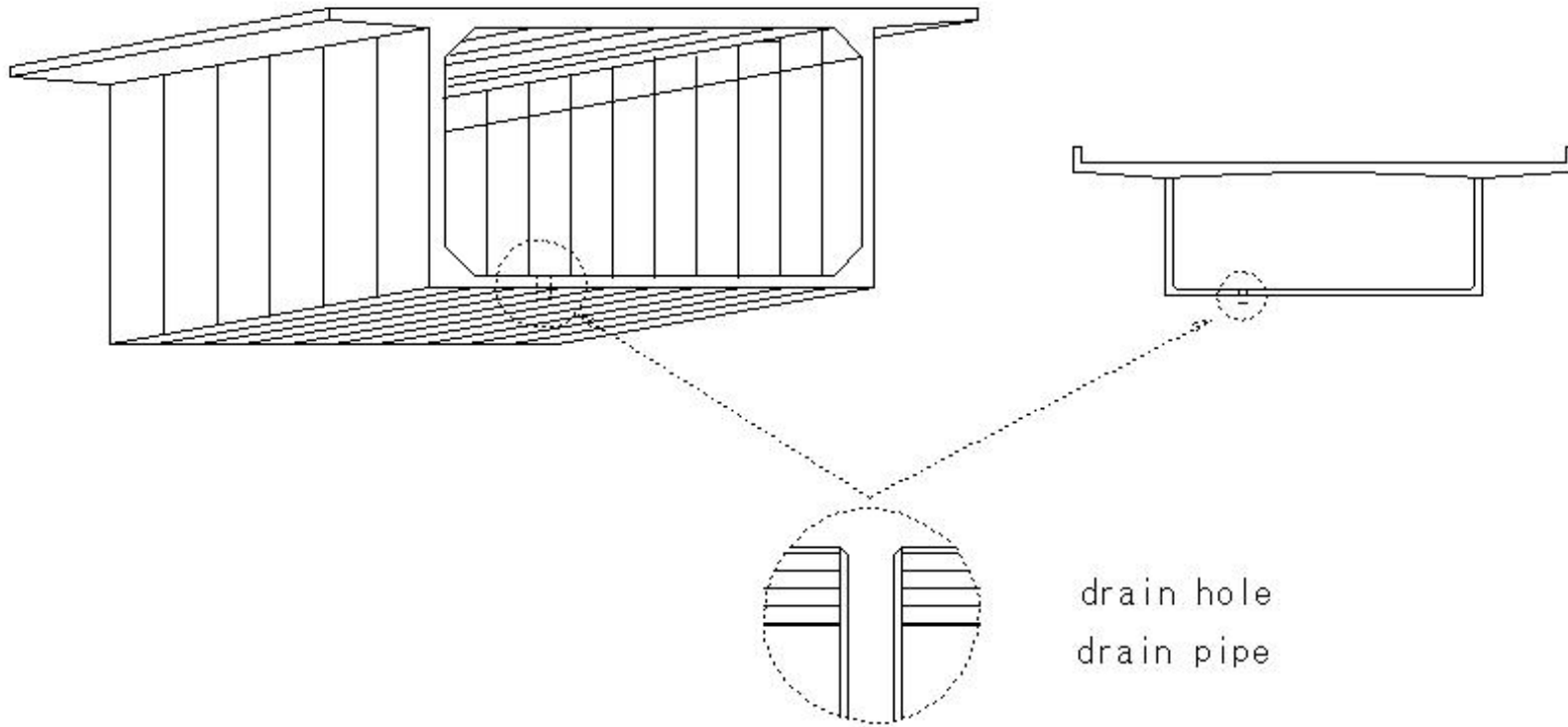
(B194) dr ip

Floor slab



(B195)Drip-box girder bridge

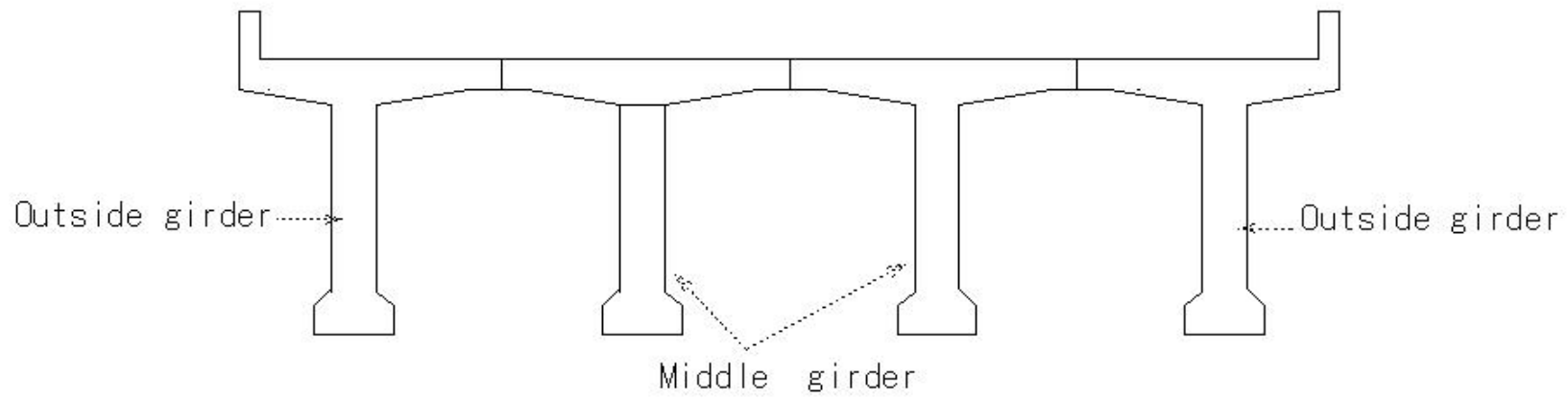
(B195)Drip-box girder bridge



drain hole
drain pipe

(B196)Outside girder

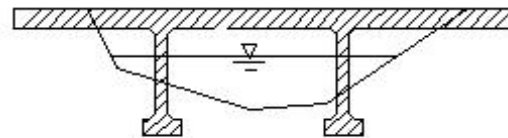
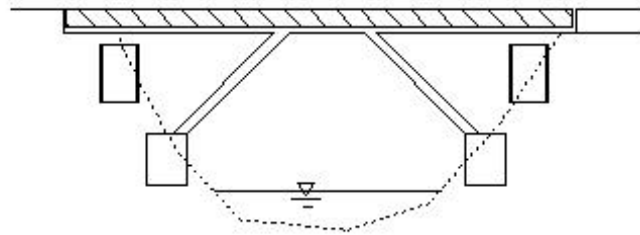
(B196)Outside girder



(B197)Rigid frame bridge(Rahmen)

(B197)Rigid frame bridge (Rahmen)

Rahmen bridge



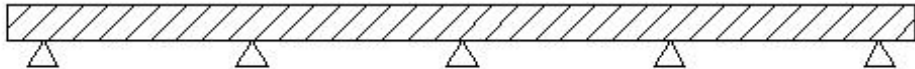
(B198)continuous girder

(B198)continuous girder

simple girder



continuos girder



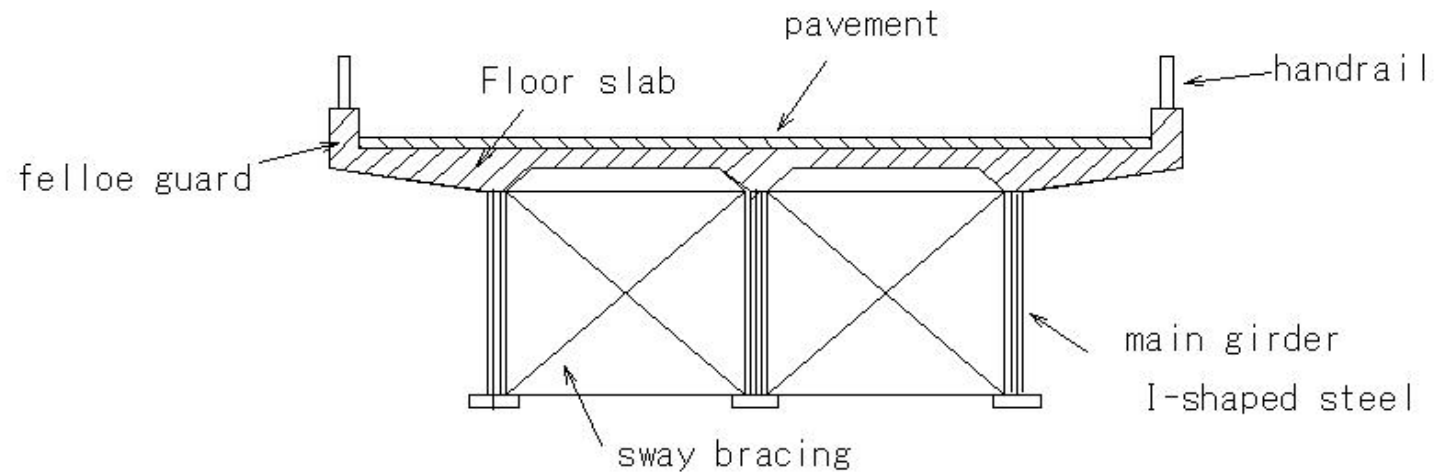
gerber girder



(B199)I-beam bridge

(B199) I-beam bridge

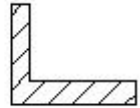
I-shaped girder bridge



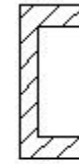
(B200)I-steel

(B200) I-steel

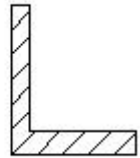
Angle iron



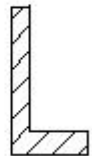
Channel steel



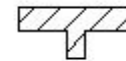
Angle iron



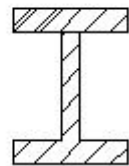
Angle iron



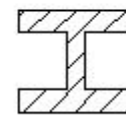
T steel



I-type steel
I-shaped steel



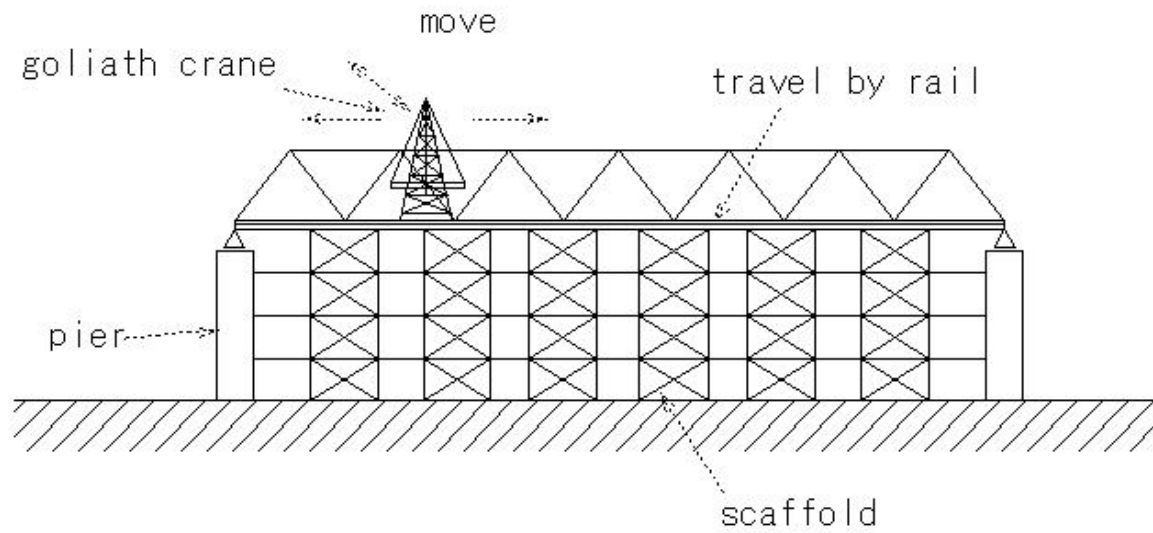
H steel
H-shaped steel



(B201)staging goliath erection

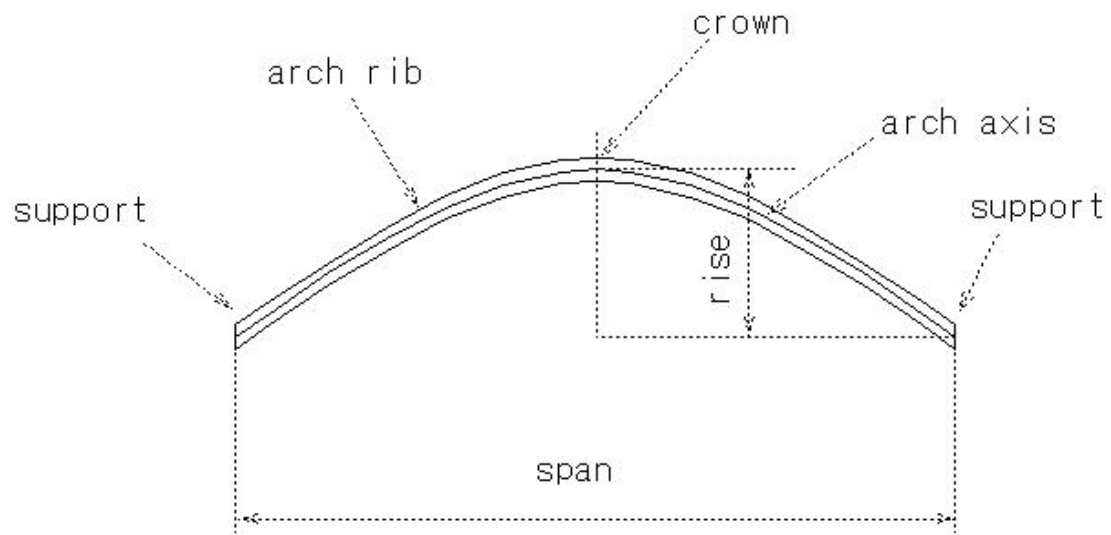
(B201)staging goliath erection

staging goliath erection



(B202)arch

(B202) arch

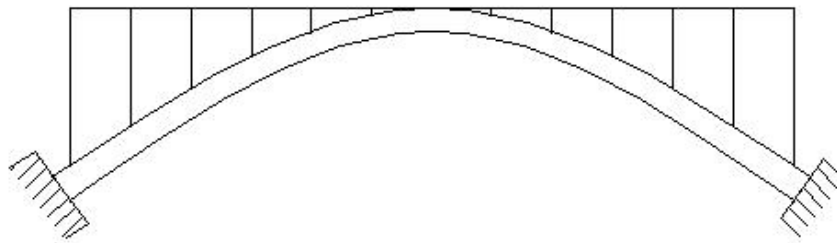


(B203)arch bridge(Arch bridge without hinges (deck bridge))

(B203) arch bridge (Arch bridge without hinges (deck bridge))

arch bridge

- Solid rib arch bridge
- Externally indeterminate arch
- Arch bridge without hinges (deck bridge)

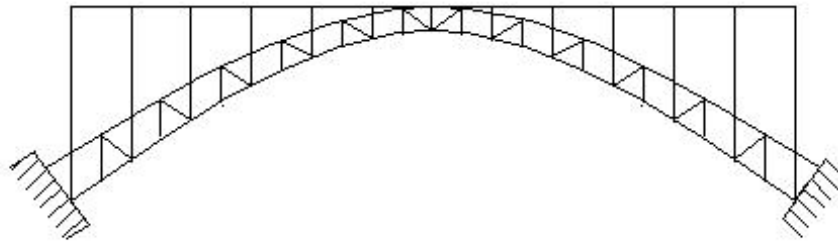


(B204)arch bridge(Arch bridge without hinges (deck bridge))

(B204) arch bridge(Arch bridge without hinges (deck bridge))

arch bridge

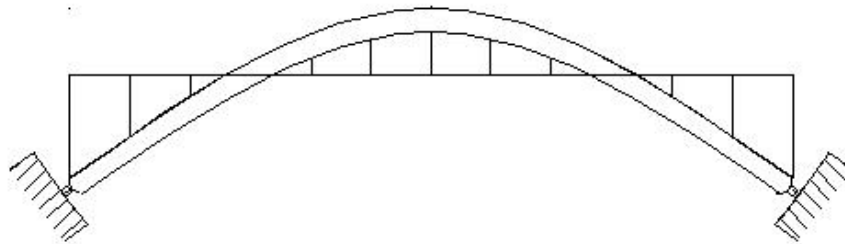
- braced arch bridge
- externally indeterminate arch
- arch bridge without hinges (deck bridge)



(B205)arch bridge(Two-hinge arch bridge(half-through bridge))

(B205) arch bridge(Two-hinge arch bridge(half-through bridge))

- Solid rib arch bridge
- Externally indeterminate arch
- Two-hinge arch bridge(half-through bridge)

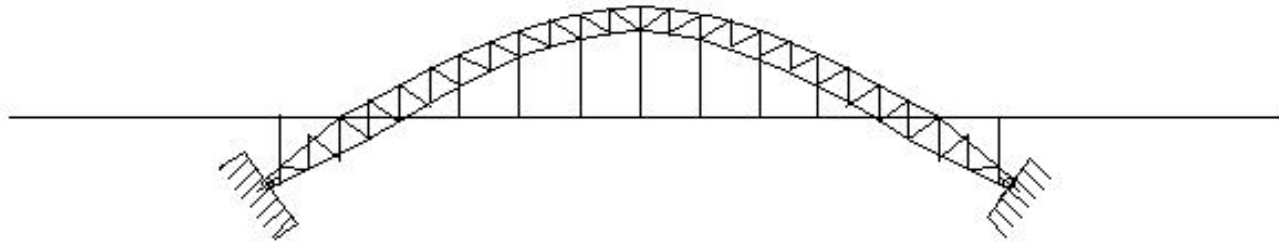


(B206)arch bridge(Two-hinge arch bridge (half-through bridge))

(B206)arch bridge(Two-hinge arch bridge (half-through bridge))

arch bridge

- braced arch bridge
- Externally indeterminate arch
- Two-hinge arch bridge (half-through bridge)

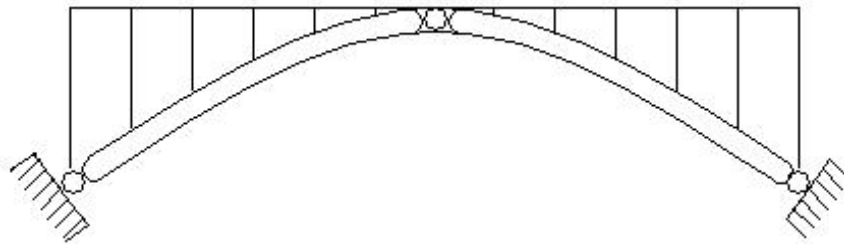


(B207)arch bridge(Three hinge arch bridge (deck bridge))

(B207) arch bridge (Three hinge arch bridge (deck bridge))

arch bridge

- Solid rib arch bridge
- Static arch
- Three hinge arch bridge (deck bridge)

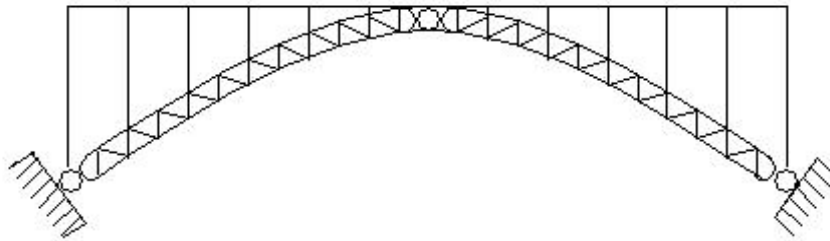


(B208)arch bridge(Three hinge arch bridge (deck bridge))

(B208) arch bridge (Three hinge arch bridge (deck bridge))

arch bridge

- braced arch bridge
- static arch
- three hinge arch bridge (deck bridge)

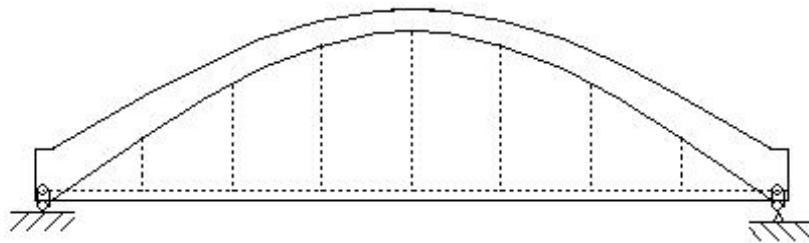


(B209)arch bridge(Tide arch bridge)

(B209) arch bridge (Tide arch bridge)

arch bridge

- Solid rib arch bridge
- Internally indeterminate arch
- Tide arch bridge

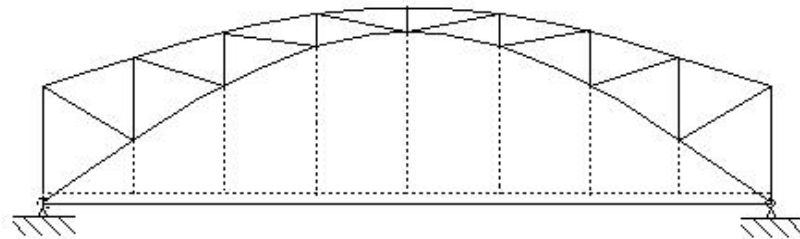


(B210)arch bridge(Tide arch bridge)

(B210)arch bridge(Tide arch bridge)

arch bridge

- braced arch bridge
- Internally indeterminate arch
- Tide arch bridge

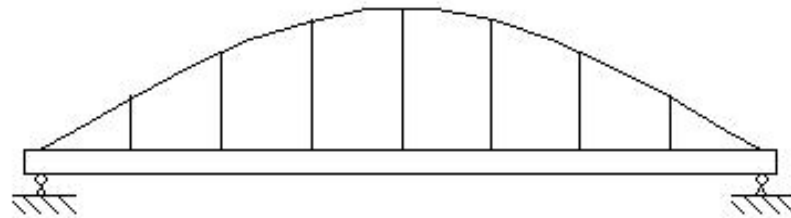


(B211)arch bridge(Langer girder bridge)

(B211)arch bridge(Langer girder bridge)

arch bridge

- Solid rib arch bridge
- Internally indeterminate arch
- Langer girder bridge

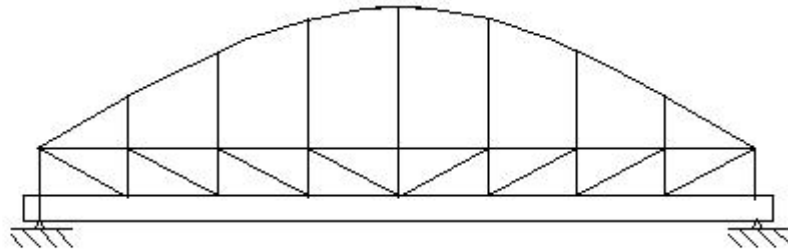


(B212)arch bridge(Langer Truss Bridge)

(B212) arch bridge (Langer Truss Bridge)

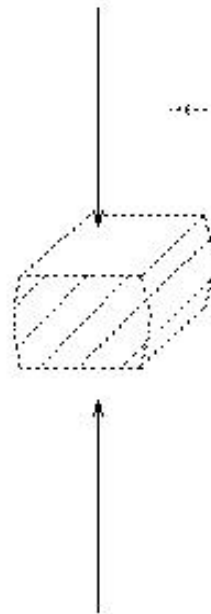
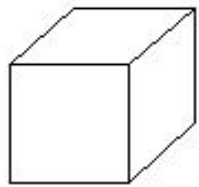
arch bridge

- braced arch bridge
- Internally indeterminate arch
- Langer Truss Bridge



(B213)squashing/Buckling

(B213)squashing/Buckling



←..... compressive force

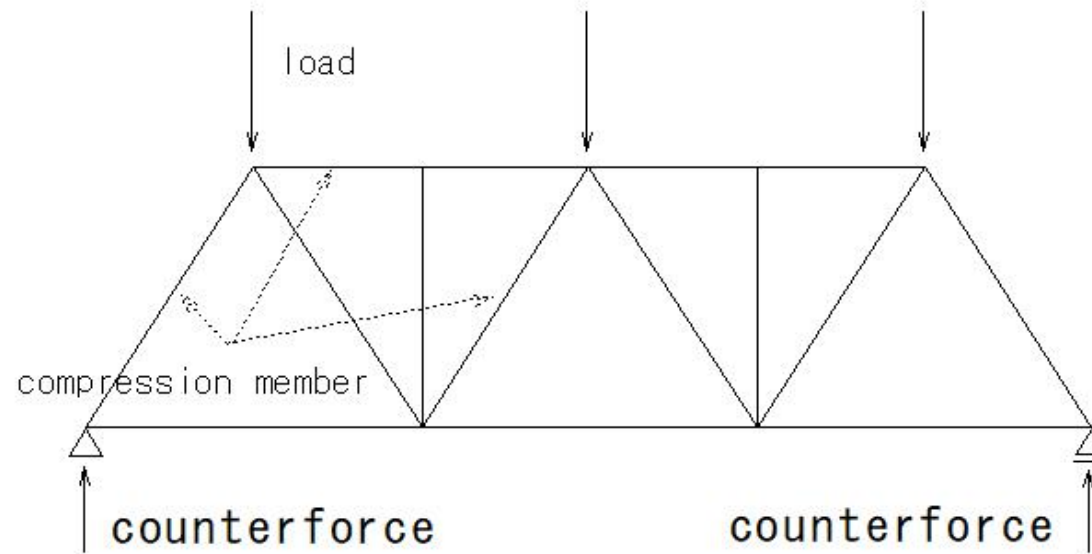
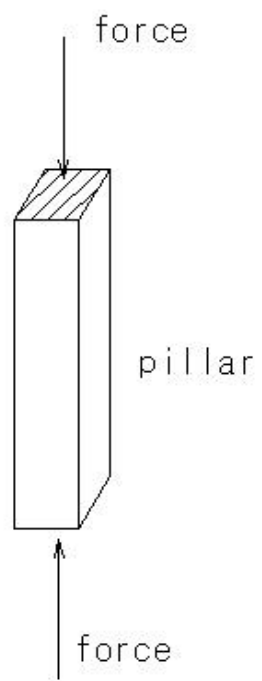
←..... collapse

pillar

(B214)compression member

(B214) compression member

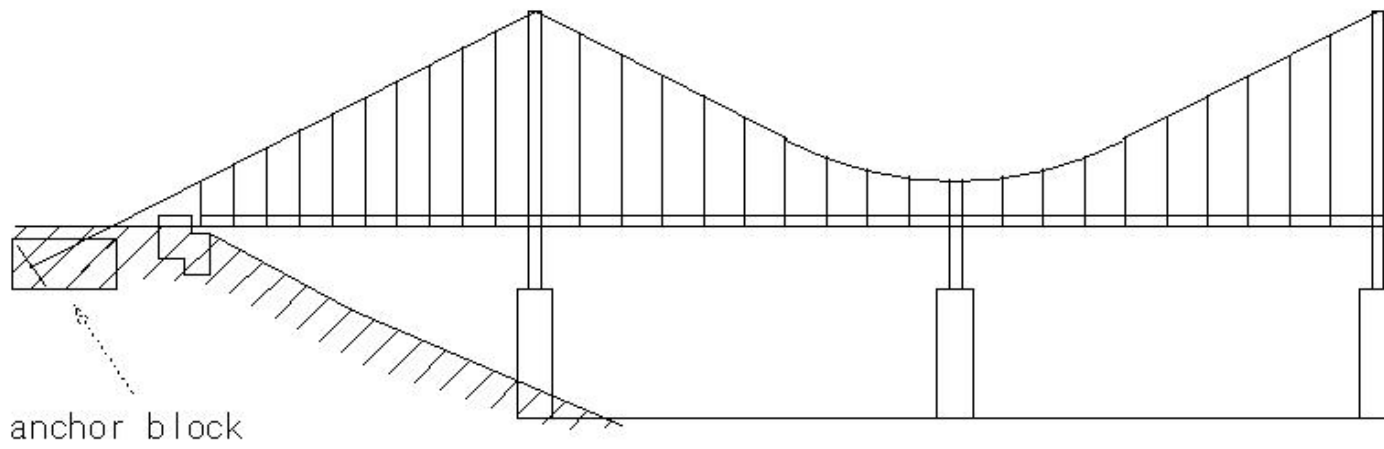
top chord of truss



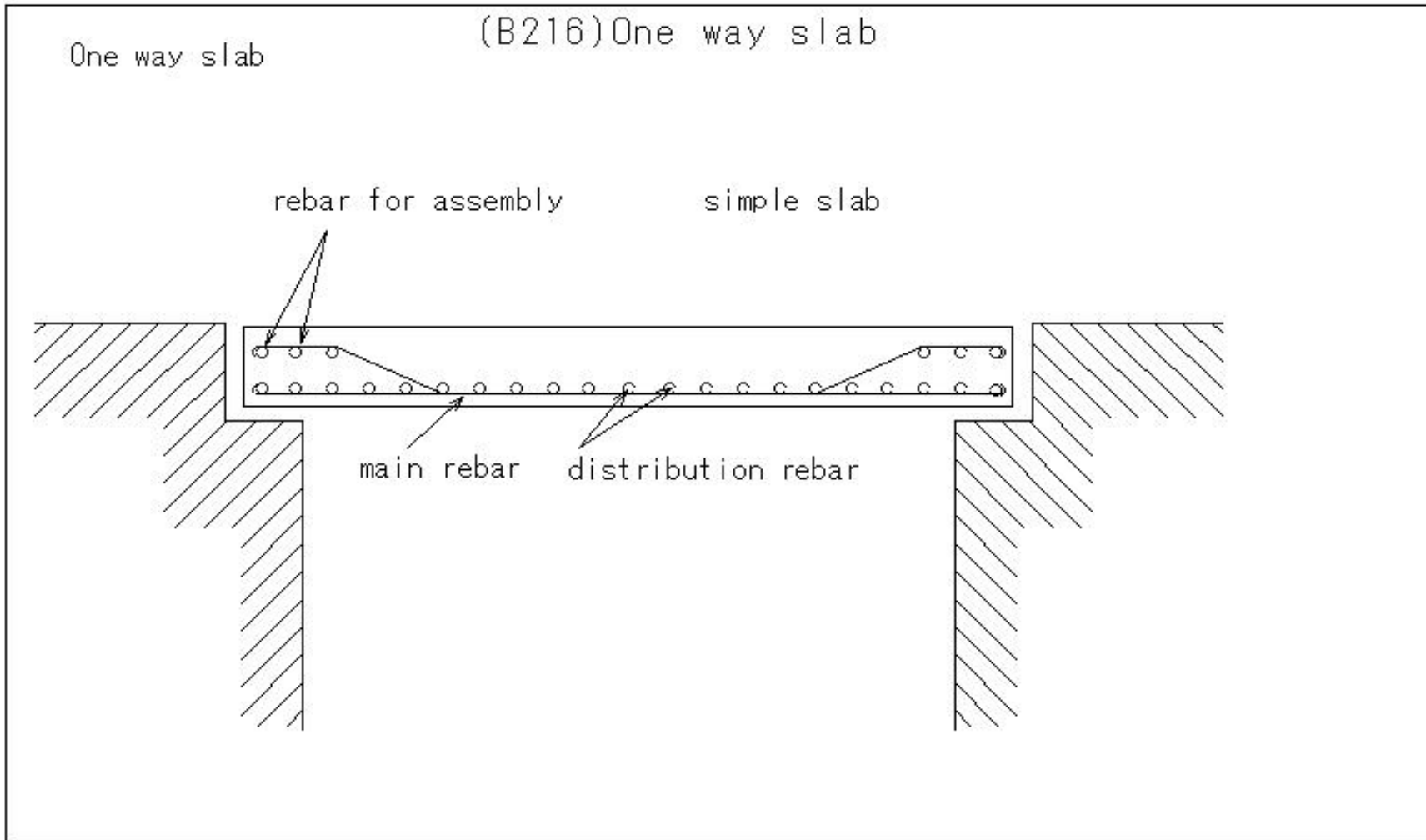
(B215)suspension bridge(anchor block)

(B215) suspension bridge (anchor block)

suspension bridge



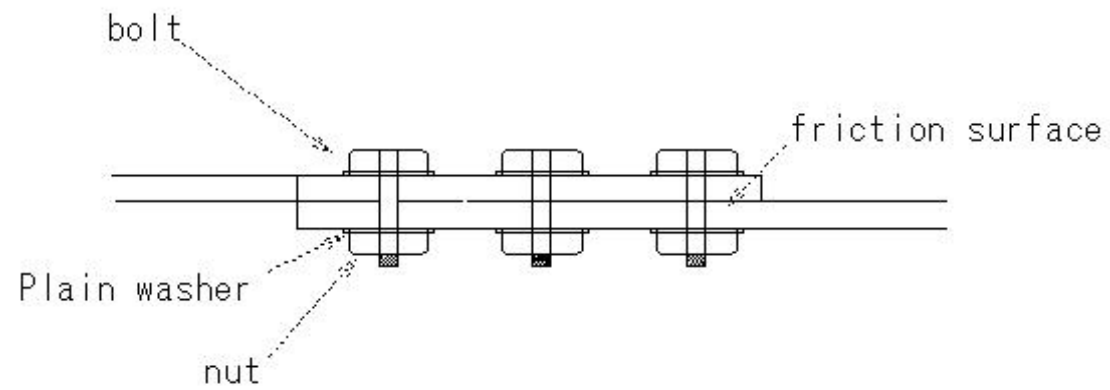
(B216)One way slab



(B217) simple friction joint

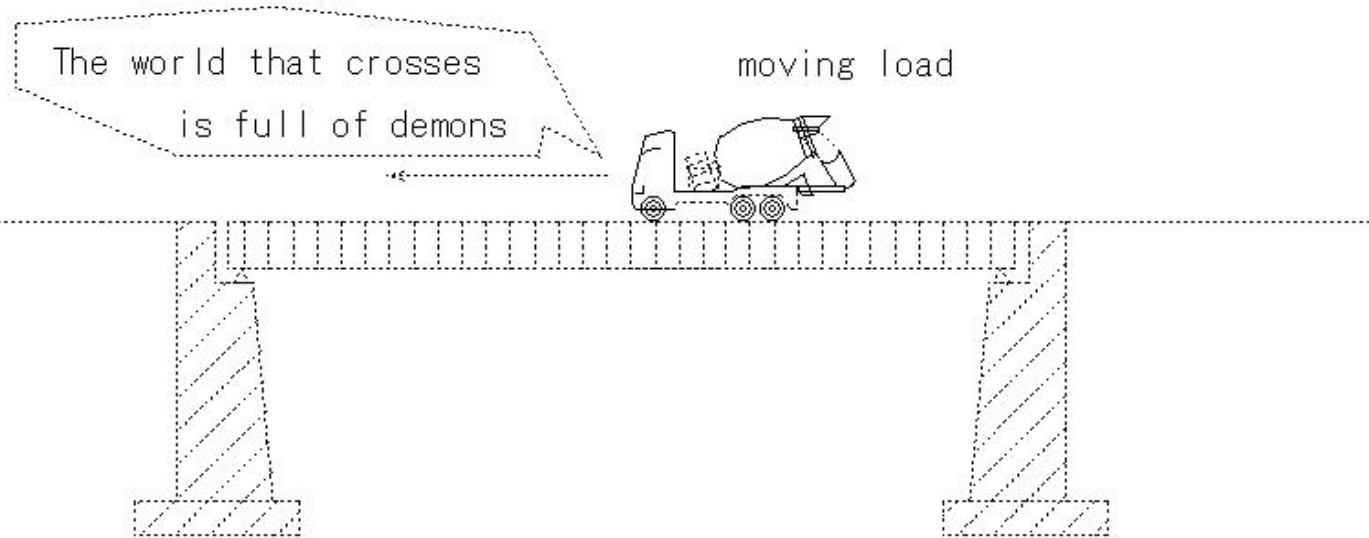
(B217) simple friction joint

simple friction joint

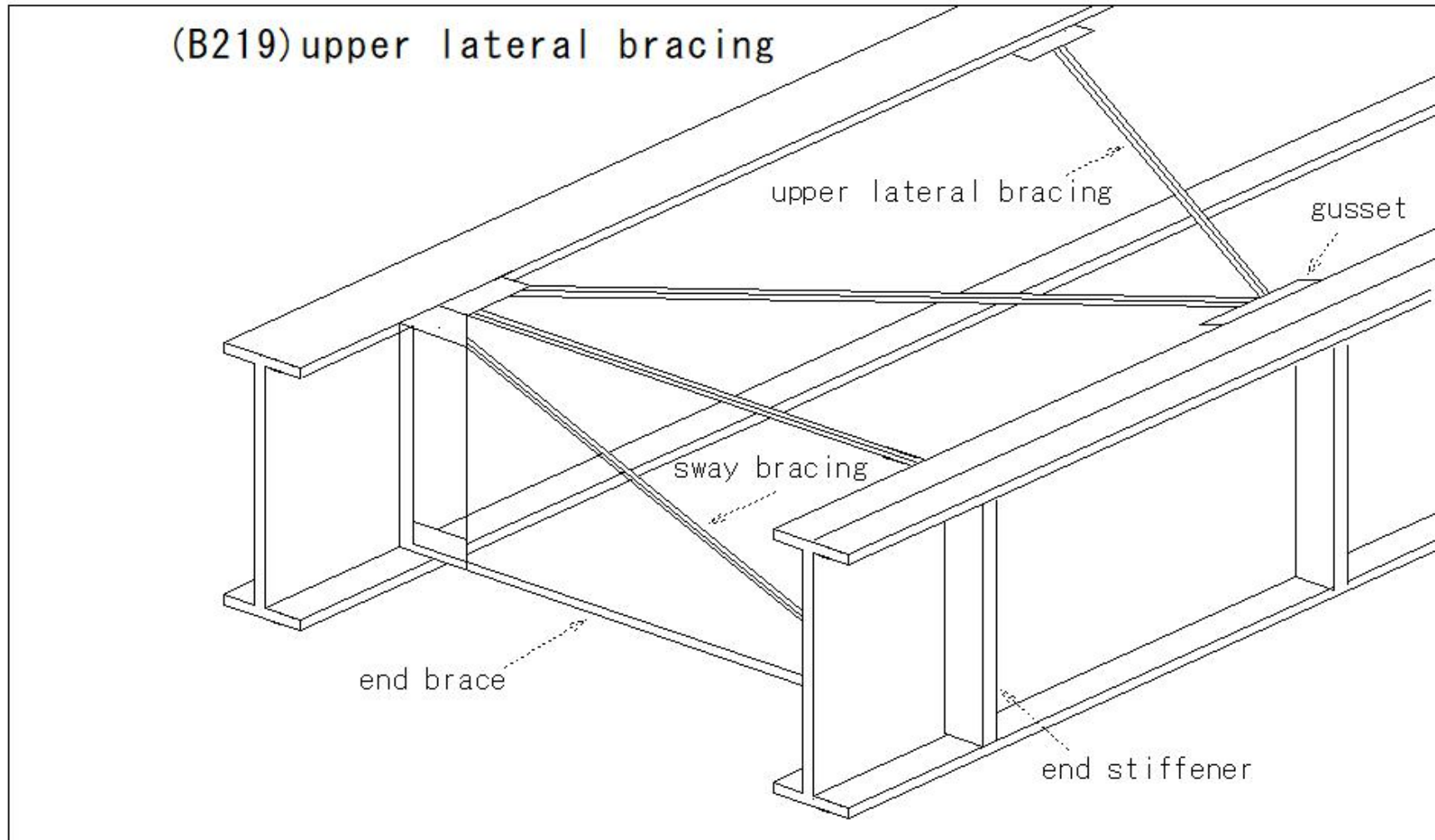


(B218)Moving load

(B218) Moving load



(B219)upper lateral bracing



(B220)web

(B220) web

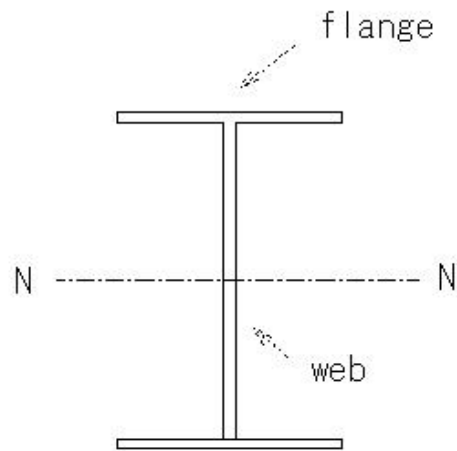
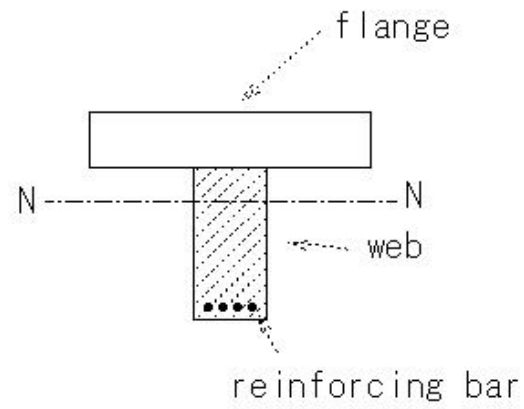


plate girder web

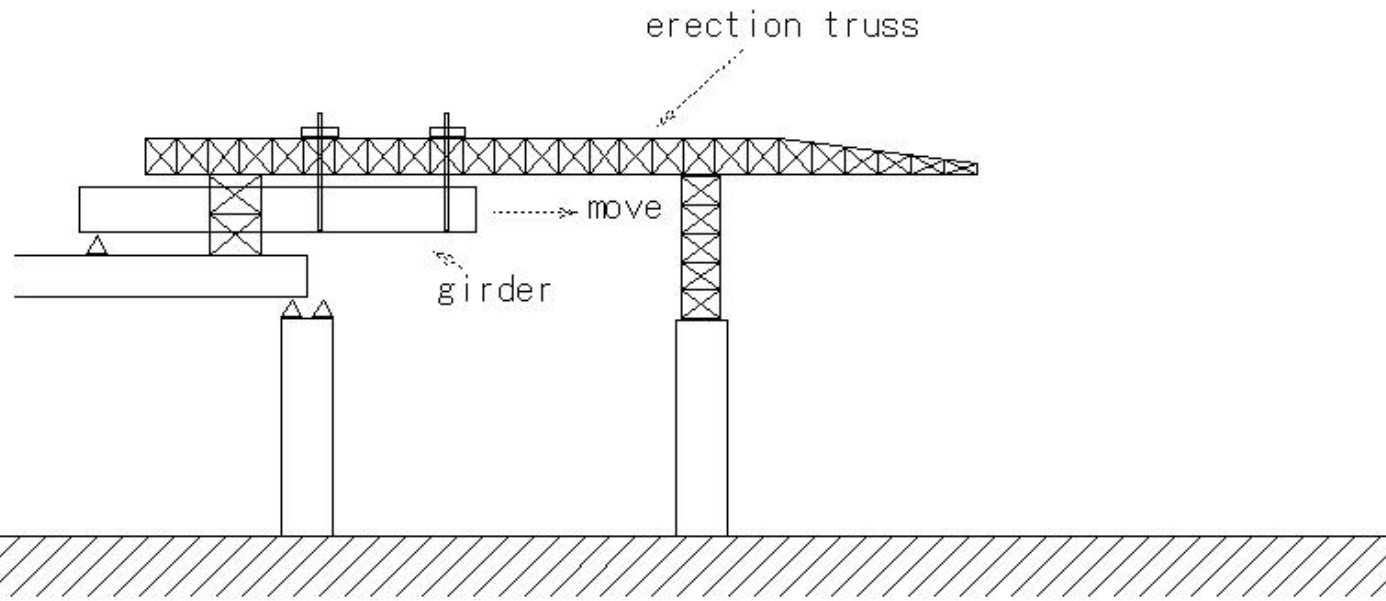
Primarily resists shear forces



Reinforced concrete T-shaped girder web

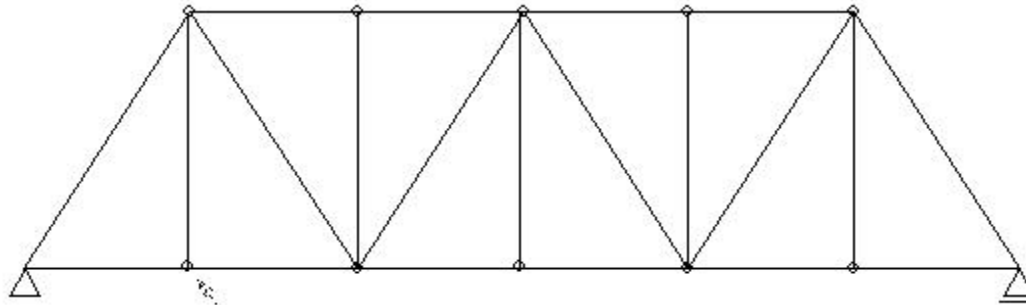
(B221)erection truss method

(B221)erection truss method



(B222)truss(panel point)

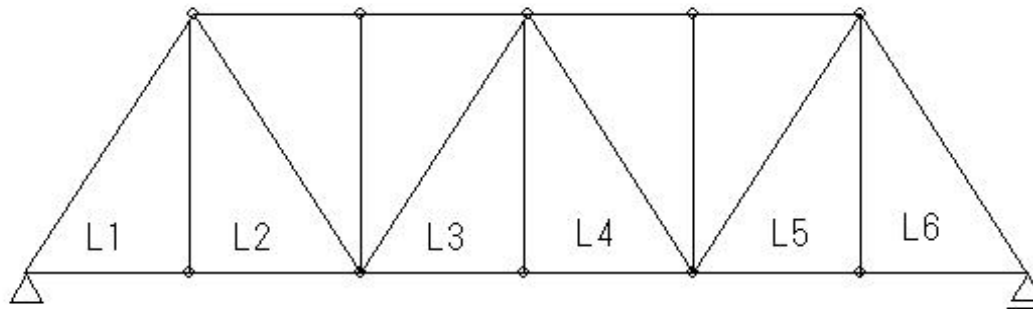
(B222) truss (panel point)



panel point
hinge joint
A joint that connects two members

(B223)lower chord member

(B223) lower chord member



lower chord member
truss
tensile stress
L1-L6

(B224)gusset plate

(B224)gusset plate

gusset plate

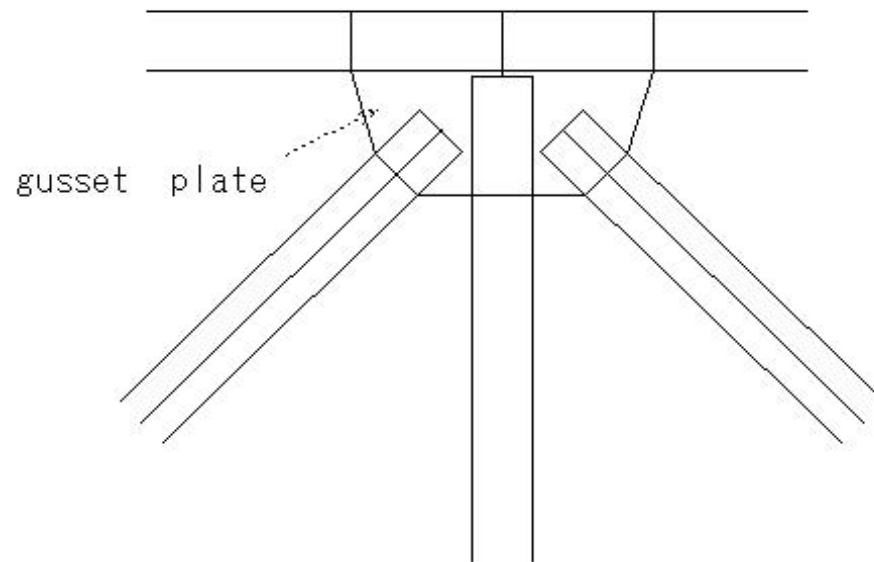
truss

plate girder

joint

connection joint

Reinforcement steel plate

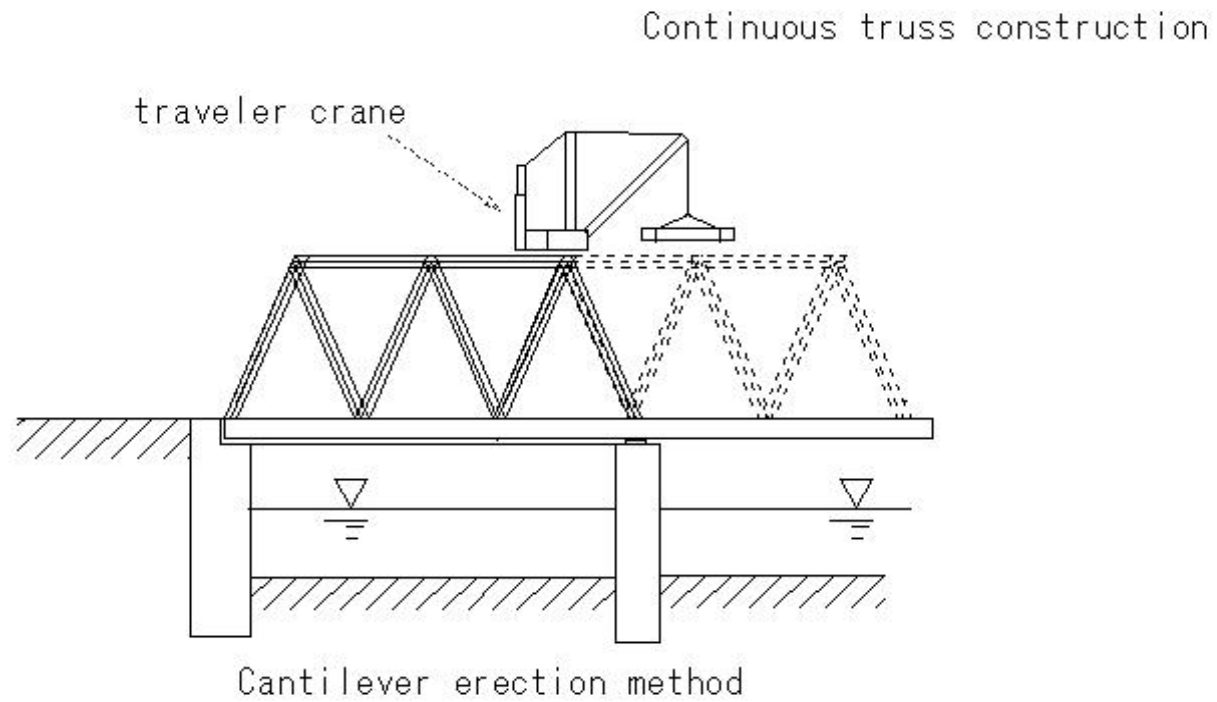


Case structure by welding

Case structure with bolts

(B225)Cantilever erection method

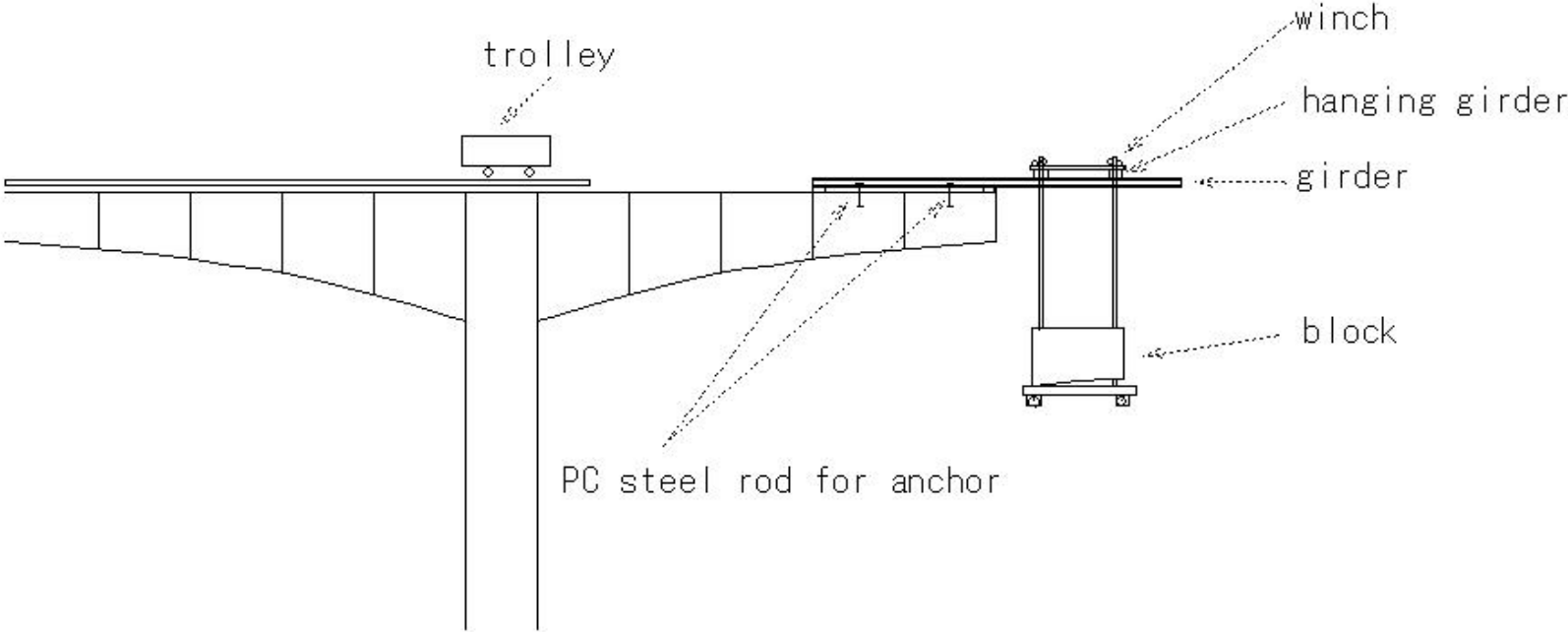
(B225) Cantilever erection method



(B226)Cantilever erection method

(B226) Cantilever erection method

Cantilever erection method using mobile erection vehicle



(B227)Cantilever

(B227) Cant i lever

3 - reaction force

H

M

V

fixed fulcrum

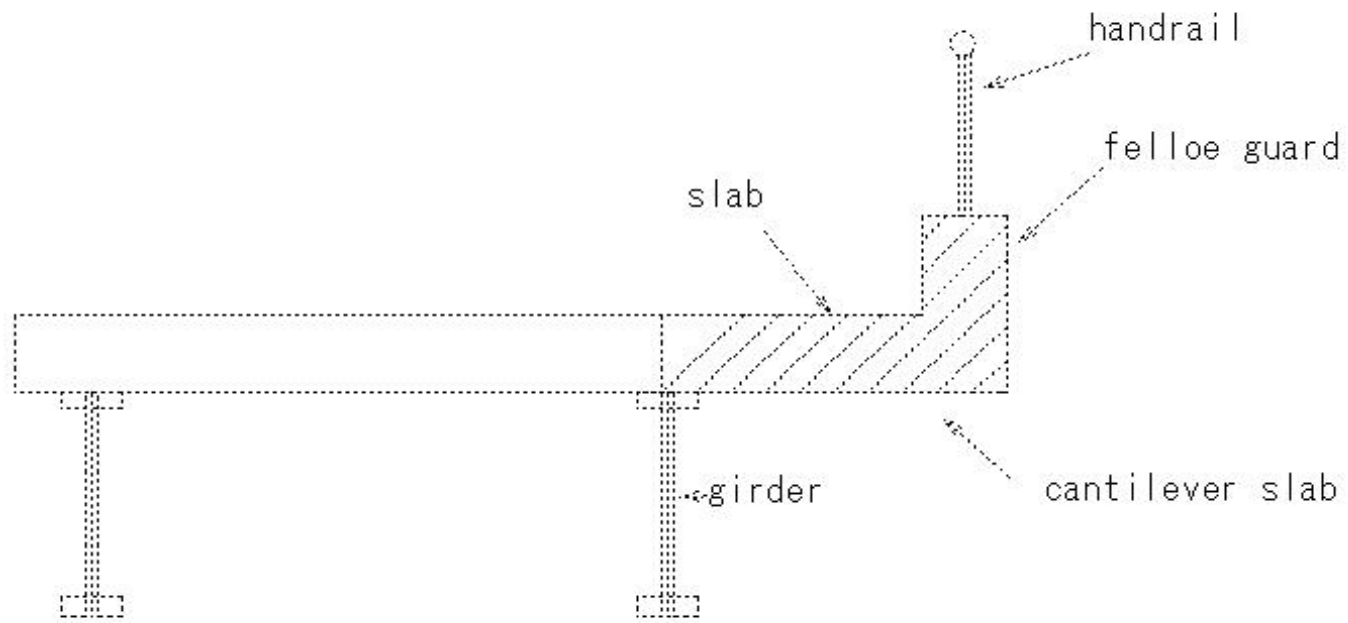
load

free end beam



(B228) Cantilever slab

(B228) Cantilever slab



(B229)movable support

(B229)movable support

movable support

roller support

temperature change

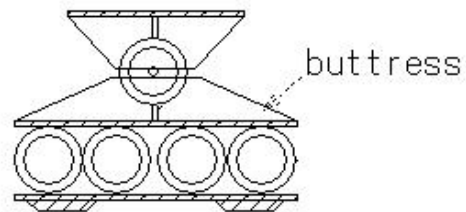
deflection angle

Member deformation

Does not restrict span changes

Roller on bearing surface

Can be moved horizontally



roller support

(B230)movable support

(B230)movable support

movable support

Rocker support

temperature change

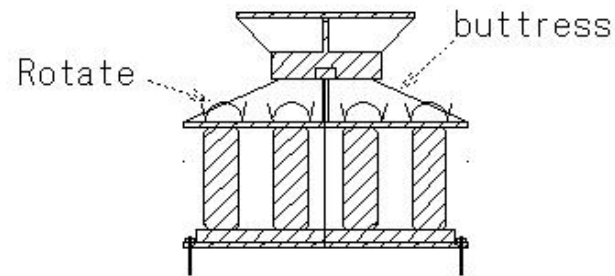
deflection angle

Member deformation

Does not restrict span changes

Roller on bearing surface

Can be moved horizontally



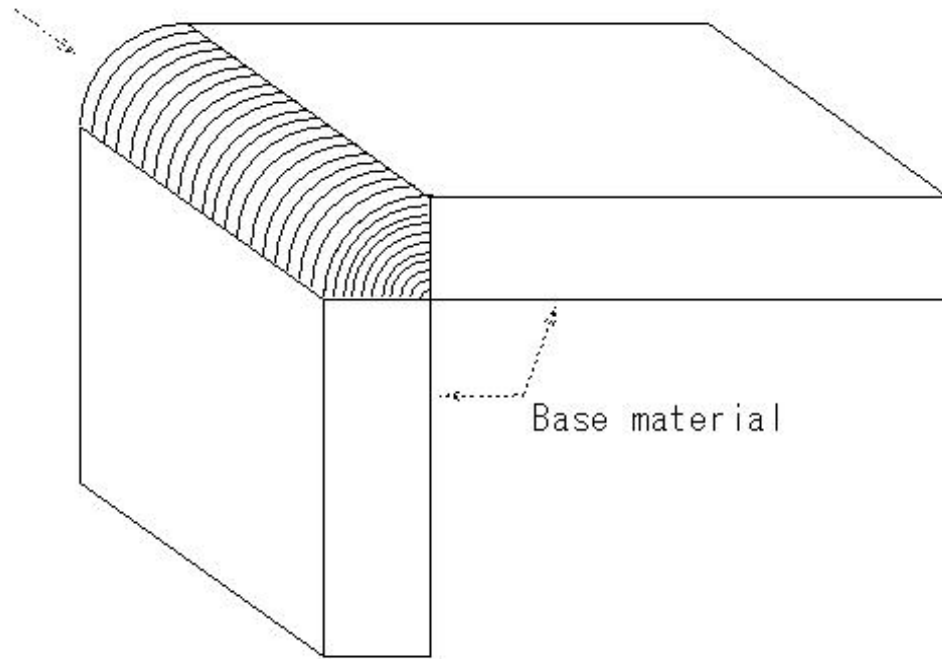
Rocker support

(B231)corner joint(Welding joint)

(B231) corner joint (Welding joint)

corner joint

Add welding metal and weld



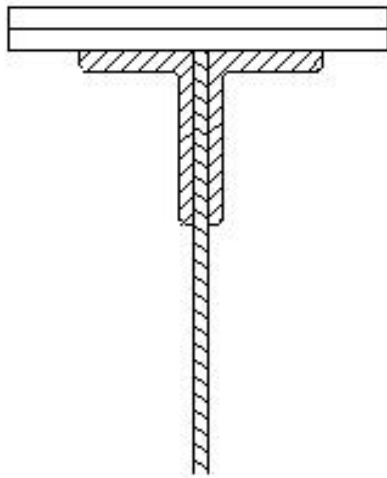
Base material

welded joints

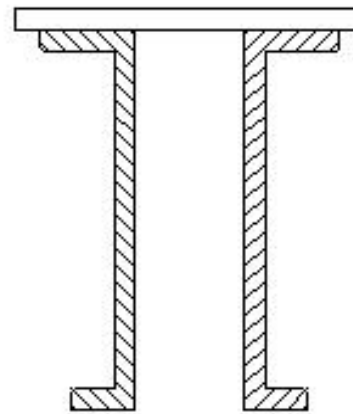
(B232)cover plate

(B232)cover plate

cover plate



Main girder cross section of plate girder

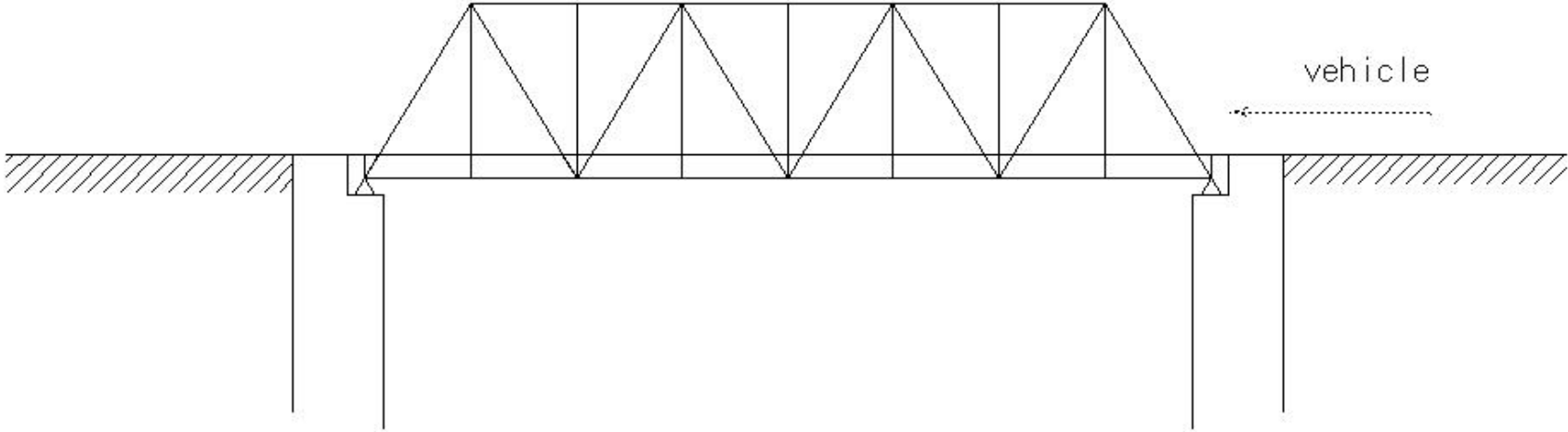


Upper chord part of steel truss bridge

(B233)through bridge

(B233) through bridge

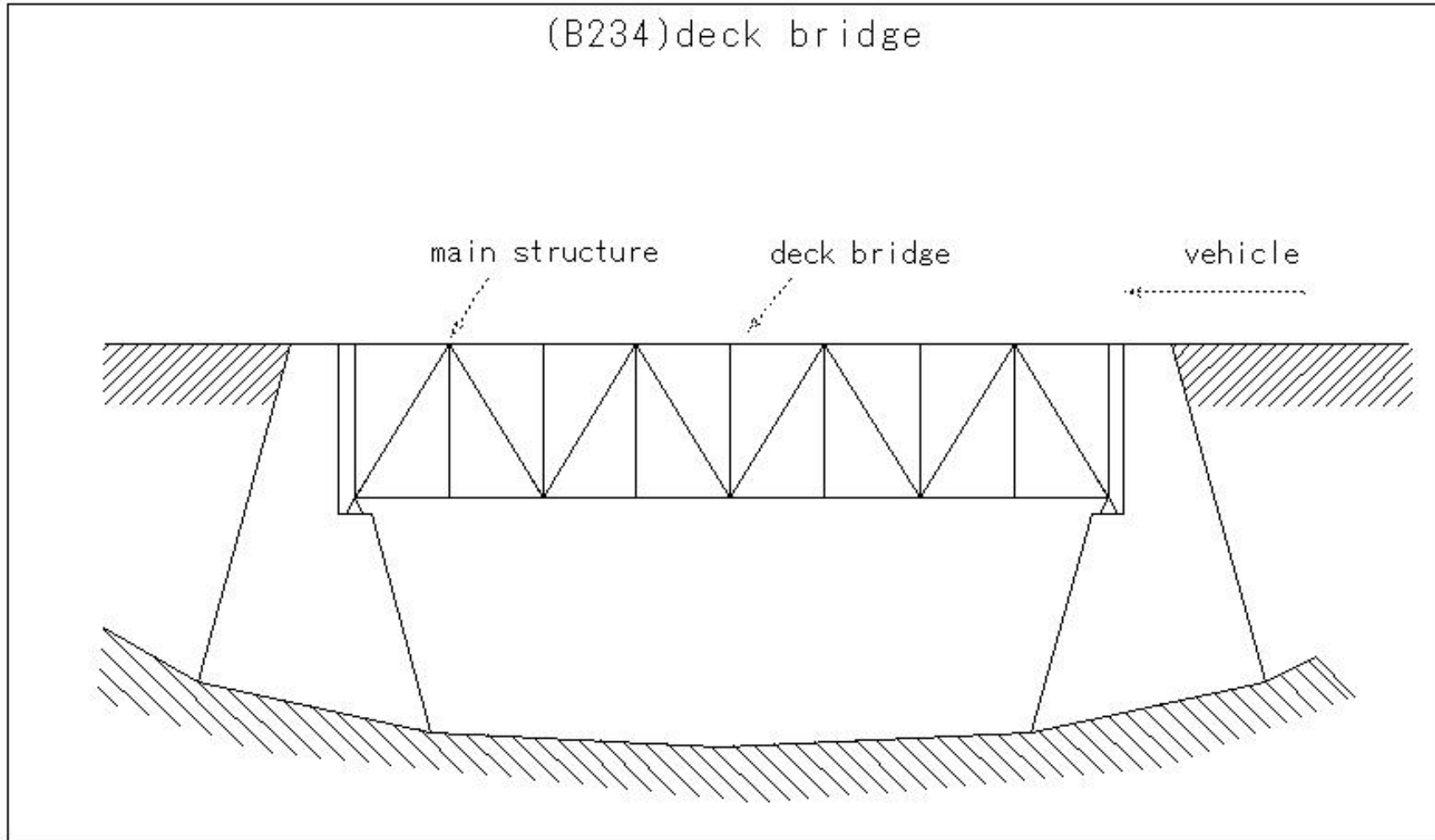
vehicle



Bridge Warren Truss(through bridge)

(B234)deck bridge

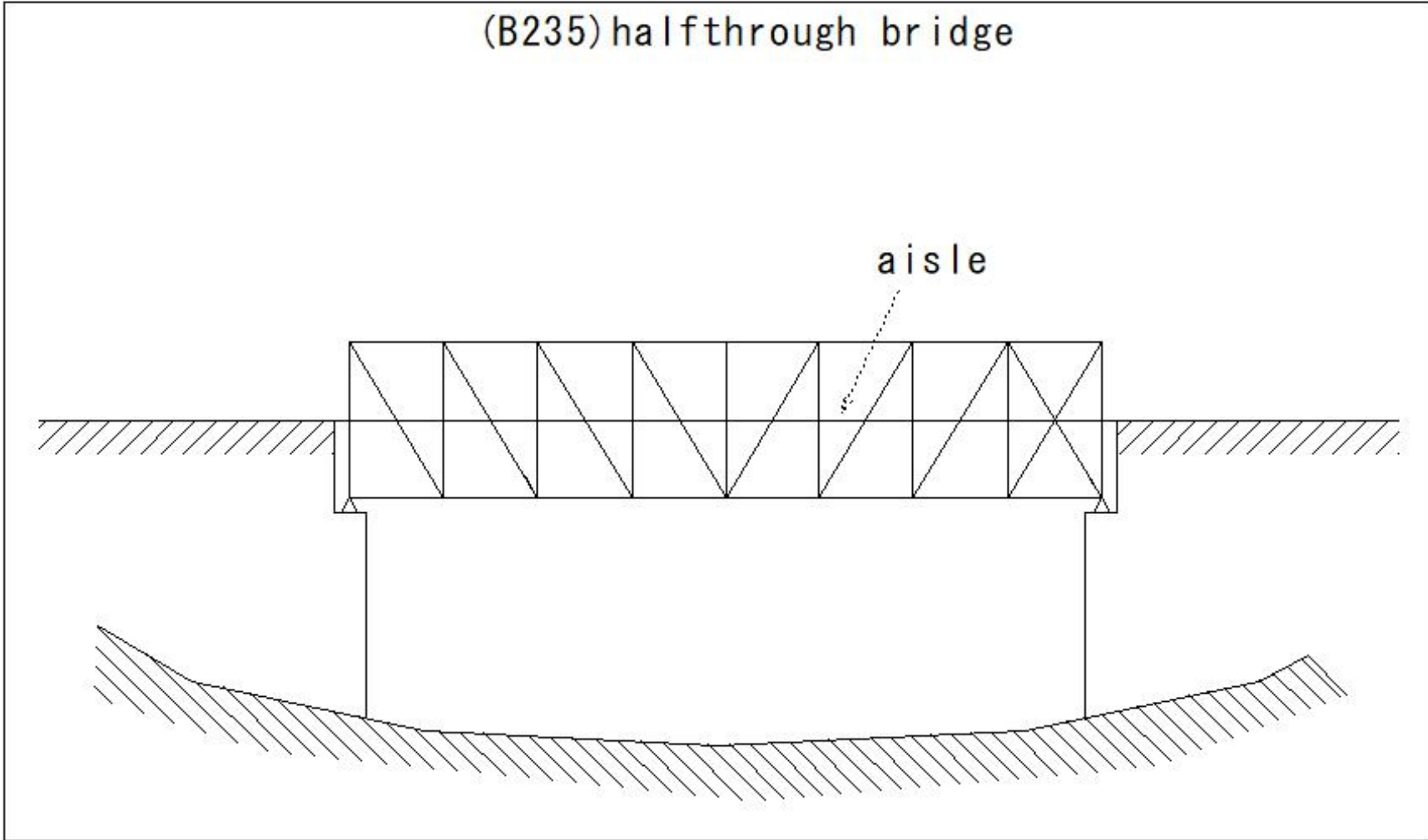
(B234)deck bridge



(B235) halfthrough bridge

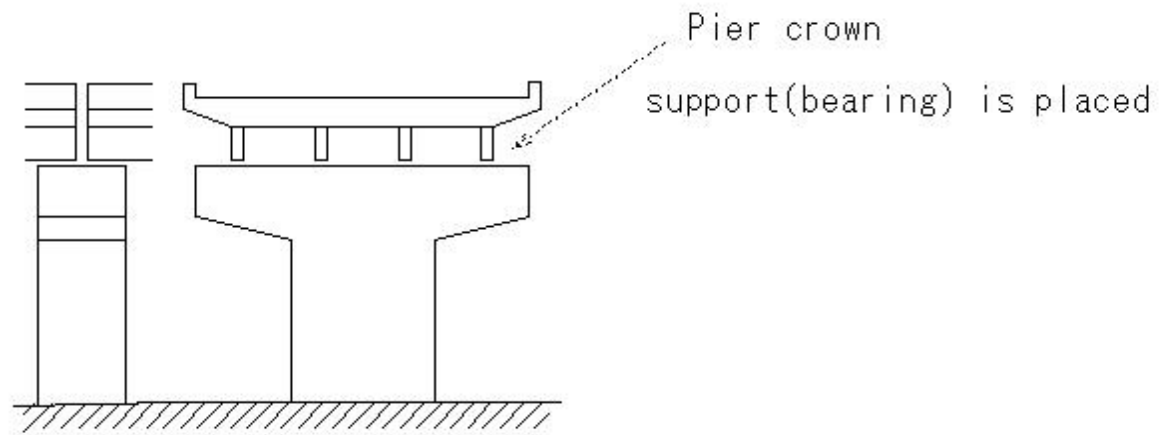
(B235) halfthrough bridge

aisle



(B236) pier crown

(B236) pier crown



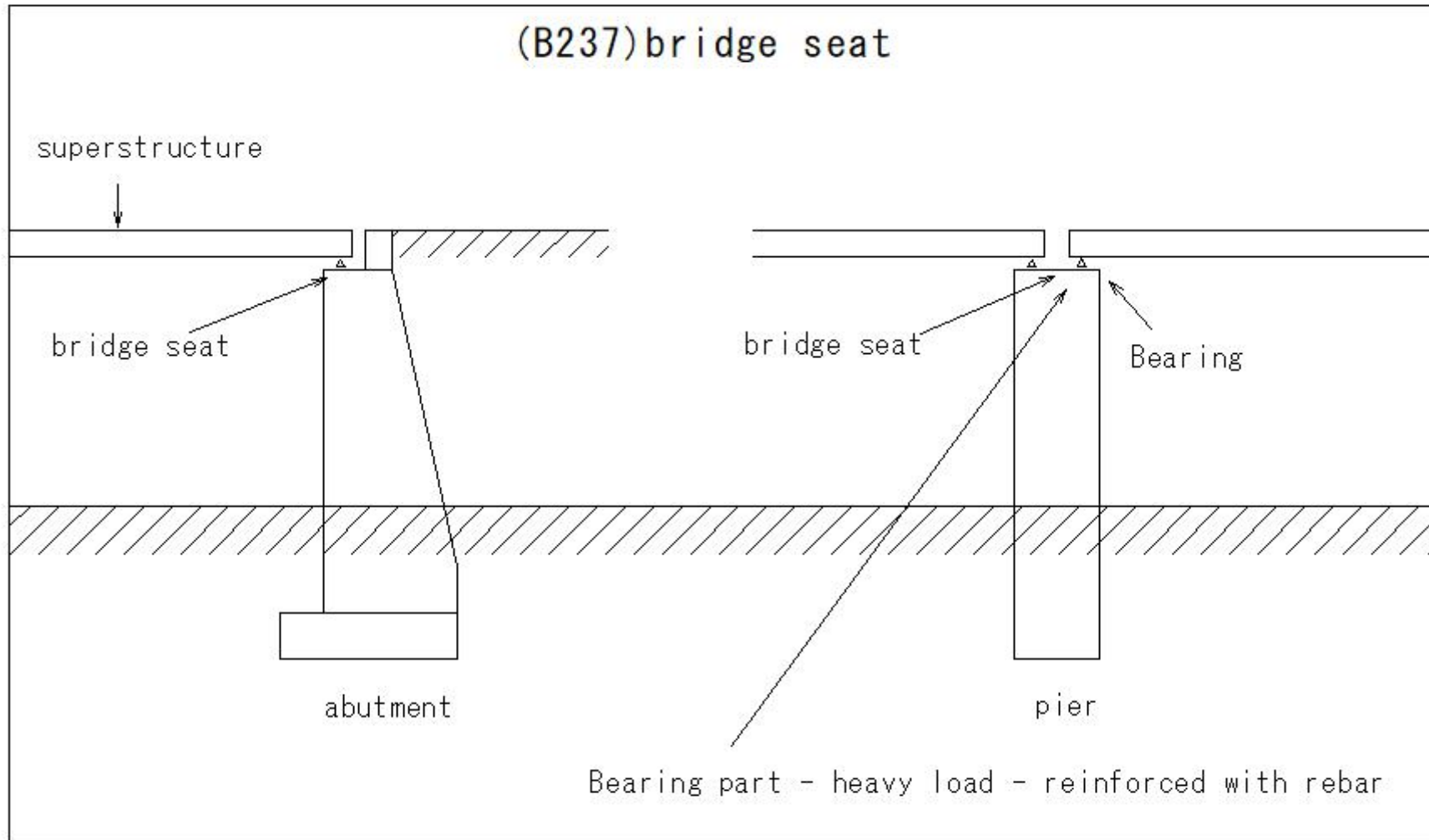
Pier crown

support (bearing) is placed

RC pier

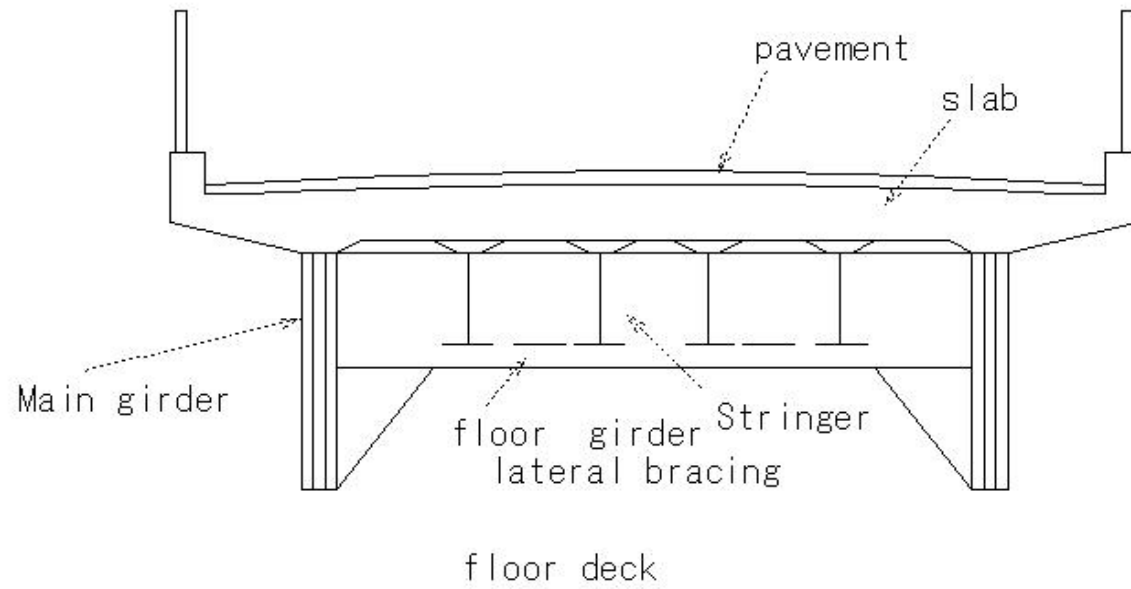
(B237)bridge seat

(B237)bridge seat



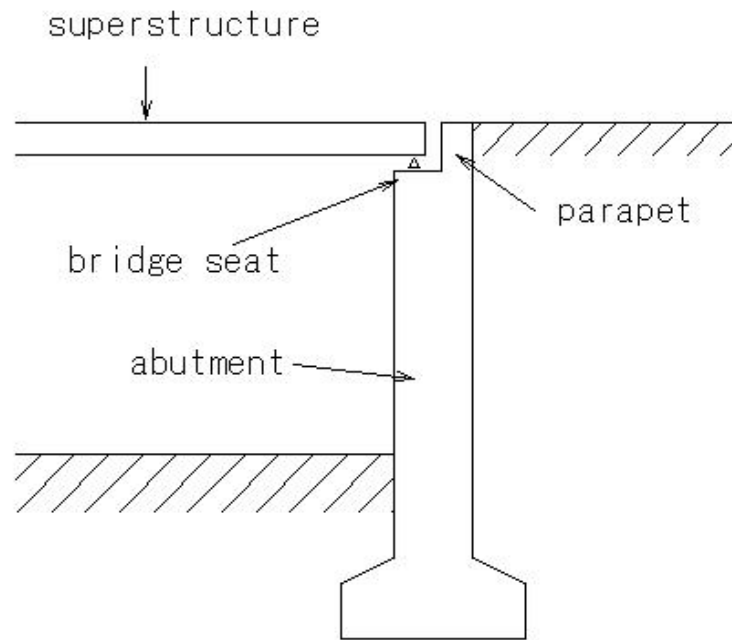
(B238) floor deck

(B238) floor deck



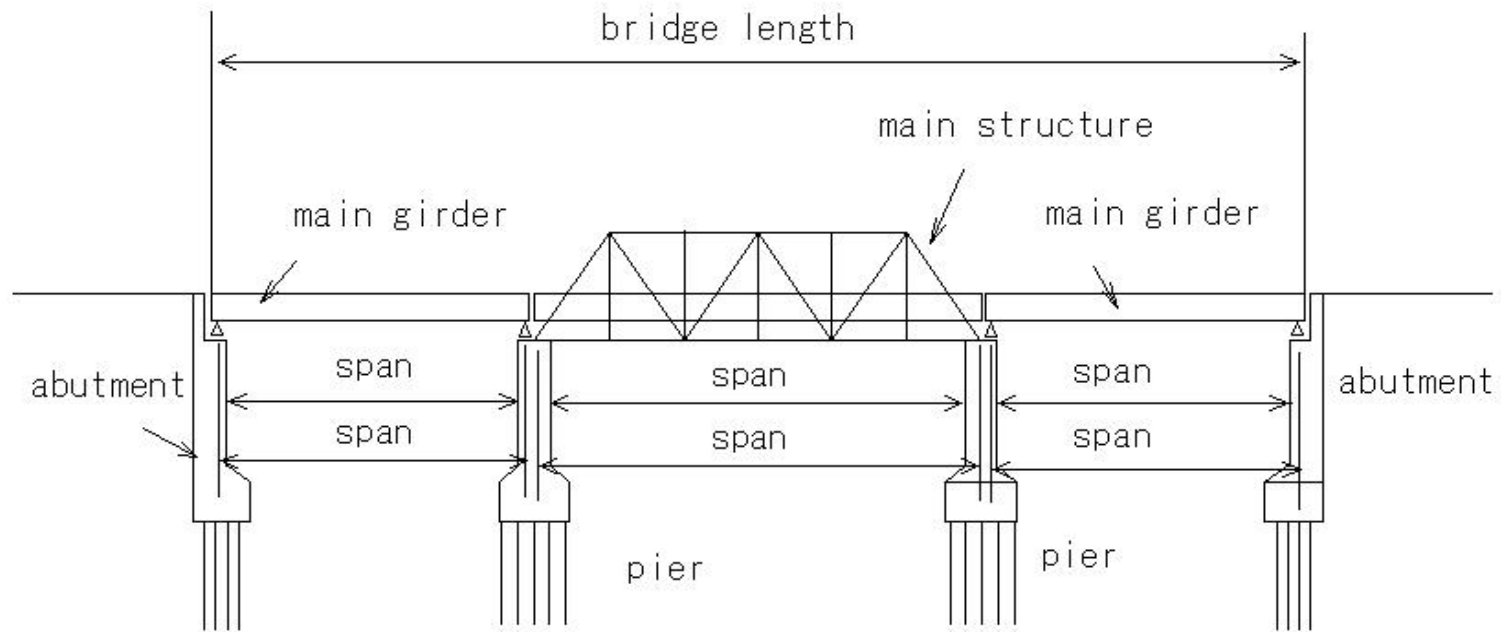
(B239)abutment

(B239) abutment



(B240)bridge length

(B240)bridge length



(B241)portal bracing

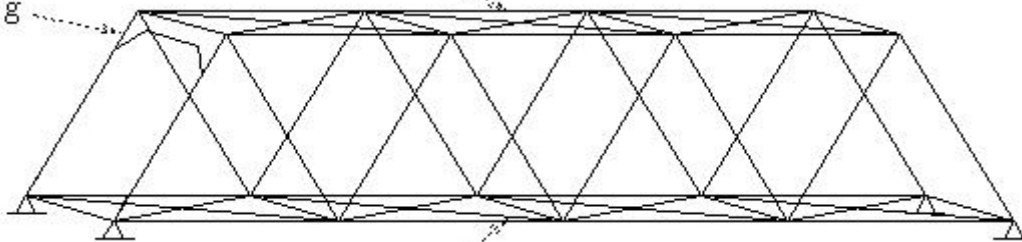
(B241)portal bracing

truss

portal bracing

Top chord

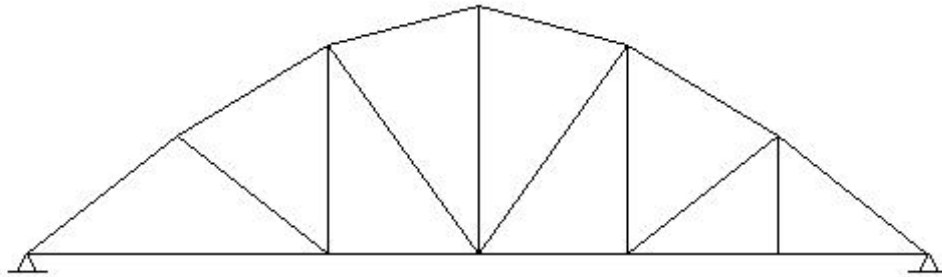
bottom chord



(B242)curved-chord truss

(B242) curved-chord truss

curved-chord truss

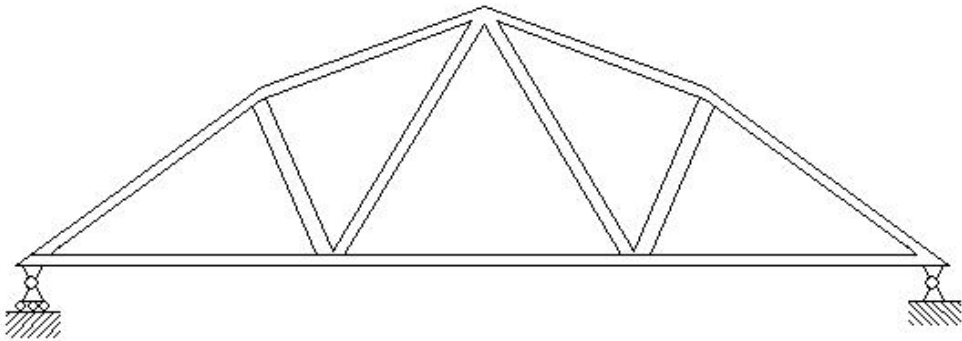


Top chord-bottom chord -not horizontal

(B243)bowstring warren truss

(B243)bowstring warren truss

bowstring warren truss

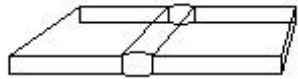


Top chord-bottom chord -not horizontal

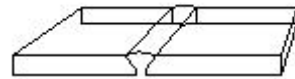
(B244)groove welding

(B244) groove welding

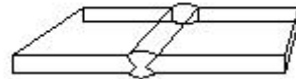
I type



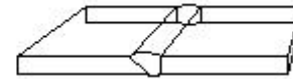
V type



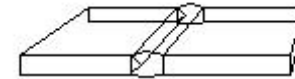
X type
Double-sided V-shaped



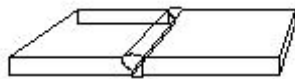
∇ type



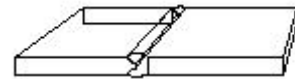
K type
Double-sided V-shaped



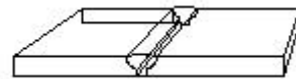
J type



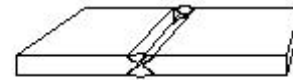
J type
Double-sided J shape



U type

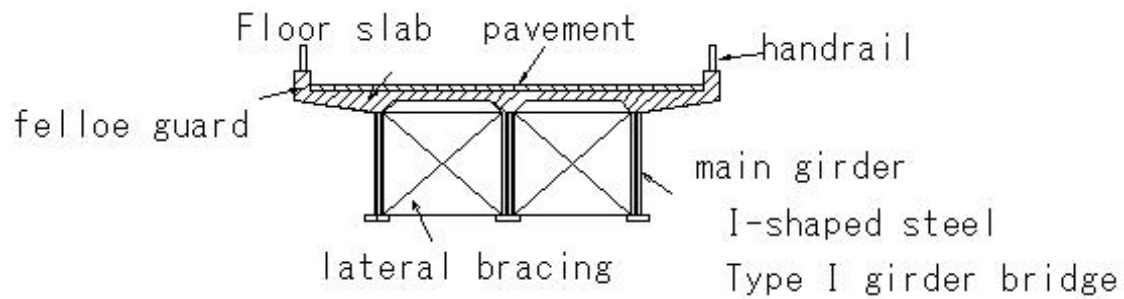
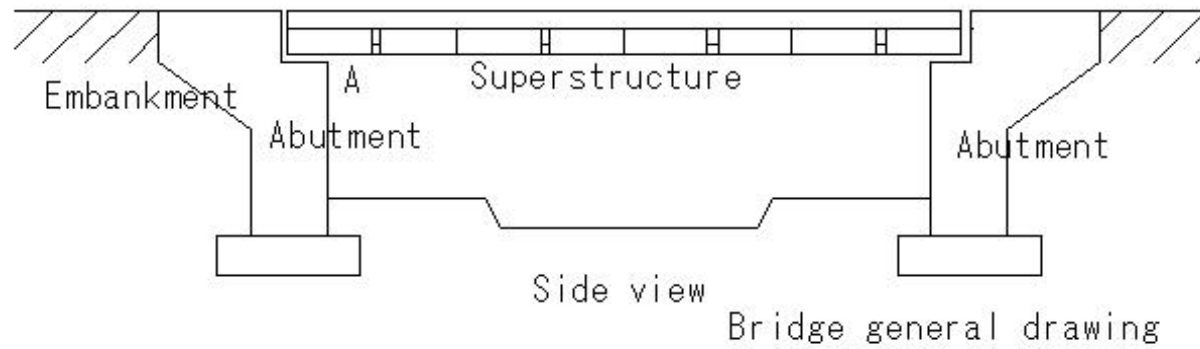


H type
Double-sided U shape



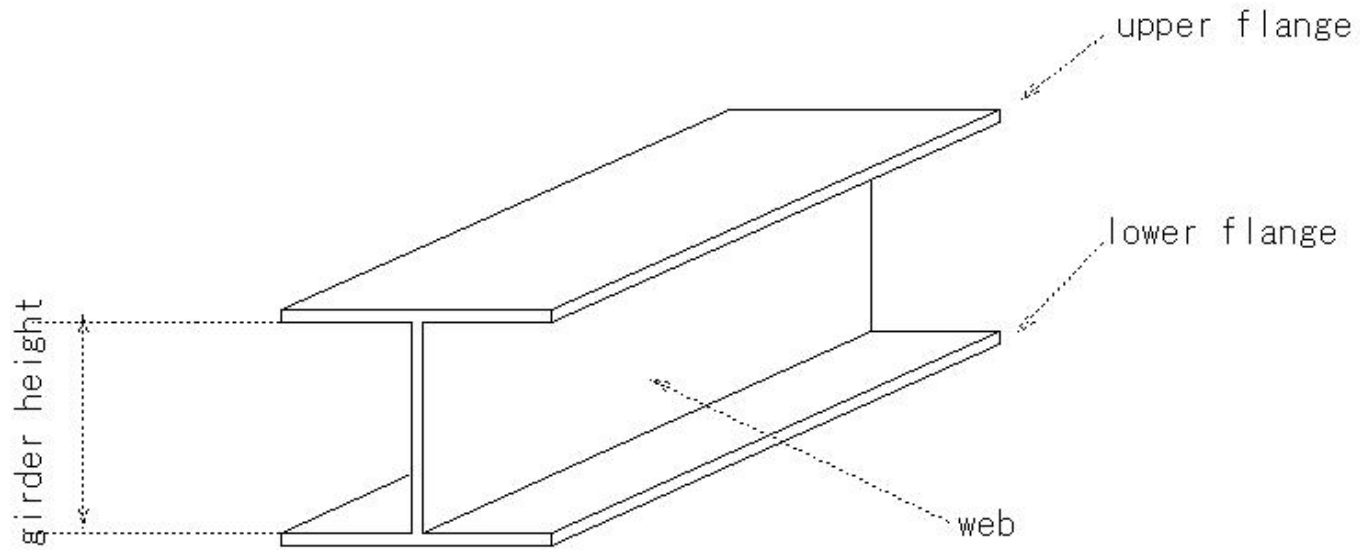
(B245)girder bridge

(B245)girder bridge

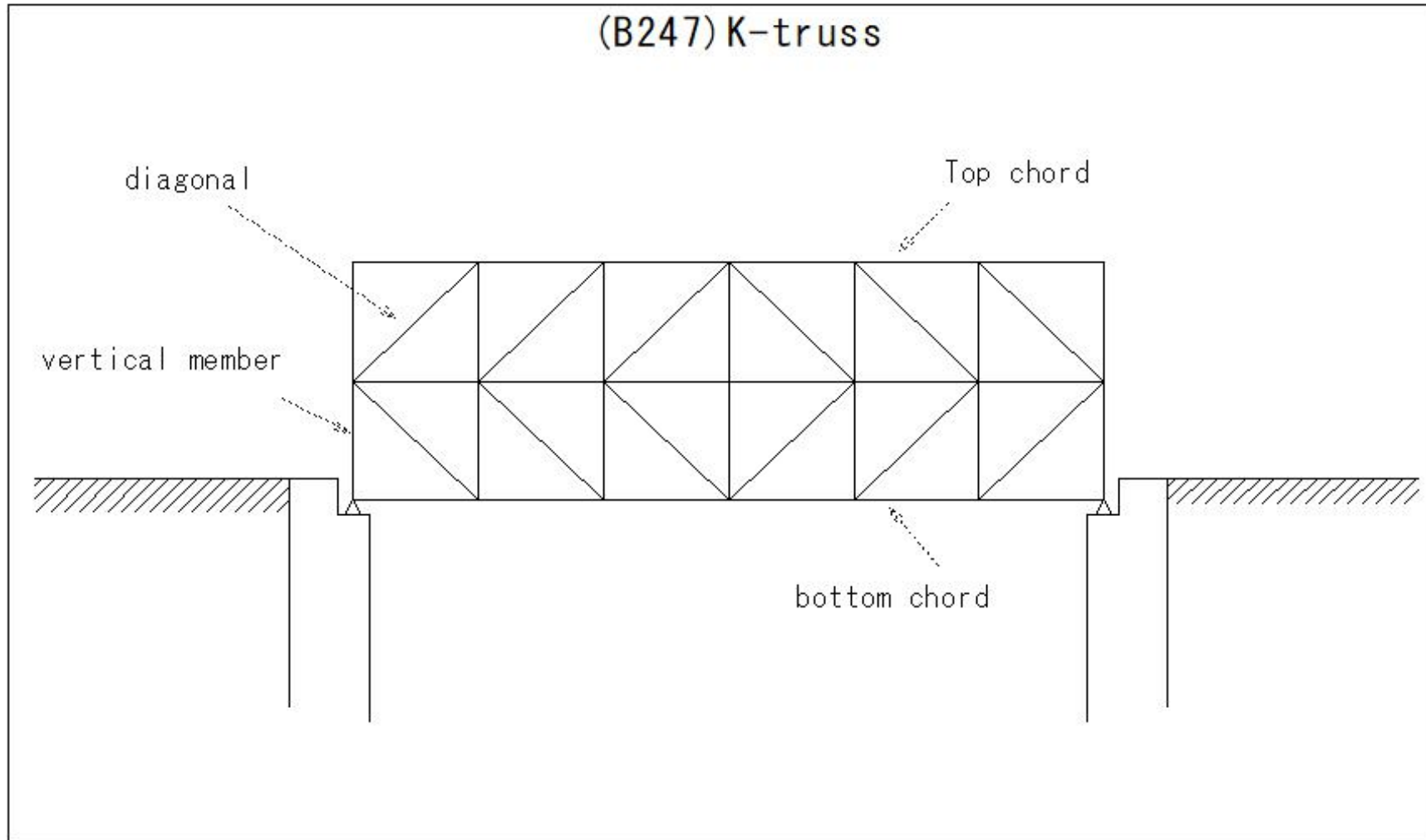


(B246)Girder height

(B246) Girder height

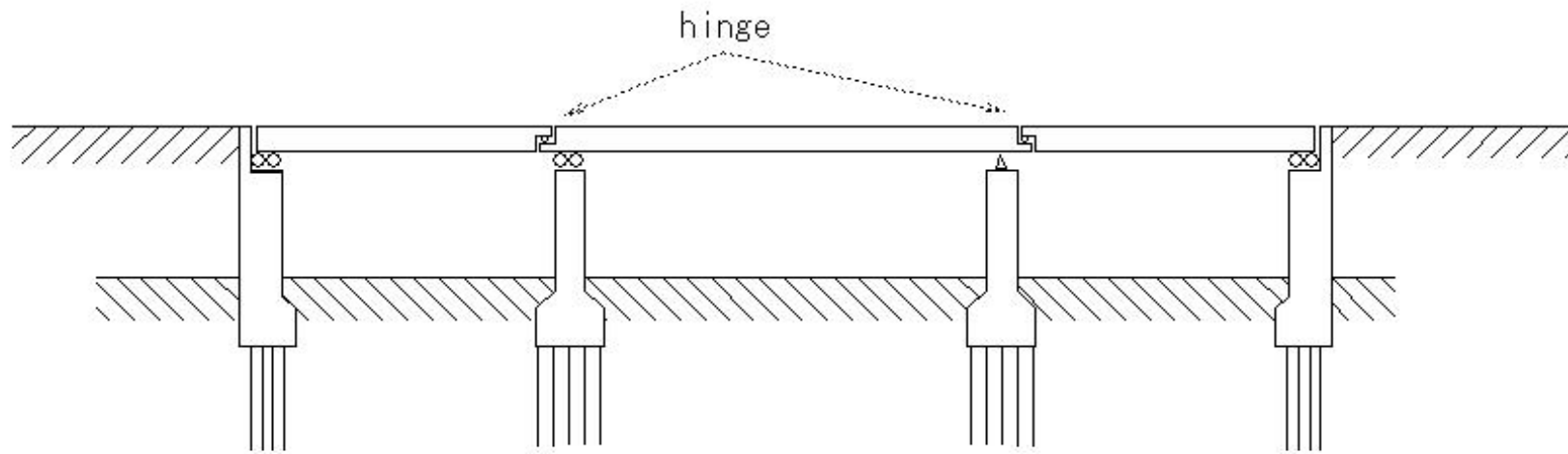


(B247)K-truss



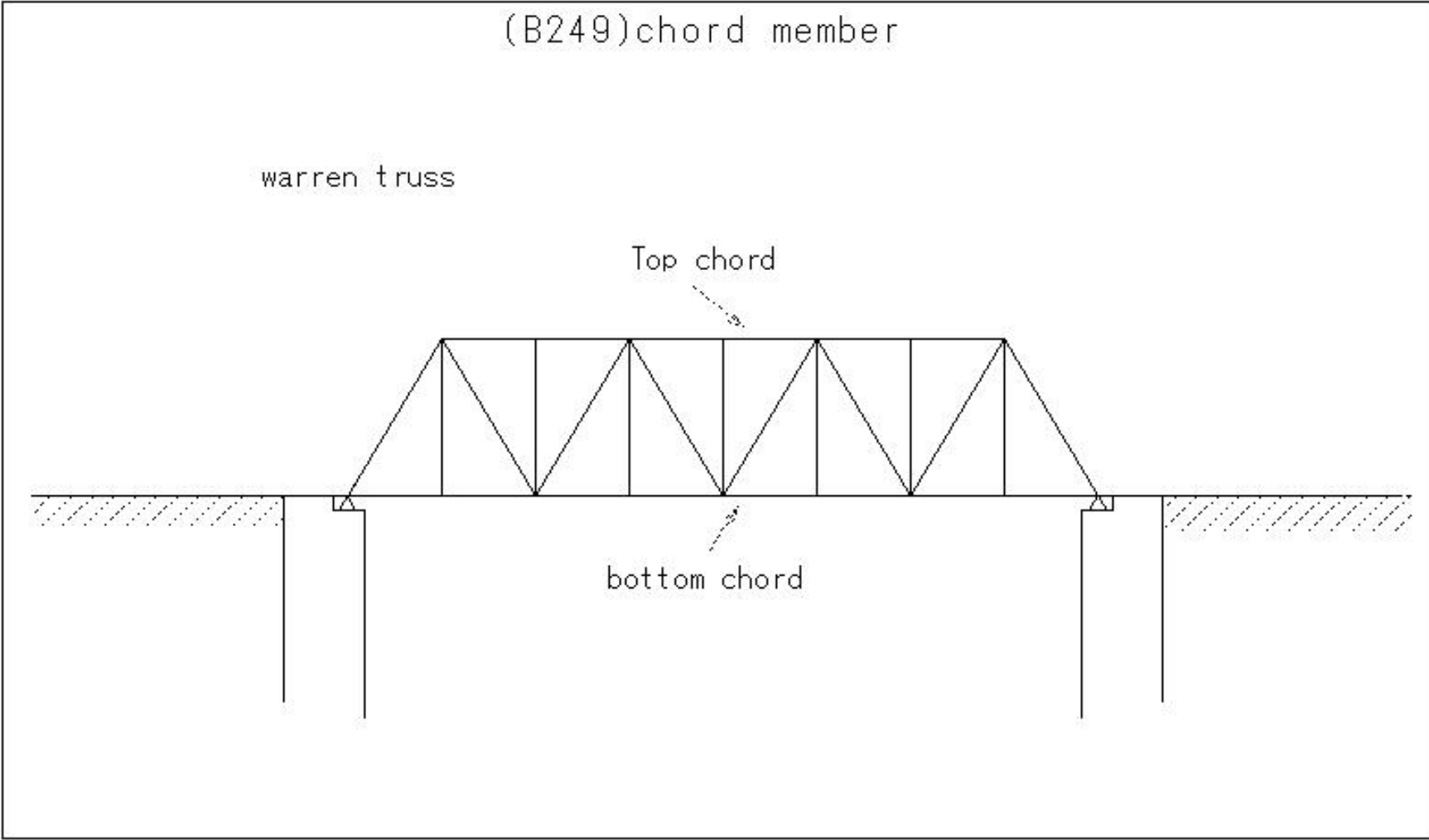
(B248)gerber bridge(cantilever bridge)

(B248) gerber bridge(cantilever bridge)



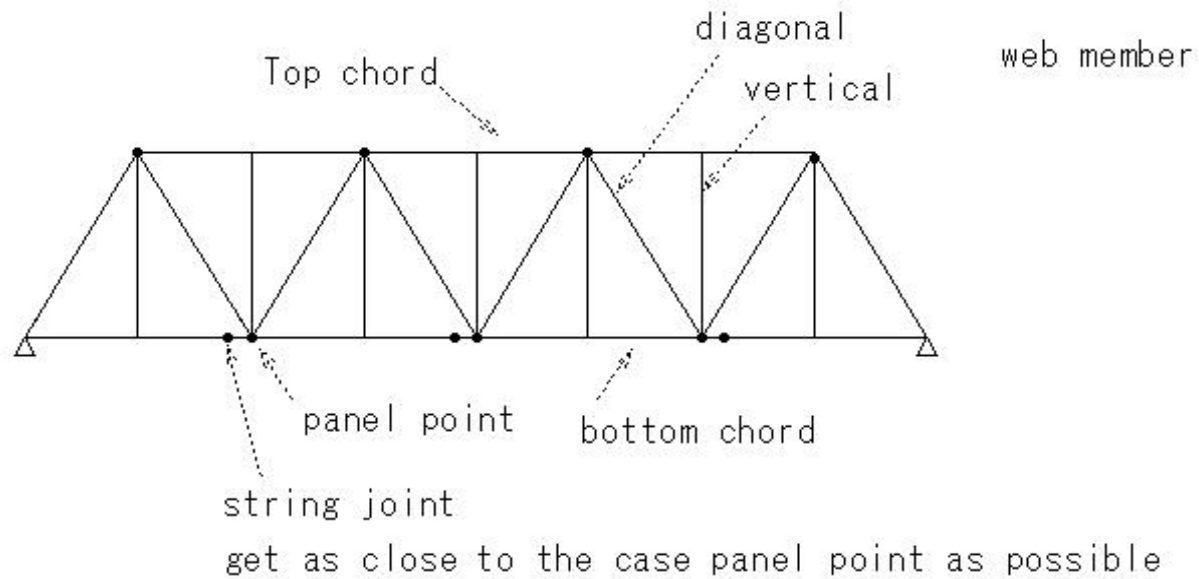
Compared to continuous girders, there is less influence from settling of the fulcrum.

(B249)chord member



(B250)chord member joint

(B250) chord member joint



(B251)field welding

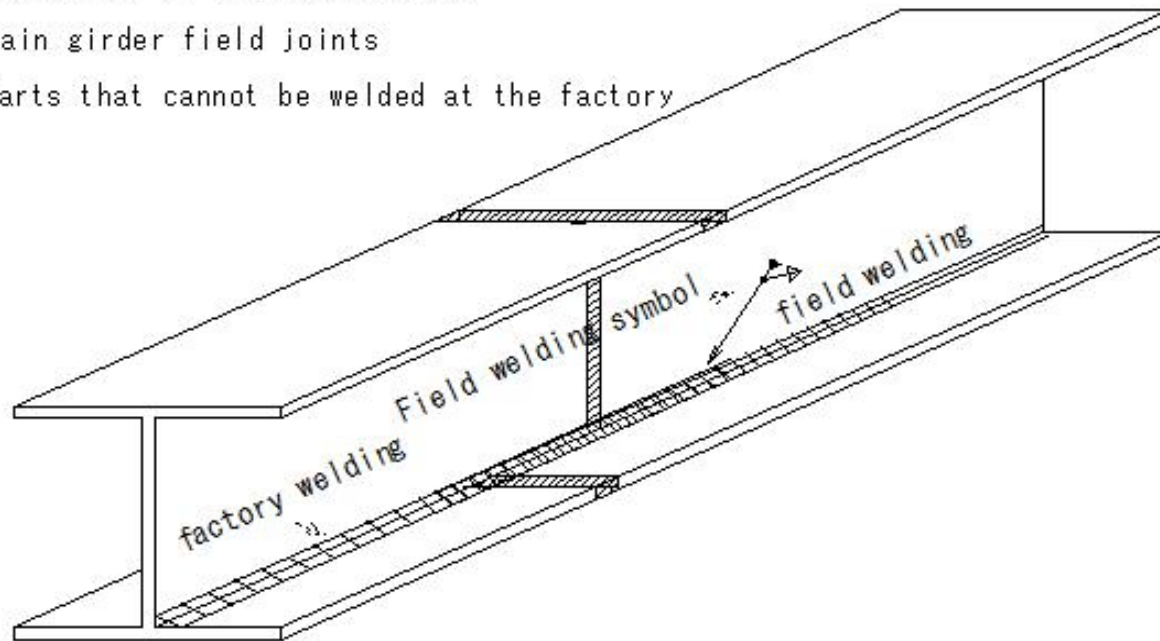
(B251)field welding

field welding

Joint part of steel deck plate

Main girder field joints

Parts that cannot be welded at the factory

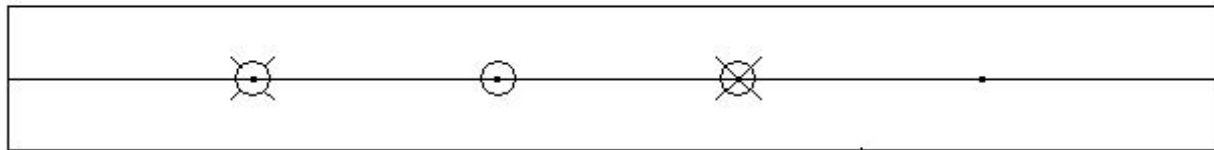
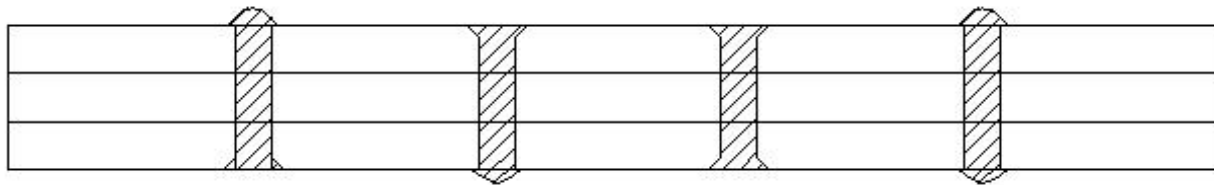


(B252)field rivet

(B252)field rivet

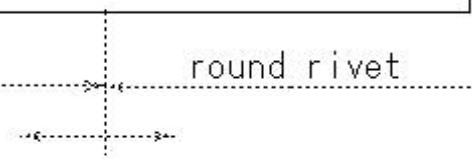
field rivet
Construction site

rivet



Flush rivet
No sharpening

round rivet

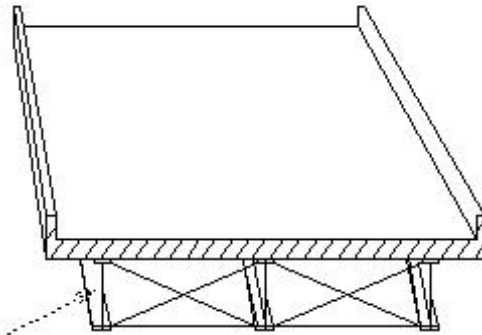


(B253)steel beam bridge

(B253)steel beam bridge

steel beam bridge

steel girder-main structure

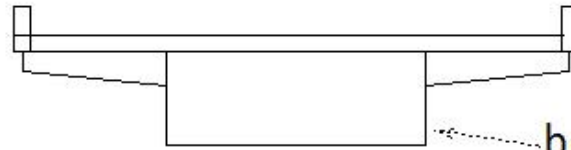


steel plate girder

• Plate girder bridge

(B254)steel beam bridge(box girder bridge)

(B254) steel beam bridge (box girder bridge)



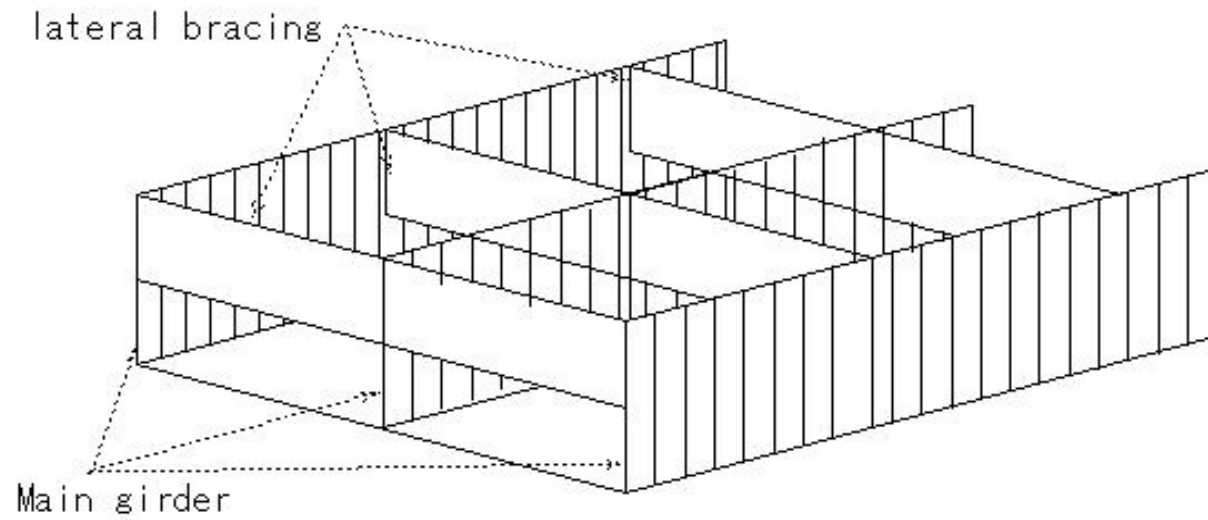
box girder bridge

box girder bridge

(B255)grating structure

(B255)grating structure

grating structure



Connect horizontally with lateral bracing
arrange in a grid

(B256)nominal stress

(B256)nominal stress

nominal stress

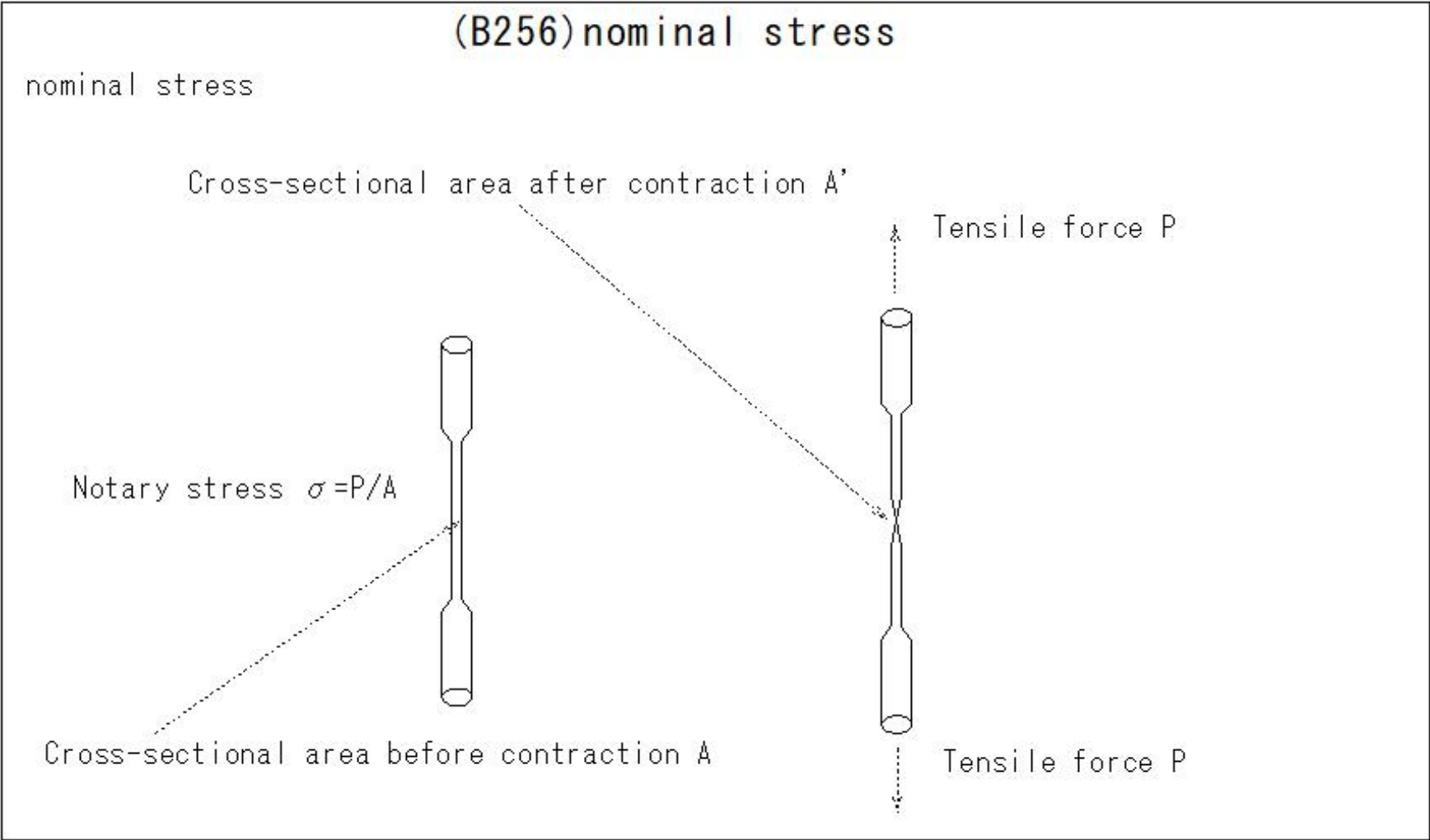
Cross-sectional area after contraction A'

Tensile force P

Notary stress $\sigma = P/A$

Cross-sectional area before contraction A

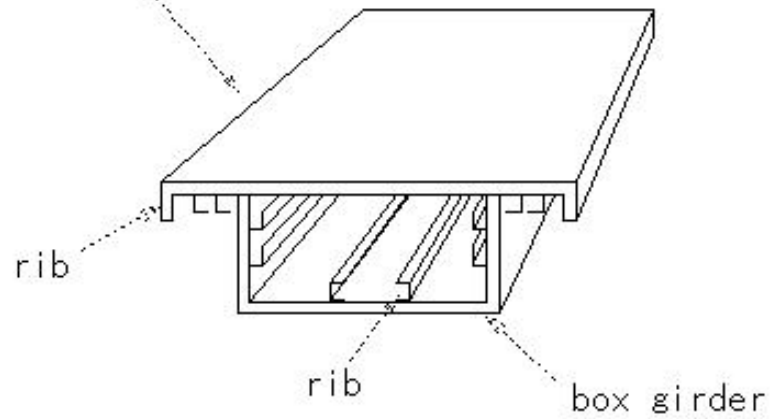
Tensile force P



(B257)beam bridge with steel plate floor

(B257)beam bridge with steel plate floor

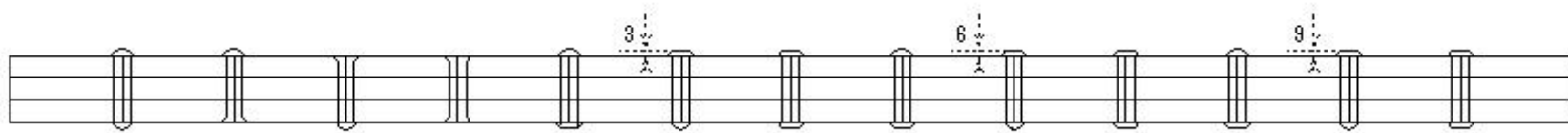
Lighter than concrete slabs
Role of upper flange and floor slab
steel deck plate



beam bridge with steel plate floor

(B258)shop rivet

(B258) shop rivet



round rivet

Flush rivet
No sharpening

Flush rivet

flat rivet

flat rivet

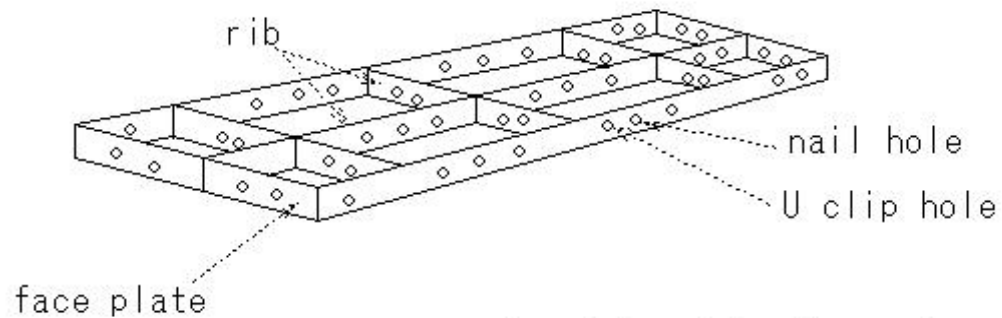
(unit:mm)

(B259)steel form

(B259) steel form

steel formwork

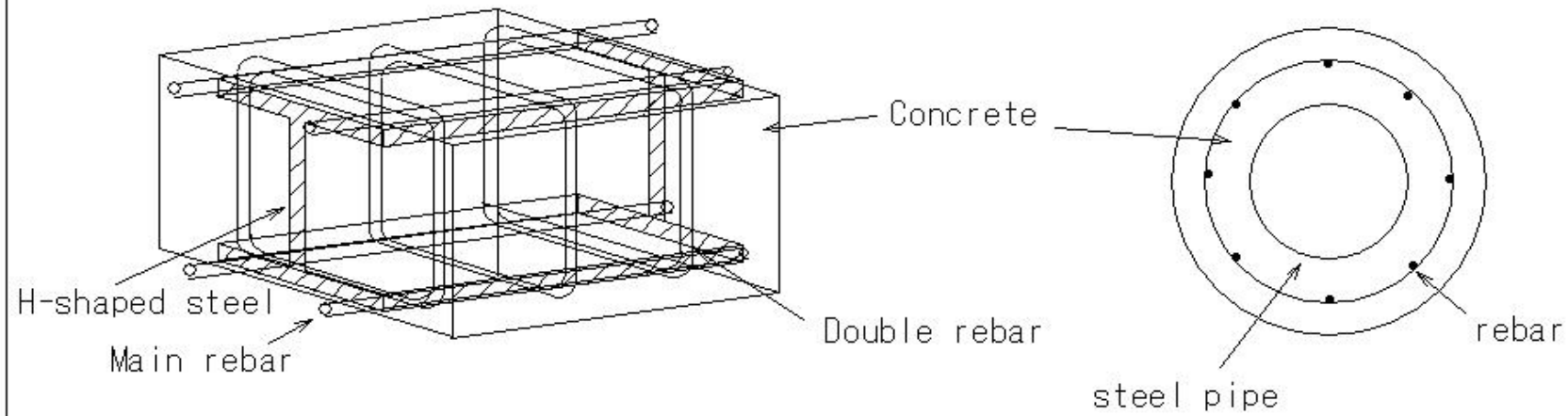
- Steel member - formwork
- factory production
- Rigidity - large
- High degree of diversion



Assemble with clips, pins, etc.
Work - easy

(B260) composite column

(B260) composite column



(B261)steel sheet pile

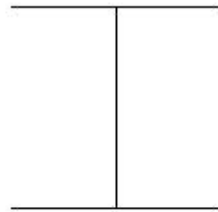
(B261)steel sheet pile

steel sheet pile

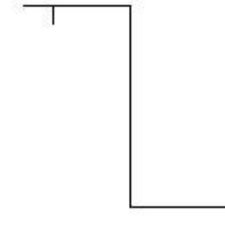
U-shaped



H-shaped steel



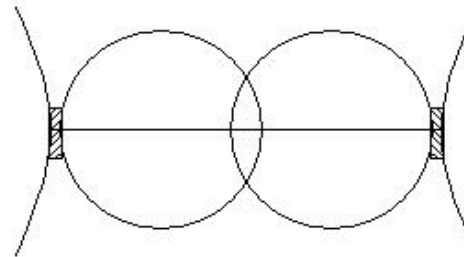
Z shape



straight line



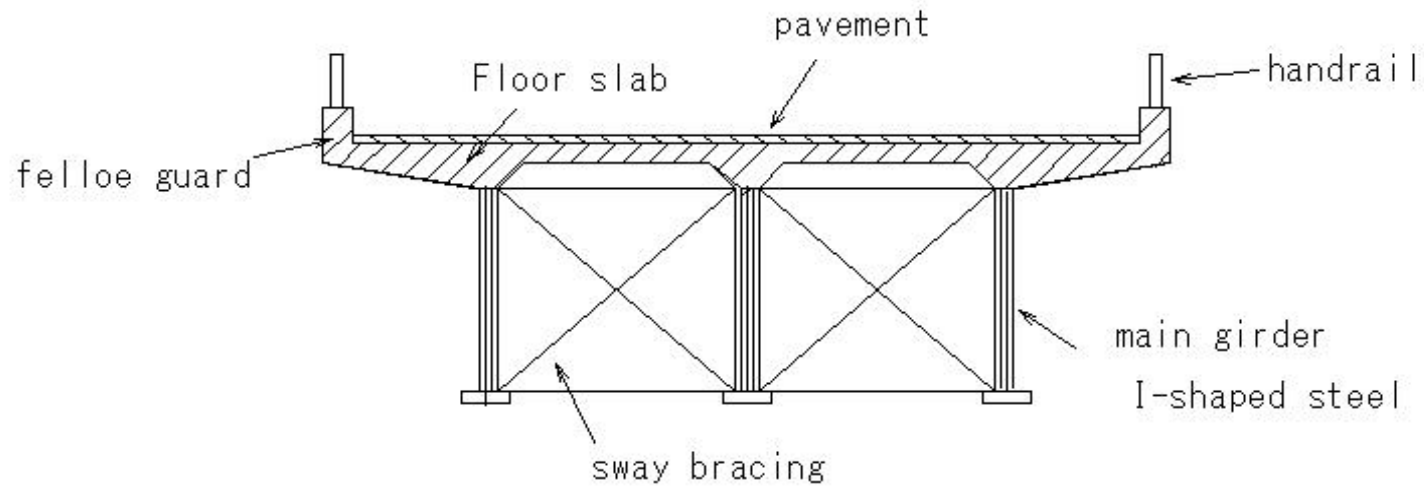
Steel pipe type



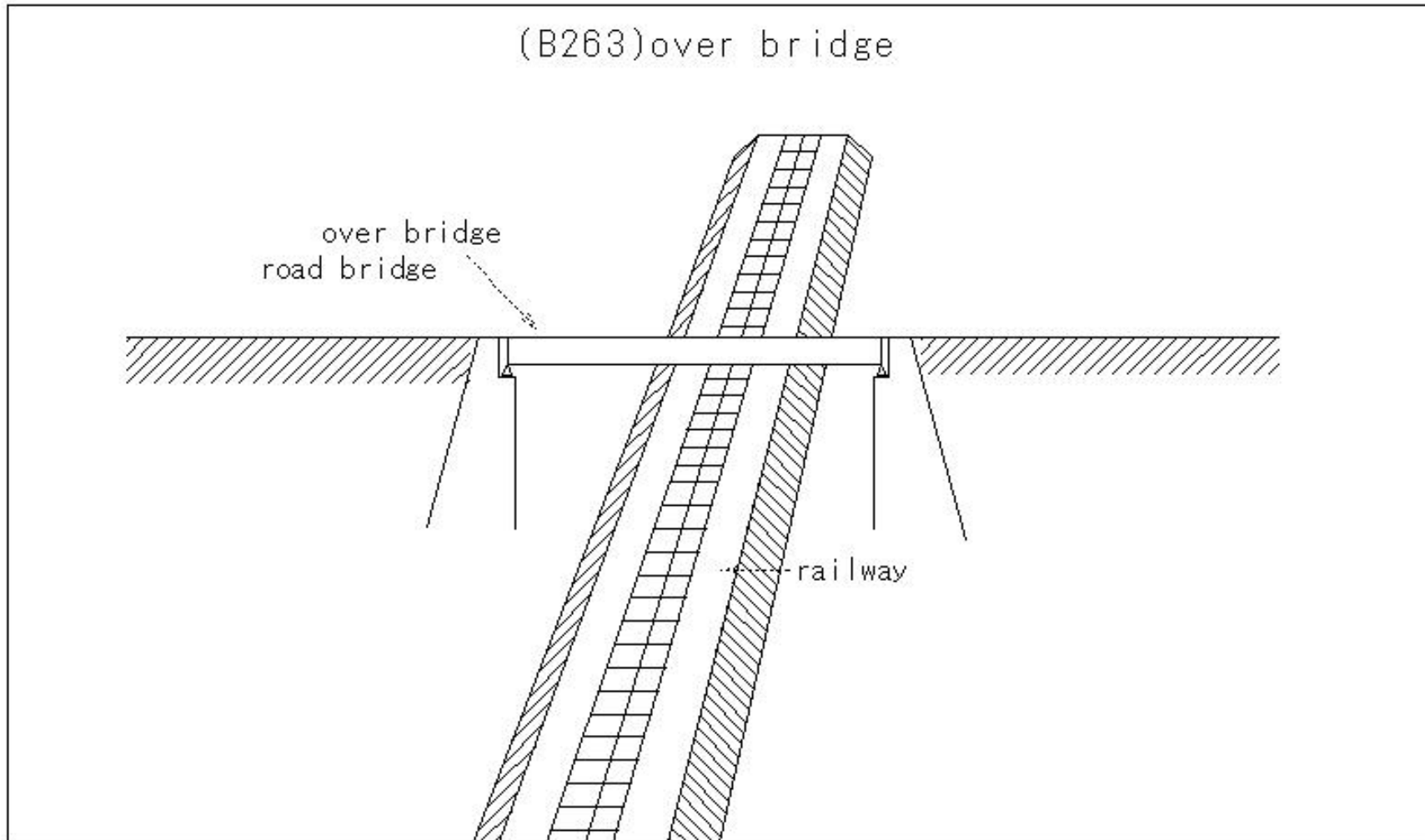
Earth retainer
water stop
Temporary works

(B262)handrail

(B262) handrail



(B263)over bridge

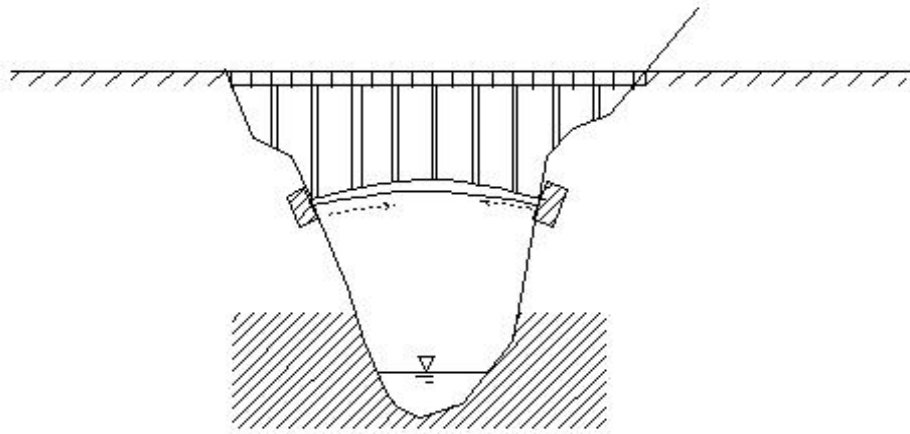


(B264)fixed arch bridge

(B264)fixed arch bridge

Fixed arch bridge

No hinge



load and reaction force

(B265)fixed bearing

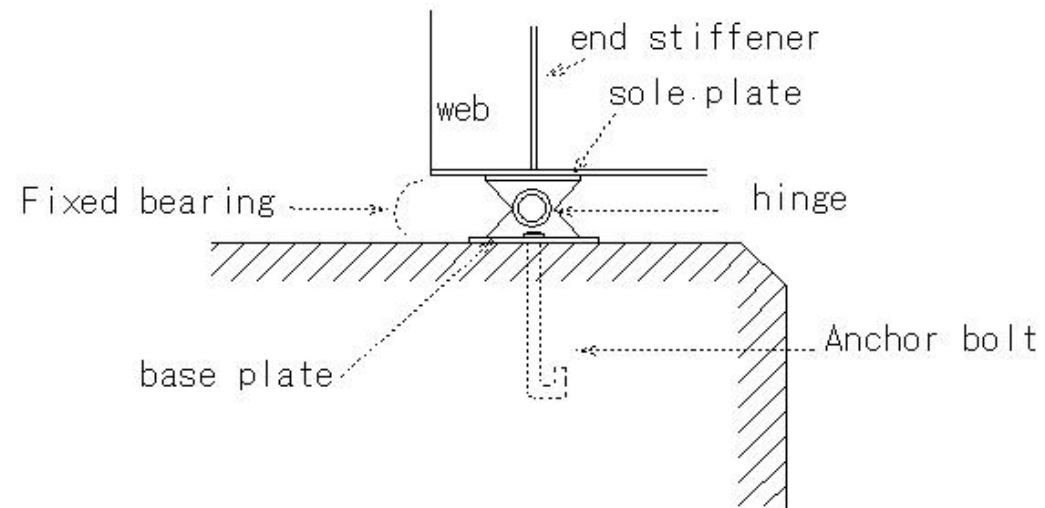
(B265) fixed bearing

fixed bearing

Bridge - Superstructure - Support

Rotational movement possible

no horizontal movement



(B266)fixed support

(B266) fixed support

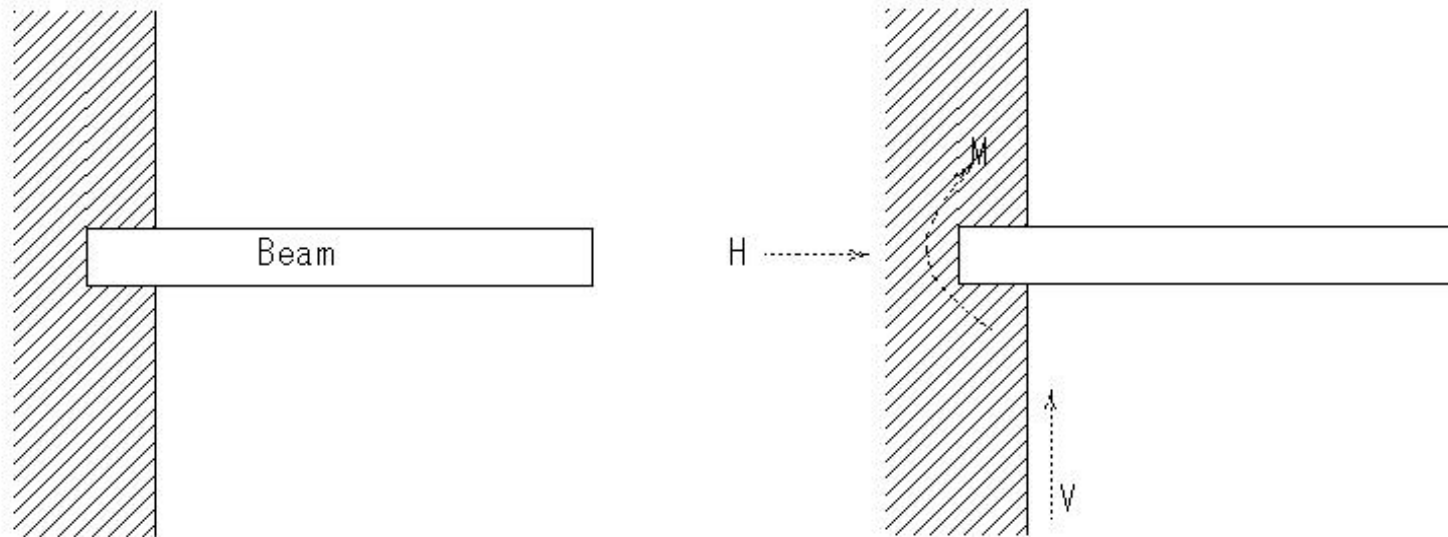
fixed support

Beam end - fixed

horizontal direction

vertical direction

rotate-fixed so that it cannot

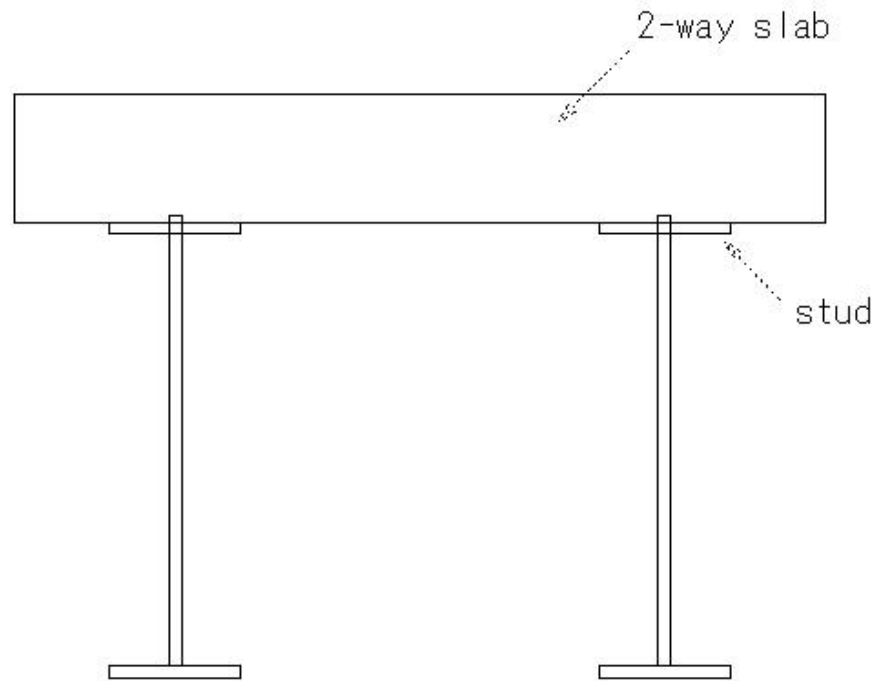


(B267)fixed slab

(B267)fixed slab

fixed slab

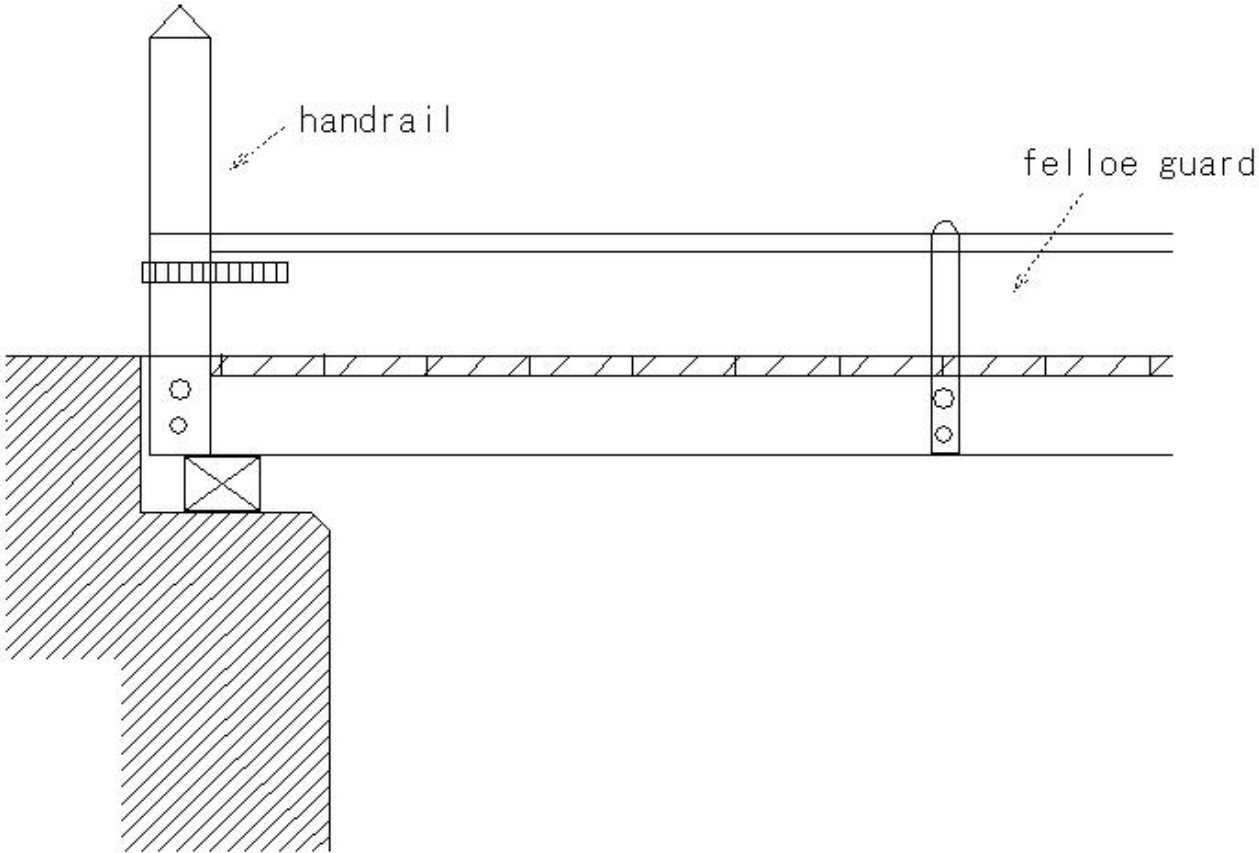
Fixed on 2nd, 3rd, and 4th sides of slab



(B268) wooden bridge

(B268) wooden bridge

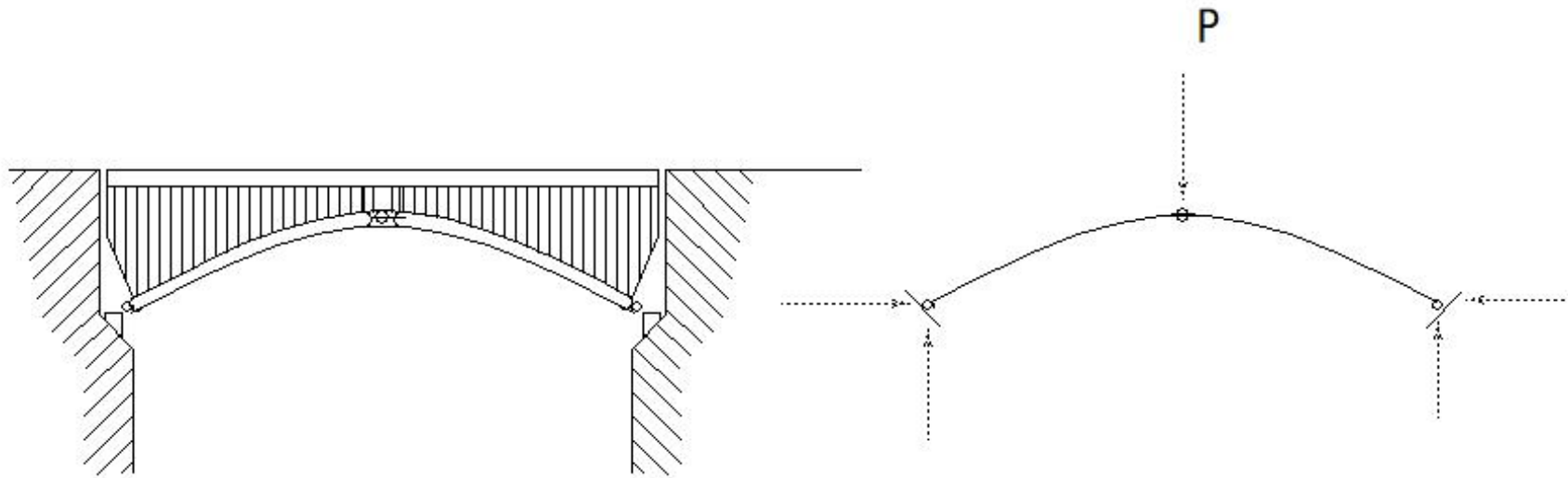
wooden bridge



(B269)three-hinged arch

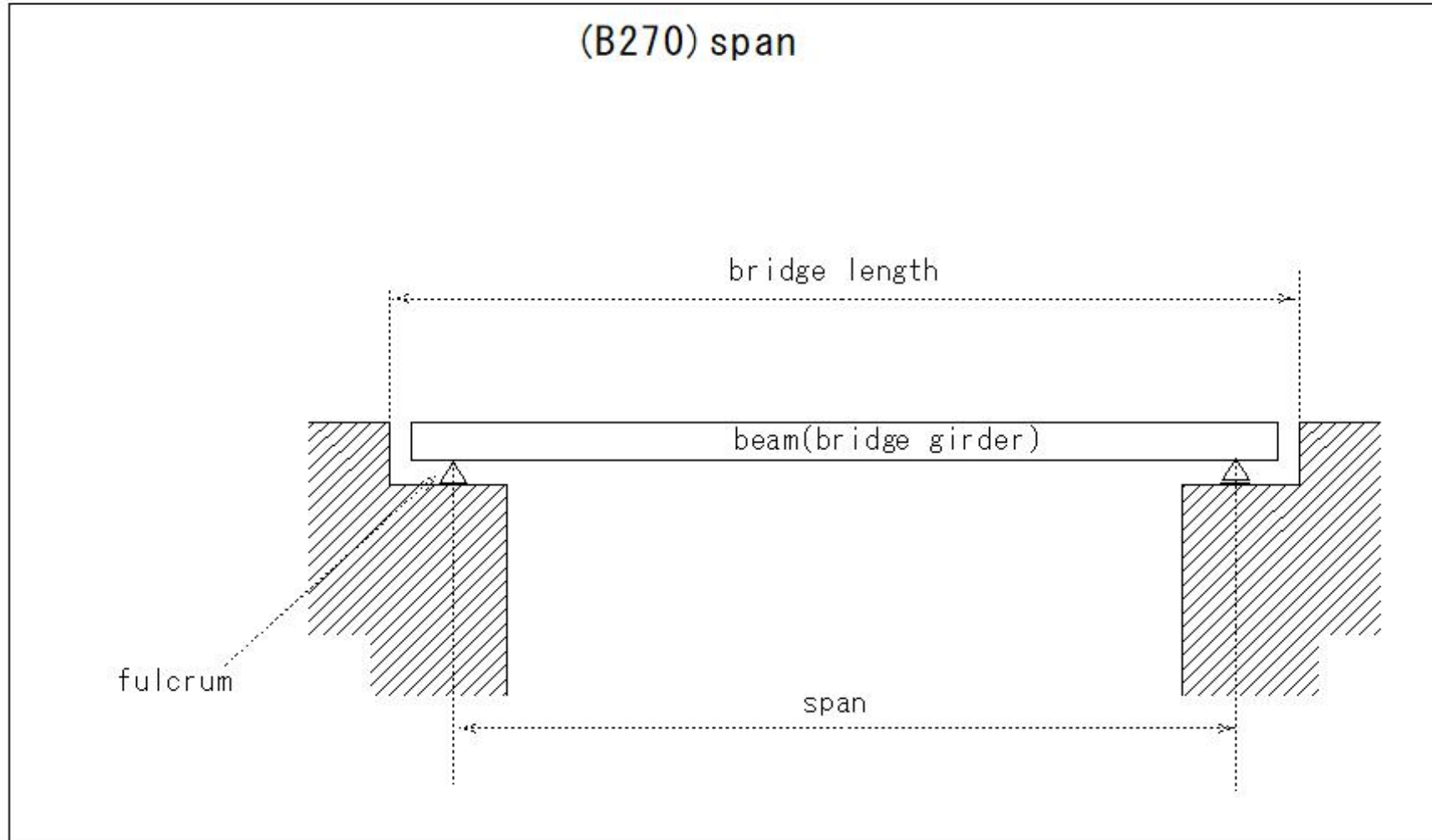
(B269) three-hinged arch

three hinge arch
Double fulcrum - hinge
apex-hinge



(B270)span

(B270) span

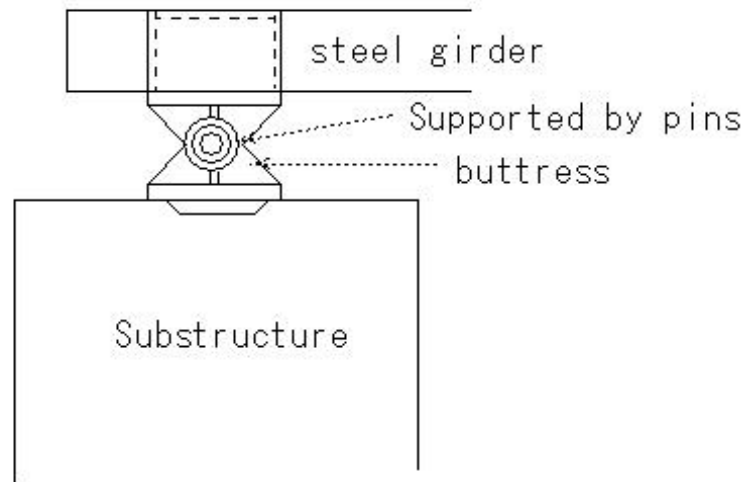


(B271) support

(B271) support

support(bearing)
bridge abutment
on the pier
Transfers superstructure loads

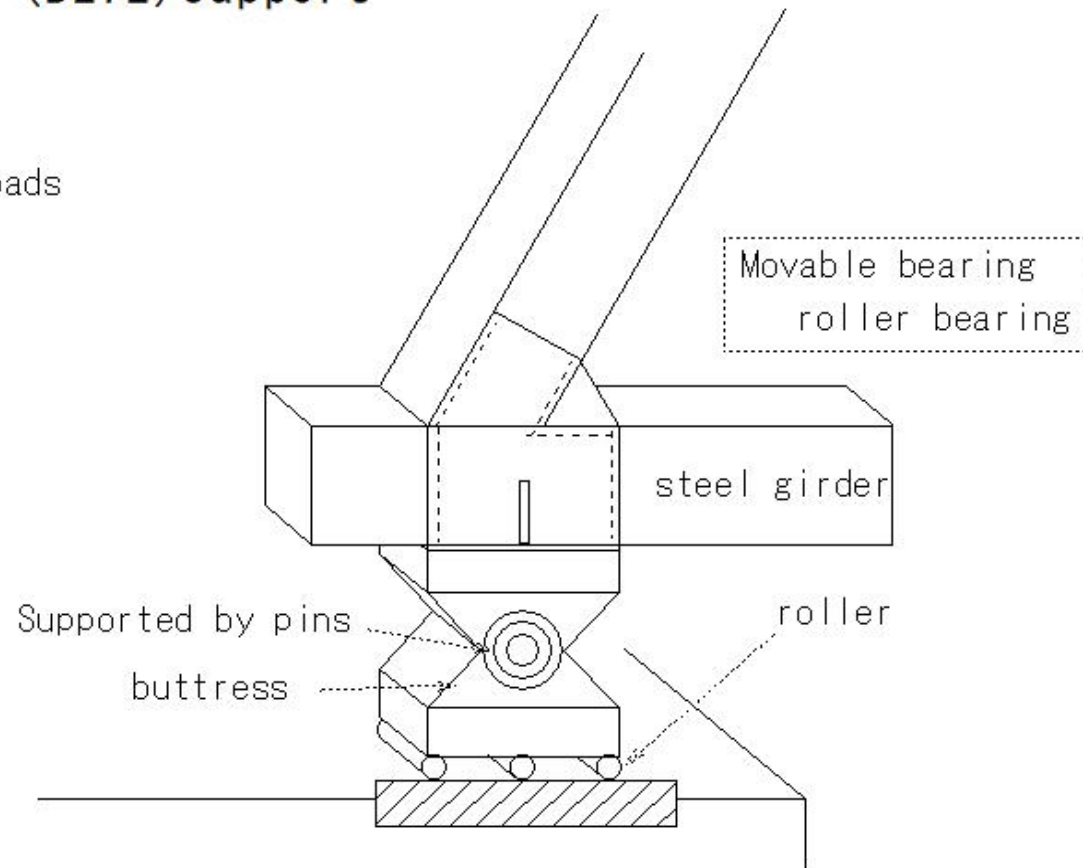
Fixed support(bearing)



(B272) support

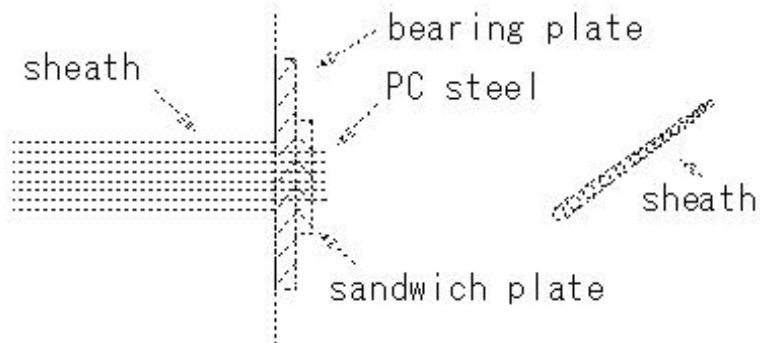
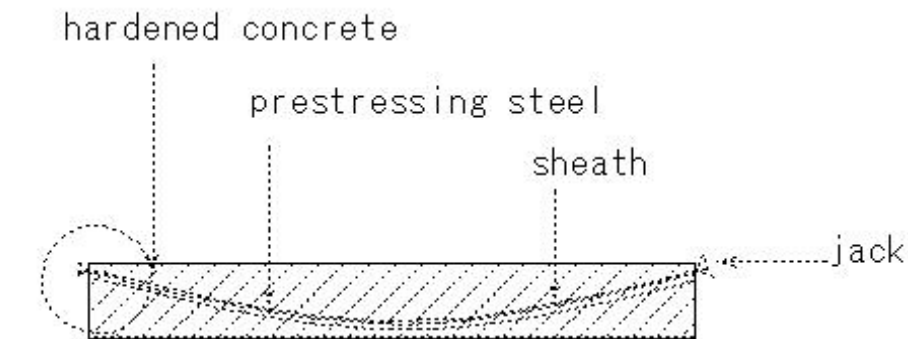
(B272) support

support (bearing)
bridge abutment
on the pier
Transfers superstructure loads



(B273)post tension(sheath)

(B273) post tension (sheath)

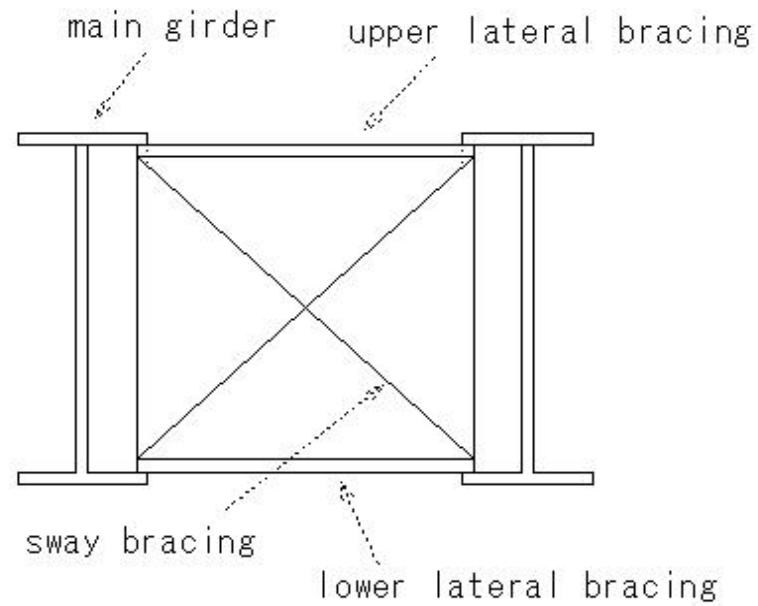


PC material
post tension
cylindrical pipe

- ① Fixed with sheath reinforcing bars
- ② Concrete placement
- ③ PC steel material insertion
- ④ Tensile force
- ⑤ PC steel wire fixing
- ⑥ Injection of mortar into the sheath

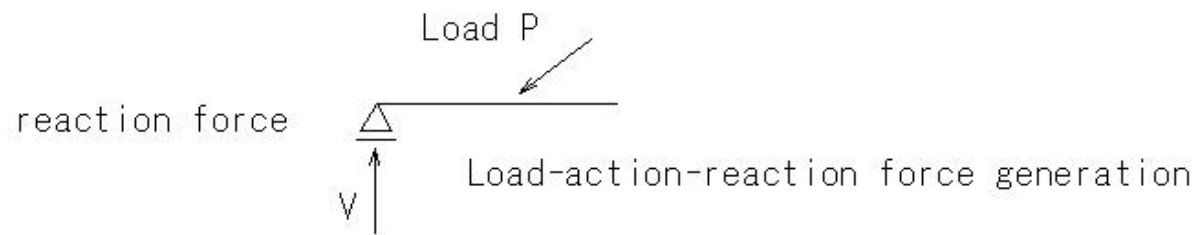
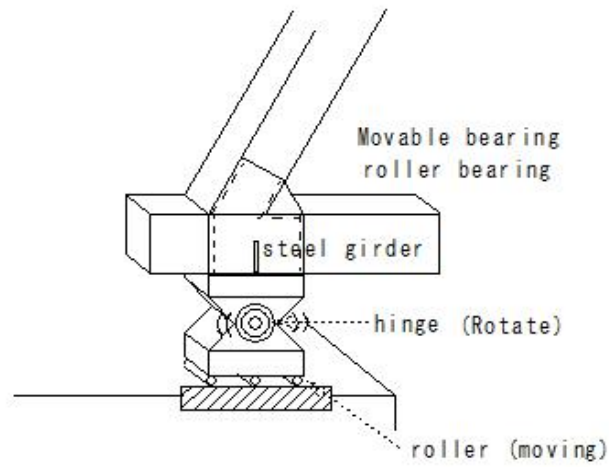
(B274)lower lateral bracing

(B274) lower lateral bracing



(B275)support(movable)

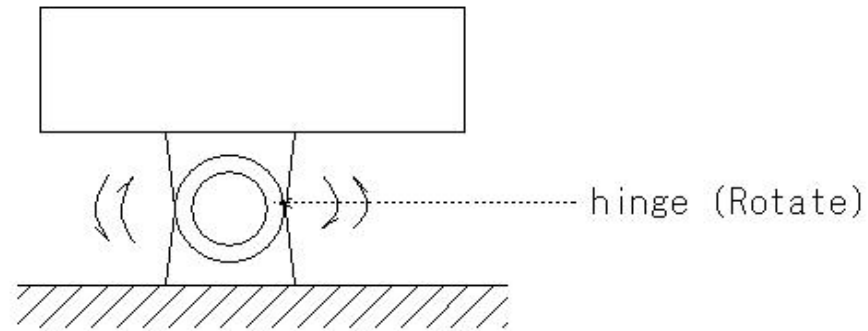
(B275) support (movable fulcrum)



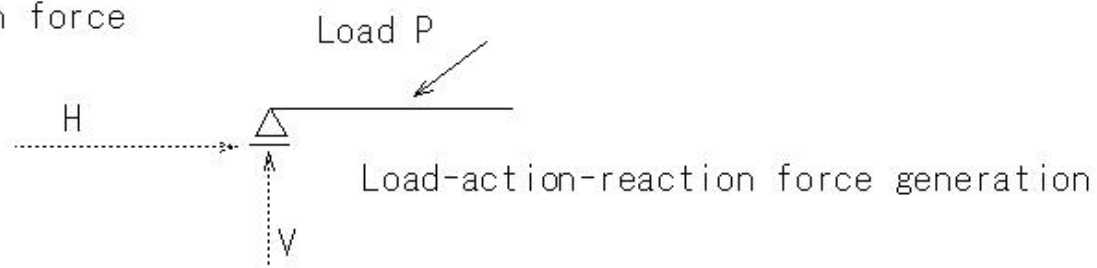
(B276)support(rotating)

(B276) support (rotating)

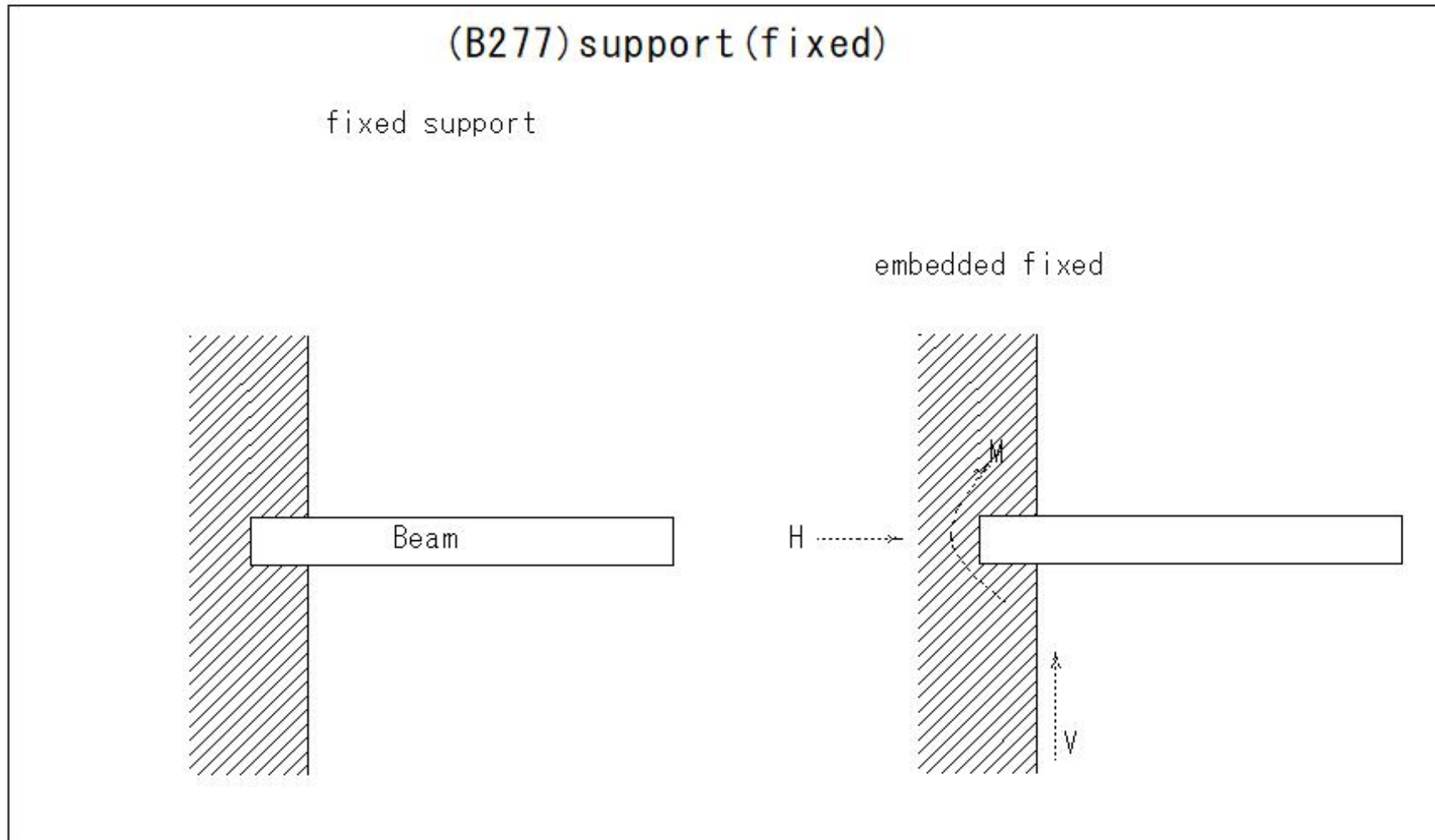
support(rotating)



reaction force

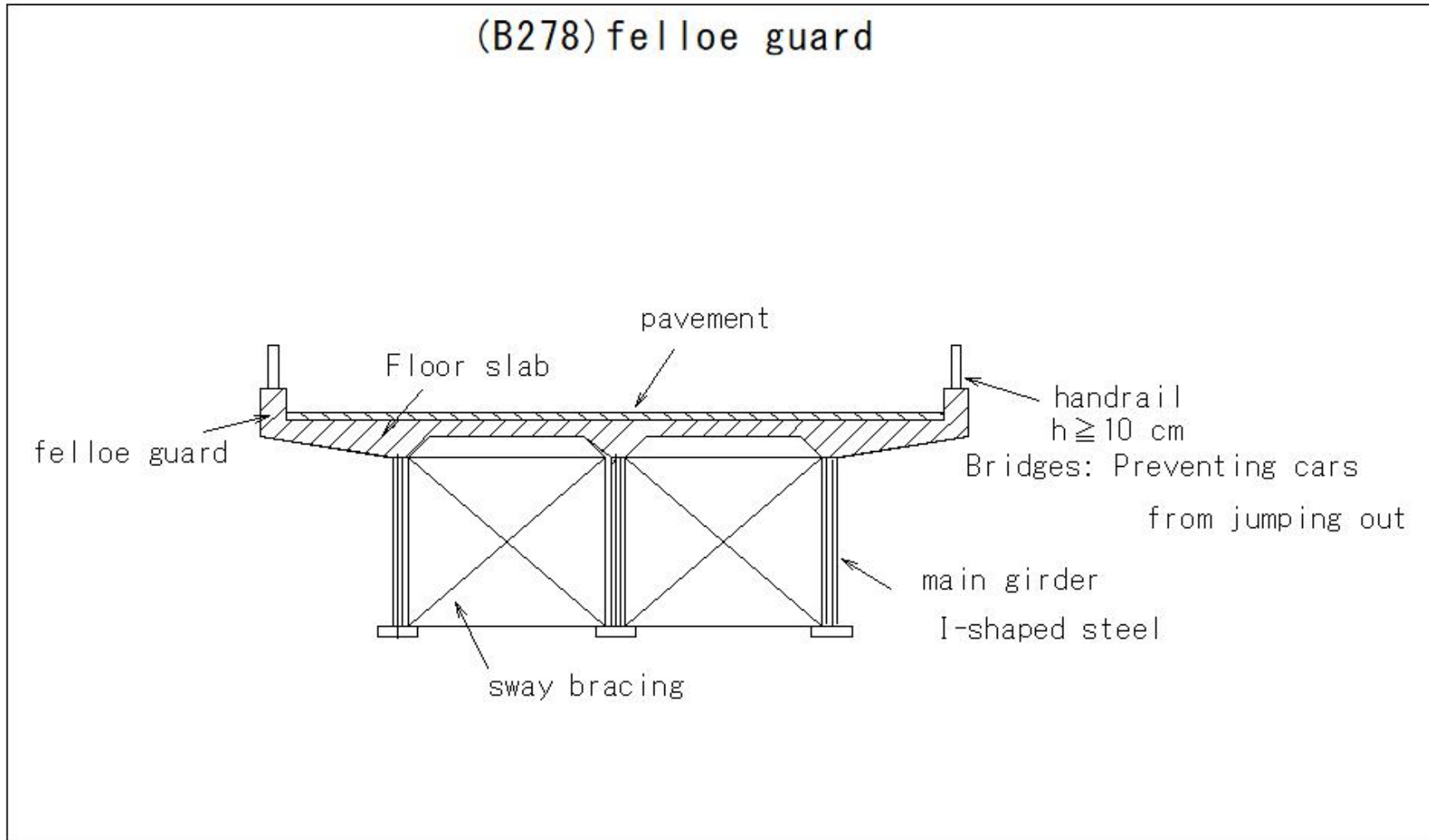


(B277)support(fixed)



(B278) felloe guard

(B278) felloe guard



(B279)dowel

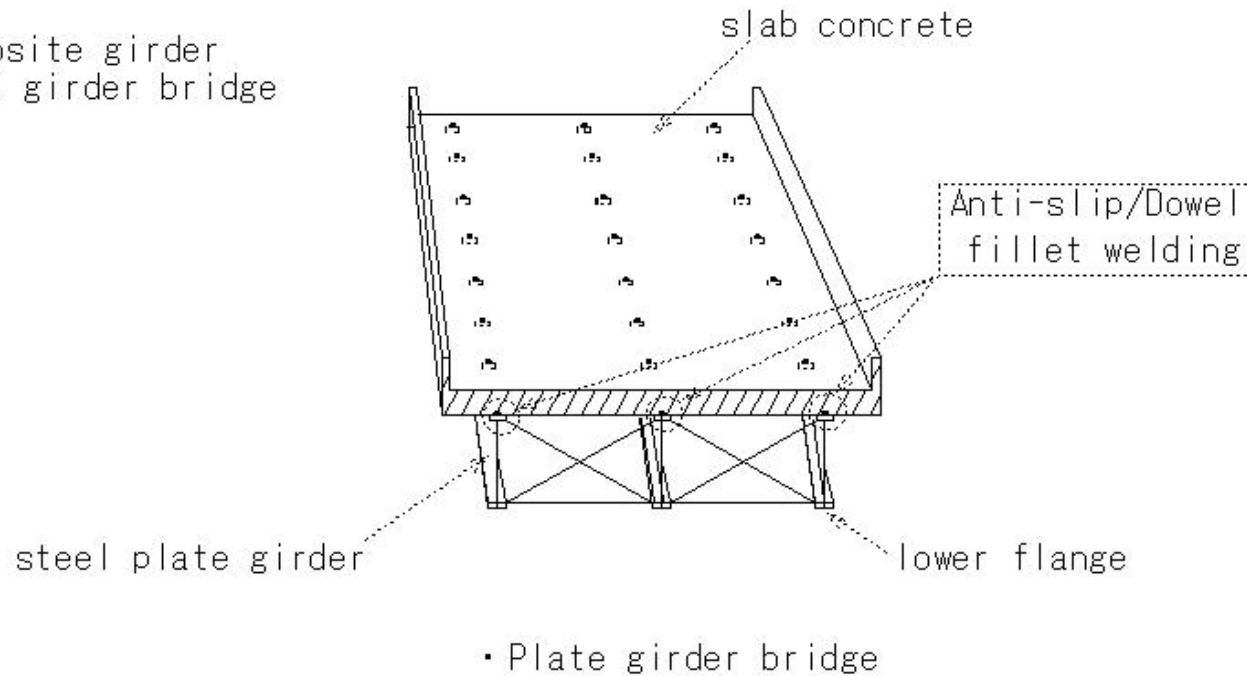
(B279) dowel

dowel

Steel main structure
slab concrete
integration
Anti-slip/Dowel

composite girder
steel girder bridge

steel beam bridge
steel girder-main structure



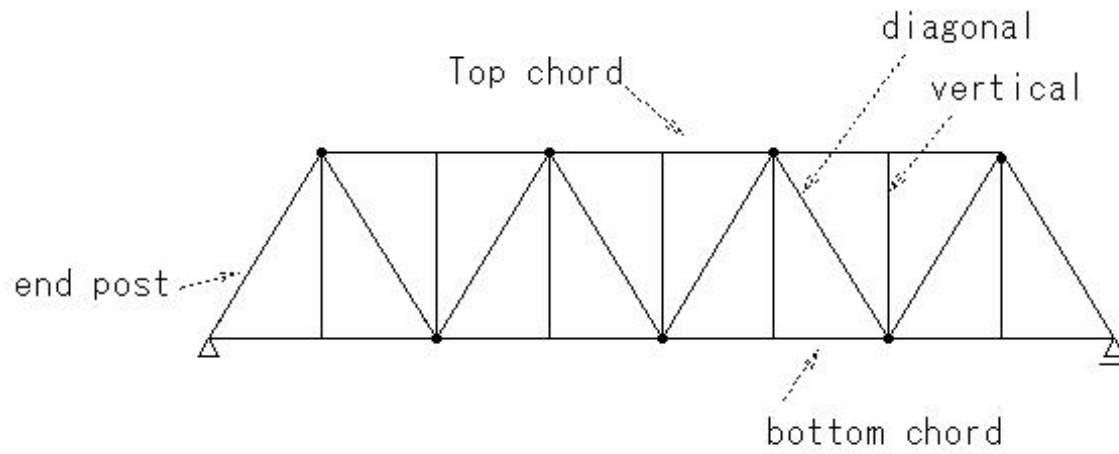
steel plate girder

lower flange

• Plate girder bridge

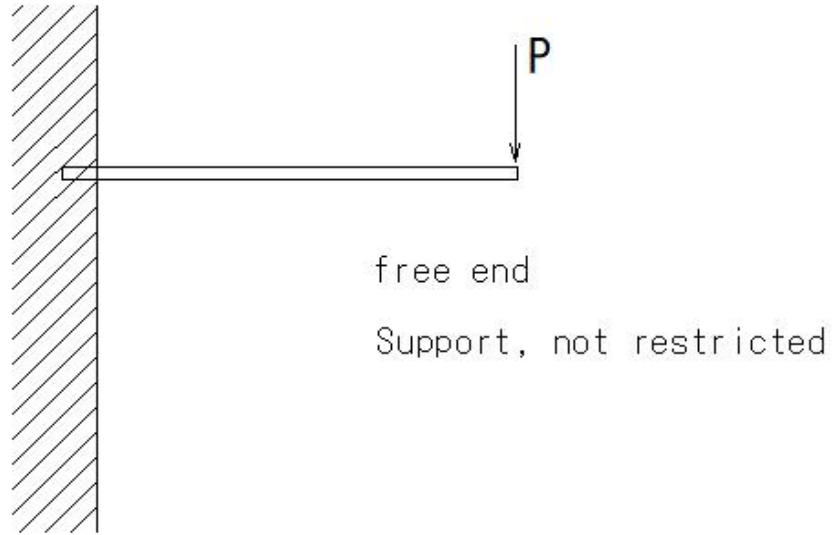
(B280)diagonal member

(B280)diagonal member



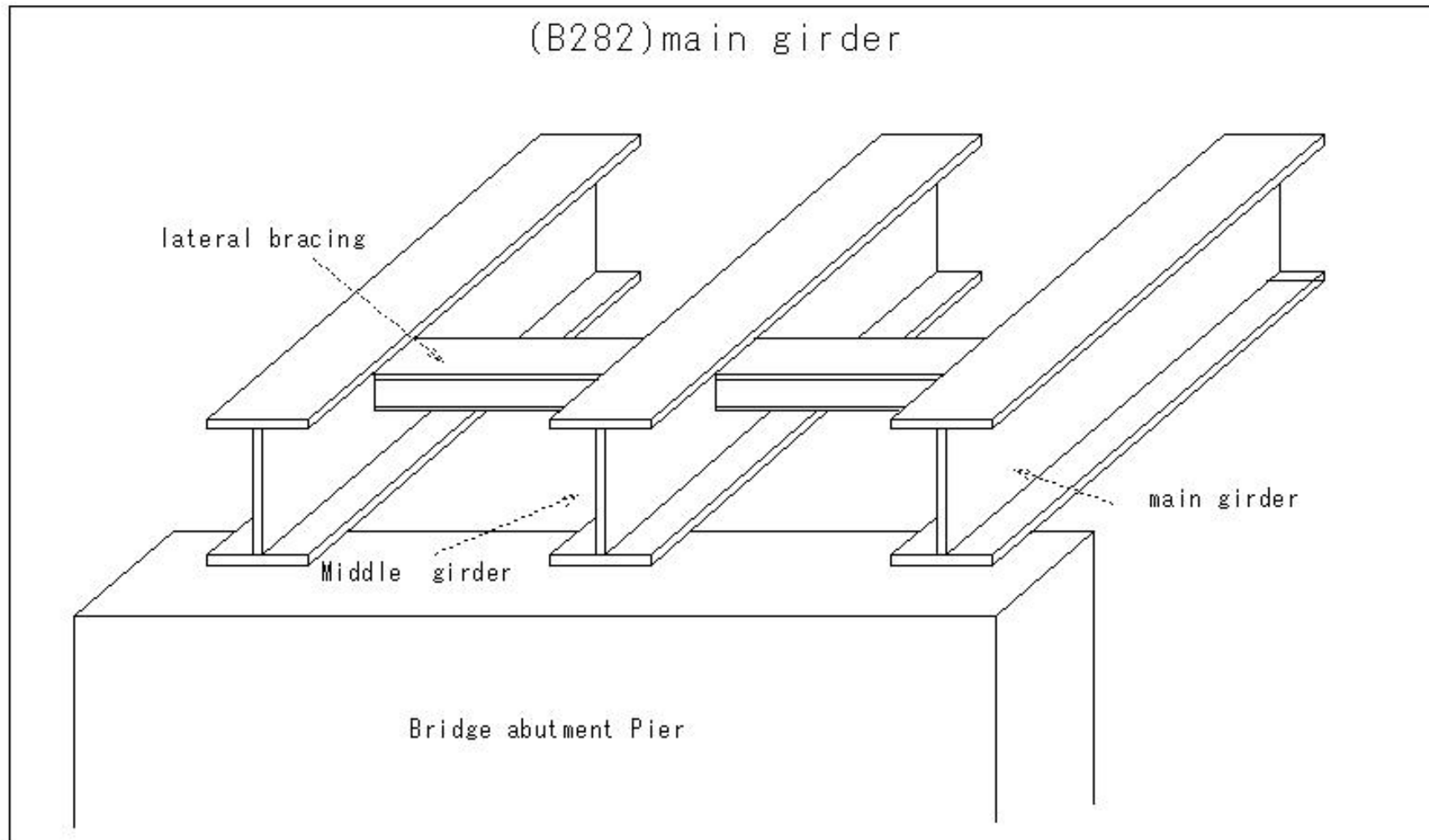
(B281) free end

(B281) free end



(B282)main girder

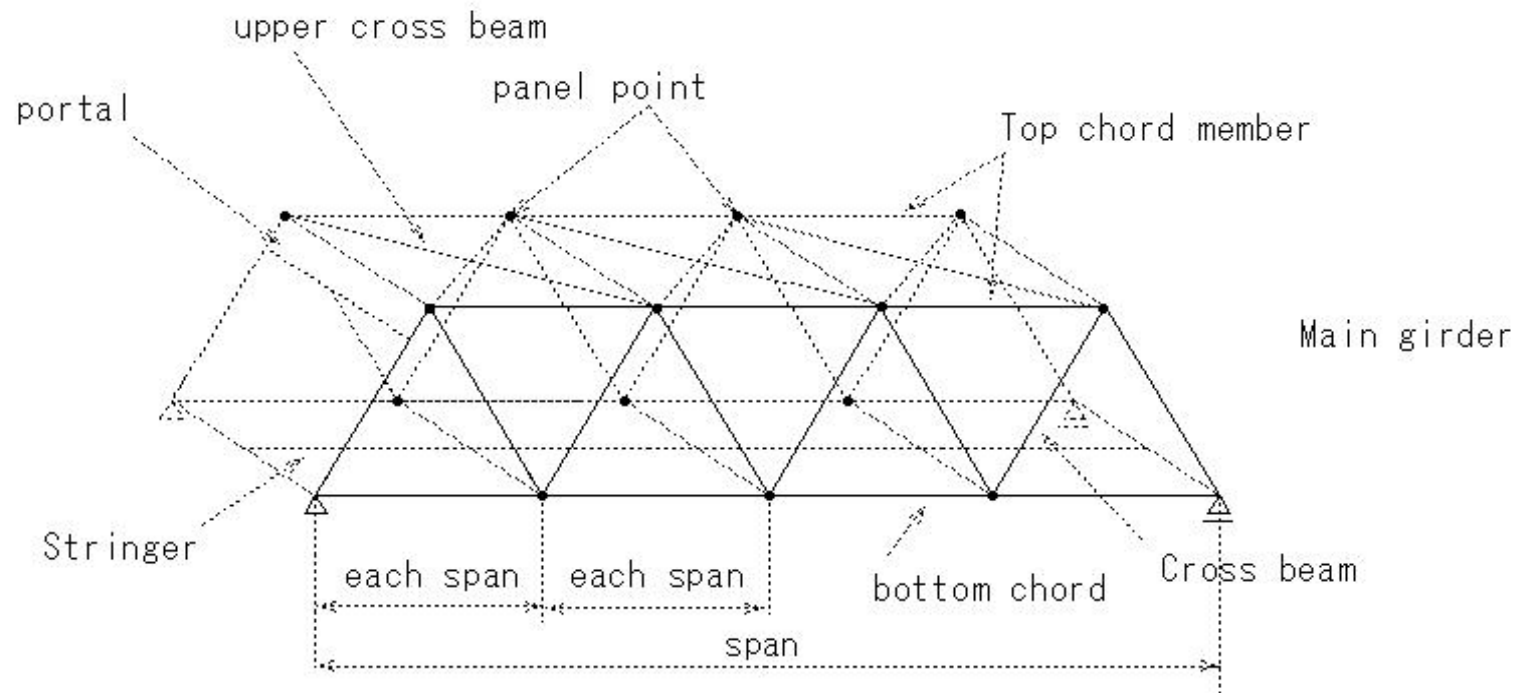
(B282)main girder



(B283]main truss(main girder)

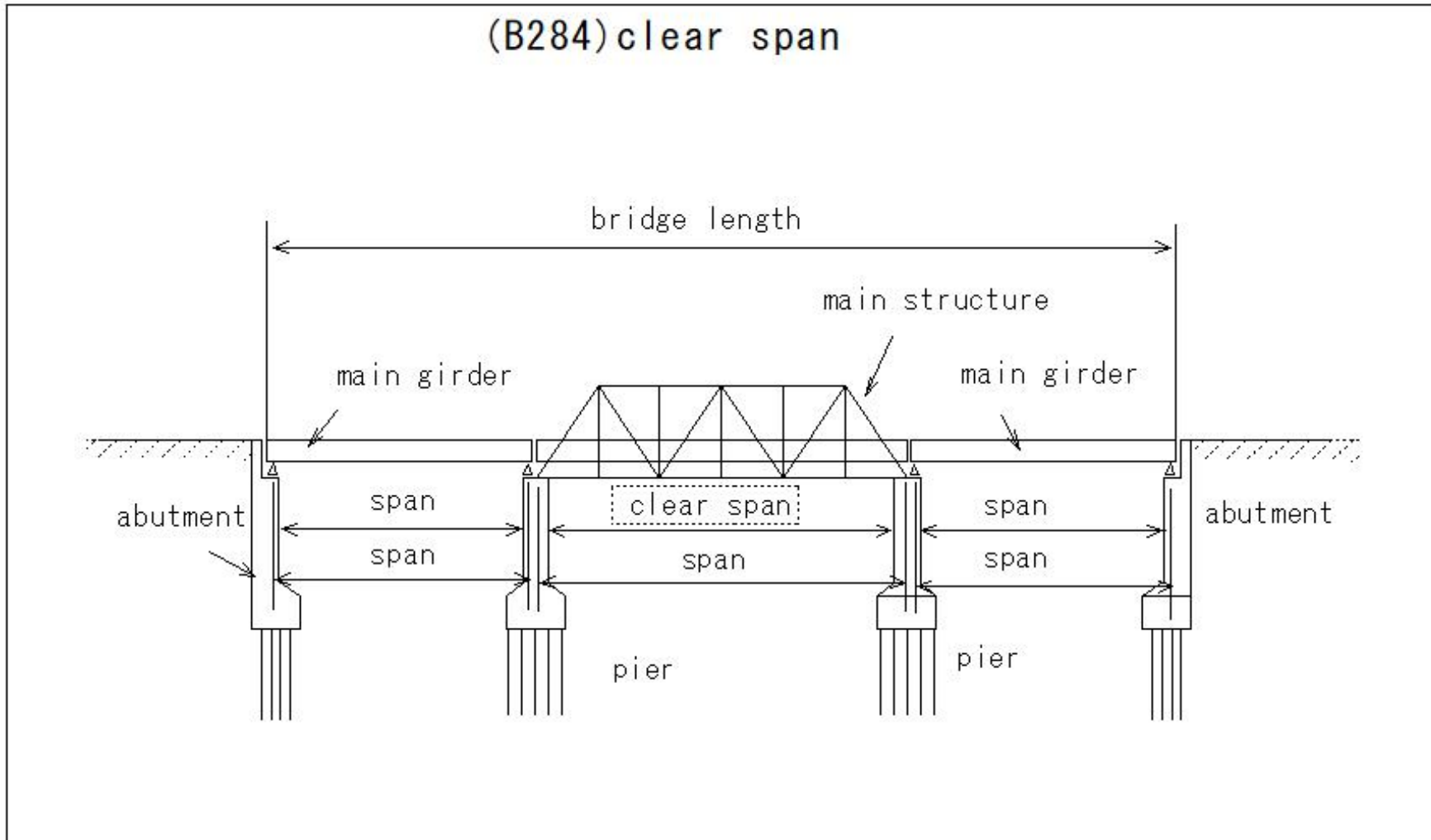
(B283]main truss(main girder)

main truss

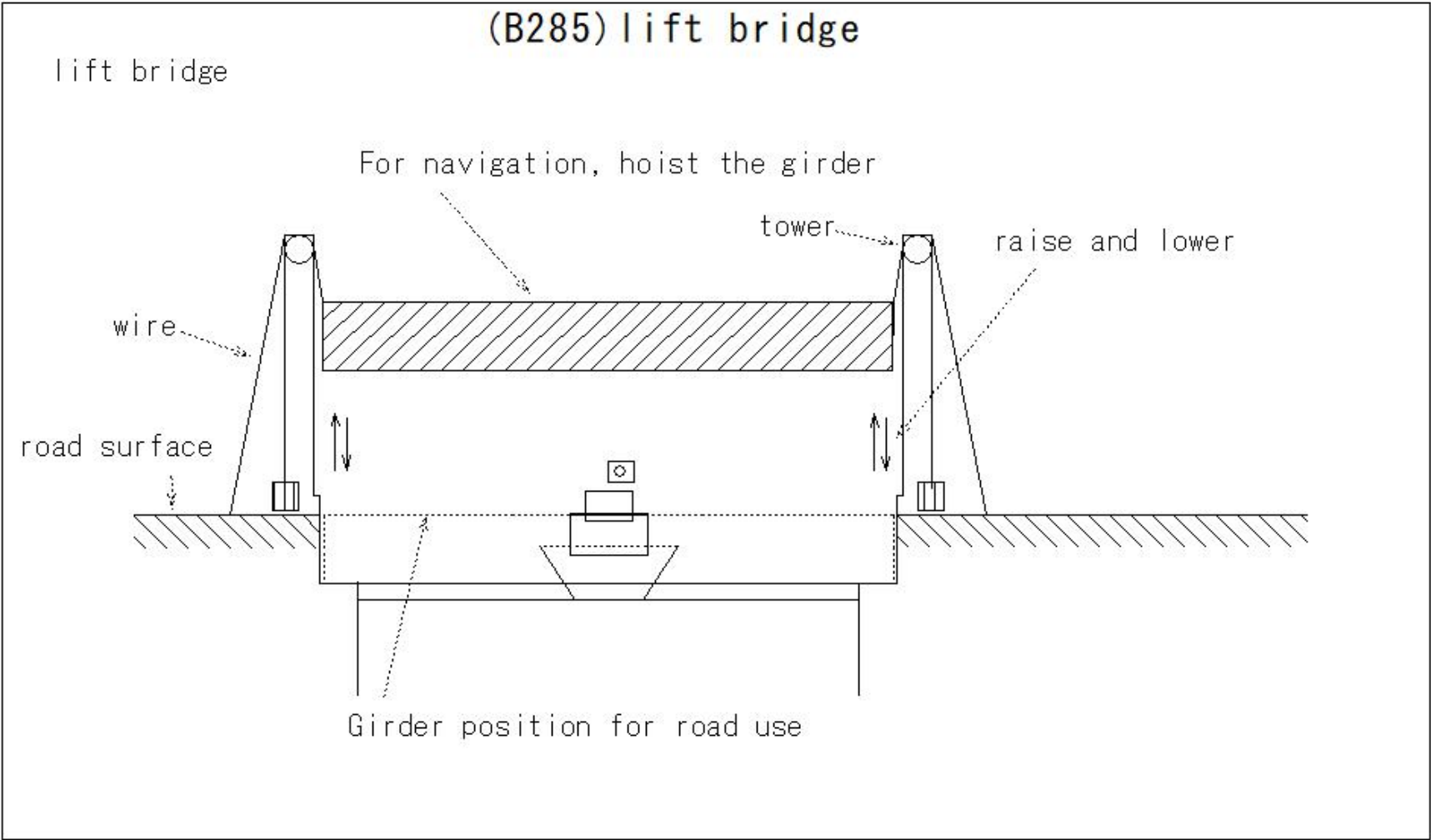


(B284)clear span

(B284)clear span



(B285)lift bridge

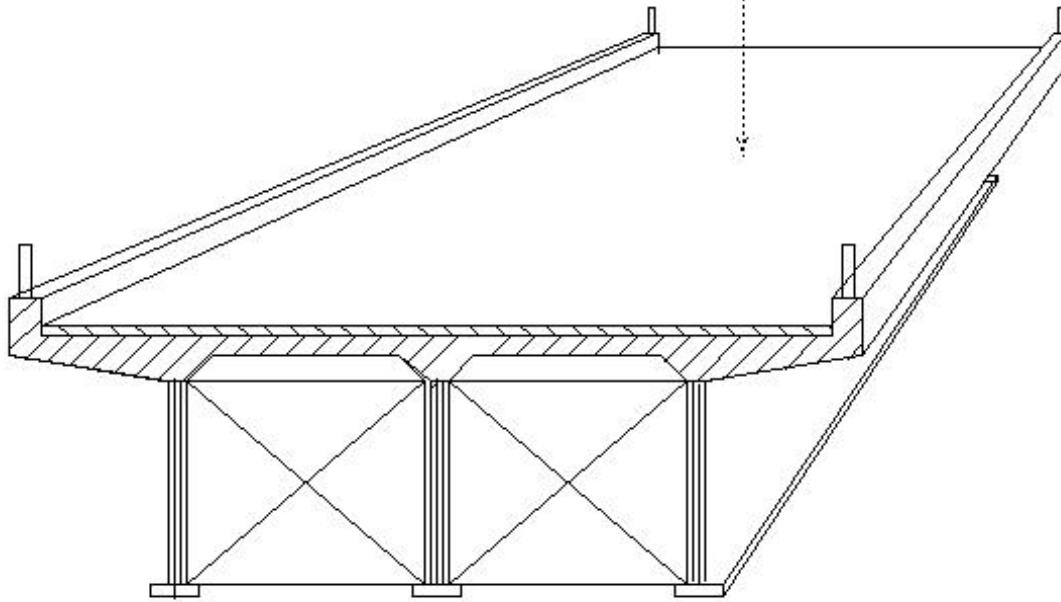


(B286) impact load

(B286) impact load

impact load

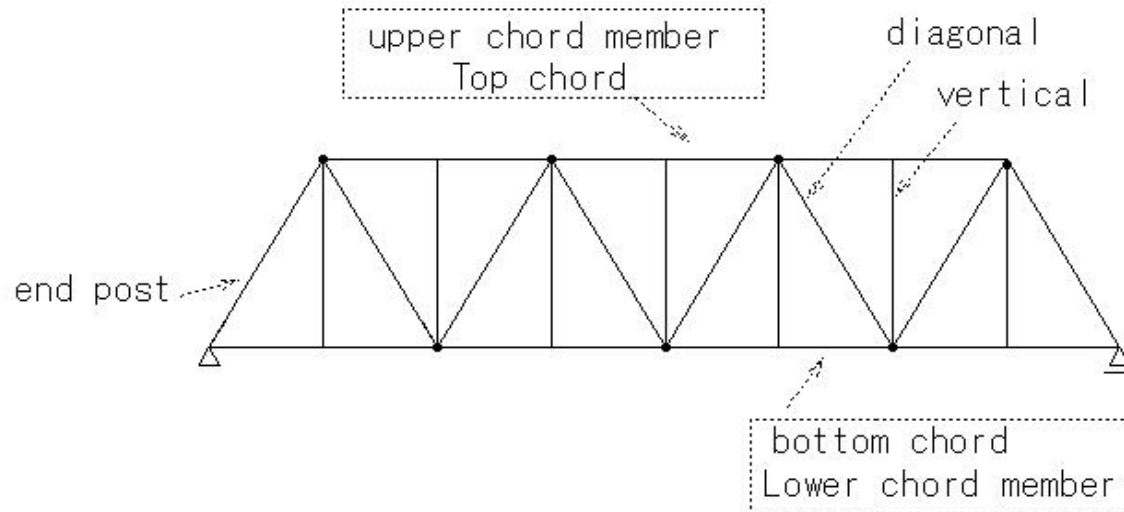
(live load+vibration)-Increase in load



(B287)truss(upper chord member)

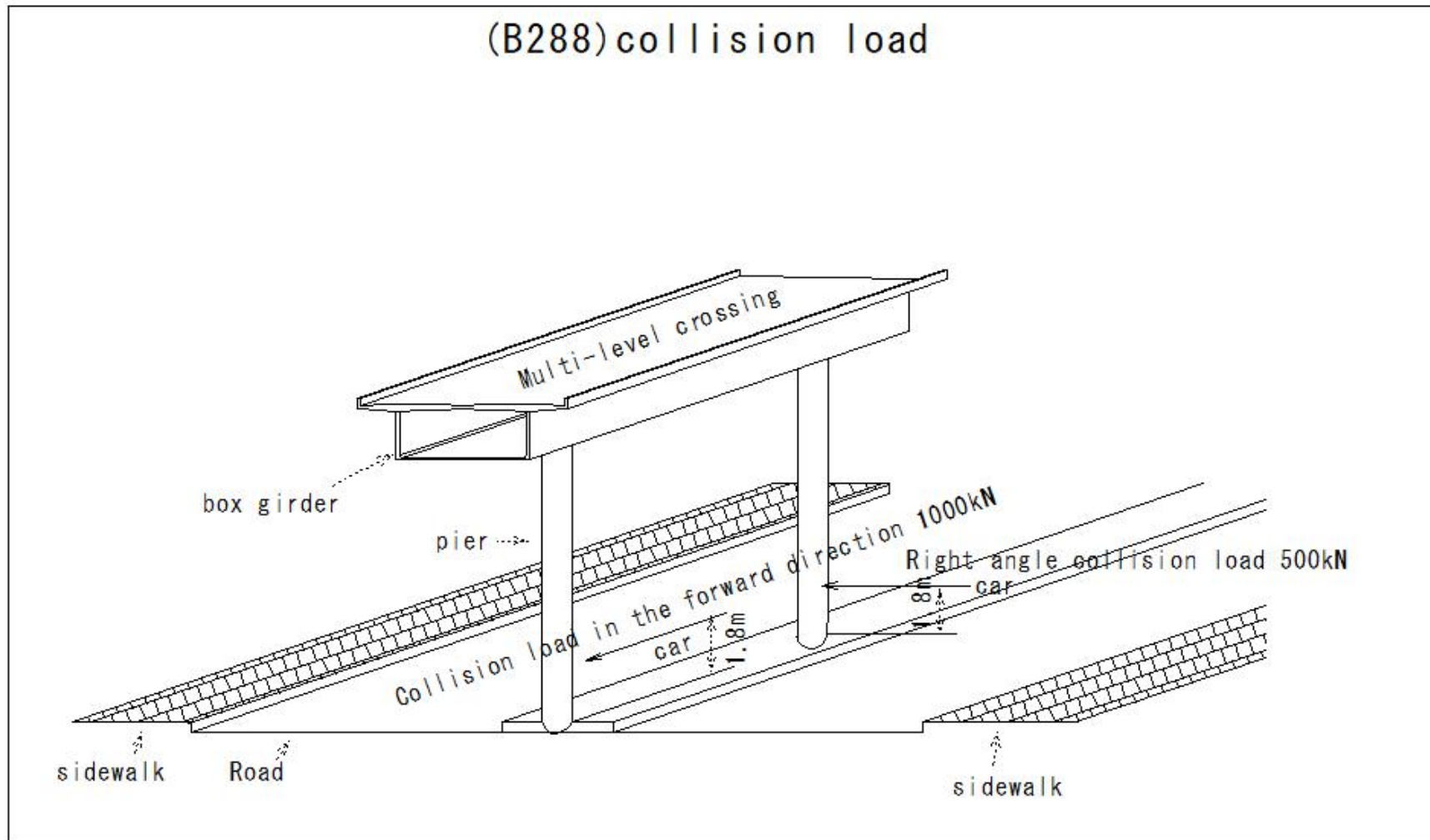
(B287) truss (upper chord member)

truss



(B288)collision load

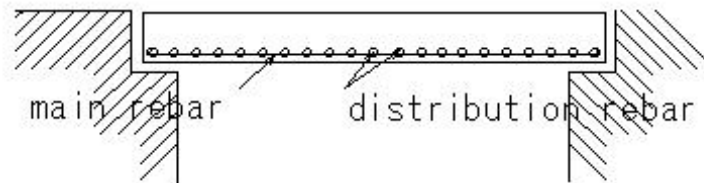
(B288)collision load



(B289) floor slab

(B289) floor slab

simple slab



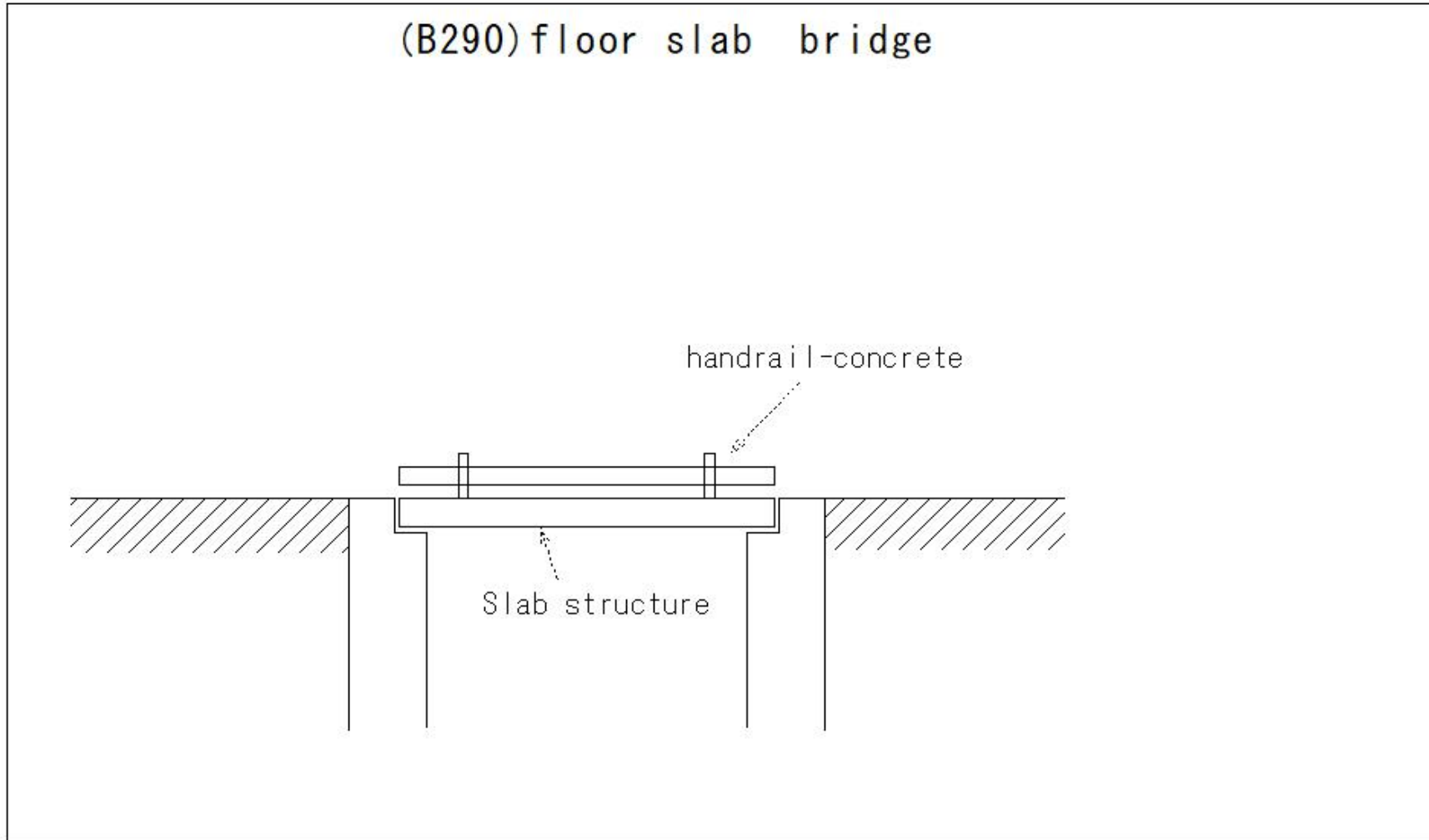
reinforced concrete

support on two opposite sides

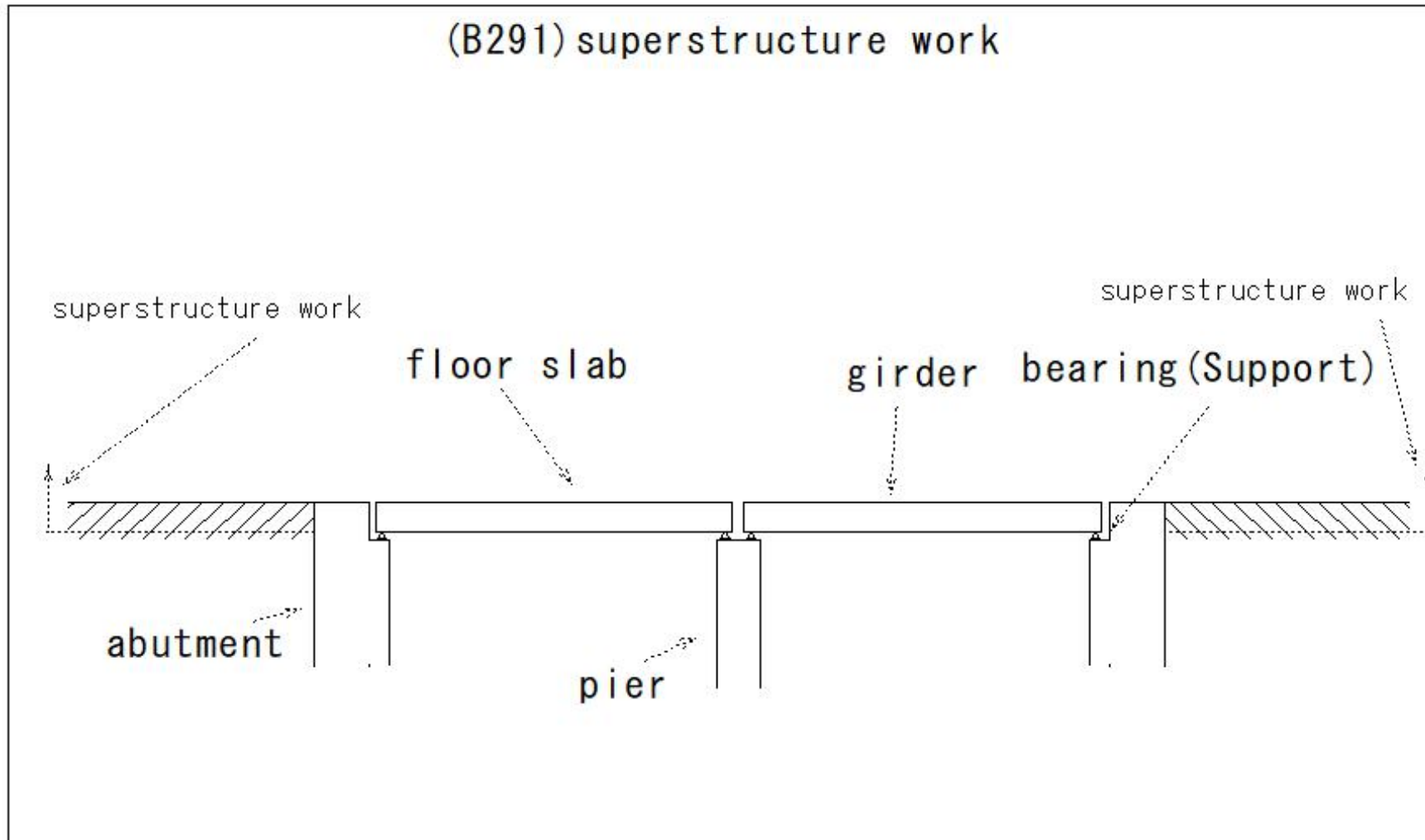
rectangular slab

(B290)floor slab bridge

(B290)floor slab bridge

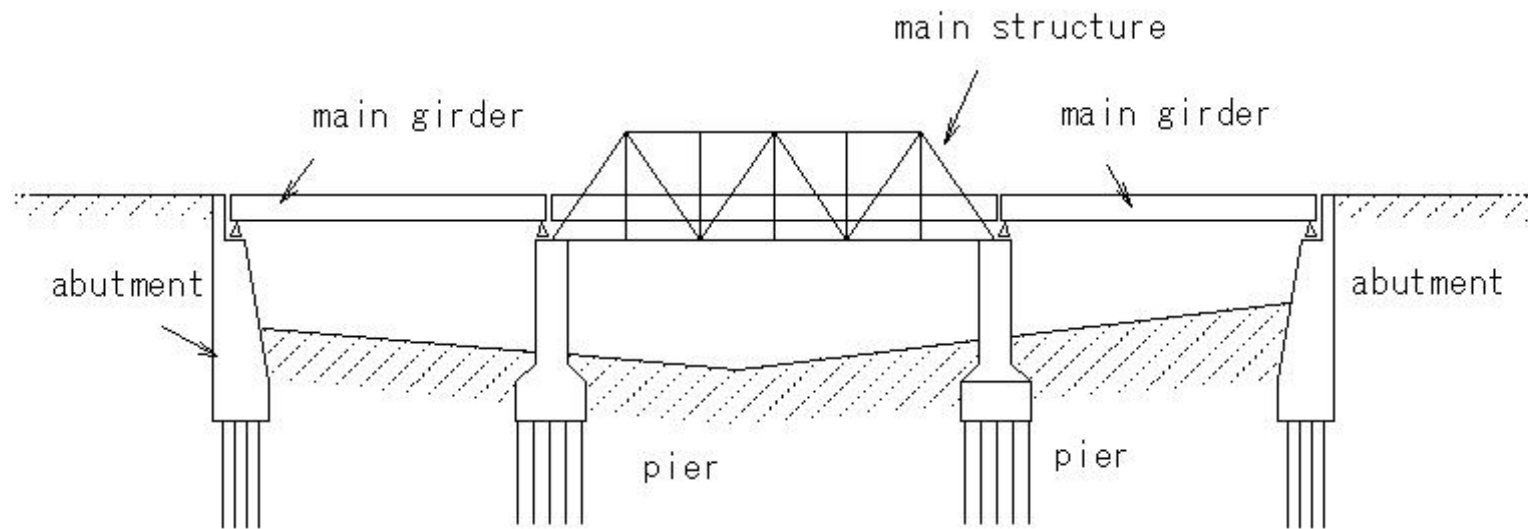


(B291)superstructure work



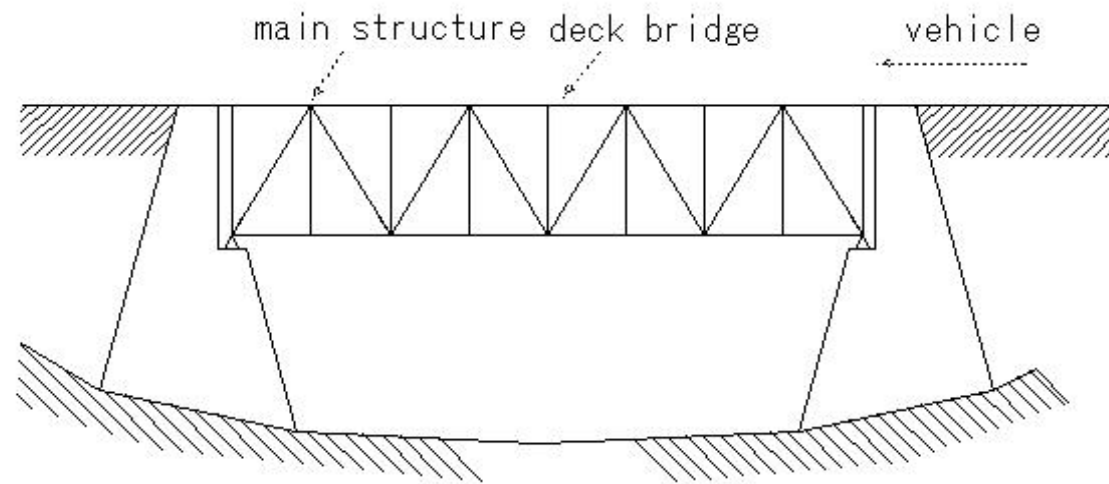
(B292)superstructure work

(B292) superstructure work



(B293)deck bridge

(B293)deck bridge

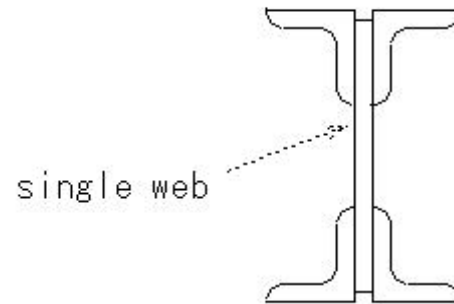
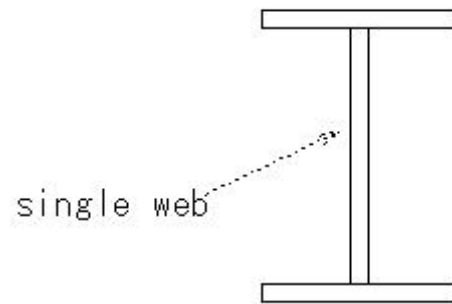


(B294)single web

(B294) single web

single web

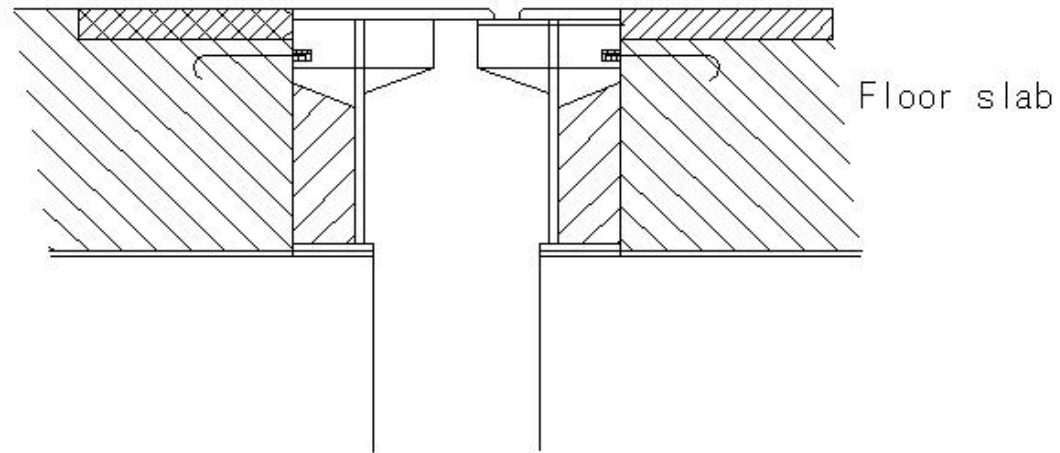
1 web plate



(B295)expansion equipment

(B295) expansion equipment

Expansion equipment

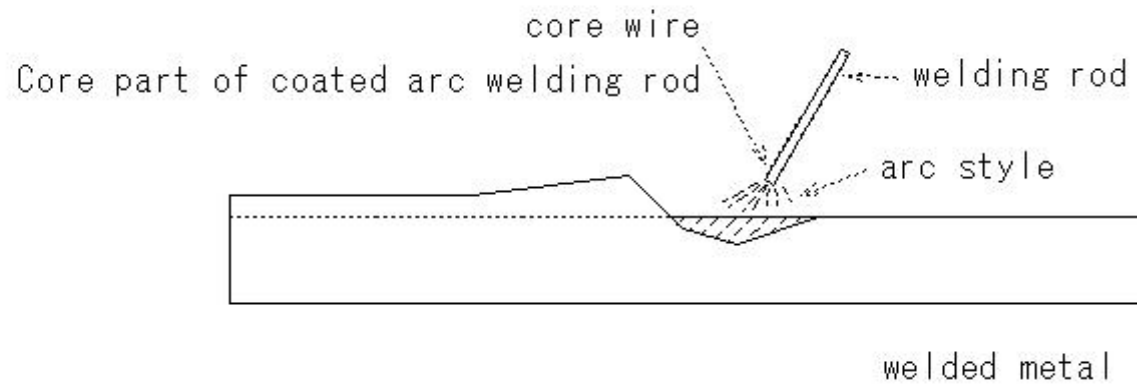


Edge of bridge slab

Elastic deformation due to temperature and load

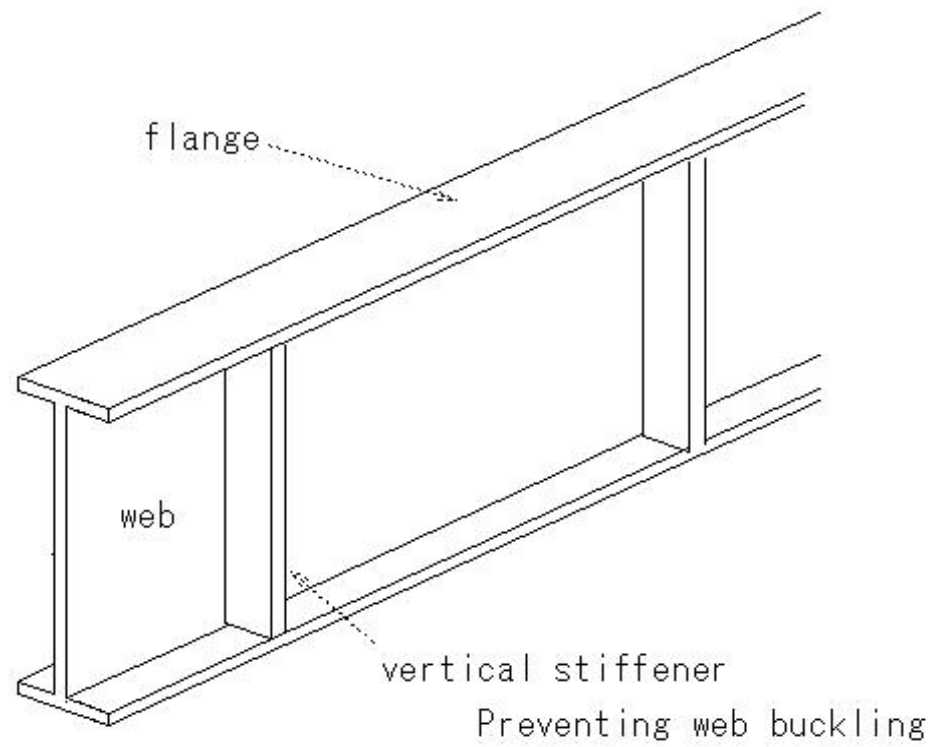
(B296)arc welding(core wire)

(B296) arc welding (core wire)



(B297)vertical stiffener

(B297) vertical stiffener



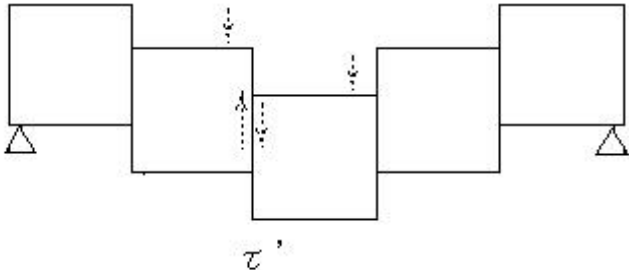
(B298)horizontal shear stress

(B298)horizontal shear stress

horizontal shear stress



Vertical shear stress



Beam shear stress

(B299)aqueduct

(B299) aqueduct

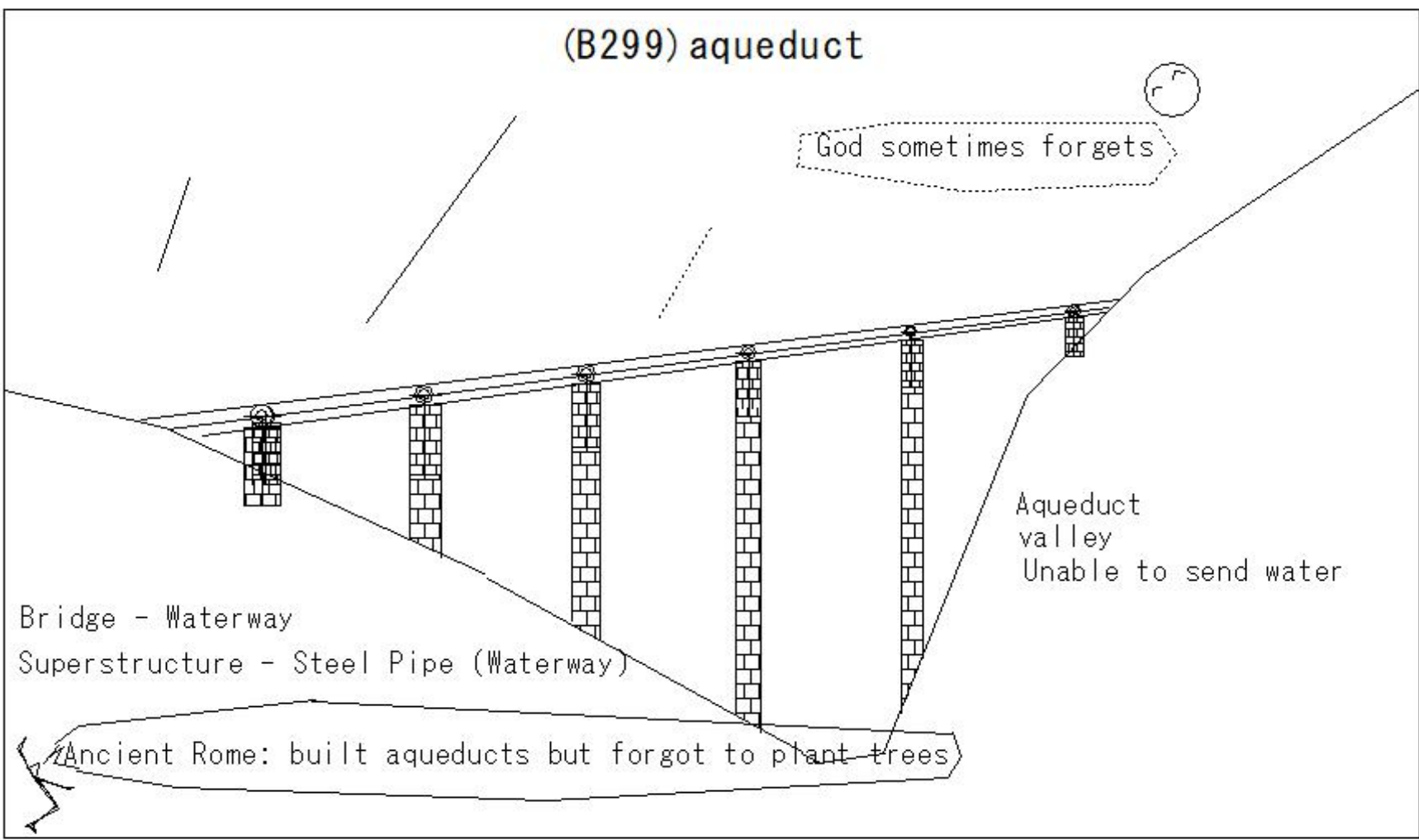
God sometimes forgets



Aqueduct valley
Unable to send water

Bridge - Waterway
Superstructure - Steel Pipe (Waterway)

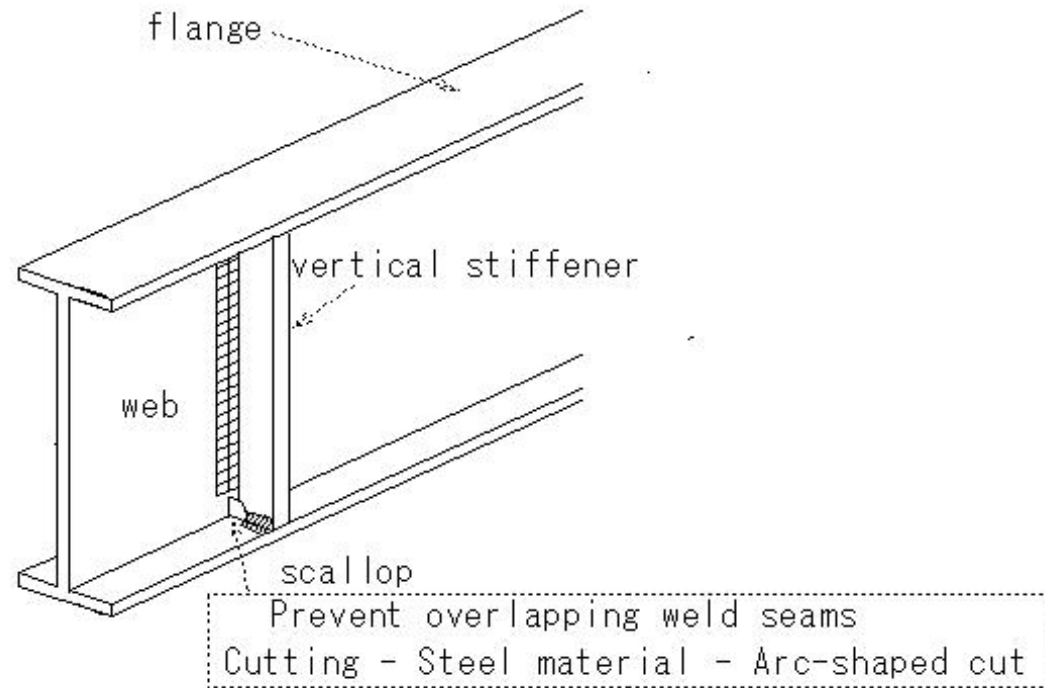
Ancient Rome: built aqueducts but forgot to plant trees



(B300)plate girder(scallop)

(B300)plate girder (scallop)

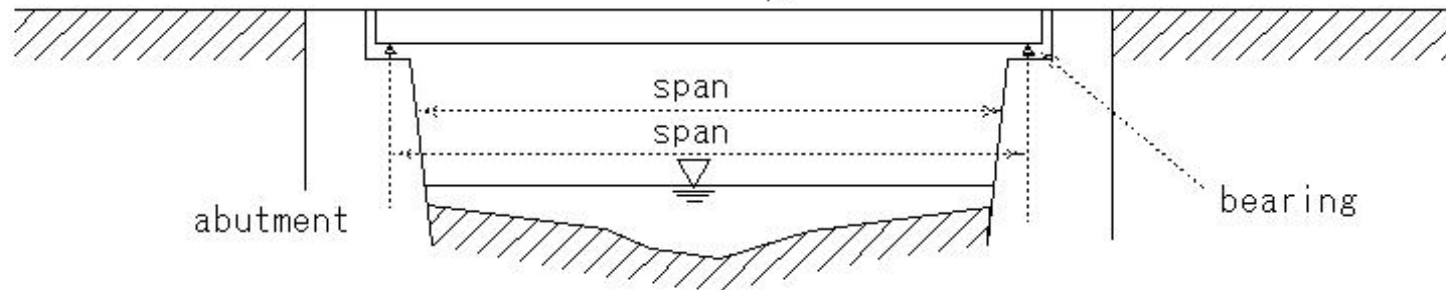
scallop
plate girder



(B301)span

(B301) span

main girder



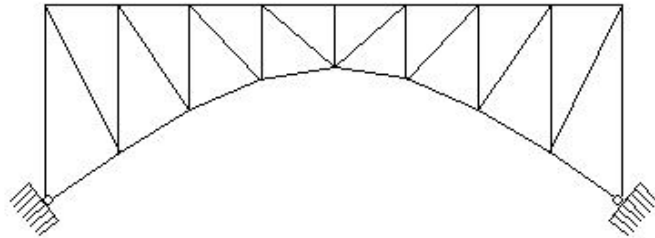
abutment

bearing

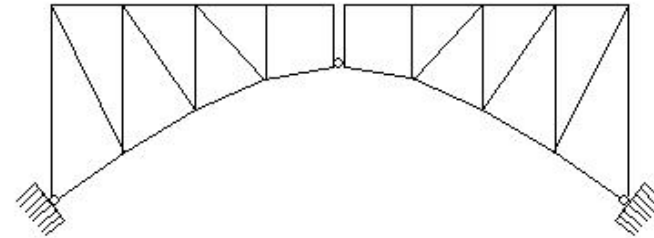
(B302)spandrel braced arch bridge

(B302) spandrel braced arch bridge

spandrel braised arch bridge



2-hinged spandrel braised arch bridge



3-hinged spandrel-braced arch bridge

Assemble an arch shape with supports

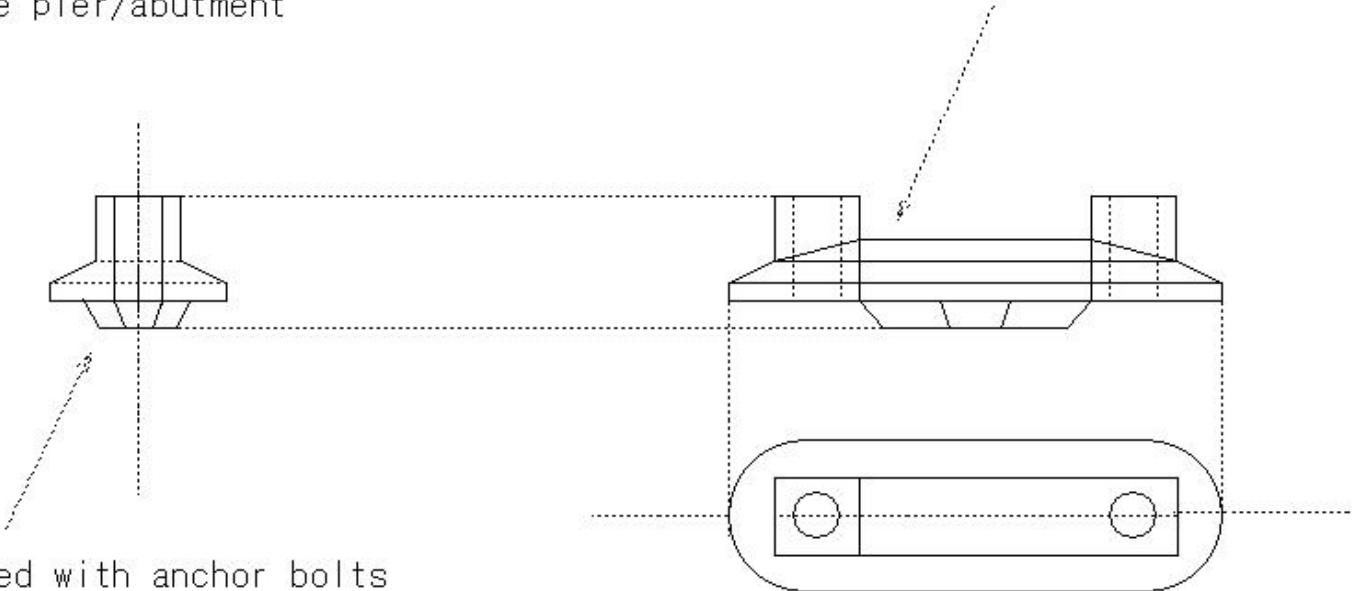
(B303)sliding expansion bearing

(B303)sliding expansion bearing

sliding expansion bearing
Movable bearing
on the pier/abutment

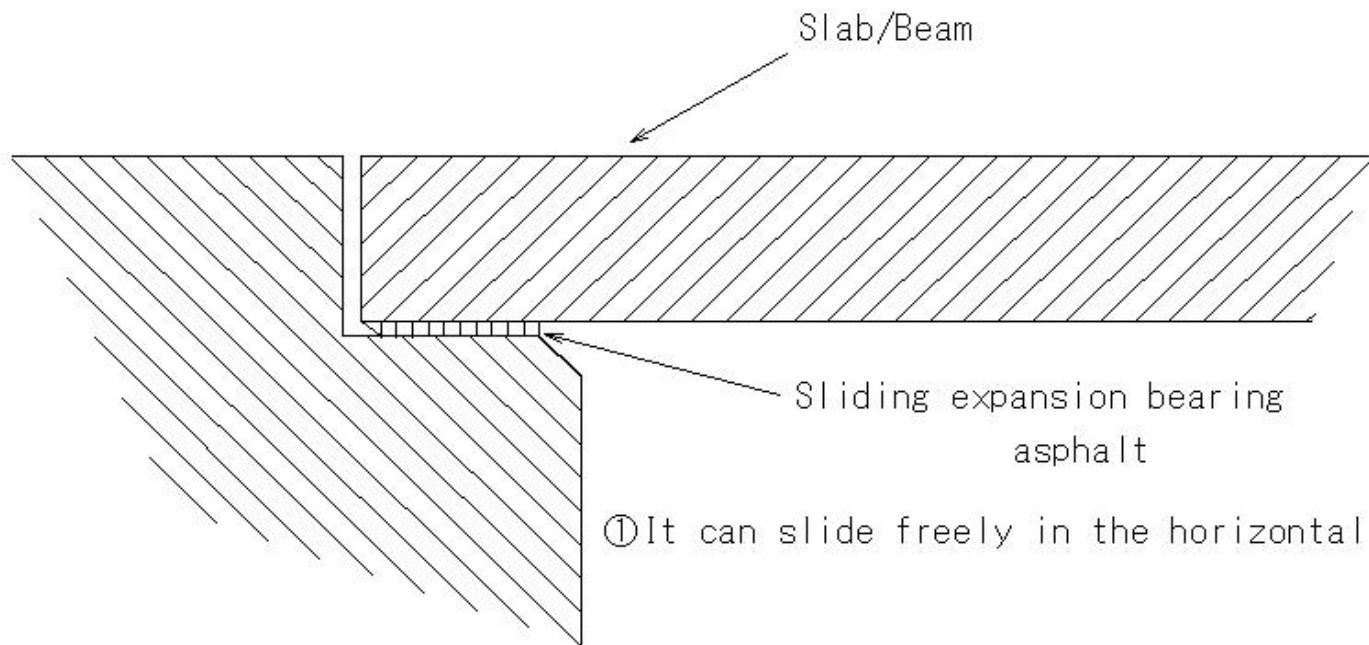
Used for both fixed end and movable end

Connected with anchor bolts



(B304)sliding expansion bearing

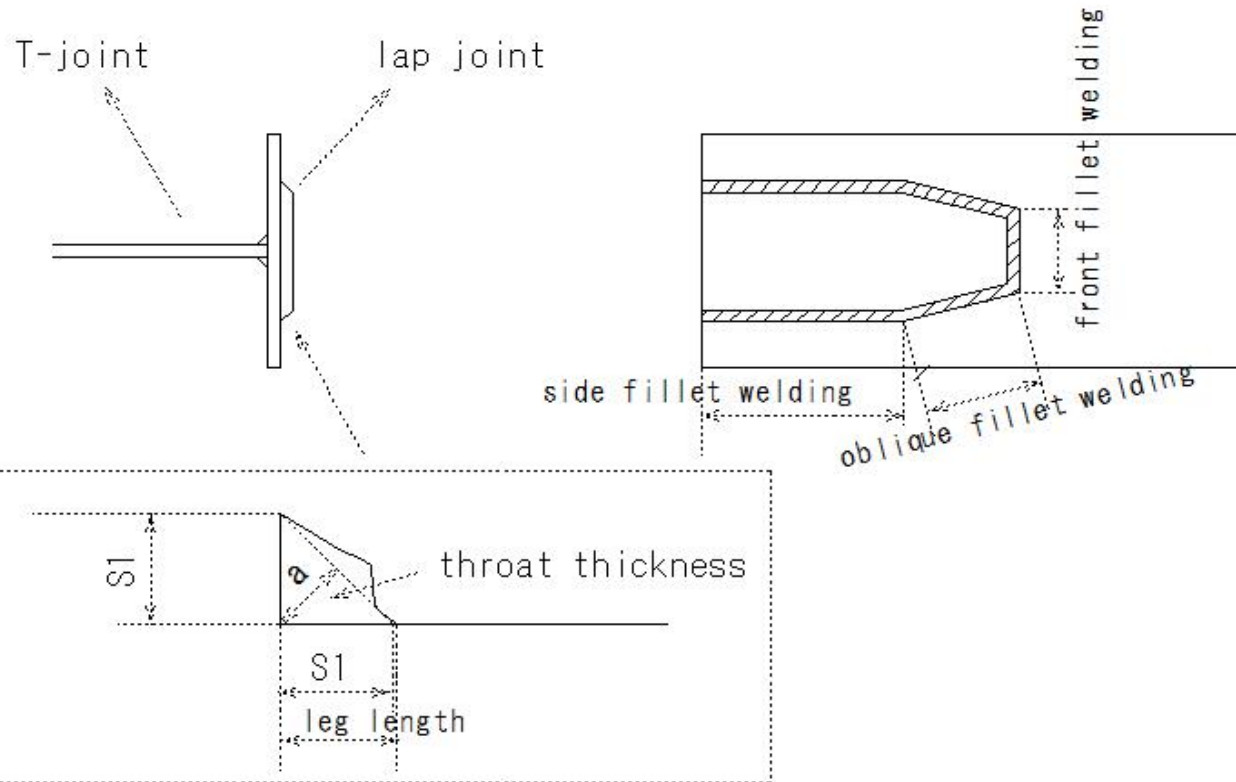
(B304) sliding expansion bearing



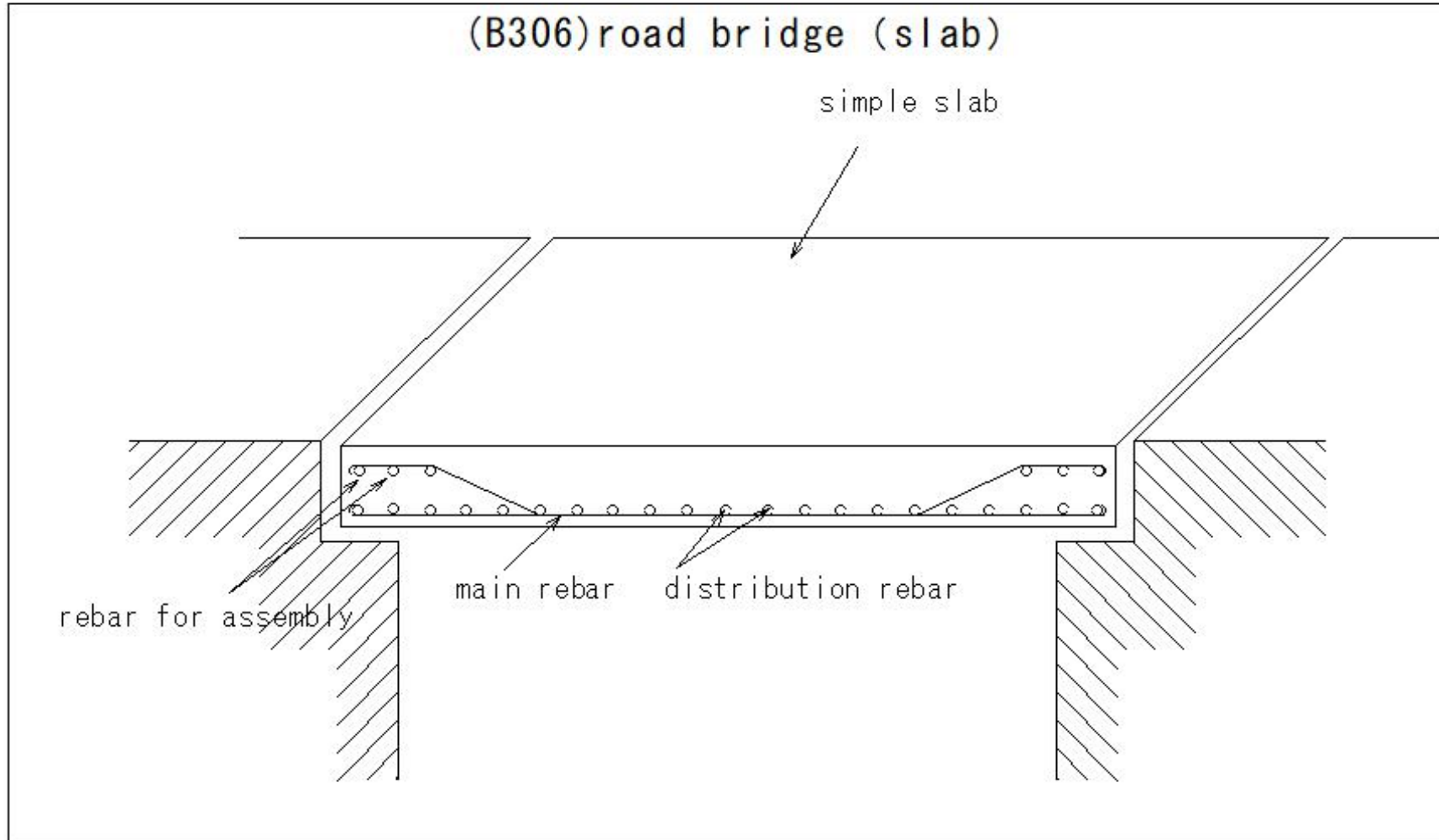
①It can slide freely in the horizontal direction.

(B305)fillet welding

(B305) fillet welding

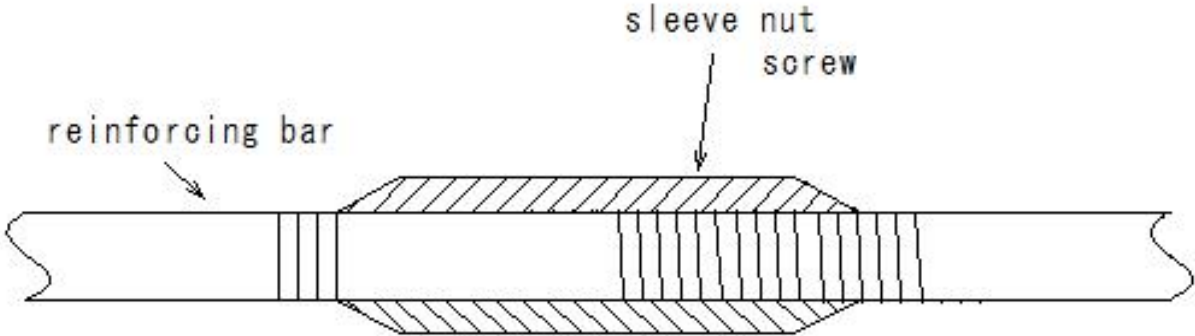


(B306)road bridge (slab)



(B307)Rebar joint(sleeve nut)

(B307)Rebar joint(sleeve nut)



Rebar joint

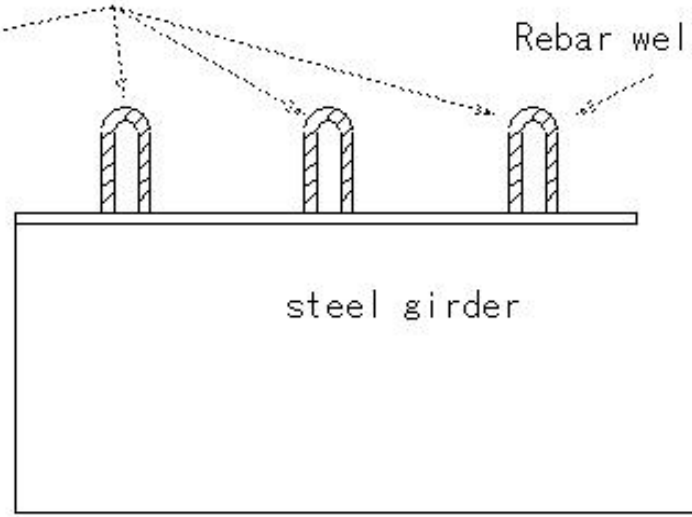
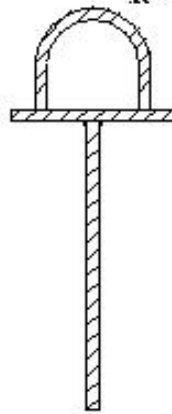
(B308)steel girder(shear connector/Dowel)

(B308)steel girder(shear connector/Dowel)

shear connector

shear connector

Rebar welding



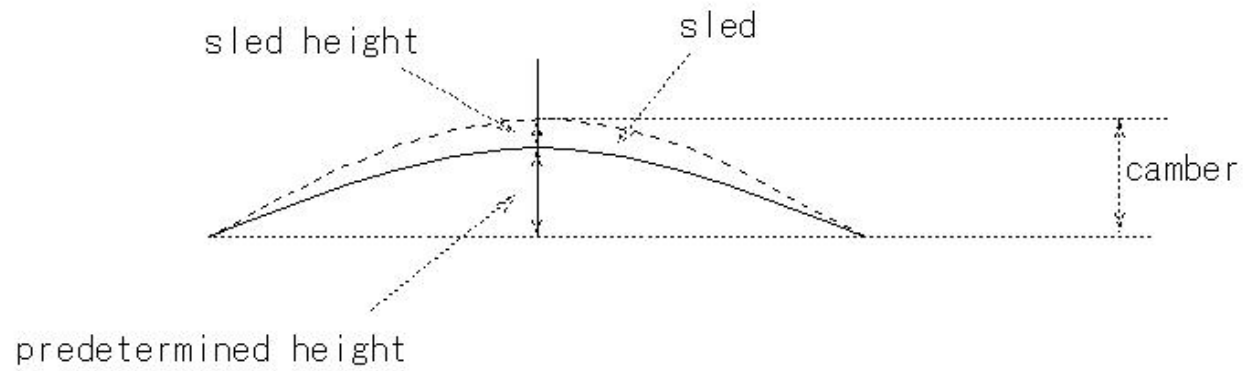
steel girder

steel bridge

(B309)camber

(B309) camber

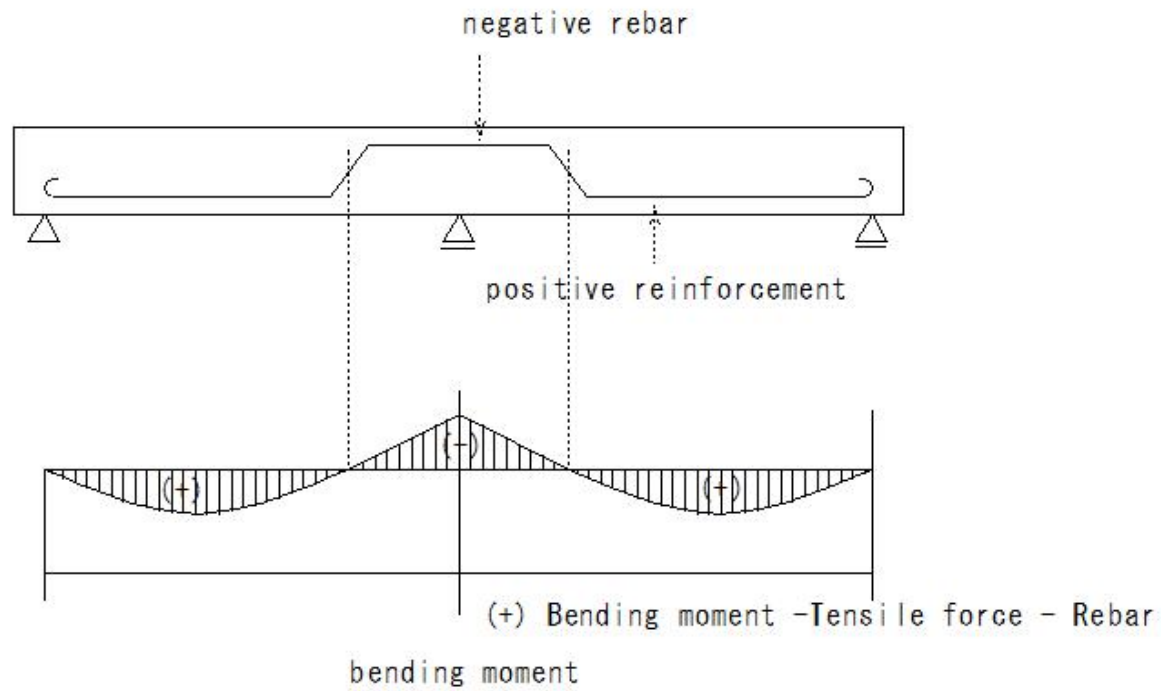
camber



Considering the weight of the girder
Deflection due to dead load

(B310) positive reinforcement

(B310) positive reinforcement

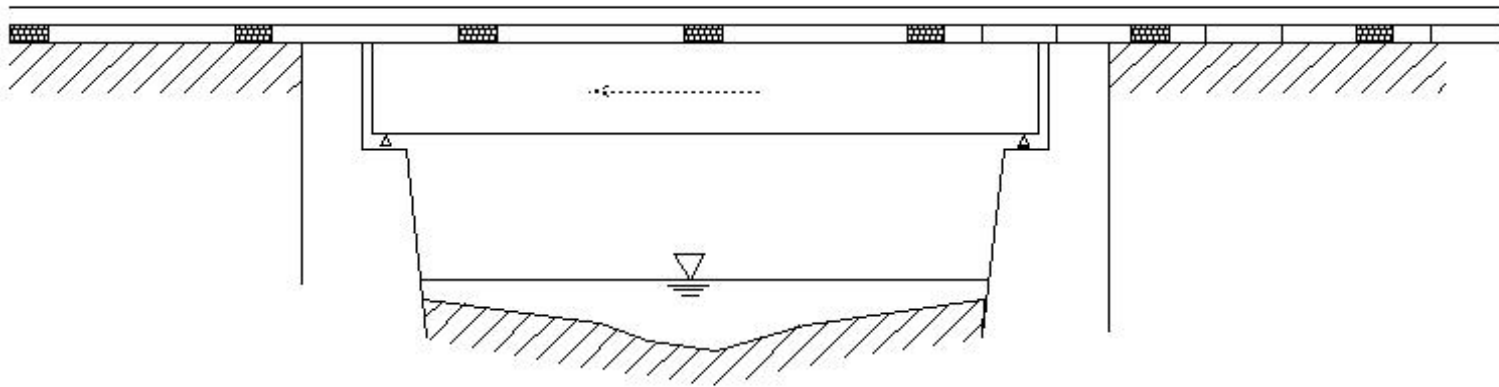


(B311)braking load

(B311)braking load

braking load

train/car-braking-Loads acting on the structure

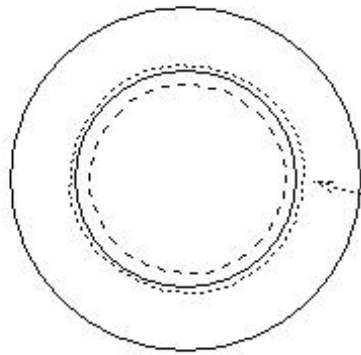


(B312)auxiliary mark full field welding

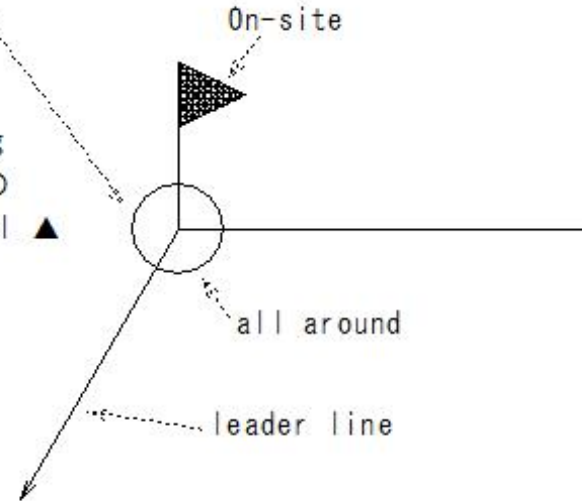
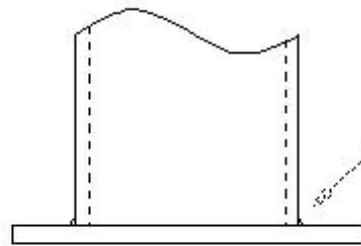
(B312)auxiliary mark full field welding

auxiliary mark full field welding
Welding the pipe to the plate

Auxiliary symbol for full circumference field welding



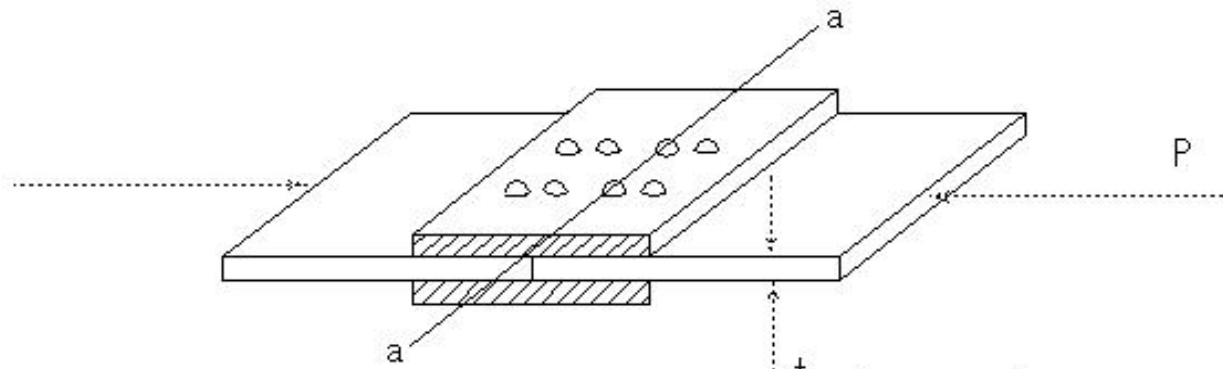
Full circumference welding
Symbol O
Field welding symbol ▲



(B313)butt joint(gross sectional area)

(B313)butt joint(gross sectional area)

butt joint



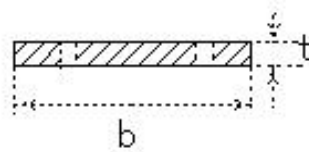
a

t

P

A_g : total cross-sectional area

$$A_g = bt$$

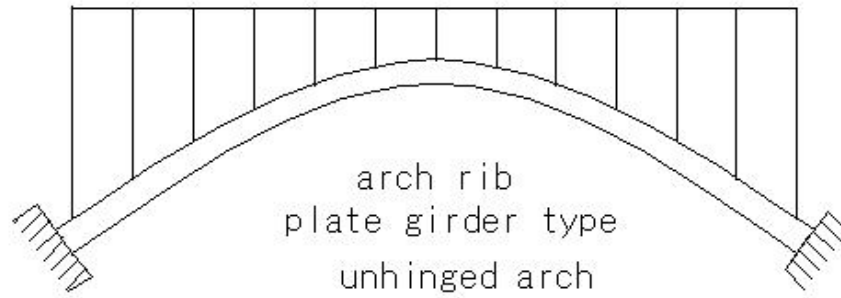


b

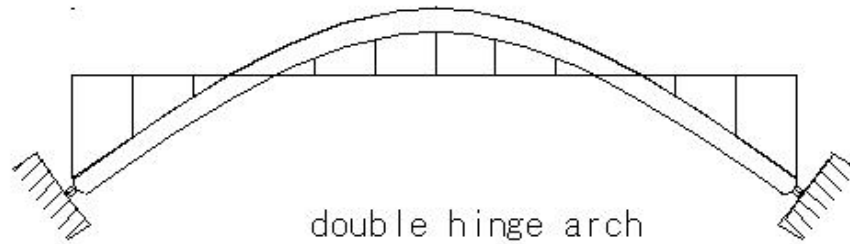
(B314)solid rib arch

(B314)solid rib arch

solid arch bridge



arch rib
plate girder type



(B315)Plate girder (sole plate)

(B315)Plate girder (sole plate)

Plate girder (sole plate)

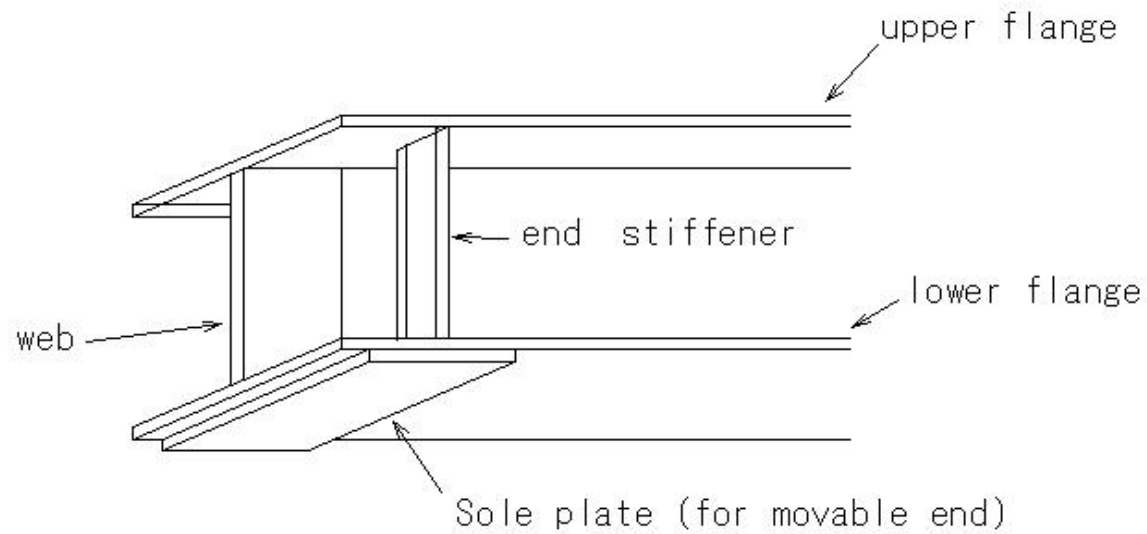


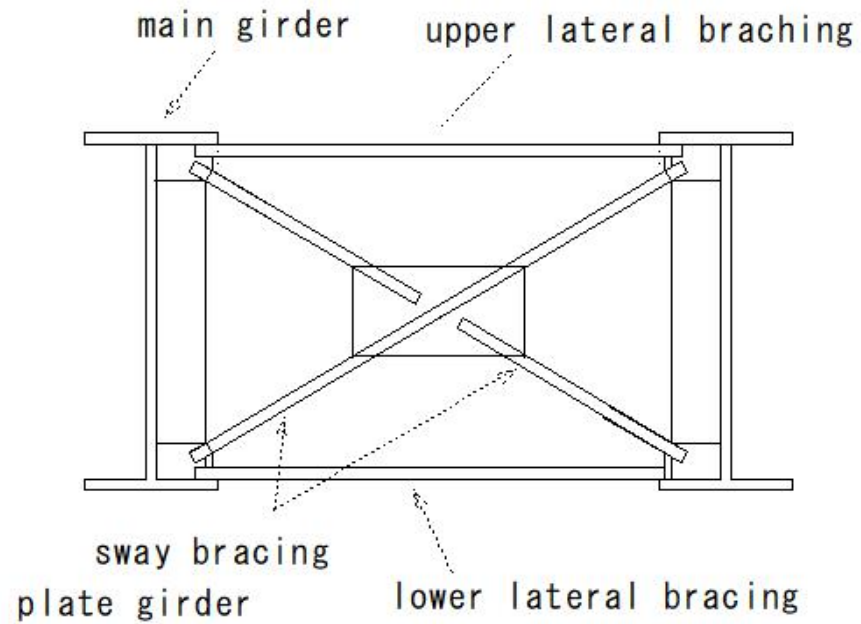
Plate girder bottom flange end
contact with bearing
Role of and floor slab

(B316)Plate girder (sway bracing)b316

(B316)Plate girder (sway bracing)

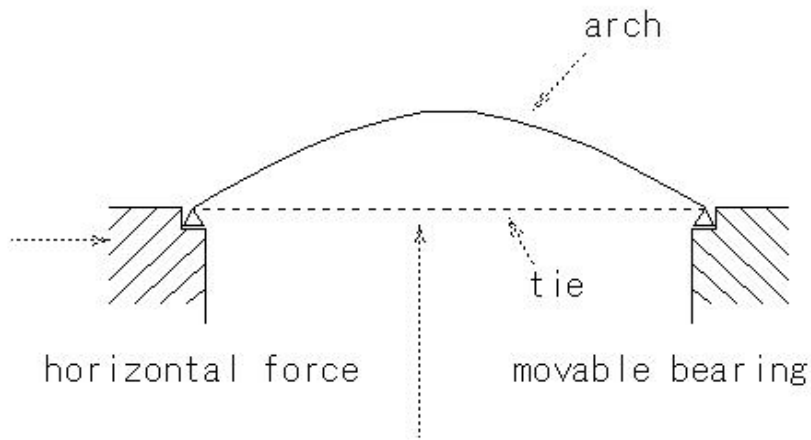
Plate girder (sway bracing)

Main girder - prevents twisting
Wind-lateral load



(B317) tied arch bridge

(B317) tied arch bridge

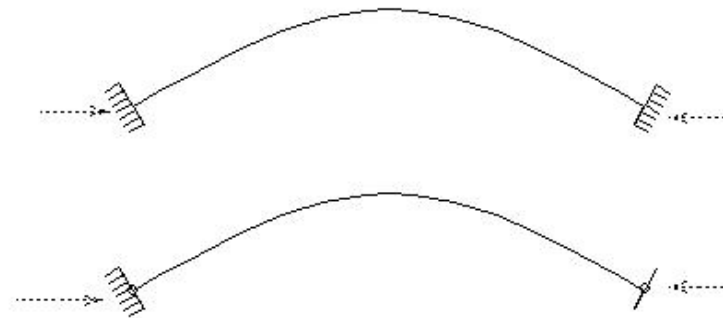


horizontal force

movable bearing

the tie absorbs the horizontal force acting on the bearing

tied arch bridge

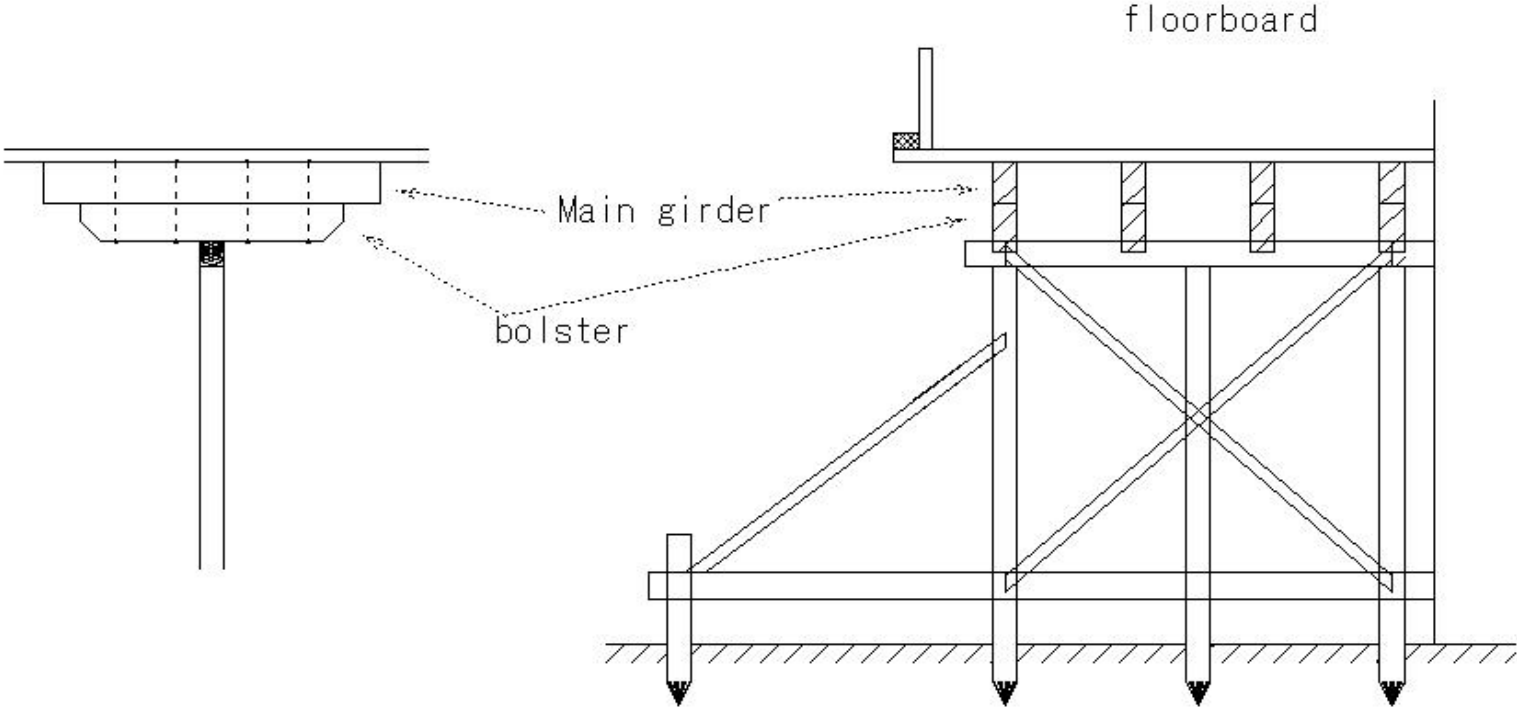


general arch

(B318) wooden bridge (bolster)

(B318) wooden bridge (bolster)

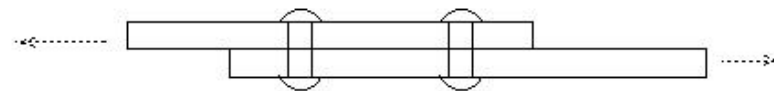
wooden bridge (bolster)



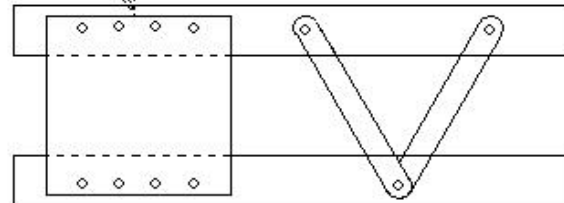
(B319)stress rivet

(B319) stress rivet

Rivet joint

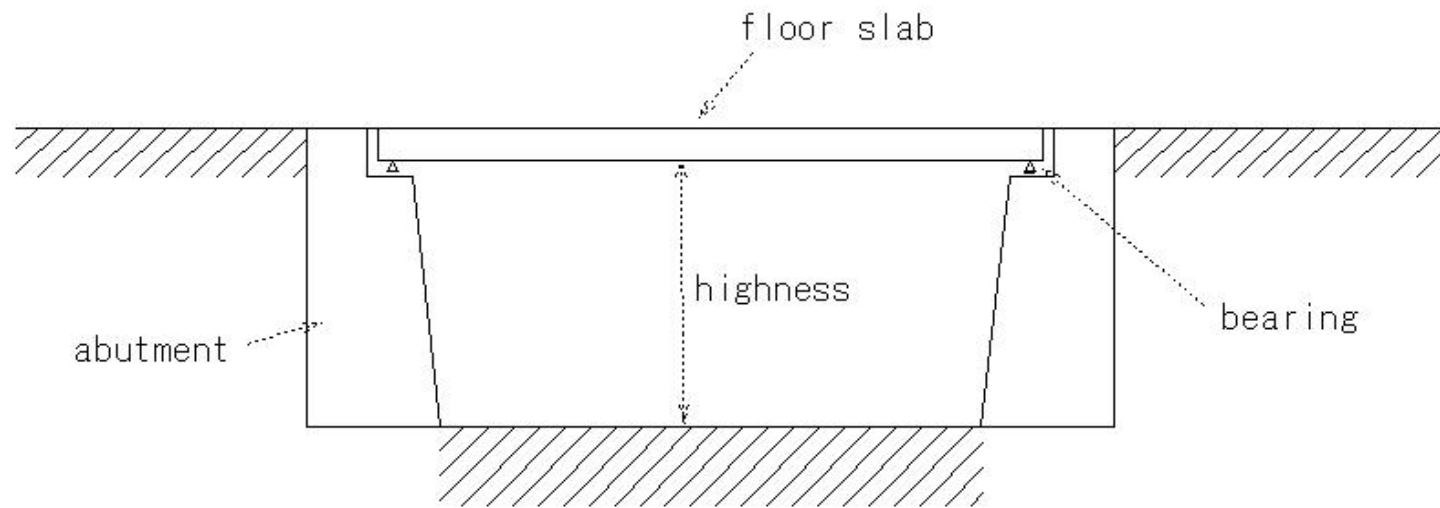


stress rivet
subjected to shear stress
tie plate



(B320)viaduct(highness)

(B320) viaduct (highness)



(B321)longitudinal load

(B321)longitudinal load

road bridge
railway bridge

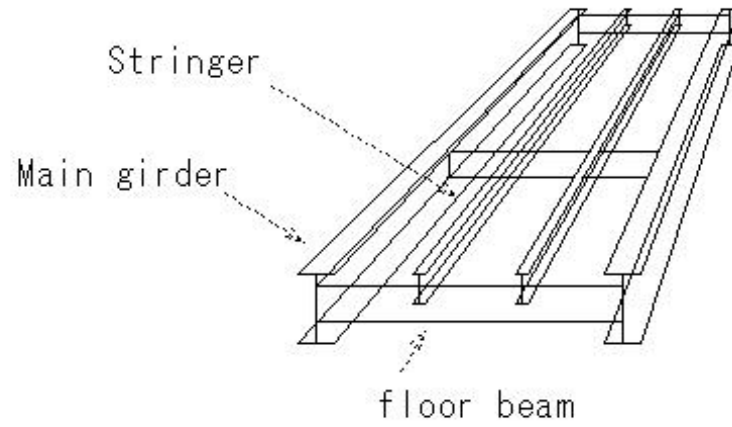
vehicle braking

$h=1.8\text{m}$



(B322)stringer

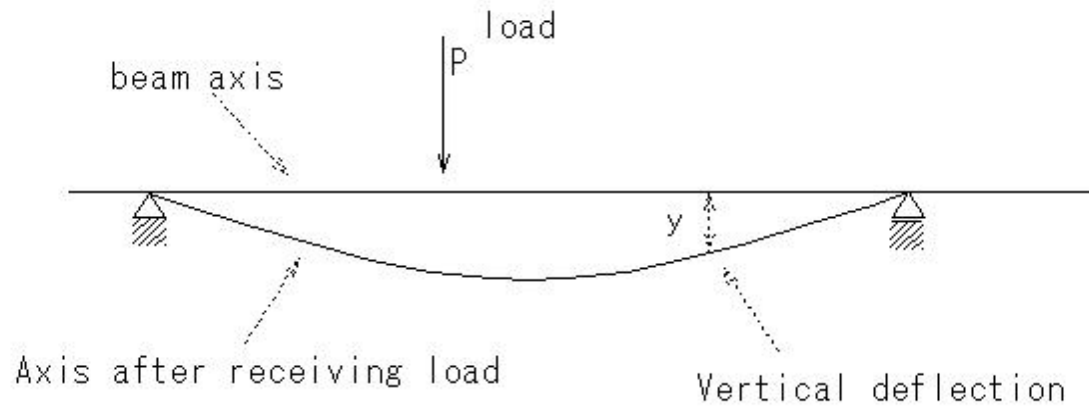
(B322) str inger



(B323)deflection

(B323) deflection

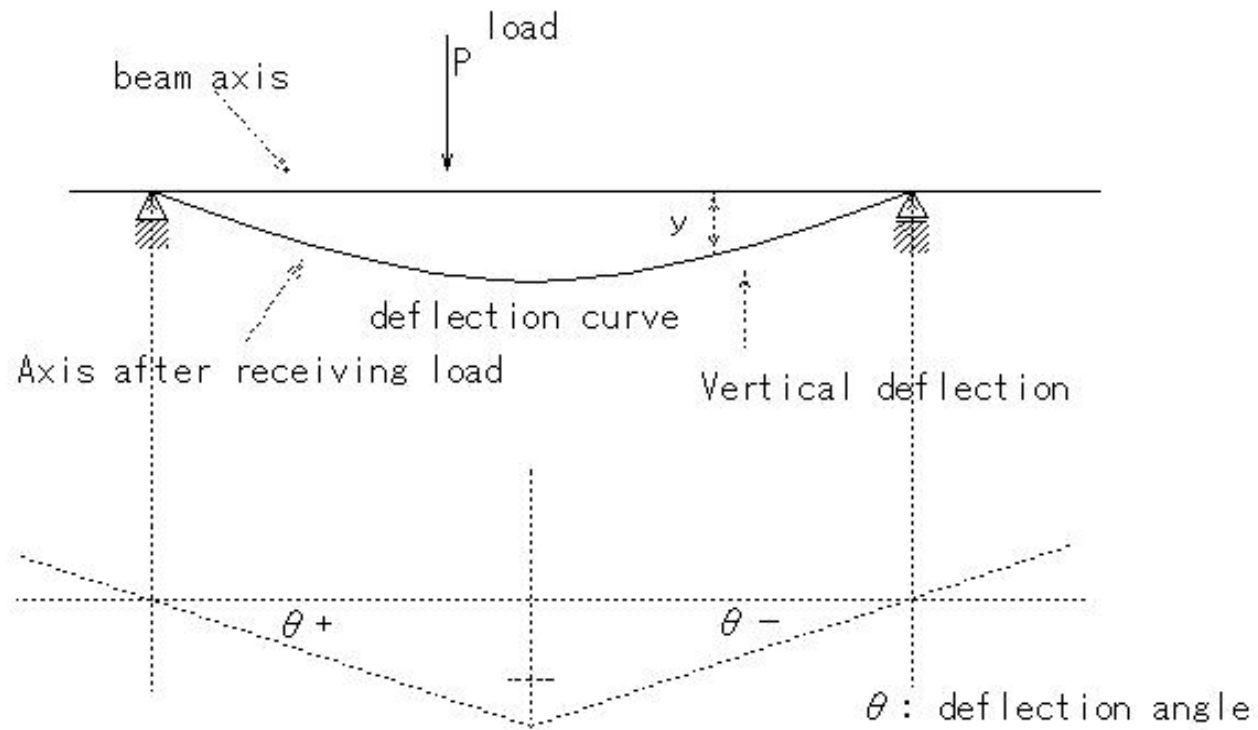
Deformed diagram of a beam



(B324)deflection angle

(B324)deflection angle

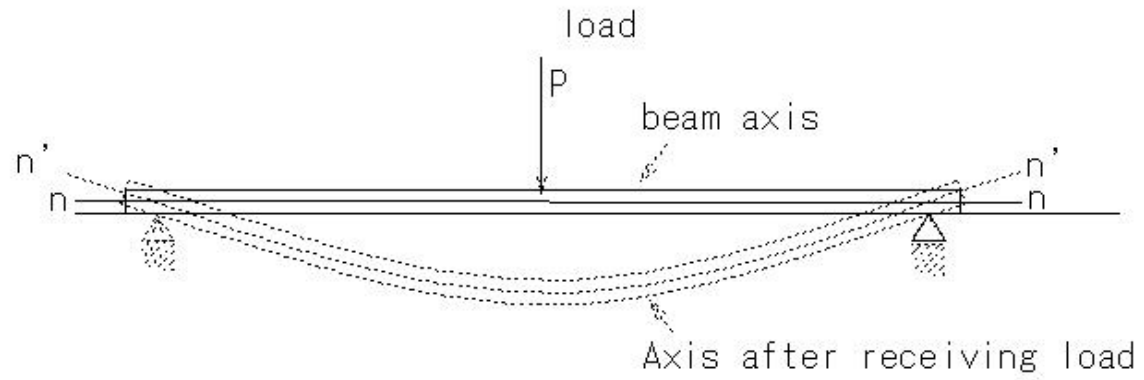
Deformed diagram of a beam



(B325)deflection curve

(B325) deflection curve

deflection curve



(B326) simple beam

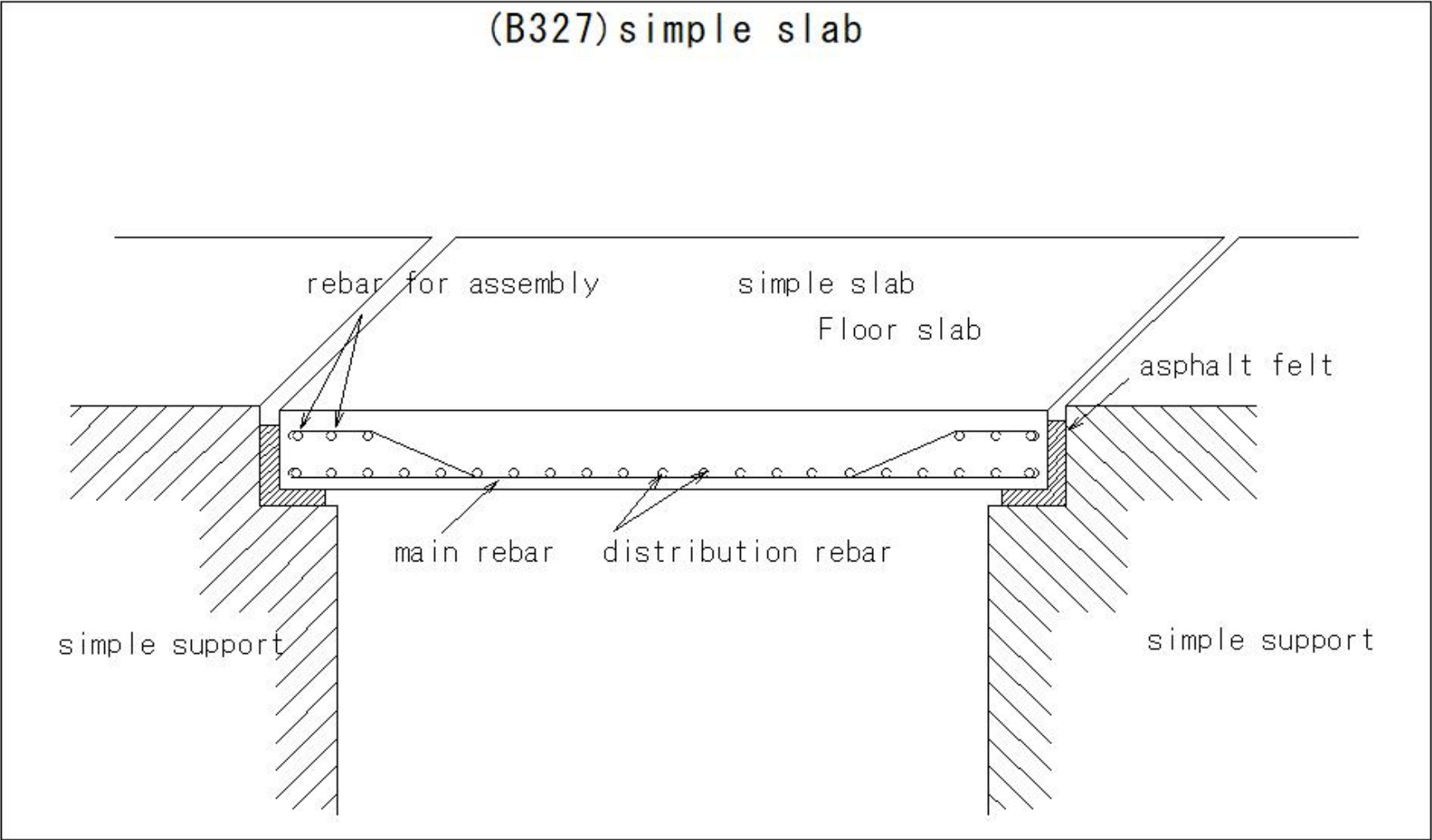
(B326) simple beam

simple beam



(B327) simple slab

(B327) simple slab

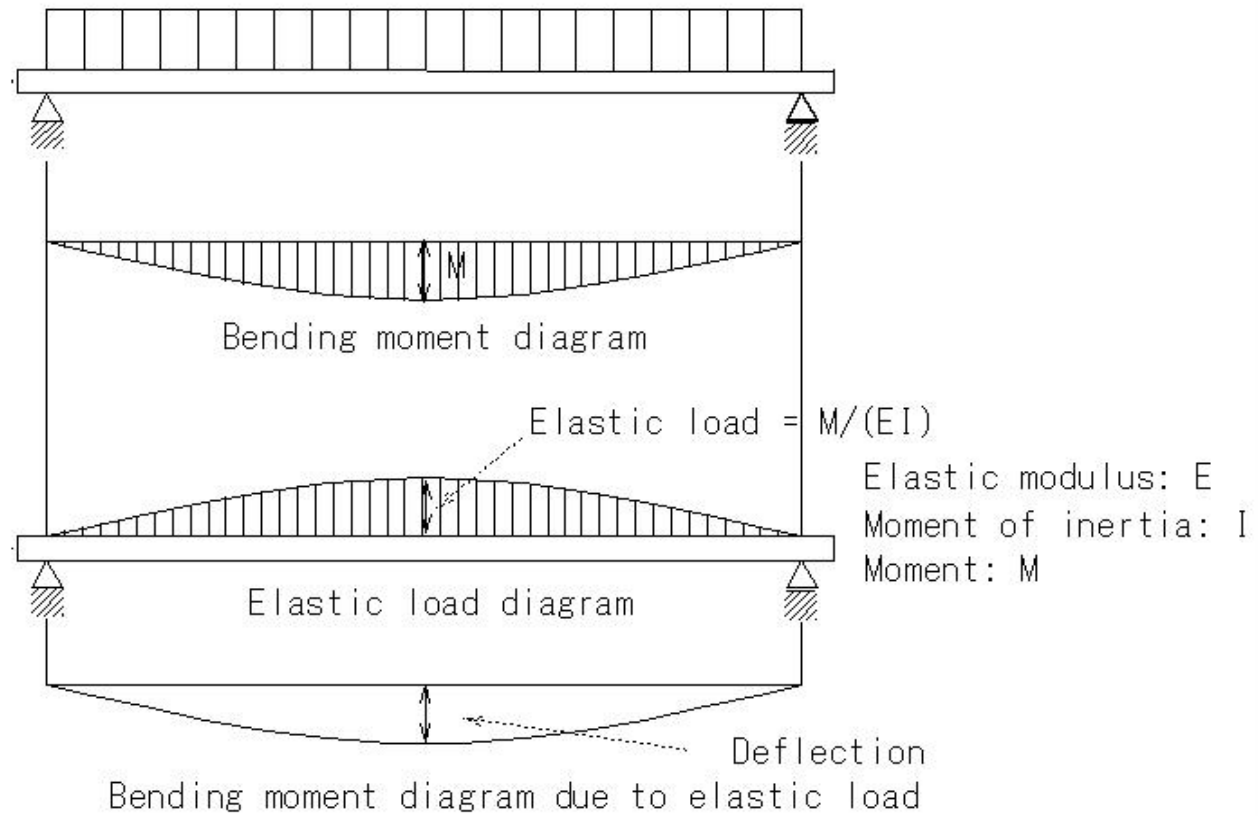


(B328)elastic load

elastic load

Deflection of the beam

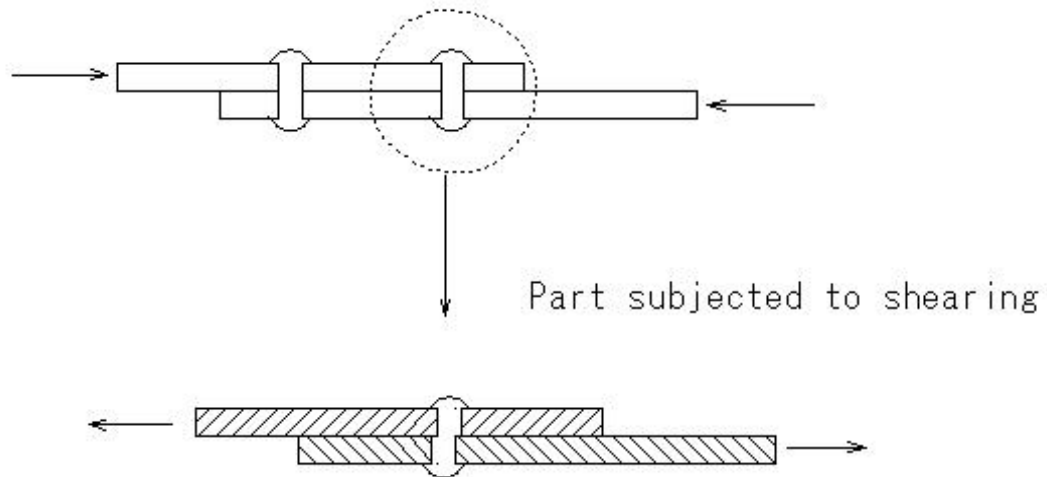
(B328)elastic load



(B329)single sheared rivet

(B329) single sheared rivet

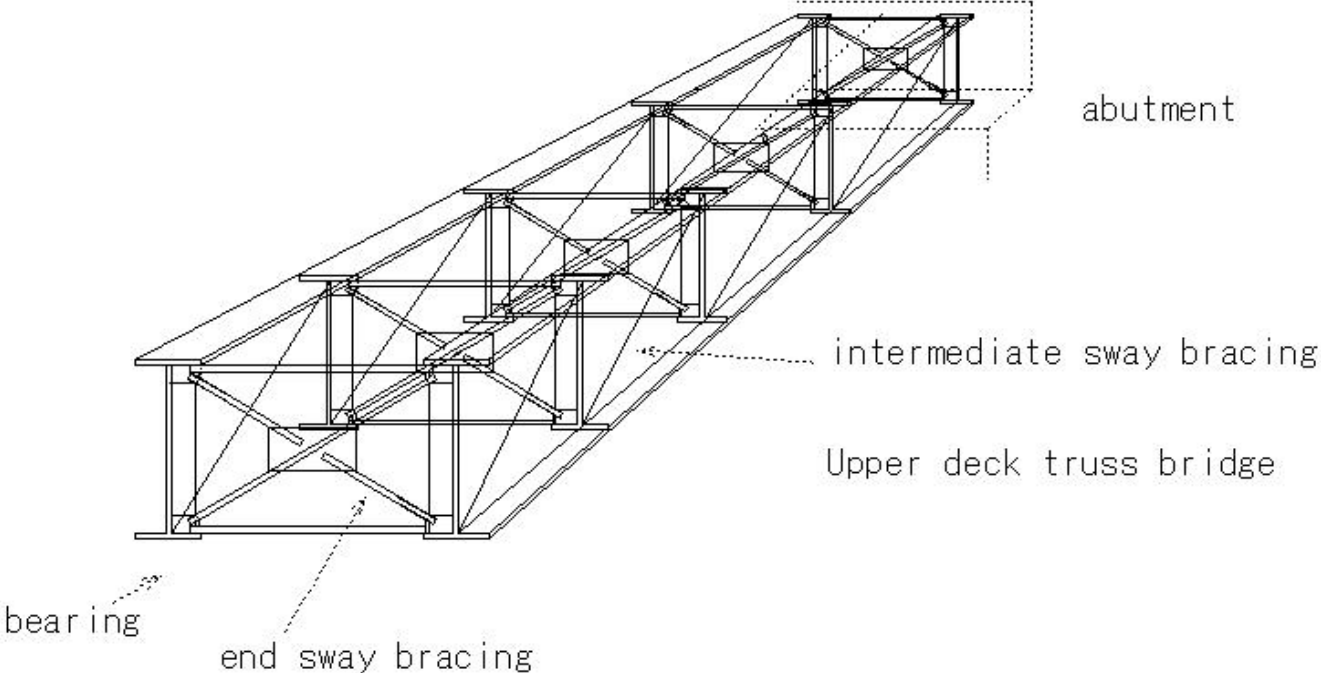
Single shear rivet
Rivet in one place that receives shear force



(B330)end sway bracing

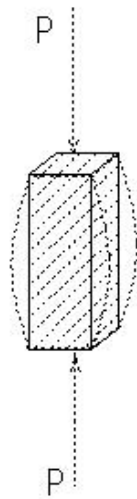
(B330) end sway bracing

ends of deck bridge



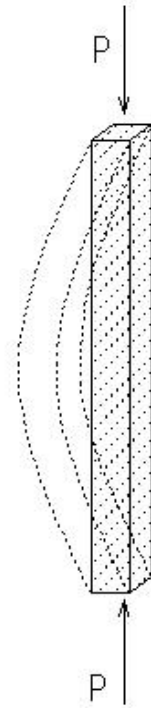
(B331)short column

(B331) short column



squashing

short column

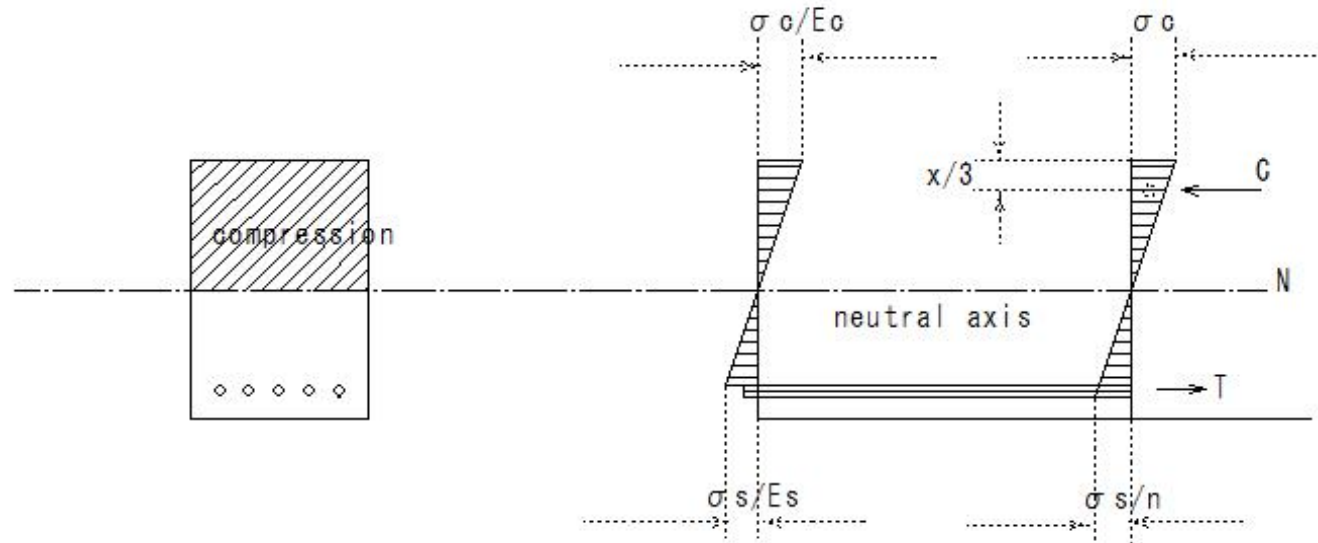


Buckling

long pillar

(B332)rectangular beam with single reinforcement

(B332)rectangular beam with single reinforcement

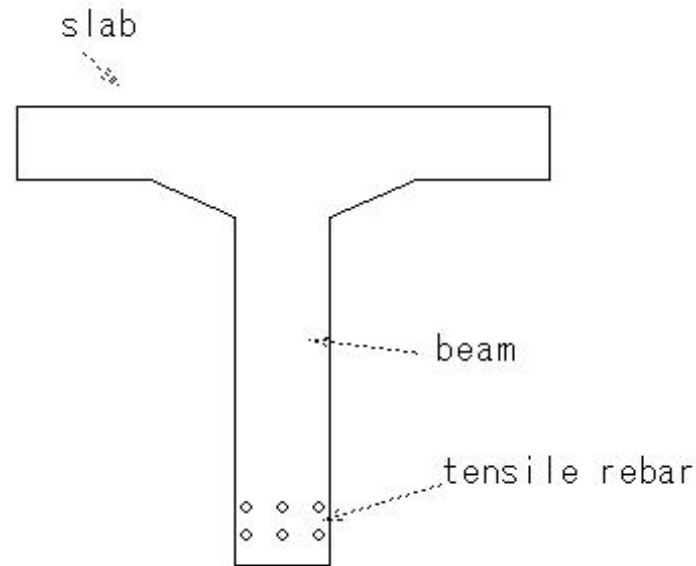


Reinforcement placed only on the tension side

(B333)T-beam with single reinforcement

(B333)T-beam with single reinforcement

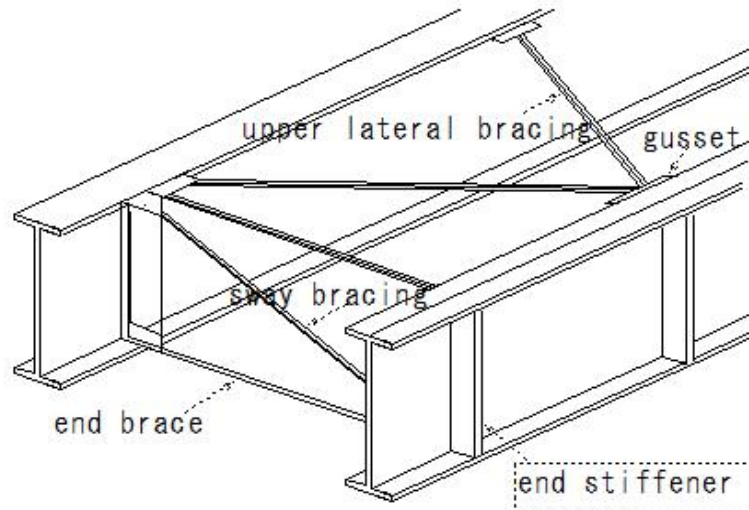
T-shaped cross section beam



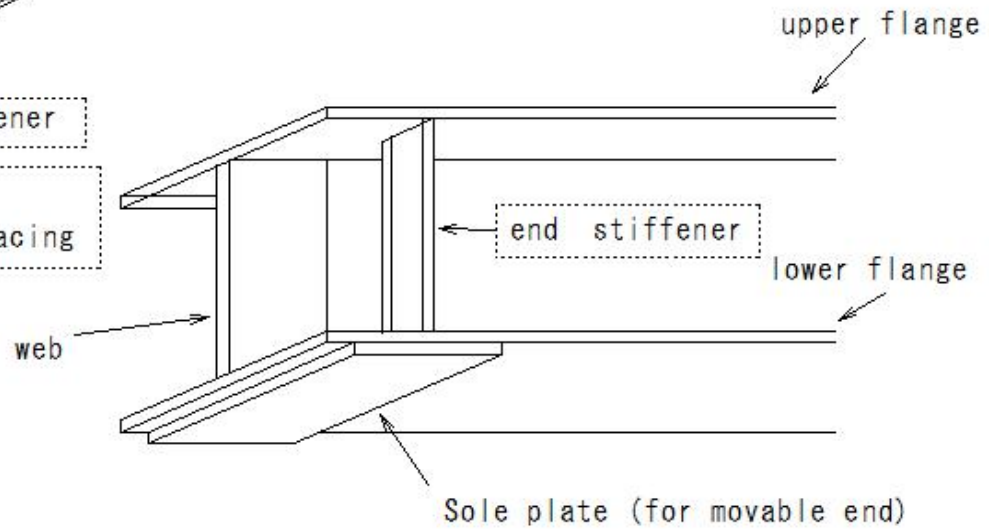
Placing reinforcing bars only on the tension side

(B334)end stiffener

(B334)end stiffener



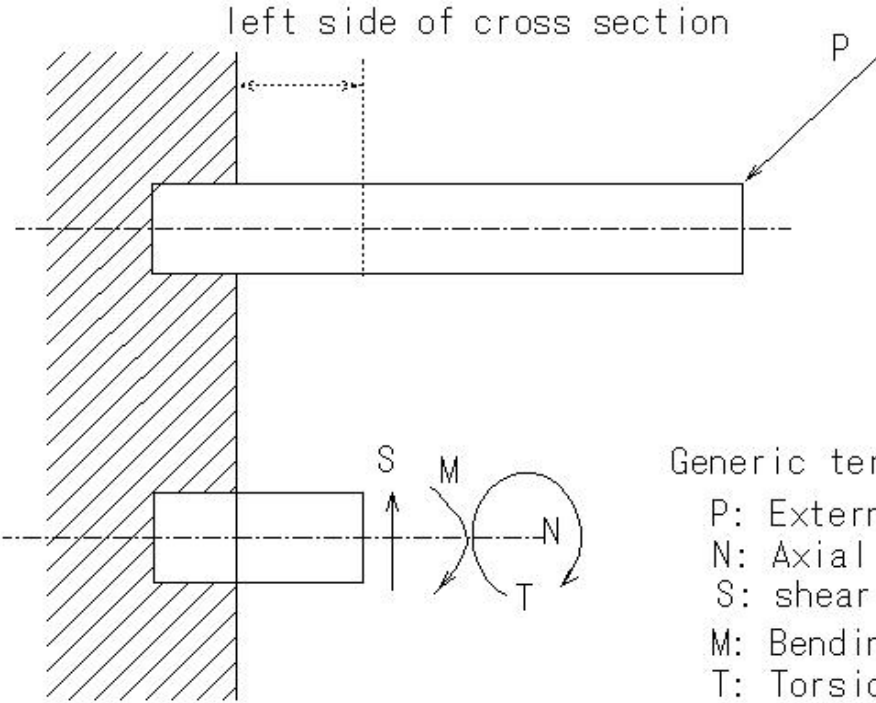
Preventing plate buckling
Can also be used as a member for sway bracing



(B335)sectional force

(B335) sectional force

Sectional force



Generic term for stress

- P: External force
- N: Axial force
- S: shear force
- M: Bending moment
- T: Torsional moment

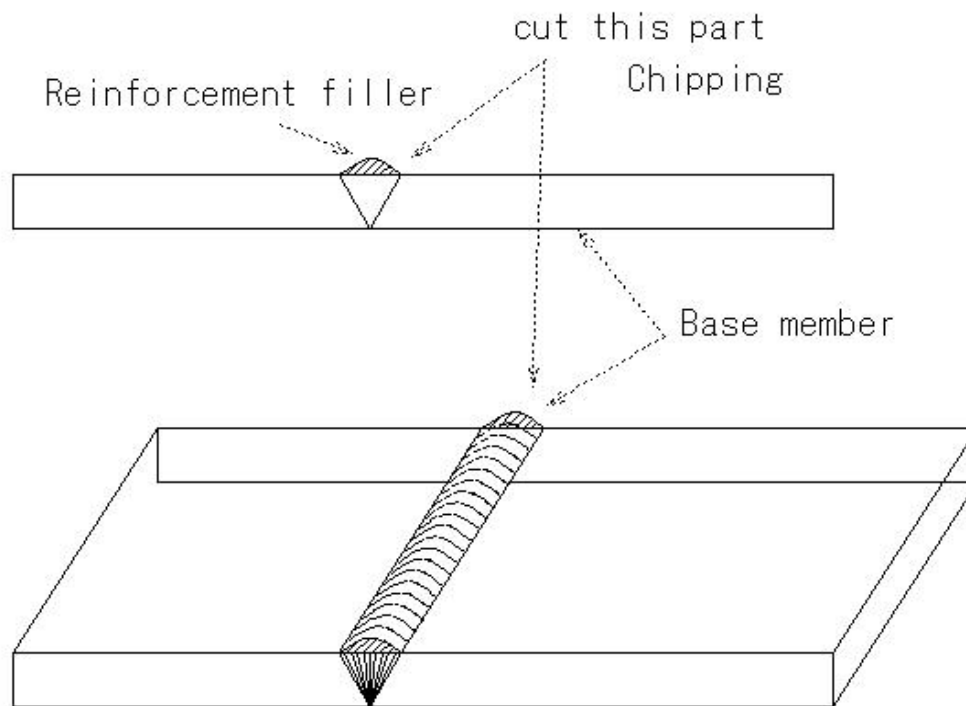
(B336)chipping

(B336) chipping

Cutting off the reinforcement part of the weld: chiseling

V-type butt welding

Excessive reinforcement



(B337)finish of chipping

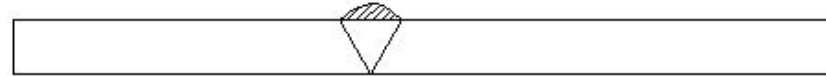
(B337) finish of chipping

Chipping finish

After cutting the welding convex part, finish the surface.

①Weld

Reinforcement fill (convex part)



②Rough cutting, chipping

scraping off convex parts



③Finishing

Grinder to finish the surface



(B338)intermediate sway bracing

(B338) intermediate sway bracing

intermediate sway bracing

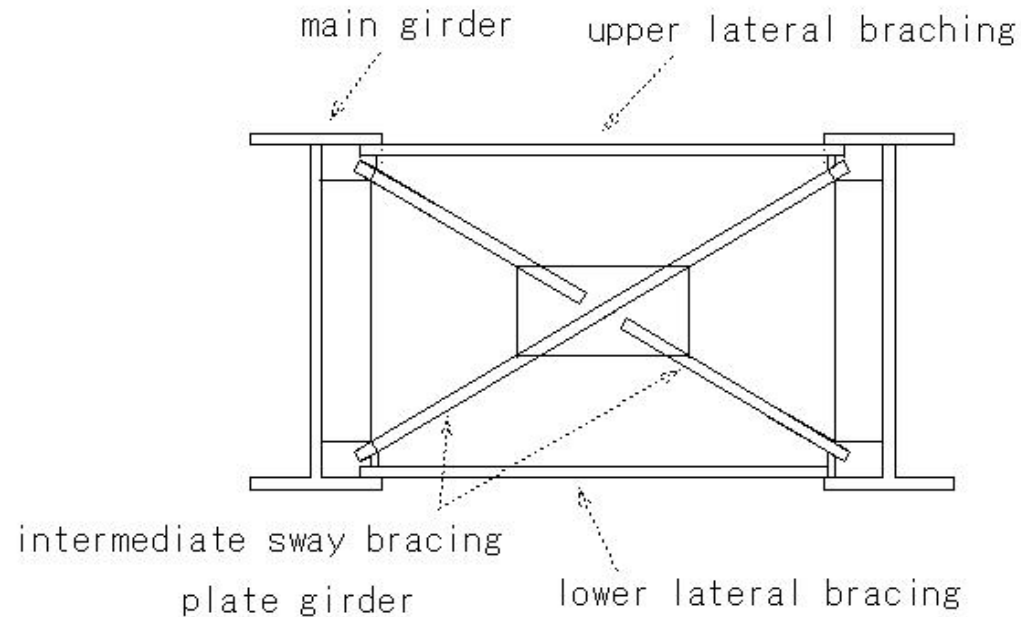
Keep main girders in position relative to each other

Resist lateral forces such as wind

sway bracing to prevent twisting

Main girder

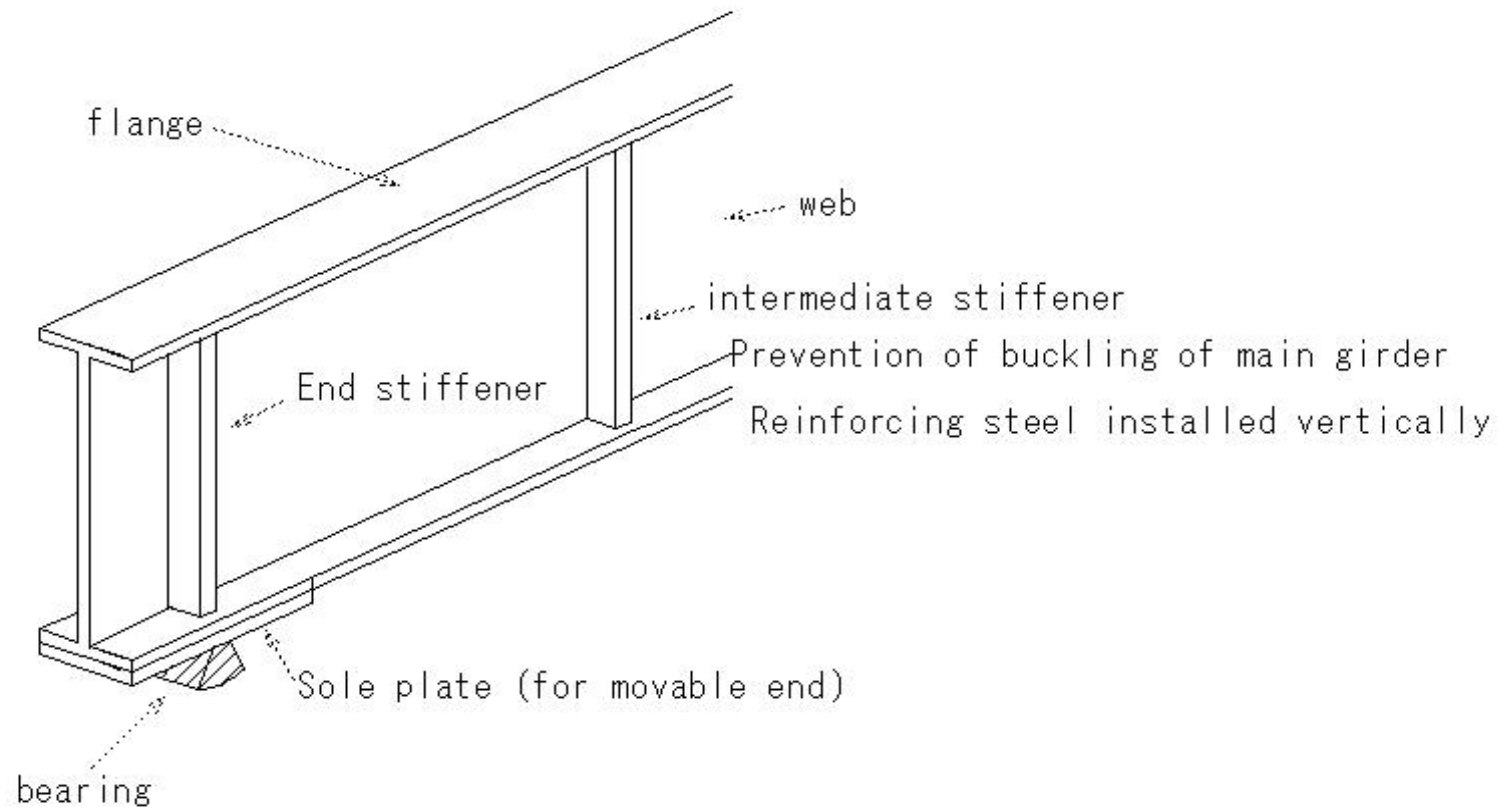
Can also be used as a member for sway bracing



(B339) intermediate stiffener

(B339) intermediate stiffener

intermediate stiffener



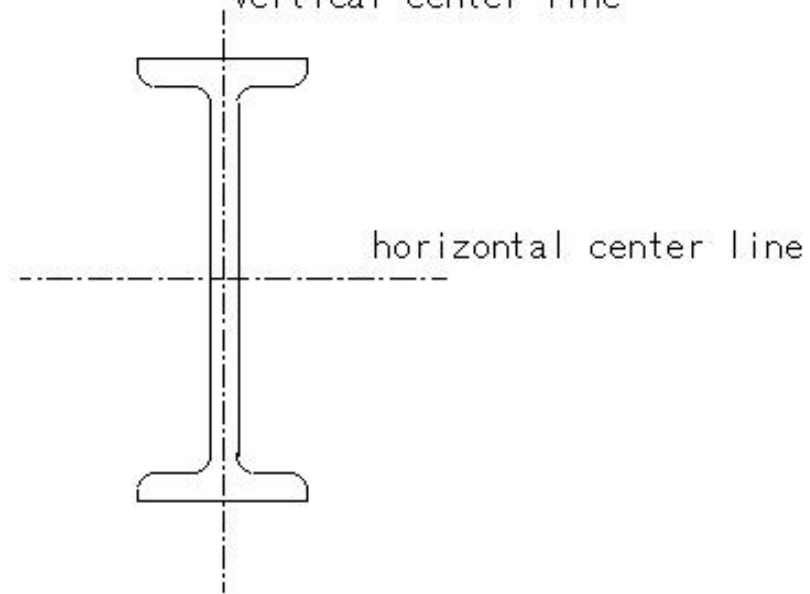
(B340)center line

(B340)center line

center line

indicates the center of the structure

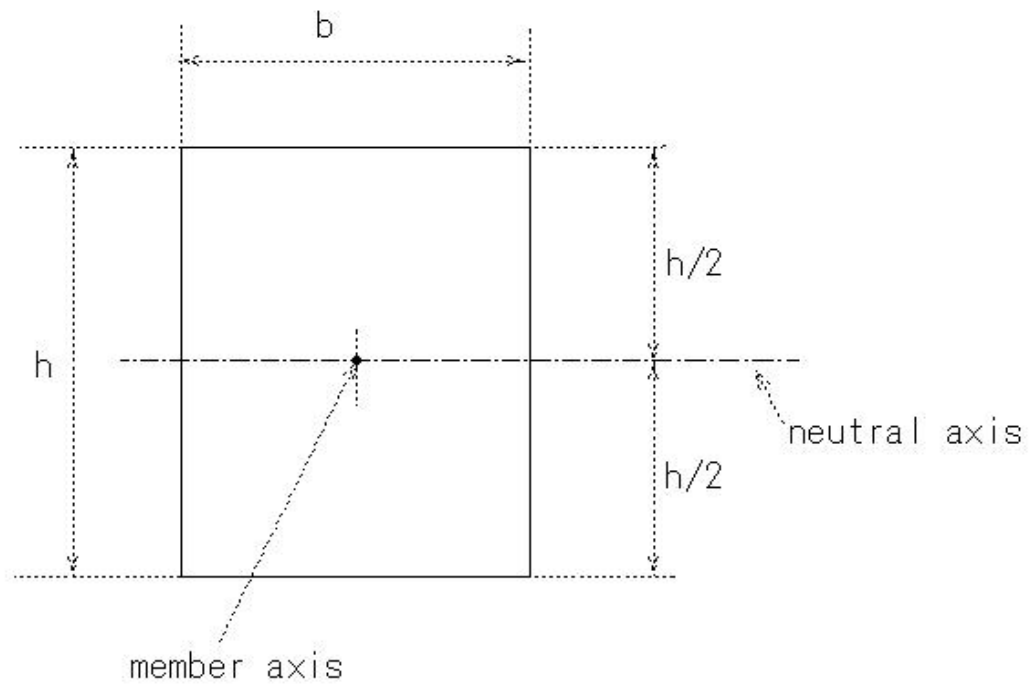
vertical center line



horizontal center line

(B341)neutral axis

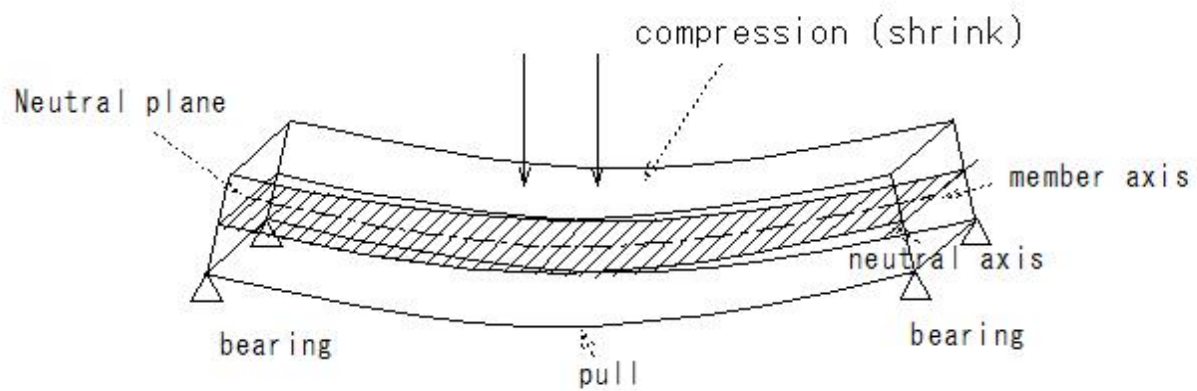
(B341)neutral axis



(B342)neutral plane

(B342)neutral plane

Neutral plane and members (beams/flat plates)

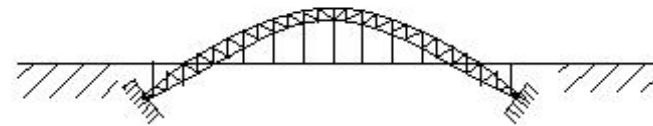
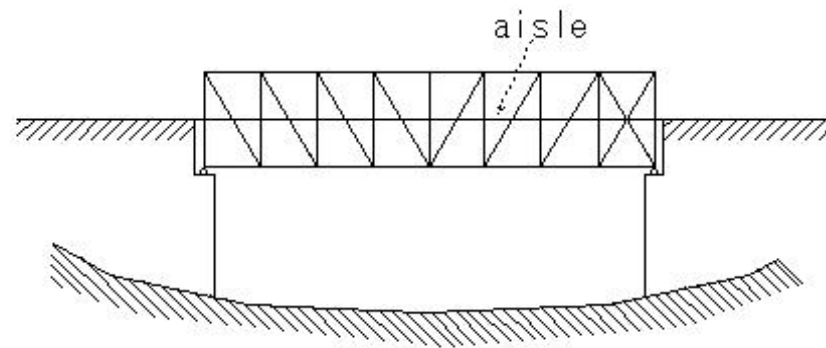


(B343)halfthrough bridge

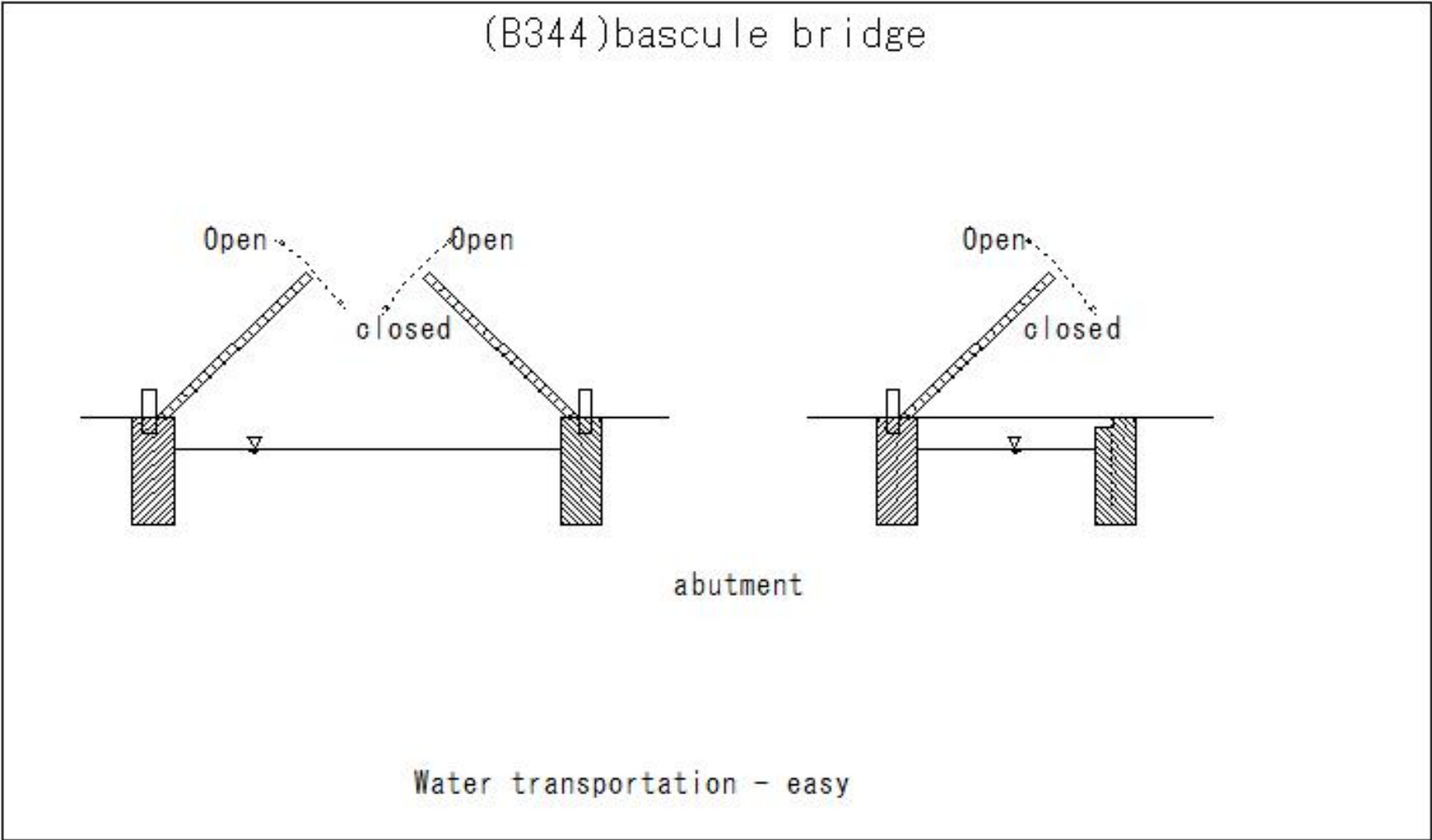
(B343)halfthrough bridge

half-through bridge

Passageway in the middle of the bridge girder



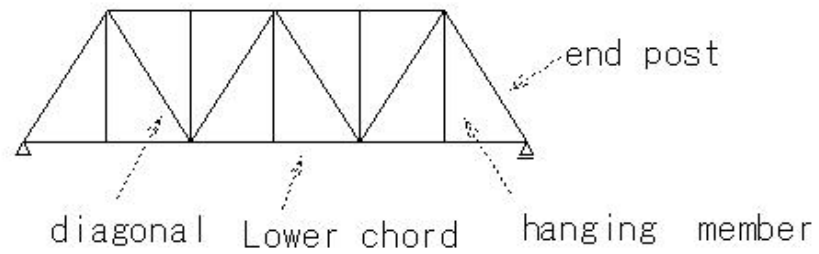
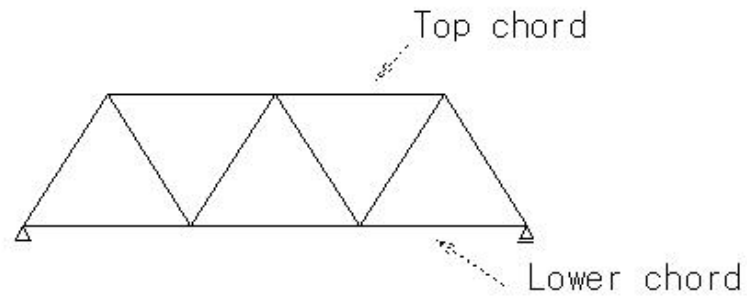
(B344)bascule bridge



(B345)parallel-chord truss

(B345)parallel-chord truss

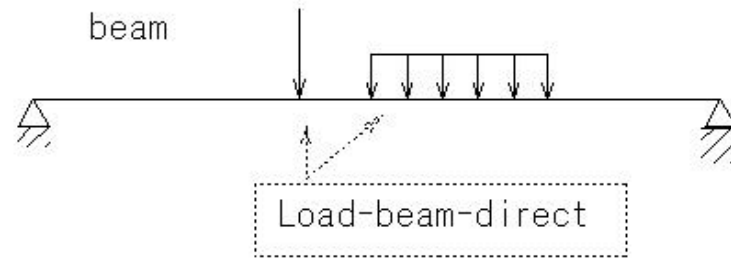
parallel-chord truss



(B346)direct load

(B346)direct load

direct load

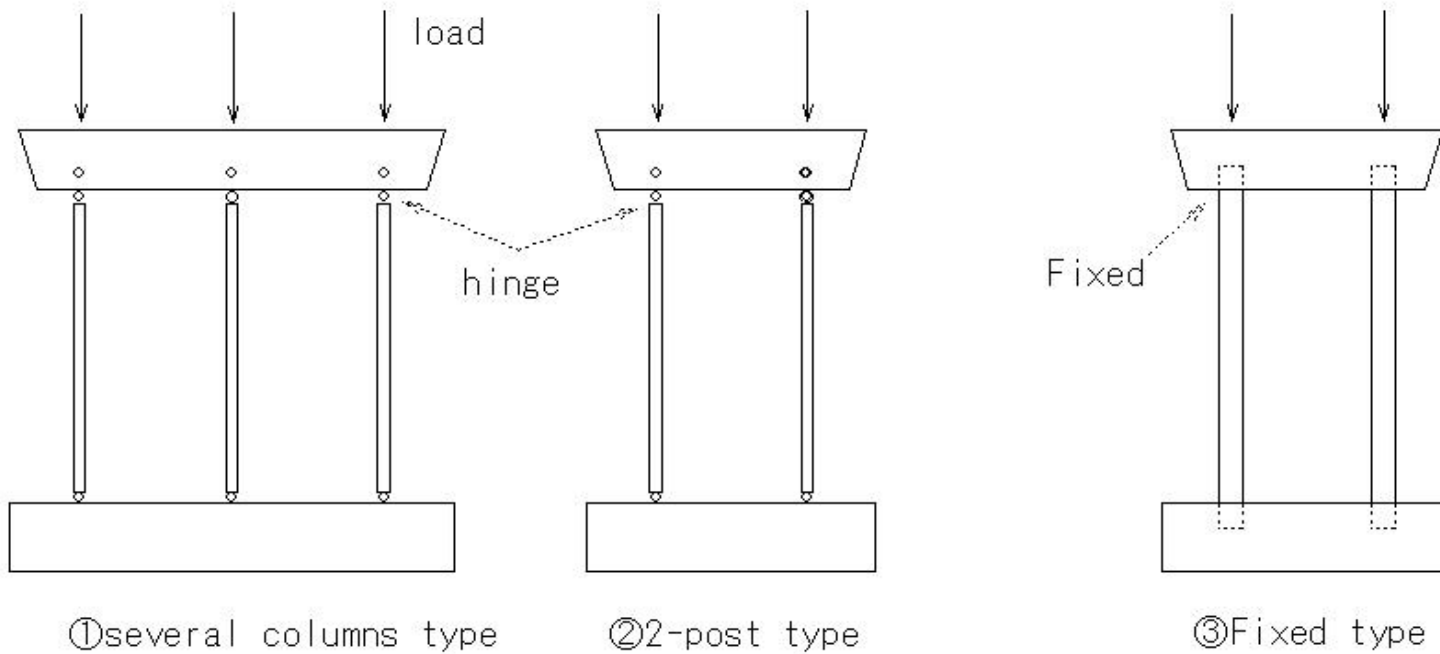


(B347) longcolumn-form pier

(B347) longcolumn-form pier

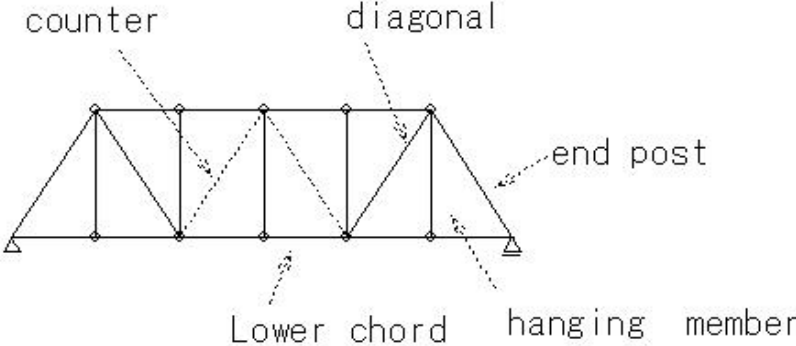
longcolumn-form pier

Two to several columns - piers that support the load



(B348) truss(counter)

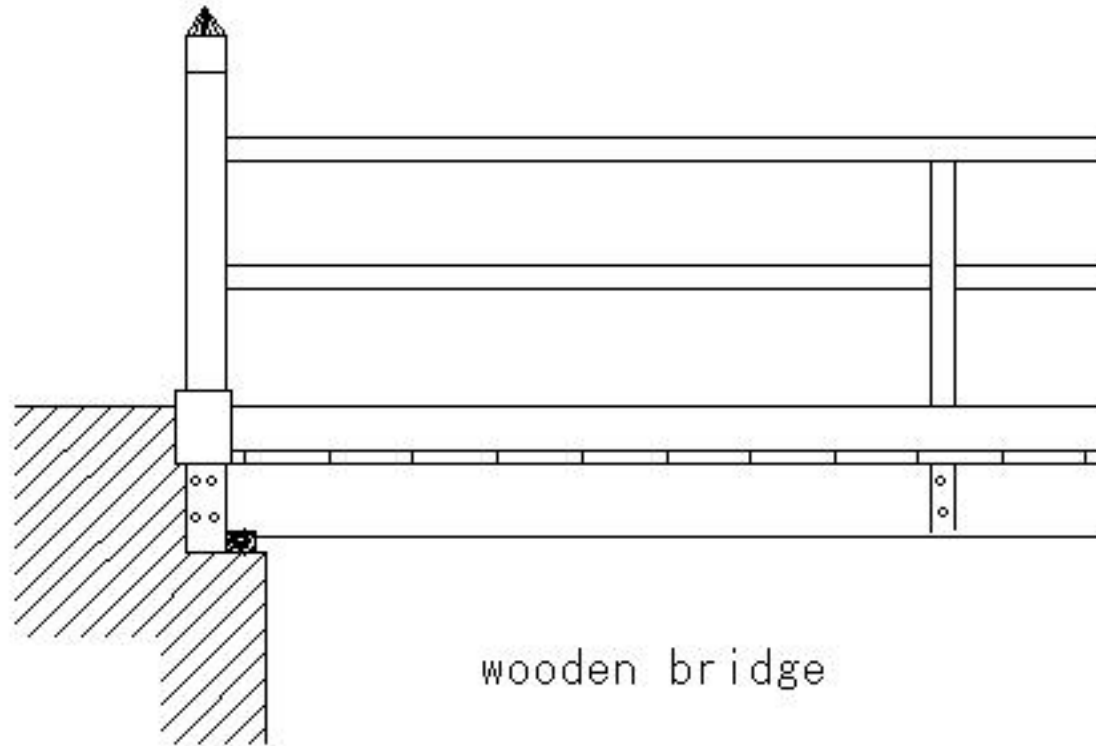
(B348) truss(counter)



pratt truss

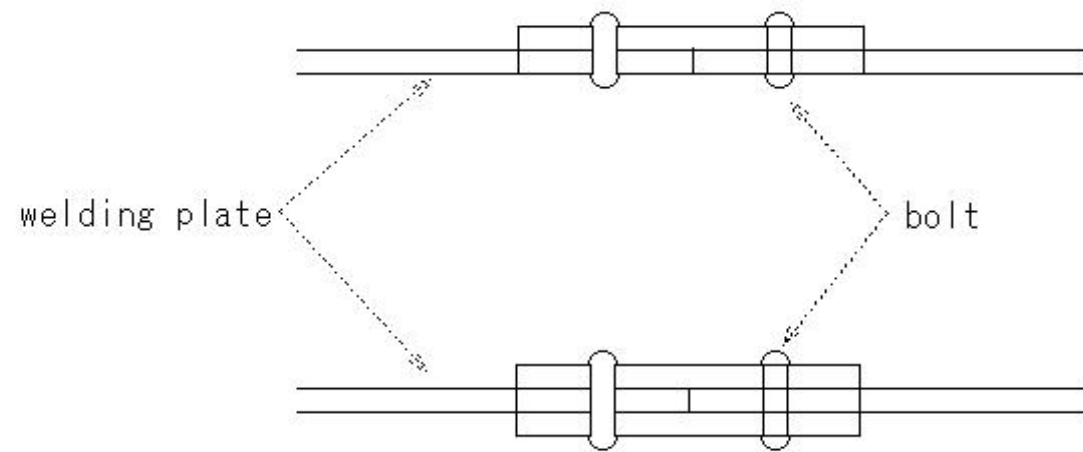
(B349)wooden bridge

(B349)wooden bridge



(B350)joint(butt joint)

(B350) joint (butt joint)



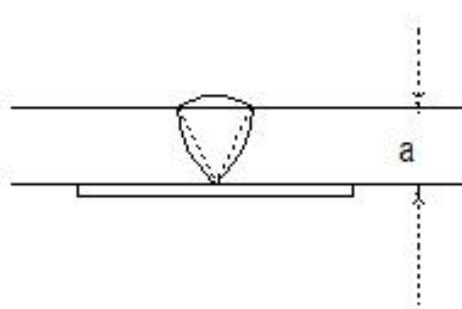
butt joint

Joint surface - butt

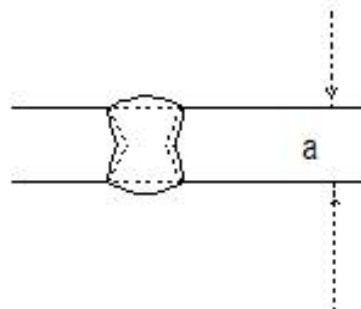
(B351)joint(butt welding)

(B351)joint(butt welding)

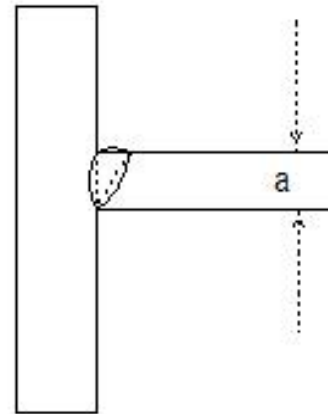
butt welding
welding
Base material (steel)



V shape



X shape



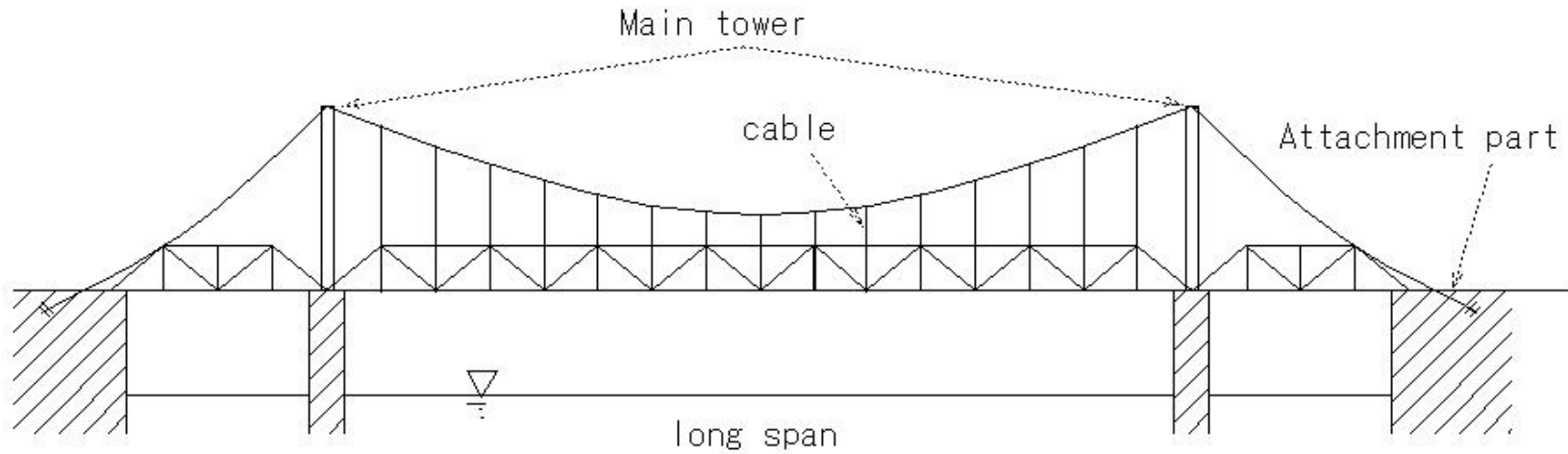
L shape

a: Throat thickness

(B352)suspension bridge(span)

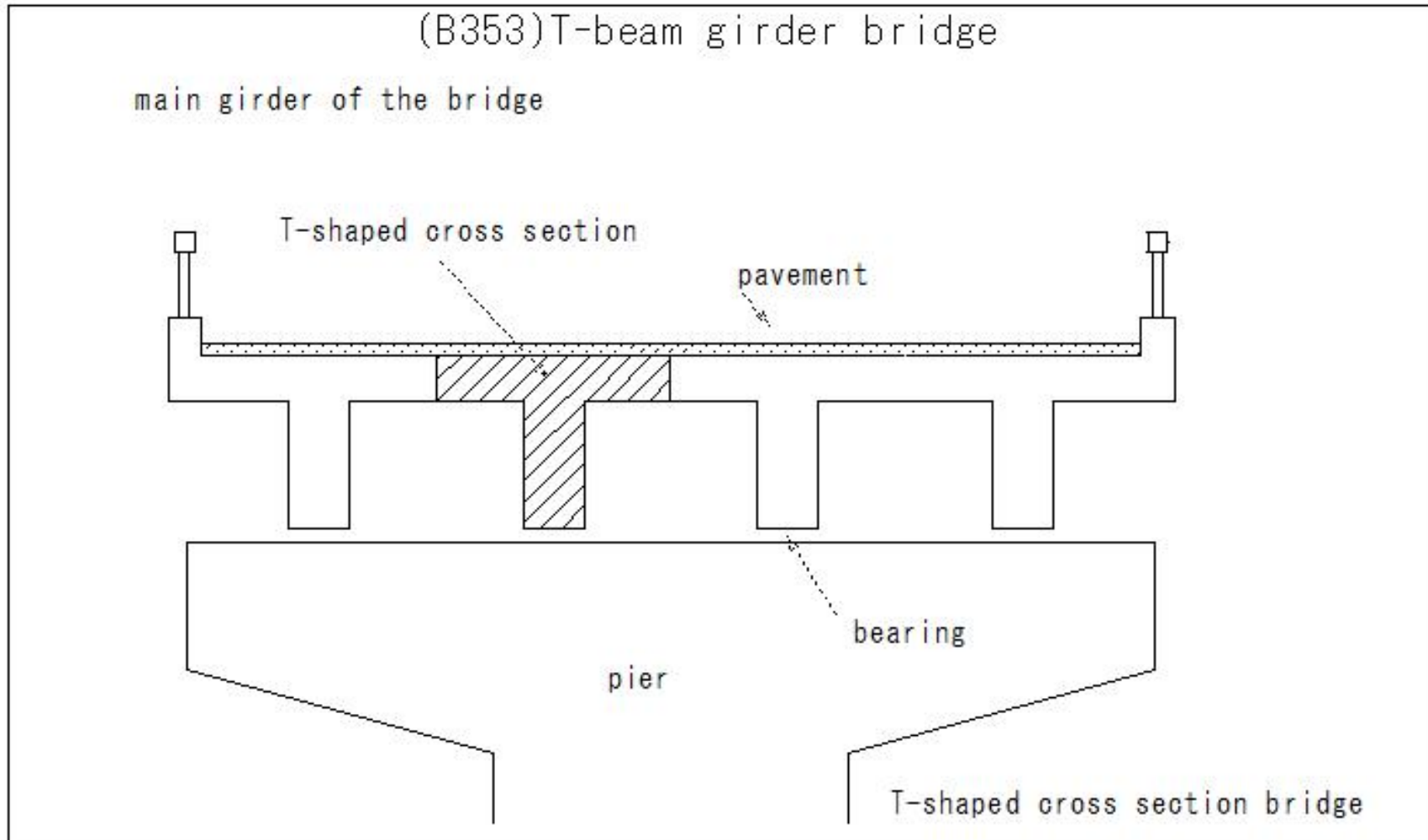
(B352) suspension bridge (span)

suspension bridge



Bridge deck - influence of wind
Truss/girder-stiffening

(B353)T-beam girder bridge

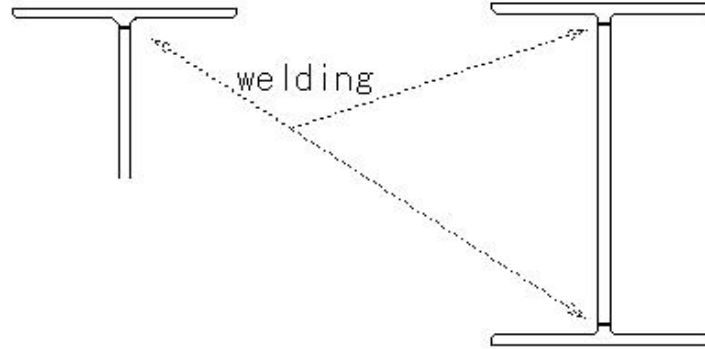


(B354)T-shaped steel

(B354) T-shaped steel



T-shaped steel

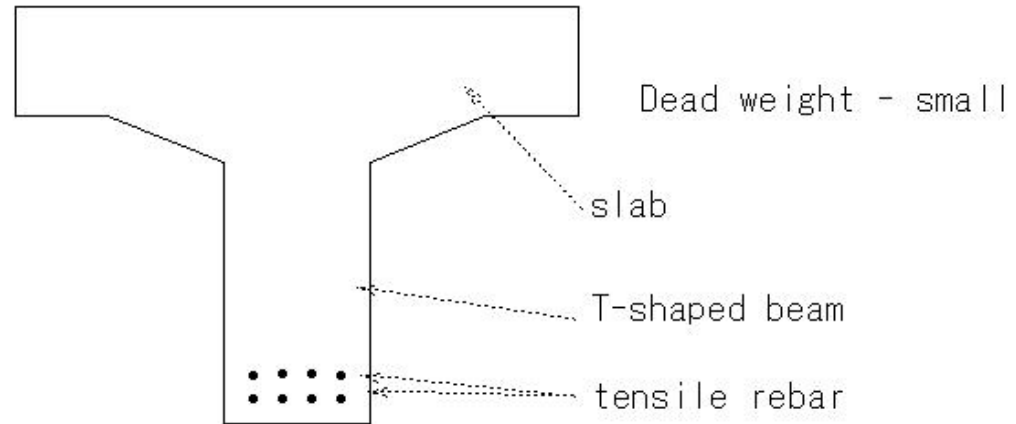


T shape

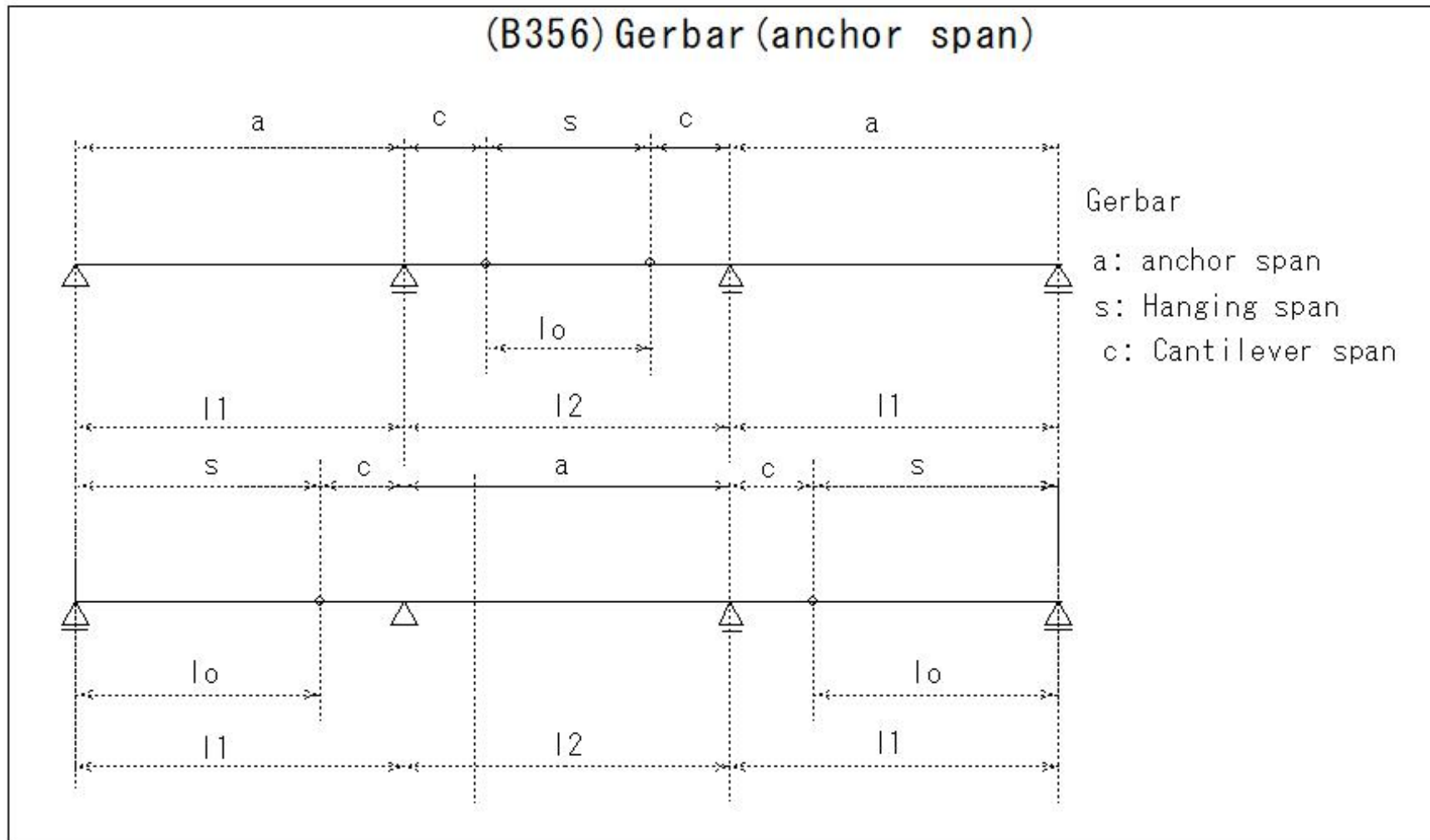
plate girder

(B355)T-beam

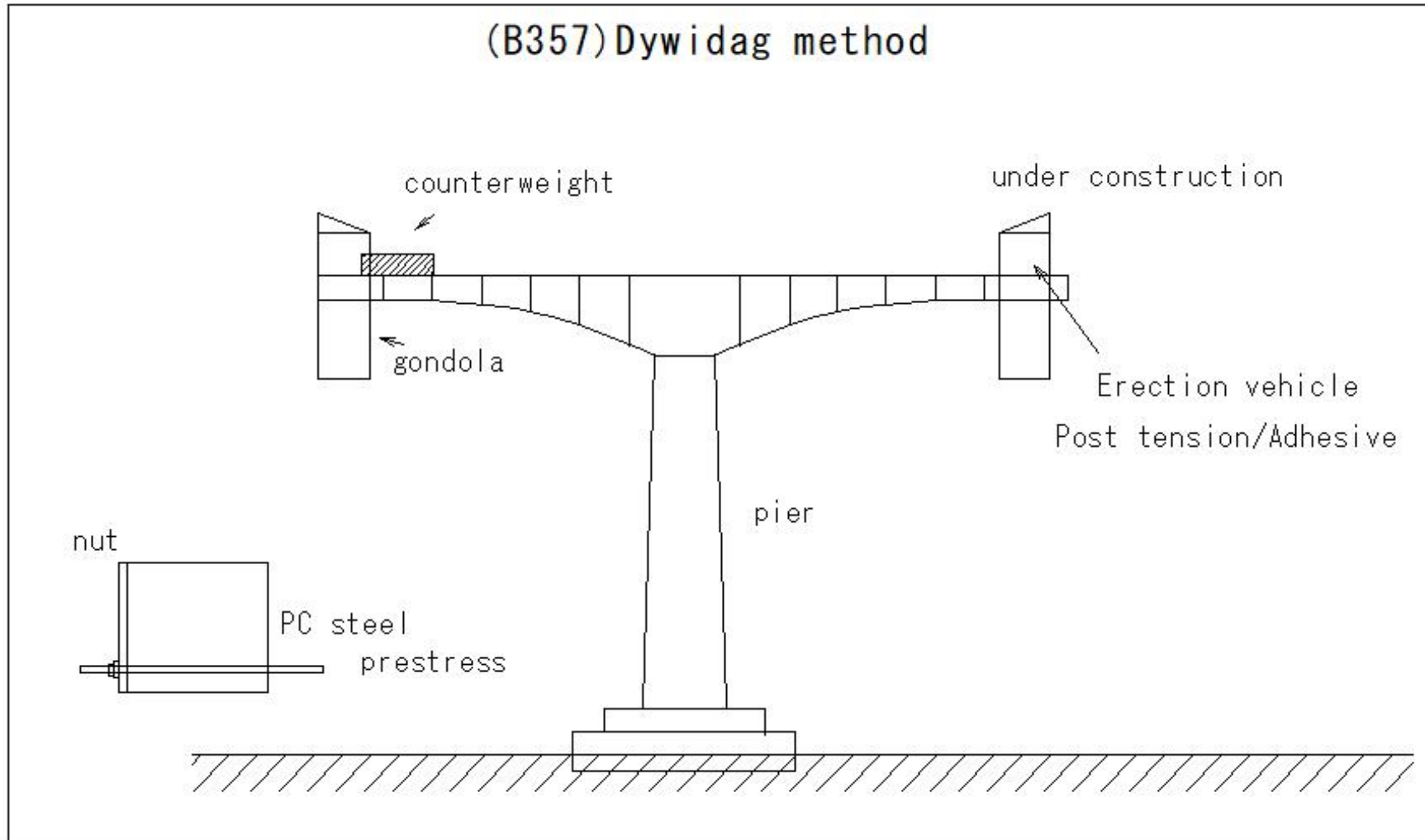
(B355) T-beam



(B356)Gerbar(anchor span)



(B357)Dywidag method

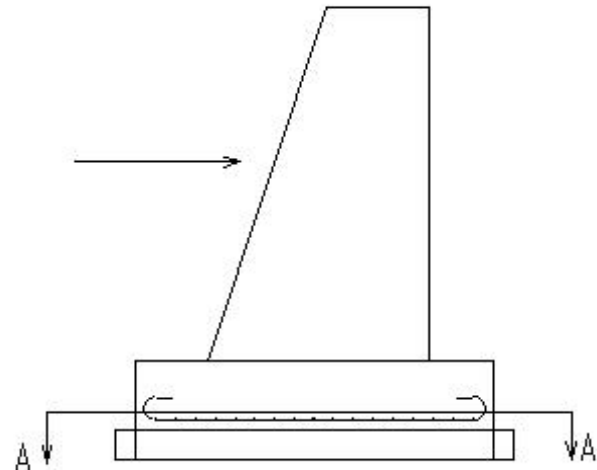


(B358)base drawing

(B358) base drawing

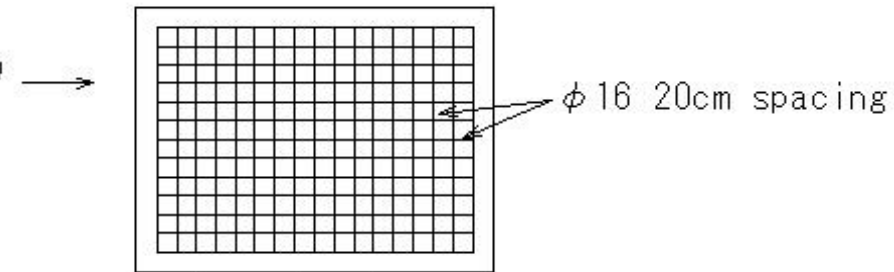
base drawing

Side view



A-A cross-section

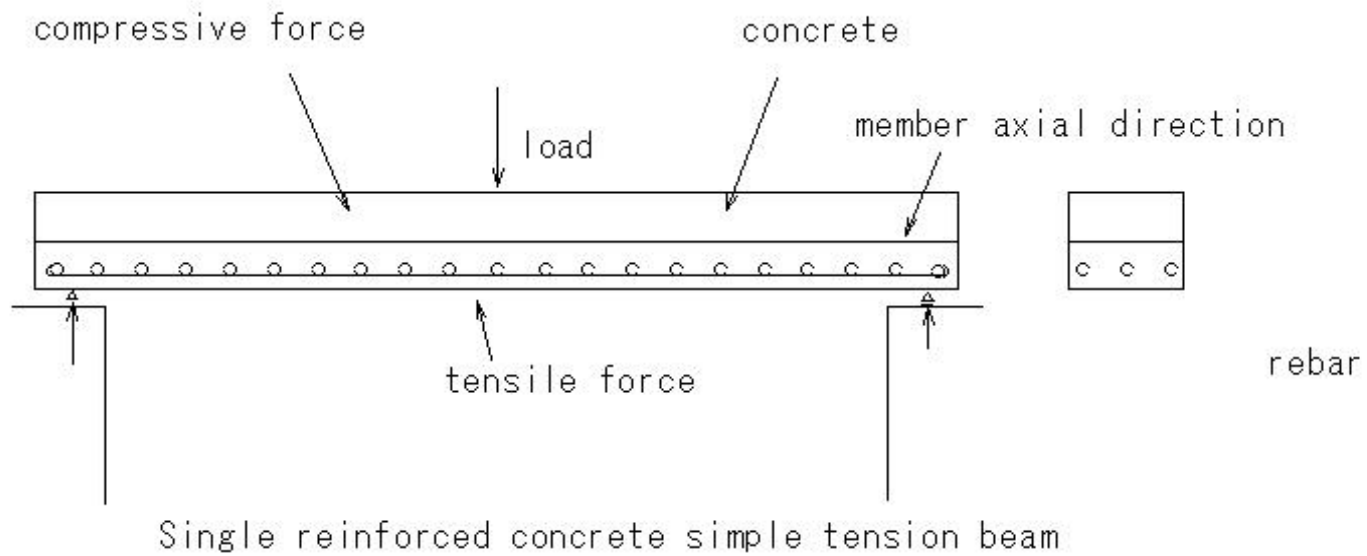
Bottom view



base drawing

(B359)reinforced concrete

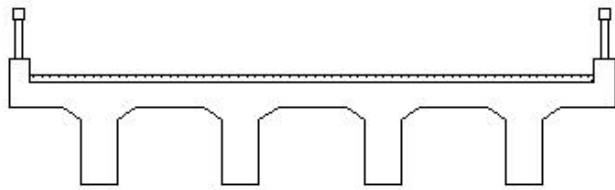
(B359) reinforced concrete



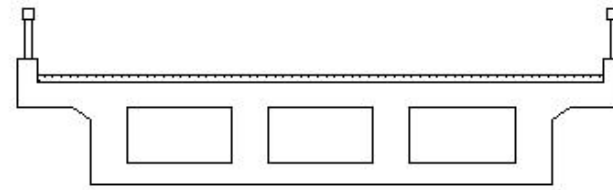
(B360)reinforced concrete girder bridge

(B360)reinforced concrete girder bridge

main girder of the bridge



T shape

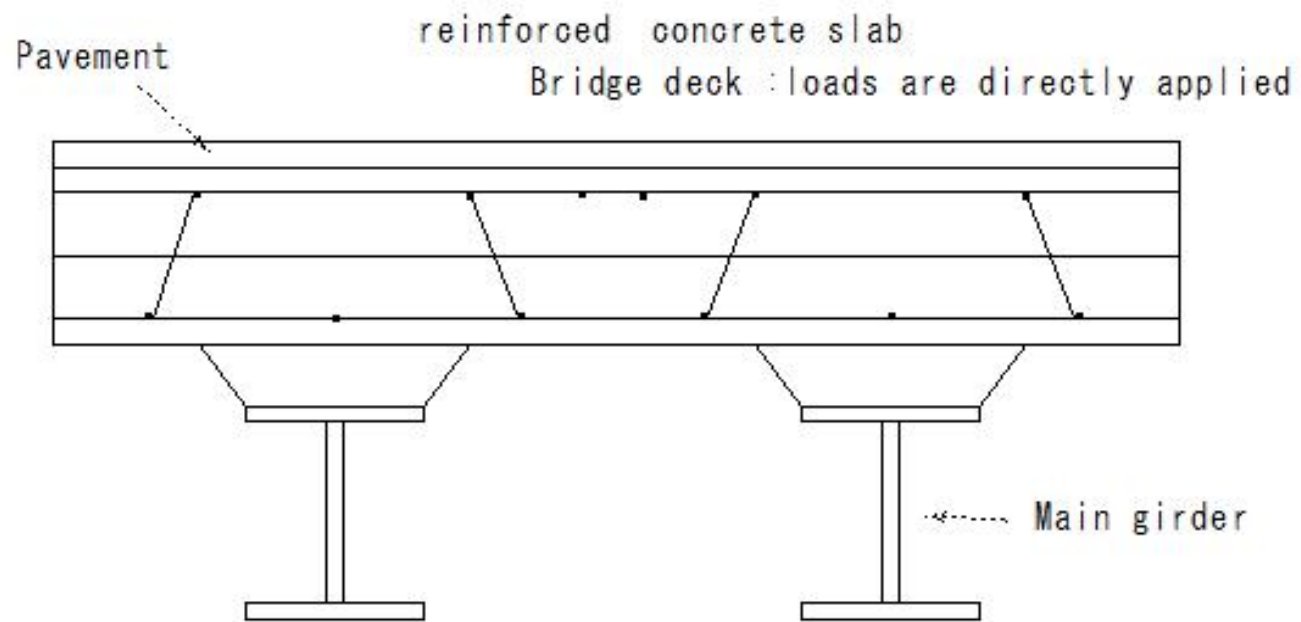


box shape

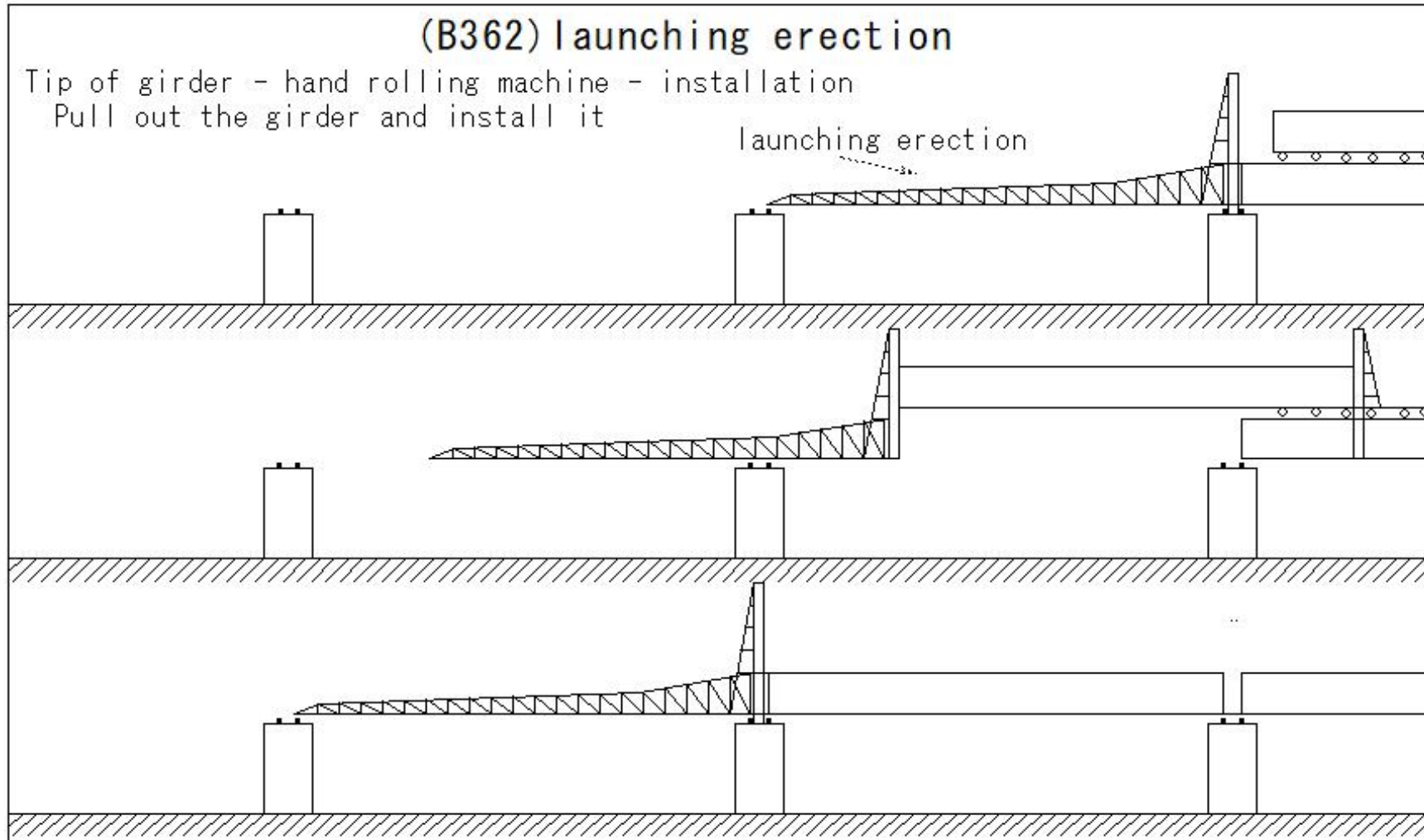
Bridge main girder - reinforced concrete structure

(B361)reinforced concrete slab

(B361)reinforced concrete slab



(B362)launching erection

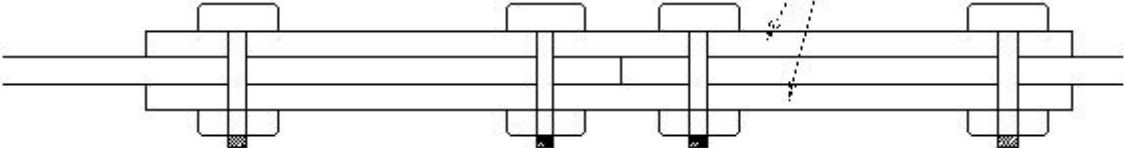


(B363)bolt splice(splice)

(B363)bolt splice(splice)

bolt splice

splice plate



(B364)uniform load

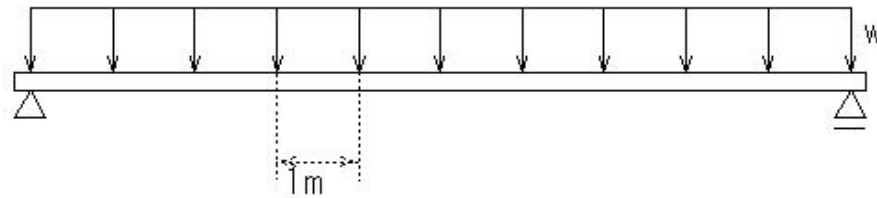
(B364) uniform load

uniform load

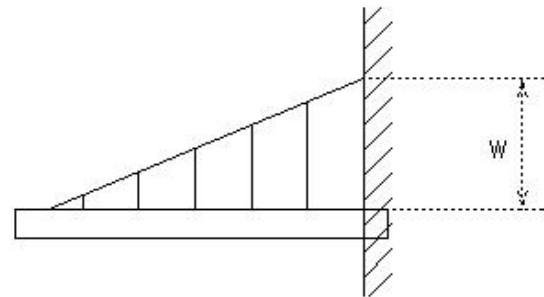
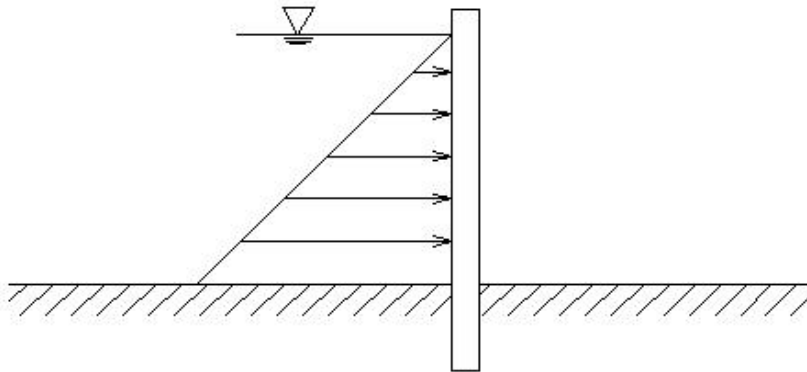
Load distribution state - constant

w: Load per unit length

uniform load

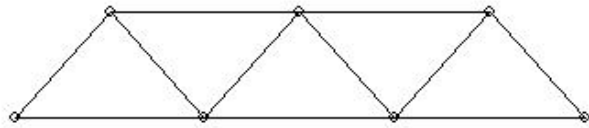


uniform varying load

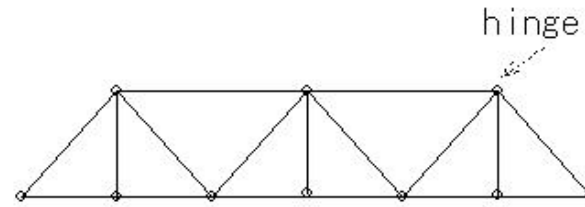


(B365)truss

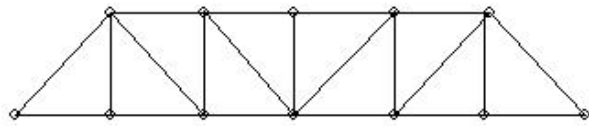
(B365) truss



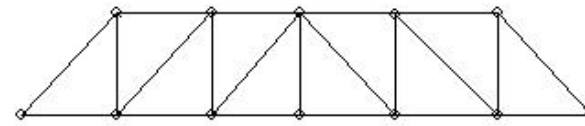
warren truss



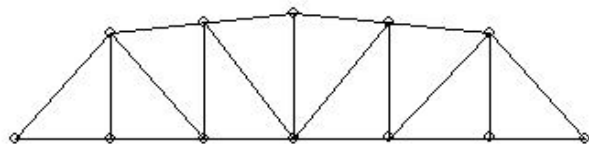
Vertical member Warren truss



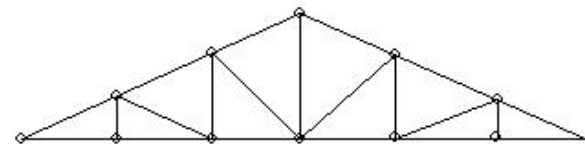
pratt truss



Howe truss



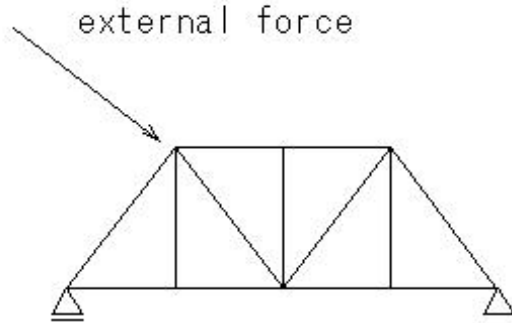
curved pratt truss



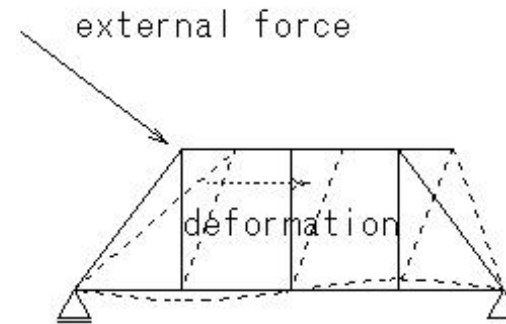
king post truss

(B366)truss(internal stable)

(B366)truss(internal stable)



internal stability



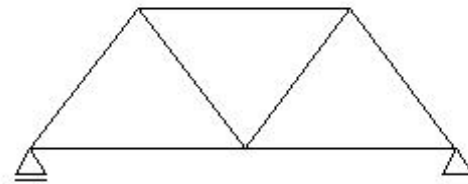
internal instability

(B367)truss(internal determinate)

(B367)truss(internal determinate)

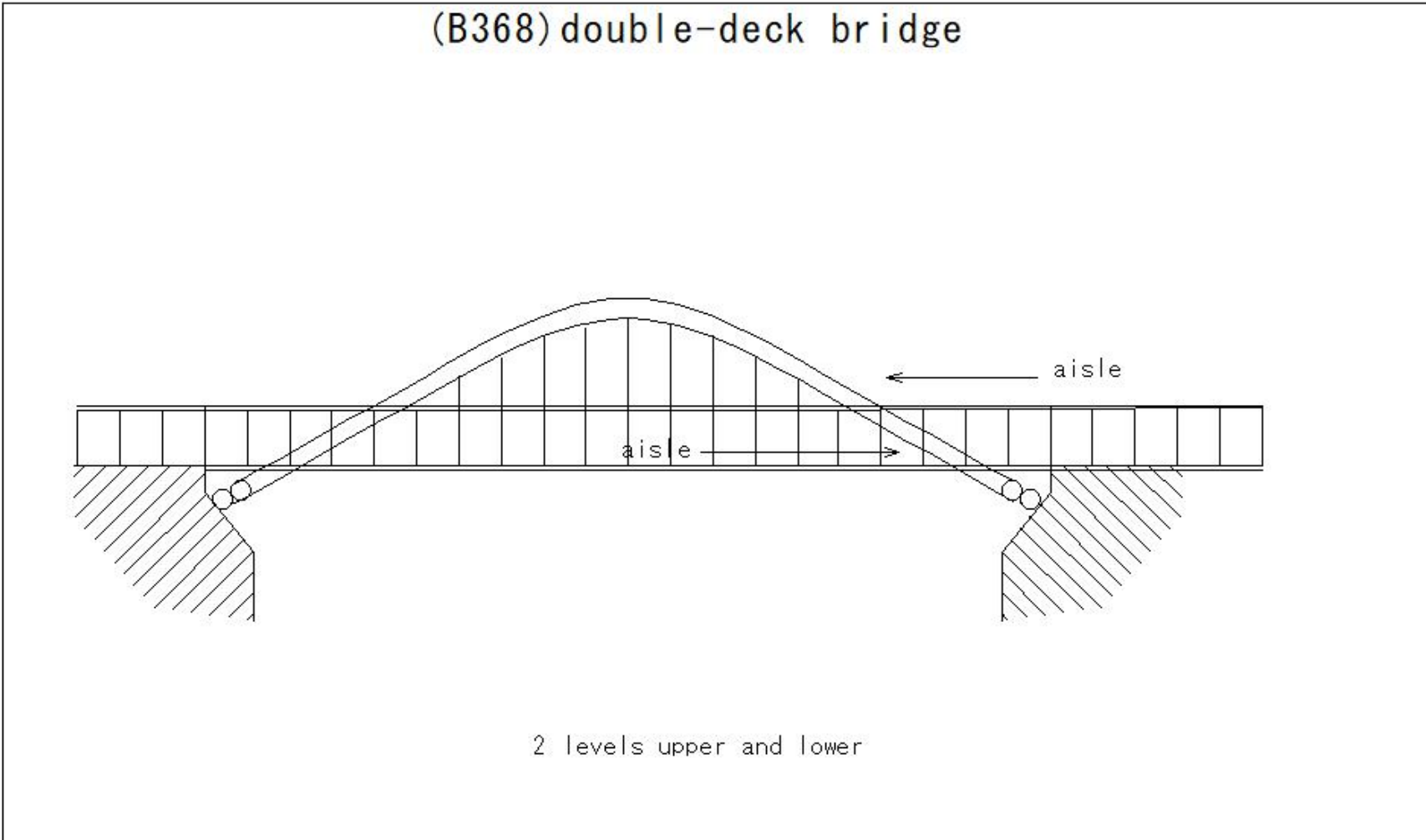
internal determinate

3 conditions for force balance



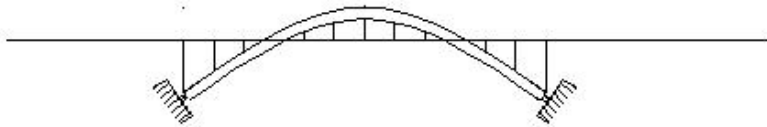
internal stability

(B368)double-deck bridge

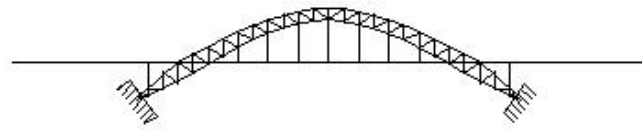


(B369)arch(two hinged arch bridge)

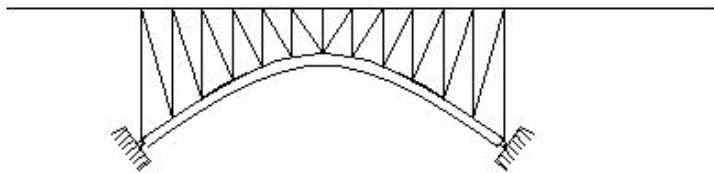
(B369) arch(two hinged arch bridge)



two hinged arch bridge



two hinged arch bridge
half-through bridge

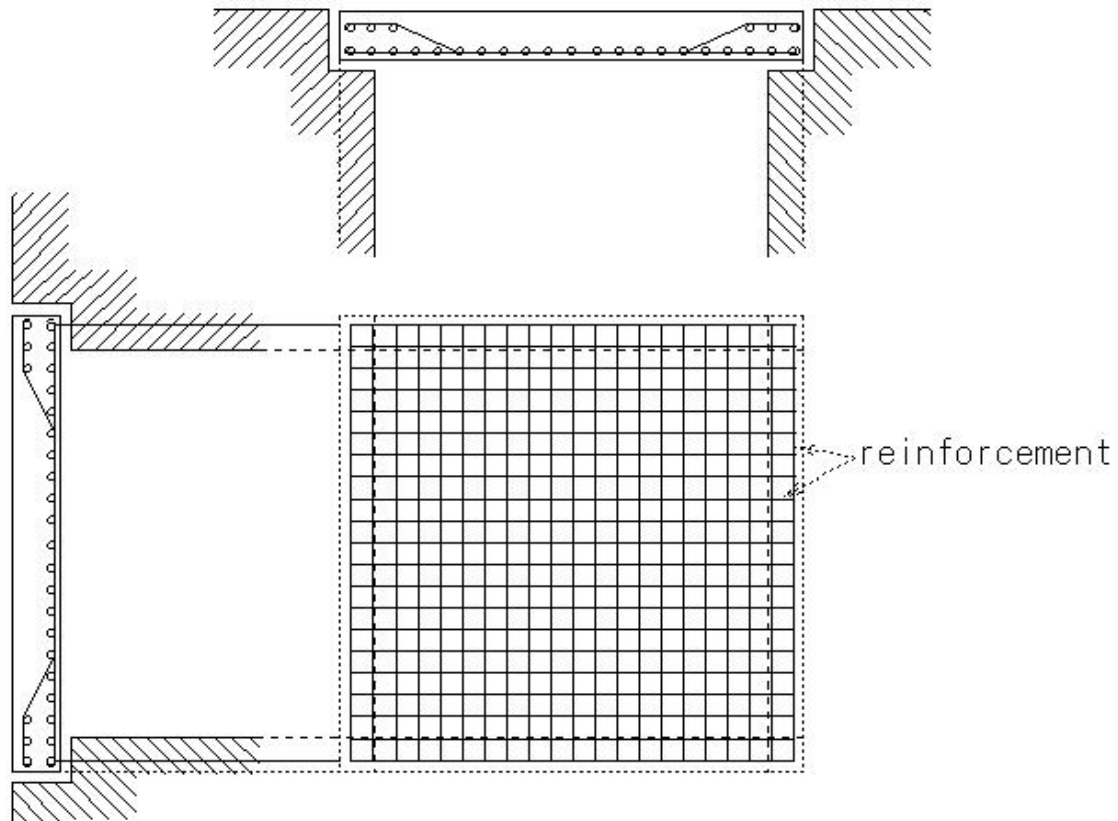


2 hinge spandrel
braced arch bridge

(B370)two way slab

(B370)two way slab

Two-way slab reinforcement diagram

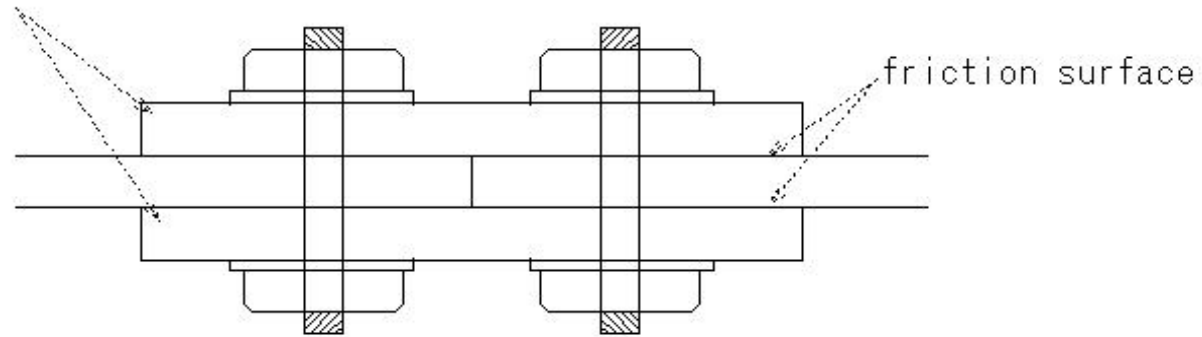


(B371) Bolt joint (double friction joint)

(B371) Bolt joint (double friction joint)

double friction joint

Consolidated plate



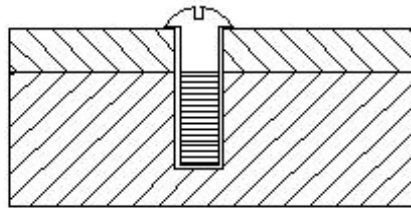
Bolt joint that connects by frictional force between two surfaces

Bolted joint

(B372)screw rivet

(B372) screw rivet

screw rivet

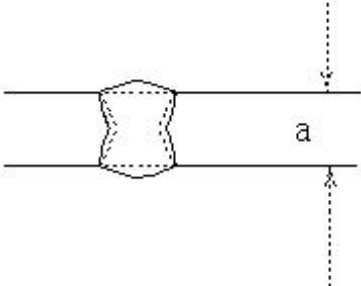
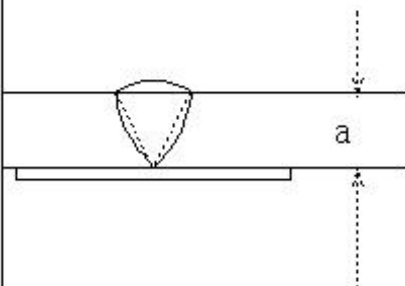


bolt rivet

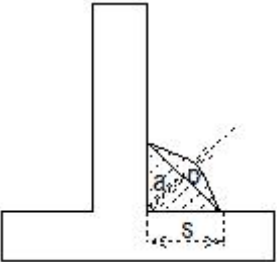
(B373)throat depth

(B373) throat depth

butt welding
welding
Base material (steel)



fillet weld



a: Throat thickness
c: Reinforcement filler
s: size

fillet weld

a: Throat thickness

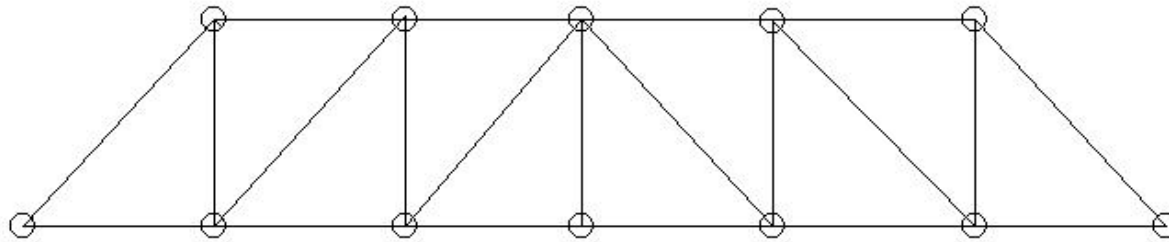
V shape

X shape

(B374)howe truss

(B374)howe truss

Long diagonals - compression forces
Short vertical members - tensile force
wooden truss



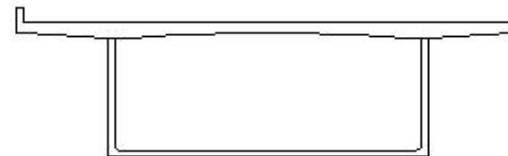
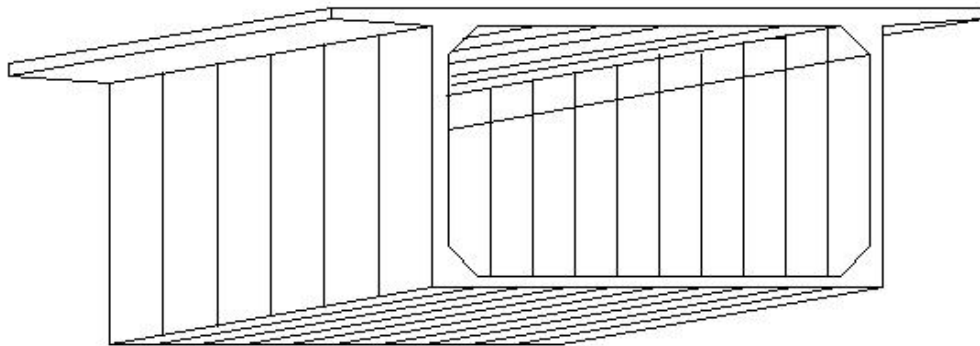
Howe truss

(B375)box girder bridge

(B375)box girder bridge

Main girder - box cross section

Torsional rigidity of girders - large



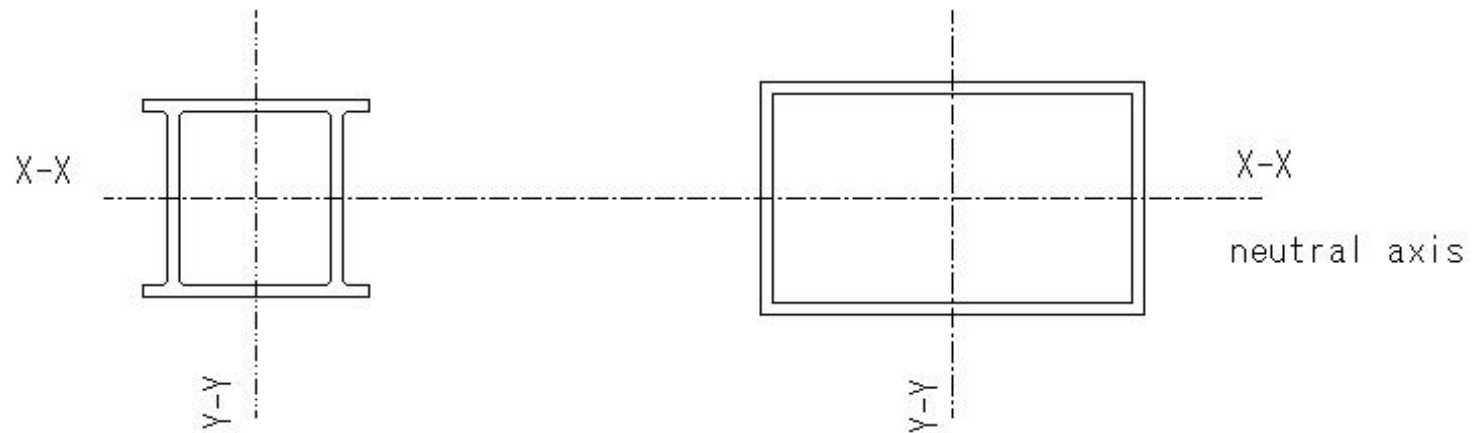
(B376)box section

(B376) box section

Bridge main girder - reinforced concrete structure
truss-rahmen-arch-pillar

Member cross section: box shape

Advantageous against twisting and buckling

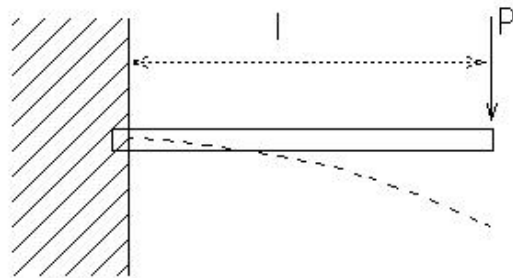


(B377)beam

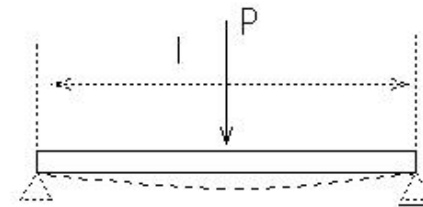
(B377) beam

Load is applied from the direction perpendicular to the axis.

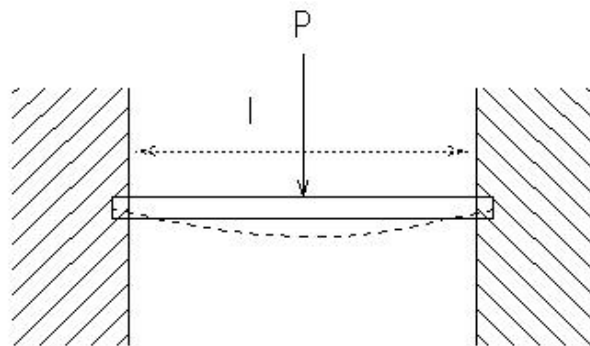
A member that resists the action of bending



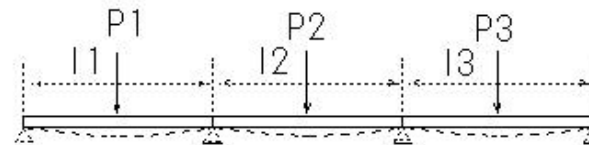
cantilever beam



simple beam



Fixed beam at both ends



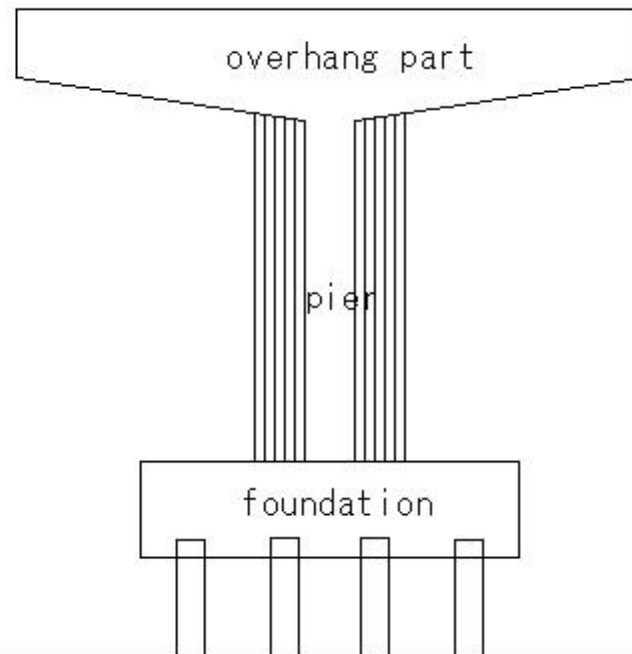
Continuous beam

(B378)overhanging pier

(B378)overhanging pier

overhanging pier
Bridge substructure

A girder is placed on top of this

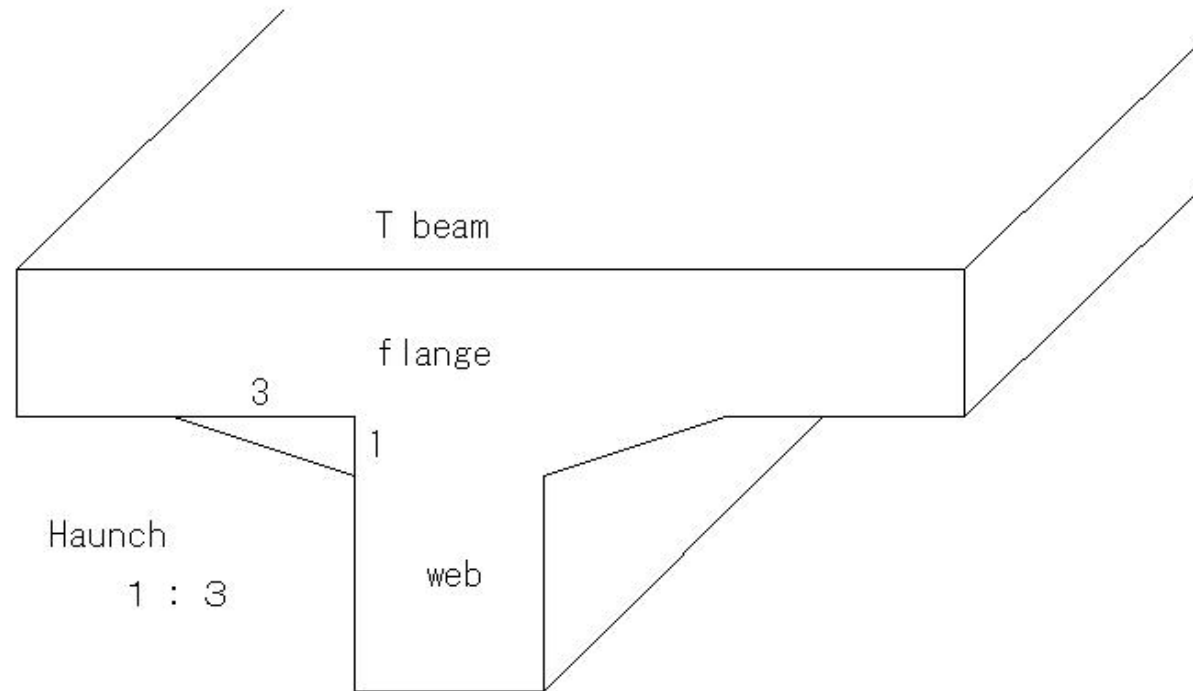


(B379)haunch

(B379) haunch

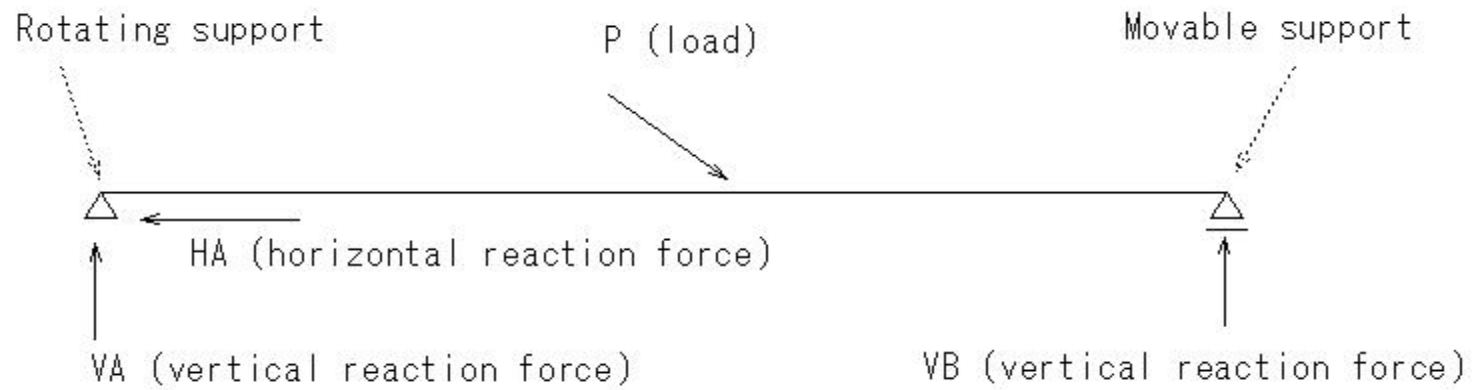
haunch

Alleviates stress concentration that occurs at corners



(B380)reaction

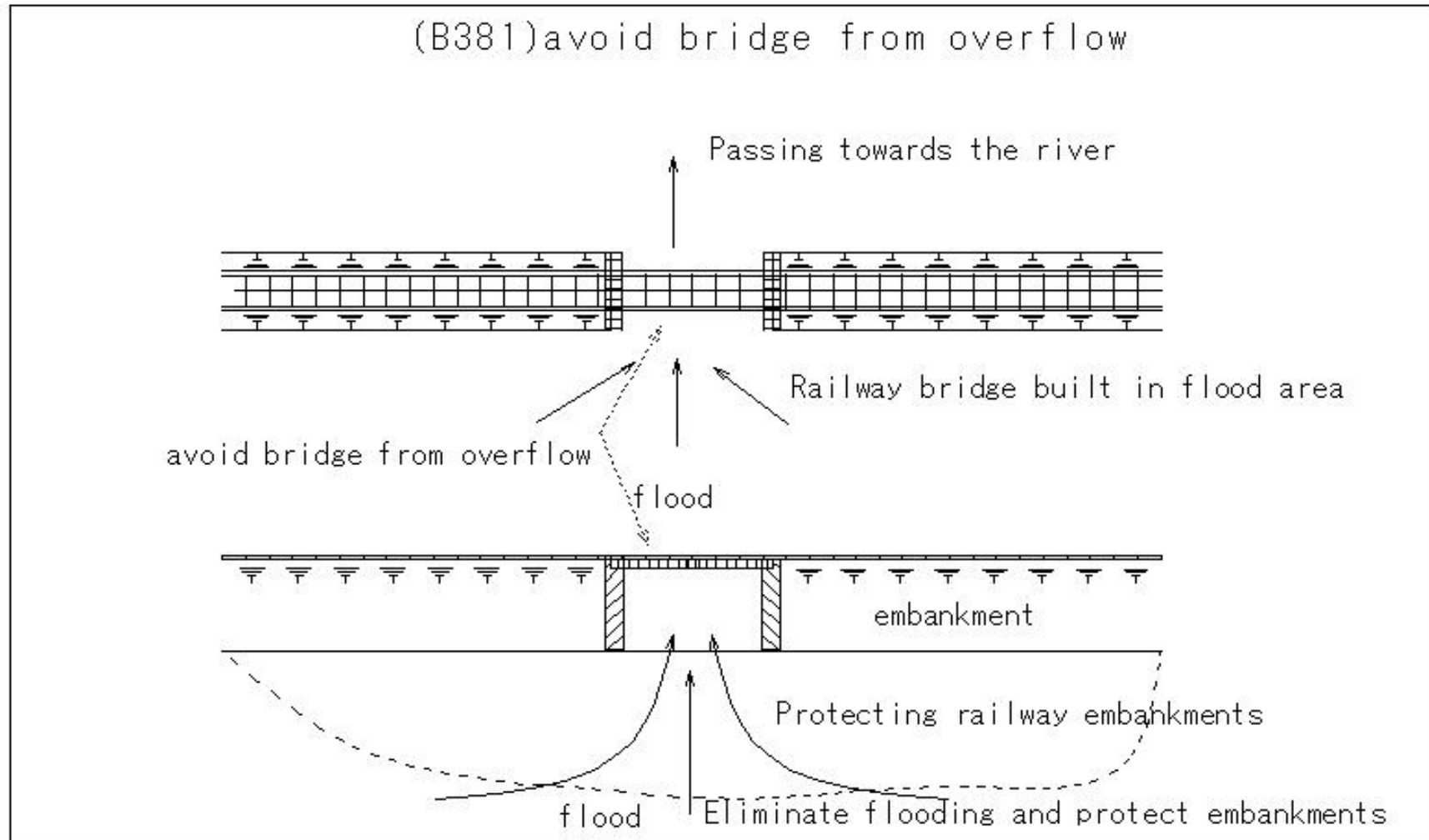
(B380) reaction



simple beam

three reaction forces

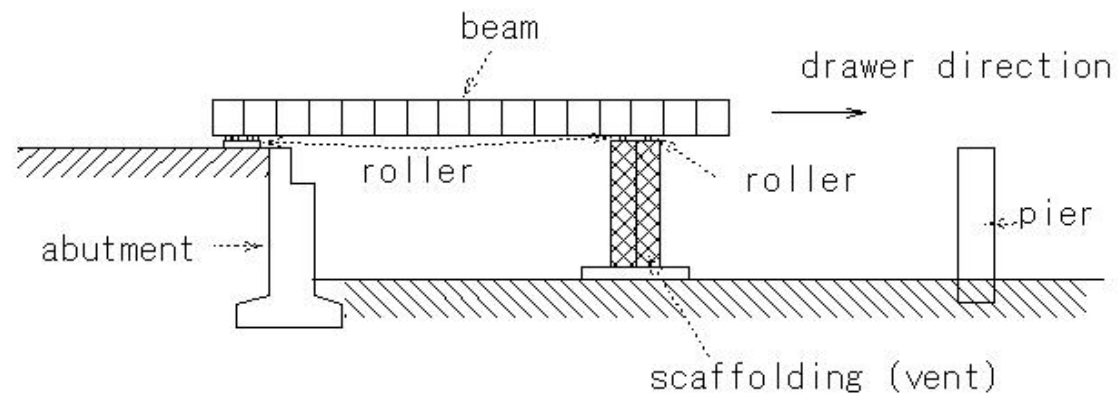
(B381)avoid bridge from overflow



(B382)sliding erection method

(B382) sliding erection method

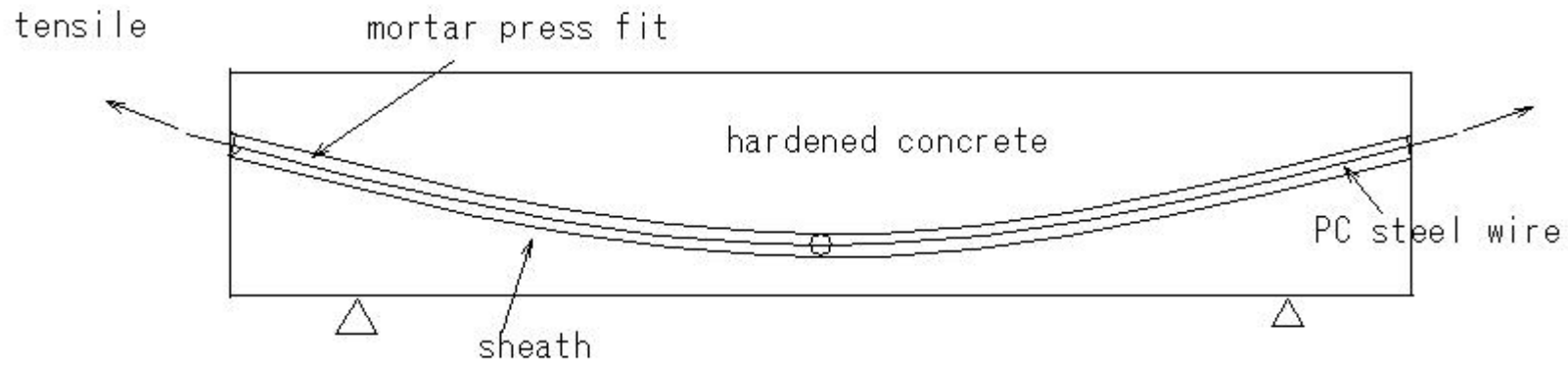
sliding erection method



(B383)prestressed concrete beam

(B383)prestressed concrete beam

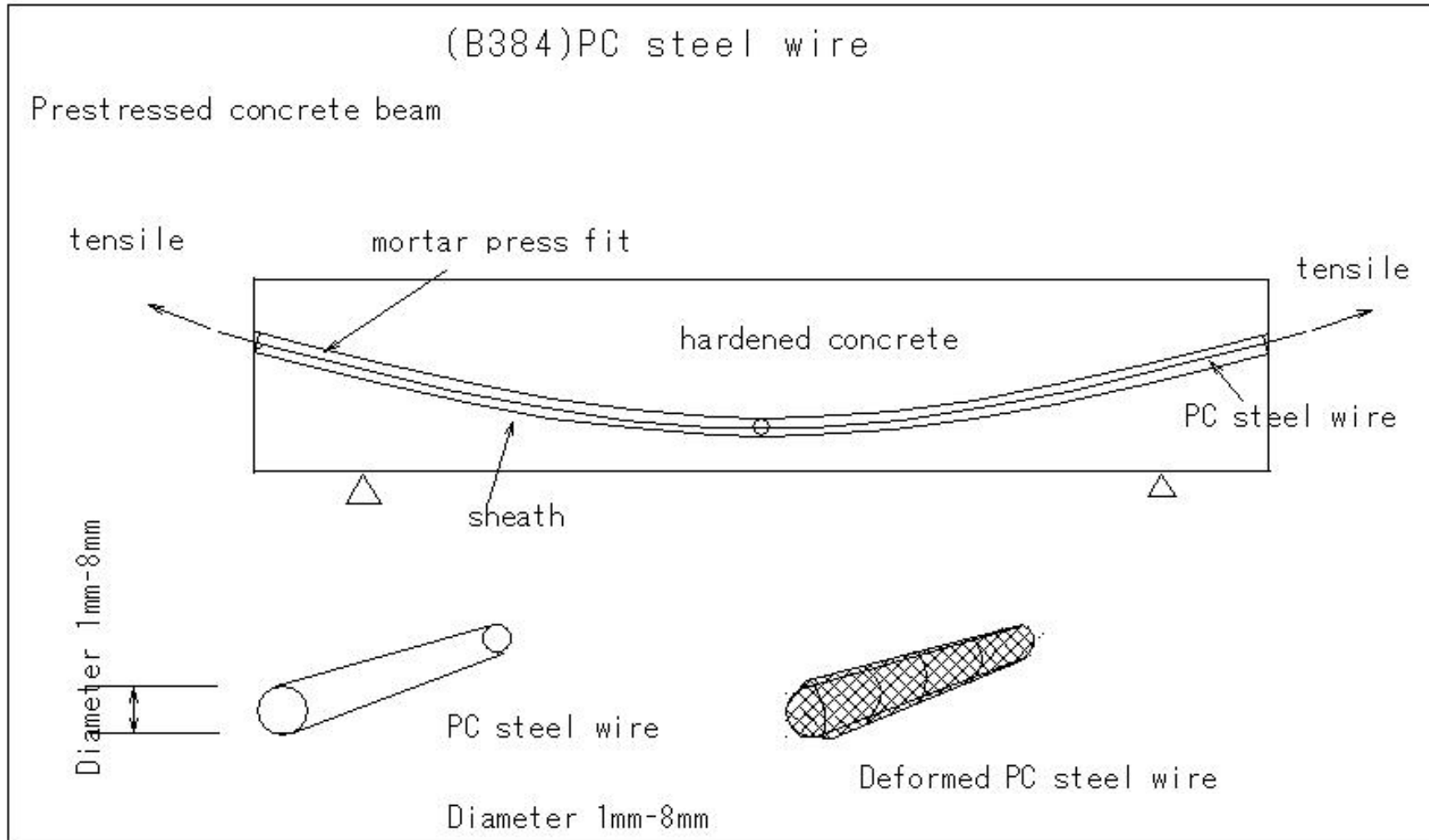
Prestressed concrete beam



①Apply compressive stress to concrete in advance

Post-tension method

(B384)PC steel wire



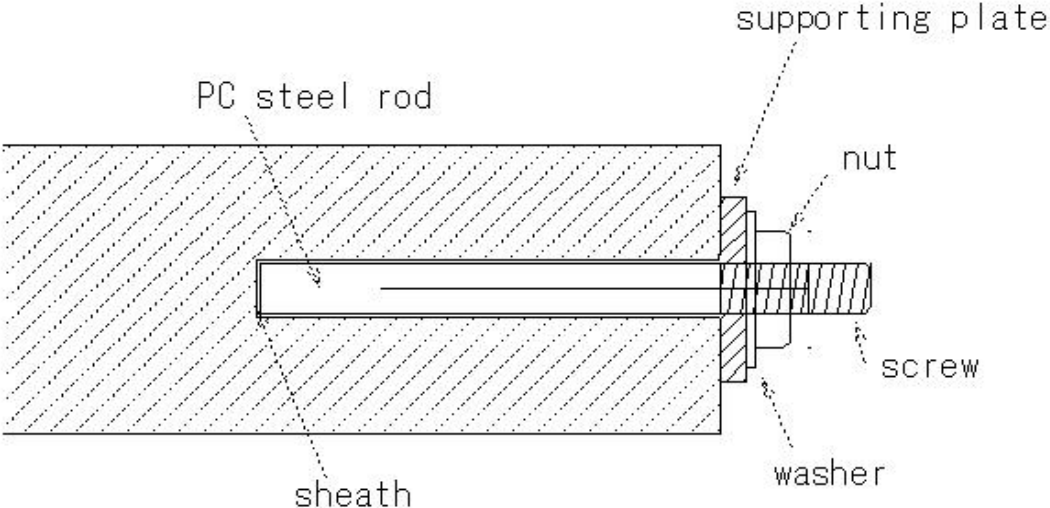
(B385)steel bar for prestressed concrete

(B385) steel bar for prestressed concrete

steel bar for prestressed concrete

10-33mm steel bar

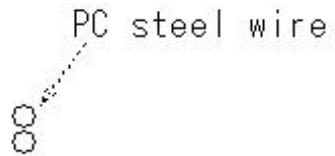
Fixed by screws on both ends of steel rod



(B386)steel strand for prestressed concrete

(B386)steel strand for prestressed concrete

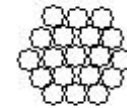
steel strand for prestressed concrete



2 pieces

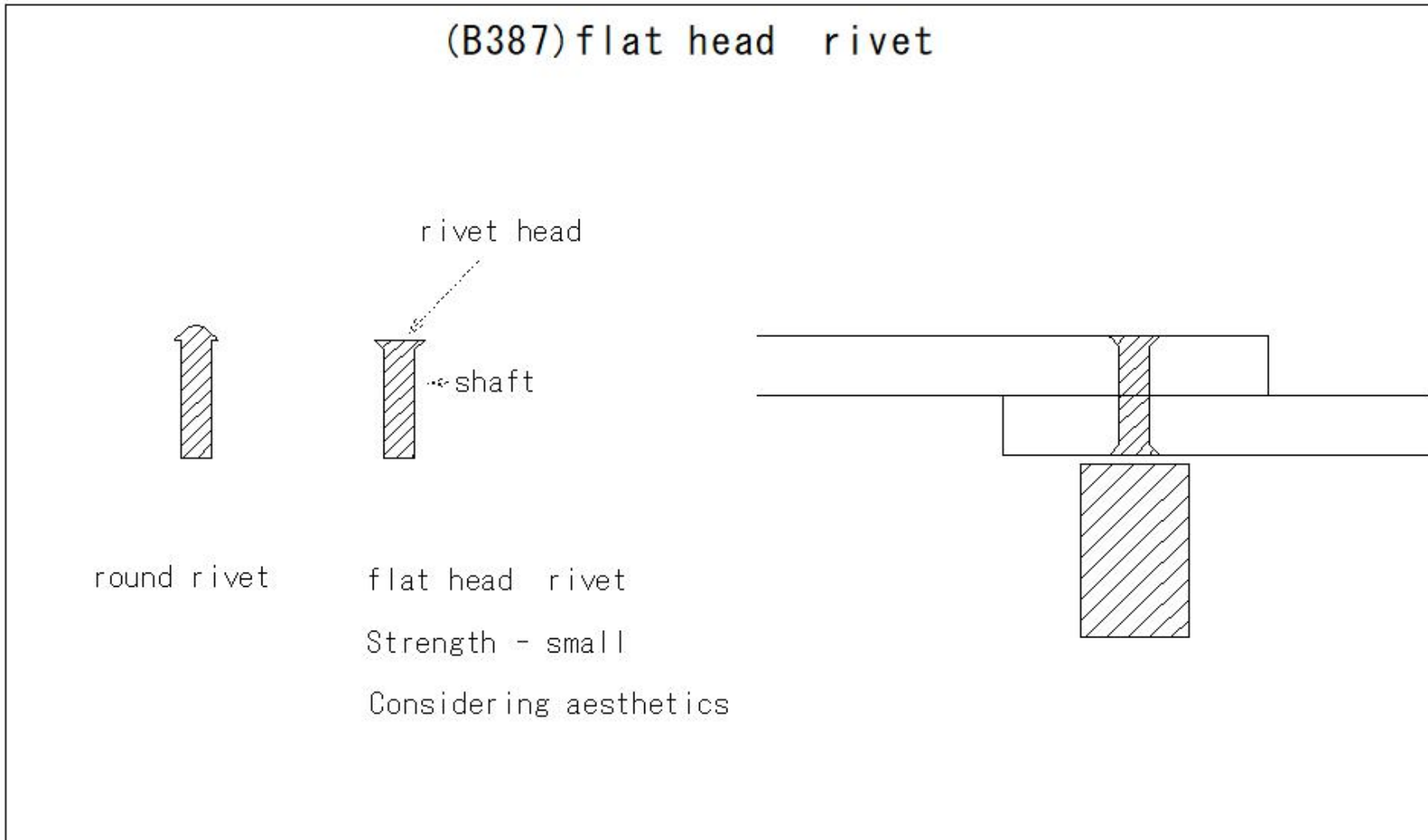


7 pieces



19 pieces

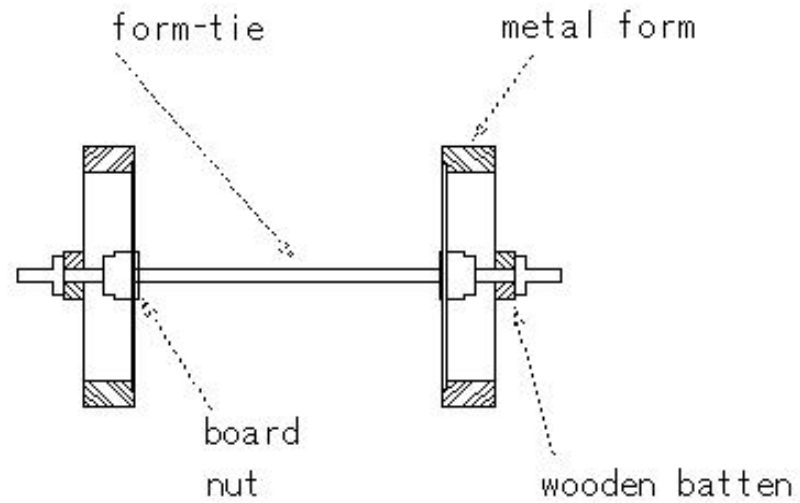
(B387)flat head rivet



(B388)form-tie

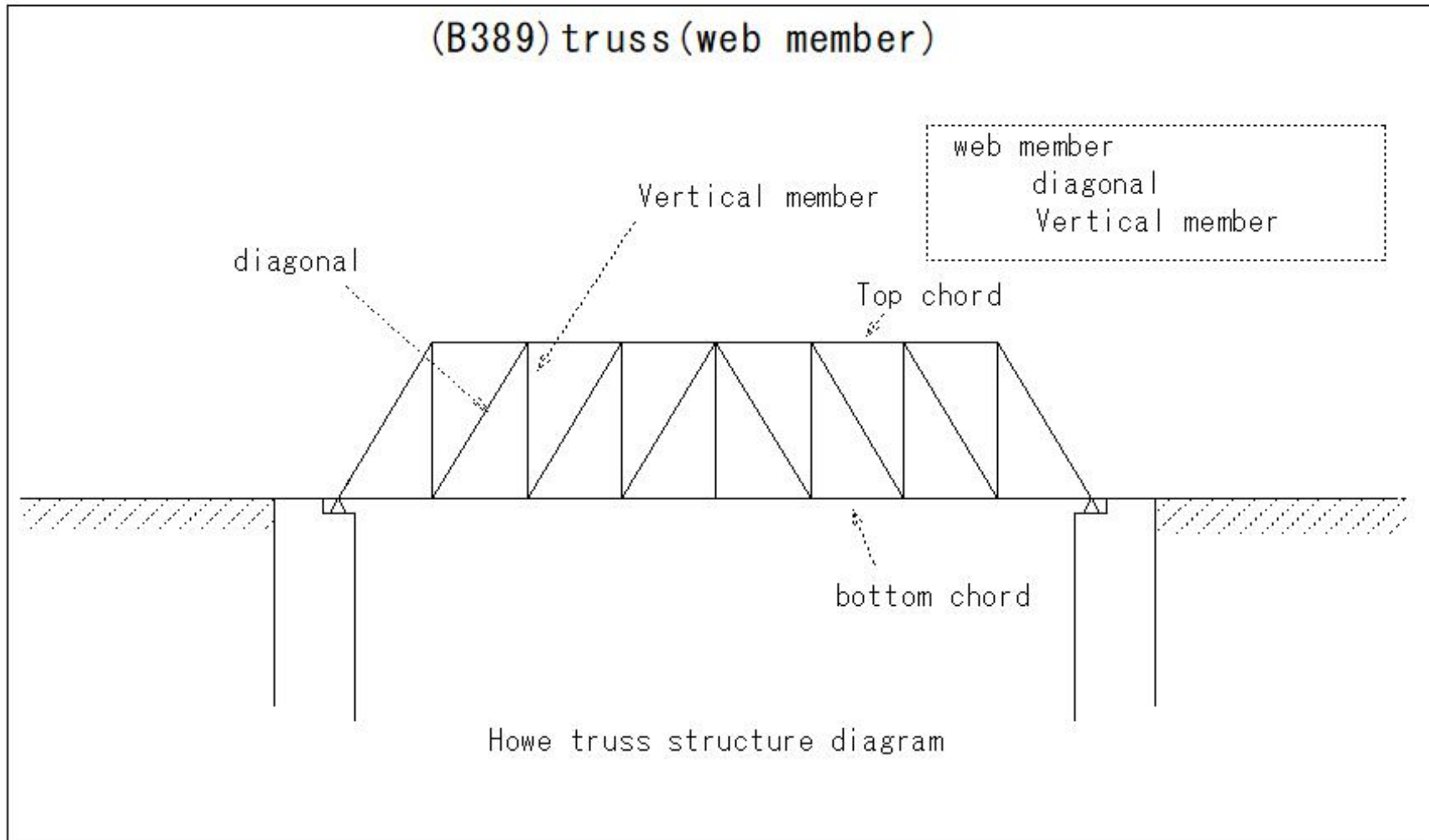
(B388)form-tie

Steel formwork fasteners



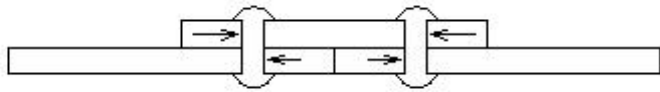
The role of a separator to maintain the distance between formwork

(B389) truss(web member)

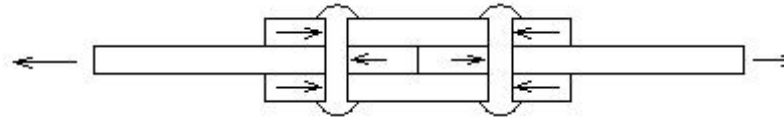


(B390) double shear rivet

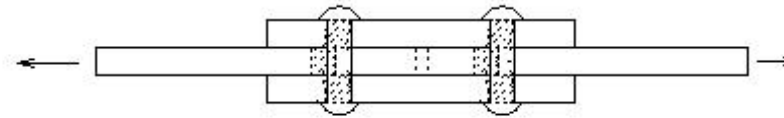
(B390) double shear rivet



single shear rivet



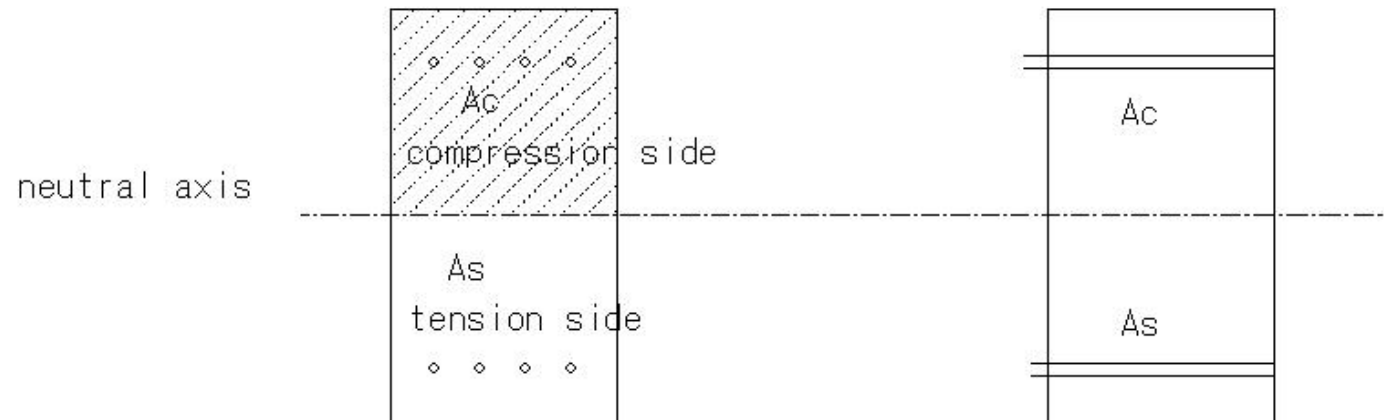
double shear rivet



double shear rivet
2 shear plane failure

(B391) double reinforcement rectangular beam

(B391) double reinforcement rectangular beam

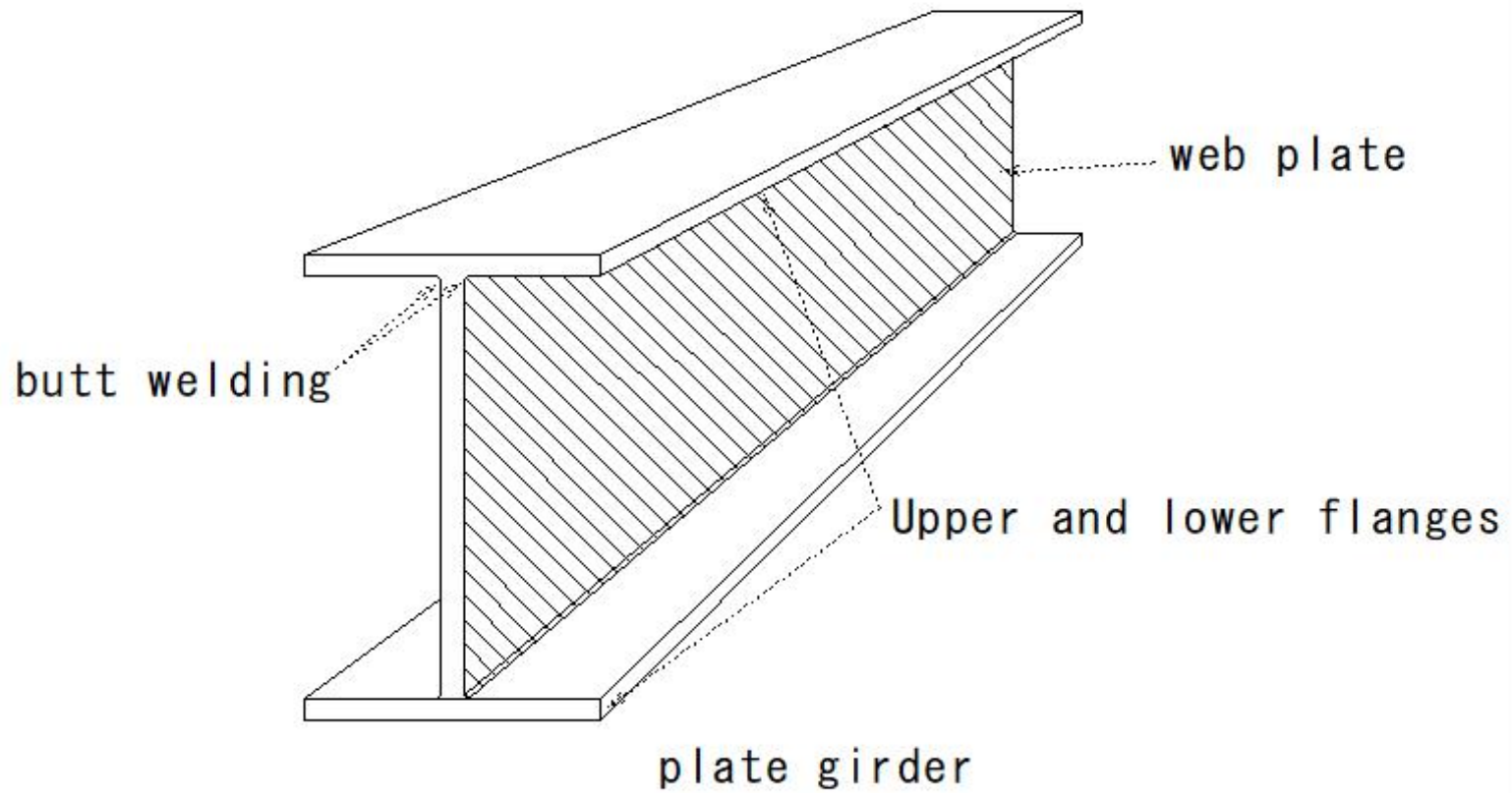


A_c : Compression reinforcing bar

A_s : Tensile reinforcing bar

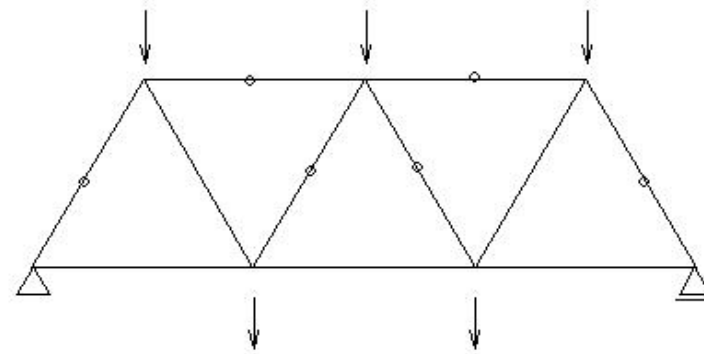
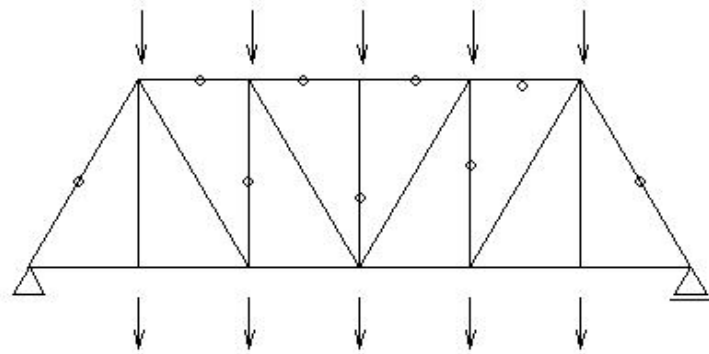
(B392)web plate

(B392)web plate



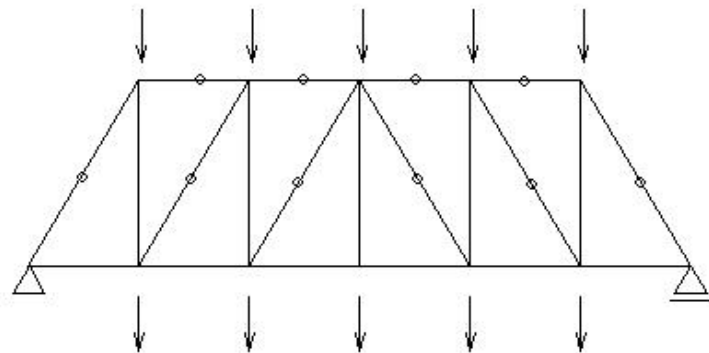
(B393)stress of member

(B393) stress of member

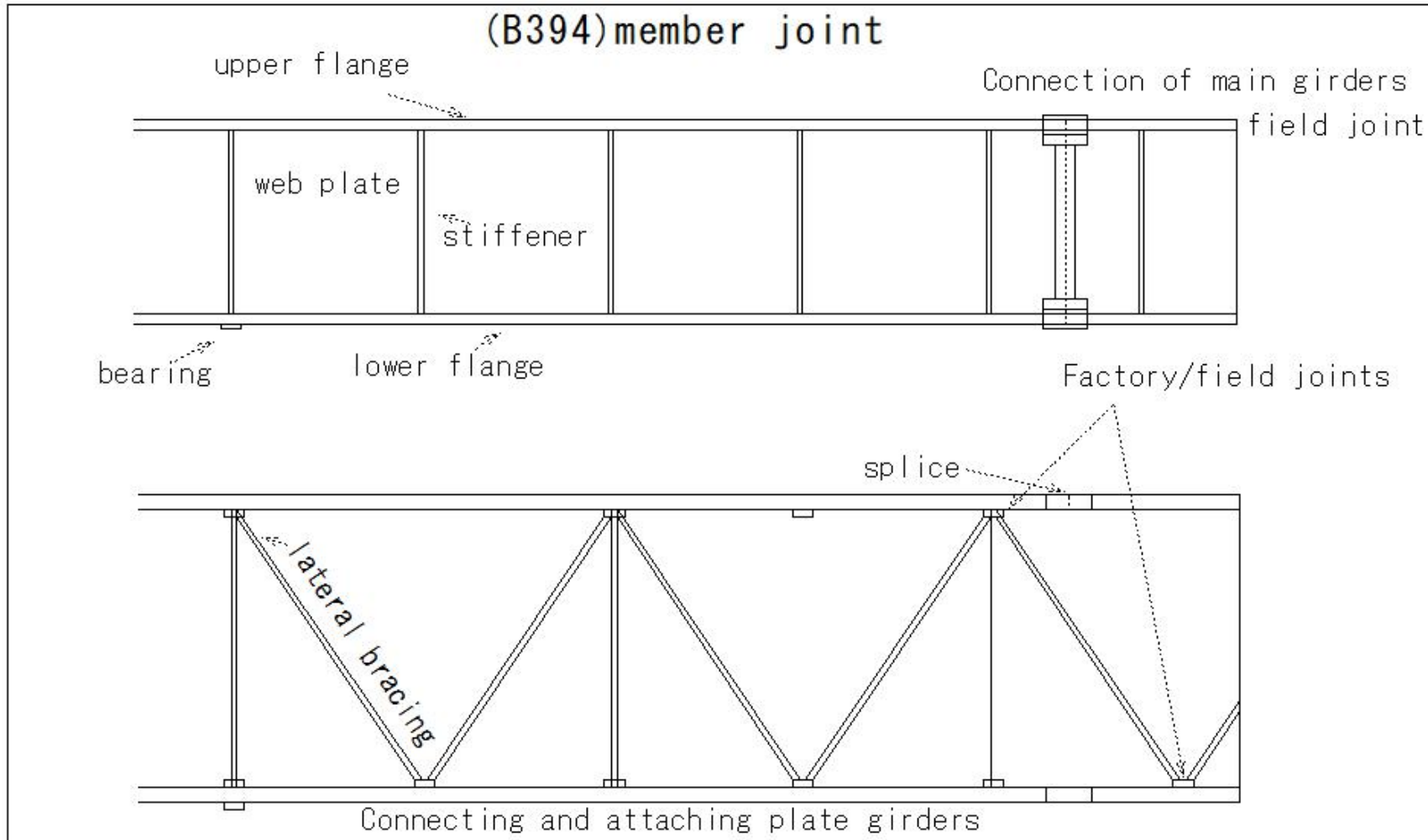


○ : compression

× : tension



(B394)member joint



(B395)bolt joint(full strength of member)

(B395) bolt joint(full strength of member)

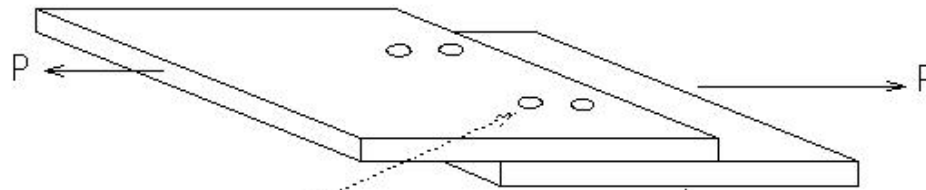
full strength

Allowable stress level

Effective cross-sectional area

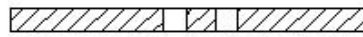
$$P = \sigma_a \cdot A$$

Maximum strength that a member can withstand by design



bolt

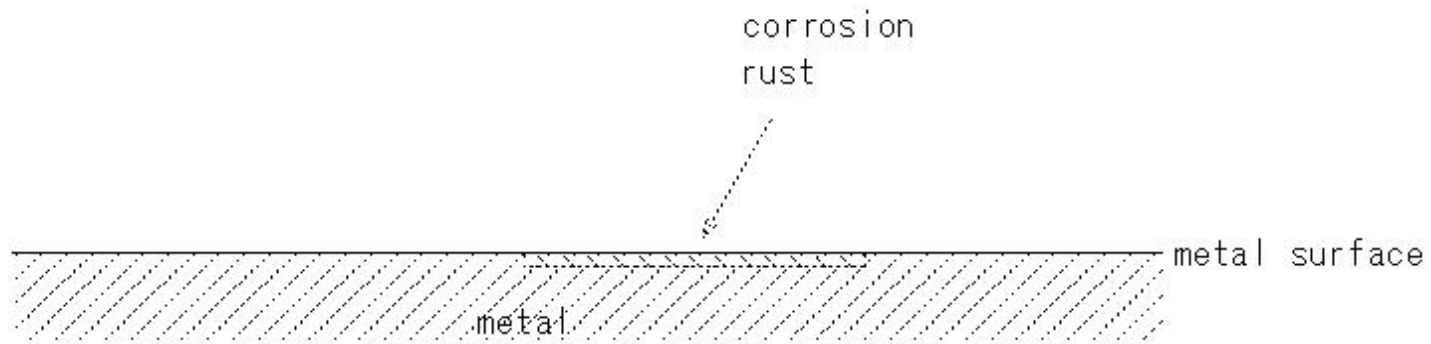
σ_a : Allowable tensile stress



A: Net cross-sectional area excluding bolt holes

(B396)corrosion

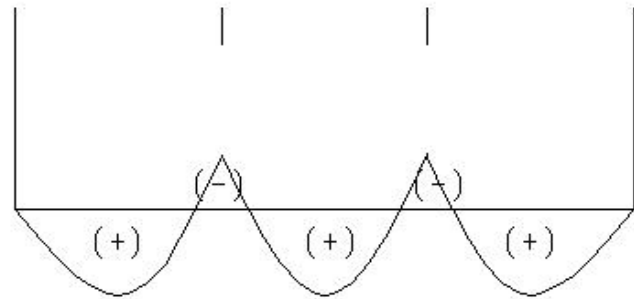
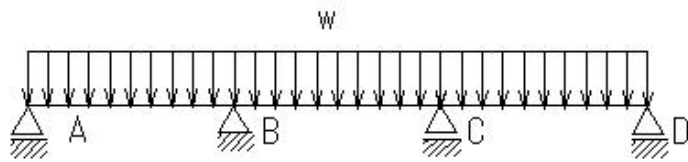
(B396) corrosion



a chemical reaction occurs and wears away from the surface.

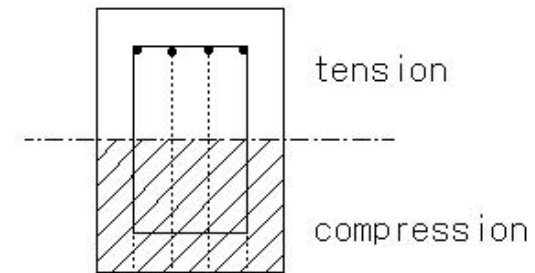
(B397)negative reinforcement

(B397)negative reinforcement



bending moment

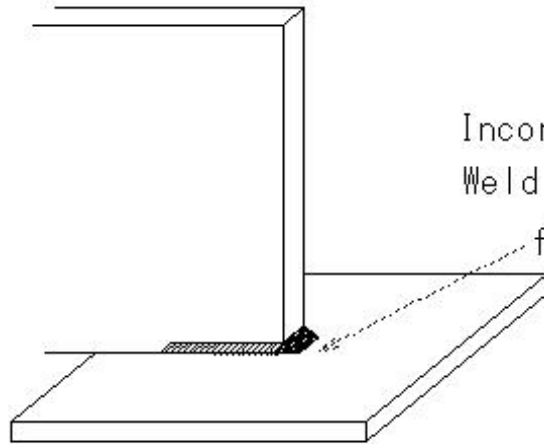
Main reinforcement under tension
negative reinforcement



main reinforcing bars in cross section at points B and C

(B398)welding(boxing of different length)

(B398)welding(boxing of different length)



Incorrect leg fillet welding with different weld thickness
Weld around the end of the part

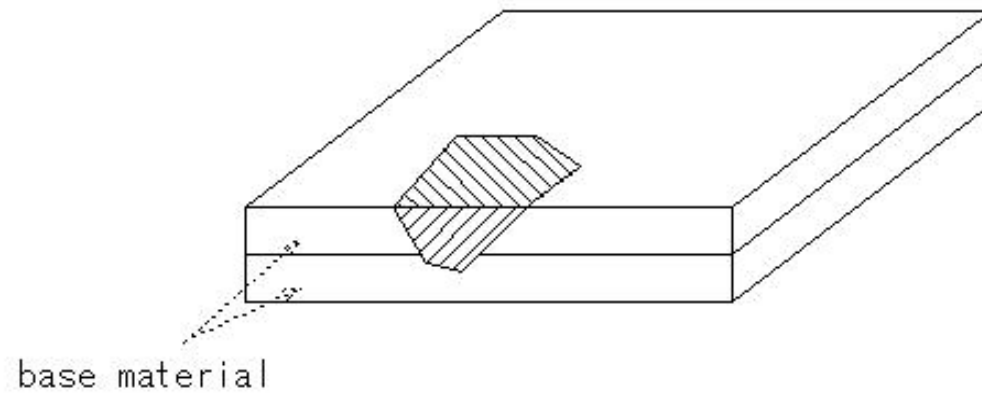
fillet welding

(B399)welding(plug welding)

(B399)welding(plug welding)

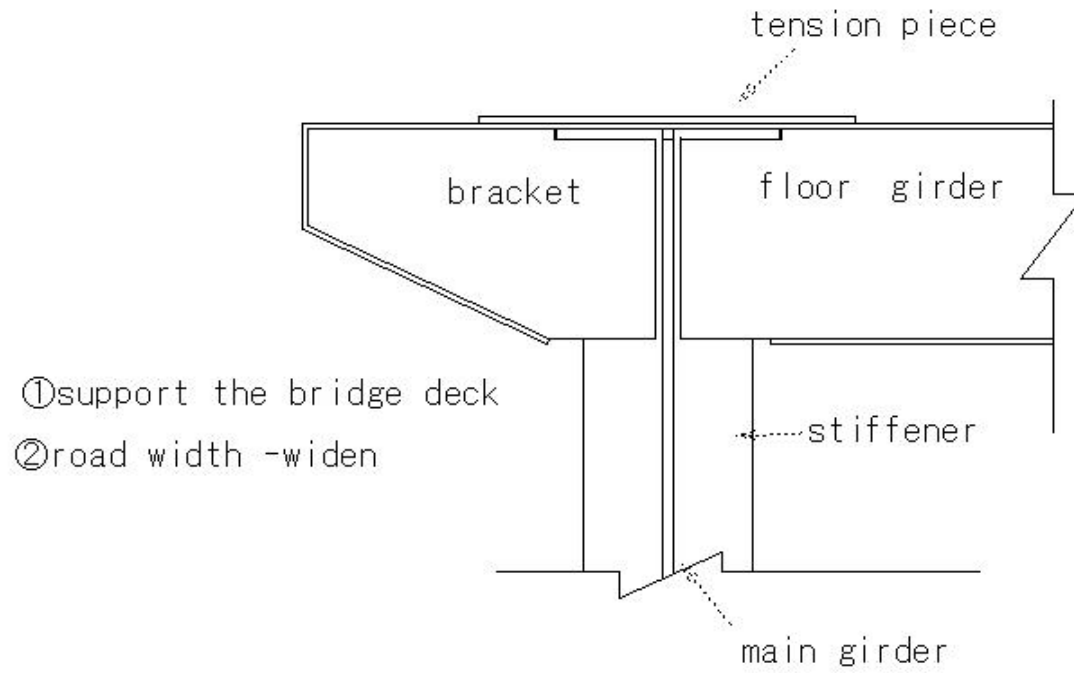
plug welding

- ①Stacked boards
- ②Drill a hole
- ③Bottom plate: Melt with welding flame
- ④Joining with base material



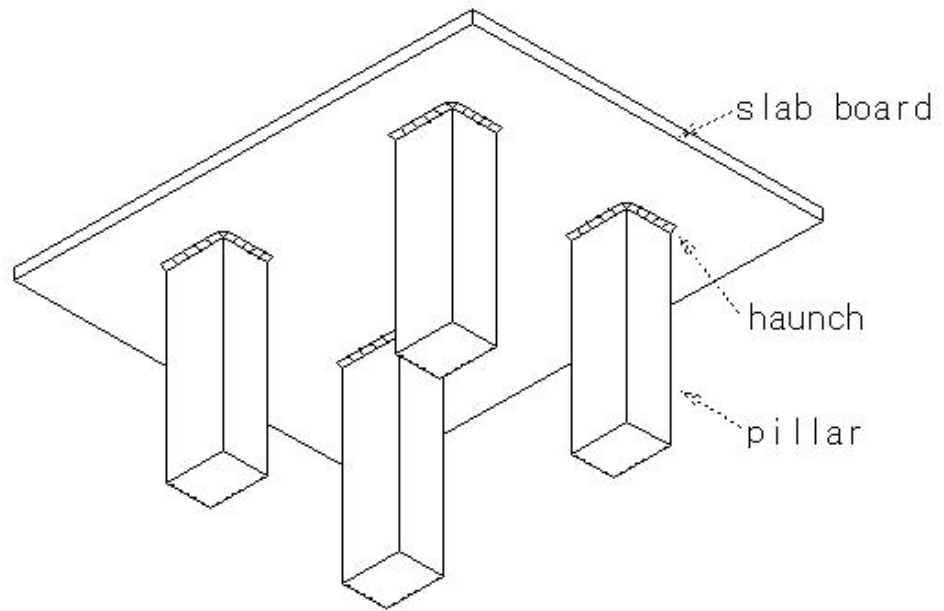
(B400) bracket

(B400) bracket



(B401)flat slab

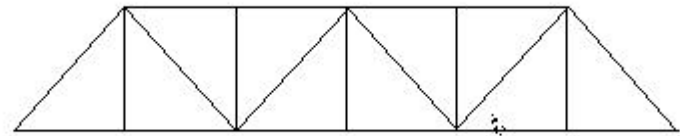
(B401) flat slab



Supported directly on pillars

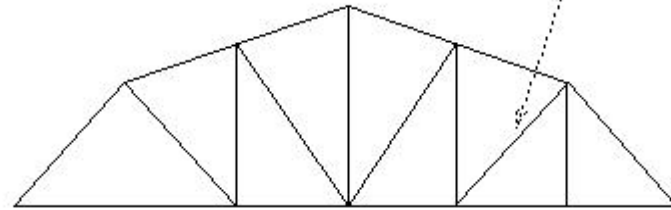
(B402)pratt truss

(B402) pratt truss



pratt truss

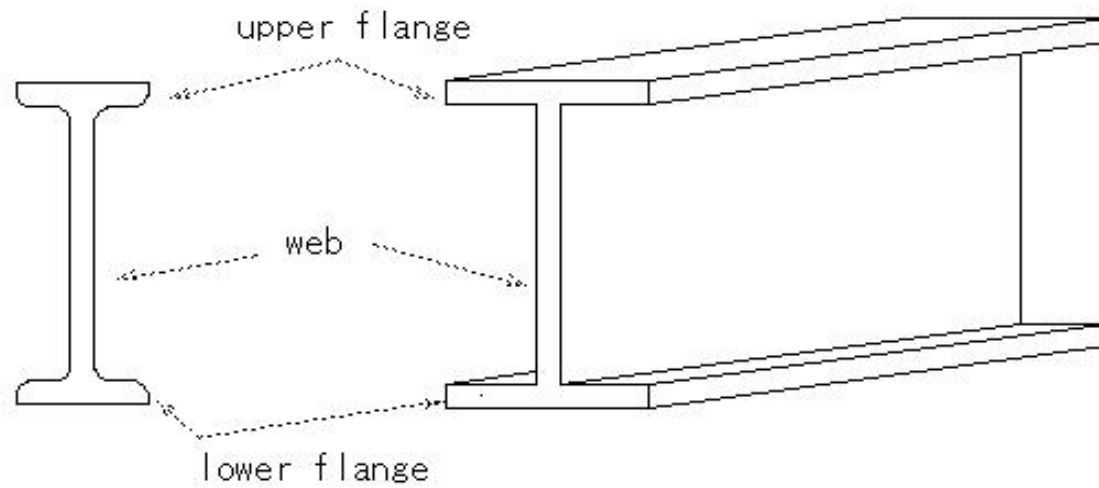
diagonal (+)



curved pratt truss

(B403)flange

(B403)flange



I-shaped steel

plate girder

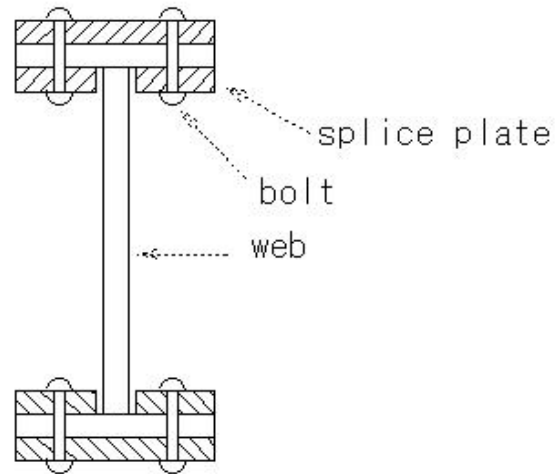
In case of acupuncture

Flange: bending moment

Web: resists shear forces

(B404)flange joint

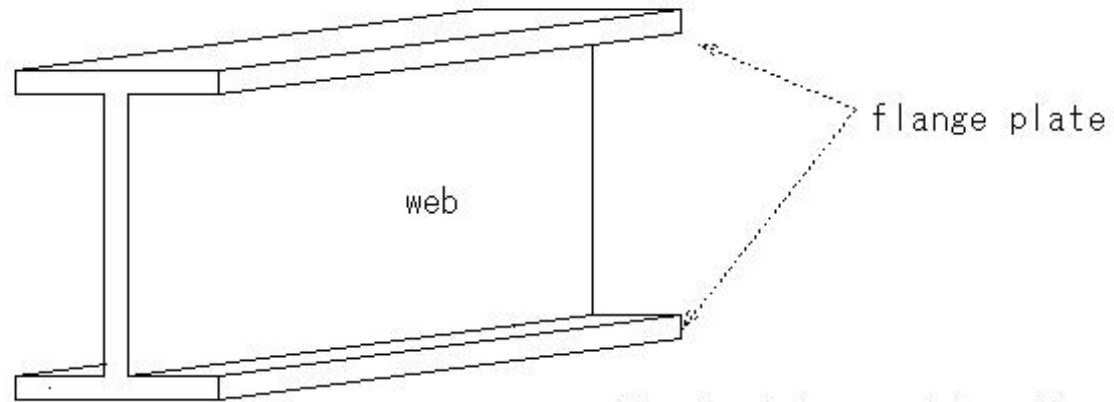
(B404) flange joint



①How to connect plate girder flanges on site

(B405)flange plate

(B405) flange plate



flange plate

web

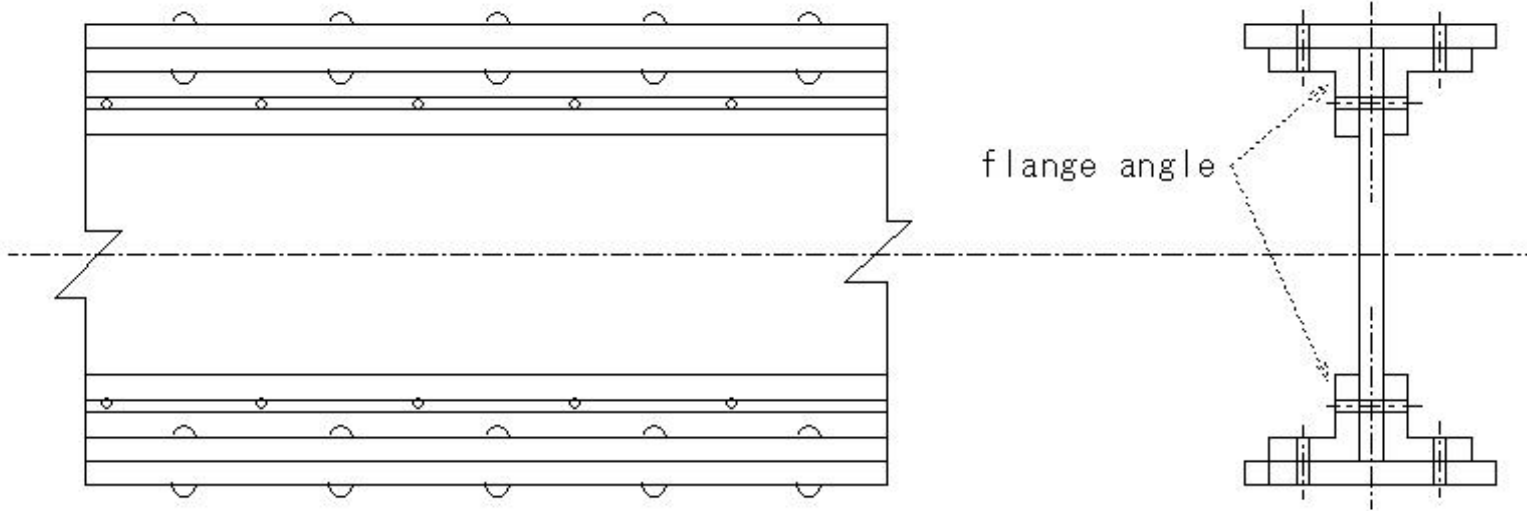
Steel plate used for flanges

Web: resists shear forces

plate girder

(B406) flange angle

(B406) flange angle



Used for flange of riveted plate girder

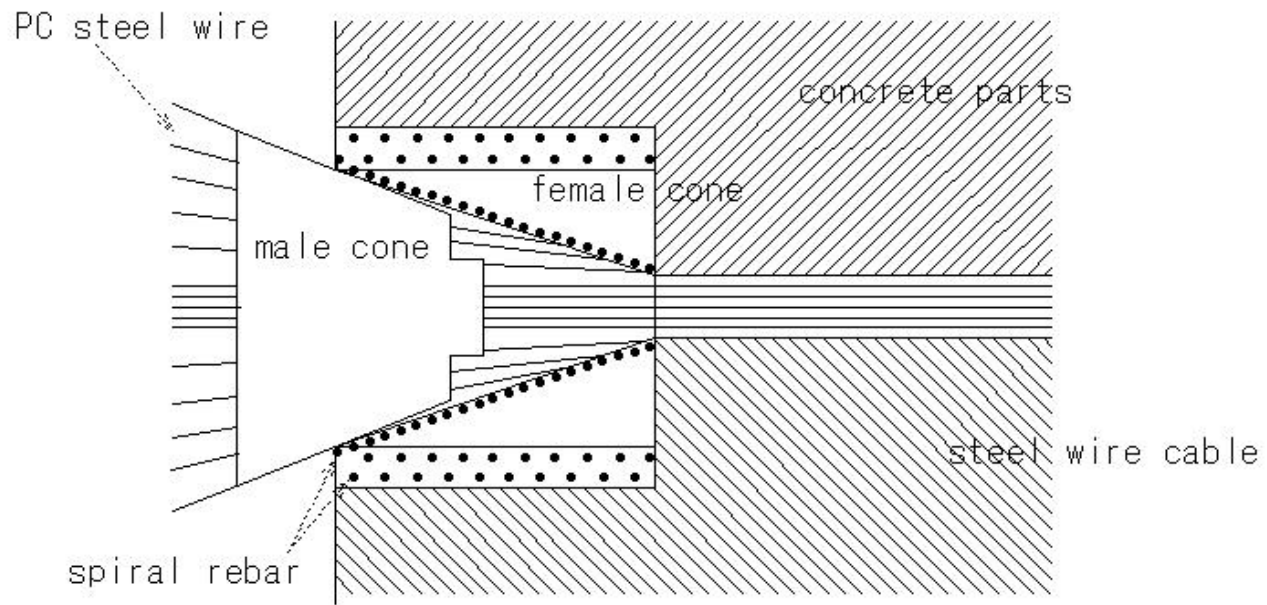
(B407)freyssinet method

(B407) freyssinet method

freyssinet method

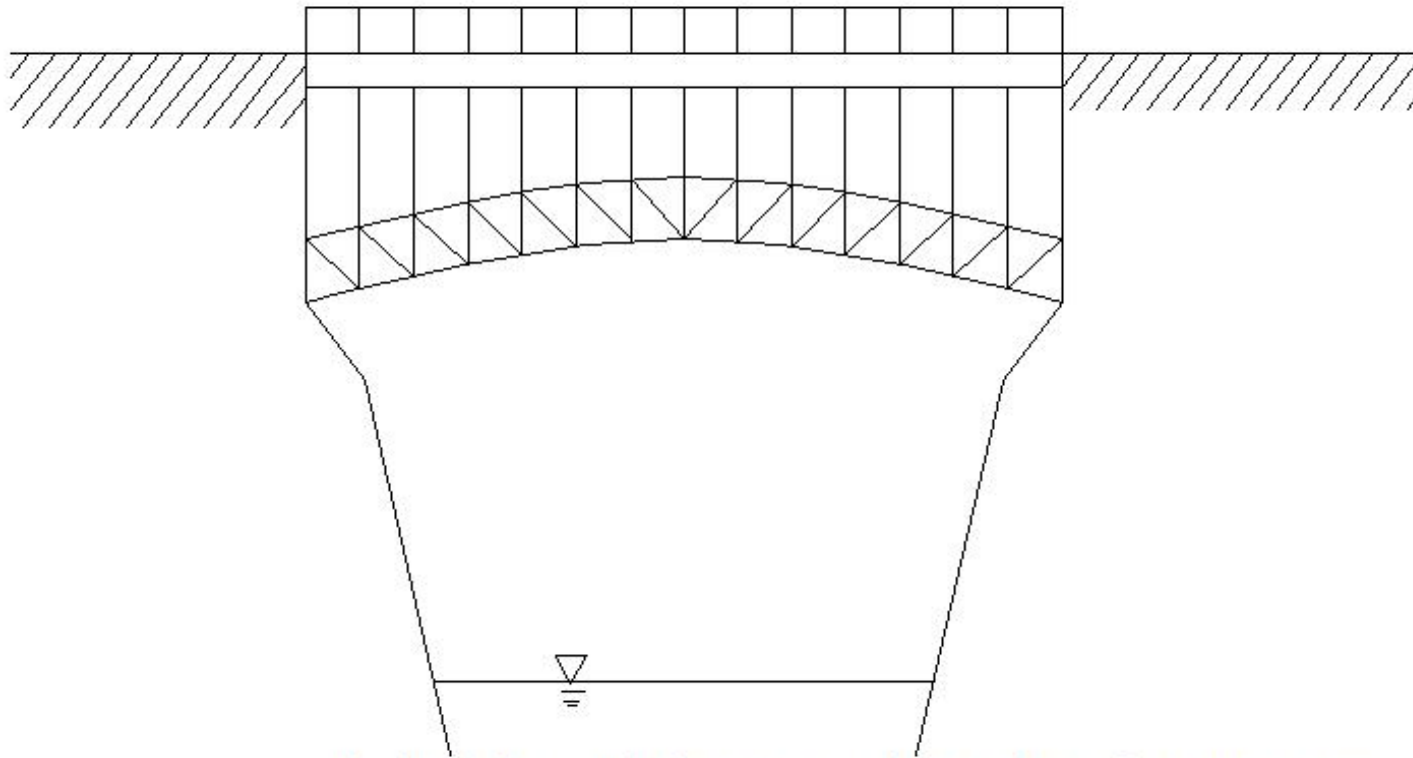
Prestressing concrete

PC steel wire fixing method



(B408)braced arch bridge

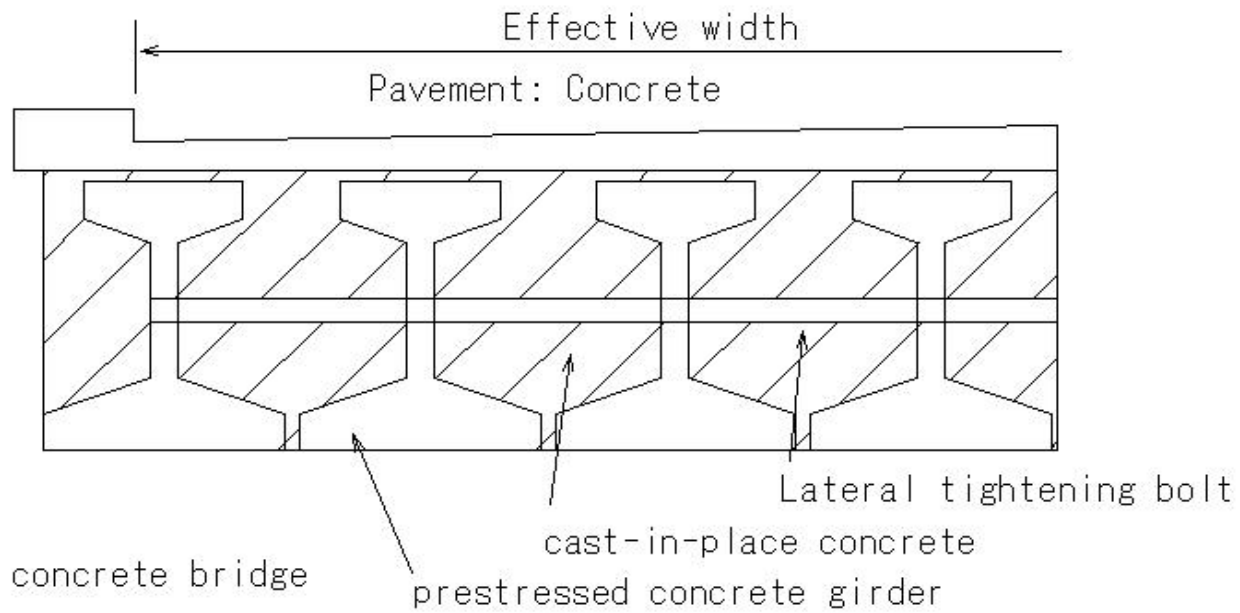
(B408)braced arch bridge



A bridge with an arch made of trusses

(B409)prestressed concrete bridge

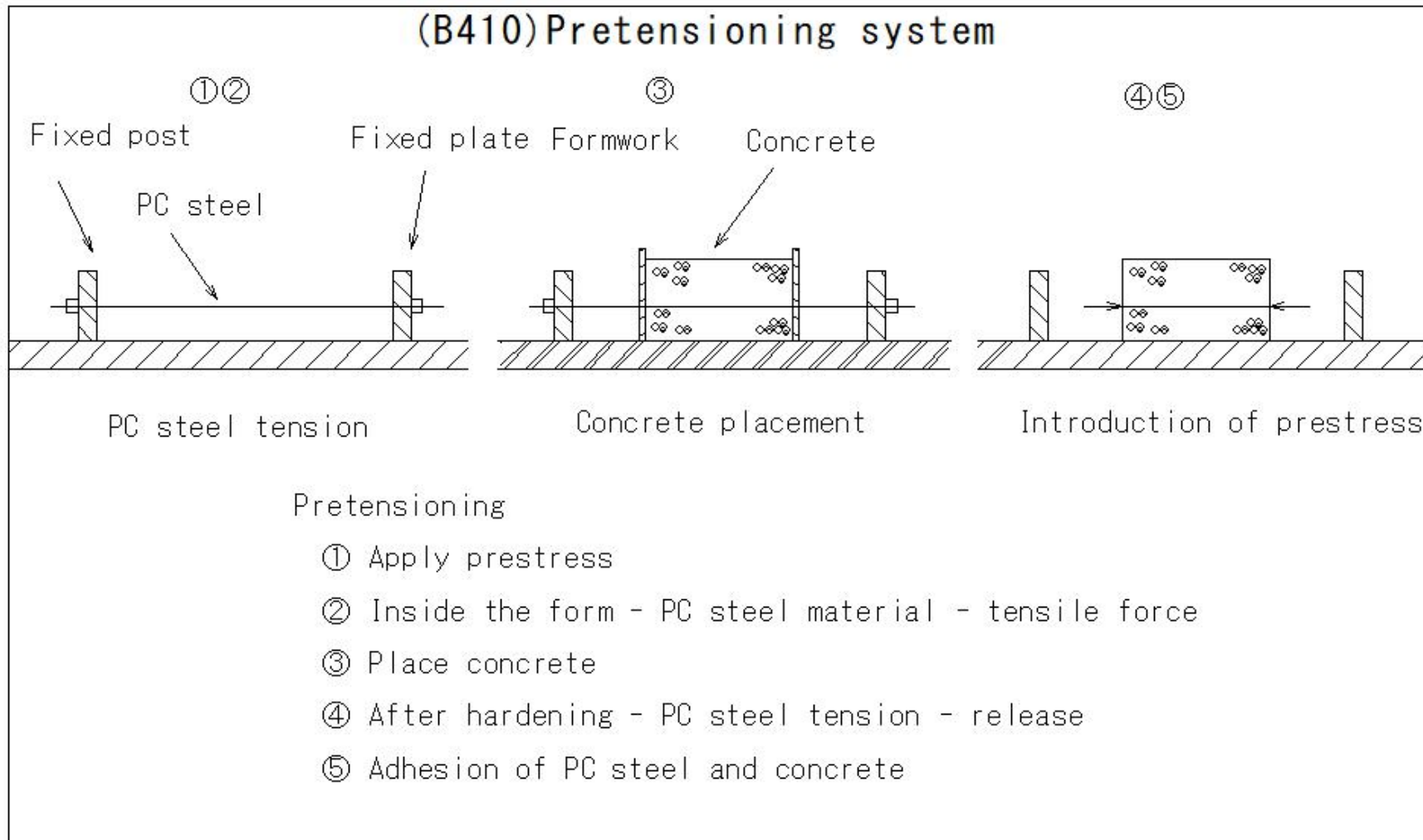
(B409)prestressed concrete bridge



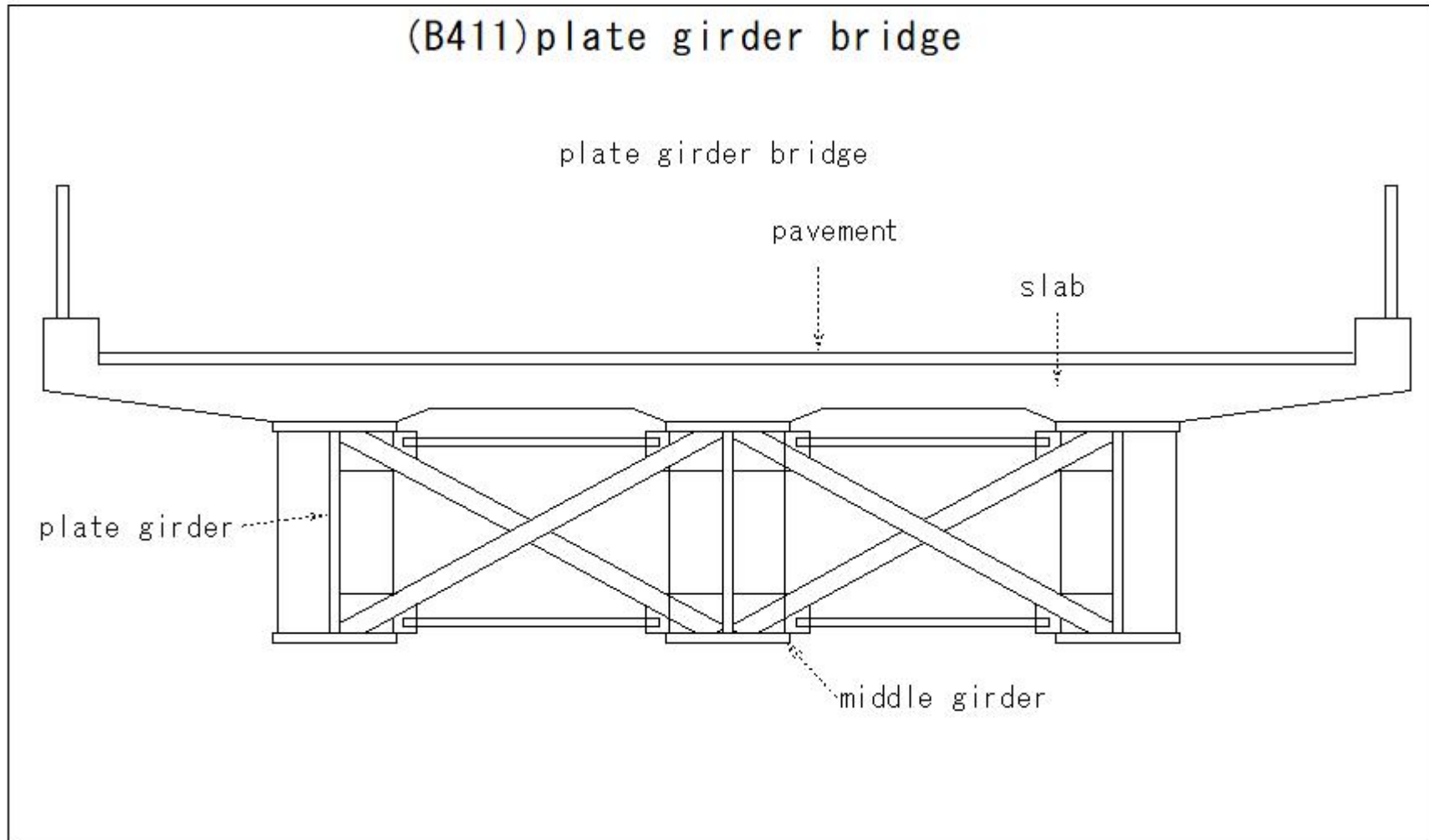
prestressed concrete bridge

- ① Self-weight - light
- ② Applicable to long spans
- ③ Construction period - short

(B410)Pretensioning system

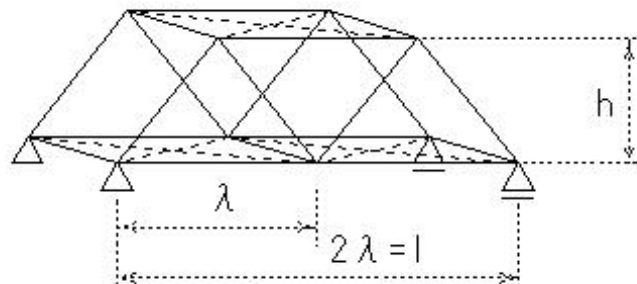


(B411)plate girder bridge

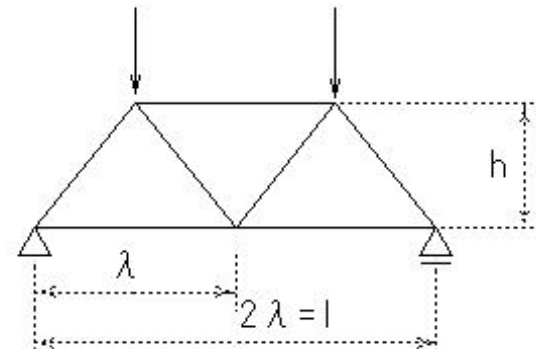


(B412)plane truss

(B412)plane truss



three-dimensional truss

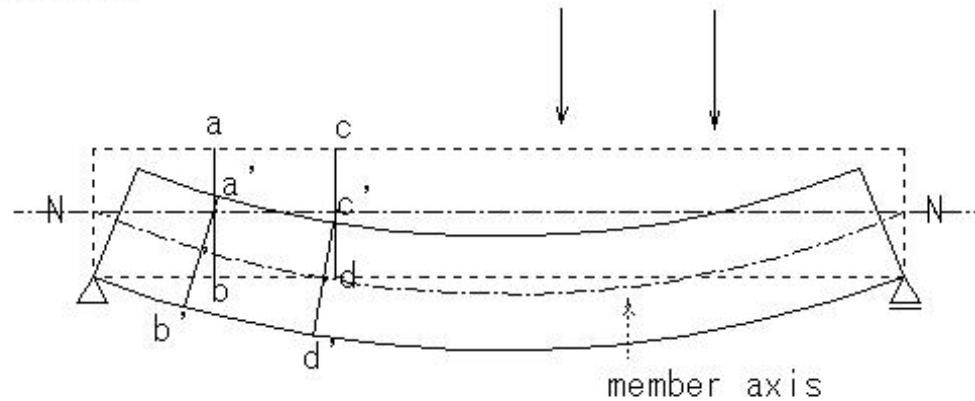


plane truss

(B413)law of plane maintenance

(B413) law of plane maintenance

law of plane maintenance



Cracks in the axial direction of the member

Cross section perpendicular to the member axis

After deformation of the member axis - perpendicular to the member axis

bending moment

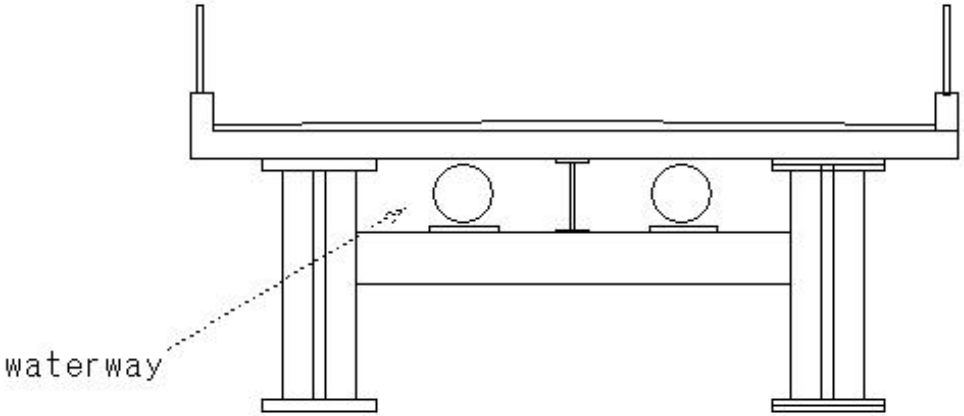
Amount of expansion and contraction

Strain can be calculated

(B414)combined bridge

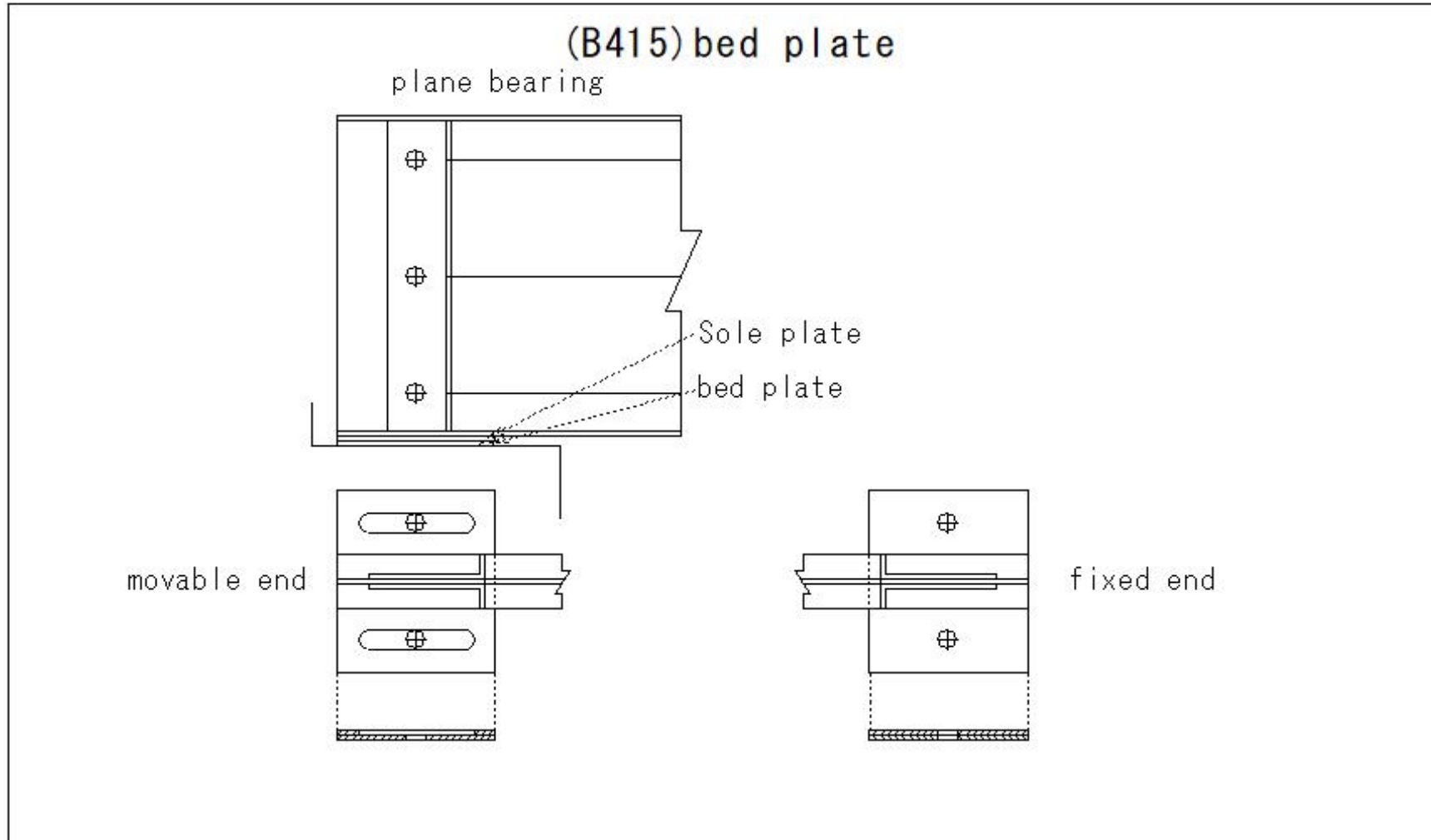
(B414)combined bridge

railways and roads
waterway and roadway



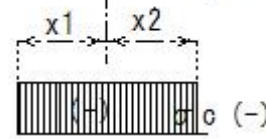
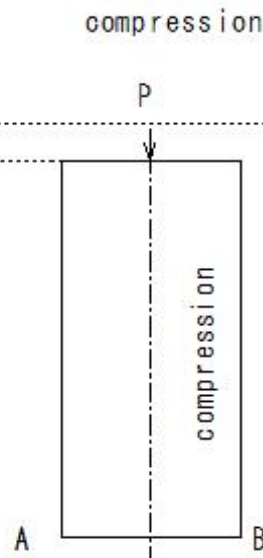
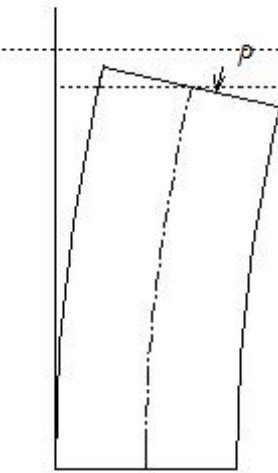
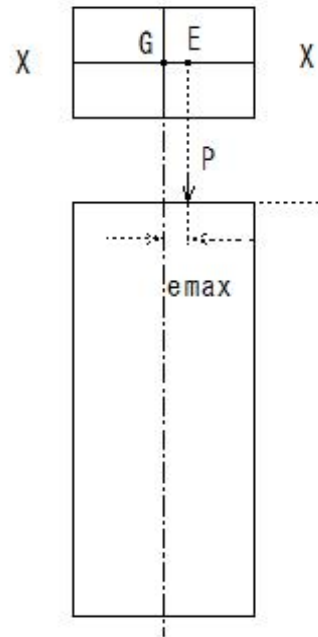
Example of combined use of aqueduct bridge and road bridge

(B415)bed plate

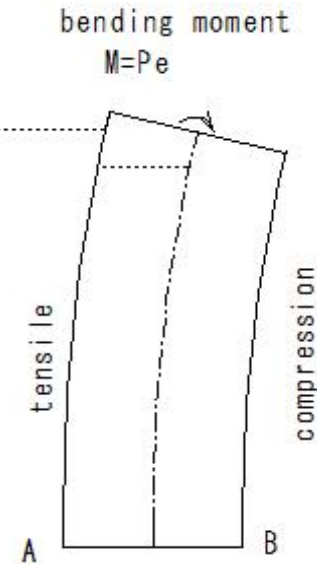


(B416)eccentric load

(B416) eccentric load



$$\sigma_c = -P/A$$



$$\sigma_t = +(M/I) \cdot x_1$$

$$\sigma_c = -(M/I) \cdot x_2$$

Before transformation

After transformation

Compressive force is provided by PC steel material

Stress due to eccentric load

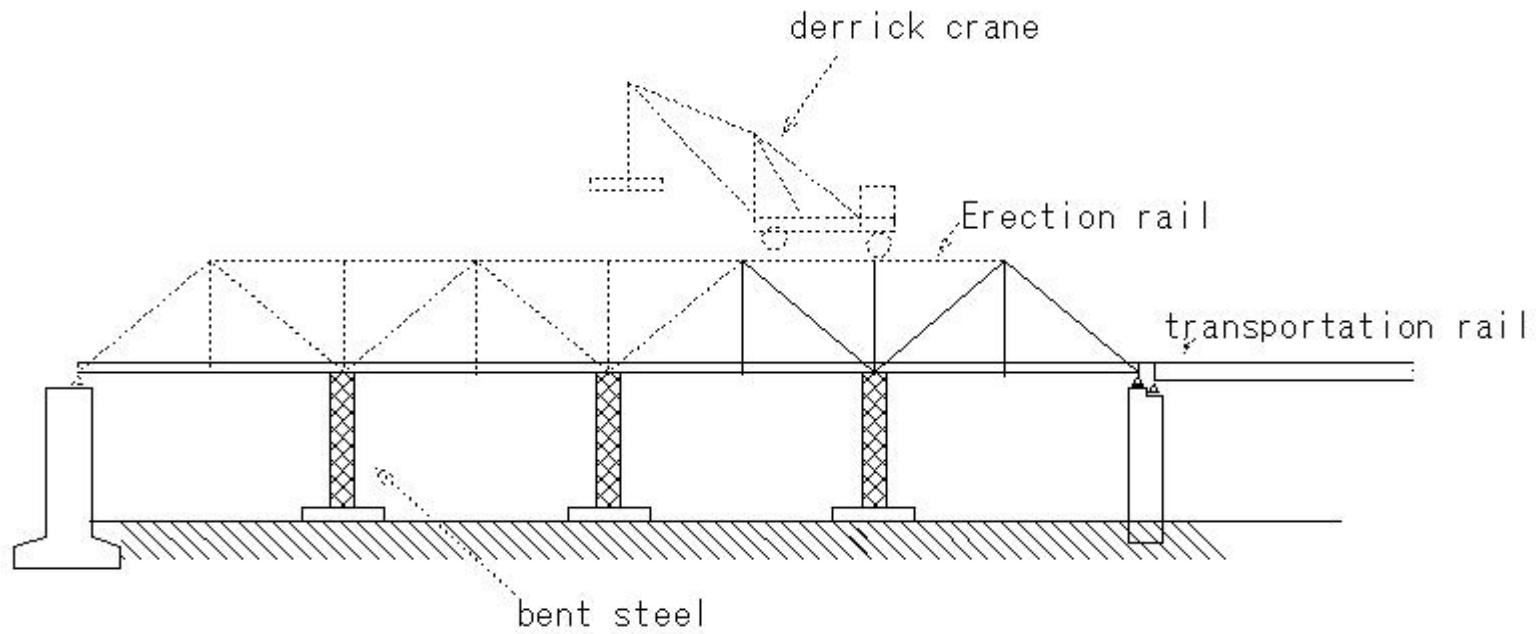
$$\sigma_A = -P/A + (M/I) \cdot x_1$$

$$\sigma_B = -P/A - (M/I) \cdot x_2$$

(B417)erection method of bent style

(B417)erection method of bent style

erection method of bent style



(B418)steel bar

(B418) steel bar

steel bar → Steel bars for reinforced concrete
 → PC steel rod
 → Bolt material

→ round steel
→ deformed steel bar

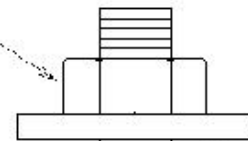
round steel



deformed steel bar



nut



washer



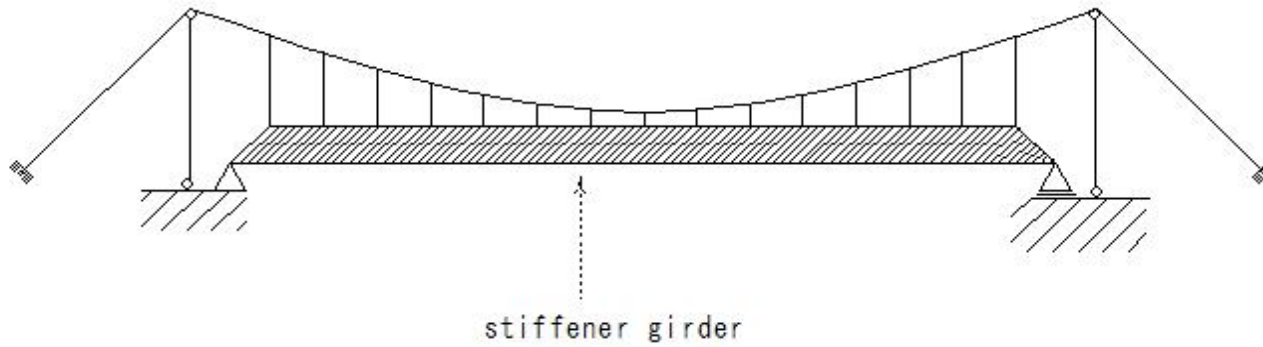
head



bolt

(B419)stiffener girder

(B419)stiffener girder



Distributing and reinforcing the heavy loads acting on suspension bridges over a wide range of girders
The stiffness of the bridge increases as a whole.

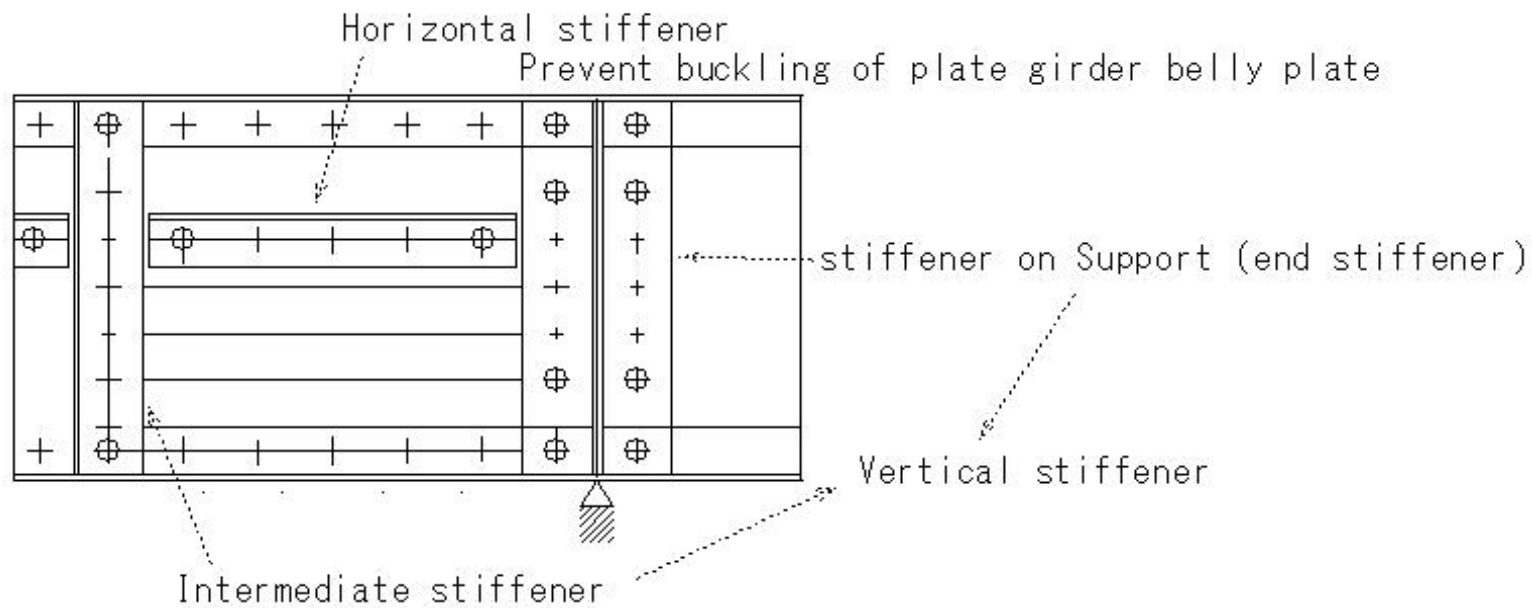
(B420)stiffener

(B420) st iffener

stiffener

To distribute concentrated loads to the abdominal plate

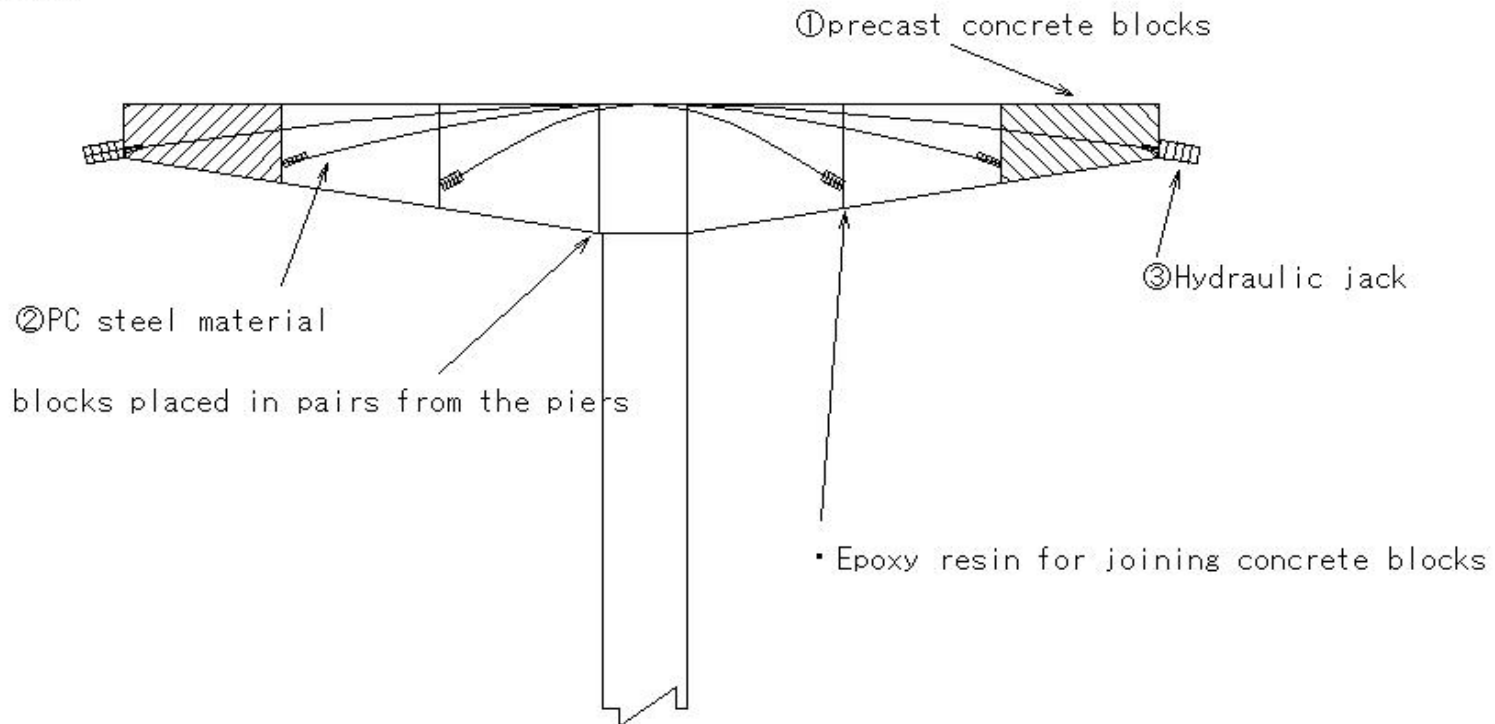
Angle iron or steel plate attached to the side of the belly plate



(B421)Post-tensioning

(B421)Post-tensioning

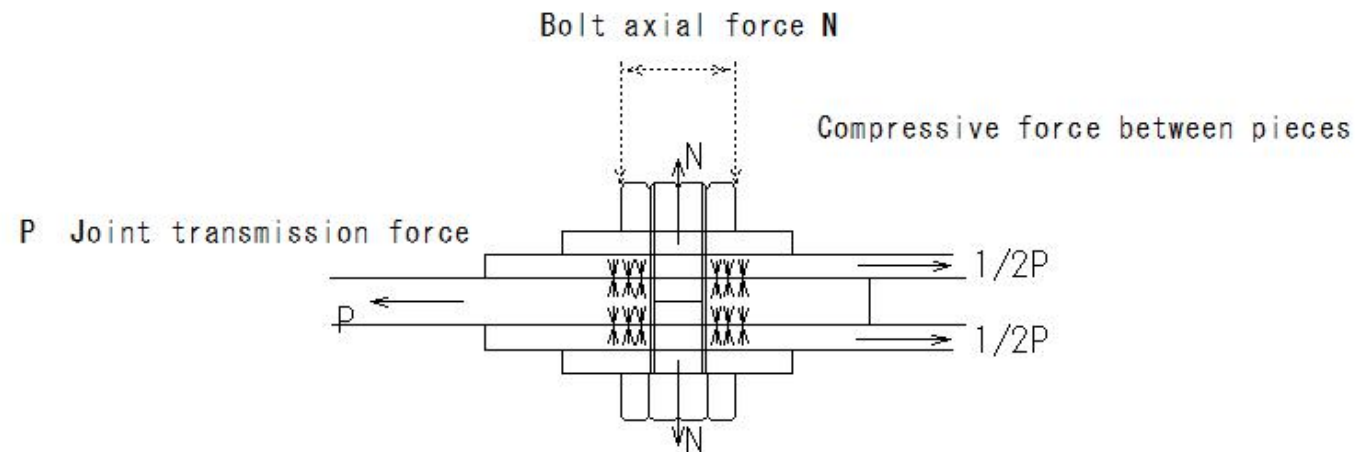
- Apply prestress after concrete hardens
 - ①Installing the sheath inside the concrete formwork
 - ②Concrete placement
 - ③After hardening, insert PC steel material - tension
 - ④Tension
 - ⑤Establishment



(B422) axial force of bolt

(B422) axial force of bolt

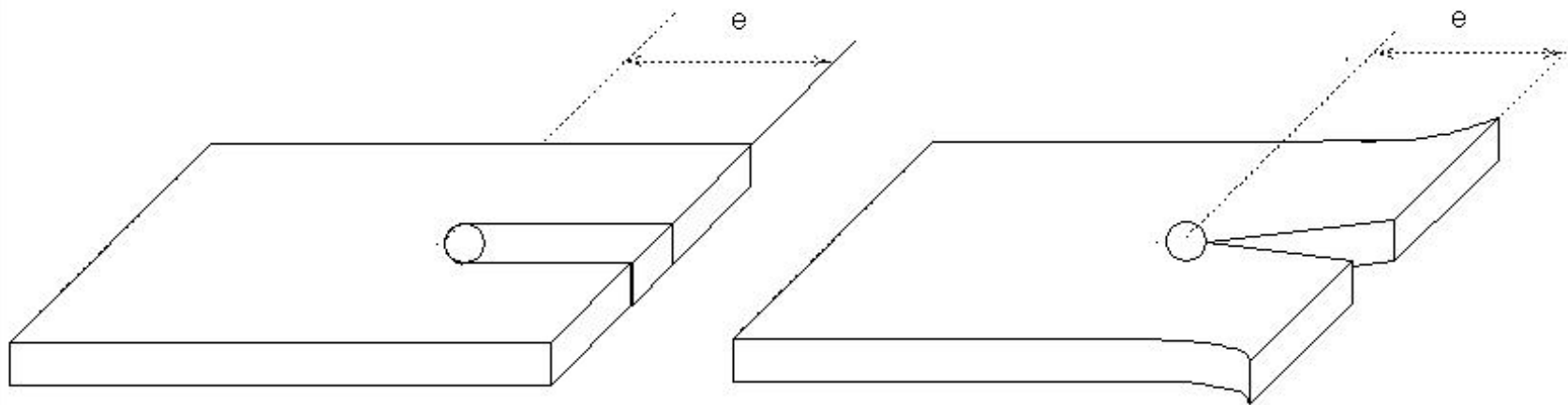
- Tighten with high strength bolts
- Axial tensile force acts on the bolt: Bolt axial force



(B423)bolt edge distance

(B423)bolt edge distance

- Distance from the center of the bolt to the edge of the piece: e



Phenomenon : bolt edge distance is not appropriate

shear

bending

(B424)nominal diameter of bolt

(B424)nominal diameter of bolt

nominal diameter of bolt

Thread name (mm)

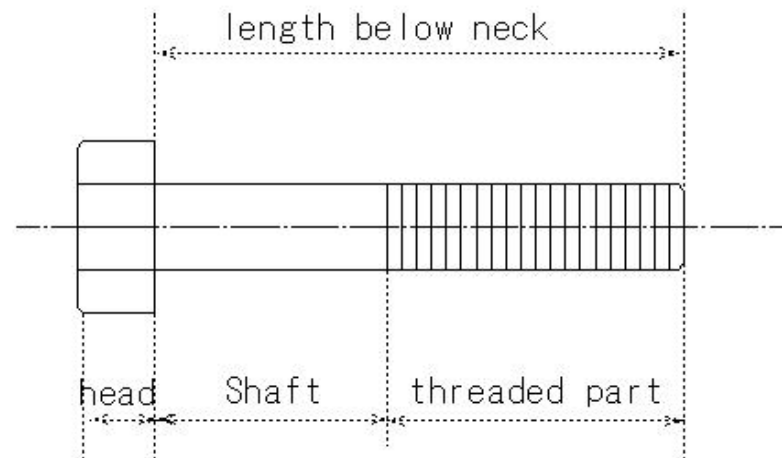
Shaft diameter 20 22 24 mm

Diameter 20mm-M20

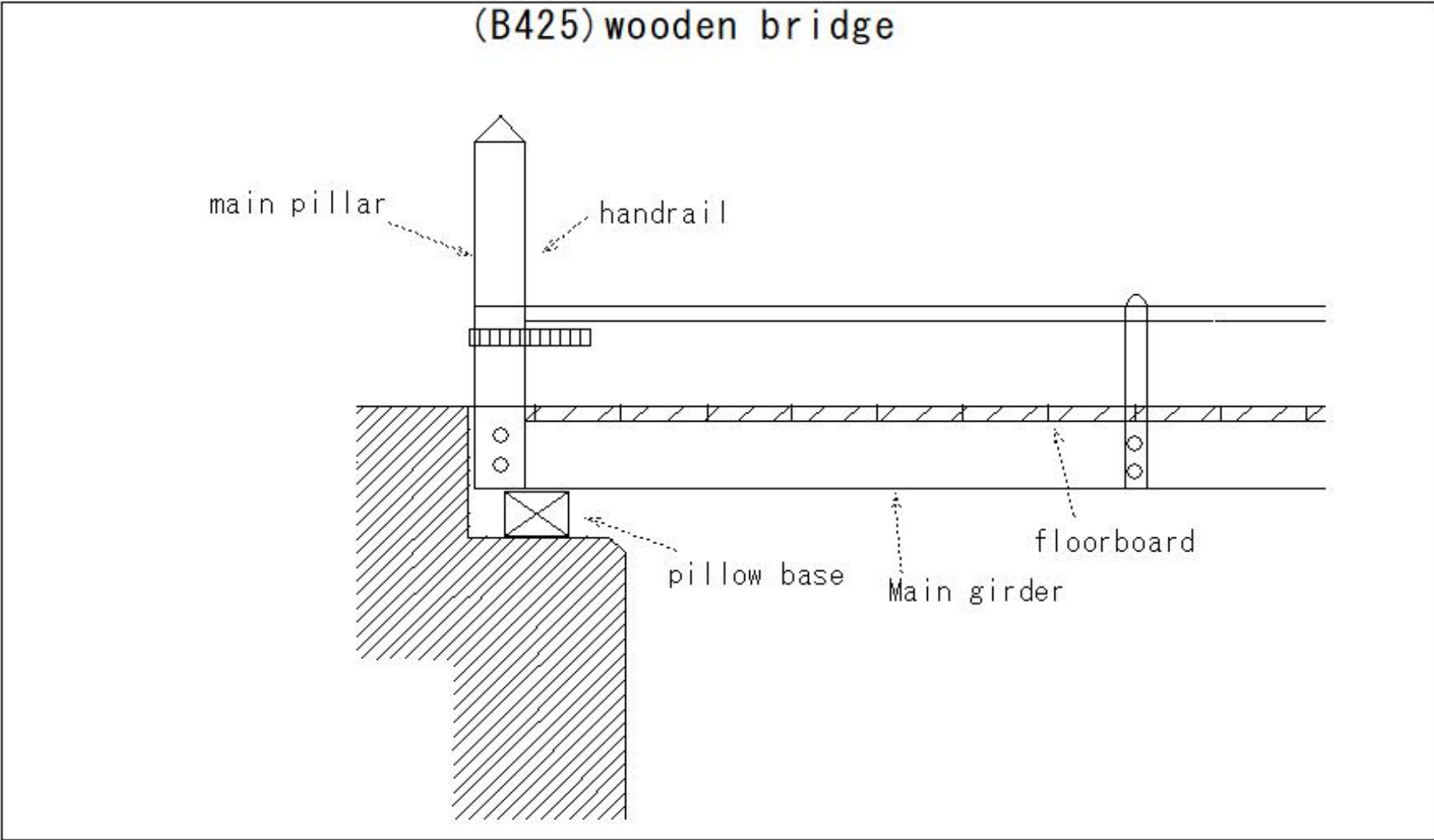
bridge

F8T (1 type)

F10T (2 types)

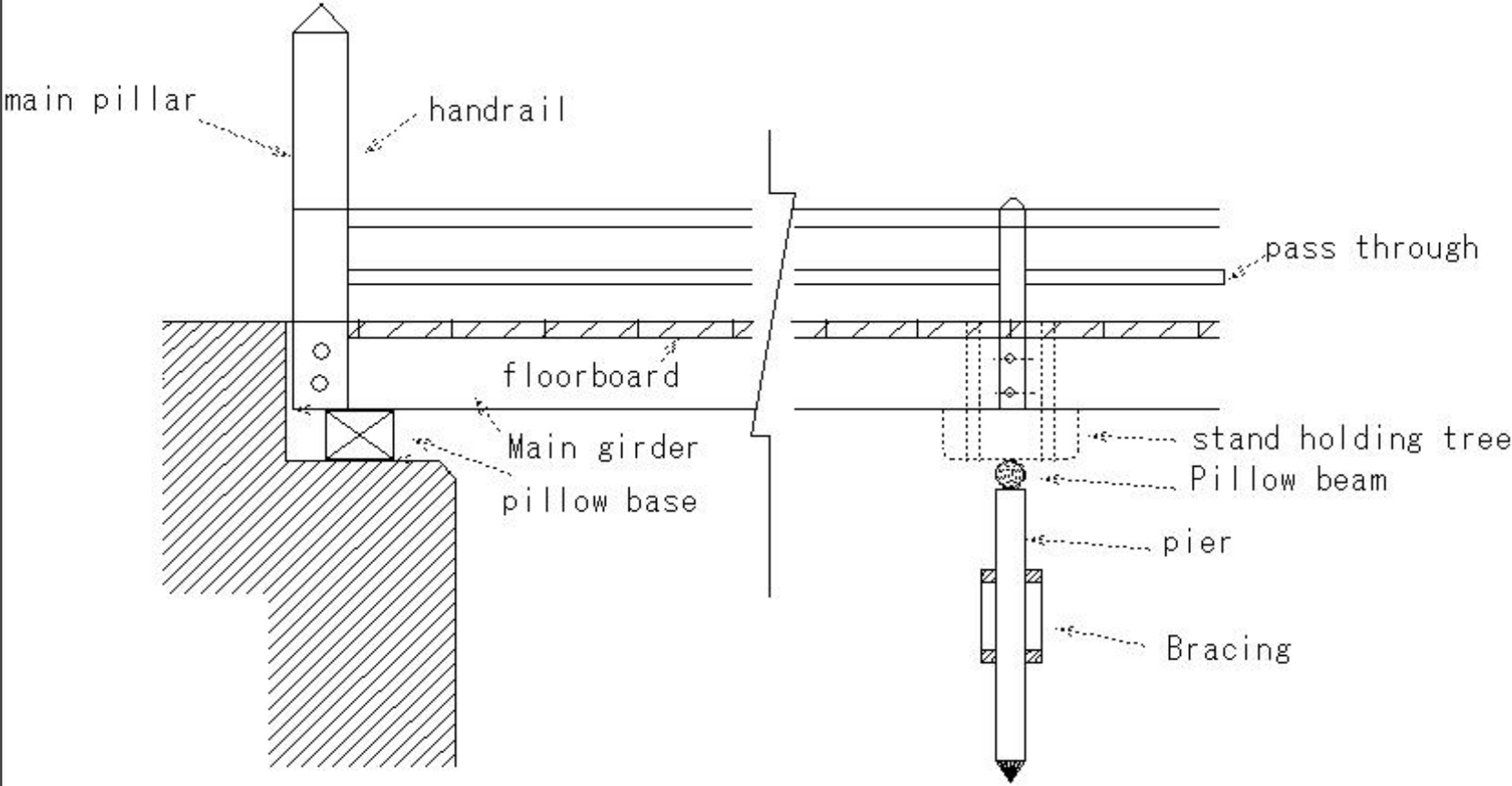


(B425) wooden bridge



(B426)wooden bridge

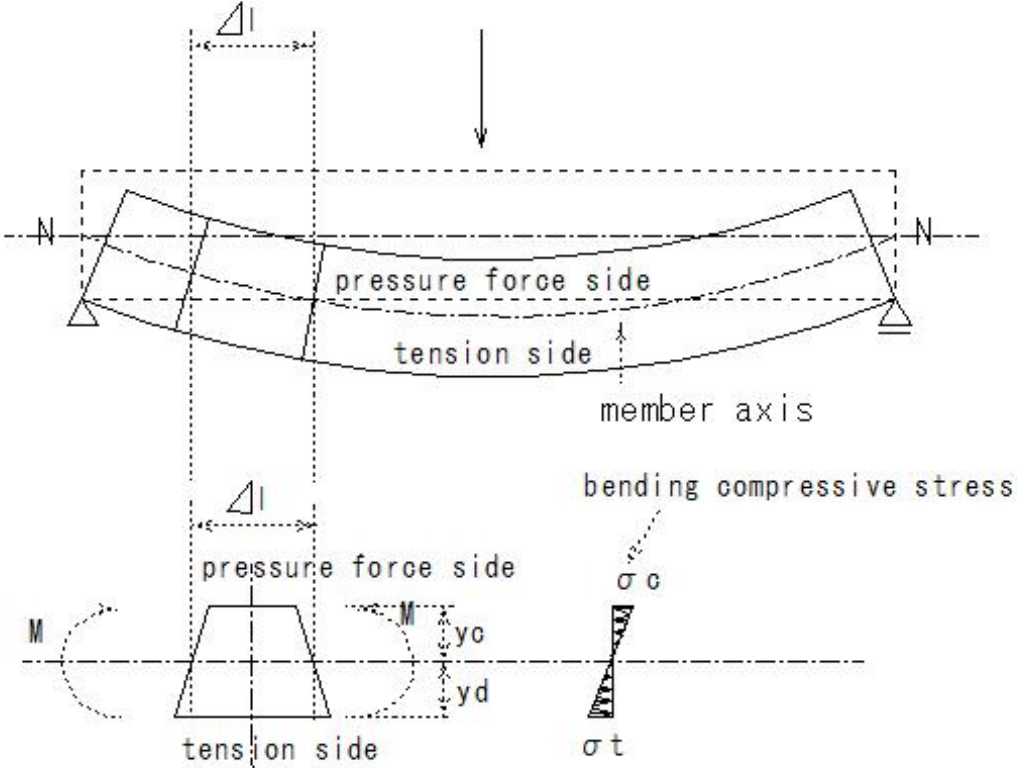
(B426)wooden bridge



(B427)bending compressive stress

(B427)bending compressive stress

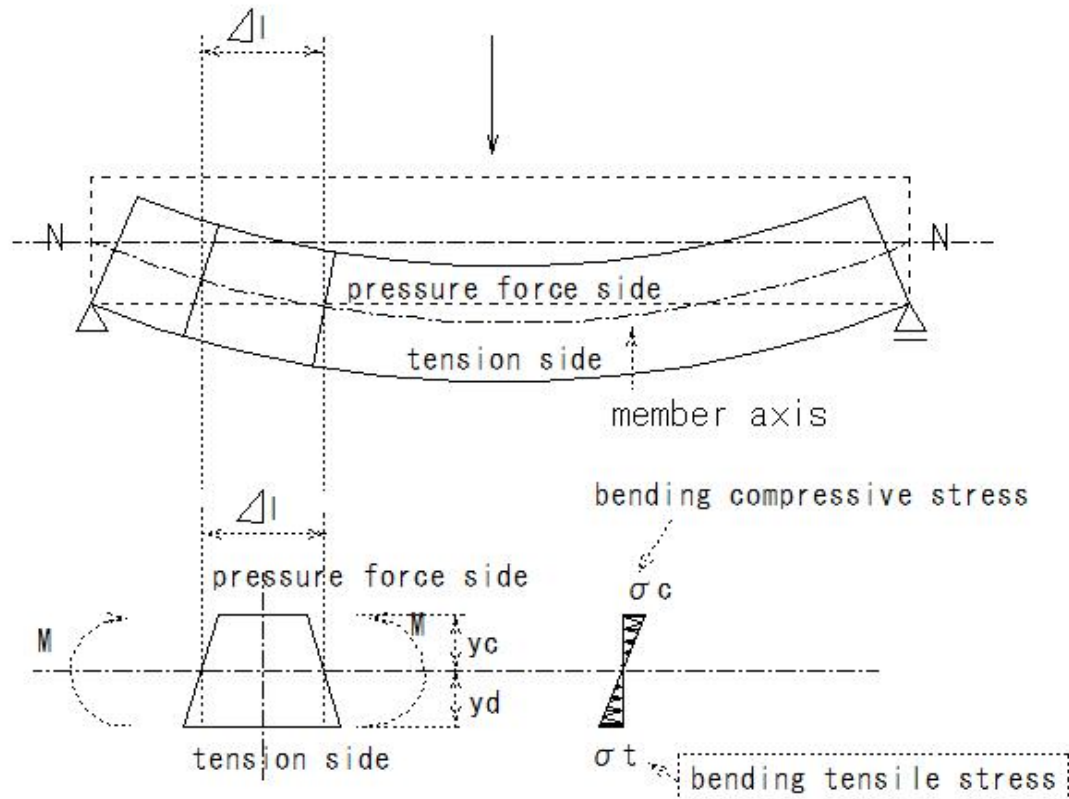
bending compressive stress



(B428)bending tensile stress

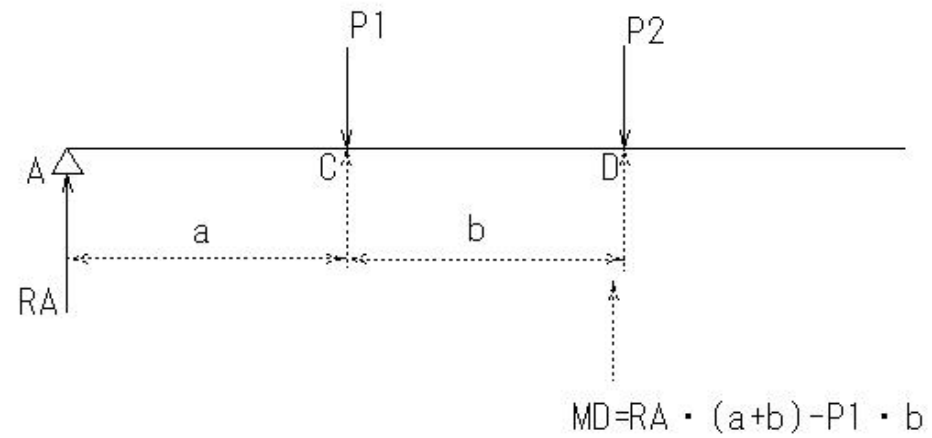
(B428)bending tensile stress

bending tensile stress



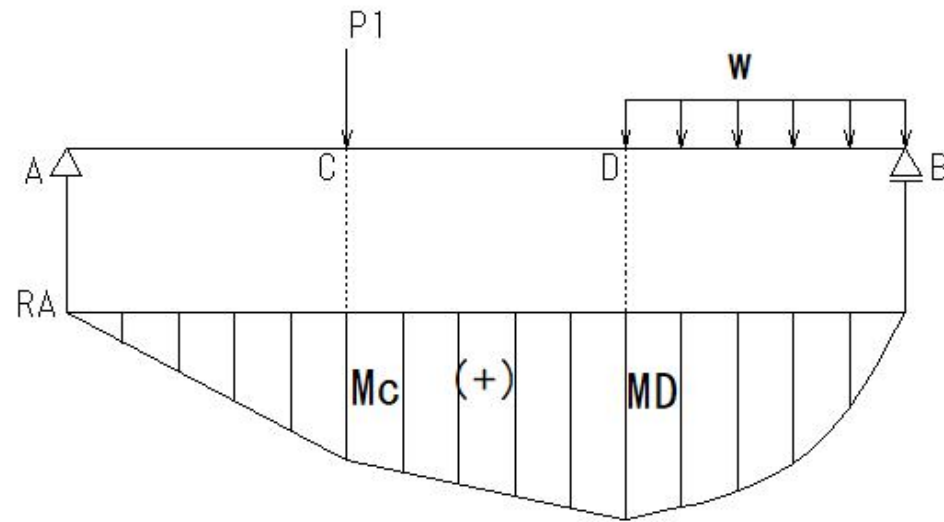
(B429)bending moment

(B429) bending moment



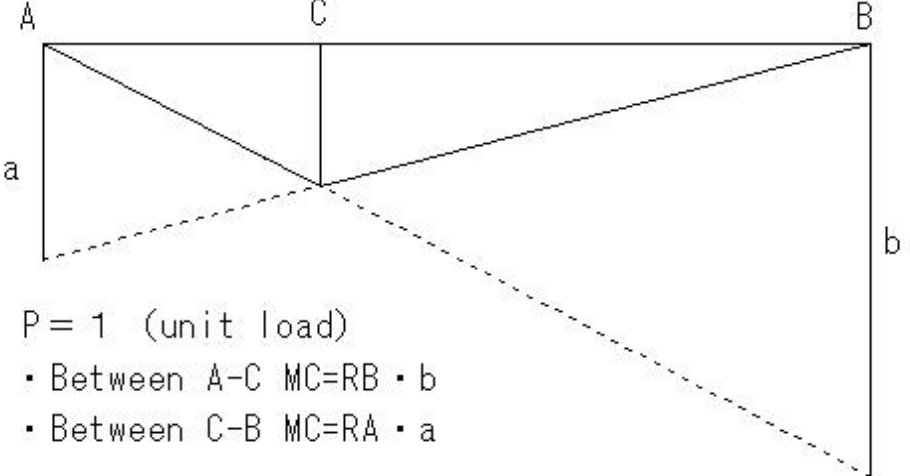
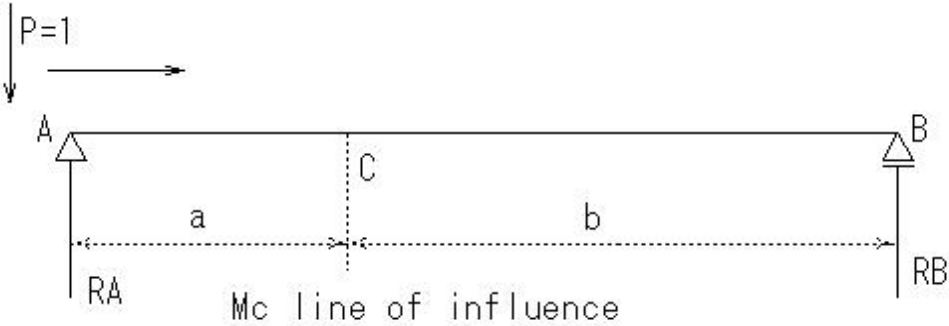
(B430)bending moment diagram

(B430) Bending moment diagram



(B431)bending moment influence line

(B431)bending moment influence line

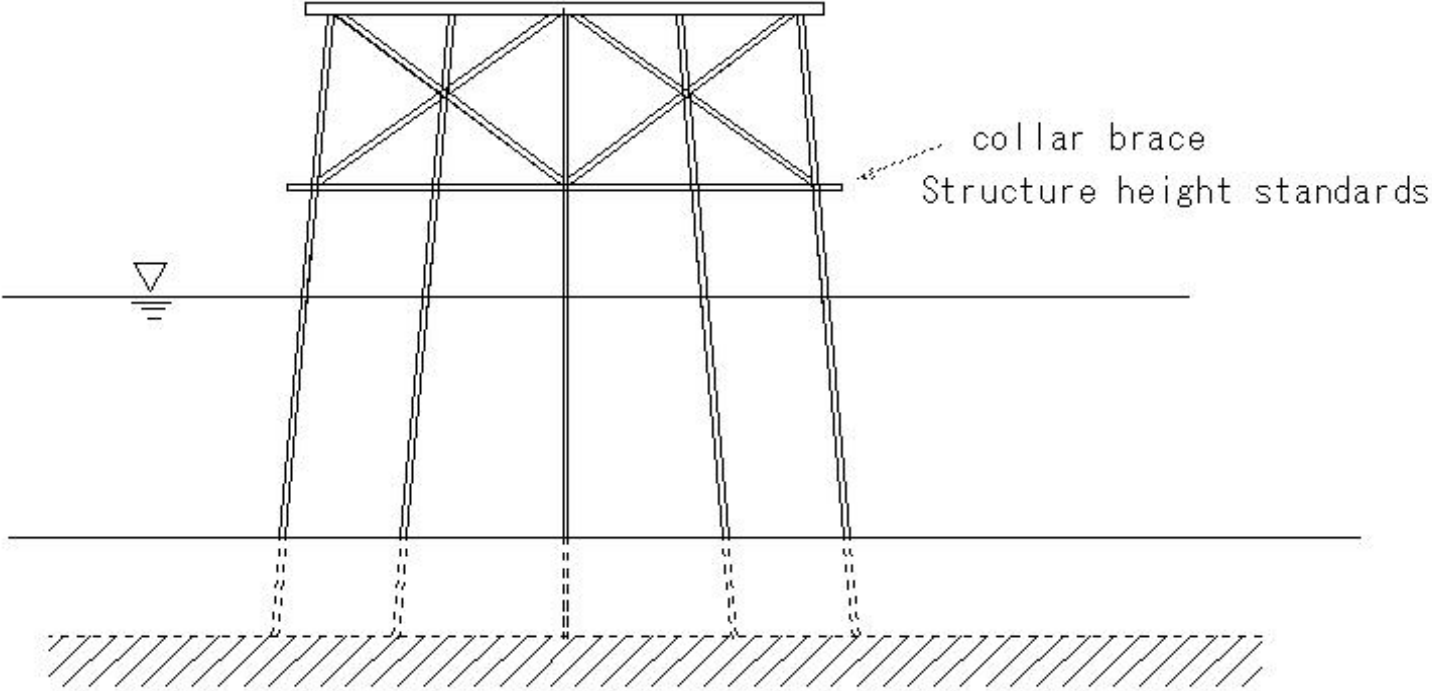


- $P = 1$ (unit load)
- Between A-C $MC = RB \cdot b$
- Between C-B $MC = RA \cdot a$

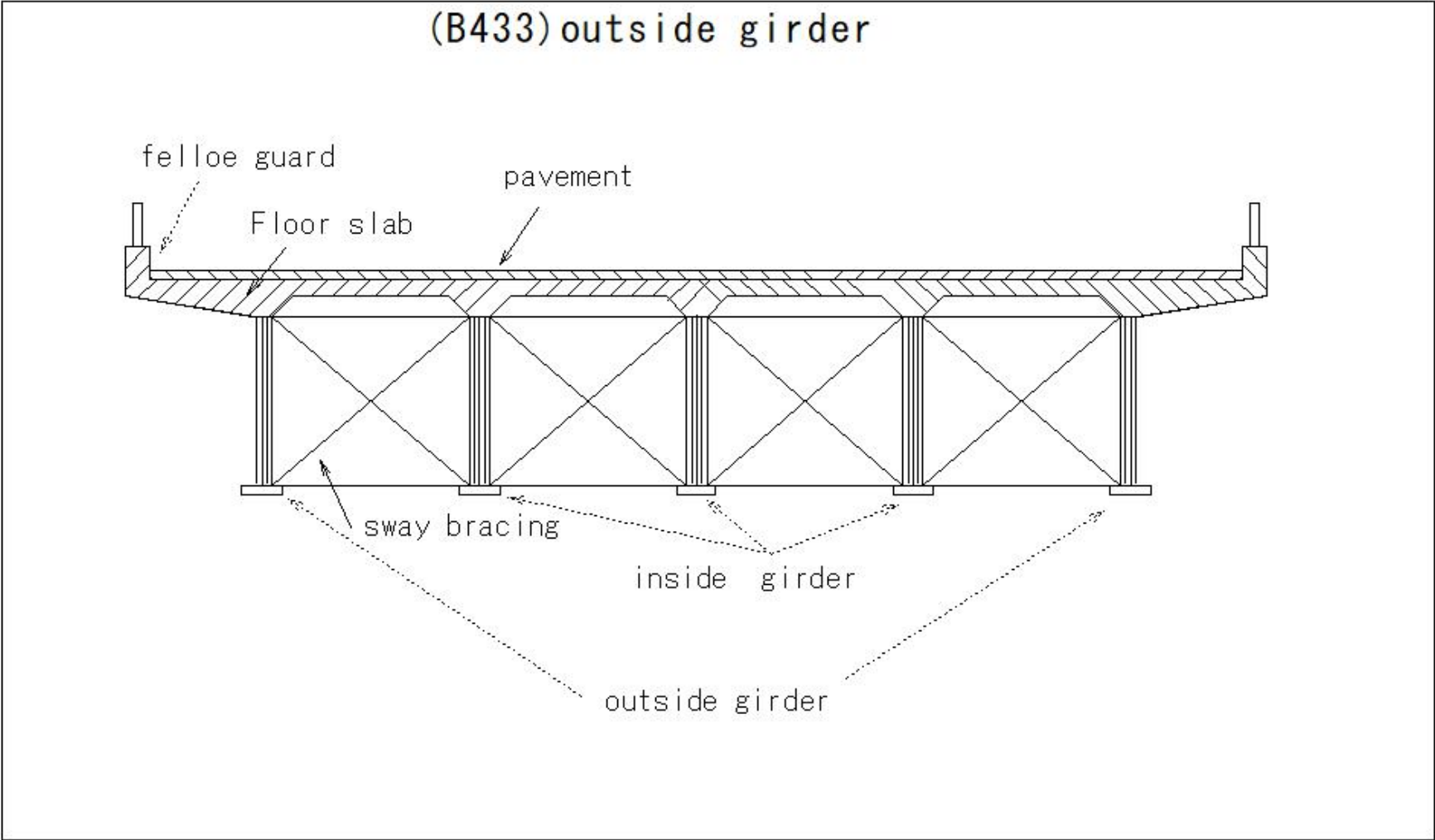
(B432) wooden bridge (collar brace)

(B432) wooden bridge (collar brace)

wooden bridge piers

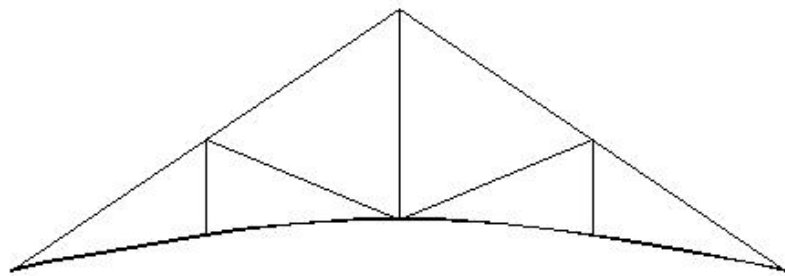
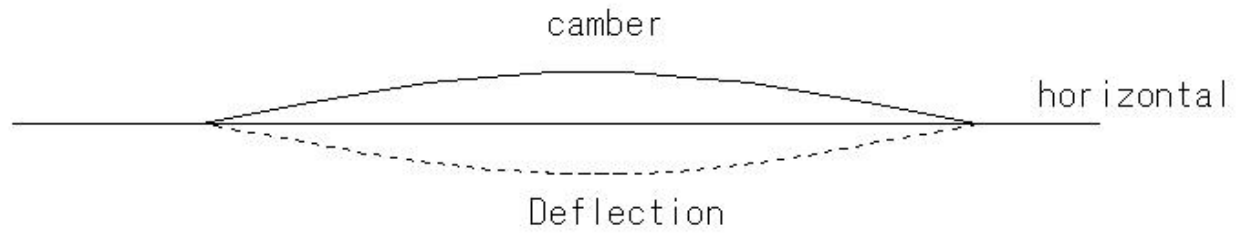


(B433)outside girder

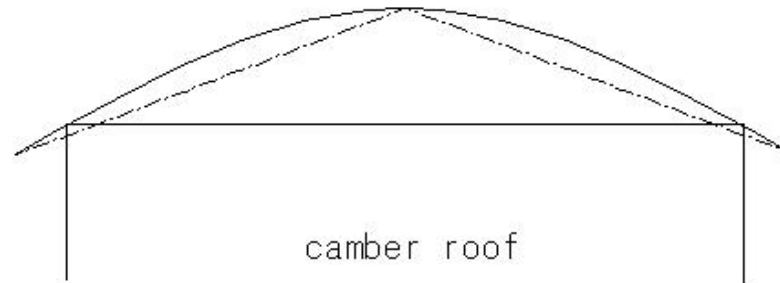


(B434)camber

(B434) camber

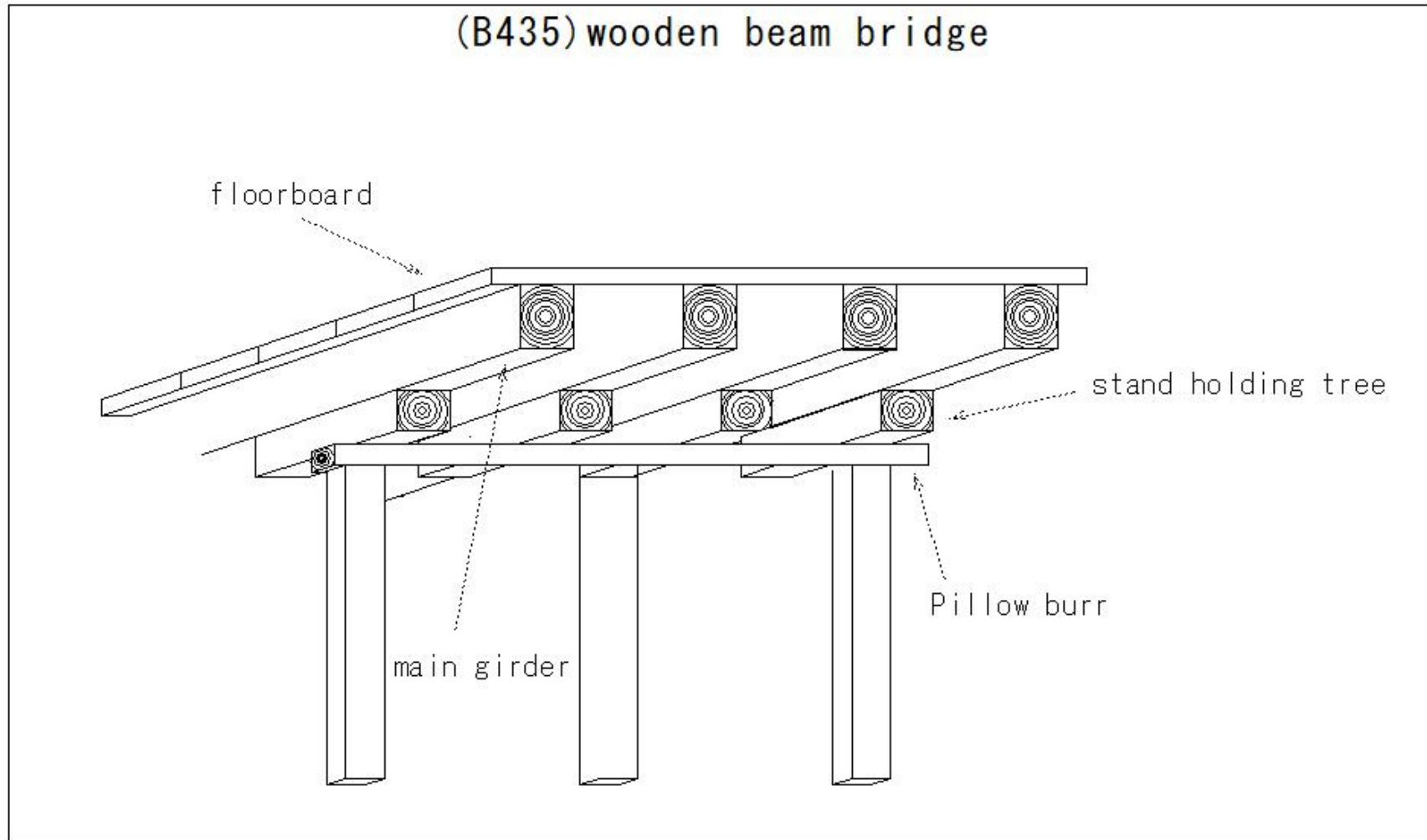


camber beam



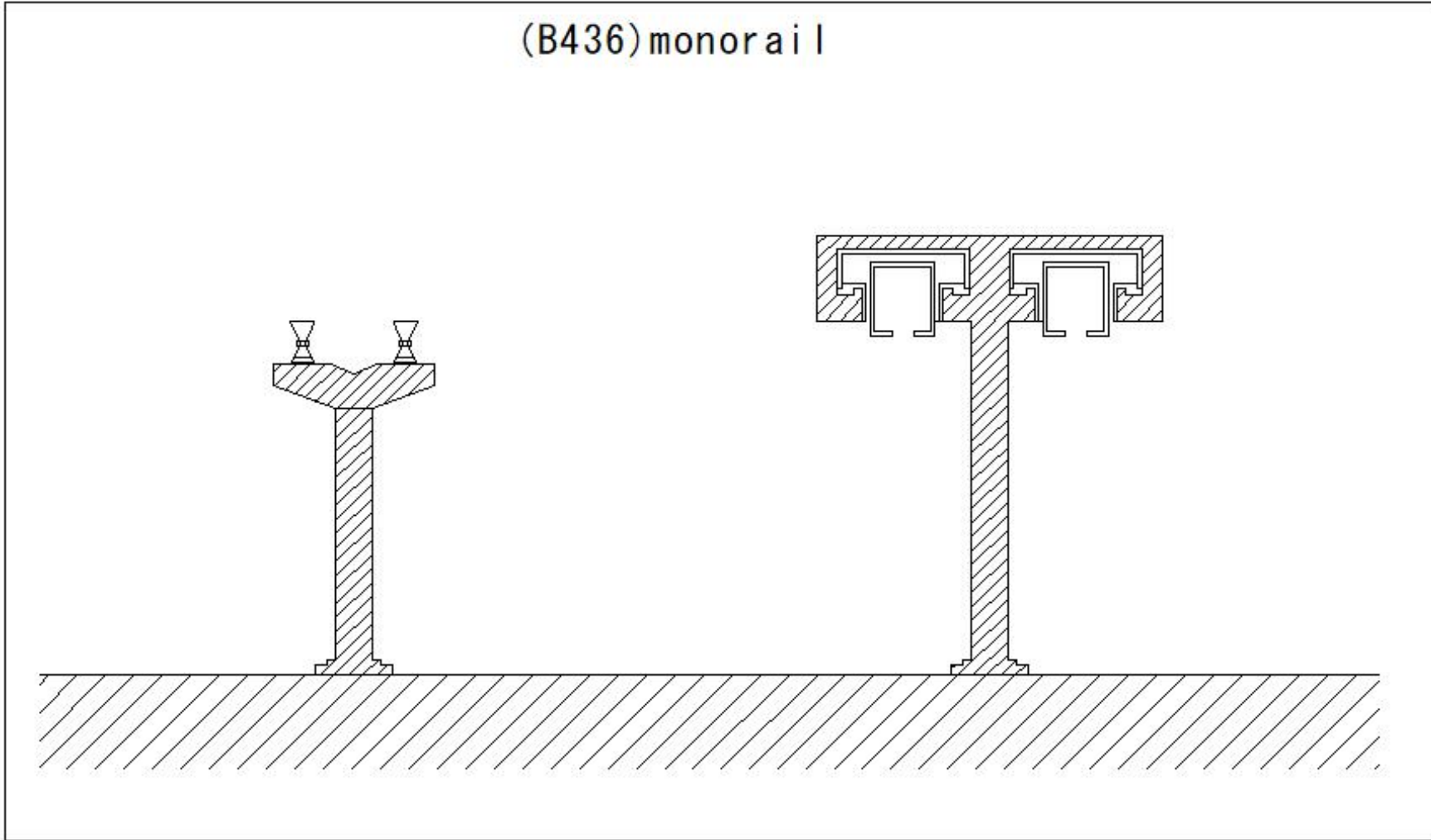
camber roof

(B435) wooden beam bridge



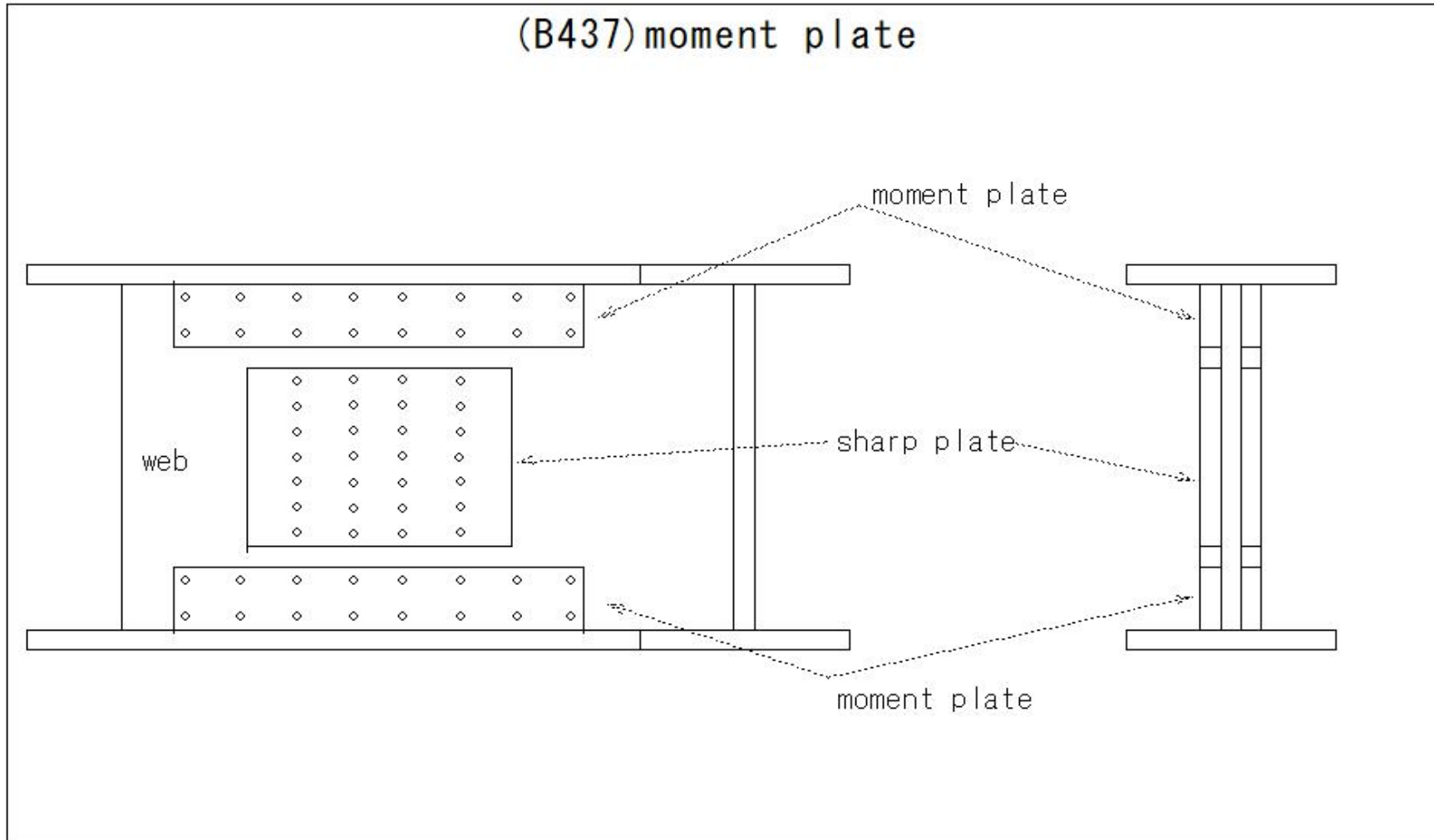
(B436)monorail

(B436)monorail



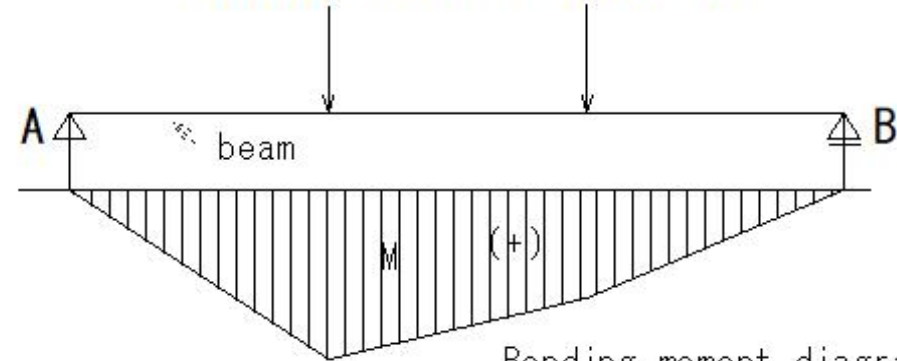
(B437)moment plate

(B437)moment plate

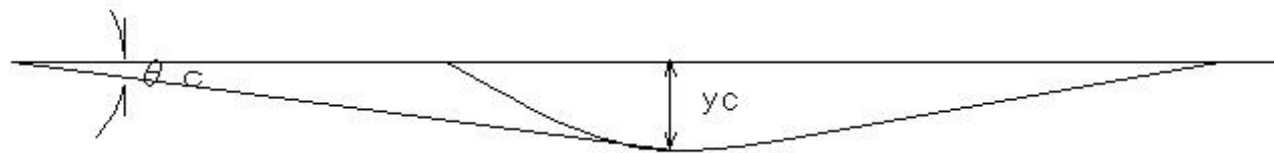
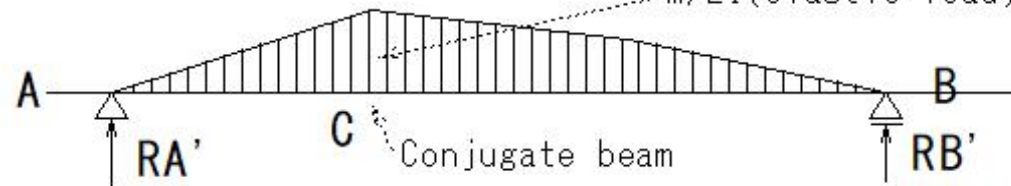


(B438) Mohr's theorem

(B438) Mohr's theorem



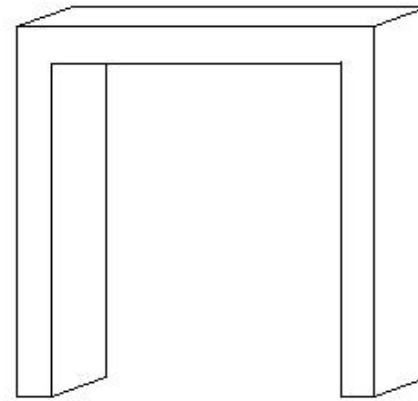
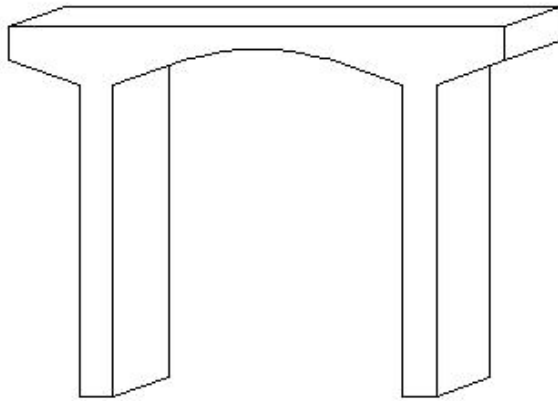
Bending moment diagram
 M/EI (elastic load)



(B439)Portal pier

(B439)Portal pier

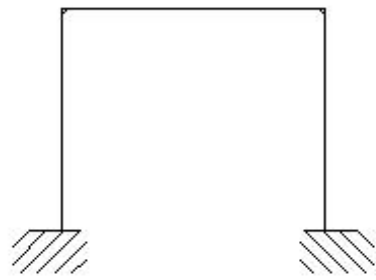
Portal pier



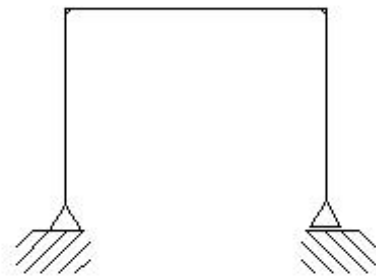
Designed as a rigid frame structure

(B440)portal bracing

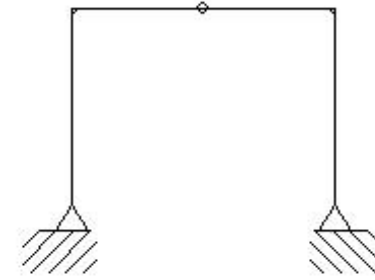
(B440)portal bracing



Indeterminate (cubic)



Static determination



Static determination

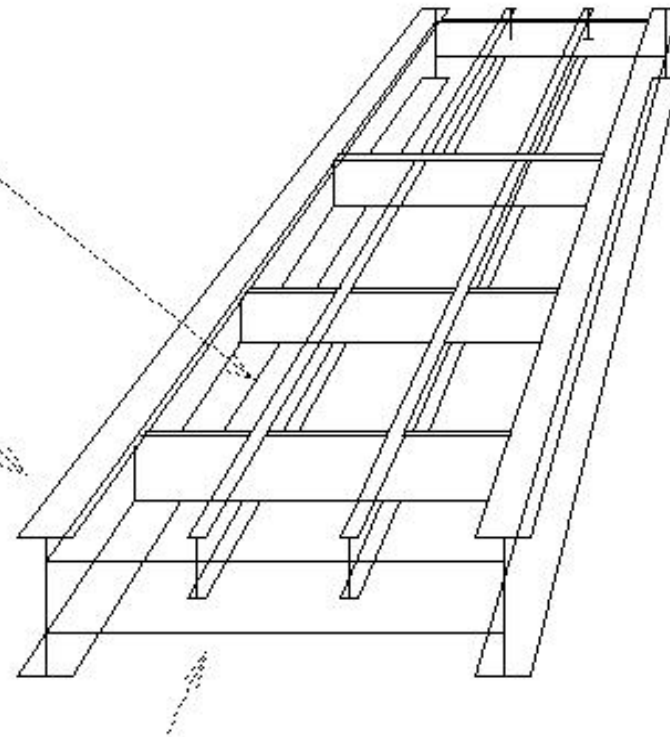
(B441)floor system

(B441)floor system

floor system

Stringer

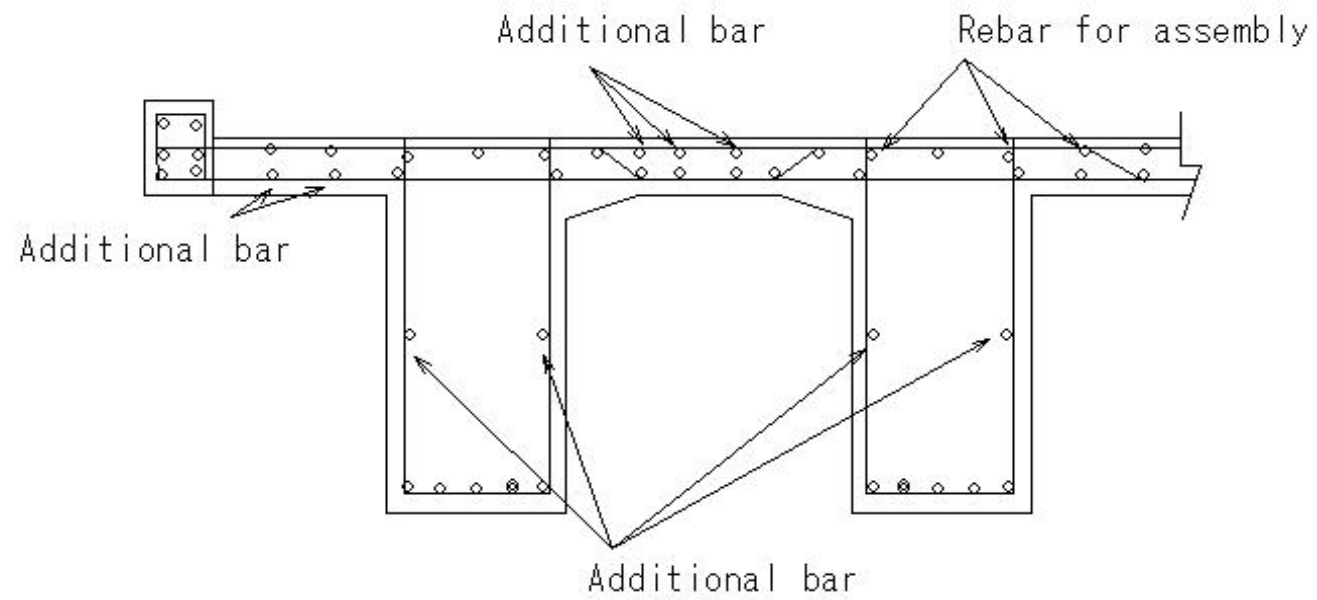
Main girder



floor beam
floor girder

(B442)Additional bar

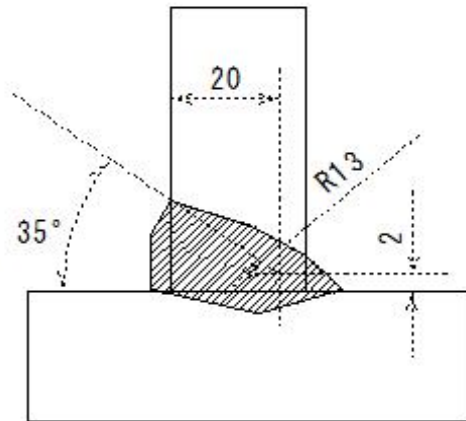
(B442) Additional bar



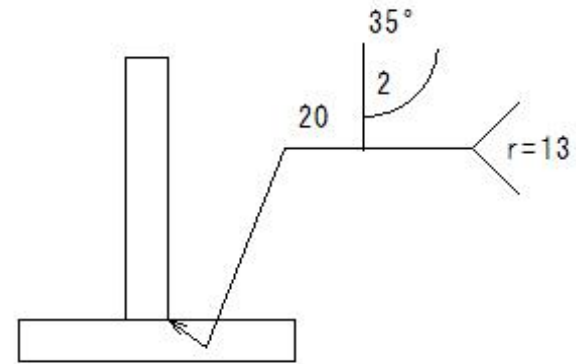
(B443)welding symbol

(B443)welding symbol

welding symbol
Welding method
kinds
welded joints



Real shape



illustration

(B444)welded steel truss bridge

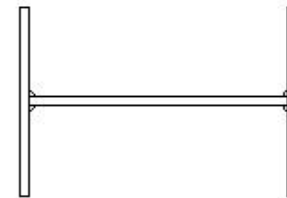
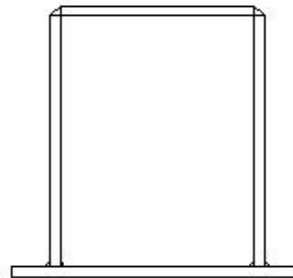
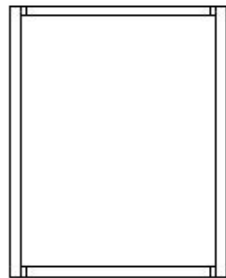
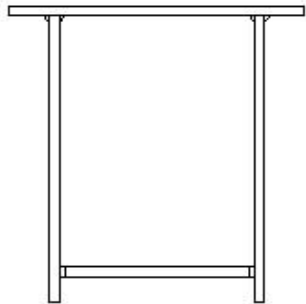
(B444)welded steel truss bridge

welded steel truss bridge

Part assembly/welding

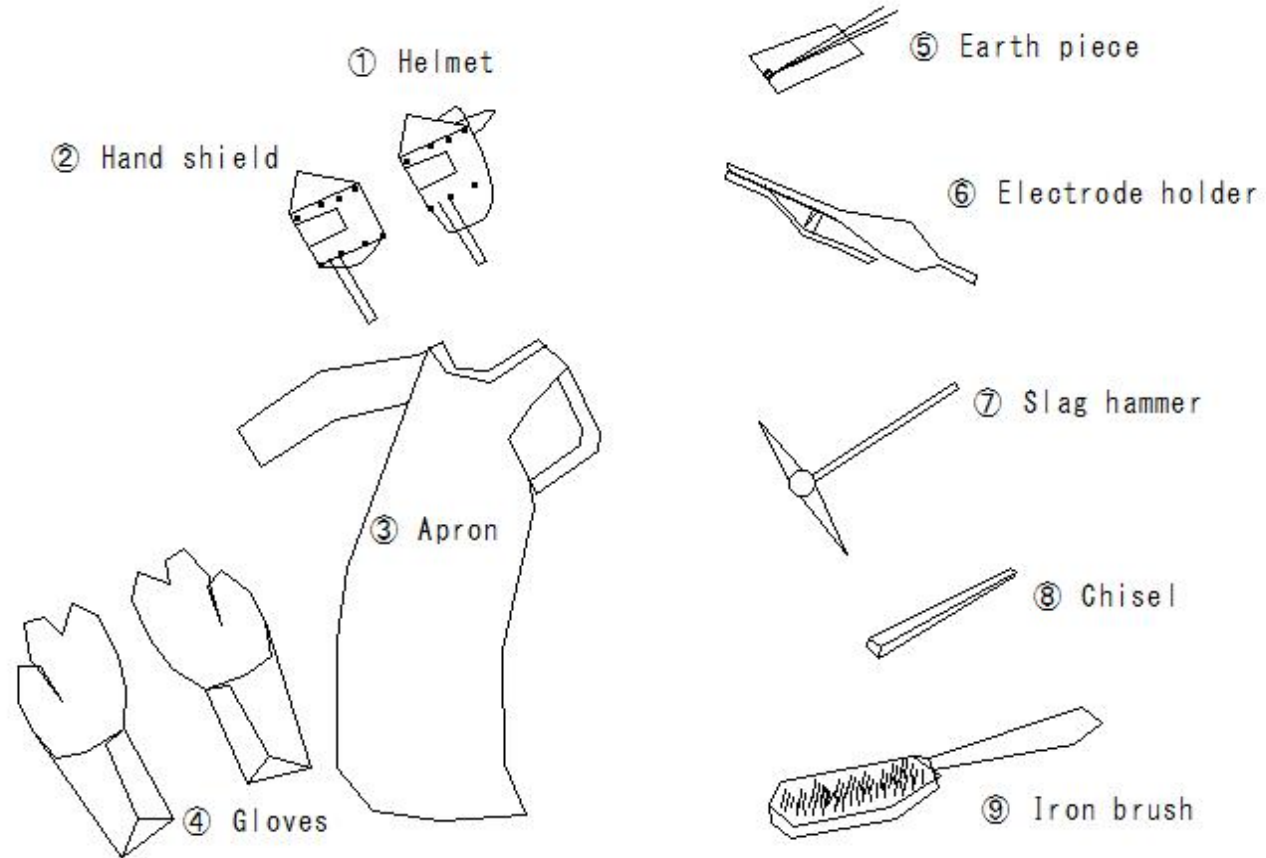
rivet

High strength bolt friction joint



(B445)arc welding tool

(B445) arc welding tool

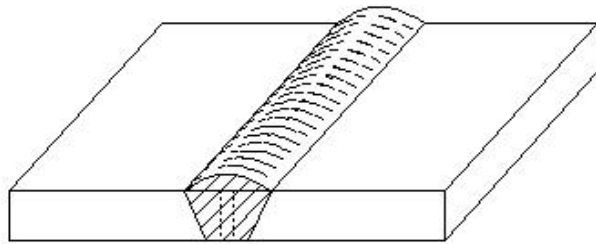


(B446)welded joints

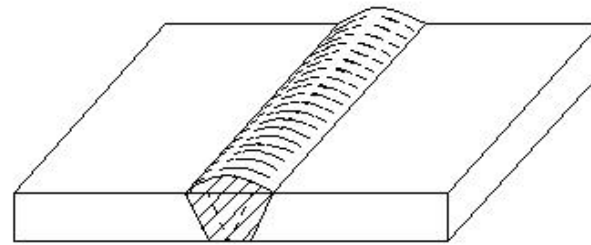
(B446)welded joints

welded joints

Butt (group) welded joint



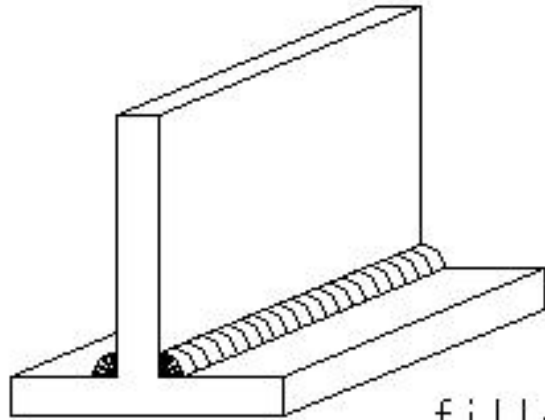
I-shaped steel



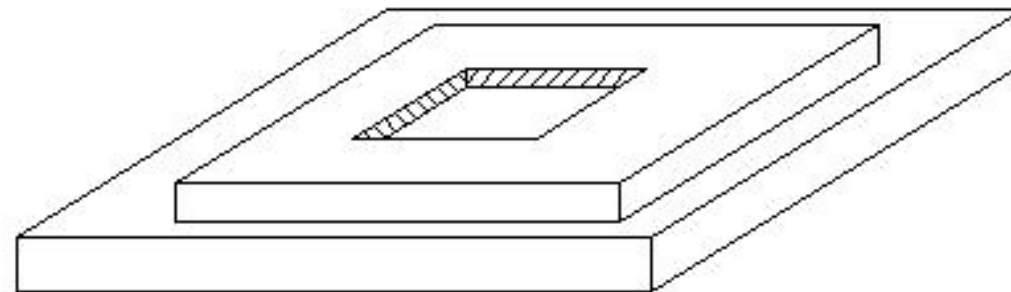
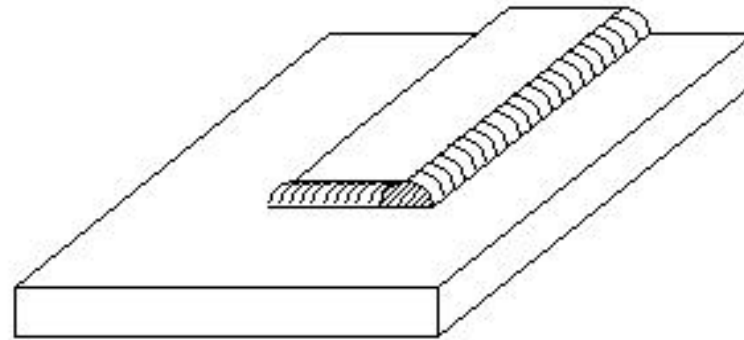
V shape

(B447)fillet welding

(B447)fillet welding

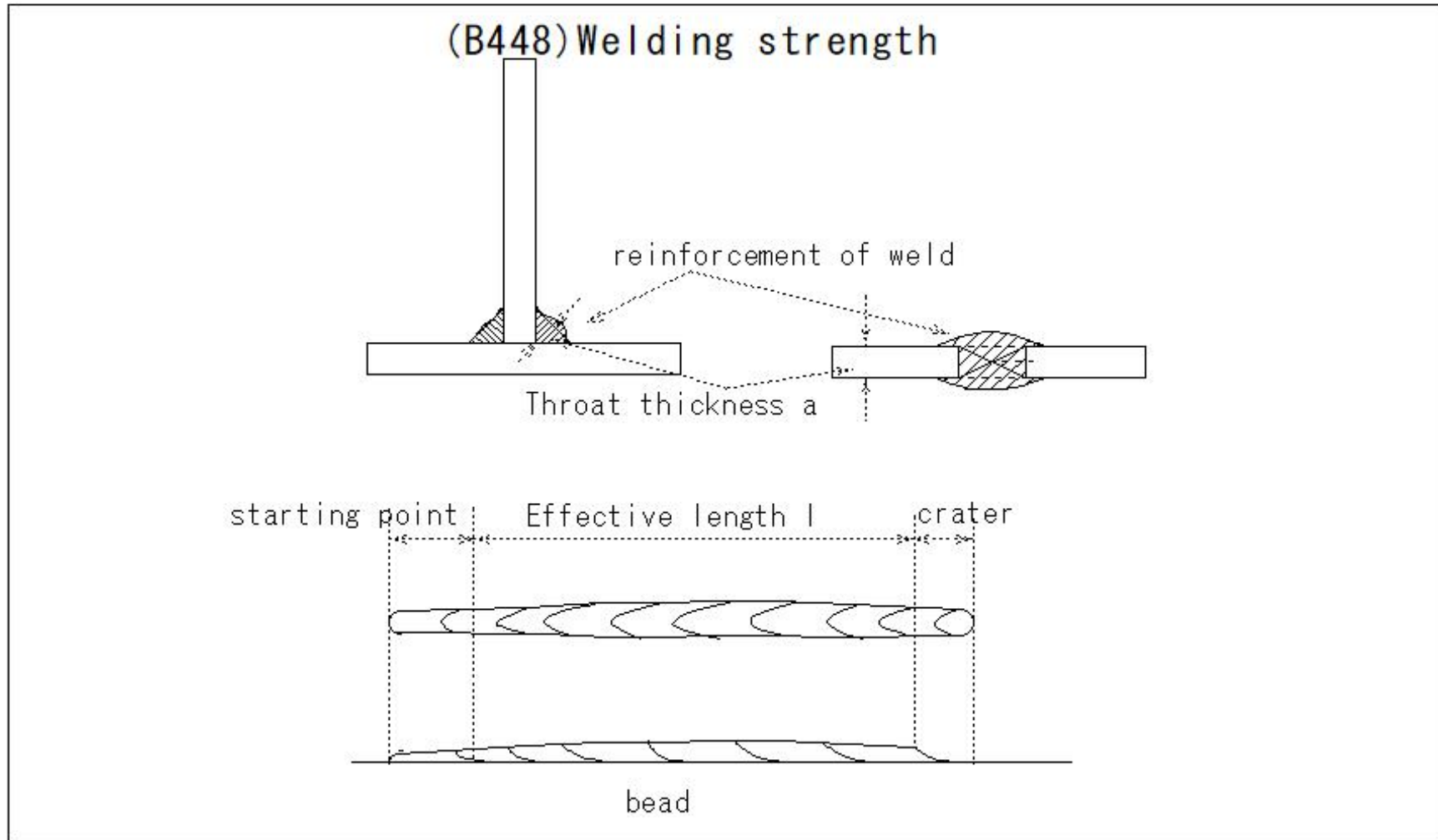


fillet welding



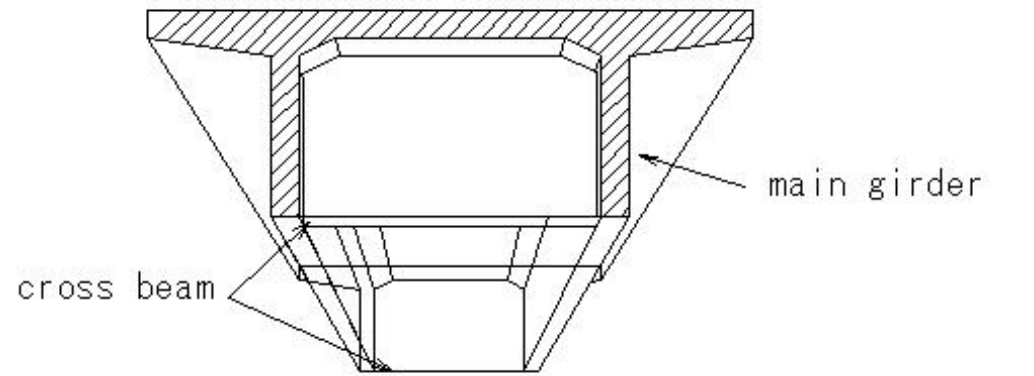
Groove welding

(B448)Welding strength



(B449)cross beam

(B449) cross beam

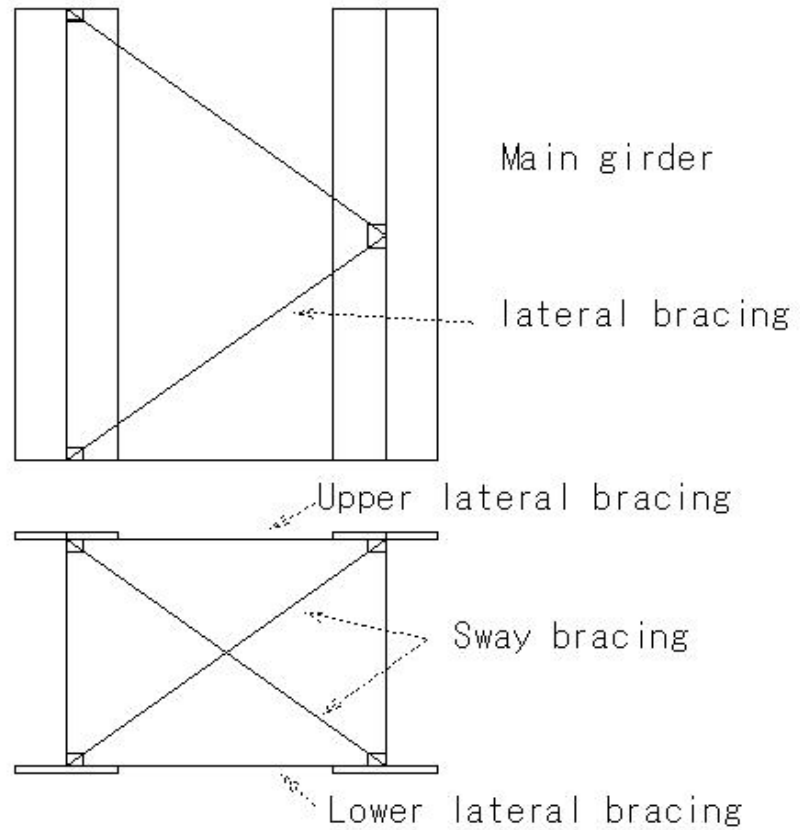


lateral - Stable

(B450)lateral bracing

(B450) lateral bracing

Lateral bracing
Earthquake load
Lateral direction - load - resistance
Connection between main girders

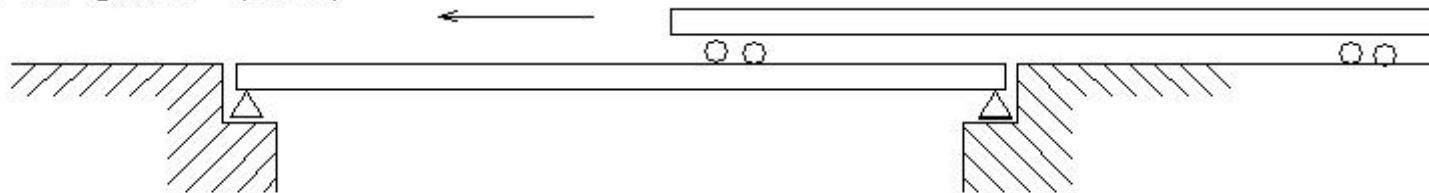


(B451)Horizontal girder erection method

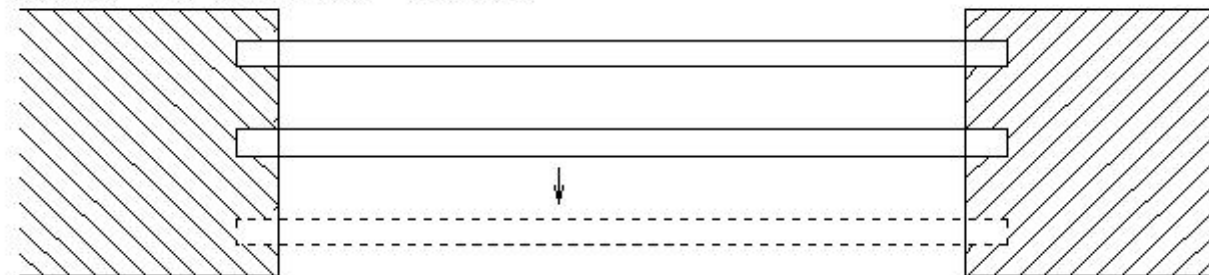
(B451)Horizontal girder erection method

Horizontal girder erection method

① Pull out the girder (side)



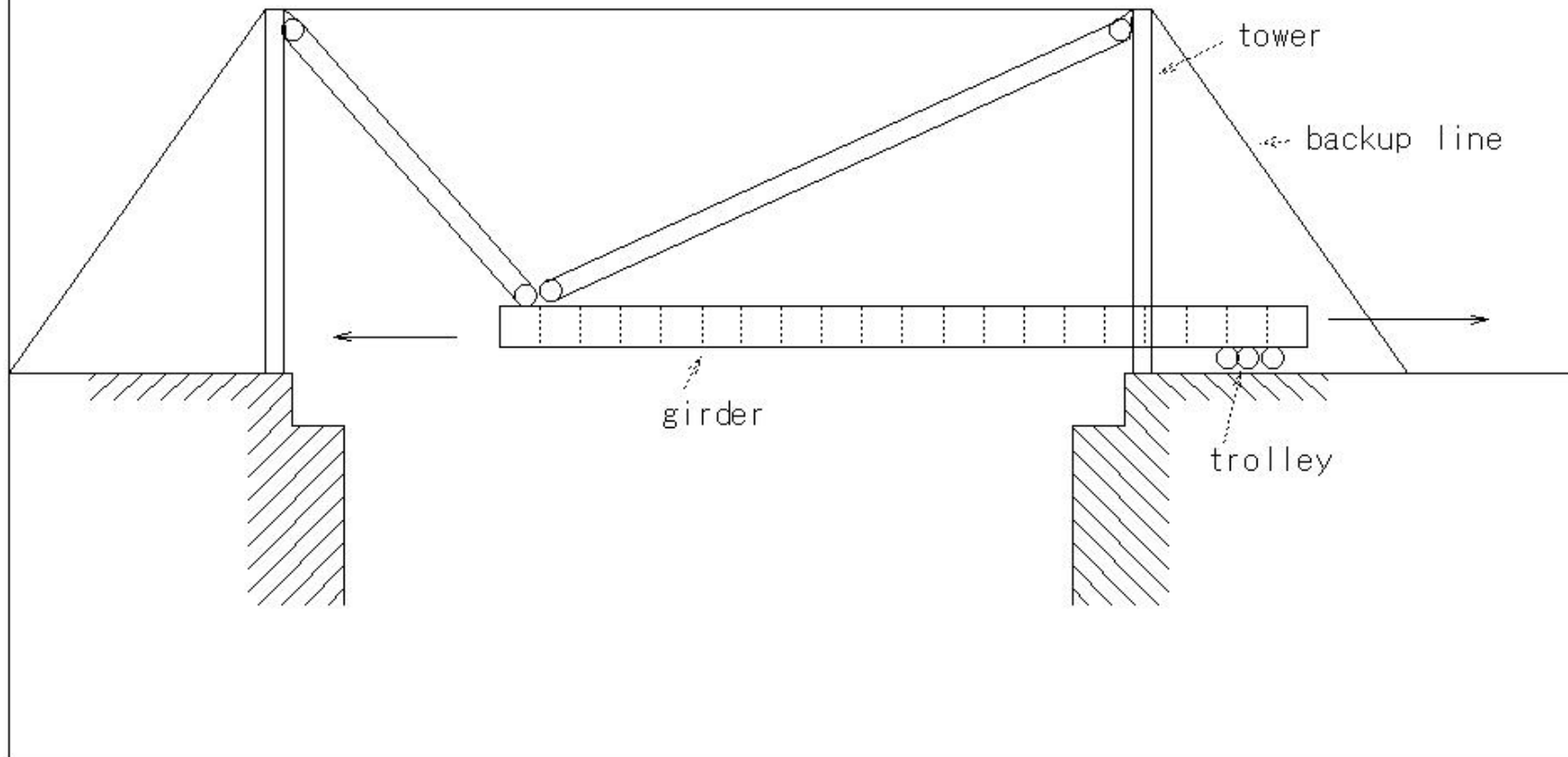
② Move the girder horizontally (plane)



(B452)drag out installation method

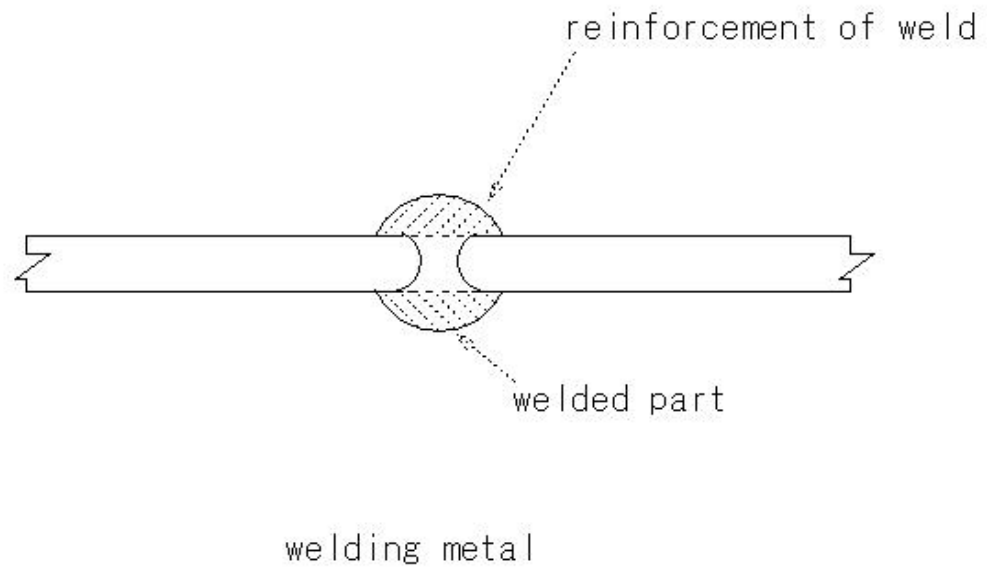
(B452) drag out installation method

drag out installation method



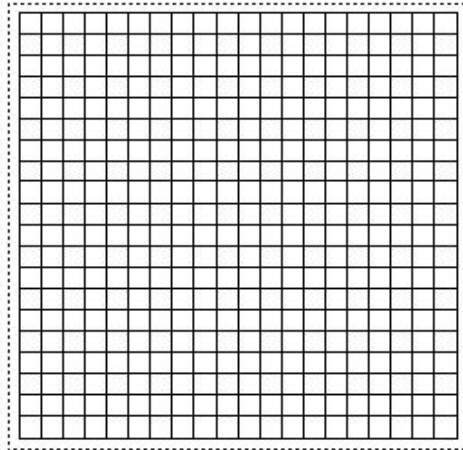
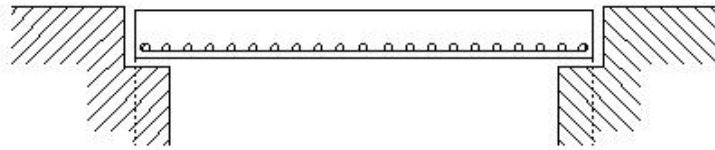
(B453)reinforcement of weld

(B453)reinforcement of weld

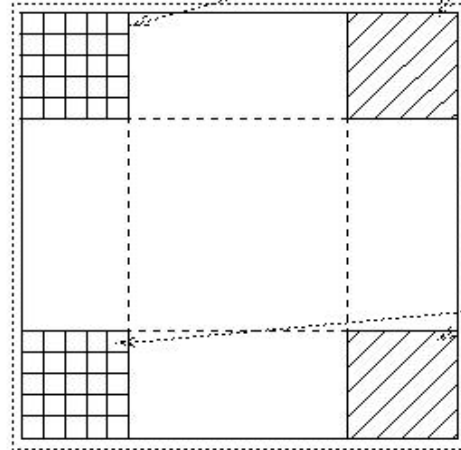


(B454) Four sides simply support slab

(B454) Four sides simply support slab



Main reinforcing bar placement
Main reinforcing bar 2 directions

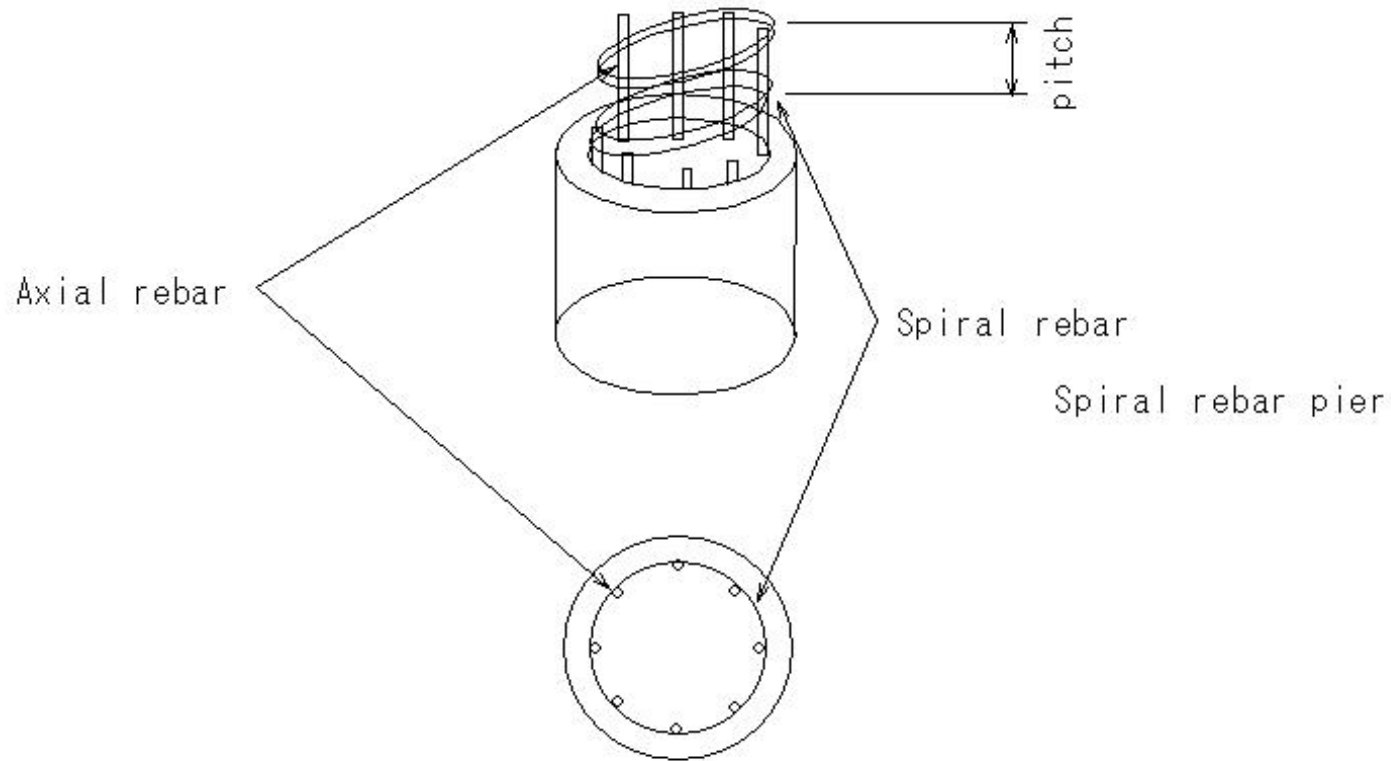


Reinforcing bars at corners
Corner - Reinforcing bar

Four sides simply support slab

(B455) Column with spiral rebar

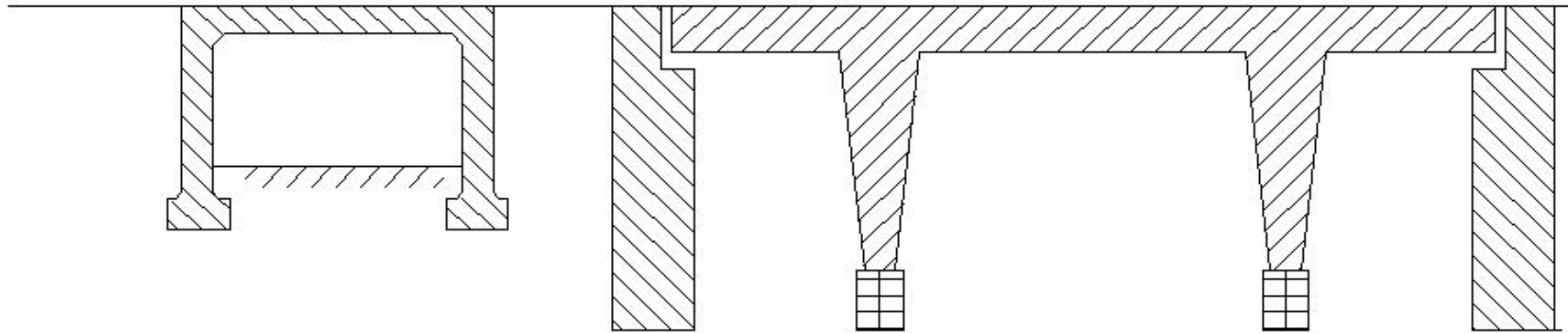
(B455) Column with spiral rebar



(B456) Rigid frame bridge

(B456) Rigid frame bridge

Rigid frame bridge



Bending moment generated in gantry rigid frame

Reinforced concrete rigid frame bridge

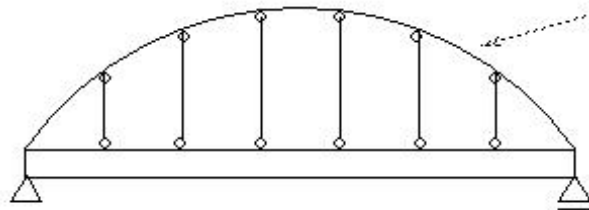
Moment - small - girder height - low

(B457)langer bridge

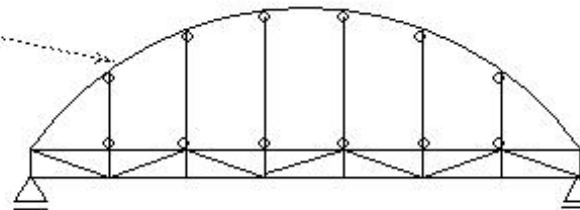
(B457) langer bridge

langer girder bridge

langer truss bridge



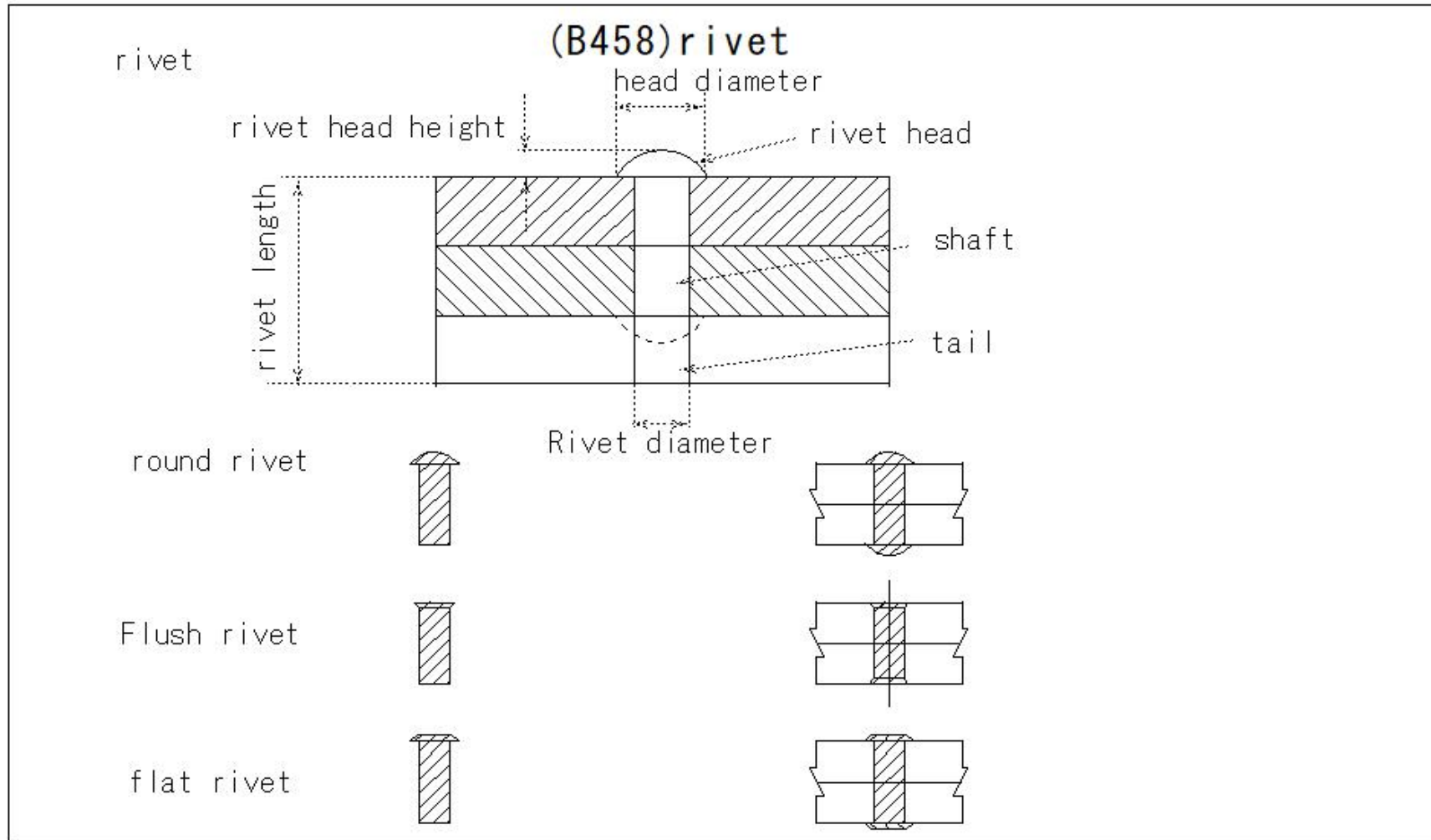
arch rib



Complementary girder

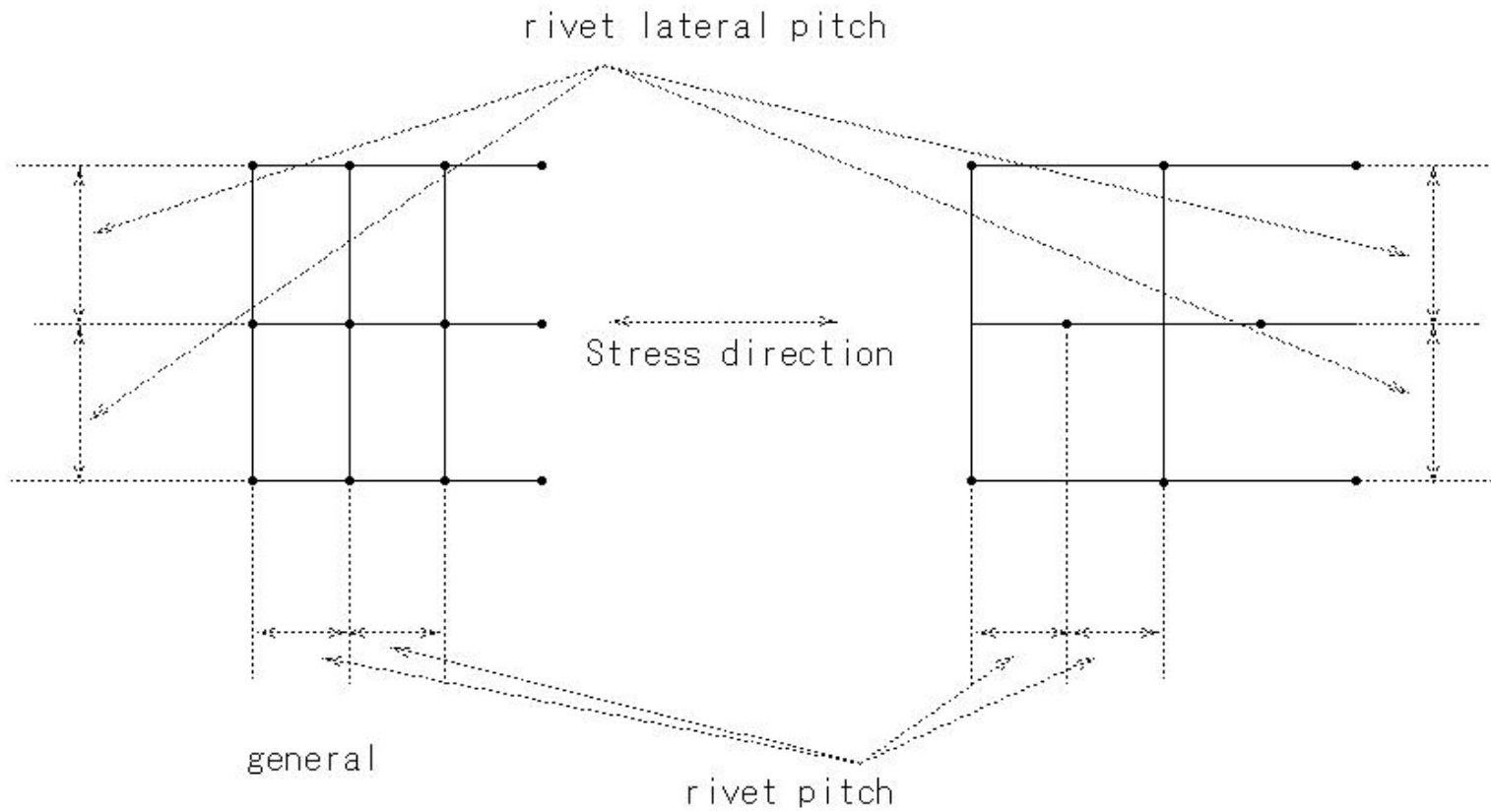
Complementary truss

(B458)rivet



(B459) rivet lateral pitch

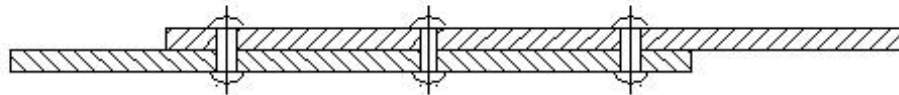
(B459) rivet lateral pitch



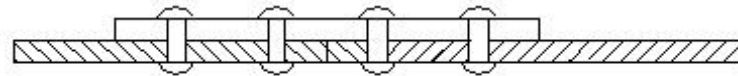
(B460)rivet joint

(B460) rivet joint

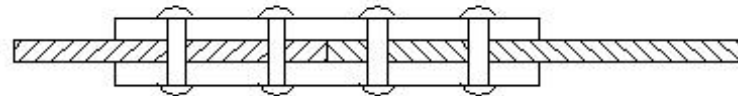
Single shear lap joint



Single shear butt joint

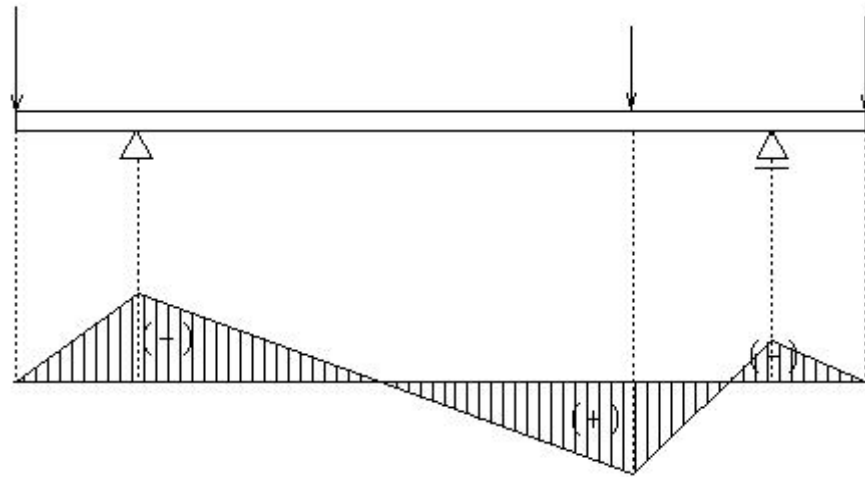


Double shear butt joint



(B461)both end overhanging beam

(B461)both end overhanging beam

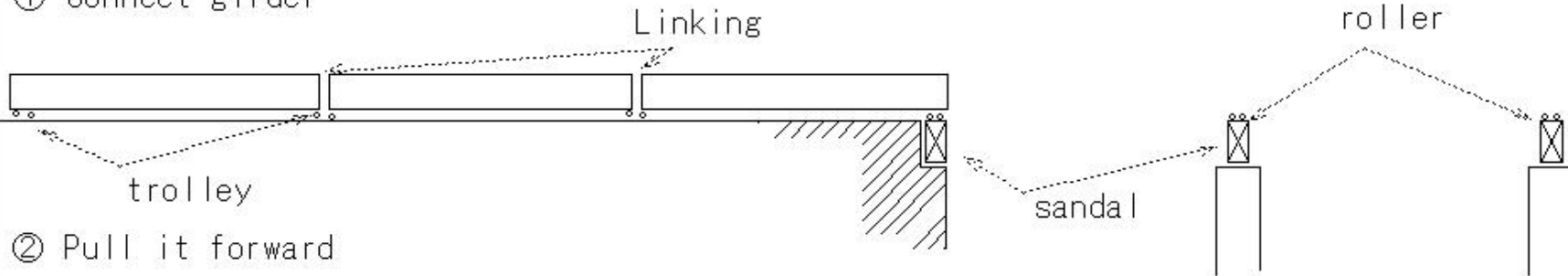


both end overhanging beam

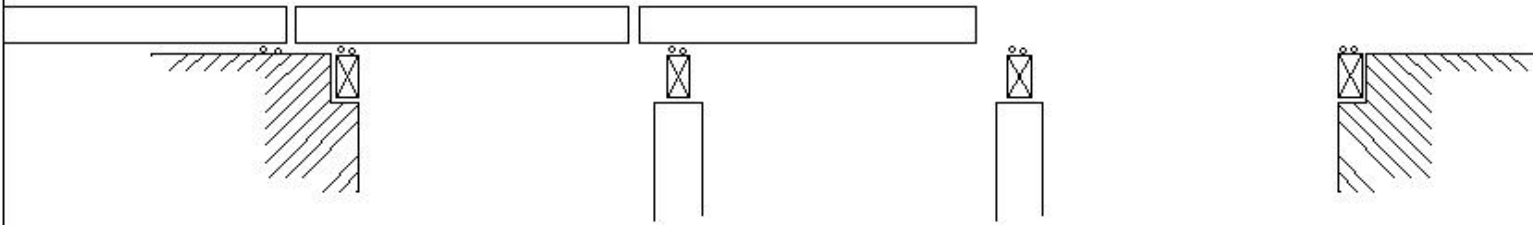
(B462) Interlocking erection method

(B462) Interlocking erection method

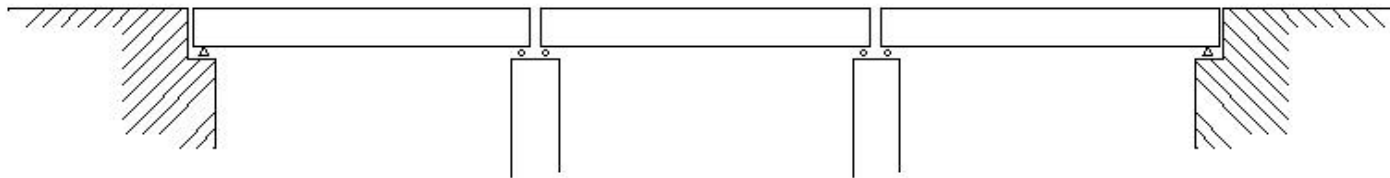
① Connect girder



② Pull it forward



③ Separate and install in a fixed position



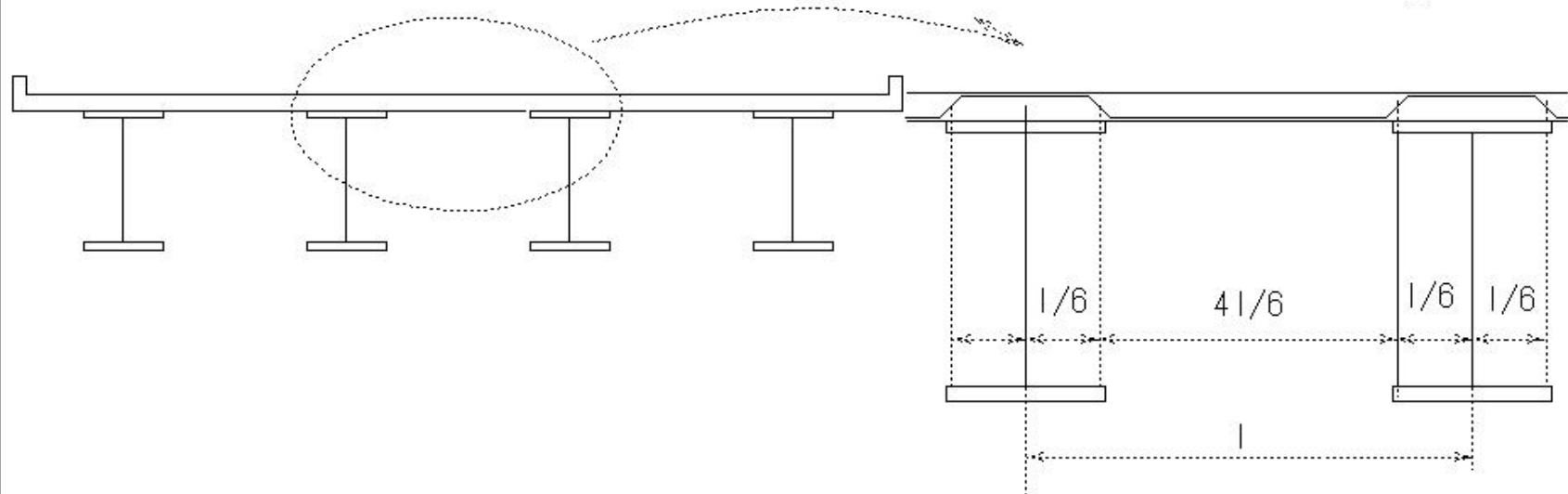
(B463) Continuous slab

(B463) Continuous slab

Continuous slab

Continuous slab of 2 or more spans

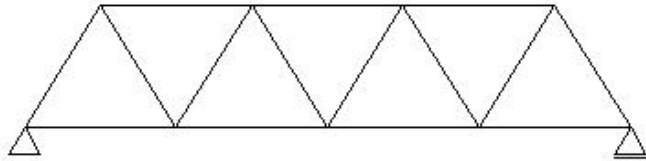
Main reinforcing bar



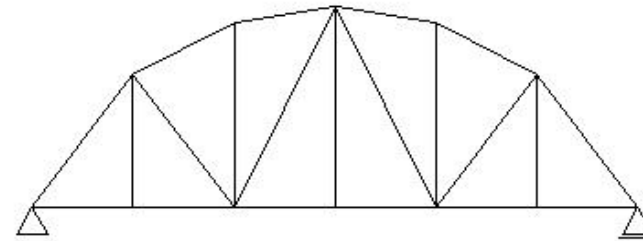
(B464)warren truss

(B464)warren truss

warren truss



straight warren truss



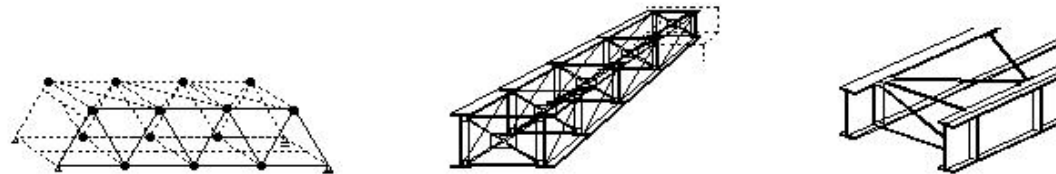
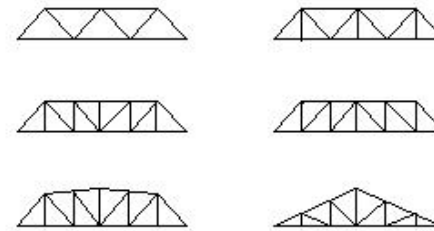
curved warrent truss

(B465) Characteristics of steel structure

(B465) Characteristics of steel structure

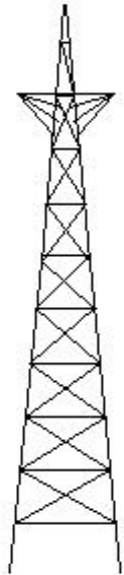
Characteristics of steel structure

- ① Maintenance costs are required to prevent rust.
- ② Easy to change in quality due to heat
- ③ Easy to repair
- ④ Construction period can be shortened
- ⑤ High strength, small weight
- ⑥ Stable in terms of quality

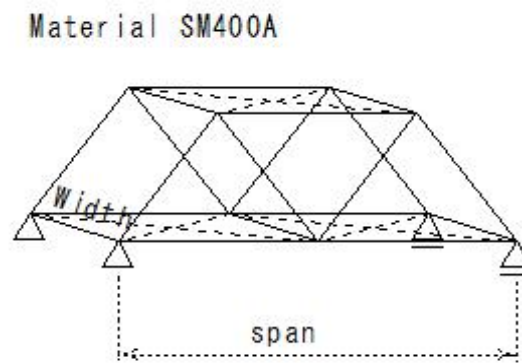


(B466) Characteristics of steel structure

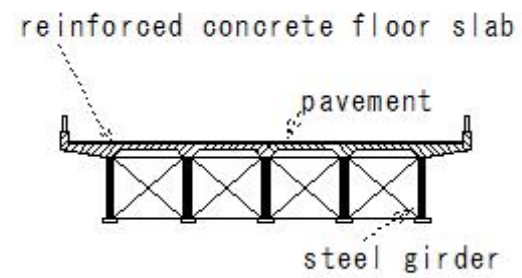
(B466) Characteristics of steel structure



steel tower

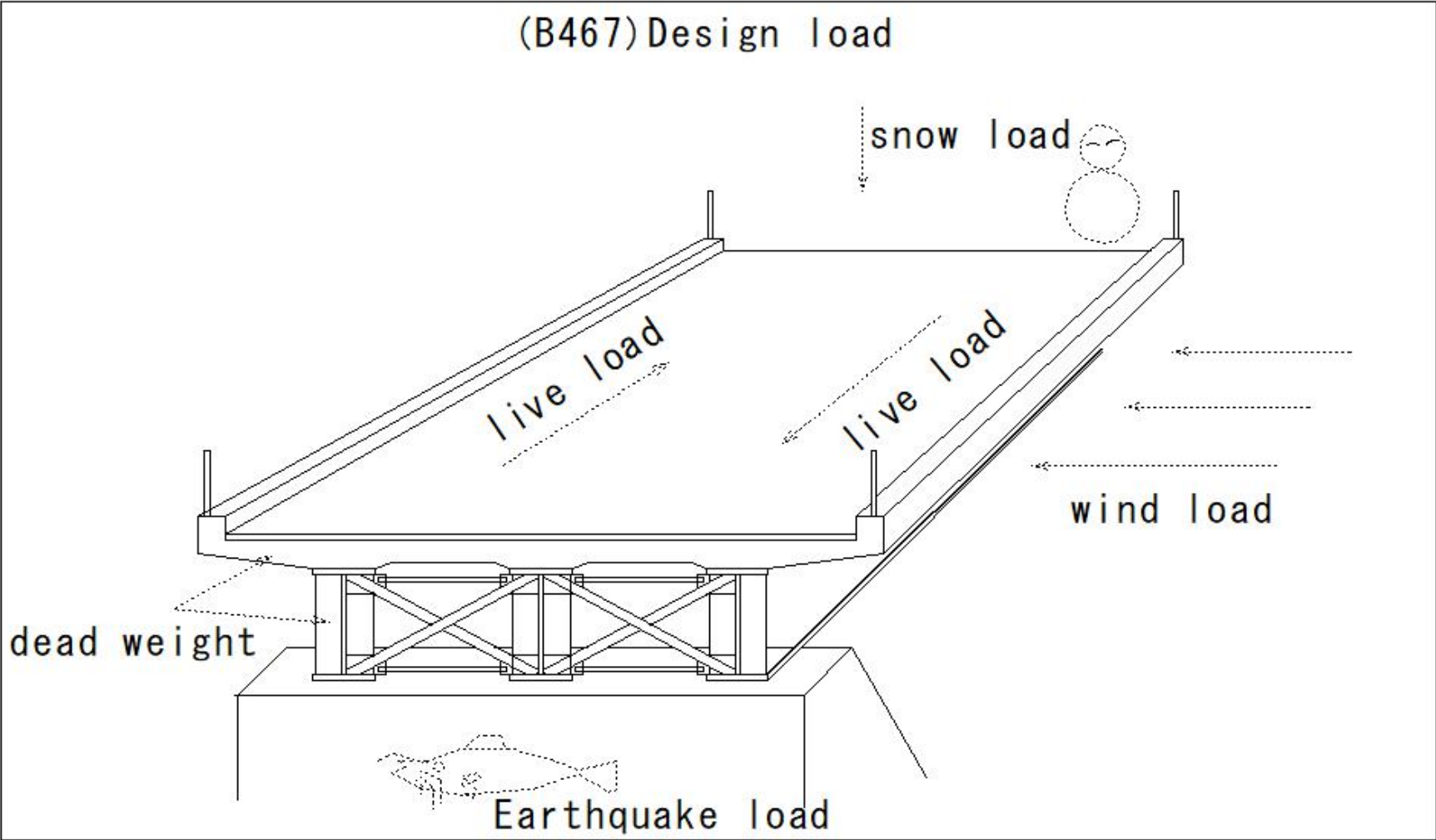


truss bridge



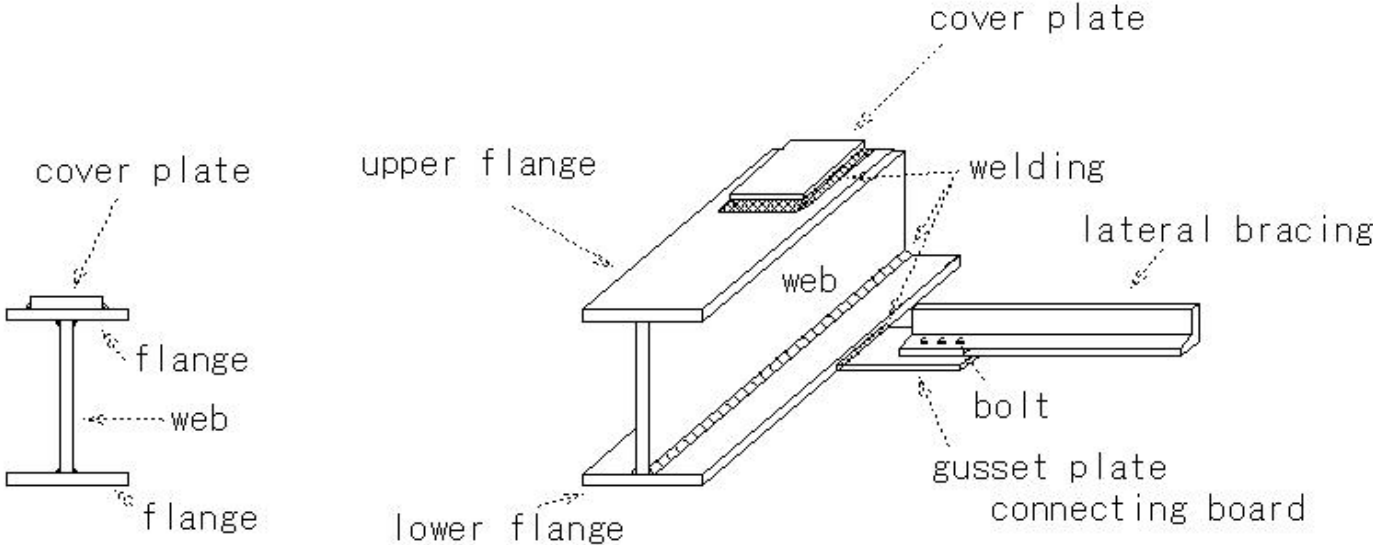
simple plate girder bridge

(B467) Design load



(B468) Type of joining

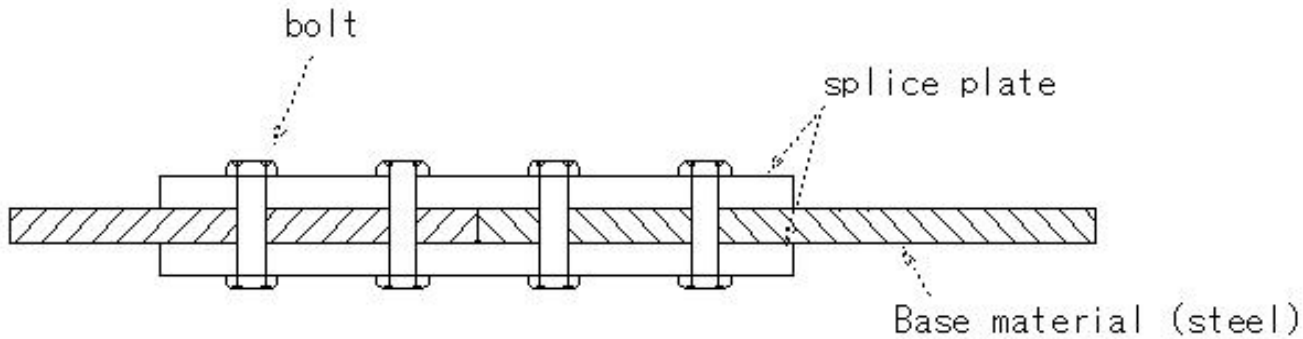
(B468) Type of joining



Structural diagram of plate girder

(B469)member splice

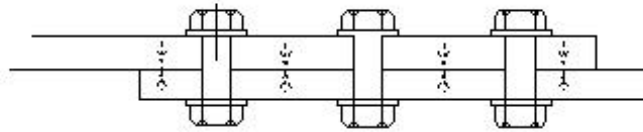
(B469)member splice



member splice

(B470)High strength bolt friction joining

(B470)High strength bolt friction joining

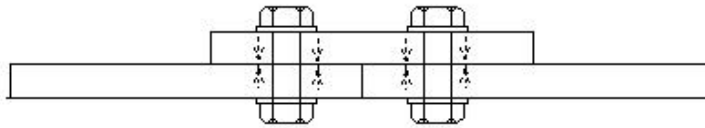


High strength bolt friction joining

One-sided friction

(B471)High strength bolt friction joining

(B471)High strength bolt friction joining

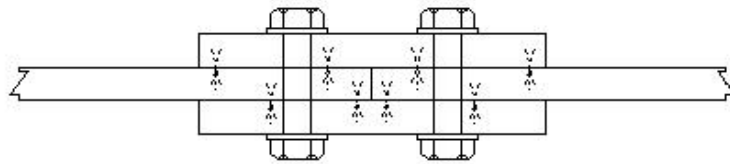


High strength bolt friction joining

One-sided friction

(B472)High strength bolt friction joining

(B472)High strength bolt friction joining



High strength bolt friction joining

two-sided friction

(B473) Allowable force Pa (N) per high-strength bolt friction joint per friction surface

Allowable force Pa (N) per high-strength bolt friction joint per friction surface

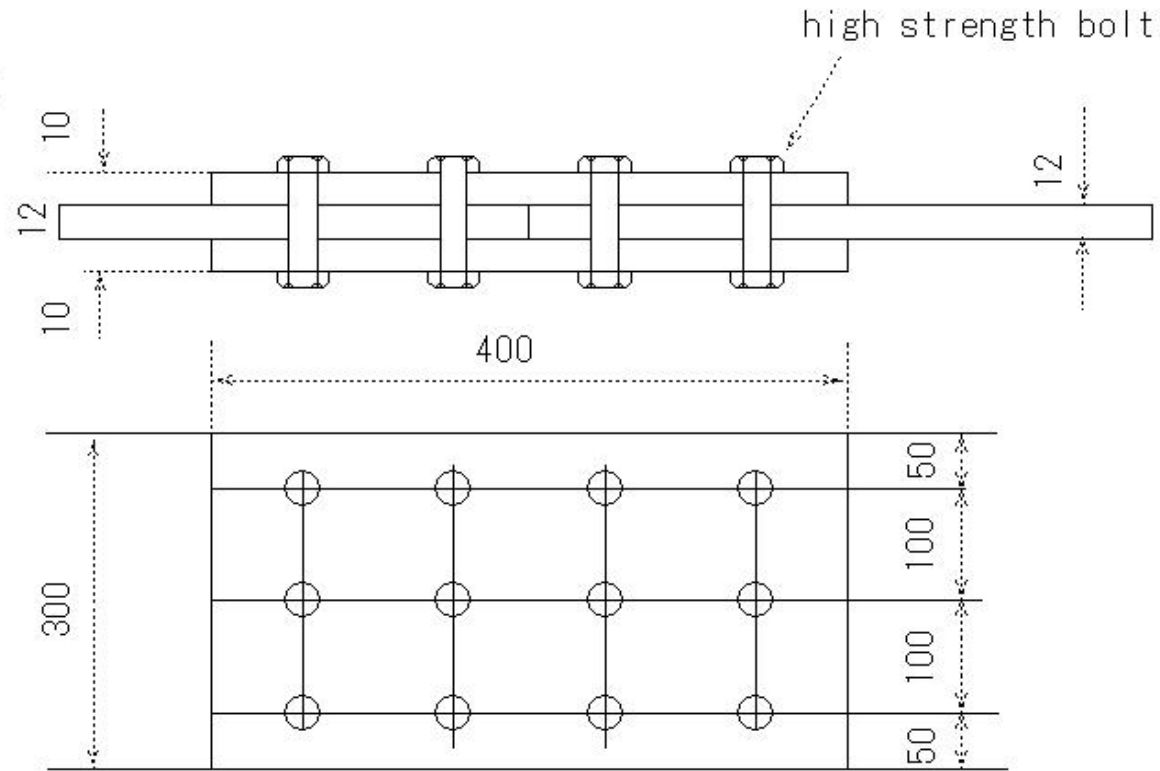
Nominal name of screw	Nominal name of screw		
	F8T	F10T	S10T
M20	30380	38220	38220
M22	38220	47040	47040
M24	44100	54880	54880

F8T
minimum tensile strength
784N/mm² (80kgf/cm²) over
steel material

(B474) Allowable force Pa (N) per high-strength bolt friction joint per friction surface

(B474) Allowable force Pa (N) per high-strength bolt friction joint per friction surface

High strength bolt M22
 Joint strength P
 Bolt material: F8T



Allowable force of one bolt $p_a = 2 \times 38220 = 76440\text{N}$
 two-sided friction
 $P = 6 \times 76440 = 458640\text{N}$

(B475)welding

(B475) welding

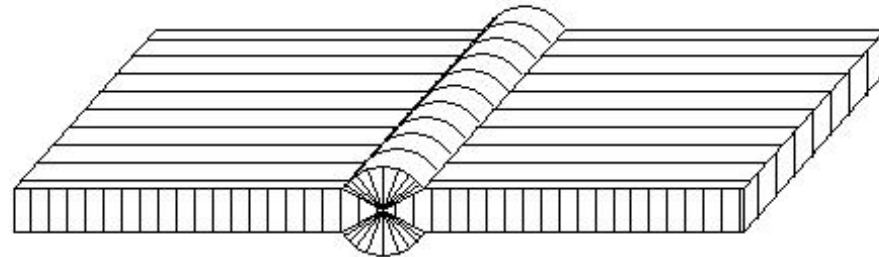
welding

Butt weld joint (group weld)

gas welding

arc welding

Welding strength - determined by material, molten metal -
minimum thickness - throat thickness



Butt weld joint (group weld)

(B476)welding

(B476)welding

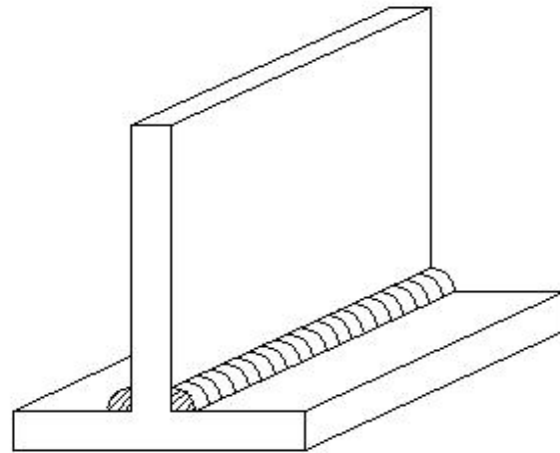
welding

T-joint(fillet weld joint).

gas welding

arc welding

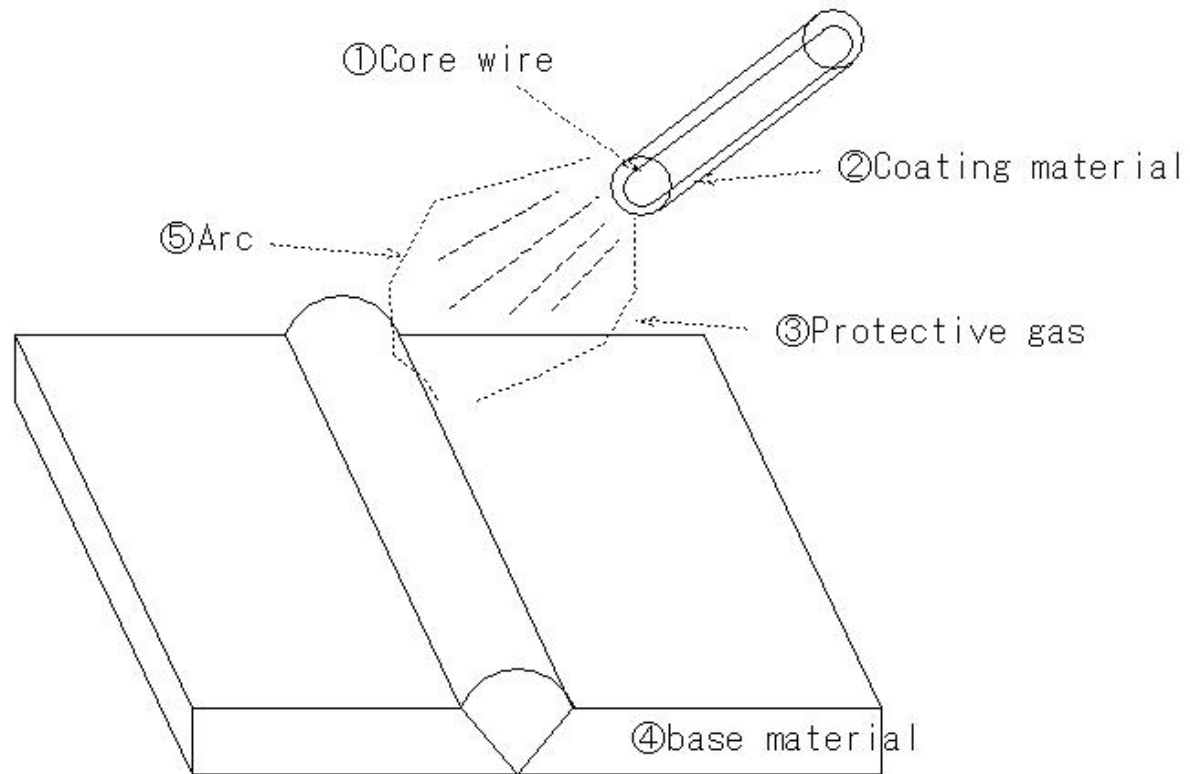
Welding strength - determined by material, molten metal -
minimum thickness - throat thickness



T-joint(fillet weld joint)

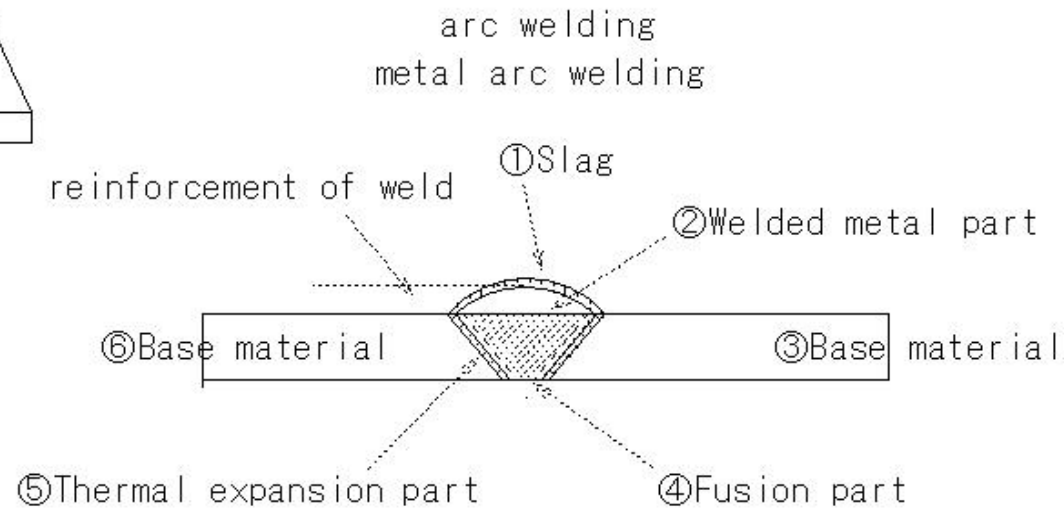
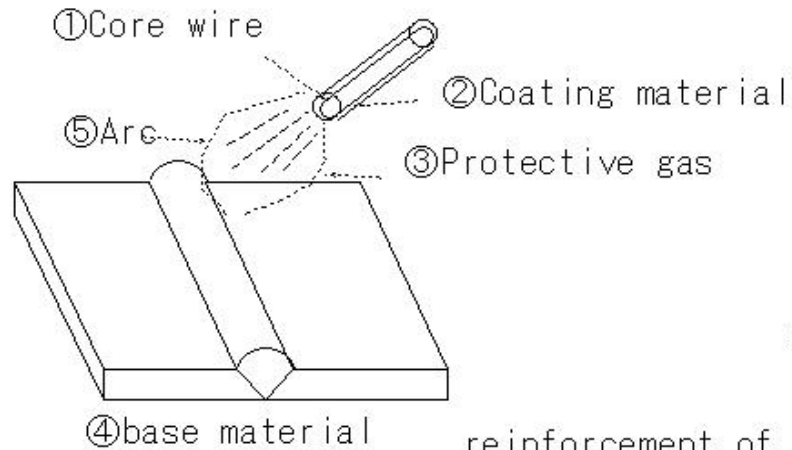
(B477)Arc welding

(B477) Arc welding



(B478)Arc welding

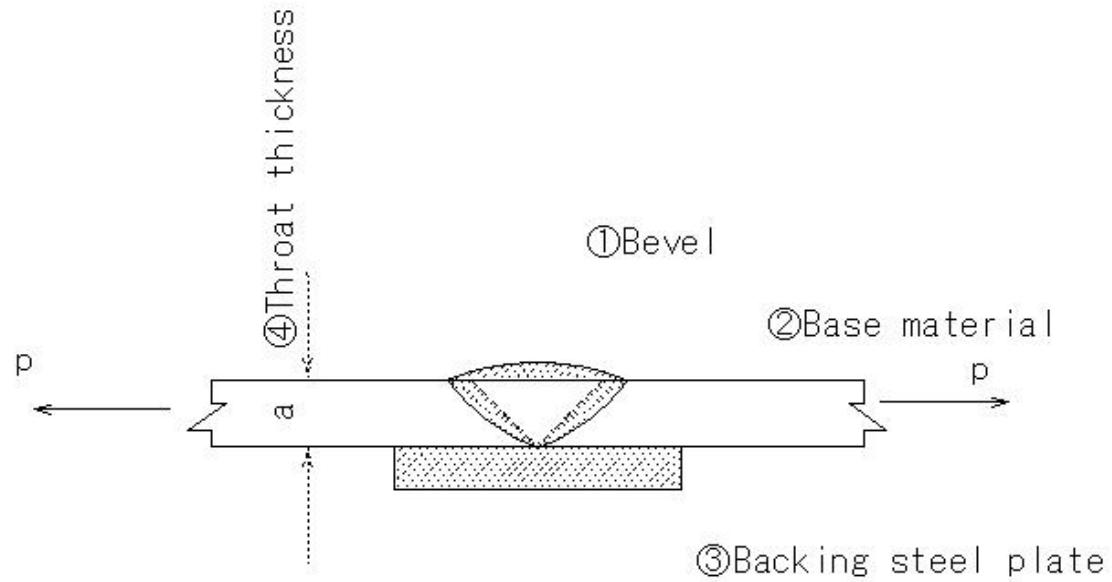
(B478) Arc welding



(B479)group welding

(B479) group welding

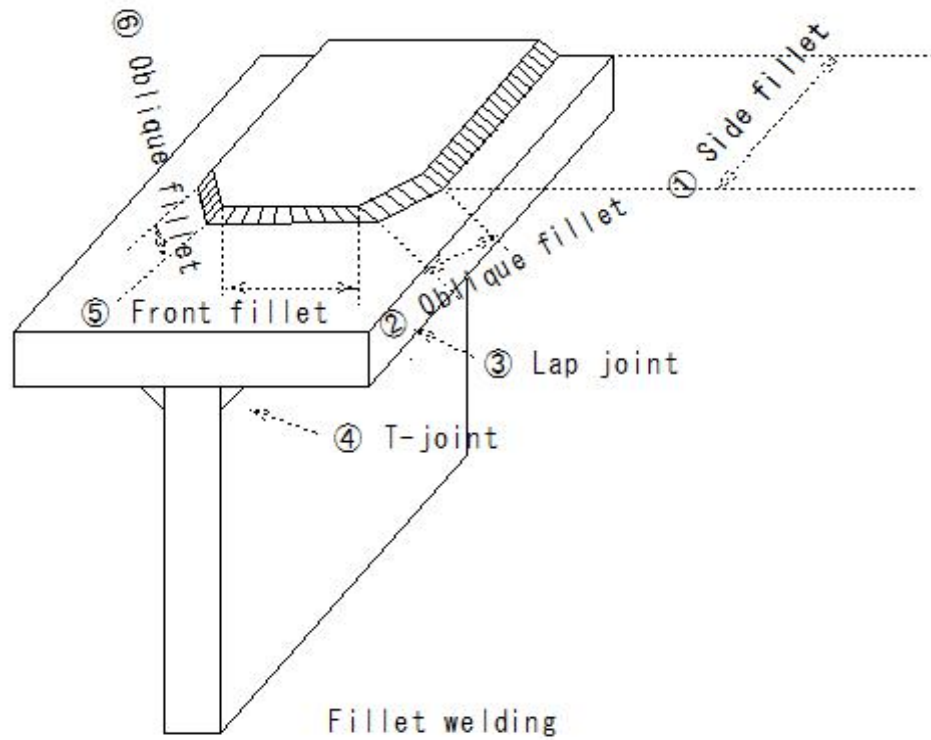
group welding



V-shaped group welding

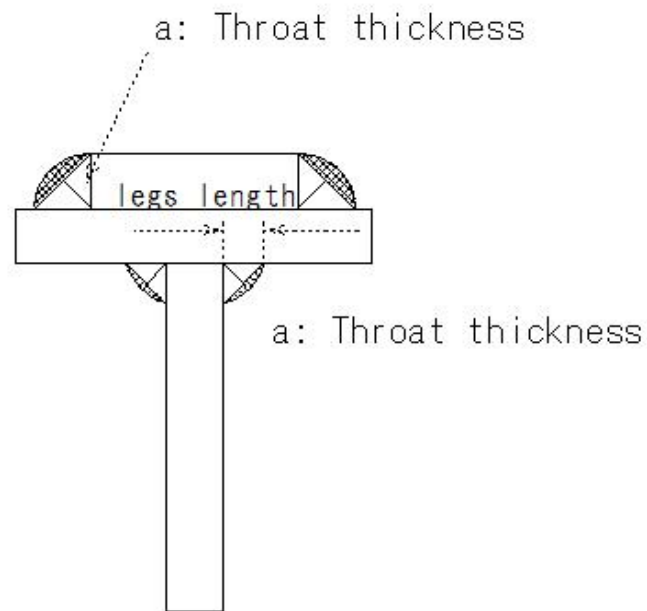
(B480) Fillet welding

(B480) Fillet welding



(B481) Fillet weld cross section

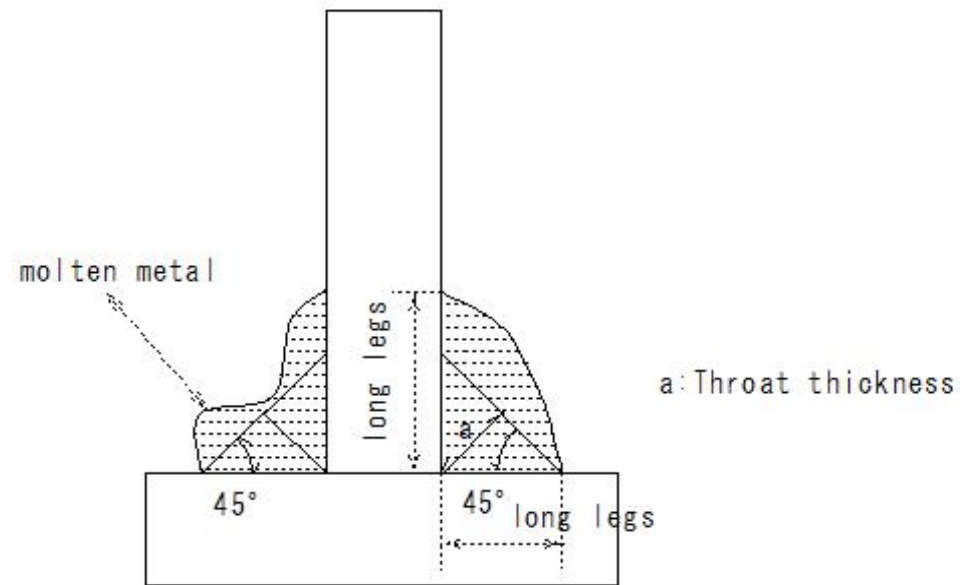
(B481) Fillet weld cross section



Fillet weld cross section

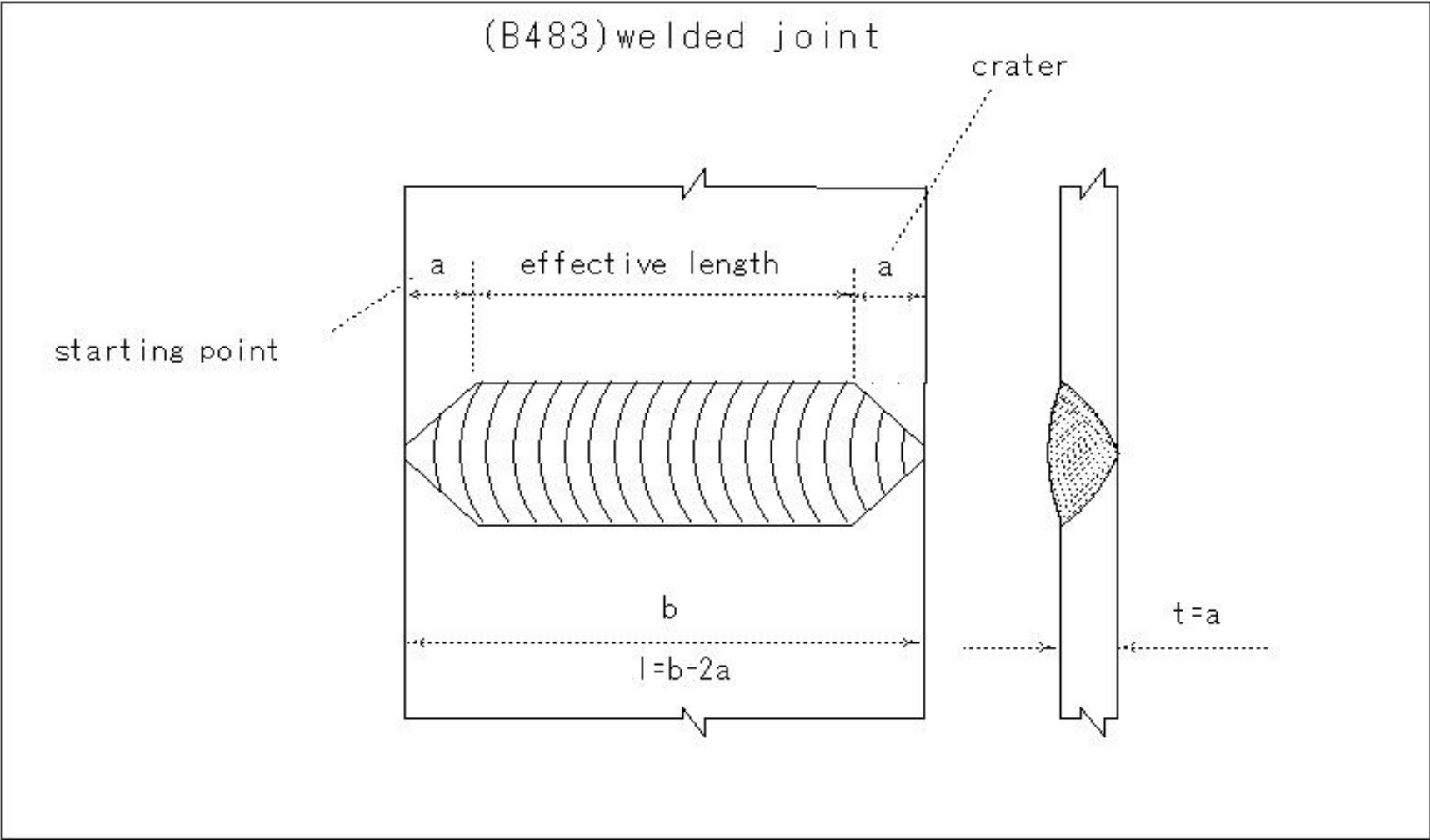
(B482)welded joint Fillet welding(Throat thickness)

(B482)welded joint Fillet welding(Throat thickness)



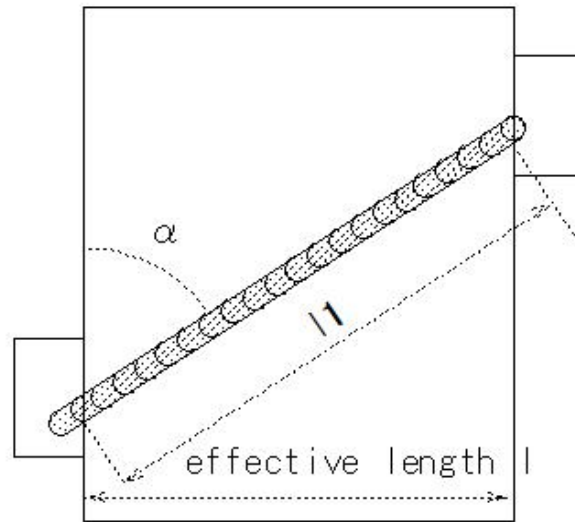
Fillet welding

(B483)welded joint



(B484)welded joint

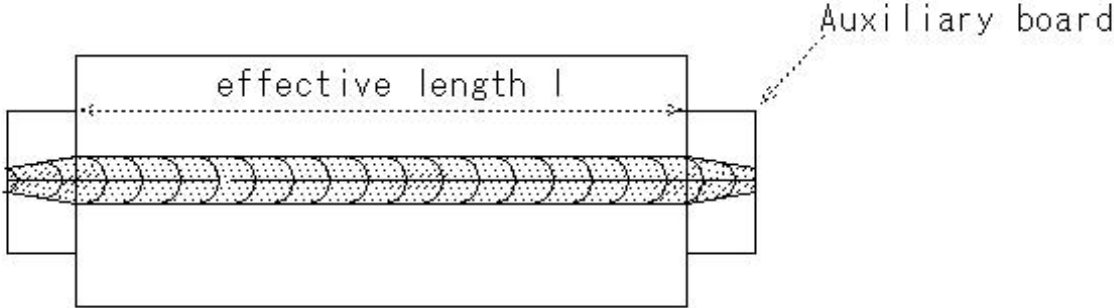
(B484)welded joint



$$l = l_1 \sin \alpha$$

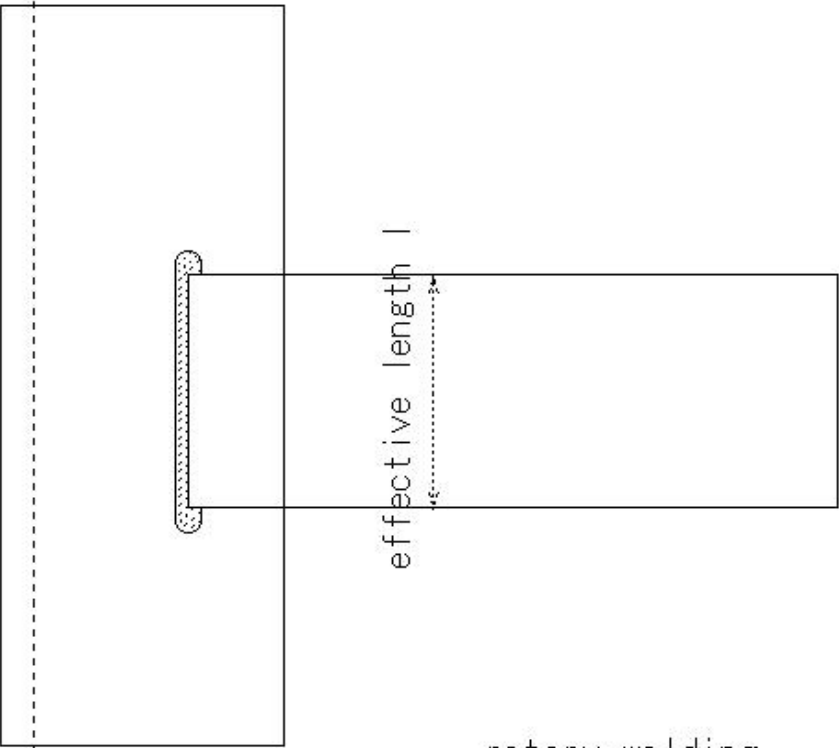
(B485)welded joint

(B485) welded joint



(B486)welded joint

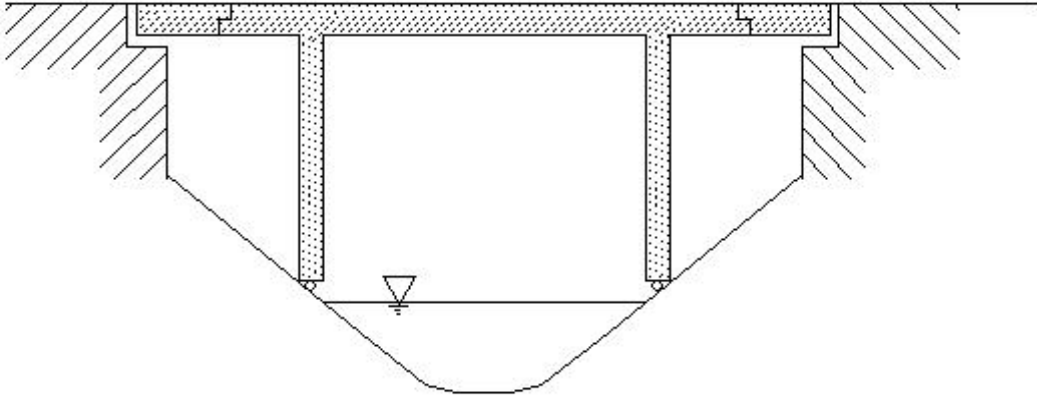
(B486)welded joint



rotary welding

(B487)rahmen bridge

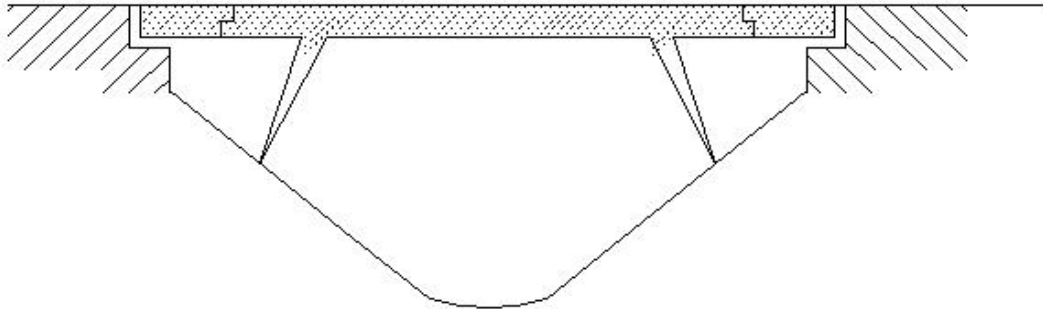
(B487)rahmen bridge



Portal rahmen bridge

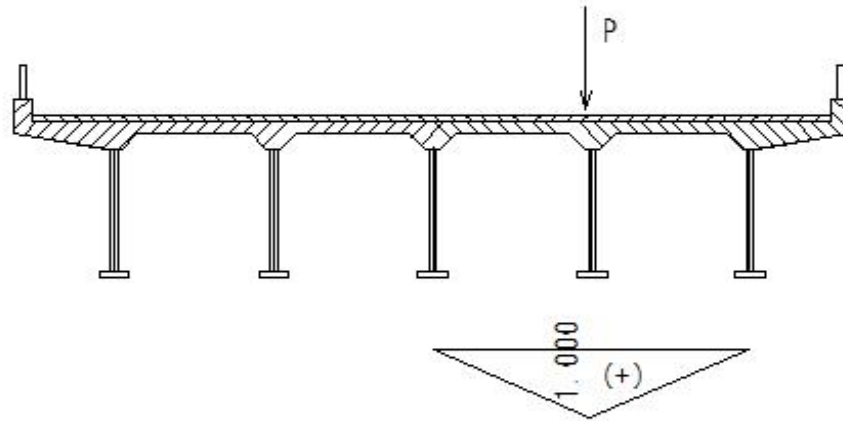
(B488)rahmen bridge

(B488) rahmen bridge



(B489) simple plate girder bridge

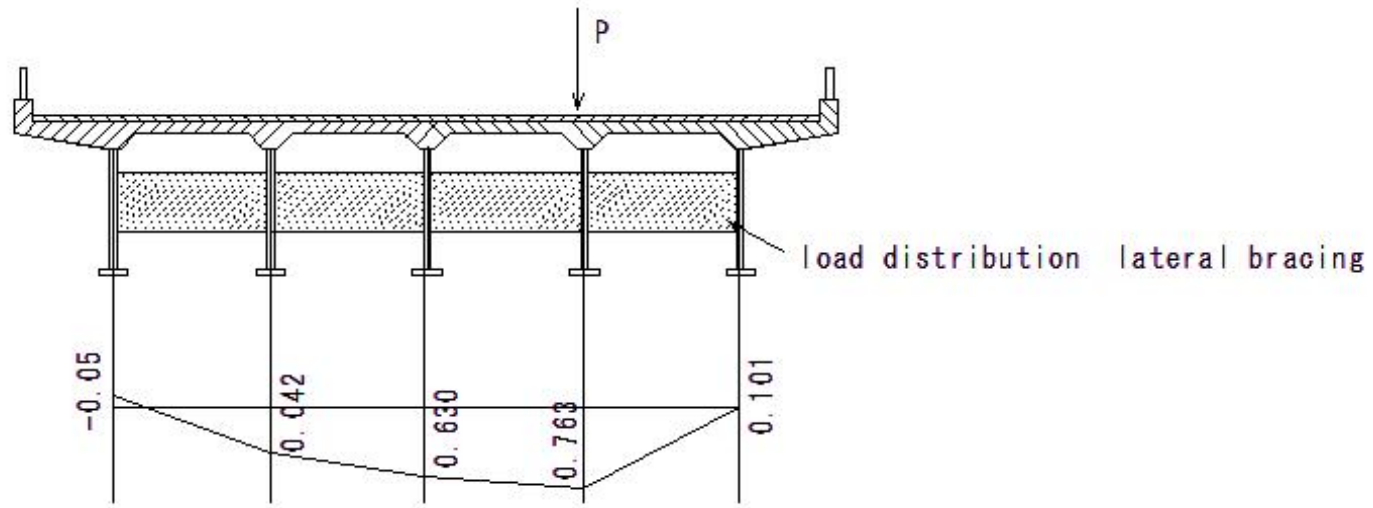
(B489) simple plate girder bridge



simple plate girder bridge

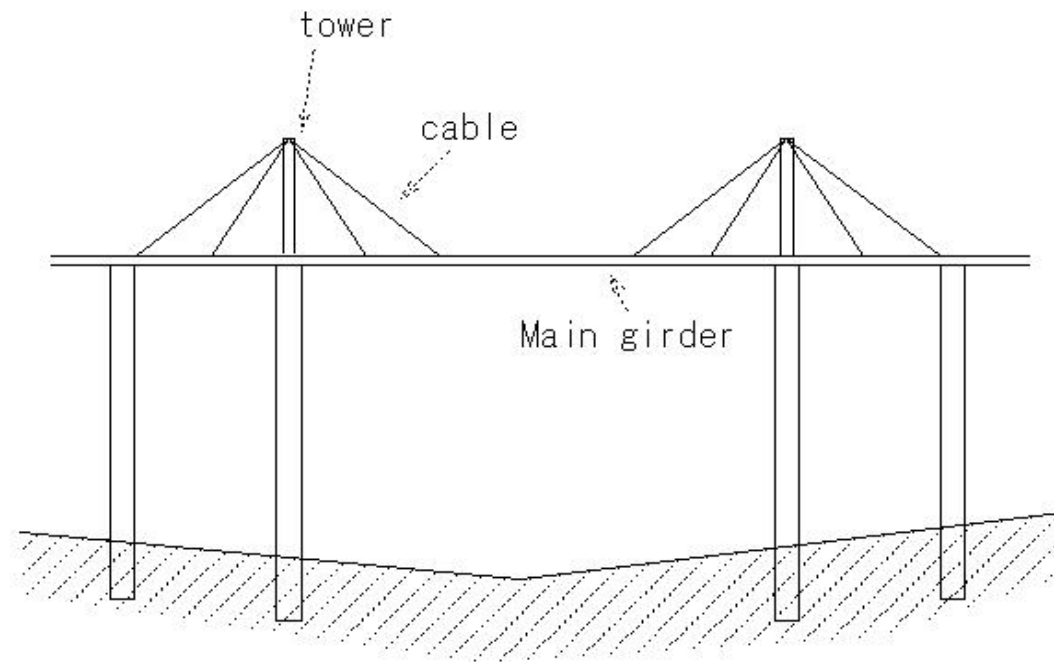
(B490) grid girder bridge

(B490) grid girder bridge



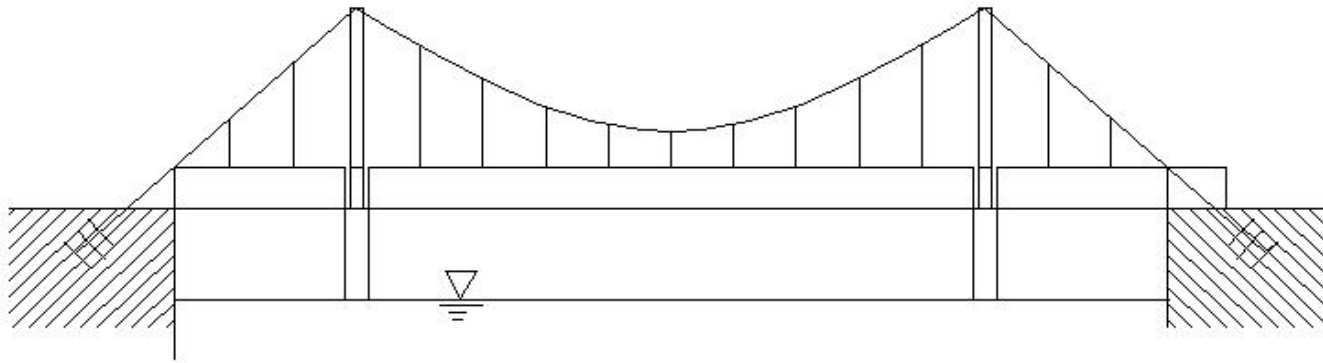
grid girder bridge

(B491) cable-stayed bridge



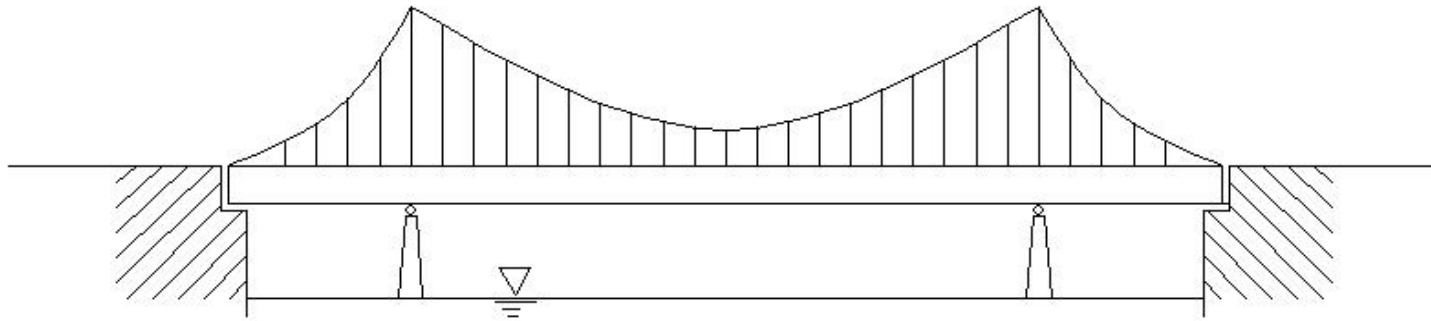
(B492)suspension bridge

(B492) suspension bridge



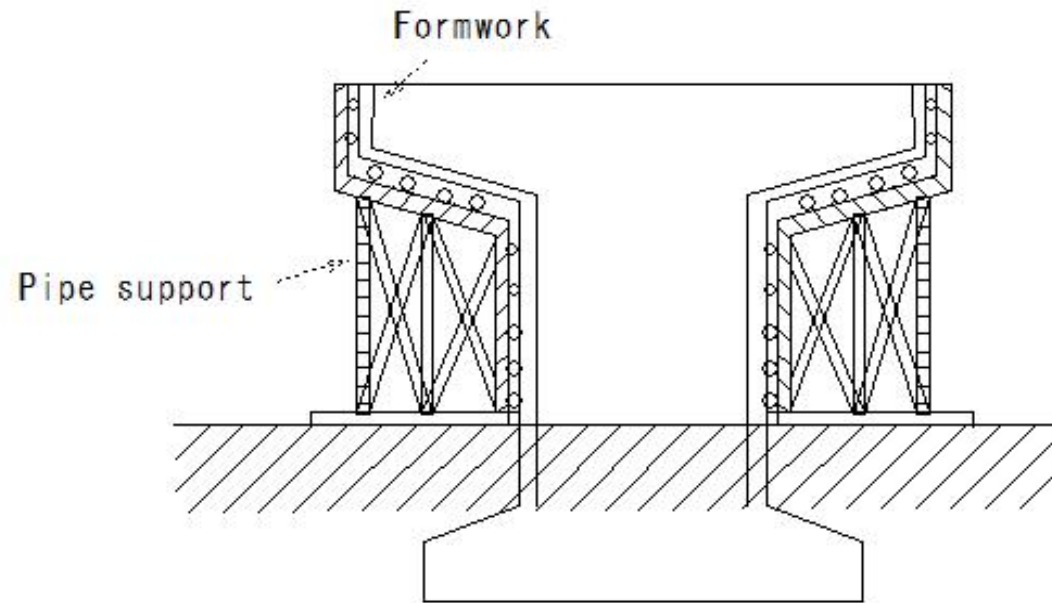
(B493)suspension bridge

(B493) suspension bridge



(B494)Formwork and Support

(B494)Formwork and Support

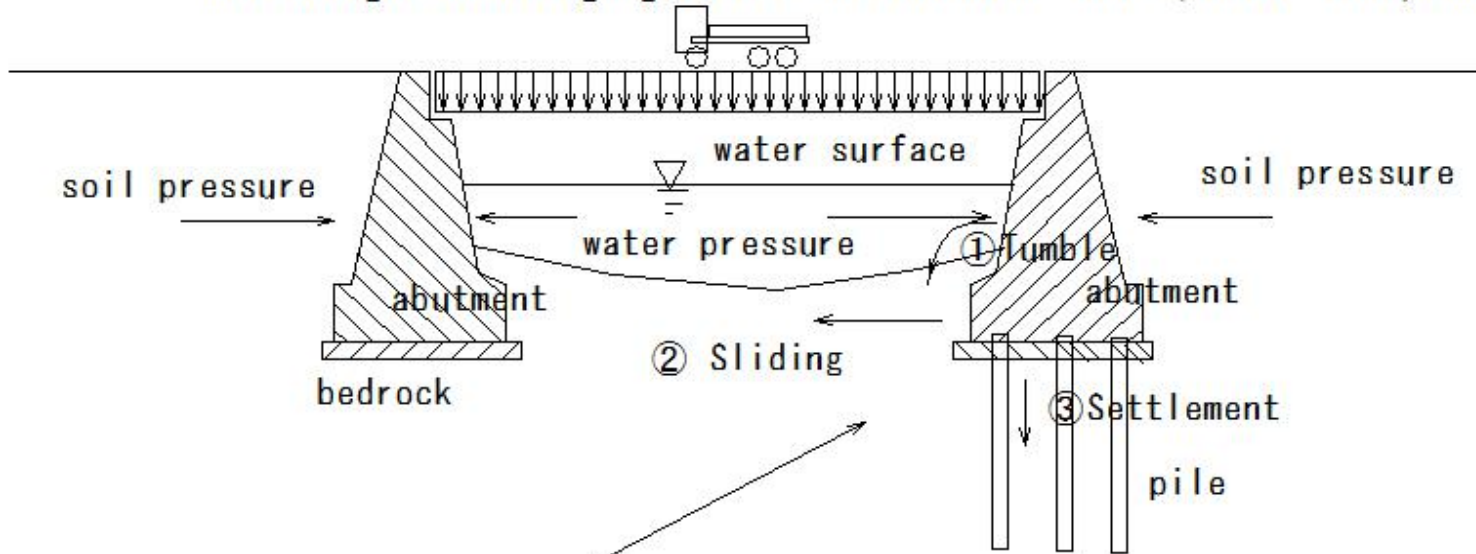


(B495)Concrete structures and loads

(B495) Concrete structures and loads

Concentrated load/dynamic load (live load)

Self-weight of bridge girder is distributed load (static load/fixed load)



Three conditions for external stability

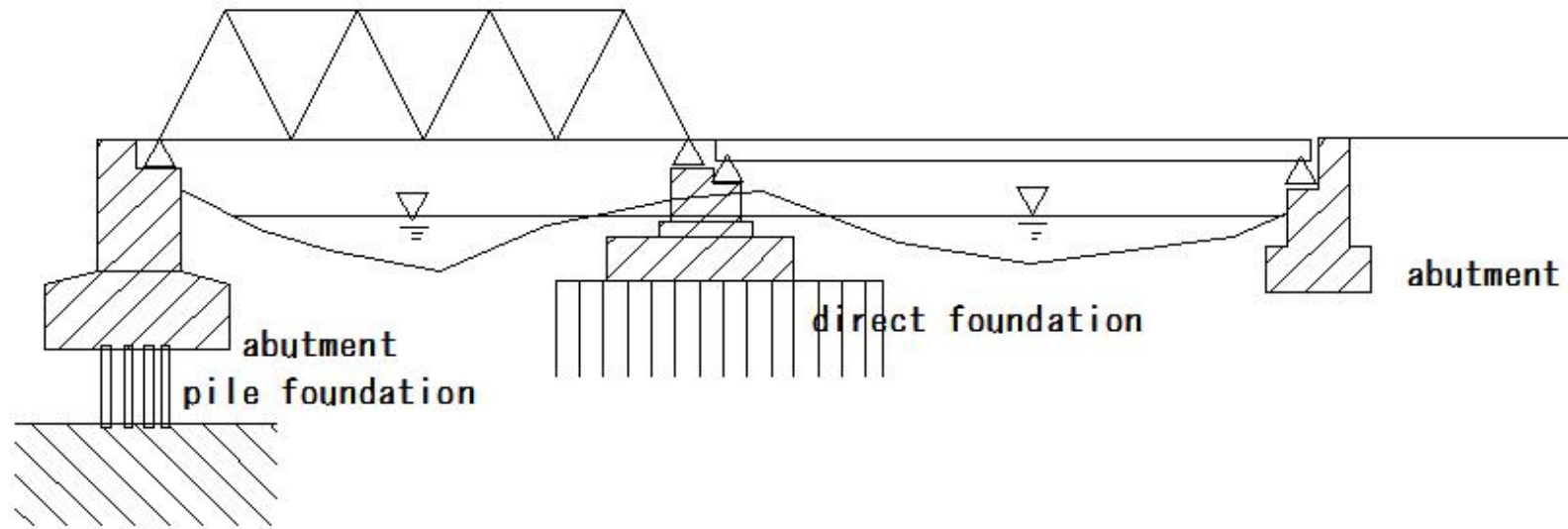
- ① Tumble
- ② Sliding
- ③ Settlement

(B496)Concrete bridge-Truss bridge

(B496) Concrete bridge-Truss bridge

Concrete bridge

① Truss bridge



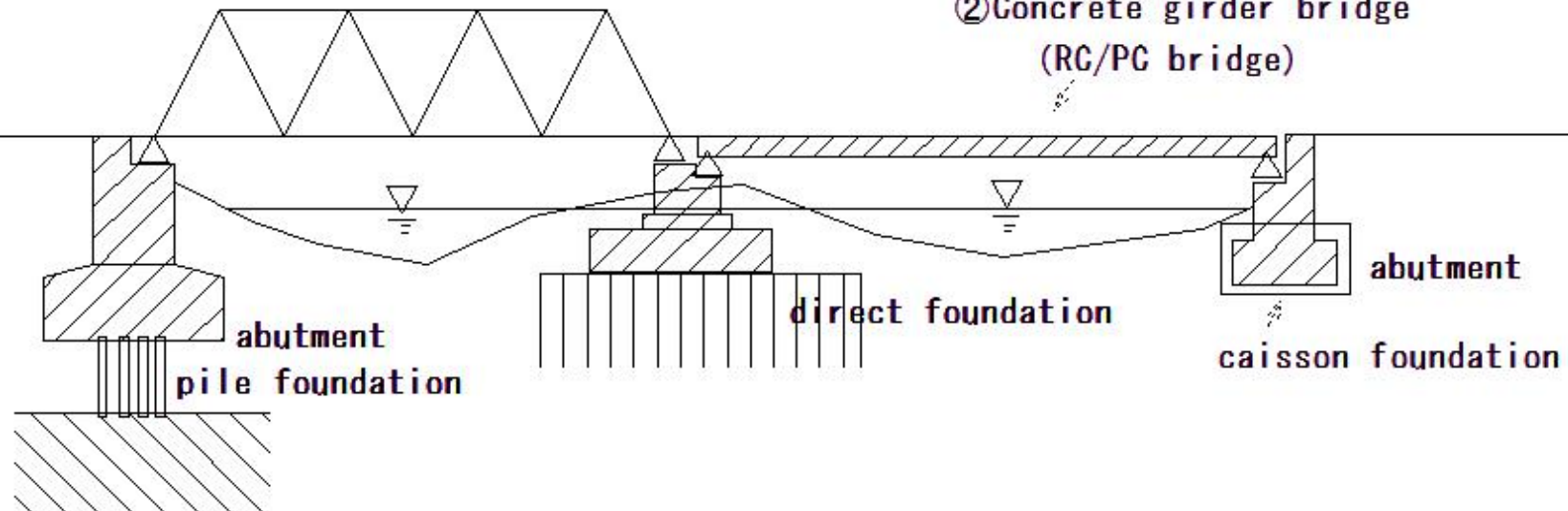
(B497)Concrete bridge-Concrete girder bridge

(B497) Concrete bridge-Concrete girder bridge

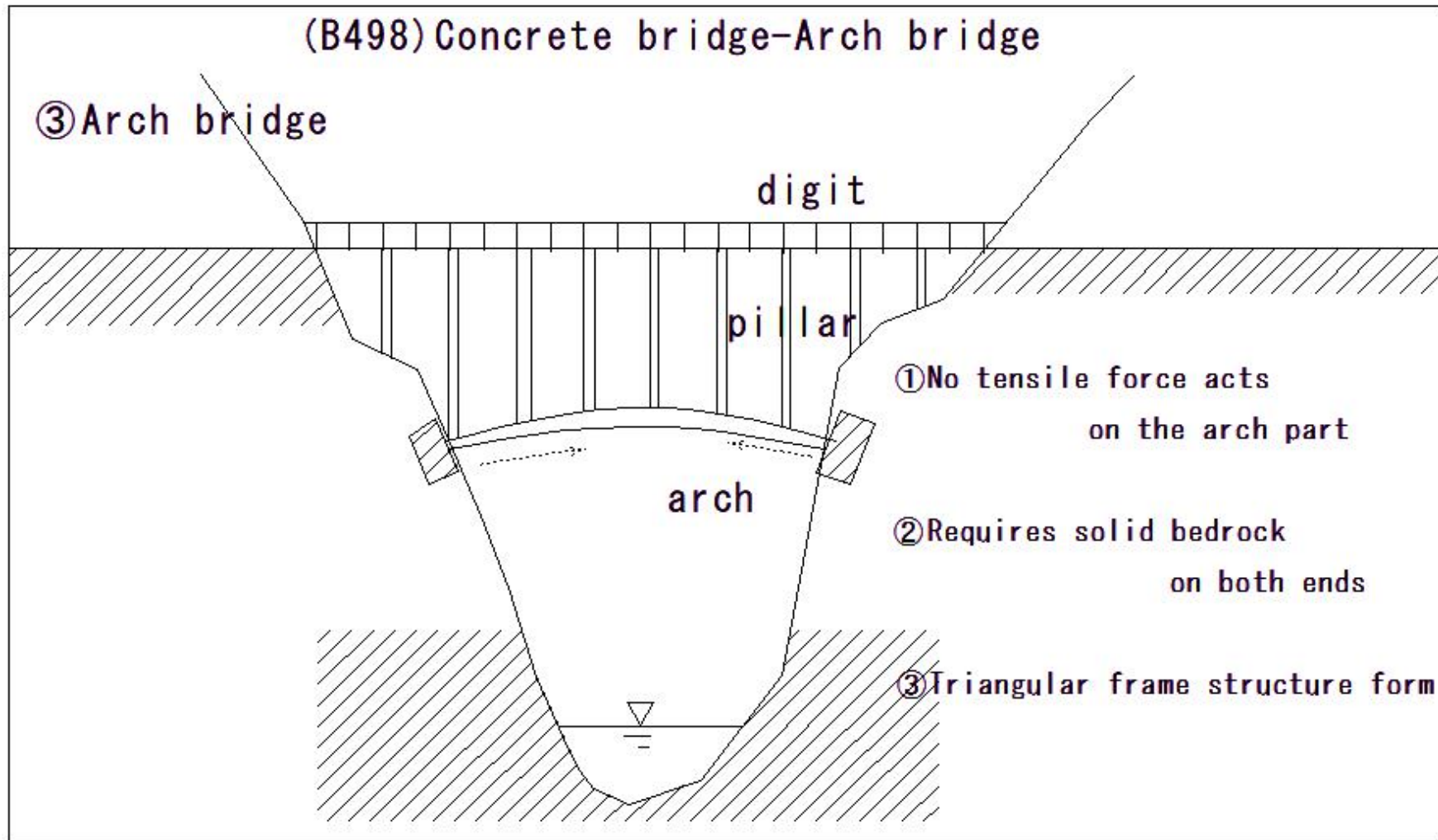
Concrete bridge

① Truss bridge

② Concrete girder bridge
(RC/PC bridge)



(B498)Concrete bridge-Arch bridge



(B498) Concrete bridge-Arch bridge

③ Arch bridge

digit

pillar

arch

① No tensile force acts on the arch part

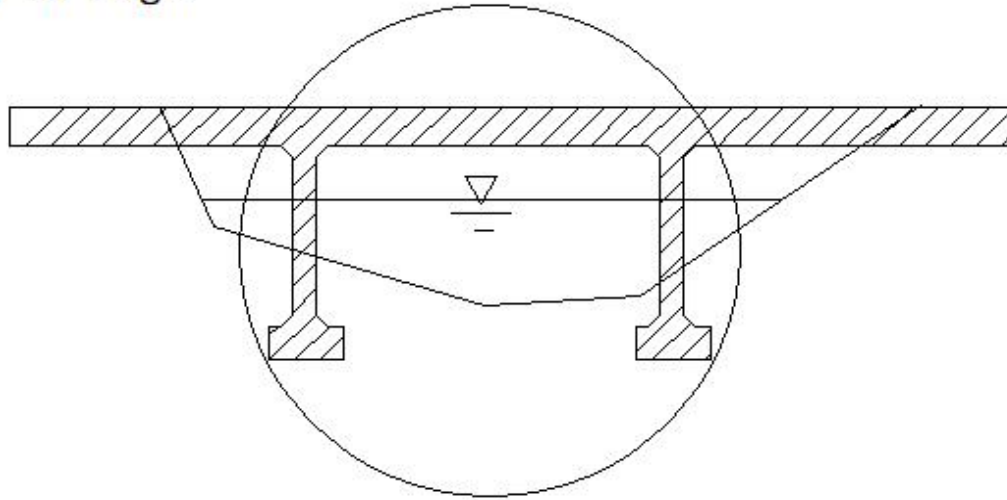
② Requires solid bedrock on both ends

③ Triangular frame structure form

(B499)Concrete bridge-Rahmen Bridge

(B499) Concrete bridge-Rahmen Bridge

④Rahmen Bridge



rigid structure

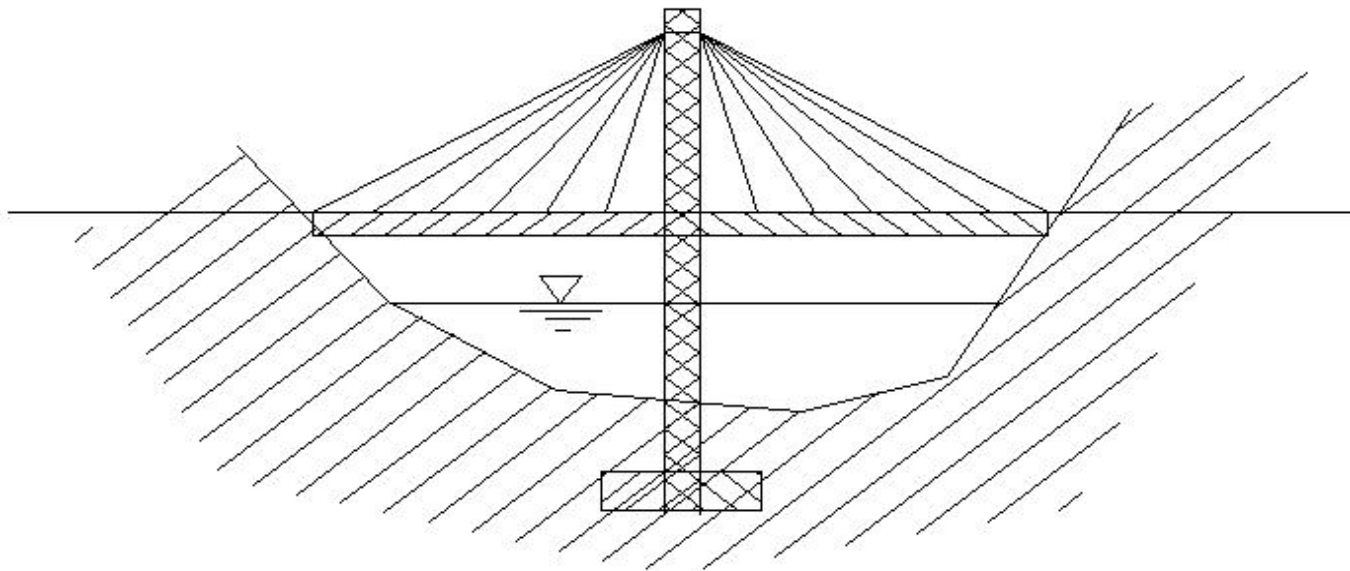
Excellent earthquake resistance

rigid connection

(B500)Concrete bridge-Cable stayed bridge

(B500) Concrete bridge-Cable stayed bridge

⑤ Cable stayed bridge



Cable stayed bridge

PC steel

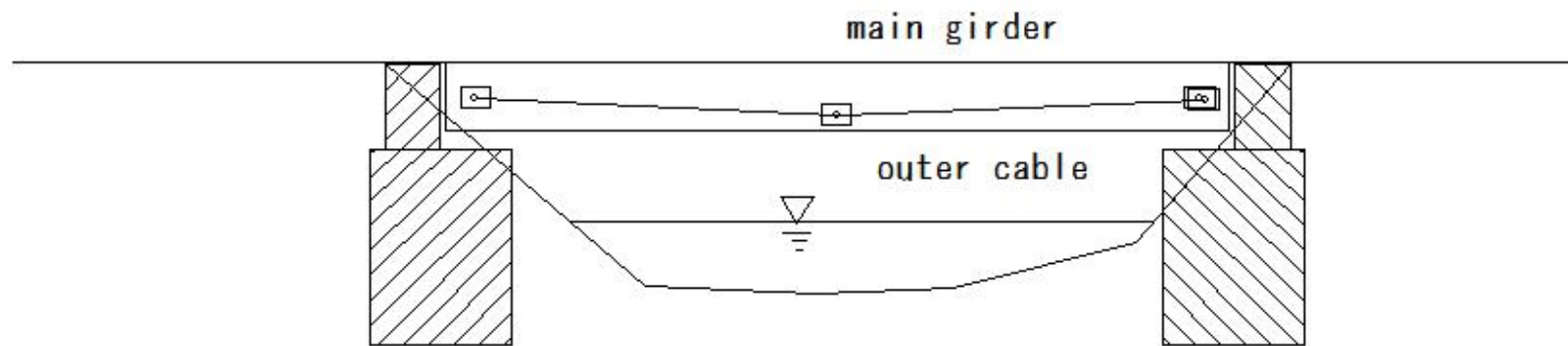
Stretch the cable (PC steel) diagonally

Good left/right balance

looks good

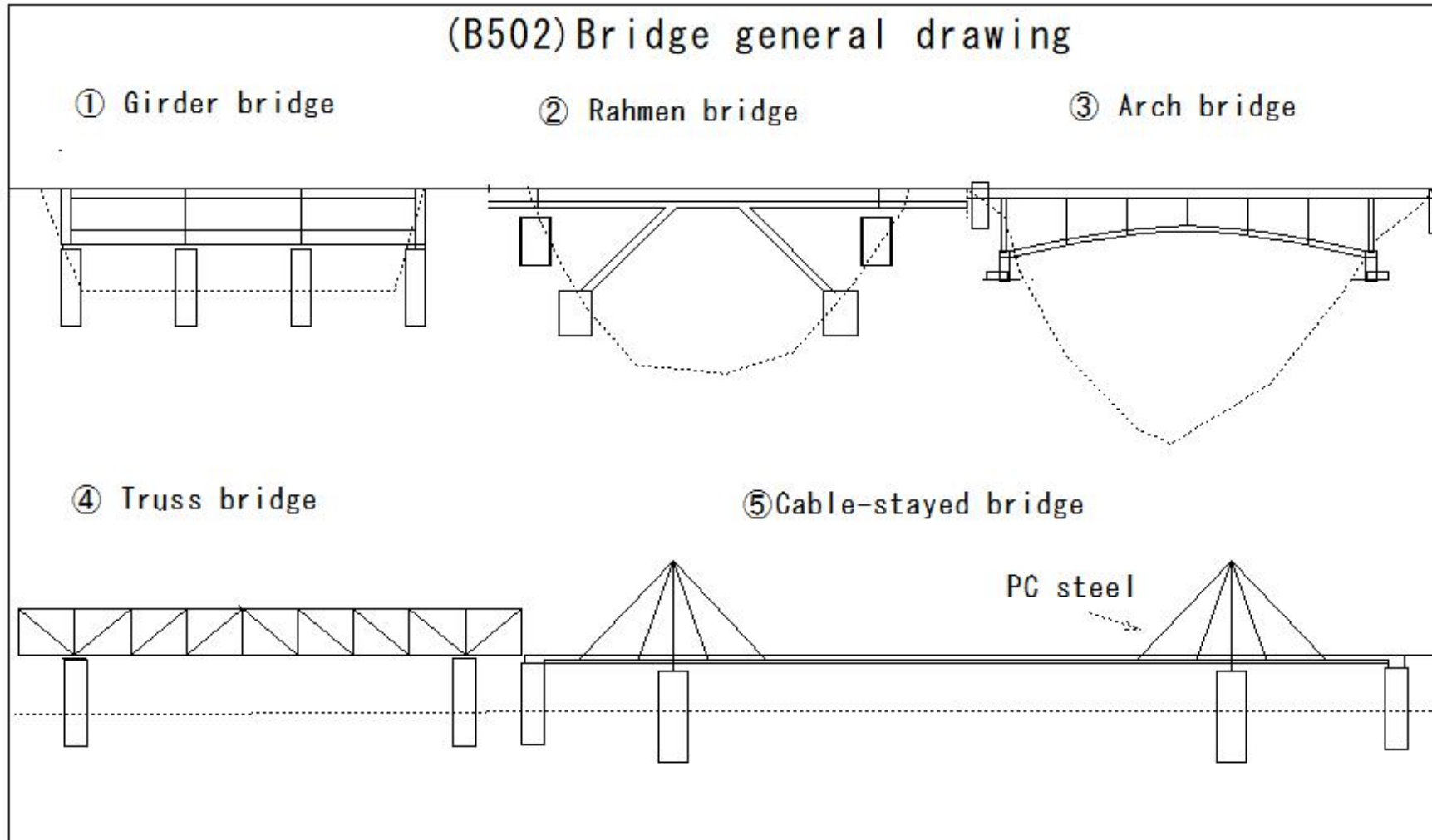
(B501)Concrete bridge-Outer cable PC bridge

(B501) Concrete bridge-Outer cable PC bridge



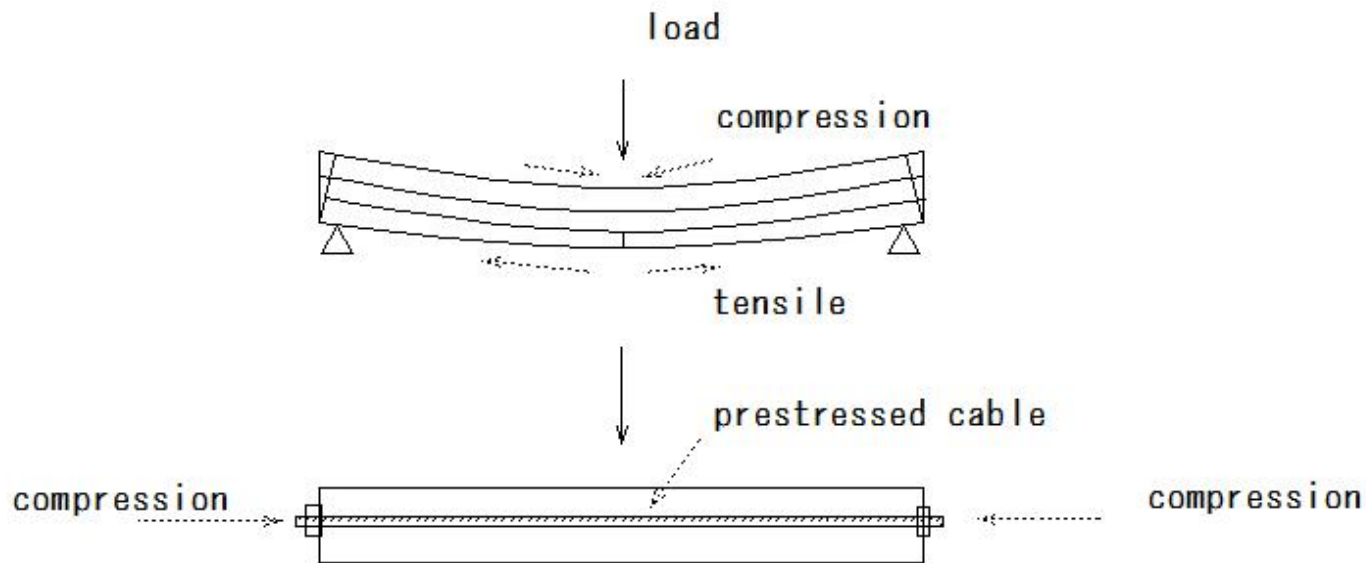
- ⑥ Outer cable PC bridge
 - Tensioning PC Steel Outside Concrete Girder
 - Improved workability
 - Lightening of the main girder is possible

(B502) Bridge general drawing



(B503) Prestressed concrete

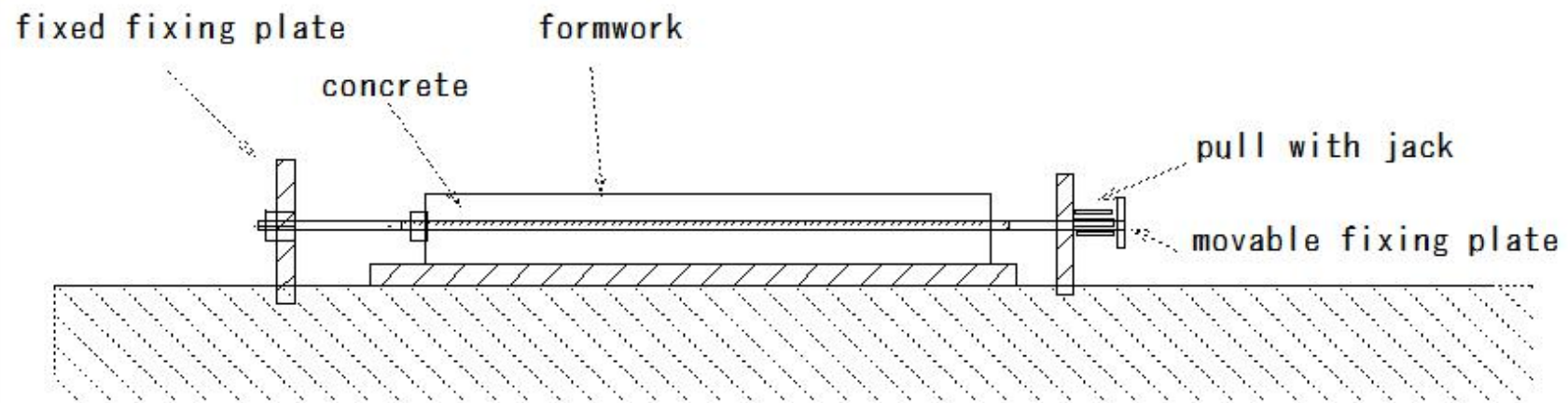
(B503) Prestressed concrete



compression force is always generated, tensile force is generated

(B504) Pretension method

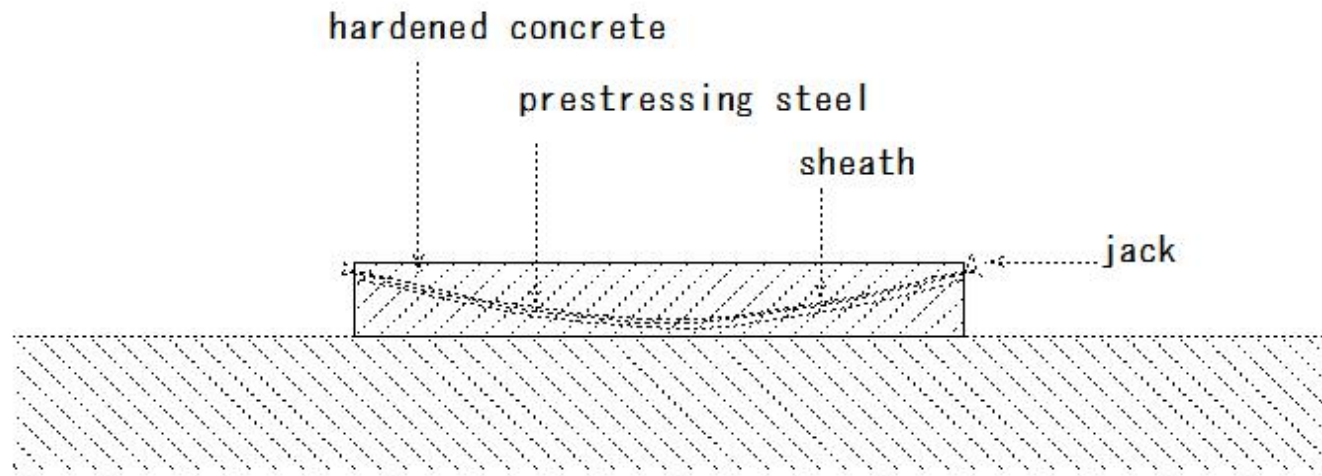
(B504) Pretension method



- ① Insert tensioned PC steel
- ② Concrete placement and curing
- ③ After the concrete hardens, move the operation fixing plate to loosen the tension of the prestressing steel material.

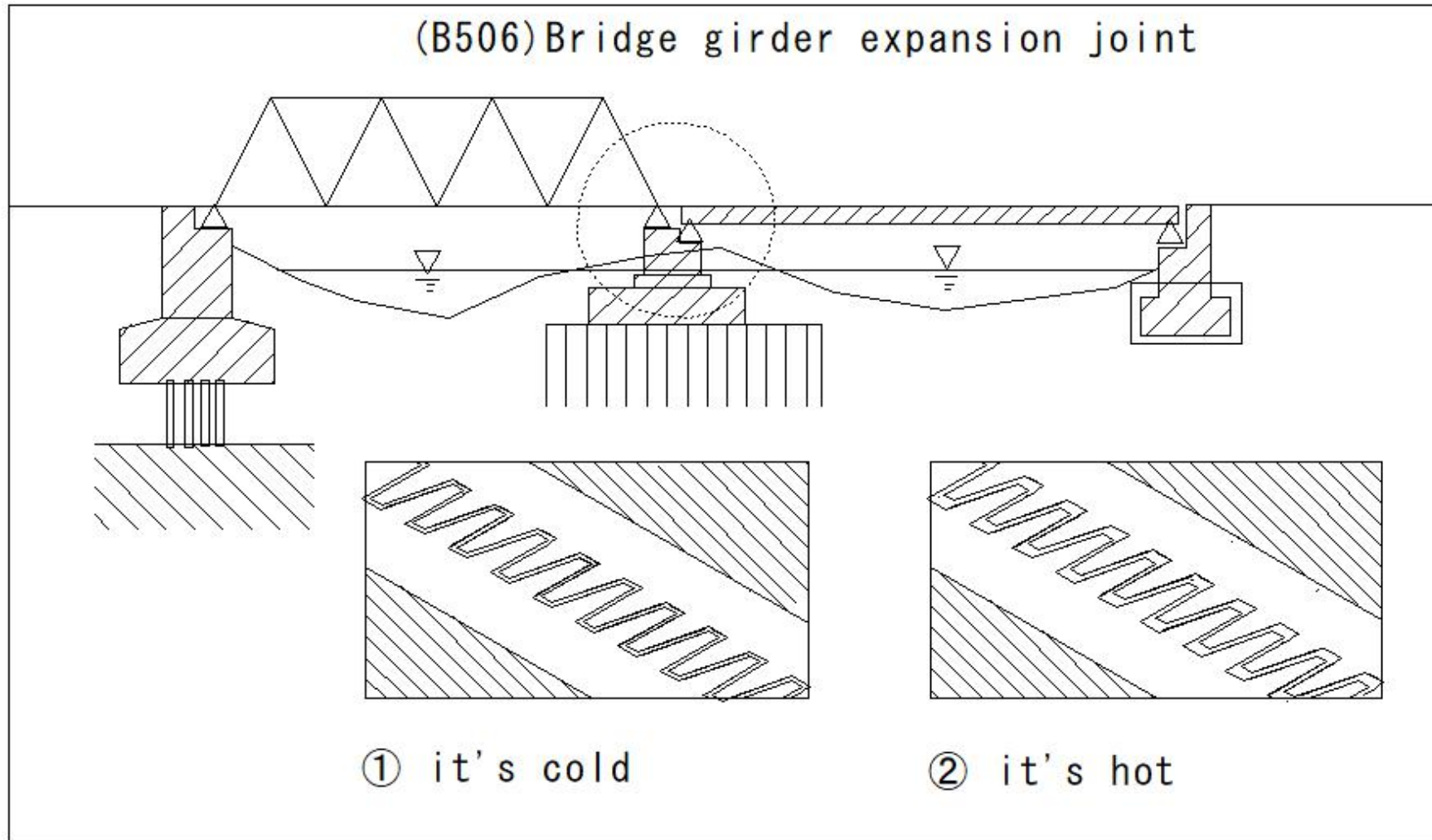
(B505)Post tension method

(B505) Post tension method

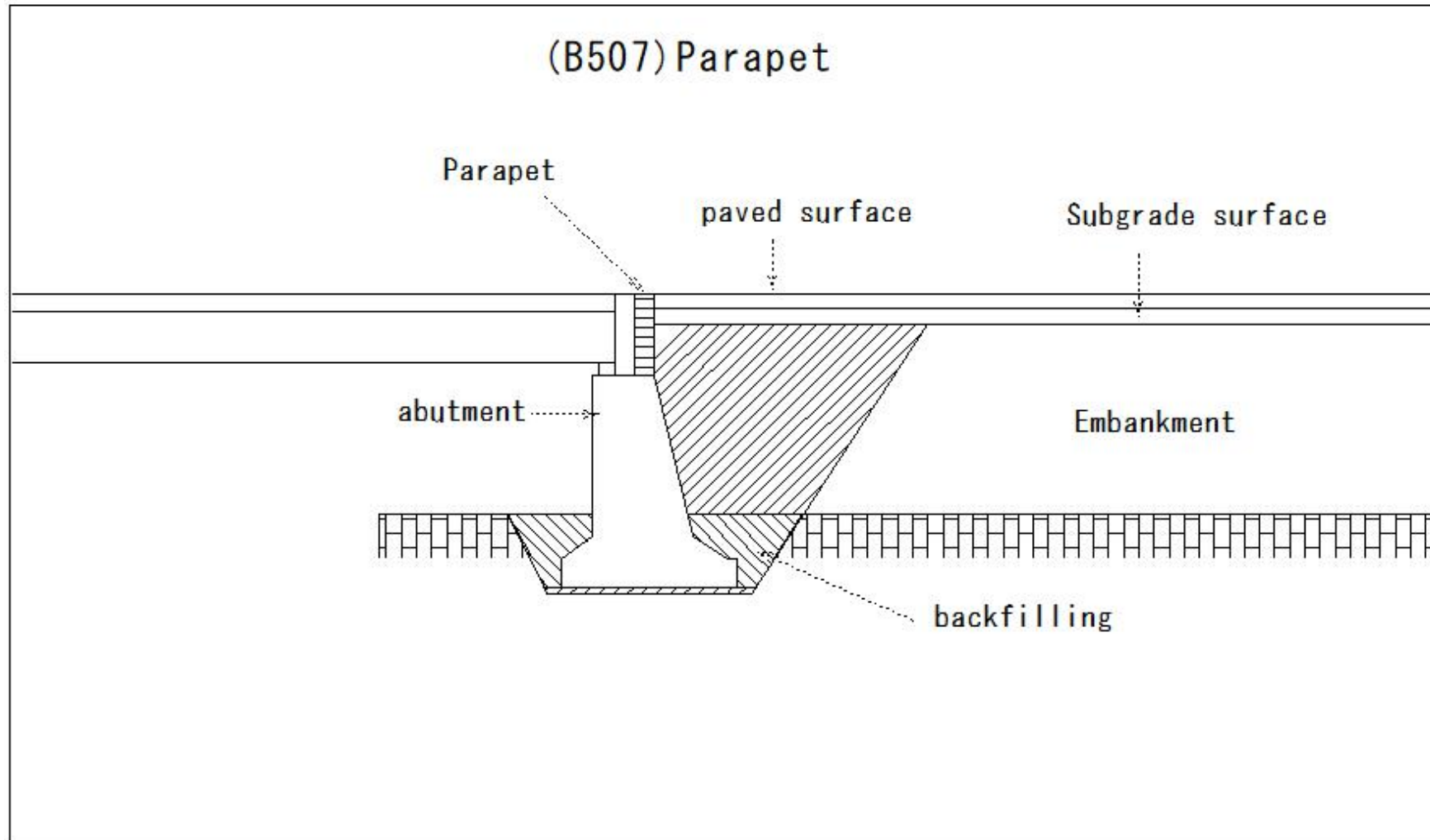


- ① Insert tensioned PC steel
- ② Concrete placement and curing
- ③ After the concrete hardens, move the operation fixing plate to loosen the tension of the prestressing steel material.

(B506) Bridge girder expansion joint

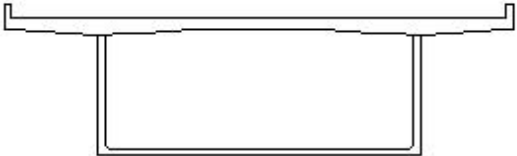
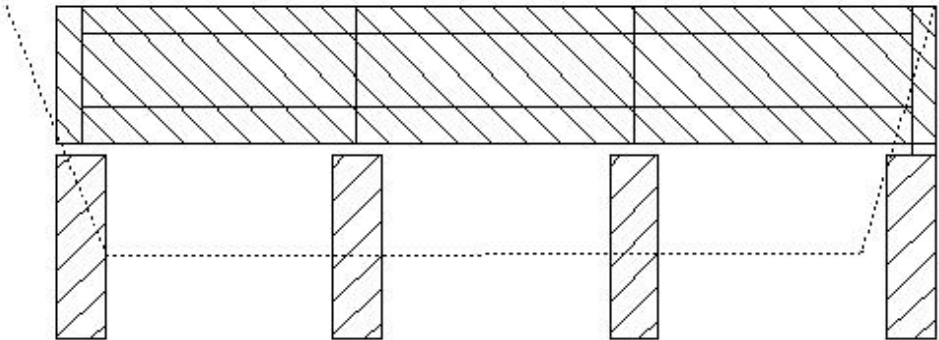


(B507)Parapet



(B508)Box girder bridge

(B508) Box girder bridge

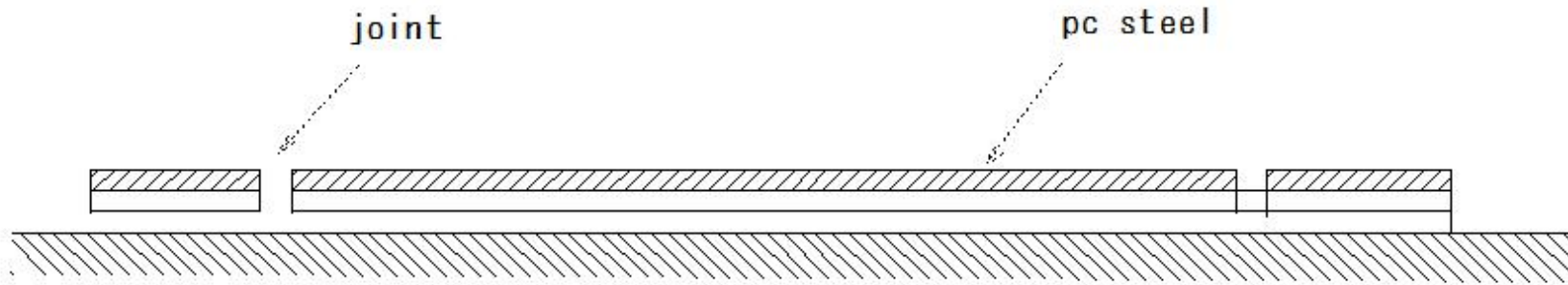


girder of box section
main girder

(B509) Prestressed concrete pavement-movable method

(B509) Prestressed concrete pavement-movable method

Prestressed concrete pavement

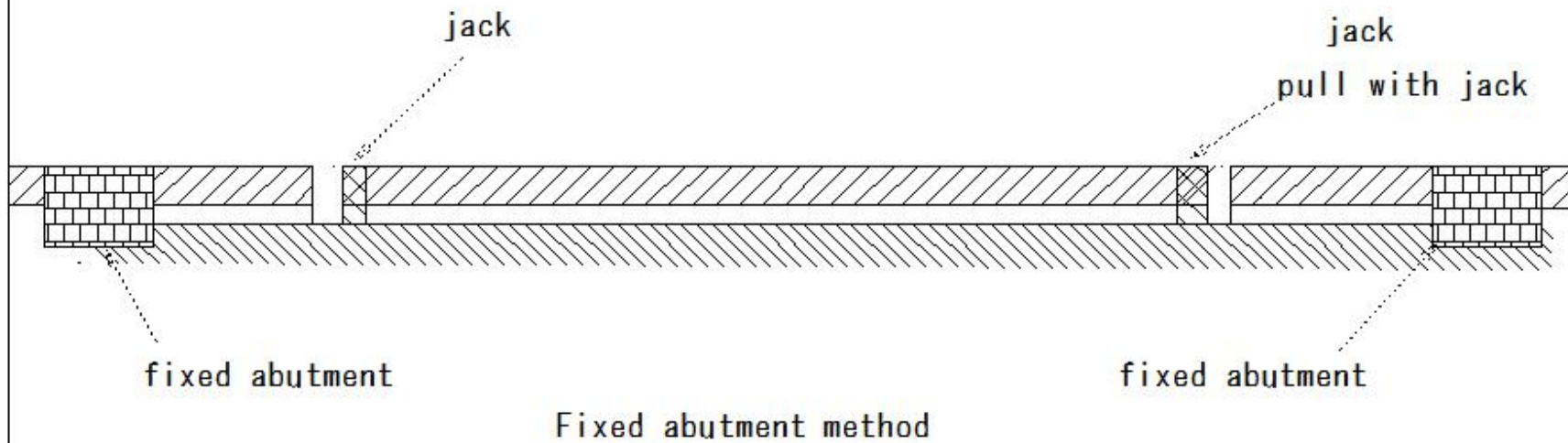


Movable method

(B510) Prestressed concrete pavement-Fixed abutment method

(B510) Prestressed concrete pavement-Fixed abutment method

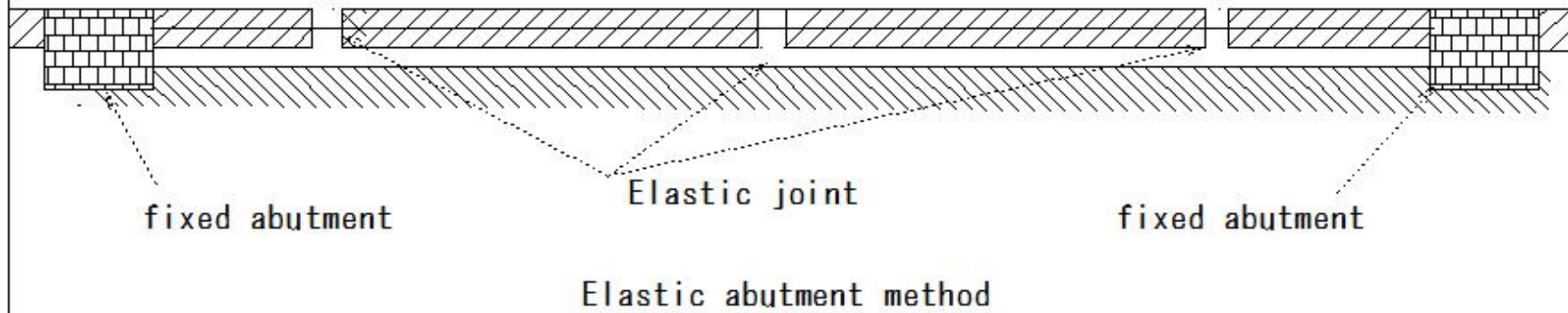
Prestressed concrete pavement



(B511) Prestressed concrete pavement-Elastic abutment method

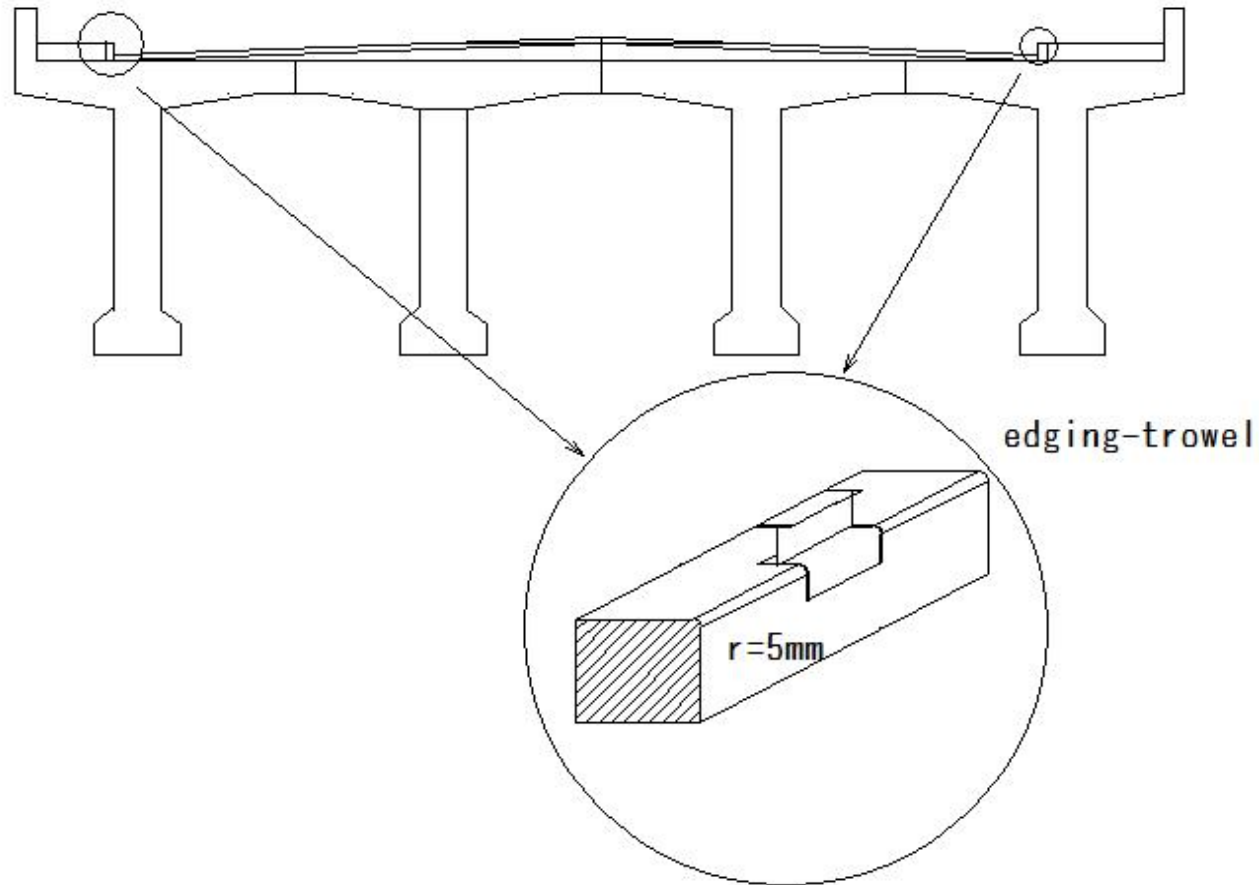
(B511) Prestressed concrete pavement-Elastic abutment method

Prestressed concrete pavement



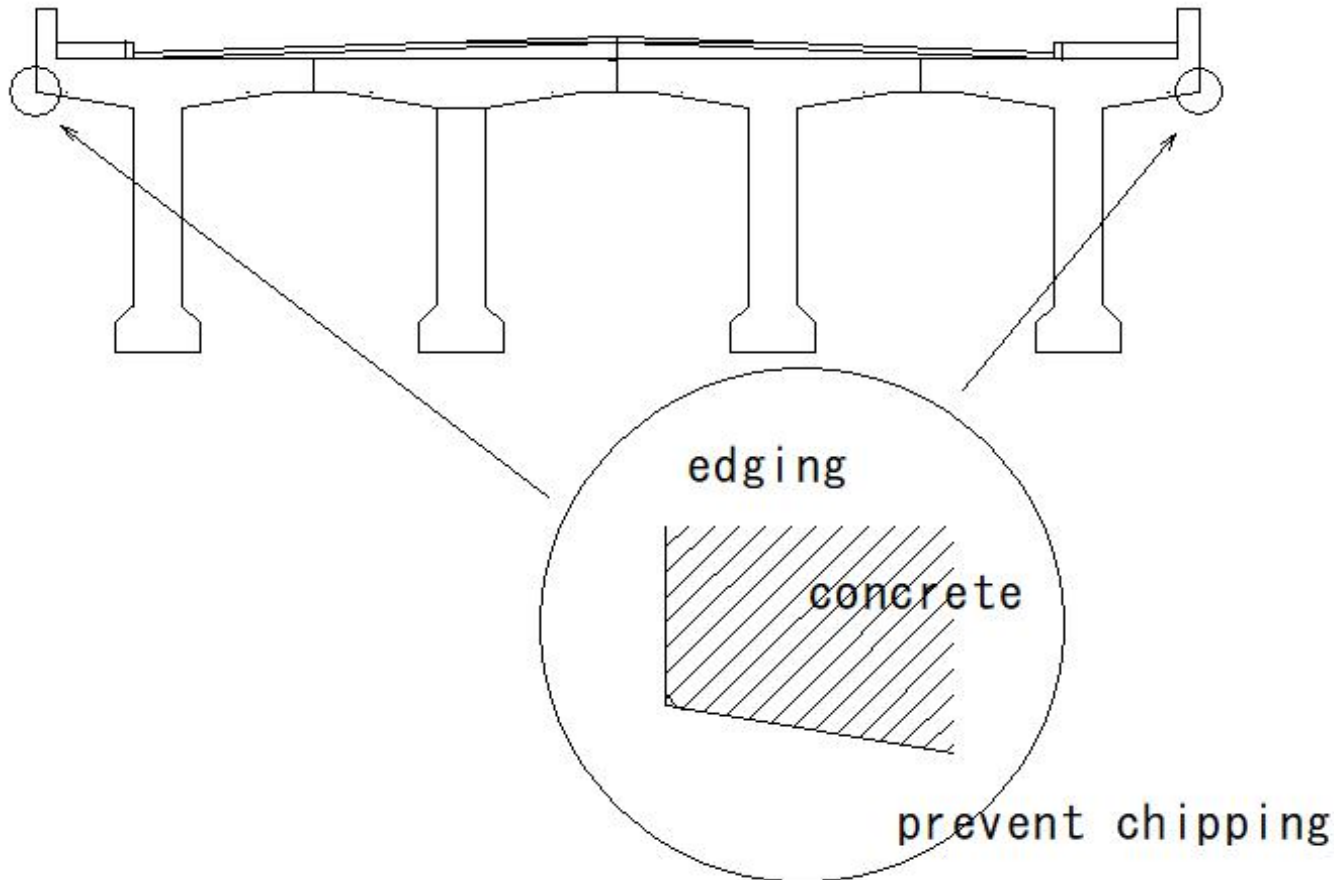
(B512)Edging-trowel

(B512) Edging-trowel



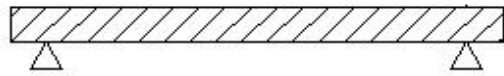
(B513)Edging

(B513) Edging

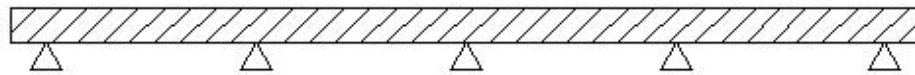


(B514) Continuos girder

simple girder



continuos girder



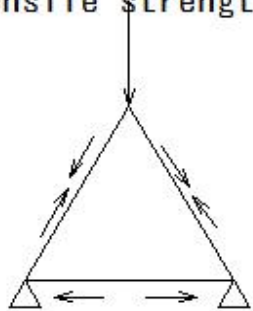
gelber girder



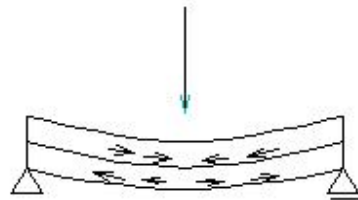
(B515)Concrete strength

(B515) Concrete strength

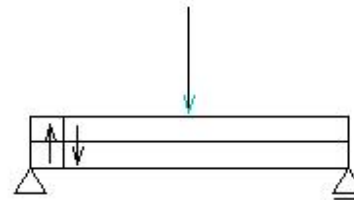
① Tensile strength



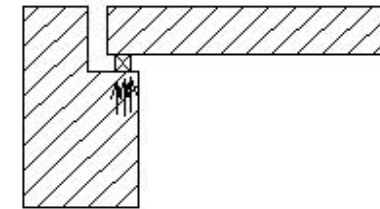
② Bending strength



③ Shear strength



④ Bearing strength



① Tensile strength
compression material
Tensile
Truss arch shell
structure

② Bending strength
compressive force
tensile force

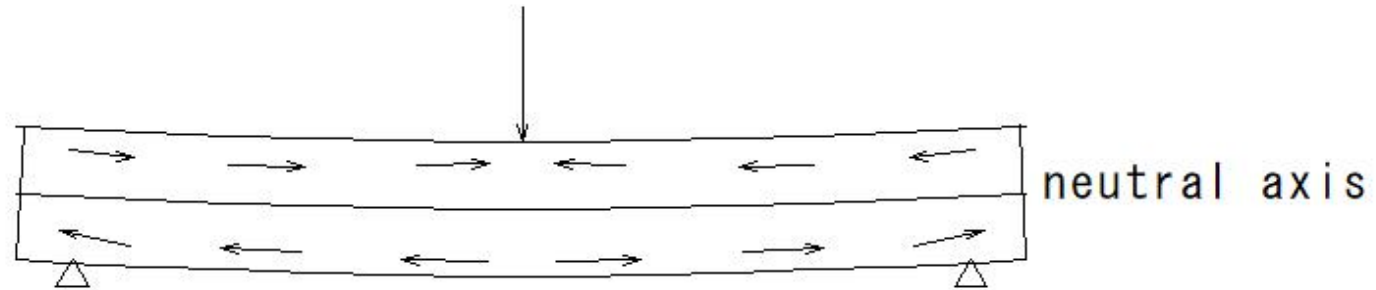
③ Shear strength:
Compressive strength
about 1/4 to 1/6

sheared surface
same as cutting
paper with scissors

④ Bearing strength
All power is
concentrated in
one part

(B516) Bending strength

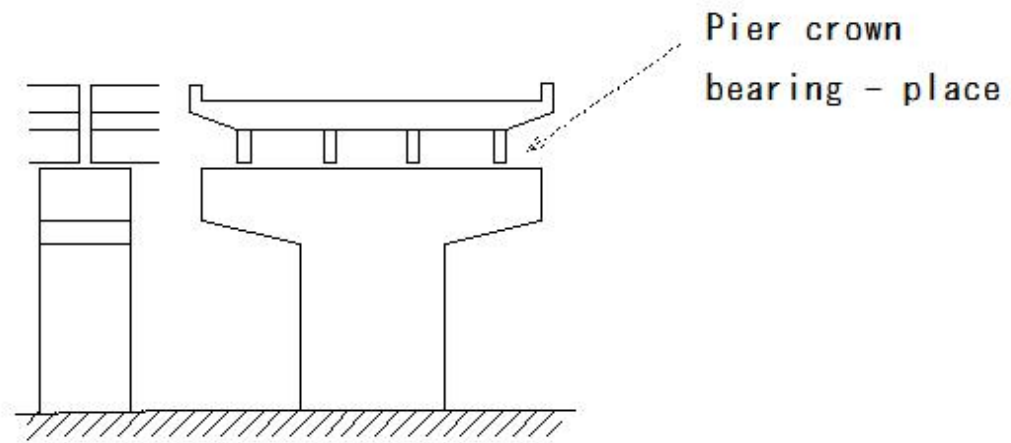
(B516) Bending strength



- ① Compressive force due to bending on the upper edge side
- ② Tensile force due to bending on the lower edge side

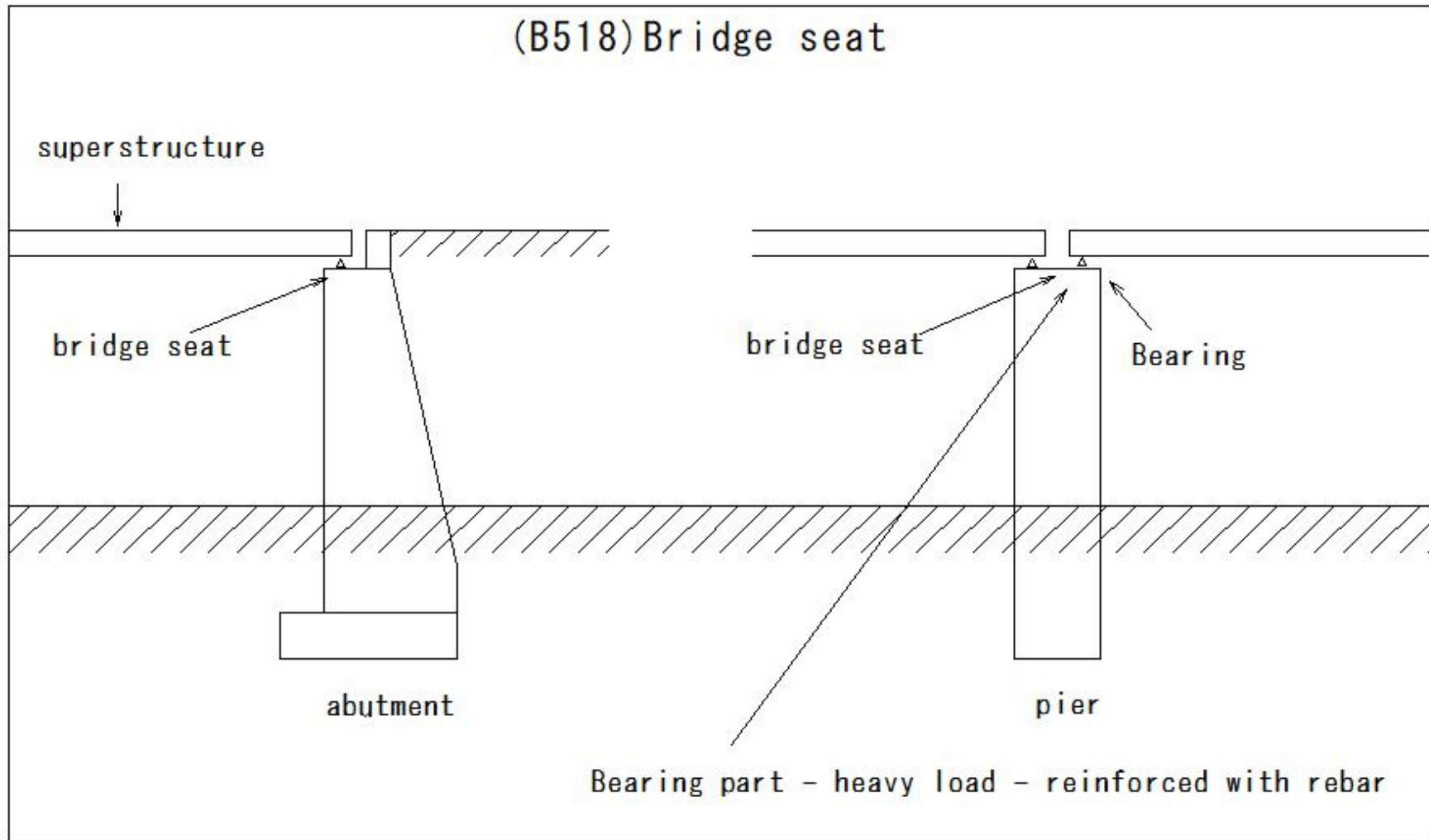
(B517) Pier crown

(B517) Pier crown



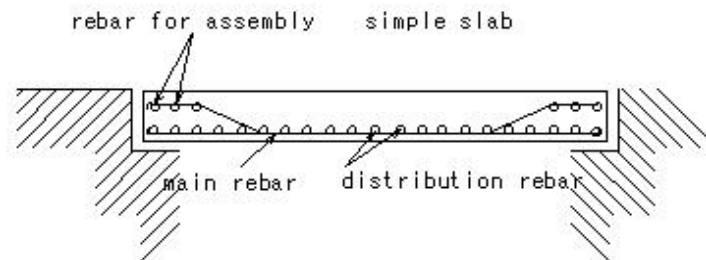
RC pier

(B518) Bridge seat

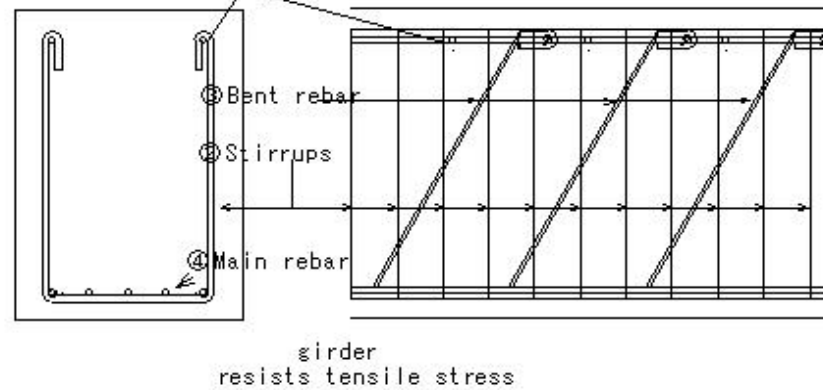


(B519)Erection bar-Rebar for assembly

(B519)Erection bar-Rebar for assembly



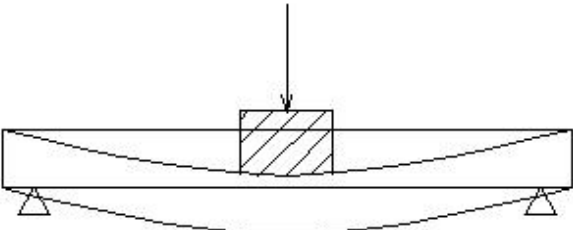
① Reinforcing bars for assembly



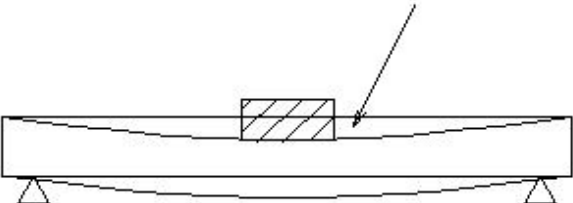
(B520)Creep

(B520) Creep

Allowable internal load



residual strain

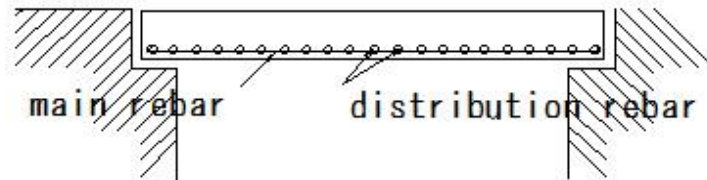


Passage of time - strain - increase

(B521)Floor slab

(B521)Floor slab

simple slab

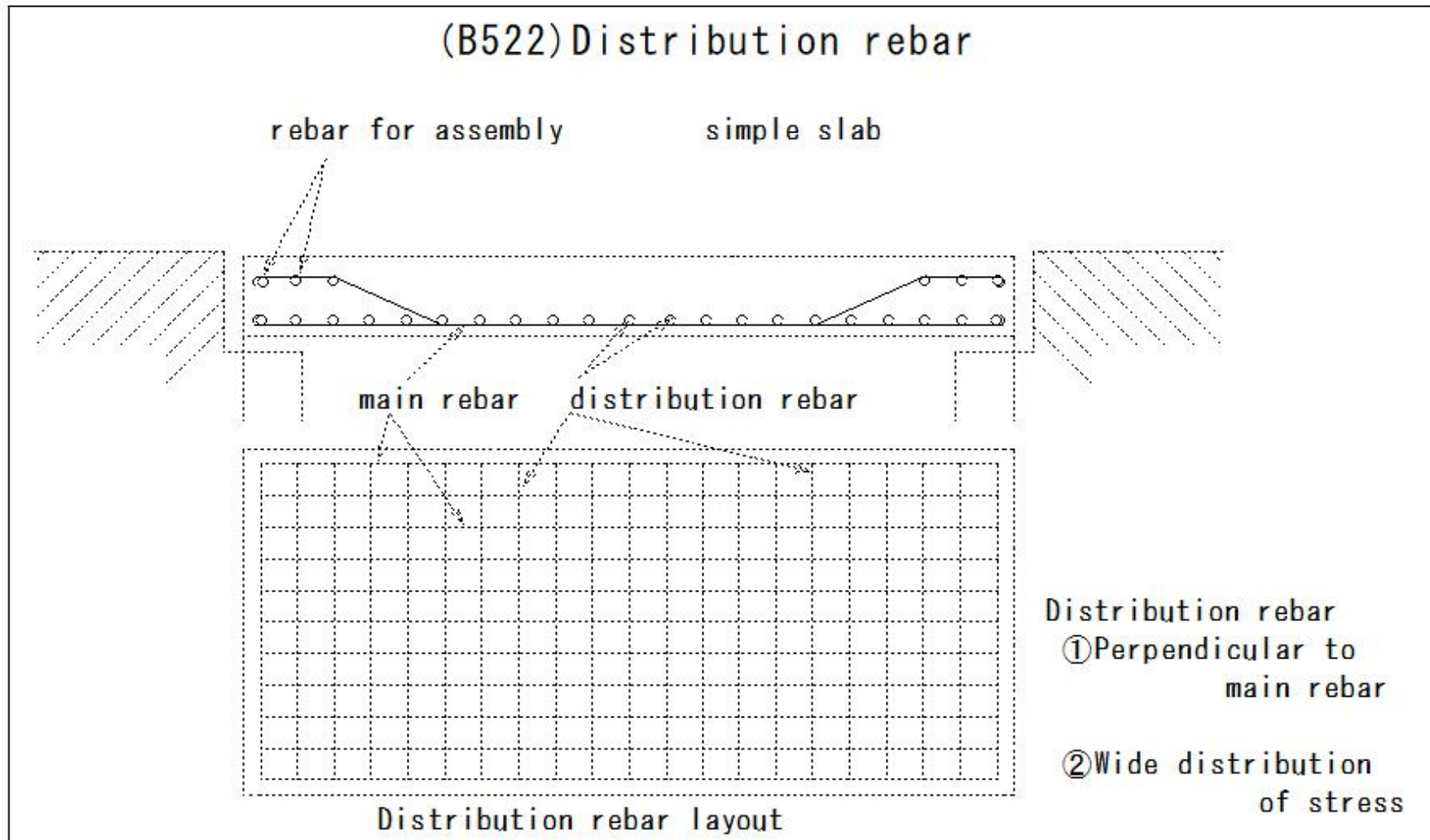


reinforced concrete

support on two opposite sides

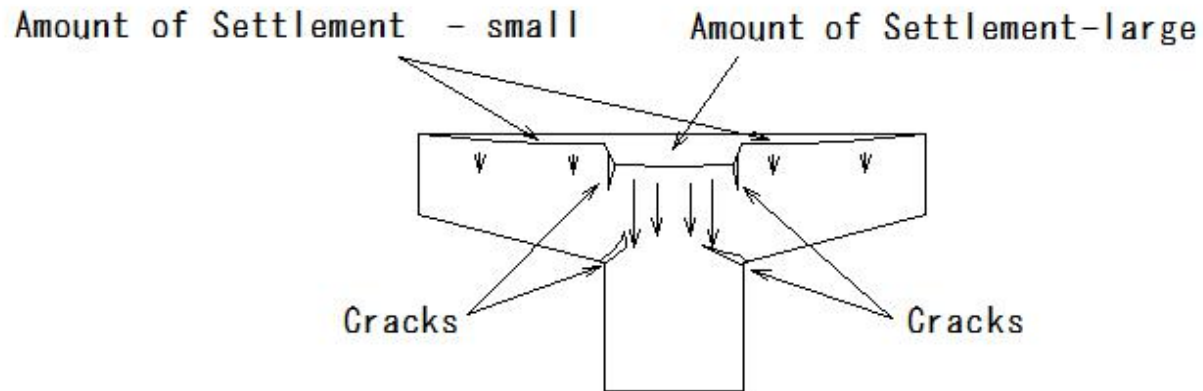
rectangular slab

(B522)Distribution rebar



(B523)Drying Shrinkage -Settlement - Different - Cracks

(B523)Drying Shrinkage -Settlement - Different - Cracks

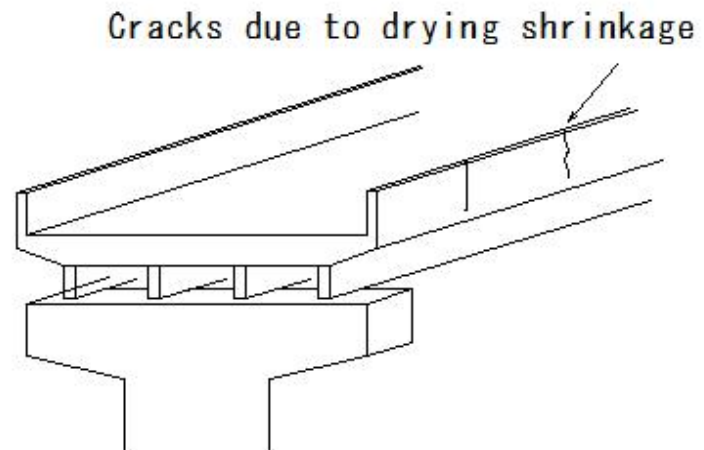
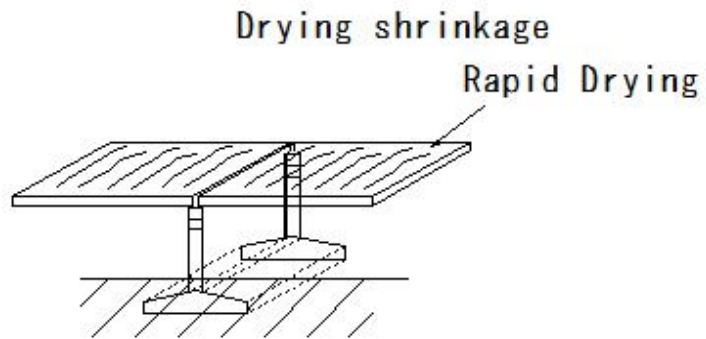


countermeasure

- ① Placing speed - slow
- ② Compaction - sufficient Settlement - less
- ③ Bleeding water -Remove
- ④ Overhang temporarily stopped 2 hours later -
replace after settlement convergence

(B524)Crack-causes-Concrete drying shrinkage

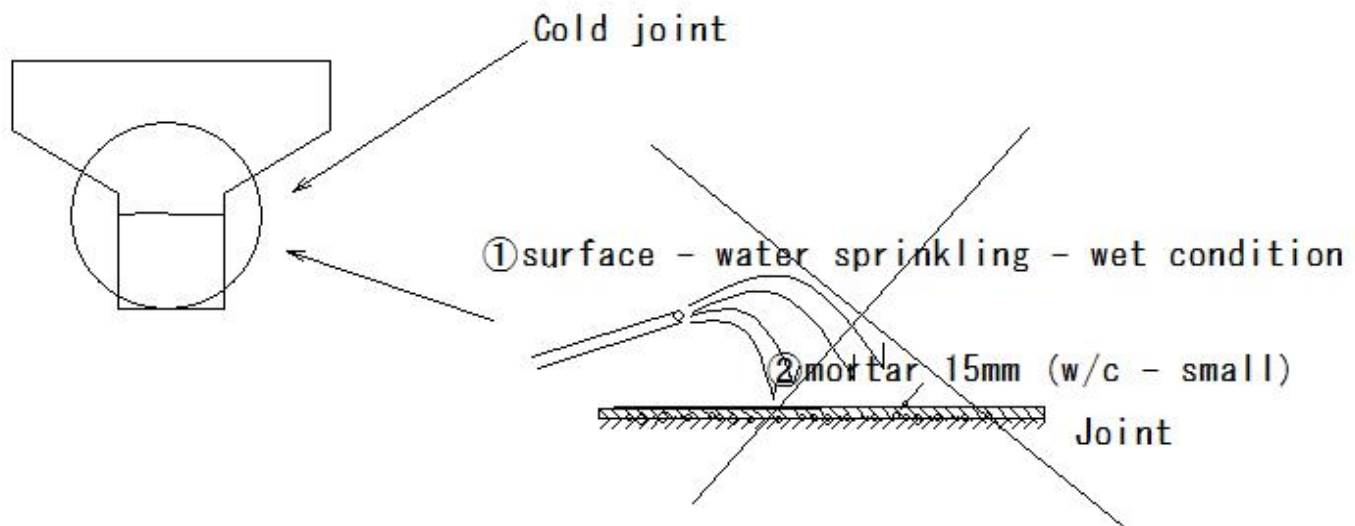
(B524) Crack-causes-Concrete drying shrinkage



- ①Moisture - Evaporation
- ②Cement paste shrinkage

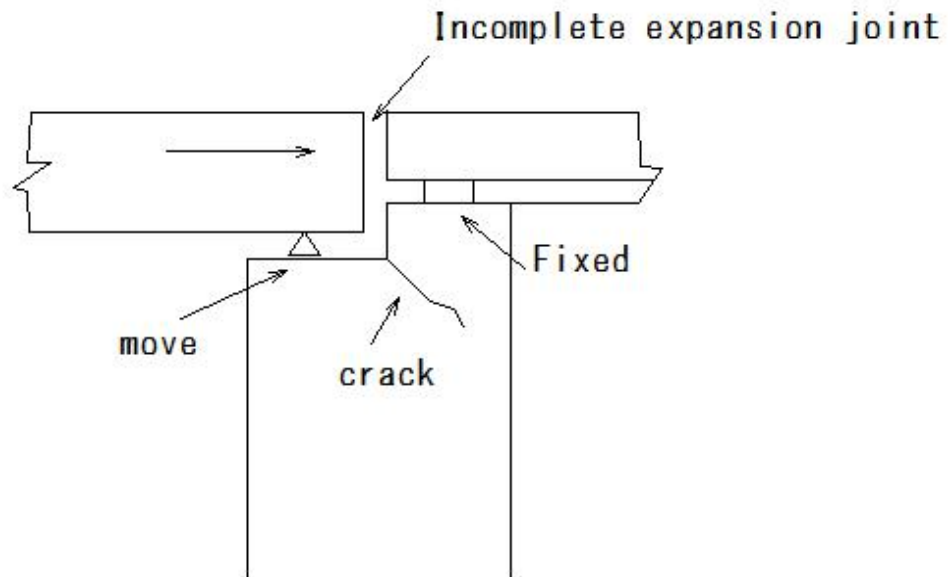
(B525)Crack-causes- joint - bad

(B525) Crack-causes- joint - bad



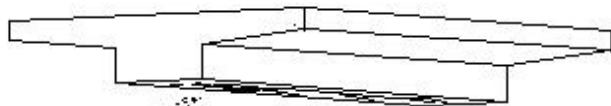
(B526)Crack-causes-Incomplete expansion joint

(B526) Crack-causes-Incomplete expansion joint



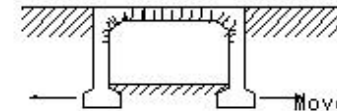
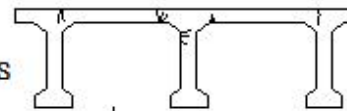
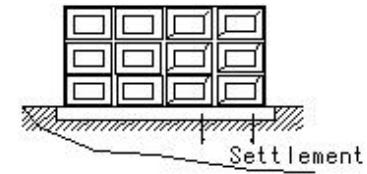
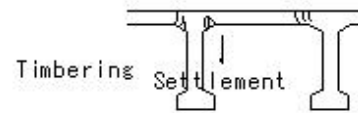
(B527)Crack-Curing to prevent cracks-Poor design

(B527) Crack-Curing to prevent cracks-Poor design



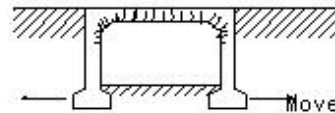
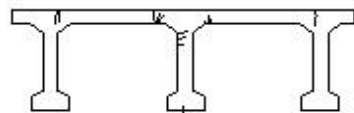
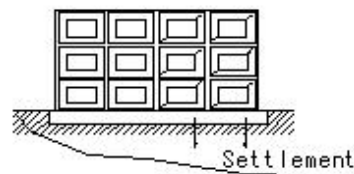
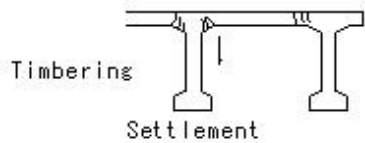
D5: Insufficient cross-section and amount of reinforcing bars

① Insufficient quantity of reinforcing bars



Differential Settlement in statically indeterminate structures such as rahmen

② Uneven Settlement- cracks

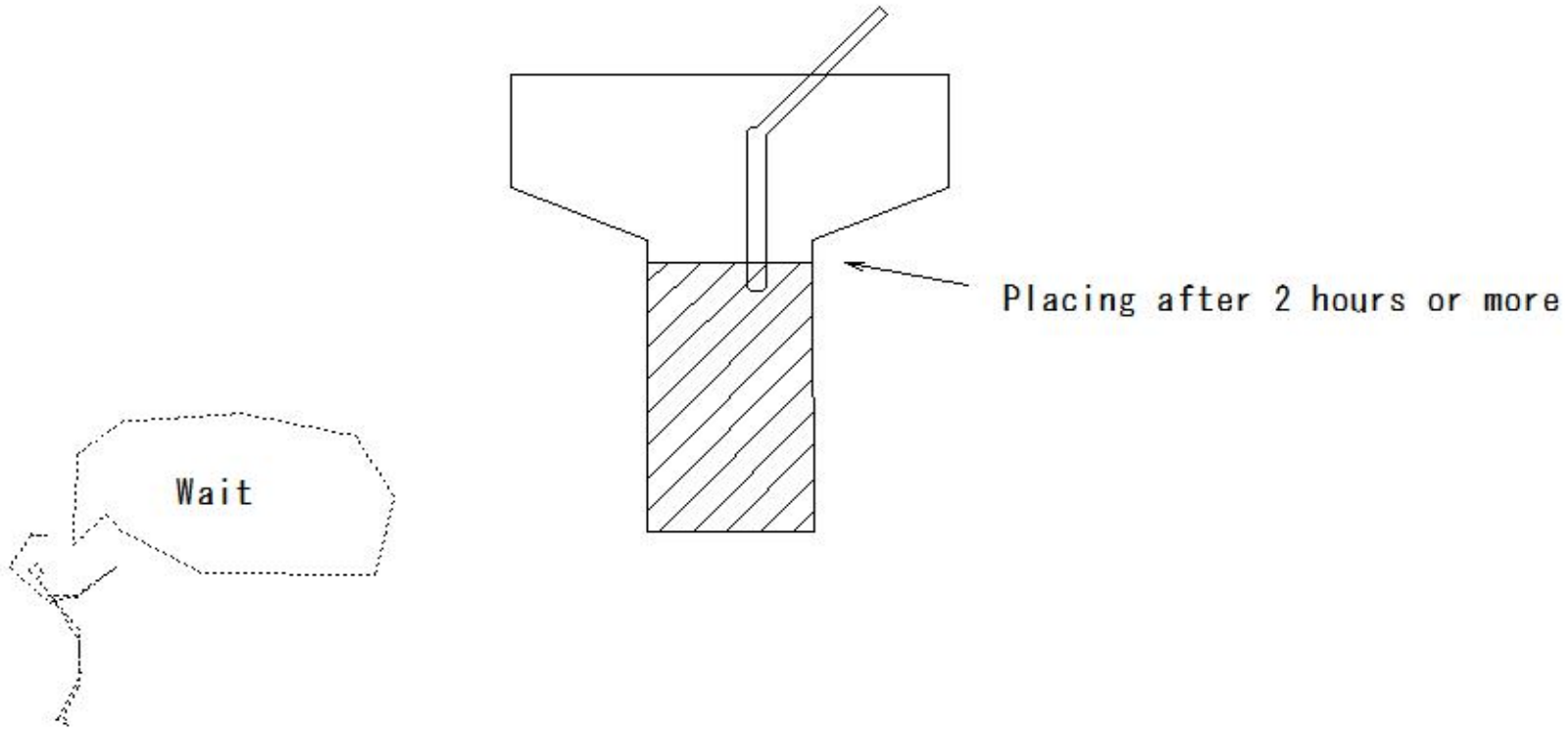


Differential Settlement in statically indeterminate structures such as rahmen

③ Cracks caused by earthquakes

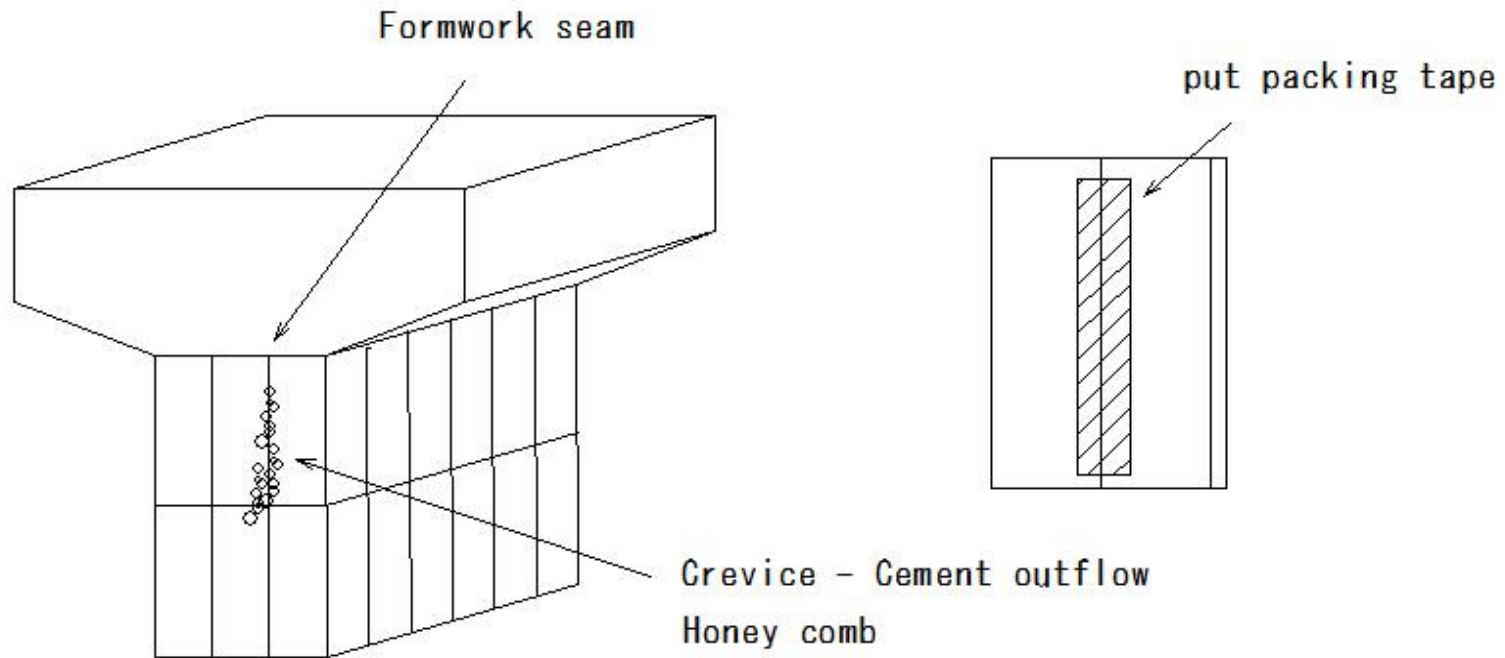
(B528)Concrete Placing

(B528) Concrete Placing



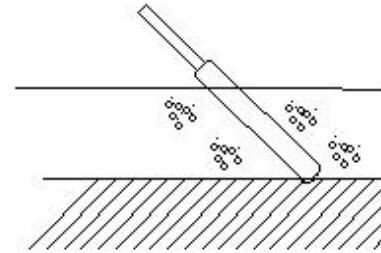
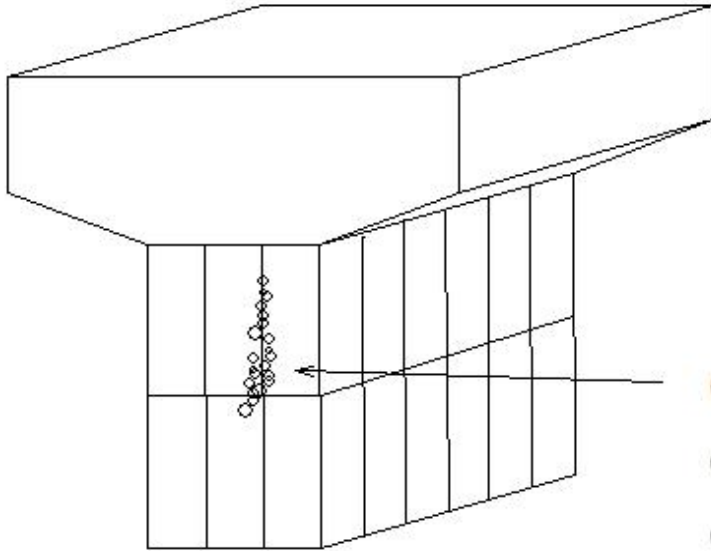
(B529)Formwork seam-Crevice - Cement outflow

(B529)Formwork seam-Crevice - Cement outflow



(B530)Concrete surface - full of holes

(B530) Concrete surface - full of holes



Concrete surface - full of holes

① Carbonation - faster - lower durability

② Too much vibrator