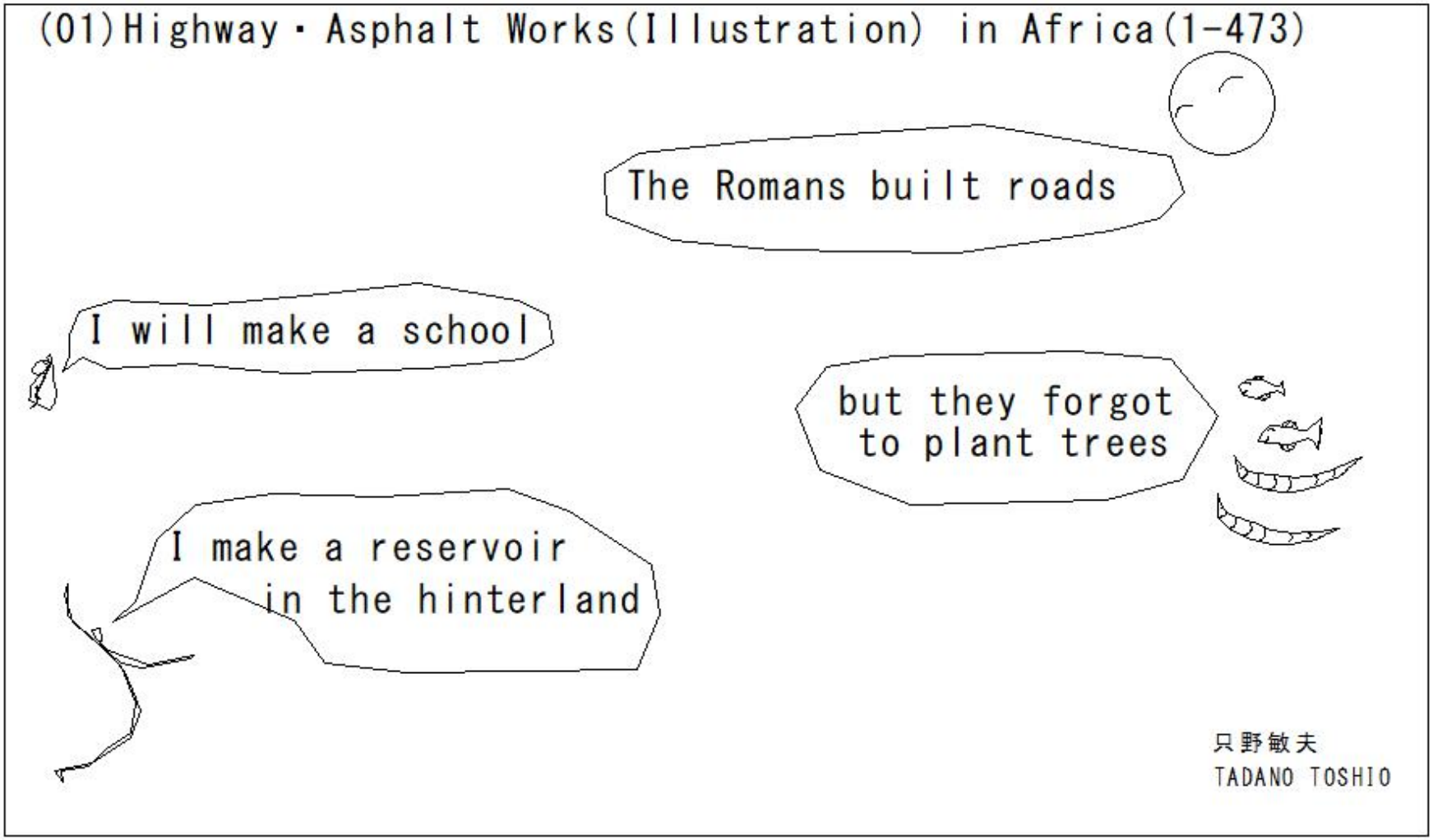
(01)Highway・Asphalt Works(Illustration) in Africa(1-473)



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只野敏夫
Tadano Toshio

(H1)Road pavement(Asphalt pavement)	Road pavement(Asphalt pavement)
(H2)Road pavement(Asphalt pavement)	Road pavement(Asphalt pavement)
(H3)Road pavement(Asphalt pavement-Subgrade design)	Asphalt pavement-Subgrade design
(H4)Road pavement(Asphalt pavement-Subgrade design)	Asphalt pavement-Subgrade design
(H5)Road pavement(Asphalt pavement-Subgrade design)	Asphalt pavement-Subgrade design
(H6)Road pavement(Asphalt pavement-Pavement design)	Asphalt pavement-Subgrade design
(H7)Road pavement(Asphalt pavement-Pavement design)	Asphalt pavement-Subgrade design
(H8)Road pavement(Asphalt pavement-Pavement design)	Asphalt pavement-Subgrade design
(H9)Road pavement(Asphalt pavement-Pavement design)	Asphalt pavement-Subgrade design
(H10)Road pavement(Asphalt pavement-Pavement design)	Asphalt pavement-Subgrade design
(H11)Road pavement(Paving methods-Subgrade)	Paving methods-Subgrade
(H12)Road pavement(Paving methods-Subgrade)	Paving methods-Subgrade
(H13)Road pavement(Paving methods-Subgrade)	Paving methods-Subgrade
(H14)Road pavement(Paving methods-Subgrade)	Paving methods-Subgrade
(H15)Road pavement(Paving methods-Base course)	Paving methods-Base course
(H16)Road pavement(Paving methods-Base course)	Paving methods-Base course
(H17)Road pavement(Paving methods-Base course)	Paving methods-Base course
(H18)Road pavement(Paving methods-Base course)	Paving methods-Base course
(H19)Road pavement(Paving methods-Base course)	Paving methods-Base course
(H20)Road pavement(Paving methods-Base course)	Paving methods-Base course
(H21)Road pavement(Paving methods-Base course)	Paving methods-Base course
(H22)Road pavement(Paving methods-Base course)	Paving methods-Base course
(H23)Road pavement(Paving methods-Base course)	Paving methods-Base course
(H24)Road pavement(Paving methods-Base course)	Paving methods-Base course
(H25)Road pavement(Paving methods-Base course/Wearing course)	Paving methods-Base course/Wearing course
(H26)Road pavement(Paving methods-Base course/Wearing course)	Paving methods-Base course/Wearing course
(H27)Road pavement(Paving methods-Base course/Wearing course)	Paving methods-Base course/Wearing course
(H28)Road pavement(Paving methods-Base course/Wearing course)	Paving methods-Base course/Wearing course
(H29)Road pavement(Paving methods-Base course/Wearing course)	Paving methods-Base course/Wearing course
(H30)Road pavement(Paving methods-Base course/Wearing course)	Paving methods-Base course/Wearing course
(H31)Road pavement(Paving methods-Subgrade)	Paving methods-Subgrade
(H32)Road pavement(Paving methods-Subgrade)	Paving methods-Subgrade
(H33)Road pavement(Paving methods-Subgrade)	Paving methods-Subgrade
(H34)Road pavement(Paving methods-Subgrade stabilization)	Paving methods-Subgrade stabilization

(H35)Road pavement(Paving methods-Replacement method)	Paving methods-Replacement method
(H36)Road pavement(Paving methods-Lower base course)	Paving methods-Lower base course
(H37)Road pavement(Paving methods-Lower base course)	Paving methods-Lower base course
(H38)Road pavement(Paving methods-Lower base course)	Paving methods-Lower base course
(H39)Road pavement(Paving methods-Upper base course)	Paving methods-Upper base course
(H40)Road pavement(Paving methods-Upper base course)	Paving methods-Upper base course
(H41)Road pavement(Paving methods-Upper base course)	Paving methods-Upper base course
(H42)Road pavement(Paving methods-Upper base course)	Paving methods-Upper base course
(H43)Road pavement(Paving methods-Upper base course)	Paving methods-Upper base course
(H44)Road pavement(Paving methods-Upper base course)	Paving methods-Upper base course
(H45)Road pavement(Paving methods-Upper base course)	Paving methods-Upper base course
(H46)Road pavement(Paving methods-Upper base course)	Paving methods-Upper base course
(H47)Road pavement(Paving methods-Upper base course)	Paving methods-Upper base course
(H48)Road pavement(Paving methods-Prime Court)	Paving methods-Prime Court
(H49)Road pavement(Paving methods-Prime Court)	Paving methods-Prime Court
(H50)Road pavement(Paving methods- Seal coat)	Paving methods- Seal coat
(H51)Road pavement(Paving methods-Tack coat)	Paving methods-Tack coat
(H52)Road pavement(Paving methods-Tack coat)	Paving methods-Tack coat
(H53)Road pavement(Paving methods-leveling)	Paving methods-leveling
(H54)Road pavement(Paving methods-leveling)	Paving methods-leveling
(H55)Road pavement(Paving methods-leveling)	Paving methods-leveling
(H56)Road pavement(Paving methods-leveling)	Paving methods-leveling
(H57)Road pavement(Paving methods-leveling)	Paving methods-leveling
(H58)Road pavement(Paving methods-Compaction)	Paving methods-Compaction
(H59)Road pavement(Paving methods-First compaction)	Paving methods-First compaction
(H60)Road pavement(Paving methods-Secondary compaction)	Paving methods-Secondary compaction
(H61)Road pavement(Paving methods-Finishing compaction)	Paving methods-Finishing compaction
(H62)Road pavement(Paving methods-common compaction)	Paving methods-common compactio
(H63)Road pavement(Paving methods-common compaction)	Paving methods-common compactio
(H64)Road pavement(Paving methods-common compaction)	Paving methods-common compactio
(H65)Road pavement(Paving methods-common compaction)	Paving methods-common compactio
(H66)Road pavement(Paving methods-Open to traffic)	Paving methods-Open to traffic
(H67)Road pavement(Paving methods-Construction of seams)	Paving methods-Construction of seams
(H68)Road pavement(Paving methods-Construction of seams)	Paving methods-Construction of seams

(H69)Road pavement(Paving methods-Construction of seams)	Paving methods-Construction of seams
(H70)Road pavement(Inspection & Control-Tests on asphalt pavement)	Inspection & Control-Tests on asphalt
(H71)Road pavement(Inspection & Control-Tests on asphalt pavement)	Inspection & Control-Tests on asphalt
(H72)Road pavement(Inspection & Control-Tests on asphalt pavement)	Inspection & Control-Tests on asphalt
(H73)Road pavement(Inspection & Control-Tests on asphalt pavement)	Inspection & Control-Tests on asphalt
(H74)Road pavement(Inspection & Control-Tests on asphalt pavement)	Inspection & Control-Tests on asphalt
(H75)Road pavement(Inspection & Control-Tests on asphalt pavement)	Inspection & Control-Tests on asphalt
(H76)Road pavement(Inspection & Control-Tests on asphalt pavement)	Inspection & Control-Tests on asphalt
(H77)Road pavement(Inspection & Control-Tests on asphalt pavement)	Inspection & Control-Tests on asphalt
(H78)Road pavement(Inspection & Control-As-built)	Inspection & Control-As-built
(H79)Road pavement(Quality control items- Subgrade)	Quality control items- Subgrade
(H80)Road pavement(Quality control items- Lower Base course(roadbed))	Quality control items- Lower Base course
(H81)Road pavement(Quality control -Grain size adjustment Base course(roadbed))	Grain size adjustment Base course(roadbed)
(H82)Road pavement(Quality control -Cement and lime stabilization Base course(roadbed))	Cement and lime stabilization Base course
(H83)Road pavement(Quality control -Bituminous stabilization treatment Base course(roadbed), surface sublayer)	Bituminous stabilization treatment Base course
(H84)Road pavement(Asphalt pavement-Special pavement)	Asphalt pavement-Special pavement)
(H85)Road pavement(Asphalt pavement-Semi-flexible pavement)	Asphalt pavement-Semi-flexible pavement
(H86)Road pavement(Asphalt pavement-Goose asphalt pavement)	Asphalt pavement-Goose asphalt pavement
(H87)Road pavement(Asphalt pavement-Rolled asphalt pavement)	Asphalt pavement-Rolled asphalt pavement
(H88)Road pavement(Asphalt pavement-Drainage pavement)	Asphalt pavement-Drainage pavement
(H89)Road pavement(Asphalt pavement- Light pavement)	Asphalt pavement- Light pavement
(H90)Road pavement(Asphalt pavement- Colored pavement)	Asphalt pavement- Colored pavement
(H91)Road pavement(Asphalt pavement-Anti-slip pavement)	Asphalt pavement-Anti-slip pavement
(H92)Road pavement(Asphalt pavement-Foamed Asphalt Pavement)	Asphalt pavement-Foamed Asphalt Pavement
(H93)Road pavement(Asphalt pavement-Full-depth asphalt pavement)	Asphalt pavement-Full-depth asphalt pavement
(H94)Road pavement(Asphalt pavement-Sandwich pavement)	Asphalt pavement-Sandwich pavement
(H95)Road pavement(Asphalt pavement-Composite pavement)	Asphalt pavement-Composite pavement
(H96)Road pavement(Special pavement applications-Semi-flexible pavement)	pavement applications-Semi-flexible pavement
(H97)Road pavement(Special pavement applications-Guss asphalt pavement)	pavement applications-Guss asphalt pavement
(H98)Road pavement(Special pavement applications-Rolled asphalt pavement)	pavement applications-Rolled asphalt pavement
(H99)Road pavement(Special pavement applications-Drainage pavement)	pavement applications-Drainage pavement
(H100)Road pavement(Special pavement applications-Light-colored pavement)	pavement applications-Light-colored pavement
(H101)Road pavement(Special pavement applications-Colored pavement)	pavement applications-Colored pavement
(H102)Road pavement(Special pavement applications-Slip-resistant pavement)	pavement applications-Slip-resistant pavement

(H103)Road pavement(Special pavement applications-Foamed Asphalt Pavement)	pavement applications-Foamed Asphalt Pavement
(H104)Road pavement(Special pavement applications-Full depth asphalt pavement	pavement applications-Full depth asphalt pavement
(H105)Road pavement(Special pavement applications-Sandwich pavement)	pavement applications-Sandwich pavement
(H106)Asphalt pavement(Maintenance + repair-Replacement method)	Maintenance-Replacement method
(H107)Asphalt pavement(Maintenance + repair-Local replacement method)	Maintenance-Local replacement method
(H108)Asphalt pavement(Maintenance + repair-Linear replacement method)	Maintenance-Linear replacement method
(H109)Asphalt pavement(Maintenance + repair-On-road regeneration roadbed method)	Maintenance-On-road regeneration roadbed method
(H110)Asphalt pavement(Maintenance + repair-Surface and base layer replacement method)	Maintenance-Surface and base layer replacement method
(H111)Asphalt pavement(Maintenance + repair-Overlay method)	Maintenance + repair-Overlay method
(H112)Asphalt pavement(Maintenance + repair-Asphalt Pavement Repair Methods)	Maintenance + repair-Asphalt Pavement Repair Methods
(H113)Asphalt pavement(Maintenance + repair-Thin layer overlay method)	Maintenance + repair-Thin layer overlay method
(H114)Asphalt pavement(Maintenance + repair-Rut overlay method)	Maintenance + repair-Rut overlay method
(H115)Asphalt pavement(Maintenance + repair- Cutting method)	Maintenance + repair- Cutting method
(H116)Asphalt pavement(Maintenance + repair- Sealing material injection method)	Maintenance + repair- Sealing material injection method
(H117)Asphalt pavement(Maintenance + repair- Surface treatment method)	Maintenance + repair- Surface treatment method
(H118)Asphalt pavement(Maintenance + repair- Patching and step-rubbing method)	Maintenance + repair- Patching and step-rubbing method
(H119)Asphalt pavement(Asphalt Paving Machine- On-road mixing: Stabilizer)	Asphalt Paving Machine- On-road mixing: Stabilizer
(H120)Asphalt pavement(Excavation and loading: Backhoe, tractor shovel)	Excavation and loading: Backhoe, tractor shovel
(H121)Asphalt pavement(Shaping: Motor grader, bulldozer)	Shaping: Motor grader, bulldozer
(H122)Asphalt pavement(Stabilizer spreader Engine sprayer Asphalt distributor)	Stabilizer spreader Engine sprayer Asphalt distributor
(H123)Asphalt pavement(Leveling: Motor grader, bulldozer, base paper, asphalt finisher)	Leveling: Motor grader, bulldozer, asphalt finisher
(H124)Asphalt pavement(Compaction: Road rollers, tire rollers, vibrating rollers, water sprinklers)	Compaction: Road rollers, tire rollers,
(H125)Asphalt pavement(Road mixing machine：Stabilizer・Wheel type・Crawler type・Small scale: Backhoe)	Road mixing machine：Stabilizer・Wheel type
(H126)Asphalt pavement(Excavation, loading and shaping machinery)	Excavation, loading and shaping machinery
(H127)Asphalt pavement(Spraying machine)	Asphalt pavement(Spraying machine)
(H128)Asphalt pavement(Leveling machine)	Asphalt pavement(Leveling machine)
(H129)Asphalt pavement(Compaction machine)	Asphalt pavement(Compaction machine)
(H130)Asphalt pavement(Compaction machine)	Asphalt pavement(Compaction machine)
(H131)Cement concrete pavement	Cement concrete pavement
(H132)Cement concrete pavement(Subgrade)	Cement concrete pavement
(H133)Cement concrete pavement (Base course(roadbed))	Cement concrete pavement
(H134)Cement concrete pavement (Concrete slab)	Cement concrete pavement
(H135)Cement concrete pavement (Concrete slab)	Cement concrete pavement
(H136)Cement concrete pavement (Concrete slab-Joints)	Cement concrete pavement

(H137)Cement concrete pavement (Concrete slab-Joints)	Cement concrete pavement
(H138)Cement concrete pavement (Concrete slab-Dummy joint)	Cement concrete pavement
(H139)Cement concrete pavement (Concrete slab-Slip bar)	Cement concrete pavement
(H140)Cement concrete pavement (Concrete slab-Tie bar)	Cement concrete pavement
(H141)Cement concrete pavement (Materials and mix)	Cement concrete pavement
(H142)Cement concrete pavement (Mixing)	Cement concrete pavement
(H143)Cement concrete pavement (Formwork)	Cement concrete pavement
(H144)Cement concrete pavement (Iron mesh and edge reinforcement rebar)	Cement concrete pavement
(H145)Cement concrete pavement (Compaction)	Cement concrete pavement
(H146)Cement concrete pavement (Surface finishing)	Cement concrete pavement
(H147)Cement concrete pavement (Curing)	Cement concrete pavement (Curing)
(H148)Cement concrete pavement (Curing)	Cement concrete pavement (Curing)
(H149)Cement concrete pavement (Curing period)	Cement concrete pavement (Curing)
(H150)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H151)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H152)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H153)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H154)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H155)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H156)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H157)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H158)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H159)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H160)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H161)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H162)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H163)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H164)Pavement(Pavement and subgrade)	Pavement(Pavement and subgrade)
(H165)Pavement(Improvement of Subgrade(roadbed) soil)	Improvement of Subgrade(roadbed) soil
(H166)Pavement(Improvement of Subgrade(roadbed) soil-Soil cement method)	Improvement of Subgrade(roadbed) soil
(H167)Pavement(Improvement of Subgrade(roadbed) soil-Soil cement method)	Improvement of Subgrade(roadbed) soil
(H168)Pavement(Improvement of Subgrade(roadbed) soil-Soil cement method)	Improvement of Subgrade(roadbed) soil
(H169)Pavement(Improvement of Subgrade(roadbed) soil-Soil cement method)	Improvement of Subgrade(roadbed) soil
(H170)Pavement(Improvement of Subgrade(roadbed) soil-Soil cement method)	Improvement of Subgrade(roadbed) soil

(H171)Pavement(Improvement of Subgrade(roadbed) soil-Soil cement method)	Improvement of Subgrade(roadbed) soil
(H172)Pavement(Stabilization method-Lime mixing method)	Pavement(Stabilization methodil)
(H173)Pavement(Stabilization method -Bituminous material spraying method)	Pavement(Stabilization methodil)
(H174)Pavement(Stabilization method-Chemical injection method)	Pavement(Stabilization methodil)
(H175)Pavement(Asphalt pavement-Base course(roadbed))	Pavement(Asphalt pavement)
(H176)Pavement(Asphalt pavement-Lower Base course(roadbed))	Pavement(Asphalt pavement)
(H177)Pavement(Asphalt pavement-Lower Base course(roadbed))	Pavement(Asphalt pavement)
(H178)Pavement(Asphalt pavement-Base course(roadbed))	Pavement(Asphalt pavement)
(H179)Pavement(Concrete pavement: Base course(roadbed))	Pavement(Concrete pavement)
(H180)Pavement(Asphalt Pavement)	Pavement(Asphalt Pavement)
(H181)Pavement(Asphalt Pavement-Comparison between straight and blown asphalt)	Asphalt Pavement-Comparison
(H182)Pavement(Asphalt Pavement-Aggregate)	Pavement(Asphalt Pavement-Aggregate)
(H183)Pavement(Asphalt Pavement-Asphalt mixture)	Pavement(Asphalt Pavement-Asphalt mixture)
(H184)Pavement(Asphalt Pavement-Asphalt mixture)	Pavement(Asphalt Pavement-Asphalt mixture)
(H185)Pavement(Asphalt Pavement-Asphalt road surface)	Asphalt Pavement-Asphalt road surface
(H186)Pavement(Asphalt Pavement-Asphalt road surface)	Asphalt Pavement-Asphalt road surface
(H187)Pavement(Asphalt road surface-Semi-flexible pavement)	Asphalt road surface-Semi-flexible pavement
(H188)Pavement(Asphalt road surface-Permeable pavement)	Asphalt road surface-Permeable pavement
(H189)Pavement(Asphalt road surface-Colored pavement)	Asphalt road surface-Colored pavement
(H190)Pavement(Asphalt road surface-Macadam method)	Asphalt road surface-Macadam method
(H191)Pavement(Asphalt pavement-Procedure)	Asphalt pavement-Procedure
(H192)Pavement(Asphalt pavement-Transporting the mixture: Dump truck)	Asphalt pavement-Transporting the mixture
(H193)Pavement(Asphalt pavement-On-site arrival temperature)	Asphalt pavement-On-site arrival temperature
(H194)Pavement(Asphalt pavement-Prime coat)	Asphalt pavement-Prime coat
(H195)Pavement(Asphalt pavement-Tack coat)	Asphalt pavement-Tack coat
(H196)Pavement(Asphalt pavement-Asphalt finisher)	Asphalt pavement-Asphalt finisher
(H197)Pavement(Asphalt pavement-Initial compaction:Secondary compaction)	Asphalt pavement-Initial compaction
(H198)Pavement(Asphalt pavement-Details)	Asphalt pavement-Details
(H199)Pavement work(Pavement design TA method)	Pavement design TA method
(H200)Pavement work(Pavement design TA method)	Pavement design TA method
(H201)Pavement work(Pavement design TA method)	Pavement design TA method
(H202)Pavement work(Pavement design TA method)	Pavement design TA method
(H203)Pavement work(Pavement design TA method)	Pavement design TA method
(H204)Pavement work(Pavement design TA method)	Pavement design TA method

(H205)Pavement work(Pavement design TA method)	Pavement design TA method
(H206)Pavement work(Concrete pavement-Mixing, mixing, transport)	Concrete pavement-Mixing, mixing, transport
(H207)Pavement work(Concrete pavement-RCCP method)	Concrete pavement-RCCP method
(H208)Pavement work(Concrete pavement-RCCP method)	Concrete pavement-RCCP method
(H209)Pavement work(Concrete pavement-Placing-in and finishing)	Concrete pavement-Placing-in and finishing
(H210)Pavement work(Concrete pavement-Placing-in and finishing)	Concrete pavement-Placing-in and finishing
(H211)Pavement work(Concrete pavement-Pouring and finishing)	Concrete pavement-Pouring and finishing
(H212)Pavement work(Concrete pavement-Joint)	Concrete pavement-Joint
(H213)Pavement work(Concrete pavement-Continuous concrete pavement)	Concrete pavement-Continuous concrete pavement
(H214)Pavement work(Asphalt pavement-Patching)	Asphalt pavement-Patching
(H215)Pavement work(Asphalt pavement-Overlay)	Asphalt pavement-Overlay
(H216)Pavement work(Asphalt pavement-Replacement method)	Asphalt pavement-Replacement method
(H217)Pavement work(Asphalt pavement-Road surface regeneration method)	Asphalt pavement-Road surface regeneration
(H218)macadam	macadam
(H219)spreading	spreading
(H220)spreading depth	spreading depth
(H221)Pavement work(Asphalt pavement-Pavement design)	Asphalt pavement-Pavement design
(H222)Pavement work(Asphalt pavement-Mixing and transportation)	Asphalt pavement-Mixing and transportation
(H223)Pavement work(Asphalt pavement-Mixing and transportation)	Asphalt pavement-Mixing and transportation
(H224)Pavement work(Asphalt pavement- Cement concrete pavement)	Asphalt pavement- Cement concrete pavement
(H225)Pavement work(Asphalt pavement)	Asphalt pavement
(H226)Pavement work(Asphalt pavement-Subgrade(roadbed))	Asphalt pavement-Subgrade(roadbed)
(H227)Pavement work(Asphalt pavement-Base course)	Asphalt pavement-Base course
(H228)Pavement work(Asphalt pavement-Base course)	Asphalt pavement-Base course
(H229)Pavement work(Asphalt pavement-Base course)	Asphalt pavement-Base course
(H230)Pavement work(Asphalt pavement design-Pavement design)	Asphalt pavement design-Pavement design
(H231)Pavement work(Asphalt pavement-Traffic conditions)	Asphalt pavement-Traffic conditions
(H232)Pavement work(Asphalt pavement-Subgrade conditions)	Asphalt pavement-Subgrade conditions
(H233)Pavement work(Asphalt pavement-Subgrade conditions)	Asphalt pavement-Subgrade conditions
(H234)Pavement work(Asphalt pavement-Weather conditions)	Asphalt pavement-Weather conditions
(H235)Pavement work(Asphalt pavement -Pavement thickness design)	Asphalt pavement -Pavement thickness design
(H236)Pavement work(Asphalt pavement - Pavement structure)	Asphalt pavement -Pavement thickness design
(H237)Pavement work(Asphalt pavement - Equivalent conversion coefficient)	Asphalt pavement -Pavement thickness design
(H238)Pavement work(Asphalt pavement - Pavement design on soft subgrade soil)	Asphalt pavement -Pavement thickness design

(H239)Pavement work(Asphalt pavement - Pavement design)	Asphalt pavement -Pavement thickness design
(H240)Pavement work(Asphalt pavement - Pavement design)	Asphalt pavement -Pavement thickness design
(H241)Pavement work(Asphalt pavement - Pavement design)	Asphalt pavement -Pavement thickness design
(H242)Pavement work(Asphalt pavement - Pavement design)	Asphalt pavement -Pavement thickness design
(H243)Pavement work(Asphalt pavement - Pavement design)	Asphalt pavement -Pavement thickness design
(H244)Pavement work(Asphalt pavement -Mixing and transportation)	Asphalt pavement -Mixing and transportation
(H245)Pavement work(Asphalt plant -Site selection)	Asphalt plant -Site selection
(H246)Pavement work(Asphalt plant -Site selection)	Asphalt plant -Site selection
(H247)Pavement work(Asphalt plant -Site selection)	Asphalt plant -Site selection
(H248)Pavement work(Asphalt plant -Site selection)	Asphalt plant -Site selection
(H249)Pavement work(Asphalt plant -Site selection)	Asphalt plant -Site selection
(H250)Pavement work(Asphalt plant -Capacity selection)	Asphalt plant -Capacity selection
(H251)Pavement work(Asphalt plant -Asphalt plant structure)	Asphalt plant -Asphalt plant structure
(H252)Pavement work(Asphalt plant -Aggregate storage device: cold bin)	Asphalt plant -Aggregate storage device: cold bin
(H253)Pavement work(Asphalt plant -Aggregate storage device: cold bin)	Asphalt plant -Aggregate storage device: cold bin
(H254)Pavement work(Asphalt plant -Aggregate storage device: cold bin)	Asphalt plant -Aggregate storage device: cold bin
(H255)Pavement work(Asphalt plant -Aggregate supply device: cold feeder)	Asphalt plant -Aggregate supply device: cold feeder
(H256)Pavement work(Asphalt plant -Aggregate supply device: cold feeder)	Asphalt plant -Aggregate supply device: cold feeder
(H257)Pavement work(Asphalt plant -Aggregate supply device: cold feeder)	Asphalt plant -Aggregate supply device: cold feeder
(H258)Pavement work(Asphalt plant -Accumulation conveyor)	Asphalt plant -Accumulation conveyor
(H259)Pavement work(Asphalt plant - Cold elevator)	Asphalt plant - Cold elevator
(H260)Pavement work(Asphalt plant - Dryer)	Asphalt plant - Dryer
(H261)Pavement work(Asphalt plant -Dust collector)	Asphalt plant -Dust collector
(H262)Pavement work(Asphalt plant -Hot elevator)	Asphalt plant -Hot elevator
(H263)Pavement work(Asphalt plant - Screening device: hot screen)	Asphalt plant - Screening device: hot screen
(H264)Pavement work(Asphalt plant - Screening device: Vibrating screen)	Asphalt plant - Screening device: Vibrating screen
(H265)Pavement work(Asphalt plant - Hot bin)	Asphalt plant - Hot bin
(H266)Pavement work(Asphalt plant - Stone powder storage device: Stone powder silo)	Asphalt plant - Stone powder storage device
(H267)Pavement work(Asphalt plant - Stone powder supply device)	Asphalt plant - Stone powder supply device
(H268)Pavement work(Asphalt plant -Stone powder bin)	Asphalt plant -Stone powder bin
(H269)Pavement work(Asphalt plant -Asphalt storage equipment)	Asphalt plant -Asphalt storage equipment
(H270)Pavement work(Asphalt plant -Asphalt supply device)	Asphalt plant -Asphalt supply device
(H271)Pavement work(Asphalt plant -Aggregate and stone powder weighing device)	Asphalt plant -Aggregate-stone powder weighing device
(H272)Pavement work(Asphalt plant -Asphalt measuring device)	Asphalt plant -Asphalt measuring device

(H273)Pavement work(Asphalt plant -Mixing equipment: mixer)	Asphalt plant -Mixing equipment: mixer
(H274)Pavement work(Mixing work)	Pavement work(Mixing work)
(H275)Pavement work(Mixing work)	Pavement work(Mixing work)
(H276)Pavement work(Mixing work-Amount of aggregate supplied)	Mixing work-Amount of aggregate supplied
(H277)Pavement work(Mixing work-Heating temperature of each material)	Mixing work-Heating temperature of each material
(H278)Pavement work(Mixing work-Mixing and measuring each ingredient)	Mixing work-Mixing and measuring each ingredient
(H279)Pavement work(Mixing work-Mixing and measuring each ingredient)	Mixing work-Mixing and measuring each ingredient
(H280)Pavement work(Mixing work-Optimum mixing time)	Mixing work-Optimum mixing time
(H281)Pavement work(Mixing work-On-site mix (plant mix))	Mixing work-On-site mix (plant mix)
(H282)Pavement work(Mixing work-On-site mix (plant mix))	Mixing work-On-site mix (plant mix)
(H283)Pavement work(Mixing work-On-site mix (plant mix))	Mixing work-On-site mix (plant mix)
(H284)Pavement work(Mixing work-On-site mix (plant mix))	Mixing work-On-site mix (plant mix)
(H285)Pavement work(Mixing work-On-site mix (plant mix))	Mixing work-On-site mix (plant mix)
(H286)Pavement work(Mixing work-On-site mix (plant mix)-Test mix)	Mixing work-On-site mix (plant mix)-Test mix
(H287)Pavement work(Mixing work-On-site mix (plant mix)-Test mix)	Mixing work-On-site mix (plant mix)-Test mix
(H288)Pavement work(Mixing work-On-site mix (plant mix)-Test mix)	Mixing work-On-site mix (plant mix)-Test mix
(H289)Pavement work(Mixing work-On-site mix (plant mix)-Test mix)	Mixing work-On-site mix (plant mix)-Test mix
(H290)Pavement work(Poor conditions of heated mixture and causes)	Poor conditions of heated mixture and causes
(H291)Pavement work(Poor conditions of heated mixture and causes)	Poor conditions of heated mixture and causes
(H292)Pavement work(Poor conditions of heated mixture and causes)	Poor conditions of heated mixture and causes
(H293)Pavement work(Poor conditions of heated mixture and causes)	Poor conditions of heated mixture and causes
(H294)Pavement work(Poor conditions of heated mixture and causes)	Poor conditions of heated mixture and causes
(H295)Pavement work(Poor conditions of heated mixture and causes)	Poor conditions of heated mixture and causes
(H296)Pavement work(Transportation-Transportation precautions)	Transportation-Transportation precautions
(H297)Pavement work(Transportation-Transportation precautions)	Transportation-Transportation precautions
(H298)Pavement work(Transportation-Transportation precautions)	Transportation-Transportation precautions
(H299)Pavement work(Transportation-Transportation precautions)	Transportation-Transportation precautions
(H300)Pavement work(Transportation-Transportation precautions)	Transportation-Transportation precautions
(H301)Pavement work(Transportation-Calculation of the number of transport vehicles required)	Transportation-number of transport vehicles
(H302)Pavement work(Transportation-Calculation of the number of transport vehicles required)	Transportation-number of transport vehicles
(H303)Pavement work(Pavement)	Pavement work(Pavement)
(H304)Pavement work(Pavement-Paving preparation)	Pavement-Paving preparation
(H305)Pavement work(Pavement-Paving preparation)	Pavement-Paving preparation
(H306)Pavement work(Pavement-Paving preparation)	Pavement-Paving preparation

(H307)Pavement work(Pavement-Paving preparation)	Pavement-Paving preparation
(H308)Pavement work(Prime coat)	Pavement work(Prime coat)
(H309)Pavement work(Prime coat)	Pavement work(Prime coat)
(H310)Pavement work(Prime coat)	Pavement work(Prime coat)
(H311)Pavement work(Prime coat)	Pavement work(Prime coat)
(H312)Pavement work(Tack coat)	Pavement work(Tack coat)
(H313)Pavement work(Distributor)	Pavement work(Distributor)
(H314)Pavement work(Bituminous Spraying Machine-Sprayer)	Bituminous Spraying Machine-Sprayer
(H315)Pavement work(Spreading the mixture)	Pavement work(Spreading the mixture)
(H316)Pavement work(Spreading the mixture-Spreading by hand)	Spreading the mixture-Spreading by hand
(H317)Pavement work(Spreading the mixture-Spreading by hand)	Spreading the mixture-Spreading by hand
(H318)Pavement work(Spreading the mixture-Spreading by hand)	Spreading the mixture-Spreading by hand
(H319)Pavement work(Spreading the mixture-Spreading by hand)	Spreading the mixture-Spreading by hand
(H320)Pavement work(Spreading the mixture-Spreading by hand)	Spreading the mixture-Spreading by hand
(H321)Pavement work(Spreading the mixture-Spreading by hand)	Spreading the mixture-Spreading by hand
(H322)Pavement work(Spreading the mixture-Spreading by hand)	Spreading the mixture-Spreading by hand
(H323)Pavement work(Spreading the mixture-Spreading by hand)	Spreading the mixture-Spreading by hand
(H324)Pavement work(Spreading the mixture-Spreading with a finisher)	Spreading the mixture-Spreading with a finisher
(H325)Pavement work(Spreading the mixture-Spreading with a finisher)	Spreading the mixture-Spreading with a finisher
(H326)Pavement work(Spreading the mixture-Spreading)	Spreading the mixture-Spreading
(H327)Pavement work(Spreading the mixture-Spreading)	Spreading the mixture-Spreading
(H328)Pavement work(Spreading the mixture-Spreading)	Spreading the mixture-Spreading
(H329)Pavement work(Spreading the mixture-Spreading)	Spreading the mixture-Spreading
(H330)Pavement work(Spreading the mixture-Spreading)	Spreading the mixture-Spreading
(H331)Pavement work(Spreading the mixture-Spreading)	Spreading the mixture-Spreading
(H332)Pavement work(Spreading the mixture-Spreading)	Spreading the mixture-Spreading
(H333)Pavement work(Spreading the mixture-Spreading)	Spreading the mixture-Spreading
(H334)Pavement work(Spreading the mixture-Spreading)	Spreading the mixture-Spreading
(H335)Pavement work(Spreading the mixture-Spreading)	Spreading the mixture-Spreading
(H336)Pavement work(Spreading the mixture-Spreading)	Spreading the mixture-Spreading
(H337)Pavement work(Spreading the mixture-Spreading)	Spreading the mixture-Spreading
(H338)Pavement work(Rolling)	Pavement work(Rolling)
(H339)Pavement work(Rolling)	Pavement work(Rolling)
(H340)Pavement work(Rolling)	Pavement work(Rolling)

(H341)Pavement work(Rolling)	Pavement work(Rolling)
(H342)Pavement work(Rolling-Rolling machine)	Pavement work(Rolling-Rolling machine)
(H343)Pavement work(Rolling-Rolling machine)	Pavement work(Rolling-Rolling machine)
(H344)Pavement work(Rolling-Rolling machine)	Pavement work(Rolling-Rolling machine)
(H345)Pavement work(Rolling-Rolling machine)	Pavement work(Rolling-Rolling machine)
(H346)Pavement work(Rolling-Rolling machine)	Pavement work(Rolling-Rolling machine)
(H347)Pavement work(Rolling-Rolling machine)	Pavement work(Rolling-Rolling machine)
(H348)Pavement work(Rolling-Precautions for rolling work)	Pavement work(Precautions for rolling work)
(H349)Pavement work(Rolling-Precautions for rolling work)	Pavement work(Precautions for rolling work)
(H350)Pavement work(Rolling-Precautions for rolling work)	Pavement work(Precautions for rolling work)
(H351)Pavement work(Rolling-Precautions for rolling work)	Pavement work(Precautions for rolling work)
(H352)Pavement work(Rolling-Precautions for rolling work)	Pavement work(Precautions for rolling work)
(H353)Pavement work(Rolling-Precautions for rolling work)	Pavement work(Precautions for rolling work)
(H354)Pavement work(Rolling-Precautions for rolling work)	Pavement work(Precautions for rolling work)
(H355)Pavement work(Pavement-Defects)	Pavement work(Pavement-Defects)
(H356)Pavement work(Pavement-Defects)	Pavement work(Pavement-Defects)
(H357)Pavement work(Pavement-Defects)	Pavement work(Pavement-Defects)
(H358)Pavement work(Pavement-Defects)	Pavement work(Pavement-Defects)
(H359)Pavement work(Pavement-Quality control)	Pavement-Quality control
(H360)Pavement work(Pavement-Quality control)	Pavement-Quality control
(H361)Pavement work(Pavement-Quality control)	Pavement-Quality control
(H362)Pavement work(Pavement-Quality control)	Pavement-Quality control
(H363)Pavement work(Pavement-Quality control)	Pavement-Quality control
(H364)Pavement work(Pavement-Quality control)	Pavement-Quality control
(H365)Pavement work(Pavement-Quality control)	Pavement-Quality control
(H366)Pavement work(Pavement-Quality control)	Pavement-Quality control
(H367)Pavement work(Pavement-Quality control)	Pavement-Quality control
(H368)Pavement work(Pavement-Quality control)	Pavement-Quality control
(H369)Pavement work(Quality control-Control chart)	Pavement-Quality control
(H370)Pavement work(Quality control-Control chart)	Pavement-Quality control
(H371)Pavement work(Quality control-Control chart)	Pavement-Quality control
(H372)Pavement work(Quality control-Control chart)	Pavement-Quality control
(H373)Pavement work(Quality control-Control chart)	Pavement-Quality control
(H374)Pavement work(Quality control-Control chart)	Pavement-Quality control

(H375)Pavement work(Quality control-Histogram)	Pavement work(Quality control-Histogram)
(H376)Pavement work(Quality control-Histogram)	Pavement work(Quality control-Histogram)
(H377)Pavement work(Quality control-Histogram)	Pavement work(Quality control-Histogram)
(H378)Pavement work(Quality control-Histogram)	Pavement work(Quality control-Histogram)
(H379)Pavement work(Quality control-Histogram)	Pavement work(Quality control-Histogram)
(H380)Pavement work(Quality control-Histogram)	Pavement work(Quality control-Histogram)
(H381)Pavement work(Quality control-Sampling inspection)	Pavement work(Quality control)
(H382)Pavement work(Quality control-Sampling inspection)	Pavement work(Quality control)
(H383)Pavement work(Asphalt mixture-Materials)	Pavement work(Asphalt mixture)
(H384)Pavement work(Asphalt mixture-Bituminous materials)	Pavement work(Bituminous materials)
(H385)Pavement work(Asphalt-Types of asphalt)	Pavement work(Asphalt-Types of asphalt)
(H386)Pavement work(Asphalt- Straight asphalt)	Pavement work(Asphalt- Straight asphalt)
(H387)Pavement work(Asphalt-Blown asphalt)	Pavement work(Asphalt-Blown asphalt)
(H388)Pavement work(Asphalt-Asphalt for waterproofing)	Pavement work(Asphalt for waterproofing)
(H389)Pavement work(Asphalt-Properties of asphalt)	Pavement work(Asphalt-Properties of asphalt)
(H390)Pavement work(Asphalt-Properties of asphalt)	Pavement work(Asphalt-Properties of asphalt)
(H391)Pavement work(Asphalt-Properties of asphalt)	Pavement work(Asphalt-Properties of asphalt)
(H392)Pavement work(Properties of asphalt-Specific gravity)	Pavement work(Properties of asphalt)
(H393)Pavement work(Properties of asphalt-Penetration)	Pavement work(Properties of asphalt)
(H394)Pavement work(Properties of asphalt-Softening point)	Pavement work(Properties of asphalt)
(H395)Pavement work(Properties of asphalt-Elongation)	Pavement work(Properties of asphalt)
(H396)Pavement work(Properties of asphalt-Flash point)	Pavement work(Properties of asphalt)
(H397)Pavement work(Properties of asphalt-Evaporation amount (%))	Pavement work(Properties of asphalt)
(H398)Pavement work(Properties of asphalt-Viscosity)	Pavement work(Properties of asphalt)
(H399)Pavement work(Petroleum asphalt emulsion)	Pavement work(Petroleum asphalt emulsion)
(H400)Pavement work(Petroleum asphalt emulsion)	Pavement work(Petroleum asphalt emulsion)
(H401)Pavement work(Petroleum asphalt emulsion)	Pavement work(Petroleum asphalt emulsion)
(H402)Pavement work(Cutback asphalt)	Pavement work(Cutback asphalt)
(H403)Pavement work(Cutback asphalt)	Pavement work(Cutback asphalt)
(H404)Pavement work(Paving tar)	Pavement work(Paving tar)
(H405)Pavement work(Modified asphalt)	Pavement work(Modified asphalt)
(H406)Pavement work(Modified asphalt)	Pavement work(Modified asphalt)
(H407)Pavement work(Modified asphalt)	Pavement work(Modified asphalt)
(H408)Pavement work(Aggregate)	Pavement work(Aggregate)

(H409)Pavement work(Aggregate-Types of aggregates)	Pavement work(Aggregate)
(H410)Pavement work(Aggregate-Required properties for aggregate)	Pavement work(Aggregate)
(H411)Pavement work(Aggregate-Aggregate size and classification)	Pavement work(Aggregate)
(H412)Pavement work(Aggregate-Aggregate size and classification)	Pavement work(Aggregate)
(H413)Pavement work(Aggregate-Aggregate size and classification)	Pavement work(Aggregate)
(H414)Pavement work(Aggregate-Example of crushed stone sieving test)	Pavement work(Aggregate)
(H415)Pavement work(Aggregate-Moisture content)	Pavement work(Aggregate)
(H416)Pavement work(Aggregate-Specific gravity of aggregate)	Pavement work(Aggregate)
(H417)Pavement work(Aggregate-Water absorption of aggregate)	Pavement work(Aggregate)
(H418)Pavement work(Aggregate-Unit volume weight of aggregate)	Pavement work(Aggregate)
(H419)Pavement work(Aggregate-Abrasion resistance of aggregate)	Pavement work(Aggregate)
(H420)Pavement work(Aggregate-Filler)	Pavement work(Aggregate)
(H421)Pavement work(Storage of materials-Storage of bitumen materials)	Pavement work(Storage of bitumen materials)
(H422)Pavement work(Storage of materials-Aggregate storage)	Pavement work(Aggregate storage)
(H423)Pavement work(Mixture)	Pavement work(Mixture)
(H424)Pavement work(Asphalt pavement method-Heated mix method)	Pavement work(Asphalt pavement method)
(H425)Pavement work(Asphalt pavement method-Normal temperature mixing method)	Pavement work(Asphalt pavement method)
(H426)Pavement work(Asphalt pavement method-On-road mixing method)	Pavement work(Asphalt pavement method)
(H427)Pavement work(Asphalt pavement method-Permeation method)	Pavement work(Asphalt pavement method)
(H428)Pavement work(Asphalt pavement method-Asphalt concrete)	Pavement work(Asphalt pavement method)
(H429)Pavement work(Type of mixture)	Pavement work(Type of mixture)
(H430)Pavement work(Type of mixture)	Pavement work(Type of mixture)
(H431)Pavement work(Type of mixture)	Pavement work(Type of mixture)
(H432)Pavement work(Type of mixture-Standard mix ratio for mixture)	Pavement work(Type of mixture)
(H433)Pavement work(Type of mixture-Definition of asphalt concrete)	Pavement work(Type of mixture)
(H434)Pavement work(Mixture properties-General properties)	Pavement work(Mixture properties)
(H435)Pavement work(Mixture properties-General properties)	Pavement work(Mixture properties)
(H436)Pavement work(Mixture properties-General properties)	Pavement work(Mixture properties)
(H437)Pavement work(Mixture properties-General properties)	Pavement work(Mixture properties)
(H438)Pavement work(Mixture properties-General properties)	Pavement work(Mixture properties)
(H439)Pavement work(Mixture properties-General properties)	Pavement work(Mixture properties)
(H440)Pavement work(Mixture properties-General properties)	Pavement work(Mixture properties)
(H441)Pavement work(Mixture properties-Tests on mixtures)	Pavement work(Mixture properties)
(H442)Pavement work(Mixture properties-Tests on mixtures)	Pavement work(Mixture properties)

(H443)Pavement work(Mixture properties-Tests on mixtures)	Pavement work(Mixture properties)
(H444)Pavement work(Mixture properties-Tests on mixtures)	Pavement work(Mixture properties)
(H445)Pavement work(Mixture properties-Tests on mixtures)	Pavement work(Mixture properties)
(H446)Pavement work(Mixture properties-Tests on mixtures)	Pavement work(Mixture properties)
(H447)Pavement work(Asphalt mixture mix design)	Pavement work(Asphalt mixture mix design)
(H448)Pavement work(Mixture mix-Material selection)	Pavement work(Mixture mix-Material selection)
(H449)Pavement work(Material selection-Asphalt)	Pavement work(Material selection-Asphalt)
(H450)Pavement work(Material selection-Aggregate)	Pavement work(Material selection-Aggregate)
(H451)Pavement work(Mixture mix-Determining aggregate mix)	Pavement work(Determining aggregate mix)
(H452)Pavement work(Mixture mix-Determining aggregate mix)	Pavement work(Determining aggregate mix)
(H453)Pavement work(Mixture mix-Asphalt test results)	Pavement work(Asphalt test results)
(H454)Pavement work(Mixture mix-Aggregate test results)	Pavement work(Aggregate test results)
(H455)Pavement work(Mixture mix-Determination of aggregate mix)	Pavement work(Determination of aggregate mix)
(H456)Pavement work(Mixture mix-Calculation of composite grading)	Pavement work(Calculation of composite grading)
(H457)Pavement work(Mixture mix- Grain size curve)	Pavement work(Grain size curve)
(H458)Pavement work(Mixture mix- Determined mix ratio and composite grading)	Pavement work(Determined mix ratio and composite grading)
(H459)Pavement work(Mixture mix- Determination of the design asphalt amount)	Pavement work(Determination of the design asphalt amount)
(H460)Pavement work(Mixture mix- Determination of the design asphalt amount)	Pavement work(Determination of the design asphalt amount)
(H461)Pavement work(Mixture mix- Amount of material required for one test piece)	Pavement work(Amount of material required for one test piece)
(H462)Pavement work(Mixture mix- Calculating the theoretical maximum density)	Pavement work(Calculating the theoretical maximum density)
(H463)Pavement work(Mixture mix-Marshall stability test results)	Pavement work(Marshall stability test results)
(H464)Pavement work(Mixture mix-Characteristic values of the specimen)	Pavement work(Characteristic values of the specimen)
(H465)Pavement work(Mixture mix-Determining the amount of asphalt designed)	Pavement work(Amount of asphalt designed)
(H466)Pavement work(Mixture mix-Determining the amount of asphalt designed)	Pavement work(Amount of asphalt designed)
(H467)Pavement work(Mixture mix-Determining the amount of asphalt designed)	Pavement work(Amount of asphalt designed)
(H468)Pavement work(Mixture mix-Determining the amount of asphalt designed)	Pavement work(Amount of asphalt designed)
(H469)Pavement work(Mixture mix-Determining the amount of asphalt designed)	Pavement work(Amount of asphalt designed)
(H470)Pavement work(Mixture mix-Determining the amount of asphalt designed)	Pavement work(Amount of asphalt designed)
(H471)Pavement work(Mixture mix-Determining the amount of asphalt designed)	Pavement work(Amount of asphalt designed)
(H472)Pavement work(Mixture mix-Determining the amount of asphalt designed)	Pavement work(Amount of asphalt designed)
(H473)Pavement work(Mixture mix-Determining the amount of asphalt designed)	Pavement work(Amount of asphalt designed)

(H225)Pavement work(Asphalt pavement)	Asphalt pavement
(H90)Road pavement(Asphalt pavement- Colored pavement)	Asphalt pavement- Colored pavement
(H224)Pavement work(Asphalt pavement- Cement concrete pavement)	Asphalt pavement- Cement concrete pavement
(H230)Pavement work(Asphalt pavement design-Pavement design)	Asphalt pavement design-Pavement design
(H89)Road pavement(Asphalt pavement- Light pavement)	Asphalt pavement- Light pavement
(H244)Pavement work(Asphalt pavement -Mixing and transportation)	Asphalt pavement -Mixing and transportation
(H235)Pavement work(Asphalt pavement -Pavement thickness design)	Asphalt pavement -Pavement thickness design
(H236)Pavement work(Asphalt pavement - Pavement structure)	Asphalt pavement -Pavement thickness design
(H237)Pavement work(Asphalt pavement - Equivalent conversion coefficient)	Asphalt pavement -Pavement thickness design
(H238)Pavement work(Asphalt pavement - Pavement design on soft subgrade soil)	Asphalt pavement -Pavement thickness design
(H239)Pavement work(Asphalt pavement - Pavement design)	Asphalt pavement -Pavement thickness design
(H240)Pavement work(Asphalt pavement - Pavement design)	Asphalt pavement -Pavement thickness design
(H241)Pavement work(Asphalt pavement - Pavement design)	Asphalt pavement -Pavement thickness design
(H242)Pavement work(Asphalt pavement - Pavement design)	Asphalt pavement -Pavement thickness design
(H243)Pavement work(Asphalt pavement - Pavement design)	Asphalt pavement -Pavement thickness design
(H128)Asphalt pavement(Leveling machine）	Asphalt pavement(Leveling machine）
(H129)Asphalt pavement(Compaction machine）	Asphalt pavement(Compaction machine）
(H130)Asphalt pavement(Compaction machine）	Asphalt pavement(Compaction machine）
(H127)Asphalt pavement(Spraying machine）	Asphalt pavement(Spraying machine）
(H91)Road pavement(Asphalt pavement-Anti-slip pavement)	Asphalt pavement-Anti-slip pavement
(H196)Pavement(Asphalt pavement-Asphalt finisher)	Asphalt pavement-Asphalt finisher
(H185)Pavement(Asphalt Pavement-Asphalt road surface)	Asphalt Pavement-Asphalt road surface
(H186)Pavement(Asphalt Pavement-Asphalt road surface)	Asphalt Pavement-Asphalt road surface
(H227)Pavement work(Asphalt pavement-Base course)	Asphalt pavement-Base course
(H228)Pavement work(Asphalt pavement-Base course)	Asphalt pavement-Base course
(H229)Pavement work(Asphalt pavement-Base course)	Asphalt pavement-Base course
(H181)Pavement(Asphalt Pavement-Comparison between straight and blown asphalt)	Asphalt Pavement-Comparison
(H95)Road pavement(Asphalt pavement-Composite pavement)	Asphalt pavement-Composite pavement
(H198)Pavement(Asphalt pavement-Details)	Asphalt pavement-Details
(H88)Road pavement(Asphalt pavement-Drainage pavement)	Asphalt pavement-Drainage pavement
(H92)Road pavement(Asphalt pavement-Foamed Asphalt Pavement)	Asphalt pavement-Foamed Asphalt Pavement
(H93)Road pavement(Asphalt pavement-Full-depth asphalt pavement)	Asphalt pavement-Full-depth asphalt pavement
(H86)Road pavement(Asphalt pavement-Goose asphalt pavement)	Asphalt pavement-Goose asphalt pavement
(H197)Pavement(Asphalt pavement-Initial compaction:Secondary compaction)	Asphalt pavement-Initial compaction

(H222)Pavement work(Asphalt pavement-Mixing and transportation)	Asphalt pavement-Mixing and transportation
(H223)Pavement work(Asphalt pavement-Mixing and transportation)	Asphalt pavement-Mixing and transportation
(H193)Pavement(Asphalt pavement-On-site arrival temperature)	Asphalt pavement-On-site arrival temperature
(H215)Pavement work(Asphalt pavement-Overlay)	Asphalt pavement-Overlay
(H214)Pavement work(Asphalt pavement-Patching)	Asphalt pavement-Patching
(H221)Pavement work(Asphalt pavement-Pavement design)	Asphalt pavement-Pavement design
(H194)Pavement(Asphalt pavement-Prime coat)	Asphalt pavement-Prime coat
(H191)Pavement(Asphalt pavement-Procedure)	Asphalt pavement-Procedure
(H216)Pavement work(Asphalt pavement-Replacement method)	Asphalt pavement-Replacement method
(H217)Pavement work(Asphalt pavement-Road surface regeneration method)	Asphalt pavement-Road surface regeneration
(H87)Road pavement(Asphalt pavement-Rolled asphalt pavement)	Asphalt pavement-Rolled asphalt pavement
(H94)Road pavement(Asphalt pavement-Sandwich pavement)	Asphalt pavement-Sandwich pavement
(H85)Road pavement(Asphalt pavement-Semi-flexible pavement)	Asphalt pavement-Semi-flexible pavement
(H84)Road pavement(Asphalt pavement-Special pavement)	Asphalt pavement-Special pavement)
(H232)Pavement work(Asphalt pavement-Subgrade conditions)	Asphalt pavement-Subgrade conditions
(H233)Pavement work(Asphalt pavement-Subgrade conditions)	Asphalt pavement-Subgrade conditions
(H3)Road pavement(Asphalt pavement-Subgrade design)	Asphalt pavement-Subgrade design
(H4)Road pavement(Asphalt pavement-Subgrade design)	Asphalt pavement-Subgrade design
(H5)Road pavement(Asphalt pavement-Subgrade design)	Asphalt pavement-Subgrade design
(H6)Road pavement(Asphalt pavement-Pavement design)	Asphalt pavement-Subgrade design
(H7)Road pavement(Asphalt pavement-Pavement design)	Asphalt pavement-Subgrade design
(H8)Road pavement(Asphalt pavement-Pavement design)	Asphalt pavement-Subgrade design
(H9)Road pavement(Asphalt pavement-Pavement design)	Asphalt pavement-Subgrade design
(H10)Road pavement(Asphalt pavement-Pavement design)	Asphalt pavement-Subgrade design
(H226)Pavement work(Asphalt pavement-Subgrade(roadbed))	Asphalt pavement-Subgrade(roadbed)
(H195)Pavement(Asphalt pavement-Tack coat)	Asphalt pavement-Tack coat
(H231)Pavement work(Asphalt pavement-Traffic conditions)	Asphalt pavement-Traffic conditions
(H192)Pavement(Asphalt pavement-Transporting the mixture: Dump truck)	Asphalt pavement-Transporting the mixture
(H234)Pavement work(Asphalt pavement-Weather conditions)	Asphalt pavement-Weather conditions
(H119)Asphalt pavement(Asphalt Paving Machine- On-road mixing: Stabilizer)	Asphalt Paving Machine- On-road mixing: Stabilizer
(H259)Pavement work(Asphalt plant - Cold elevator)	Asphalt plant - Cold elevator
(H260)Pavement work(Asphalt plant - Dryer)	Asphalt plant - Dryer
(H265)Pavement work(Asphalt plant - Hot bin)	Asphalt plant - Hot bin
(H263)Pavement work(Asphalt plant - Screening device: hot screen)	Asphalt plant - Screening device: hot screen

(H264)Pavement work(Asphalt plant - Screening device: Vibrating screen)	Asphalt plant - Screening device: Vibrating screen
(H266)Pavement work(Asphalt plant - Stone powder storage device: Stone powder silo)	Asphalt plant - Stone powder storage device
(H267)Pavement work(Asphalt plant - Stone powder supply device)	Asphalt plant - Stone powder supply device
(H258)Pavement work(Asphalt plant -Accumulation conveyor)	Asphalt plant -Accumulation conveyor
(H252)Pavement work(Asphalt plant -Aggregate storage device: cold bin)	Asphalt plant -Aggregate storage device: cold bin
(H253)Pavement work(Asphalt plant -Aggregate storage device: cold bin)	Asphalt plant -Aggregate storage device: cold bin
(H254)Pavement work(Asphalt plant -Aggregate storage device: cold bin)	Asphalt plant -Aggregate storage device: cold bin
(H255)Pavement work(Asphalt plant -Aggregate supply device: cold feeder)	Asphalt plant -Aggregate supply device: cold feeder
(H256)Pavement work(Asphalt plant -Aggregate supply device: cold feeder)	Asphalt plant -Aggregate supply device: cold feeder
(H257)Pavement work(Asphalt plant -Aggregate supply device: cold feeder)	Asphalt plant -Aggregate supply device: cold feeder
(H271)Pavement work(Asphalt plant -Aggregate and stone powder weighing device)	Asphalt plant -Aggregate-stone powder weighing device
(H272)Pavement work(Asphalt plant -Asphalt measuring device)	Asphalt plant -Asphalt measuring device
(H251)Pavement work(Asphalt plant -Asphalt plant structure)	Asphalt plant -Asphalt plant structure
(H269)Pavement work(Asphalt plant -Asphalt storage equipment)	Asphalt plant -Asphalt storage equipment
(H270)Pavement work(Asphalt plant -Asphalt supply device)	Asphalt plant -Asphalt supply device
(H250)Pavement work(Asphalt plant -Capacity selection)	Asphalt plant -Capacity selection
(H261)Pavement work(Asphalt plant -Dust collector)	Asphalt plant -Dust collector
(H262)Pavement work(Asphalt plant -Hot elevator)	Asphalt plant -Hot elevator
(H273)Pavement work(Asphalt plant -Mixing equipment: mixer)	Asphalt plant -Mixing equipment: mixer
(H245)Pavement work(Asphalt plant -Site selection)	Asphalt plant -Site selection
(H246)Pavement work(Asphalt plant -Site selection)	Asphalt plant -Site selection
(H247)Pavement work(Asphalt plant -Site selection)	Asphalt plant -Site selection
(H248)Pavement work(Asphalt plant -Site selection)	Asphalt plant -Site selection
(H249)Pavement work(Asphalt plant -Site selection)	Asphalt plant -Site selection
(H268)Pavement work(Asphalt plant -Stone powder bin)	Asphalt plant -Stone powder bin
(H189)Pavement(Asphalt road surface-Colored pavement)	Asphalt road surface-Colored pavement
(H190)Pavement(Asphalt road surface-Macadam method)	Asphalt road surface-Macadam method
(H188)Pavement(Asphalt road surface-Permeable pavement)	Asphalt road surface-Permeable pavement
(H187)Pavement(Asphalt road surface-Semi-flexible pavement)	Asphalt road surface-Semi-flexible pavement
(H314)Pavement work(Bituminous Spraying Machine-Sprayer)	Bituminous Spraying Machine-Sprayer
(H83)Road pavement(Quality control -Bituminous stabilization treatment Base course(roadbed), surface sublayer)	Bituminous stabilization treatment Base course
(H82)Road pavement(Quality control -Cement and lime stabilization Base course(roadbed))	Cement and lime stabilization Base course
(H131)Cement concrete pavement	Cement concrete pavement
(H132)Cement concrete pavement(Subgrade)	Cement concrete pavement

(H133)Cement concrete pavement (Base course(roadbed))	Cement concrete pavement
(H134)Cement concrete pavement (Concrete slab)	Cement concrete pavement
(H135)Cement concrete pavement (Concrete slab)	Cement concrete pavement
(H136)Cement concrete pavement (Concrete slab-Joints)	Cement concrete pavement
(H137)Cement concrete pavement (Concrete slab-Joints)	Cement concrete pavement
(H138)Cement concrete pavement (Concrete slab-Dummy joint)	Cement concrete pavement
(H139)Cement concrete pavement (Concrete slab-Slip bar)	Cement concrete pavement
(H140)Cement concrete pavement (Concrete slab-Tie bar)	Cement concrete pavement
(H141)Cement concrete pavement (Materials and mix)	Cement concrete pavement
(H142)Cement concrete pavement (Mixing)	Cement concrete pavement
(H143)Cement concrete pavement (Formwork)	Cement concrete pavement
(H144)Cement concrete pavement (Iron mesh and edge reinforcement rebar)	Cement concrete pavement
(H145)Cement concrete pavement (Compaction)	Cement concrete pavement
(H146)Cement concrete pavement (Surface finishing)	Cement concrete pavement
(H147)Cement concrete pavement (Curing)	Cement concrete pavement (Curing)
(H148)Cement concrete pavement (Curing)	Cement concrete pavement (Curing)
(H149)Cement concrete pavement (Curing period)	Cement concrete pavement (Curing)
(H150)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H151)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H152)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H153)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H154)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H155)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H156)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H157)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H158)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H159)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H160)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H161)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H162)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H163)Cement concrete pavement (Initial cracks)	Cement concrete pavement (Initial cracks)
(H124)Asphalt pavement(Compaction: Road rollers, tire rollers, vibrating rollers, water sprinklers）	Compaction: Road rollers, tire rollers,
(H213)Pavement work(Concrete pavement-Continuous concrete pavement)	Concrete pavement-Continuous concrete pavement
(H212)Pavement work(Concrete pavement-Joint)	Concrete pavement-Joint

(H206)Pavement work(Concrete pavement-Mixing, mixing, transport)	Concrete pavement-Mixing, mixing, transport
(H209)Pavement work(Concrete pavement-Placing-in and finishing)	Concrete pavement-Placing-in and finishing
(H210)Pavement work(Concrete pavement-Placing-in and finishing)	Concrete pavement-Placing-in and finishing
(H211)Pavement work(Concrete pavement-Pouring and finishing)	Concrete pavement-Pouring and finishing
(H207)Pavement work(Concrete pavement-RCCP method)	Concrete pavement-RCCP method
(H208)Pavement work(Concrete pavement-RCCP method)	Concrete pavement-RCCP method
(H120)Asphalt pavement(Excavation and loading: Backhoe, tractor shovel）	Excavation and loading: Backhoe, tractor shovel
(H126)Asphalt pavement(Excavation, loading and shaping machinery）	Excavation, loading and shaping machinery
(H81)Road pavement(Quality control -Grain size adjustment Base course(roadbed))	Grain size adjustment Base course(roadbed)
(H165)Pavement(Improvement of Subgrade(roadbed) soil)	Improvement of Subgrade(roadbed) soil
(H166)Pavement(Improvement of Subgrade(roadbed) soil-Soil cement method)	Improvement of Subgrade(roadbed) soil
(H167)Pavement(Improvement of Subgrade(roadbed) soil-Soil cement method)	Improvement of Subgrade(roadbed) soil
(H168)Pavement(Improvement of Subgrade(roadbed) soil-Soil cement method)	Improvement of Subgrade(roadbed) soil
(H169)Pavement(Improvement of Subgrade(roadbed) soil-Soil cement method)	Improvement of Subgrade(roadbed) soil
(H170)Pavement(Improvement of Subgrade(roadbed) soil-Soil cement method)	Improvement of Subgrade(roadbed) soil
(H171)Pavement(Improvement of Subgrade(roadbed) soil-Soil cement method)	Improvement of Subgrade(roadbed) soil
(H78)Road pavement(Inspection & Control-As-built)	Inspection & Control-As-built
(H70)Road pavement(Inspection & Control-Tests on asphalt pavement)	Inspection & Control-Tests on asphalt
(H71)Road pavement(Inspection & Control-Tests on asphalt pavement)	Inspection & Control-Tests on asphalt
(H72)Road pavement(Inspection & Control-Tests on asphalt pavement)	Inspection & Control-Tests on asphalt
(H73)Road pavement(Inspection & Control-Tests on asphalt pavement)	Inspection & Control-Tests on asphalt
(H74)Road pavement(Inspection & Control-Tests on asphalt pavement)	Inspection & Control-Tests on asphalt
(H75)Road pavement(Inspection & Control-Tests on asphalt pavement)	Inspection & Control-Tests on asphalt
(H76)Road pavement(Inspection & Control-Tests on asphalt pavement)	Inspection & Control-Tests on asphalt
(H77)Road pavement(Inspection & Control-Tests on asphalt pavement)	Inspection & Control-Tests on asphalt
(H123)Asphalt pavement(Leveling: Motor grader, bulldozer, base paper, asphalt finisher）	Leveling: Motor grader, bulldozer, asphalt finisher
(H218)macadam	macadam
(H115)Asphalt pavement(Maintenance + repair- Cutting method）	Maintenance + repair- Cutting method
(H118)Asphalt pavement(Maintenance + repair- Patching and step-rubbing method）	Maintenance + repair- Patching and step-rubbing method
(H116)Asphalt pavement(Maintenance + repair- Sealing material injection method）	Maintenance + repair- Sealing material injection method
(H117)Asphalt pavement(Maintenance + repair- Surface treatment method）	Maintenance + repair- Surface treatment method
(H112)Asphalt pavement(Maintenance + repair-Asphalt Pavement Repair Methods）	Maintenance + repair-Asphalt Pavement Repair Methods
(H111)Asphalt pavement(Maintenance + repair-Overlay method）	Maintenance + repair-Overlay method
(H114)Asphalt pavement(Maintenance + repair-Rut overlay method）	Maintenance + repair-Rut overlay method

(H113)Asphalt pavement(Maintenance + repair-Thin layer overlay method）	Maintenance + repair-Thin layer overlay method
(H108)Asphalt pavement(Maintenance + repair-Linear replacement method）	Maintenance-Linear replacement method
(H107)Asphalt pavement(Maintenance + repair-Local replacement method）	Maintenance-Local replacement method
(H109)Asphalt pavement(Maintenance + repair-On-road regeneration roadbed method）	Maintenance-On-road regeneration roadbed method
(H106)Asphalt pavement(Maintenance + repair-Replacement method）	Maintenance-Replacement method
(H110)Asphalt pavement(Maintenance + repair-Surface and base layer replacement method）	Maintenance-Surface and base layer replacement method
(H276)Pavement work(Mixing work-Amount of aggregate supplied)	Mixing work-Amount of aggregate supplied
(H277)Pavement work(Mixing work-Heating temperature of each material)	Mixing work-Heating temperature of each material
(H278)Pavement work(Mixing work-Mixing and measuring each ingredient)	Mixing work-Mixing and measuring each ingredient
(H279)Pavement work(Mixing work-Mixing and measuring each ingredient)	Mixing work-Mixing and measuring each ingredient
(H281)Pavement work(Mixing work-On-site mix (plant mix))	Mixing work-On-site mix (plant mix)
(H282)Pavement work(Mixing work-On-site mix (plant mix))	Mixing work-On-site mix (plant mix)
(H283)Pavement work(Mixing work-On-site mix (plant mix))	Mixing work-On-site mix (plant mix)
(H284)Pavement work(Mixing work-On-site mix (plant mix))	Mixing work-On-site mix (plant mix)
(H285)Pavement work(Mixing work-On-site mix (plant mix))	Mixing work-On-site mix (plant mix)
(H286)Pavement work(Mixing work-On-site mix (plant mix)-Test mix)	Mixing work-On-site mix (plant mix)-Test mix
(H287)Pavement work(Mixing work-On-site mix (plant mix)-Test mix)	Mixing work-On-site mix (plant mix)-Test mix
(H288)Pavement work(Mixing work-On-site mix (plant mix)-Test mix)	Mixing work-On-site mix (plant mix)-Test mix
(H289)Pavement work(Mixing work-On-site mix (plant mix)-Test mix)	Mixing work-On-site mix (plant mix)-Test mix
(H280)Pavement work(Mixing work-Optimum mixing time)	Mixing work-Optimum mixing time
(H101)Road pavement(Special pavement applications-Colored pavement)	pavement applications-Colored pavement
(H99)Road pavement(Special pavement applications-Drainage pavement)	pavement applications-Drainage pavement
(H103)Road pavement(Special pavement applications-Foamed Asphalt Pavement)	pavement applications-Foamed Asphalt Pavement
(H104)Road pavement(Special pavement applications-Full depth asphalt pavement	pavement applications-Full depth asphalt pavement
(H97)Road pavement(Special pavement applications-Guss asphalt pavement)	pavement applications-Guss asphalt pavement
(H100)Road pavement(Special pavement applications-Light-colored pavement)	pavement applications-Light-colored pavement
(H98)Road pavement(Special pavement applications-Rolled asphalt pavement)	pavement applications-Rolled asphalt pavement
(H105)Road pavement(Special pavement applications-Sandwich pavement）	pavement applications-Sandwich pavement
(H96)Road pavement(Special pavement applications-Semi-flexible pavement)	pavement applications-Semi-flexible pavement
(H102)Road pavement(Special pavement applications-Slip-resistant pavement)	pavement applications-Slip-resistant pavement
(H199)Pavement work(Pavement design TA method)	Pavement design TA method
(H200)Pavement work(Pavement design TA method)	Pavement design TA method
(H201)Pavement work(Pavement design TA method)	Pavement design TA method
(H202)Pavement work(Pavement design TA method)	Pavement design TA method

(H203)Pavement work(Pavement design TA method)	Pavement design TA method
(H204)Pavement work(Pavement design TA method)	Pavement design TA method
(H205)Pavement work(Pavement design TA method)	Pavement design TA method
(H422)Pavement work(Storage of materials-Aggregate storage)	Pavement work(Aggregate storage)
(H454)Pavement work(Mixture mix-Aggregate test results)	Pavement work(Aggregate test results)
(H408)Pavement work(Aggregate)	Pavement work(Aggregate)
(H409)Pavement work(Aggregate-Types of aggregates)	Pavement work(Aggregate)
(H410)Pavement work(Aggregate-Required properties for aggregate)	Pavement work(Aggregate)
(H411)Pavement work(Aggregate-Aggregate size and classification)	Pavement work(Aggregate)
(H412)Pavement work(Aggregate-Aggregate size and classification)	Pavement work(Aggregate)
(H413)Pavement work(Aggregate-Aggregate size and classification)	Pavement work(Aggregate)
(H414)Pavement work(Aggregate-Example of crushed stone sieving test)	Pavement work(Aggregate)
(H415)Pavement work(Aggregate-Moisture content)	Pavement work(Aggregate)
(H416)Pavement work(Aggregate-Specific gravity of aggregate)	Pavement work(Aggregate)
(H417)Pavement work(Aggregate-Water absorption of aggregate)	Pavement work(Aggregate)
(H418)Pavement work(Aggregate-Unit volume weight of aggregate)	Pavement work(Aggregate)
(H419)Pavement work(Aggregate-Abrasion resistance of aggregate)	Pavement work(Aggregate)
(H420)Pavement work(Aggregate-Filler)	Pavement work(Aggregate)
(H465)Pavement work(Mixture mix-Determining the amount of asphalt designed)	Pavement work(Amount of asphalt designed)
(H466)Pavement work(Mixture mix-Determining the amount of asphalt designed)	Pavement work(Amount of asphalt designed)
(H467)Pavement work(Mixture mix-Determining the amount of asphalt designed)	Pavement work(Amount of asphalt designed)
(H468)Pavement work(Mixture mix-Determining the amount of asphalt designed)	Pavement work(Amount of asphalt designed)
(H469)Pavement work(Mixture mix-Determining the amount of asphalt designed)	Pavement work(Amount of asphalt designed)
(H470)Pavement work(Mixture mix-Determining the amount of asphalt designed)	Pavement work(Amount of asphalt designed)
(H471)Pavement work(Mixture mix-Determining the amount of asphalt designed)	Pavement work(Amount of asphalt designed)
(H472)Pavement work(Mixture mix-Determining the amount of asphalt designed)	Pavement work(Amount of asphalt designed)
(H473)Pavement work(Mixture mix-Determining the amount of asphalt designed)	Pavement work(Amount of asphalt designed)
(H461)Pavement work(Mixture mix- Amount of material required for one test piece)	Pavement work(Amount of material required for one test piece)
(H388)Pavement work(Asphalt-Asphalt for waterproofing)	Pavement work(Asphalt for waterproofing)
(H447)Pavement work(Asphalt mixture mix design)	Pavement work(Asphalt mixture mix design)
(H383)Pavement work(Asphalt mixture-Materials)	Pavement work(Asphalt mixture)
(H424)Pavement work(Asphalt pavement method-Heated mix method)	Pavement work(Asphalt pavement method)
(H425)Pavement work(Asphalt pavement method-Normal temperature mixing method)	Pavement work(Asphalt pavement method)
(H426)Pavement work(Asphalt pavement method-On-road mixing method)	Pavement work(Asphalt pavement method)

(H427)Pavement work(Asphalt pavement method-Permeation method)	Pavement work(Asphalt pavement method)
(H428)Pavement work(Asphalt pavement method-Asphalt concrete)	Pavement work(Asphalt pavement method)
(H386)Pavement work(Asphalt- Straight asphalt)	Pavement work(Asphalt- Straight asphalt)
(H453)Pavement work(Mixture mix-Asphalt test results)	Pavement work(Asphalt test results)
(H387)Pavement work(Asphalt-Blown asphalt)	Pavement work(Asphalt-Blown asphalt)
(H389)Pavement work(Asphalt-Properties of asphalt)	Pavement work(Asphalt-Properties of asphalt)
(H390)Pavement work(Asphalt-Properties of asphalt)	Pavement work(Asphalt-Properties of asphalt)
(H391)Pavement work(Asphalt-Properties of asphalt)	Pavement work(Asphalt-Properties of asphalt)
(H385)Pavement work(Asphalt-Types of asphalt)	Pavement work(Asphalt-Types of asphalt)
(H384)Pavement work(Asphalt mixture-Bituminous materials)	Pavement work(Bituminous materials)
(H462)Pavement work(Mixture mix- Calculating the theoretical maximum density)	Pavement work(Calculating the theoretical maximum density)
(H456)Pavement work(Mixture mix-Calculation of composite grading)	Pavement work(Calculation of composite grading)
(H464)Pavement work(Mixture mix-Characteristic values of the specimen)	Pavement work(Characteristic values of the specimen)
(H402)Pavement work(Cutback asphalt)	Pavement work(Cutback asphalt)
(H403)Pavement work(Cutback asphalt)	Pavement work(Cutback asphalt)
(H455)Pavement work(Mixture mix-Determination of aggregate mix)	Pavement work(Determination of aggregate mix)
(H459)Pavement work(Mixture mix- Determination of the design asphalt amount)	Pavement work(Determination of the design asphalt amount)
(H460)Pavement work(Mixture mix- Determination of the design asphalt amount)	Pavement work(Determination of the design asphalt amount)
(H458)Pavement work(Mixture mix- Determined mix ratio and composite grading)	Pavement work(Determined mix ratio and composite grading)
(H451)Pavement work(Mixture mix-Determining aggregate mix)	Pavement work(Determining aggregate mix)
(H452)Pavement work(Mixture mix-Determining aggregate mix)	Pavement work(Determining aggregate mix)
(H313)Pavement work(Distributor)	Pavement work(Distributor)
(H457)Pavement work(Mixture mix- Grain size curve)	Pavement work(Grain size curve)
(H463)Pavement work(Mixture mix-Marshall stability test results)	Pavement work(Marshall stability test results)
(H450)Pavement work(Material selection-Aggregate)	Pavement work(Material selection-Aggregate)
(H449)Pavement work(Material selection-Asphalt)	Pavement work(Material selection-Asphalt)
(H274)Pavement work(Mixing work)	Pavement work(Mixing work)
(H275)Pavement work(Mixing work)	Pavement work(Mixing work)
(H448)Pavement work(Mixture mix-Material selection)	Pavement work(Mixture mix-Material selection)
(H434)Pavement work(Mixture properties-General properties)	Pavement work(Mixture properties)
(H435)Pavement work(Mixture properties-General properties)	Pavement work(Mixture properties)
(H436)Pavement work(Mixture properties-General properties)	Pavement work(Mixture properties)
(H437)Pavement work(Mixture properties-General properties)	Pavement work(Mixture properties)
(H438)Pavement work(Mixture properties-General properties)	Pavement work(Mixture properties)

(H439)Pavement work(Mixture properties-General properties)	Pavement work(Mixture properties)
(H440)Pavement work(Mixture properties-General properties)	Pavement work(Mixture properties)
(H441)Pavement work(Mixture properties-Tests on mixtures)	Pavement work(Mixture properties)
(H442)Pavement work(Mixture properties-Tests on mixtures)	Pavement work(Mixture properties)
(H443)Pavement work(Mixture properties-Tests on mixtures)	Pavement work(Mixture properties)
(H444)Pavement work(Mixture properties-Tests on mixtures)	Pavement work(Mixture properties)
(H445)Pavement work(Mixture properties-Tests on mixtures)	Pavement work(Mixture properties)
(H446)Pavement work(Mixture properties-Tests on mixtures)	Pavement work(Mixture properties)
(H423)Pavement work(Mixture)	Pavement work(Mixture)
(H405)Pavement work(Modified asphalt)	Pavement work(Modified asphalt)
(H406)Pavement work(Modified asphalt)	Pavement work(Modified asphalt)
(H407)Pavement work(Modified asphalt)	Pavement work(Modified asphalt)
(H303)Pavement work(Pavement)	Pavement work(Pavement)
(H355)Pavement work(Pavement-Defects)	Pavement work(Pavement-Defects)
(H356)Pavement work(Pavement-Defects)	Pavement work(Pavement-Defects)
(H357)Pavement work(Pavement-Defects)	Pavement work(Pavement-Defects)
(H358)Pavement work(Pavement-Defects)	Pavement work(Pavement-Defects)
(H404)Pavement work(Paving tar)	Pavement work(Paving tar)
(H399)Pavement work(Petroleum asphalt emulsion)	Pavement work(Petroleum asphalt emulsion)
(H400)Pavement work(Petroleum asphalt emulsion)	Pavement work(Petroleum asphalt emulsion)
(H401)Pavement work(Petroleum asphalt emulsion)	Pavement work(Petroleum asphalt emulsion)
(H348)Pavement work(Rolling-Precautions for rolling work)	Pavement work(Precautions for rolling work)
(H349)Pavement work(Rolling-Precautions for rolling work)	Pavement work(Precautions for rolling work)
(H350)Pavement work(Rolling-Precautions for rolling work)	Pavement work(Precautions for rolling work)
(H351)Pavement work(Rolling-Precautions for rolling work)	Pavement work(Precautions for rolling work)
(H352)Pavement work(Rolling-Precautions for rolling work)	Pavement work(Precautions for rolling work)
(H353)Pavement work(Rolling-Precautions for rolling work)	Pavement work(Precautions for rolling work)
(H354)Pavement work(Rolling-Precautions for rolling work)	Pavement work(Precautions for rolling work)
(H308)Pavement work(Prime coat)	Pavement work(Prime coat)
(H309)Pavement work(Prime coat)	Pavement work(Prime coat)
(H310)Pavement work(Prime coat)	Pavement work(Prime coat)
(H311)Pavement work(Prime coat)	Pavement work(Prime coat)
(H392)Pavement work(Properties of asphalt-Specific gravity)	Pavement work(Properties of asphalt)
(H393)Pavement work(Properties of asphalt-Penetration)	Pavement work(Properties of asphalt)

(H394)Pavement work(Properties of asphalt-Softening point)	Pavement work(Properties of asphalt)
(H395)Pavement work(Properties of asphalt-Elongation)	Pavement work(Properties of asphalt)
(H396)Pavement work(Properties of asphalt-Flash point)	Pavement work(Properties of asphalt)
(H397)Pavement work(Properties of asphalt-Evaporation amount (%))	Pavement work(Properties of asphalt)
(H398)Pavement work(Properties of asphalt-Viscosity)	Pavement work(Properties of asphalt)
(H381)Pavement work(Quality control-Sampling inspection)	Pavement work(Quality control)
(H382)Pavement work(Quality control-Sampling inspection)	Pavement work(Quality control)
(H375)Pavement work(Quality control-Histogram)	Pavement work(Quality control-Histogram)
(H376)Pavement work(Quality control-Histogram)	Pavement work(Quality control-Histogram)
(H377)Pavement work(Quality control-Histogram)	Pavement work(Quality control-Histogram)
(H378)Pavement work(Quality control-Histogram)	Pavement work(Quality control-Histogram)
(H379)Pavement work(Quality control-Histogram)	Pavement work(Quality control-Histogram)
(H380)Pavement work(Quality control-Histogram)	Pavement work(Quality control-Histogram)
(H338)Pavement work(Rolling)	Pavement work(Rolling)
(H339)Pavement work(Rolling)	Pavement work(Rolling)
(H340)Pavement work(Rolling)	Pavement work(Rolling)
(H341)Pavement work(Rolling)	Pavement work(Rolling)
(H342)Pavement work(Rolling-Rolling machine)	Pavement work(Rolling-Rolling machine)
(H343)Pavement work(Rolling-Rolling machine)	Pavement work(Rolling-Rolling machine)
(H344)Pavement work(Rolling-Rolling machine)	Pavement work(Rolling-Rolling machine)
(H345)Pavement work(Rolling-Rolling machine)	Pavement work(Rolling-Rolling machine)
(H346)Pavement work(Rolling-Rolling machine)	Pavement work(Rolling-Rolling machine)
(H347)Pavement work(Rolling-Rolling machine)	Pavement work(Rolling-Rolling machine)
(H315)Pavement work(Spreading the mixture)	Pavement work(Spreading the mixture)
(H421)Pavement work(Storage of materials-Storage of bitumen materials)	Pavement work(Storage of bitumen materials)
(H312)Pavement work(Tack coat)	Pavement work(Tack coat)
(H429)Pavement work(Type of mixture)	Pavement work(Type of mixture)
(H430)Pavement work(Type of mixture)	Pavement work(Type of mixture)
(H431)Pavement work(Type of mixture)	Pavement work(Type of mixture)
(H432)Pavement work(Type of mixture-Standard mix ratio for mixture)	Pavement work(Type of mixture)
(H433)Pavement work(Type of mixture-Definition of asphalt concrete)	Pavement work(Type of mixture)
(H175)Pavement(Asphalt pavement-Base course(roadbed))	Pavement(Asphalt pavement)
(H176)Pavement(Asphalt pavement-Lower Base course(roadbed))	Pavement(Asphalt pavement)
(H177)Pavement(Asphalt pavement-Lower Base course(roadbed))	Pavement(Asphalt pavement)

(H178)Pavement(Asphalt pavement-Base course(roadbed))	Pavement(Asphalt pavement)
(H180)Pavement(Asphalt Pavement)	Pavement(Asphalt Pavement)
(H182)Pavement(Asphalt Pavement-Aggregate)	Pavement(Asphalt Pavement-Aggregate)
(H183)Pavement(Asphalt Pavement-Asphalt mixture)	Pavement(Asphalt Pavement-Asphalt mixture)
(H184)Pavement(Asphalt Pavement-Asphalt mixture)	Pavement(Asphalt Pavement-Asphalt mixture)
(H179)Pavement(Concrete pavement: Base course(roadbed))	Pavement(Concrete pavement)
(H164)Pavement(Pavement and subgrade)	Pavement(Pavement and subgrade)
(H172)Pavement(Stabilization method-Lime mixing method)	Pavement(Stabilization methodil)
(H173)Pavement(Stabilization method -Bituminous material spraying method)	Pavement(Stabilization methodil)
(H174)Pavement(Stabilization method-Chemical injection method)	Pavement(Stabilization methodil)
(H304)Pavement work(Pavement-Paving preparation)	Pavement-Paving preparation
(H305)Pavement work(Pavement-Paving preparation)	Pavement-Paving preparation
(H306)Pavement work(Pavement-Paving preparation)	Pavement-Paving preparation
(H307)Pavement work(Pavement-Paving preparation)	Pavement-Paving preparation
(H359)Pavement work(Pavement-Quality control)	Pavement-Quality control
(H360)Pavement work(Pavement-Quality control)	Pavement-Quality control
(H361)Pavement work(Pavement-Quality control)	Pavement-Quality control
(H362)Pavement work(Pavement-Quality control)	Pavement-Quality control
(H363)Pavement work(Pavement-Quality control)	Pavement-Quality control
(H364)Pavement work(Pavement-Quality control)	Pavement-Quality control
(H365)Pavement work(Pavement-Quality control)	Pavement-Quality control
(H366)Pavement work(Pavement-Quality control)	Pavement-Quality control
(H367)Pavement work(Pavement-Quality control)	Pavement-Quality control
(H368)Pavement work(Pavement-Quality control)	Pavement-Quality control
(H369)Pavement work(Quality control-Control chart)	Pavement-Quality control
(H370)Pavement work(Quality control-Control chart)	Pavement-Quality control
(H371)Pavement work(Quality control-Control chart)	Pavement-Quality control
(H372)Pavement work(Quality control-Control chart)	Pavement-Quality control
(H373)Pavement work(Quality control-Control chart)	Pavement-Quality control
(H374)Pavement work(Quality control-Control chart)	Pavement-Quality control
(H50)Road pavement(Paving methods- Seal coat)	Paving methods- Seal coat
(H15)Road pavement(Paving methods-Base course)	Paving methods-Base course
(H16)Road pavement(Paving methods-Base course)	Paving methods-Base course
(H17)Road pavement(Paving methods-Base course)	Paving methods-Base course

(H18)Road pavement(Paving methods-Base course)	Paving methods-Base course
(H19)Road pavement(Paving methods-Base course)	Paving methods-Base course
(H20)Road pavement(Paving methods-Base course)	Paving methods-Base course
(H21)Road pavement(Paving methods-Base course)	Paving methods-Base course
(H22)Road pavement(Paving methods-Base course)	Paving methods-Base course
(H23)Road pavement(Paving methods-Base course)	Paving methods-Base course
(H24)Road pavement(Paving methods-Base course)	Paving methods-Base course
(H25)Road pavement(Paving methods-Base course/Wearing course)	Paving methods-Base course/Wearing course
(H26)Road pavement(Paving methods-Base course/Wearing course)	Paving methods-Base course/Wearing course
(H27)Road pavement(Paving methods-Base course/Wearing course)	Paving methods-Base course/Wearing course
(H28)Road pavement(Paving methods-Base course/Wearing course)	Paving methods-Base course/Wearing course
(H29)Road pavement(Paving methods-Base course/Wearing course)	Paving methods-Base course/Wearing course
(H30)Road pavement(Paving methods-Base course/Wearing course)	Paving methods-Base course/Wearing course
(H62)Road pavement(Paving methods-common compaction)	Paving methods-common compactio
(H63)Road pavement(Paving methods-common compaction)	Paving methods-common compactio
(H64)Road pavement(Paving methods-common compaction)	Paving methods-common compactio
(H65)Road pavement(Paving methods-common compaction)	Paving methods-common compactio
(H58)Road pavement(Paving methods-Compaction)	Paving methods-Compaction
(H67)Road pavement(Paving methods-Construction of seams)	Paving methods-Construction of seams
(H68)Road pavement(Paving methods-Construction of seams)	Paving methods-Construction of seams
(H69)Road pavement(Paving methods-Construction of seams)	Paving methods-Construction of seams
(H61)Road pavement(Paving methods-Finishing compaction)	Paving methods-Finishing compaction
(H59)Road pavement(Paving methods-First compaction)	Paving methods-First compaction
(H53)Road pavement(Paving methods-leveling)	Paving methods-leveling
(H54)Road pavement(Paving methods-leveling)	Paving methods-leveling
(H55)Road pavement(Paving methods-leveling)	Paving methods-leveling
(H56)Road pavement(Paving methods-leveling)	Paving methods-leveling
(H57)Road pavement(Paving methods-leveling)	Paving methods-leveling
(H36)Road pavement(Paving methods-Lower base course)	Paving methods-Lower base course
(H37)Road pavement(Paving methods-Lower base course)	Paving methods-Lower base course
(H38)Road pavement(Paving methods-Lower base course)	Paving methods-Lower base course
(H66)Road pavement(Paving methods-Open to traffic)	Paving methods-Open to traffic
(H48)Road pavement(Paving methods-Prime Court)	Paving methods-Prime Court
(H49)Road pavement(Paving methods-Prime Court)	Paving methods-Prime Court

(H35)Road pavement(Paving methods-Replacement method)	Paving methods-Replacement method
(H60)Road pavement(Paving methods-Secondary compaction)	Paving methods-Secondary compaction
(H11)Road pavement(Paving methods-Subgrade)	Paving methods-Subgrade
(H12)Road pavement(Paving methods-Subgrade)	Paving methods-Subgrade
(H13)Road pavement(Paving methods-Subgrade)	Paving methods-Subgrade
(H14)Road pavement(Paving methods-Subgrade)	Paving methods-Subgrade
(H31)Road pavement(Paving methods-Subgrade)	Paving methods-Subgrade
(H32)Road pavement(Paving methods-Subgrade)	Paving methods-Subgrade
(H33)Road pavement(Paving methods-Subgrade)	Paving methods-Subgrade
(H34)Road pavement(Paving methods-Subgrade stabilization)	Paving methods-Subgrade stabilization
(H51)Road pavement(Paving methods-Tack coat)	Paving methods-Tack coat
(H52)Road pavement(Paving methods-Tack coat)	Paving methods-Tack coat
(H39)Road pavement(Paving methods-Upper base course)	Paving methods-Upper base course
(H40)Road pavement(Paving methods-Upper base course)	Paving methods-Upper base course
(H41)Road pavement(Paving methods-Upper base course)	Paving methods-Upper base course
(H42)Road pavement(Paving methods-Upper base course)	Paving methods-Upper base course
(H43)Road pavement(Paving methods-Upper base course)	Paving methods-Upper base course
(H44)Road pavement(Paving methods-Upper base course)	Paving methods-Upper base course
(H45)Road pavement(Paving methods-Upper base course)	Paving methods-Upper base course
(H46)Road pavement(Paving methods-Upper base course)	Paving methods-Upper base course
(H47)Road pavement(Paving methods-Upper base course)	Paving methods-Upper base course
(H290)Pavement work(Poor conditions of heated mixture and causes)	Poor conditions of heated mixture and causes
(H291)Pavement work(Poor conditions of heated mixture and causes)	Poor conditions of heated mixture and causes
(H292)Pavement work(Poor conditions of heated mixture and causes)	Poor conditions of heated mixture and causes
(H293)Pavement work(Poor conditions of heated mixture and causes)	Poor conditions of heated mixture and causes
(H294)Pavement work(Poor conditions of heated mixture and causes)	Poor conditions of heated mixture and causes
(H295)Pavement work(Poor conditions of heated mixture and causes)	Poor conditions of heated mixture and causes
(H80)Road pavement(Quality control items- Lower Base course(roadbed))	Quality control items- Lower Base course
(H79)Road pavement(Quality control items- Subgrade)	Quality control items- Subgrade
(H125)Asphalt pavement(Road mixing machine：Stabilizer・Wheel type・Crawler type・Small scale: Backhoe）	Road mixing machine：Stabilizer・Wheel type
(H1)Road pavement(Asphalt pavement)	Road pavement(Asphalt pavement)
(H2)Road pavement(Asphalt pavement)	Road pavement(Asphalt pavement)
(H121)Asphalt pavement(Shaping: Motor grader, bulldozer）	Shaping: Motor grader, bulldozer
(H219)spreading	spreading

(H220)spreading depth	spreading depth
(H326)Pavement work(Spreading the mixture-Spreading)	Spreading the mixture-Spreading
(H327)Pavement work(Spreading the mixture-Spreading)	Spreading the mixture-Spreading
(H328)Pavement work(Spreading the mixture-Spreading)	Spreading the mixture-Spreading
(H329)Pavement work(Spreading the mixture-Spreading)	Spreading the mixture-Spreading
(H330)Pavement work(Spreading the mixture-Spreading)	Spreading the mixture-Spreading
(H331)Pavement work(Spreading the mixture-Spreading)	Spreading the mixture-Spreading
(H332)Pavement work(Spreading the mixture-Spreading)	Spreading the mixture-Spreading
(H333)Pavement work(Spreading the mixture-Spreading)	Spreading the mixture-Spreading
(H334)Pavement work(Spreading the mixture-Spreading)	Spreading the mixture-Spreading
(H335)Pavement work(Spreading the mixture-Spreading)	Spreading the mixture-Spreading
(H336)Pavement work(Spreading the mixture-Spreading)	Spreading the mixture-Spreading
(H337)Pavement work(Spreading the mixture-Spreading)	Spreading the mixture-Spreading
(H316)Pavement work(Spreading the mixture-Spreading by hand)	Spreading the mixture-Spreading by hand
(H317)Pavement work(Spreading the mixture-Spreading by hand)	Spreading the mixture-Spreading by hand
(H318)Pavement work(Spreading the mixture-Spreading by hand)	Spreading the mixture-Spreading by hand
(H319)Pavement work(Spreading the mixture-Spreading by hand)	Spreading the mixture-Spreading by hand
(H320)Pavement work(Spreading the mixture-Spreading by hand)	Spreading the mixture-Spreading by hand
(H321)Pavement work(Spreading the mixture-Spreading by hand)	Spreading the mixture-Spreading by hand
(H322)Pavement work(Spreading the mixture-Spreading by hand)	Spreading the mixture-Spreading by hand
(H323)Pavement work(Spreading the mixture-Spreading by hand)	Spreading the mixture-Spreading by hand
(H324)Pavement work(Spreading the mixture-Spreading with a finisher)	Spreading the mixture-Spreading with a finisher
(H325)Pavement work(Spreading the mixture-Spreading with a finisher)	Spreading the mixture-Spreading with a finisher
(H122)Asphalt pavement(Stabilizer spreader Engine sprayer Asphalt distributor)	Stabilizer spreader Engine sprayer Asphalt distributor
(H301)Pavement work(Transportation-Calculation of the number of transport vehicles required)	Transportation-number of transport vehicles
(H302)Pavement work(Transportation-Calculation of the number of transport vehicles required)	Transportation-number of transport vehicles
(H296)Pavement work(Transportation-Transportation precautions)	Transportation-Transportation precautions
(H297)Pavement work(Transportation-Transportation precautions)	Transportation-Transportation precautions
(H298)Pavement work(Transportation-Transportation precautions)	Transportation-Transportation precautions
(H299)Pavement work(Transportation-Transportation precautions)	Transportation-Transportation precautions
(H300)Pavement work(Transportation-Transportation precautions)	Transportation-Transportation precautions

(H1)Road pavement(Asphalt pavement)

(H1)Road pavement(Asphalt pavement)

Road pavement

Asphalt pavement

Structure

Asphalt pavement composition

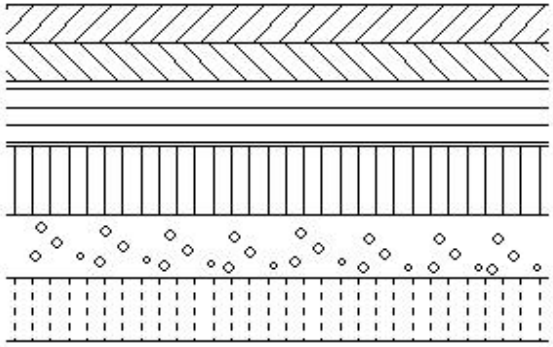
・A wear course(layer) is placed on the surface layer to reduce wear and slipping

・The wear course(layer) is not included in the pavement thickness

・in case of there are two or more base course, the bottom layer is the base course, and the other courses are the middle courses

・in case of little traffic, the base course may not be placed

・Heated asphalt is used for the wearing course・base course



① surface layer(wearing course)

② base course(Base layer)

③ Upper base course

④ Lower base course

⑤ base course

⑥ Pavement

⑦ Subgrade (approx. 1m)

⑧ Road body

(H2)Road pavement(Asphalt pavement)

(H2)Road pavement(Asphalt pavement)

Asphalt pavement

Design

① Design traffic volume

Design period: 10 years in principle

Design traffic volume - depending on design period and traffic volume of large vehicles

- Method based on traffic volume of large vehicles
- Method based on wheel load of traveling vehicles

Classification of design traffic volume by traffic volume of large vehicles	
Classification of design traffic volume	Range of traffic volume of large vehicles (vehicles/day, direction)
L traffic	～100
A traffic	100～250
B traffic	250～1000
C traffic	1000～3000
D traffic	3000～

(H3)Road pavement(Asphalt pavement-Subgrade design)

(H3)Road pavement(Asphalt pavement-Subgrade design)

Asphalt pavement

Subgrade design

subgrade: Approximately 1m deep below the roadbed

Pavement construction base

Supports traffic load

Distributes load to the road body below

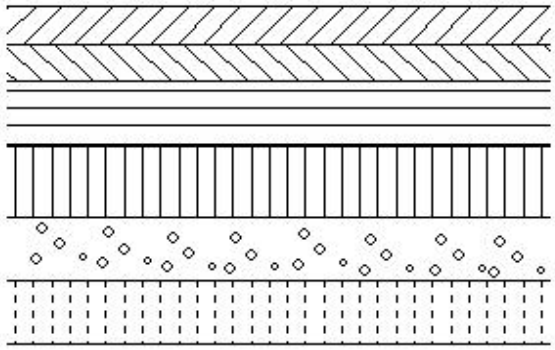
Subgrade construction

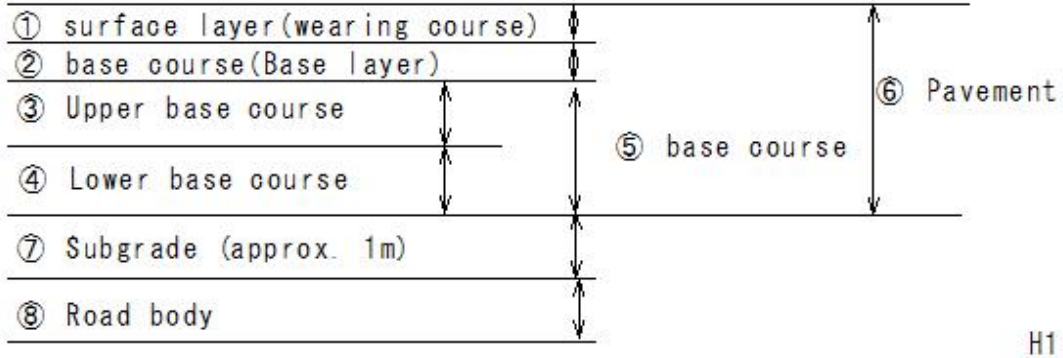
① Subgrade design CBR is less than 3

② Subgrade drainage and freeze-thaw measures are required

③ in case of the finished height of the pavement is limited

④ in case of improving the subgrade is economically advantageous





H1

(H4)Road pavement(Asphalt pavement-Subgrade design)

(H4)Road pavement(Asphalt pavement-Subgrade design)

Asphalt pavement

Subgrade design

General subgrade with CBR of 3 or more

Soft subgrade with CBR of less than 3

・Subgrade is cut or filled

・in case of CBR is less than 2,
replace with material with CBR of 3 or more

・Compacting the blocking layer is difficult

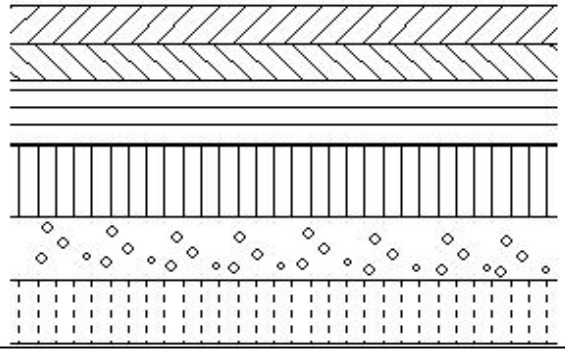
Compacting degree is not specified

Lightweight rollers: Use a small soil compactor, etc.,
to compact evenly with fewer rolling attempts

Cement or lime stabilization

Design CBR 3 or more

・To avoid mixing of roadbed material and subgrade soil
in case of design CBR is 2 or more but less than 3
A blocking layer is provided as part of the subgrade
and used in conjunction with subgrade improvement



① surface layer(wearing course)

② base course(Base layer)

③ Upper base course

④ Lower base course

⑤ base course

⑥ Pavement

⑦ Subgrade (approx. 1m)

⑧ Road body

(H5)Road pavement(Asphalt pavement-Subgrade design)

(H5)Road pavement(Asphalt pavement-Subgrade design)

Asphalt pavement

Subgrade design

Soft subgrade: 30-100cm thick
Very soft subgrade: 50-100cm thick

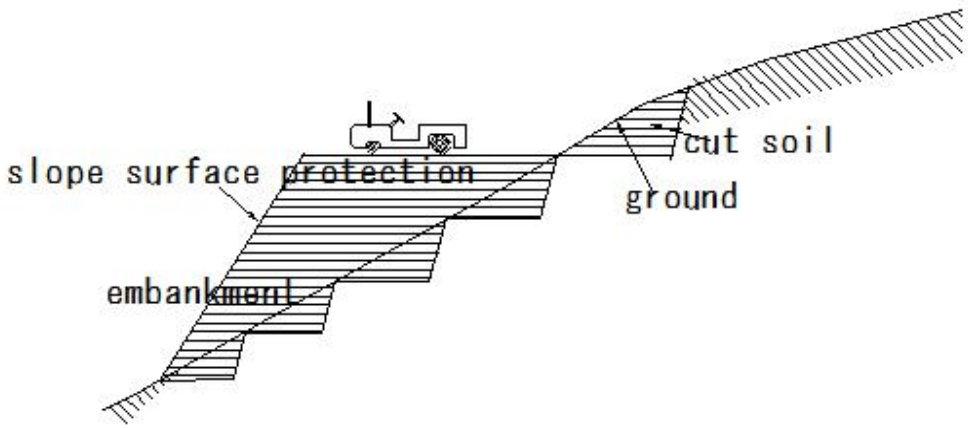
・Subgrade design CBR - Determine the thickness of the pavement

・In the case of cutting: Subgrade surface

Collect samples from a position 1m or deeper than the expected subgrade surface - Conduct CBR test

・In the case of embankment

Collect samples from the ground where the subgrade soil will be used - Conduct CBR test



E4

(H6)Road pavement(Asphalt pavement-Pavement design)

(H6)Road pavement(Asphalt pavement-Pavement design)

Asphalt pavement

Pavement design

①TA method

Minimum thickness of surface and base

Specification of minimum thickness of each subgrade

・Subgrade design CBR-design traffic volume category-TA target value

Find TA' (equivalent thickness of set pavement cross section)
so as not to fall below the TA target value

TA target value

Design CBR	L Transportation	A Transportation	B Transportation	C Transportation	D Transportation
(2)	(17)	(21)	(29)	(39)	(51)
3	15	19	26	35	45
4	14	18	24	32	41
6	12	16	21	28	37
8	11	14	19	26	34
12	11	13	17	23	30
20	11	13	17	20	26

(　) is used in case of the design CBR of the existing subgrade is 2,
but subgrade improvement is difficult

(H7)Road pavement(Asphalt pavement-Pavement design)

(H7)Road pavement(Asphalt pavement-Pavement design)

Asphalt pavement

Pavement design

①TA method

Design traffic volume classification

Minimum thickness of wearing course(top layer) and base course(base layer)	
Classification of design traffic volume	The thickness of the wearing course(surface layer) and base course(base layer)
L traffic	5
A traffic	5
B traffic	10(5)
C traffic	15(10)
D traffic	20(15)

Note: in case of bitumen stabilization method is used for the upper base course(roadbed) it can be reduced to within ( ).

(H8)Road pavement(Asphalt pavement-Pavement design)

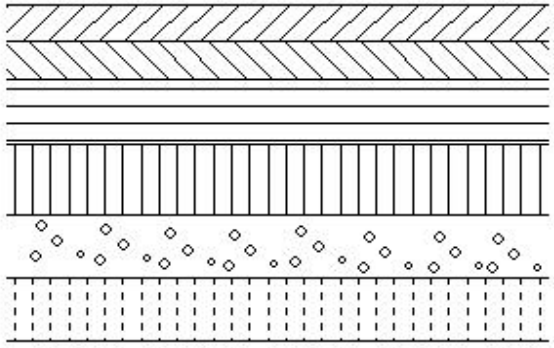
(H8)Road pavement(Asphalt pavement-Pavement design)

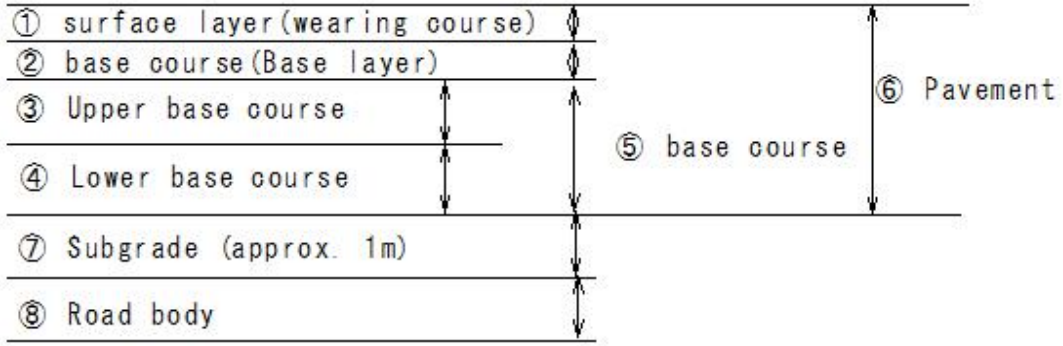
Asphalt pavement

Pavement design

①TA method

Minimum thickness of each subgrade layer	
Construction method and materials	Minimum thickness of one layer
Bituminous stabilization treatment	2 times the minimum grain size and 5cm
Other subgrades	3 times the minimum grain size and 10cm





(H9)Road pavement(Asphalt pavement-Pavement design)

(H9)Road pavement(Asphalt pavement-Pavement design)

Asphalt pavement

Pavement design

①TA method　　Equivalent conversion coefficient

Location	Construction method, material		Equivalent conversion coefficient, an
①Surface, base	②③Heated asphalt mixture for wearing course and base course		1.00
④Upper base course	⑤Bituminous stabilization	⑥Heated mixing	0.80
		⑦Normal temperature mixing	0.55
	⑧Cement, Bituminous stabilization		0.65
	⑨Cement stabilization		0.55
	⑩Lime stabilization		0.45
	⑪Grain-adjusted crushed stone　Grain-adjusted steel slag		0.35
	⑫Water Hard grain-adjusted steel slag		0.55
⑬ Lower base course	⑭ Crusher run, steel slag, sand	⑮ Modified CBR 30 or higher	0.25
		⑯ Modified CBR 20-30	0.20
	⑰ Cement stabilization		0.25
	⑱ Lime stabilization		0.25

Note: in case of bituminous stabilization is used for the upper base course

① Frost suppression layer: intended to prevent damage to the pavement due to freezing and thawing of the subgrade

② Frost suppression layer: part of the roadbed, not included in the TA calculation

(H10)Road pavement(Asphalt pavement-Pavement design)

(H10)Road pavement(Asphalt pavement-Pavement design)

Asphalt pavement

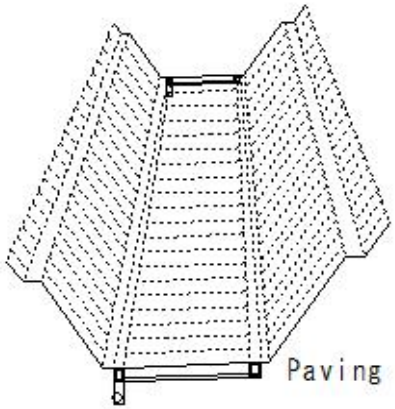
Pavement design

Other design methods

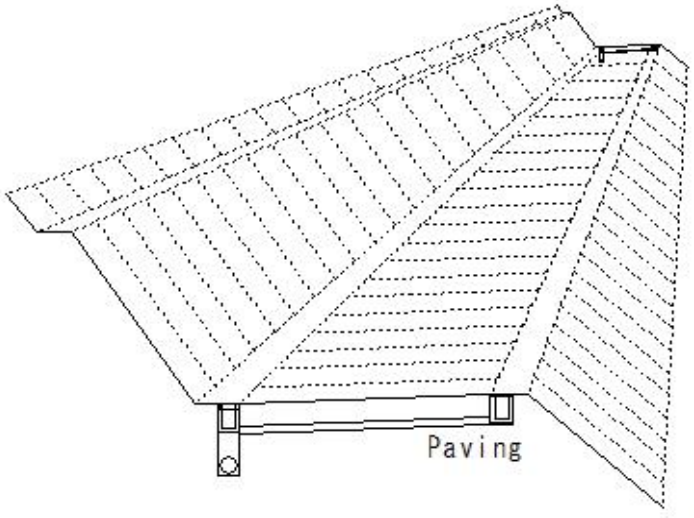
Testing: Methods for measuring through experiments, etc.

Multilayer elastic theory based on analysis of stress and strain, etc.

Methods based on past performance



H32



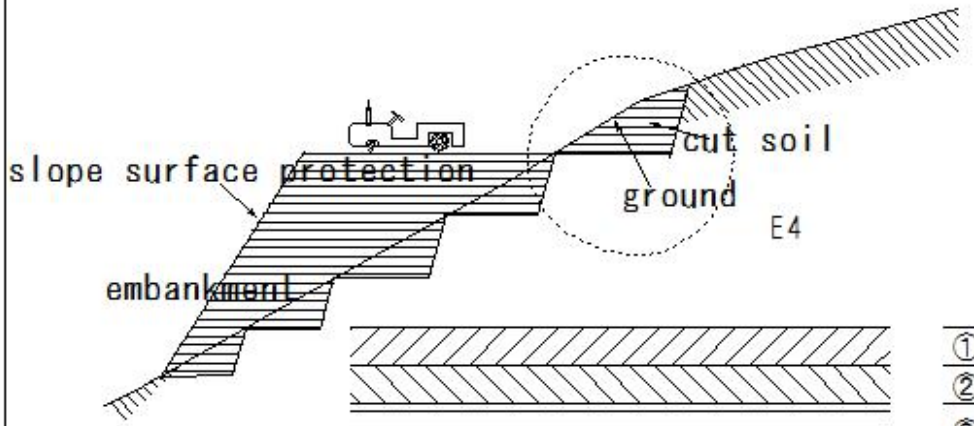
H33

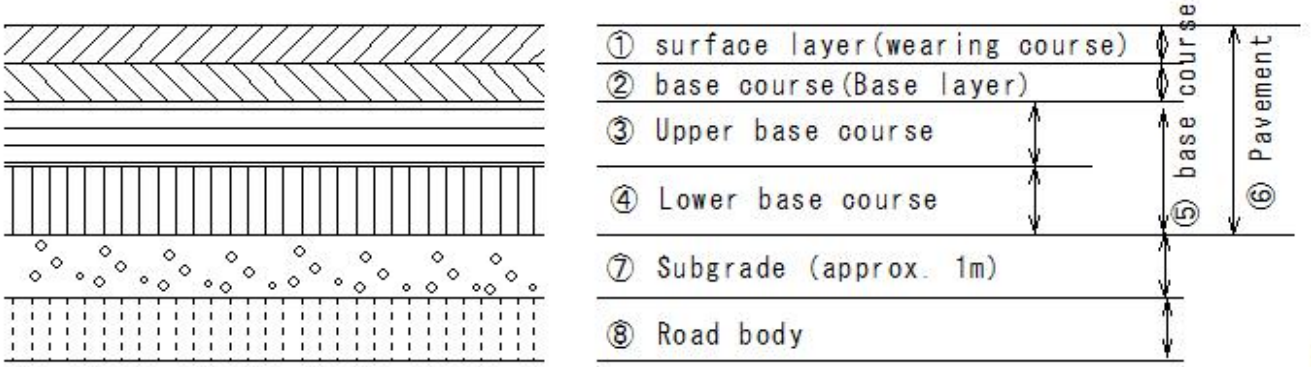
(H11)Road pavement(Paving methods-Subgrade)

(H11)Road pavement(Paving methods-Subgrade)

Asphalt pavement
Paving methods
Subgrade
Subgrade construction methods

Methods	Features
Cutting soil	A method in which the original ground
	is excavated and leveled to create a subgrade





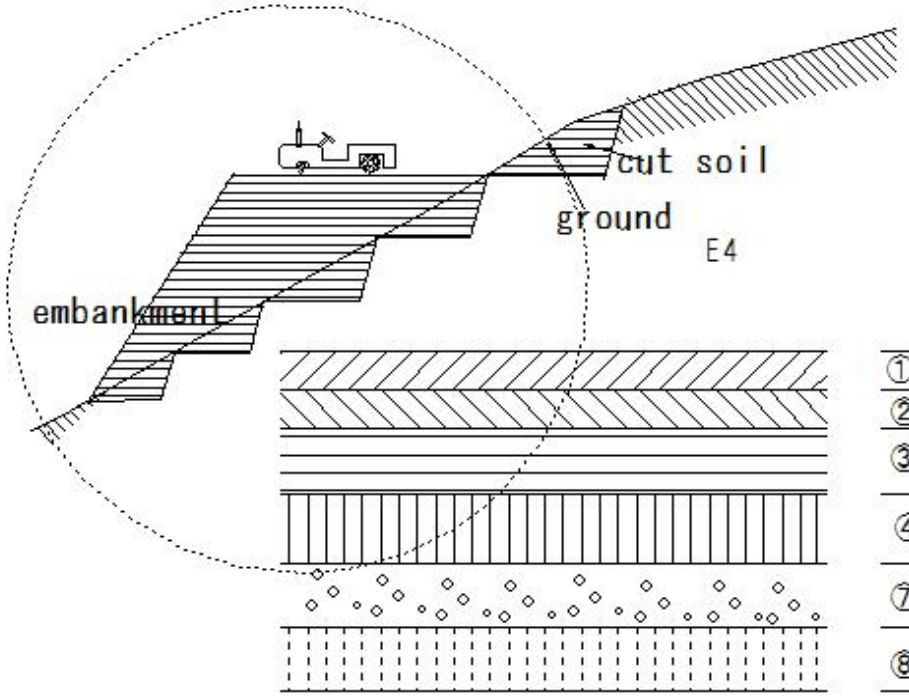
H1

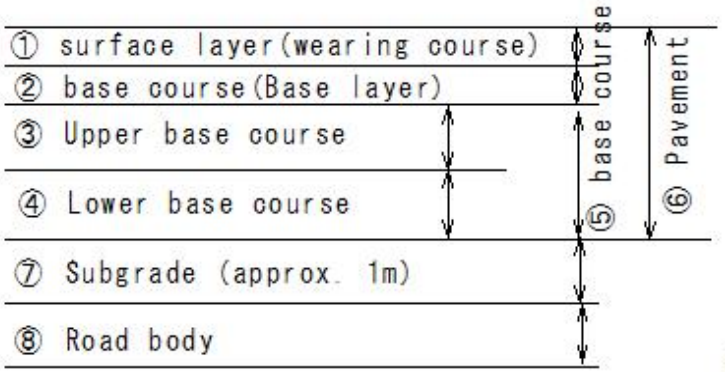
(H12)Road pavement(Paving methods-Subgrade)

(H12)Road pavement(Paving methods-Subgrade)

Asphalt pavement
Paving methods
Subgrade
Subgrade construction methods

Methods	Features
Embankment	A method of using good quality soil to pile up on the original ground to create a subgrade





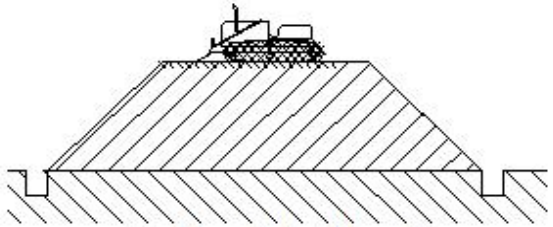
H1

(H13)Road pavement(Paving methods-Subgrade)

(H13)Road pavement(Paving methods-Subgrade)

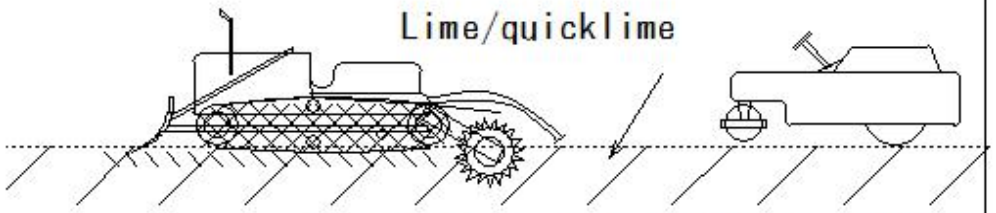
Asphalt pavement
Paving methods
Subgrade
Subgrade construction methods

Methods	Features
Stabilization	① A method of improving the bearing capacity of the subgrade by mixing the subgrade material and stabilizing material (cement, lime, etc.) in situ. The advantage is that it allows for effective use of local materials. ② Cement is suitable for sandy soil, and lime is suitable for clayey soil. Solidification material: For stabilization treatment only (stabilizing material) ③ Stabilizing material and subgrade material are mixed on-site on the road.



Soil stabilization
(soil + cement / asphalt mixture)
- increase bearing capacity

E60



tire rollers and vibrating rollers

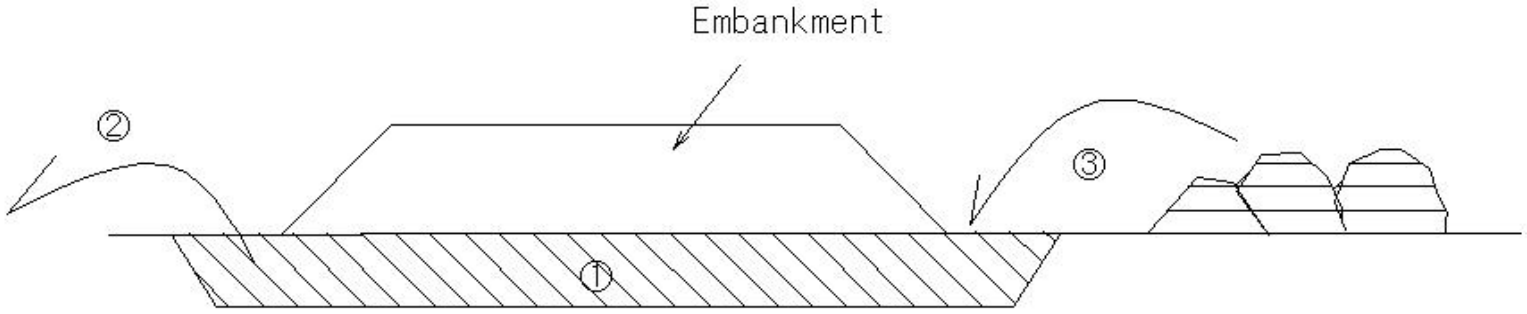
E109

(H14)Road pavement(Paving methods-Subgrade)

(H14)Road pavement(Paving methods-Subgrade)

Asphalt pavement
Paving methods
Subgrade
Subgrade construction methods

Methods	Features
Replacement method	In the case of soft subgrade soil in cut areas A method to replace part or all of the subgrade High-quality soil or stabilized soil is used for replacement



Replacement method

E102

(H15)Road pavement(Paving methods-Base course)

(H15)Road pavement(Paving methods-Base course)

Asphalt pavement

Paving methods

Base course

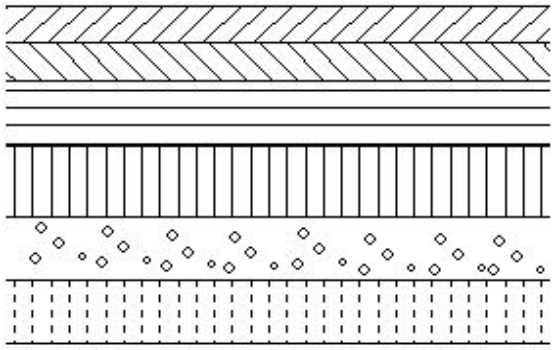
○ Lower base course

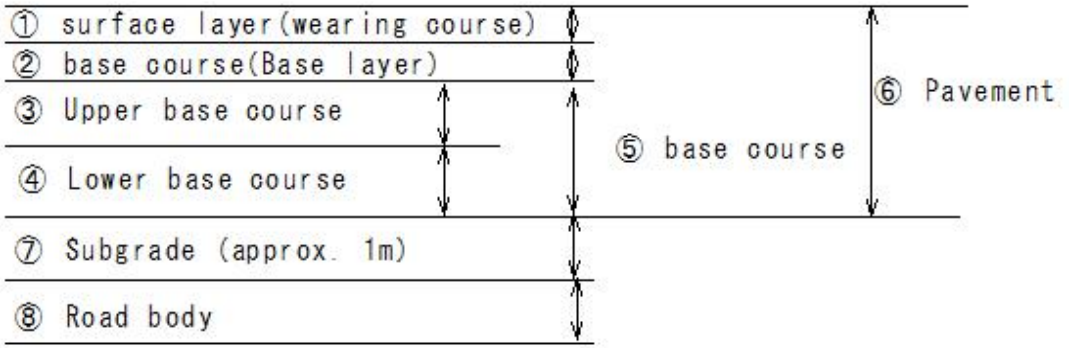
Lower bearing capacity than upper road base

Uses materials that are close to the site and economically easy to obtain

Even with non-standard materials, standards can be met with supplementary and stabilizing materials

Maximum particle size 50 cm or less





H1

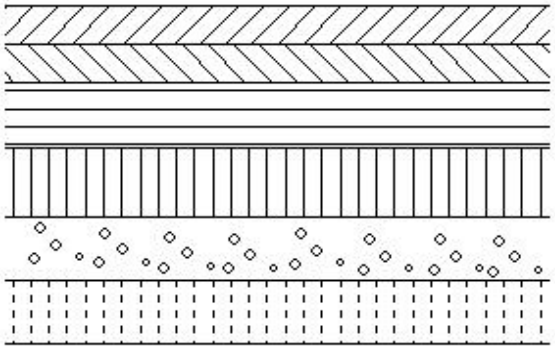
(H16)Road pavement(Paving methods-Base course)

(H16)Road pavement(Paving methods-Base course)

Asphalt pavement
Paving methods
Base course

Lower base course(Sub-base) construction method

Methods	Features
Granular road base method	Characteristics: Uses crusher run, crusher run steel slag, gravel or sand, etc. Modified CBR 20% or more Materials below P16



① surface layer(wearing course)
② base course(Base layer)
③ Upper base course
④ Lower base course
⑤ base course
⑥ Pavement
⑦ Subgrade (approx. 1m)
⑧ Road body

H1

(H17)Road pavement(Paving methods-Base course)

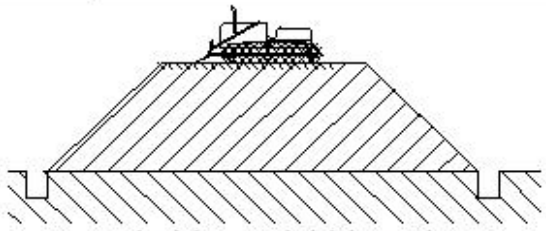
(H17)Road pavement(Paving methods-Base course)

Asphalt pavement

Paving methods

Base course　　Lower base course(Sub-base) construction method

Methods	Features
Cement stable treatment method	Locally generated materials, locally produced materials, or supplementary materials are added as aggregates. Cement is added and treated. 1axial compressive strength: 7 days, strength: about 10kgf/cm2 Aggregate: Modified CBR10 or more, P 19 or less is preferred. ・Mixing method on the street With the addition of cement - increase the strength Impermeability - increased ・Improved durability against "weather effects"



Soil stabilization
(soil + cement / asphalt mixture)
- increase bearing capacity

H13
E60

(H18)Road pavement(Paving methods-Base course)

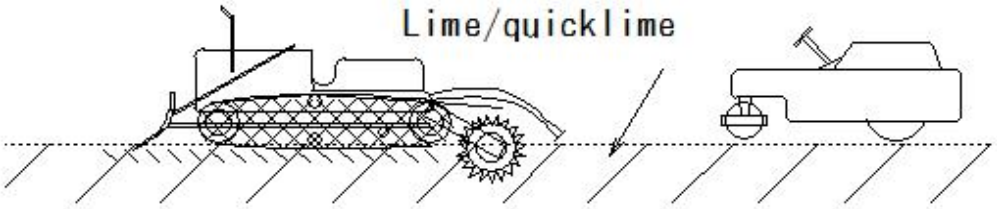
(H18)Road pavement(Paving methods-Base course)

Asphalt pavement

Paving methods

Base course　　Lower base course(Sub-base) construction method

Methods	Features
Lime stabilization treatment	Locally generated materials, locally produced materials, or supplementary materials are added as aggregates. Treat with the addition of lime ・Stabilized by a chemical reaction between clay minerals and lime in aggregates Intensity onset - slow Improved durability and stability in the long term 1axial compressive strength: 7 days, strength: about 7kgf/cm2 Aggregate modified CBR10 or more, P 16~18 or less is desirable Slaked lime is used for lime in case of the water content is high - use quicklime



tire rollers and vibrating rollers

H13
E109

(H19)Road pavement(Paving methods-Base course)

(H19)Road pavement(Paving methods-Base course)

Asphalt pavement

Paving construction method

Base course

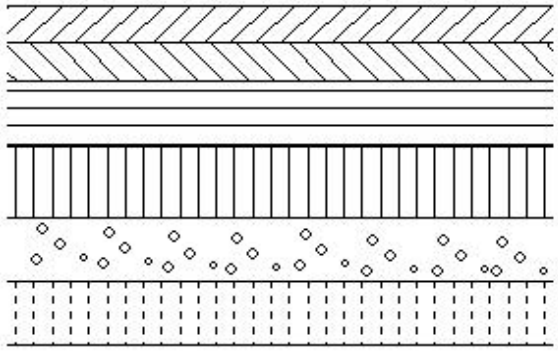
○Upper base course

Base course material manufacturing

Central mixing method

Maximum grain of aggregate: 40 mm or less

Aggregate particle size distribution: Continuous smooth, fine grain - less - Stabilizer added - less



① surface layer(wearing course)

② base course(Base layer)

③ Upper base course

④ Lower base course

⑤ base course

⑥ Pavement

⑦ Subgrade (approx. 1m)

⑧ Road body

H1
H15

(H20)Road pavement(Paving methods-Base course)

(H20)Road pavement(Paving methods-Base course)

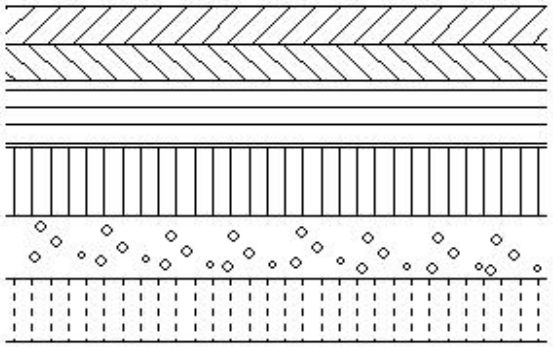
Asphalt pavement

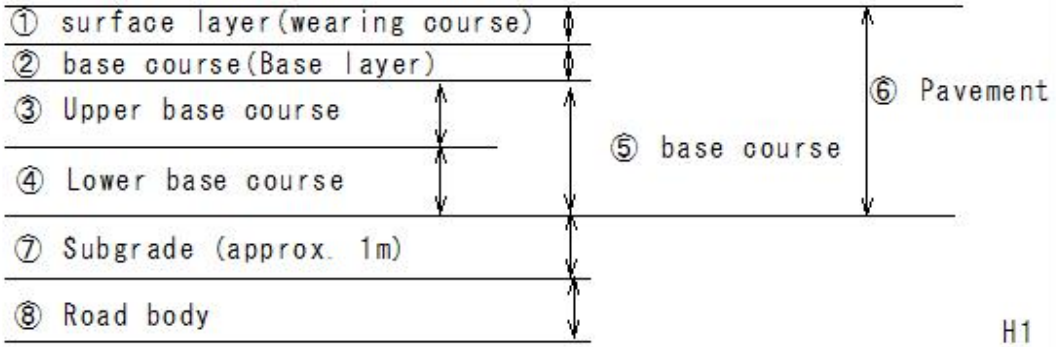
Paving construction method

Base course

○Upper base course ・Upper base course construction method

Methods	Features
Particle size adjustment method	Fine-sized crushed stone adjusted to good grain size Particle size adjustment steel slag Crushed stone, steel slag, sand, screening mixed in appropriate proportions 75 μm sieve passage amount of aggregate is less than 10% It is better to have as little compaction as possible Modified CBR 80% or more, PI14 or less





H1

(H21)Road pavement(Paving methods-Base course)

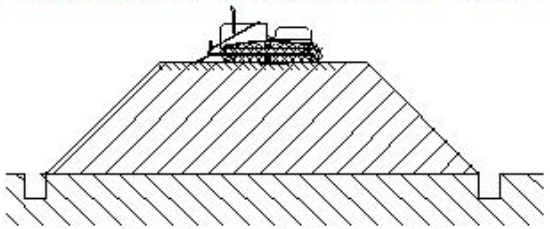
(H21)Road pavement(Paving methods-Base course)

Asphalt pavement　　Base course

Paving construction method　　Upper base course construction method

Methods	Features
Cement stabilization treatment	Crusher run Local material + aggregate with added supplementary material A method of processing by adding cement Increases strength Prevents loss of strength due to changes in water content Improves durability ・Central mixing method Not suitable for areas where large settlement or uneven settlement is expected Type of cement Ordinary Portland cement　Blast furnace cement　Fly ash Uniaxial compressive strength 7-day strength approx. 30kgf/cm2

1kgf/cm2≒0.098N/mm2≒9.8N/cm2



Soil stabilization
(soil + cement / asphalt mixture)
- increase bearing capacity

H17
H13
E60

(H22)Road pavement(Paving methods-Base course)

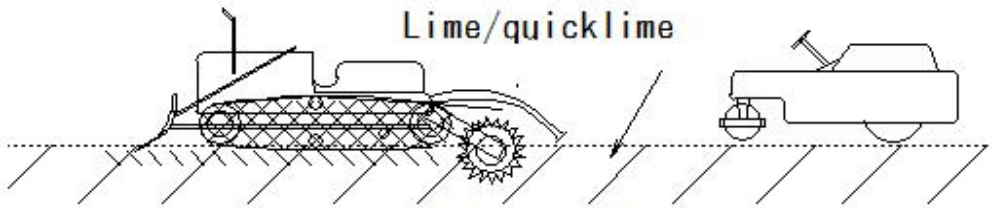
(H22)Road pavement(Paving methods-Base course)

Asphalt pavement　　Base course

Paving construction method　　Upper base course construction method

Methods	Features
Lime stabilization method	Lime stabilization of lower road base Uniaxial compressive strength 10-day strength approx. 10kgf/cm2

1kgf/cm2≒0.098N/mm2



tire rollers and vibrating rollers

H18
H13
E109

(H23)Road pavement(Paving methods-Base course)

(H23)Road pavement(Paving methods-Base course)

Asphalt pavement — Base course

Paving construction method — Upper base course construction method

Methods	Features
Bituminous stabilization method	Single-grain crushed stone Sand Mixed in appropriate ratio Crusher run Local material + crushed stone Gravel Steel slag Aggregate with supplementary materials such as sand A method of adding bitumen material to this and processing it Heated mixing Normal temperature mixing Bituminous material: Petroleum asphalt for paving + asphalt emulsion Bituminous material: in cases of using petroleum asphalt for paving and heated mixing, it is called heated asphalt stabilization Finish is flat, flexible, and durable Smooth particle size distribution - good workability The less fine particles within the standard range, the better - less asphalt is required Finished thickness of one layer exceeds 10 cm Method: Thick lift method: Used for large-scale construction, rapid construction, etc.

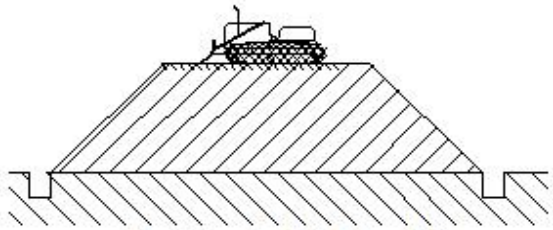
(H24)Road pavement(Paving methods-Base course)

(H24)Road pavement(Paving methods-Base course)

Asphalt pavement — Base course

Paving construction method — Upper base course construction method

Methods	Features
Cement and Bituminous stabilization method	Pavement waste materials, locally produced materials with supplementary materials added - aggregate Processed by adding cement and Bituminous materials A method that provides appropriate rigidity and ability to follow deformation



Soil stabilization
(soil + cement / asphalt mixture)
- increase bearing capacity

H24
H17
H13
E60

(H25)Road pavement(Paving methods-Base course/Wearing course)

(H25)Road pavement(Paving methods-Base course/Wearing course)

Asphalt pavement

Paving methods

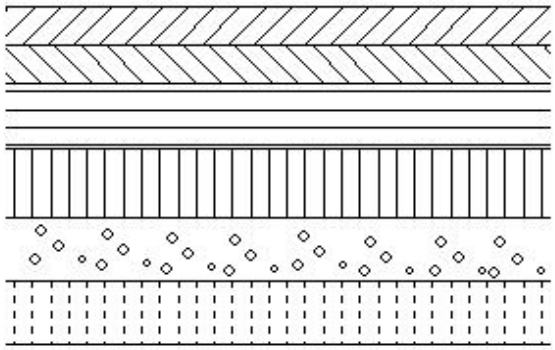
○ Base course/Wearing course

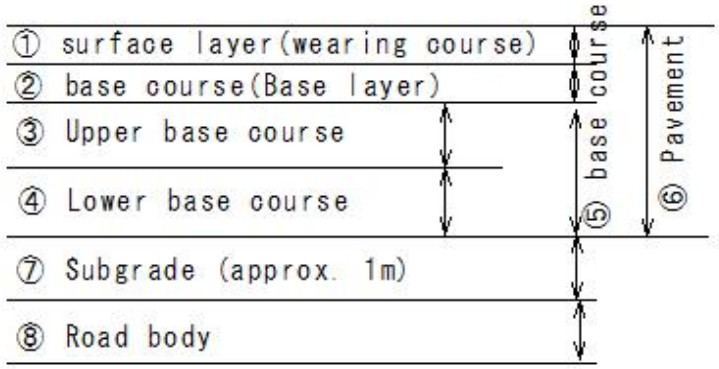
Uses heated asphalt mixture

Base course(Base layer): Uses coarse-grained asphalt mixture

Wearing course(Surface layer): Heated asphalt mixture

Dense-grained asphalt mixture: Suitable for resistance to flow, wear resistance, skid resistance, water resistance, and crack resistance





H1

(H26)Road pavement(Paving methods-Base course/Wearing course)

(H26)Road pavement(Paving methods-Base course/Wearing course)

Asphalt pavement

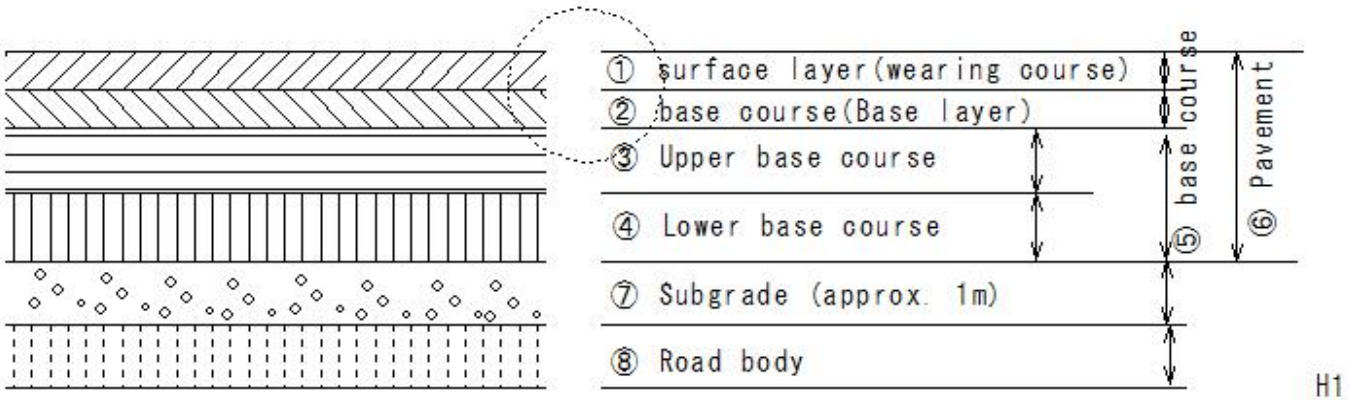
Paving methods

○ Base course/Wearing course

Roads with heavy traffic of large vehicles

Mixture with excellent resistance to fluidity

Areas with low traffic volume: Mixture with excellent flexibility, water resistance, and crack resistance



H1

(H27)Road pavement(Paving methods-Base course/Wearing course)

(H27)Road pavement(Paving methods-Base course/Wearing course)

Asphalt pavement

Paving methods

○ Base course/Wearing course

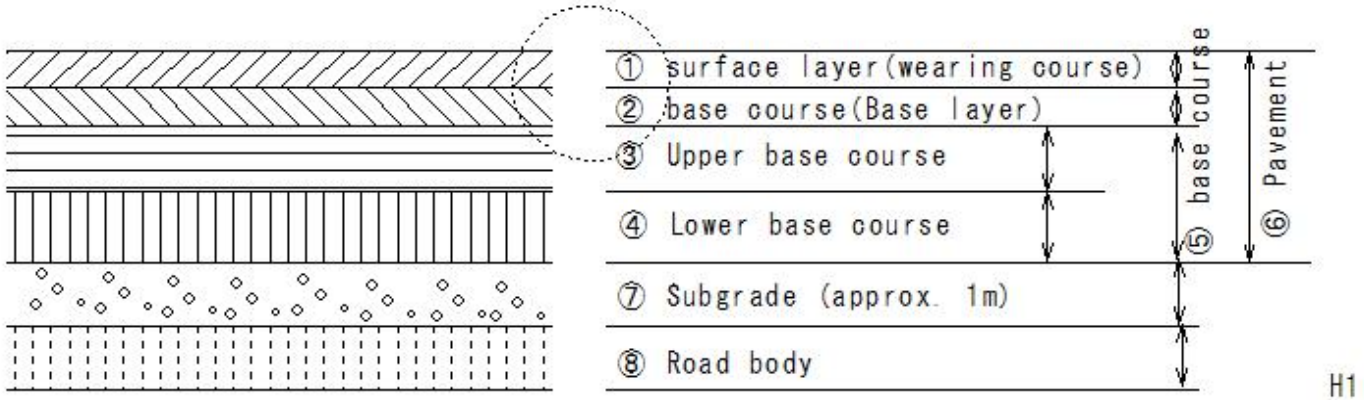
・Snowy areas

Abrasion resistance Uses a mixture with F

F: Tends to have a large amount of fine grains and poor fluid resistance

Maximum aggregate particle size 20 mm: Excellent fluid resistance, abrasion resistance, and slip resistance

13mm: Excellent water resistance and crack resistance



H1

(H28)Road pavement(Paving methods-Base course/Wearing course)

(H28)Road pavement(Paving methods-Base course/Wearing course)

Asphalt pavement

Paving construction method

○ Base course/Wearing course

Open-graded asphalt mixture

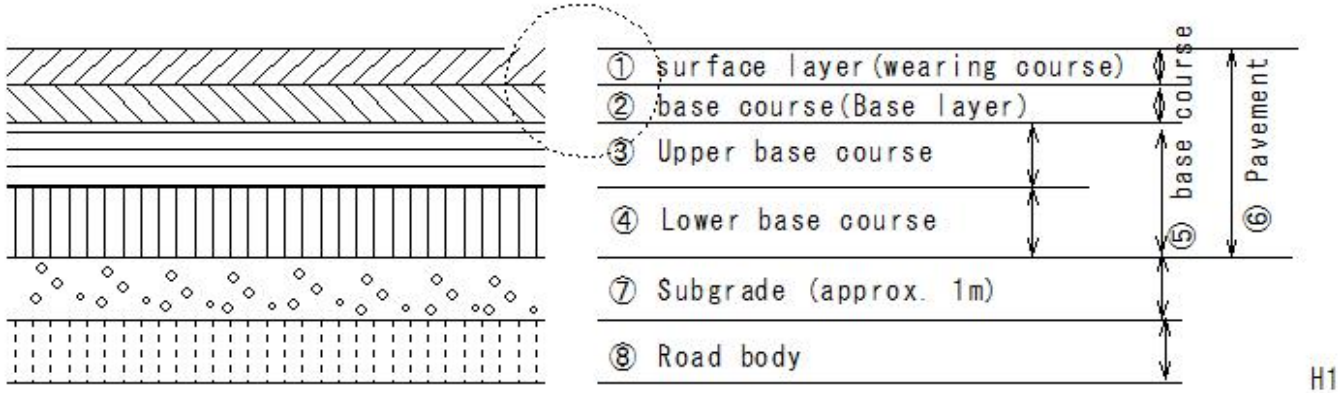
Slip resistance - excellent

Used as wear layer

Rainwater easily penetrates

Easily peels off

Durability - lacking



H1

(H29)Road pavement(Paving methods-Base course/Wearing course)

(H29)Road pavement(Paving methods-Base course/Wearing course)

Asphalt pavement

Paving methods

○ Base course/Wearing course

Comparison of dense-graded asphalt mixtures

asphalt mixtures	Advantages	Inferiority
1 Fine Particle Size(13)	Water Resistant, Crack Resistant	Fluid Resistance
2 Dense Particle Size Gap(13)	Slip resistance	
3 Dense particle size (20F, 13F)	Abrasion resistance	Fluid Resistance
4 Fine Particle Size Gap (13F)	abrasion-resistant, water-resistant,	Fluid Resistance
	crack-resistant	
5 Fine grain size (13F)	abrasion-resistant, water-resistant,	Fluid Resistance
	crack-resistant	
6 Dense Particle Size Gap (13F)	abrasion-resistant, water-resistant,	Fluid Resistance
	crack-resistant	

( ) indicates maximum aggregate particle size

F uses a lot of filler

(H30)Road pavement(Paving methods-Base course/Wearing course)

(H30)Road pavement(Paving methods-Base course/Wearing course)

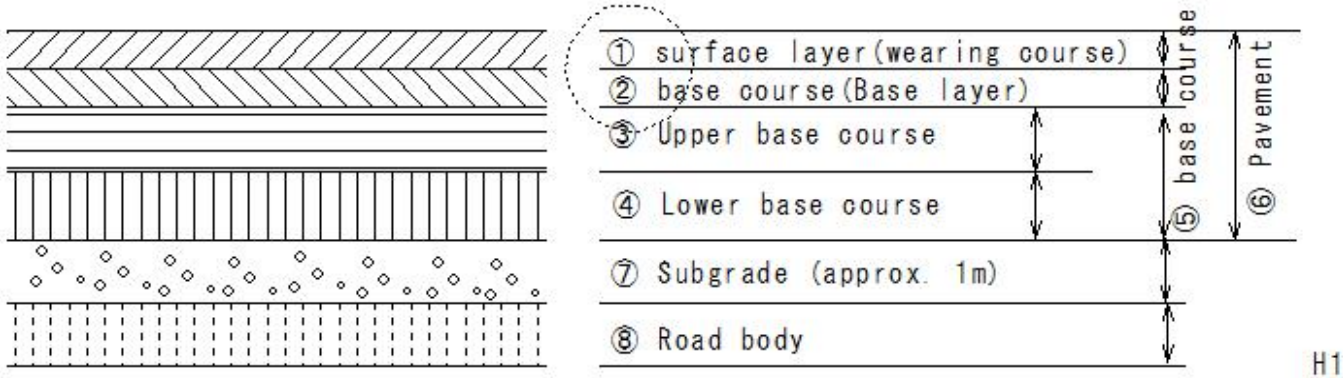
Asphalt pavement

Paving methods

○ Base course/Wearing course

Types and characteristics of modified asphalt

type		Features
Asphalt with rubber and thermoplastic elastomers	Modified Asphalt Type I	Slip resistance, abrasion resistance
	Modified Asphalt Type II	Fluid resistance, abrasion resistance, slip resistance
semi-pro on asphalt (AC-100)		Flow Resistance



H1

(H31)Road pavement(Paving methods-Subgrade)

(H31)Road pavement(Paving methods-Subgrade)

Asphalt pavement

Paving methods

Subgrade and Base course(roadbed) construction

Subgrade

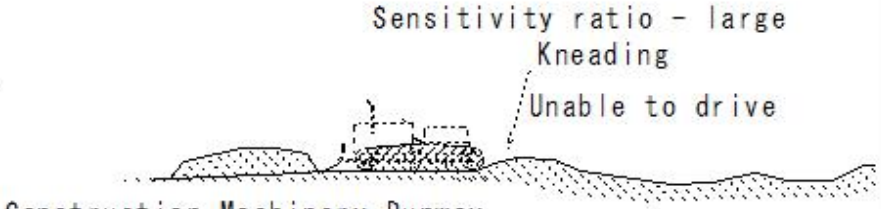
Cut earth subgrade

Subgrade construction

Excavation, shaping, compaction, finishing

In the case of clayey soil or soil with high moisture content

Avoid over-kneading or over-compacting



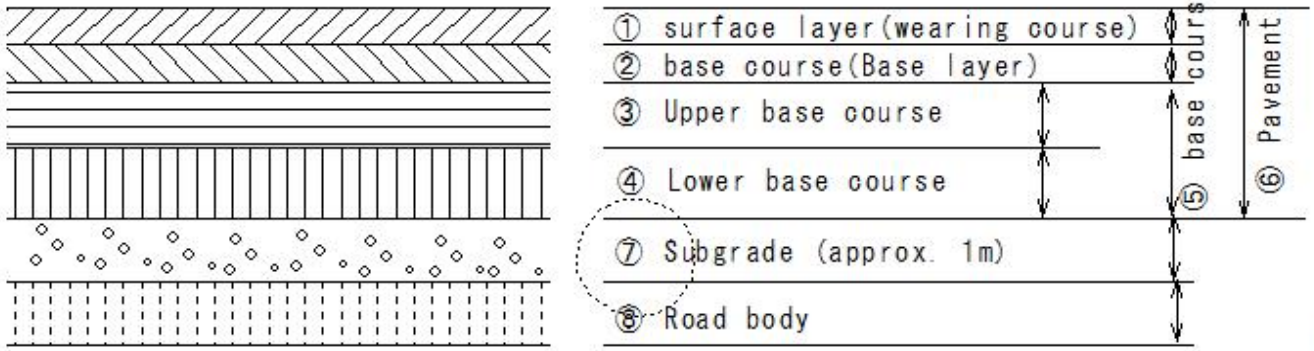
Construction Machinery Runway

Selection of compaction machines

Soft and clay soil

Kneading

E499



H1

(H32)Road pavement(Paving methods-Subgrade)

(H32)Road pavement(Paving methods-Subgrade)

Asphalt pavement

Paving methods

Subgrade and Base course(roadbed) construction

Subgrade

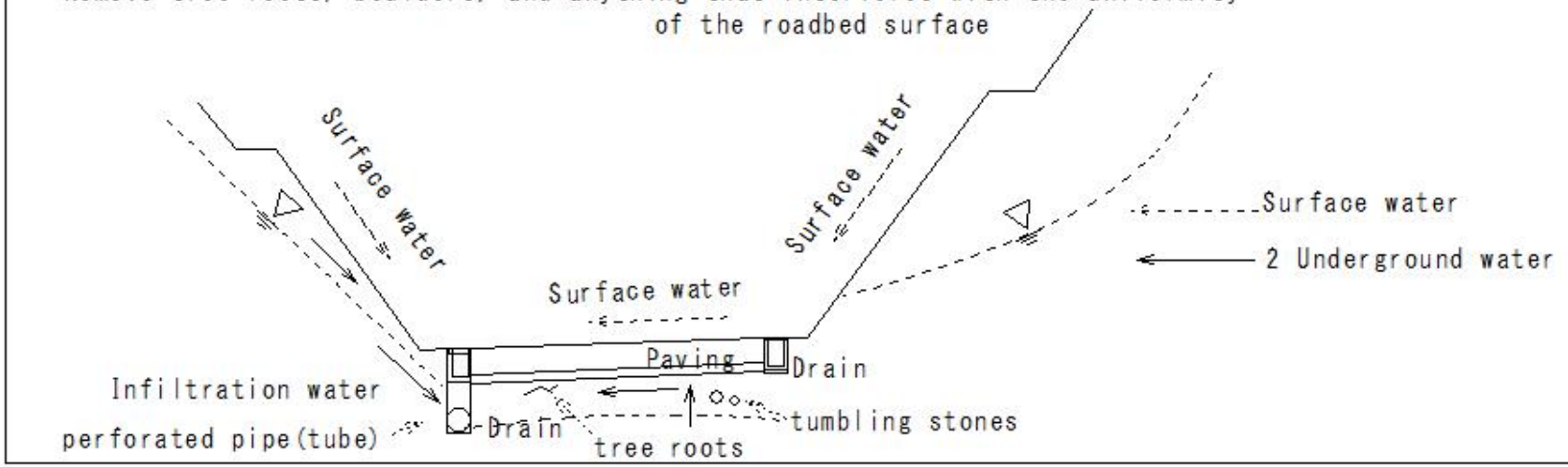
Cut earth subgrade

Subgrade construction

n case of there is groundwater, install a perforated pipe on the mountain side

Drain seepage water from the roadbed

Remove tree roots, boulders, and anything that interferes with the uniformity of the roadbed surface



(H33)Road pavement(Paving methods-Subgrade)

(H33)Road pavement(Paving methods-Subgrade)

Asphalt pavement

Paving construction method

Construction of Subgrade and Base course

○Embankment Subgrade(roadbed)

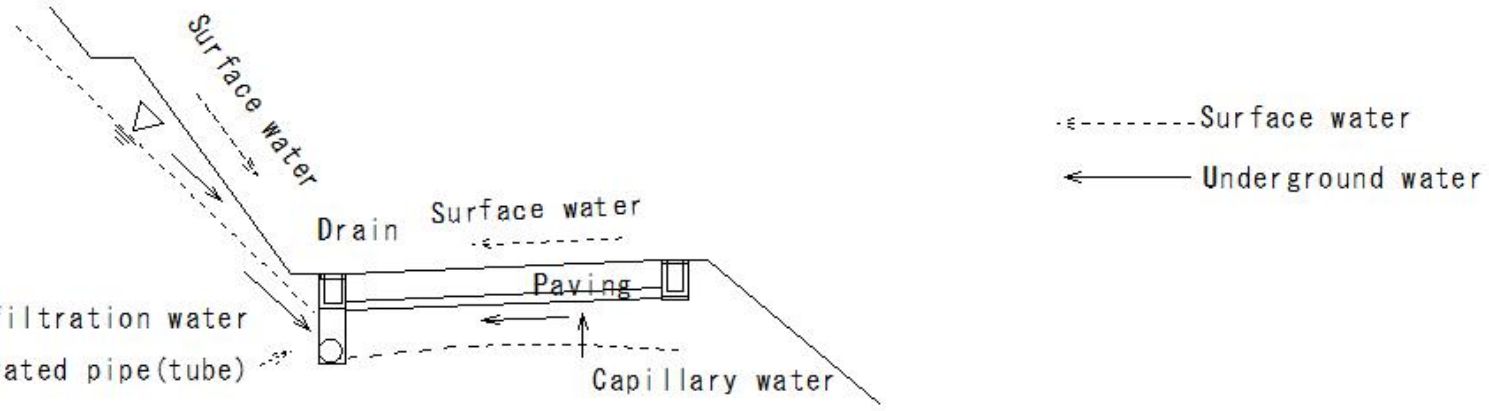
Understanding the nature of embankment materials

Laying, compaction, and finishing so as not to reduce strength

Leveling thickness of one layer Finished thickness 20 cm or less

After the construction of the roadbed - Temporary drainage channel for rainwater -

Protection of the roadbed



(H34)Road pavement(Paving methods-Subgrade stabilization)

(H34)Road pavement(Paving methods-Subgrade stabilization)

Asphalt pavement

Paving methods

Construction of Subgrade and Base course

○Subgrade stabilization

Subgrade mixing method

Road mixer (stabilizer)

Before spreading stabilizer

Leveling unevenness

Install temporary drainage channel

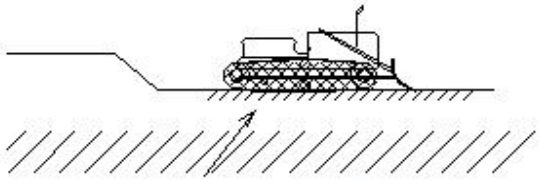
Check the specified mixing depth and mixing condition,

and after mixing, shape and compact

in case of the material is too soft to use a compaction machine,

Wetland bulldozer - lightly compact

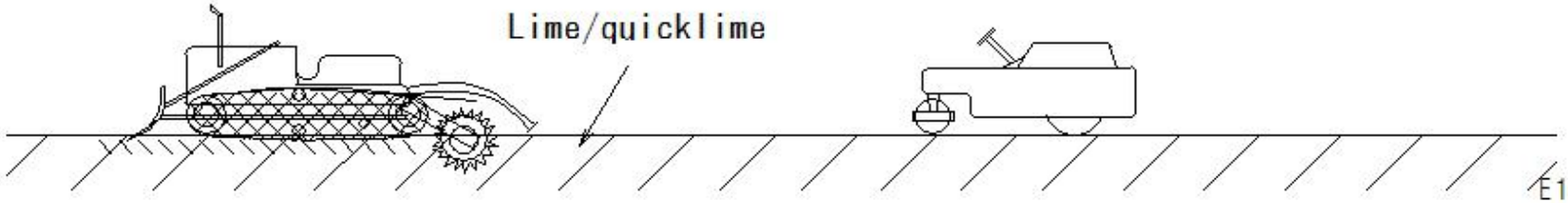
After a few days of curing, shape and compact with tire rollers, etc.



wetland bulldozer

E176

tire rollers and vibrating rollers



E109

(H35)Road pavement(Paving methods-Replacement method)

(H35)Road pavement(Paving methods-Replacement method)

Asphalt pavement

Paving methods

Construction of Subgrade and Base course

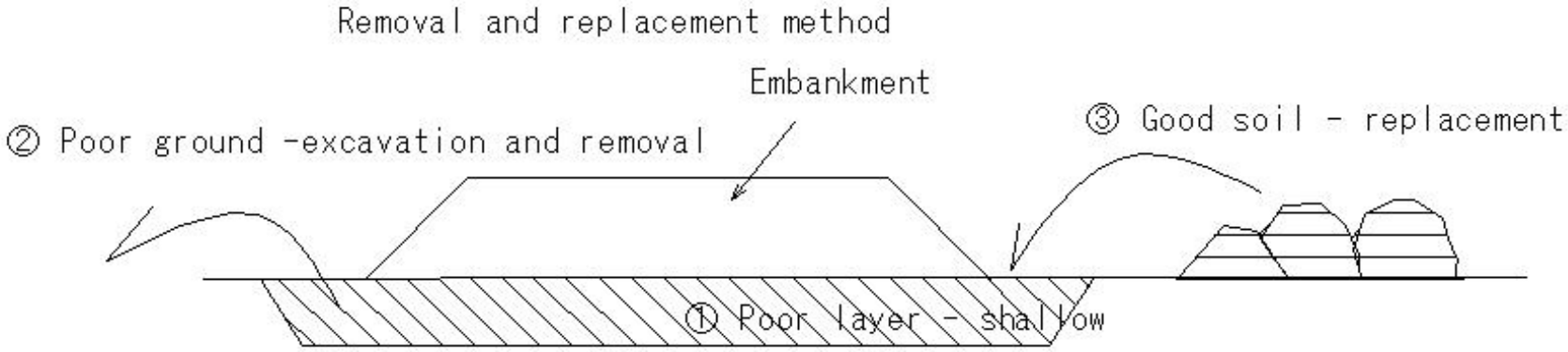
○Replacement method

High-quality soil for the roadbed

Construction of a frost heave suppression layer

To prevent disturbance below the excavation surface

Construction with a finished thickness of 20 cm or less per layer



E102

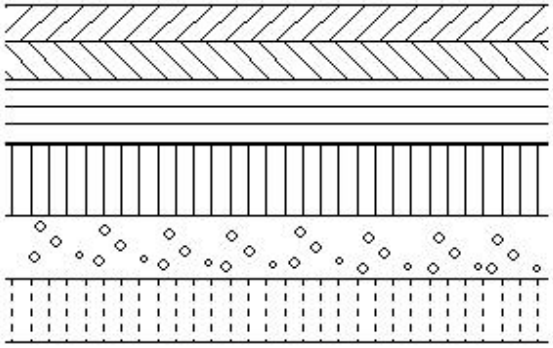
(H36)Road pavement(Paving methods-Lower base course)

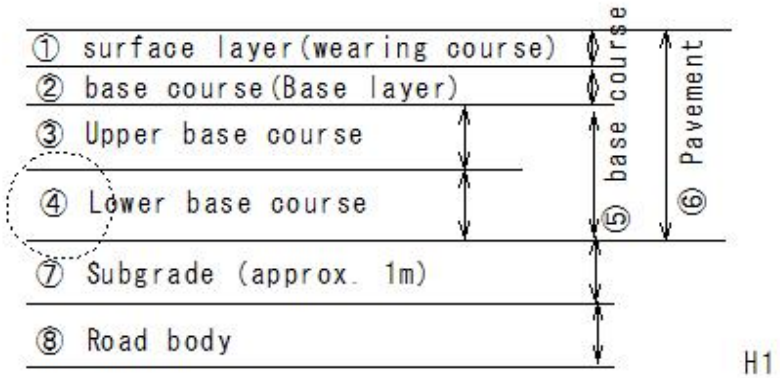
(H36)Road pavement(Paving methods-Lower base course)

Asphalt pavement
Paving methods
Construction of Subgrade and Base course

○Lower base course
Finished thickness
Finished thickness of subgrade

Construction method	Finished thickness
Granular roadbed	Standard 20 cm or less
Cement Lime stabilized roadbed	Standard 15~30cm





(H37)Road pavement(Paving methods-Lower base course)

(H37)Road pavement(Paving methods-Lower base course)

Asphalt pavement

Paving methods

Construction of Subgrade and Base course

○ Lower base course

Considerations for construction

○ Lower base course construction considerations

Construction method: Granular roadbed

Considerations for construction

Laying: Motor grader, bulldozer, aggregate spreader

Compacting: 10-12t road roller, 8-20t tire roller

Vibrating roller with equivalent effect

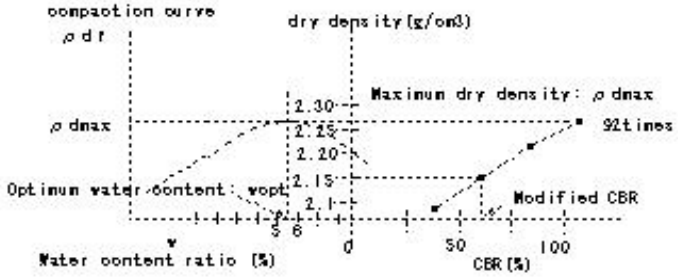
in case of the granular roadbed material is too dry, sprinkle water

Compact in case of near the optimal moisture content

in case of compaction is difficult due to rainfall,

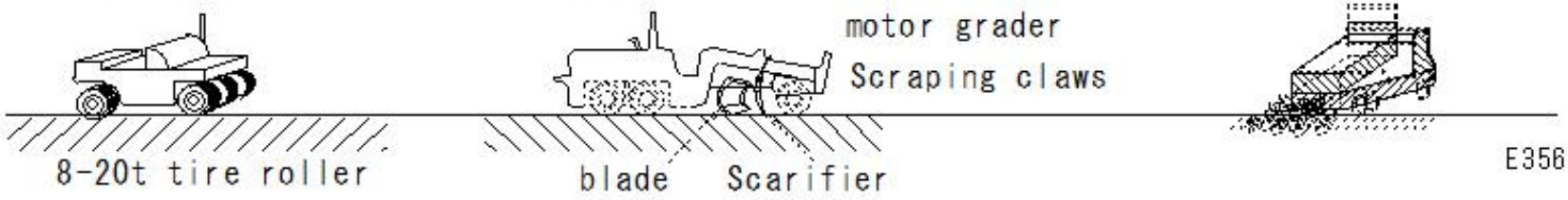
wait for fine weather and perform aeration drying

Sprinkle a small amount of lime or cement



Optimun water content: wopt
Degree of compaction-Modified CBR

E110



E356

(H38)Road pavement(Paving methods-Lower base course)

(H38)Road pavement(Paving methods-Lower base course)

Lower base course(Lower roadbed)

Considerations for construction

○ Lower base course(Lower roadbed) construction considerations

○ Construction method: Cement lime stabilized Base course(roadbed)

Depending on the condition of the Subgrade(roadbed), rake it in advance, sprinkle water and adjust the moisture content

Mixing: Road mixer (stabilizer)

After mixing

Motor grader, etc. - rough leveling

Tired roller: Light compaction

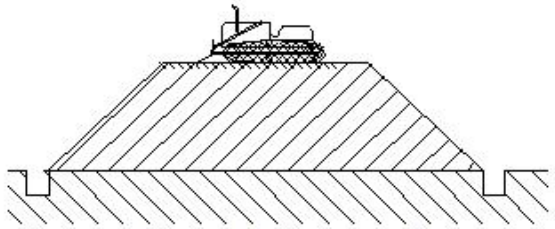
Paving roller: Compaction

Use two or more types of paving rollers in combination

Compact until the desired degree of compaction is achieved

Traffic can be opened immediately after compaction

In case of the road mixing method, pour the mixture at an early stage

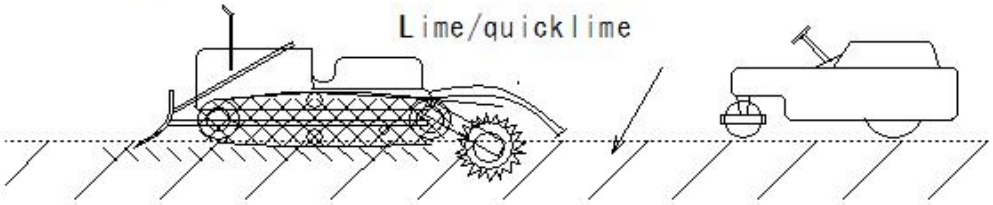


Soil stabilization

(soil + cement / asphalt mixture)

- increase bearing capacity

H17
H13
E60



tire rollers and vibrating rollers

H18
H13
E109

(H39)Road pavement(Paving methods-Upper base course)

(H39)Road pavement(Paving methods-Upper base course)

Asphalt pavement

Paving methods

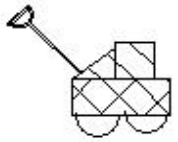
Construction of Subgrade and Base course

Upper base course

vibrating roller

E240

vibrating compactor

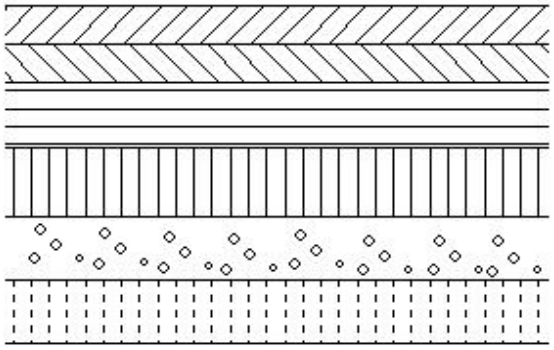


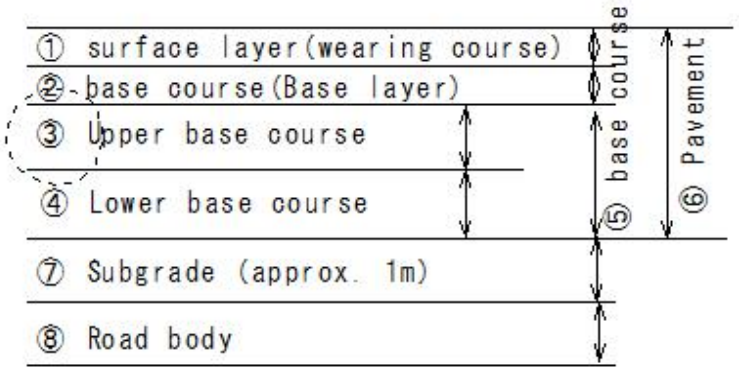
E448

vibrating roller

Upper base course(Upper roadbed) finished thickness

Construction method	Finished thickness
○Grain-adjusted Base course(roadbed)	Standard 15cm or less in case of using vibratory rollers, maximum 20cm





H1

(H40)Road pavement(Paving methods-Upper base course)

(H40)Road pavement(Paving methods-Upper base course)

Asphalt pavement

Paving method

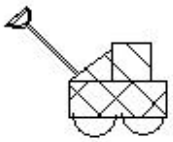
Subgrade and Base course(roadbed)construction

Upper base course(Upper roadbed)

vibrating roller

E240

vibrating compactor

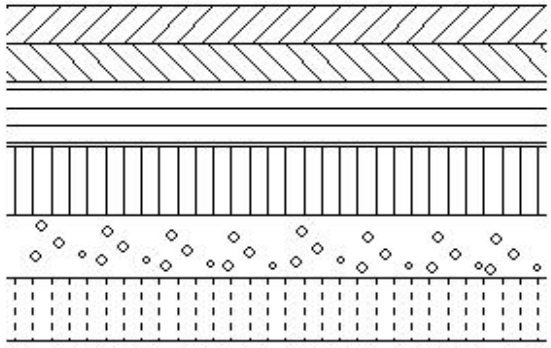


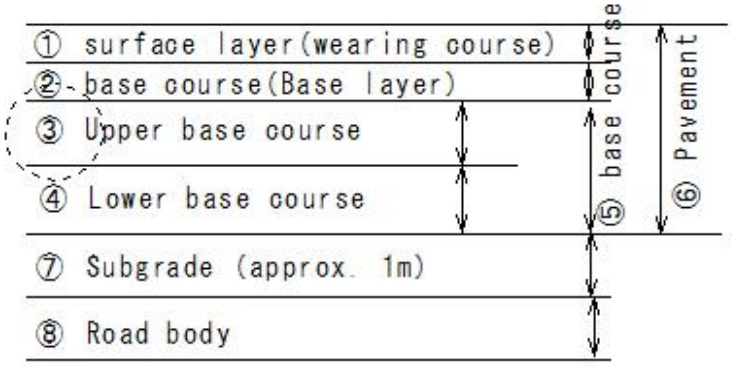
E448

vibrating roller

Upper base course(Upper roadbed) finished thickness

Construction method	Finished thickness
Cement, lime stabilized Base course(roadbed)	Standard 10-20cm in case of using vibratory rollers, maximum 25cm





H1

(H41)Road pavement(Paving methods-Upper base course)

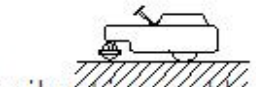
(H41)Road pavement(Paving methods-Upper base course)

Asphalt pavement

Paving method

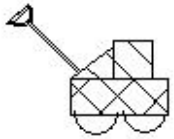
Subgrade and Base course(roadbed)construction

Upper base course(Upper roadbed)



E240

vibrating compactor



E448

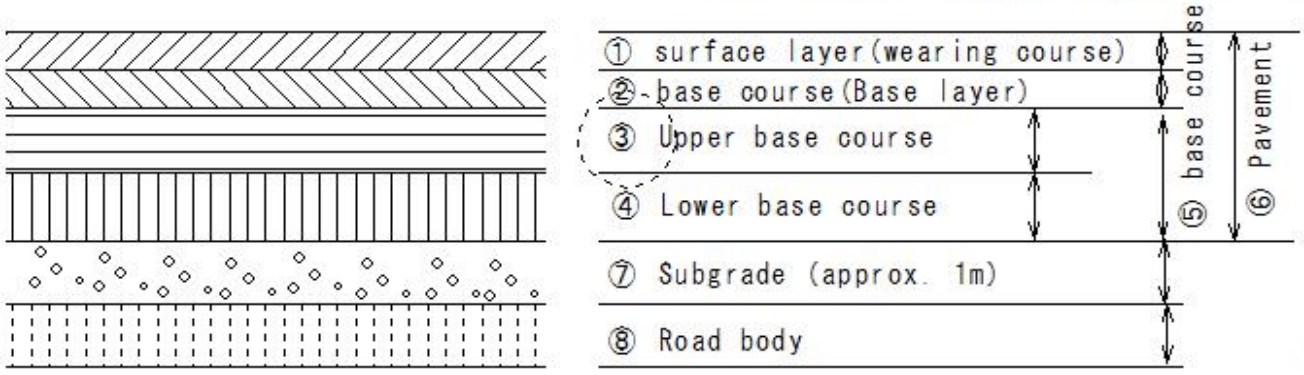
vibrating roller

Upper base course(Upper roadbed) finished thickness

Construction method	Finished thickness
○Bituminous stabilized Base course(roadbed)	General method: 10cm or less Thick lift method: over 10cm

Thick lift method: over 10cm

A method of construction in which a layer of asphalt is laid in one thicker than usual, with a finished thickness of 10cm or more.



H1

(H42)Road pavement(Paving methods-Upper base course)

(H42)Road pavement(Paving methods-Upper base course)

Asphalt pavement

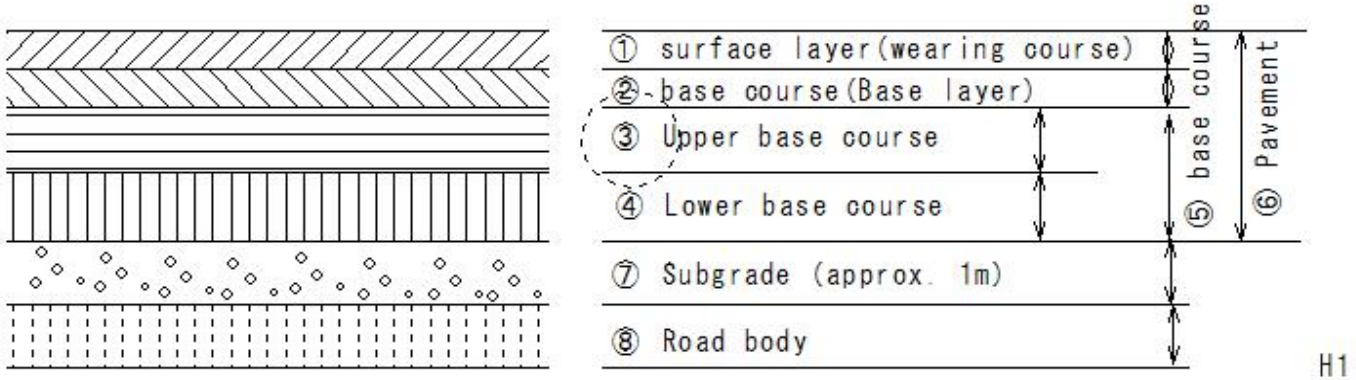
Paving method

Subgrade and Base course(roadbed)construction

Upper base course(Upper roadbed)

Check points for Upper Base course(roadbed) construction

Construction method	Check points for construction
○Grain-adjusted Base course(roadbed)	Grain-adjusted Base course(roadbed) material - already adjusted and used
	Same check points as for the granular Base course (lower roadbed)



(H43)Road pavement(Paving methods-Upper base course)

(H43)Road pavement(Paving methods-Upper base course)

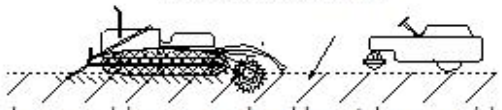
Asphalt pavement

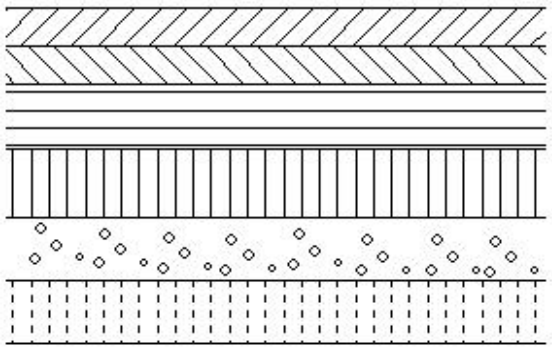
Paving method

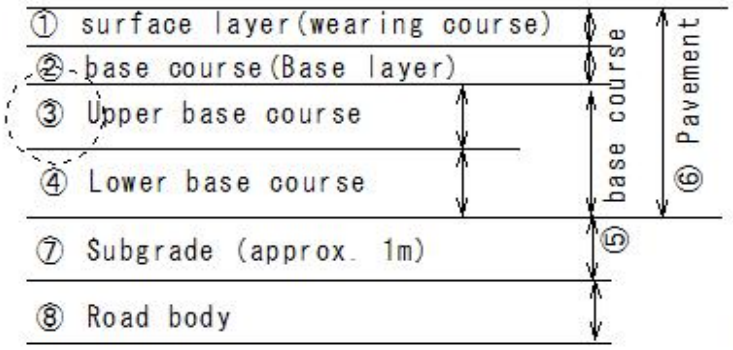
Subgrade and Base course(roadbed)construction

Upper base course(Upper roadbed)

Check points for Upper Base course(roadbed) construction

Construction method	Check points for construction
Cement lime stabilized Base course(roadbed) Lime stabilization method Lime/quicklime  tire rollers and vibrating rollers H18 H13 E109	In the case of cement stabilization, compaction must be completed before hardening begins The wetter side is preferable for compaction of lime stabilized Base course(roadbed) material than the optimal moisture content Traffic opening - Maintain constant moisture content Road surface protection - Seal coat Construct the upper layer quickly





H1

(H44)Road pavement(Paving methods-Upper base course)

(H44)Road pavement(Paving methods-Upper base course)

Asphalt pavement

Paving method

Subgrade and Base course(roadbed)construction

Upper base course(Upper roadbed)　　Check points for Upper Base course(roadbed) construction

Construction method	Check points for construction
Cement lime stabilized Base course(roadbed)	Horizontal construction joints in case of using cement Cut the edge vertically in case of using lime Disturb the edge from the previous day before pouring the Base course(roadbed) Vertical construction joints Install a formwork of the same height as the finished thickness Pour joints early Others Granular roadbed for lower Base course(roadbed) Follow the precautions for stabilized Base course(roadbed)

(H45)Road pavement(Paving methods-Upper base course)

(H45)Road pavement(Paving methods-Upper base course)

Asphalt pavement

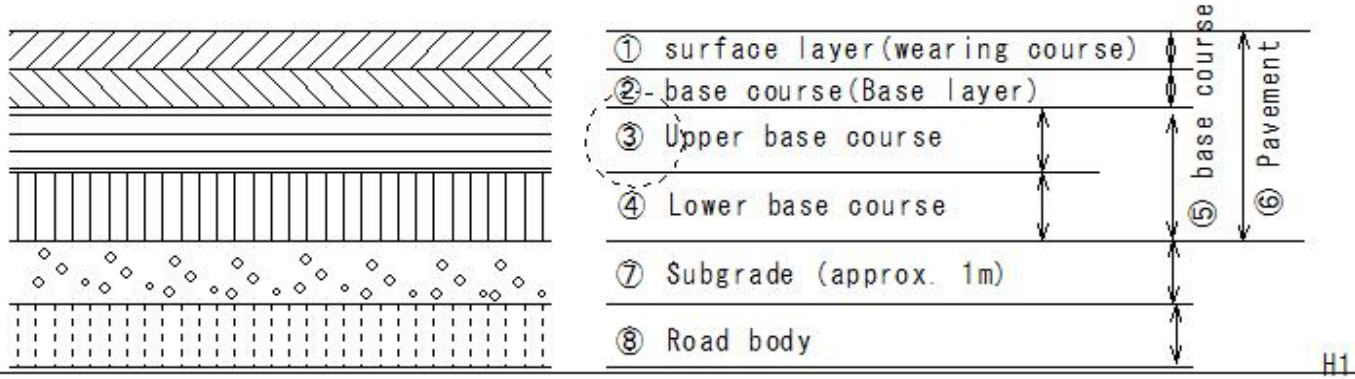
Paving method

Subgrade and Base course(roadbed)construction

Upper base course(Upper roadbed)

Check points for Upper Base course(roadbed) construction

Construction method	Check points for construction
○Bituminous stabilization treatment Base course(subbed) Heating and mixing general method General hot-mixing method	Compared to the mixture for the Base course (base layer) and the Wearing course, the amount of asphalt is small in case of: to take a long mixing time Laying: Using asphalt finisher Use a motor grader, etc.



H1

(H46)Road pavement(Paving methods-Upper base course)

(H46)Road pavement(Paving methods-Upper base course)

Asphalt pavement

Paving method

Subgrade and Base course(roadbed)construction

Upper base course(Upper roadbed)

Check points for Upper Base course(roadbed) construction

Construction method

○Bituminous stabilization treatment

Base course(subbed)

Heated Mixing thick lift method

Check points for construction

In adopting the thick lift method

Carefully check past construction conditions

Determine the formulation and construction method

The mixture temperature at the time of leveling does not fall below 110° C

Laying work is continuous and in large quantities

Pay attention to the supply capacity of the asphalt plant, transportation traffic conditions, etc.

Leveling: Use asphalt finisher

In general, in case of using a bulldozer or motor grader
During compaction, unevenness is likely to occur

Temporary compaction is performed with a vibrating roller before the first compaction.

(H47)Road pavement(Paving methods-Upper base course)

(H47)Road pavement(Paving methods-Upper base course)

Asphalt pavement

Paving method

Subgrade and Base course(roadbed)construction

Upper base course(Upper roadbed)

Check points for Upper Base course(roadbed) construction

Construction method
○Bituminous stabilization treatment Base course(subbed) Heated Mixing thick lift method

Check points for construction
Heated Mixing Thick Lift The construction thickness is large. in case of the traffic is opened early after compaction, rutting is likely to occur in the early stages. In the case of early release, it is necessary to take measures such as cooling after paving. Avoid construction in the summer

(H48)Road pavement(Paving methods-Prime Court)

(H48)Road pavement(Paving methods-Prime Court)

Asphalt pavement

Paving construction method

Subgrade and Base course(roadbed) construction

○Prime Court

For roadbeds except for bituminous stabilization treatment Base course(roadbed)

Quickly and evenly sprays a predetermined amount

Purpose of Prime Coat and Points to Note in Construction

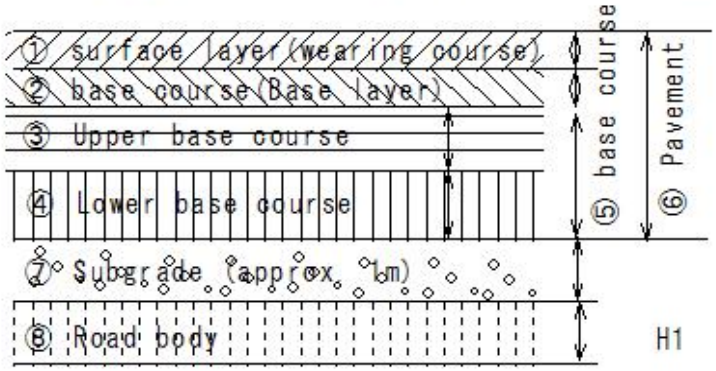
○purpose

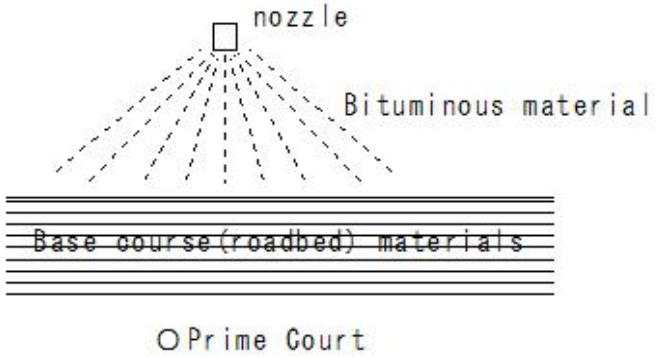
Penetrates the surface of the Base course(roadbed) and stabilizes the part.

Familiarization of the Base course(roadbed) with asphalt mixture

Washing of roadbeds due to rainfall to prevent surface water seepage, etc.

Blocks the evaporation of moisture from the Base course(roadbed)





○Prime Court

(H49)Road pavement(Paving methods-Prime Court)

(H49)Road pavement(Paving methods-Prime Court)

Asphalt pavement

Paving construction method

Subgrade and Base course(roadbed) construction

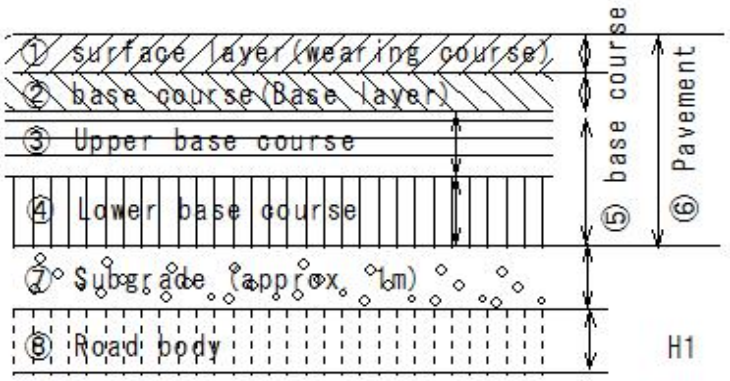
○Prime Court

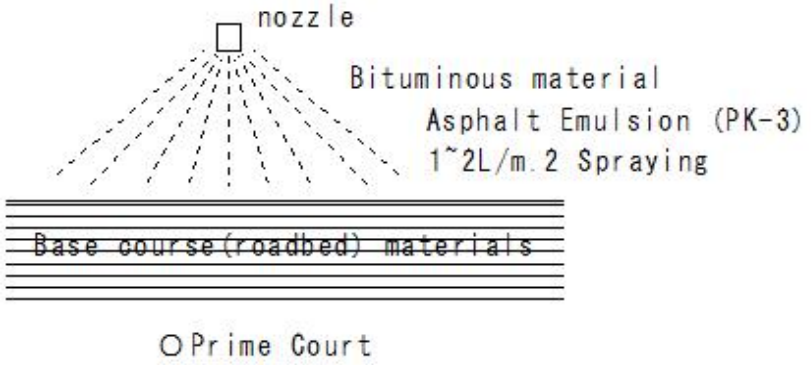
Points in case of constructing

Material: Asphalt Emulsion (PK-3)

1~2L/m.2 Spraying

After coating, traffic is opened - sand spraying - bituminous material - wheel adhesion prevention check to the predetermined amount and uniformity at the time of spraying.





(H50)Road pavement(Paving methods- Seal coat)

(H50)Road pavement(Paving methods- Seal coat)

Asphalt pavement

Paving construction method

Subgrade and Base course(roadbed) construction

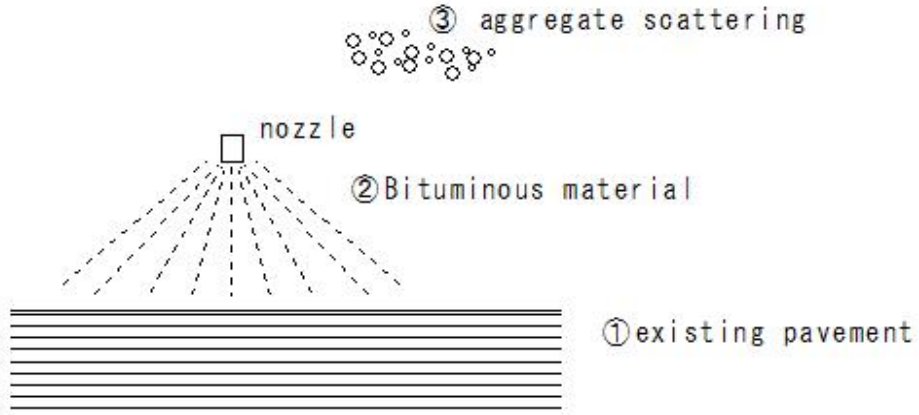
○ Seal coat

On the existing pavement - bituminous material spraying - aggregate scattering on this - finish in one layer

Watertightness - increased

Anti-aging

Anti-slip Applied to closing cracks, etc.



(H51)Road pavement(Paving methods-Tack coat)

(H51)Road pavement(Paving methods-Tack coat)

Asphalt pavement

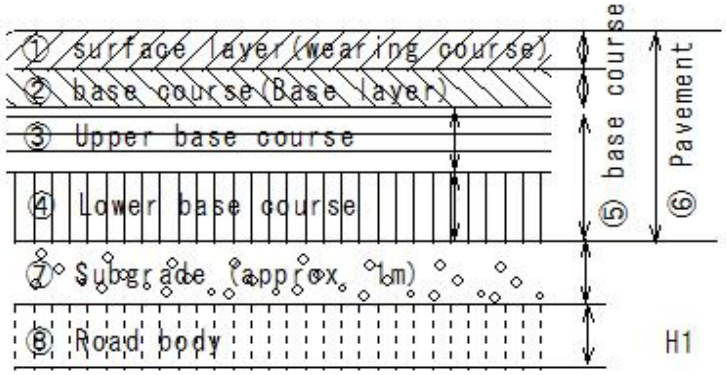
Paving construction method

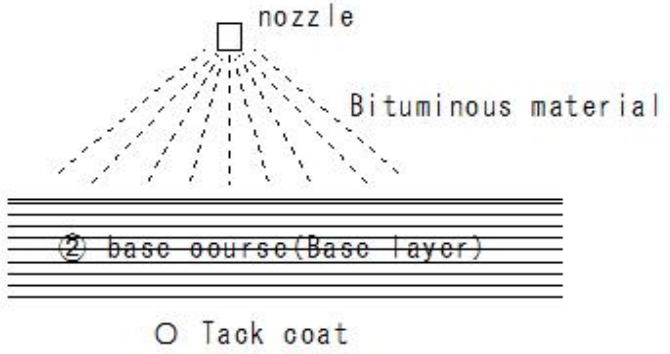
Construction of Base course and Wearing course(surface layers)

○ Tack coat

Purpose and points to note in construction

Objective: Intermediate layer, Base course(base layer), adhesion with asphalt mixture, improvement of seam adhesion





(H52)Road pavement(Paving methods-Tack coat)

(H52)Road pavement(Paving methods-Tack coat)

Asphalt pavement

Paving construction method

Construction of Base course and Wearing course(surface layers)

○ Tack coat

Points to keep in constructing

Asphalt Emulsion (PK-4)

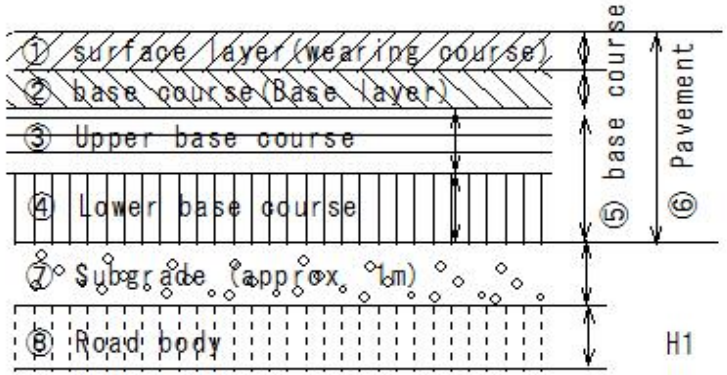
0.3~0.6L/m.3 - Spraying

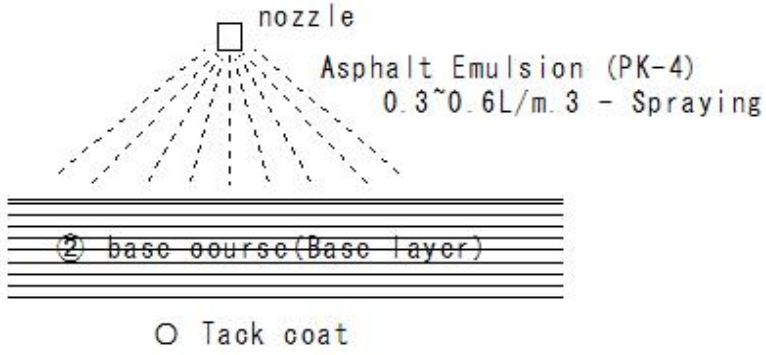
Cold Season: Road Heater - Heating

Predetermined amount - sprayed in 2 doses

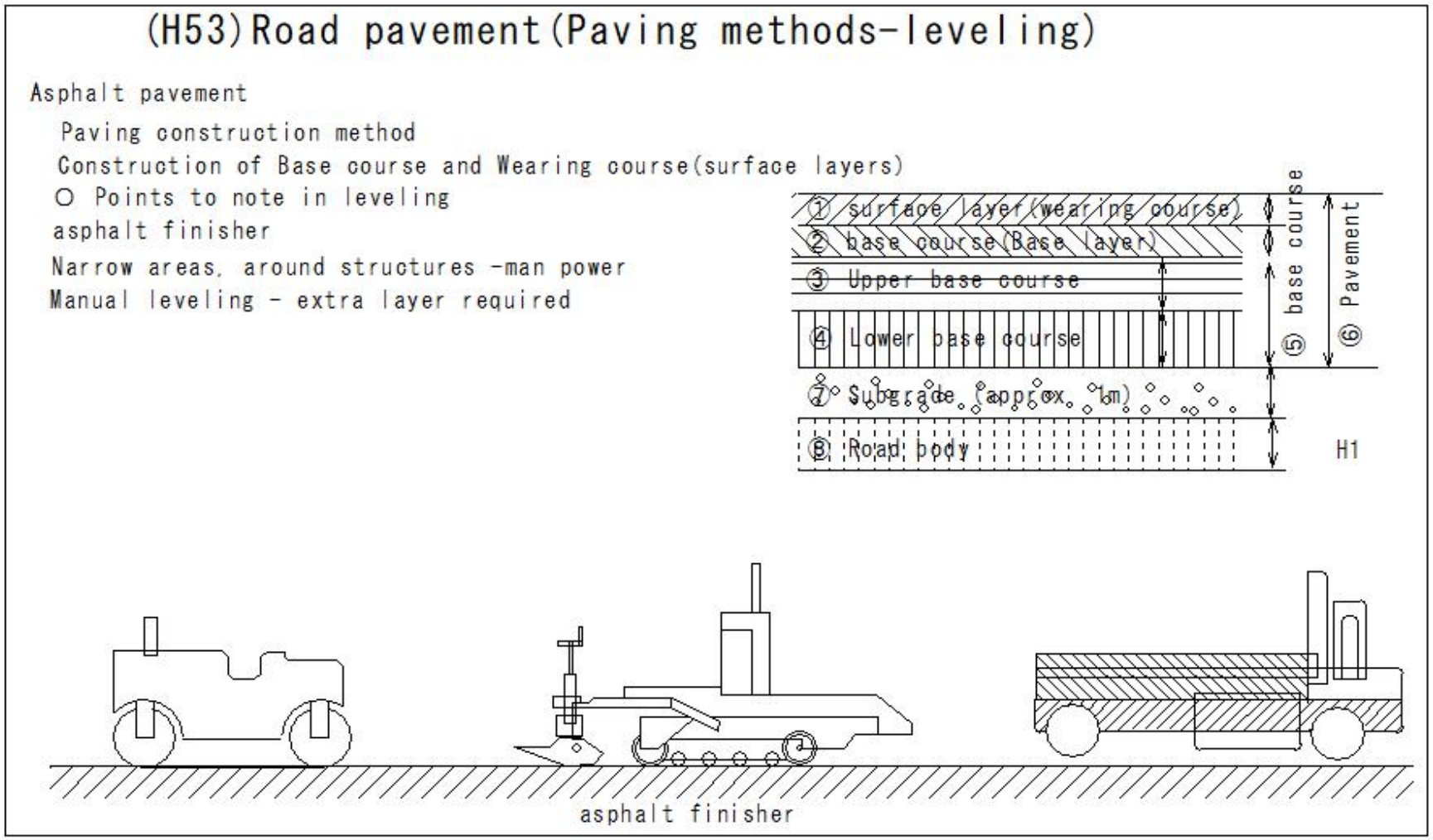
After spraying, be careful of foreign matter adhesion.

Moisture disappears quickly in the Wearing course(Surface layer) - paving

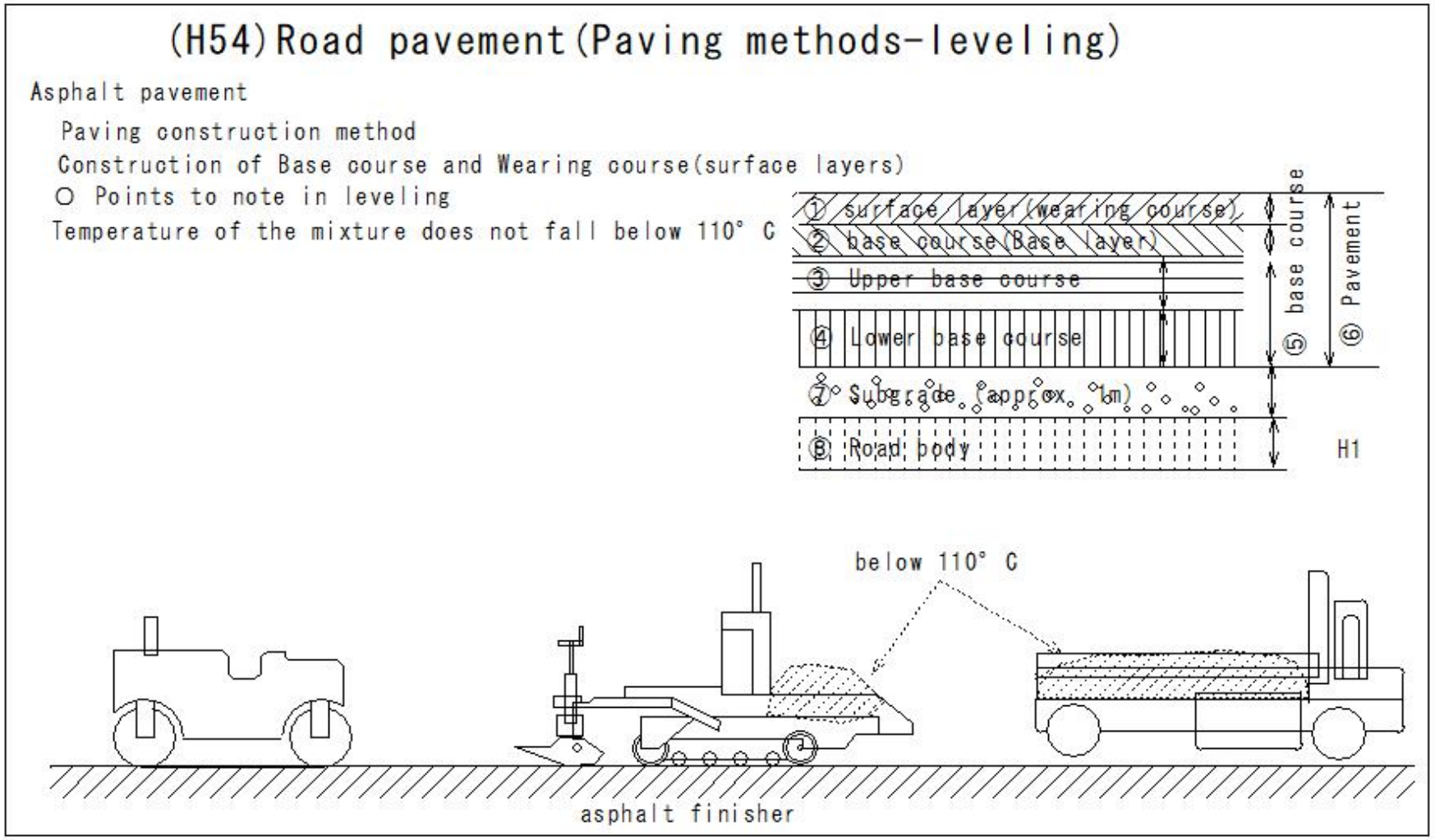




(H53)Road pavement(Paving methods-leveling)



(H54)Road pavement(Paving methods-leveling)



(H55)Road pavement(Paving methods-leveling)

(H55)Road pavement(Paving methods-leveling)

Asphalt pavement

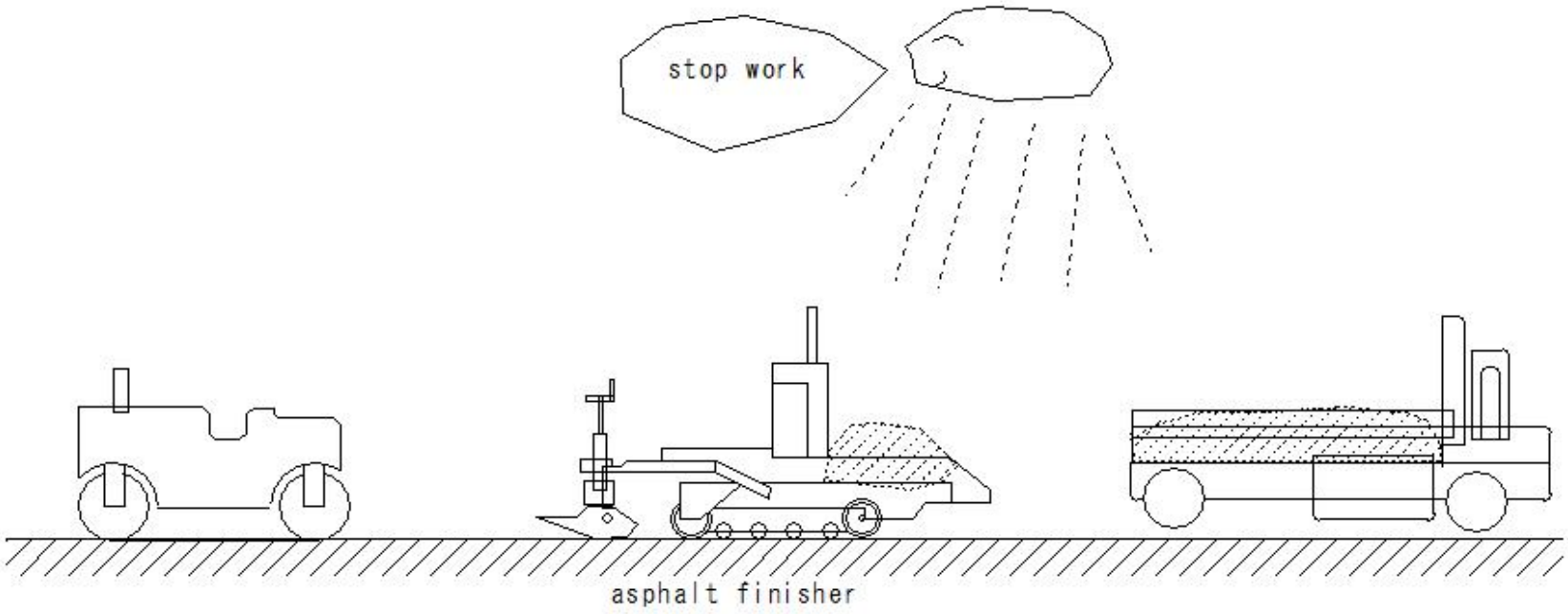
Paving construction method

Construction of Base course and Wearing course(surface layers)

○ Points to note in leveling

In case of rainfall - stop work

Leveling Mixture - Compaction - Finishing



(H56)Road pavement(Paving methods-leveling)

(H56)Road pavement(Paving methods-leveling)

Asphalt pavement

Paving construction method

Construction of Base course and Wearing course(surface layers)

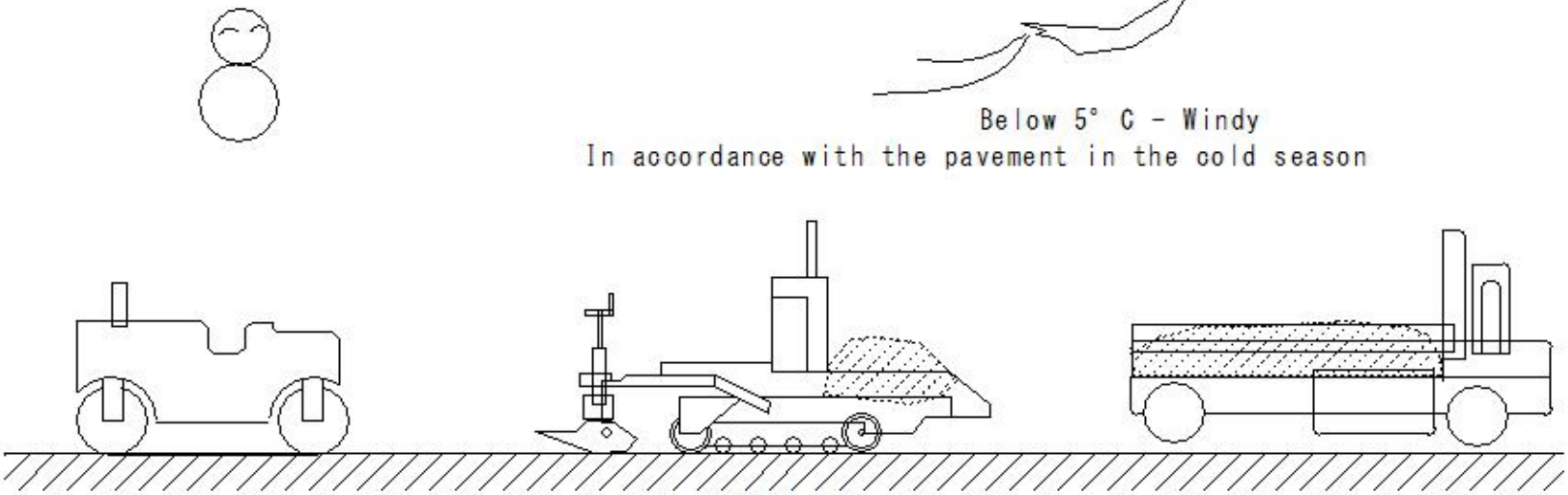
○ Points to note in leveling

Below 5° C - Windy - Working - Temperature Drop - Intense

In accordance with the pavement in the cold season

Below 5° C - Windy

In accordance with the pavement in the cold season



asphalt finisher

(H57)Road pavement(Paving methods-leveling)

(H57)Road pavement(Paving methods-leveling)

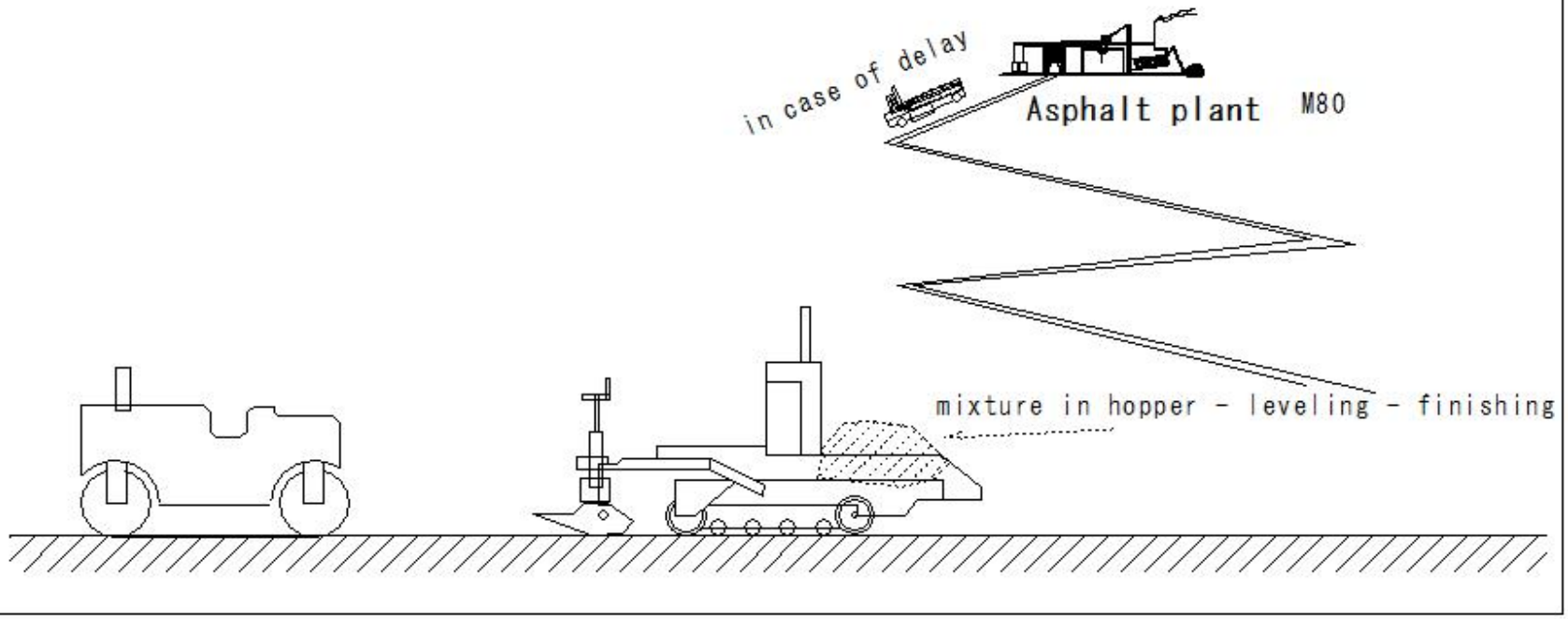
Asphalt pavement

Paving construction method

Construction of Base course and Wearing course(surface layers)

○ Points to note in leveling

Mixture arrival time - in case of delay - mixture in hopper - leveling - finishing



(H58)Road pavement(Paving methods-Compaction)

(H58)Road pavement(Paving methods-Compaction)

Asphalt pavement

Paving construction method

Construction of Base course and Wearing course(surface layers)

○ Points to keep in compaction work

Compaction work

Seam compaction→ first compaction→ secondary compaction→ finishing compaction

Work-compaction machine

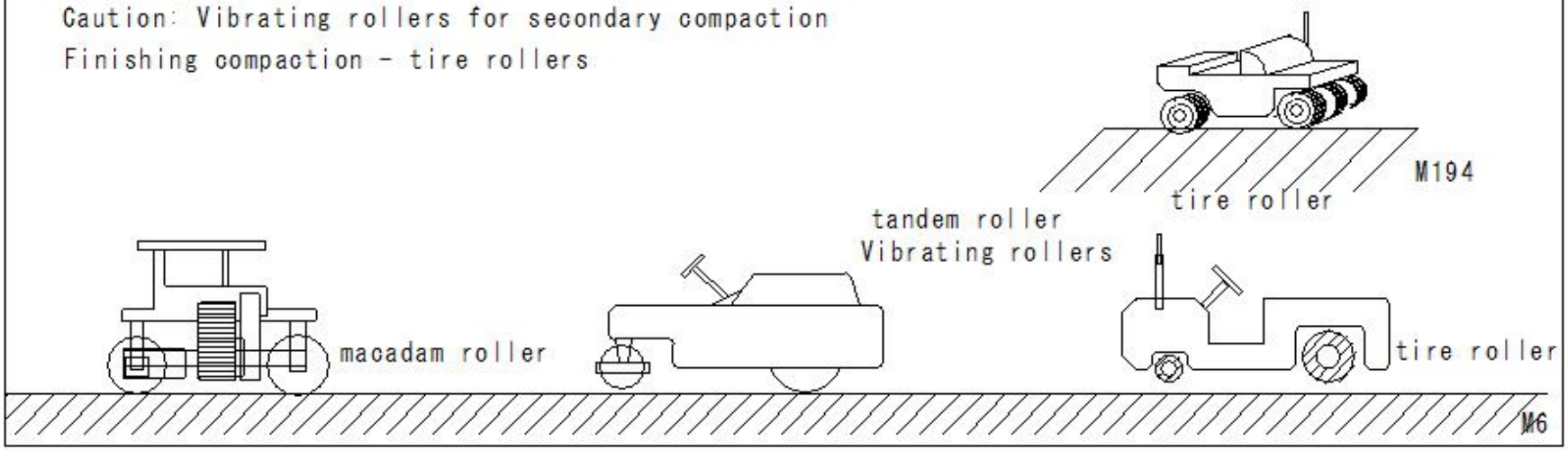
①First compaction: 10-12t road roller 2 times (1 round trip)

②Secondary compaction: 8-20t tire rollers 6-10t vibrating rollers

③Finishing compaction: Tire roller Road roller 2 times (1 round trip)

Caution: Vibrating rollers for secondary compaction

Finishing compaction - tire rollers



(H59)Road pavement(Paving methods-First compaction)

(H59)Road pavement(Paving methods-First compaction)

Asphalt pavement

Paving construction method

Construction of Base course and Wearing course(surface layers)

・Precautions for compaction work

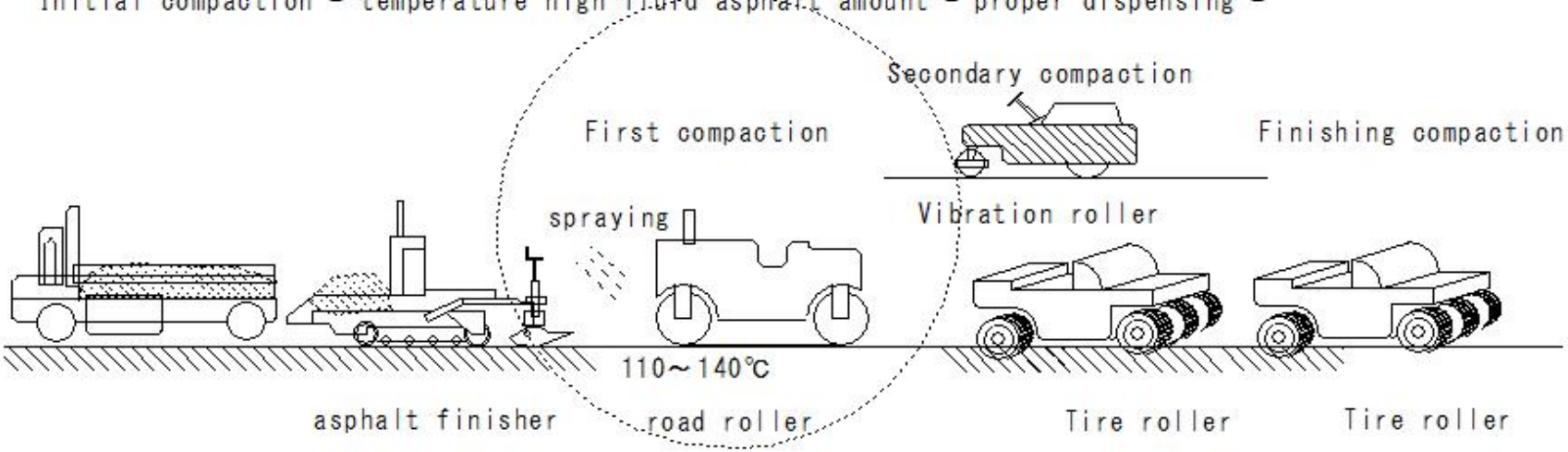
First compaction

Initial compaction: as high temperature as possible

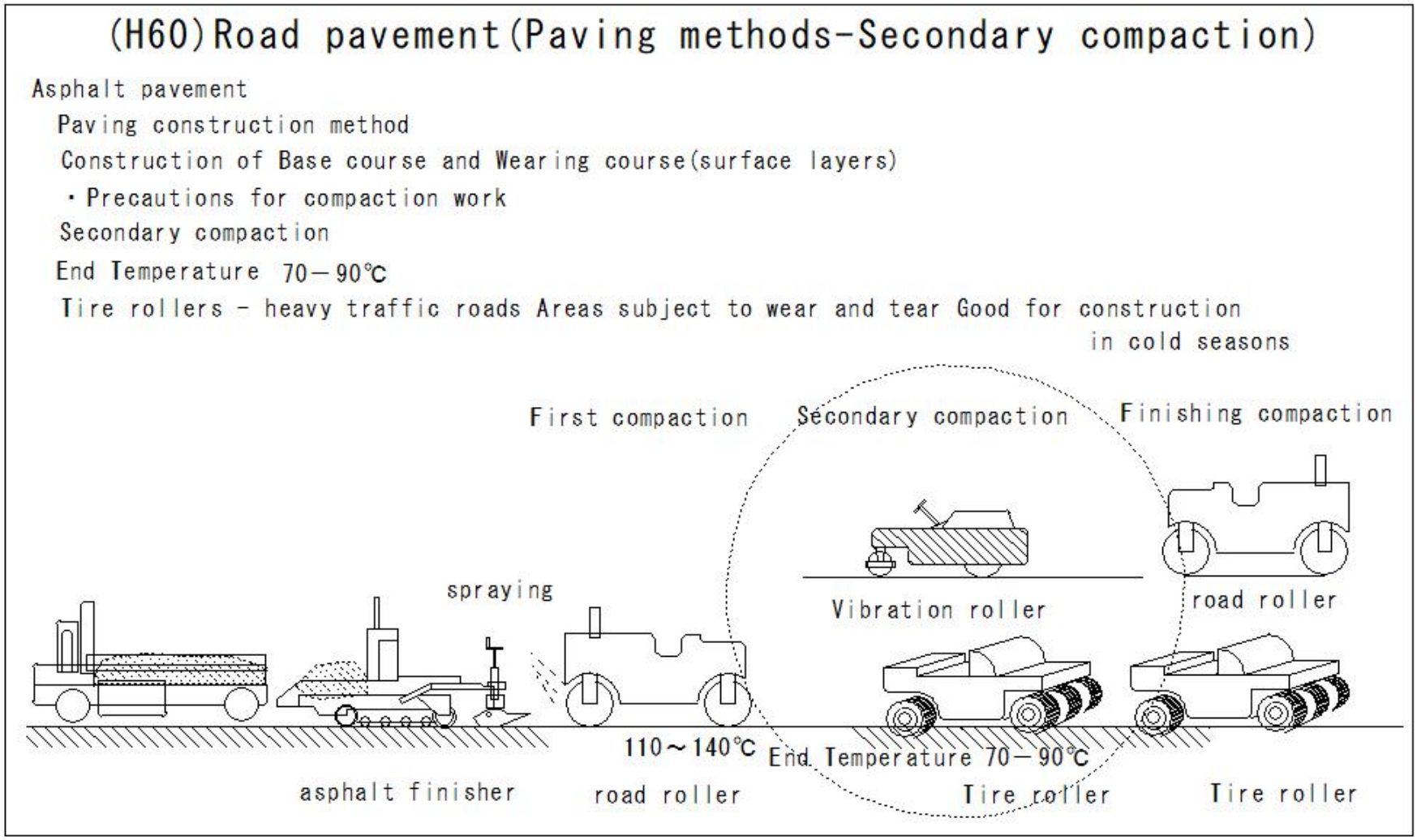
110～140℃

A small amount of water Diluent Diesel oil - spraying - Prevention of adhesion of the mixture to the roller

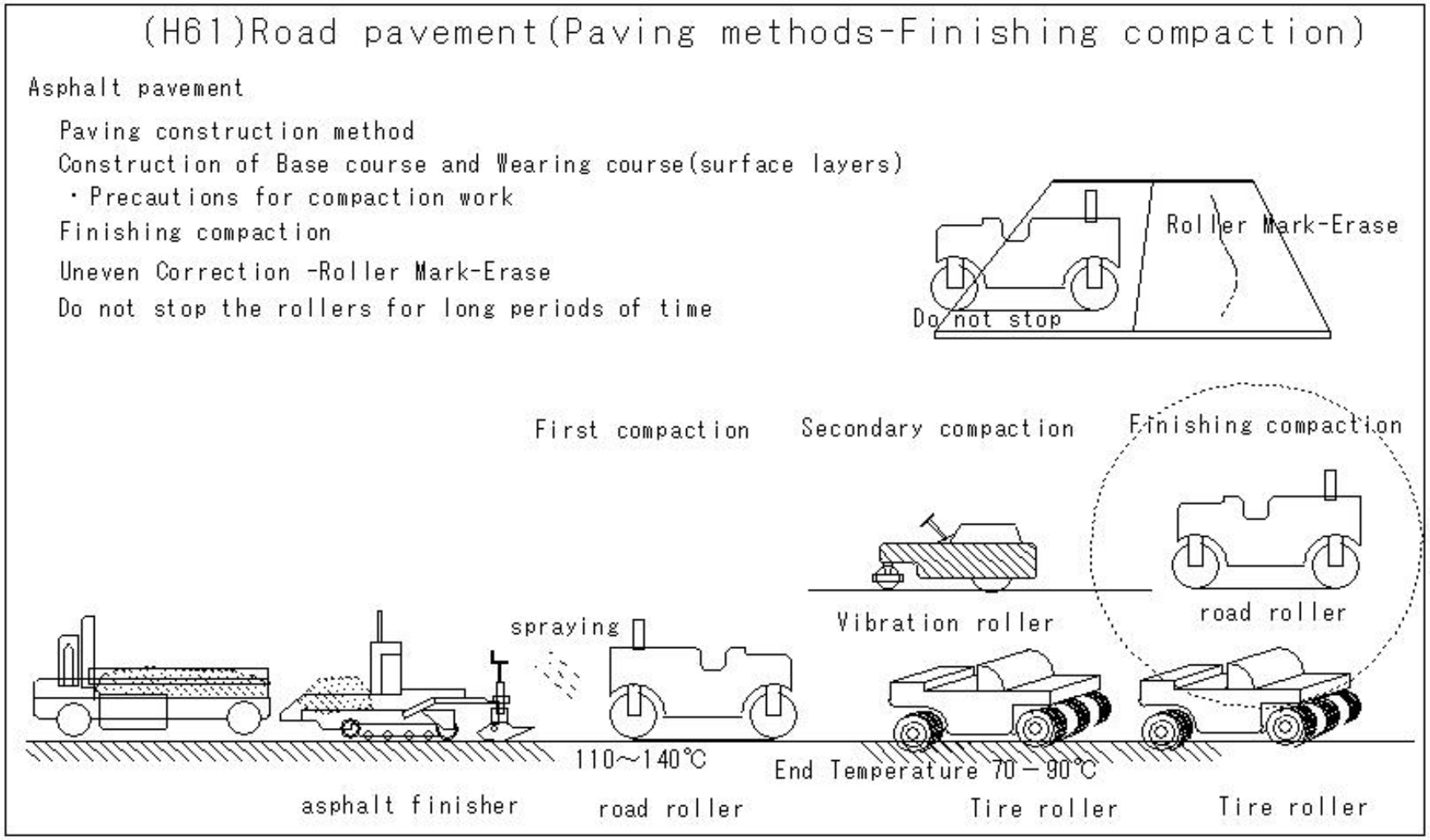
Initial compaction - temperature high fluid asphalt amount - proper dispensing -



(H60)Road pavement(Paving methods-Secondary compaction)



(H61)Road pavement(Paving methods-Finishing compaction)



(H62)Road pavement(Paving methods-common compaction)

(H62)Road pavement(Paving methods-common compaction)

Asphalt pavement

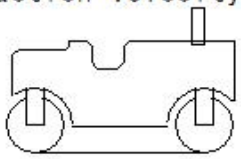
Paving construction method

Construction of Base course and Wearing course(surface layers)

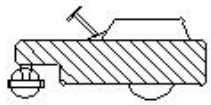
・Precautions for compaction work

common

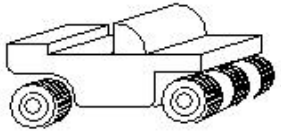
Roller compaction velocity



Road Roller 2-3km/h



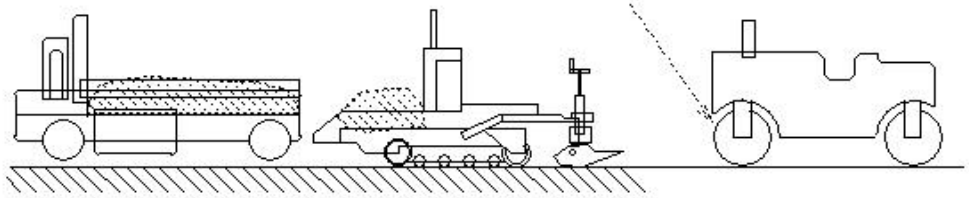
vibrating roller 3-6km/h



Tire rollers 6-10km/h

Roller - Drive wheel - tip (finisher side)

Drive wheel - tip (finisher side)



asphalt finisher

road roller

(H63)Road pavement(Paving methods-common compaction)

(H63)Road pavement(Paving methods-common compaction)

Asphalt pavement

Paving construction method

Construction of Base course and Wearing course(surface layers)

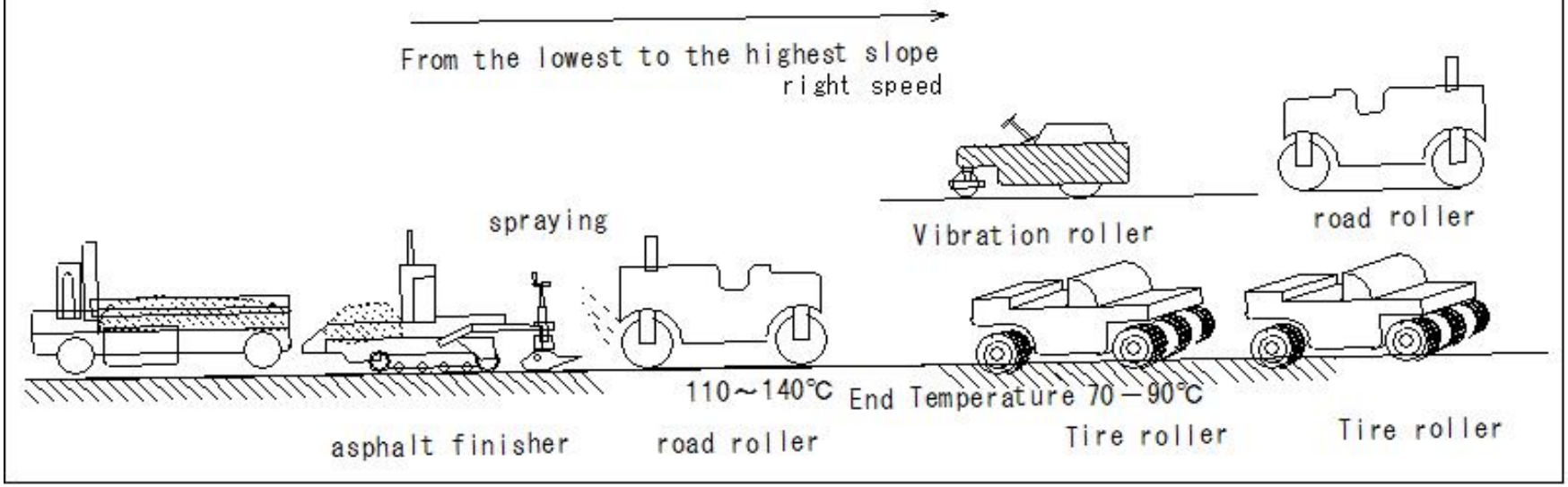
・Precautions for compaction work

common

From the lowest to the highest slope

Compaction at the right speed

Large longitudinal slope (more than 7%) - do the same



(H64)Road pavement(Paving methods-common compaction)

(H64)Road pavement(Paving methods-common compaction)

Asphalt pavement

Paving construction method

Construction of Base course and Wearing course(surface layers)

・Precautions for compaction work

common

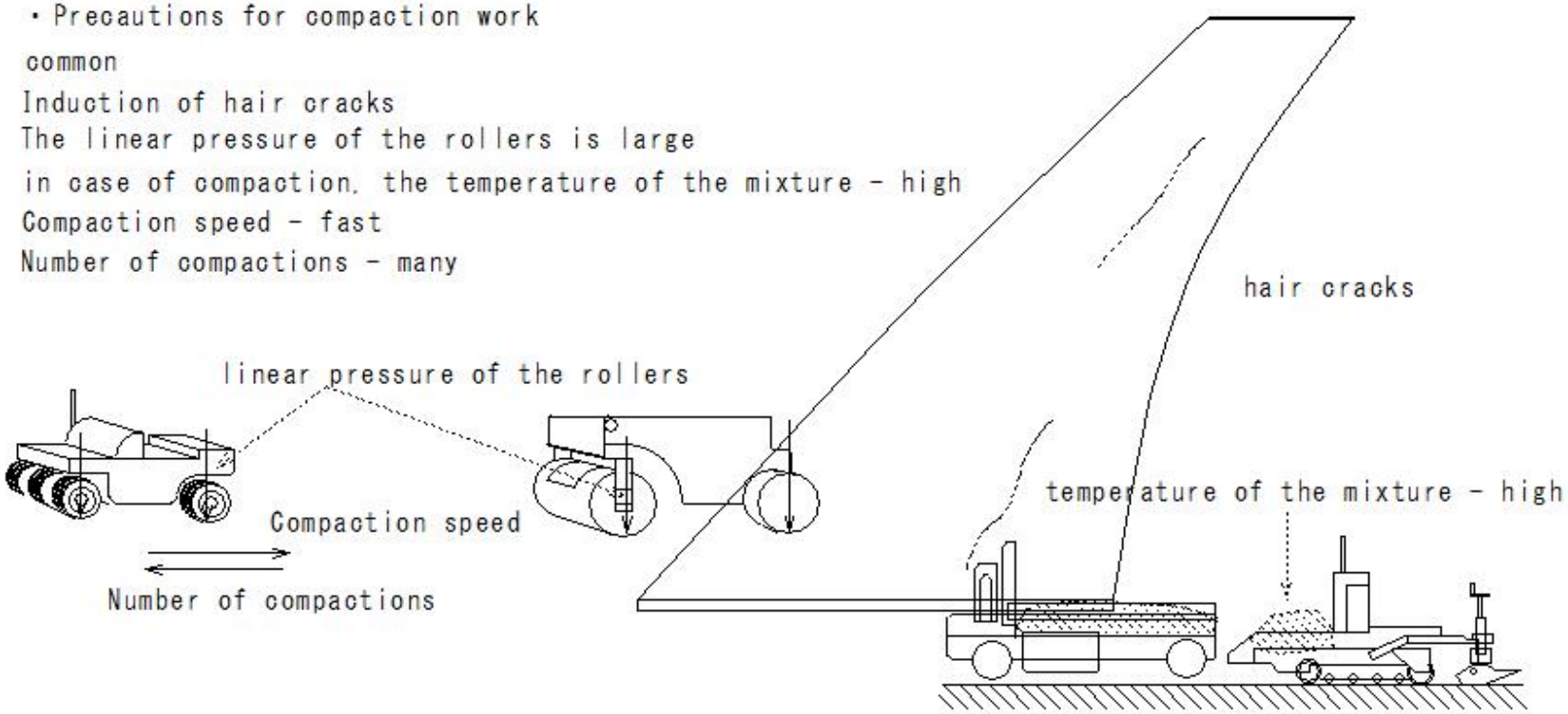
Induction of hair cracks

The linear pressure of the rollers is large

in case of compaction, the temperature of the mixture - high

Compaction speed - fast

Number of compactions - many



(H65)Road pavement(Paving methods-common compaction)

(H65)Road pavement(Paving methods-common compaction)

Asphalt pavement

Paving construction method

Construction of Base course and Wearing course(surface layers)

・Precautions for compaction work

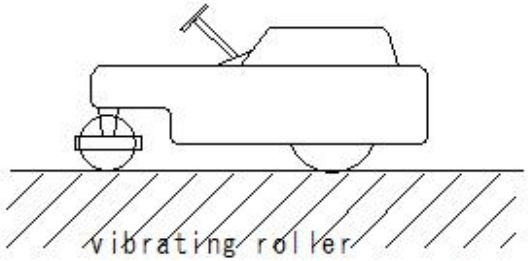
common

Vibrating rollers - compaction

Compaction speed - fast - small wave generation

Slow - overturning

Vibrating rollers - suitable vibration frequency 0.03 m/time or less



Compaction speed - fast - small wave

Slow - overturning

vibration frequency 0.03 m/time or less

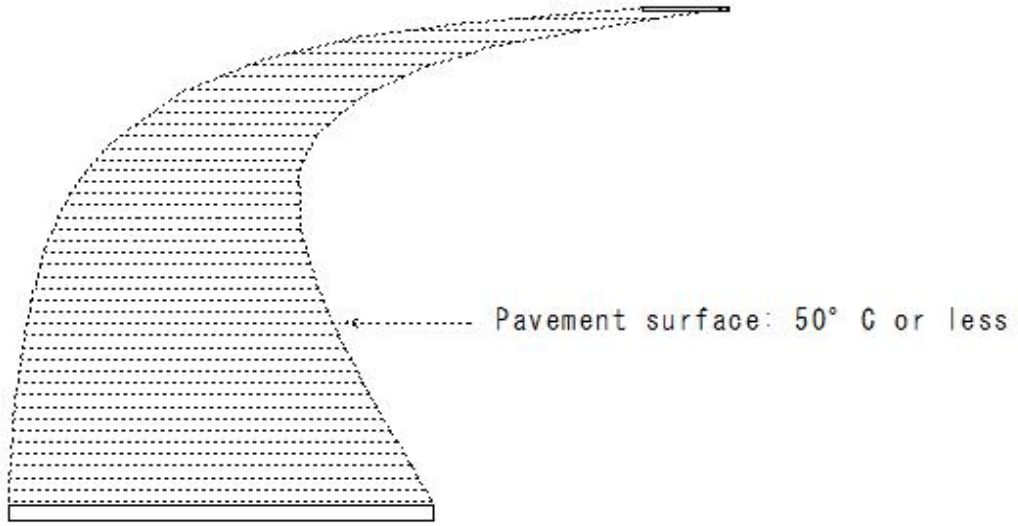
(H66)Road pavement(Paving methods-Open to traffic)

(H66)Road pavement(Paving methods-Open to traffic)

Asphalt pavement

Paving construction method

Construction of Base course and Wearing course(surface layers)



Open to traffic

(H67)Road pavement(Paving methods-Construction of seams)

(H67)Road pavement(Paving methods-Construction of seams)

Asphalt pavement

Paving construction method

Construction of Base course and Wearing course(surface layers)

・Construction of seams

Horizontal seam Vertical seam

Transverse seams: the transverse direction of the road

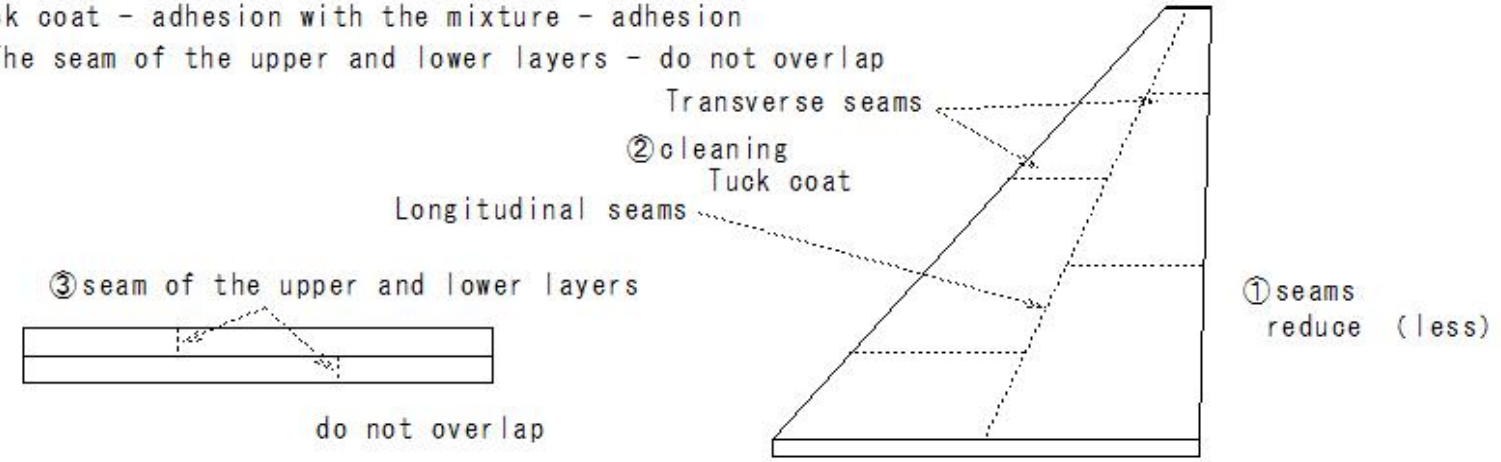
Longitudinal seams: Divided into several lanes, parallel to the road centerline

①Construction seams: compaction - insufficient Discontinuous - planned to be less

②Construction of seams - seams structures boundaries - after cleaning

Tack coat - adhesion with the mixture - adhesion

③The seam of the upper and lower layers - do not overlap



(H68)Road pavement(Paving methods-Construction of seams)

(H68)Road pavement(Paving methods-Construction of seams)

Asphalt pavement

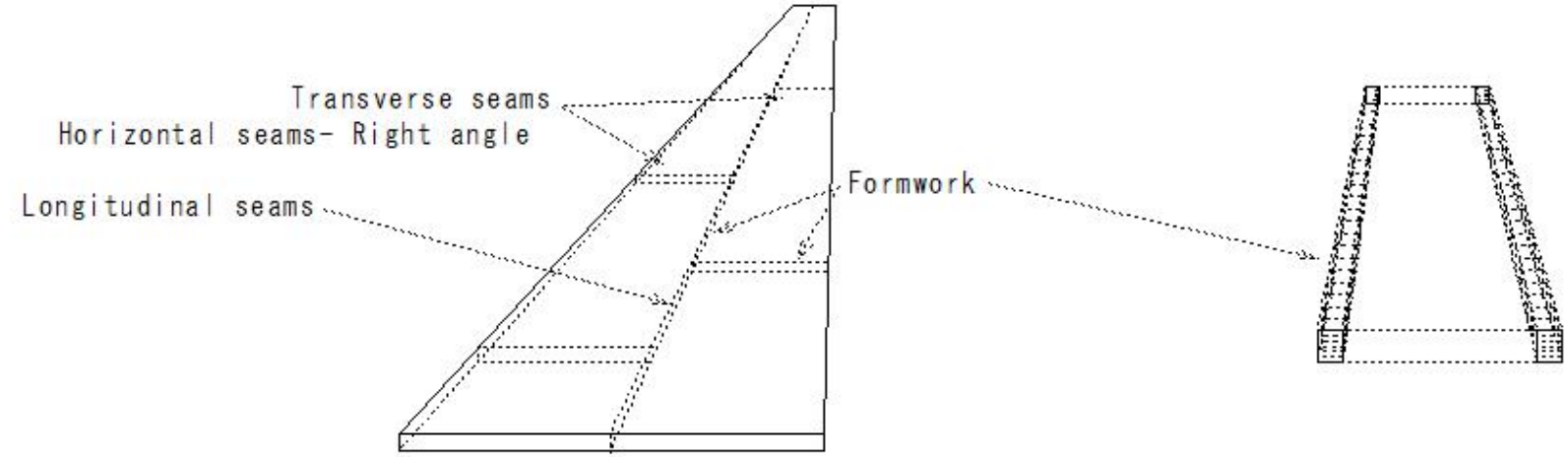
Paving construction method

Construction of Base course and Wearing course(surface layers)

・Construction of seams

・Horizontal seams: Direction of travel - Right angle - Flat

Formwork use - predetermined height - finishing



(H69)Road pavement(Paving methods-Construction of seams)

(H69)Road pavement(Paving methods-Construction of seams)

Asphalt pavement

Paving construction method

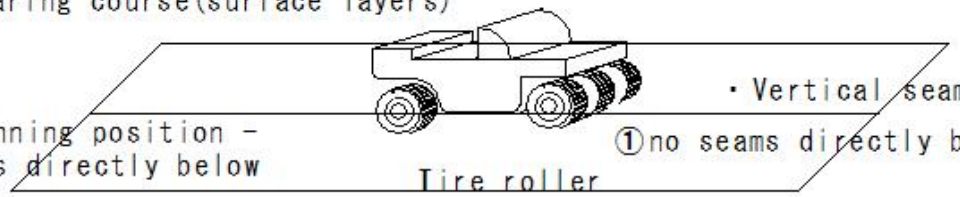
Construction of base and surface layers

Construction of Base course and Wearing course(surface layers)

・Vertical seams

Plan according to lane marks

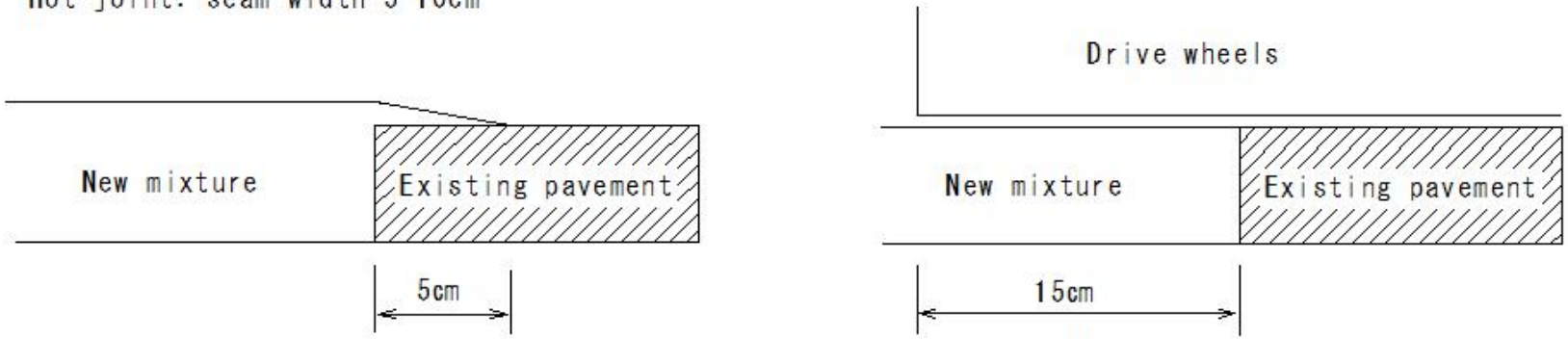
①Upper and lower wheels in the running position - no seams directly below



②Hammered seams

Existing pavement about 5 cm New mixture is layered - Leveled - Roller drive wheels are compacted by applying about 15 cm

Hot joint: seam width 5-10cm



Longitudinal seam construction

(H70)Road pavement(Inspection & Control-Tests on asphalt pavement)

(H70)Road pavement(Inspection & Control-Tests on asphalt pavement)

Asphalt pavement

Paving methods

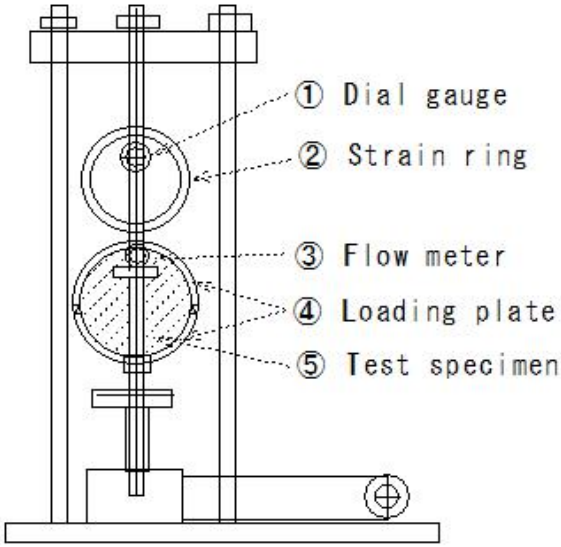
Inspection & Control

Testing

Tests on asphalt pavement

①Marshall stability test: Measures resistance to plastic flow

Asphalt mixture mix design



Marshall testing machine

(H71)Road pavement(Inspection & Control-Tests on asphalt pavement)

(H71)Road pavement(Inspection & Control-Tests on asphalt pavement)

Asphalt pavement

Paving methods
Inspection & Control
Testing
Tests on asphalt pavement
②Labeling test: Asphalt mortar - measuring wear resistance
Evaluation of abrasion resistance

(H72)Road pavement(Inspection & Control-Tests on asphalt pavement)

(H72)Road pavement(Inspection & Control-Tests on asphalt pavement)

Asphalt pavement

Paving methods

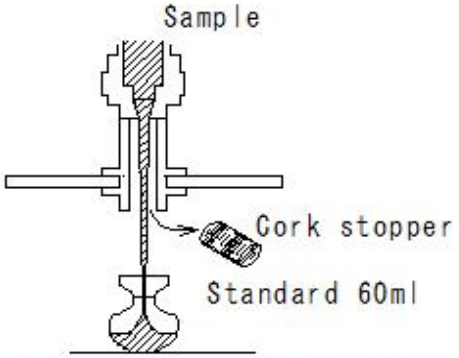
Inspection & Control

Testing

Tests on asphalt pavement

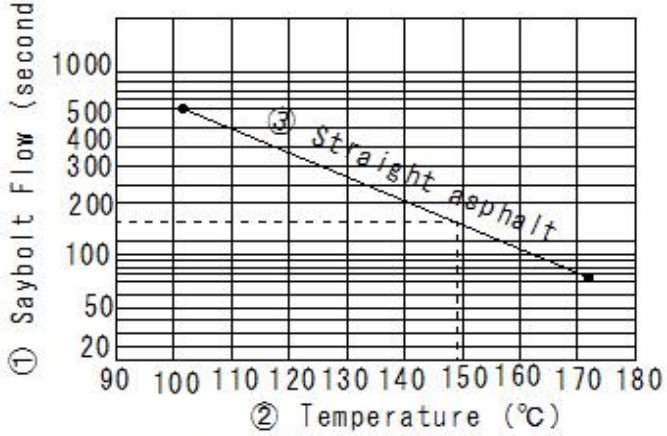
③Saybolt-Flow second test: A method for measuring the relationship between asphalt temperature and viscosity

Checking viscosity at high temperatures



Saybolt Flow test (seconds):

④ Asphalt temperature-viscosity diagram



Saybolt Flow test (seconds):
Viscosity of asphalt at high temperatures

H398

(H73)Road pavement(Inspection & Control-Tests on asphalt pavement)

(H73)Road pavement(Inspection & Control-Tests on asphalt pavement)

Asphalt pavement

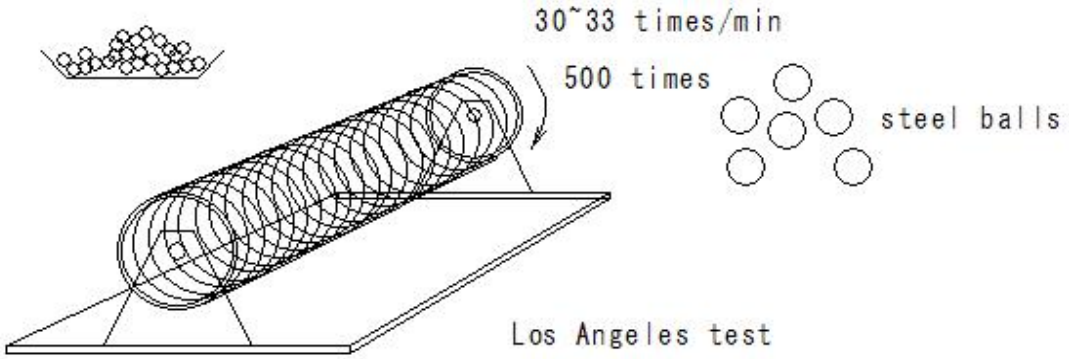
- Paving methods
- Inspection & Control
- Testing
- Tests on asphalt pavement
  - ④Wheel tracking test: Evaluate the resistance of asphalt mixture to compaction and flow

(H74)Road pavement(Inspection & Control-Tests on asphalt pavement)

(H74)Road pavement(Inspection & Control-Tests on asphalt pavement)

Asphalt pavement

- Paving methods
- Inspection & Control
- Testing
- Tests on asphalt pavement
  - ⑤Los Angeles test: Check the wear and loss of coarse aggregate to evaluate its suitability as aggregate



H419

(H75)Road pavement(Inspection & Control-Tests on asphalt pavement)

(H75)Road pavement(Inspection & Control-Tests on asphalt pavement)

Asphalt pavement

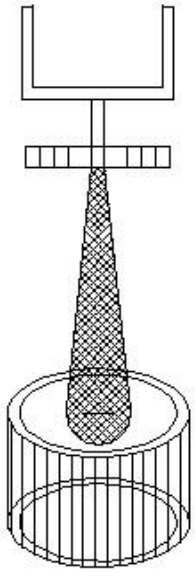
Paving methods

Inspection & Control

Testing

Tests on asphalt pavement

⑥ Toughness and tenacity test: A test that indicates the grip and adhesion of viscoelastic materials such as rubberized asphalt



Toughness and tenacity test

(H76)Road pavement(Inspection & Control-Tests on asphalt pavement)

(H76)Road pavement(Inspection & Control-Tests on asphalt pavement)

Asphalt pavement

Paving methods

Inspection & Control

Testing

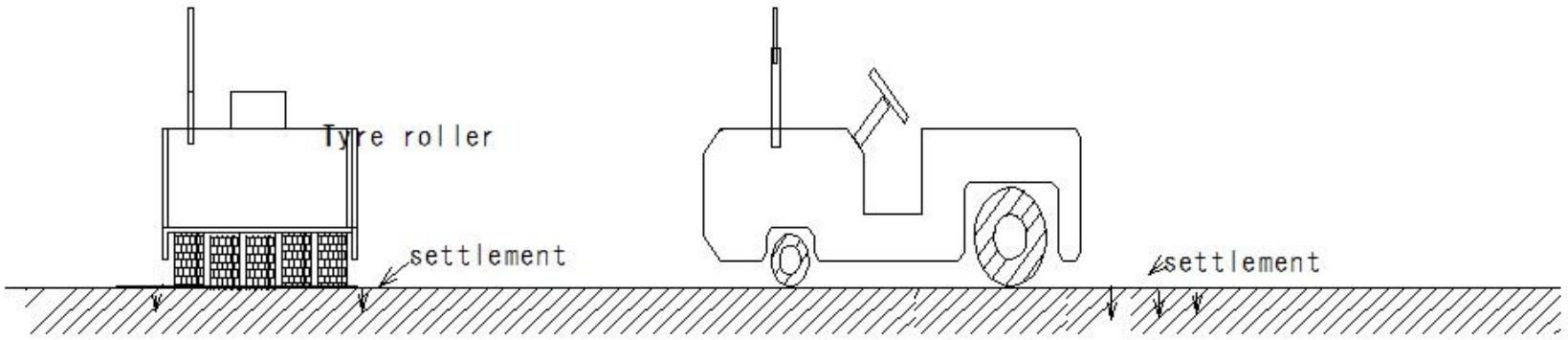
Tests on asphalt pavement

⑦Proof rolling test: Evaluation of compaction of Subgrade(roadbed) and Base course(roadbed)

Investigation of the presence or absence of defects

・Proof rolling regulations

・Supporting capacity -determined by the amount of settlement of Proof rolling



E166

(H77)Road pavement(Inspection & Control-Tests on asphalt pavement)

(H77)Road pavement(Inspection & Control-Tests on asphalt pavement)

Asphalt pavement

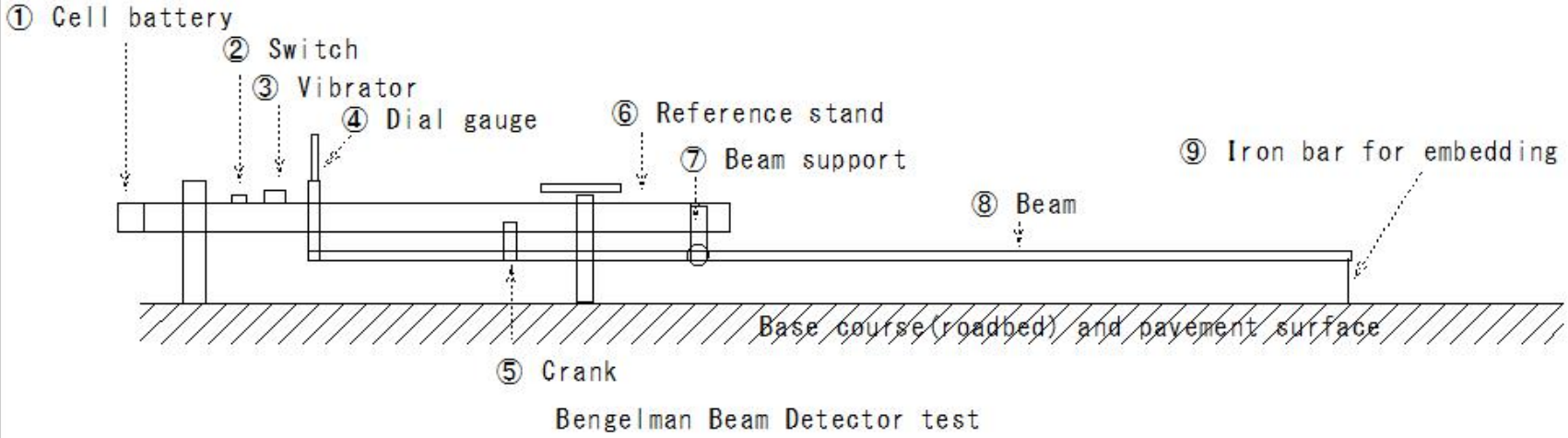
Paving methods

Inspection & Control

Testing

Tests on asphalt pavement

⑧Bengelman Beam Detector test: Measures the amount of deflection of the Base course(roadbed) and pavement surface, used for structural design of simple pavements and overlay thickness design



Bengelman Beam Detector test

(H78)Road pavement(Inspection & Control-As-built)

(H78)Road pavement(Inspection & Control-Tests on asphalt pavement)

Asphalt pavement

Paving methods

Inspection & Control

Testing

Tests on asphalt pavement

①As-built

As-built inspection items

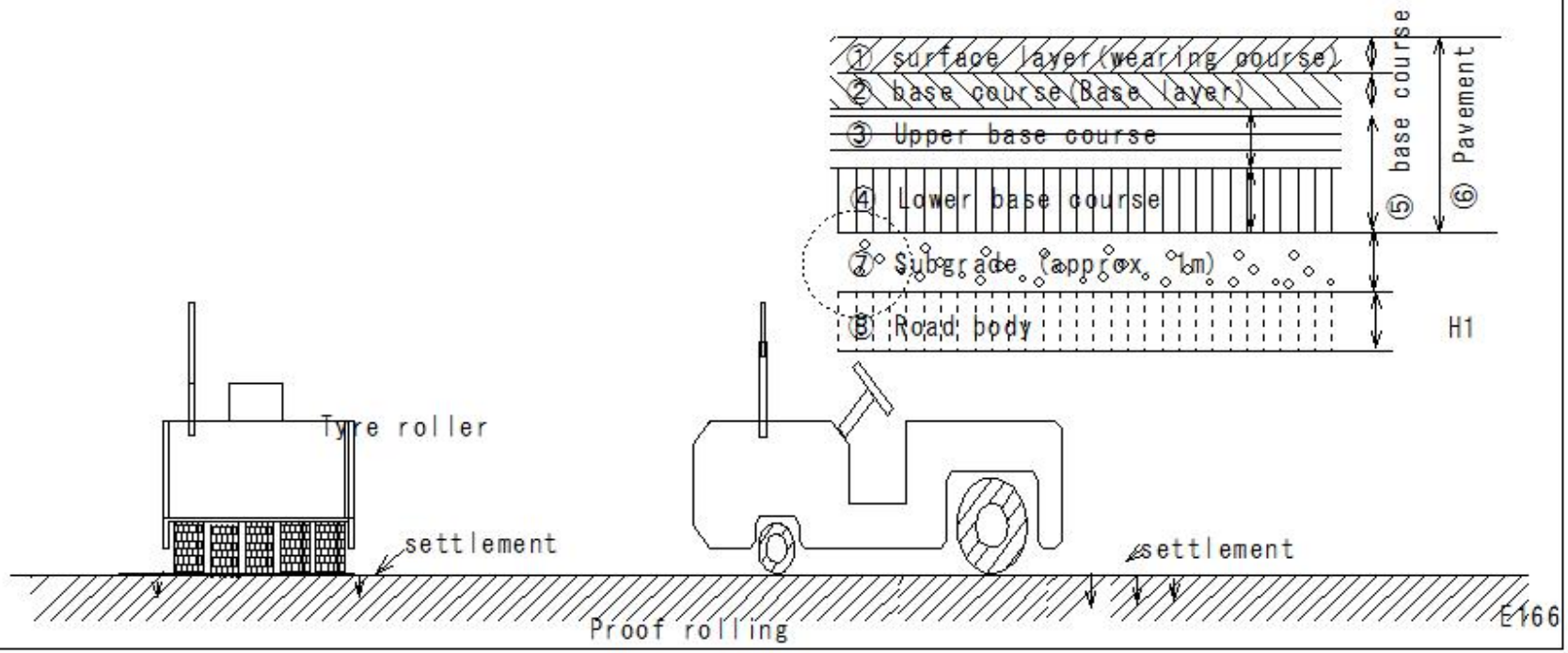
	As-built inspection items			
Inspection items / Type of work	Width	Thickness	Reference height	Flatness
Wearing course (Surface)	○	○		○
Base course	○	○		
Upper base course(roadbed)	○	○		
Lower Base course(roadbed)	○	○	○	

(H79)Road pavement(Quality control items- Subgrade)

(H79)Road pavement(Quality control items- Subgrade)

Asphalt pavement
Paving method
Quality
Subgrade

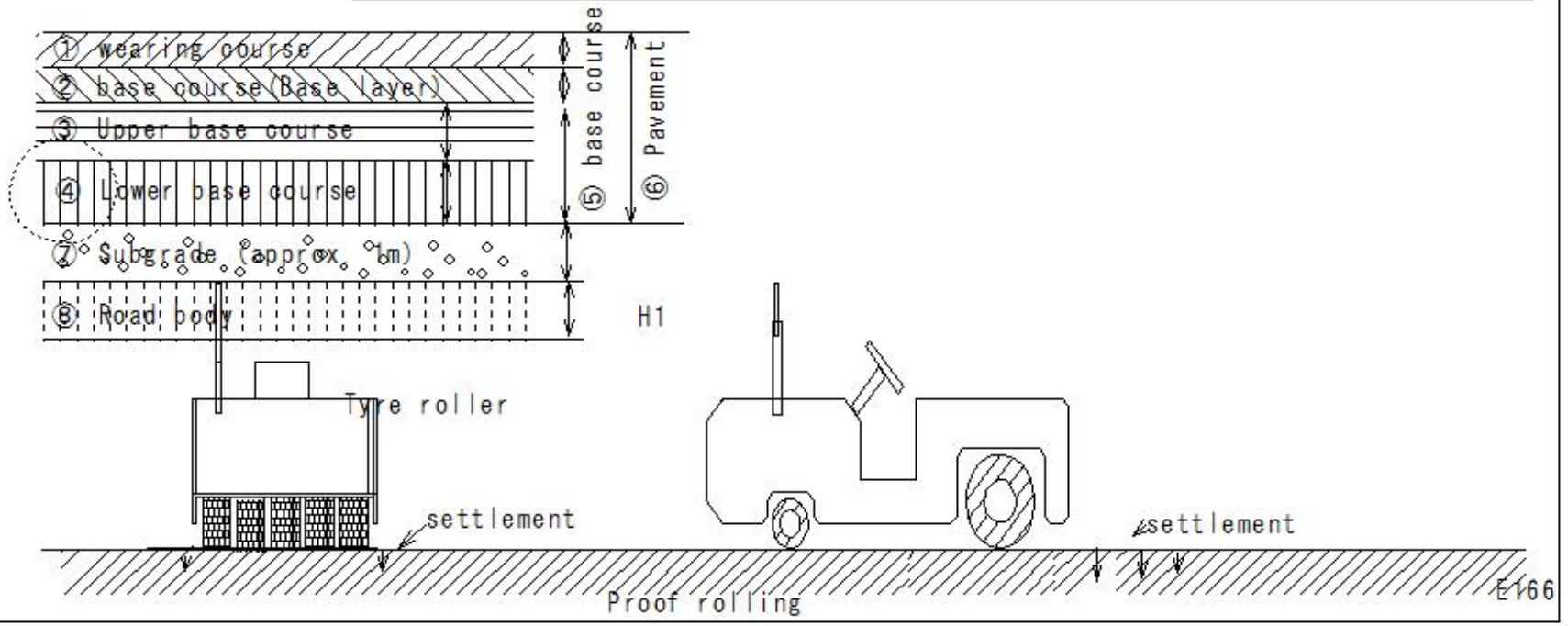
Type of work	Quality control items
Subgrade	Managed by degree of compaction Leveling - Visual inspection After compaction - Proof rolling



(H80)Road pavement(Quality control items- Lower Base course(roadbed))

Asphalt pavement
Paving method
Quality

Type of work	Quality control items
Lower Base course(roadbed)	・Degree of compaction-1 time/1000m2 ・Management by the number of compactions ・Grasp of abnormal areas by proof flooring ・Particle size, water content ratio, PI- visual inspection



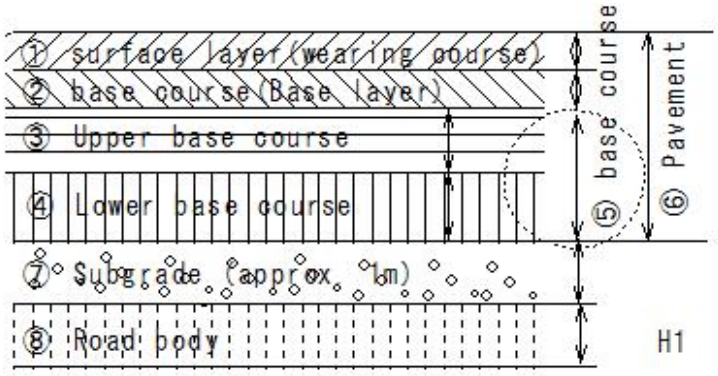
(H81)Road pavement(Quality control -Grain size adjustment Base course(roadbed))

(H81)Road pavement(Quality control -Grain size adjustment Base course(roadbed))

Asphalt pavement
Paving method
Quality
Quality control items

Type of work	Quality control items
・Grain size adjustment Base course(roadbed)	Compactness, grain size, moisture content control - same as lower roadbed Grain size test - sieving test

in case of the roadbed material is not suitable, the roadbed has been improved by adding other materials (crushed stone, gravel, slag, sand, silty clay, gravel mixed with



(H82)Road pavement(Quality control -Cement and lime stabilization Base course(roadbed))

(H82)Road pavement(Quality control -Cement and lime stabilization Base course(roadbed))

Asphalt pavement

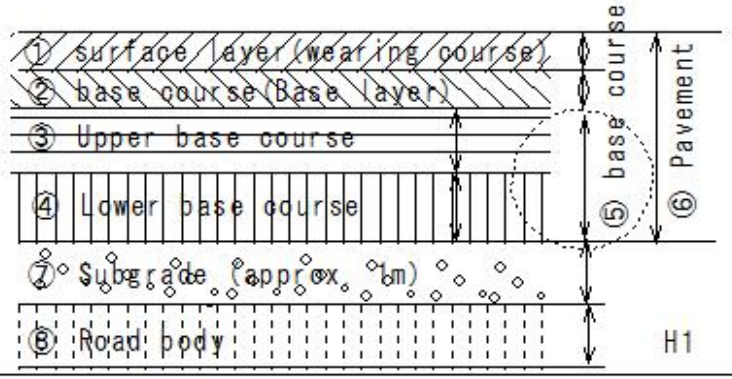
Paving method

Quality

Quality control items

Type of work	Quality control items
Cement and lime stabilization Base course(roadbed)	・Control of compaction degree, particle size, and moisture content - in accordance with the particle size adjustment roadbed ・Amount of additives - Amount of blending corresponding to the target strength - Quantitative testing and use - Management

The stabilization method is to mix cement-based or lime-based improvement materials in powder or slurry form with "low-quality generated soil" and chemically improve



Lime stabilization method

Lime/quicklime

tire rollers and vibrating rollers

H18
H13
E109

(H83)Road pavement(Quality control -Bituminous stabilization treatment Base course(roadbed), surface sublayer)

(H83)Road pavement(Quality control -Bituminous stabilization treatment (roadbed), surface sublayer)

Asphalt pavement

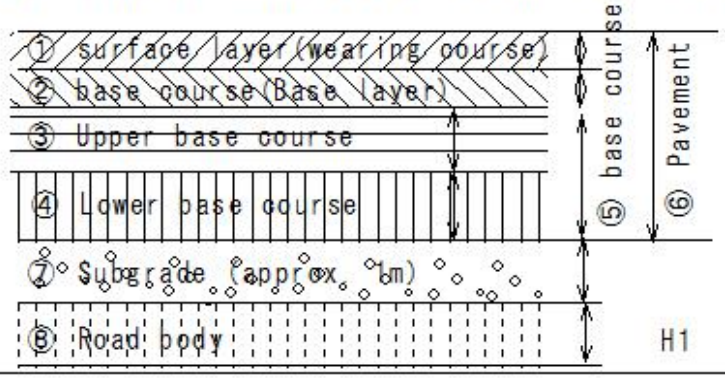
Paving method

Quality

Quality control items

Type of work	Quality control items
Bituminous stabilization treatment Base course(roadbed), surface sublayer	Particle size and asphalt amount - Printing record Other cases - extraction and sieving tests Degree of compaction - density of the core - measurement Reference Density - Collation

A method in which aggregate made from a mixture of single-grained crushed stone and sand in an appropriate ratio, or crushed run or locally produced materials with supplementary materials added, is used as aggregate, and then asphalt is added to the aggregate.



(H84)Road pavement(Asphalt pavement-Special pavement)

(H84)Road pavement(Asphalt pavement-Special pavement)

Asphalt pavement

Special pavement

Classification	Method/name
Special structure	①Semi-flexible pavement ②Goose asphalt pavement ③Rolled asphalt pavement ④Drainage pavement ⑤Light-colored pavement ⑥Colored pavement ⑦Slip-resistant pavement ⑧Farmed asphalt pavement
Mixing techniques	⑨Full-depth asphalt pavement ⑩Sandwich pavement ⑪Composite pavement

(H85)Road pavement(Asphalt pavement-Semi-flexible pavement)

(H85)Road pavement(Asphalt pavement-Semi-flexible pavement)

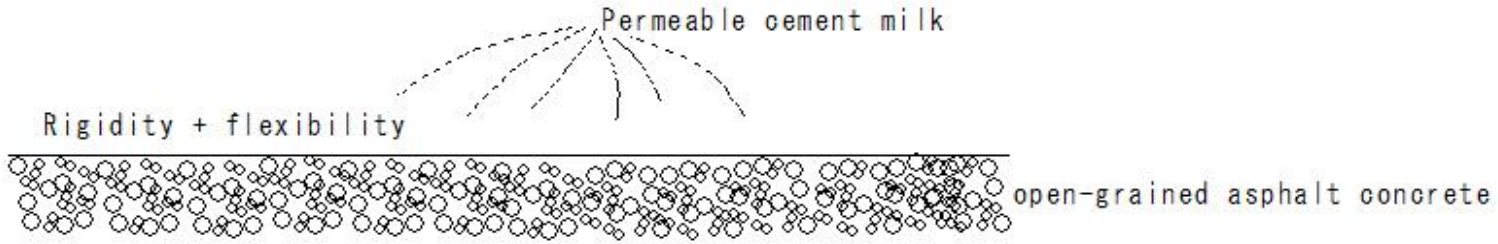
Asphalt pavement

Special pavement

Special pavement	
Method/name ①Semi-flexible pavement	Permeable cement milk - permeates into the surface gaps of open-grained asphalt concrete Rigidity + flexibility Flow resistance, oil resistance, low viscosity, bright color - excellent

It is often used in factories where heavy vehicles frequently pass through

in case of construction time or location restrictions make it difficult to use concrete paving.



①Semi-flexible pavement

(H86)Road pavement(Asphalt pavement-Goose asphalt pavement)

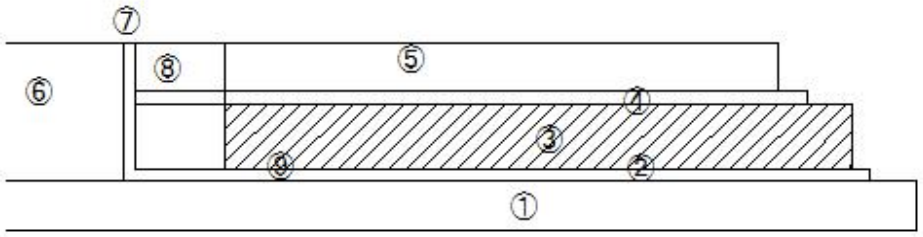
(H86)Road pavement(Asphalt pavement-Goose asphalt pavement)

Asphalt pavement
Special pavement

Special pavement

Construction method	
②Goose asphalt pavement	At high temperatures, mixture-flowability-leveling Impermeable - Waterproof - Deflection - Excellent

This pavement uses a goose-asphalt mixture that has high water tightness and excellent deflection-following properties, and has a proven track record primarily in bridge surface pavements such as such as steel deck pavements.



②Goose asphalt pavement

① Steel deck
② Adhesive
③ Base layer (gusset asphalt)
④ Tack coat
⑤ Surface layer (modified asphalt concrete)
⑥ Structure
⑦ Adhesive
⑧ Formed joint or poured joint
⑨ Formed joint

(H87)Road pavement(Asphalt pavement-Rolled asphalt pavement)

(H87)Road pavement(Asphalt pavement-Rolled asphalt pavement)

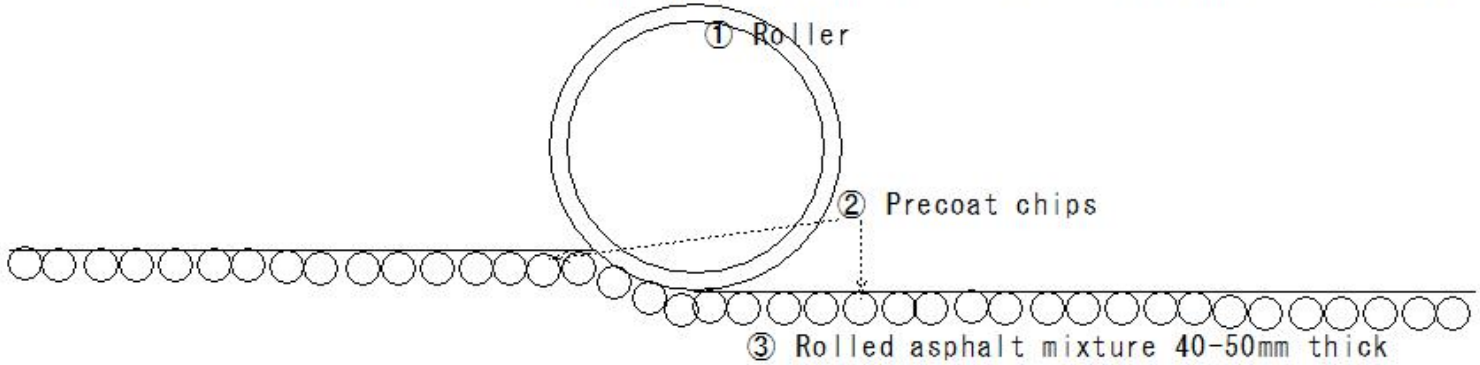
Asphalt pavement

Special pavement

Special pavement

Construction method	
③Rolled asphalt pavement	Asphalt Stone powder Sand - Sand asphalt mortar - Single-grain crushed stone - Fixed amount mixed Discontinuous grain pavement Slip resistance - Watertightness - Abrasion resistance - Durability - Excellent

This is a method in which single-grain crushed stone (pre-coated chips) coated with asphalt coated in advance is evenly scattered on an asphalt mixture with a gap



③Rolled asphalt pavement

(H88)Road pavement(Asphalt pavement-Drainage pavement)

(H88)Road pavement(Asphalt pavement-Drainage pavement)

Asphalt pavement

Special pavement

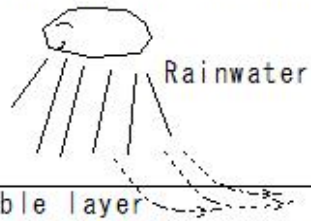
Special pavement

Construction method	
④Drainage pavement	Water on road surface - roadbed side - seepage and drainage Asphalt for drainage pavement - used for surface and base layers Below roadbed - water seepage - none

It is a pavement that quickly discharges rainwater from the road surface through a porous asphalt mixture layer to drainage structures on the shoulder of the road

(1) Surface layer
(2) Substratum
(3) Base course(roadbed)
(4) Subgrade (Roadbed)

Normal pavement



(1) Permeable layer
(2) Impermeable layer (base layer)
(3) Base course(roadbed)
(4) Subgrade (Roadbed)

Drainage pavement

(H89)Road pavement(Asphalt pavement- Light pavement)

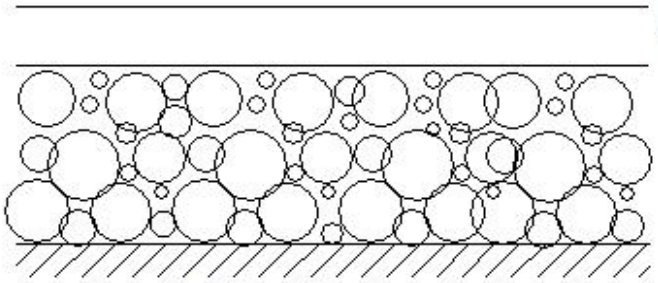
(H89)Road pavement(Asphalt pavement- Light pavement)

Asphalt pavement

Special pavement

Special pavement

Construction method	
⑤ Light pavement	Surface layer - light-colored aggregate - Ensuring brightness of the road surface



⑤ Light pavement

(H90)Road pavement(Asphalt pavement- Colored pavement)

(H90)Road pavement(Asphalt pavement- Colored pavement)

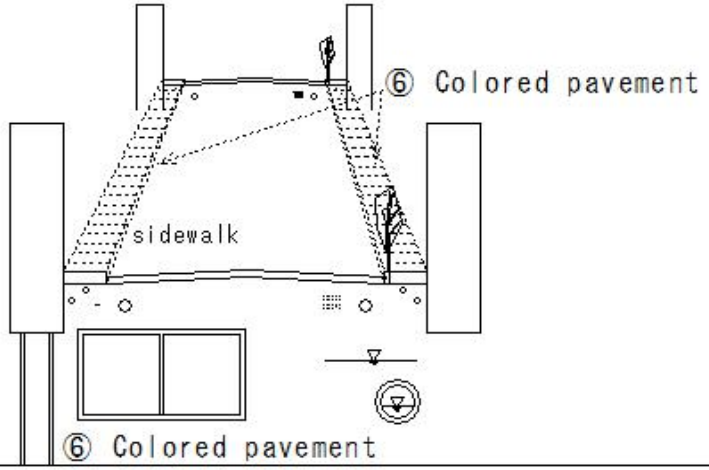
Asphalt pavement

Special pavement

Special pavement

Construction method	
⑥ Colored pavement	Heated asphalt mixture + mixed pigment Colored aggregate contamination

It is an asphalt pavement using a colored asphalt mixture with pigments and colored paving materials



(H91)Road pavement(Asphalt pavement-Anti-slip pavement)

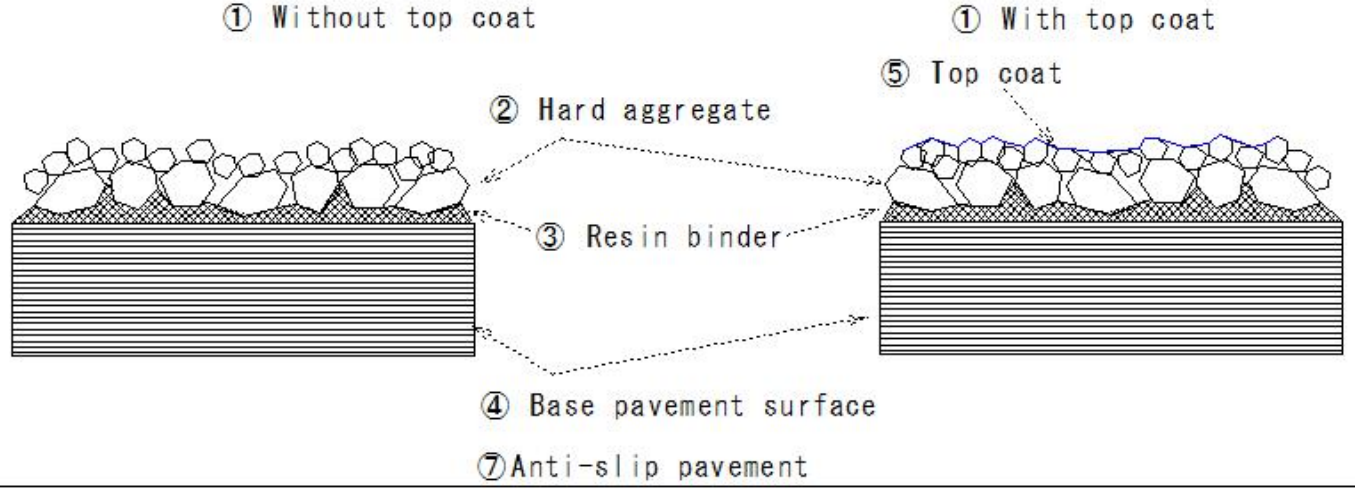
(H91)Road pavement(Asphalt pavement-Anti-slip pavement)

Asphalt pavement

Special pavement

Special pavement

Construction method	
⑦Anti-slip pavement	Slip resistance - enhanced pavement



(H92)Road pavement(Asphalt pavement-Foamed Asphalt Pavement)

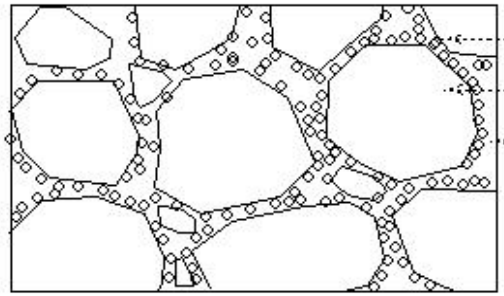
(H92)Road pavement(Asphalt pavement-Foamed Asphalt Pavement)

Asphalt pavement

Special pavement

Special pavement

Construction method	
⑧Foamed Asphalt Pavement	Heated asphalt mixture - foamy - in mixer - injection Cold Weather - Abrasion Resistant Pavement - Finishability - Excellent



① Microbubbles

② Aggregate

③ Asphalt

④ There are many microbubbles in the asphalt
Easy to compact in case of the temperature drops

⑧Foamed Asphalt Pavement

(H93)Road pavement(Asphalt pavement-Full-depth asphalt pavement)

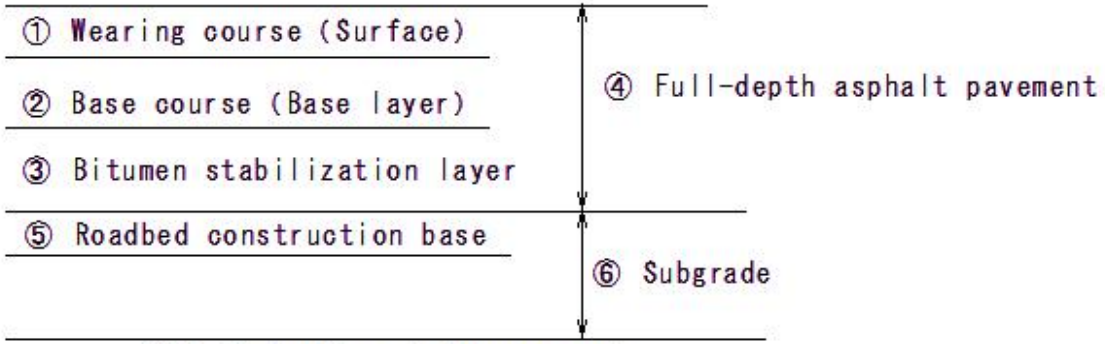
(H93)Road pavement(Asphalt pavement-Full-depth asphalt pavement)

Asphalt pavement
Special pavement

Special pavement

Construction method	
⑨Full-depth asphalt pavement	Full layer above the subbed - heated asphalt mixture - Bituminous stabilization treatment subbed material Pavement thickness - can be thinned Shortened construction period - possible

Full-depth asphalt pavement is a pavement that uses heated asphalt mixture and bitumen stabilized roadbed material for all layers above the constructed



(H94)Road pavement(Asphalt pavement-Sandwich pavement)

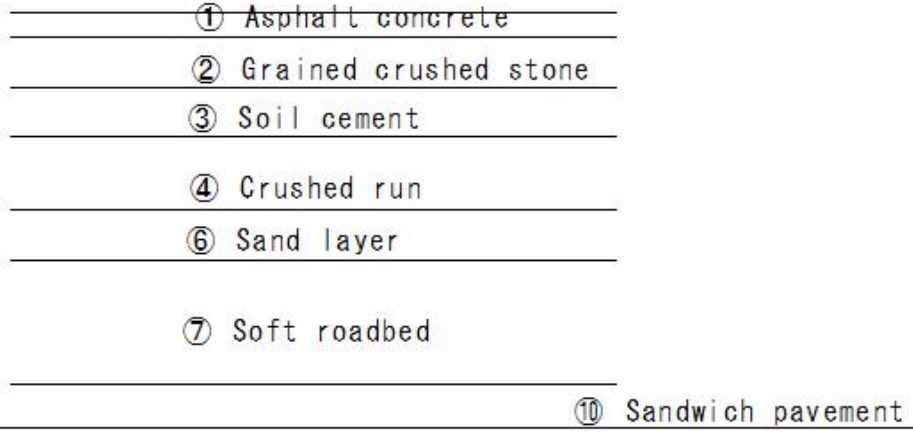
(H94)Road pavement(Asphalt pavement-Sandwich pavement)

Asphalt pavement
Special pavement

Special pavement

Construction method	
⑩ Sandwich pavement	Weak roadbed with barrier layer, granular roadbed layer, lean concrete, cement stabilization layer Pavement on top

The sandwich method involves laying an insulating layer, a layer of granular roadbed material, and a layer of cement-stabilized or lean-mix concrete on top of a soft



⑩ Sandwich pavement

(H95)Road pavement(Asphalt pavement-Composite pavement)

(H95)Road pavement(Asphalt pavement-Composite pavement)

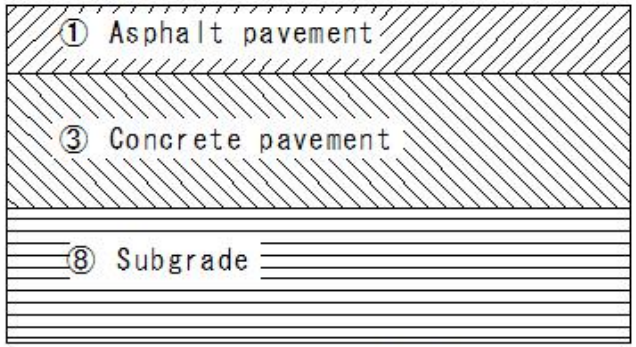
Asphalt pavement

Special pavement

Special pavement

Construction method	
⑪ Composite pavement	On top of cement slab, Made of asphalt mixture Surface layer Base layer On top of cement slab Cement concrete Continuously reinforced concrete Roller compacted concrete Semi-flexible pavement Durability, runnability, ease of maintenance and repair

A pavement that combines the structural durability of concrete pavement with the good driving characteristics and ease of maintenance and repair of asphalt pavement.



② Surface layer/base layer

④ Concrete pavement
⑤ Continuously reinforced concrete
⑥ Roller compacted concrete
⑦ Semi-flexible pavement

⑪ Composite pavement

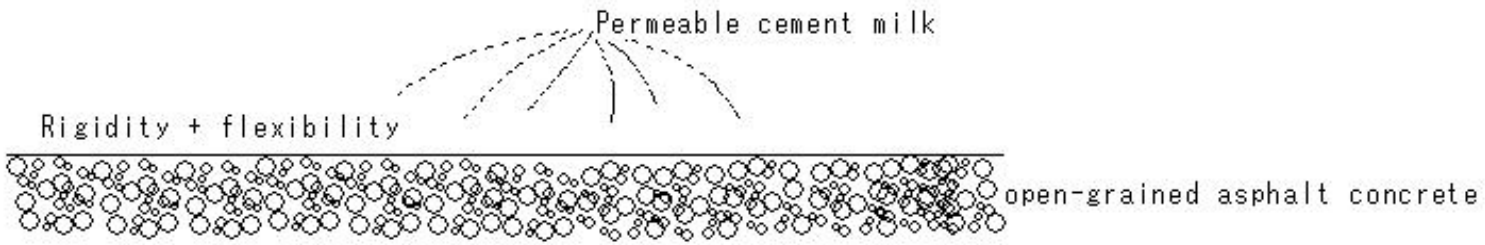
(H96)Road pavement(Special pavement applications-Semi-flexible pavement)

(H96)Road pavement(Special pavement applications-Semi-flexible pavement)

Asphalt pavement

Special pavement applications

Special pavement applications	
Method/name	Intersection
①Semi-flexible pavement	Bus terminal
	Toll booth
	Factory
	Gas station



①Semi-flexible pavement

H85

(H97)Road pavement(Special pavement applications-Guss asphalt pavement)

(H97)Road pavement(Special pavement applications-Guss asphalt pavement)

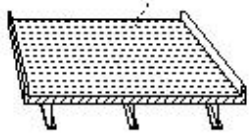
Asphalt pavement

Special pavement applications

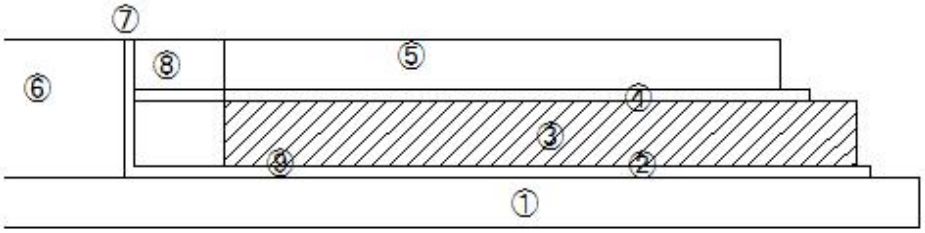
Special pavement applications

Construction method	
②Goose asphalt pavement	Steel deck pavement Bridge surface pavement

Goose asphalt pavement



B139



②Goose asphalt pavement

① Steel deck
② Adhesive
③ Base layer (gusset asphalt)
④ Tack coat
⑤ Surface layer (modified asphalt concrete)
⑥ Structure
⑦ Adhesive
⑧ Formed joint or poured joint
⑨ Formed joint

H86

(H98)Road pavement(Special pavement applications-Rolled asphalt pavement)

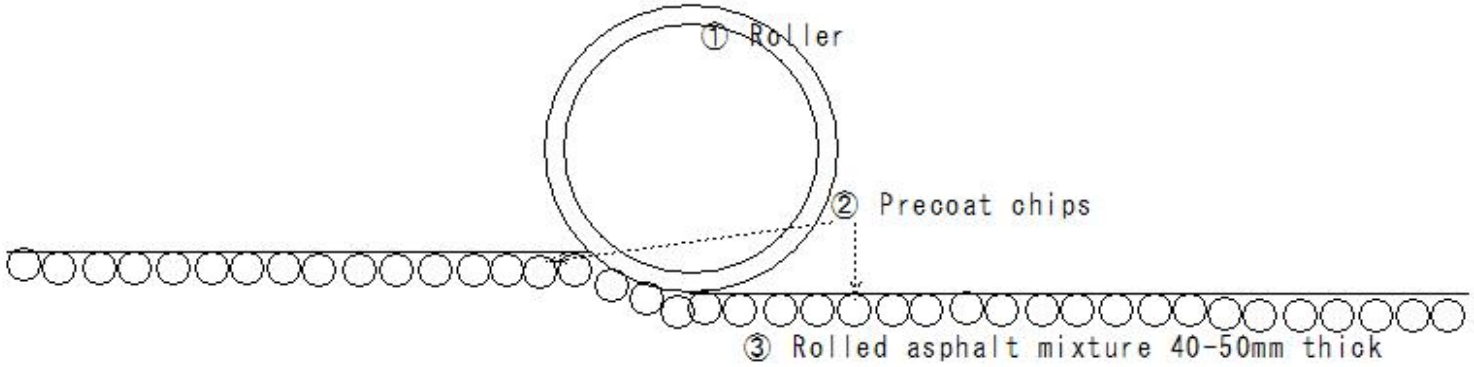
(H98)Road pavement(Special pavement applications-Rolled asphalt pavement)

Asphalt pavement

Special pavement applications

Special pavement applications

Construction method	
③Rolled asphalt pavement	Snowy and cold regions Mountain roads



③Rolled asphalt pavement

(H99)Road pavement(Special pavement applications-Drainage pavement)

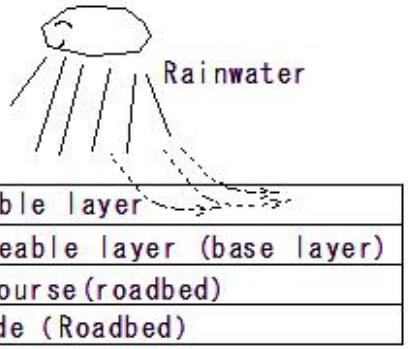
(H99)Road pavement(Special pavement applications-Drainage pavement)

Asphalt pavement

Special pavement applications

Special pavement applications

Construction method	
④Drainage pavement	Prevents water splashing Prevents hydroplaning Improves visibility at night and in rain Noise reduction



Drainage pavement

H88

(H100)Road pavement(Special pavement applications-Light-colored pavement)

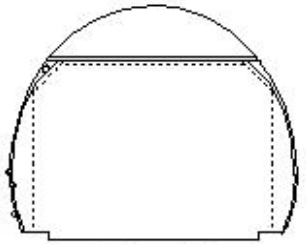
(H100)Road pavement(Special pavement applications-Light-colored pavement)

Asphalt pavement

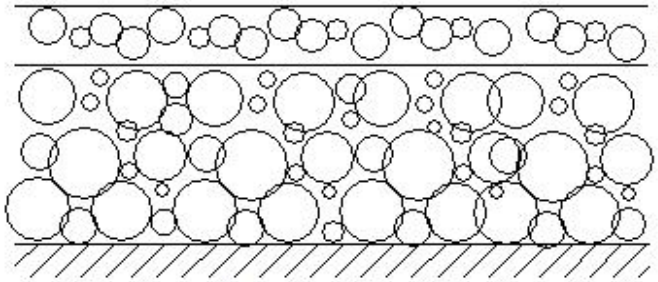
Special pavement applications

Special pavement applications

Construction method	
⑤Light-colored pavement	Pavement inside tunnels Around intersections Road shoulders Side strips, etc.



Pavement inside tunnels T 23



Asphalt concrete with colored aggregate 40mm

Crushed stone subbed 100~150mm

⑤Light-colored pavement

H89

(H101)Road pavement(Special pavement applications-Colored pavement)

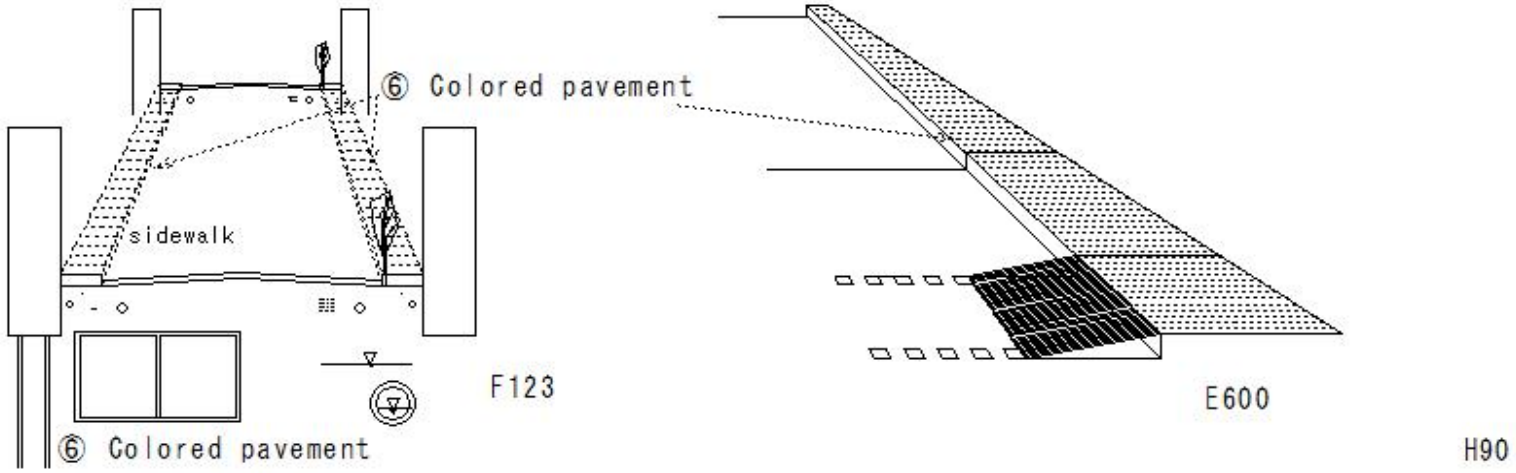
(H101)Road pavement(Special pavement applications-Colored pavement)

Asphalt pavement

Special pavement applications

Special pavement applications

Construction method	
⑥ Colored pavement	Streets - landscape-oriented School routes Intersections Bus lanes



(H102)Road pavement(Special pavement applications-Slip-resistant pavement)

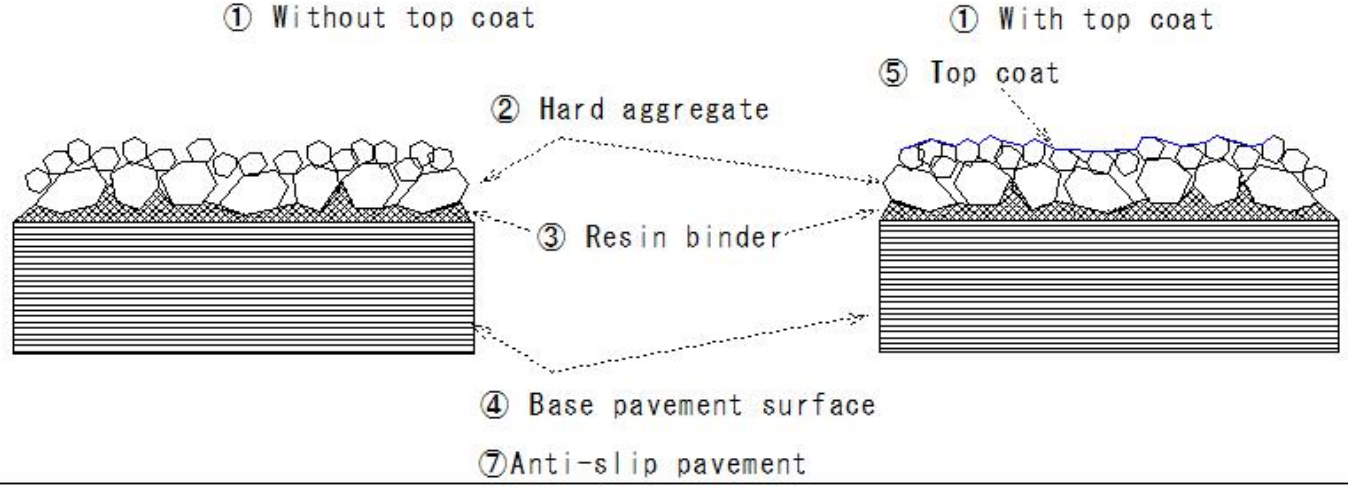
(H102)Road pavement(Special pavement applications-Slip-resistant pavement)

Asphalt pavement

Special pavement

Special pavement applications

Construction method	
⑦Anti-slip pavement	Steep slopes Curved sections Railway crossings, etc. - areas where slip resistance is required



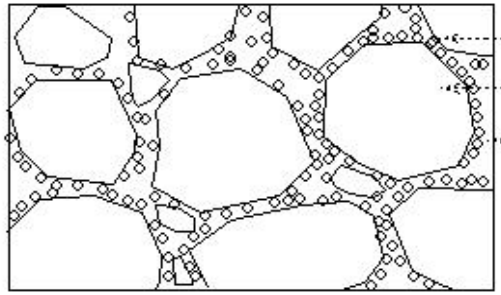
(H103)Road pavement(Special pavement applications-Foamed Asphalt Pavement)

(H103)Road pavement(Special pavement applications-Foamed Asphalt Pavement)

Asphalt pavement
Special pavement

Special pavement applications

Construction method	
⑧Foamed Asphalt Pavement	Snowy and cold regions - wear-resistant pavement, etc.



① Microbubbles
② Aggregate
③ Asphalt
④ There are many microbubbles in the asphalt
Easy to compact in case of the temperature drops

⑧Foamed Asphalt Pavement

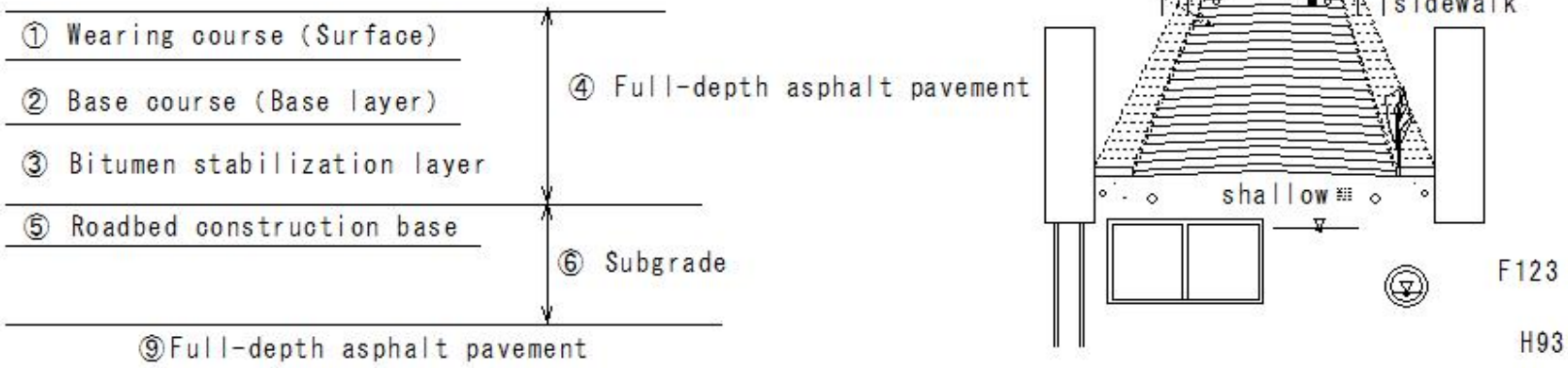
H92

(H104)Road pavement(Special pavement applications-Full depth asphalt pavement

Asphalt pavement
Special pavement

Special pavement applications

Construction method	
⑨Full-depth asphalt pavement	Height restrictions apply Underground buried objects - shallow Groundwater level - high



(H105)Road pavement(Special pavement applications-Sandwich pavement)

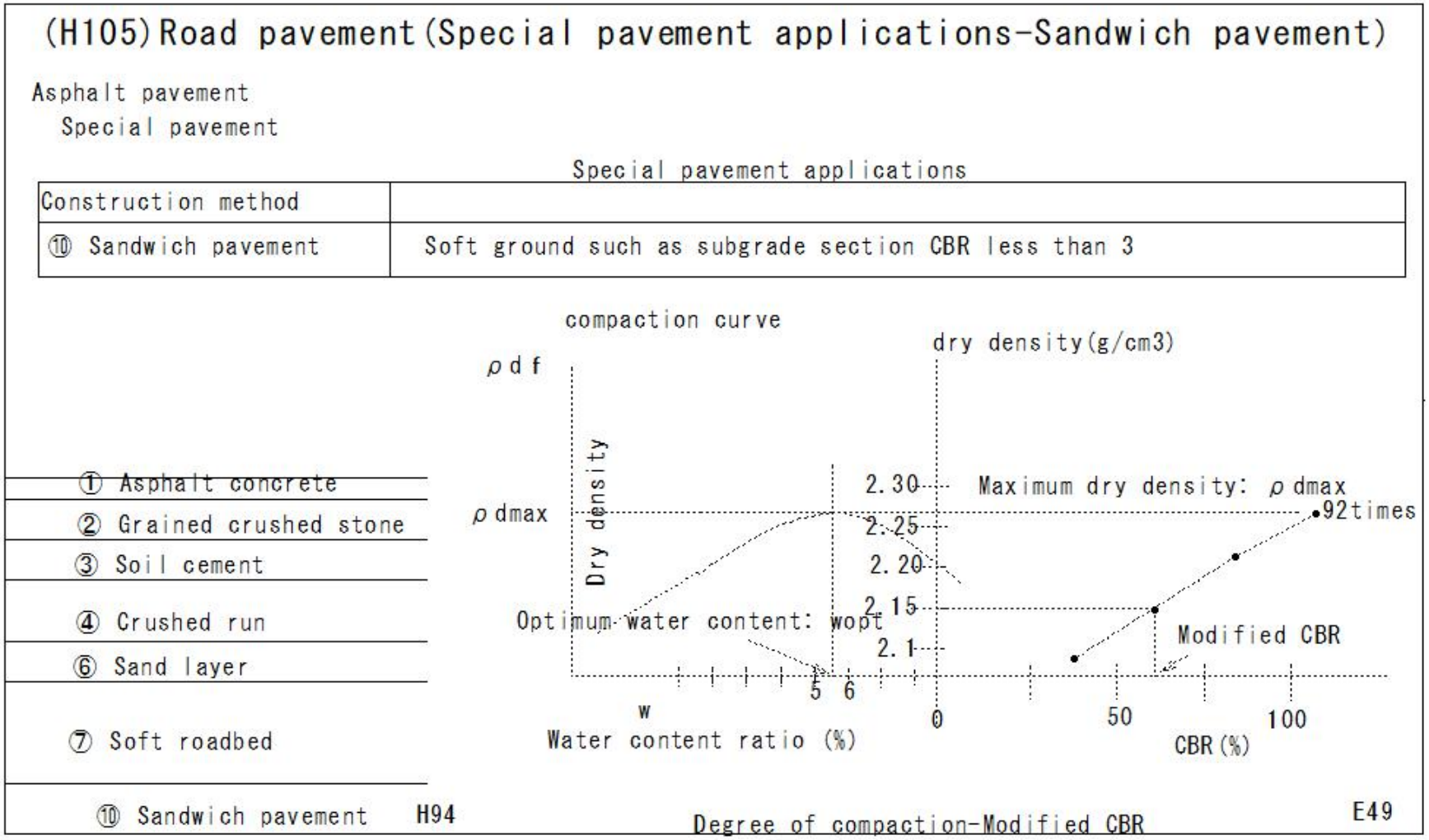
(H105)Road pavement(Special pavement applications-Sandwich pavement)

Asphalt pavement

Special pavement

Special pavement applications

Construction method	
⑩ Sandwich pavement	Soft ground such as subgrade section CBR less than 3



(H106)Asphalt pavement(Maintenance + repair-Replacement method）

(H106)Asphalt pavement(Maintenance + repair-Replacement method)

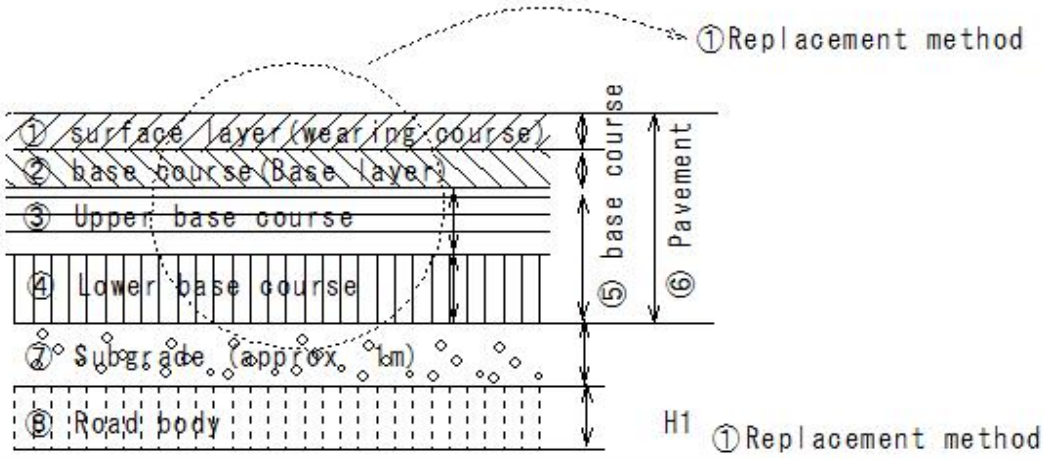
Asphalt pavement

Maintenance + repair

Maintenance: Maintaining and improving function: Filling, patching, thin overlay

Repair: Restoring function, overlay, cutting overlay, replacement, etc.

	Maintenance + repair
①Replacement method	Replacing of existing pavement May also include roadbed



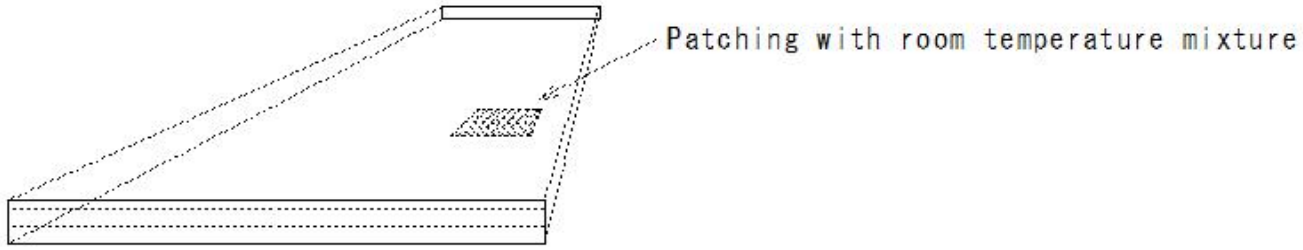
(H107)Asphalt pavement(Maintenance + repair-Local replacement method）

(H107)Asphalt pavement(Maintenance + repair-Local replacement method)

Asphalt pavement

Maintenance + repair

	Maintenance + repair
②Local replacement method	Localized - Damage Other methods - Parts that cannot be repaired



②Local replacement method

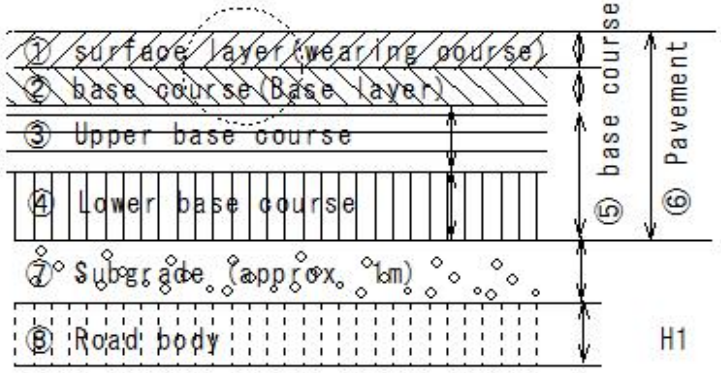
(H108)Asphalt pavement(Maintenance + repair-Linear replacement method）

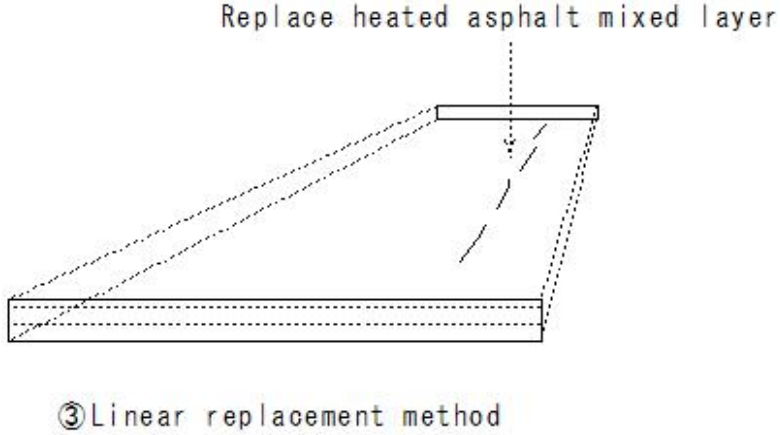
(H108)Asphalt pavement(Maintenance + repair-Linear replacement method)

Asphalt pavement

Maintenance + repair

	Maintenance + repair
③Linear replacement method	Applied to linearly damaged areas Bituminous stabilized layer Replace heated asphalt mixed layer





(H109)Asphalt pavement(Maintenance + repair-On-road regeneration roadbed method）

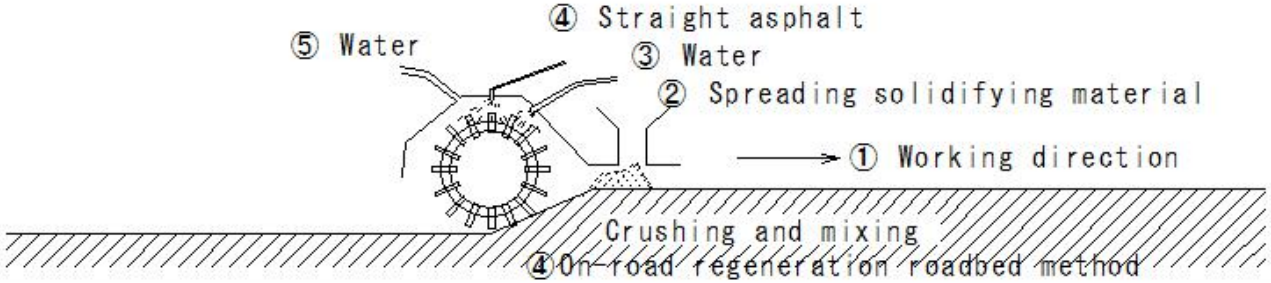
(H109)Asphalt pavement(Maintenance + repair-On-road regeneration roadbed method)

Asphalt pavement

Maintenance + repair

	Maintenance + repair
④On-road regeneration roadbed method	Existing asphalt mixed layer - crushed at current location Mixed with additives such as cement asphalt emulsion Compacted - stabilization treatment - roadbed Construction procedure Spraying additives → Crushing and mixing (emulsion, water spraying) → Shaping → Compaction → Curing On-road crushing and mixing machine Motor grader (shaping) → Tire roller → Road roller (compaction)

The on-road roadbed restoration method involves crushing the damaged surface layer of existing asphalt on the road and mixing it with the underlying granular roadbed to create a new roadbed.



(H110)Asphalt pavement(Maintenance + repair-Surface and base layer replacement method)

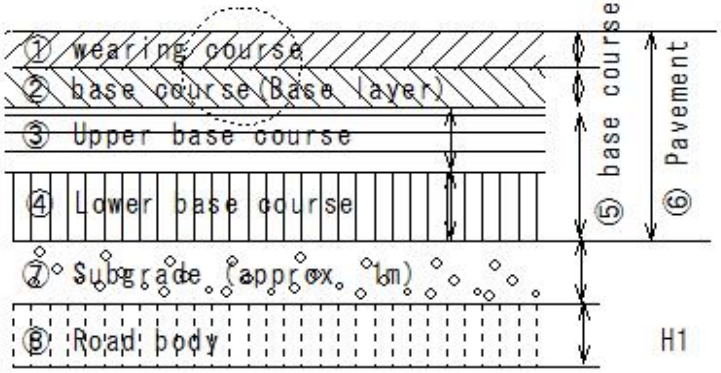
(H110)Asphalt pavement(Maintenance + repair-Surface and base layer replacement method)

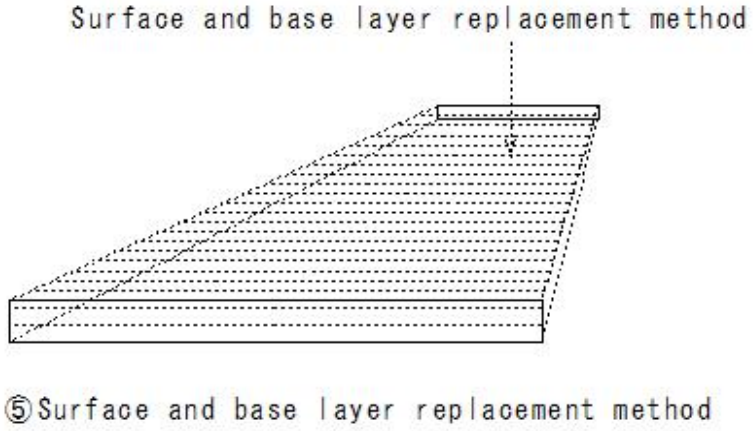
Asphalt pavement

Maintenance + repair

	Maintenance + repair
⑤Surface and base layer replacement method	Surface and base layers of existing pavement - replacement Cutting overlay: Cutting - existing layer - removal

The worn out old pavement surface is scraped off and new pavement is laid on top to a thickness of 5-10cm.





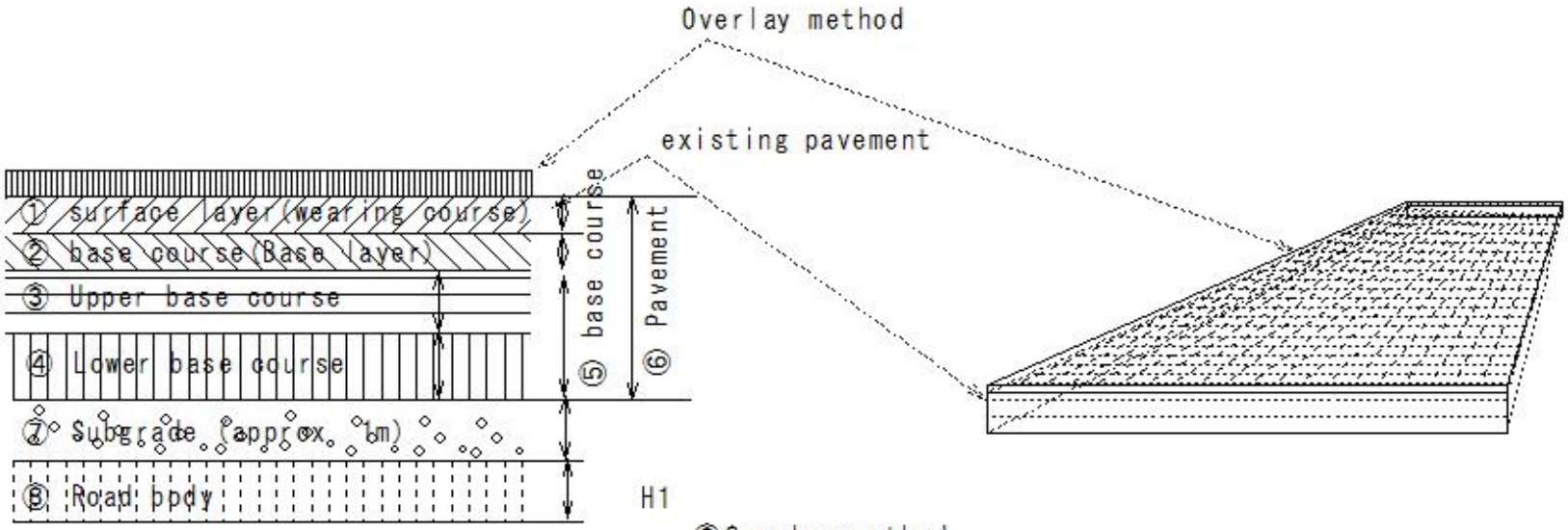
(H111)Asphalt pavement(Maintenance + repair-Overlay method)

(H111)Asphalt pavement(Maintenance + repair-Overlay method)

Asphalt pavement

Maintenance + repair

	Maintenance + repair
⑥Overlay method	On the existing pavement, a heated asphalt mixed layer with a thickness of 3 cm or more is provided.



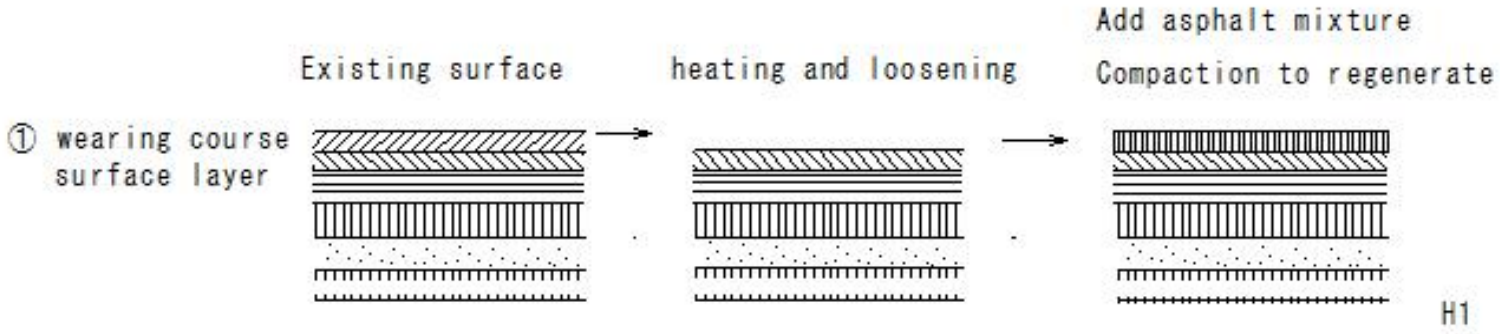
(H112)Asphalt pavement(Maintenance + repair-Asphalt Pavement Repair Methods)

(H112)Asphalt pavement(Maintenance + repair-Asphalt Pavement Repair Methods)

Asphalt pavement

Maintenance + repair

	Maintenance + repair
⑦Asphalt Pavement Repair Methods	Current Location Existing surface layer - heating and loosening Add asphalt mixture and additives and spread evenly
	Compact and regenerate the surface



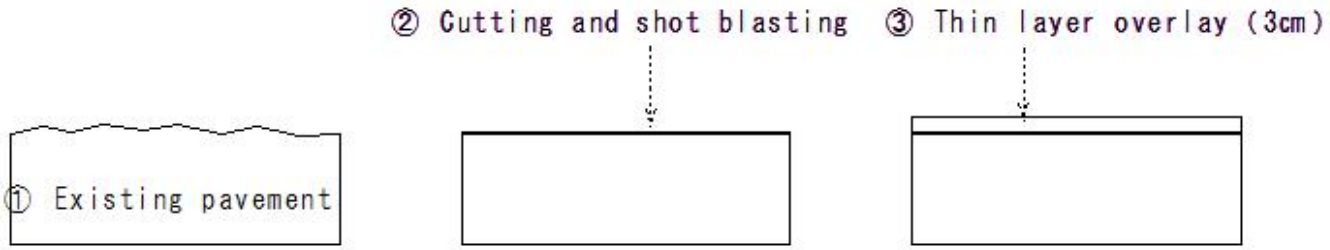
(H113)Asphalt pavement(Maintenance + repair-Thin layer overlay method)

(H113)Asphalt pavement(Maintenance + repair-Thin layer overlay method)

Asphalt pavement

Maintenance + repair

	Maintenance + repair
⑧Thin layer overlay method	On the existing pavement, a heated asphalt mixed layer is provided with a thickness of less than 3 cm.



(H114)Asphalt pavement(Maintenance + repair-Rut overlay method）

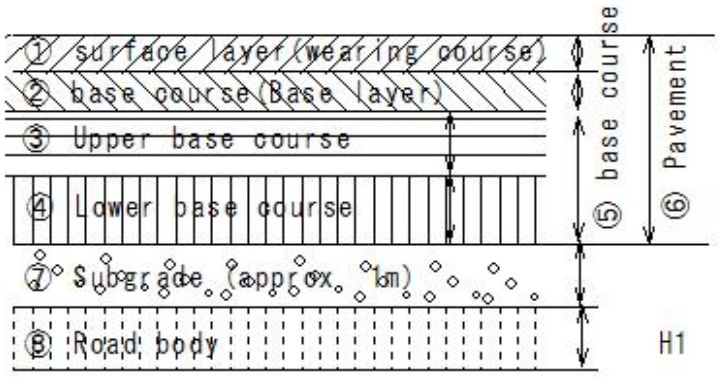
(H114)Asphalt pavement(Maintenance + repair-Rut overlay method)

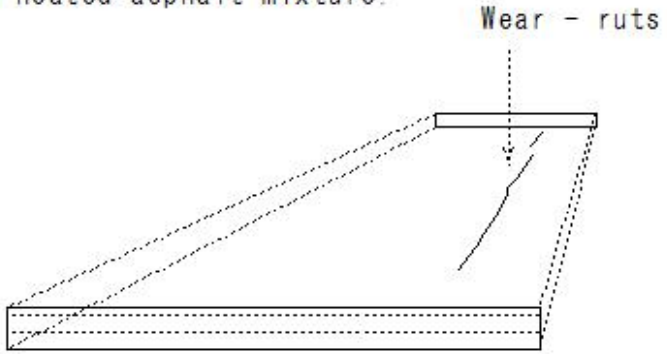
Asphalt pavement

Maintenance + repair

	Maintenance + repair
⑨ Rut overlay method	Replacement of existing pavement Wear - ruts Repairs with heated asphalt mixture Leveling work Not included in TA

A construction method in which only the rutted areas of existing pavement are paved with heated asphalt mixture.





⑨ Rut overlay method

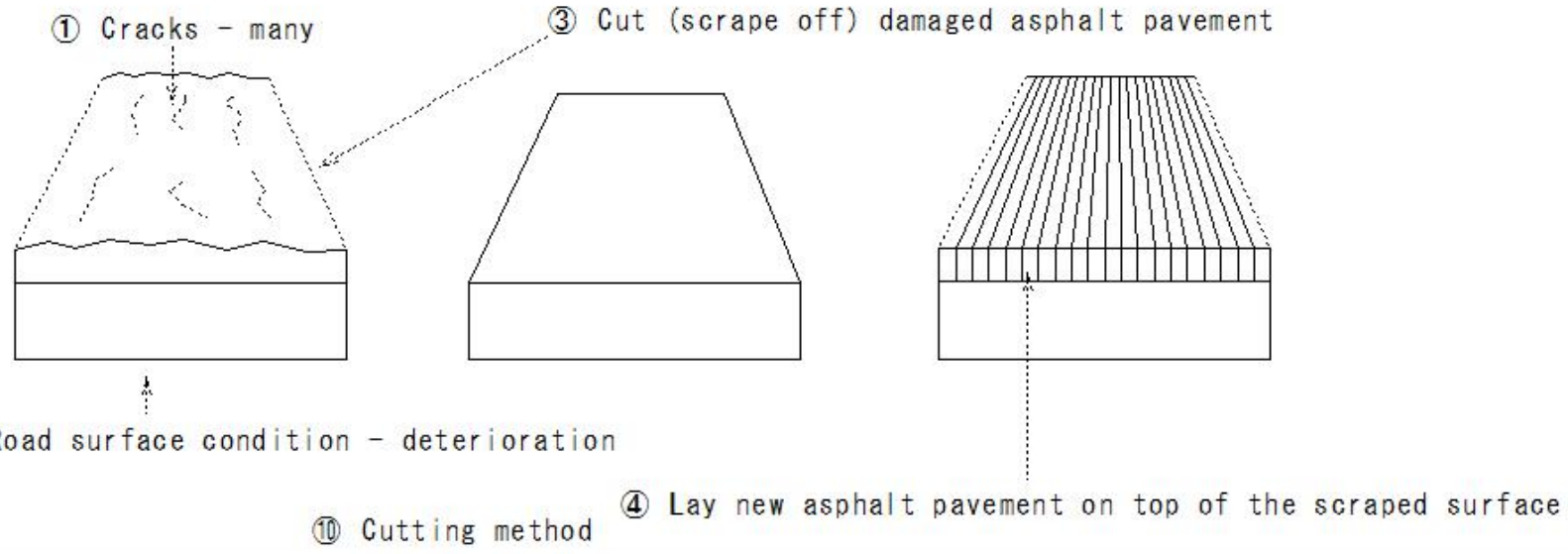
(H115)Asphalt pavement(Maintenance + repair- Cutting method）

(H115)Asphalt pavement(Maintenance + repair- Cutting method)

Asphalt pavement

Maintenance + repair

	Maintenance + repair
⑩ Cutting method	Correction of uneven road surfaces Convex parts - Cutting and removal



(H116)Asphalt pavement(Maintenance + repair- Sealing material injection method）

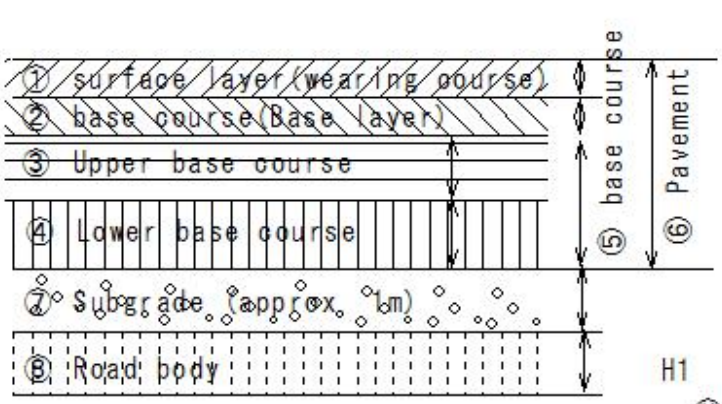
(H116)Asphalt pavement(Maintenance + repair- Sealing material injection method)

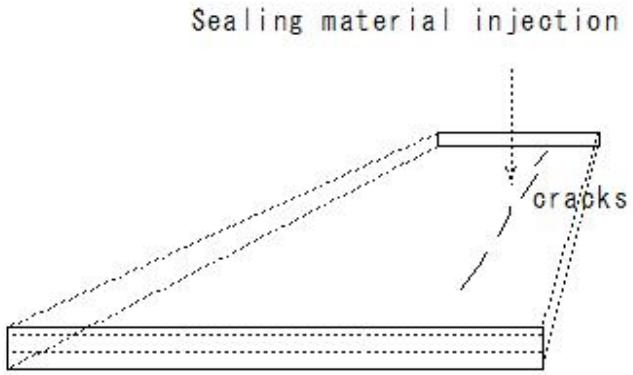
Asphalt pavement

Maintenance + repair

	Maintenance + repair
⑪Sealing material injection method	Wide joints Injection Joint - Filling

This is a construction method in which cracks in the pavement are repaired by filling them with sealing material





⑪Sealing material injection method

(H117)Asphalt pavement(Maintenance + repair- Surface treatment method）

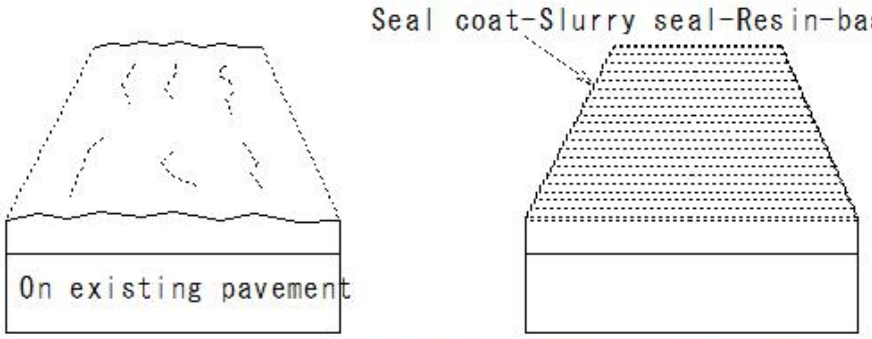
(H117)Asphalt pavement(Maintenance + repair- Surface treatment method)

Asphalt pavement

Maintenance + repair

	Maintenance + repair
⑫Surface treatment method	On existing pavement Materials other than heated asphalt mixture Apply a sealing layer less than 3 cm thick Seal coat Slurry seal Resin-based surface treatment, etc.

This is a spreading type surface treatment method (chip seal) in which binder and pre-coated aggregate are evenly spread and compacted onto the surface of conventional pavement to form a sealing layer of approximately 1.3 cm.



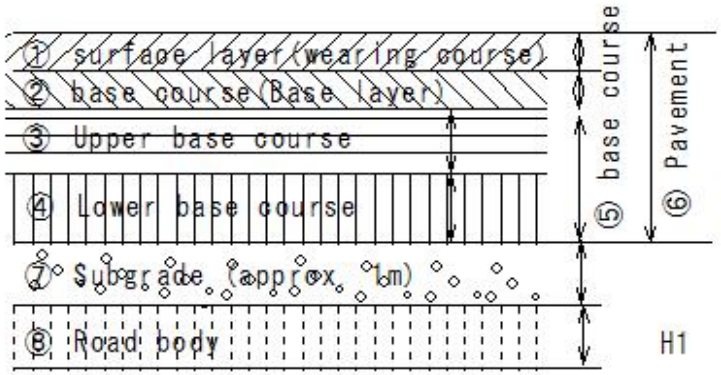
⑫Surface treatment method

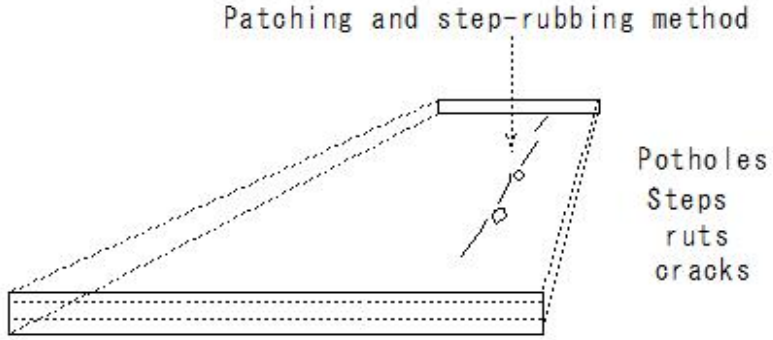
(H118)Asphalt pavement(Maintenance + repair- Patching and step-rubbing method）

(H118)Asphalt pavement(Maintenance + repair- Patching and step-rubbing method)

	Maintenance + repair
⑬Patching and step--rubbing method	Localized small holes (potholes) in roads Potholes Steps Emergency filling Transportation Normal temperature asphalt mixture - use

A repair method in which potholes (dents) and cracks on the surface of a paved road are filled with asphalt mixture or piled on top of a small area.





⑬Patching and step-rubbing method

(H119)Asphalt pavement(Asphalt Paving Machine- On-road mixing: Stabilizer)

(H119)Asphalt pavement(Asphalt Paving Machine- On-road mixing: Stabilizer)

Asphalt pavement

Asphalt Paving Machine

①On-road mixing: Stabilizer

Purpose of use	Machine name
On-road mixing	Stabilizer

Stabilizer

(H120)Asphalt pavement(Excavation and loading: Backhoe, tractor shovel)

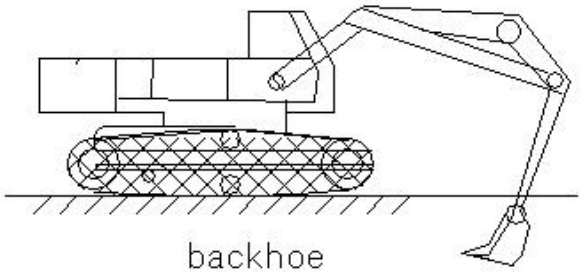
(H120)Asphalt pavement(Excavation and loading: Backhoe, tractor shovel)

Asphalt pavement

Asphalt Paving Machine

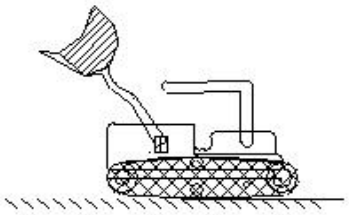
② Excavation and loading: Backhoe, tractor shovel

Purpose of use	Machine name
Excavation and loading	Backhoe, tractor shovel



backhoe

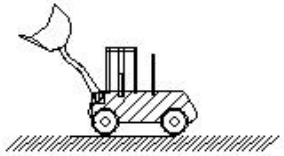
E229
M20



bucket dozer

①Crawler type tractor excavator

E237
M24



tractor excavator

②Wheeled tractor excavator

E237
M25

(H121)Asphalt pavement(Shaping: Motor grader, bulldozer)

(H121)Asphalt pavement(Shaping: Motor grader, bulldozer)

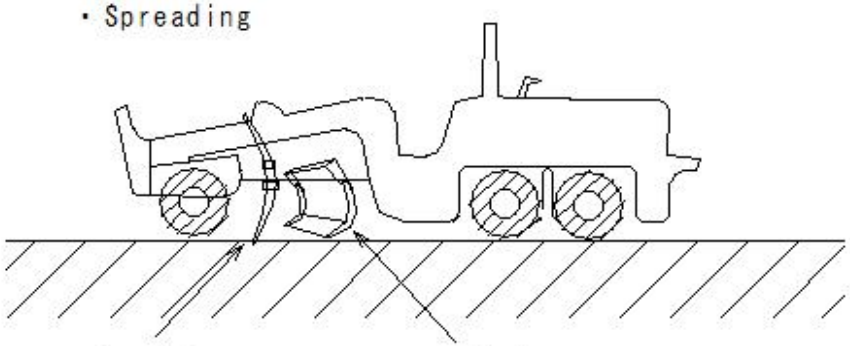
Asphalt pavement

Asphalt Paving Machine

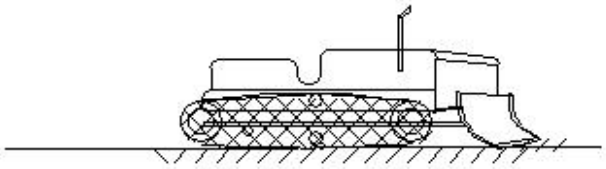
③ Shaping

Purpose of use	Machine name
Shaping	Motor grader, bulldozer

・Spreading



motor grader M51



bulldozer M30

③ Shaping

(H122)Asphalt pavement(Stabilizer spreader Engine sprayer Asphalt distributor)

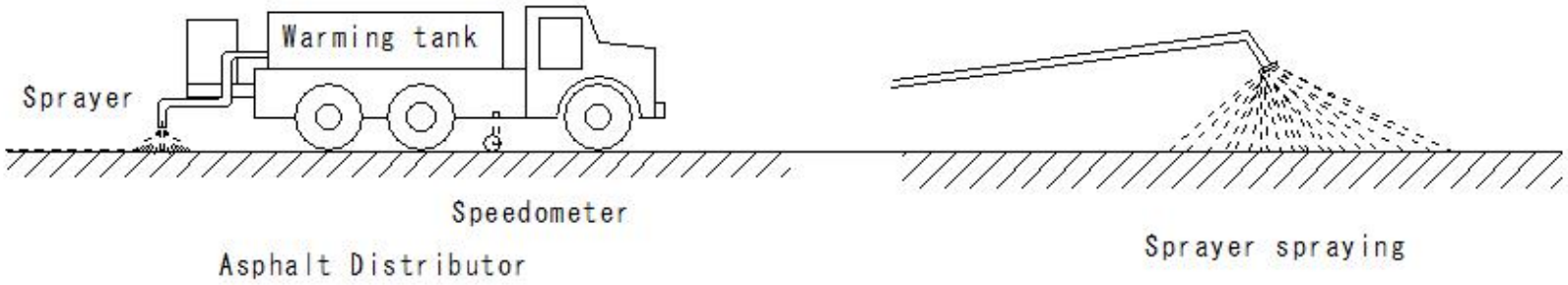
(H122)Asphalt pavement(Stabilizer spreader Engine sprayer Asphalt distributor)

Asphalt pavement

Asphalt Paving Machine

④Spraying: Stabilizer sprayer, engine sprayer, asphalt distributor

Purpose of use	Machine name
Spraying	Stabilizer sprayer, engine sprayer, asphalt distributor



(H123)Asphalt pavement(Leveling: Motor grader, bulldozer, base paper, asphalt finisher)

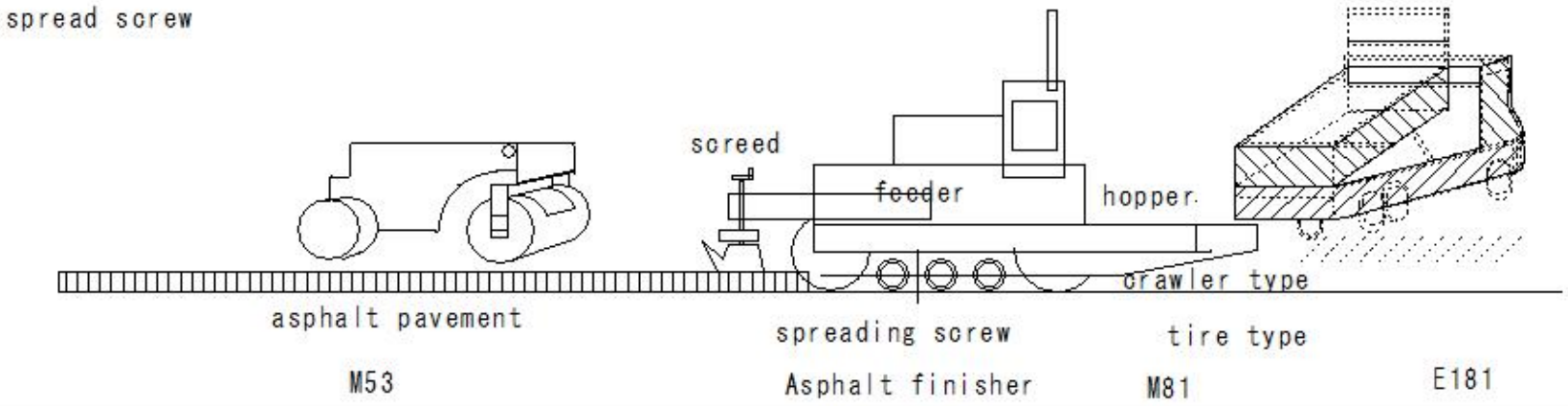
(H123)Asphalt pavement(Leveling: Motor grader, bulldozer, base paper, asphalt finisher)

Asphalt pavement

Asphalt Paving Machine

⑤Leveling: Motor grader, bulldozer, base paper, asphalt finisher

Purpose of use	Machine name
Leveling	Motor grader, bulldozer, base paper, asphalt finisher



(H124)Asphalt pavement(Compaction: Road rollers, tire rollers, vibrating rollers, water sprinklers）

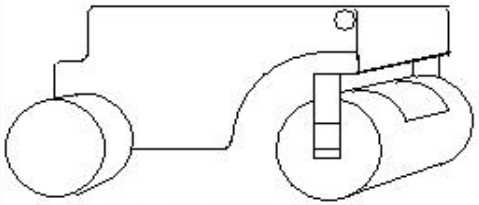
(H124)Asphalt pavement(Compaction: Road rollers, tire rollers, vibrating rollers, water sprinklers)

Asphalt pavement

Asphalt Paving Machine

⑥Compaction: Road rollers, tire rollers, vibrating rollers, water sprinklers

Purpose of use	Machine name
Compaction	Road rollers, tire rollers, vibrating rollers, water sprinklers

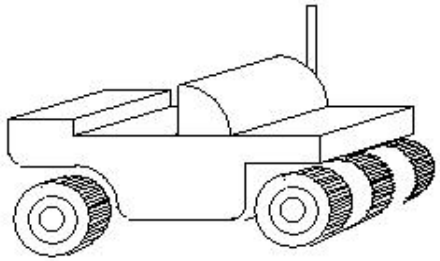


Road Rollers

macadam roller

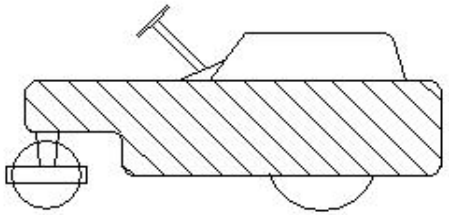
M53

E311



Tire roller

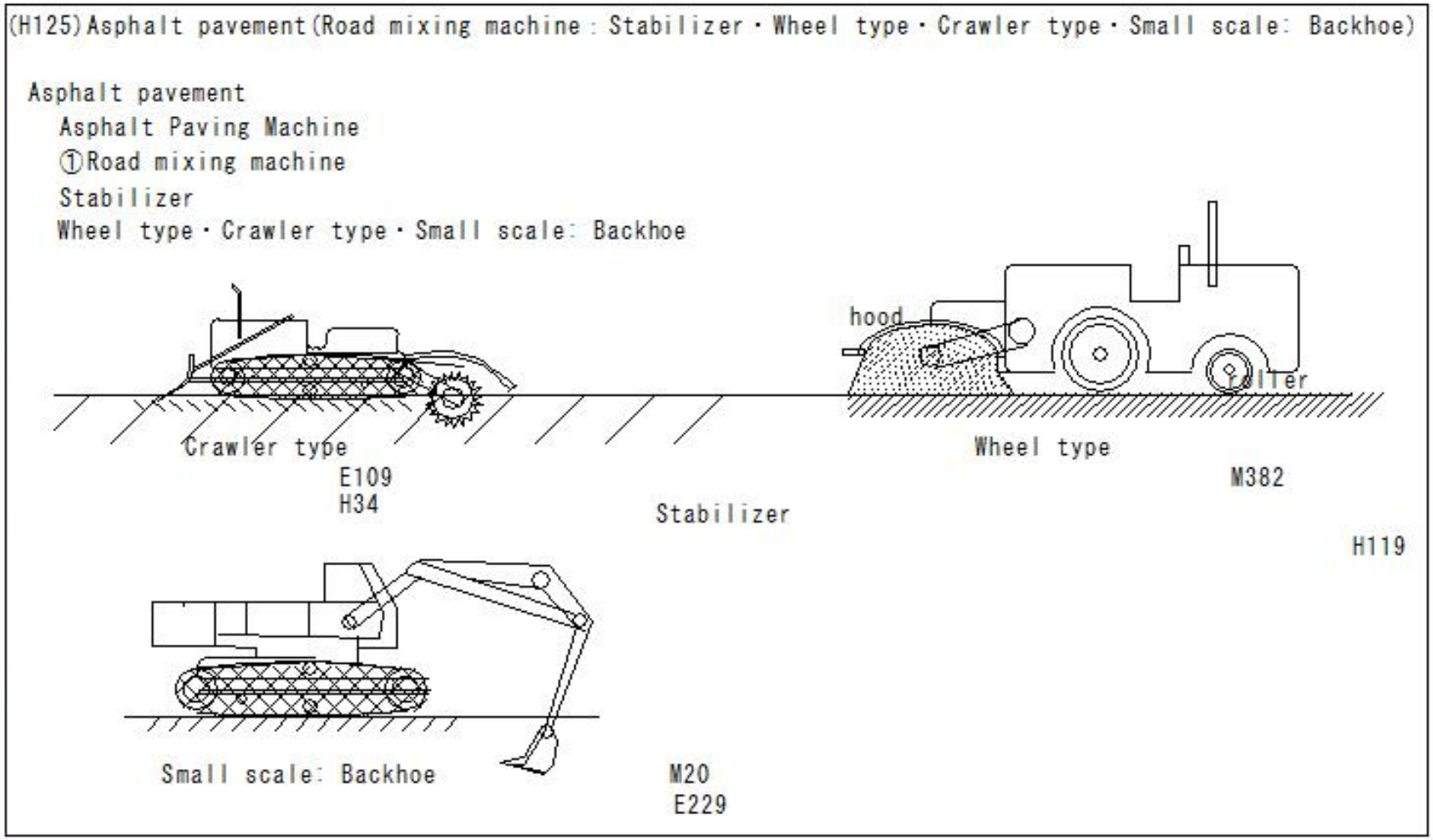
M57



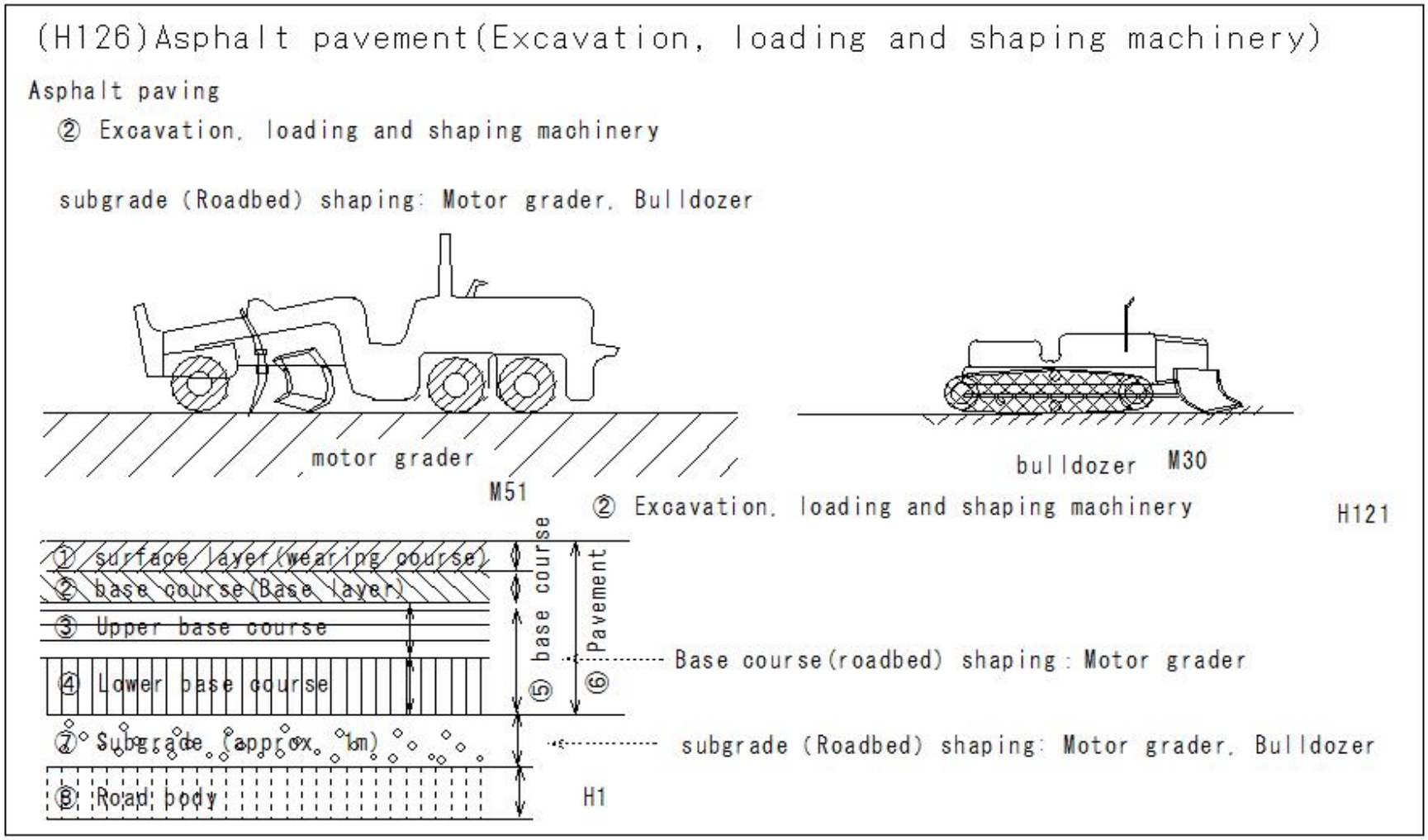
Vibrating Rollers

M58

(H125)Asphalt pavement(Road mixing machine：Stabilizer・Wheel type・Crawler type・Small scale: Backhoe)



(H126)Asphalt pavement(Excavation, loading and shaping machinery)



(H127)Asphalt pavement(Spraying machine）

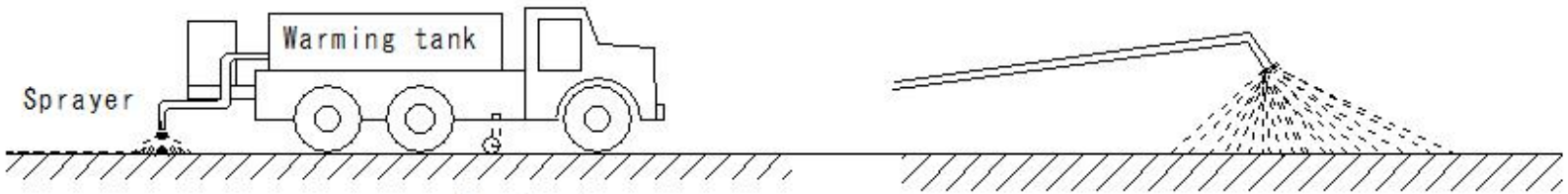
(H127)Asphalt pavement(Spraying machine)

Asphalt paving

③Spraying machine

large-scale：Asphalt distributor

Small-scale：Engine sprayer



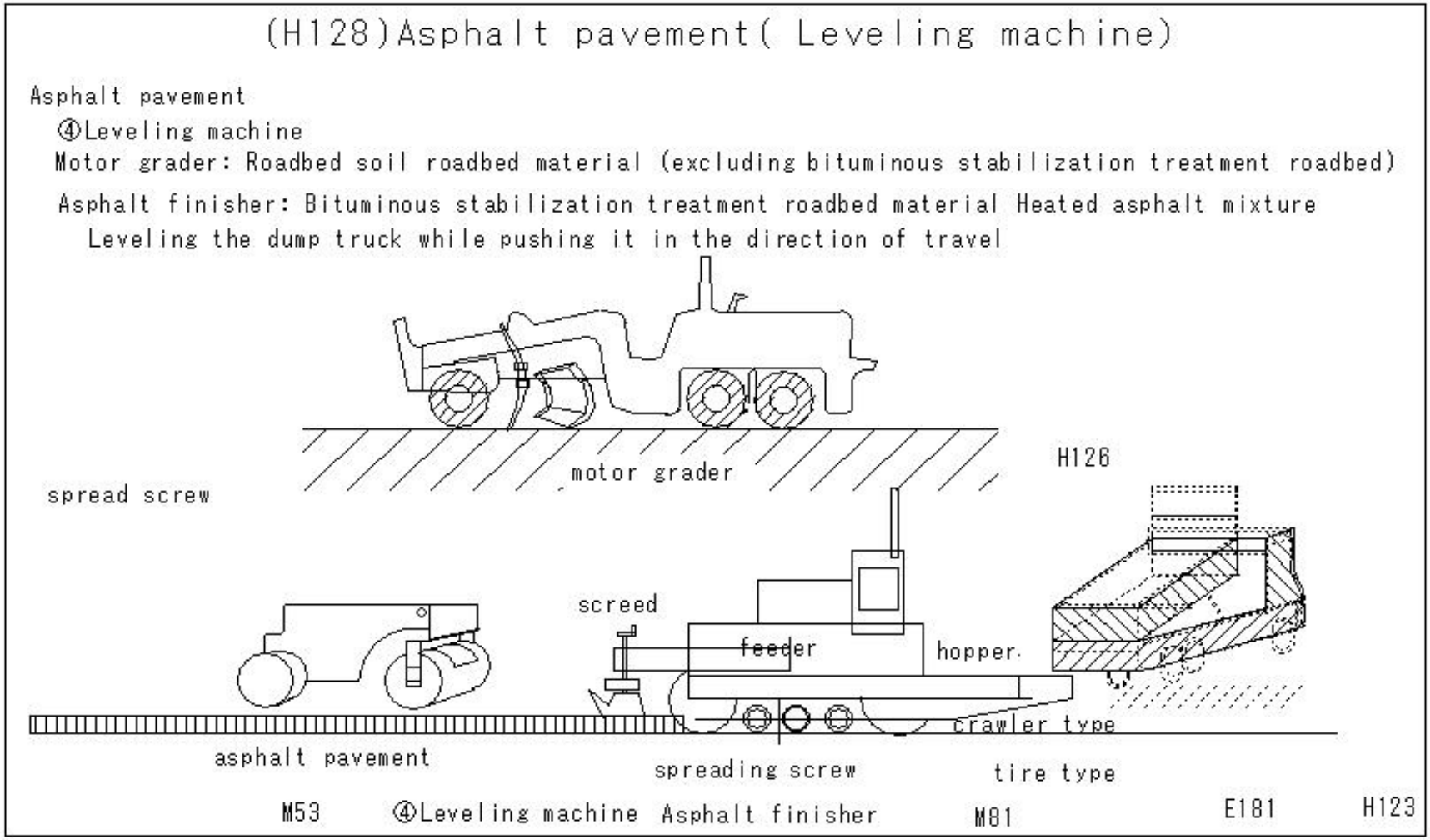
Speedometer

large-scale：Asphalt distributor

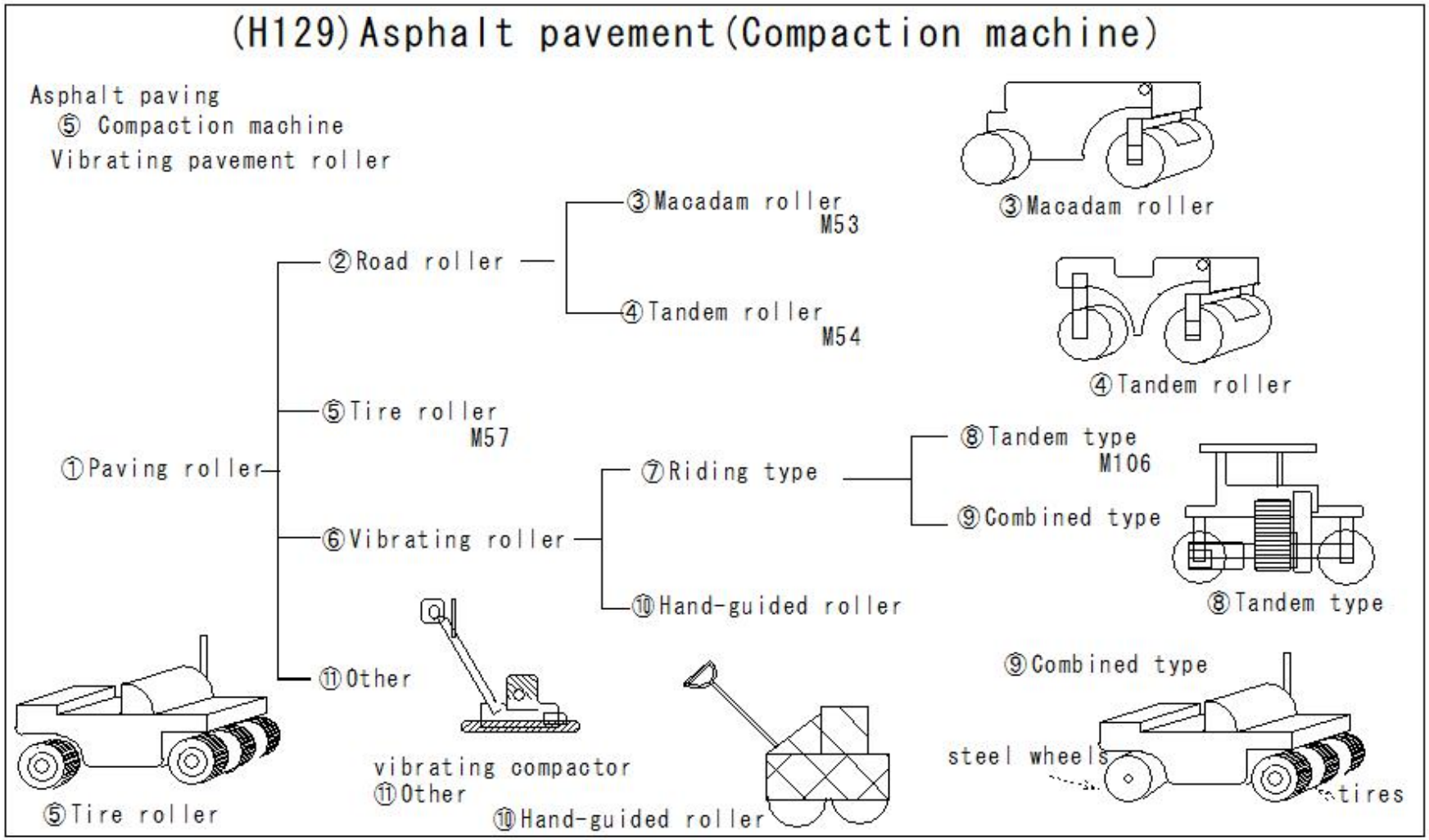
Small-scale：Engine sprayer

H122

(H128)Asphalt pavement(Leveling machine）



(H129)Asphalt pavement(Compaction machine）



(H130)Asphalt pavement(Compaction machine）

(H130)Asphalt pavement(Compaction machine)

Asphalt pavement

⑤ Compaction machine

Vibration roller for paving

① Road roller: Both front and rear wheels are steel wheels

② Tandem type vibratory roller: Both front and rear wheels are steel wheels

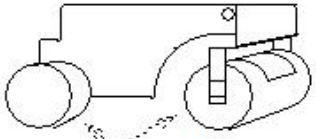
③ Combined type vibratory roller: Front wheels are tires, rear wheels are steel wheels

④ Tandem type vibratory roller: Both front and rear wheels are steel wheels

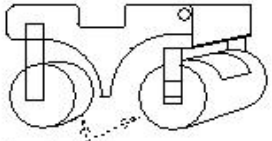
⑤ Tandem type vibratory roller: No vibration - Alternative to road roller

⑥ Subgrade compaction: Strength decreases due to kneading - Alternative to bulldozer

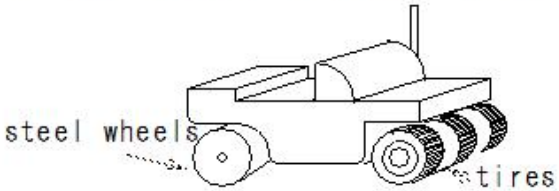
① Road roller



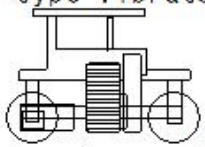
② Tandem type vibratory roller



③ Combined type vibratory roller

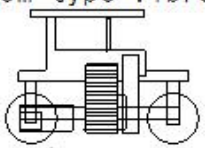


④ Tandem type vibratory roller



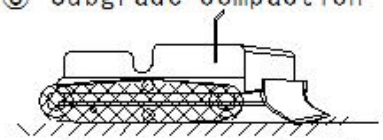
Both front and rear wheels are steel wheels

⑤ Tandem type vibratory roller



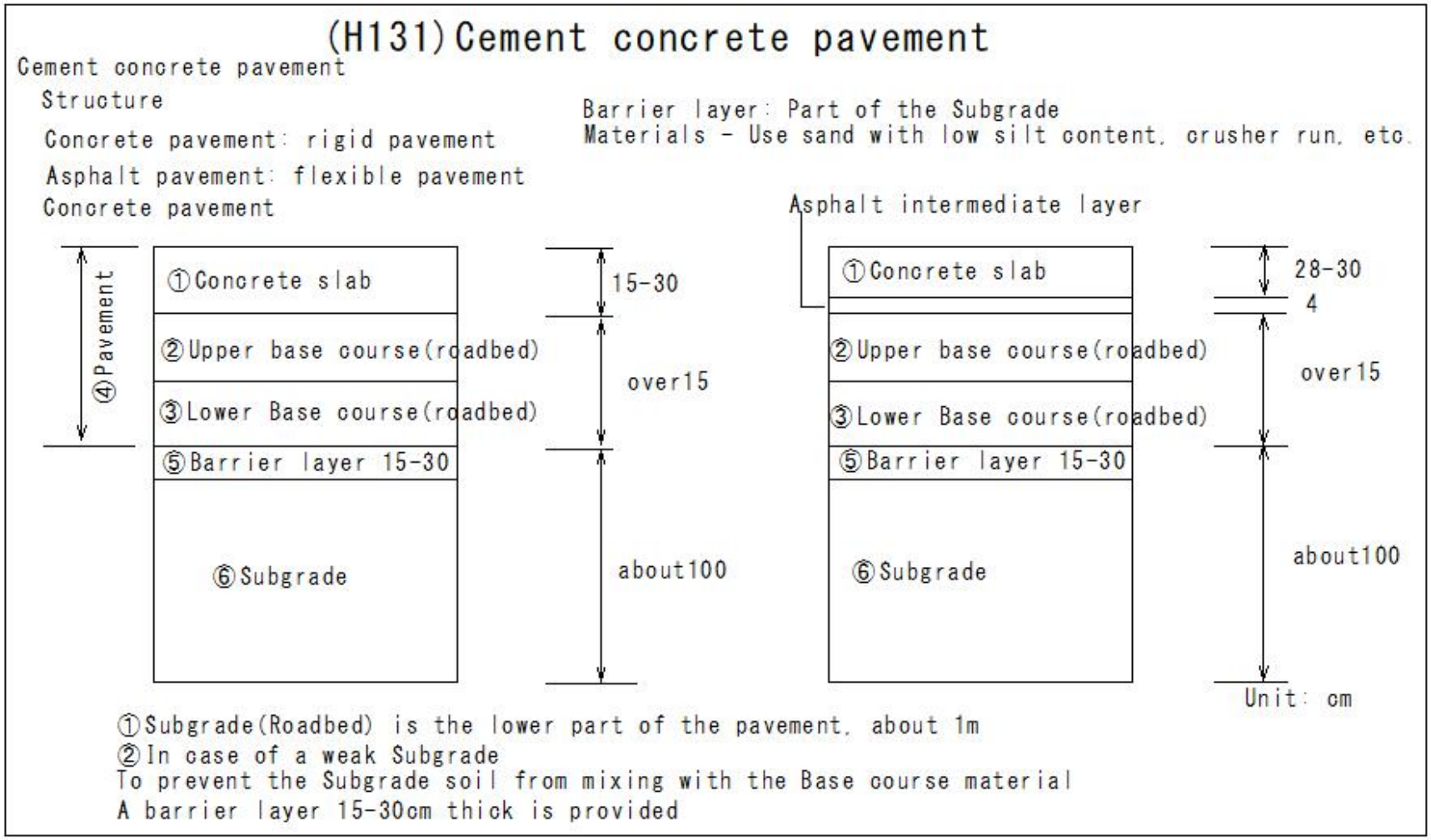
No vibration - Alternative to road roller

⑥ Subgrade compaction



Strength decreases due to kneading - Alternative to bulldozer

(H131)Cement concrete pavement



(H132)Cement concrete pavement(Subgrade)

(H132)Cement concrete pavement(Subgrade)

Cement concrete pavement

Design

Subgrade

①Design bearing capacity coefficient: 2 or less

Design CBR: less than 2

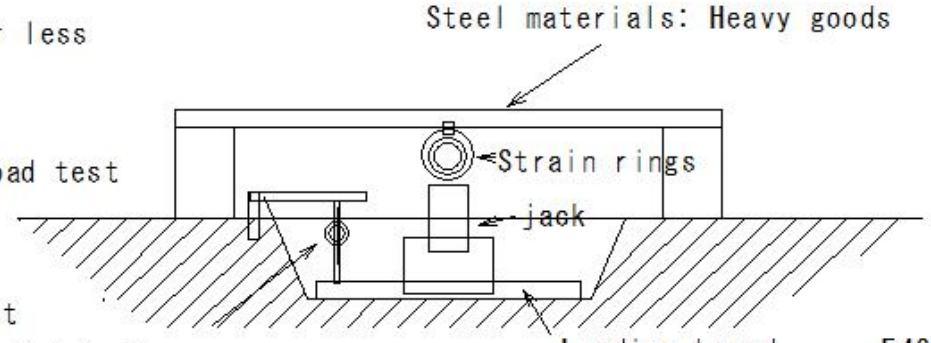
Soft subgrade - Improve

②Subgrade bearing capacity - Flat plate load test

Subgrade soil strength characteristics - Determined by CBR test

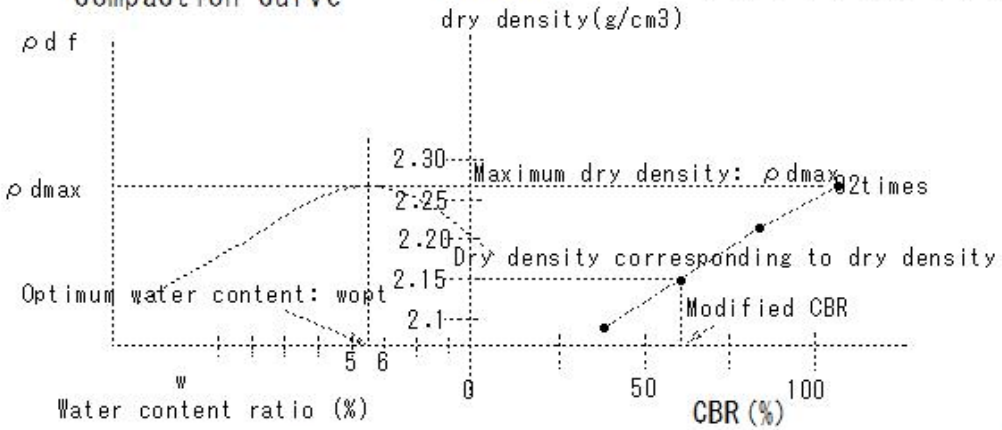
Subgrade thickness - Determined compaction curve

Flat plate load test



E432

CBR test



Degree of compaction-Modified CBR

E49

(H133)Cement concrete pavement (Base course(roadbed))

(H133)Cement concrete pavement (Base course(roadbed))

Cement concrete pavement

Design

Base course(roadbed)

①Base course(roadbed) thickness 30cm or more - divided into upper and lower layers

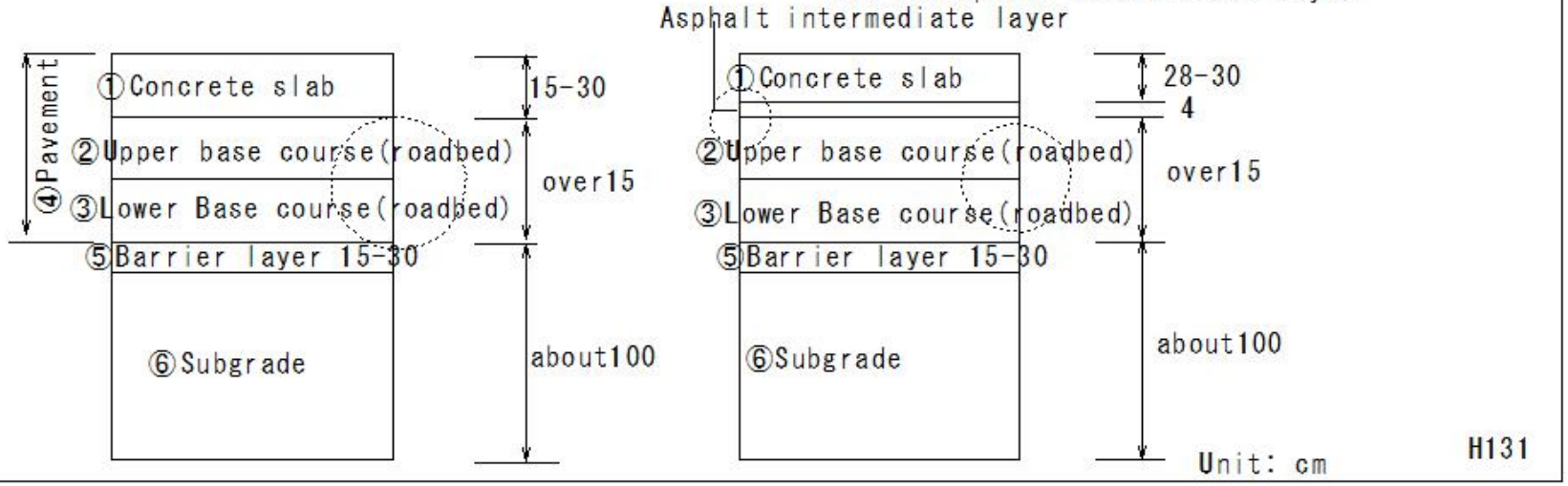
Asphalt intermediate layer-improves the water resistance and durability of the Base course(roadbed)

Base course(roadbed) flatness - increased

Maintains uniformity of concrete slab thickness

Prevents work vehicles from disturbing the Base course(roadbed) during construction

C, D Traffic: in case of using granular materials for the Upper base course(roadbed), use an asphalt intermediate layer.



(H134)Cement concrete pavement (Concrete slab)

(H134)Cement concrete pavement (Concrete slab)

Cement concrete pavement

Design

Concrete slab

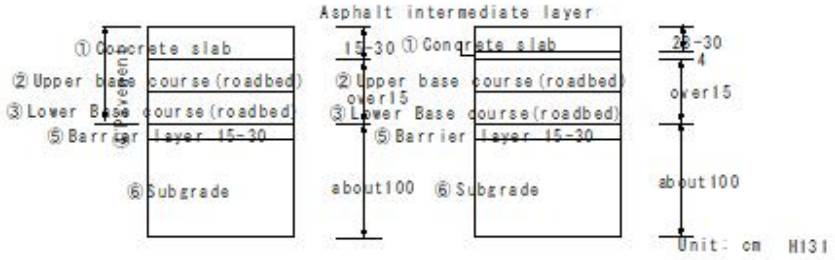
①Design standard bending strength 45kgf/cm2 Material age 28 days

②Thickness of concrete slab Traffic volume classification 15-30cm

Thickness of concrete slab　　1kgf/cm2≒0.098N/mm2

Traffic volume classification	Thickness (cm)
L traffic	15 (20)
A traffic	20 (25)
B traffic	25
C traffic	28
D traffic	30

(　　) indicates L A traffic bending strength 40kgf/cm2



(H135)Cement concrete pavement (Concrete slab)

(H135)Cement concrete pavement (Concrete slab)

Cement concrete pavement

Design

Concrete slab

③Concrete slab

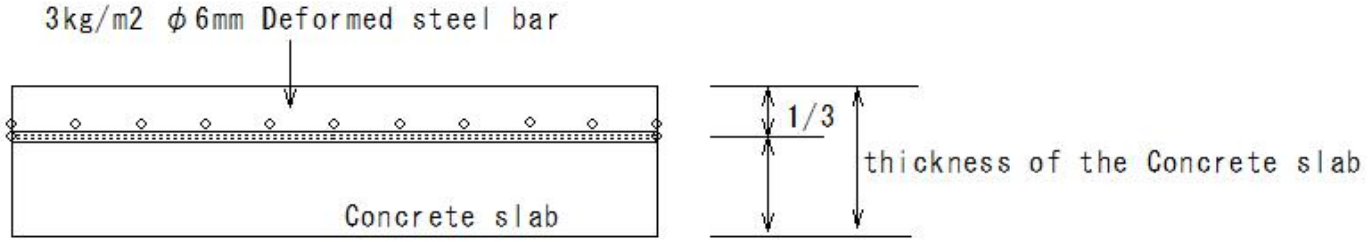
Iron mesh Edge reinforcement steel

Amount of steel bars: 3kg/m2 φ6mm Deformed steel bar

Iron-embedded position: Surface: 1/3 of the thickness of the Concrete slab

Iron: Prevents cracking and expansion

Prevents destruction



③Concrete slab

(H136)Cement concrete pavement (Concrete slab-Joints)

(H136)Cement concrete pavement (Concrete slab-Joints)

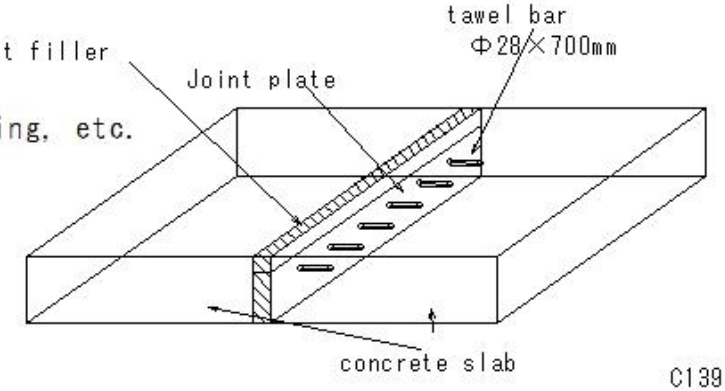
Cement concrete pavement

Design
Concrete slab
④Joints

・Expansion and contraction, stress reduction by warping, etc.
・Classification of joints

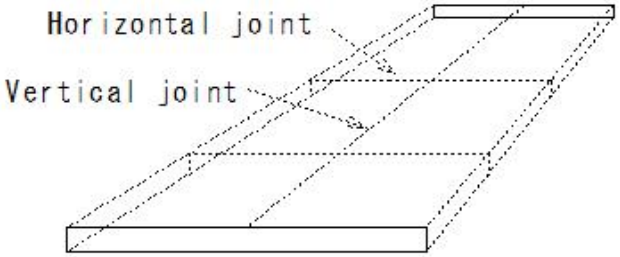
Position: Vertical joint, Horizontal joint

Purpose: Stretching, contracting, warping

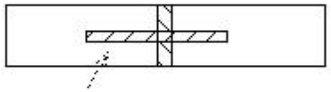


C1394

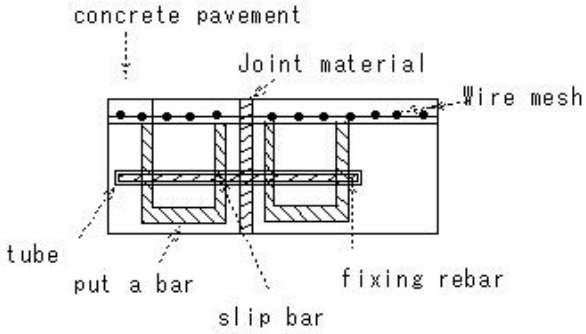
Lateral expansion joint



Concrete slab

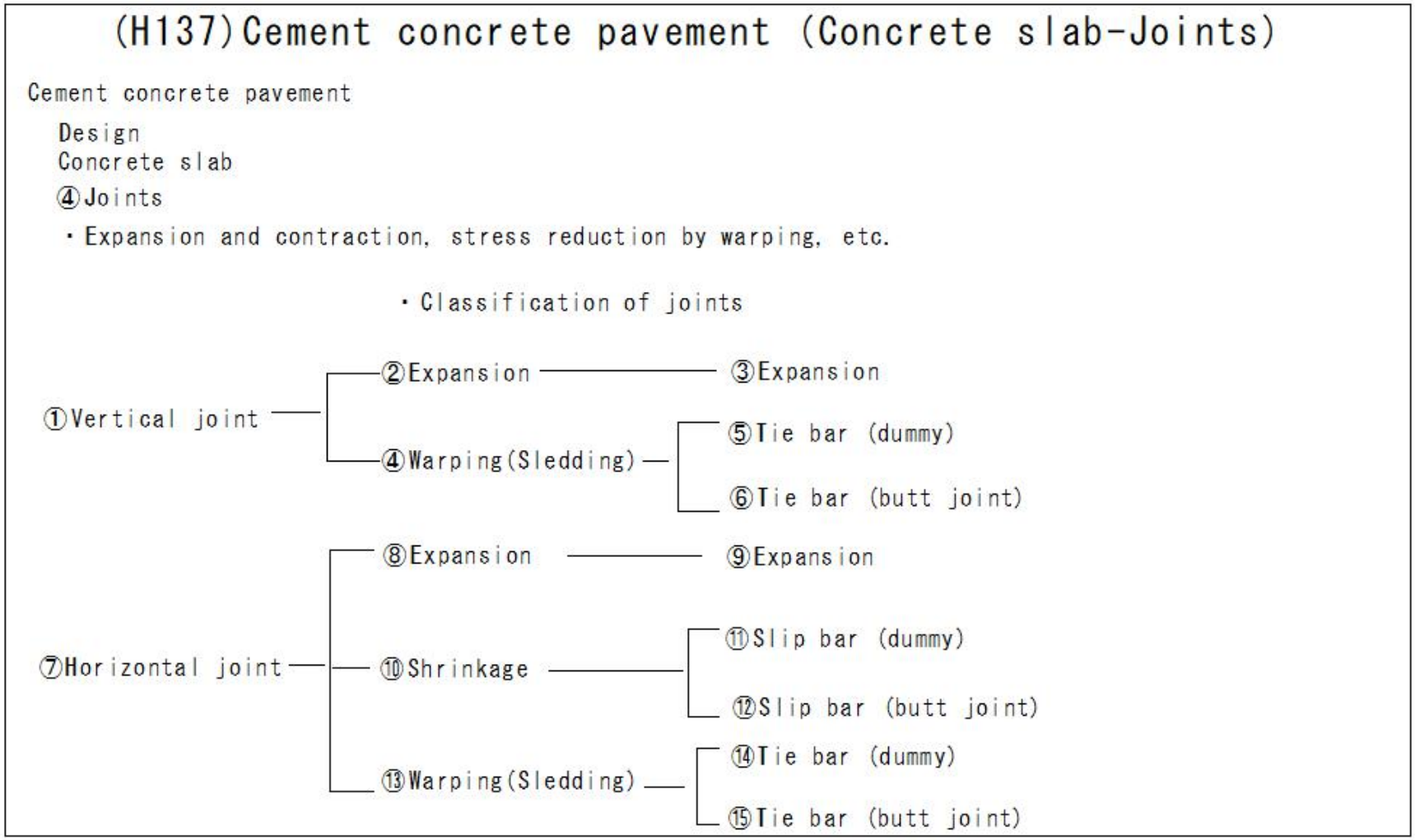


tie bar (steel bar)



C883

(H137)Cement concrete pavement (Concrete slab-Joints)



(H138)Cement concrete pavement (Concrete slab-Dummy joint)

(H138)Cement concrete pavement (Concrete slab-Dummy joint)

Cement concrete pavement

Design

Concrete slab

④Joints

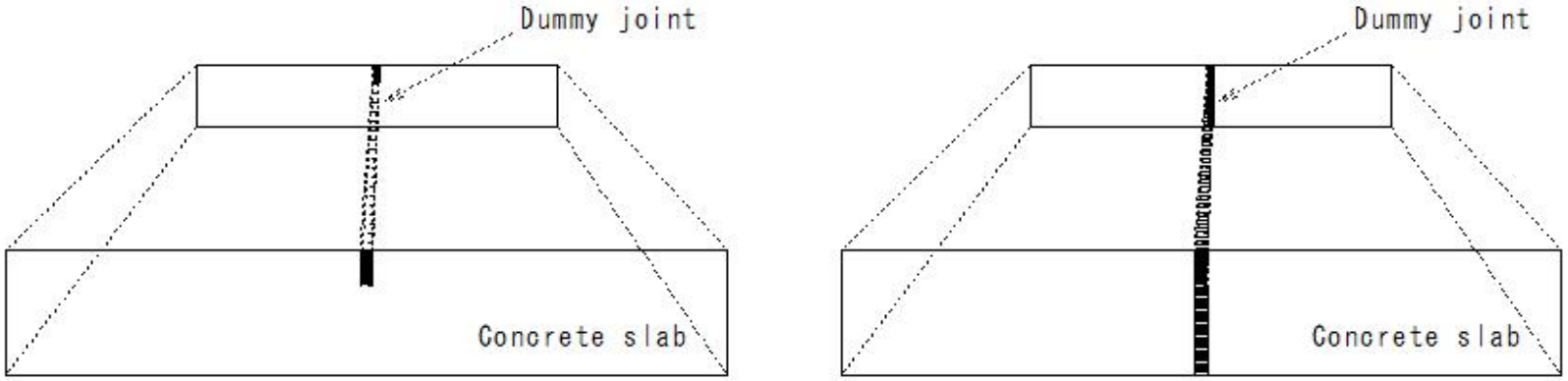
・Dummy joint

Early stage

Cutter - Cut groove - Cutter joint

Concrete - Inner - Vibration joint cutting machine -

Inserting joint material - Driving joint



・Dummy joint

(H139)Cement concrete pavement (Concrete slab-Slip bar)

(H139)Cement concrete pavement (Concrete slab-Slip bar)

Cement concrete pavement

Design
Concrete slab

④Joints

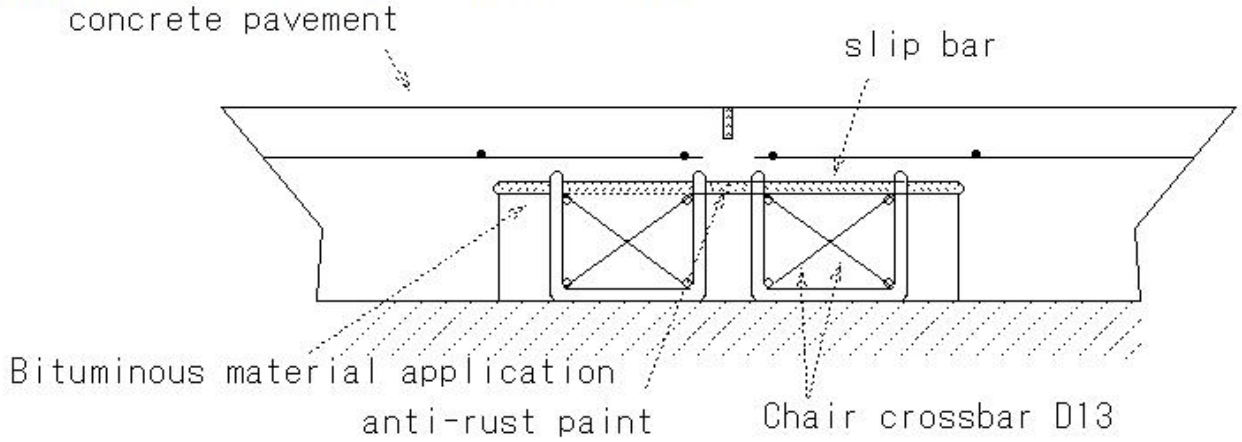
・Slip bar

Expansion joints: Round steel used across contraction joints

Load transfer

Following shrinkage - one side - applying bituminous material, etc.

Expansion joints - slip bar - cap on one side



C1039

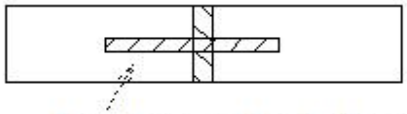
Reduction of contraction stress and warpage constraint stress due to temperature change

(H140)Cement concrete pavement (Concrete slab-Tie bar)

(H140)Cement concrete pavement (Concrete slab-Tie bar)

Cement concrete pavement

Design
Concrete slab
④Joints
・Tie bar
Dummy joint Crossing butt joints, etc.
Deformed steel bar inserted into slab
Opening of joint Prevents misalignment



tie bar (steel bar)

C883

(H141)Cement concrete pavement (Materials and mix)

(H141) Cement concrete pavement (Materials and mix)

Cement concrete pavement

Materials and mix

Concrete slab - cement

Portland cement

Blast furnace cement

Silica

Fly ash

Concrete slab mix

Volume change

Wear resistance - large

Mechanical application range

Amount of cement paste - small

Dry(hard) mix concrete

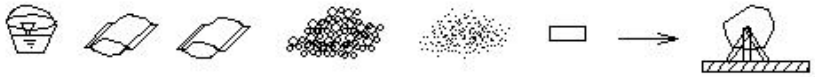
Plastic cracking

Prevention of temperature cracking, etc.

Unit cement amount: 280-350 kg

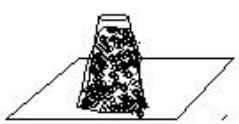
Paving position: Slump 2.5 cm, Settlement 30 seconds

Mix strength: Design standard bending strength x extra coefficient

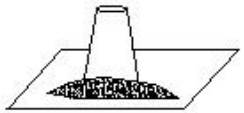


					Unit amount (kg/m3)				
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
Gmax(mm)	SL(cm)	(%)	(%)	(%)	W	C	S	G(5～25mm) mm～mm	

Hard Mixed concrete



Soft concrete



C731

(H142)Cement concrete pavement (Mixing)

(H142)Cement concrete pavement (Mixing)

Cement concrete pavement

Construction

○Mixing

Amount of concrete

Road base and concrete slab - Error in finished height - Loss

Allow an extra 3-4%

○Transportation

Concrete transportation - slump less than 5cm

Dump truck use

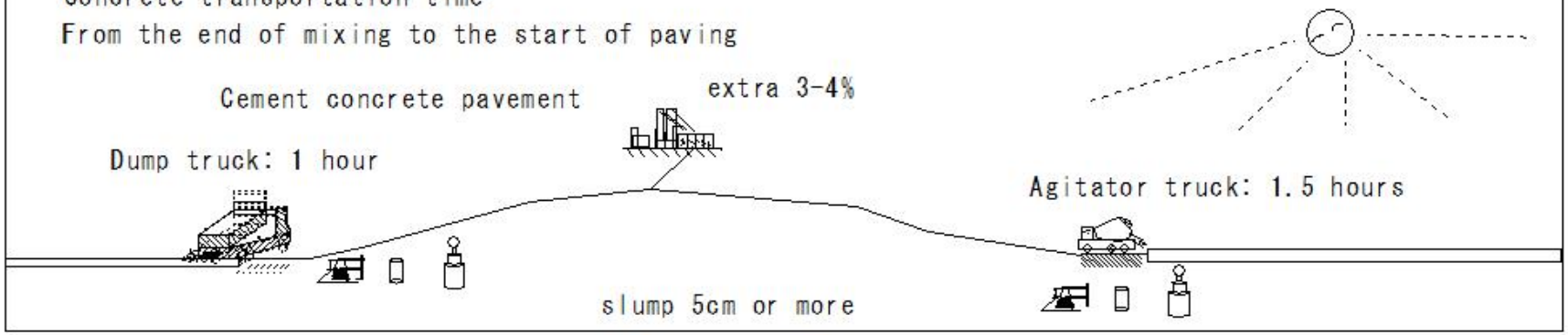
Simple paving machine, manual paving, treading board, etc. -

Special section paving - slump 5cm or more

Agitator Truck Use

Concrete transportation time

From the end of mixing to the start of paving



(H143)Cement concrete pavement (Formwork)

(H143)Cement concrete pavement (Formwork)

Cement concrete pavement

Construction

○Formwork

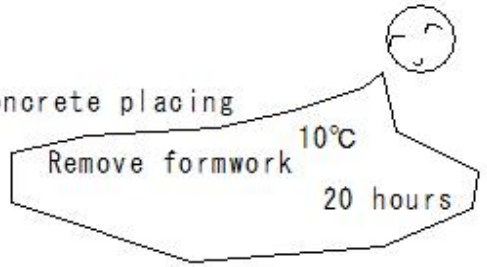
Remove formwork

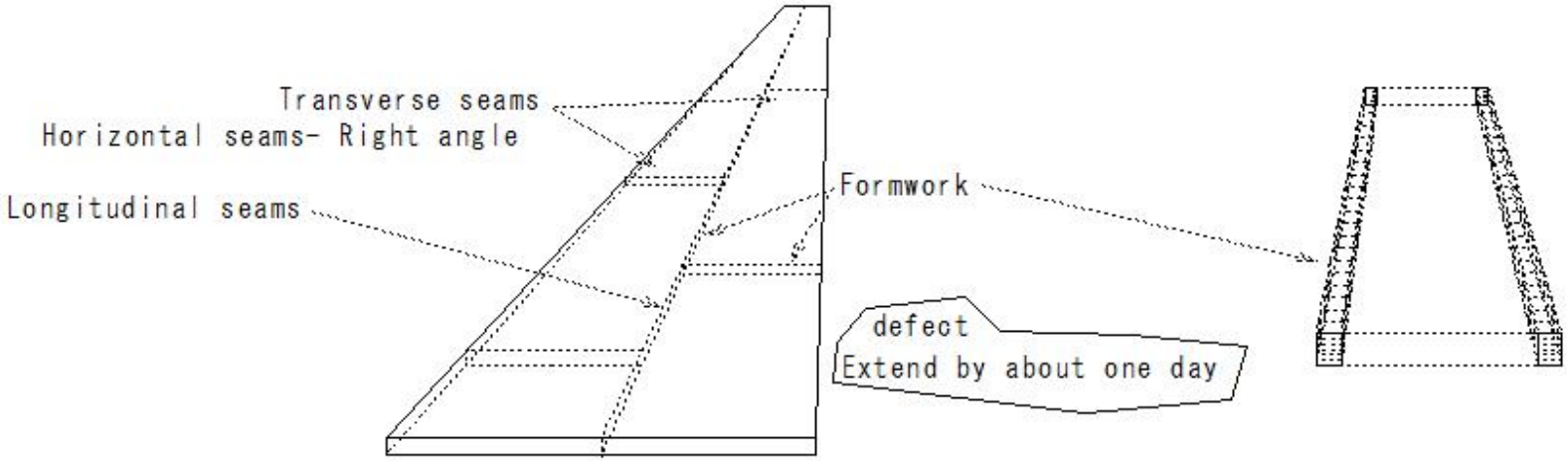
Temperature: 10℃ in case of not below 20 hours after concrete placing

Remove formwork

Temperature: below 10℃ in case of there is a defect

Extend by about one day





H68

(H144)Cement concrete pavement (Iron mesh and edge reinforcement rebar)

(H144)Cement concrete pavement (Iron mesh and edge reinforcement rebar)

Cement concrete pavement

Construction

○Iron mesh and edge reinforcement rebar

After placing the underlayer concrete

Installed by hand

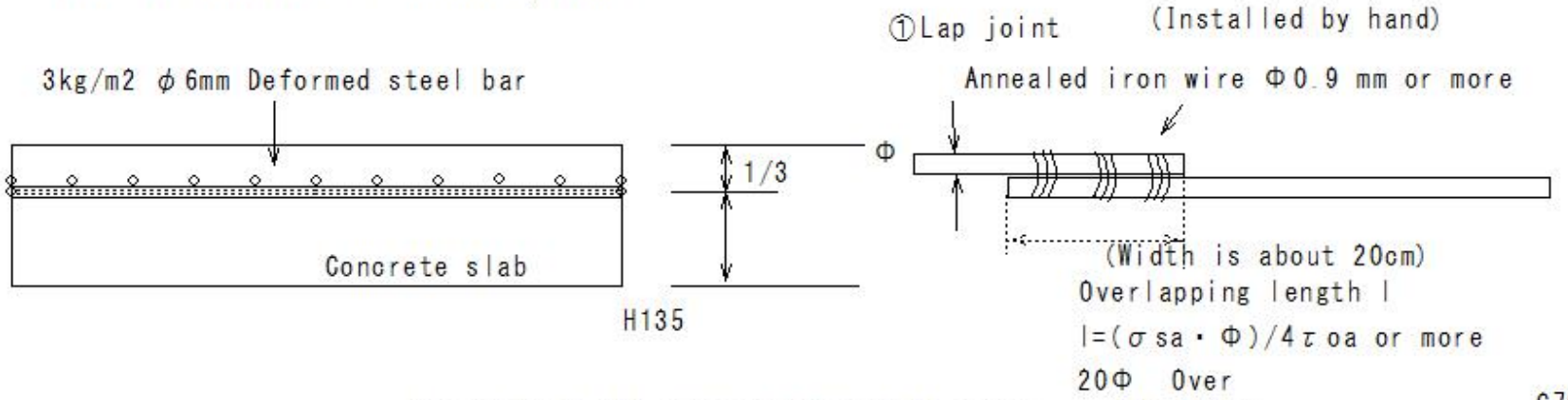
Iron net: Installed at a depth of 1/3 of the top of the slab

Iron mesh jointing: overlapping joints

Width is about 20cm

Annealed iron wire - bundling

More than 30 times the diameter of the rebar - by overlapping annealed iron wire - 2 or more places.



○Iron mesh and edge reinforcement rebar

C797

(H145)Cement concrete pavement (Compaction)

(H145)Cement concrete pavement (Compaction)

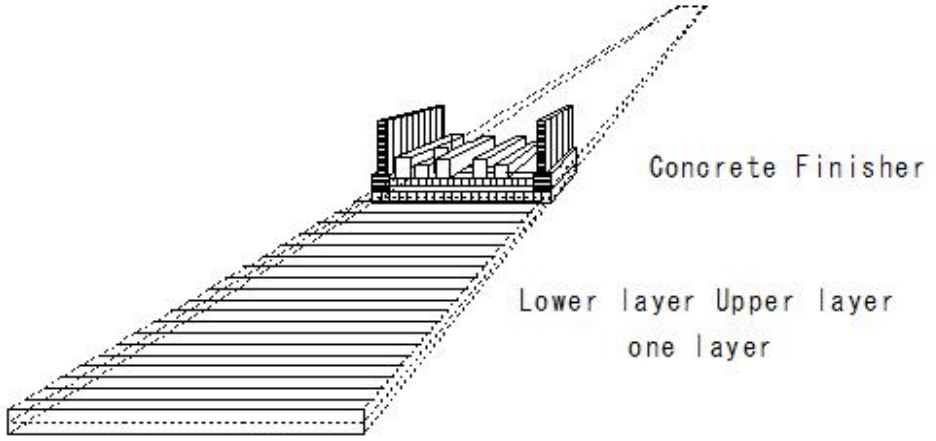
Cement concrete pavement

Construction

○Compaction

Lower layer Upper layer Concrete Compact the entire thickness in one layer

Finisher



○Compaction

(H146)Cement concrete pavement (Surface finishing)

(H146)Cement concrete pavement (Surface finishing)

Cement concrete pavement

Construction

○Surface finishing

Finishing screed

①Rough finishing: uniform finish surface at a specified height

②Flat finishing: surface finishing machine, done by sliding the screed

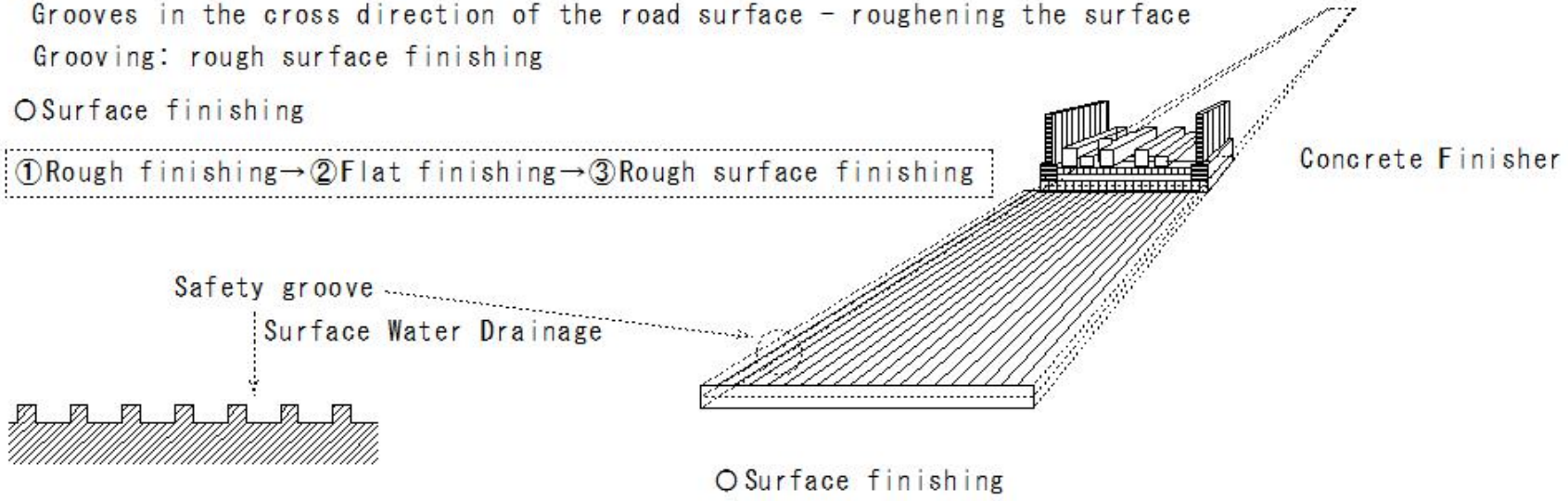
③Rough surface finishing: rough surface finishing machine, done by hand

Grooves in the cross direction of the road surface - roughening the surface

Grooving: rough surface finishing

○Surface finishing

①Rough finishing→②Flat finishing→③Rough surface finishing



(H147)Cement concrete pavement (Curing)

(H147)Cement concrete pavement (Curing)

Cement concrete pavement

Construction

○Curing

Initial curing

Immediately after surface finishing → Initial curing → Curing work

Initial curing: Hardening action

Prevent cracks due to drying

Appropriate temperature

Moisture curing

Initial curing

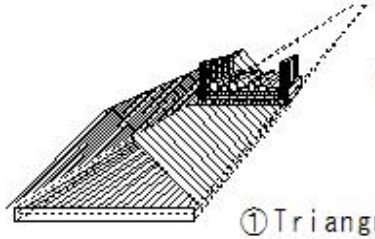
①Triangular roof curing

②Membrane curing: Spraying membrane curing agent on the surface - creating a membrane

Prevent water evaporation - Use in conjunction with triangular roof curing

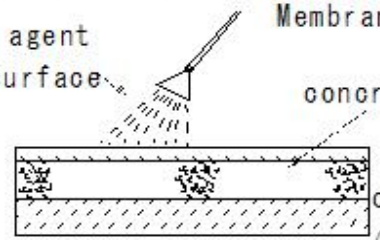
Small-scale construction: Triangular roof curing - omitted

Membrane curing: High construction ability - Initial curing to later curing



Concrete Finisher

①Triangular roof curing



②Membrane curing:

(H148)Cement concrete pavement (Curing)

(H148)Cement concrete pavement (Curing)

Cement concrete pavement

Construction

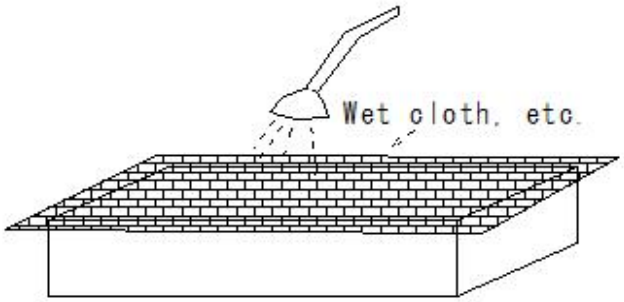
○Late curing

Initial curing → Late curing

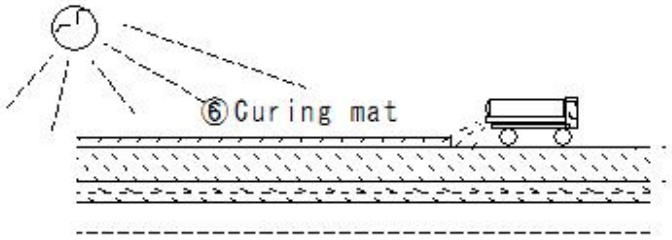
Prevent water evaporation and temperature changes

①Sponge, linen cloth, straw mat, etc. : Cover the surface and keep it moist

②Watering truck - Watering



C813



C895

(H149)Cement concrete pavement (Curing period)

(H149)Cement concrete pavement (Curing period)

Cement concrete pavement

Construction

Curing period

① In the case of a test	② Bending strength of specimen cured on-site: 35kgf/cm2 or more	
③ Not testing	④ Ordinary Portland cement	⑦ 2 weeks
	⑤ High-early-strength Portland cement	⑧ 1 week
	⑥ Moderate-heat Portland cement Fly ash	⑨ 3 weeks

1kgf/cm2≒0.098N/mm2

(H150)Cement concrete pavement (Initial cracks)

(H150)Cement concrete pavement (Initial cracks)

Cement concrete pavement

Construction

Initial cracks

①Immediately after paving - within a few days

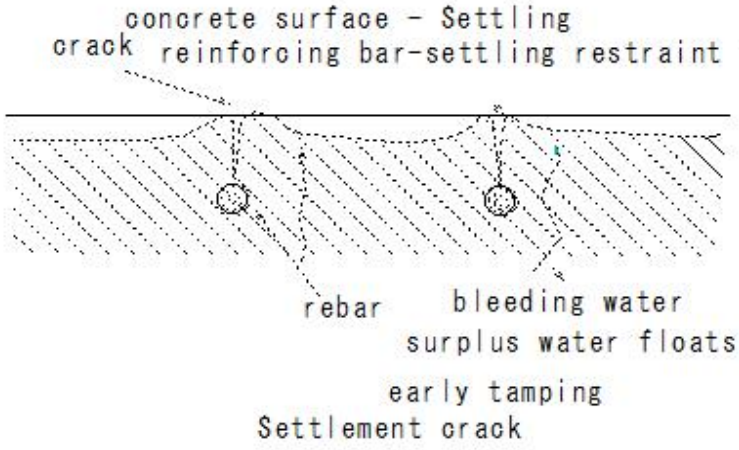
Settlement crack

Plastic cracks

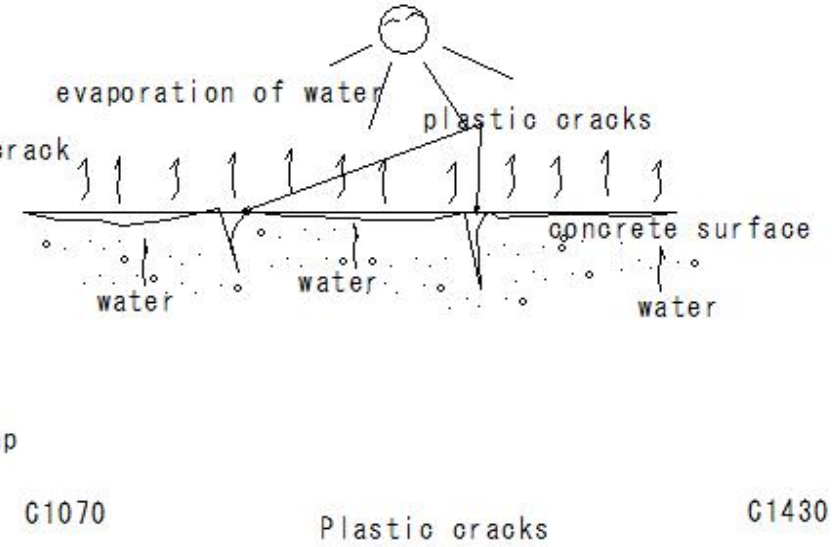
Temperature cracks, etc.

Plastic cracks: in case of the concrete has not yet hardened

Hit with a trowel, etc.



C1070



C1430

(H151)Cement concrete pavement (Initial cracks)

(H151)Cement concrete pavement (Initial cracks)

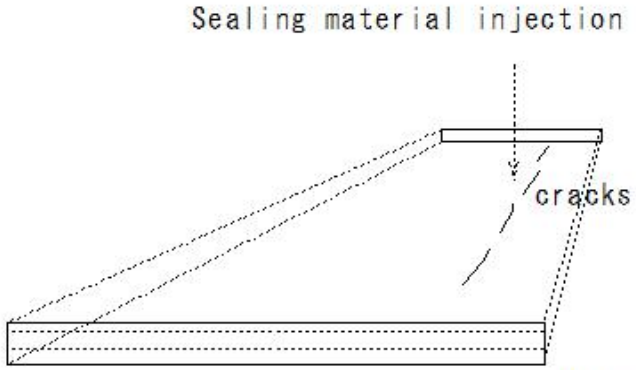
Cement concrete pavement

Construction

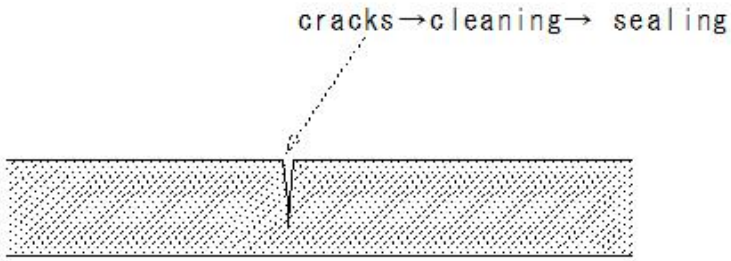
○Initial cracks

②After hardening

After cleaning cracks→ seal with polymer materials such as paraffin synthetic rubber



H116



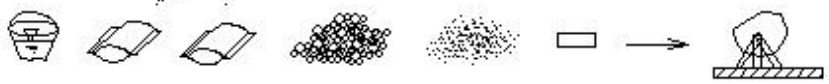
(H152)Cement concrete pavement (Initial cracks)

(H152)Cement concrete pavement (Initial cracks)

Cement concrete pavement
construction
Initial cracks
③Unit cement amount - less

① Maximum size of coarse aggregate:Gmax(mm)
② Slump:SL(cm)
③ Air volume:(%)
④ Water-cement ratio:(%)
⑤ Fine aggregate ratio:(%)
⑥ Water:(W)
⑦ Cement:(C)
⑧ Fine aggregate:(S)
⑨ Coarse aggregate :(G)
⑩ Admixture

Unit cement amount - less



	①	②	③	④	⑤	Unit amount (kg/m3) ⑥	⑦	⑧	⑨	⑩
	Gmax(mm)	SL(cm)	(%)	(%)	(%)	W	C	S	G(5～25mm) mm～mm	

Hard Mixed concrete

Soft concrete

C713

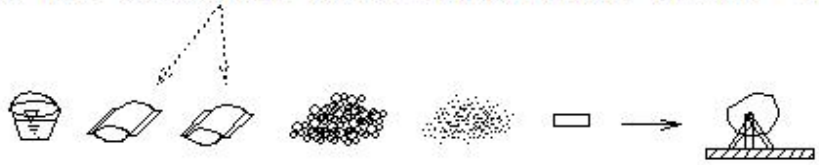
(H153)Cement concrete pavement (Initial cracks)

(H153)Cement concrete pavement (Initial cracks)

Cement concrete pavement
construction
Initial cracks
④ Heat generation amount and shrinkage amount - small cement

① Maximum size of coarse aggregate:Gmax(mm)
② Slump:SL(cm)
③ Air volume:(%)
④ Water-cement ratio:(%)
⑤ Fine aggregate ratio:(%)
⑥ Water:(W)
⑦ Cement:(C)
⑧ Fine aggregate:(S)
⑨ Coarse aggregate :(G)
⑩ Admixture

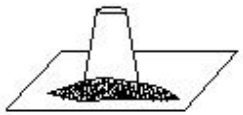
④ Heat generation amount and shrinkage amount - small cement



①	②	③	④	⑤	Unit amount (kg/m3) ⑥	⑦	⑧	⑨	⑩
Gmax(mm)	SL(cm)	(%)	(%)	(%)	W	C	S	G(5～25mm) mm～mm	

Hard Mixed concrete

Soft concrete



C713

(H154)Cement concrete pavement (Initial cracks)

(H154)Cement concrete pavement (Initial cracks)

Cement concrete pavement
construction
Initial cracks
⑤Do not use high-temperature cement (maximum 70℃)

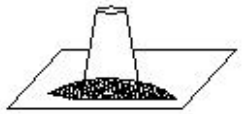
① Maximum size of coarse aggregate:Gmax(mm)
② Slump:SL(cm)
③ Air volume:(%)
④ Water-cement ratio:(%)
⑤ Fine aggregate ratio:(%)
⑥ Water:(W)
⑦ Cement:(C)
⑧ Fine aggregate:(S)
⑨ Coarse aggregate :(G)
⑩ Admixture

⑤Do not use high-temperature cement (maximum 70℃)

①	②	③	④	⑤	Unit amount (kg/m3) ⑥	⑦	⑧	⑨	⑩
Gmax(mm)	SL(cm)	(%)	(%)	(%)	W	C	S	G(5～25mm) mm～mm	

Hard Mixed concrete

Soft concrete



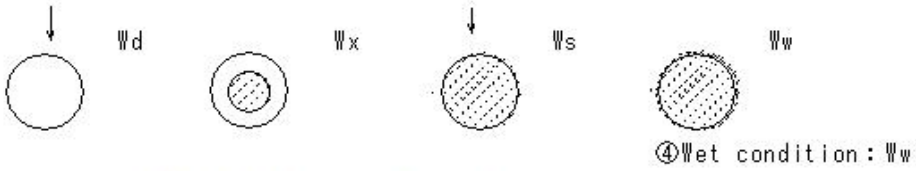
C713

(H155)Cement concrete pavement (Initial cracks)

(H155)Cement concrete pavement (Initial cracks)

Cement concrete pavement
construction
Initial cracks
⑥Aggregate → Wet condition

① Maximum size of coarse aggregate:Gmax(mm)
② Slump:SL(cm)
③ Air volume:(%)
④ Water-cement ratio:(%)
⑤ Fine aggregate ratio:(%)
⑥ Water:(W)
⑦ Cement:(C)
⑧ Fine aggregate:(S)
⑨ Coarse aggregate :(G)
⑩ Admixture



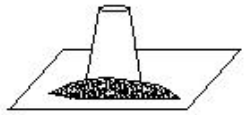
C709

⑥Aggregate → Wet condition

①	②	③	④	⑤	Unit amount (kg/m3) ⑥	⑦	⑧	⑨	⑩
Gmax(mm)	SL(cm)	(%)	(%)	(%)	W	C	S	G(5～25mm) mm～mm	

Hard Mixed concrete

Soft concrete

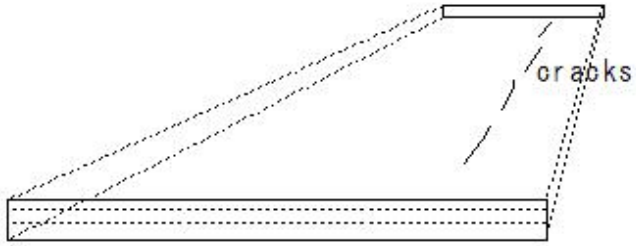


C713

(H156)Cement concrete pavement (Initial cracks)

(H156)Cement concrete pavement (Initial cracks)

Cement concrete pavement
construction
Initial cracks
⑦Unit water volume - little



H116

⑦Unit water volume - little

① Maximum size of coarse aggregate:Gmax(mm)
② Slump:SL(cm)
③ Air volume:(%)
④ Water-cement ratio:(%)
⑤ Fine aggregate ratio:(%)
⑥ Water:(W)
⑦ Cement:(C)
⑧ Fine aggregate:(S)
⑨ Coarse aggregate :(G)
⑩ Admixture

①	②	③	④	⑤	Unit amount (kg/m3) ⑥	⑦	⑧	⑨	⑩
Gmax(mm)	SL(cm)	(%)	(%)	(%)	W	C	S	G(5～25mm) mm～mm	

Hard Mixed concrete

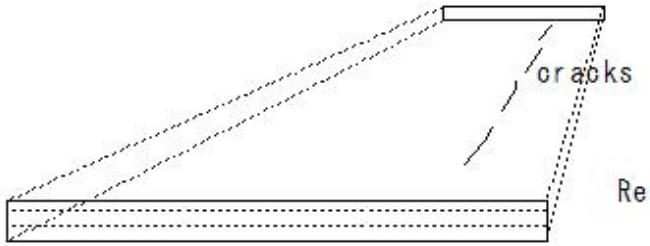
Soft concrete

C713

(H157)Cement concrete pavement (Initial cracks)

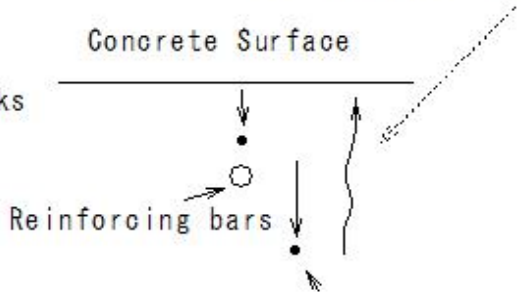
(H157)Cement concrete pavement (Initial cracks)

Cement concrete pavement
construction
Initial cracks
⑧ Mixture with less bleeding



H116

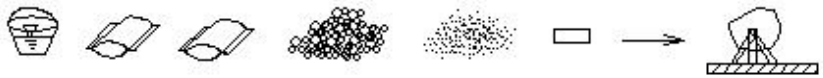
Water emerges - Bleeding



Difference in Settlement - Cracking
C309

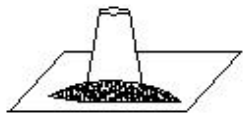
① Maximum size of coarse aggregate:Gmax(mm)
② Slump:SL(cm)
③ Air volume:(%)
④ Water-cement ratio:(%)
⑤ Fine aggregate ratio:(%)
⑥ Water:(W)
⑦ Cement:(C)
⑧ Fine aggregate:(S)
⑨ Coarse aggregate :(G)
⑩ Admixture

⑧ Mixture with less bleeding



Hard Mixed concrete

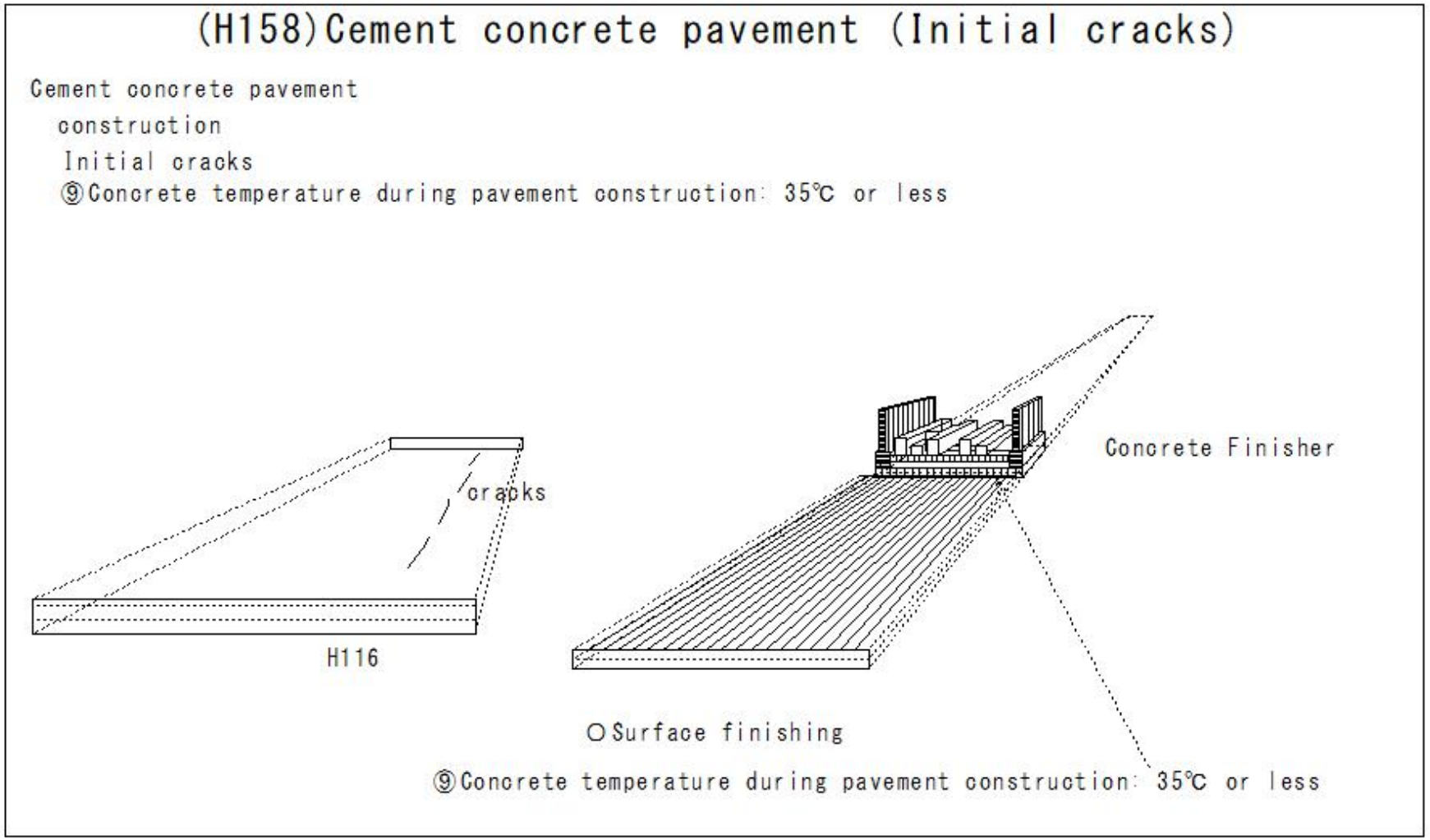
Soft concrete



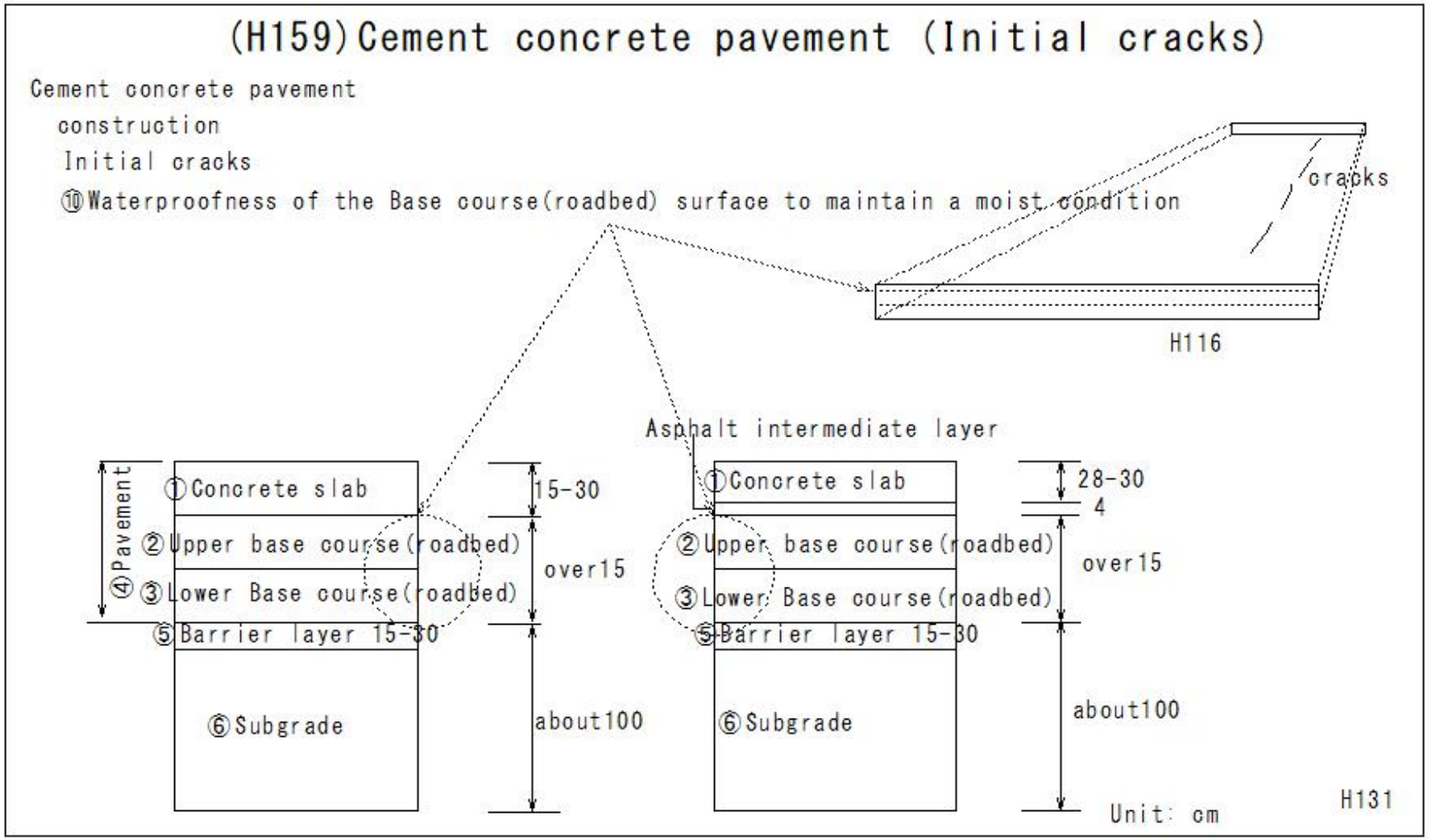
					Unit amount (kg/m3)				
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
Gmax(mm)	SL(cm)	(%)	(%)	(%)	W	C	S	G(5～25mm) mm～mm	

C713

(H158)Cement concrete pavement (Initial cracks)



(H159)Cement concrete pavement (Initial cracks)



(H160)Cement concrete pavement (Initial cracks)

(H160)Cement concrete pavement (Initial cracks)

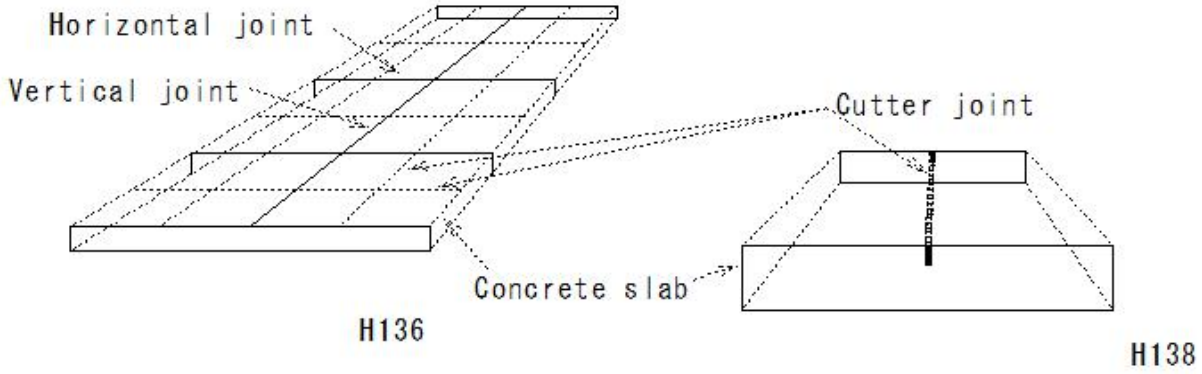
Cement concrete pavement

construction

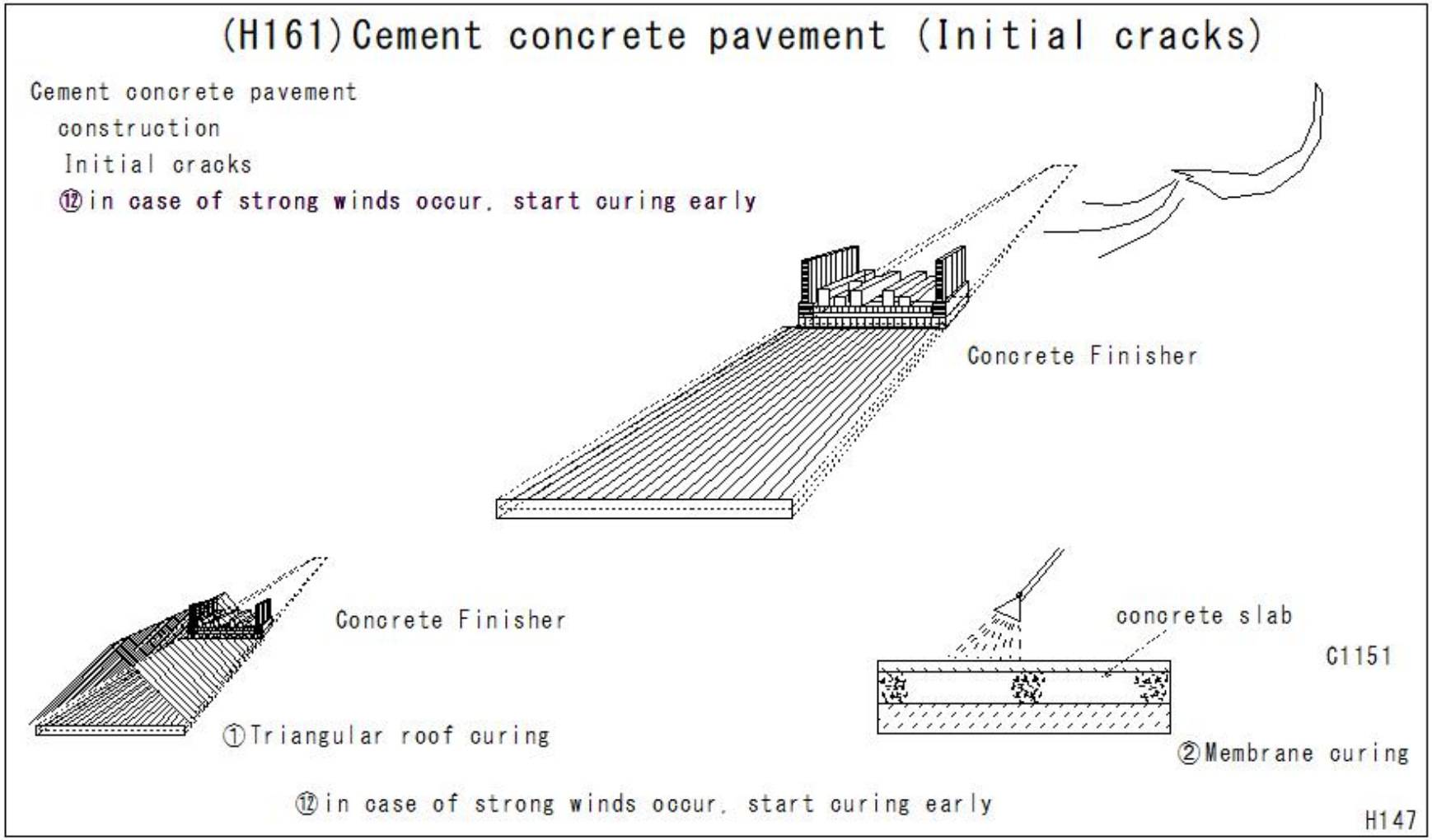
Initial cracks

⑪Cutter joints:Cut as quickly as possible

Joint cutter work involves cutting fine grooves into hard surfaces such as concrete and asphalt.



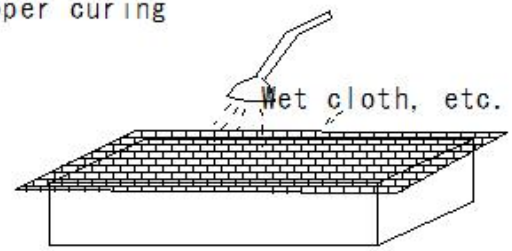
(H161)Cement concrete pavement (Initial cracks)



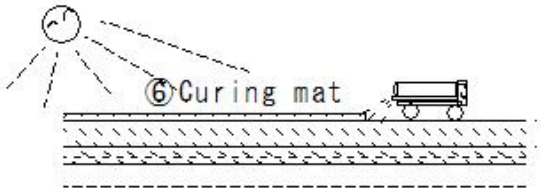
(H162)Cement concrete pavement (Initial cracks)

(H162)Cement concrete pavement (Initial cracks)

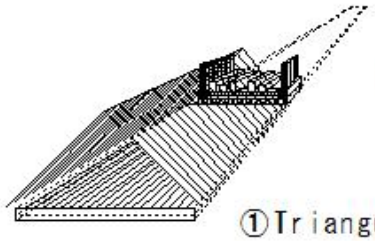
Cement concrete pavement
construction
Initial cracks
⑬Proper curing



C813

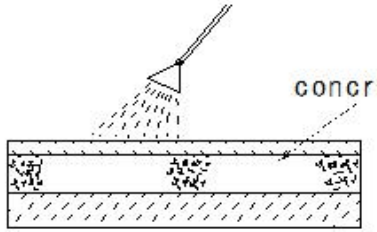


C895 H148



Concrete Finisher

①Triangular roof curing



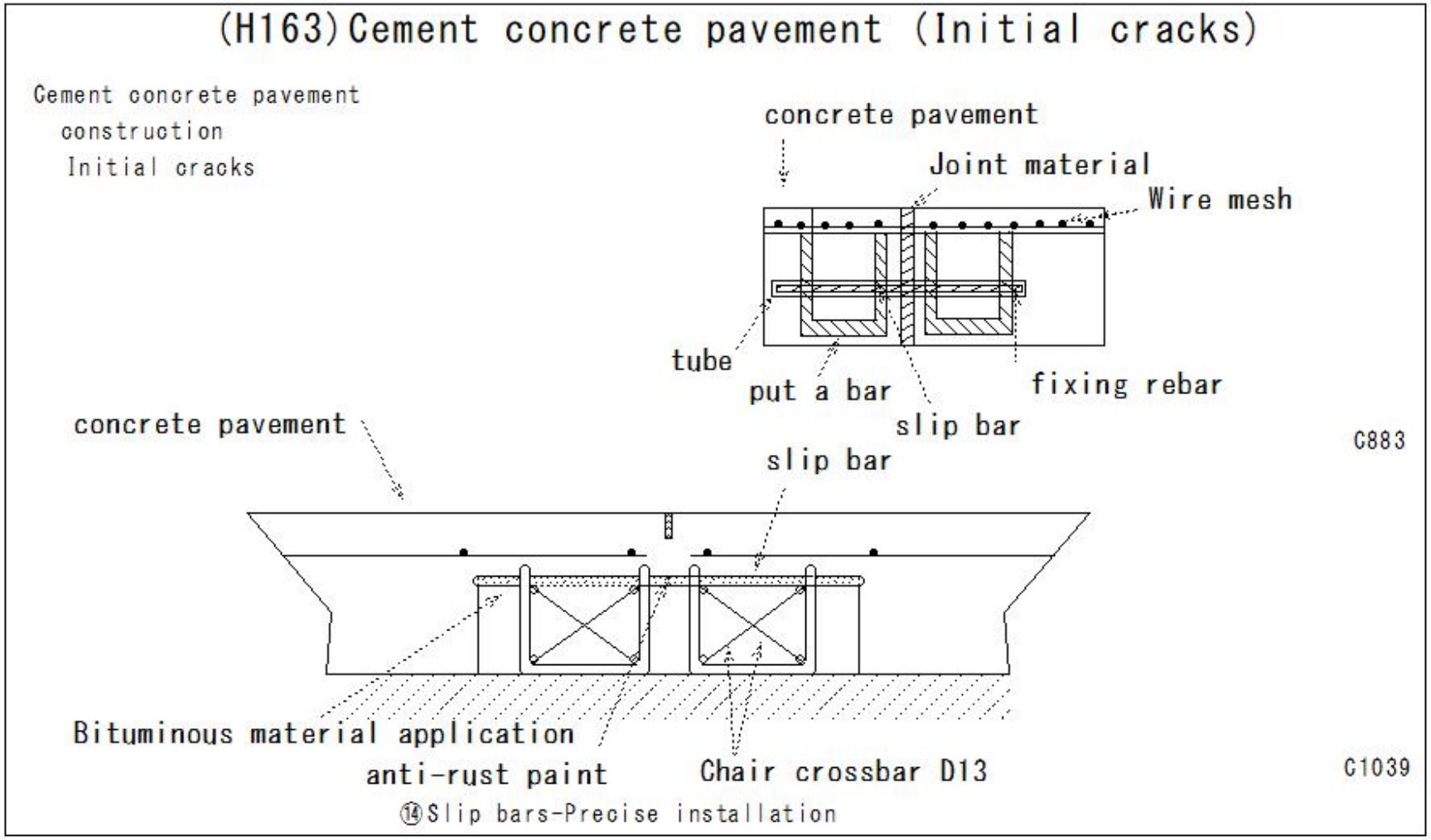
C1151

②Membrane curing

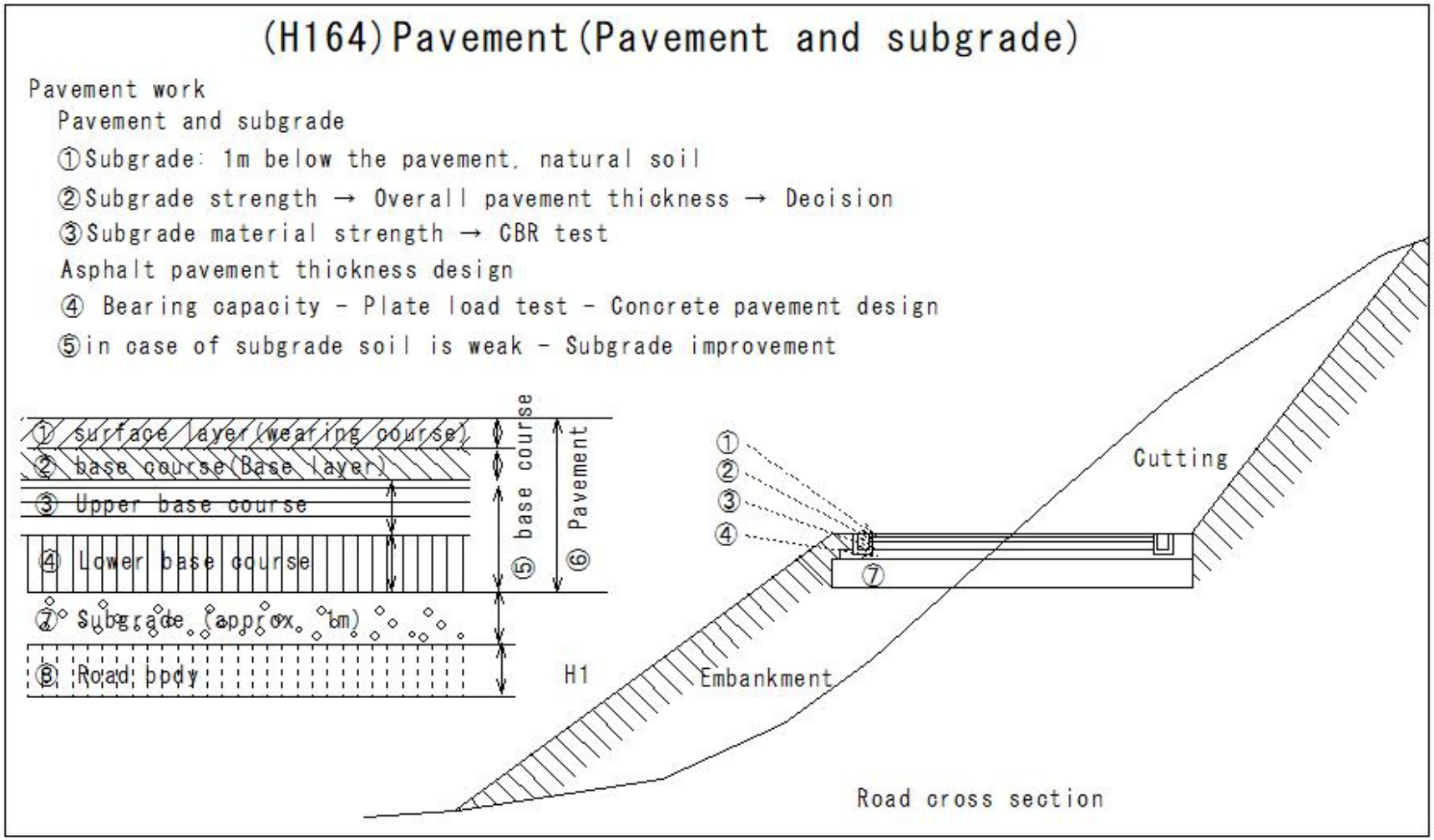
⑬Proper curing

H147

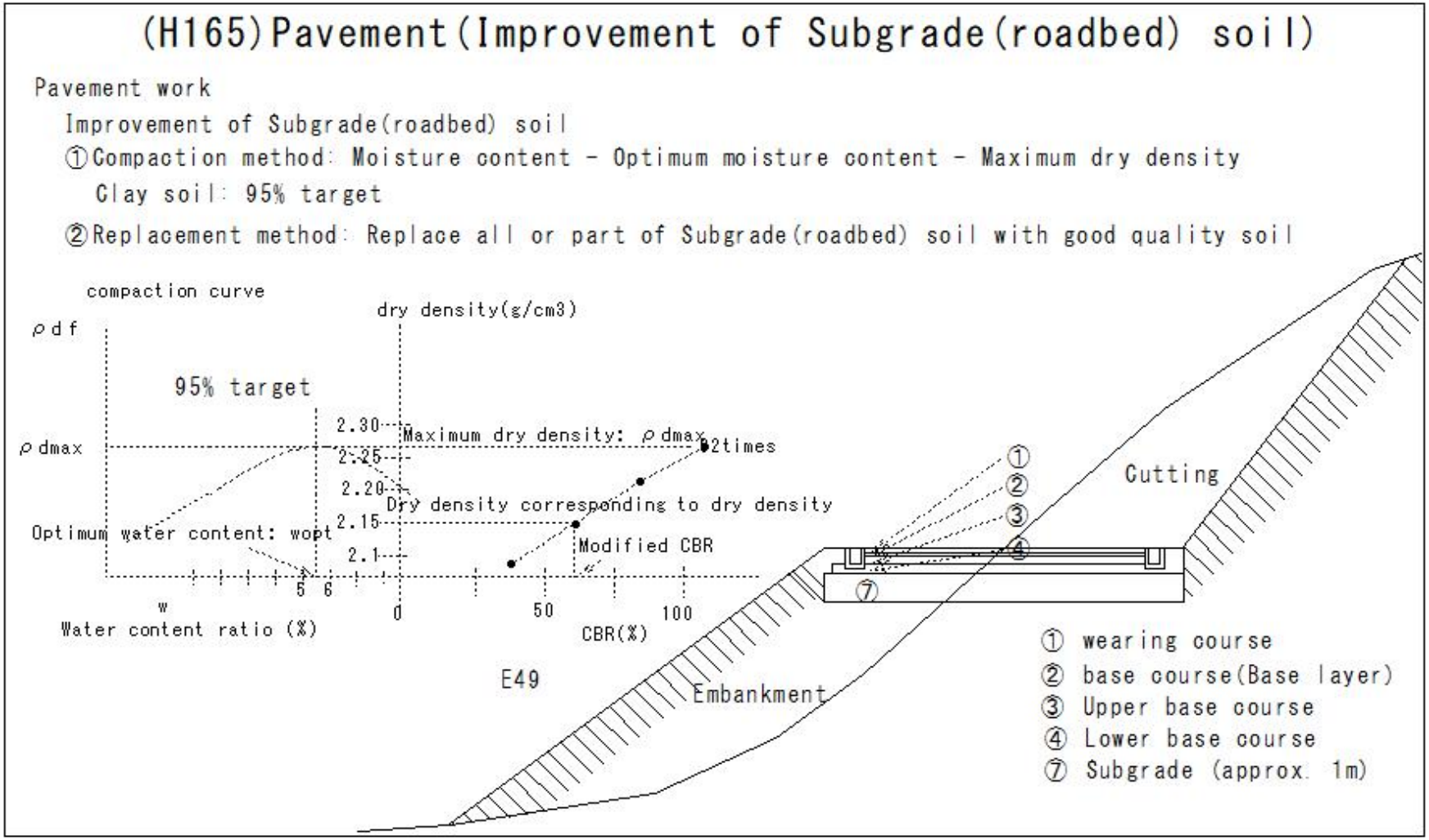
(H163)Cement concrete pavement (Initial cracks)



(H164)Pavement(Pavement and subgrade)



(H165)Pavement(Improvement of Subgrade(roadbed) soil)



(H166)Pavement(Improvement of Subgrade(roadbed) soil-Soil cement method)

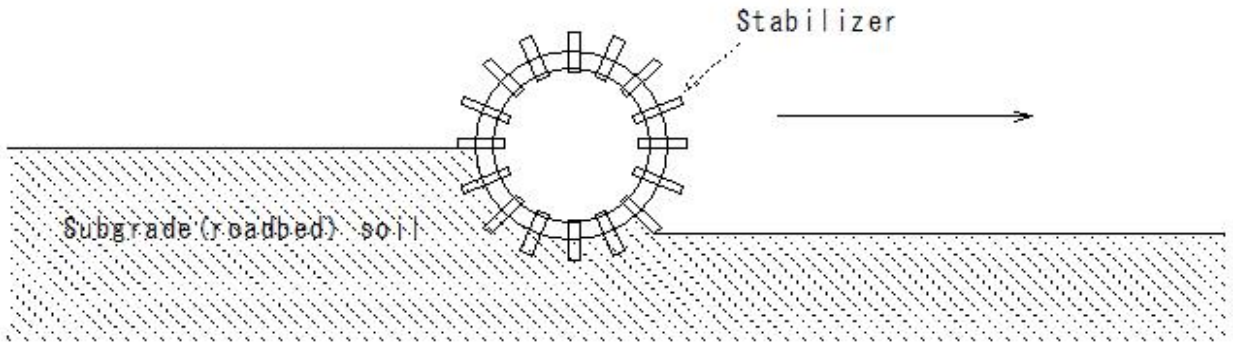
(H166)Pavement(Improvement of Subgrade(roadbed) soil-Soil cement method)

Pavement work

Improvement of Subgrade(roadbed) soil

・Soil cement method

①After shaping, crushing and preliminary water distribution



①After shaping, crushing and preliminary water distribution

・Soil cement method

(H167)Pavement(Improvement of Subgrade(roadbed) soil-Soil cement method)

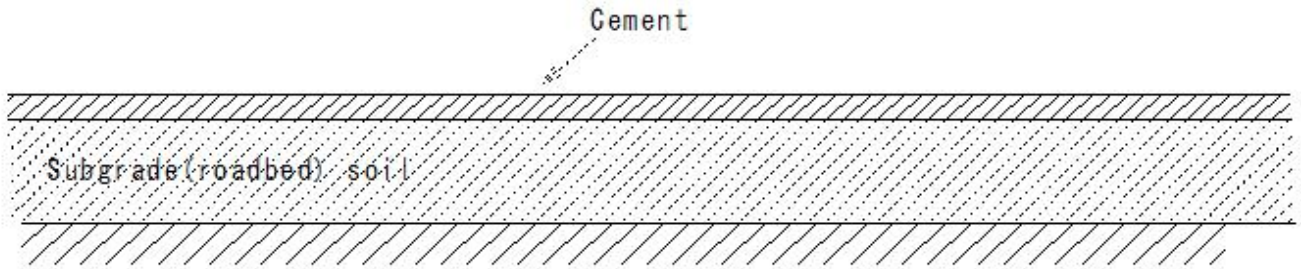
(H167)Pavement(Improvement of Subgrade(roadbed) soil-Soil cement method)

Pavement work

Improvement of Subgrade(roadbed) soil

・Soil cement method

②Spreading cement



②Spreading cement

・Soil cement method

(H168)Pavement(Improvement of Subgrade(roadbed) soil-Soil cement method)

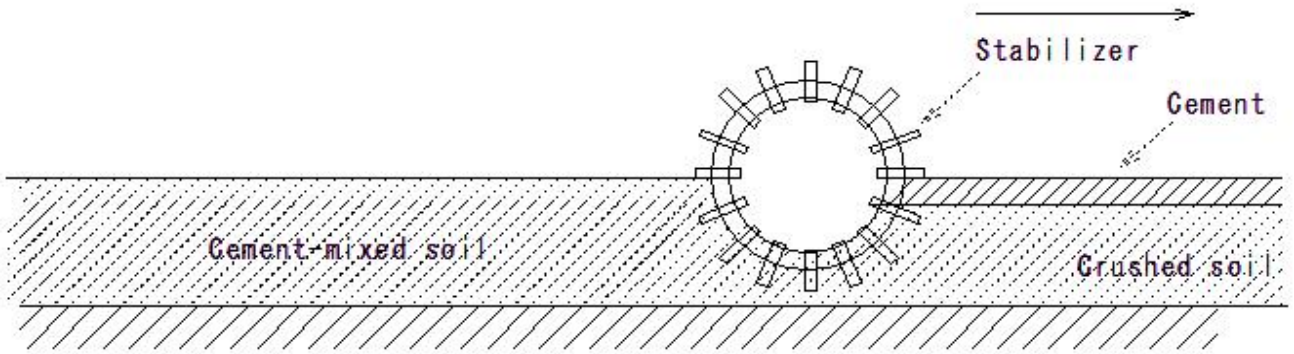
(H168)Pavement(Improvement of Subgrade(roadbed) soil-Soil cement method)

Pavement work

Improvement of Subgrade(roadbed) soil

・Soil cement method

③Mixing



③Mixing

・Soil cement method

(H169)Pavement(Improvement of Subgrade(roadbed) soil-Soil cement method)

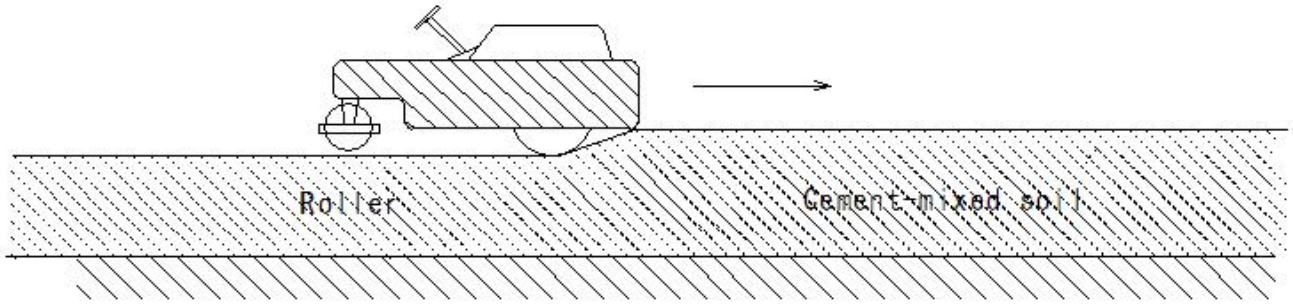
(H169)Pavement(Improvement of Subgrade(roadbed) soil-Soil cement method)

Pavement work

Improvement of Subgrade(roadbed) soil

・Soil cement method

④Compaction, finishing, curing



④Compaction, finishing, curing

・Soil cement method

(H170)Pavement(Improvement of Subgrade(roadbed) soil-Soil cement method)

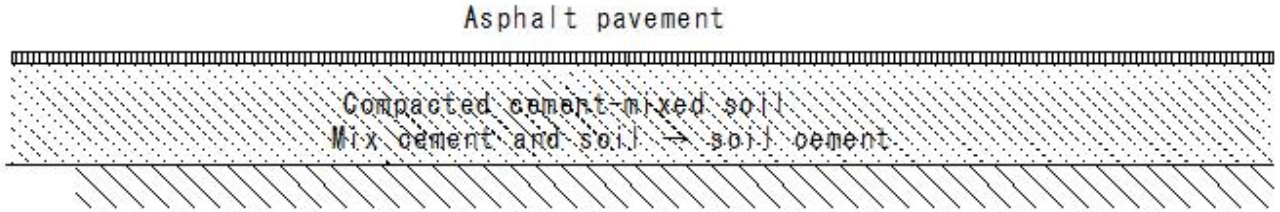
(H170)Pavement(Improvement of Subgrade(roadbed) soil-Soil cement method)

Pavement work

Improvement of Subgrade(roadbed) soil

・Soil cement method

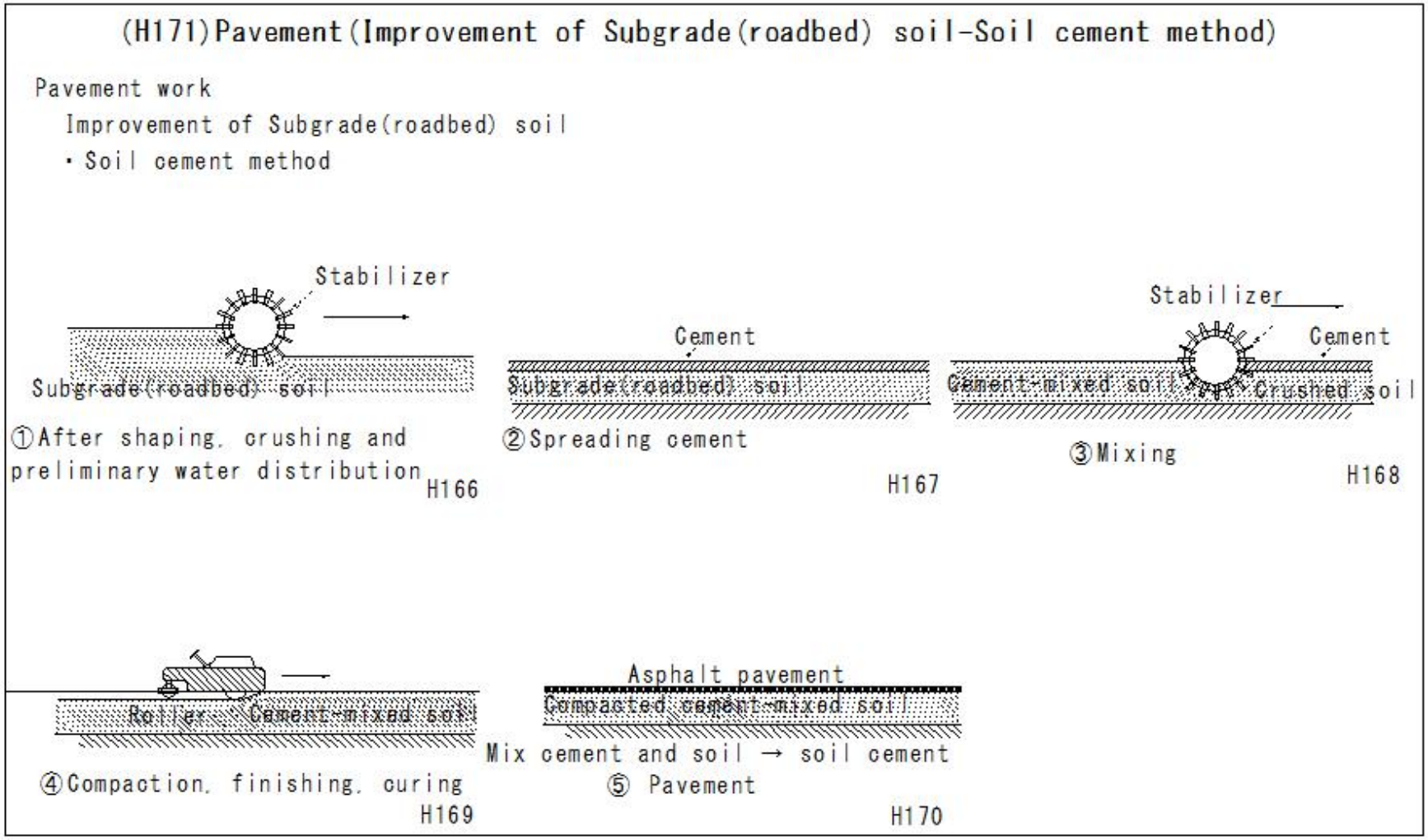
⑤ Pavement



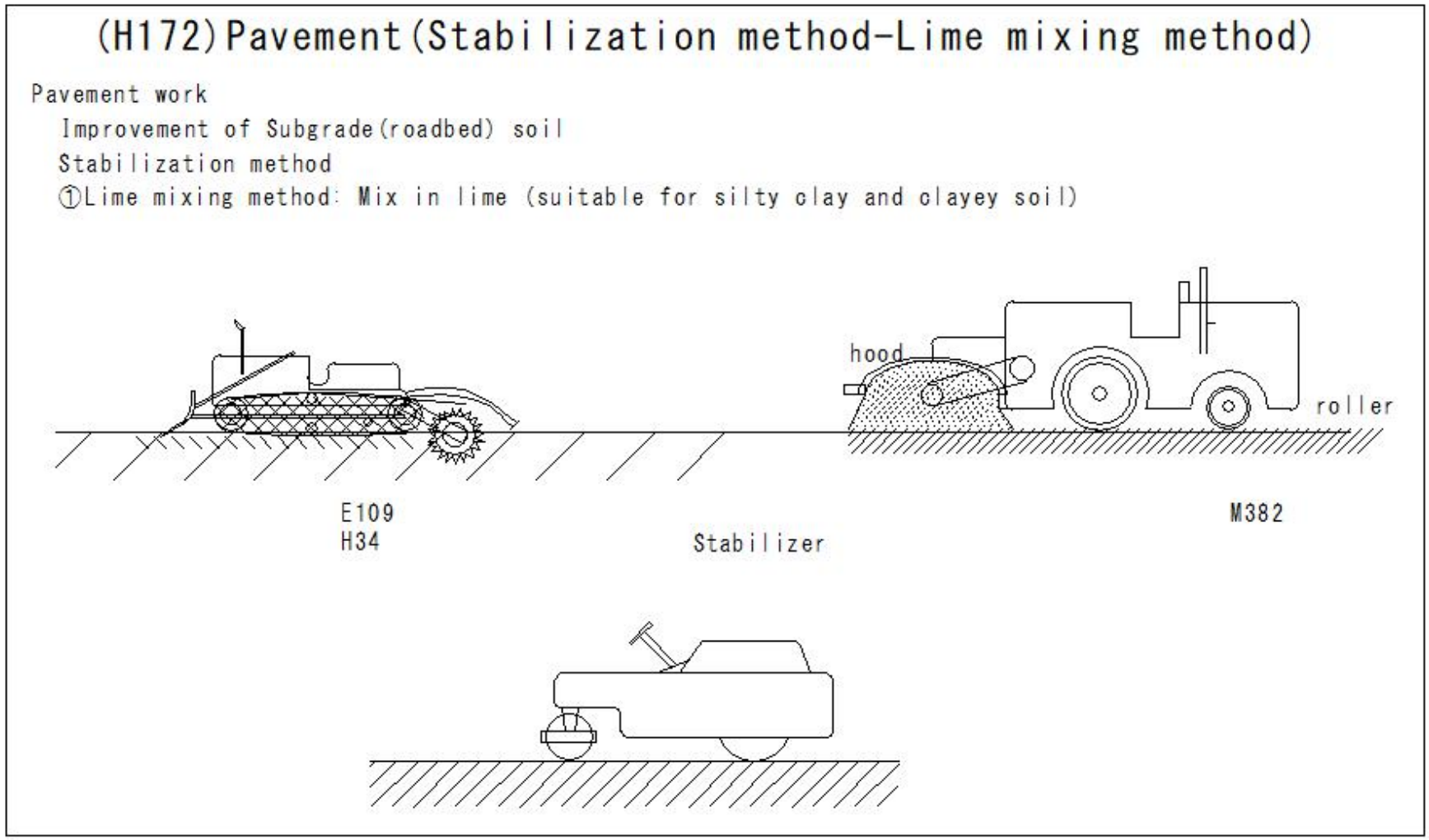
⑤ Pavement

・Soil cement method

(H171)Pavement(Improvement of Subgrade(roadbed) soil-Soil cement method)



(H172)Pavement(Stabilization method-Lime mixing method)



(H173)Pavement(Stabilization method -Bituminous material spraying method)

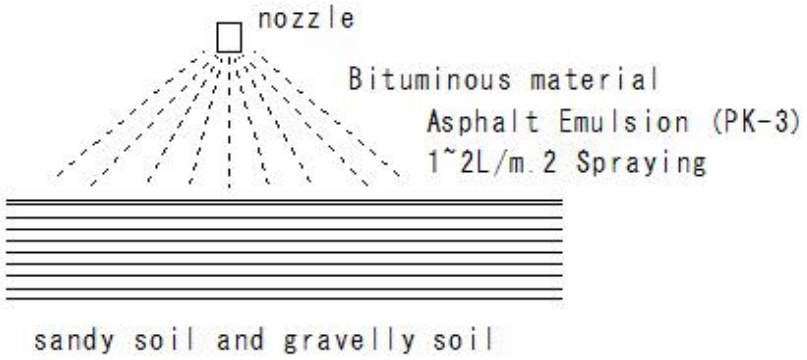
(H173)Pavement(Stabilization method -Bituminous material spraying method)

Pavement work

Improvement of Subgrade(roadbed) soil

Stabilization method

②Bituminous material spraying method: Spraying asphalt emulsion
(suitable for sandy soil and gravel soil)



H49

(H174)Pavement(Stabilization method -Chemical injection method)

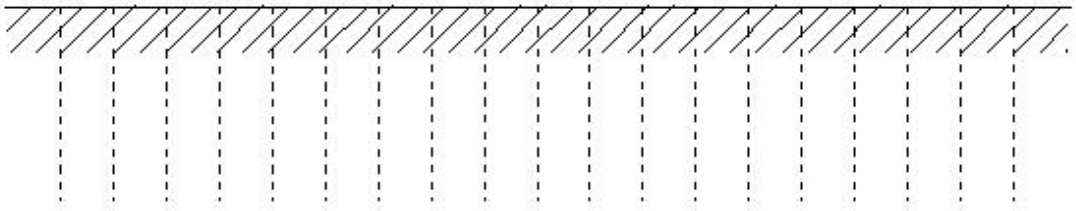
(H174)Pavement(Stabilization method -Chemical injection method)

Pavement work

Improvement of Subgrade(roadbed) soil

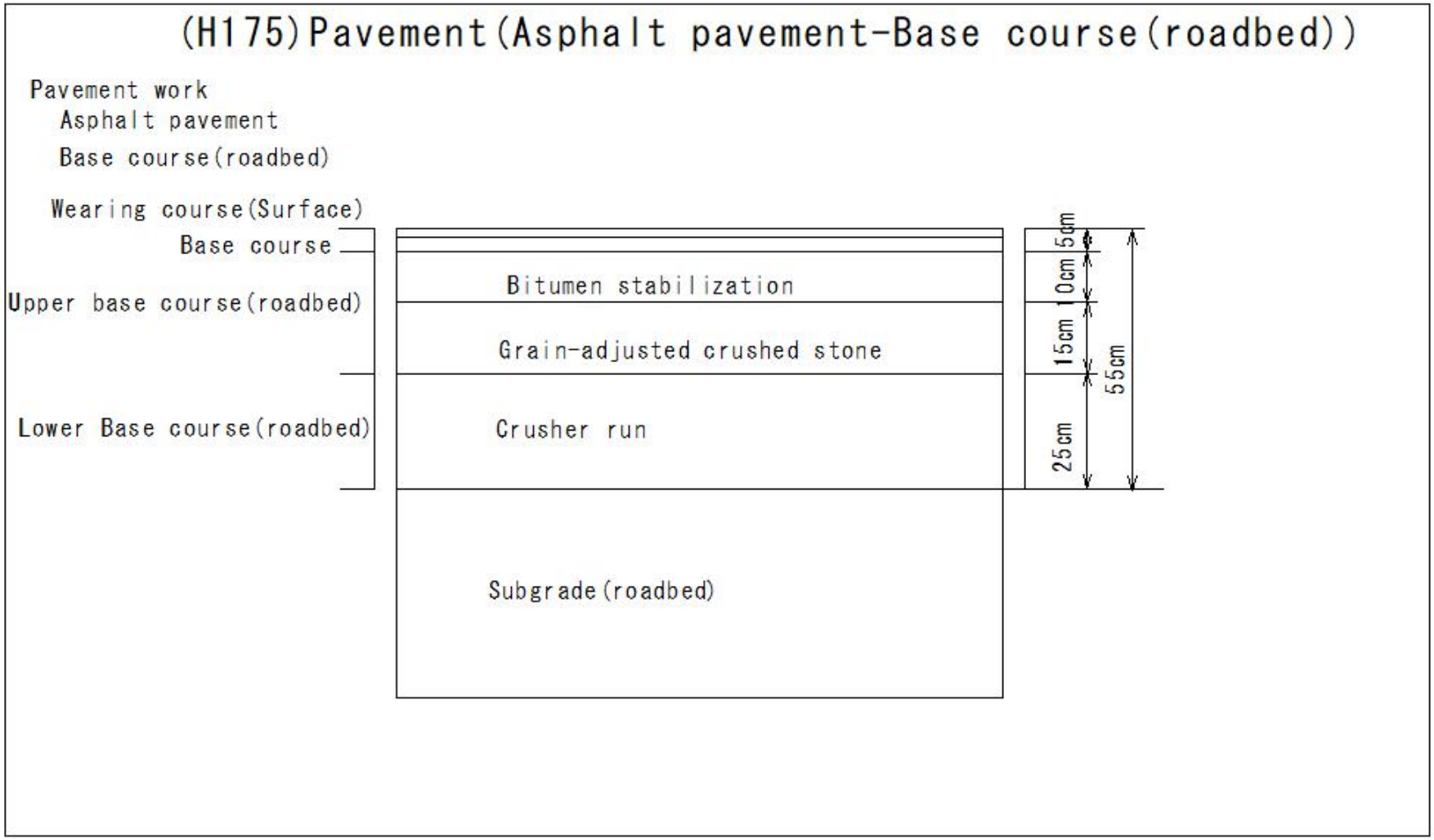
Stabilization method

③Chemical injection method: Inject synthetic resin, water glass, and lignin into the soil



③Chemical injection method

(H175)Pavement(Asphalt pavement-Base course(roadbed))



(H176)Pavement(Asphalt pavement-Lower Base course(roadbed))

(H176)Pavement(Asphalt pavement-Lower Base course(roadbed))

Pavement work

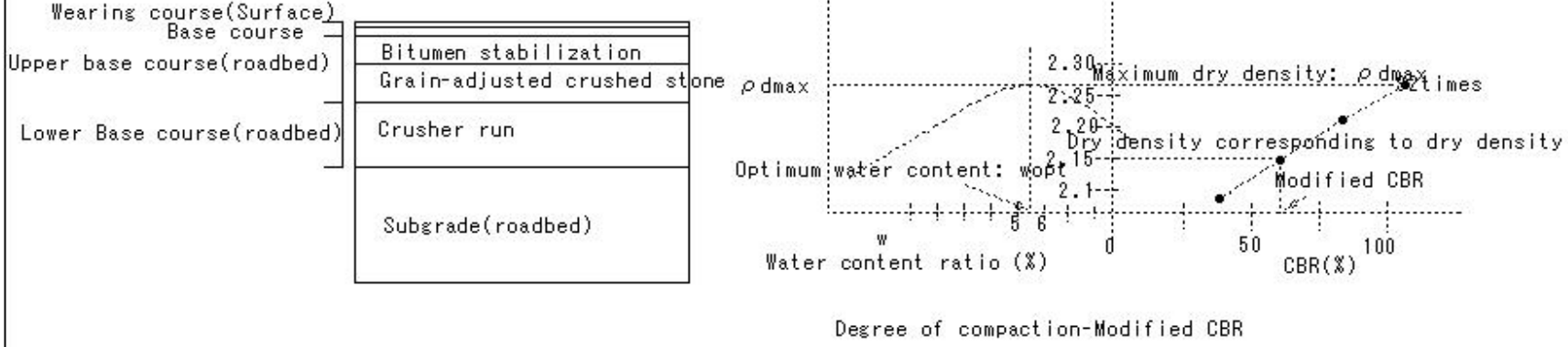
Base course(roadbed)

・Lower Base course(roadbed)

Use materials that are close to the site and economically easy to obtain

Modified CBR 20 or more materials

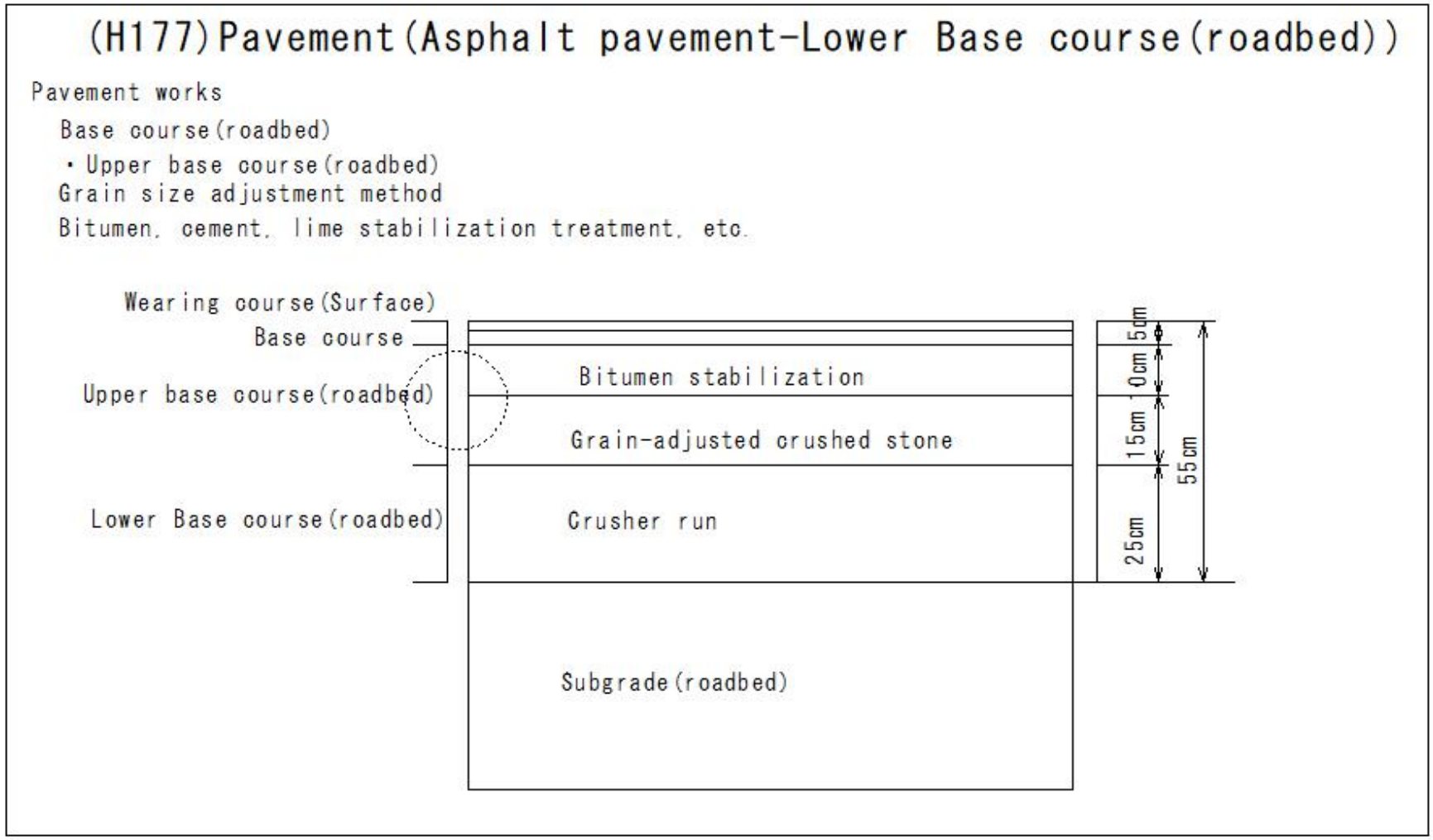
Grain size adjustment Stabilization treatment - modified CBR of 10 or higher - Compaction



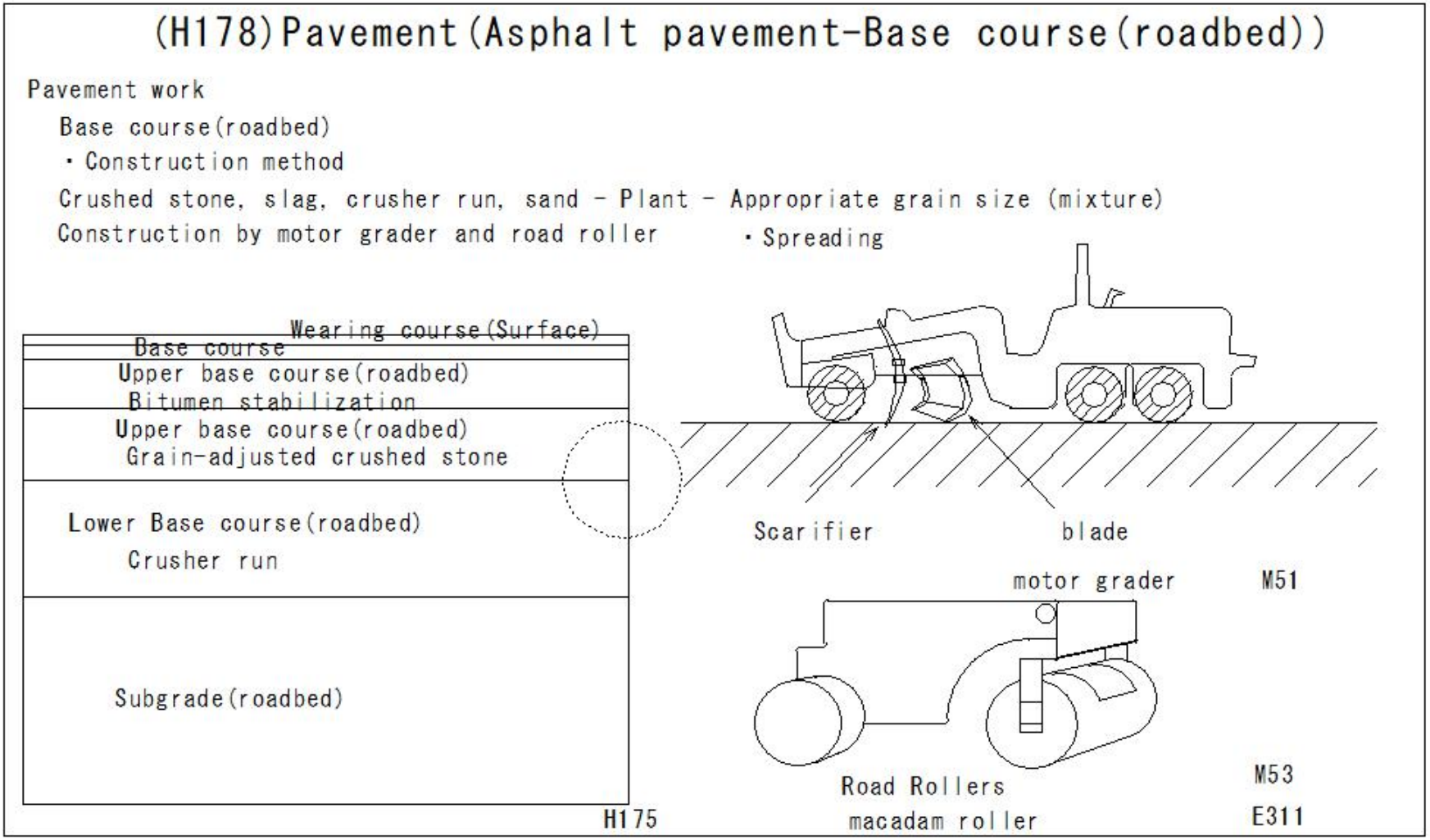
Degree of compaction-Modified CBR

E49

(H177)Pavement(Asphalt pavement-Lower Base course(roadbed))



(H178)Pavement(Asphalt pavement-Base course(roadbed))



(H179)Pavement(Concrete pavement: Base course(roadbed))

(H179)Pavement(Concrete pavement: Base course(roadbed))

Pavement work

Base course(roadbed)

・Concrete pavement: Base course(roadbed)

① Supports the weight of the concrete slab and traffic load, and transfers the load to the roadbed

② Base course(roadbed) thickness: 15-30cm, single layer
30cm or more, constructed in two layers

③ Lower Base course(roadbed) material: cut gravel, crusher run, sand, slag

④ Upper base course(roadbed): Gradient-adjusted crushed stone, grain-adjusted slag, cement stabilization material

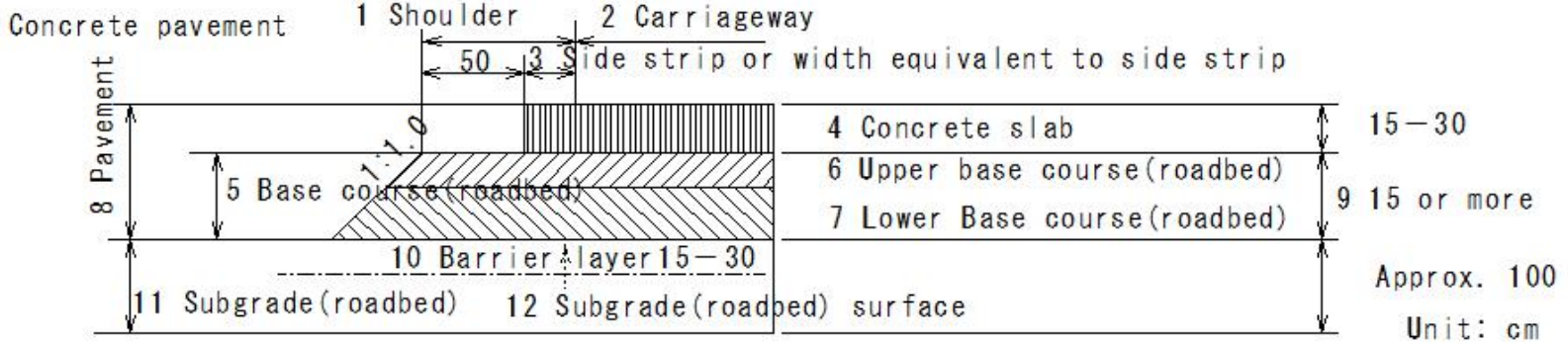
⑤ Concrete slab: High rigidity

・Concrete Young's modulus of the roadbed: 2.55*10^4 to 3.92*10^4N/mm2

・Young's modulus of the Base course(roadbed) material: 98 to 294N/mm2

⑥The concrete slab is supported only vertically

1kgf/cm2≒0.098N/mm2



(H180)Pavement(Asphalt Pavement)

(H180)Pavement(Asphalt Pavement)

Asphalt Pavement

Asphalt

①Straight asphalt

Fluidity, viscosity - road paving, etc.

②Blown asphalt

Used as insulation material, etc.

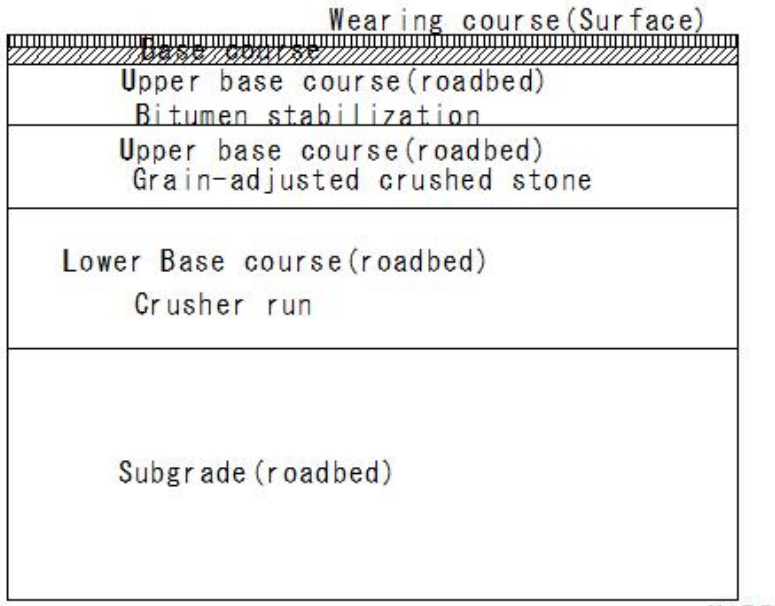
③Asphalt emulsion

④Remiphalt

Storage - possible

Backfilling of road surface

Convenient for patching



H175

(H181)Pavement(Asphalt Pavement-Comparison between straight and blown asphalt)

(H181)Pavement(Asphalt Pavement-Comparison between straight and blown asphalt)

Pavement works

Asphalt

Comparison between straight and blown asphalt

①Type	⑩Straight	⑪Blown
	②Properties	
③Specific gravity	1.01～1.04	1.02～1.05
④Softening point	35～60℃	70～130℃
⑤Elongation	100 over(25℃)	10below (25℃)
⑥Penetration	60～80	5 below
⑦Adhesive strength	Large	Small
⑧Emulsification	Good	Bad
⑨Uses	Road paving	Waterproofing material, joint material

(H182)Pavement(Asphalt Pavement-Aggregate)

(H182)Pavement(Asphalt Pavement-Aggregate)

Pavement

Asphalt

・Aggregate

Coarse aggregate: crushed stone, blast furnace slag, etc., which are retained on a 2.5 mm sieve

① No. 5 aggregate (S-20): Maximum grain size 20 mm

② No. 6 aggregate (S-13): Maximum grain size 13 mm

③ No. 7 aggregate (S-5): Maximum grain size 5 mm

・Fine aggregate

Sea sand, crushed sand, screenings

Sand: Passes 2.5 mm - retains on a 0.074 mm sieve

Screenings - 2.36 mm or less

・Filler

Limestone powder, calcium chloride, etc. - passes through a 0.074 mm sieve

・Mix

3 types of coarse aggregate by grain size

2 types of fine aggregate by grain size

1 type of filler is mixed

(H183)Pavement(Asphalt Pavement-Asphalt mixture)

(H183)Pavement(Asphalt Pavement-Asphalt mixture)

Pavement work

Asphalt mixture

Asphalt, aggregate, and filler (stone powder) are mixed at a heating temperature (180℃)

Types

① Coarse-grained asphalt mixture

A mix used in the base layer of general asphalt pavement, with a sieve passing rate of 2.36 mm in the particle size range of 20-35%.

② Dense-grained asphalt mixture

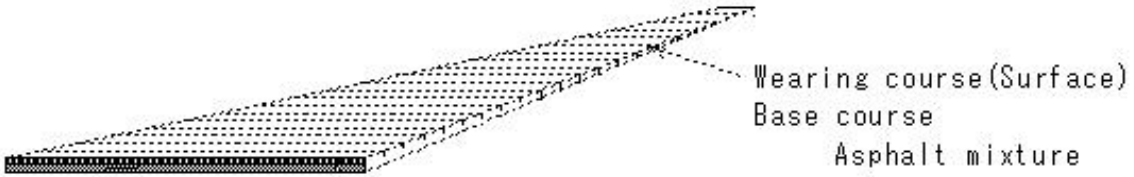
used in general areas and on steep slopes.

③ Fine-grained asphalt mixture

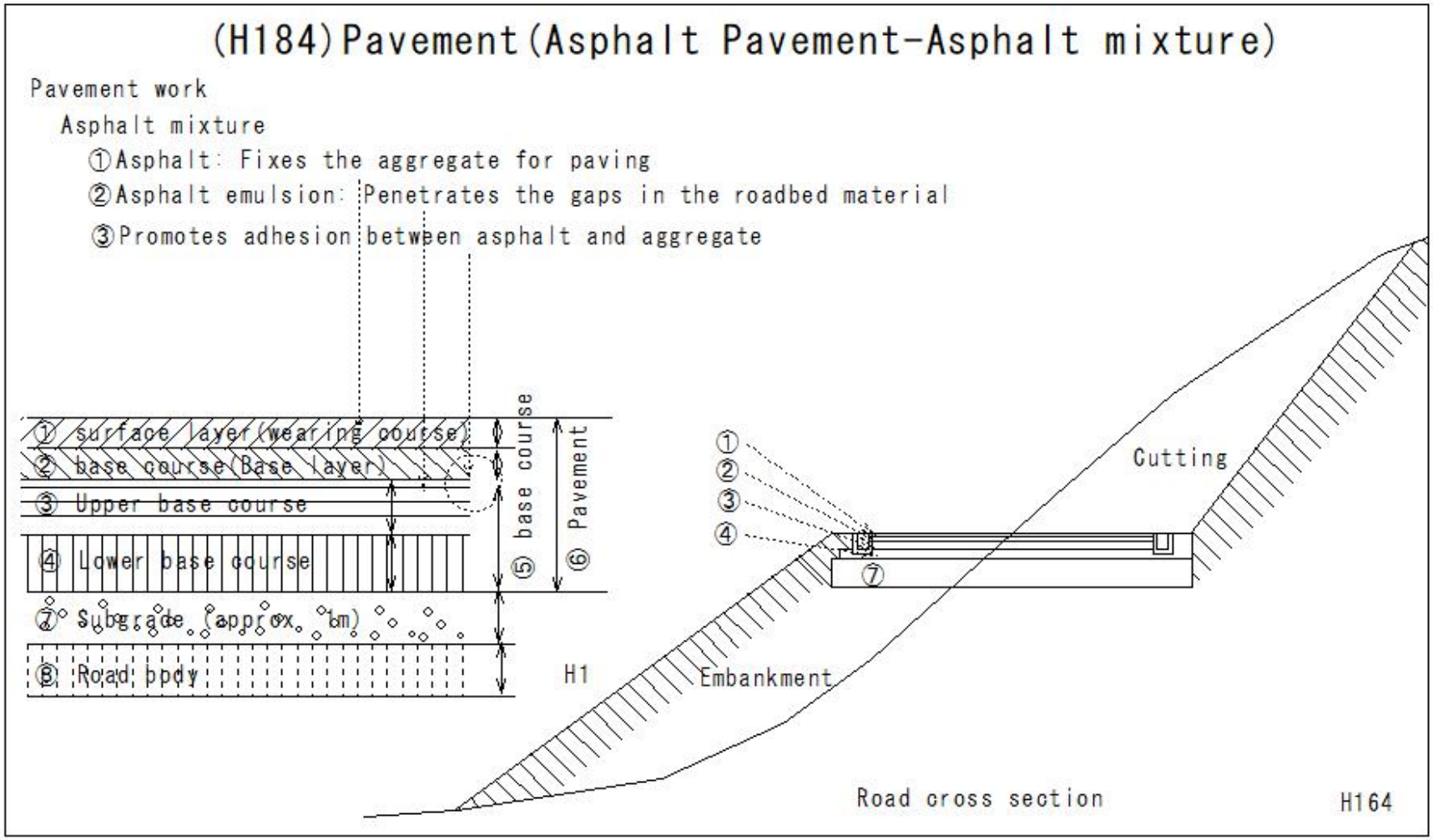
It may be used as a wearing course or as the surface course of pedestrian road pavements.

④ Open-grained asphalt mixture

It is used on roadways as an anti-slip surface and as a permeable surface.



(H184)Pavement(Asphalt Pavement-Asphalt mixture)



(H185)Pavement(Asphalt Pavement-Asphalt road surface)

(H185)Pavement(Asphalt Pavement-Asphalt road surface)

Pavement work

Asphalt road surface

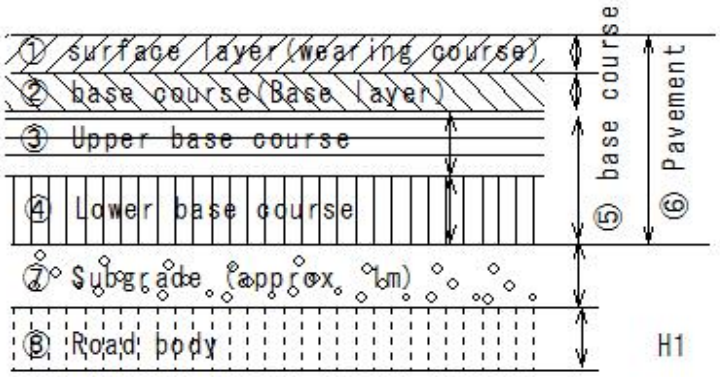
Wearing course(Surface)、Base course

①Top of pavement Wearing course(Surface)、Base course: Asphalt mixture

②Asphalt mixture: Resists only shear forces

Does not resist bending - flexible pavement

③Pavement material using bituminous material - Asphalt mixture



(H186)Pavement(Asphalt Pavement-Asphalt road surface)

(H186)Pavement(Asphalt Pavement-Asphalt road surface)

Pavement works

Asphalt road surface

①Type	②Use	③Percentage passing 2.5mm sieve
④Open-graded asphalt mixture	⑩For wear layer	15～30%
⑤Coarse-graded asphalt mixture	⑪For base layer	20～35%
⑥Dense-graded asphalt mixture	⑫For surface layer	35～50%
⑦Fine-graded asphalt mixture	⑬For surface layer	50～80%
⑧Dense-graded gap asphalt mixture	⑭For surface layer	Gap asphalt made from
⑨Fine-graded gap asphalt mixture	⑮For wear layer	discontinuous grading

(H187)Pavement(Asphalt road surface-Semi-flexible pavement)

(H187)Pavement(Asphalt road surface-Semi-flexible pavement)

Pavement

Asphalt road surface

Semi-flexible pavement

①Density - Gaps in coarse asphalt mixture - Highly fluid cement milk penetrates

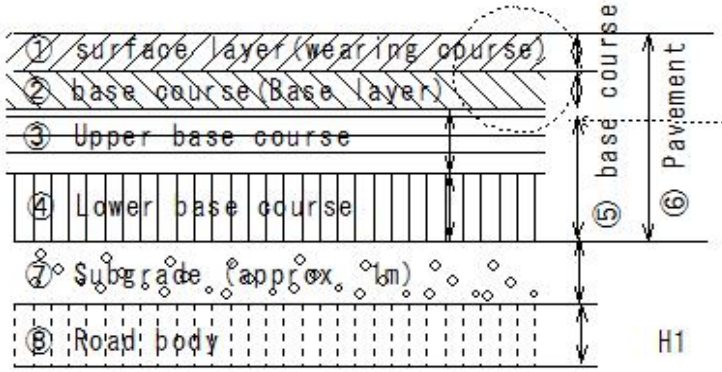
Bituminous pavement: Speed ??of construction

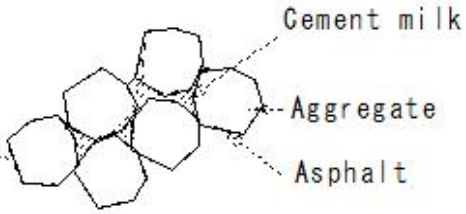
Concrete pavement: Strength

②Excellent resistance to fluidity and oil

Intersection Bus terminal pavement

③Surface - Covered with cement milk





Asphalt mixture

Semi-flexible pavement

(H188)Pavement(Asphalt road surface-Permeable pavement)

(H188)Pavement(Asphalt road surface-Permeable pavement)

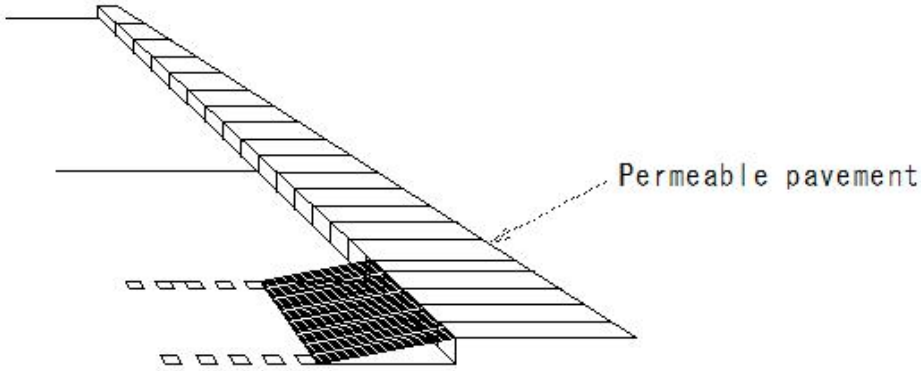
Pavement work

Asphalt road surface

○Permeable pavement

Paved part of sidewalk - no puddles - easy to walk

Coarse bituminous pavement with good density of permeability



E600

(H189)Pavement(Asphalt road surface-Colored pavement)

(H189)Pavement(Asphalt road surface-Colored pavement)

Pavement work

Asphalt road surface

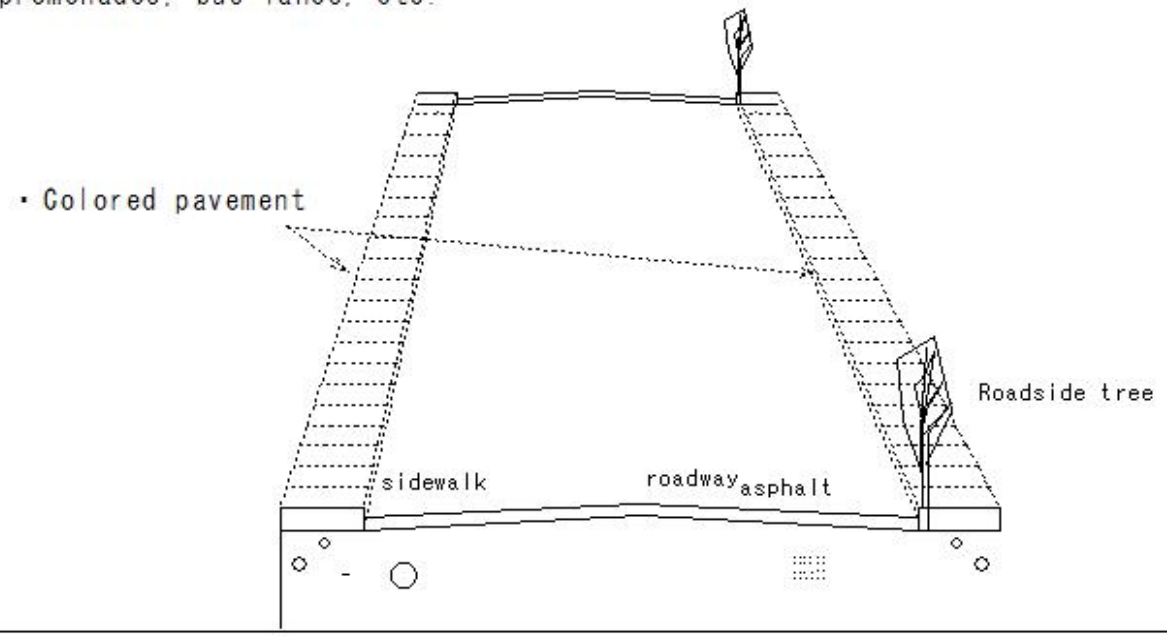
・Colored pavement

①Asphalt mixture + pigment (coloring material)

②Harmony with the streetscape, beauty, scenery, traffic safety measures

Improvement of road functions

③Paving of park roads, promenades, bus lanes, etc.



F124

(H190)Pavement(Asphalt road surface-Macadam method)

(H190)Pavement(Asphalt road surface-Macadam method)

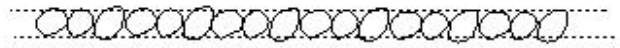
Pavement work

Asphalt road surface

①Macadam method

A method of spreading bitumen (asphalt emulsion) on a laid aggregate (crushed stone) of a single grain size

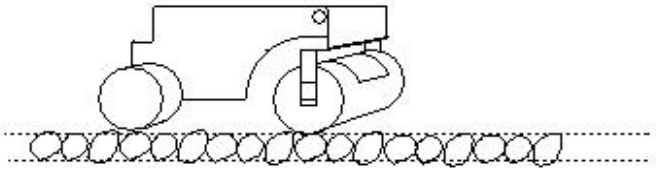
Macadam method



Water + crushed stone mixture - spraying

Laying the main aggregate

Crushed stone (diameter 20 mm or less)



Compaction poured with water

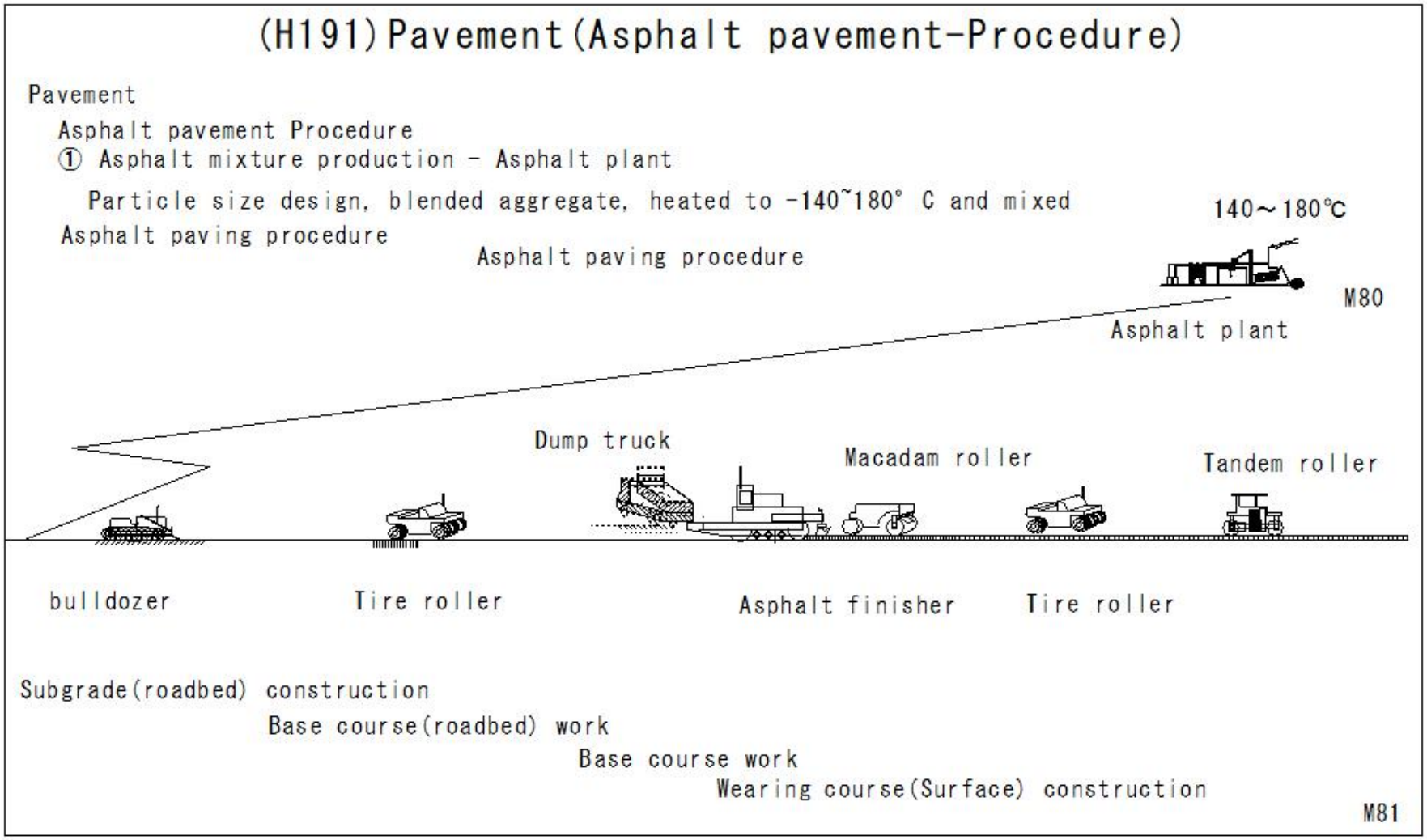
Last-5-13mm crushed stone spraying finish

macadam roller

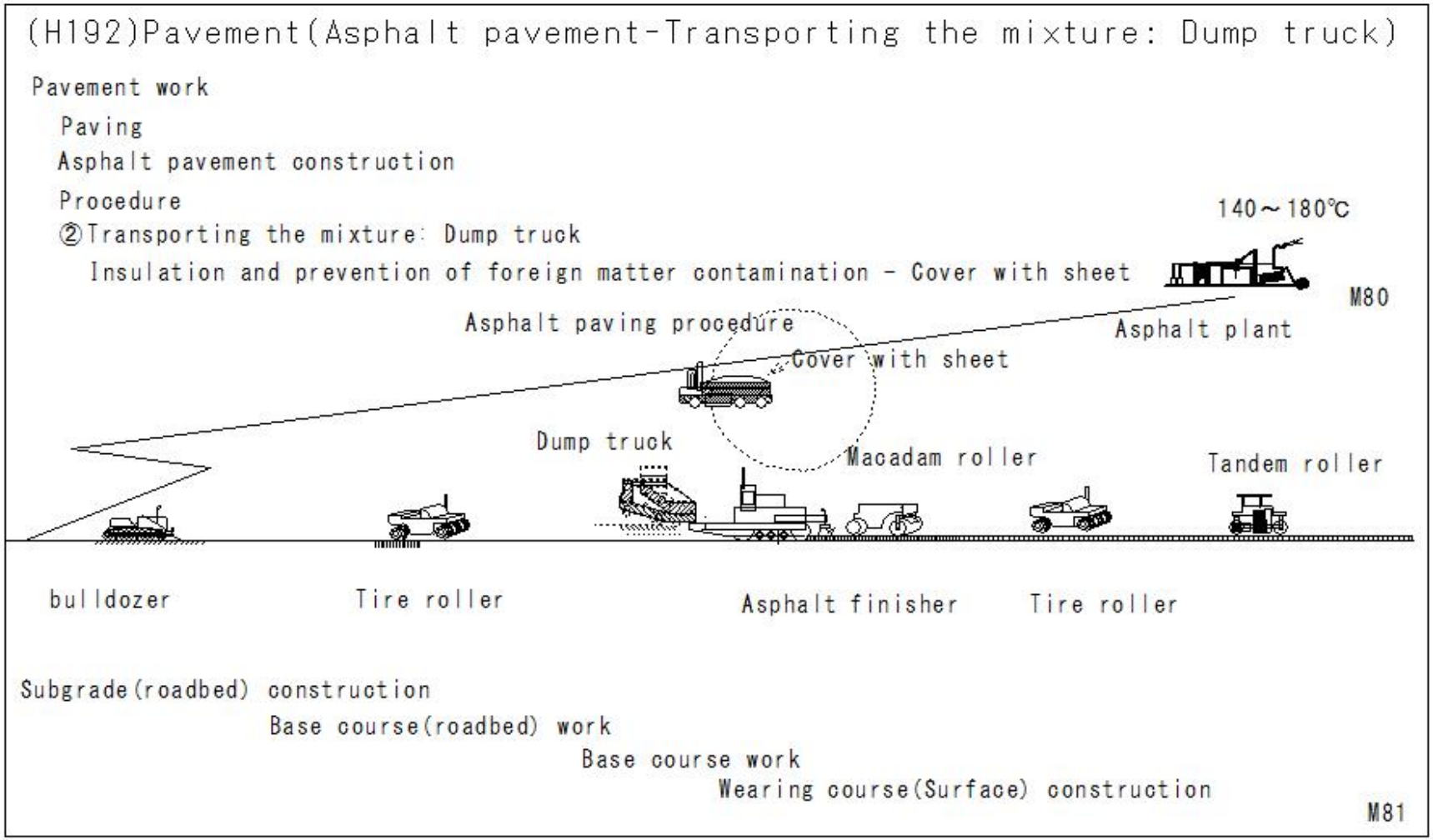
Compaction with macadam rollers

E625

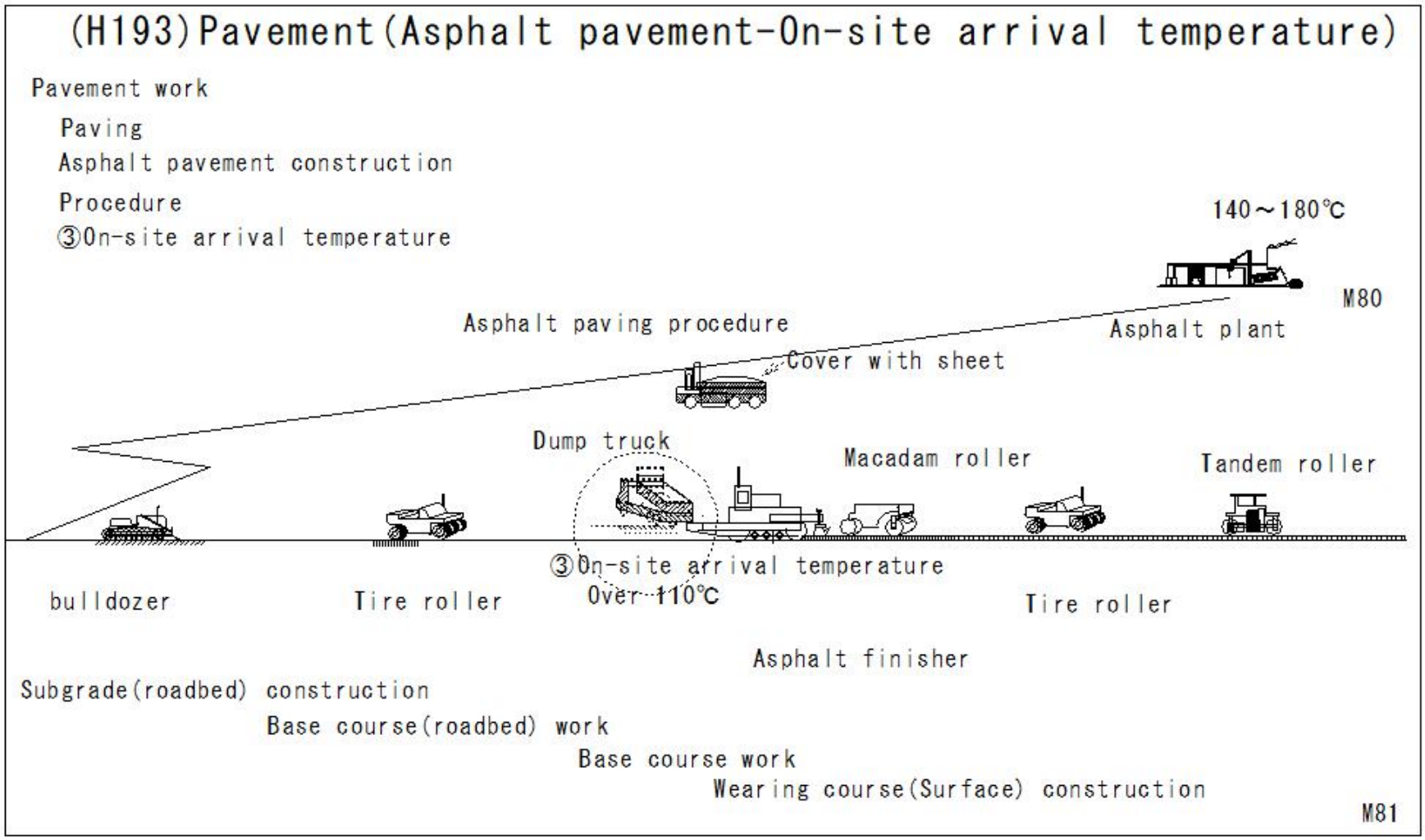
(H191)Pavement(Asphalt pavement-Procedure)



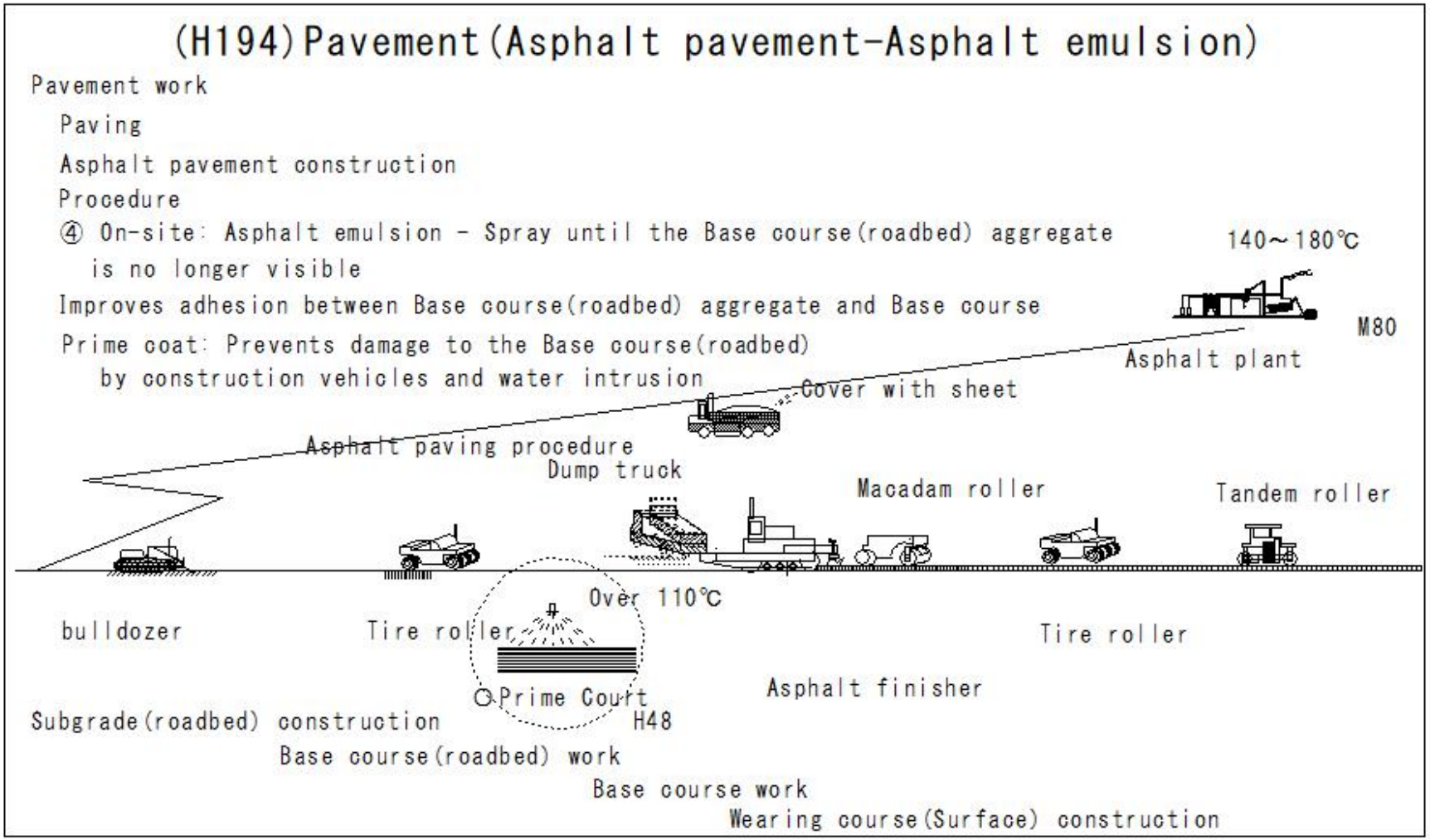
(H192)Pavement(Asphalt pavement-Transporting the mixture: Dump truck)



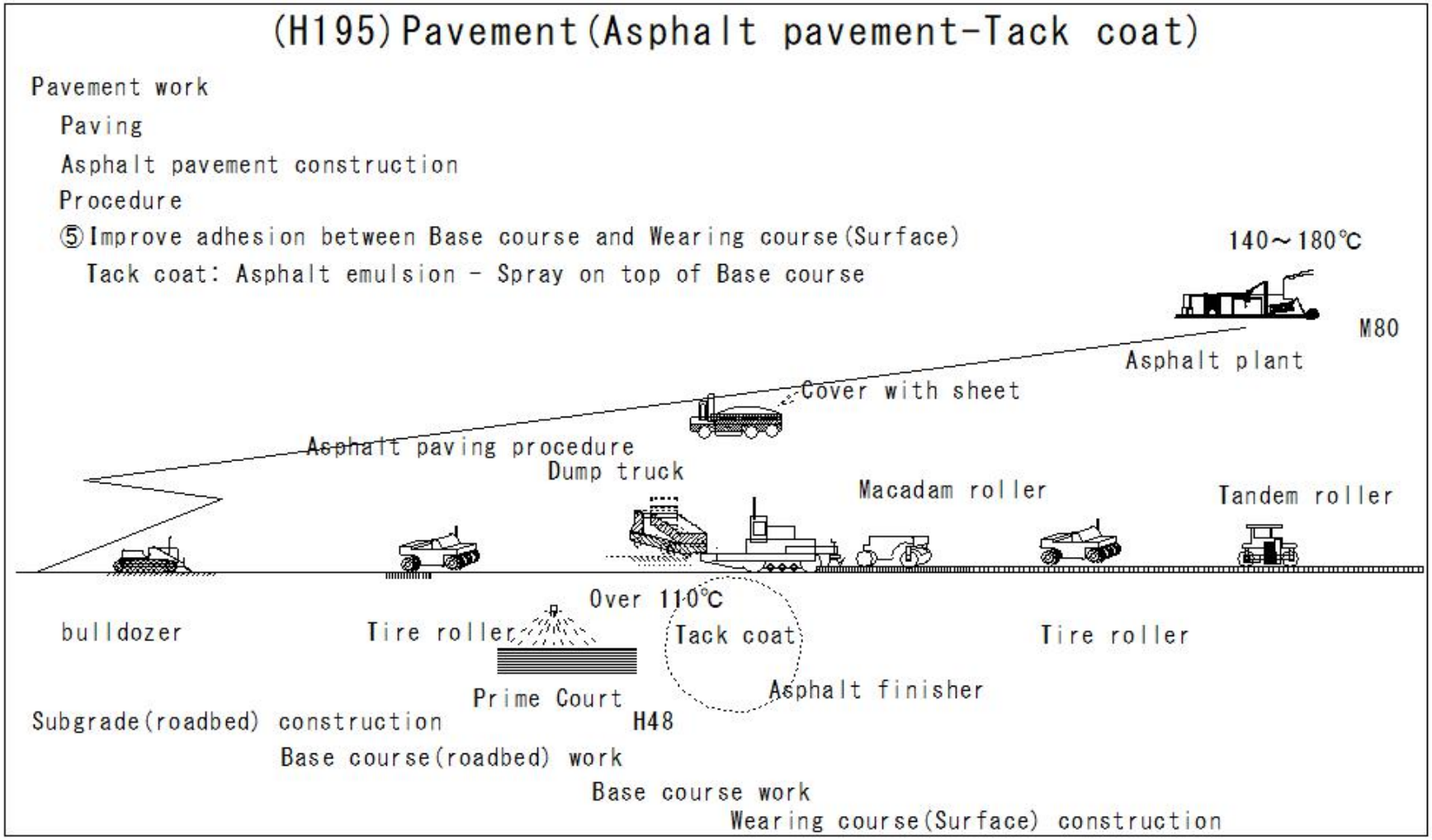
(H193)Pavement(Asphalt pavement-On-site arrival temperature)



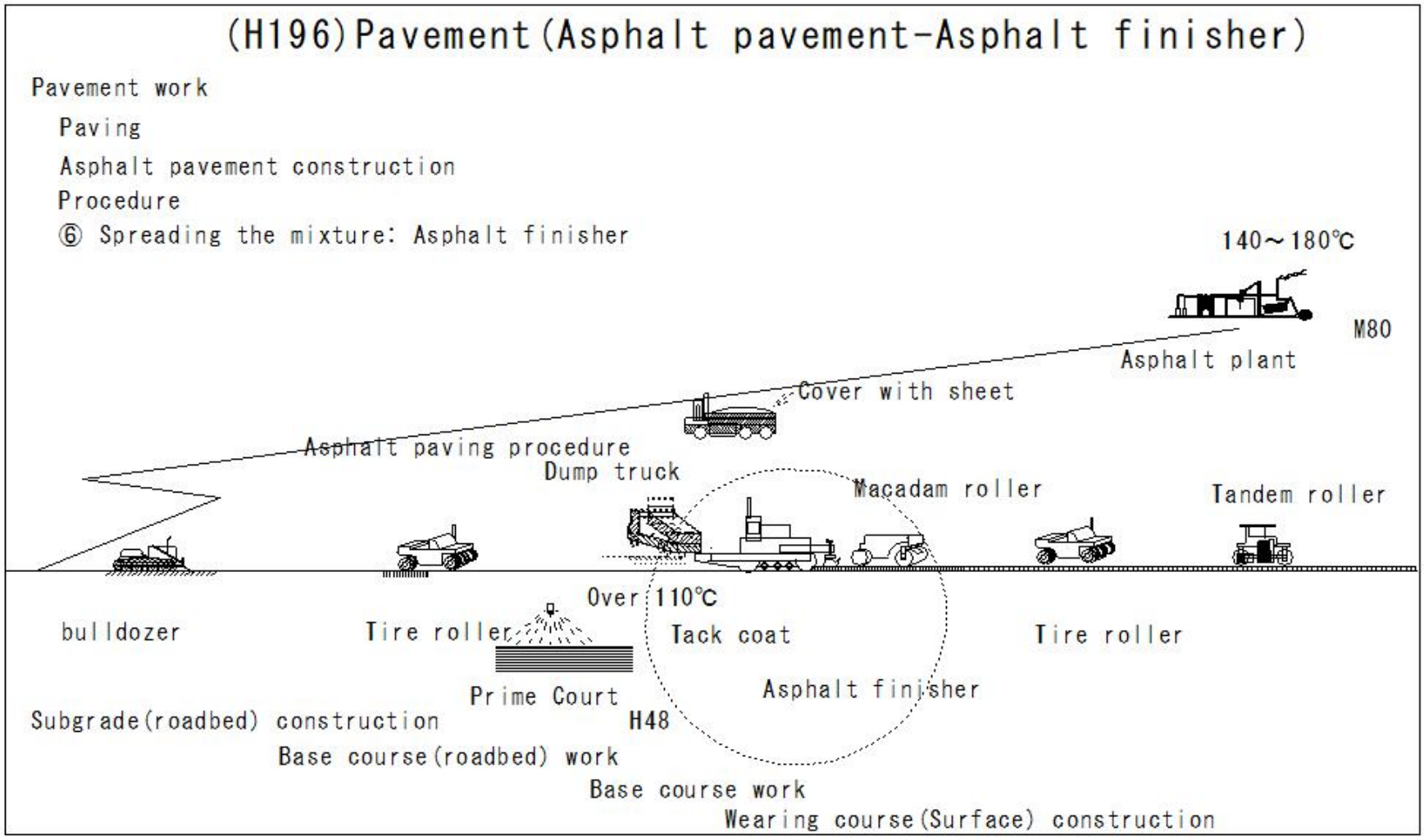
(H194)Pavement(Asphalt pavement-Prime coat)



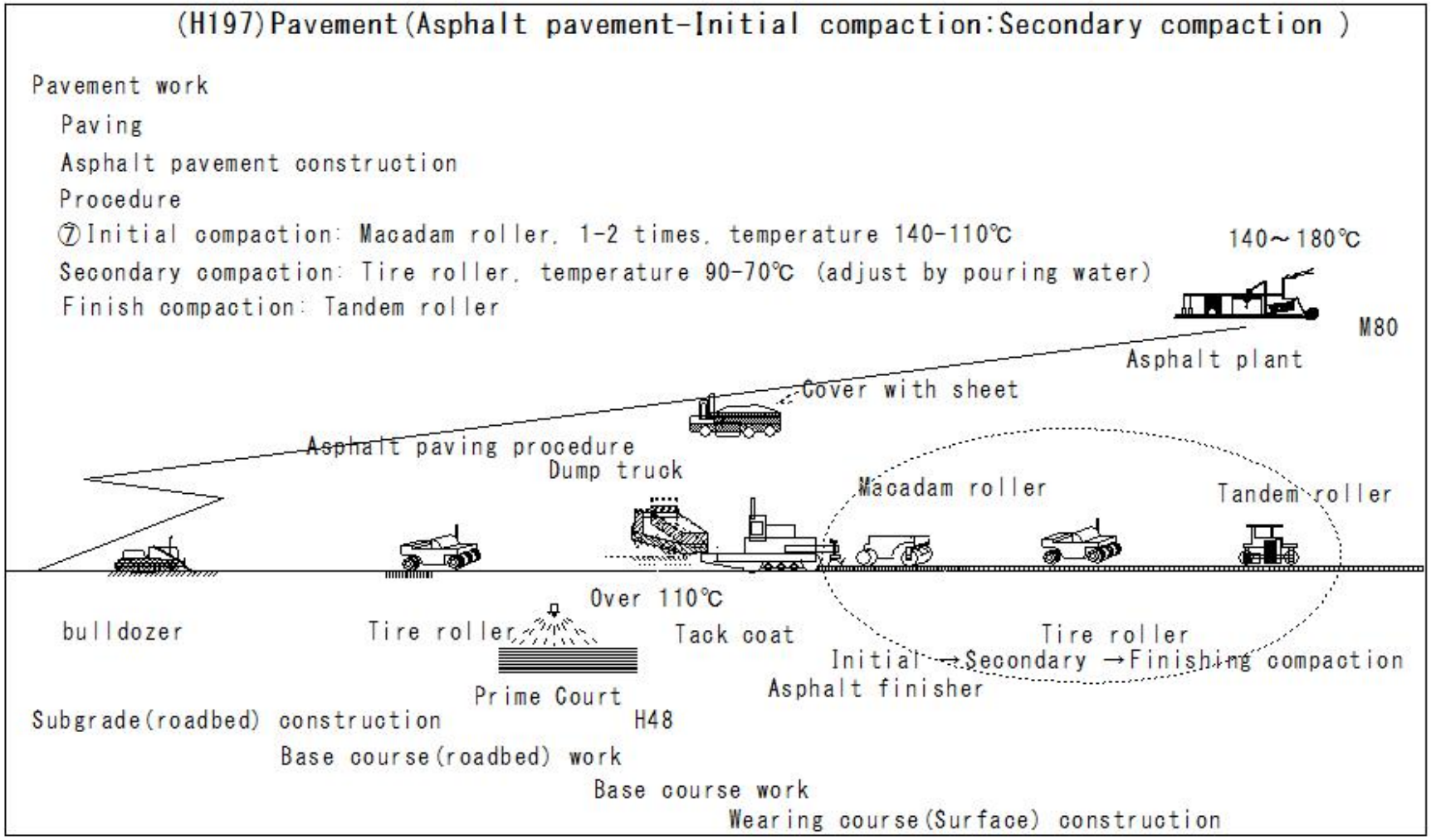
(H195)Pavement(Asphalt pavement-Tack coat)



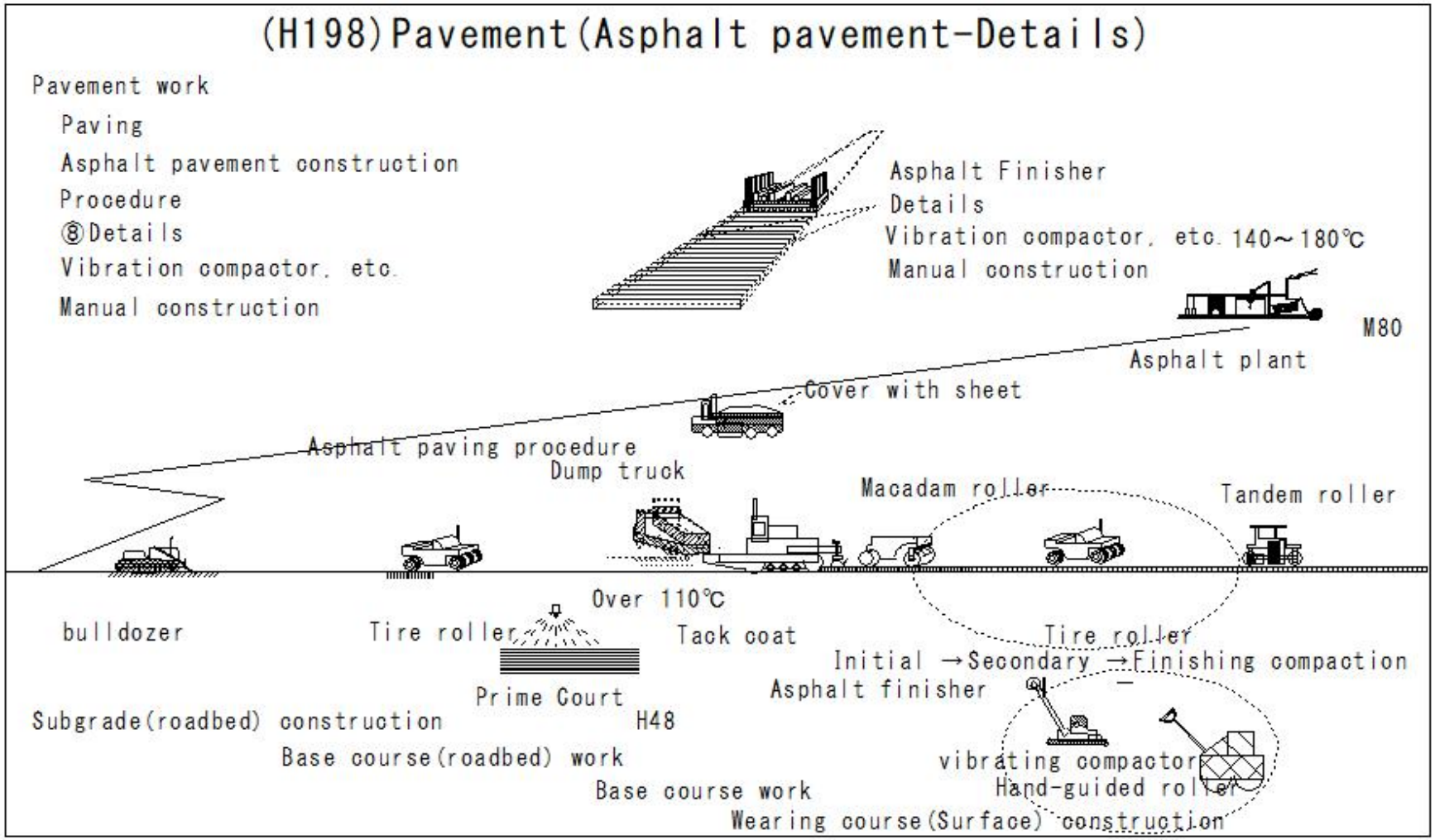
(H196)Pavement(Asphalt pavement-Asphalt finisher)



(H197)Pavement(Asphalt pavement-Initial compaction:Secondary compaction)



(H198)Pavement(Asphalt pavement-Details)



(H199)Pavement work(Pavement design TA method)

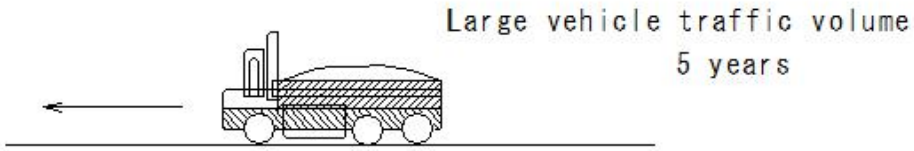
(H199)Pavement work(Pavement design TA method)

Pavement work

Pavement thickness

Pavement design TA method

①Estimate the daily one-way traffic volume of large vehicles 5 years from now



Classification of design traffic volume by traffic volume of large vehicles	
Classification of design traffic volume	Range of traffic volume of large vehicles (vehicles/day, direction)
L traffic	～100
A traffic	100～250
B traffic	250～1000
C traffic	1000～3000
D traffic	3000～

H2

(H200)Pavement work(Pavement design TA method)

(H200)Pavement work(Pavement design TA method)

Pavement work

Pavement thickness

Pavement design TA method

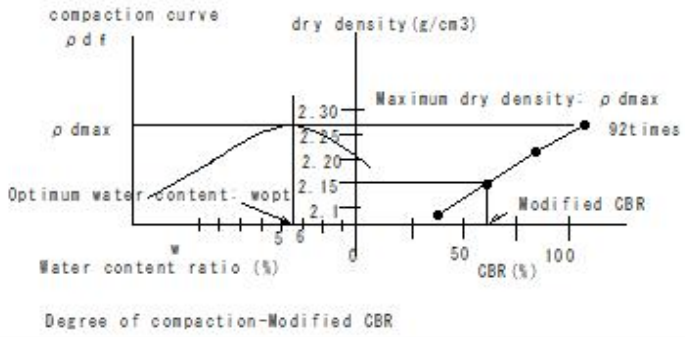
② Coefficient used for design CBR (value of C in the formula)

Sample subgrade soil and calculate design CBR

Design CBR = average CBR at each point - ((maximum CBR - minimum CBR)/C)

Coefficient used for design CBR (value of C in the formula)

Number of samples	2	3	4	5	6	7	8	9	10over
C	1.41	1.91	2.24	2.48	2.61	2.83	2.96	3.08	3.18



Degree of compaction-Modified CBR

(H201)Pavement work(Pavement design TA method)

Pavement work

Pavement thickness

Pavement design TA method

③ Determine the target TA and total thickness based on the design CBR of the subgrade soil and traffic volume classification

TA, target value of total thickness

TA target value

Design CBR	L traffic	Total Thicknes	A traffic	Total Thicknes	B traffic	Total Thicknes	C traffic	Total Thicknes	D traffic	Total Thicknes
2	17	52	21	61	29	74	39	90	51	105
3	15	41	19	48	26	58	35	70	45	83
4	14	35	18	41	24	49	32	59	41	70
6	12	27	16	32	21	38	28	47	37	55
8	11	23	14	27	19	32	26	39	34	46
12	-	-	13	21	17	26	23	31	30	36
20over	-	-	-	-	-		20	23	26	27

(H202)Pavement work(Pavement design TA method)

(H202)Pavement work(Pavement design TA method)

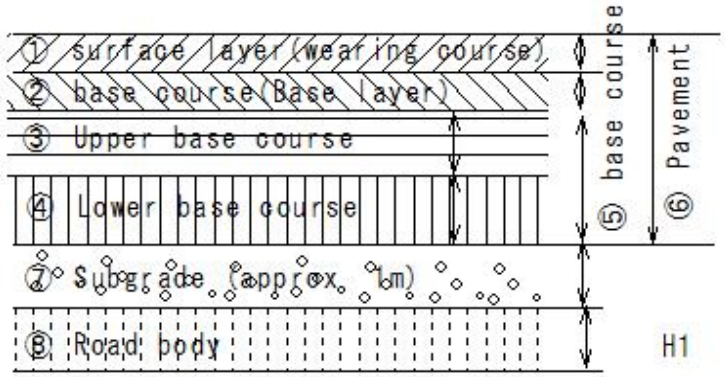
Pavement work

Pavement thickness

Pavement design TA method

④Depending on traffic volume classification

Calculate the minimum total thickness of the surface layer and base layer



(H203)Pavement work(Pavement design TA method)

(H203)Pavement work(Pavement design TA method)

Pavement work

Pavement thickness

TA method for pavement design

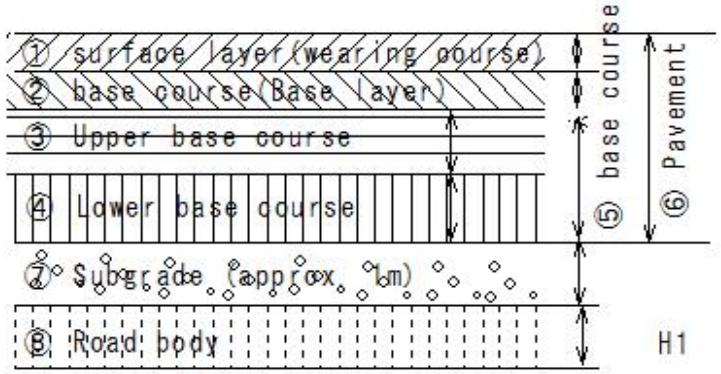
⑤The remainder obtained by subtracting the minimum thickness of the Wearing course(Surface) and Base course from the target TA is distributed to the upper and lower subgrade using an equivalent conversion coefficient

Distribute to the Upper +Lower base course(roadbed)

Minimum value of Wearing course(Surface) + Base course

Traffic volume classification	L、A Traffic	B Traffic	C Traffic	D Traffic
	5cm	10(5)	15(10)	20(15)

( ) indicates the minimum value in case of using bituminous stabilization work on the Upper base course(roadbed)



(H204)Pavement work(Pavement design TA method)

(H204)Pavement work(Pavement design TA method)

Pavement work

Pavement thickness

TA=a1T1+a2T2+a3T3+・・・・・・・・・・・・・・・+anTn

a1,a2a3・・・・・・・・・・・・・・・an: equivalent value conversion coefficient

T1,T2,T3・・・・・・Tn: thickness of each layer

Equivalent value conversion coefficient used to calculate TA

		③ Equivalent value conversion coefficient
④ Surface layer and base laye	⑤ Heated asphalt mixture for surface layer and base layer	1
⑥ Upper subgrade	⑦ Bitumen stabilization treatment 250-350kgf/cm2 (24.5-34.3N/mm2)	0.55～0.80
	⑧ Cement stabilization treatment 15-30kgf/cm2 (1.47-2.94N/mm2)	0.55
	⑨ Cement stabilization treatment 10kgf/cm2 (0.98N/mm2)	0.45
	⑩ Grain-adjusted steel slag Modified CBR 80 or more	0.35
⑪ Subbase	⑫ Crusher run, steel slag, sand Modified CBR 30 or more	0.20～0.25
	⑬ Cement stabilization 10kgf/cm2 (0.98N/mm2)	0.25
	⑭ Lime stabilization 7kgf/cm2 (0.69N/mm2)	0.25

(H205)Pavement work(Pavement design TA method)

(H205)Pavement work(Pavement design TA method)

Pavement work

Pavement thickness

Asphalt pavement thickness design

Traffic volume category B

Design CBR 6

Upper base course(roadbed): Grain-adjusted crushed stone (equivalent conversion coefficient 0.35)

Lower Base course(roadbed): Crusher run (equivalent conversion coefficient 0.20)

Asphalt pavement

TA (target value)...21 cm

Total thickness = 38 cm

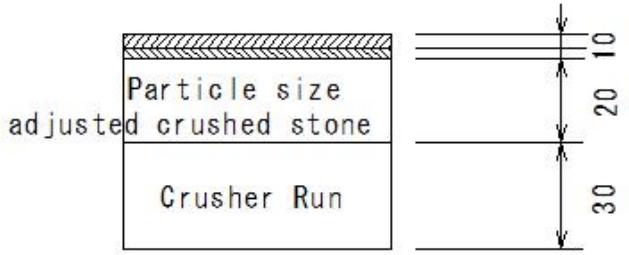
Minimum thickness of Wearing course(Surface) +Base course = 10 cm

Assuming Upper base course(roadbed) is 20 cm

Assuming Lower Base course(roadbed) is 30 cm

Total thickness H = 10 + 20 + 30 = 60 cm > Target pavement thickness 38 x 4/5 = 30.4 cm

TA = 1.0 x 10 + 0.35 x 20 + 0.20 x 30 = 23 > 21 cm



(H206)Pavement work(Concrete pavement-Mixing, mixing, transport)

(H206)Pavement work(Concrete pavement-Mixing, mixing, transport)

Pavement work

Concrete pavement

Mixing, mixing, transport

Concrete for paving

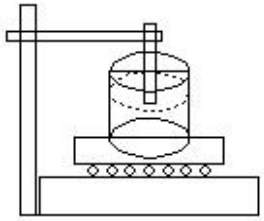
Slump 0-2cm

Low slump (Dry・ Hard)concrete

①Measurement in case of there is no slump

Site: Use Iribaren Kelly ball

Factory: Use vibration table type consistency meter (sinking degree (sec))



vibration table type consistency meter

②Mixing: Batcher plant

Road pavement specification mix chart

①Design standard bending strength (N/mm2)

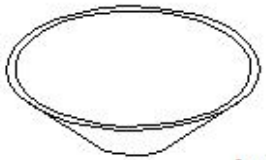
②Unit water volume (kg)

③Unit cement volume (kg)

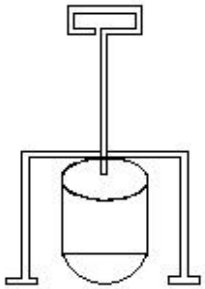
④Maximum dimensions of coarse aggregate (mm)

⑤Slump (cm) Sinking degree (S)

⑥Air volume (%)



Iribaren



Kelly ball

③Transportation: Truck agitator

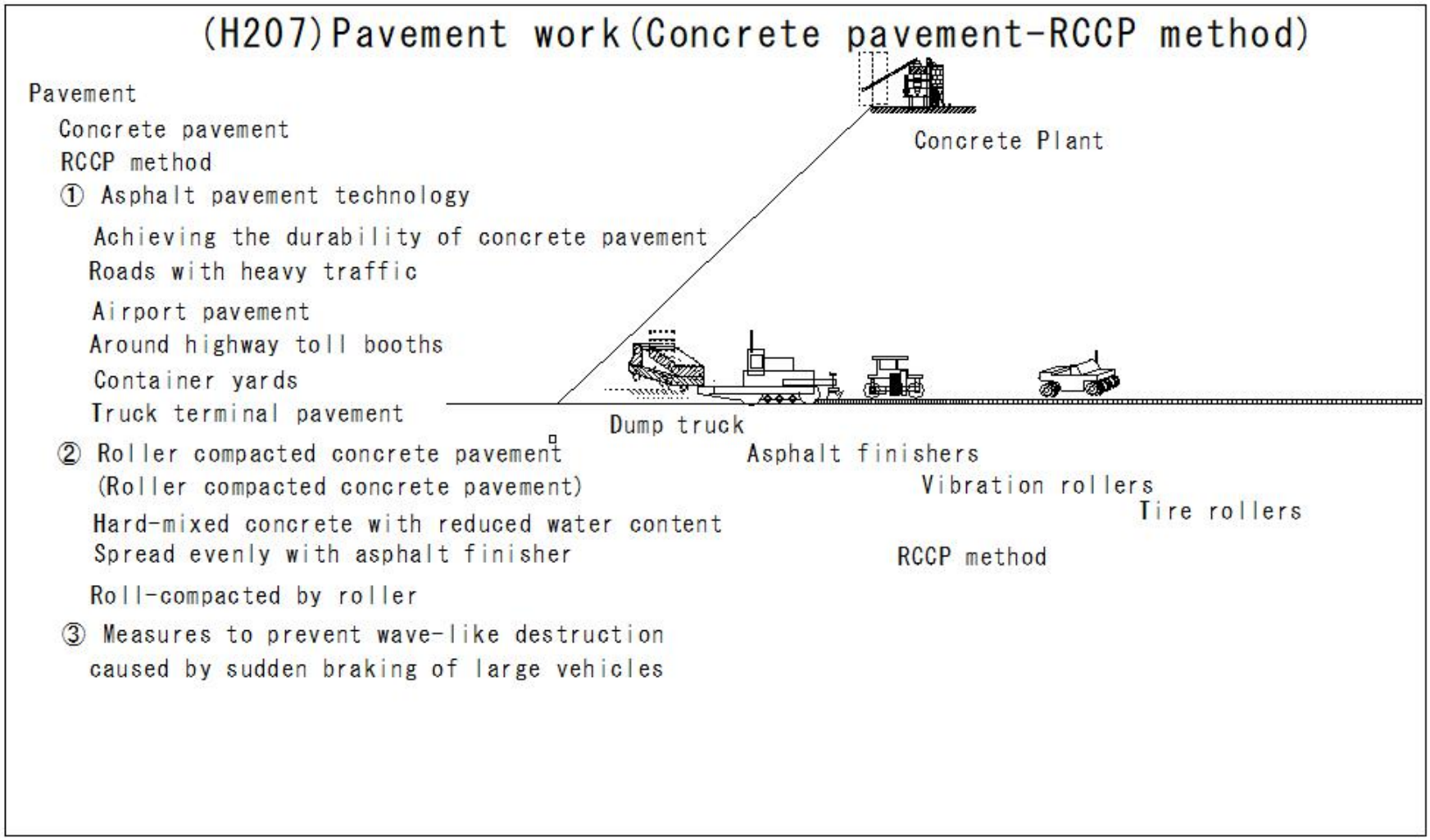
Avoid rainwater and moisture contamination

Transportation time: Within 1 hour

Road pavement specification mix chart

①	②	③	④	⑤	⑥
4.4	150	280-340	40	2.0below 30over	4

(H207)Pavement work(Concrete pavement-RCCP method)



(H208)Pavement work(Concrete pavement-RCCP method)

(H208)Pavement work(Concrete pavement-RCCP method)

Pavement work

Concrete pavement

RCCP method

① Construction speed - fast

② Traffic opens early after construction

③ Cheaper than conventional concrete pavement

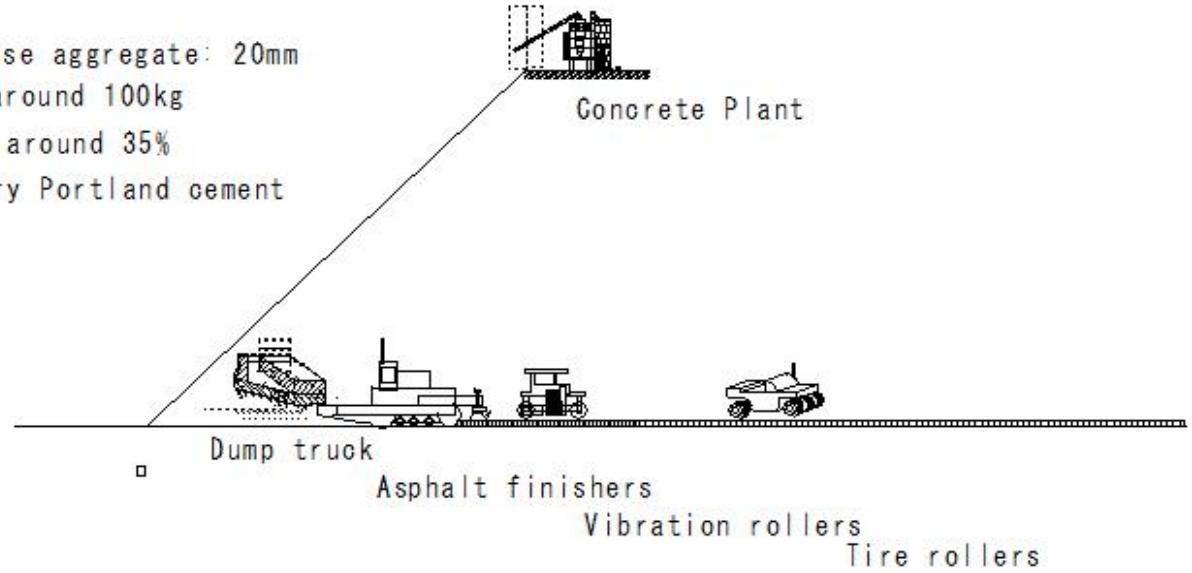
④ Concrete mix

1 Maximum size of coarse aggregate: 20mm

2 Unit water volume: around 100kg

3 Water-cement ratio: around 35%

4 Cement type: ordinary Portland cement



RCCP method

H207

(H209)Pavement work(Concrete pavement-Placing-in and finishing)

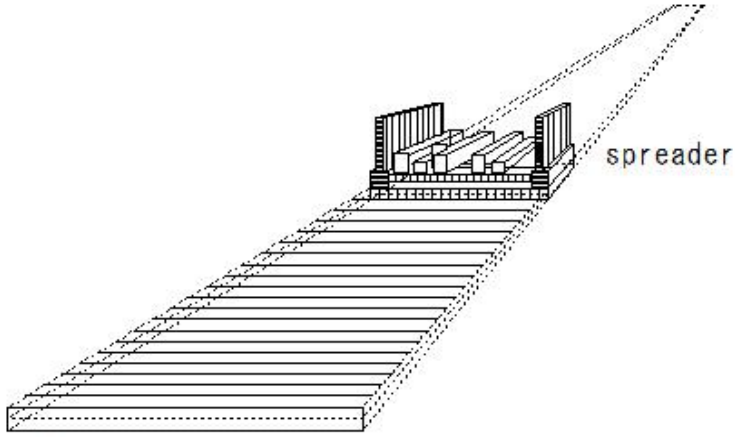
(H209)Pavement work(Concrete pavement-Placing-in and finishing)

Pavement work

Pavement surface

Placing-in and finishing

① Placing-in: placing the pavement evenly with a spreader



① Placing-in: placing the pavement evenly with a spreader

H145

(H210)Pavement work(Concrete pavement-Placing-in and finishing)

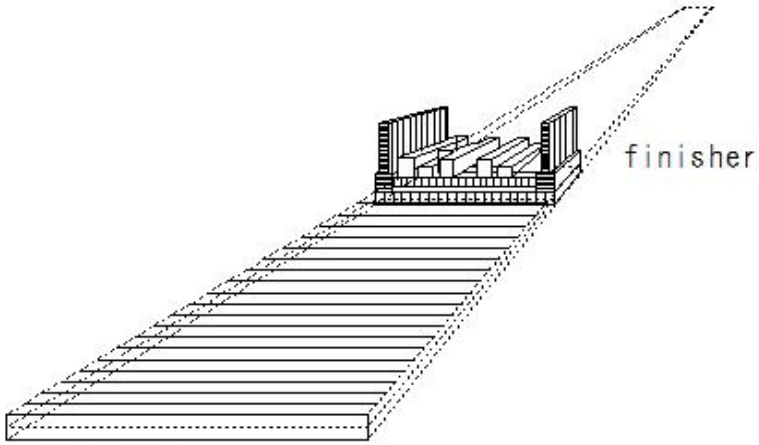
(H210)Pavement work(Concrete pavement-Placing-in and finishing)

Pavement work

Pavement surface

Placing and finish

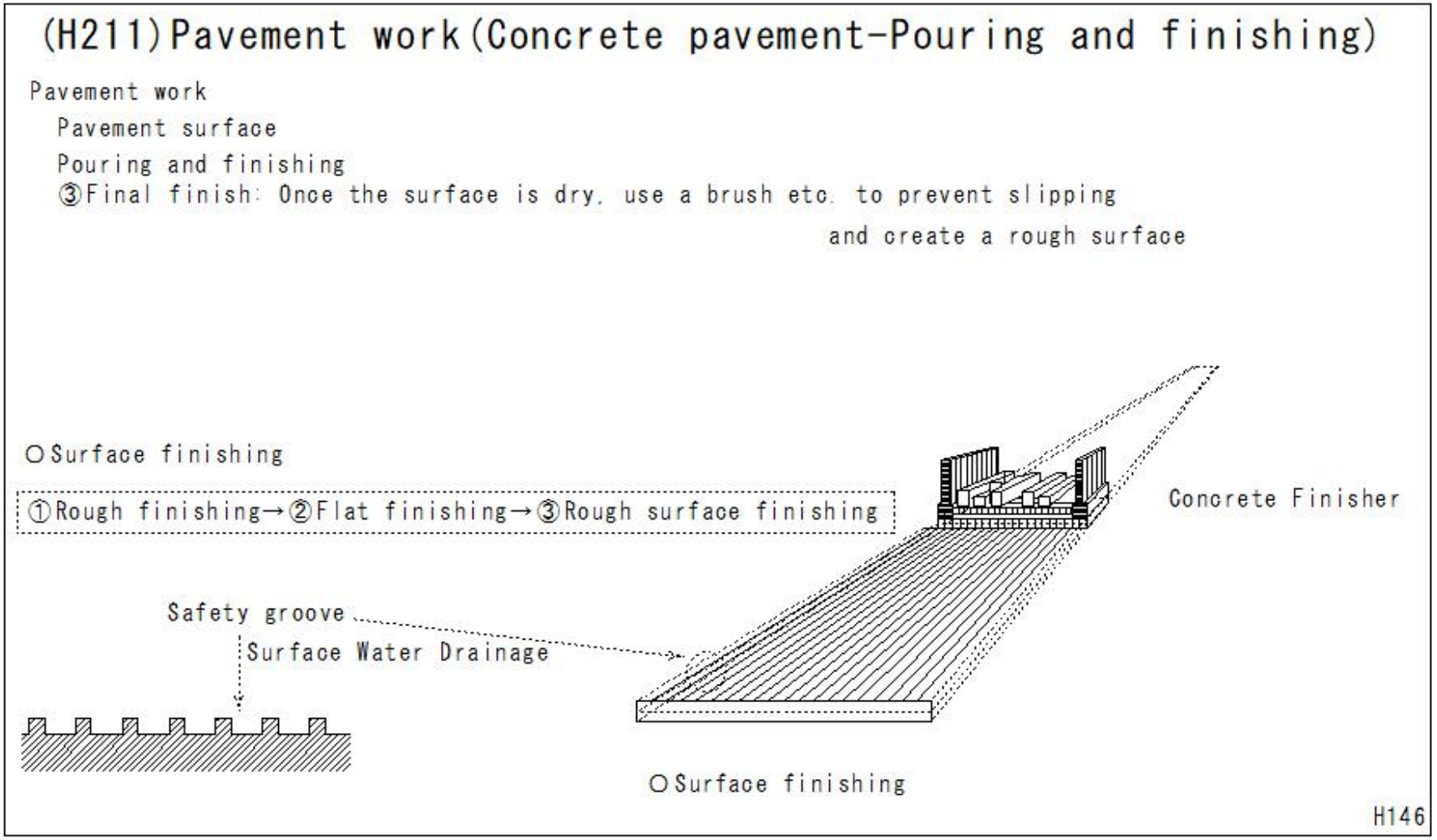
②Finishing: Compact thoroughly with a finisher



②Finishing: Compact thoroughly with a finisher

H145

(H211)Pavement work(Concrete pavement-Pouring and finishing)



(H212)Pavement work(Concrete pavement-Joint)

(H212)Pavement work(Concrete pavement-Joint)

Pavement work

Pavement surface

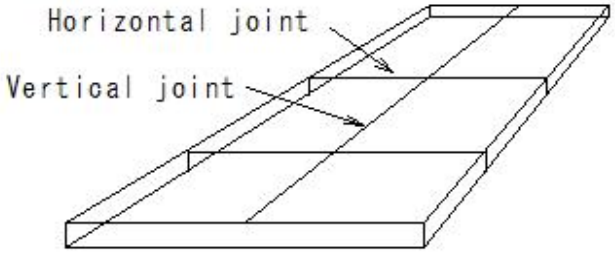
Pouring and finishing

④ Joint: Concrete causes drying, shrinkage, expansion and contraction due to temperature changes.

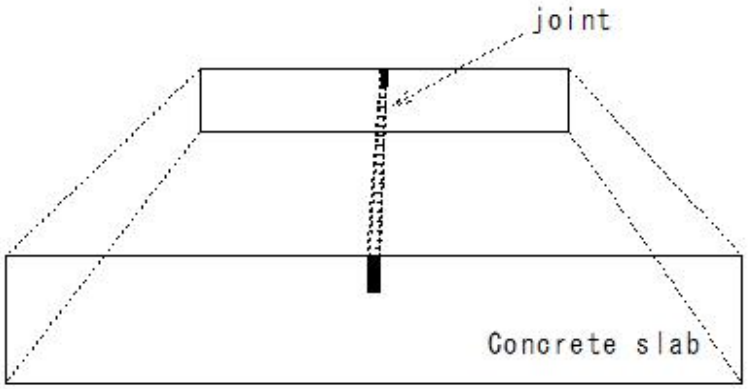
Cut with a cutter

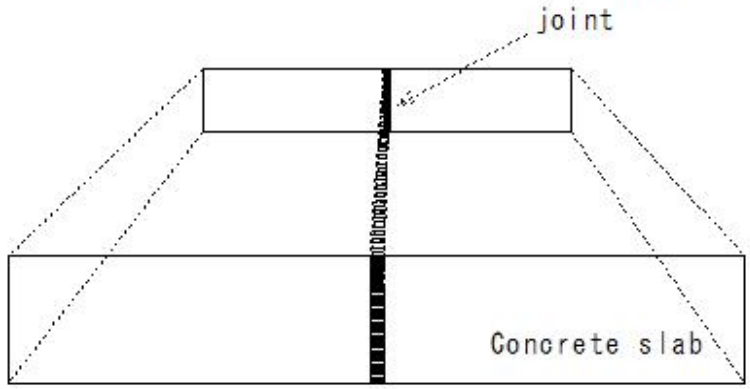
Sealed with injection joints

Vertical joints are placed for each lane.



H136



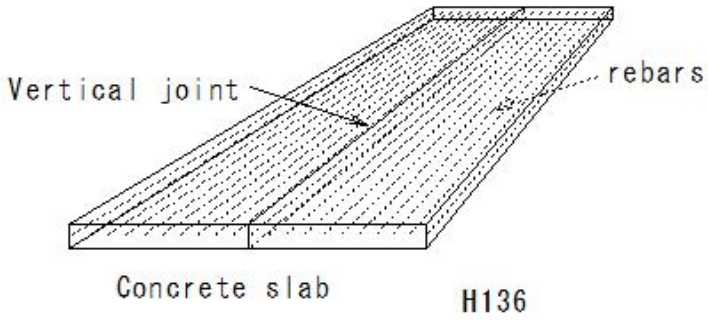


H138

(H213)Pavement work(Concrete pavement-Continuous concrete pavement)

(H213)Pavement work(Concrete pavement-Continuous concrete pavement)

Pavement work
- Pavement surface
- Pouring and finishing
- ⑤Continuous concrete pavement
- Eliminate horizontal joints
- Insert continuous rebars vertically
- Create fine cracks
- Improving the comfort of passing vehicles



⑤Continuous concrete pavement

(H214)Pavement work(Asphalt pavement-Patching)

(H214)Pavement work(Asphalt pavement-Patching)

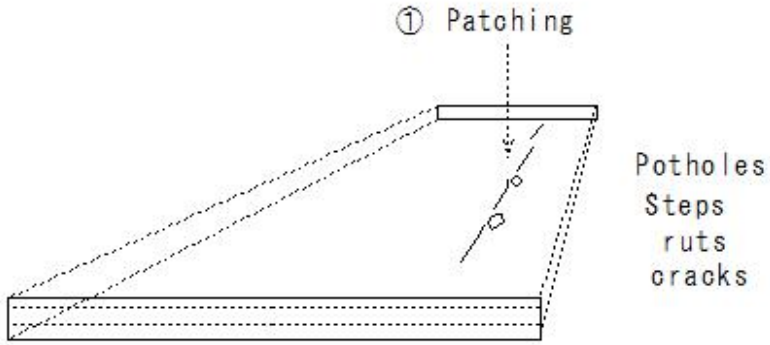
Pavement work

Asphalt pavement

Pavement surface

Maintenance and repair of road surface damage

① Patching: Localized cracks, depressions, and steps - Temporary treatment with repair materials



Asphalt pavement

H118

(H215)Pavement work(Asphalt pavement-Overlay)

(H215)Pavement work(Asphalt pavement-Overlay)

Pavement work

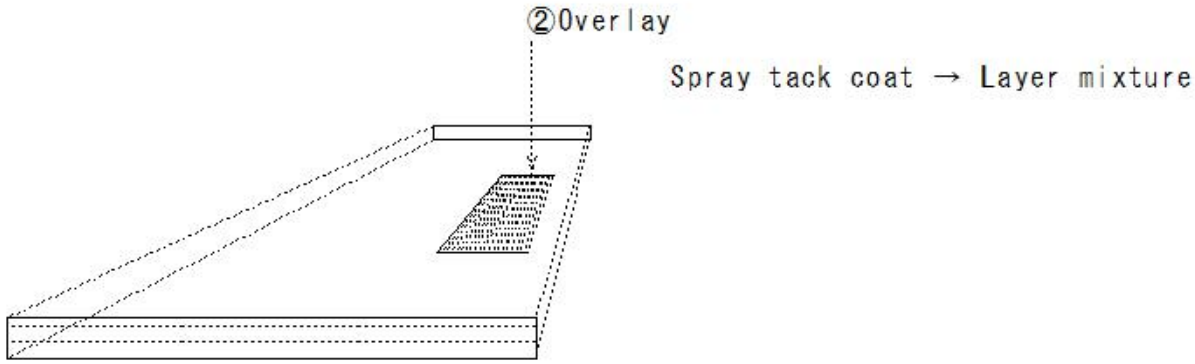
Asphalt pavement

Pavement surface

Maintenance and repair of road surface damage

②Overlay

Existing pavement surface Spray tack coat → Layer mixture



H111

(H216)Pavement work(Asphalt pavement-Replacement method)

(H216)Pavement work(Asphalt pavement-Replacement method)

Pavement work

Asphalt pavement

Pavement surface

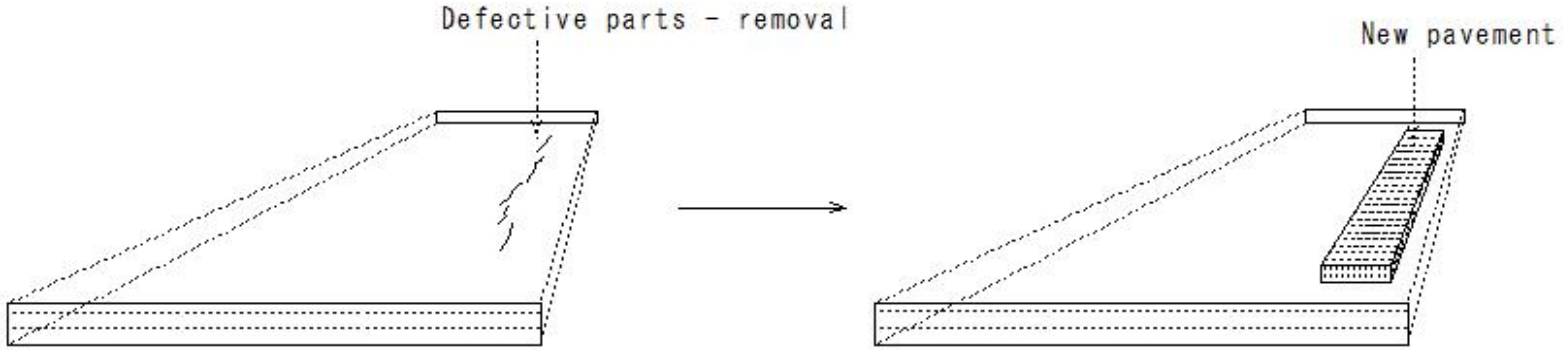
Maintenance and repair of road surface damage

③Replacement method

Defective parts - removal

New pavement

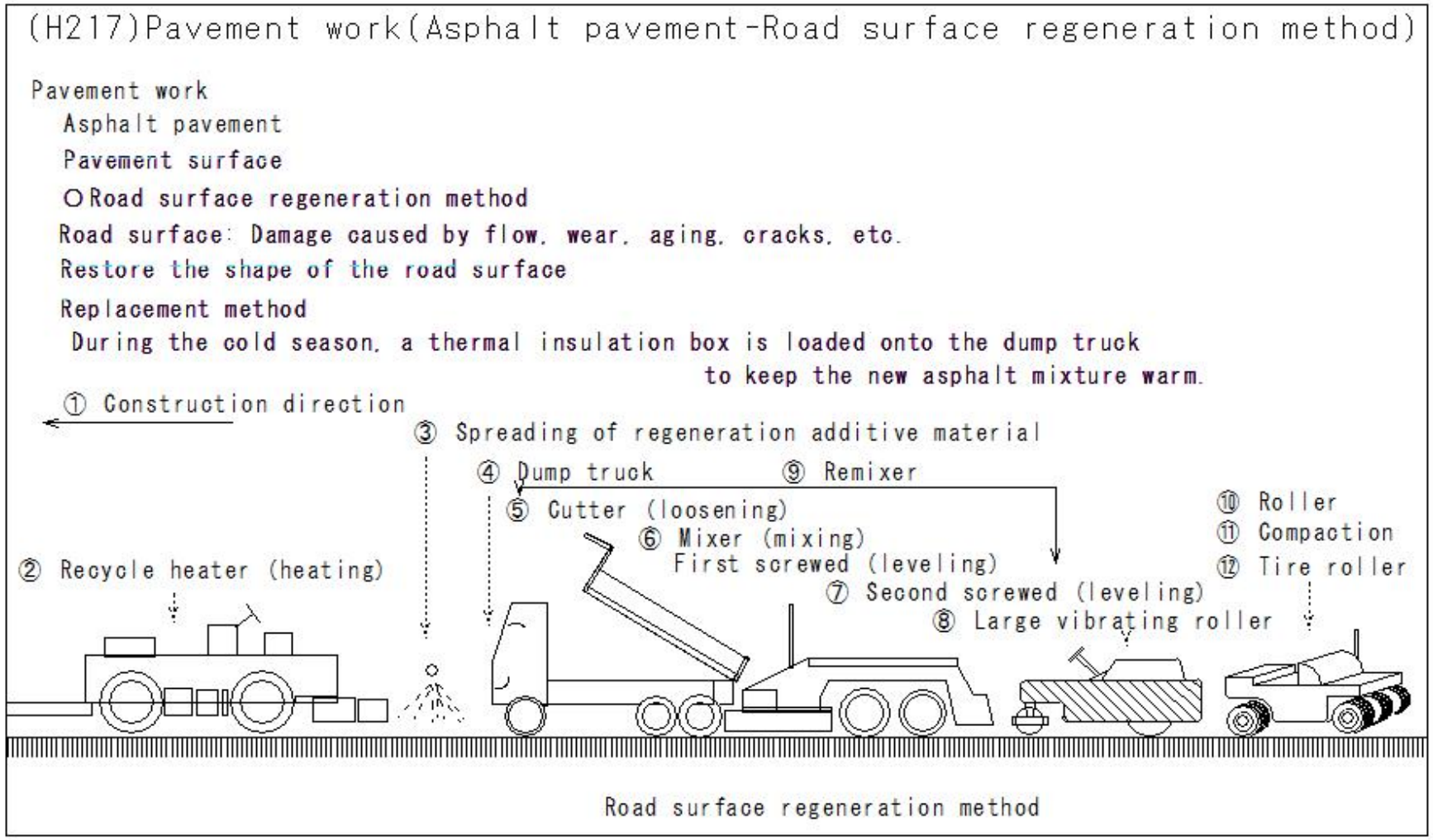
Replacement method (road surface restoration)



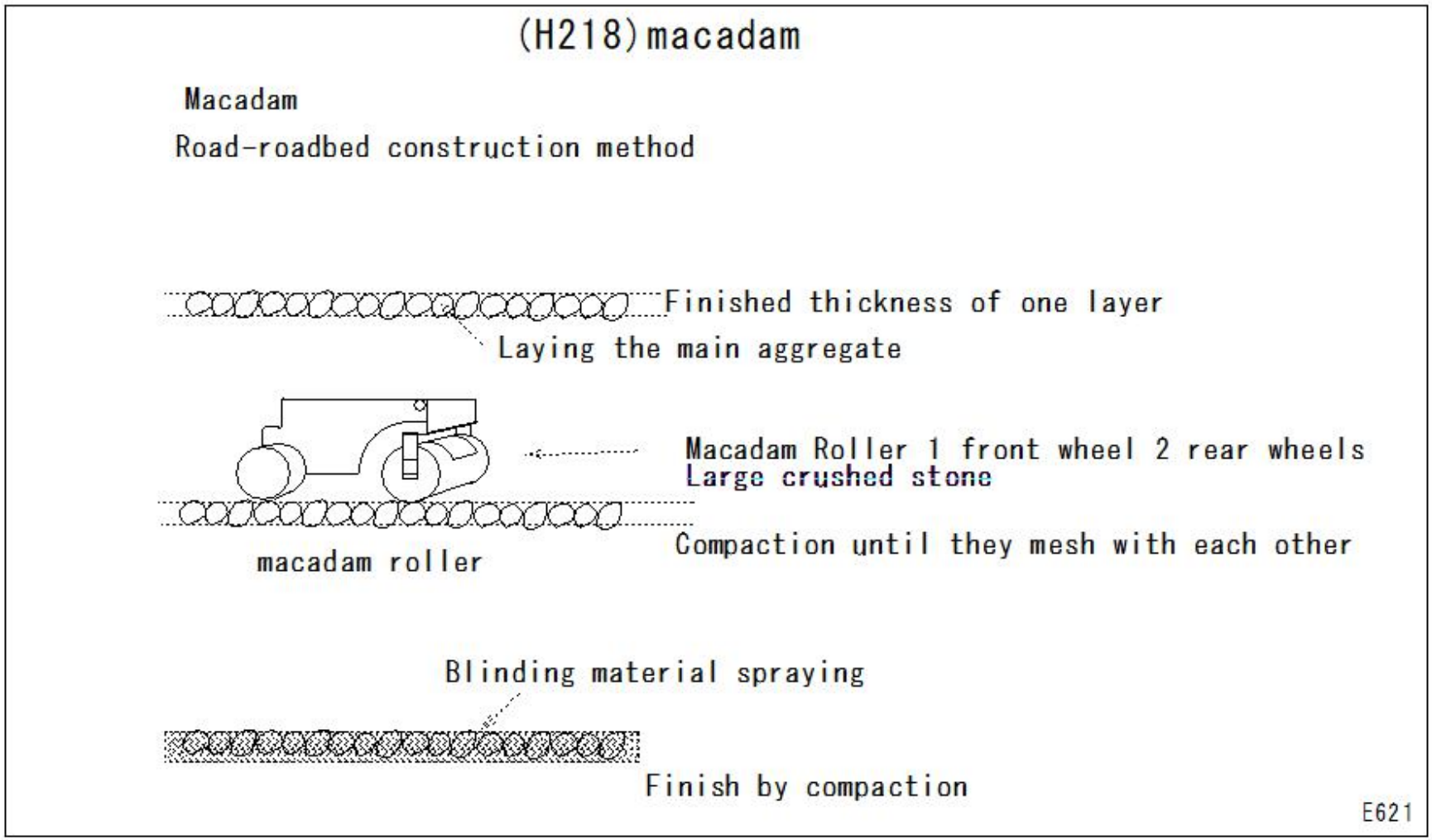
③Replacement method

H110

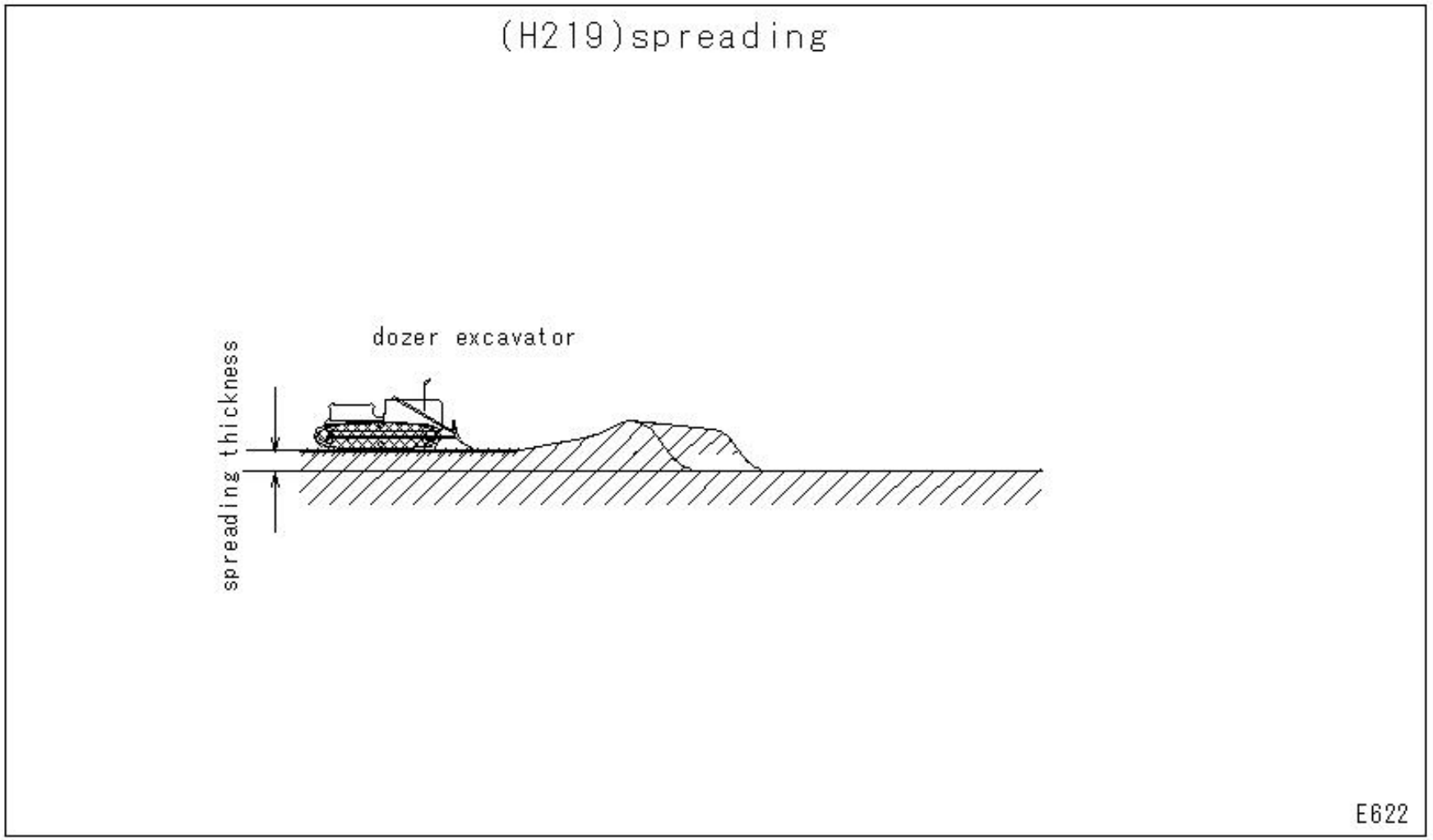
(H217)Pavement work(Asphalt pavement-Road surface regeneration method)



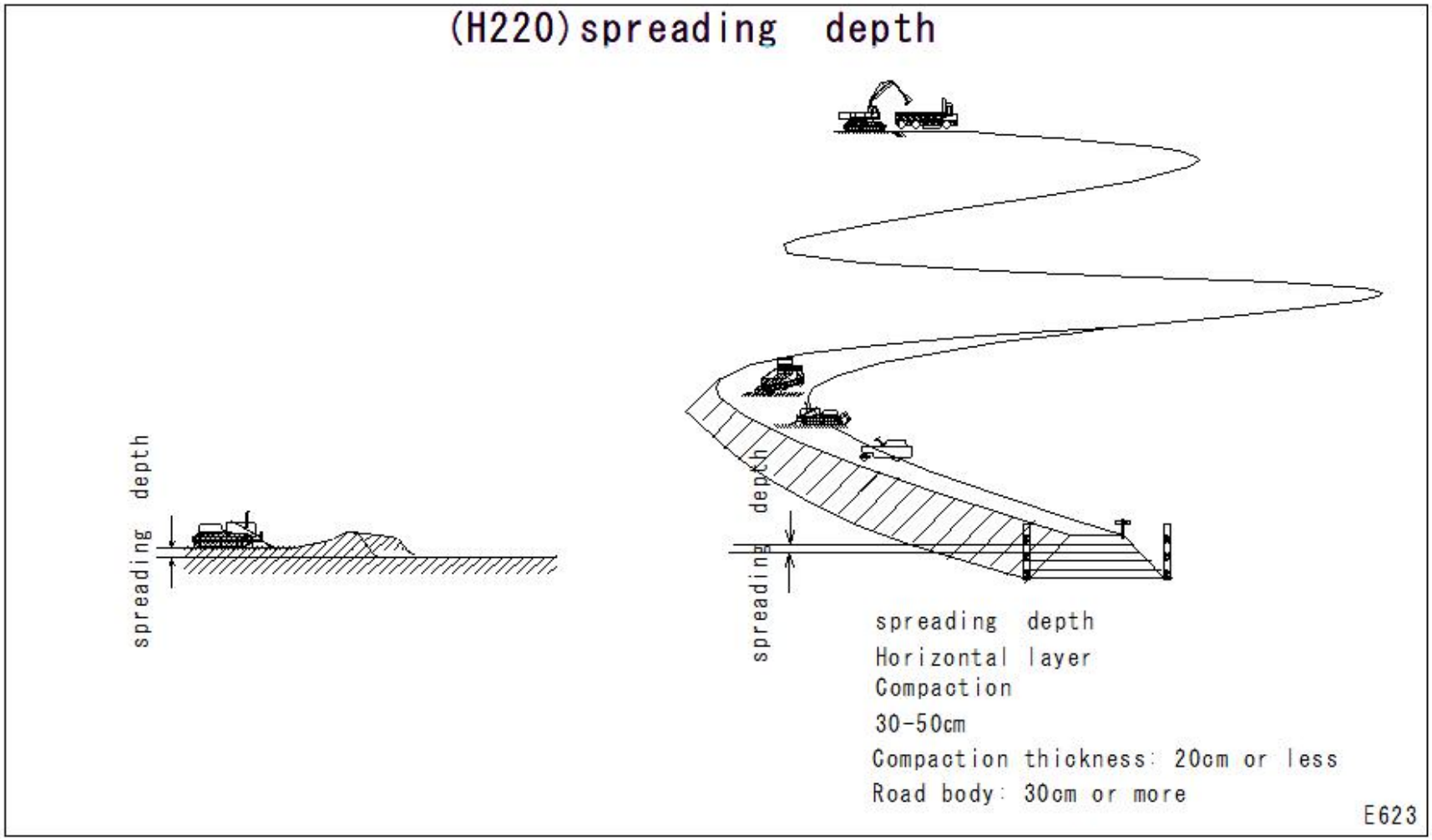
(H218)macadam



(H219)spreading



(H220)spreading depth



(H221)Pavement work(Asphalt pavement-Pavement design)

(H221)Pavement work(Asphalt pavement-Pavement design)

Pavement work

Pavement

Pavement design

①CBR test of subgrade soil

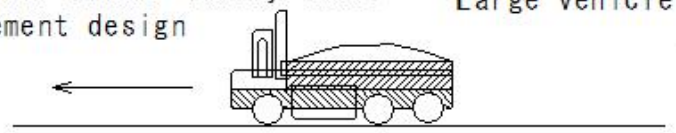
⑤Large vehicle traffic volume (vehicles)

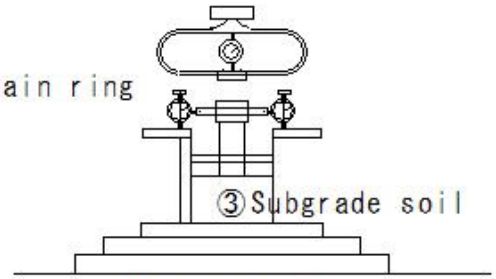
⑥Traffic volume survey table

⑦Pavement design

Large vehicle traffic volume

5 years





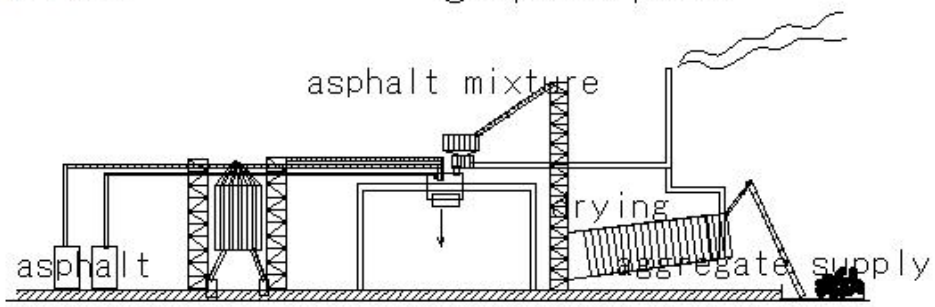
①CBR test of subgrade soil

Classification of design traffic volume by traffic volume of large vehicles

Range of traffic volume of large vehicles	
Classification of design traffic volume	(vehicles/day, direction)
L traffic	～100
A traffic	100～250
B traffic	250～1000
C traffic	1000～3000
D traffic	3000～

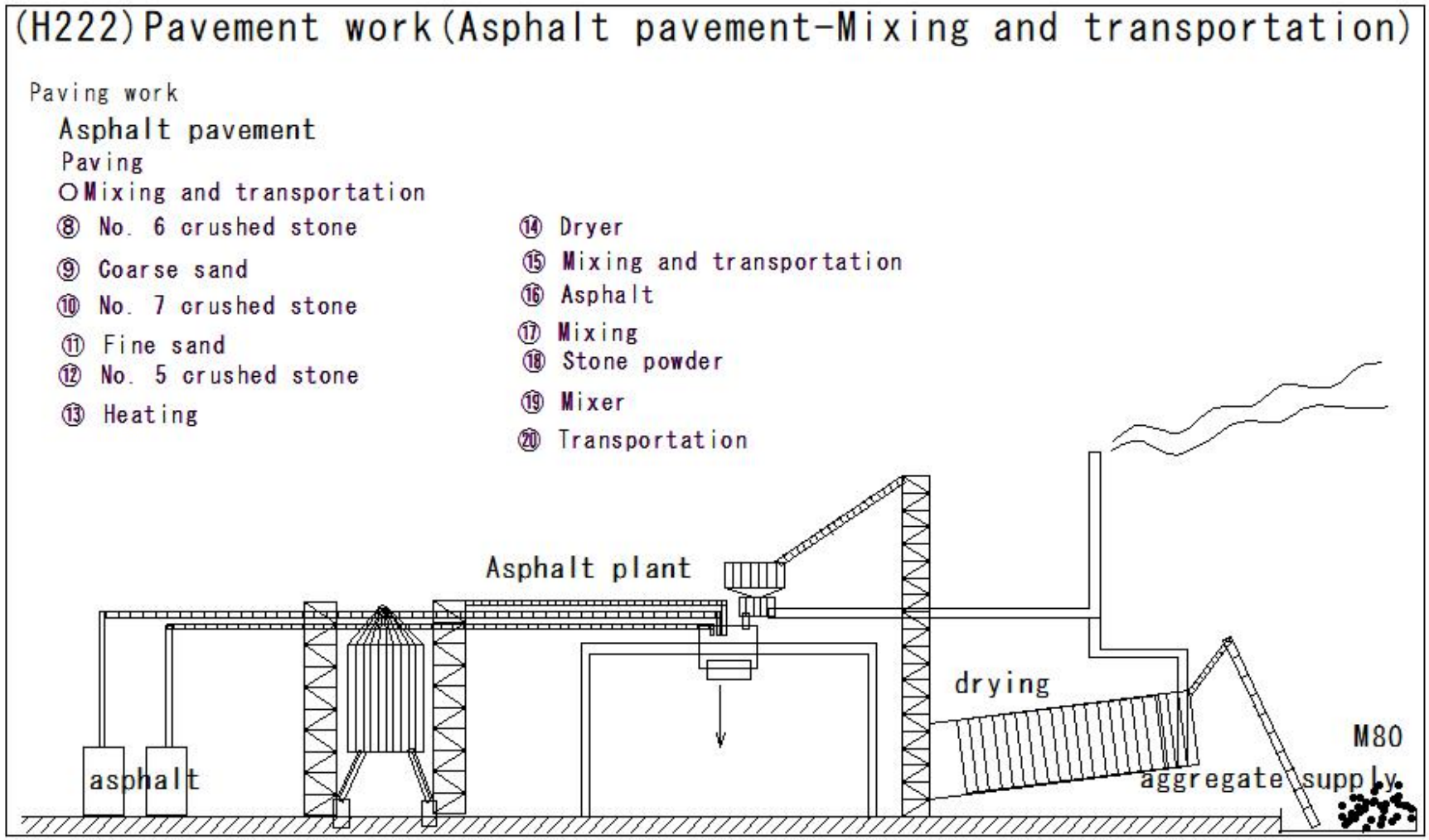
H2
H199

⑧ No. 6 crushed stone
⑨ Coarse sand
⑩ No. 7 crushed stone
⑪ Fine sand
⑫ No. 5 crushed stone
⑬ Heating
⑭ Dryer

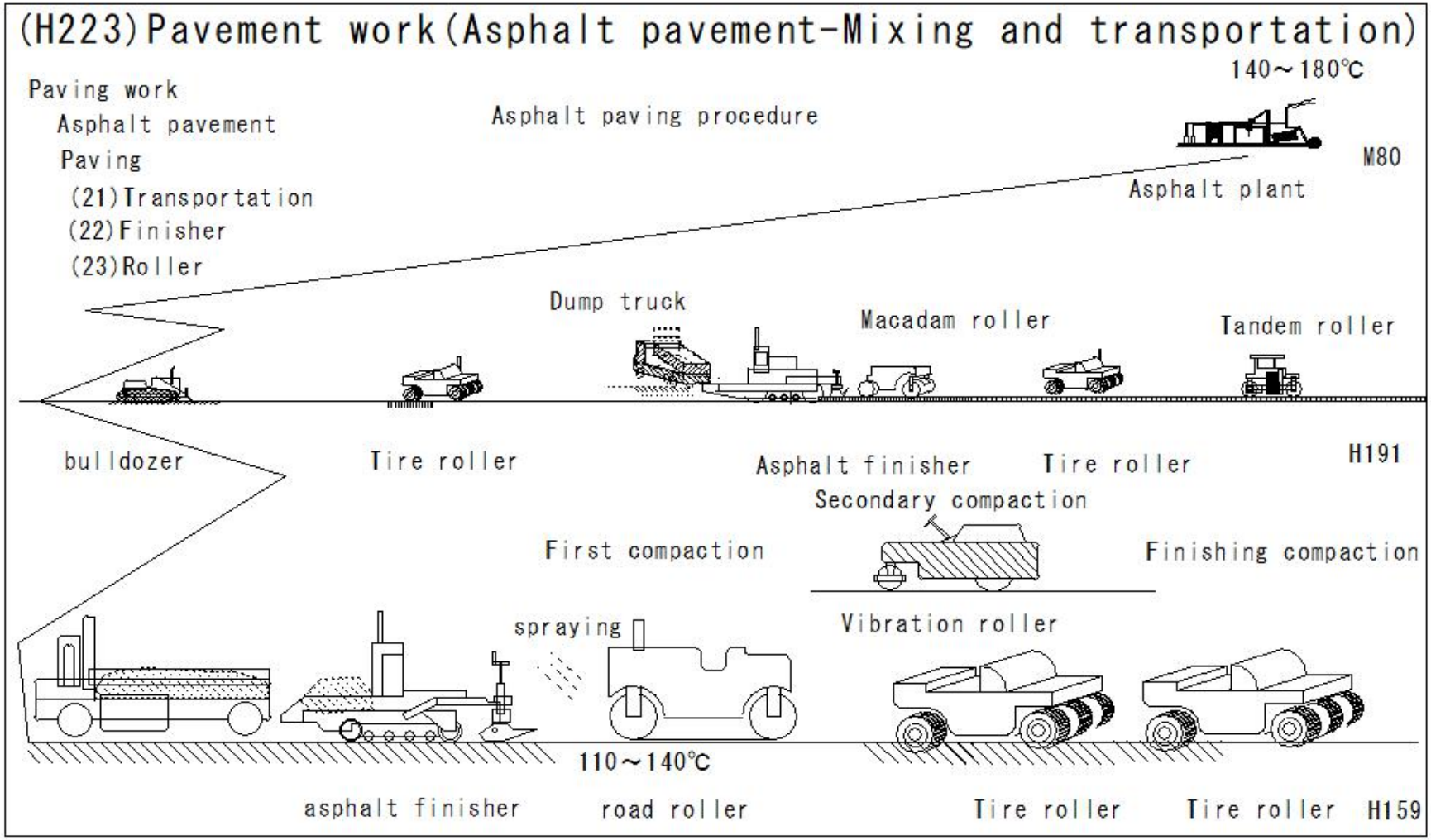


M80

(H222)Pavement work(Asphalt pavement-Mixing and transportation)



(H223)Pavement work(Asphalt pavement-Mixing and transportation)



(H224)Pavement work(Asphalt pavement- Cement concrete pavement)

(H224)Pavement work(Asphalt pavement- Cement concrete pavement)

Pavement construction

Pavement structure

① Asphalt concrete pavement (flexible pavement)

② Cement concrete pavement (rigid pavement)

Asphalt pavement

① Flexibility - high

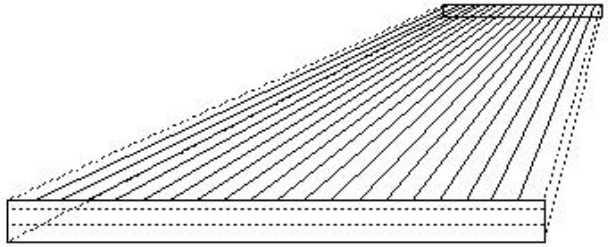
② Curing - not required

③ Construction speed - fast

④ No joints - continuously flat

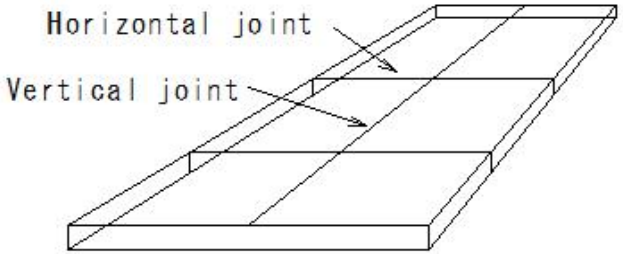
⑤ Maintenance and repair - easy

⑥ Staged construction possible



① Asphalt concrete pavement (flexible pavement)

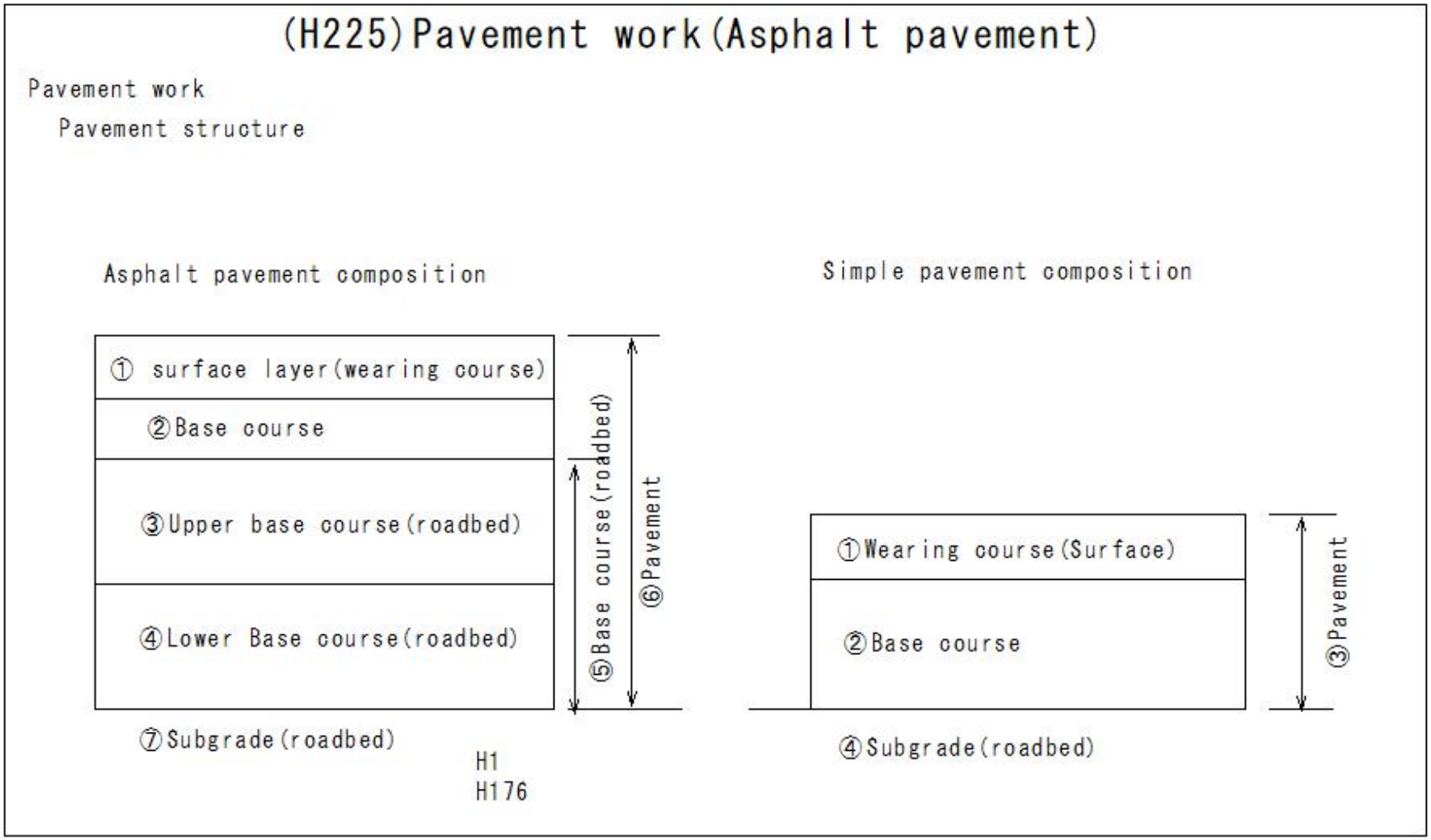
H116



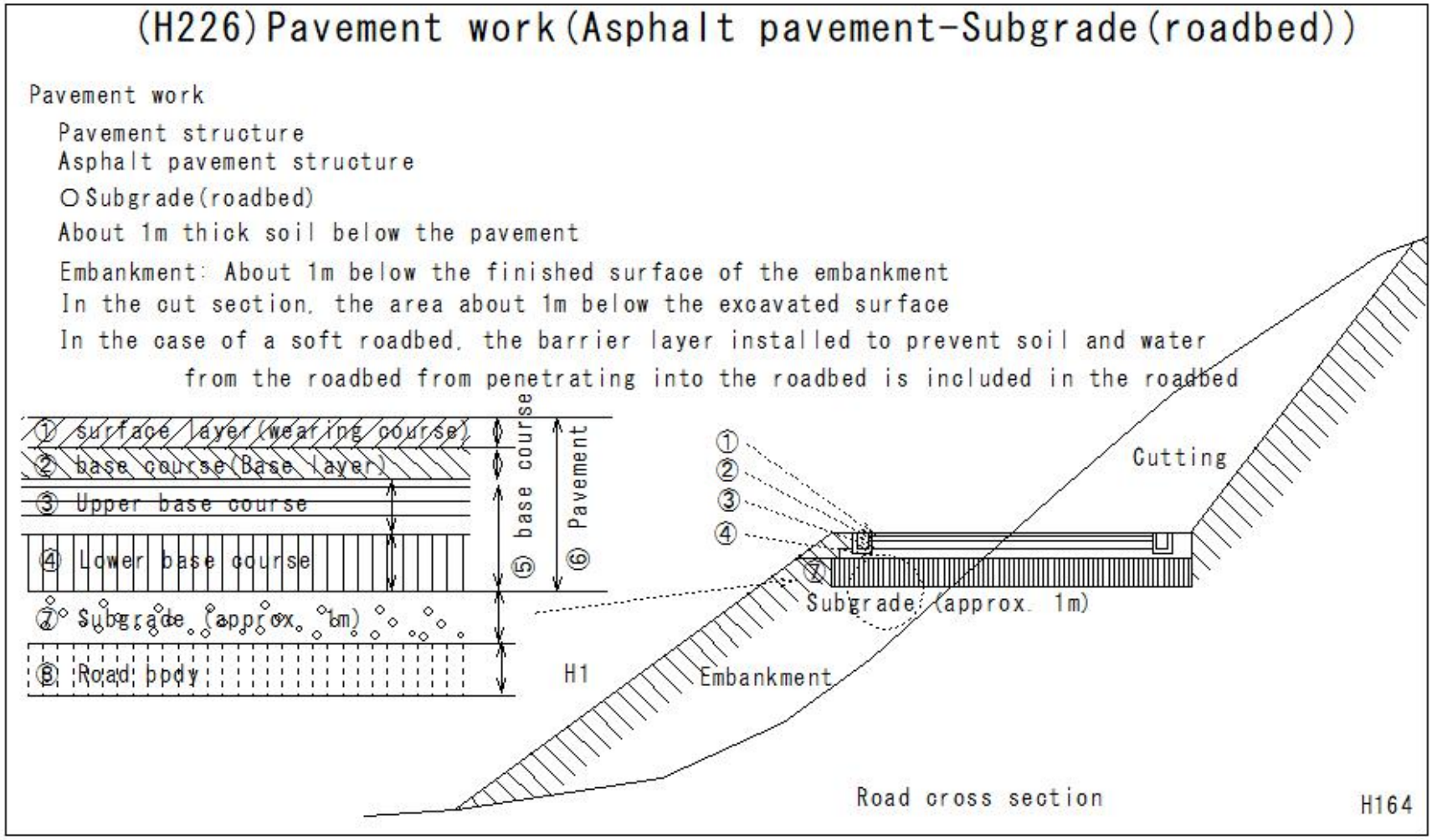
② Cement concrete pavement (rigid pavement)

H136

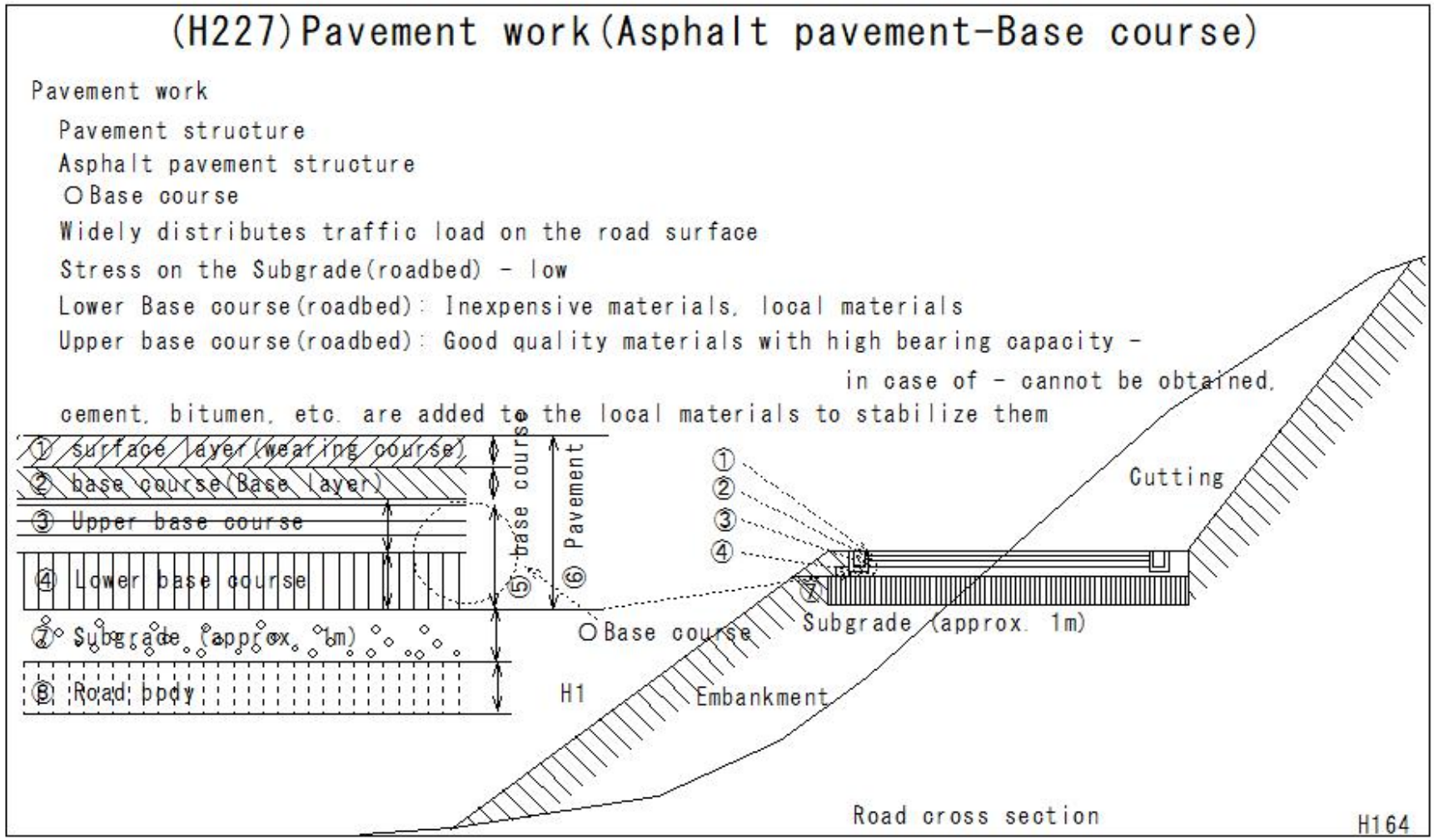
(H225)Pavement work(Asphalt pavement)



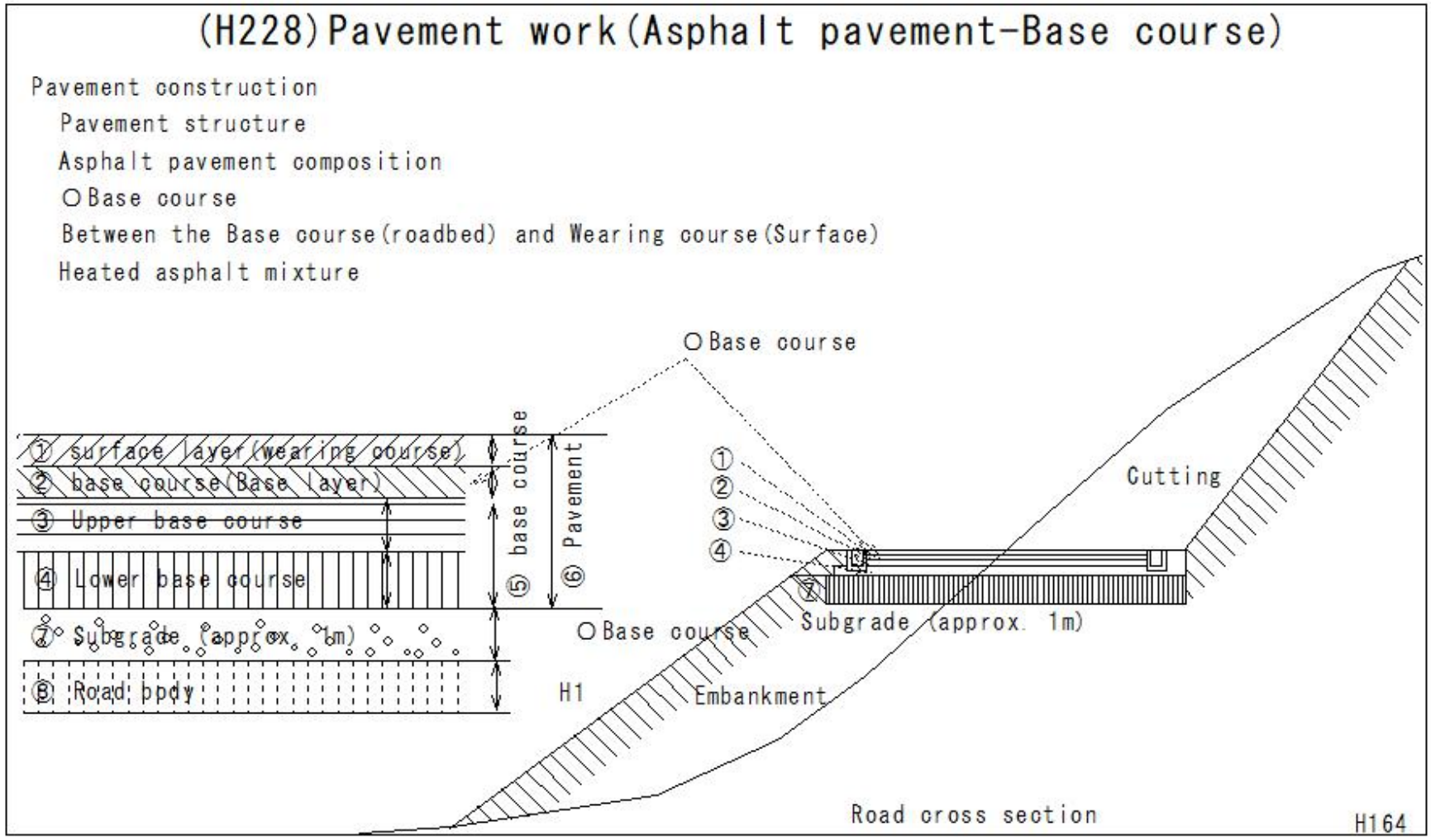
(H226)Pavement work(Asphalt pavement-Subgrade(roadbed))



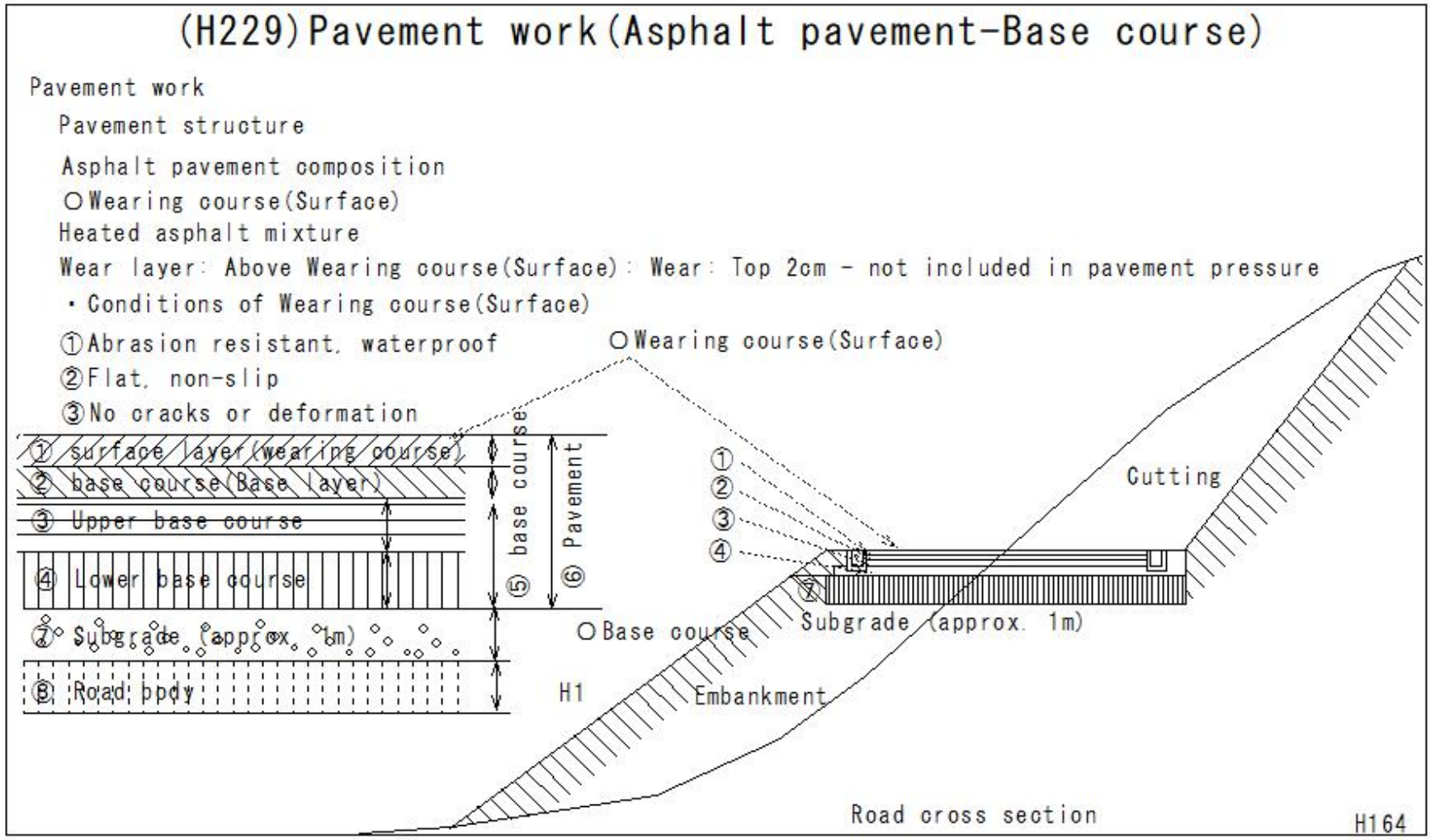
(H227)Pavement work(Asphalt pavement-Base course)



(H228)Pavement work(Asphalt pavement-Base course)



(H229)Pavement work(Asphalt pavement-Base course)



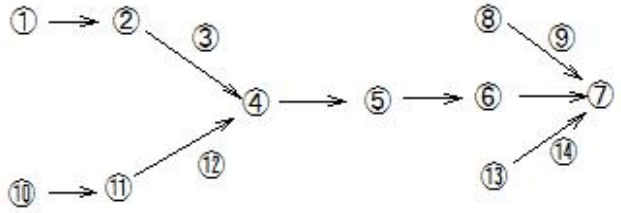
(H230)Pavement work(Asphalt pavement-Pavement design)

(H230)Pavement work(Asphalt pavement-Pavement design)

Pavement works

○Pavement design

① Traffic conditions
② Traffic classification
③ Traffic volume/traffic load
④ Pavement thickness/TA target
⑤ Minimum thickness of Wearing course(Surface)/Base course
⑥ Selection of Base course(roadbed)
⑦ Pavement composition
⑧ Economic efficiency
⑨ Low cost
⑩ Subgrade(roadbed)(approx. 1m) conditions
⑪ Design CBR
⑫ Subgrade(roadbed)(approx. 1m) bearing capacity
⑬ Weather conditions
⑭ Snowy cold/warm/heavy rain/humid



Pavement design procedure

(H231)Pavement work(Asphalt pavement-Traffic conditions)

(H231)Pavement work(Asphalt pavement-Traffic conditions)

Pavement work

Pavement design

①Traffic conditions

Traffic volume survey

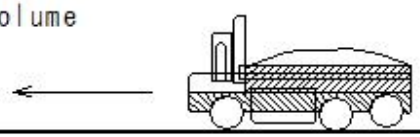
Five years later - Estimate the daily traffic volume of large vehicles per direction

Traffic volume classification

Classification of design traffic volume by large vehicle traffic volume

Large vehicle traffic volume
5 years

Classification of design traffic volume



Classification of design traffic volume by traffic volume of large vehicles	
Classification of design traffic volume	Range of traffic volume of large vehicles (vehicles/day, direction)
L traffic	～100
A traffic	100～250
B traffic	250～1000
C traffic	1000～3000
D traffic	3000～

H199
H2

(H232)Pavement work(Asphalt pavement-Subgrade conditions)

(H232)Pavement work(Asphalt pavement-Subgrade conditions)

Pavement work

Pavement design

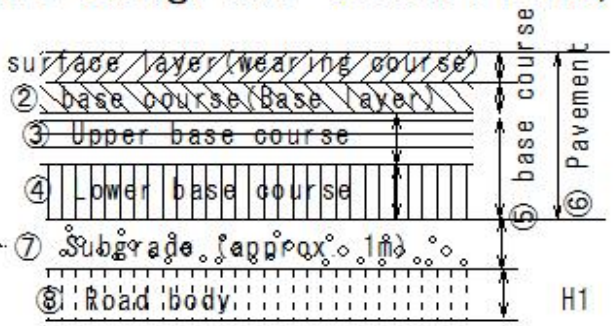
②Subgrade conditions

Determining pavement thickness

Design CBR of subgrade soil

Design CBR - soil collected in soil survey - CBR test

①CBR test



Collect soil for different soil types from about 1m below the subgrade surface

Excluding aggregates with a grain size of 40mm or more, the collected subgrade soil is divided into three layers in a mold with natural moisture content

Tamp each layer 67 times

Calculate the CBR after 4 days of water immersion

Use the following formula to calculate the average CBR for a depth of 1m

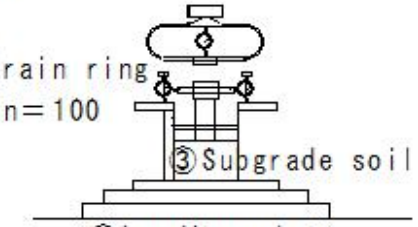
$CBRm=((h_1CBR_1^{(1/3)} + h_2CBR_2^{(1/3)} + \cdots + h_nCBR_n^{(1/3)})/100)$

CBRm: CBR at a certain point

h1, h2,: Thickness of each layer (cm)・・・・・・・・$h_1+h_2+\cdots+h_n=100$

CBR1, CBR2・・・・・・・・・CBRn: CBR of each layer of soil

①CBR test of subgrade soil



①CBR test of subgrade soil

H221

(H233)Pavement work(Asphalt pavement-Subgrade conditions)

(H233)Pavement work(Asphalt pavement-Subgrade conditions)

Pavement work

Pavement design

②Subgrade conditions

Determining pavement thickness

Design CBR of subgrade soil

Design CBR - soil collected in soil survey - CBR test

②Design CBR

Design CBR for sections to be constructed with uniform pavement thickness

Determined using the following formula from the CBR at each point

Design CBR = average CBR at each point - ((maximum CBR - minimum CBR)/C)

C: Correction coefficient

Number of samples	2	3	4	5	6	7	8	9	10over
C	1.41	1.91	2.24	2.48	2.61	2.83	2.96	3.08	3.18

H200

(H234)Pavement work(Asphalt pavement-Weather conditions)

(H234)Pavement work(Asphalt pavement-Weather conditions)

Pavement construction

Pavement design

③Weather conditions

Weather conditions - Freezing depth

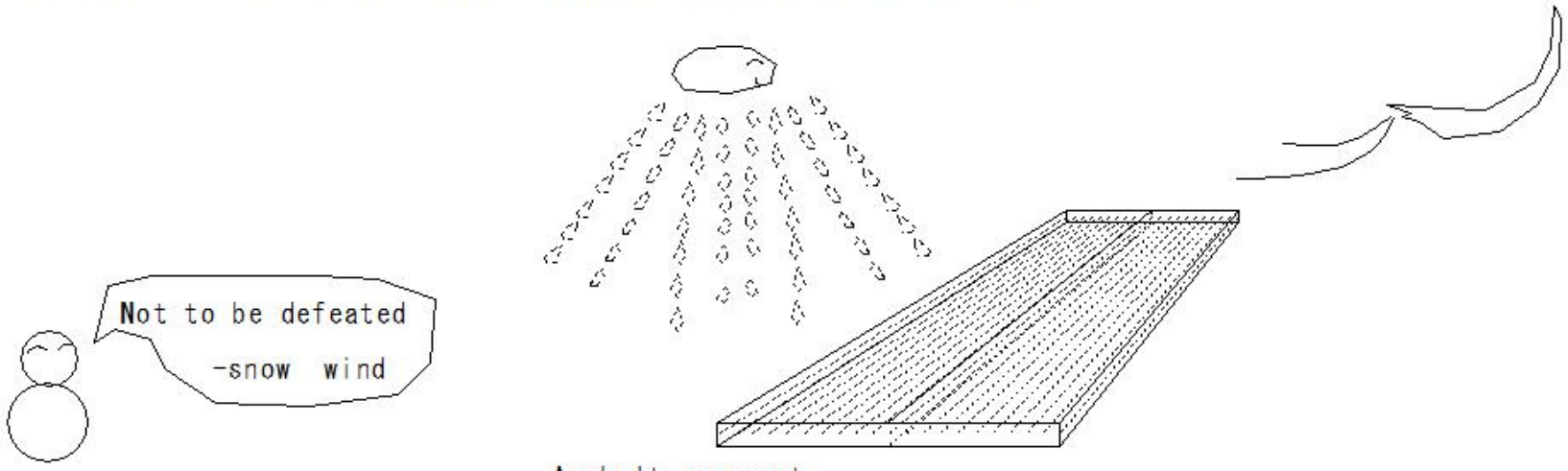
$Z = C\sqrt{F}$

Z: Freezing depth (cm)

C: Constant

F: Freezing index

A number indicating how deeply the ground freezes during cold periods.



(H235)Pavement work(Asphalt pavement -Pavement thickness design)

(H235)Pavement work(Asphalt pavement -Pavement thickness design)

Pavement work

Pavement design

④ Pavement thickness design

TA and total thickness (H) target values

Pavement design TA method

③ Determine target TA and total thickness based on subgrade soil design CBR and traffic volume classification

TA and total thickness target values

TA target value

Design CBR	L Traffic		A Traffic		B Traffic		C Traffic		D Traffic	
	TA	Total Thickness	TA	Total Thickness	TA	Total Thickness	TA	Total Thickness	TA	Total Thickness
2	17	52	21	61	29	74	39	90	51	105
3	15	41	19	48	26	58	35	70	45	83
4	14	35	18	41	24	49	32	59	41	70
6	12	27	16	32	21	38	28	47	37	55
8	11	23	14	27	19	32	26	39	34	46
12	-	-	13	21	17	26	23	31	30	36
20over	-	-	-	-	-	-	20	23	26	27

Subgrade soil design CBR is 2 or more but less than 3, and a barrier layer 15 to 30 cm thick is provided

Determining pavement thickness - Use the design CBR of the subgrade soil excluding the barrier layer

TA: Thickness required when all pavement is made with heated asphalt mixture for surface and base layers

H6,H201

(H236)Pavement work(Asphalt pavement - Pavement structure)

(H236)Pavement work(Asphalt pavement - Pavement structure)

Pavement work

Pavement design

⑤ Pavement structure

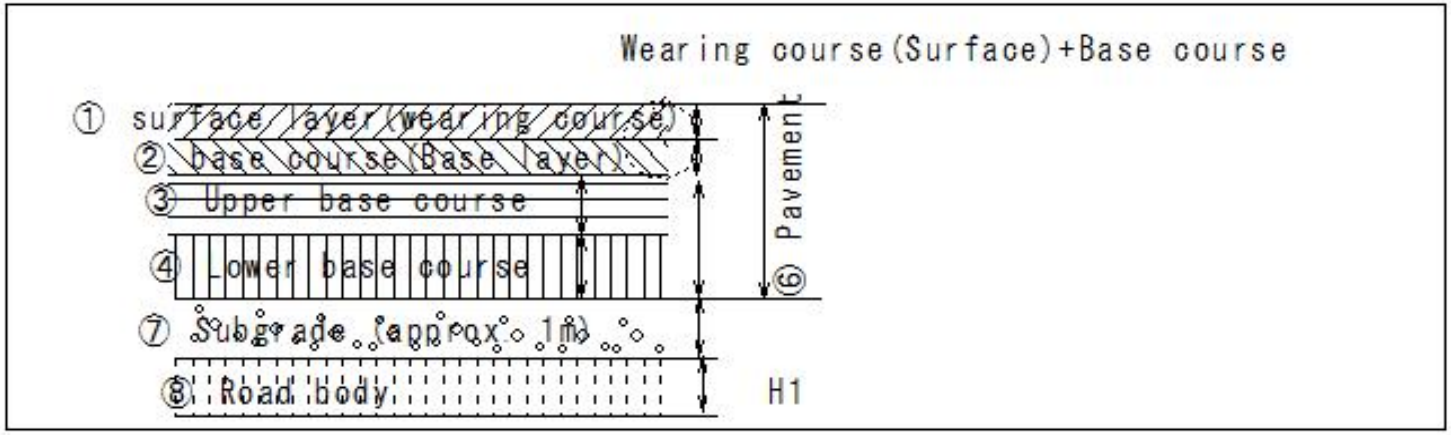
Minimum thickness of Wearing course(Surface)+Base course

Minimum value of Wearing course(Surface)+Base course

Traffic volume classification	Minimum value of Wearing course(Surface)+Base course
L、A Traffic	5
B Traffic	10(5)
C Traffic	15(10)
D Traffic	20(15)

( ) indicates the minimum value when bituminous stabilization work is used for the upper subgrade

H7
H203



(H237)Pavement work(Asphalt pavement - Equivalent conversion coefficient)

(H237)Pavement work(Asphalt pavement - Equivalent conversion coefficient)

Pavement work

Pavement design

⑤ Pavement structure

(a) Equivalent conversion coefficient:an

TA=a1T1+a2T2+a3T3+・・・・・・・・・・・・・・+anTn

a1, a2a3・・・・・・・・・・・・・・・・・・an: Equivalent conversion coefficient

T1, T2, T3・・・・・Tn: Thickness of each layer

Equivalent conversion coefficient used to calculate TA

①TA method

Equivalent conversion coefficient

H9 H204

Location	Construction method, material		Equivalent conversion coefficient, an
①Surface, base	②③Heated asphalt mixture for wearing course and base course		1.00
④Upper base course	⑤Bituminous stabilization	⑥Heated mixing	0.80
		⑦Normal temperature mixing	0.55
	⑧Cement, Bituminous stabilization		0.65
	⑨Cement stabilization		0.55
	⑩Lime stabilization		0.45
	⑪Grain-adjusted crushed stone	Grain-adjusted steel slag	0.35
	⑫Water Hard grain-adjusted steel slag		0.55
⑬ Lower base course	⑭ Crusher run, steel slag, sand	⑮ Modified CBR 30 or higher	0.25
		⑯ Modified CBR 20-30	0.20
	⑰ Cement stabilization		0.25
	⑱ Lime stabilization		0.25

(H238)Pavement work(Asphalt pavement - Pavement design on soft subgrade soil)

(H238)Pavement work(Asphalt pavement - Pavement design on soft subgrade soil)

Pavement construction

Pavement design

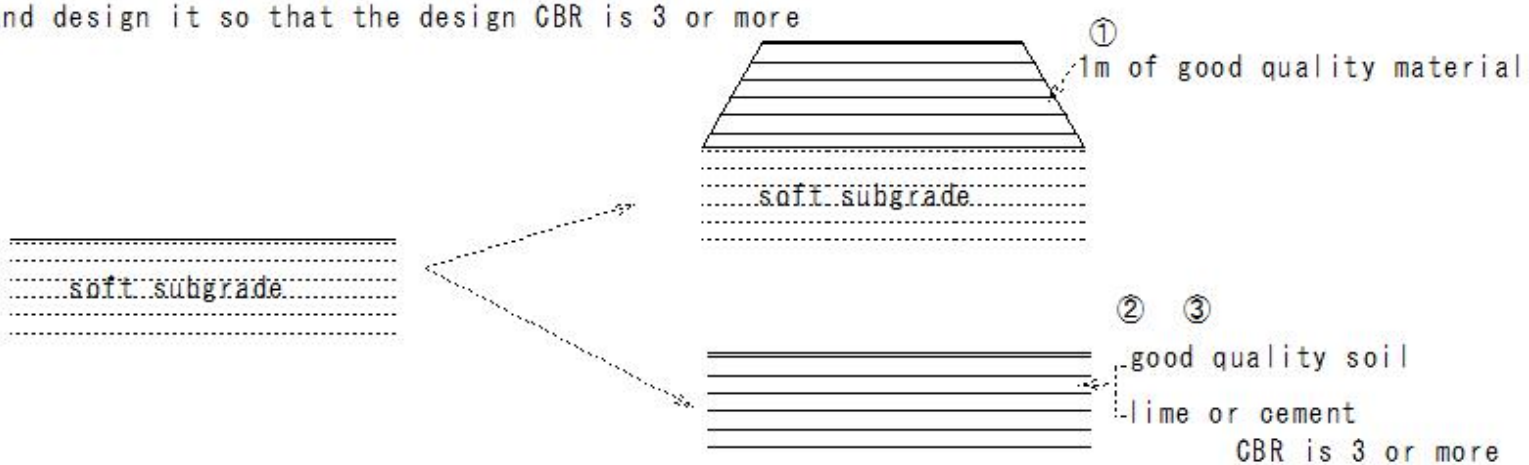
⑥ Pavement design on soft subgrade soil

For a soft subgrade with a design CBR of less than 2, use the following method

① In case of the planned height of the pavement can be raised, create a new subgrade by piling up 1m of good quality material

② In case of the pavement surface cannot be raised above the existing base, replace the subgrade soil with good quality soil and design it so that the design CBR is 3 or more

③ Stabilize the soft subgrade soil with lime or cement and design it so that the design CBR is 3 or more



(H239)Pavement work(Asphalt pavement - Pavement design)

(H239)Pavement work(Asphalt pavement - Pavement design)

Pavement work

Pavement design

Traffic category B H236, H7, H203

Design CBR 4 ..... H235, H201, H6

Base course(roadbed) material: Grain-adjusted crushed stone (corrected CBR>80)

crushed stone (corrected CBR>30) H237, H204, H9

①Target values for TA and H

TA: 24cm

H: 49cm

(H240)Pavement work(Asphalt pavement - Pavement design)

(H240)Pavement work(Asphalt pavement - Pavement design)

Pavement work

Pavement design

Traffic category B ← H236, H7, H203

Design CBR 4 ← H235, H201, H6

Base course(roadbed) material: Grain-adjusted crushed stone (corrected CBR>80)

crushed stone (corrected CBR>30) ← H237, H204, H9

①Target values for TA and H

TA: 24cm

H: 49cm

②Total thickness of Wearing course(Surface)+Base course

Wearing course(Surface)
Base course
Base course(roadbed)
Subgrade(roadbed)

Total thickness of Wearing course(Surface)+Base course H1: 10cm

TA1 = 1.0 x 10 = 10cm

TA2 and H2 required for Base course(roadbed)

TA2 = 24 - 10 = 14cm

H2 = 49 - 10 = 39cm

(H241)Pavement work(Asphalt pavement - Pavement design)

(H241)Pavement work(Asphalt pavement - Pavement design)

Pavement work

Pavement design

Traffic category B ← H236, H7, H203

Design CBR 4 ← H235, H201, H6

Base course(roadbed) material: Grain-adjusted crushed stone (corrected CBR>80)

crushed stone (corrected CBR>30) ← H237, H204, H9

①Target values for TA and H

TA: 24cm

H: 49cm

②Total thickness of Wearing course(Surface)+Base course

Wearing course(Surface)
Base course
Base course(roadbed)
Subgrade(roadbed)

Total thickness of Wearing course(Surface)+Base course H1: 10cm

TA1 = 1.0 x 10 = 10cm H236

TA2 and H2 required for Base course(roadbed)

TA2 = 24 - 10 = 14cm

H2 = 49 - 10 = 39cm

③Selection of subgrade material

Equivalent conversion coefficients for materials used in subgrade H237

Grain-adjusted crushed stone (corrected CBR>80): 0.35

crushed stone (corrected CBR>30): 0.25

Grain-adjusted crushed stone for Upper base course(roadbed)

crushed stone for Lower Base course(roadbed)

(H242)Pavement work(Asphalt pavement - Pavement design)

(H242)Pavement work(Asphalt pavement - Pavement design)

Pavement work

Pavement design
Traffic category B H236, H7, H203
Design CBR 4 ..... H235, H201, H6

Base course(roadbed) material: Grain-adjusted crushed stone (corrected CBR>80)
crushed stone (corrected CBR>30) H237, H204, H9

①Target values for TA and H

TA: 24cm
H: 49cm

②Total thickness of Wearing course(Surface)+Base course

Wearing course(Surface)
Base course
Base course(roadbed)
Subgrade(roadbed)

Total thickness of Wearing course(Surface)+Base course H1: 10cm
TA1 = 1.0 x 10 = 10cm H236
TA2 and H2 required for Base course(roadbed)
TA2 = 24 - 10 = 14cm
H2 = 49 - 10 = 39cm

③Selection of subgrade material H237
Equivalent conversion coefficients for materials used in subgrade
Grain-adjusted crushed stone (corrected CBR>80): 0.35
crushed stone (corrected CBR>30): 0.25
Grain-adjusted crushed stone for Upper base course(roadbed)
crushed stone for Lower Base course(roadbed)

④Determine the thickness of each Base course(roadbed)
Calculate the necessary thickness for each subgrade considering economic efficiency H237
0.35×Upper base course(roadbed) thickness+0.25×Lower subgrade thickness≧TA2
Upper subgrade thickness (grain-adjusted crushed stone) 30cm
Lower Base course(roadbed) thickness (cut crushed stone) 15cm

TA2'
0.35×30+0.25×15=14.25>TA2 (=14cm)
H2' 30+15=45>H2 (=39cm)

(H243)Pavement work(Asphalt pavement - Pavement design)

(H243)Pavement work(Asphalt pavement - Pavement design)

Pavement work

Pavement design

Traffic category B ← H236,H7,H203

Design CBR 4 ← H235,H201,H6

Base course(roadbed) material: Grain-adjusted crushed stone (corrected CBR>80)

crushed stone (corrected CBR>30) ← H237,H204,H9

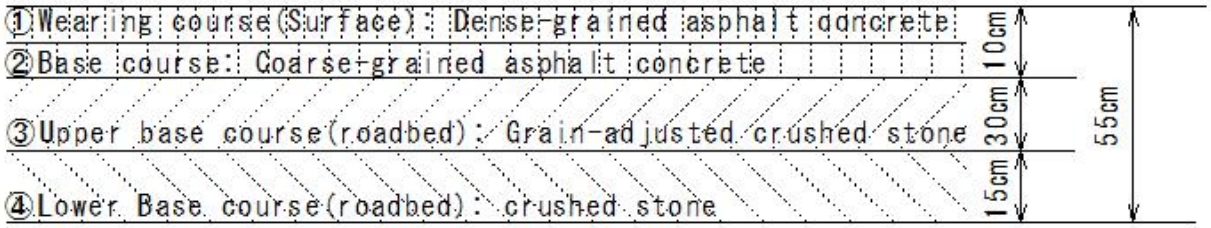
⑤Determine pavement thickness and composition

TA and H

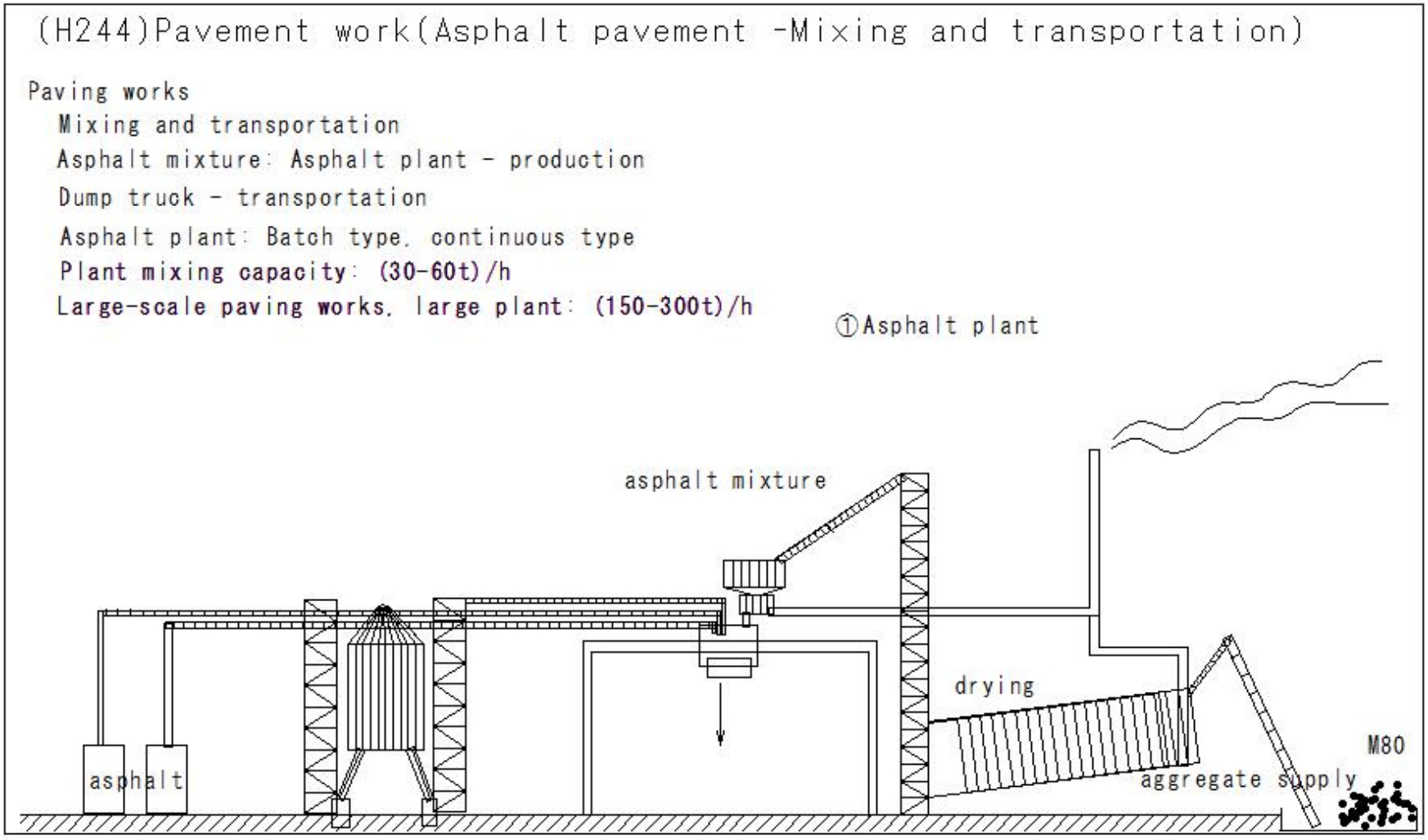
TA' = TA1 + TA2' = 24.25 cm > TA (= 24)

H' = H1 + H2' = 55 cm > H (= 49)

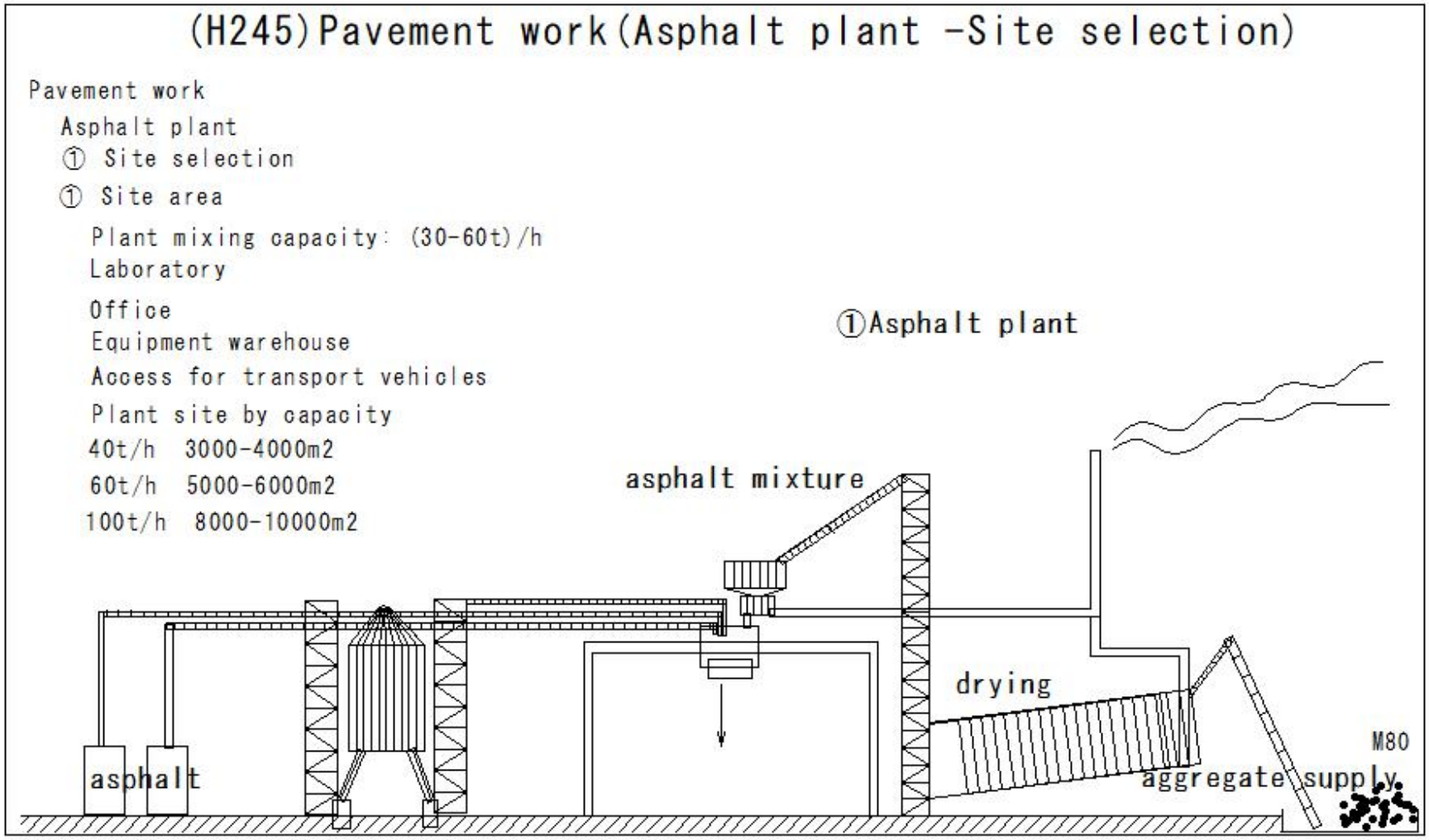
Note: The thickness of the surface and base layers is determined taking into account workability



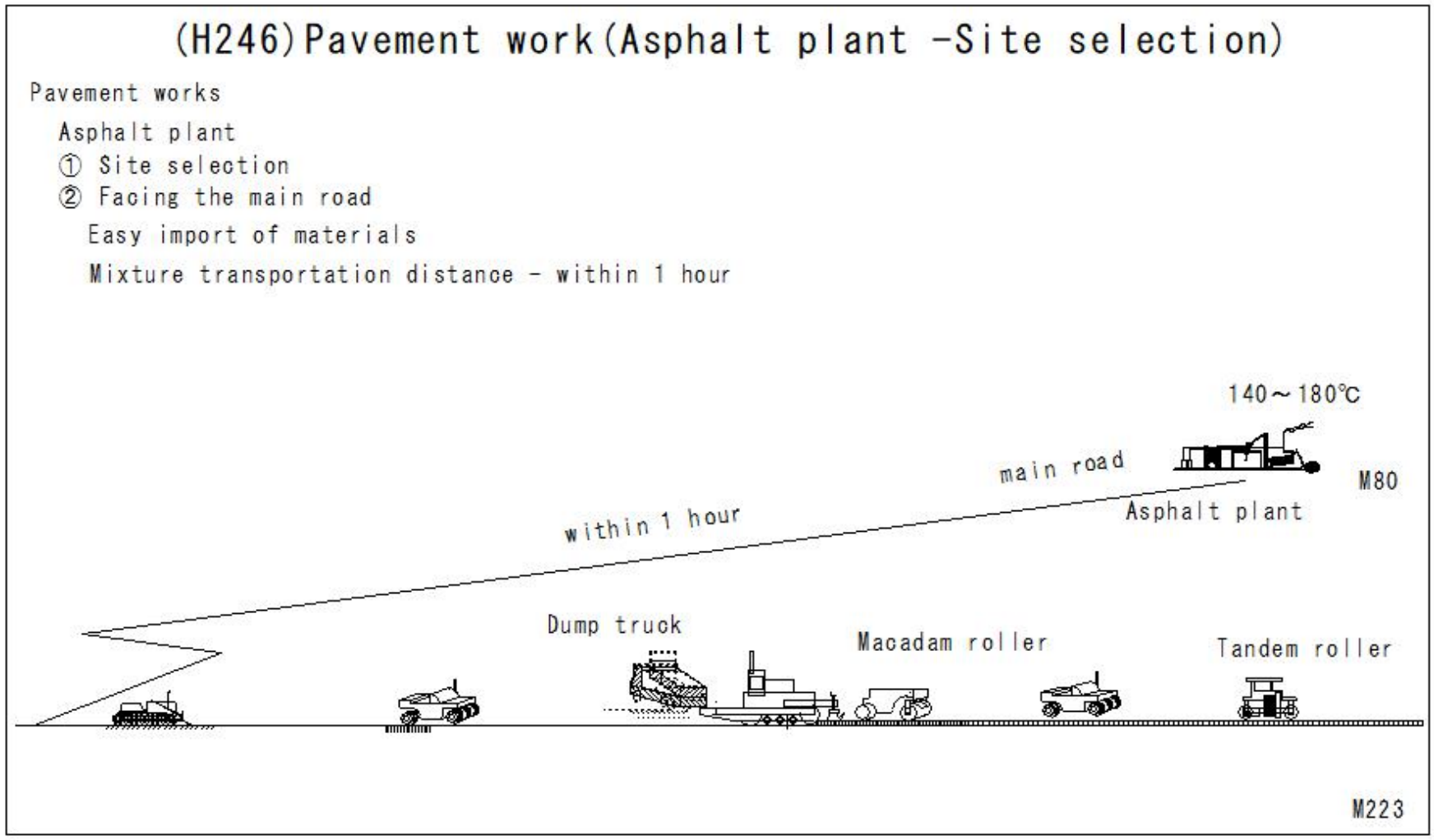
(H244)Pavement work(Asphalt pavement -Mixing and transportation)



(H245)Pavement work(Asphalt plant -Site selection)



(H246)Pavement work(Asphalt plant -Site selection)



(H247)Pavement work(Asphalt plant -Site selection)

(H247)Pavement work(Asphalt plant -Site selection)

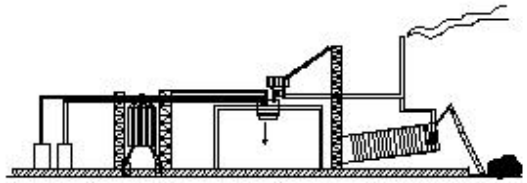
Pavement works

Asphalt plant

① Site selection

③ Environment that does not cause harm to surrounding residents due to noise, soot, sewage, etc.

residents



Asphalt plant

M80

(H248)Pavement work(Asphalt plant -Site selection)

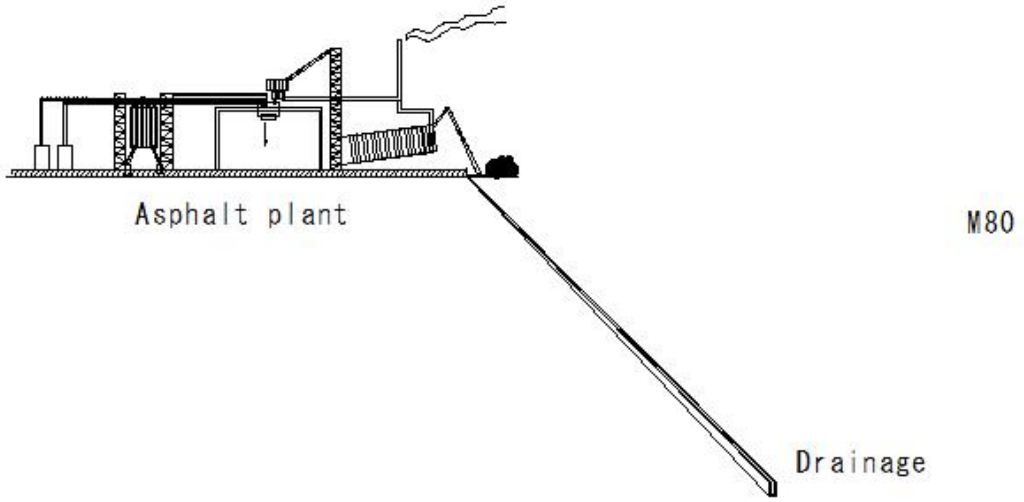
(H248)Pavement work(Asphalt plant -Site selection)

Pavement works

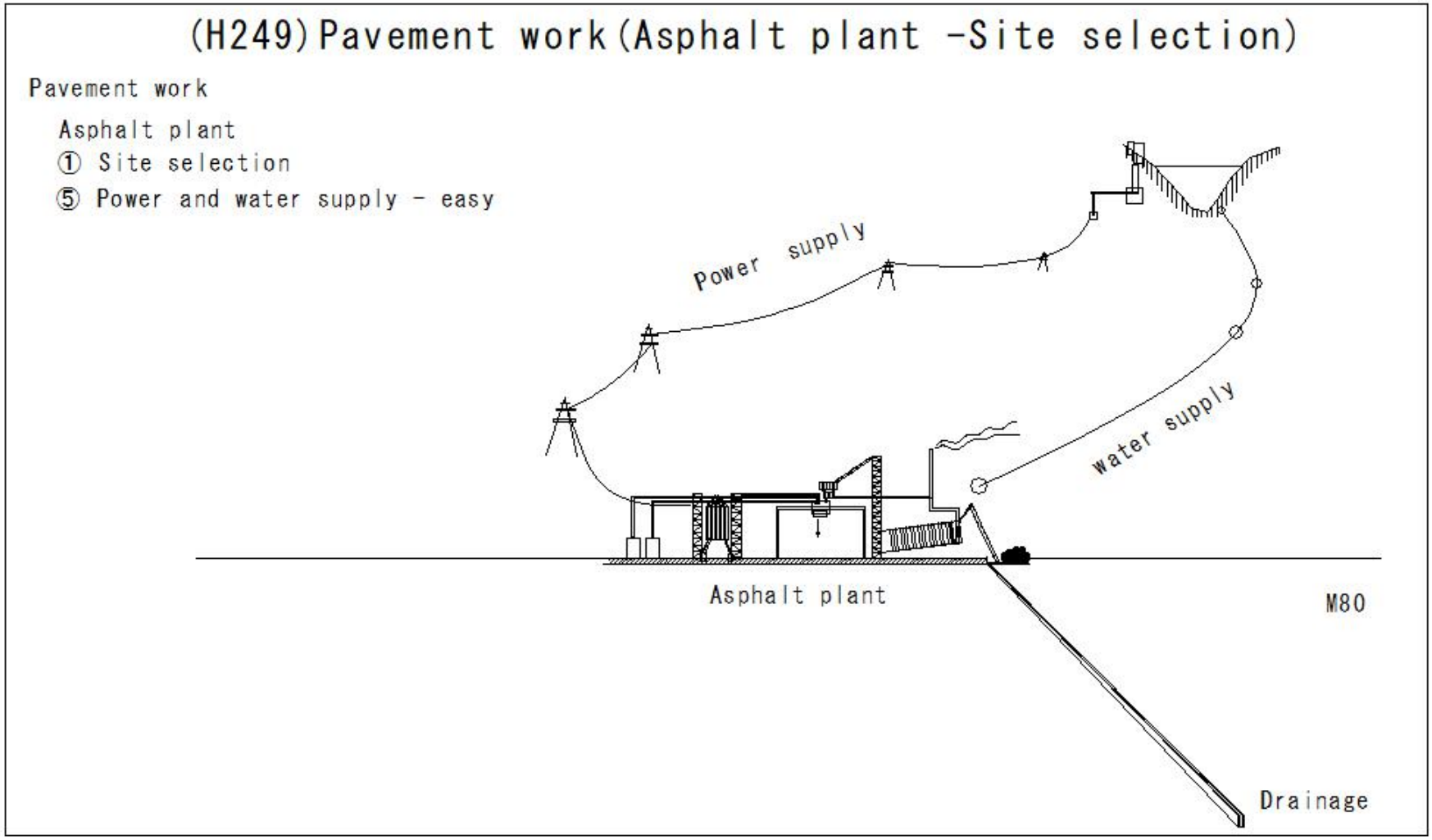
Asphalt plant

① Site selection

④ Drainage - Good



(H249)Pavement work(Asphalt plant -Site selection)



(H250)Pavement work(Asphalt plant -Capacity selection)

(H250)Pavement work(Asphalt plant -Capacity selection)

Pavement work

Asphalt plant

Capacity selection

Plant mixing capacity: (30-60t)/h

Mobile plant

Fixed plant

How to determine the capacity of a mobile plant

C = (A x H x d)/(T x p x t)

C: Required plant capacity (t/h)

A: Paving area (m2)

H: Paving thickness of heated asphalt mixture (m)

T: Planned number of days for paving (days)

t: Operating hours per day (h)

d: Finished density of heated mixture (t/m3)

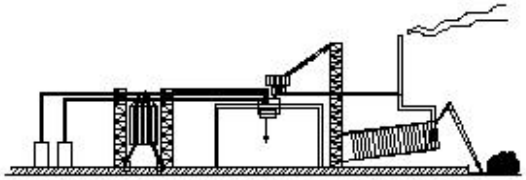
p: Operating rate (days/30 days)

Finally

Aggregate properties Mixture type Construction time Machine efficiency Relationship between each work type

10-20% margin

Plant: 60-70 t/h



Asphalt plant

How to determine the capacity of a mobile plant

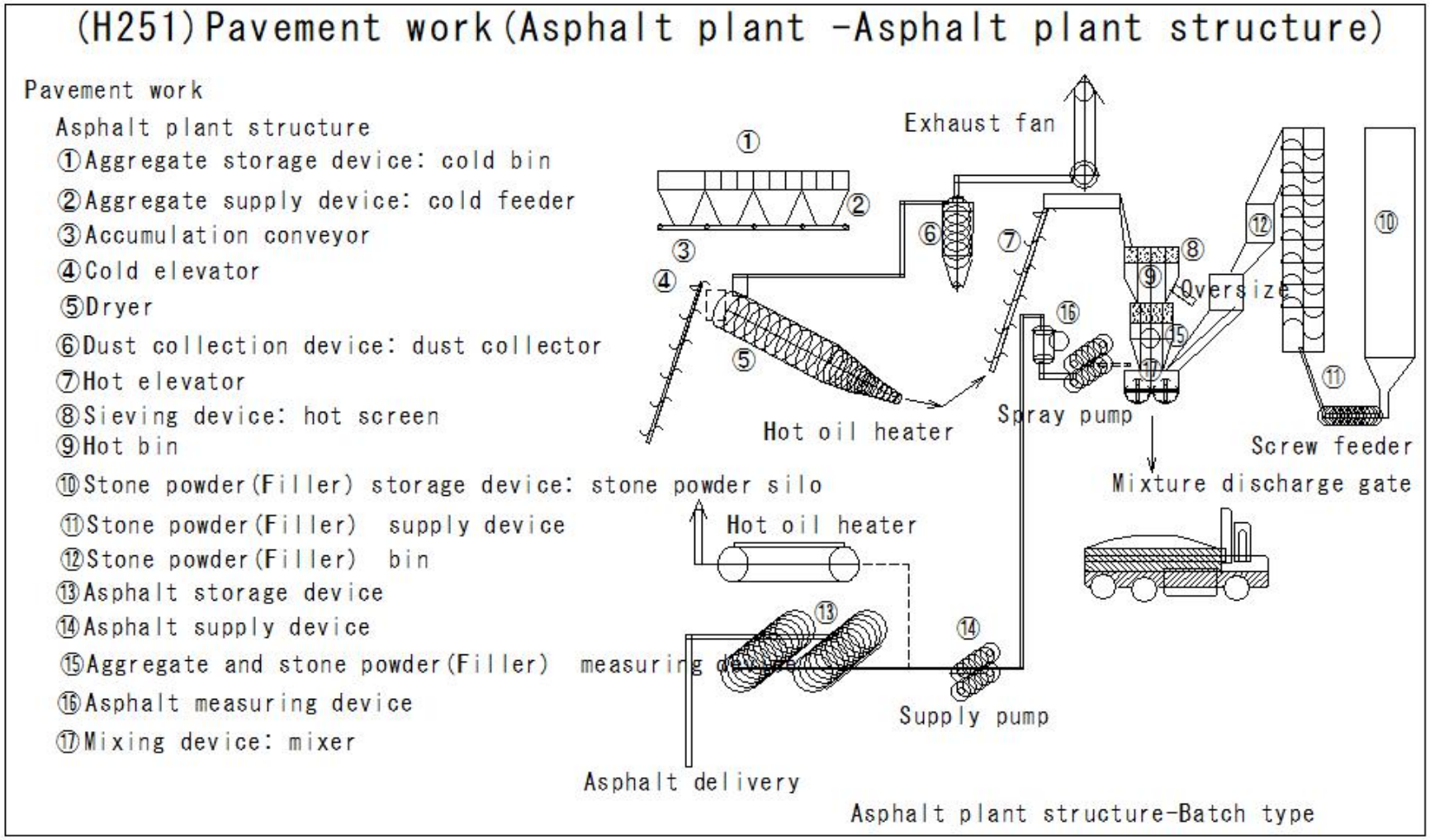
A: 80,000 m2 H: 0.20 m T: 140 days t: 7 h d: 2.32 t/m3 p: (20 days/30 days)

C = (A x H x d)/(T x p x t)

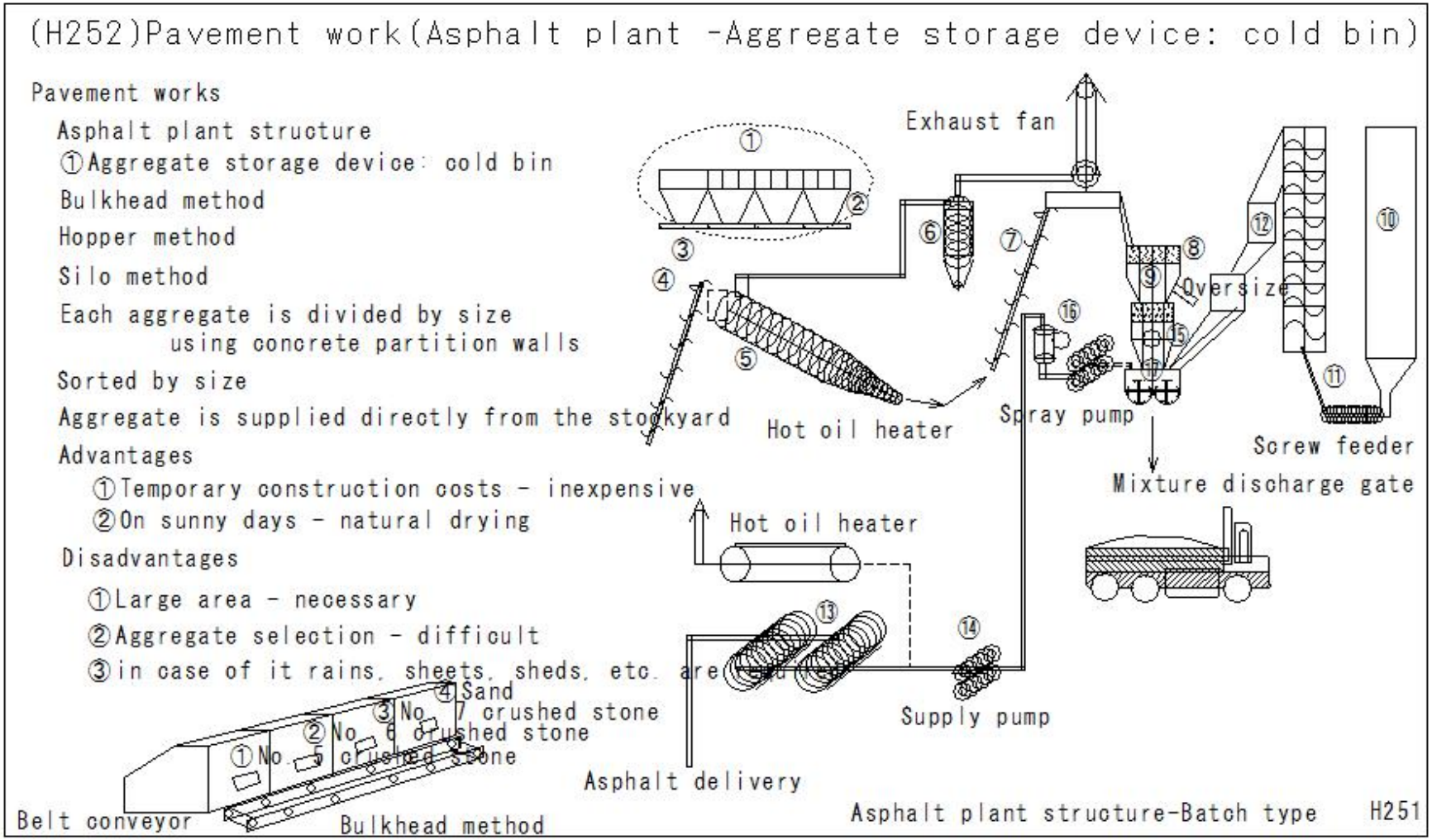
C = (80,000 x 0.20 x 2.32)/(140 x (20/30) x 7)

≒ 57 (t/h) Required plant capacity

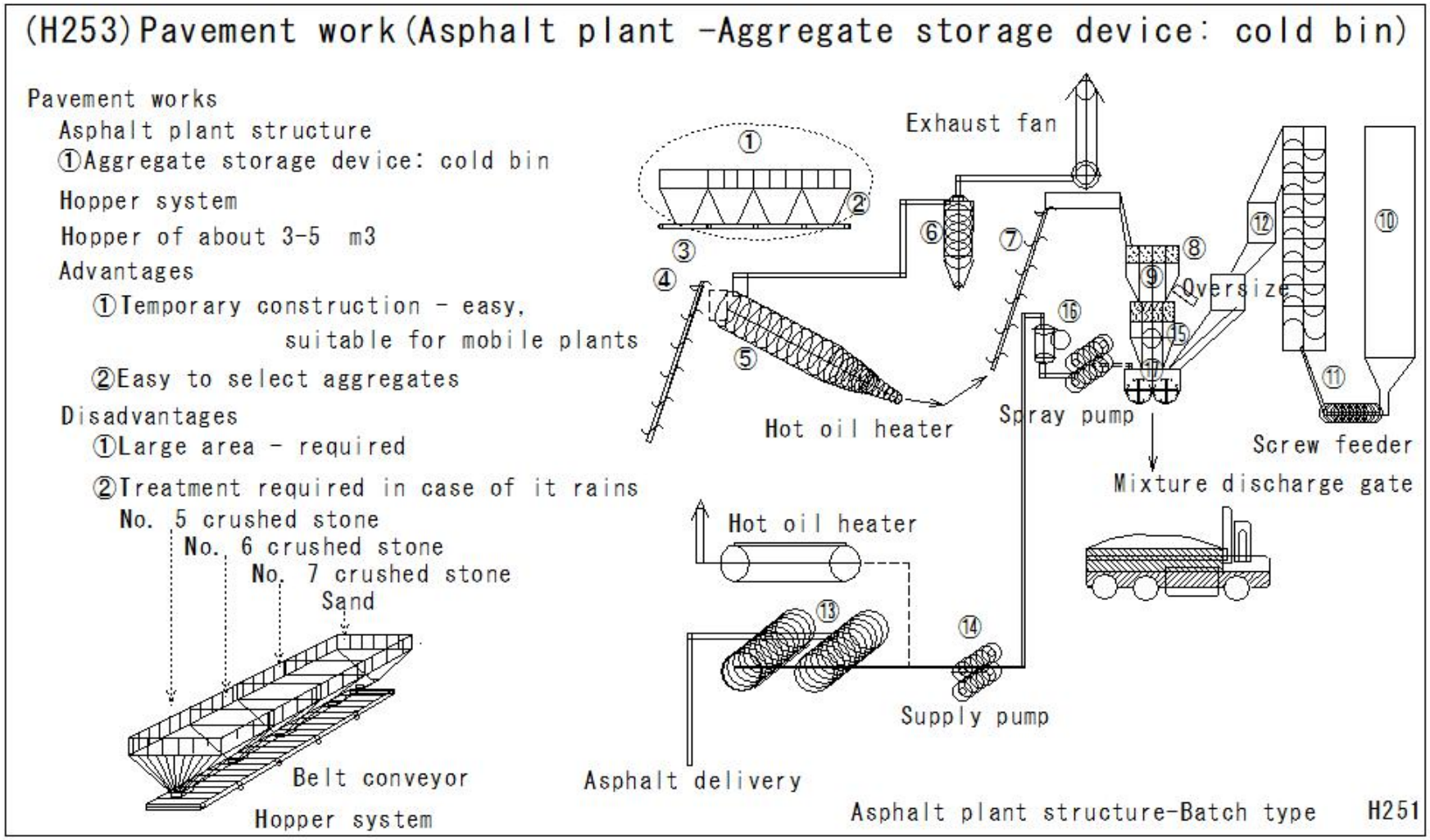
(H251)Pavement work(Asphalt plant -Asphalt plant structure)



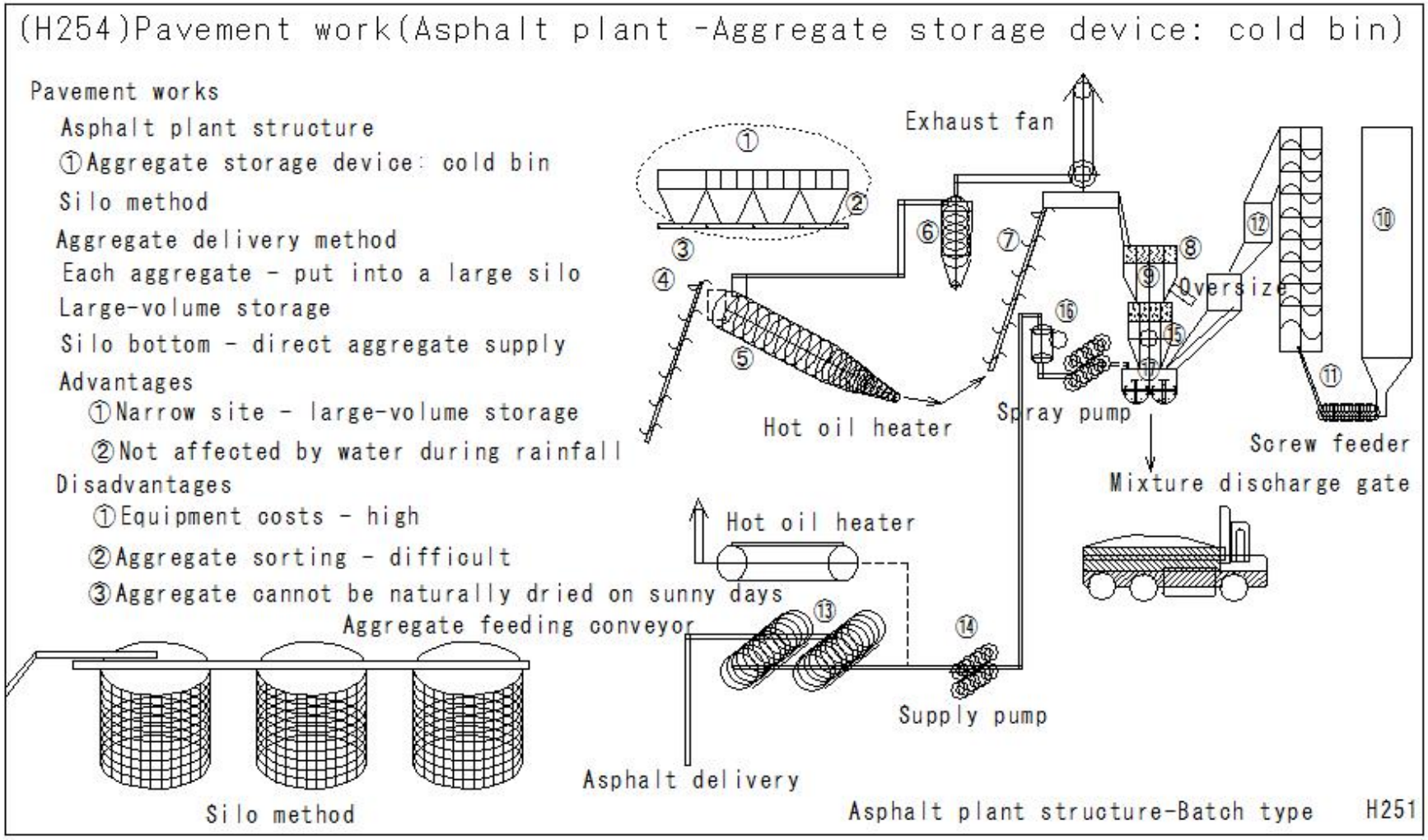
(H252)Pavement work(Asphalt plant -Aggregate storage device: cold bin)



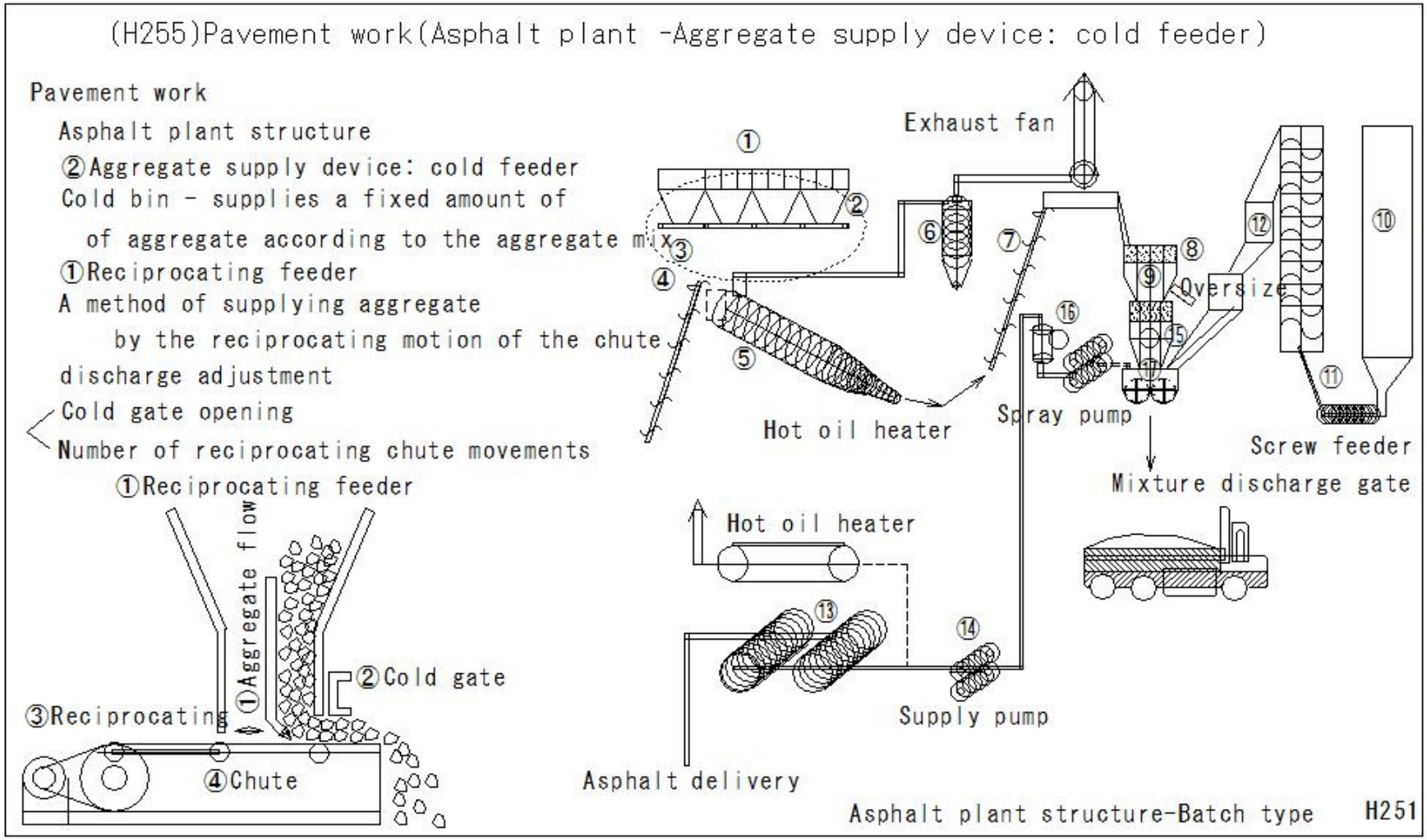
(H253)Pavement work(Asphalt plant -Aggregate storage device: cold bin)



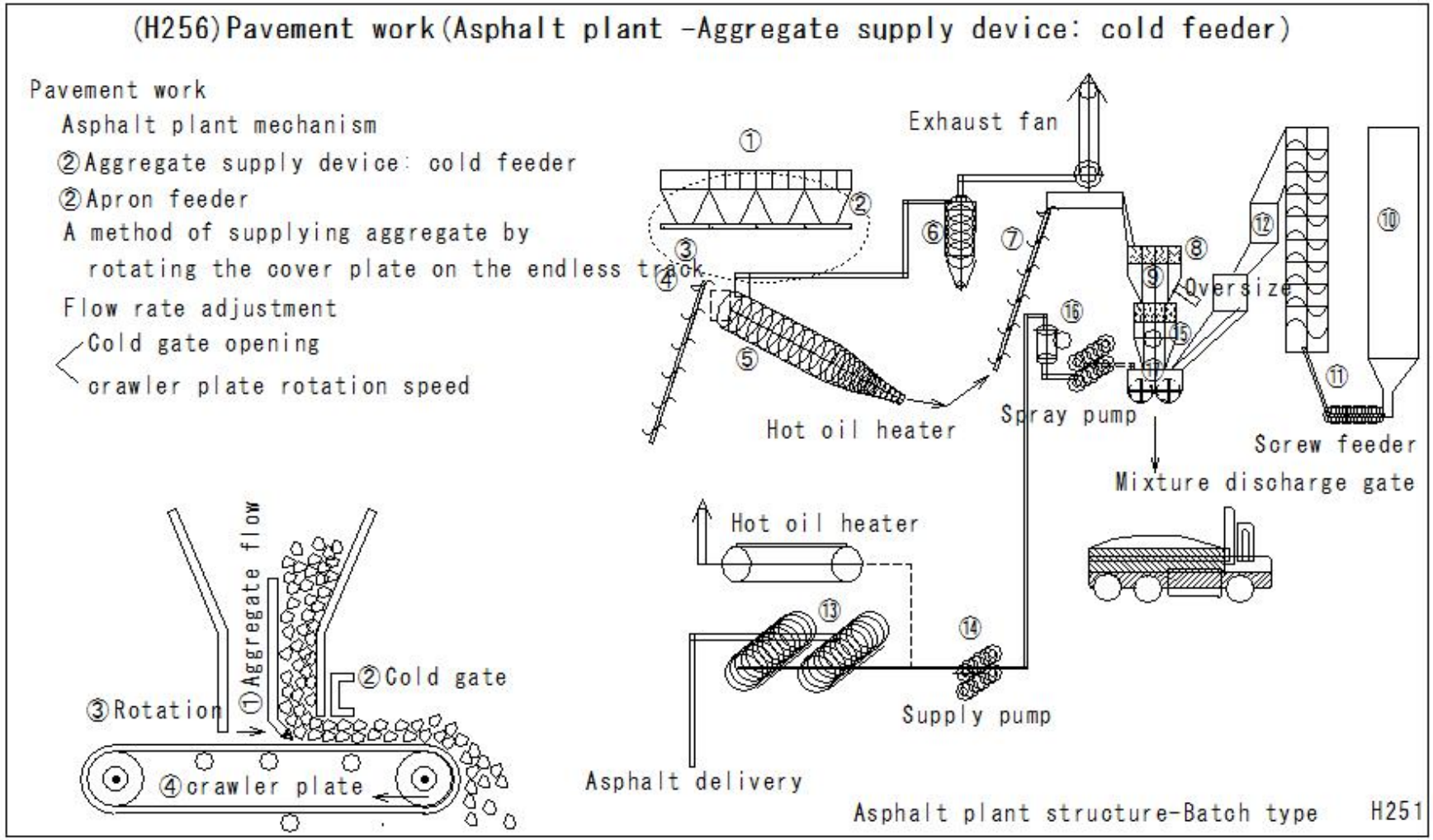
(H254)Pavement work(Asphalt plant -Aggregate storage device: cold bin)



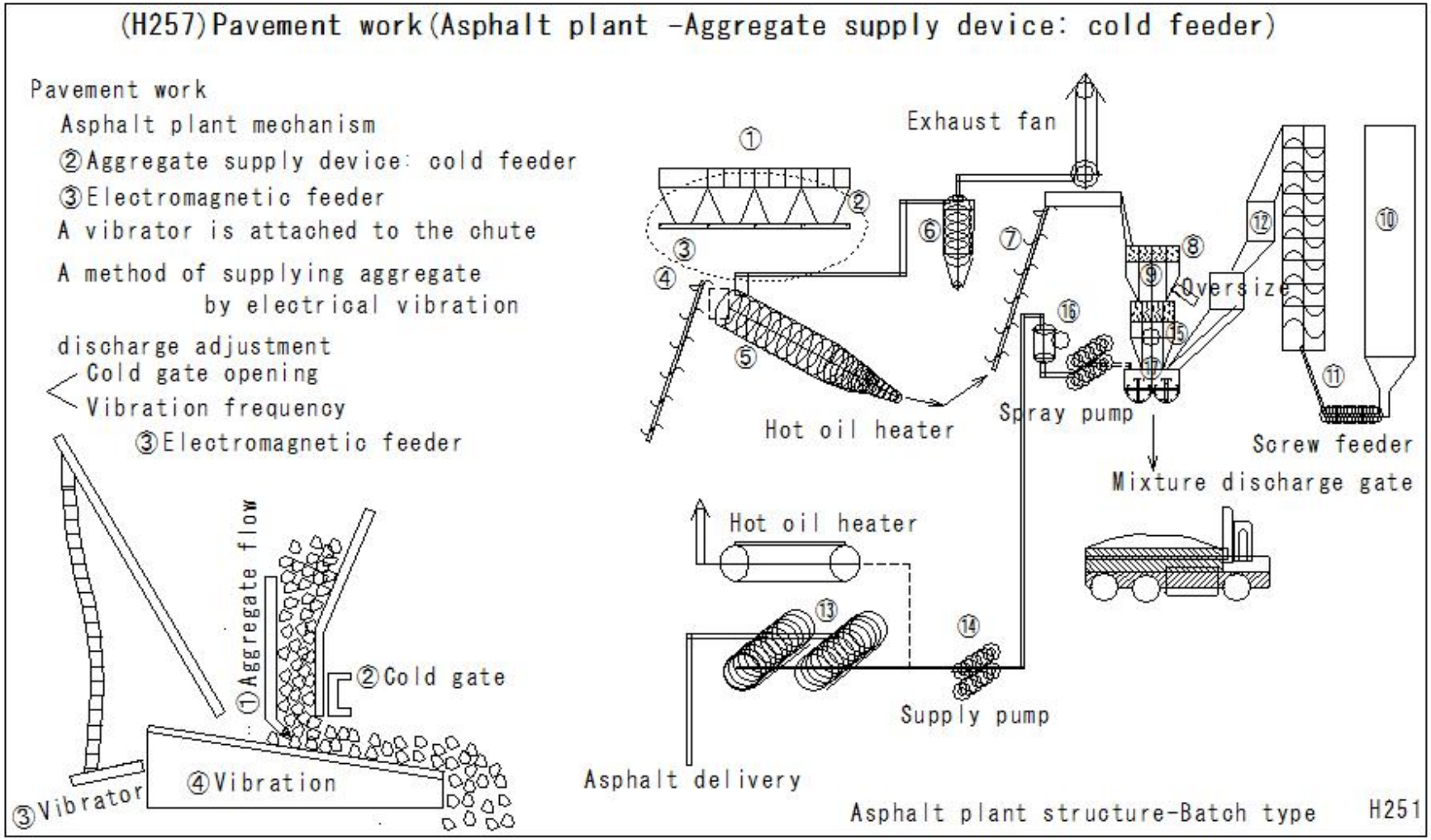
(H255)Pavement work(Asphalt plant -Aggregate supply device: cold feeder)



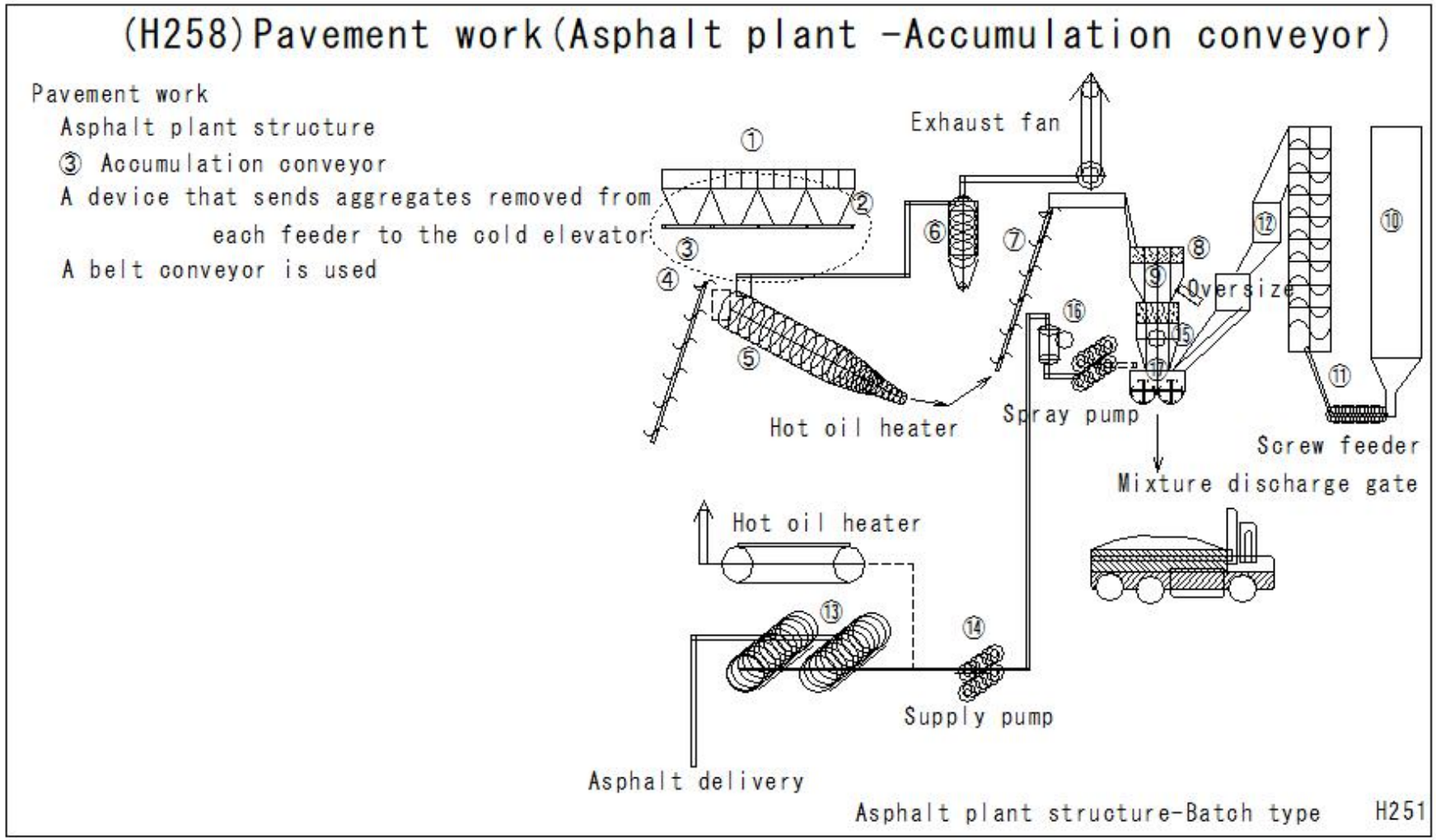
(H256)Pavement work(Asphalt plant -Aggregate supply device: cold feeder)



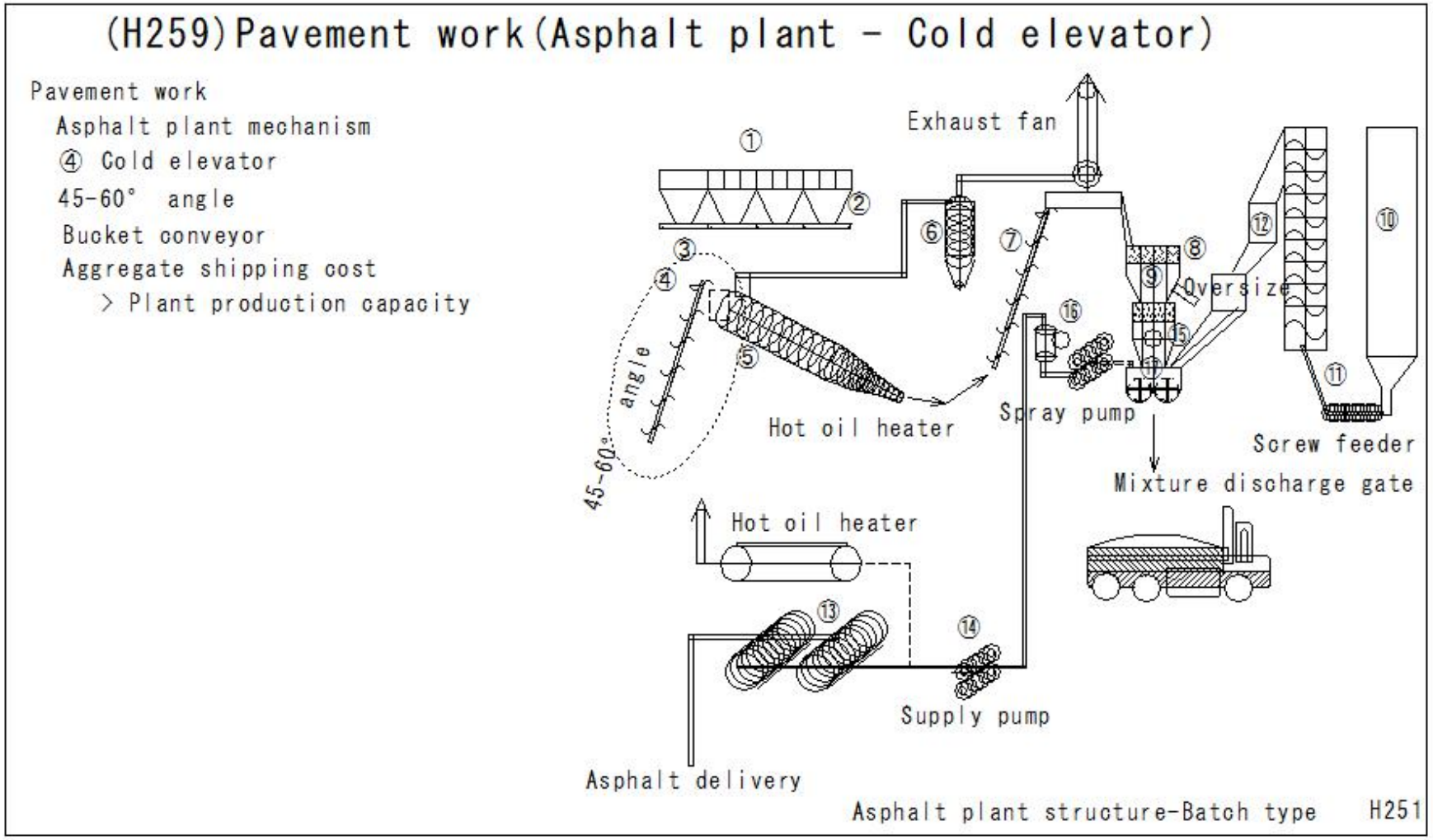
(H257)Pavement work(Asphalt plant -Aggregate supply device: cold feeder)



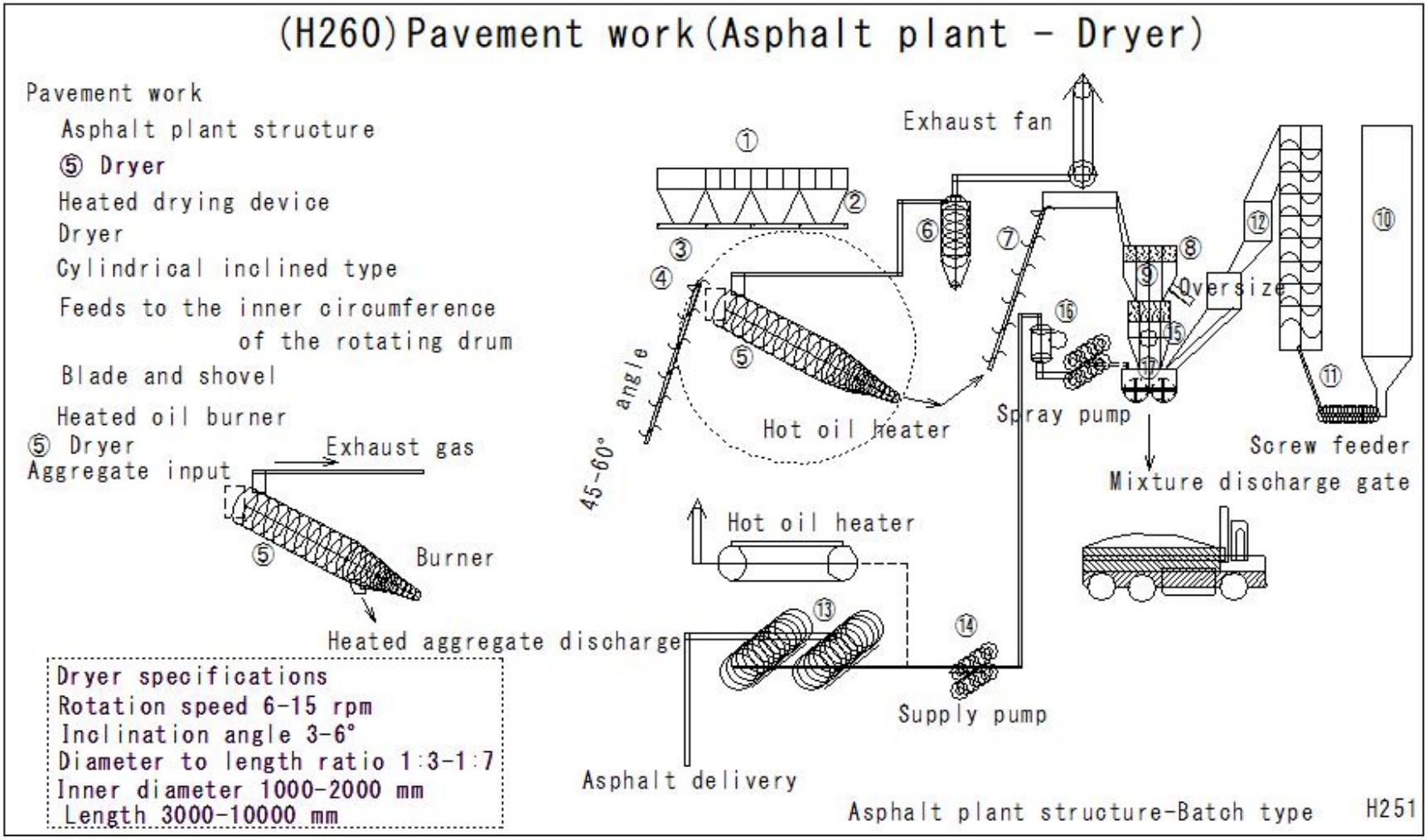
(H258)Pavement work(Asphalt plant -Accumulation conveyor)



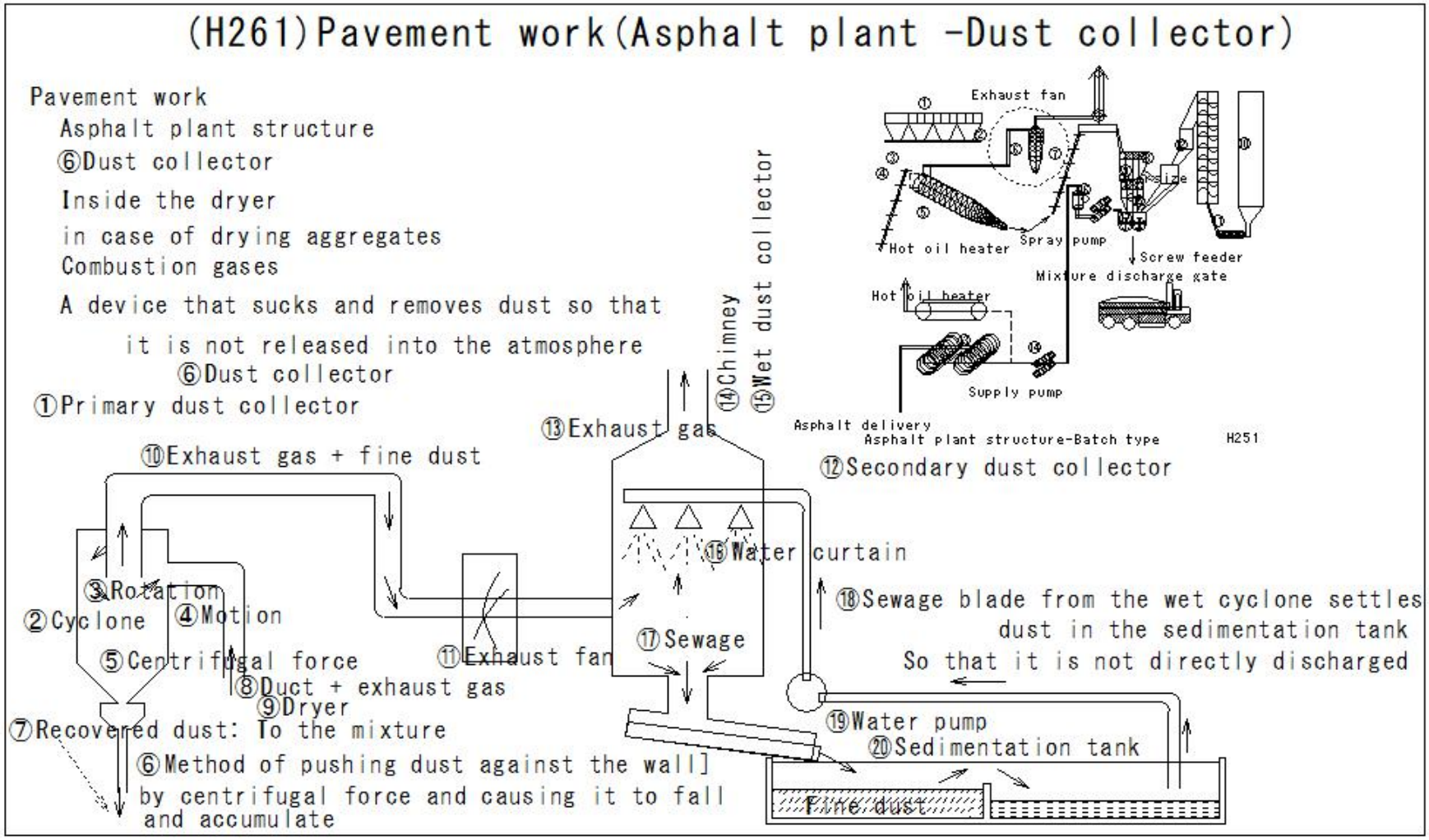
(H259)Pavement work(Asphalt plant - Cold elevator)



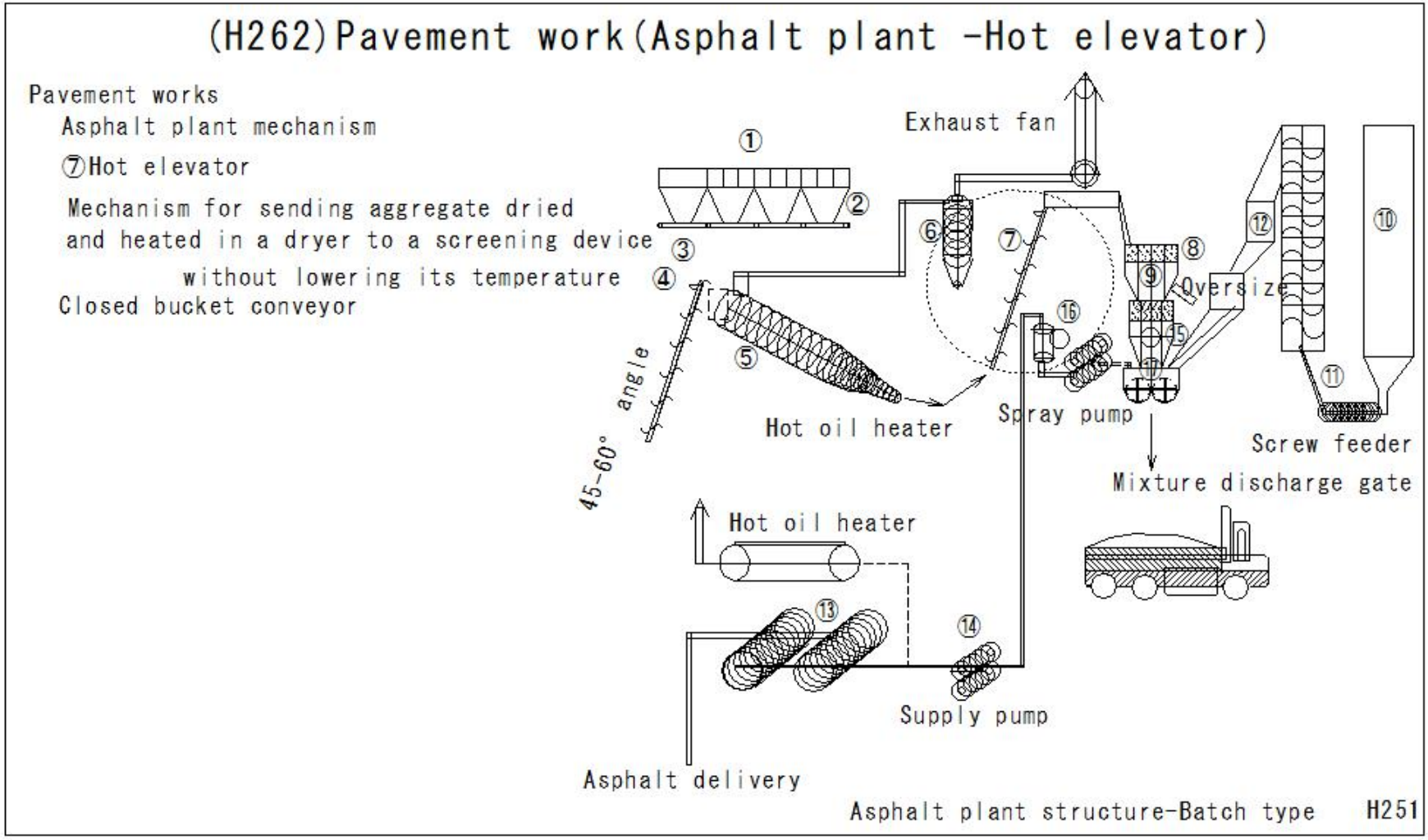
(H260)Pavement work(Asphalt plant - Dryer)



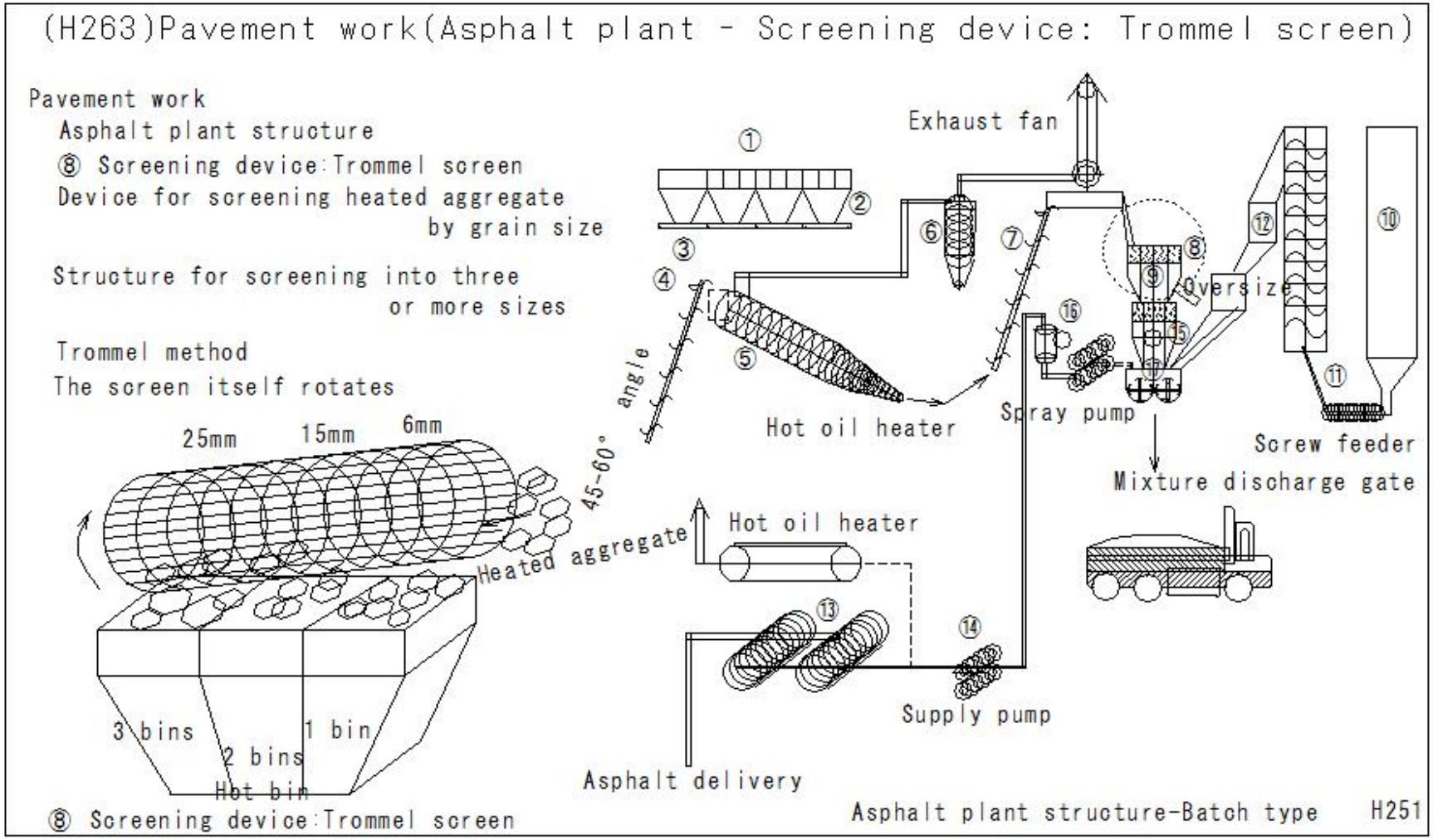
(H261)Pavement work(Asphalt plant -Dust collector)



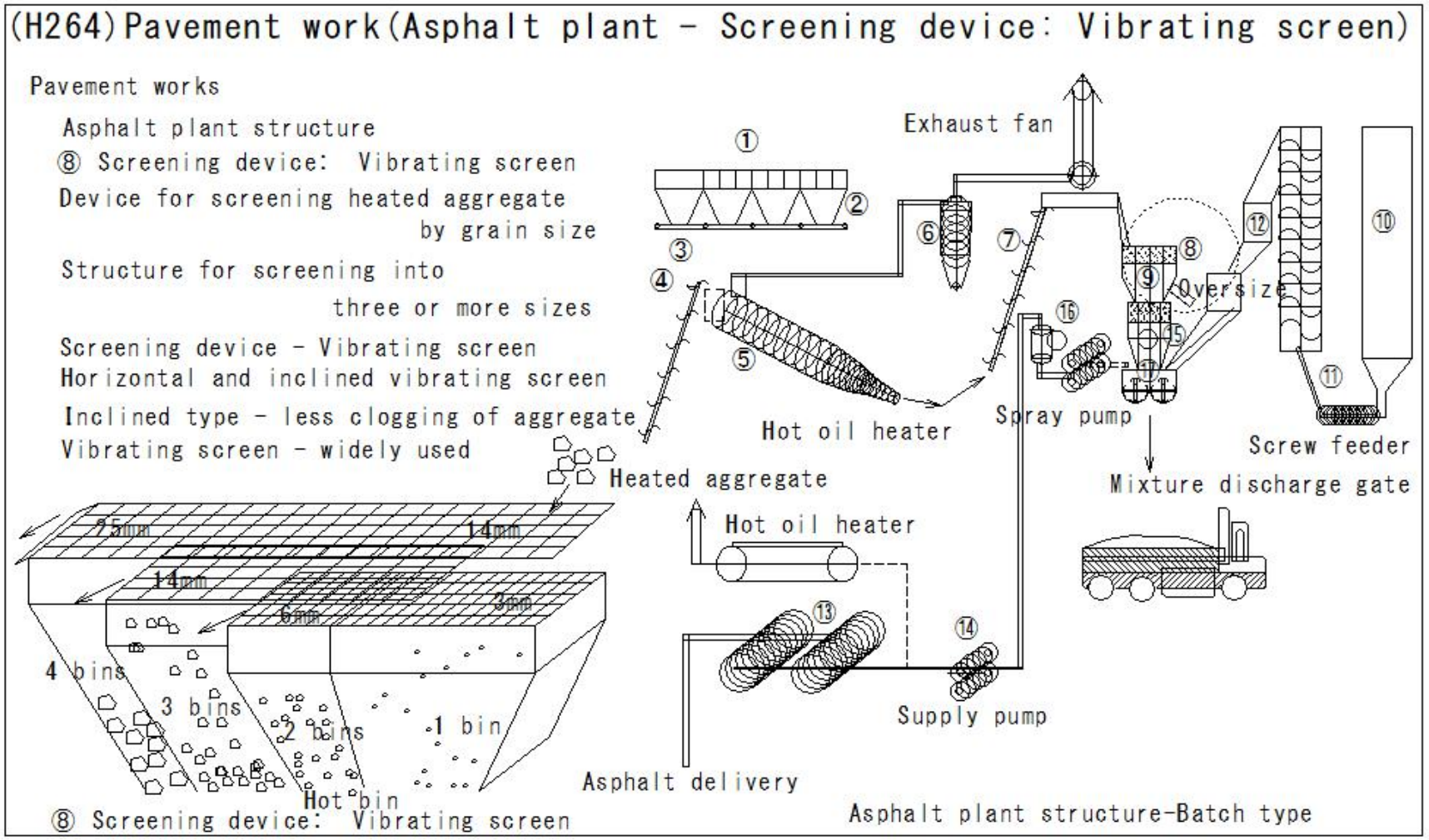
(H262)Pavement work(Asphalt plant -Hot elevator)



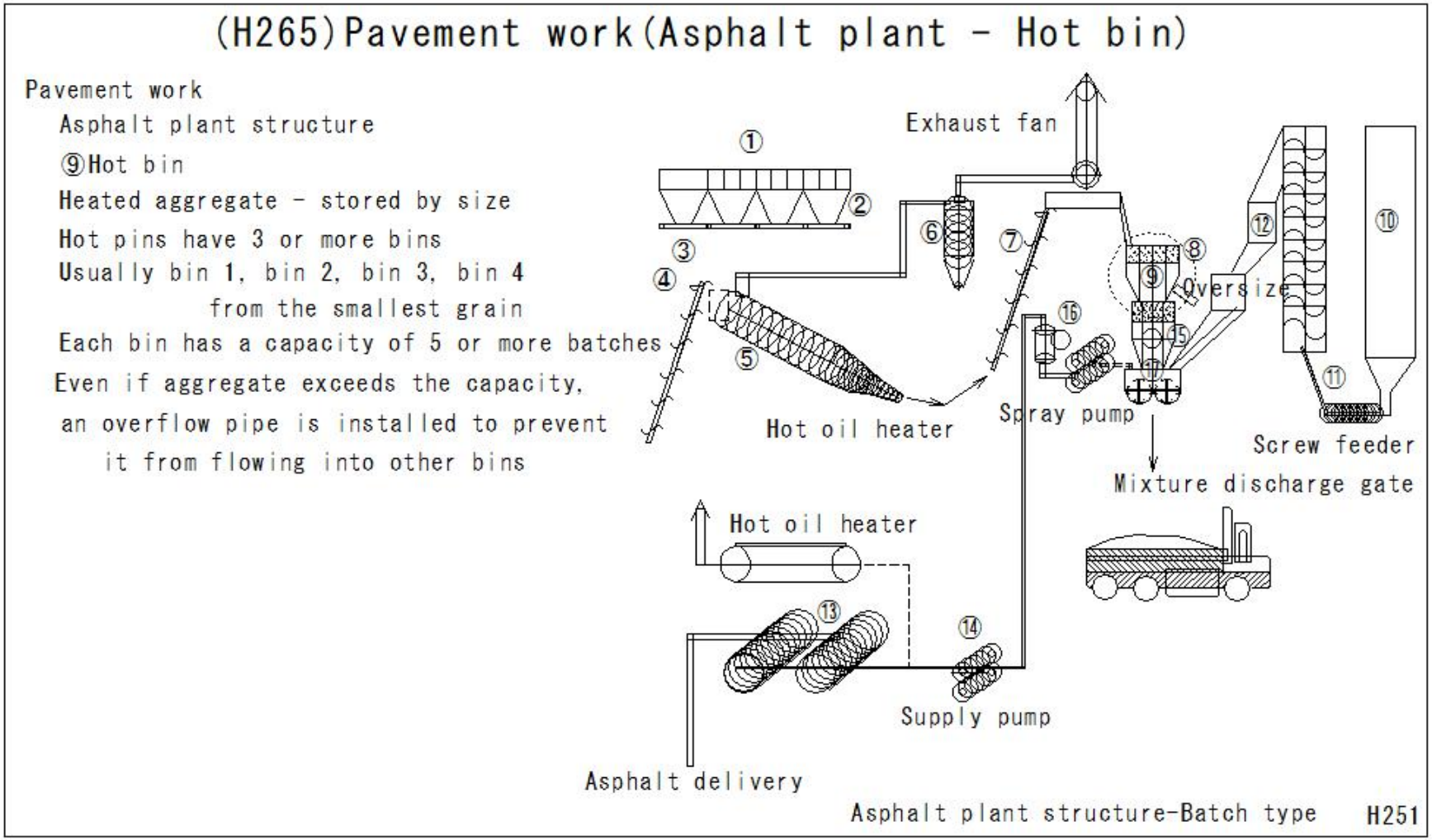
(H263)Pavement work(Asphalt plant - Screening device: Trommel screen)



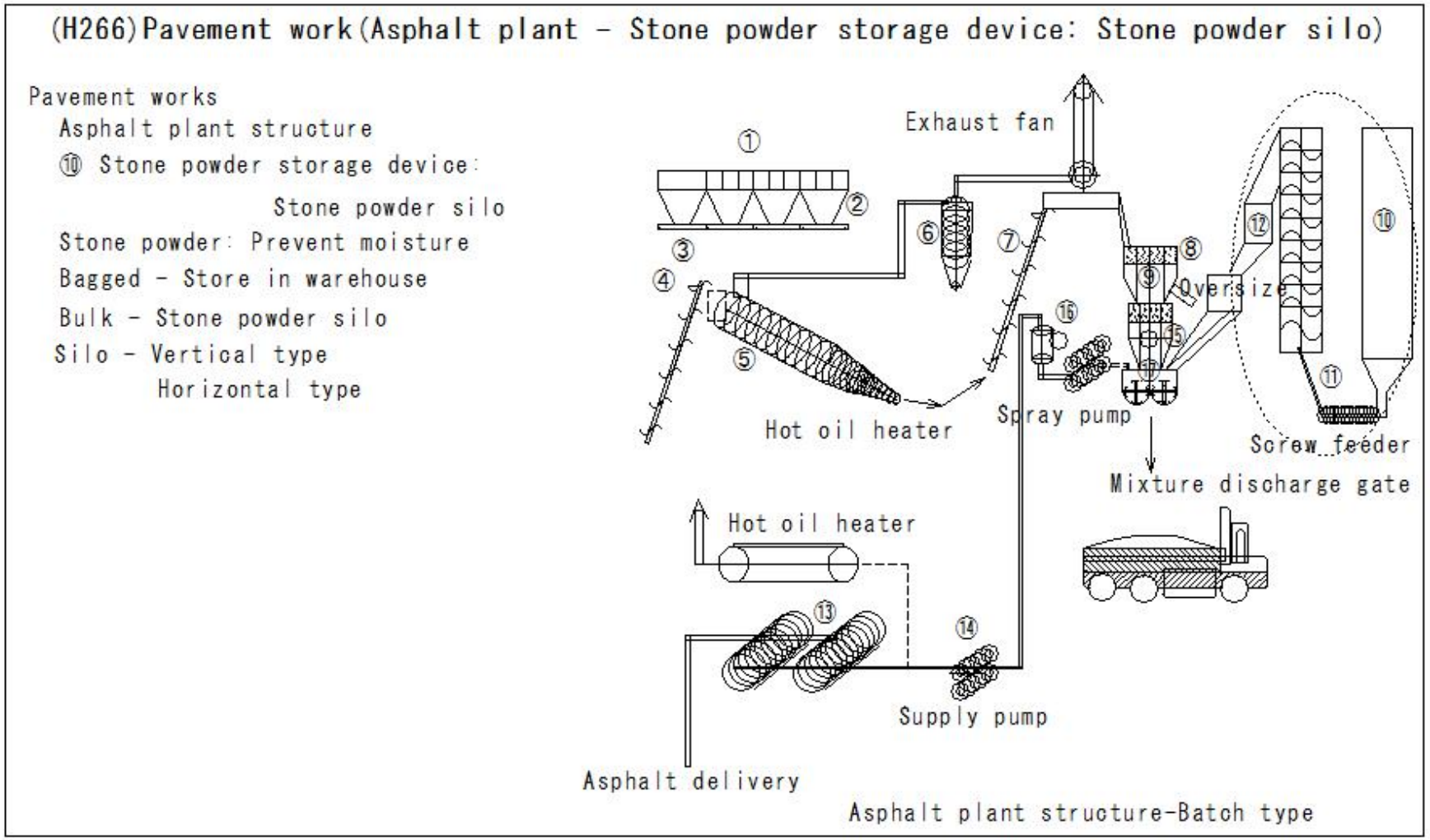
(H264)Pavement work(Asphalt plant - Screening device: Vibrating screen)



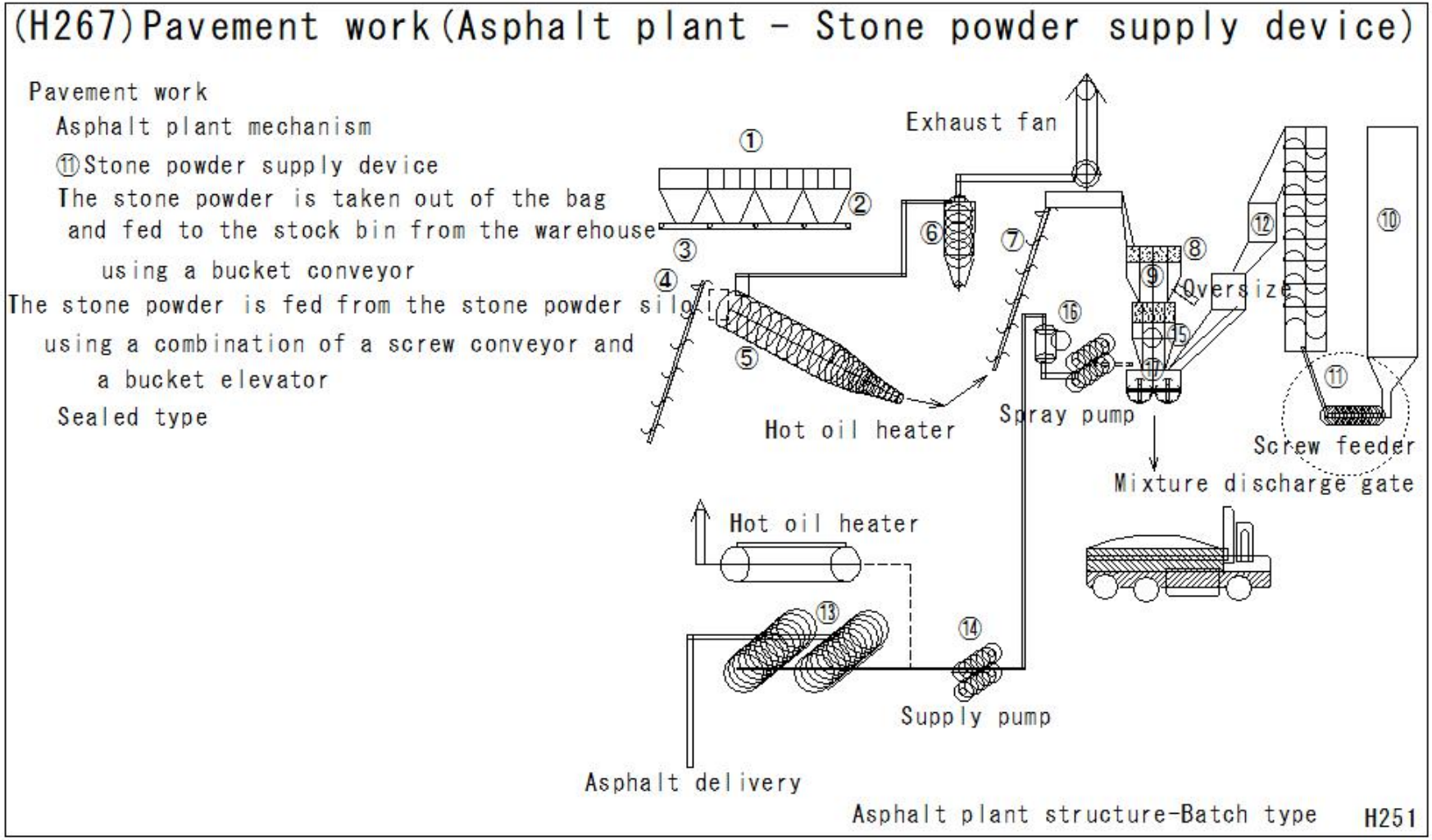
(H265)Pavement work(Asphalt plant - Hot bin)



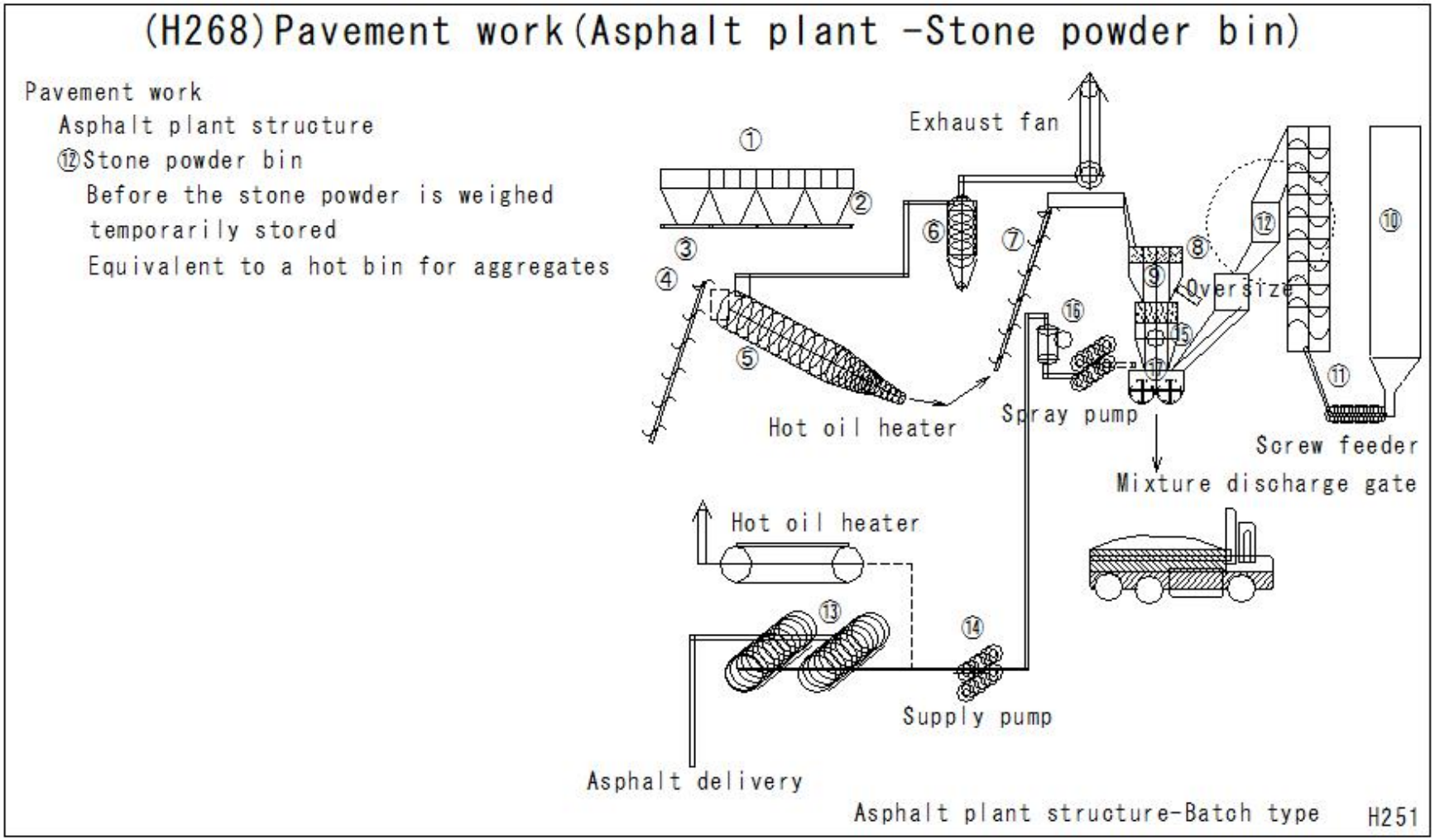
(H266)Pavement work(Asphalt plant - Stone powder storage device: Stone powder silo)



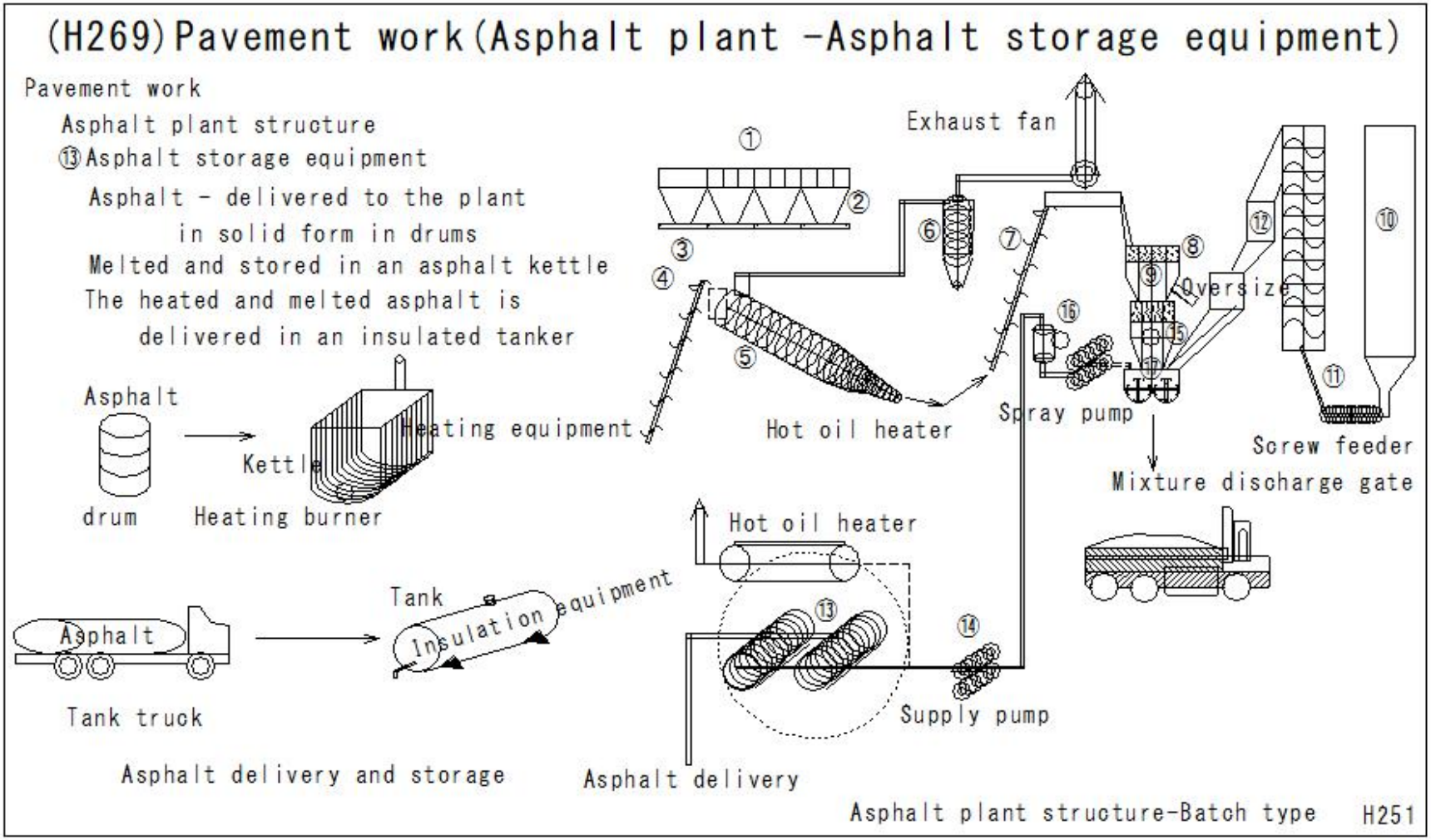
(H267)Pavement work(Asphalt plant - Stone powder supply device)



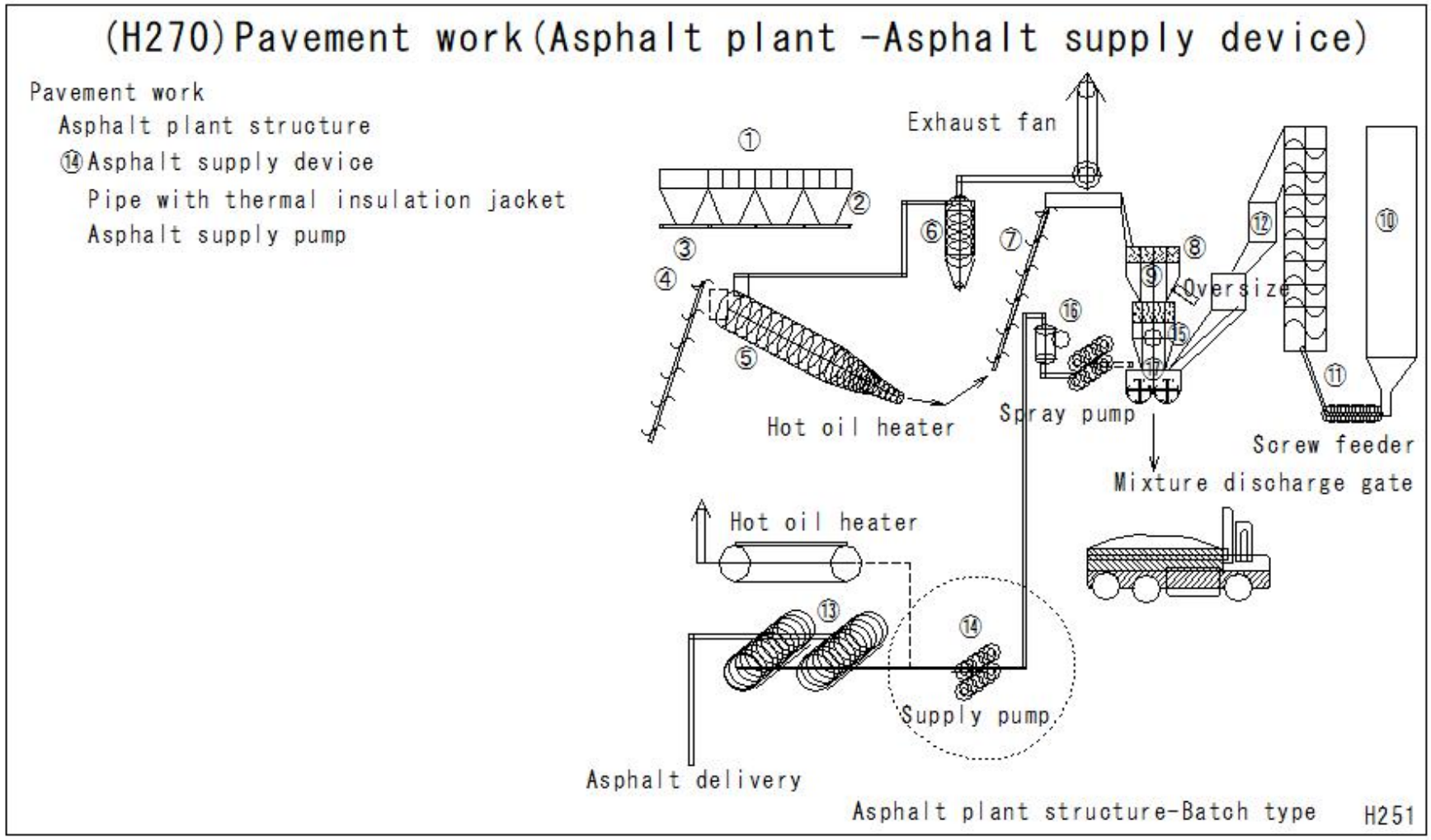
(H268)Pavement work(Asphalt plant -Stone powder bin)



(H269)Pavement work(Asphalt plant -Asphalt storage equipment)



(H270)Pavement work(Asphalt plant -Asphalt supply device)



(H271)Pavement work(Asphalt plant -Aggregate and stone powder weighing device)

(H271)Pavement work(Asphalt plant -Aggregate and stone powder weighing device)

Pavement works

Asphalt plant structure

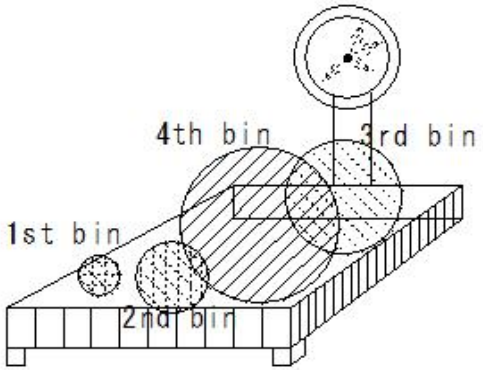
⑮Aggregate and stone powder weighing device

Equipment for weighing each batch

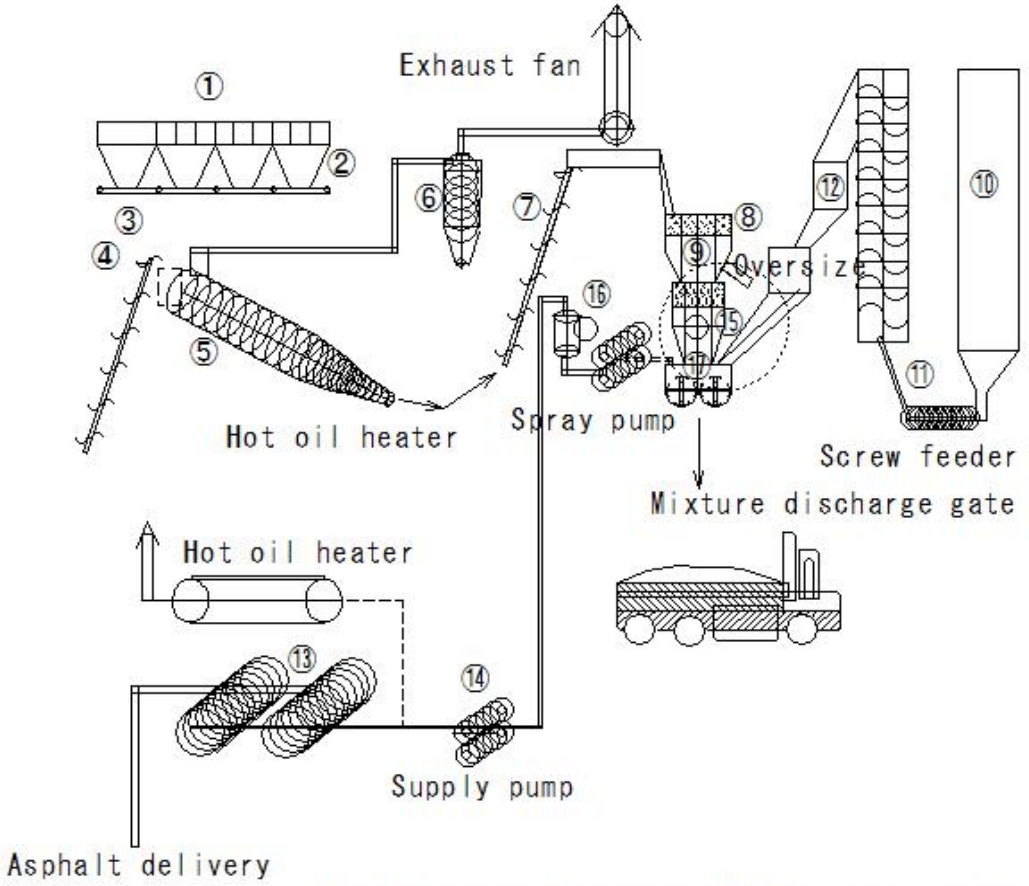
Weighing method: Accumulation from the largest particle size by weight

Stone powder - weighing separately

Weighing device - platform scale - spring type, pendulum type



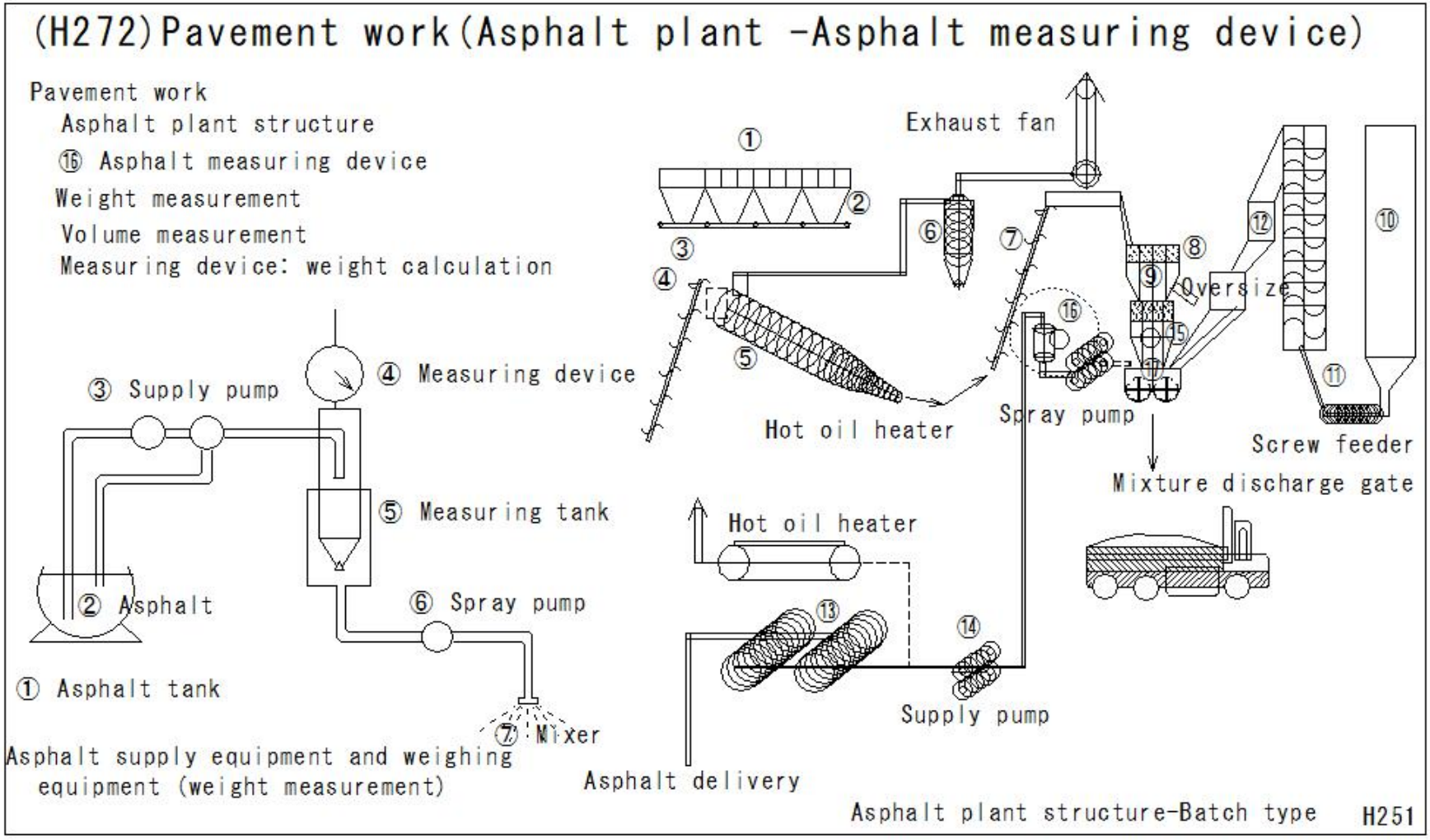
Accumulation calculation for one batch



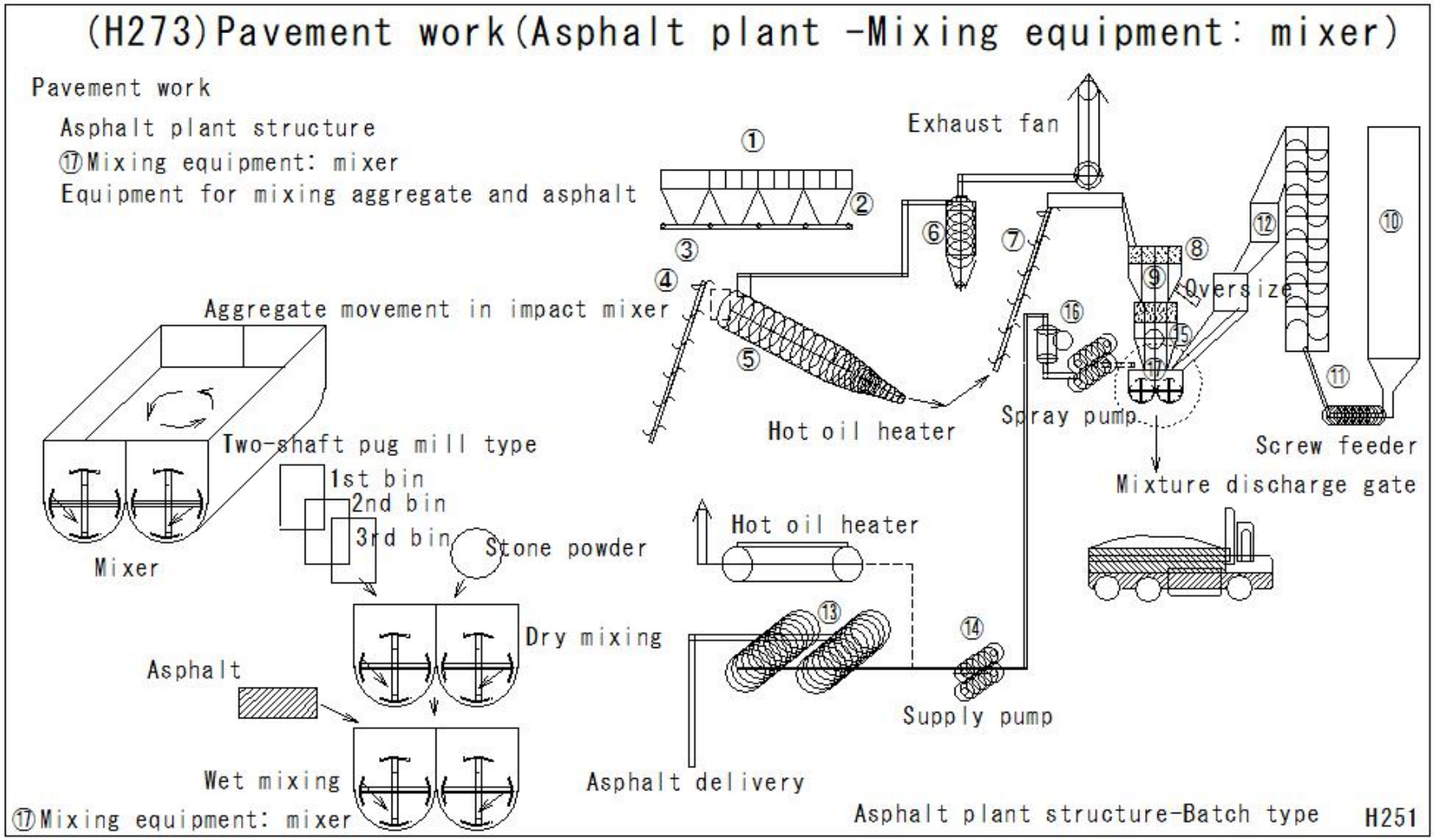
Asphalt plant structure-Batch type

H251

(H272)Pavement work(Asphalt plant -Asphalt measuring device)



(H273)Pavement work(Asphalt plant -Mixing equipment: mixer)



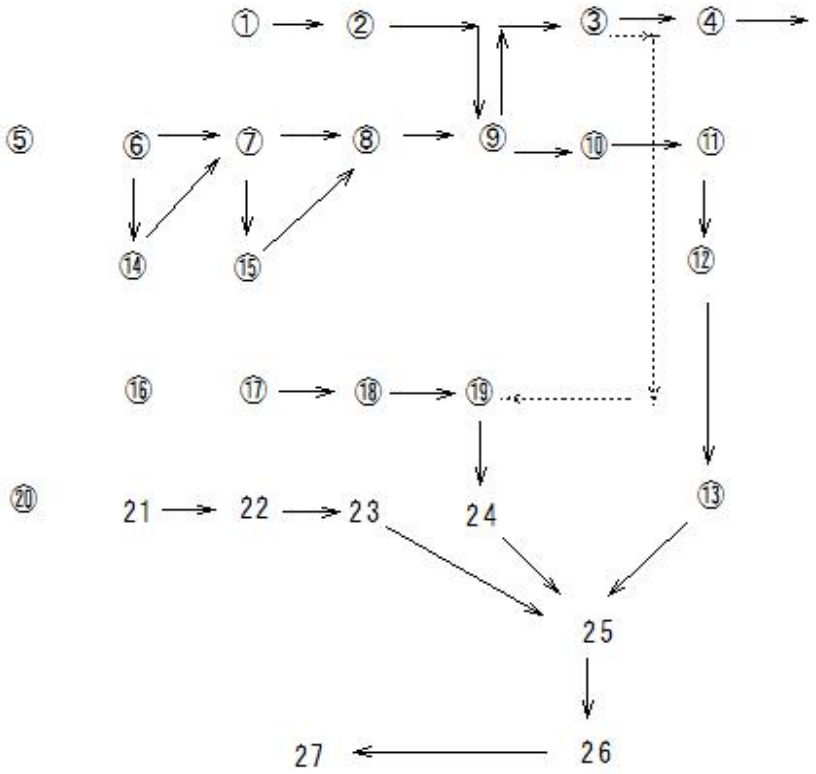
(H274)Pavement work(Mixing work)

(H274)Pavement work(Mixing work)

Pavement work

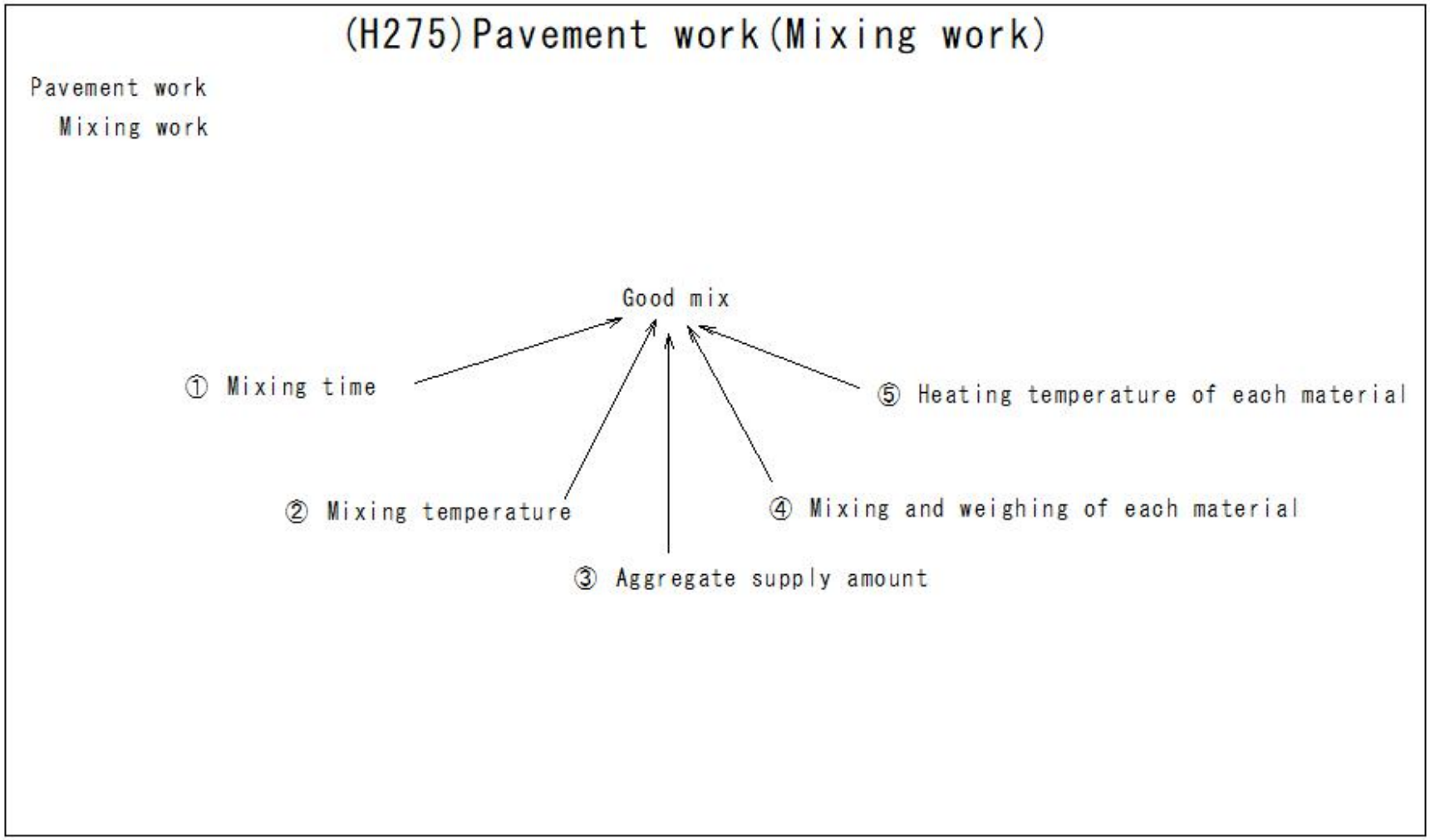
Mixing work

①Fuel tank
②Burner
③Dust collector
④Exhaust fan
⑤Aggregate
⑥Stockyard
⑦Cold feeder
⑧Cold elevator
⑨Dryer
⑩Hot elevator
⑪Vibrating sieve
⑫Hot bin
⑬Aggregate weighing machine
⑭Shovel loader
⑮Conveyor
⑯Stone powder
⑰Stone powder silo
⑱Stone powder elevator
⑲Hopper
⑳Asphalt
21Tank
22Supply pump
23Asphalt weighing machine
24Stone powder weighing machine
25Mixer
26Dump truck
27Paving site



System diagram of mixing work

(H275)Pavement work(Mixing work)



(H276)Pavement work(Mixing work-Amount of aggregate supplied)

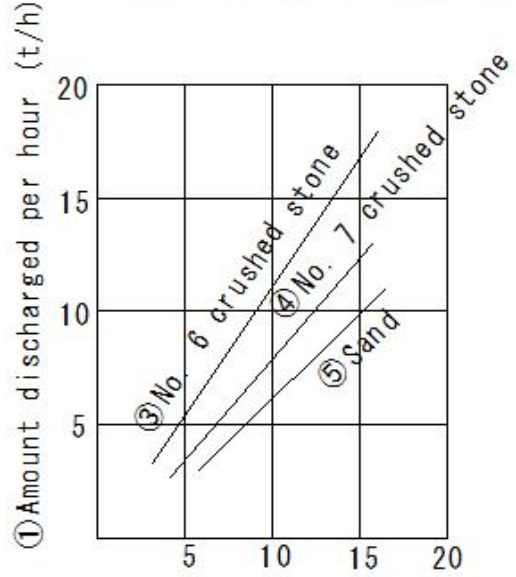
(H276)Pavement work(Mixing work-Amount of aggregate supplied)

Pavement work

Mixing work

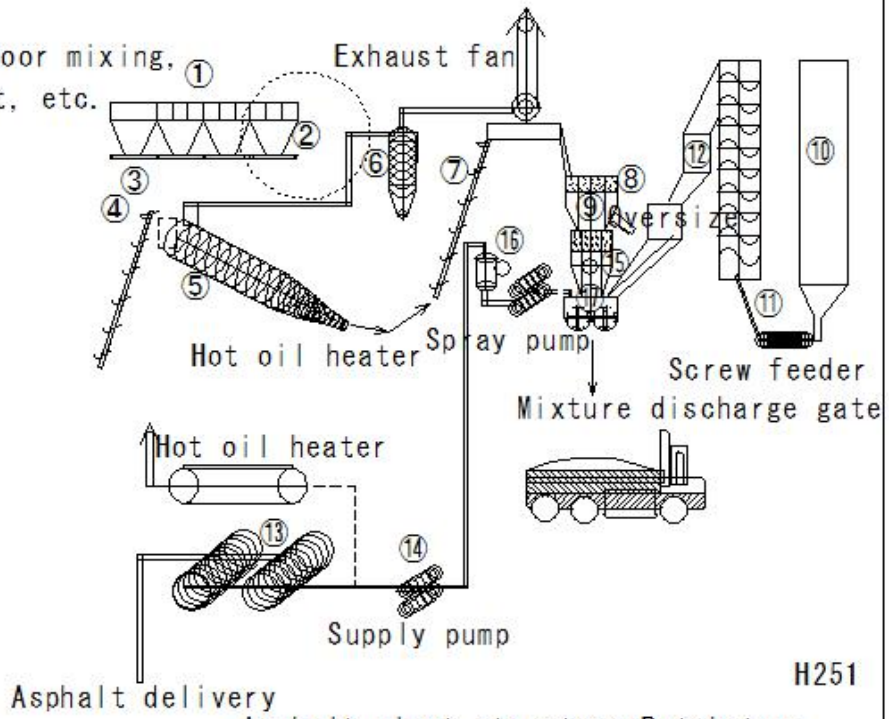
①Amount of aggregate supplied

Amount of aggregate supplied: Determined by indoor mixing, plant capacity, aggregate moisture content, etc.



⑥Relationship diagram between cold gate and aggregate discharge amount

Cold feeder set



Asphalt plant structure-Batch type

(H277)Pavement work(Mixing work-Heating temperature of each material)

(H277)Pavement work(Mixing work-Heating temperature of each material)

Pavement work

Mixing work

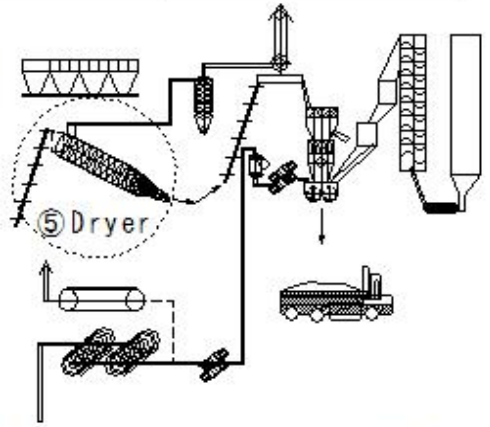
Heating temperature of each material

Drying capacity conversion coefficient of dryer			
① Type of mixture	② Good condition	③ Normal condition	④ Bad condition
⑤ Coarse-grained asphalt concrete	1.15	1.00	0.70
⑥ Open-grained asphalt concrete	1.20	1.10	0.80
⑦ Dense-grained asphalt concrete	1.00	0.85	0.60
⑧ Fine-grained asphalt concrete	0.90	0.75	0.50
⑨ Asphalt mortar	0.70	0.60	0.40

Heated mixture of fine aggregate, filler and asphalt

② Good condition: Low moisture content of aggregate in summer

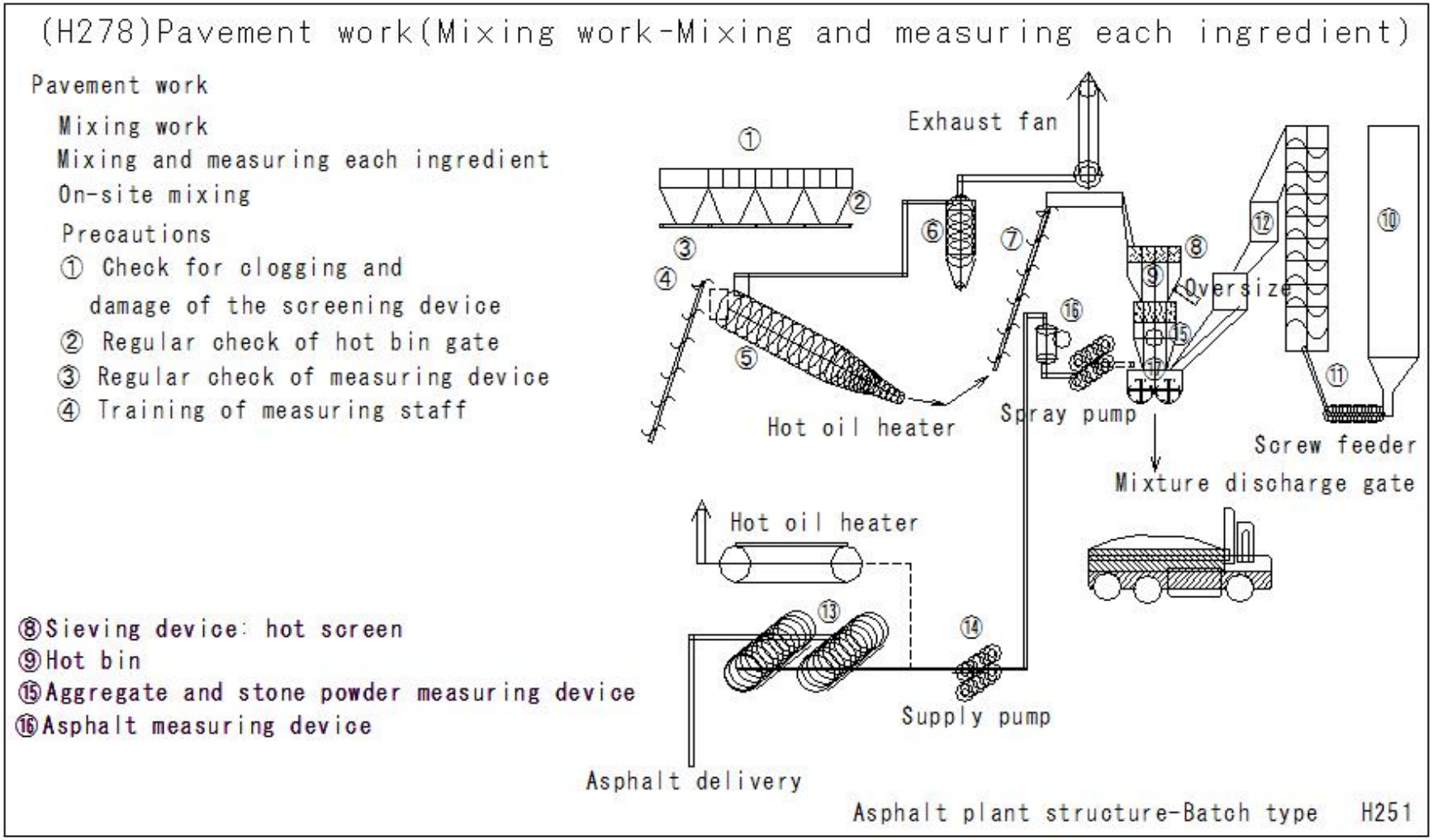
④ Bad condition: High moisture content of aggregate in winter



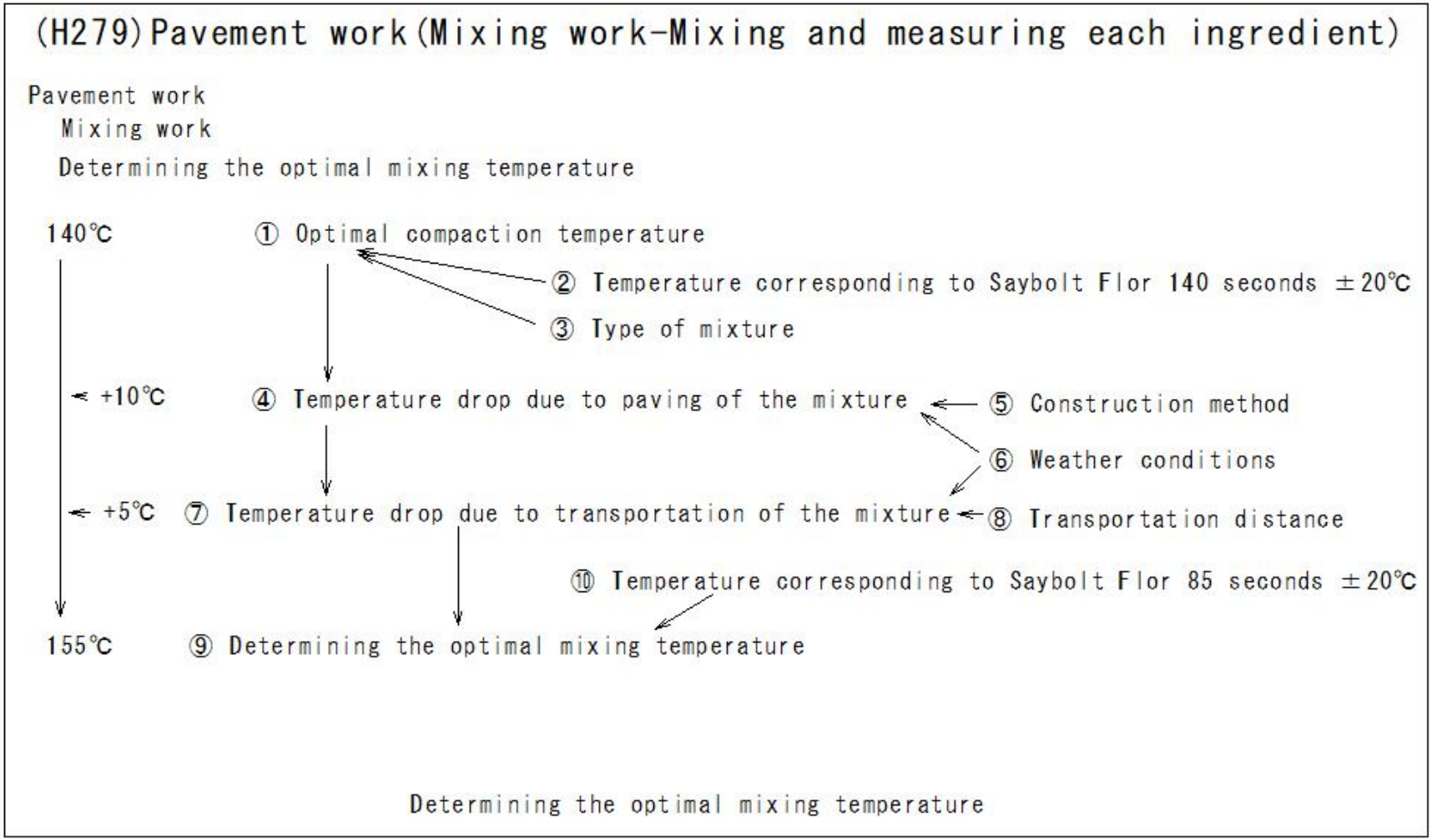
H251

Asphalt plant structure-Batch type

(H278)Pavement work(Mixing work-Mixing and measuring each ingredient)



(H279)Pavement work(Mixing work-Mixing and measuring each ingredient)



(H280)Pavement work(Mixing work-Optimum mixing time)

(H280)Pavement work(Mixing work-Optimum mixing time)

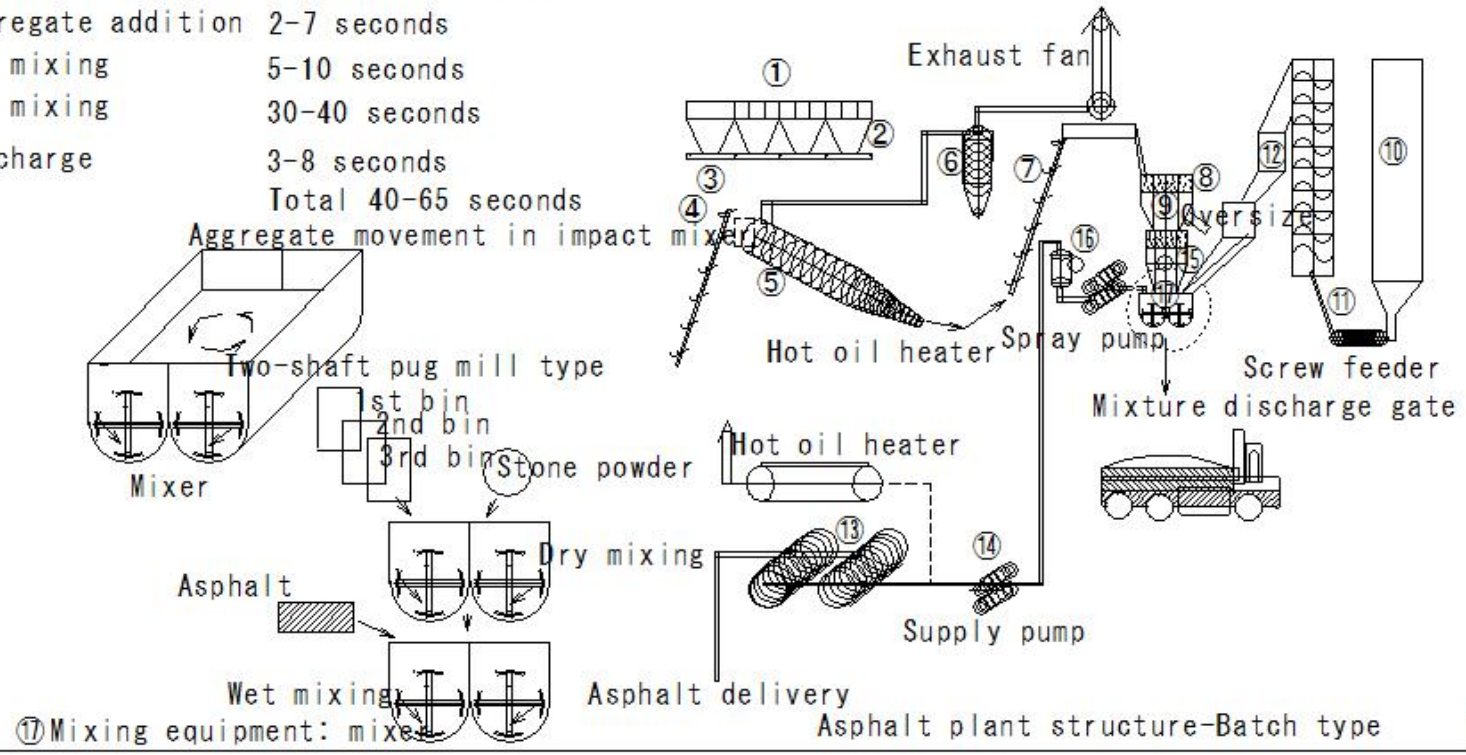
Pavement construction

Mixing time

Optimum mixing time: Determined by plant mix

Example of mixing time for a plant mixer

①	Aggregate addition	2-7 seconds
②	Dry mixing	5-10 seconds
③	Wet mixing	30-40 seconds
④	Discharge	3-8 seconds
		Total 40-65 seconds



(H281)Pavement work(Mixing work-Optimum mixing time)

(H281)Pavement work(Mixing work-On-site mix (plant mix))

Pavement works

On-site mix (plant mix)

On-site mix procedure

How to determine on-site mix

① Mixing cold aggregate

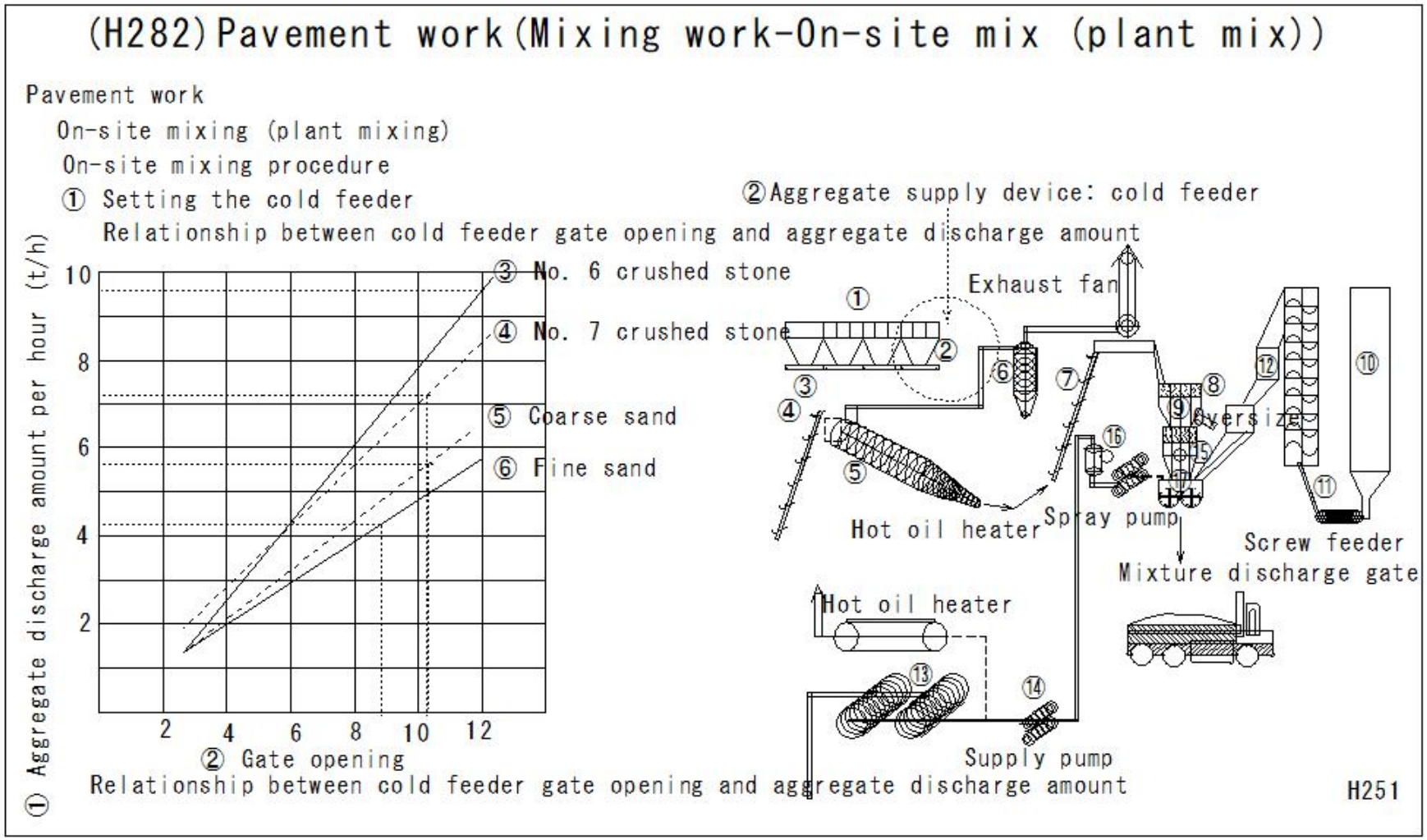
② Setting the cold feeder

③ Sifting hot bin aggregate

④ Determining hot bin aggregate mix ratio (determining on-site mix grain size)

⑤ Determining the mix amount for one batch (determining on-site mix)

(H282)Pavement work(Mixing work-On-site mix (plant mix))



(H283)Pavement work(Mixing work-On-site mix (plant mix))

(H283)Pavement work(Mixing work-On-site mix (plant mix))

Pavement work

On-site mix (plant mix)

On-site mix procedure

Indoor mix ratio

Calculate gate opening for each aggregate

Calculate gate opening for each aggregate

Plant capacity 30t/h

Table-A

Materials	Indoor mix ratio (%)	Supply volume per hour (t/h)	Gate opening (cm)
No. 6 crushed stone	32	30×0.32=9.6	12.0
No. 7 crushed stone	24	30×0.24=7.2	10.2
Coarse sand	18	30×0.18=5.4	10.3
Fine sand	14	30×0.14=4.2	8.4
Stone powder	6	30×0.06=1.8	Asphalt: Stone powder
Asphalt	6	30×0.06=1.8	is supplied separately
Total	100	30	

(H284)Pavement work(Mixing work-On-site mix (plant mix))

(H284)Pavement work(Mixing work-On-site mix (plant mix))
Pavement work
On-site mix (plant mix)
Determining the hot bin aggregate mix ratio
Hot bin aggregate particle size in Table A → Target particle size in Table B →
Aggregate mix ratio → On-site composite particle size

Table A						Table B					
	Hot bin aggregate particle size (passing weight percentage)					Calculation of composite particle size					
Hot bin		3 bins	2 bins	1 bin	Stone powder	3 bins	2 bins	1 bin	Stone powder	Composite particle size	Target particle size
Plant sieve mesh opening (mm)		14	6	3							
Mix ratio		36	21	37	6						
Sieve	20	100				36.0	21.0	37.0	6.0	100.0	100.0
opening	13	98	100			35.3	21.0	37.0	6.0	99.3	95-100
(mm)	5	3	88	100		1.1	18.5	37.0	6.0	62.6	62.8
	2.5	0	4	96		0	0.8	35.5	6.0	42.3	42.5
	0.6		0	53			0	19.6	6.0	25.6	25.0
	0.3			29	100			10.7	6.0	16.7	17.0
	0.15			13	98			4.8	5.9	10.7	11.0
	0.074			3	83			1.1	5.0	6.1	6.2

(H285)Pavement work(Mixing work-On-site mix (plant mix))

(H285)Pavement work(Mixing work-On-site mix (plant mix))

Pavement work

On-site mix (plant mix)

Determine hot bin aggregate mix ratio

Determine 1 batch mix amount

Hot bin mix ratio in Table A → Each mix amount in 1 batch

Designed asphalt amount 6% 1 batch mixing capacity 500kg

Table-A

Hot bin mix ratio (%)	Mix ratio (%)		1 batch mix amount (kg)	
3 bins	36（1－0.06）×36	33.8	500×0.338	169
2 bins	21（1－0.06）×21	19.7	500×0.197	99
1 bin	37（1－0.06）×37	34.8	500×0.348	174
Stone powder	6（1－0.06）×6	5.6	500×0.056	28
Asphalt	-	6	500×0.06	30
Total		100		500

(H286)Pavement work(Mixing work-On-site mix (plant mix)-Test mix)

(H286)Pavement work(Mixing work-On-site mix (plant mix)-Test mix)

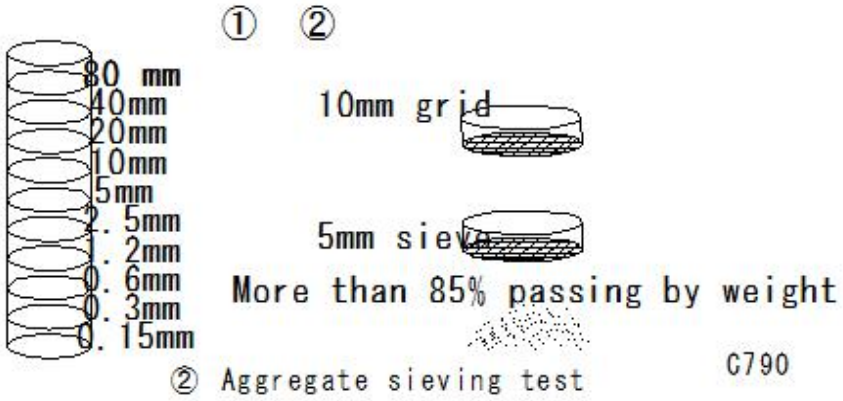
Pavement work

On-site mix (plant mix)

Test mix

Decision items

① Items to be decided	② Related tests	③ Method
a: Decision on plant mix ratio	① Cold aggregate and heating ② Aggregate sieving test ③ Extraction test (sieving grain size)	④ Sieving results and mix ratio of each aggregate On-site target grain size - check Extraction grain size - check



(H287)Pavement work(Mixing work-On-site mix (plant mix)-Test mix)

(H287)Pavement work(Mixing work-On-site mix (plant mix)-Test mix)

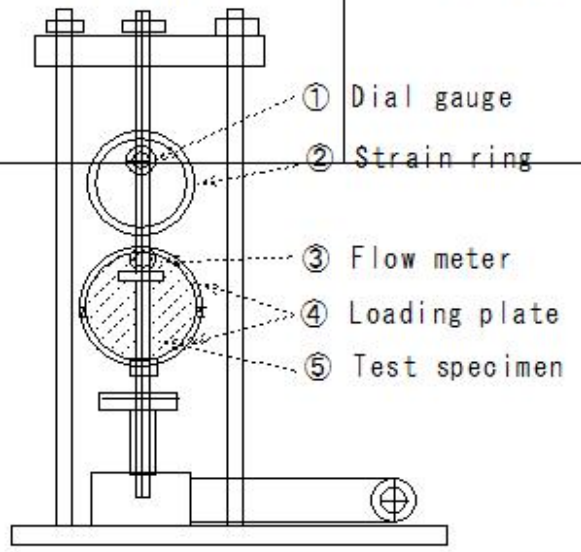
Pavement work

On-site mix (plant mix)

Test mix

Decision items

① Items to be decided	② Related tests	③ Method
b: Determining the amount of asphalt	①Marshall stability test Extraction test	②Change the amount of asphalt by 0.3-0.5% before and after the design amount Consider the mixed condition ③Consider and decide based on each test value



Marshall testing machine

H70

(H288)Pavement work(Mixing work-On-site mix (plant mix)-Test mix)

(H288)Pavement work(Mixing work-On-site mix (plant mix)-Test mix)

Pavement work

On-site mix (plant mix)

Test mix

Decision items

① Items to be decided	② Related tests	③ Method
c: Decision on mixing time	①Marshall test ②Water-immersed Marshall test ③Loss count test	④Change the wet mixing time and examine the coating condition ⑤Obtain residual stability by water-immersed Marshall test ⑥Consider and decide based on on each test value

(H289)Pavement work(Mixing work-On-site mix (plant mix)-Test mix)

(H289)Pavement work(Mixing work-On-site mix (plant mix)-Test mix)

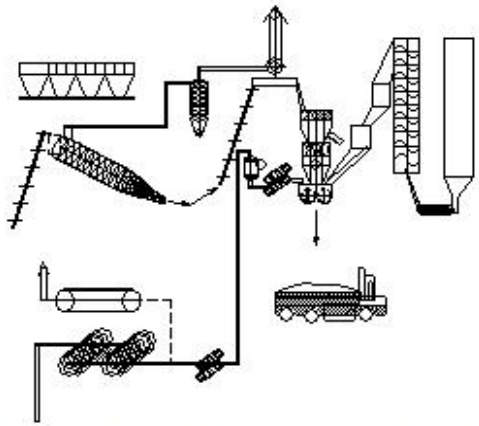
Pavement work

On-site mix (plant mix)

Test mix

Decision items

① Items to be decided	② Related tests	③ Method
d: Determine target temperature	①Cold aggregate moisture content test ②Measure temperature of each material ③Measure mixture temperature	④Investigate the relationship between the heating temperature of aggregate and asphalt and the temperature of the mixture ⑤Consider the temperature drop from shipment to paving Determine the target temperature of the mixture



H251

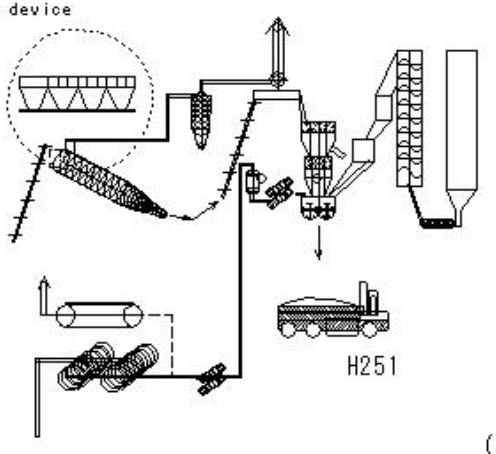
Asphalt plant structure-Batch type

(H290)Pavement work(Poor conditions of heated mixture and causes)

(H290)Pavement work(Poor conditions of heated mixture and causes)

Poor condition of heated mixture

○Aggregate storage device



(● Main causes)

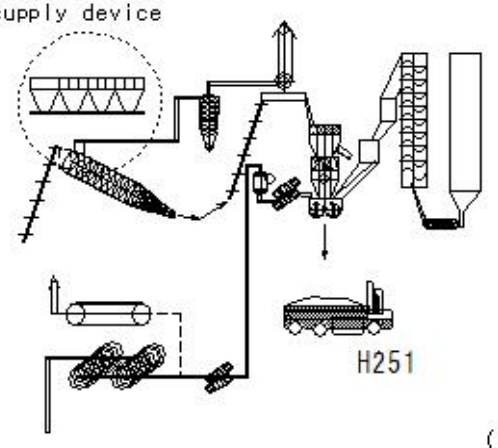
Cause of poor mixture		① In case of the mixture is dripping	② In case of steam or bubbles are coming out of the mixture	③ In case of the mixture is crumbly	④ In case of smoke is coming out of the mixture	⑤ In case of the mixture is swelling	⑥ In case of the mixture is brown or gray	⑦ In case of the mixture is heated	⑧ In case of the mixture on the truck is flat	⑨ In case of the mixture on the truck is not uniform	⑩ In case of the coverage of the coarse aggregate is poor	⑪ In case of Fine particles of the mixture on the truck are loose Cases	⑫ In case of the asphalt of the mixture on the truck is loose	⑬ In case of the truck load does not match	⑭ In case of the mixture discharge time is irregular	⑮ In case of the temperature cannot be kept constant	⑯ In case of there is a lot of fine particles in the mixture	⑰ In case of the aggregate particle size in the mixture is incorrect	⑱ In case of the amount of asphalt is incorrect
○Aggregate storage device	① Poor aggregate quality		○				○				○								
	② Large variation in aggregate particle size									○					○	○		○	
	③ High moisture content of aggregate		●				○		●		○					○			

(H291)Pavement work(Poor conditions of heated mixture and causes)

(H291)Pavement work(Poor conditions of heated mixture and causes)

Poor condition of heated mixture

○Aggregate supply device

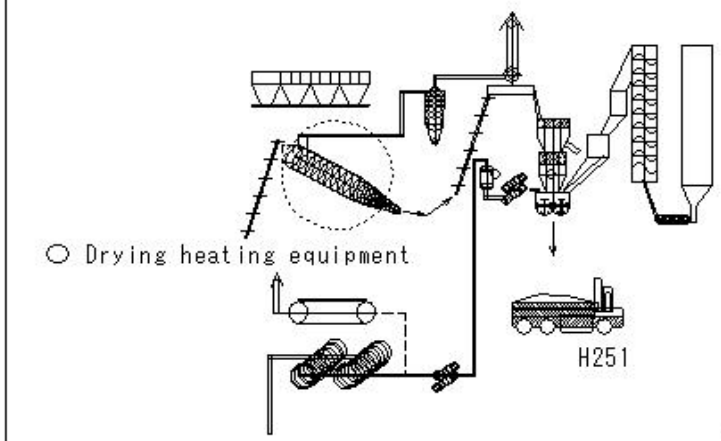


(● Main causes)

Cause of poor mixture		① In case of the mixture is dripping	② In case of steam or bubbles are coming out of the mixture	③ In case of the mixture is crumbly	④ In case of smoke is coming out of the mixture	⑤ In case of the mixture is swelling	⑥ In case of the mixture is brown or gray	⑦ In case of the mixture is heated	⑧ In case of the mixture on the truck is flat	⑨ In case of the mixture on the truck is not uniform	⑩ In case of the coverage of the coarse aggregate is poor	⑪ In case of fine particles of the mixture on the truck are loose cases	⑫ In case of the asphalt of the mixture on the truck is loose	⑬ In case of the truck load does not match	⑭ In case of the mixture discharge time is irregular	⑮ In case of the temperature cannot be kept constant	⑯ In case of there is a lot of fine particles in the mixture	⑰ In case of the aggregate particle size in the mixture is incorrect	⑱ In case of the amount of asphalt is incorrect
○Aggregate supply device	④Poor aggregate management in stockyard		○	○				○								○	○	○	
	⑤Incomplete aggregate feeder gate			○				○							○	●	○	○	

(H292)Pavement work(Poor conditions of heated mixture and causes)

(H292) Pavement work (Poor conditions of heated mixture and causes)



(● Main causes)

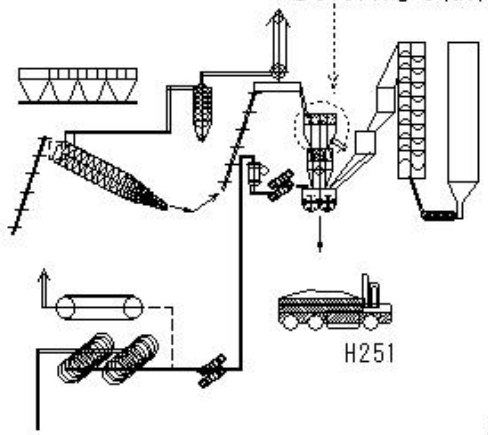
Cause of poor mixture		① In case of the mixture is dripping	② In case of steam or bubbles are coming out of the mixture	③ In case of the mixture is crumbly	④ In case of smoke is coming out of the mixture	⑤ In case of the mixture is swelling	⑥ In case of the mixture is brown or gray	⑦ In case of the mixture is heated	⑧ In case of the mixture on the truck is flat	⑨ In case of the mixture on the truck is not uniform	⑩ In case of the coverage of the coarse aggregate is poor	⑪ In case of Fine particles of the mixture on the truck are loose Cases	⑫ In case of the asphalt of the mixture on the truck is loose	⑬ In case of the truck load does not match	⑭ In case of the mixture discharge time is irregular	⑮ In case of the temperature cannot be kept constant	⑯ In case of there is a lot of fine particles in the mixture	⑰ In case of the aggregate particle size in the mixture is incorrect	⑱ In case of the amount of asphalt is incorrect
○ Drying heating equipment	⑥ Aggregate supply exceeding dryer capacity		●				●		○		●								
	⑦ Dryer gradient is too steep		○				○		○		○								
	⑧ Dryer operation failure	○	○		●		○	○	○		○					●			
	⑨ Thermometer is incomplete	○	○		○		○	○			○					○			
	⑩ Aggregate temperature is too high	●			●			●											

(H293)Pavement work(Poor conditions of heated mixture and causes)

(H293)Pavement work(Poor conditions of heated mixture and causes)

Poor condition of heated mixture

○Sieving equipment and stock bin



(● Main causes)

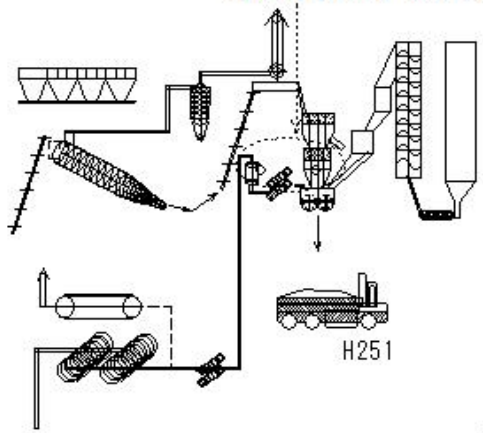
Cause of poor mixture		① In case of the mixture is dripping	② In case of steam or bubbles are coming out of the mixture	③ In case of the mixture is crumbly	④ In case of smoke is coming out of the mixture	⑤ In case of the mixture is swelling	⑥ In case of the mixture is brown or gray	⑦ In case of the mixture is heated	⑧ In case of the mixture on the truck is flat	⑨ In case of the mixture on the truck is not uniform	⑩ In case of the coverage of the coarse aggregate is poor	⑪ In case of Fine particles of the mixture on the truck are loose Cases	⑫ In case of the asphalt of the mixture on the truck is loose	⑬ In case of the truck load does not match	⑭ In case of the mixture discharge time is irregular	⑮ In case of the temperature cannot be kept constant	⑯ In case of there is a lot of fine particles in the mixture	⑰ In case of the aggregate particle size in the mixture is incorrect	⑱ In case of the amount of asphalt is incorrect
○Sieving equipment and stock bin	⑪Incomplete sieve			○						●					○		●	●	
	⑫Hot bin aggregate leakage			○						○				○			○	○	
	⑬Separation of hot bin aggregate			○						○							○	○	
	⑭Aggregate mixed into other hot bins			○						○							○	○	
	⑮Dust mixed into hot bin	○								○							○	○	
	⑯Shortage of hot bin aggregate									○					●			○	
	⑰Uneven amount of filler supply	○				○				○							○	○	

(H294)Pavement work(Poor conditions of heated mixture and causes)

(H294)Pavement work(Poor conditions of heated mixture and causes)

Poor condition of heated mixture

○Weighing device

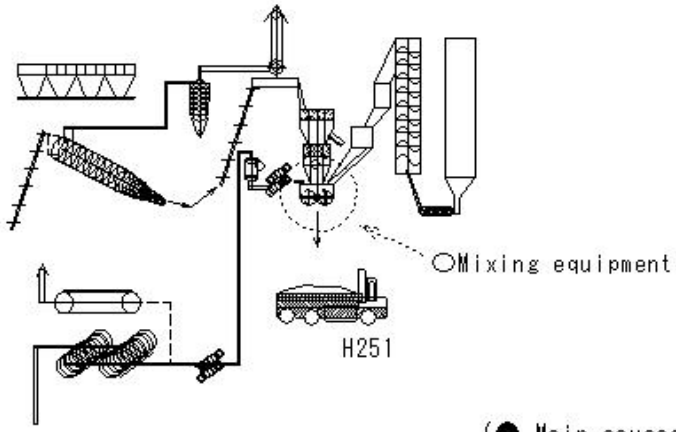


(● Main causes)

Cause of poor mixture		① In case of the mixture is dripping	② In case of steam or bubbles are coming out of the mixture	③ In case of the mixture is crumbly	④ In case of smoke is coming out of the mixture	⑤ In case of the mixture is swelling	⑥ In case of the mixture is brown or gray	⑦ In case of the mixture is heated	⑧ In case of the mixture on the truck is flat	⑨ In case of the mixture on the truck is not uniform	⑩ In case of the coverage of the coarse aggregate is poor	⑪ In case of Fine particles of the mixture on the truck are loose Cases	⑫ In case of the asphalt of the mixture on the truck is loose	⑬ In case of the truck load does not match	⑭ In case of the mixture discharge time is irregular	⑮ In case of the temperature cannot be kept constant	⑯ In case of there is a lot of fine particles in the mixture	⑰ In case of the aggregate particle size in the mixture is incorrect	⑱ In case of the amount of asphalt is incorrect
○Weighing device	⑱Incorrect weighing	○		●		●				●			○	●	○		●	●	○
	⑲Insufficient amount of asphalt			●			●				●								○
	⑳Excessive amount of asphalt	●				○			●				●						○
	21Incomplete asphalt weighing device	○		○		○	○		○	○	○		○						●
	22Incomplete aggregate weighing device			○		●	○		○	○	○		○				○	○	

(H295)Pavement work(Poor conditions of heated mixture and causes)

(H295)Pavement work(Poor conditions of heated mixture and causes)



(● Main causes)

Poor condition of heated mixture / Cause of poor mixture		① In case of the mixture is dripping	② In case of steam or bubbles are coming out of the mixture	③ In case of the mixture is crumbly	④ In case of smoke is coming out of the mixture	⑤ In case of the mixture is swelling	⑥ In case of the mixture is brown or gray	⑦ In case of the mixture is heated	⑧ In case of the mixture on the truck is flat	⑨ In case of the mixture on the truck is not uniform	⑩ In case of the coverage of the coarse aggregate is poor	⑪ In case of Fine particles of the mixture on the truck are loose Cases	⑫ In case of the asphalt of the mixture on the truck is loose	⑬ In case of the truck load does not match	⑭ In case of the mixture discharge time is irregular	⑮ In case of the temperature cannot be kept constant	⑯ In case of there is a lot of fine particles in the mixture	⑰ In case of the aggregate particle size in the mixture is incorrect	⑱ In case of the amount of asphalt is incorrect
○Mixing equipment	23Excessive/insufficient volume for one batch					○	○		○		○		○	●	○		○		
	24Insufficient mixing time			○							○						○	○	○
	25Mixer blades worn/inappropriate position			○						○	○	●	○					○	○
	26Mixer discharge gate incomplete											○			●				
	Irregular plant operation	○	○			○	○		○		○			○	○	○			

(H296)Pavement work(Transportation-Transportation precautions)

(H296)Pavement work(Transportation-Transportation precautions)

Pavement work

Transportation

Transportation precautions

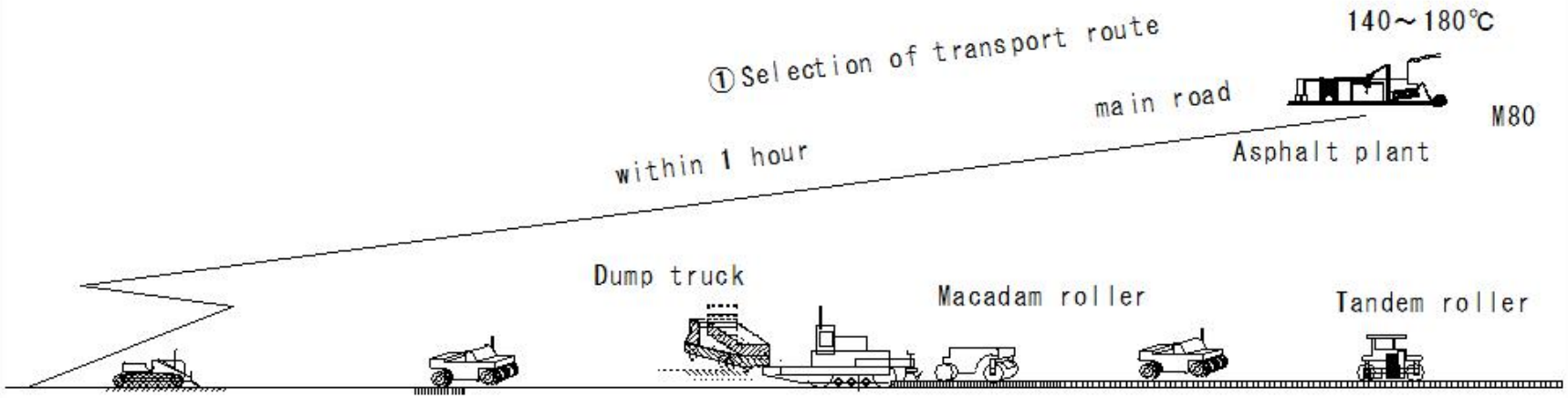
①Selection of transport route

Transportation round trip time

Traffic volume

Road width survey

Safe and efficient route



H246

M223

(H297)Pavement work(Transportation-Transportation precautions)

(H297)Pavement work(Transportation-Transportation precautions)

Pavement work

Transportation

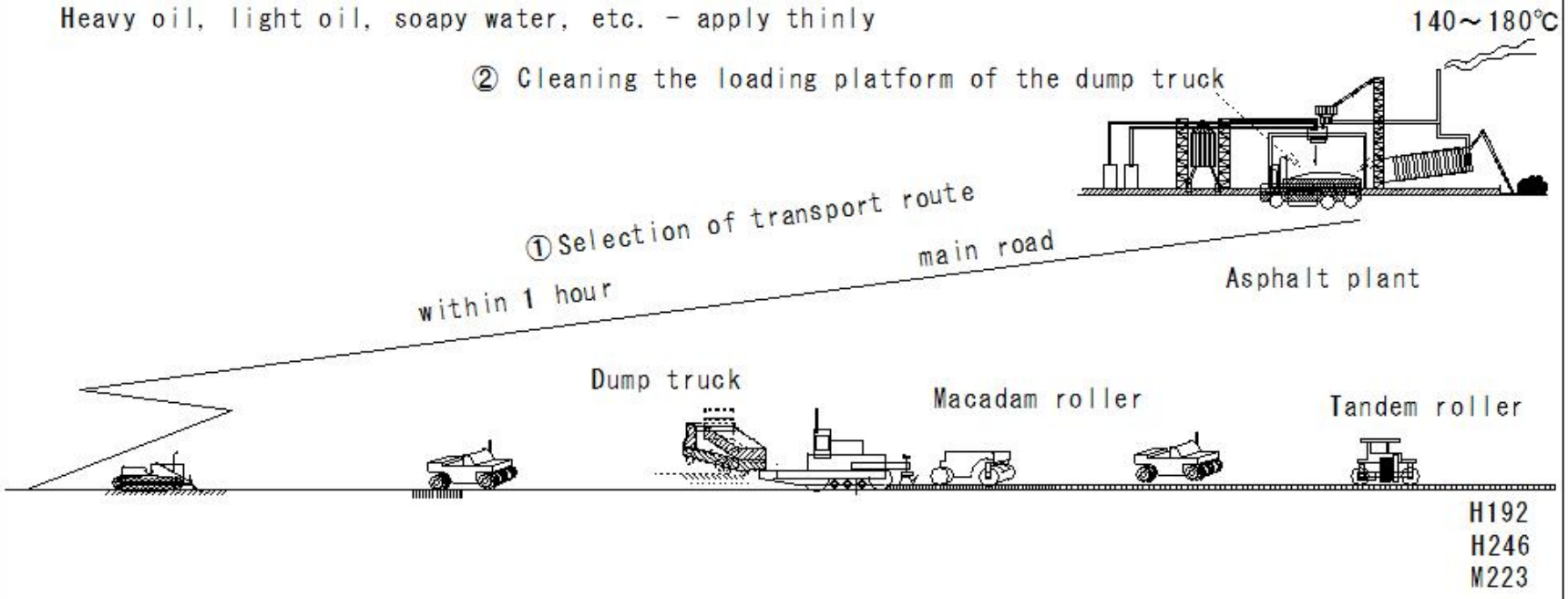
Transportation precautions

② Cleaning the loading platform of the dump truck

Clean the loading platform thoroughly

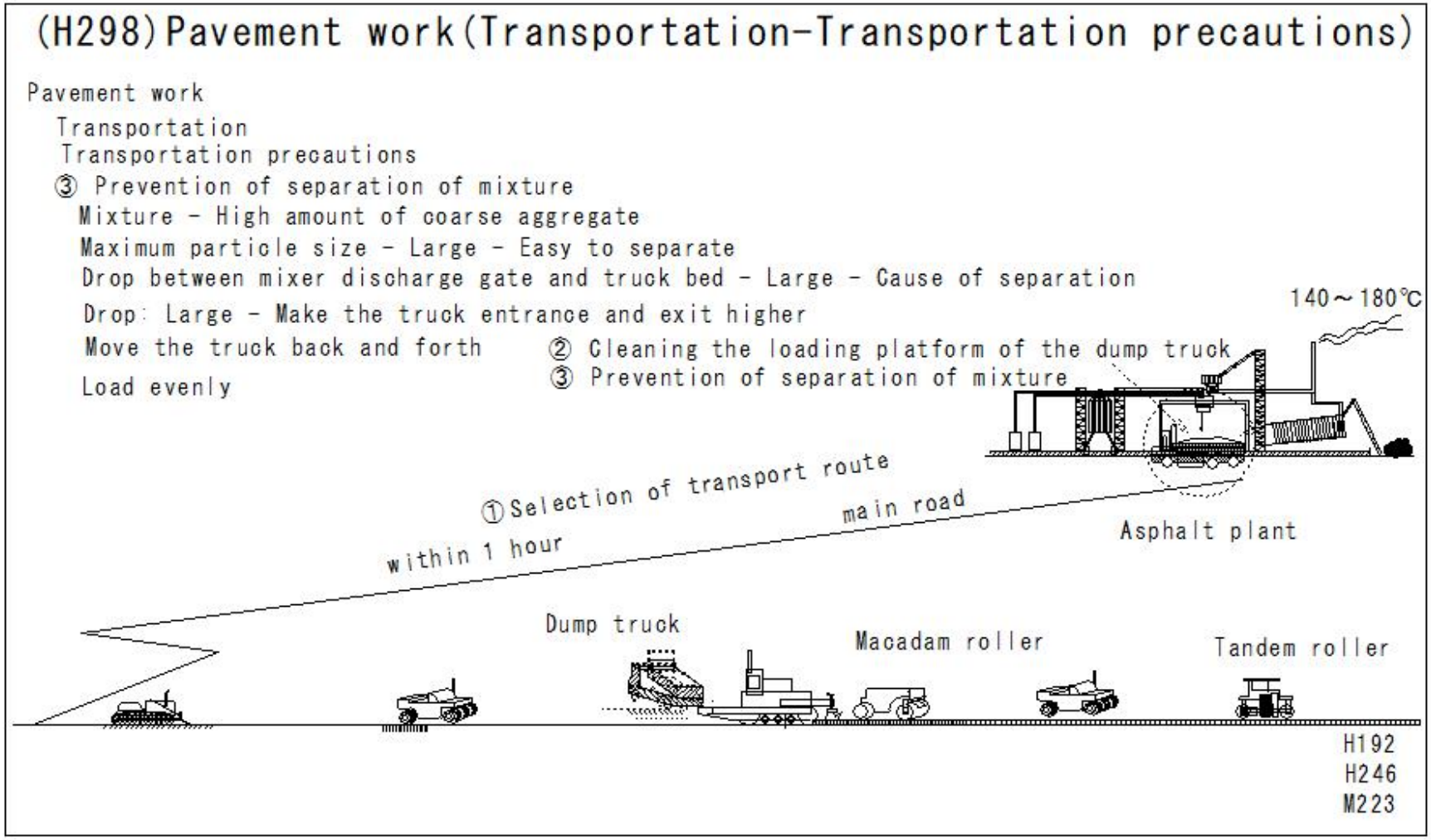
Prevent the mixture from adhering

Heavy oil, light oil, soapy water, etc. - apply thinly



H192
H246
M223

(H298)Pavement work(Transportation-Transportation precautions)



(H299)Pavement work(Transportation-Transportation precautions)

(H299)Pavement work(Transportation-Transportation precautions)

Pavement work

Transportation

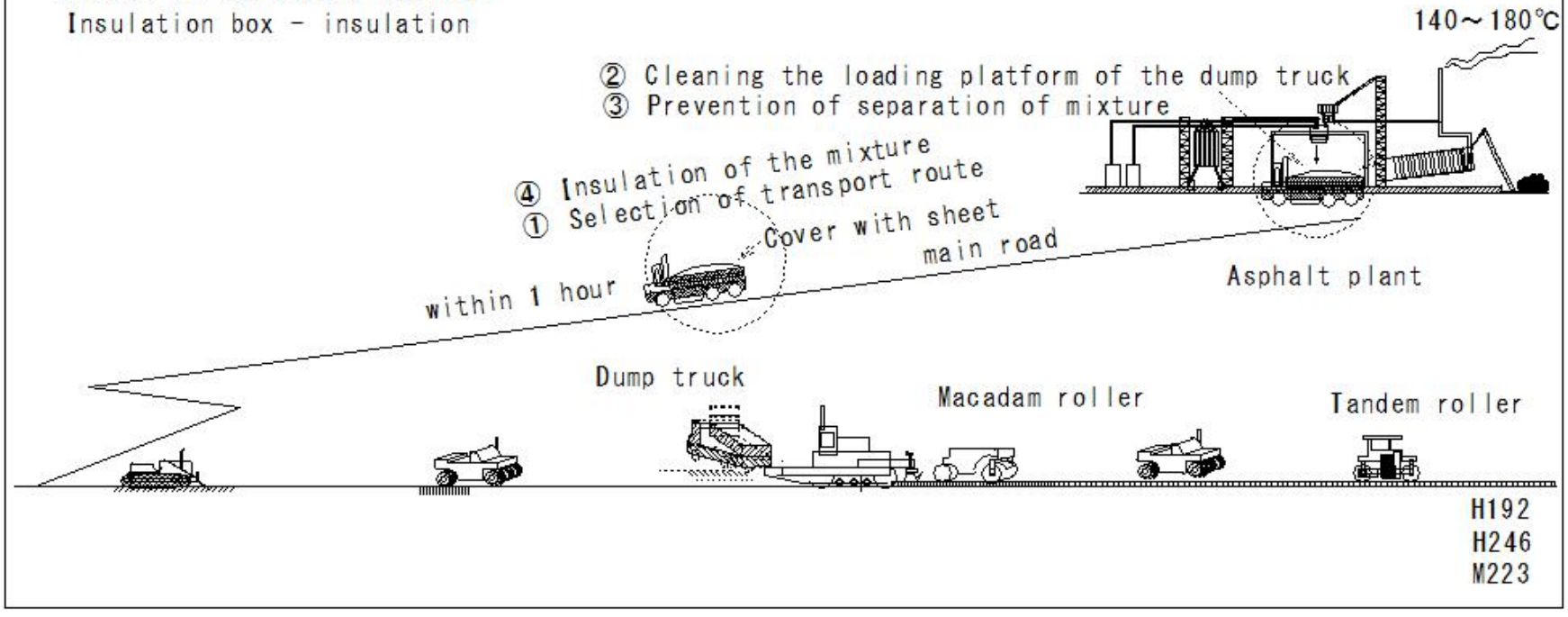
Transportation precautions

④ Insulation of the mixture

Preventing temperature drop during transport

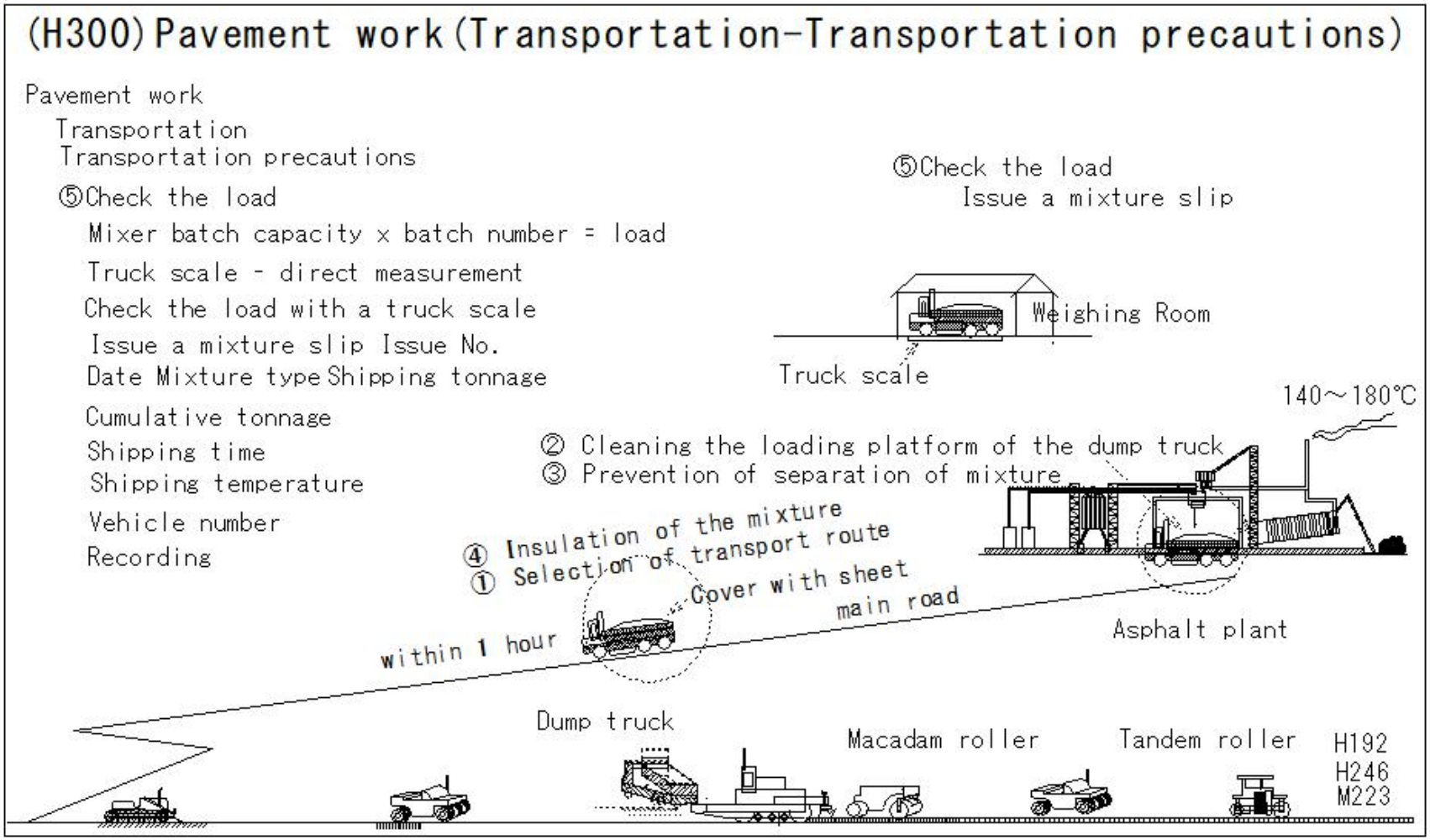
Sheets for temporary rainfall

Insulation box - insulation

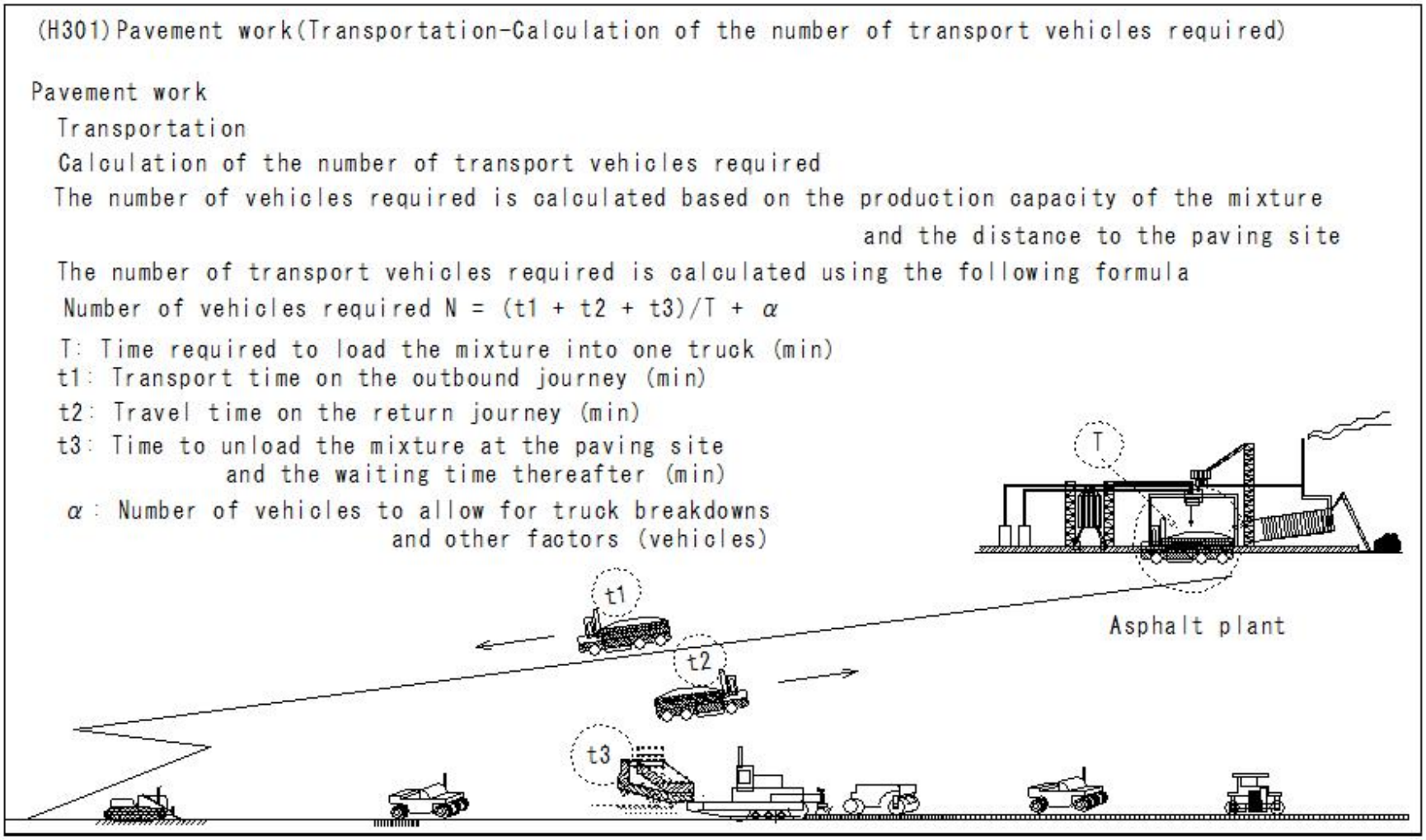


H192
H246
M223

(H300)Pavement work(Transportation-Transportation precautions)



(H301)Pavement work(Transportation-Calculation of the number of transport vehicles required)



(H302)Pavement work(Transportation-Calculation of the number of transport vehicles required)

(H302)Pavement work(Transportation-Calculation of the number of transport vehicles required)

Pavement work

Transportation

Calculation of the number of transport vehicles required

Production capacity per hour: 50t/h

Mixed amount per batch: 800kg

Transport distance to pavement site: 15km

The number of transport vehicles required is calculated using the following formula

Solution

(a) Time required to load one truck with mixed materials (T)

Number of batches per hour: 5000/800 ≒ 62.5 batches

Time required per batch: (60 x 60) / 62.5 = 58 sec

In case of a dump truck with a load capacity of 11 ton is used

Number of batches per truck: 11000/800 = 13 batches

Time required for loading (T): 58 x 13 / 60 = 12.6 min

(b) Travel time for round trip

Average travel speed

Outbound 30 km/h

Return 35 km/h

Transport time for outbound trip (t1): 60 x 15/30 = 30.0 min

Return travel time (t2): 60 x 15/35 = 25.7 min

(c) Unloading time at the paving site and waiting time t3: 20 min

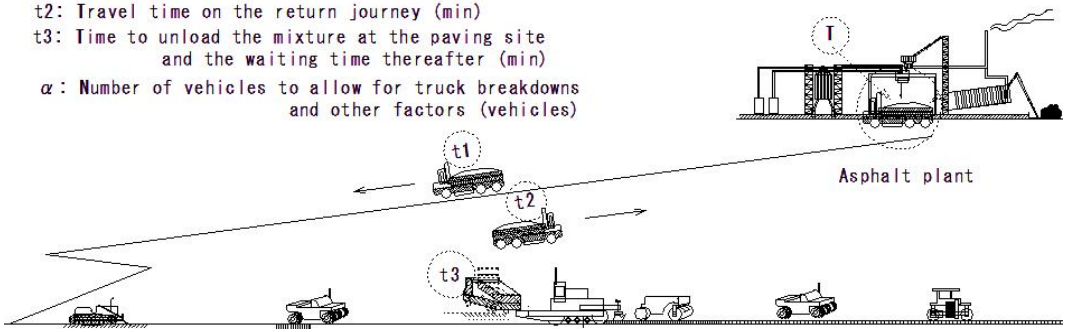
(d) Spare number of vehicles α: 2 vehicles

(e) Required number of vehicles N = (30.0 + 25.7 + 20.0)/12.6 + 2 ≒ 8

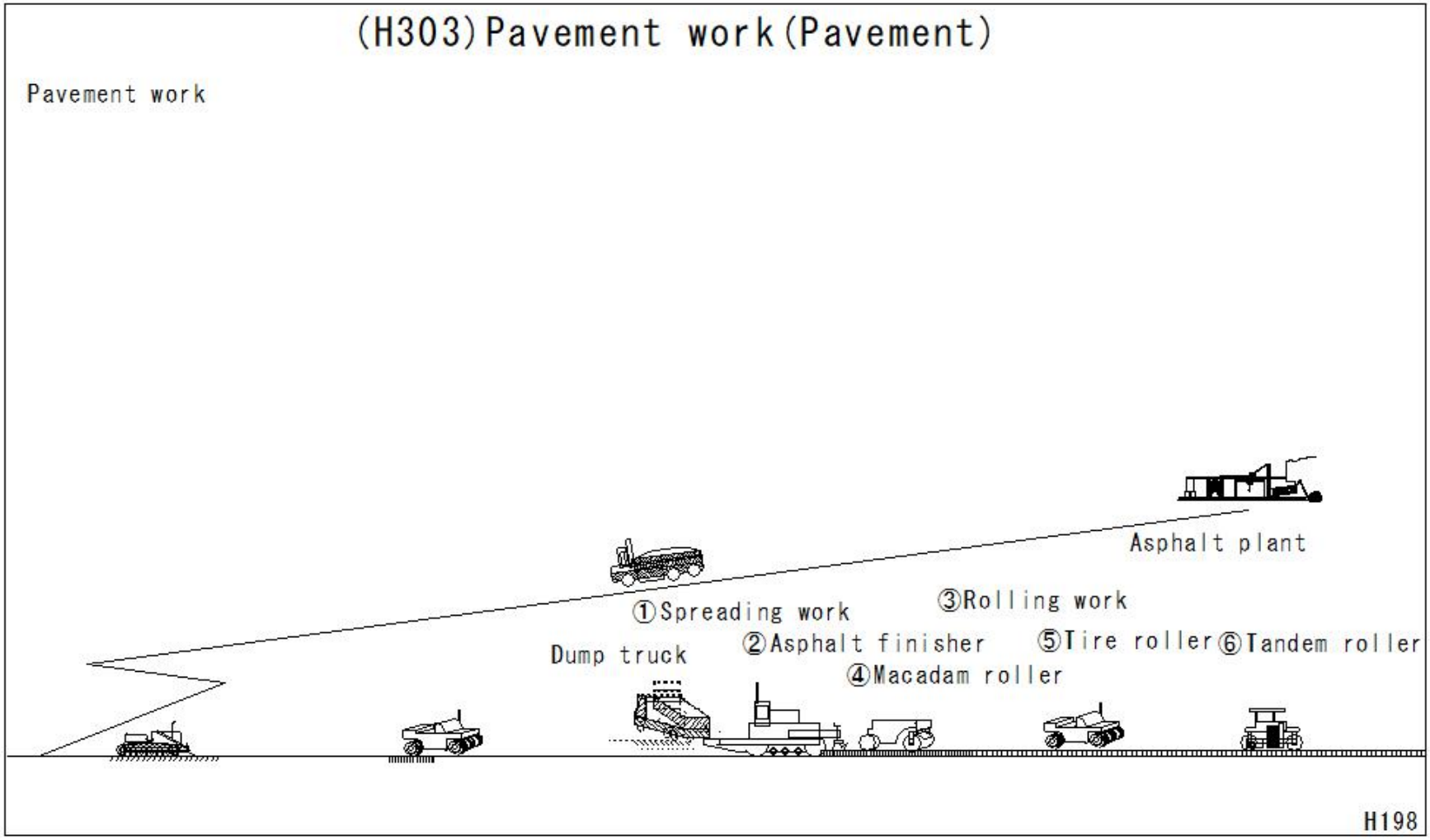
8 transport vehicles

Number of vehicles required **N** = (t1 + t2 + t3)/T + α

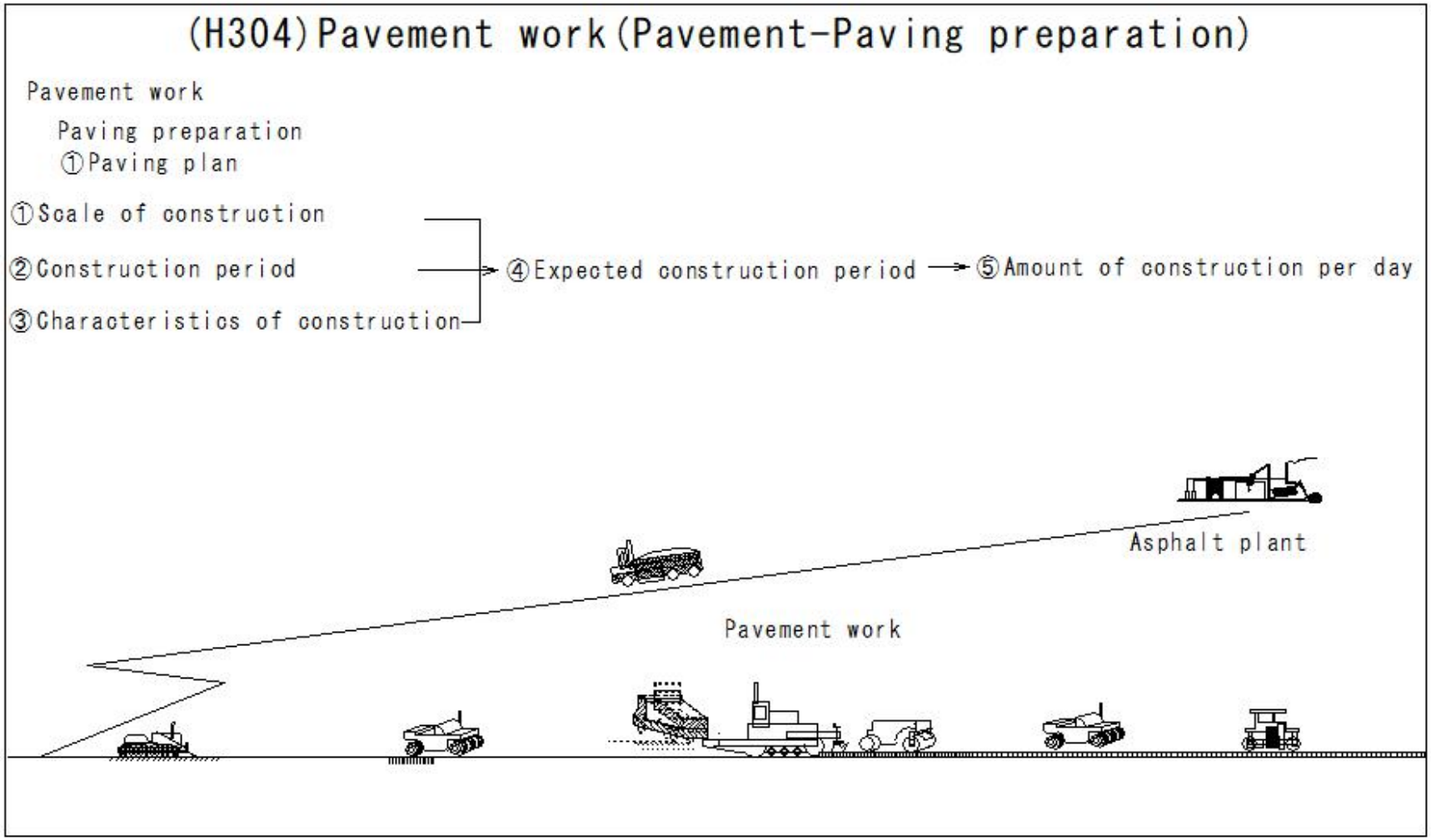
T: Time required to load the mixture into one truck (min)
t1: Transport time on the outbound journey (min)
t2: Travel time on the return journey (min)
t3: Time to unload the mixture at the paving site and the waiting time thereafter (min)
α: Number of vehicles to allow for truck breakdowns and other factors (vehicles)



(H303)Pavement work(Pavement)



(H304)Pavement work(Pavement-Paving preparation)



(H305)Pavement work(Pavement-Paving preparation)

(H305)Pavement work(Pavement-Paving preparation)

Pavement work

Preparation for paving

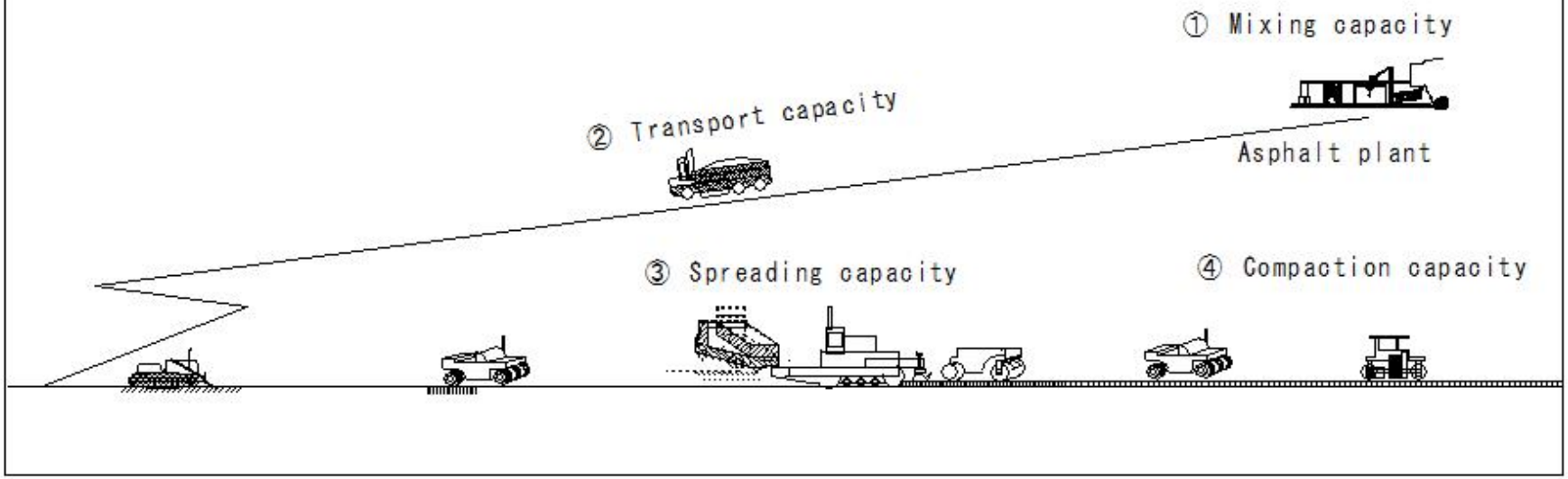
② Preparation of machines and equipment to be used

Construction machine models

Combination

Number of machines - Decision

Preparation and inspection of necessary equipment



(H306)Pavement work(Pavement-Paving preparation)

(H306)Pavement work(Pavement-Paving preparation)

Pavement work

Preparation for paving

③Inspection of Base course and Base course(roadbed)

Inspection of flatness and bearing capacity of Base course and Base course(roadbed)

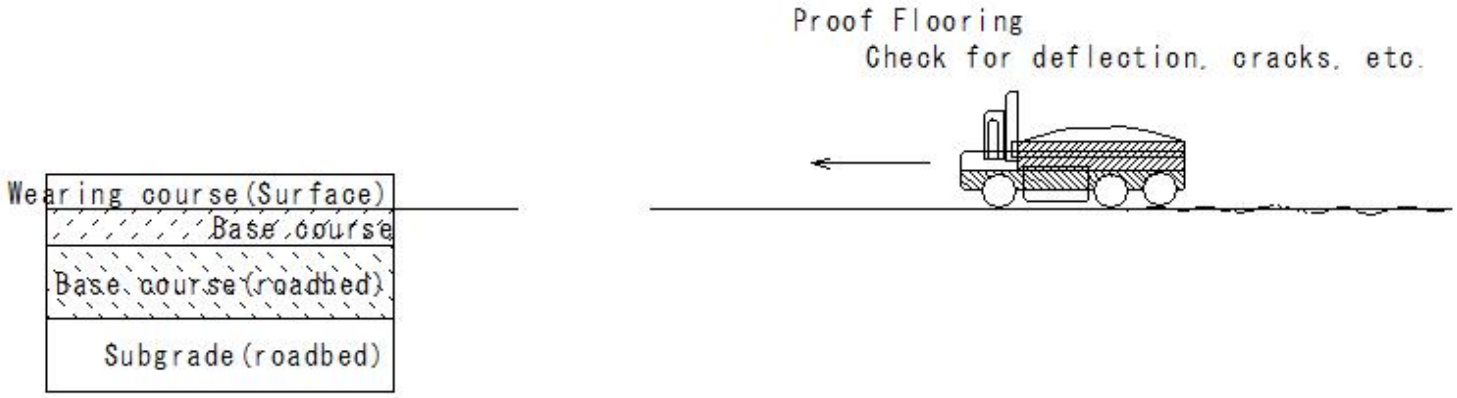
Defective areas - shaping and replacement

Inspection:Proof Flooring

Loaded vehicle - drive slowly - observe road conditions from behind

Check for deflection, cracks, etc.

Loaded vehicle: tire roller, loaded truck



H80

(H307)Pavement work(Pavement-Paving preparation)

(H307)Pavement work(Pavement-Paving preparation)

Pavement work

Preparation for paving

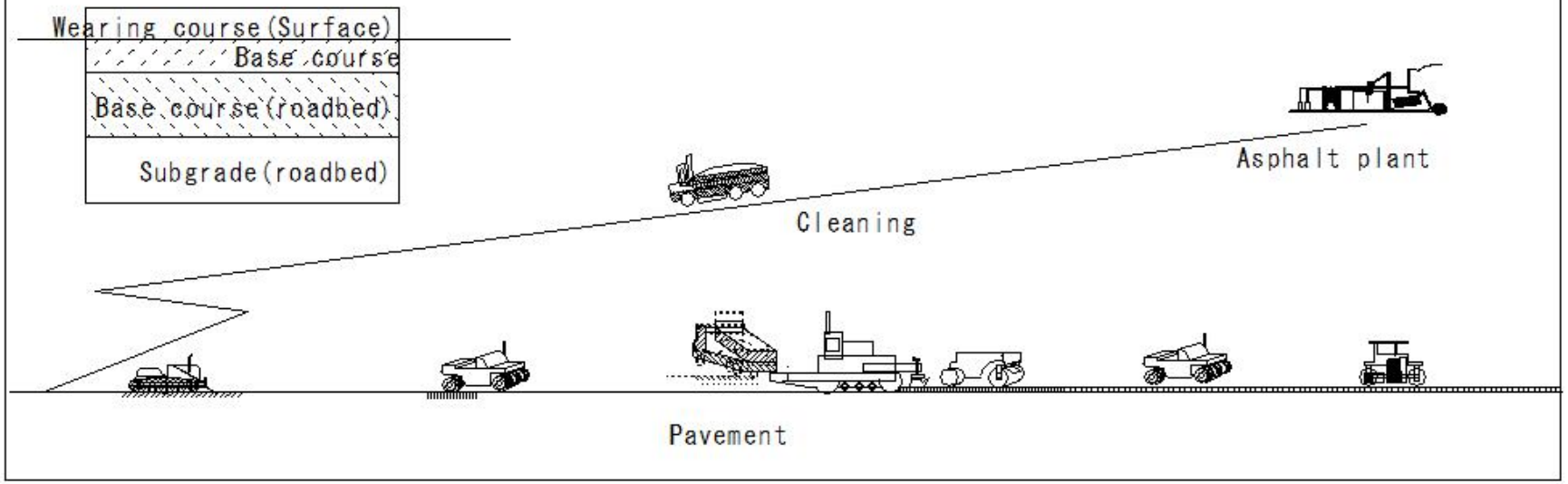
④Cleaning the roadbed and base

Garbage, mud, and loose stones on the flat surface of the Base course(roadbed)
and Base course- adhesion after paving - worsens

Causes of pavement damage

Cleaning process - necessary

○Rainfall/snowfall -in case of the surface is wet - wait until it dries before paving



(H308)Pavement work(Prime coat)

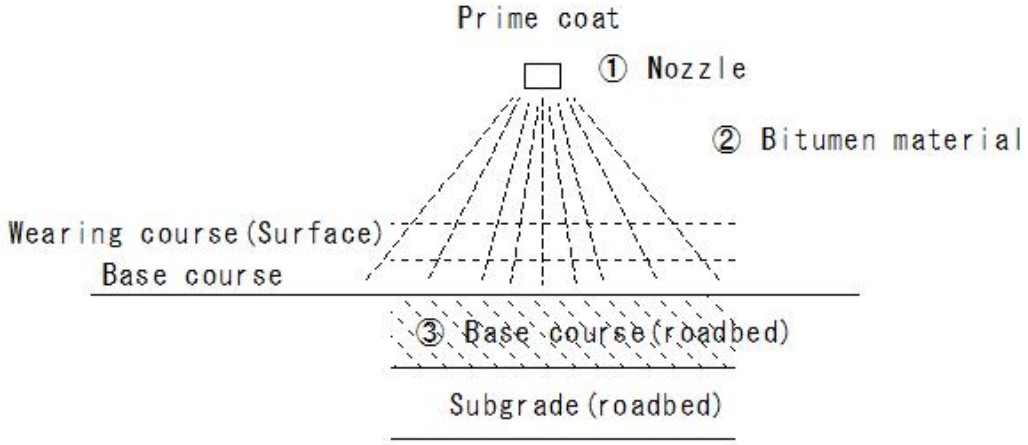
(H308)Pavement work(Prime coat)

Pavement work

Prime coat
After the Base course(roadbed) is finished

Spread a thin layer of bitumen material on the road surface

Purpose
① Prevent surface water from penetrating into Base course(roadbed)
② Block capillary rise of water from Base course(roadbed)
③ Improve adhesion between Base course(roadbed) and the asphalt mixture to be paved on top of it
④ Wrap fine debris and dust on Base course(roadbed) to stabilize the aggregate on the surface



(H309)Pavement work(Prime coat)

(H309)Pavement work(Prime coat)

Pavement work

Prime coat

①Material

Asphalt emulsion: Decomposes quickly

a Bitumen material for prime coat

b Base course(roadbed) conditions

①Asphalt emulsion (pk-3) ・・・

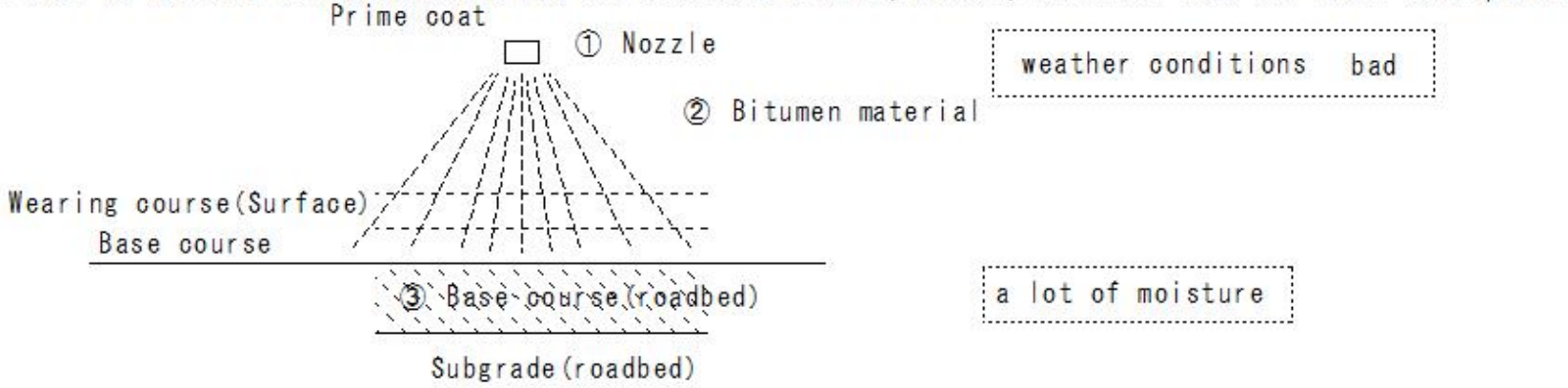
in case of weather conditions are bad and Base course(roadbed) material has a lot of moisture

②Cutback asphalt (RC-70 MC-70)

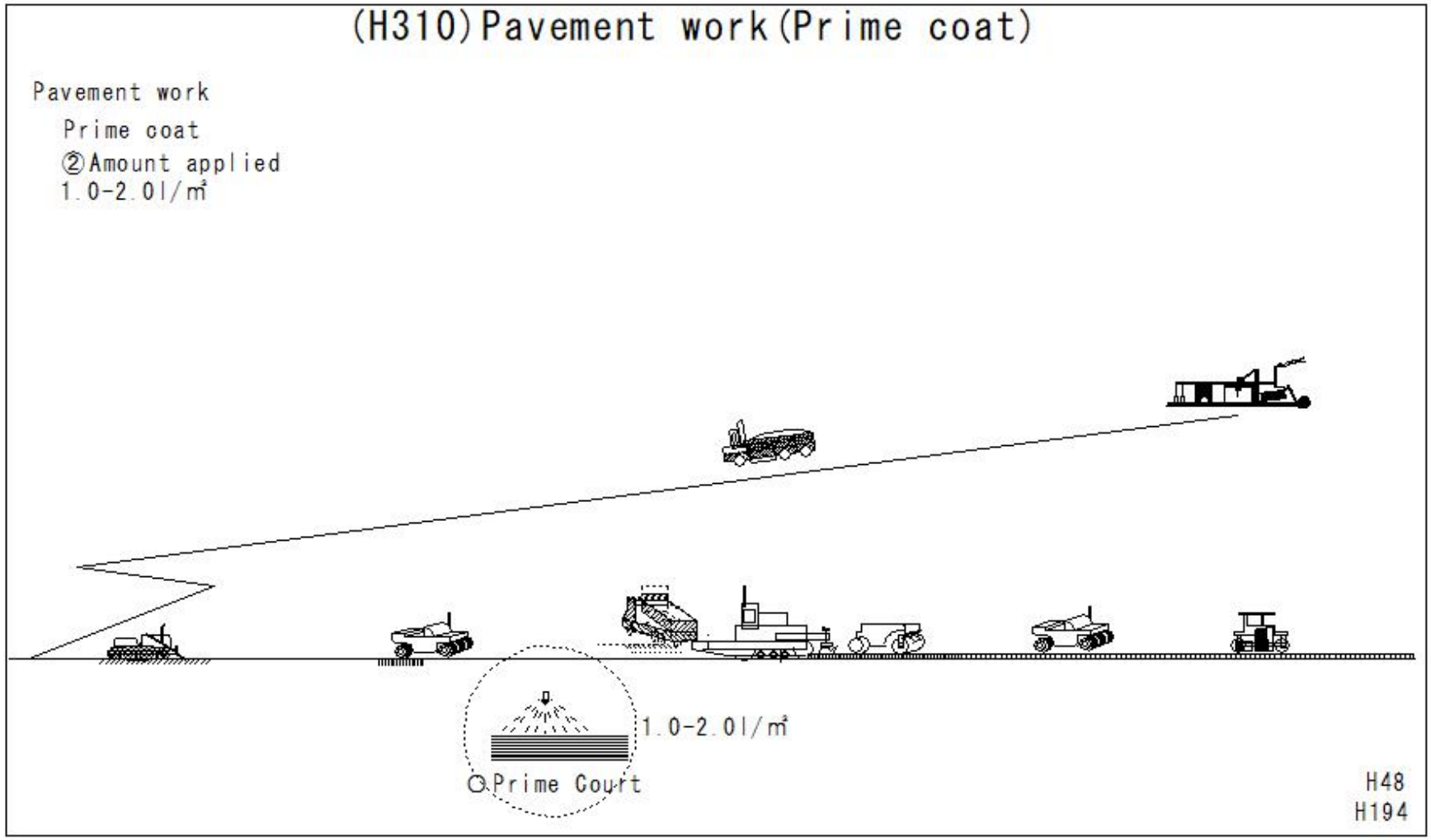
in case of weather conditions are bad and the roadbed material has high water absorption

③Paving tar (A-1 to 3, B-1 to 3)

in case of weather conditions are bad and the Base course(roadbed) material has low water absorption



(H310)Pavement work(Prime coat)



(H311)Pavement work(Prime coat)

(H311)Pavement work(Prime coat)

Pavement work

Prime coat

③ Spraying and curing

a Spraying

① Clean Base course(roadbed) before spraying

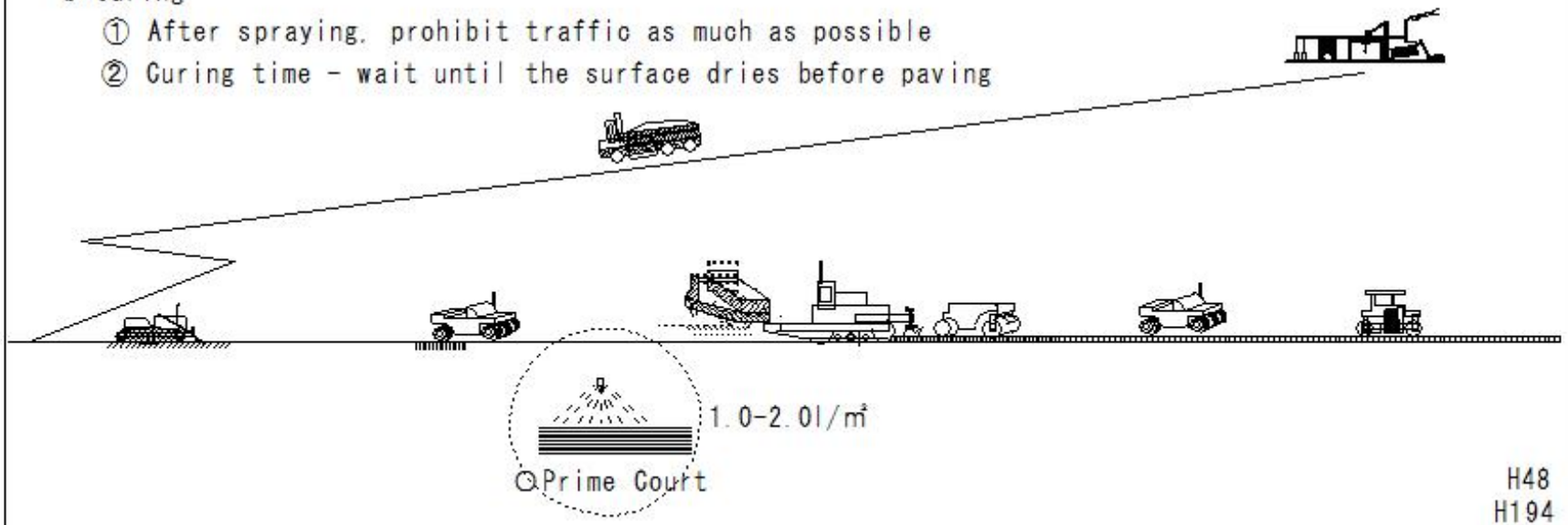
② Do it on a sunny day

③ Spray the specified amount evenly using a sprayer that matches the size of the pavement

b Curing

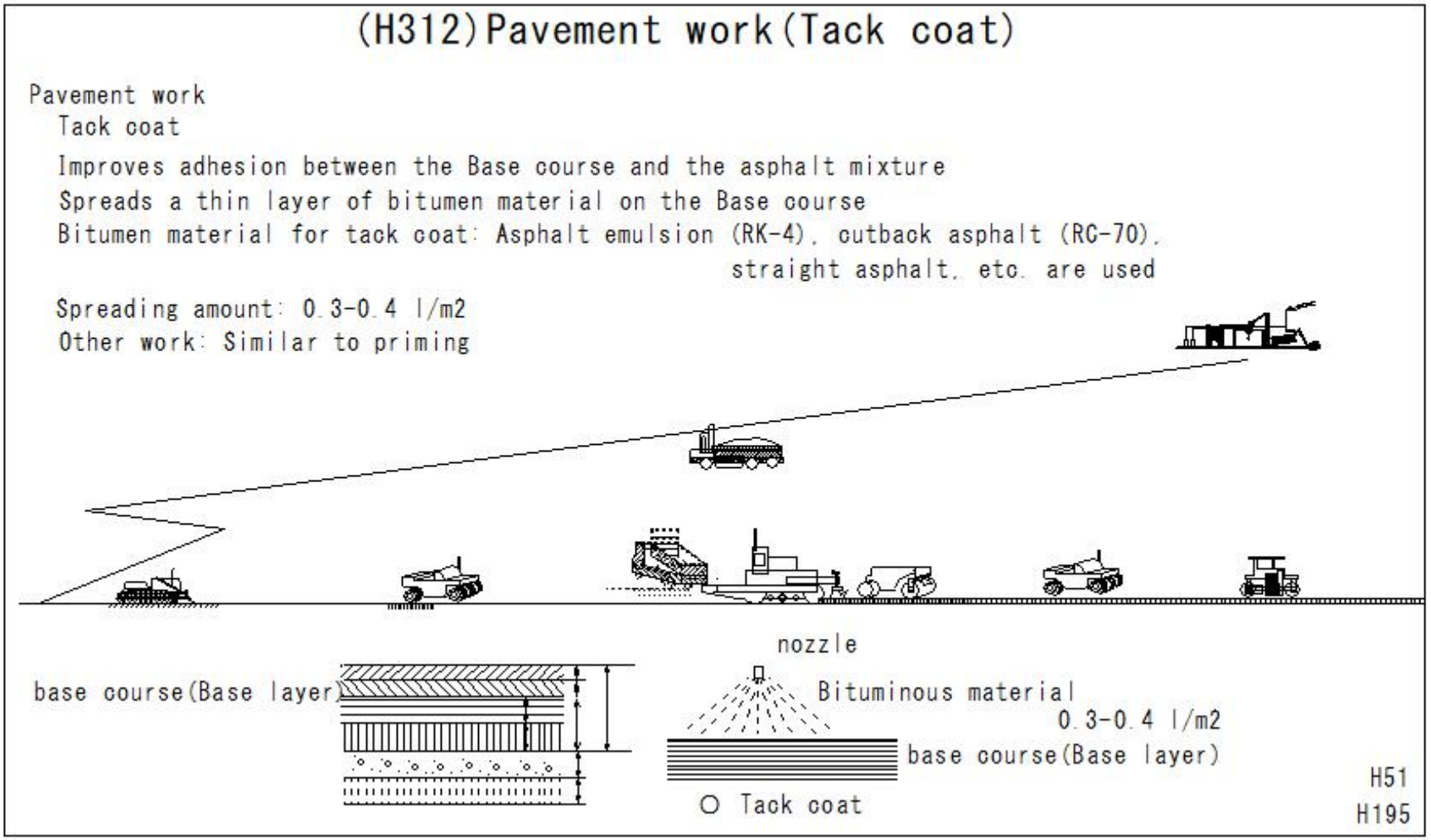
① After spraying, prohibit traffic as much as possible

② Curing time - wait until the surface dries before paving



H48
H194

(H312)Pavement work(Tack coat)



(H313)Pavement work(Bituminous Spraying Machine-Distributor)

(H313)Pavement work(Bituminous Spraying Machine-Distributor)

Pavement work

Bituminous Spraying Machine

①Distributor

A machine with an insulated tank for putting bitumen on the truck

spreads it evenly on the road surface from the spray bar at the rear

The amount spread is adjusted according to the driving speed

suitable for large-scale construction

Adjusting the amount spread according to the driving speed

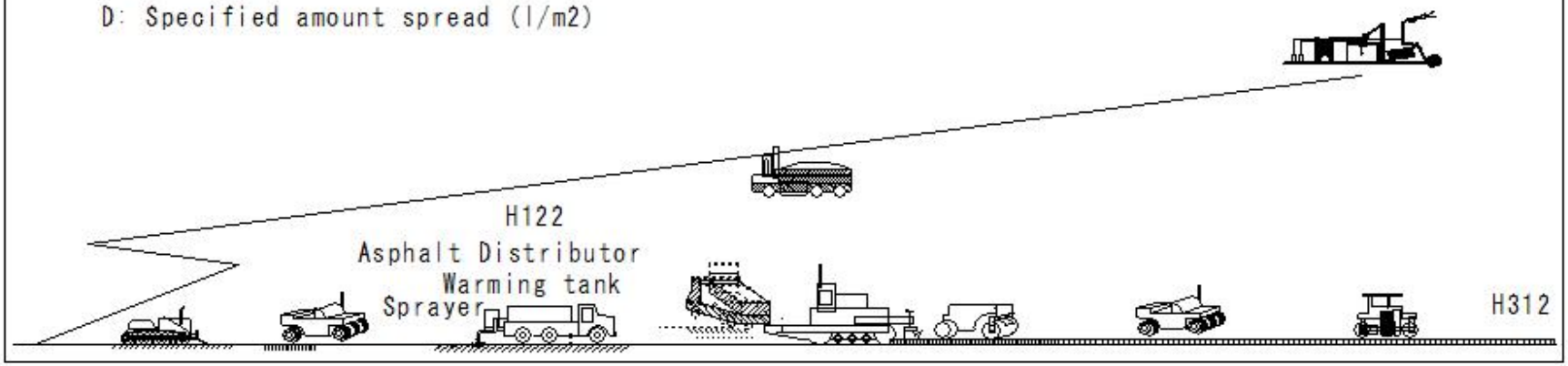
$V=Q/(D\times L)$

V: Driving speed (m/min)

Q: Discharge amount from nozzle (l/min)

L: Spray width by spray bar (m)

D: Specified amount spread (l/m2)



(H314)Pavement work(Bituminous Spraying Machine-Sprayer)

(H314)Pavement work(Bituminous Spraying Machine-Sprayer)

Pavement work

Bituminous Spraying Machine

②Sprayer

Engine sprayer

Hand sprayer

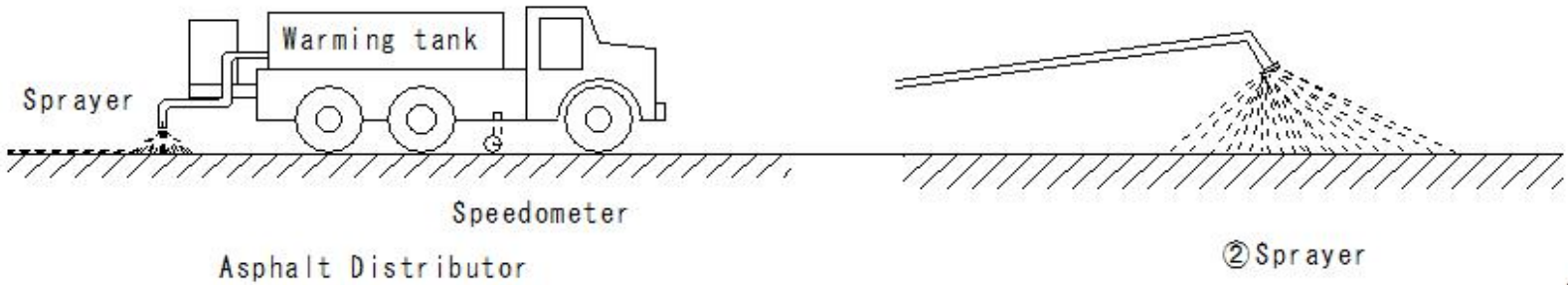
Single nozzle: Spraying by hand with hand bar

Easy to handle

Wide range of use

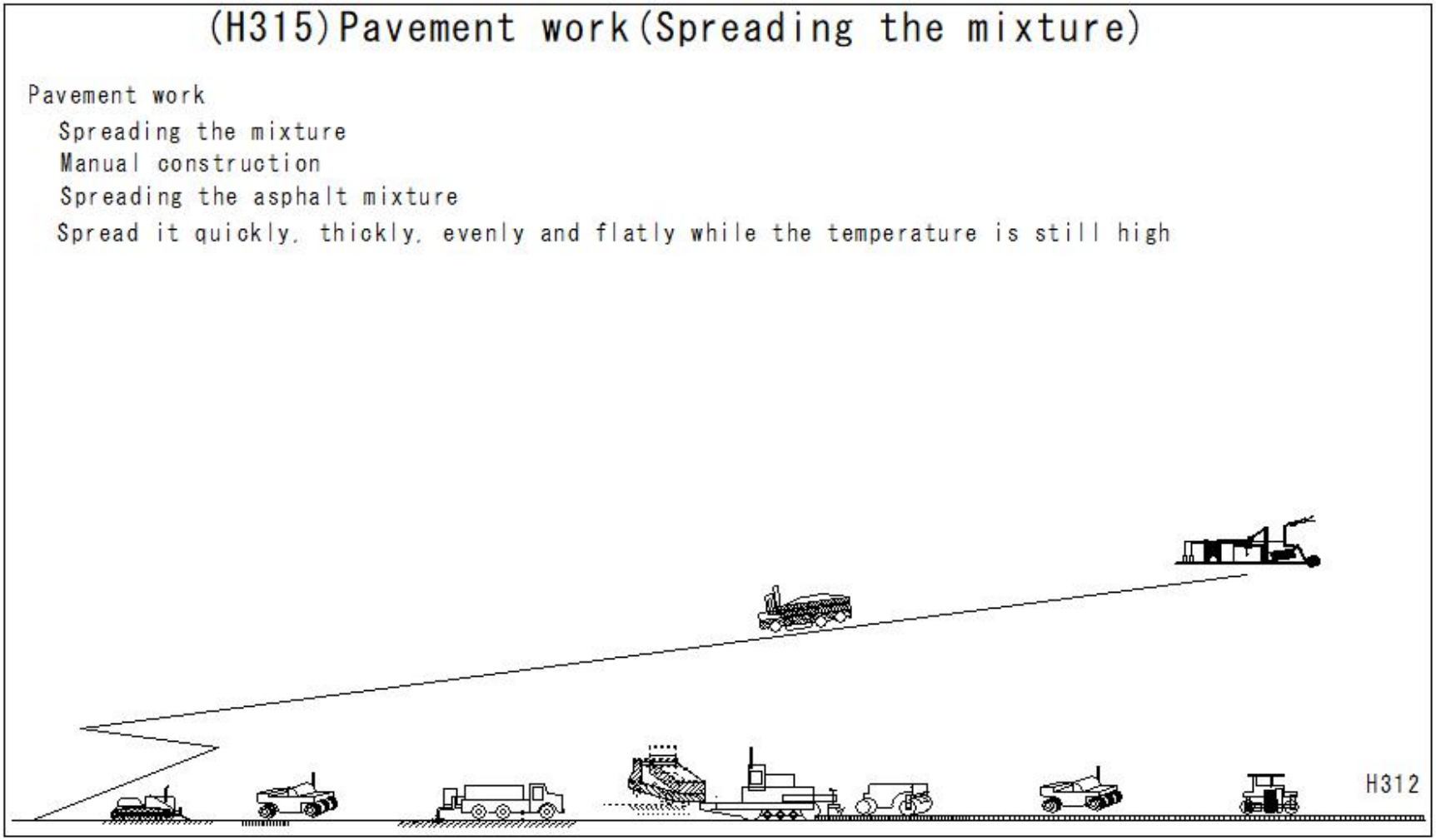
Amount sprayed: Adjusted by nozzle height above ground and travel speed

Sprayer spraying



H122

(H315)Pavement work(Spreading the mixture)



(H316)Pavement work(Spreading the mixture-Spreading by hand)

(H316)Pavement work(Spreading the mixture-Spreading by hand)

Pavement work

Spreading the mixture

①Spreading by hand

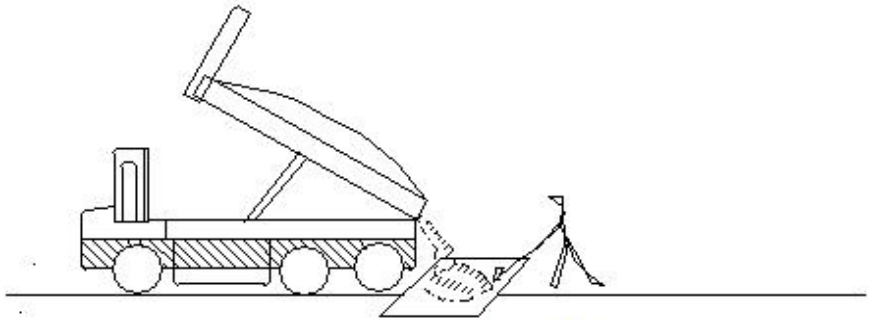
Small-scale construction that cannot be done by machine

(a)Spreading work

①The transported mixture is lowered little by little onto the iron plate

in case of separation of aggregate is observed, remix

To prevent material separation



①remix

(H317)Pavement work(Spreading the mixture-Spreading by hand)

(H317)Pavement work(Spreading the mixture-Spreading by hand)

Pavement work

Spreading the mixture

①Spreading by hand

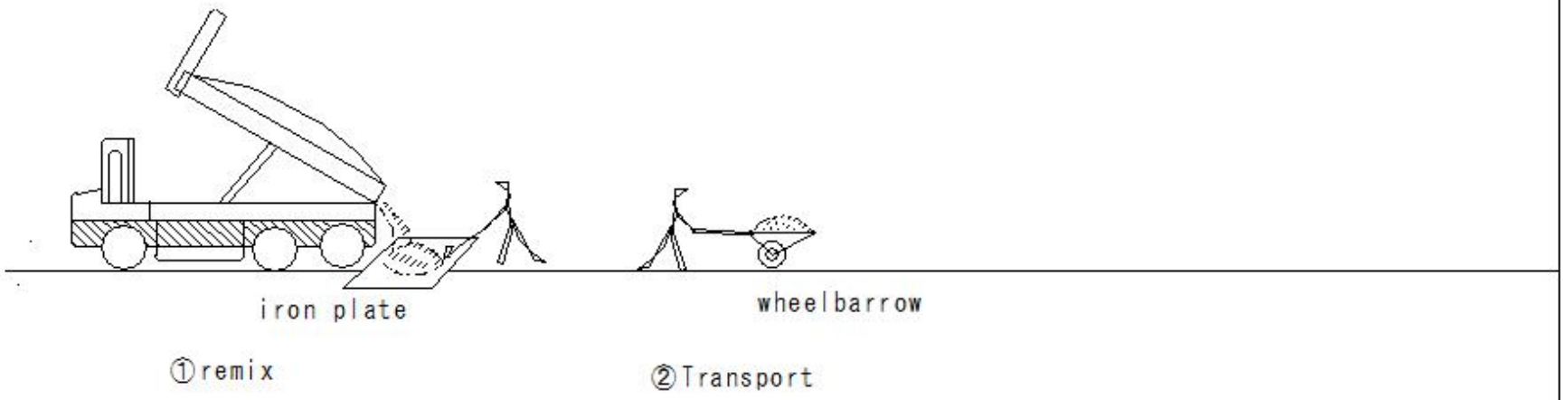
Small-scale construction that cannot be done by machine

(a)Spreading work

②Transport to the area to be spread using a wheelbarrow or shovel

Apply a thin layer of light oil or heavy oil to prevent the mixture from sticking to the transport vehicle

Promptly to prevent the temperature dropping



(H318)Pavement work(Spreading the mixture-Spreading by hand)

(H318)Pavement work(Spreading the mixture-Spreading by hand)

Pavement work

Spreading the mixture

①Spreading by hand

Small-scale construction that cannot be done by machine

(a)Spreading work

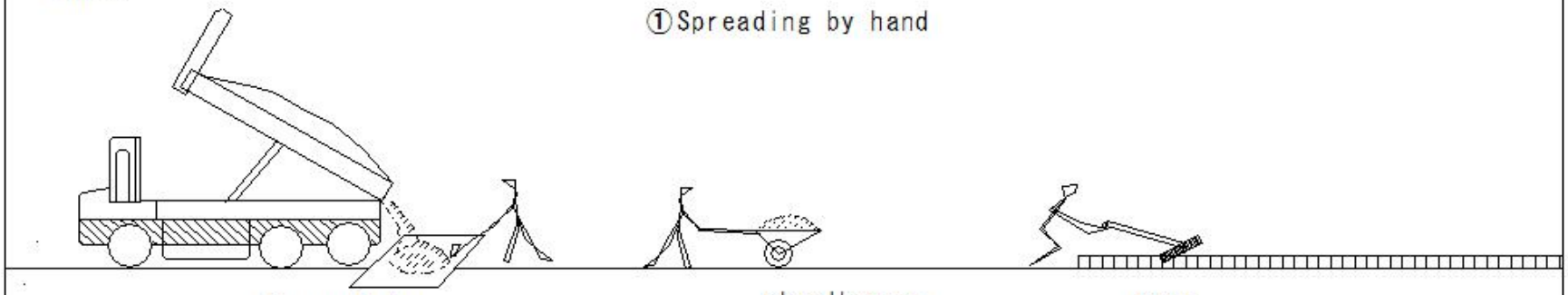
③ Spread using a rake

Finish to the required thickness

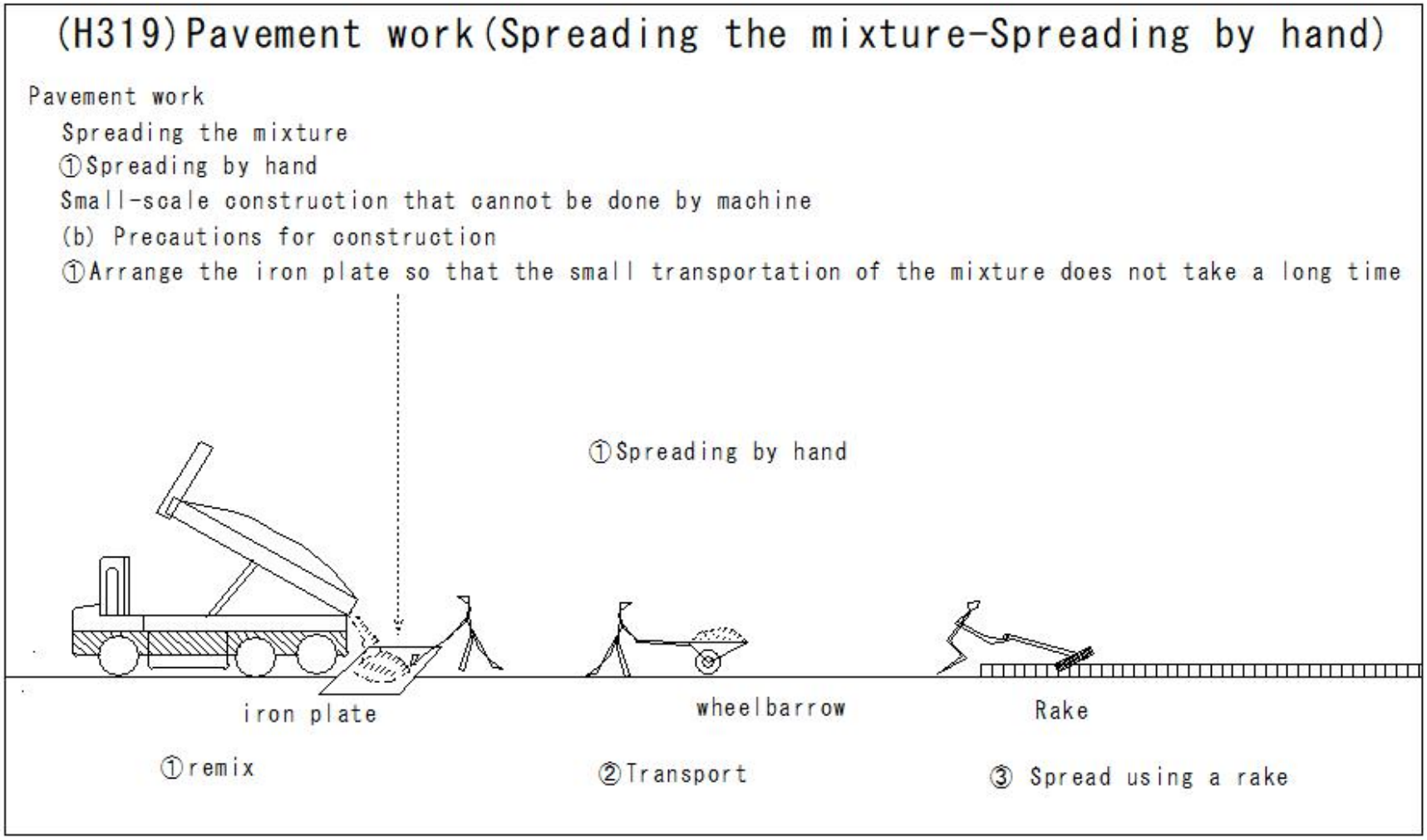
Do this carefully so that the coarse aggregate does not float

Make the grain size uniform and make it flat

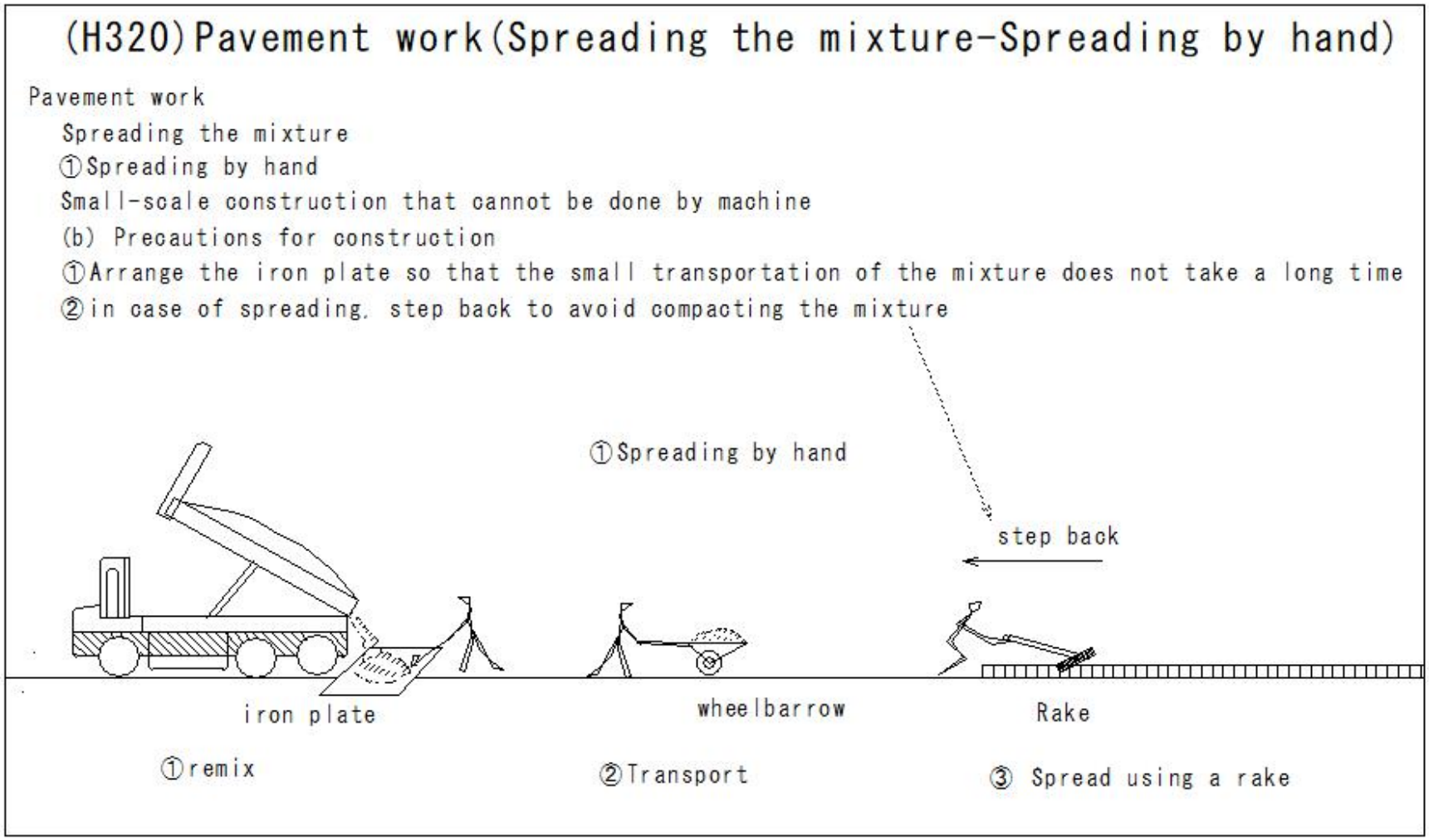
Rake



(H319)Pavement work(Spreading the mixture-Spreading by hand)



(H320)Pavement work(Spreading the mixture-Spreading by hand)



(H321)Pavement work(Spreading the mixture-Spreading by hand)

(H321)Pavement work(Spreading the mixture-Spreading by hand)

Pavement work

Spreading the mixture

①Spreading by hand

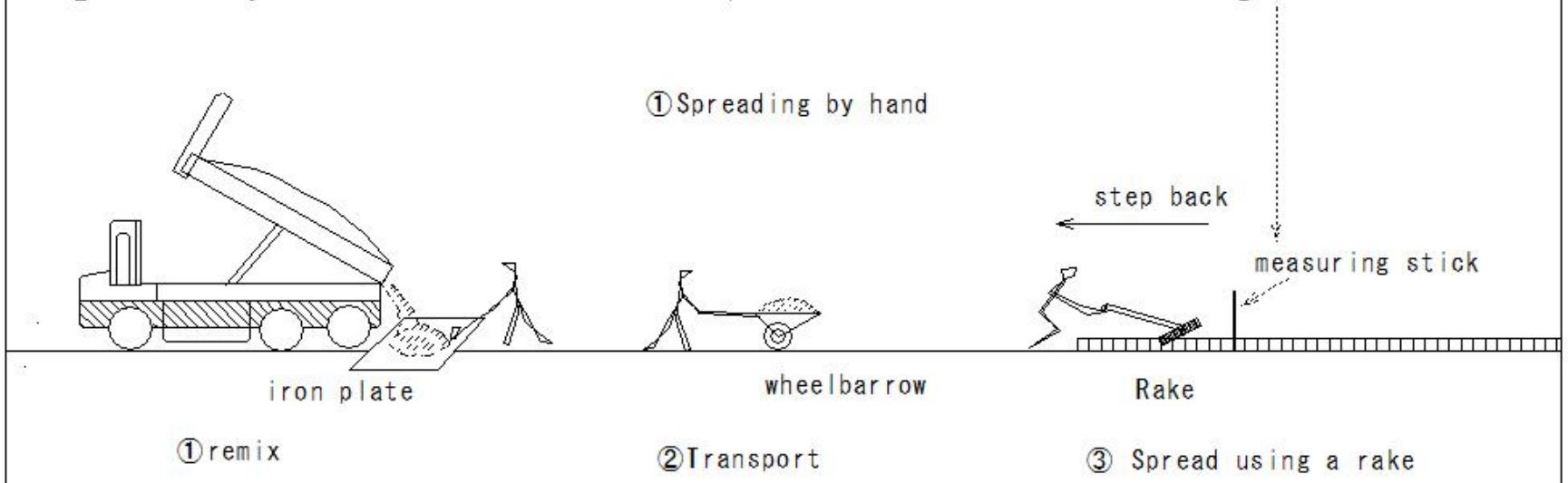
Small-scale construction that cannot be done by machine

(b) Precautions for construction

①Arrange the iron plate so that the small transportation of the mixture does not take a long time

②in case of spreading, step back to avoid compacting the mixture

③ Constantly measure the thickness of the spread and check it with a measuring stick



(H322)Pavement work(Spreading the mixture-Spreading by hand)

(H322)Pavement work(Spreading the mixture-Spreading by hand)

Pavement work

Spreading the mixture

①Spreading by hand

Small-scale construction that cannot be done by machine

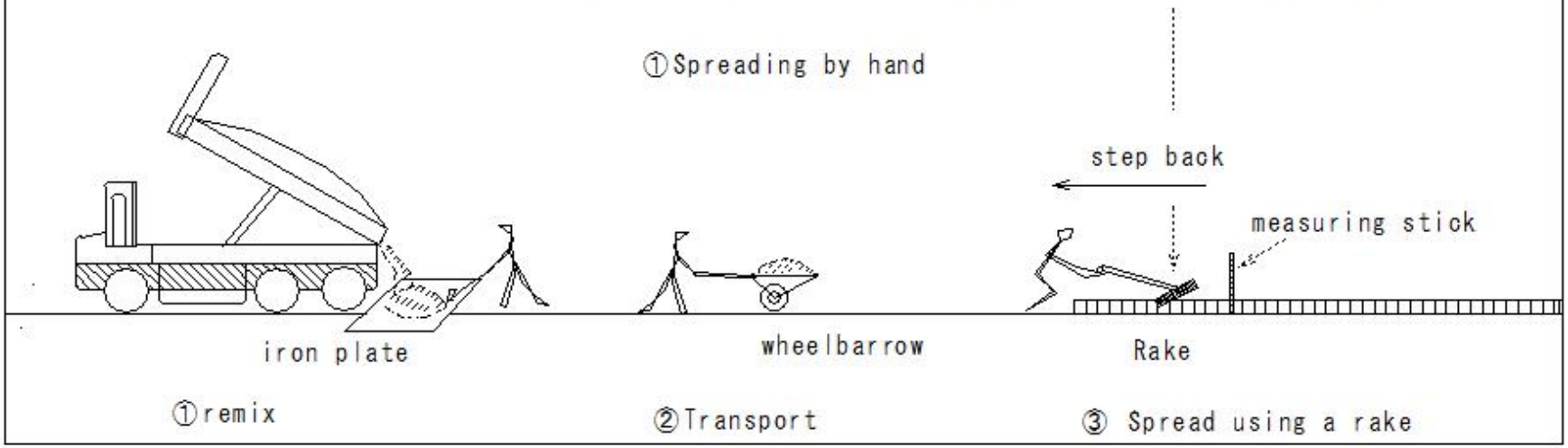
(b) Precautions for construction

①Arrange the iron plate so that the small transportation of the mixture does not take a long time

②in case of spreading, step back to avoid compacting the mixture

③ Constantly measure the thickness of the spread and check it with a measuring stick

④ Mixtures with a high content of fine particles are loosened using the teeth of a rake to ensure uniform density, and then finished with a board rake.



(H323)Pavement work(Spreading the mixture-Spreading by hand)

(H323)Pavement work(Spreading the mixture-Spreading by hand)

Pavement work

Spreading the mixture

①Spreading by hand

Small-scale construction that cannot be done by machine

(b) Precautions for construction

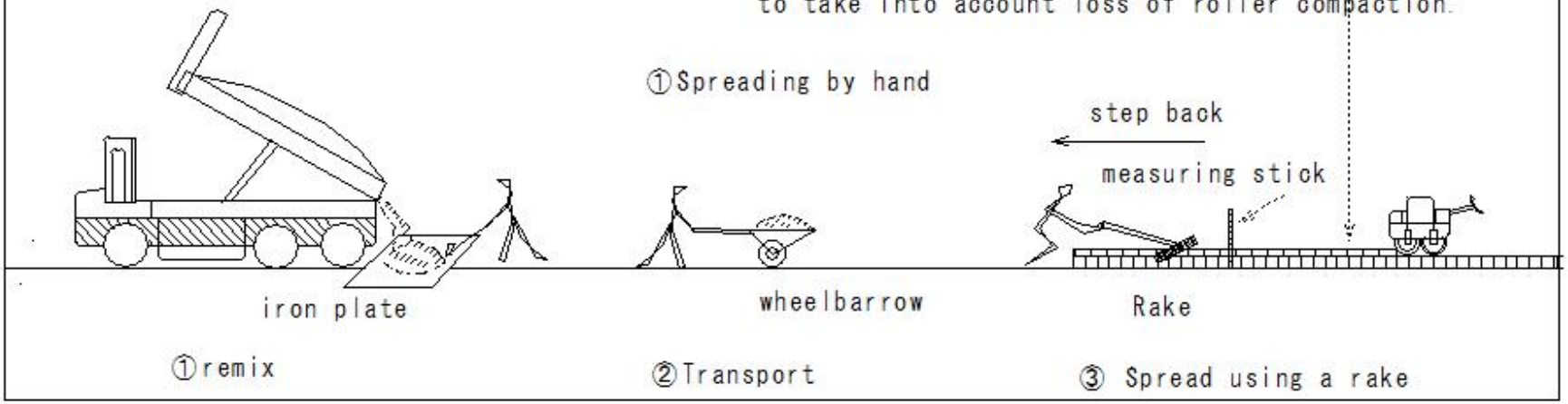
①Arrange the iron plate so that the small transportation of the mixture does not take a long time

②in case of spreading, step back to avoid compacting the mixture

③ Constantly measure the thickness of the spread and check it with a measuring stick

④ Mixtures with a high content of fine particles are loosened using the teeth of a rake to ensure uniform density, and then finished with a board rake.

⑤ Depending on the type of mixture and the thickness of application, prepare extra material to take into account loss of roller compaction.



(H324)Pavement work(Spreading the mixture-Spreading with a finisher)

(H324)Pavement work(Spreading the mixture-Spreading with a finisher)

Pavement work

Spreading the mixture

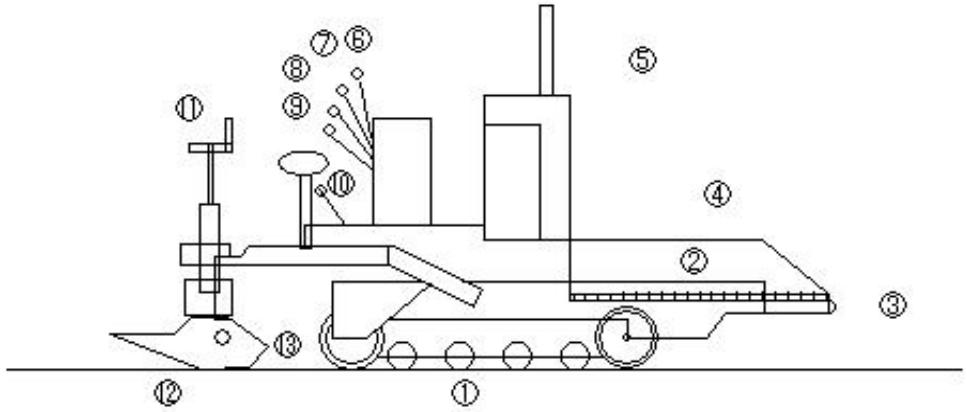
②Spreading with a finisher

Spreading the mixture and lightly compacting it at the same time

A uniform surface composition can be obtained

(a) Asphalt finisher

①Crawler
②Bar feeder
③Push roller
④Hopper
⑤Engine
⑥Transmission lever
⑦Screw-spreader clutch bar
⑧Left forward/reverse lever
⑨Right forward/reverse lever
⑩Screw-spreader clutch bar
⑪Thickness controller
⑫Screed
⑬Tamper



Spreading (screed) part　　Tractor part

(a) Asphalt finisher

(H325)Pavement work(Spreading the mixture-Spreading with a finisher)

(H325)Pavement work(Spreading the mixture-Spreading with a finisher)

Pavement work

Spreading the mixture

②Spreading with a finisher

Spreading the mixture and lightly compacting it at the same time

A uniform surface composition can be obtained

(a) Asphalt finisher

①Crawler

②Pivot

③Hopper

④Hopper gate

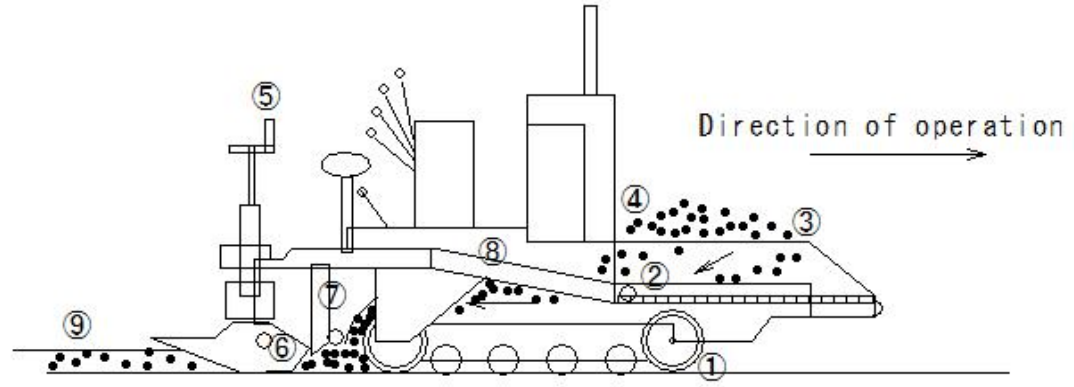
⑤Thickness controller

⑥Musreed

⑦Tamper

⑧Leveling arm

⑨Spreading surface



(a) Asphalt finisher

(H326)Pavement work(Spreading the mixture-Spreading)

(H326)Pavement work(Spreading the mixture-Spreading)

Pavement work

Spreading the mixture

②Spreading with a finisher

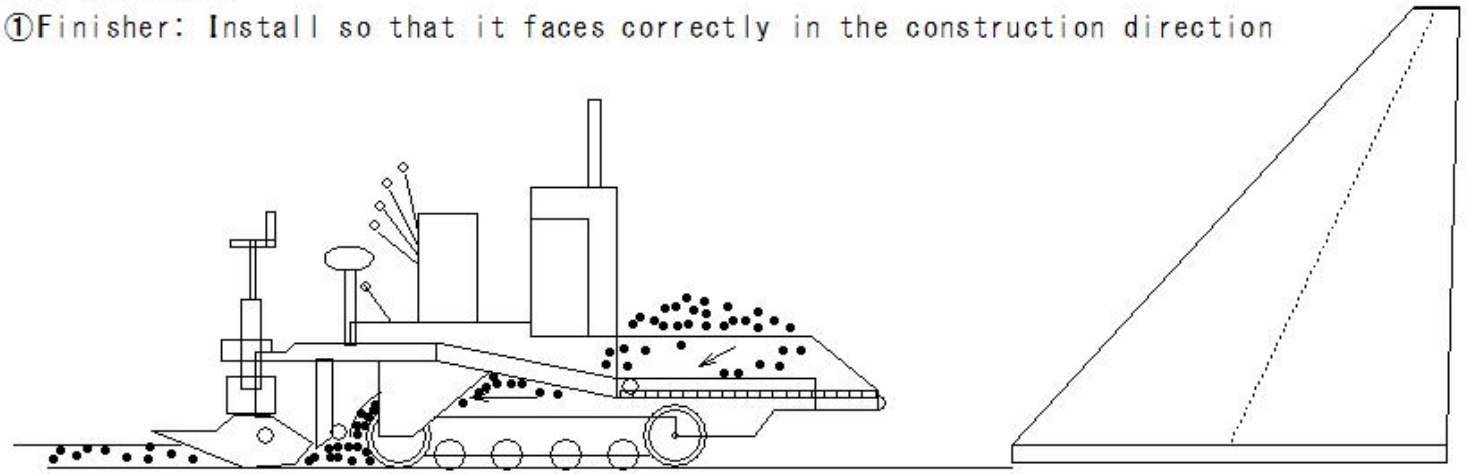
Spreading the mixture and lightly compacting it at the same time

A uniform surface composition can be obtained

(b) Spreading

Work procedure

①Finisher: Install so that it faces correctly in the construction direction



(H327)Pavement work(Spreading the mixture-Spreading)

(H327)Pavement work(Spreading the mixture-Spreading)

Pavement work

Spreading the mixture

②Spreading with a finisher

Spreading the mixture and lightly compacting it at the same time

A uniform surface composition can be obtained

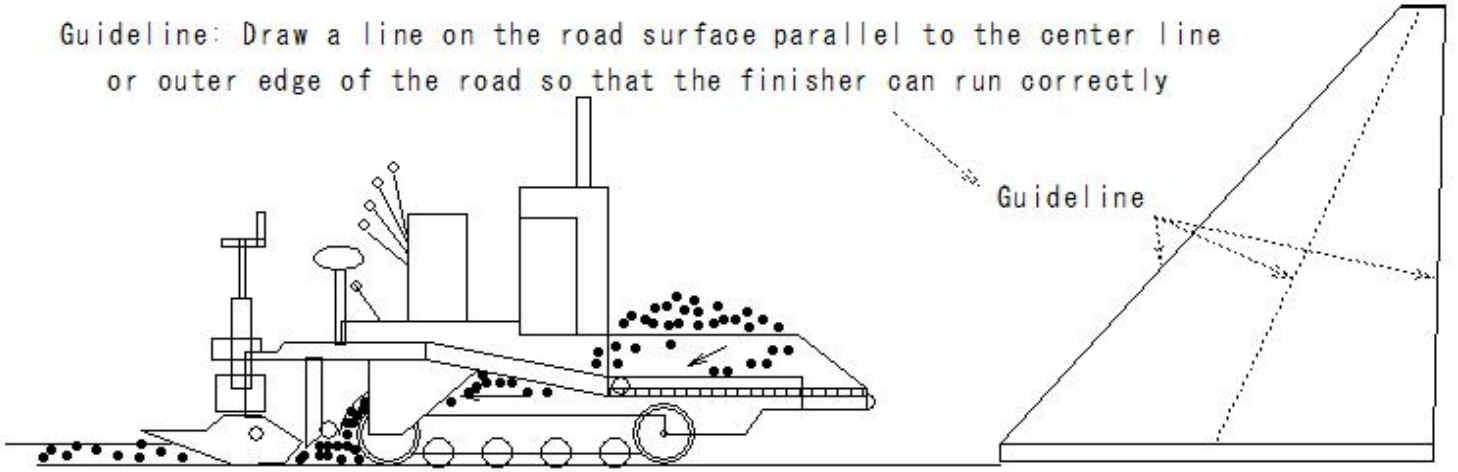
(b) Spreading

Work procedure

①Finisher: Install so that it faces correctly in the construction direction

②Running of the finisher: Set a guideline parallel to the outer edge of the road to maintain the direction of travel

Guideline: Draw a line on the road surface parallel to the center line or outer edge of the road so that the finisher can run correctly



(H328)Pavement work(Spreading the mixture-Spreading)

(H328)Pavement work(Spreading the mixture-Spreading)

Pavement work

Spreading the mixture

②Spreading with a finisher

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A uniform surface composition can be obtained

(b) Spreading

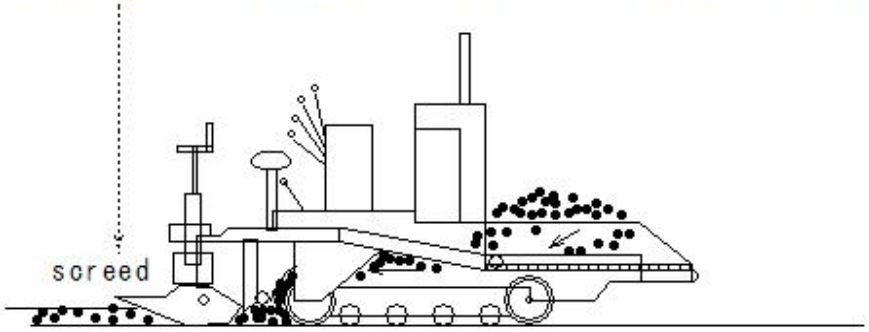
Work procedure

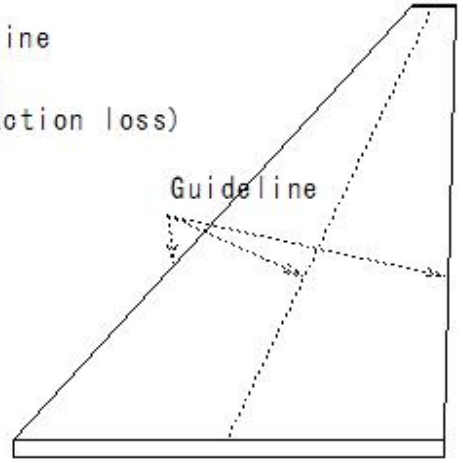
①Finisher: Install so that it faces correctly in the construction direction

②Running of the finisher: Set a guideline parallel to the outer edge of the road to maintain the direction of travel

Guideline: Draw a line on the road surface parallel to the center line or outer edge of the road so that the finisher can run correctly

③ Set the screed to the specified thickness (taking into account compaction loss)





(H329)Pavement work(Spreading the mixture-Spreading)

(H329)Pavement work(Spreading the mixture-Spreading)

Pavement work

Spreading the mixture

②Spreading with a finisher

Spreading the mixture and lightly compacting it at the same time

A uniform surface composition can be obtained

(b) Spreading

Work procedure

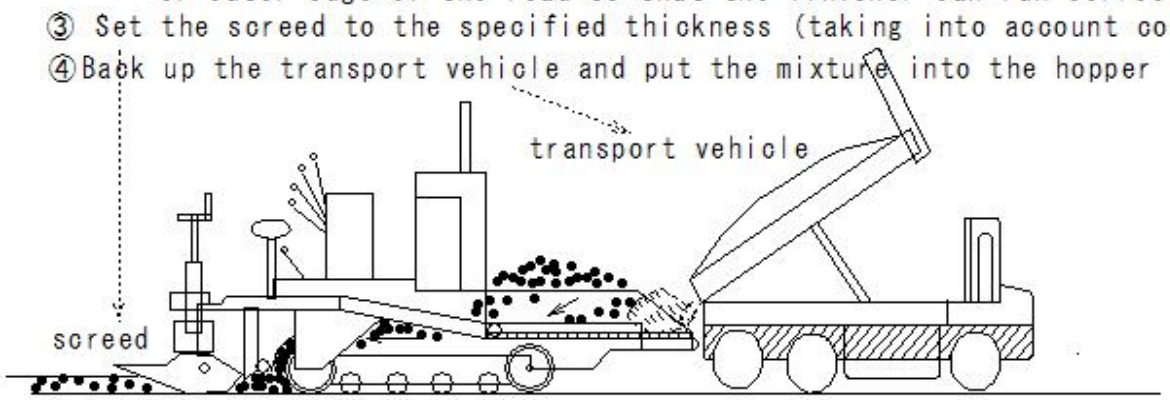
①Finisher: Install so that it faces correctly in the construction direction

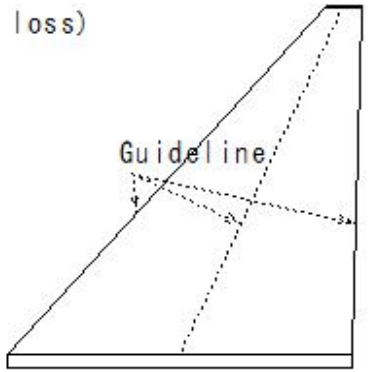
②Running of the finisher: Set a guideline parallel to the outer edge of the road to maintain the direction of travel

Guideline: Draw a line on the road surface parallel to the center line or outer edge of the road so that the finisher can run correctly

③ Set the screed to the specified thickness (taking into account compaction loss)

④Back up the transport vehicle and put the mixture into the hopper





(H330)Pavement work(Spreading the mixture-Spreading)

(H330)Pavement work(Spreading the mixture-Spreading)

Pavement work

Spreading the mixture

②Spreading with a finisher

Spreading the mixture and lightly compacting it at the same time

A uniform surface composition can be obtained

(b) Spreading

Work procedure

①Finisher: Install so that it faces correctly in the construction direction

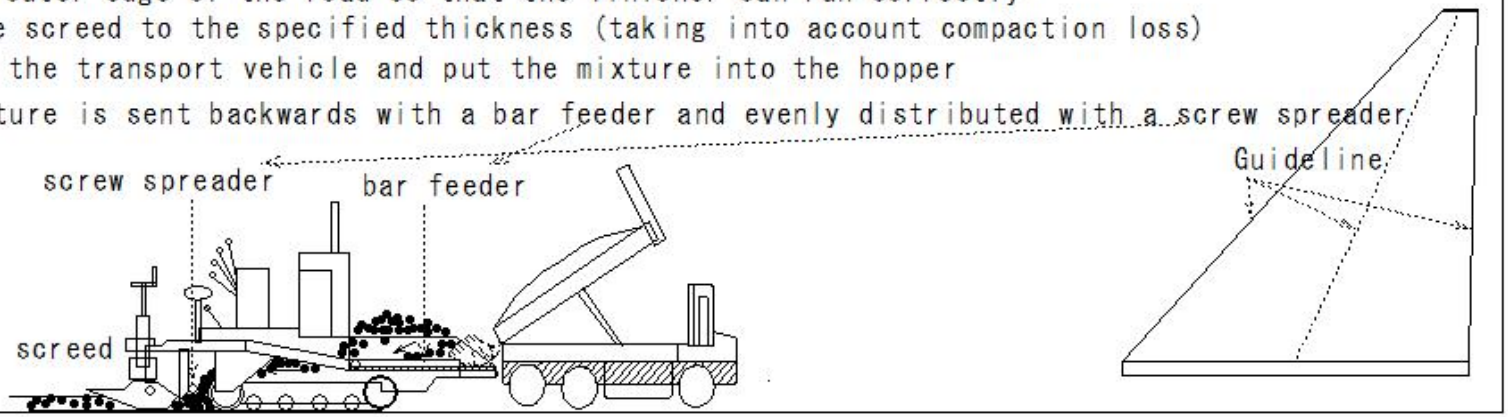
②Running of the finisher: Set a guideline parallel to the outer edge of the road to maintain the direction of travel

Guideline: Draw a line on the road surface parallel to the center line or outer edge of the road so that the finisher can run correctly

③ Set the screed to the specified thickness (taking into account compaction loss)

④Back up the transport vehicle and put the mixture into the hopper

⑤The mixture is sent backwards with a bar feeder and evenly distributed with a screw spreader



(H331)Pavement work(Spreading the mixture-Spreading)

(H331)Pavement work(Spreading the mixture-Spreading)

Pavement work

Spreading the mixture

②Spreading with a finisher

Spreading the mixture and lightly compacting it at the same time

A uniform surface composition can be obtained

(b) Spreading

Work procedure

①Finisher: Install so that it faces correctly in the construction direction

②Running of the finisher: Set a guideline parallel to the outer edge of the road to maintain the direction of travel

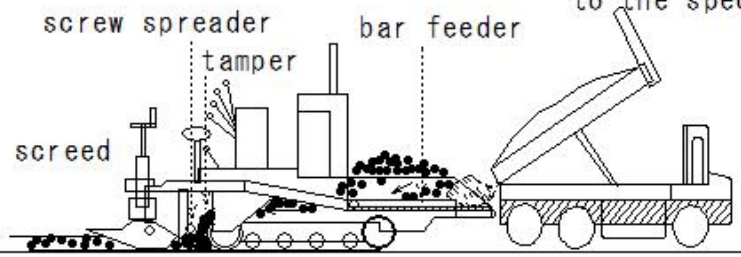
Guideline: Draw a line on the road surface parallel to the center line or outer edge of the road so that the finisher can run correctly

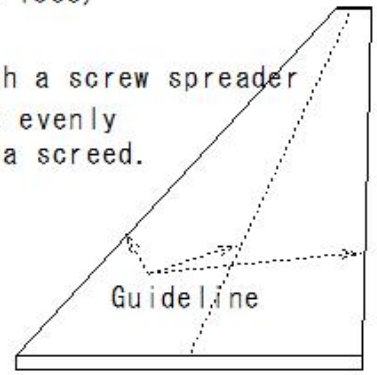
③ Set the screed to the specified thickness (taking into account compaction loss)

④Back up the transport vehicle and put the mixture into the hopper

⑤The mixture is sent backwards with a bar feeder and evenly distributed with a screw spreader

⑥ While moving the finisher forward, compact it with a tamper and spread it evenly to the specified thickness with a screed.





(H332)Pavement work(Spreading the mixture-Spreading)

(H332)Pavement work(Spreading the mixture-Spreading)

Pavement work

Spreading the mixture

②Spreading with a finisher

Spreading the mixture and lightly compacting it at the same time

A uniform surface composition can be obtained

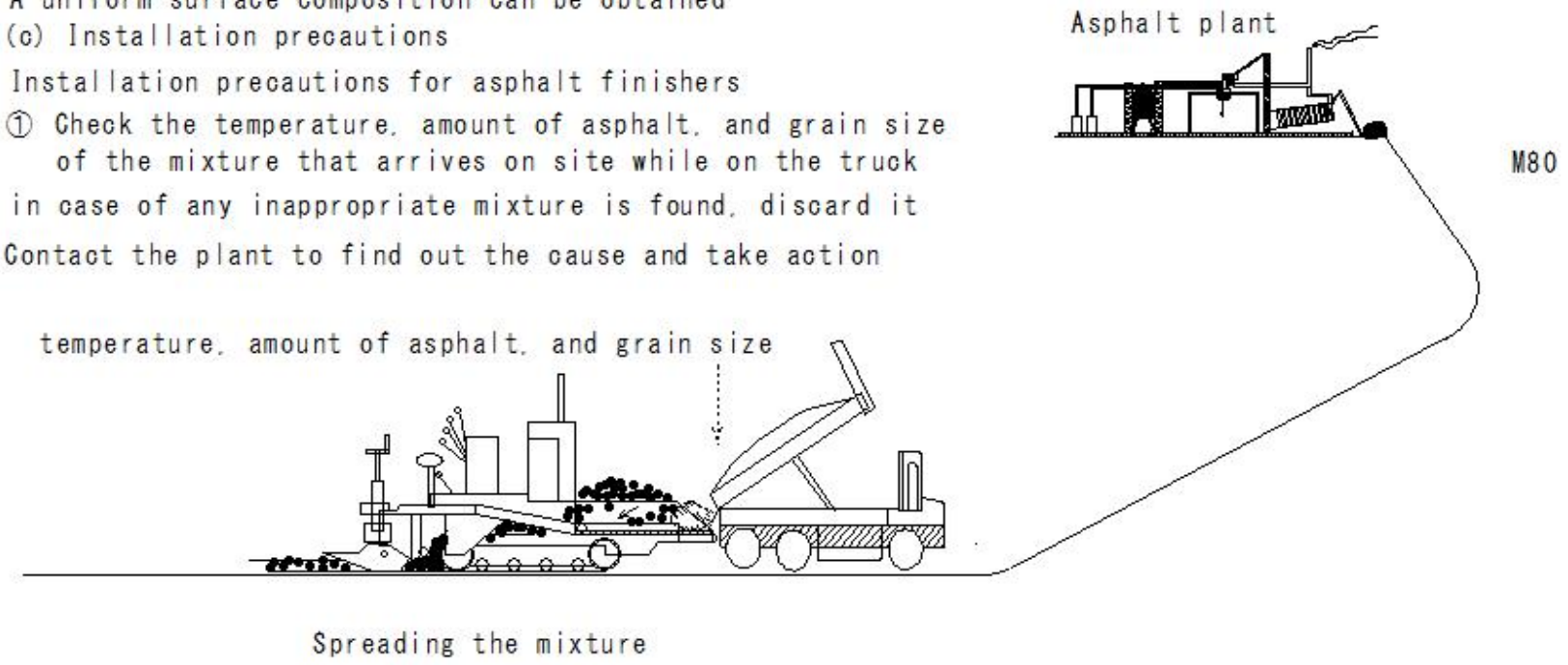
(c) Installation precautions

Installation precautions for asphalt finishers

① Check the temperature, amount of asphalt, and grain size of the mixture that arrives on site while on the truck

in case of any inappropriate mixture is found, discard it

Contact the plant to find out the cause and take action



Spreading the mixture

(H333)Pavement work(Spreading the mixture-Spreading)

(H333)Pavement work(Spreading the mixture-Spreading)

Pavement work

Spreading the mixture

②Spreading with a finisher

Spreading the mixture and lightly compacting it at the same time

A uniform surface composition can be obtained

(c) Installation precautions

Installation precautions for asphalt finishers

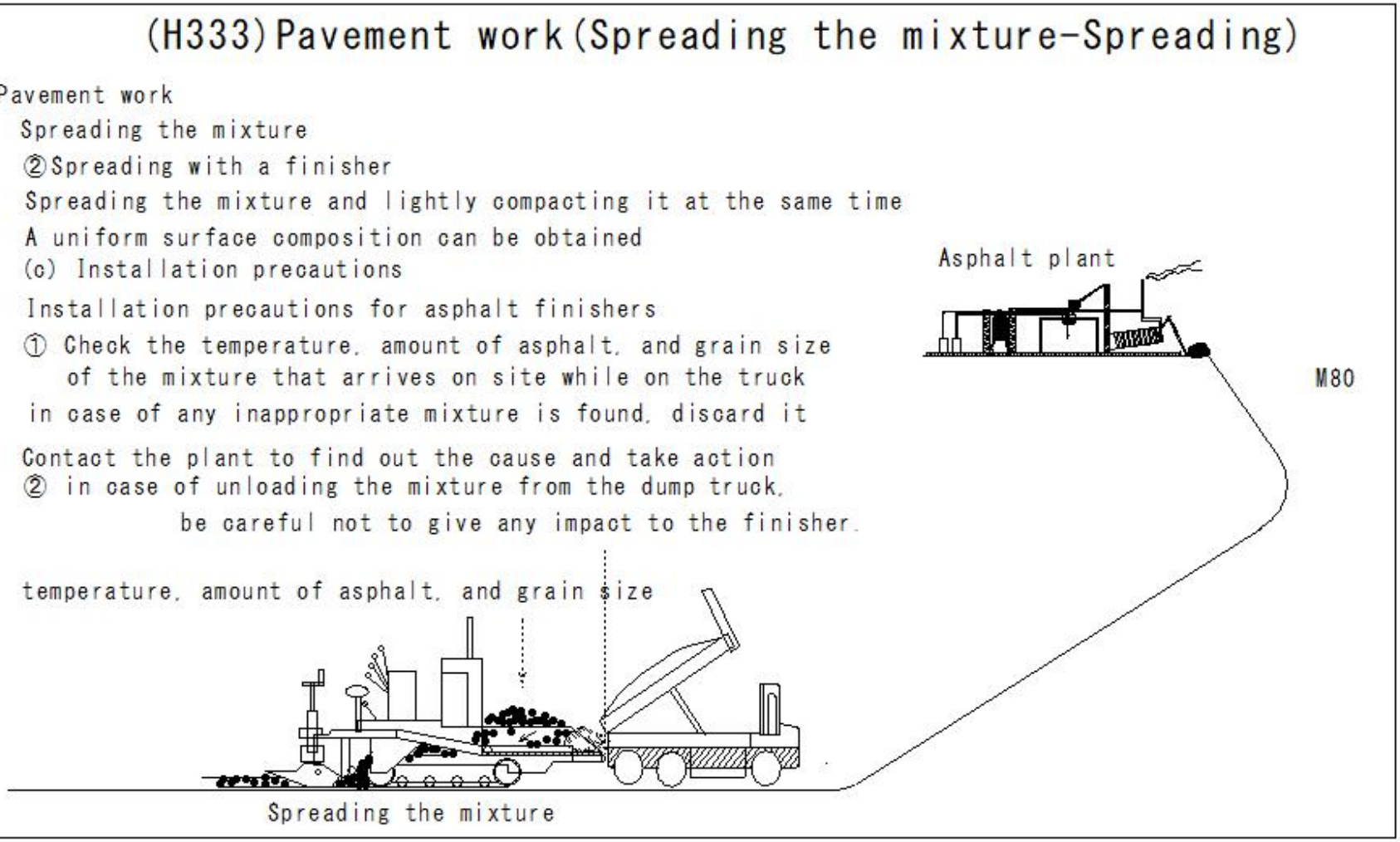
① Check the temperature, amount of asphalt, and grain size of the mixture that arrives on site while on the truck

in case of any inappropriate mixture is found, discard it

Contact the plant to find out the cause and take action

② in case of unloading the mixture from the dump truck,

be careful not to give any impact to the finisher.



(H334)Pavement work(Spreading the mixture-Spreading)

(H334)Pavement work(Spreading the mixture-Spreading)

Pavement work

Spreading the mixture

②Spreading with a finisher

Spreading the mixture and lightly compacting it at the same time

A uniform surface composition can be obtained

(c) Installation precautions

Installation precautions for asphalt finishers

① Check the temperature, amount of asphalt, and grain size of the mixture that arrives on site while on the truck

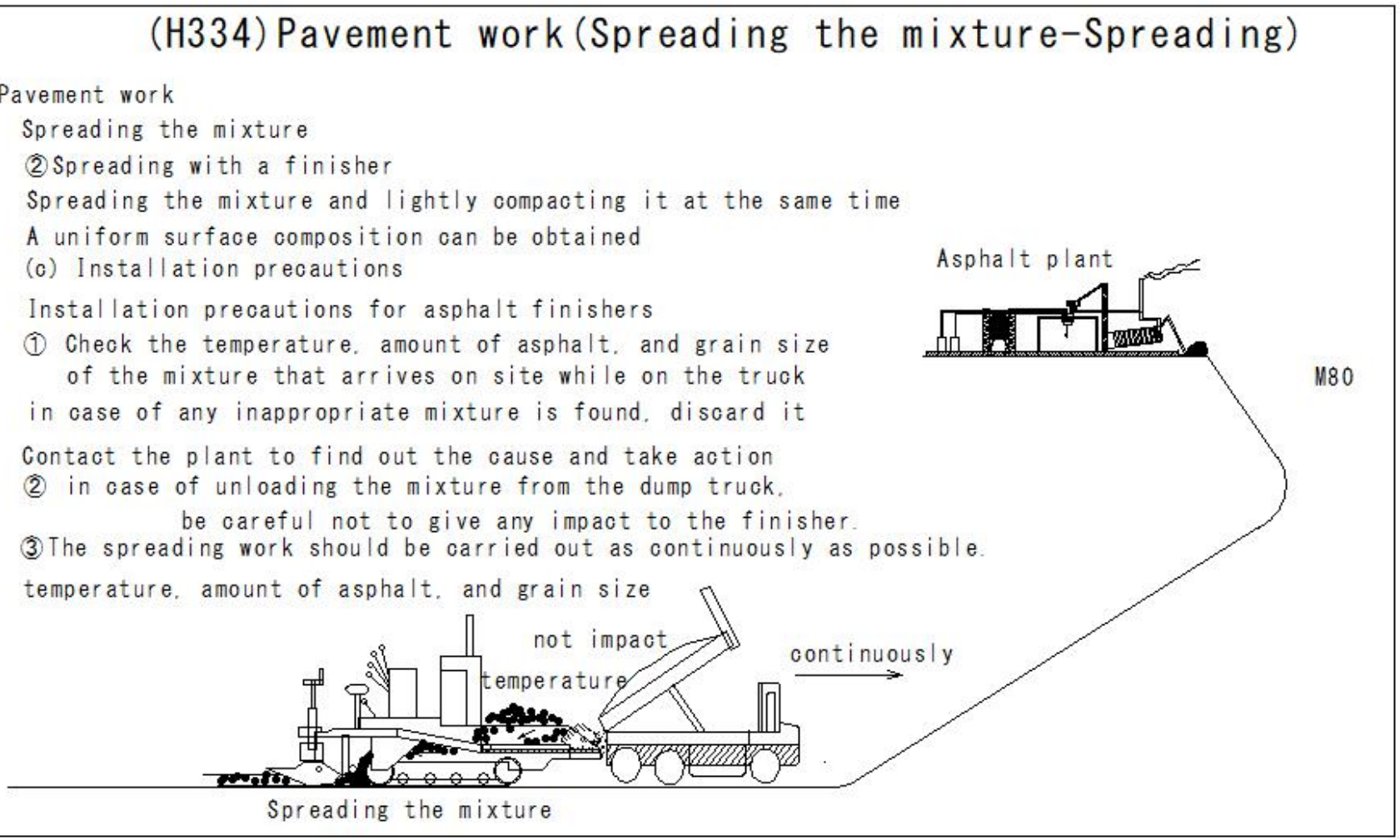
in case of any inappropriate mixture is found, discard it

Contact the plant to find out the cause and take action

② in case of unloading the mixture from the dump truck,

be careful not to give any impact to the finisher.

③The spreading work should be carried out as continuously as possible.



(H335)Pavement work(Spreading the mixture-Spreading)

(H335)Pavement work(Spreading the mixture-Spreading)

Pavement work

Spreading the mixture

②Spreading with a finisher

Spreading the mixture and lightly compacting it at the same time

A uniform surface composition can be obtained

(c) Installation precautions

Installation precautions for asphalt finishers

① Check the temperature, amount of asphalt, and grain size of the mixture that arrives on site while on the truck

in case of any inappropriate mixture is found, discard it

Contact the plant to find out the cause and take action

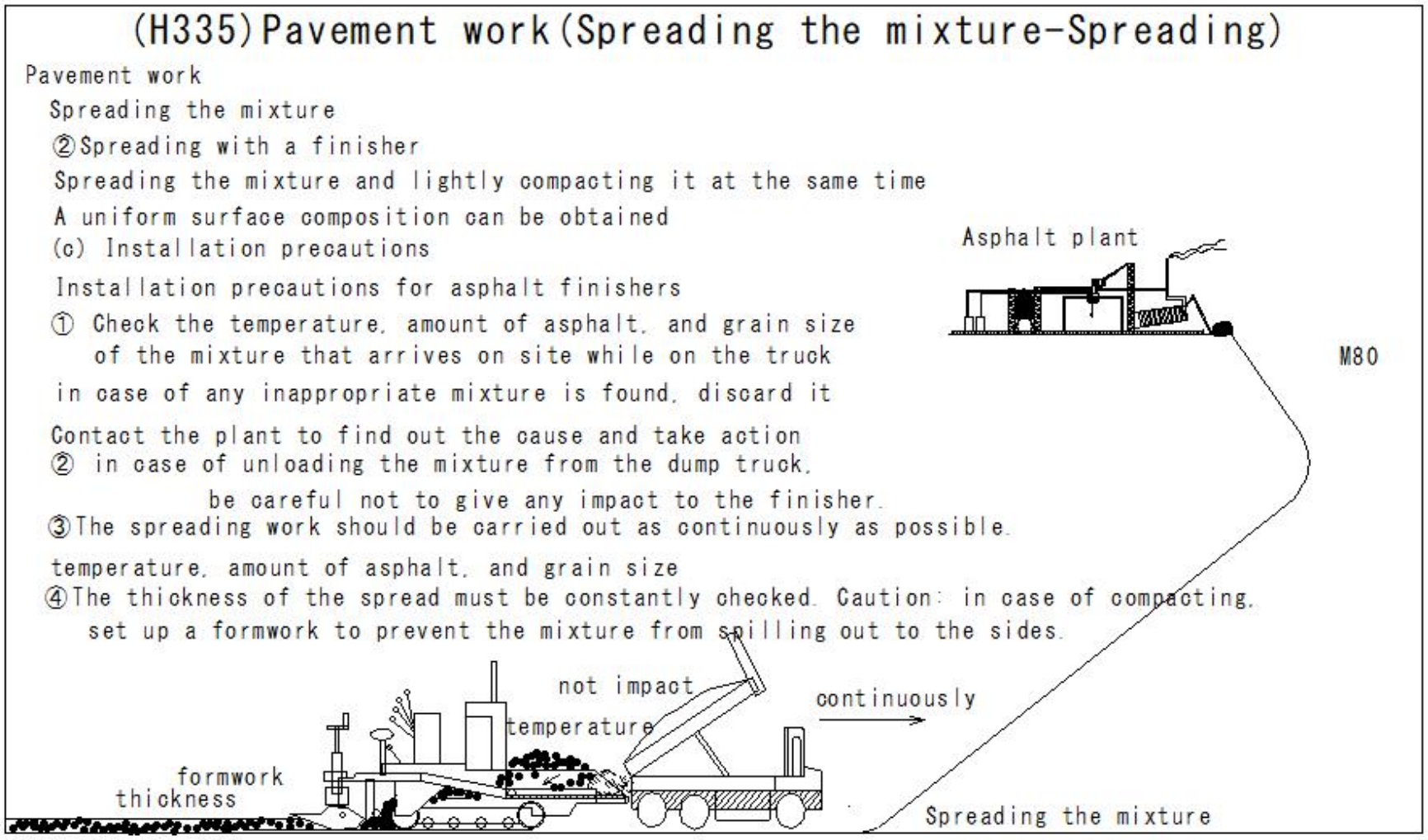
② in case of unloading the mixture from the dump truck,

be careful not to give any impact to the finisher.

③The spreading work should be carried out as continuously as possible.

temperature, amount of asphalt, and grain size

④The thickness of the spread must be constantly checked. Caution: in case of compacting, set up a formwork to prevent the mixture from spilling out to the sides.



(H336)Pavement work(Spreading the mixture-Spreading)

(H336)Pavement work(Spreading the mixture-Spreading)

Pavement work

Spreading the mixture

②Spreading with a finisher

Spreading the mixture and lightly compacting it at the same time

A uniform surface composition can be obtained

(d) Determining the thickness of the pavement

Thickness of the pavement to be laid to obtain the specified pavement thickness:

Differs depending on the type of mixture, pavement thickness, finisher model, compaction model, etc.

Confirm by carrying out a test construction in advance

Calculating the thickness of the pavement

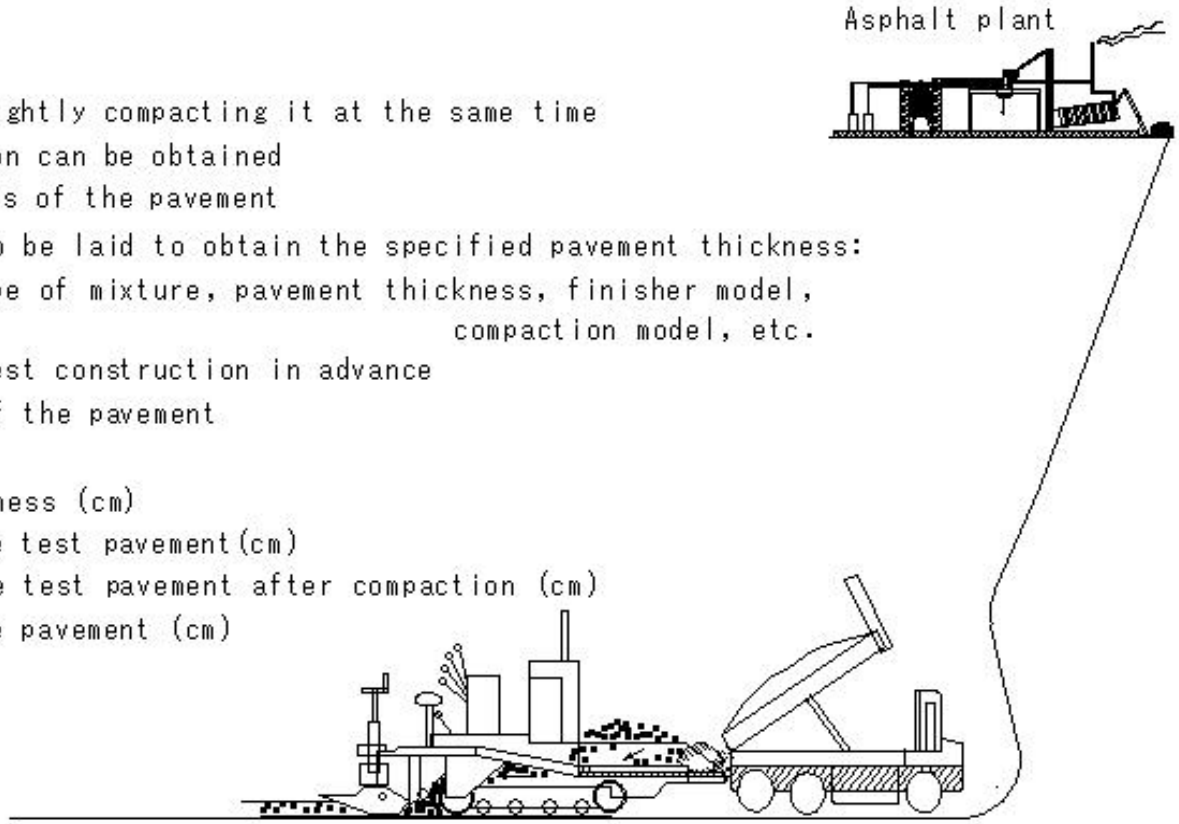
$T=D\times(T'/D')$

D: Specified pavement thickness (cm)

T': Average thickness of the test pavement(cm)

D': Average thickness of the test pavement after compaction (cm)

T: Required thickness of the pavement (cm)



(H337)Pavement work(Spreading the mixture-Spreading)

(H337)Pavement work(Spreading the mixture-Spreading)

Pavement work

Spreading the mixture

②Spreading with a finisher

Spreading the mixture and lightly compacting it at the same time

A uniform surface composition can be obtained

(e) Confirmation of pavement thickness

L = Q/(r x D x W)

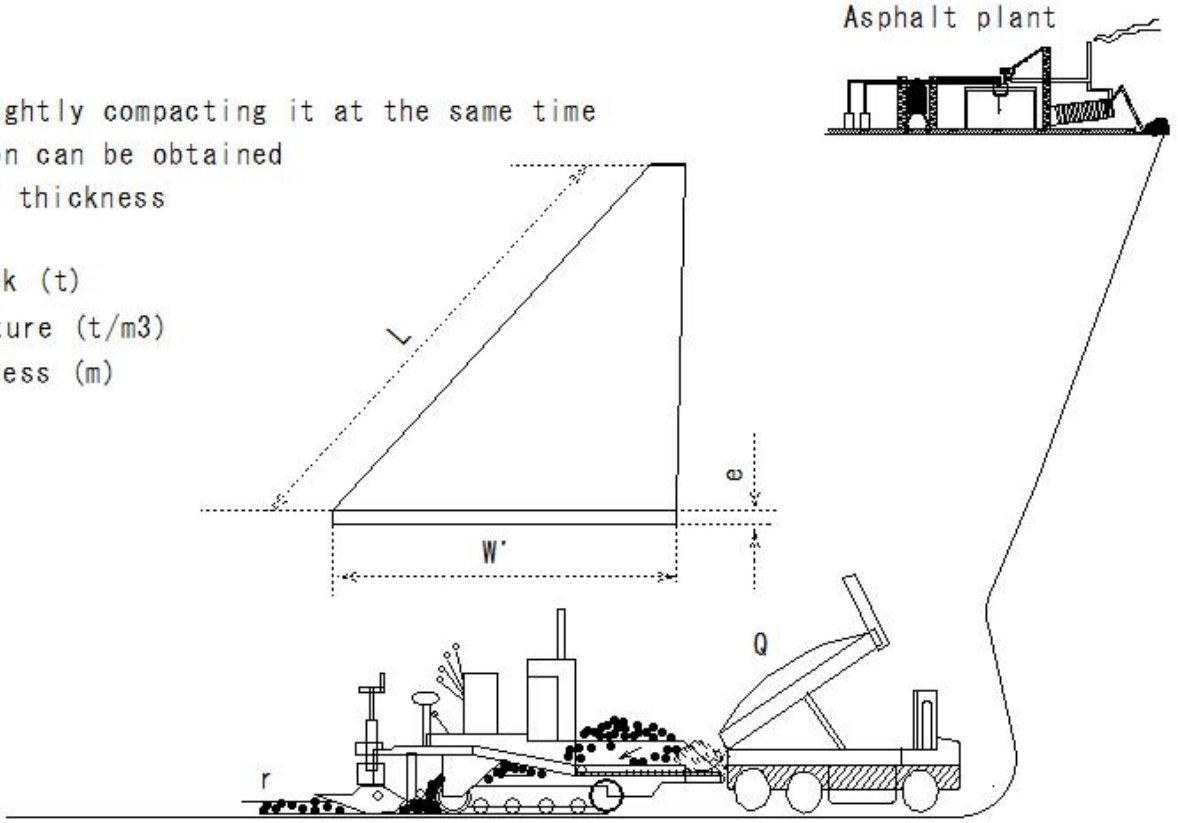
Q: Load capacity of one truck (t)

r: Density of compacted mixture (t/m3)

D: Specified pavement thickness (m)

W': Spreading width (m)

L: Spreading length (m)



(H338)Pavement work(Rolling)

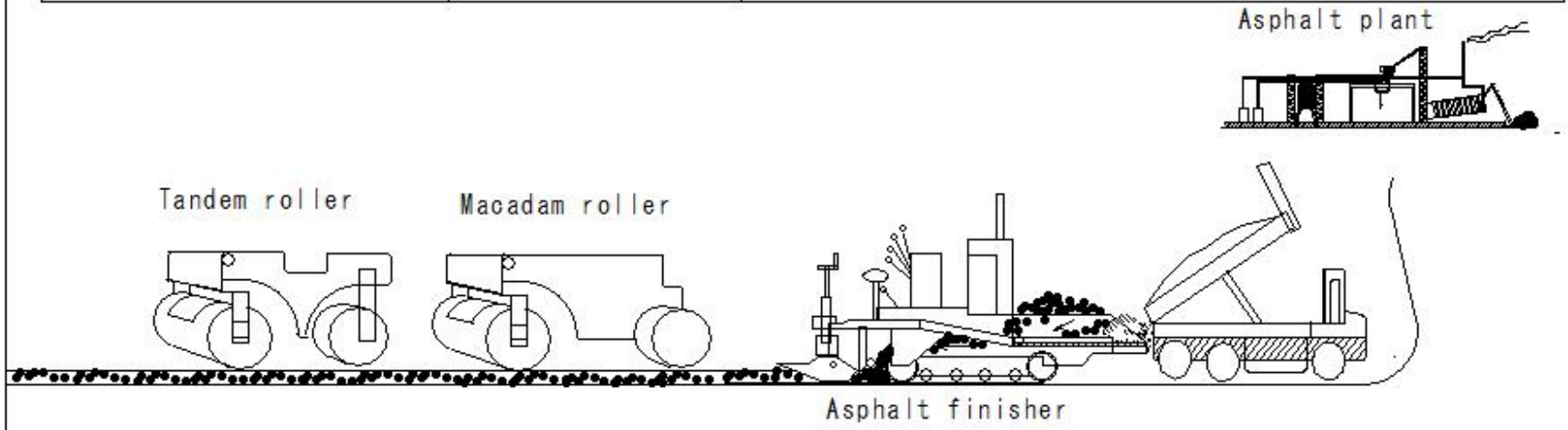
(H338) Pavement work (Rolling)

Pavement work

Rolling work

① Order of rolling work

a: Order of rolling	b: Rolling machine	c: Key points of work
① Initial rolling	Macadam roller Tandem roller (6-10t)	In order to increase the compaction effect of the initial compaction, the mixture is prevented from deforming. High enough temperature that cracks do not appear: Perform at the optimum compaction temperature.



(H339)Pavement work(Rolling)

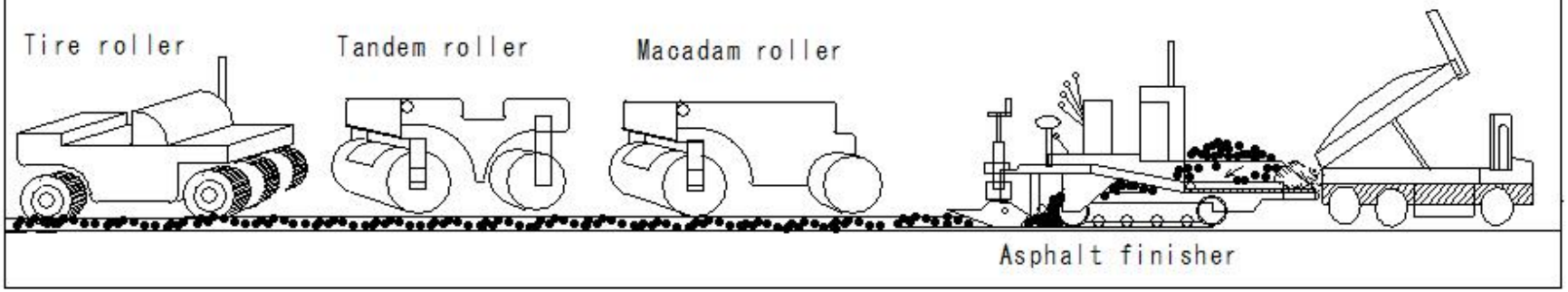
(H339) Pavement work (Rolling)

Pavement work

Rolling work

① Order of rolling work

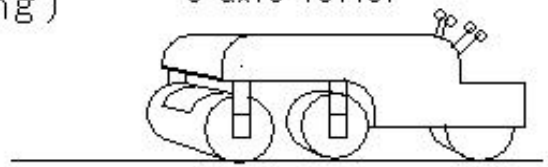
a: Order of rolling	b: Rolling machine	c: Key points of work
① Initial rolling	Macadam roller Tandem roller (6-10t)	In order to increase the compaction effect of the initial compaction, the mixture is prevented from deforming. High enough temperature that cracks do not appear: Perform at the optimum compaction temperature.
② Secondary compaction	Tire roller Macadam roller (12-15t)	Work carried out following initial compaction Compact thoroughly to obtain maximum compaction density before the mixture temperature drops



(H340)Pavement work(Rolling)

(H340)Pavement work(Rolling)

3-axis roller



Pavement work

Rolling work

① Order of rolling work

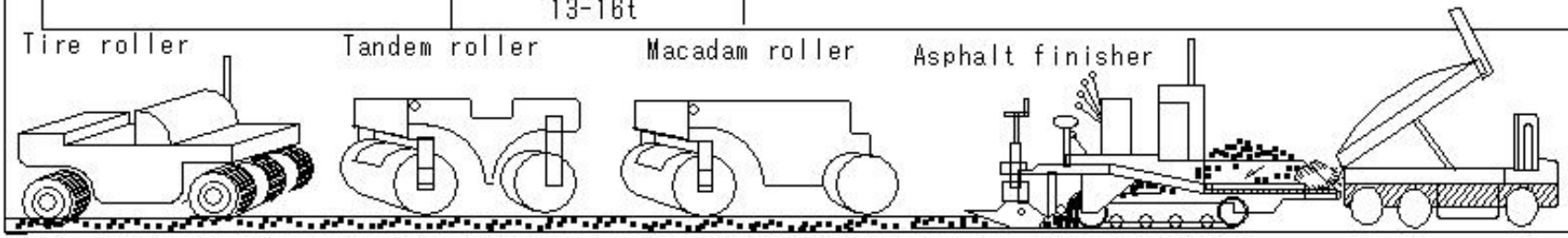
a: Order of rolling	b: Rolling machine	c: Key points of work
① Initial rolling	Macadam roller Tandem roller (6-10t)	In order to increase the compaction effect of the initial compaction, the mixture is prevented from deforming. High enough temperature that cracks do not appear: Perform at the optimum compaction temperature.
② Secondary compaction	Tire roller Macadam roller (12-15t)	Work carried out following initial compaction Compact thoroughly to obtain maximum compaction density before the mixture temperature drops
③ Finishing compaction	Tandem roller Macadam roller 13-16t	The purpose is to remove roller marks caused by secondary compaction and ensure flatness.

Tire roller

Tandem roller

Macadam roller

Asphalt finisher



(H341)Pavement work(Rolling)

(H341)Pavement work(Rolling)

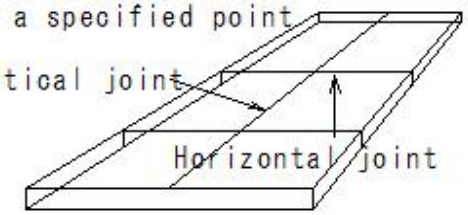
Pavement work

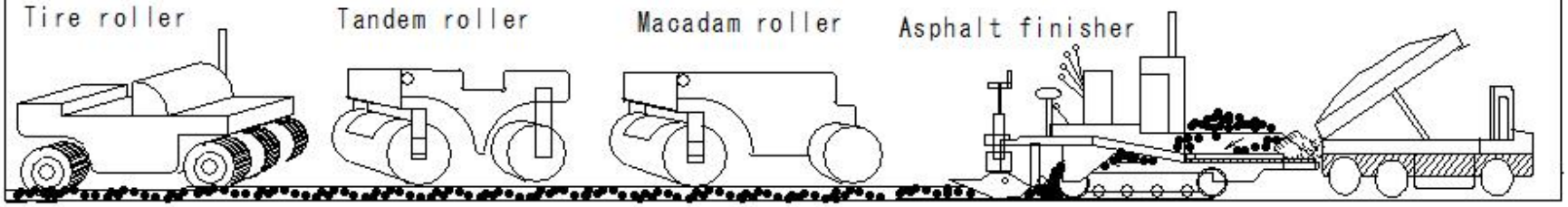
Rolling work

○Rolling temperature and number of times

①Conditions	④Rolling temperature ℃			⑤Number of times of rolling
②Asphalt penetration / ③Rolling	40－60	60－80	80－100	
⑥Outer edge or joint	130 Over	125 Over	120 Over	2
⑦Initial rolling	130 Over	125 Over	120 Over	2
⑧Secondary rolling	105-130	100-125	90-120	8
⑨Finishing rolling	95 Over	90 Over	80 Over	2

*The number of times of rolling is the number of times the roller passes a specified point.





(H342)Pavement work(Rolling-Rolling machine)

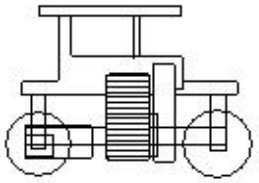
(H342)Pavement work(Rolling-Rolling machine)

Pavement work
Rolling work
○Rolling machine
Asphalt pavement

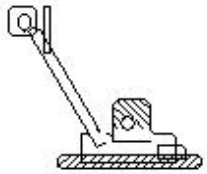
①Iron wheel roller
- Macadam roller
- Tandem roller
- 3-axis roller

②Tire roller

③Vibration roller Vibrating compactor

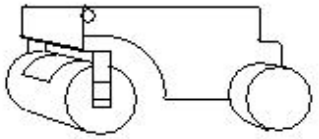


Vibration roller

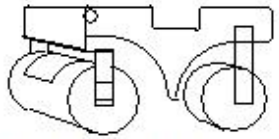


vibrating compactor

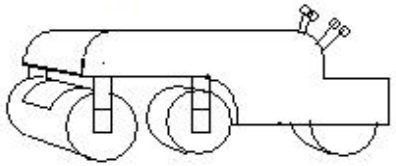
Macadam roller



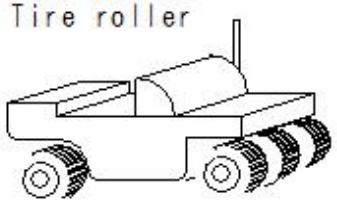
Tandem roller



3-axis roller



Tire roller



H129

(H343)Pavement work(Rolling-Rolling machine)

(H343)Pavement work(Rolling-Rolling machine)

Pavement work

Rolling work

○Rolling machine

Asphalt pavement

①Macadam roller

3-wheel roller

Large rear wheel load

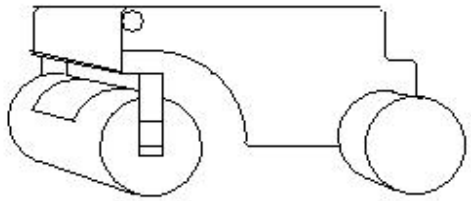
Aggregate interlocking

Large compaction effect

Self-weight 8-12t

Drive wheel (rear wheel) Line pressure 50-90kg/cm

Macadam roller

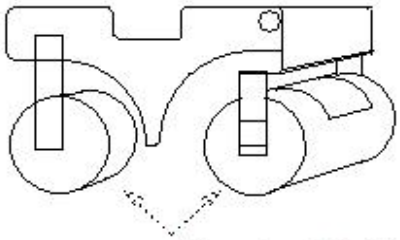


H129

(H344)Pavement work(Rolling-Rolling machine)

(H344)Pavement work(Rolling-Rolling machine)

Pavement work
- Rolling work
- ○Rolling machine
- Asphalt pavement
- ②Tandem roller
- Diameter/width: Same type 2-wheel roller
- Weight: 4-10t
- Finishing rolling



Diameter/width: Same type 2-wheel roller

②Tandem roller

(H345)Pavement work(Rolling-Rolling machine)

(H345)Pavement work(Rolling-Rolling machine)

Pavement work

Rolling work

○Rolling machine

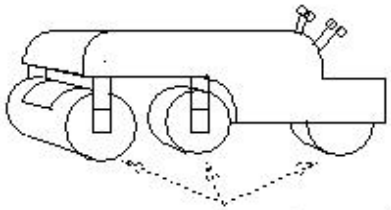
Asphalt pavement

③3-axis roller

3-wheel roller with the same type of iron rods at the front, back and center

Achieve flatness of the surface

3 iron rods-Can change the load distributed to each wheel



same type of iron rods

③3-axis roller

(H346)Pavement work(Rolling-Rolling machine)

(H346)Pavement work(Rolling-Rolling machine)

Pavement work

Rolling work

○Rolling machine

Asphalt pavement

④ Tire roller

Front wheels: 3-5, rear wheels: 4-6 rubber tire rollers

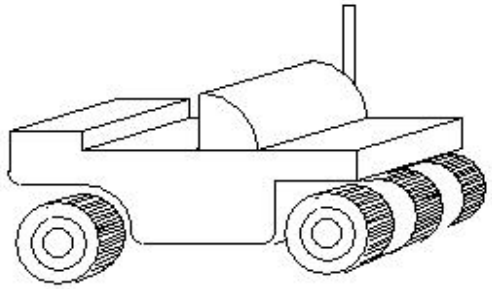
Improves surface composition

Produces dense pavement

Weight of tire roller itself

Adjusts installation pressure by changing tire air pressure

Compacting effect suited to the type of mixture can be obtained

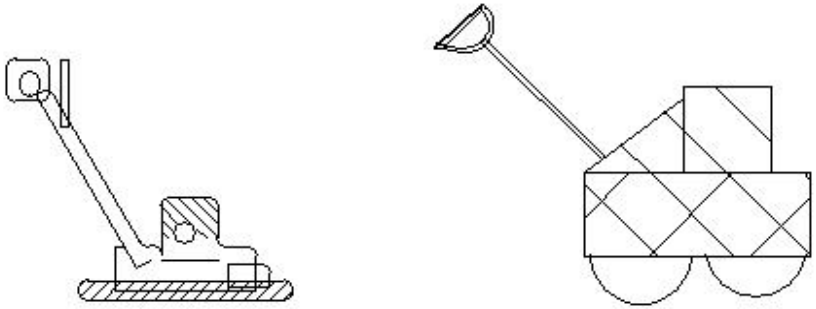


④ Tire roller

(H347)Pavement work(Rolling-Rolling machine)

(H347)Pavement work(Rolling-Rolling machine)

Pavement work
Rolling work
○Rolling machine
Asphalt pavement
⑤Vibration roller Vibrating compactor
Rolling with large rollers is difficult
Narrow areas
Self-weight 1-8t



Narrow areas

vibrating compactor

Hand-guided roller

H129

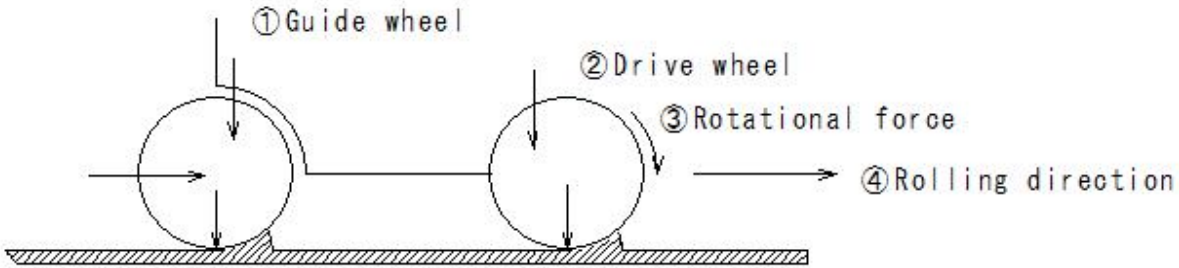
(H348)Pavement work(Rolling-Precautions for rolling work)

(H348)Pavement work(Rolling-Precautions for rolling work)

Pavement work

Rolling work

○Precautions for rolling work



How to move the roller

(H349)Pavement work(Rolling-Precautions for rolling work)

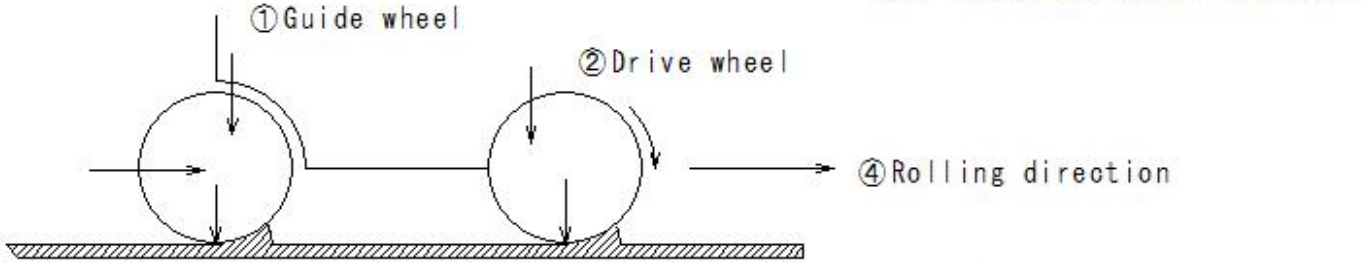
(H349) Pavement work (Rolling-Precautions for rolling work)

Pavement work

Rolling work

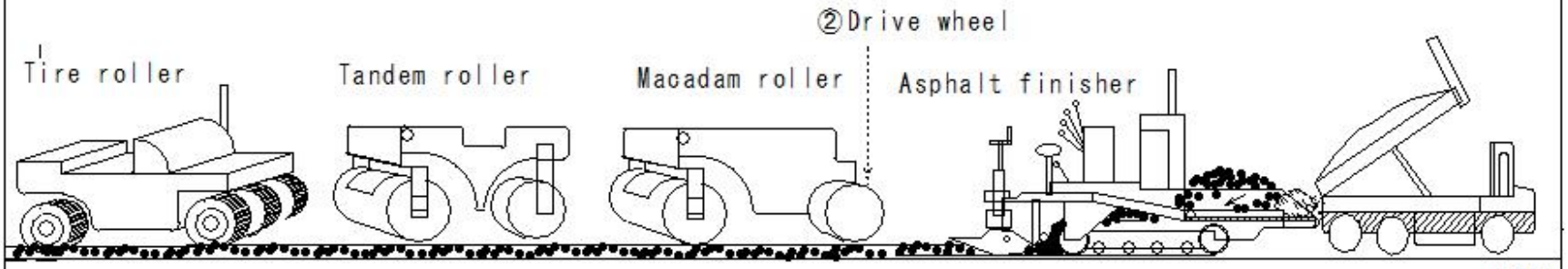
○Precautions for rolling work

①in case of rolling with a Iron wheel roller, always move in the direction of the pavement, with the drive wheels forward.



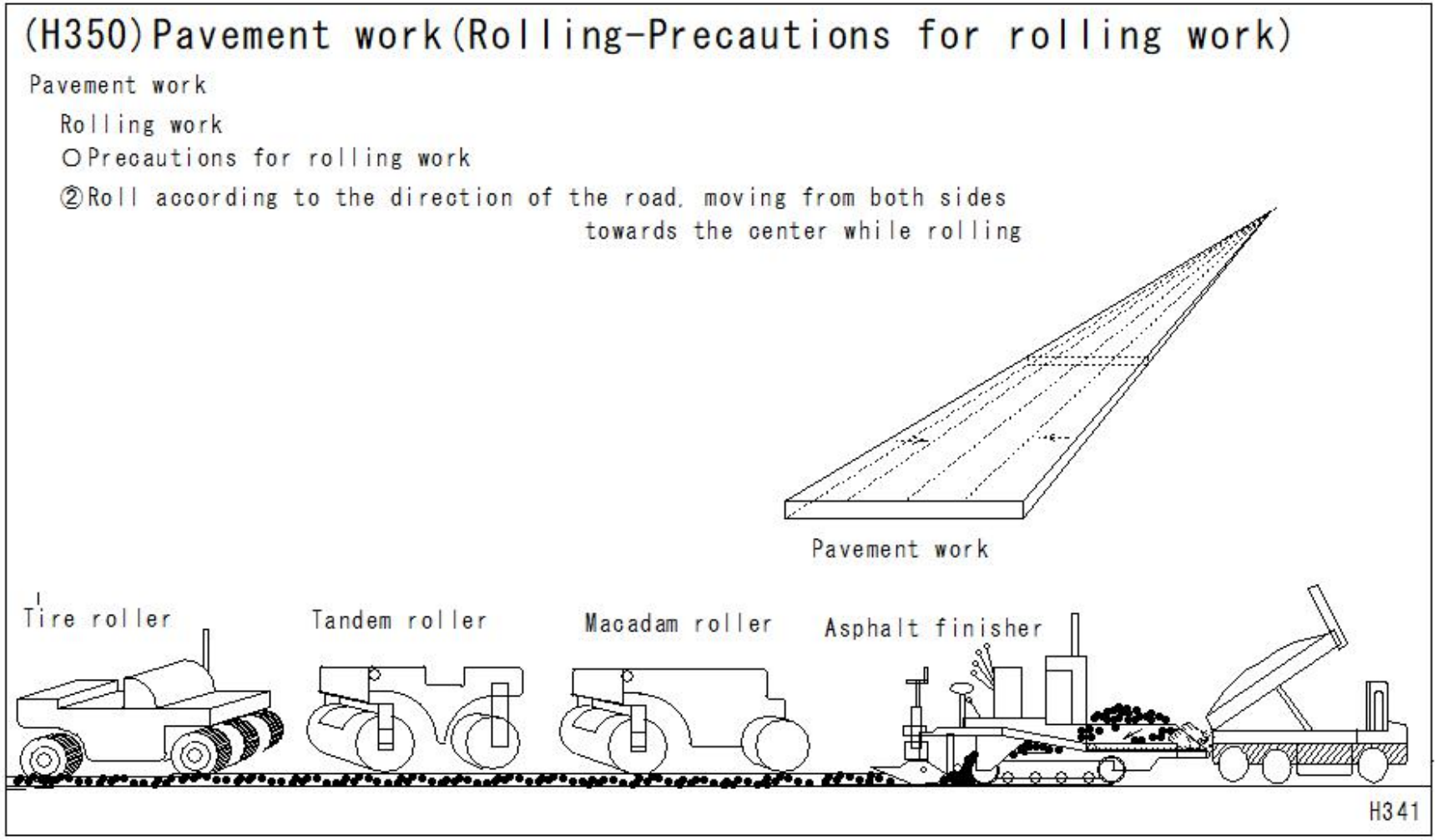
How to move the roller

H348

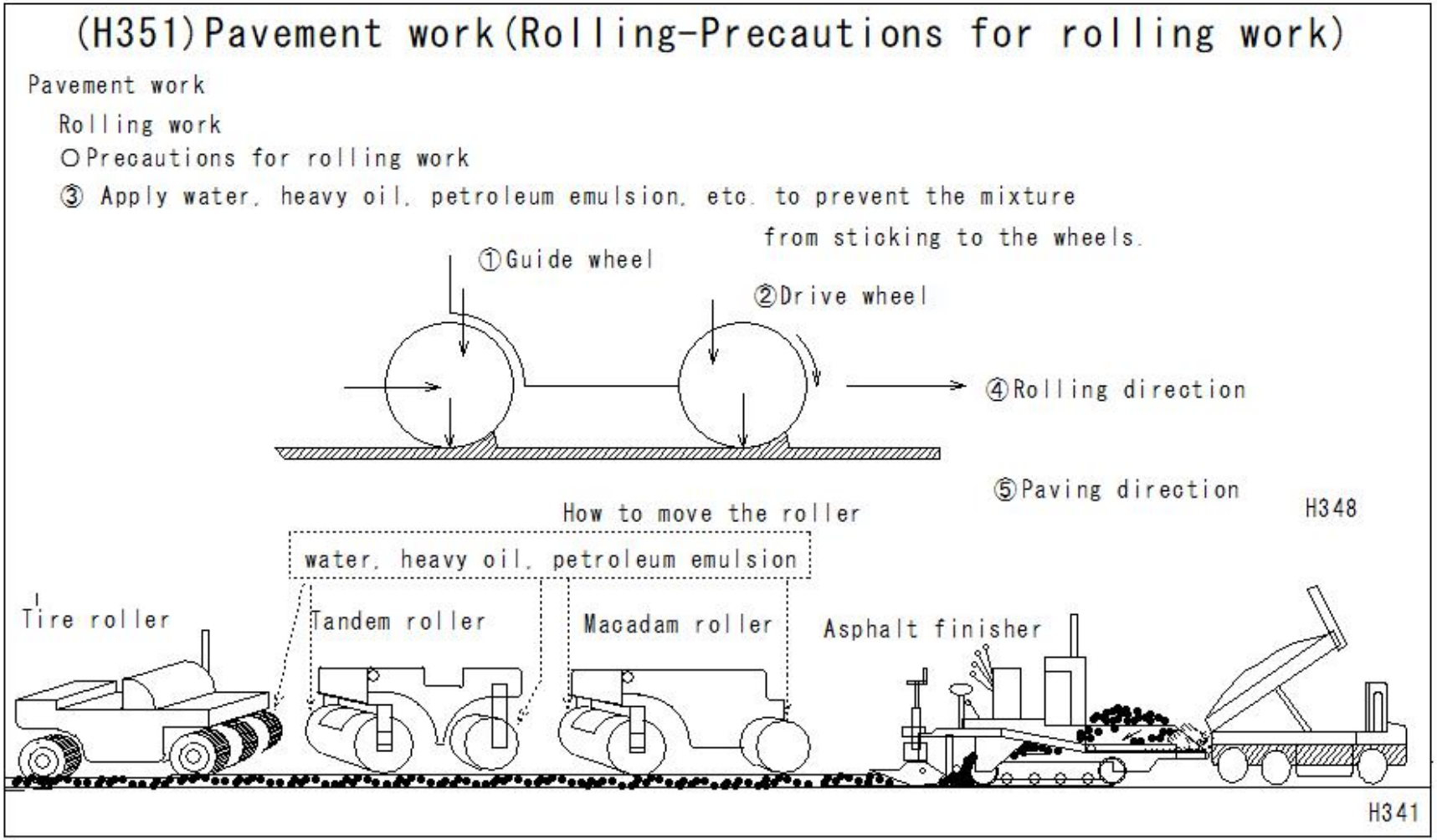


H341

(H350)Pavement work(Rolling-Precautions for rolling work)



(H351)Pavement work(Rolling-Precautions for rolling work)



(H352)Pavement work(Rolling-Precautions for rolling work)

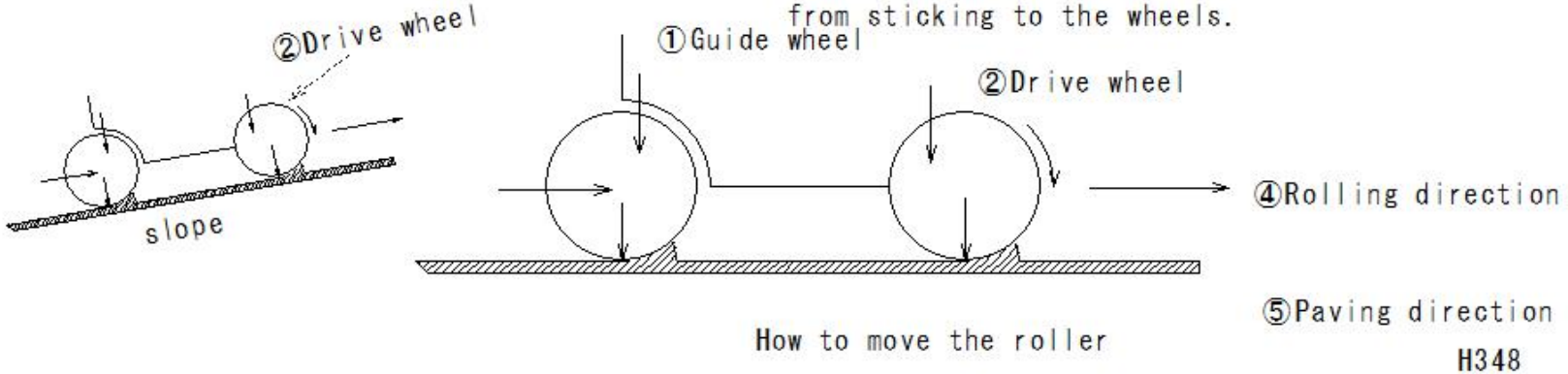
(H352)Pavement work(Rolling-Precautions for rolling work)

Pavement work

Rolling work

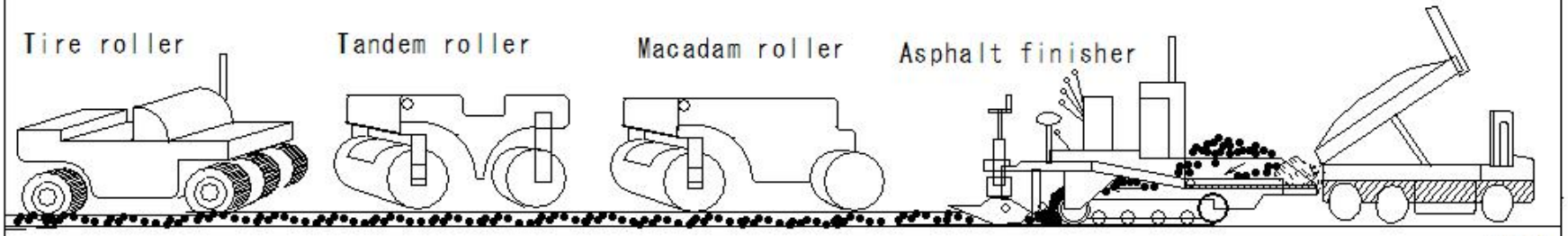
○Precautions for rolling work

④Rolling a slope should be done from bottom to top with the drive wheels moving upwards from sticking to the wheels.



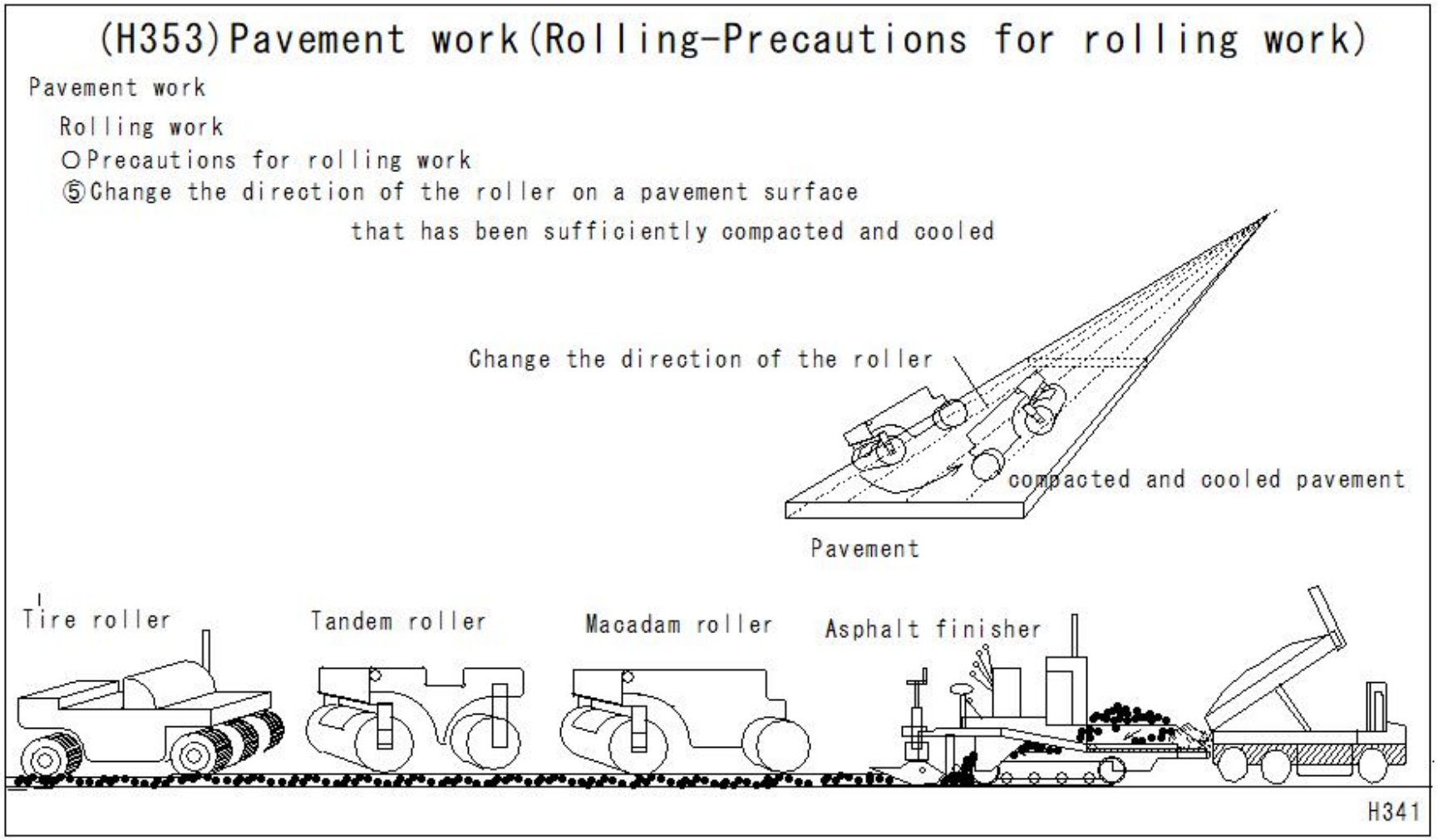
How to move the roller

H348



H341

(H353)Pavement work(Rolling-Precautions for rolling work)



(H354)Pavement work(Rolling-Precautions for rolling work)

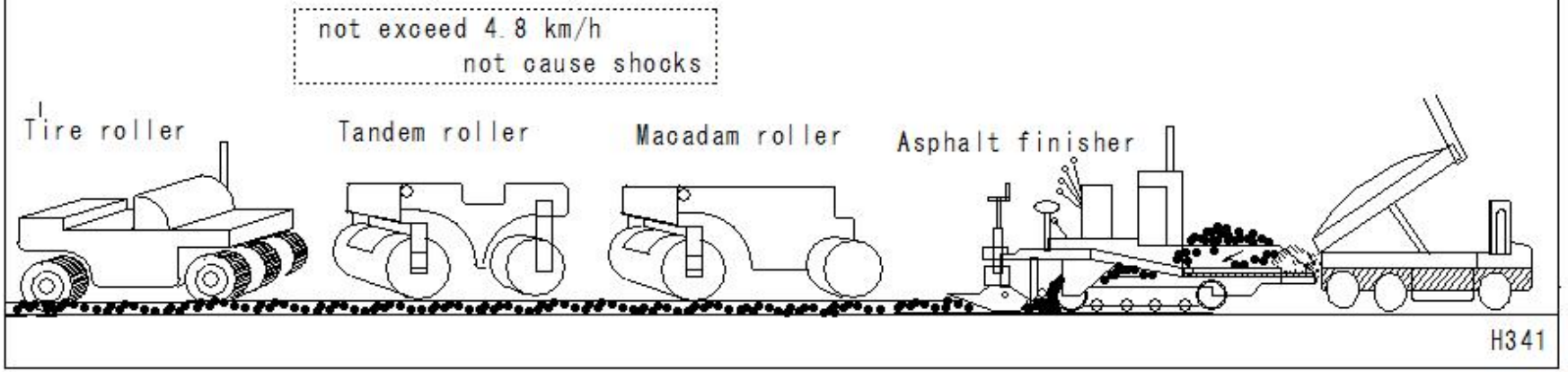
(H354)Pavement work(Rolling-Precautions for rolling work)

Pavement work

Rolling work

○Precautions for rolling work

⑥Roll at a constant speed so that the rolling speed does not exceed 4.8 km/h, and operate the vehicle in a way that does not cause shocks in case of moving forward or backward.



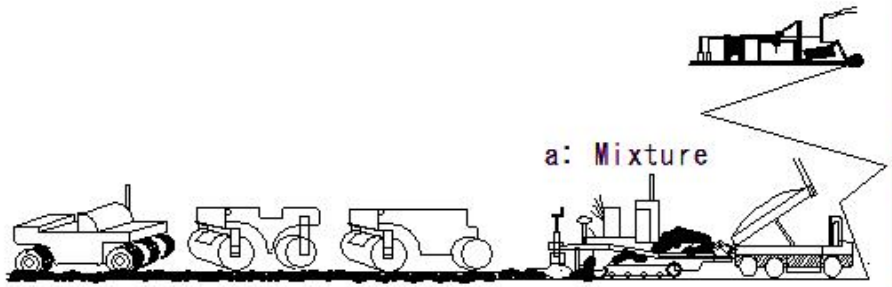
H341

(H355)Pavement work(Pavement-Defects)

(H355) Pavement work (Pavement-Defects)

Pavement work

Defects that occur during paving and their causes



a: Classification of work types	b: Causes ●: Main causes	c: Conditions during paving																				
		① Surface sliding on the base	② Surface scratching during paving	③ Stones cracked by roller	④ Large long cracks	⑤ Many thin cracks	⑥ Unevenness/waves	⑦ Roller marks	⑧ Lack of flatness at joints	⑨ Honeycomb: Many pockmarks	⑩ Rough, uneven surface	⑪ Poor surface texture	⑫ Excess asphalt: Sticky spots	⑬ Brown or dull color: Appearance	⑭ Oozing asphalt				
a: Mixture	① Mixture temperature is too low	●	●	●				○	●	●	●	●										
	② Mixture overheating		○											●								
	③ Excess water in the mixture	○					○	●					○		●							
	④ Insufficient batch measurement						○			○	○	○	○	○	○							
	⑤ Improper mixture mix	○	○	○		○	○	○		○	○	○	○		○							
	⑥ Excess asphalt	○					○	●					●		●							
	⑦ Insufficient asphalt		●			●								●								
	⑧ Excess fines in the mixture	○				○	○	○														
	⑨ Excess coarse particles in the mixture		○	○					○	○	○	○										

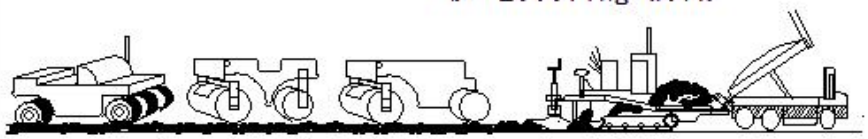
(H356)Pavement work(Pavement-Defects)

(H356)Pavement work(Pavement-Defects)

Pavement work

Defects that occur during paving and their causes

b: Leveling work



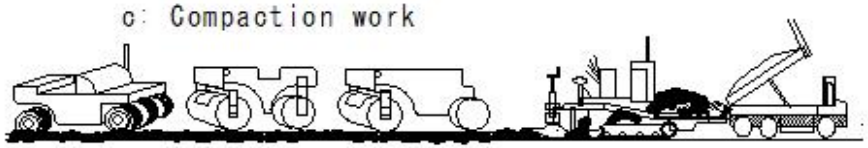
a: Classification of work types	b: Causes ●: Main causes	c:Conditions during paving ① Surface sliding on the base	② Surface scratching during paving	③ Stones cracked by roller	④ Large long cracks	⑤ Many thin cracks	⑥ Unevenness/waves	⑦ Roller marks	⑧ Lack of flatness at joints	⑨ Honeycomb: Many rockmarks	⑩ Rough, uneven surface	⑪ Poor surface texture	⑫ Excess asphalt: Sticky spots	⑬ Brown or dull color: Appearance	⑭ Oozing asphalt
b: Leveling work	① Separation of the mixture during paving		○		○				○	●	●	○	○		
	② Carelessness or inexperience of the worker							○	○	○	○	○			
	③ Excessive application of the hand brake						○		○	○	○	●			
	④ Failure to finish by hand after finishing with the finisher								●	○	○	○			
	⑤ Poor maintenance of the finisher		○				○		○	○	○	○			
	⑥ Poor operation of the finisher		○				●		○	○	●	○			
	⑦ Finisher operating speed is too fast		●								○	○			

(H357)Pavement work(Pavement-Defects)

(H357) Pavement work (Pavement-Defects)

Pavement work
Defects that occur during paving and their causes

c: Compaction work



a: Classification of work types	b: Causes ●: Main causes	c: Conditions during paving ① Surface sliding on the base	② Surface scratching during paving	③ Stones cracked by roller	④ Large long cracks	⑤ Many thin cracks	⑥ Unevenness/waves	⑦ Roller marks	⑧ Lack of flatness at joints	⑨ Honeycomb: Many pockmarks	⑩ Rough, uneven surface	⑪ Poor surface texture	⑫ Excess asphalt: Sticky spots	⑬ Brown or dull color: Appearance	⑭ Oozing asphalt				
c: Compaction work	① Excessive roller vibration						○				○								
	② Roller weight too heavy	●		●	●	○	○	○			○								
	③ Roller left on warm pavement							○			○								
	④ Mixture temperature too low when compacting	○						○	●	●	○	●							
	⑤ Mixture temperature too high when compacting					●	○	○	○		○								
	⑥ Rolling too hard	○		○	○	○													
	⑦ Inappropriate compaction timing	○		○		○	●	○	○	○	○	○							
	⑧ Insufficient compaction	○						●	○	○	○	○							

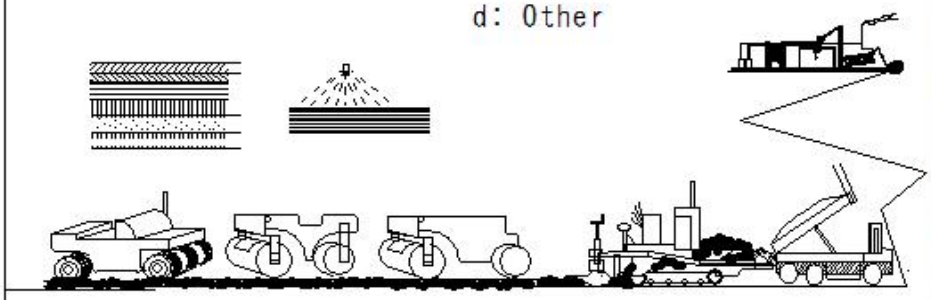
(H358)Pavement work(Pavement-Defects)

(H358) Pavement work (Pavement-Defects)

Pavement work

Defects that occur during paving and their causes

d: Other



a: Classification of work types	b: Causes ●: Main causes	c: Conditions during paving																			
		① Surface sliding on the base	② Surface scratching during paving	③ Stones cracked by roller	④ Large long cracks	⑤ Many thin cracks	⑥ Unevenness/waves	⑦ Roller marks	⑧ Lack of flatness at joints	⑨ Honeycomb: Many pockmarks	⑩ Rough, uneven surface	⑪ Poor surface texture	⑫ Excess asphalt: Sticky spots	⑬ Brown or dull color: Appearance	⑭ Oozing asphalt				
d: Other	① Vehicles passing before the temperature has cooled						○												
	② Finishing layer is too thick or roadbed is uneven						●												
	③ Insufficient estimate of compaction loss								○										
	④ Excessive prime coat												○		○				
	⑤ Excessive moisture in the roadbed soil	○			○	○													
	⑥ Insufficient bearing capacity of the roadbed	○		○	●	●				○									

(H359)Pavement work(Pavement-Quality control)

(H359)Pavement work(Pavemen-Quality control)

Pavement construction

a Quality control

① Prevent defects

② Prevent variation

③ Increase reliability

④ Work standards - Probability

⑤ Problems - Discover

b Use of statistical methods

Construction stage - Various tests

Regular intervals - Continuous - Statistical processing

c Use of technical knowledge

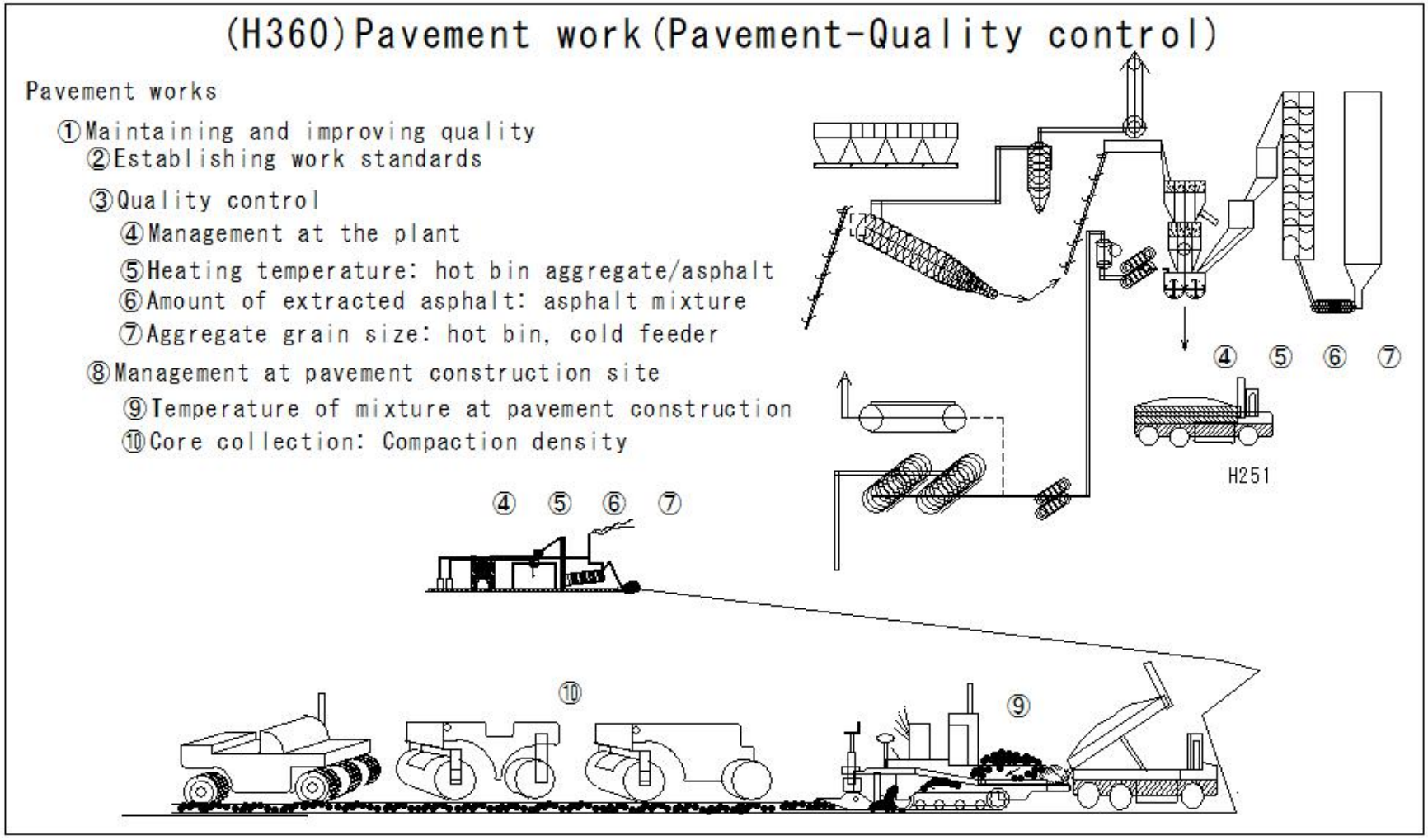
Observation skills

Things that cannot be evaluated by testing

Discovery of abnormalities

Quality control measures

(H360)Pavement work(Pavement-Quality control)



(H361)Pavement work(Pavement-Quality control)

(H361)Pavement work(Pavement-Quality control)

Pavement works

Types of quality control

① Quality assurance

② Random inspection

③ Quality inspection

④ Subgrade bearing capacity, density

⑤ Extracted asphalt volume, aggregate grain size, density

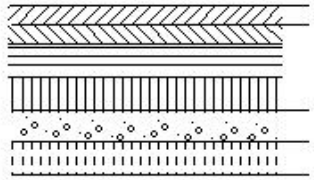
⑥ As-built inspection

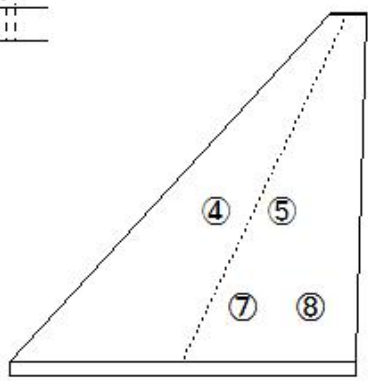
⑦ Reference height, thickness, width, flatness

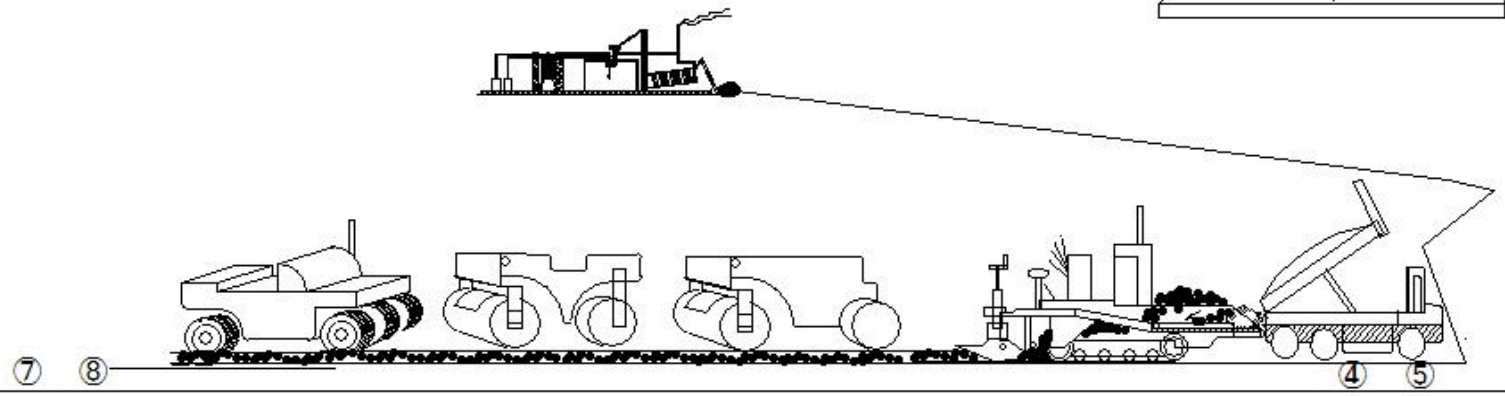
⑧ Progress management by photographs

⑨ Visual inspection

10 Quality control types







(H362)Pavement work(Pavement-Quality control)

(H362)Pavement work(Pavement-Quality control)

Pavement works

Types of quality control

①Establishment of work standards

Standard testing (design)

Material specification testing

Mix design testing

・Quality confirmation (inspection)

Plant inspection

Test mixing

Test paving

・Procedure for establishing work standards

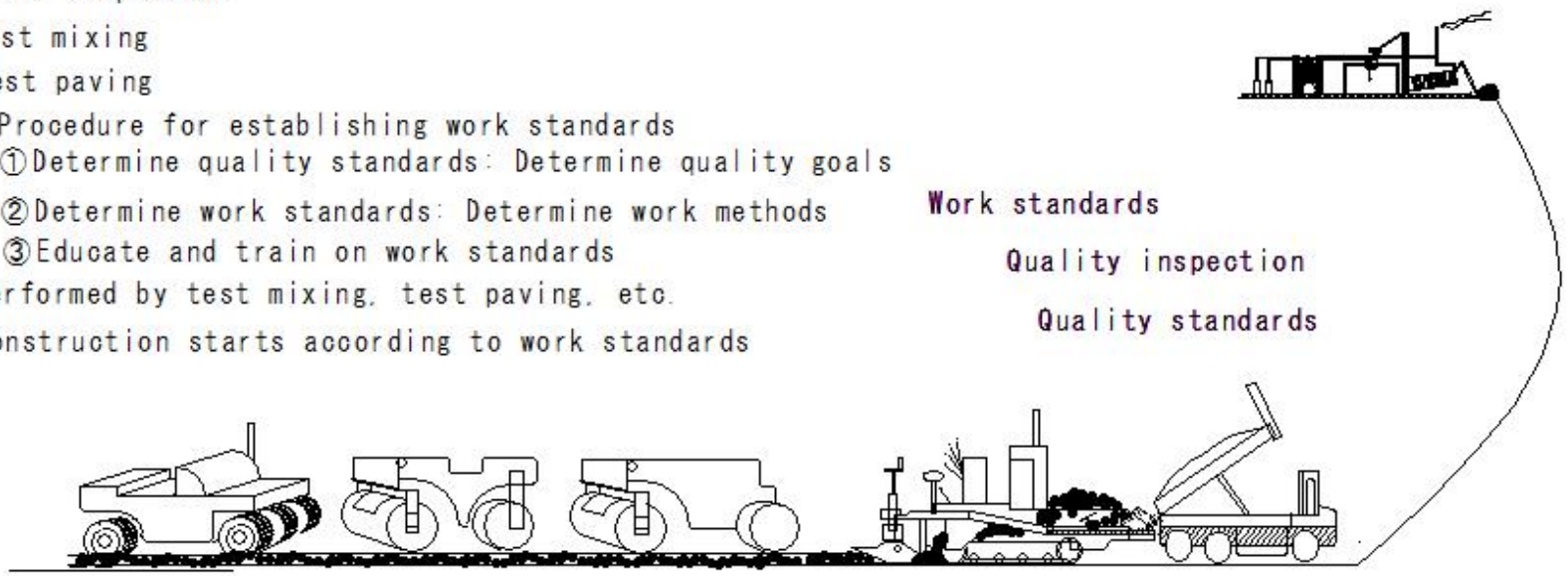
①Determine quality standards: Determine quality goals

②Determine work standards: Determine work methods

③Educate and train on work standards

Performed by test mixing, test paving, etc.

Construction starts according to work standards



(H363)Pavement work(Pavement-Quality control)

(H363)Pavement work(Pavement-Quality control)

Pavement works

Types of quality control

②Daily management

Understand the contents of the specifications

Management items

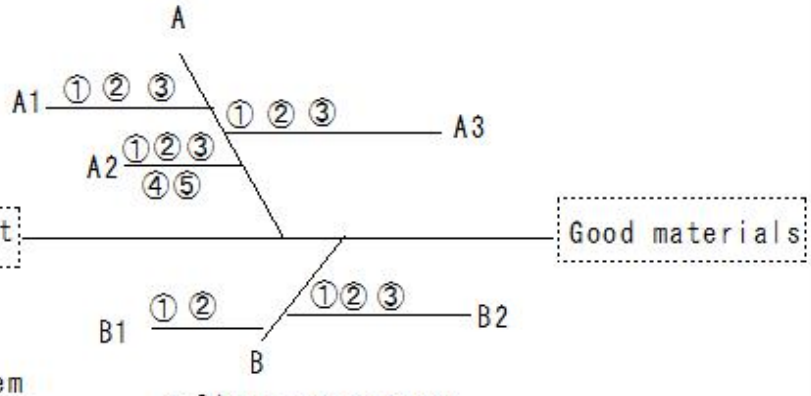
Test frequency

Standard values

・in case of standards are not satisfied

Corrective action-Understand the production system

a:Plant management



Material management

Good materials

A:Incoming material management

A1:Particle size

A1①Crushed stone

A1②Sand

A1③Stone powder

A2:Properties

A2①Penetration

A2②Softening point

A2③Specific gravity

A2④Water absorption

A2⑤Hazardous substance content

A3:Content

A3①Crushed stone

A3②Stone powder

A3③Sand

B:Stockyard management

B1:Water content

B1①Drainage

B1②Shed sheet

B2Particle size

B2①Capacity

B2②Size classification

B2③Separation

(H364)Pavement work(Pavement-Quality control)

Paving
Types of quality control
② Daily management
Understand the contents of the specification
Control Items
Test Frequency
Standard value
・in case of not satisfied with the standard
Corrective Actions - Understanding the Production System
A: Plant management
B: Plant: control items and their characteristic factors
Plant Management
Good mixture
A: Particle size management
B: Asphalt volume control
C: Temperature control
D: Mixability management
A1: Incoming materials
asphalt
crushed stone
sand
Stone powder
A2: Cold Feeder
Gate Sets
Discharge Diagram
Water content
Aching
A3; sampling
way
quantity
Number
A4: Dust collector
Accumulation Capacity
Granularity
Redemption method
A5: Vibrating sieve
Sieves
ability
Pretend width
A6: Hot bin
capacity
separation
A7: Weighing
sensitivity
way
order

B: Asphalt volume control
B1: Weighing instrument
B2: Sampling
way
Number
quantity
test
Test method
Examiner

C: Temperature control
C1: Thermometer
Installation location
sensitivity
C2: Asphalt temperature
Incoming Temperature
tank
Kettle
C3: Aggregate temperature
Water content
Water absorption
Granularity
C4: Dryer -
ability
Aggregate residence time
Burner adjustment
Continuous operation

D: Mixability management
D1: Mixing time
Dry Mixing
Waist Mixing
Asphalt Spray
Injection order
D2: Mixer
Mixing method
Vane liner wear
Mixer Gate
D4: Mixing volume

(H365)Pavement work(Pavement-Quality control)

Pavement works
Types of quality control
②Daily control
Understand the contents of the specifications
Control items
Test frequency
Standard values
・in case of standards are not satisfied
Corrective action - Understand the production system
(b) Control at the pavement site
Control items and characteristic factors at the pavement site
Good pavement

A: Temperature control
A1: Dump truck
①Transport distance
②Load capacity
③Mixture protection
A2:Construction temperature
①Spreading
②Initial compaction
③Secondary compaction
④Finishing compaction
⑤Arrival

B:Constructibility control
B1:Prime tack coat
①Bituminous material
②Amount of application
③Elapsed time
B2Subgrade/foundation
①Bearing capacity
②Finished condition
③Drainage
B3Compaction
①Model
②Sequence
③Method
④Number of times
⑤Operation
B4:Spreading
①Model
②Construction width
③Construction speed
④Construction thickness
⑤Operation

(H366)Pavement work(Pavement-Quality control)

(H366)Pavement work(Pavement-Quality control)

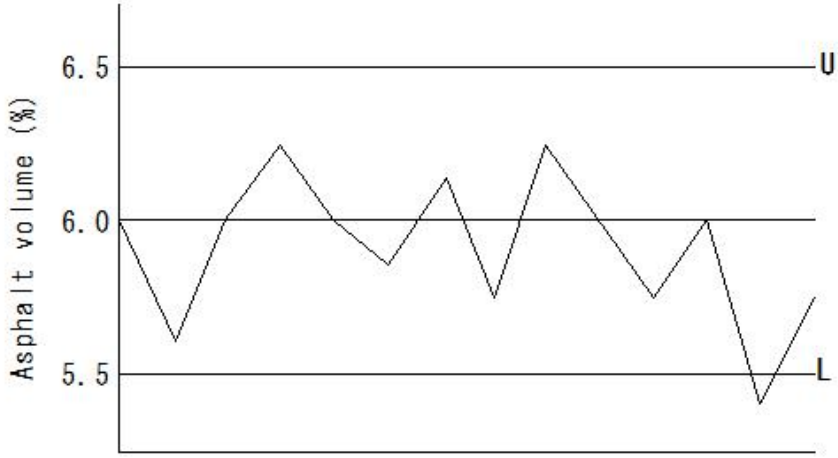
Pavement work

Statistical quality control: statistical methods

Process capability chart

Asphalt volume

Process capability chart



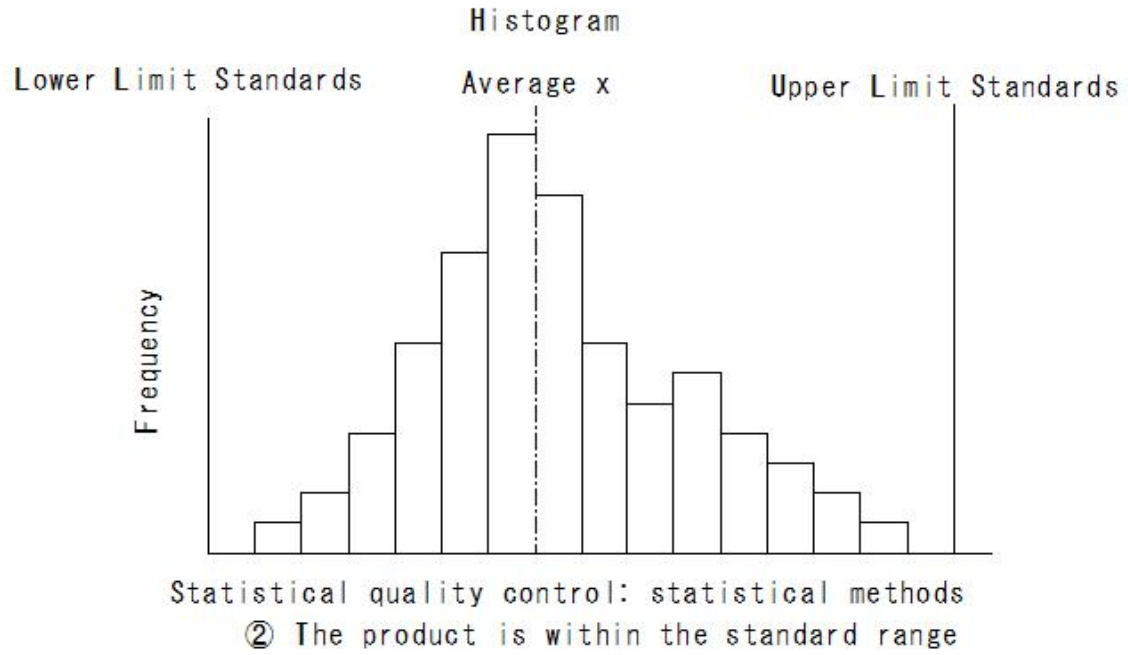
① Process is stable

Control chart

(H367)Pavement work(Pavement-Quality control)

(H367)Pavement work(Pavement-Quality control)

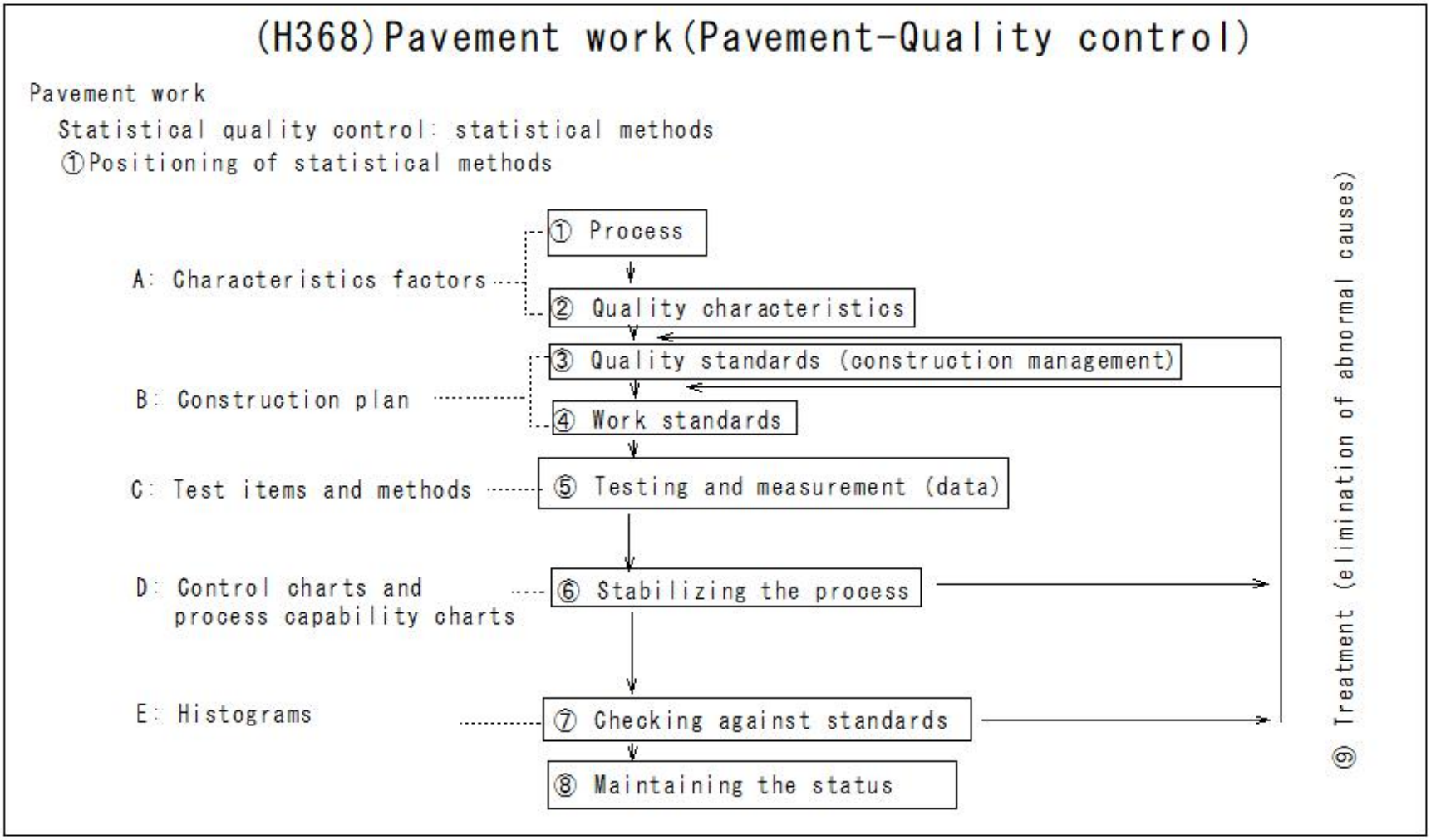
Pavement work



Statistical quality control: statistical methods

② The product is within the standard range

(H368)Pavement work(Pavement-Quality control)



(H369)Pavement work(Quality control-Control chart)

(H369)Pavement work(Quality control-Control chart)

Pavement work

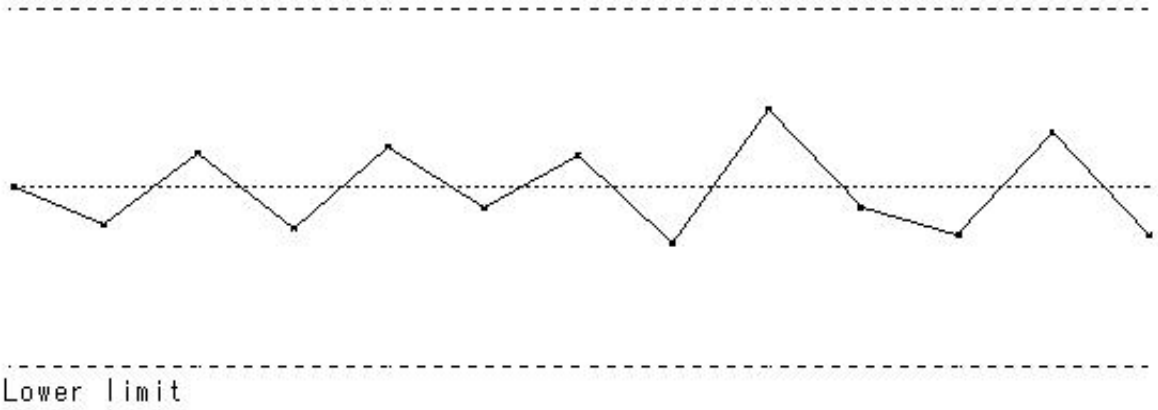
Statistical quality control: statistical methods

②Control chart

Process stability - confirmation

a: Shape and interpretation of process capability chart

①Stable state



The degree of variation is small, and the average value is stable at almost the center of the standard

(H370)Pavement work(Quality control-Control chart)

(H370)Pavement work(Quality control-Control chart)

Pavement work

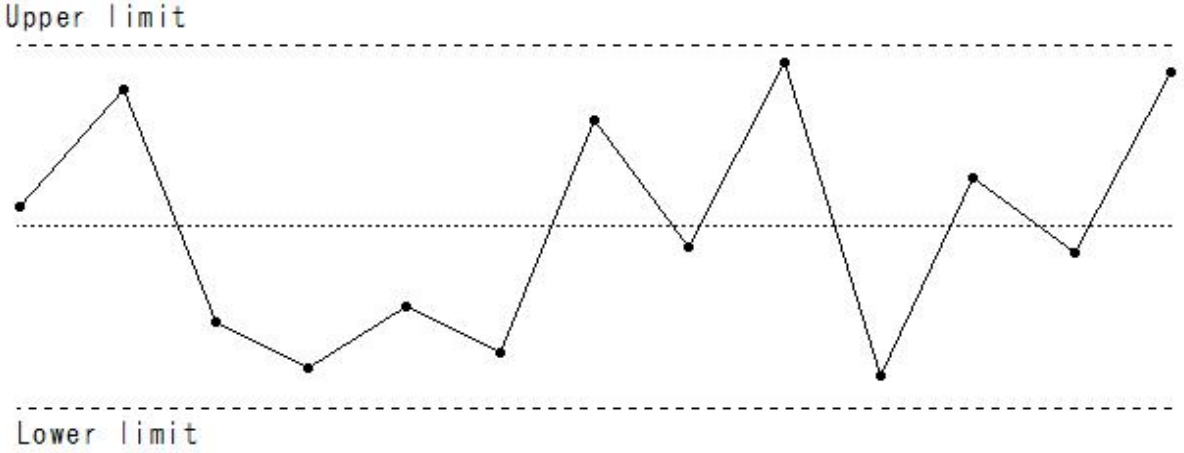
Statistical quality control: statistical methods

②Control chart

Process stability - confirmation

a: Shape and interpretation of process capability chart

② Unstable state



Within specifications, but large degree of variation

Not sure in case of specifications will be violated

Variation needs to be reduced

(H371)Pavement work(Quality control-Control chart)

(H371)Pavement work(Quality control-Control chart)

Pavement work

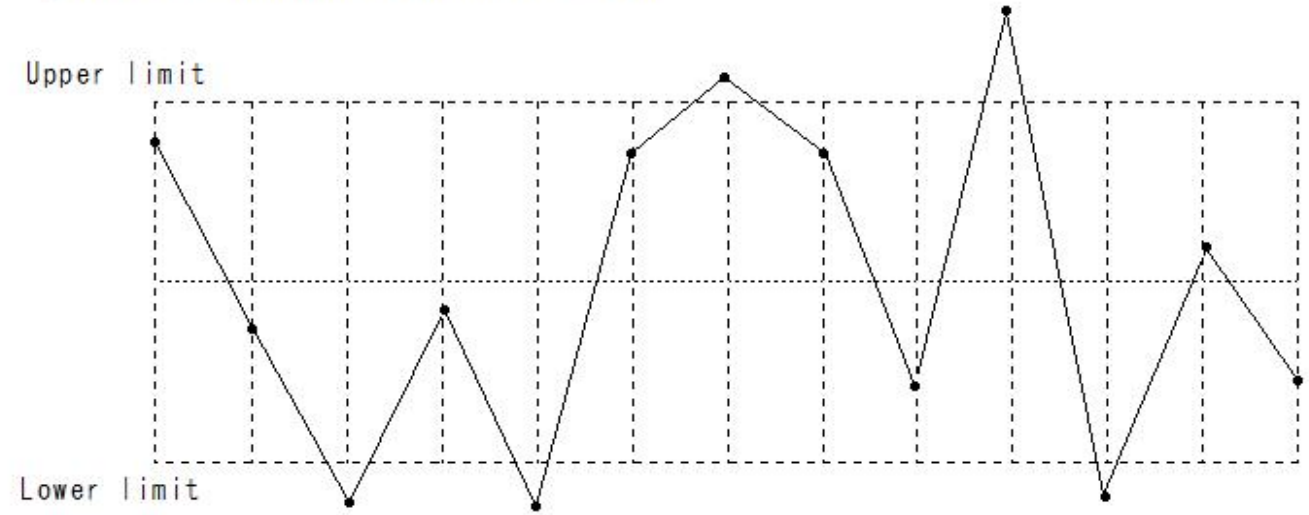
Statistical quality control: statistical methods

②Control chart

Process stability - confirmation

a: Shape and interpretation of process capability chart

③ Unstable and out-of-standard state



Variation is large and there are many out-of-standard points

Variation needs to be reduced

(H372)Pavement work(Quality control-Control chart)

(H372)Pavement work(Quality control-Control chart)

Pavement work

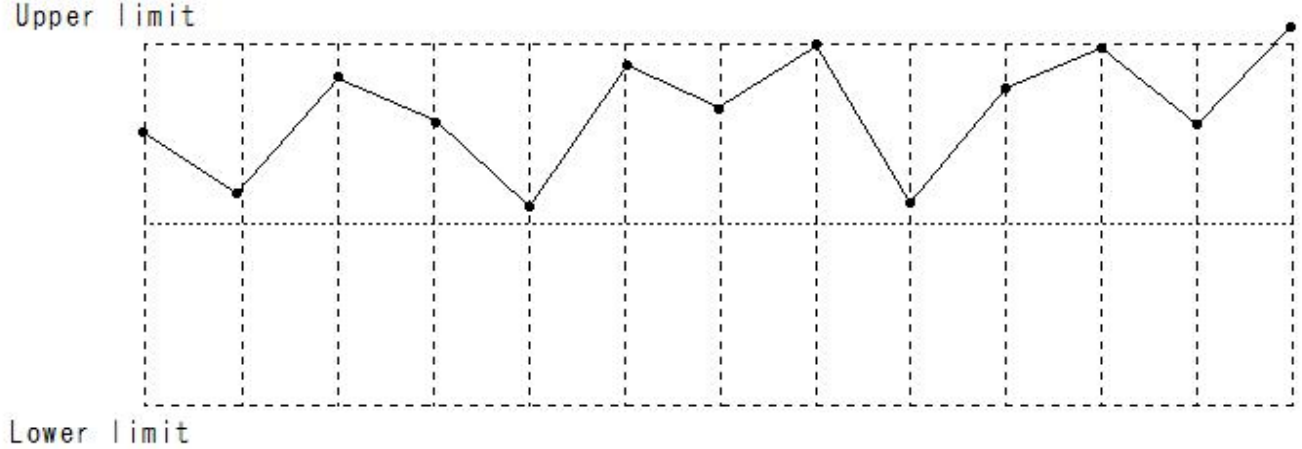
Statistical quality control: statistical methods

②Control chart

Process stability - confirmation

a: Shape and interpretation of process capability chart

④ Uneven state



Variation is small, but the average is too high compared to the standard

Process is stable, but the average needs to be lowered

(H373)Pavement work(Quality control-Control chart)

(H373)Pavement work(Quality control-Control chart)

Pavement work

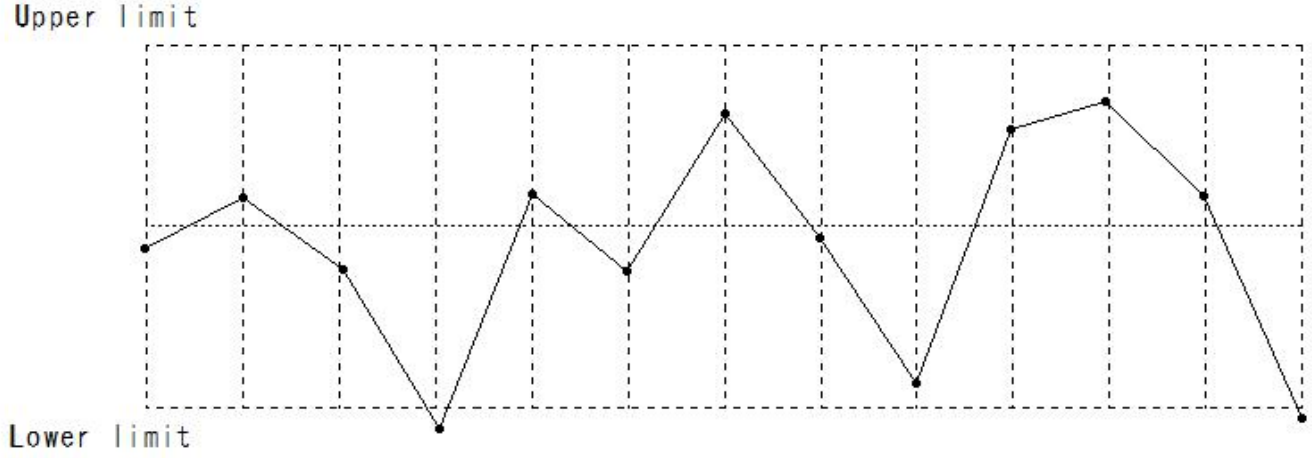
Statistical quality control: statistical methods

②Control chart

Process stability - confirmation

a: Shape and interpretation of process capability chart

⑤ Unbalanced and unstable state



The degree of variation is large

There are many points that are out of standard,

so it is necessary to reduce the variation and lower the average

(H374)Pavement work(Quality control-Control chart)

(H374)Pavement work(Quality control-Control chart)

Pavement work

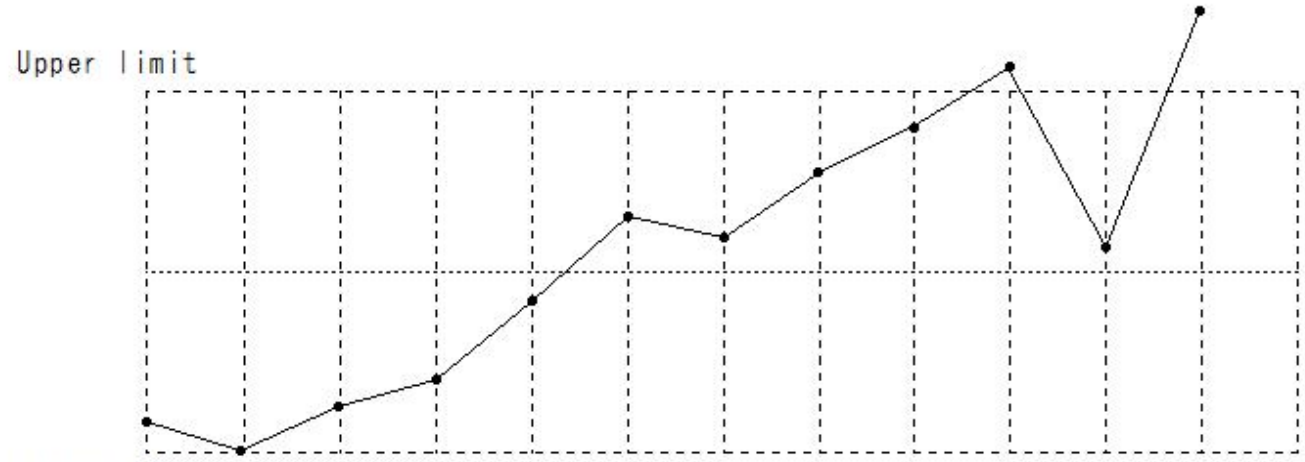
Statistical quality control: statistical methods

②Control chart

Process stability - confirmation

a: Shape and interpretation of process capability chart

⑥ Rising or falling state



in case of points appear consecutively on one side of the center line

in case of there are 5 points in a row, be careful

in case of there are 6 points in a row, investigate

in case of there are 7 points in a row, take action

(H375)Pavement work(Quality control-Histogram)

(H375)Pavement work(Quality control-Histogram)

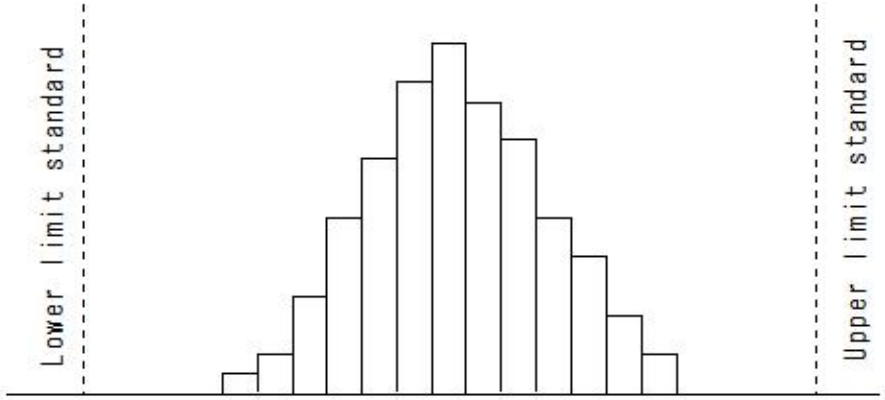
Pavement work

Statistical quality control: statistical methods

③ Histogram

b : To intuitively know what the characteristics of the product are in as a group

① Satisfactory distribution



There is sufficient margin for the standard

Variation is mostly under control

The capacity of the manufacturing process is satisfactory

(H376)Pavement work(Quality control-Histogram)

(H376)Pavement work(Quality control-Histogram)

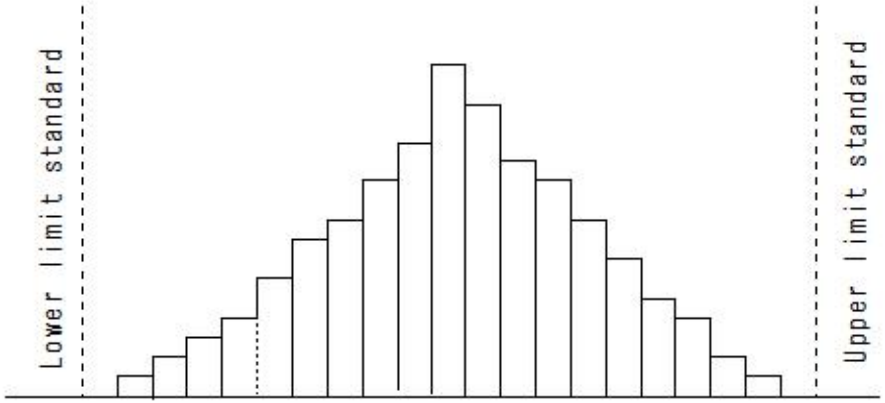
Pavement work

Statistical quality control: statistical methods

③ Histogram

b : To intuitively know what the characteristics of the product are in as a group

② Distribution with no margin for the standard



There is not much margin for the standard
There is a large variation
It is necessary to take measures to reduce the variation

(H377)Pavement work(Quality control-Histogram)

(H377)Pavement work(Quality control-Histogram)

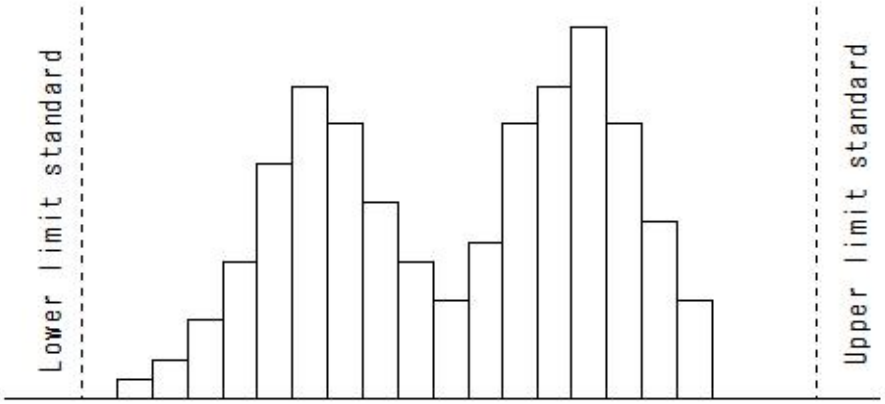
Pavement work

Statistical quality control: statistical methods

③ Histogram

b : To intuitively know what the characteristics of the product are in as a group

③ Two distributions are mixed



Islands are formed, it is necessary to investigate the cause and take fundamental measures

(H378)Pavement work(Quality control-Histogram)

(H378)Pavement work(Quality control-Histogram)

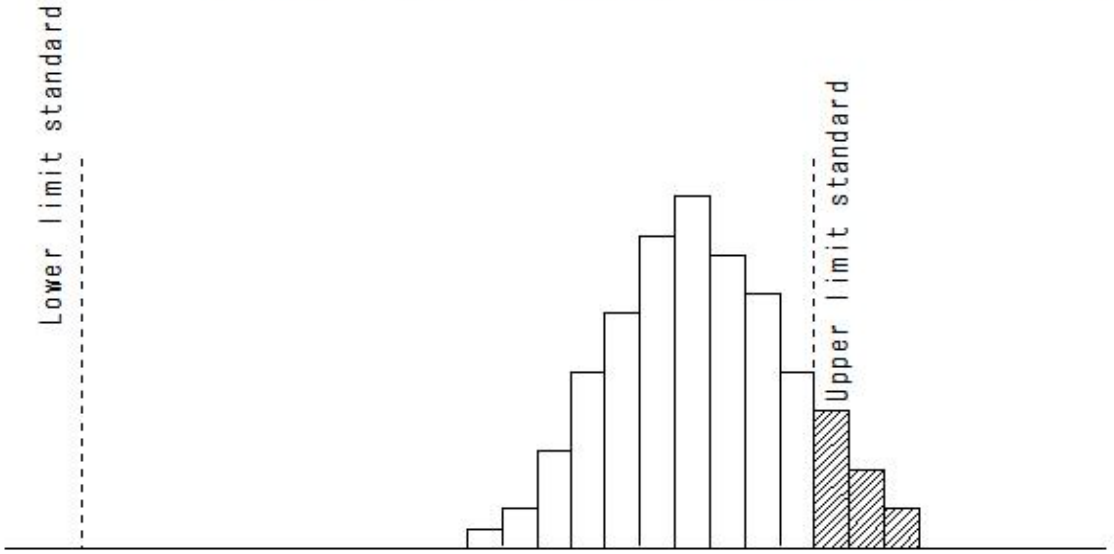
Pavement work

Statistical quality control: statistical methods

③ Histogram

b : To intuitively know what the characteristics of the product are in as a group

④ The degree of variation is good, but the center is off,
so defects that are out of specification are occurring.



The average value should be brought closer to the center of the standard.

(H379)Pavement work(Quality control-Histogram)

(H379)Pavement work(Quality control-Histogram)

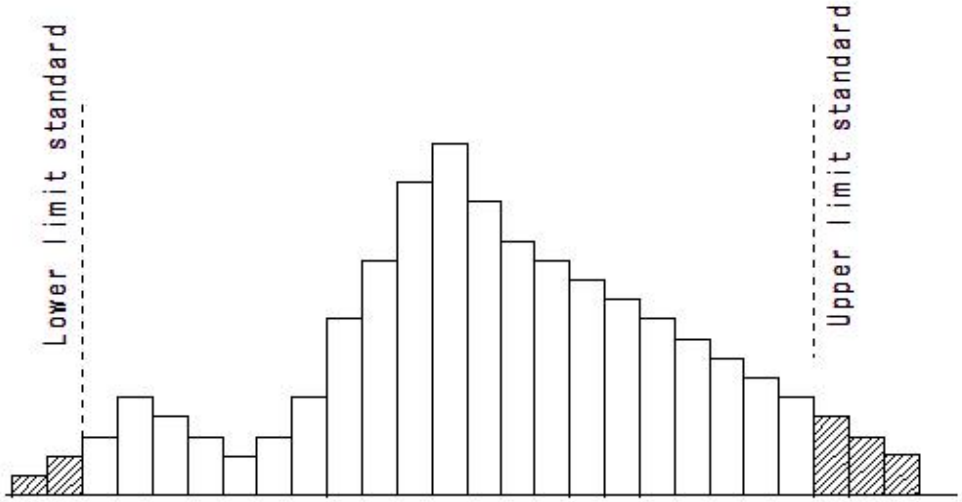
Pavement work

Statistical quality control: statistical methods

③ Histogram

b : To intuitively know what the characteristics of the product are in as a group

⑤There is a large variation and some products are out of spec.



so measures to reduce the variation are necessary.

(H380)Pavement work(Quality control-Histogram)

(H380)Pavement work(Quality control-Histogram)

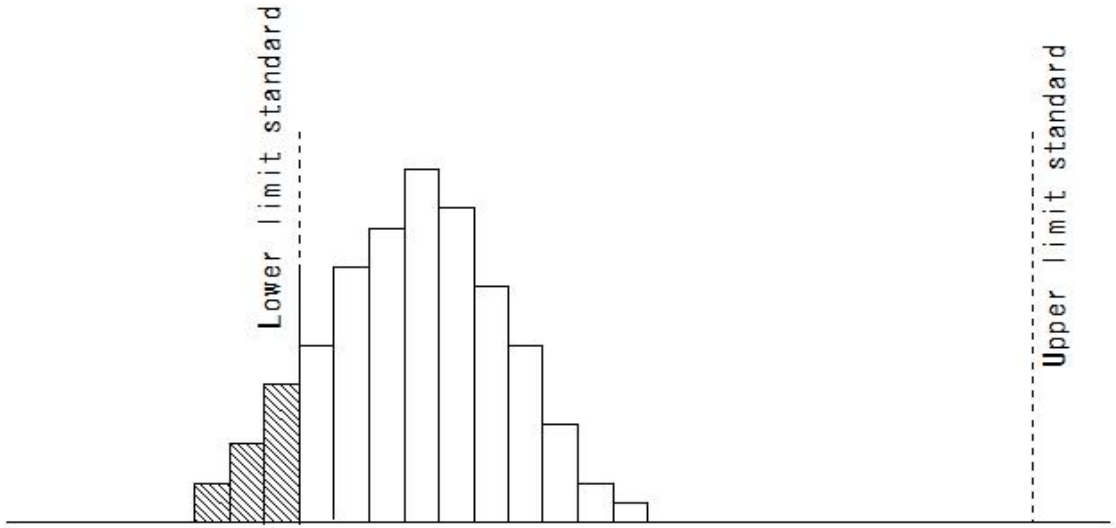
Pavement work

Statistical quality control: statistical methods

③ Histogram

b : To intuitively know what the characteristics of the product are in as a group

⑥ Truncated distributions



This is common in histograms in case of outliers are removed.

(H381)Pavement work(Quality control-Sampling inspection)

(H381)Pavement work(Quality control-Sampling inspection)

Pavement work

Sampling inspection

Judge whether the pavement meets the design and specifications

Sampling inspection method is used

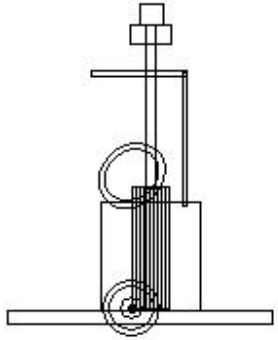
A sample is taken from the entire pavement

Measurements, tests, etc. are performed

Inspection method to judge pass/fail according to the inspection criteria

①Client

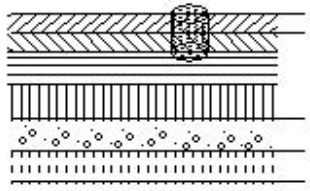
③Specification

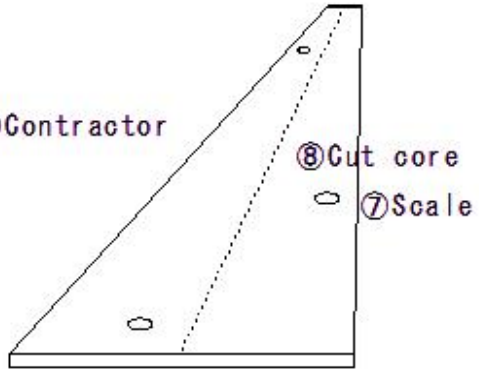


④Core cutter

②Pavement thickness

⑤( ) cm





Sampling inspection

(H382)Pavement work(Quality control-Sampling inspection)

(H382)Pavement work(Quality control-Sampling inspection)

Pavement construction

Sampling inspection

Precautions during inspection

① Both the client and the contractor must be fair

② Inspection samples must be randomly selected and not selected

③ Measurement and testing of samples - assign experienced personnel
Use a reliable institution

④ in case of inspecting the appearance and workmanship,
subdivide the observation items into smaller ones to make them easier to evaluate

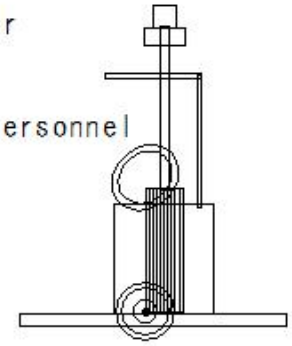
Client

Specification

①fair

Contractor

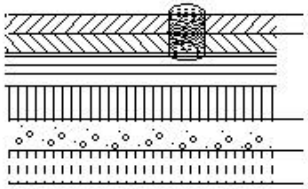
③erienced personnel



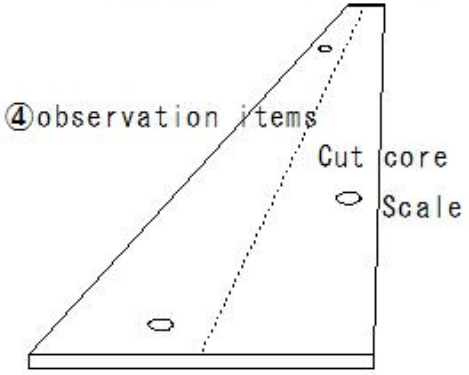
Core cutter

Pavement thickness

( ) cm

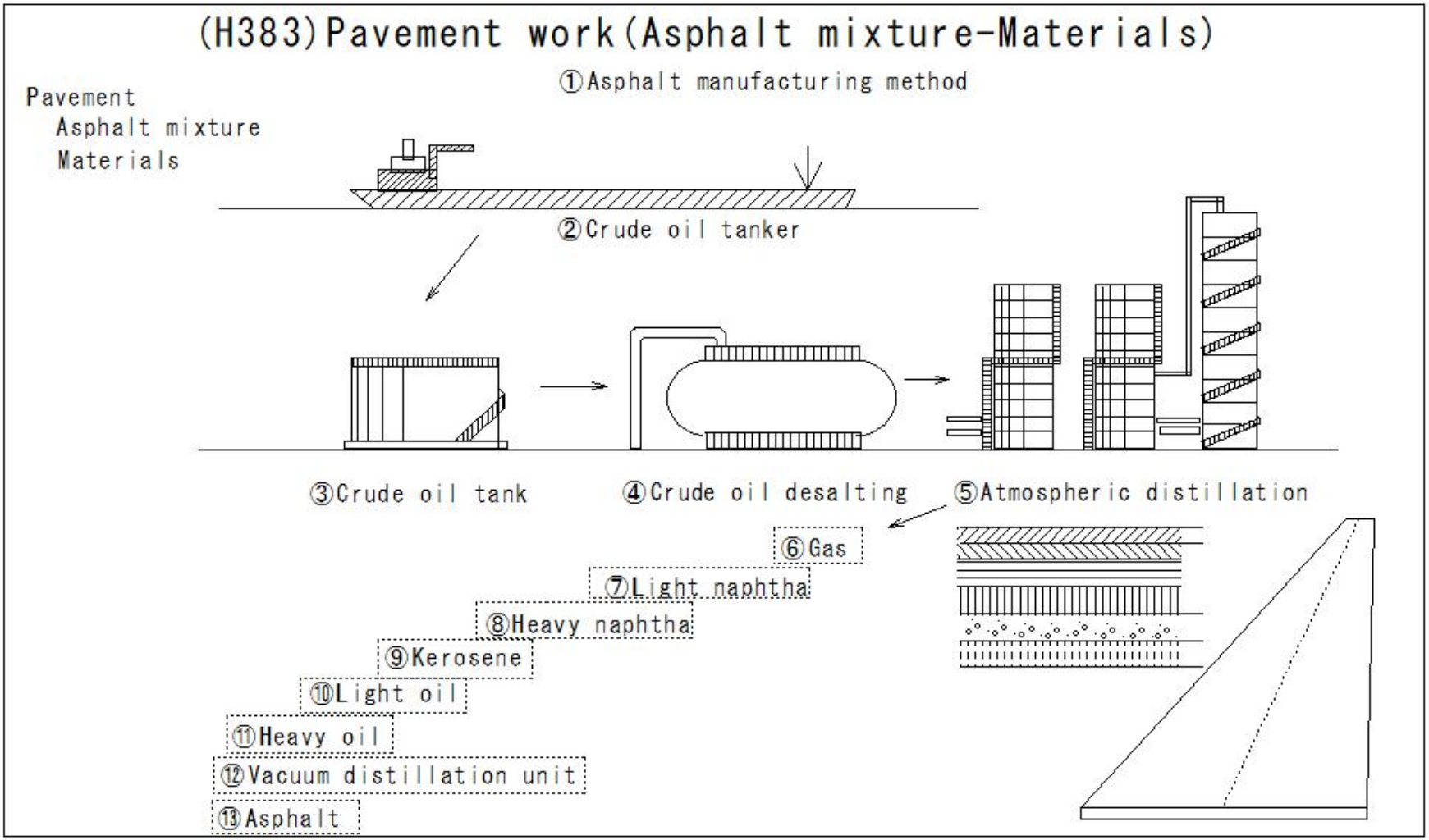


②randomly selected



Sampling inspection

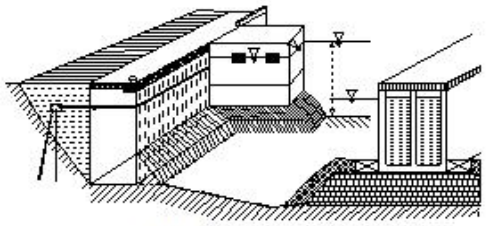
(H383)Pavement work(Asphalt mixture-Materials)



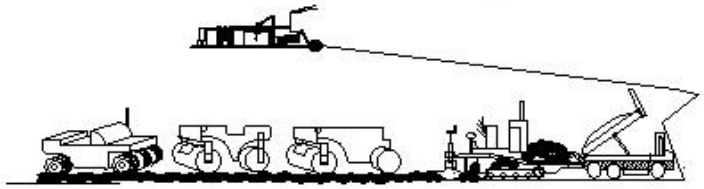
(H384)Pavement work(Asphalt mixture-Bituminous materials)

(H384)Pavement work(Asphalt mixture-Bituminous materials)

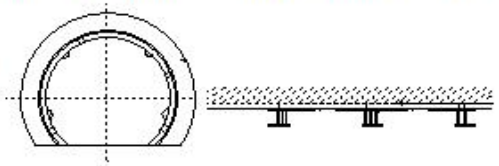
Pavement works
- Asphalt mixtures
- Bituminous materials
- Types and uses
- ○Bituminous materials
- ①Petroleum asphalt
  - Straight asphalt
  - Blown asphalt
- ②Natural asphalt
  - Rock asphalt
  - Lake asphalt
  - Sand asphalt
- ③Asphalt emulsion
- ④Tar
- ⑤Cutback asphalt
- ⑥Construction works-Tunnel -Waterproofing works
- ⑦Harbor works
- ⑧Paving works
- ⑨River works



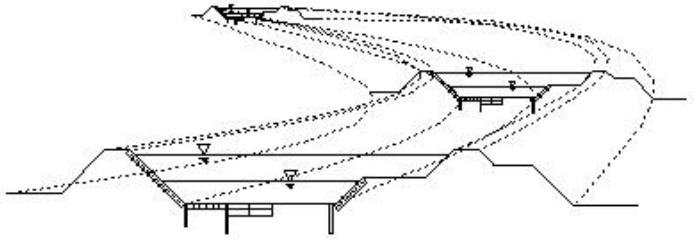
⑦Harbor works P1



⑧Paving works H361



⑥Construction works-Tunnel T218



⑨River works R77

(H385)Pavement work(Asphalt-Types of asphalt)

(H385)Pavement work(Asphalt-Types of asphalt)

Pavement

Asphalt

Types of asphalt: Natural asphalt, petroleum asphalt

Natural asphalt: Mesopotamia, Egyptian era - Adhesive, waterproofing material, preservative

Petroleum asphalt: Road paving material

①Natural asphalt

Lake asphalt
Sand asphalt
Rock asphalt

Production volume -little
Quality - unstable

Uses - small

②Petroleum asphalt

Crude oil - fractional distillation

Petroleum straightening - by-product

Distillation method

Straight asphalt - petroleum asphalt for paving
Blown asphalt

(H386)Pavement work(Asphalt- Straight asphalt)

(H386)Pavement work(Asphalt- Straight asphalt)

Pavement

Asphalt

Types of asphalt: Natural asphalt, petroleum asphalt

Natural asphalt: Mesopotamia, Egyptian era - Adhesive, waterproofing material, preservative

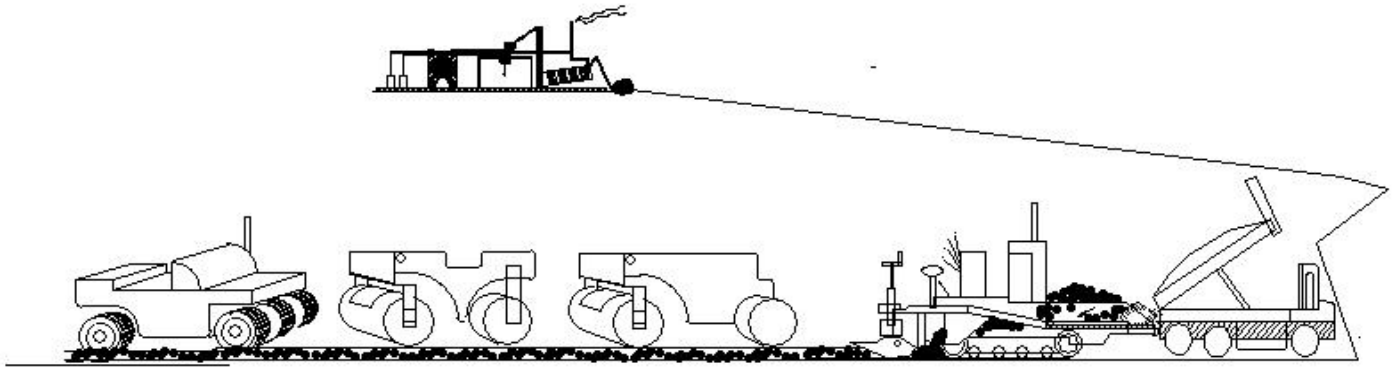
Petroleum asphalt: Road paving material

① Straight asphalt: Manufactured to minimize changes caused by heat in the asphalt components in crude oil

Advantages: Highly stretchable, adhesive, and waterproof

Disadvantages: Low melting point, high temperature sensitivity

Uses: Asphalt for paving



(H387)Pavement work(Asphalt-Blown asphalt)

(H387)Pavement work(Asphalt-Blown asphalt)

Pavement

Asphalt

Types of asphalt: Natural asphalt, petroleum asphalt

②Blown asphalt

Asphalt raw oil is heated

Air is blown in and then cooled

Advantages: Impact resistance - high

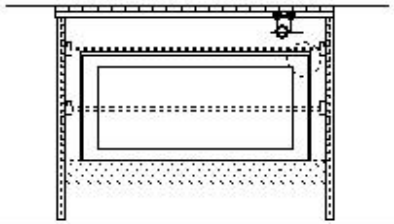
Melting point - high

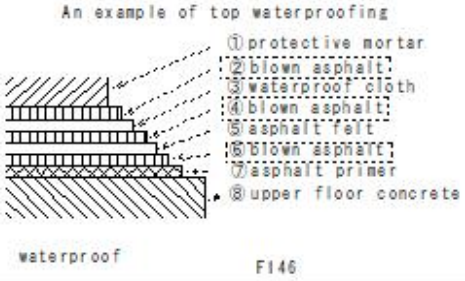
Temperature sensitivity - low

Chemically stable

Disadvantages: Stretchability, adhesion, waterproofing, and permeability - poor

Uses: Joint material, waterproofing material, electrical insulation material





F146

(H388)Pavement work(Asphalt-Asphalt for waterproofing)

(H388)Pavement work(Asphalt-Asphalt for waterproofing)

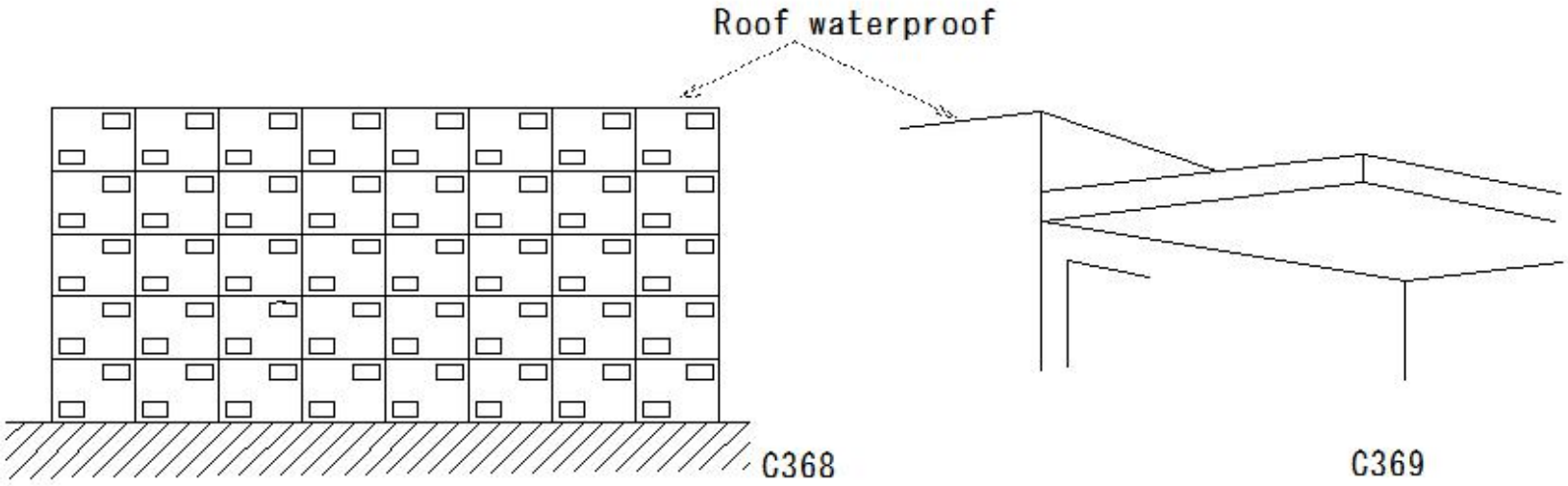
Pavement

Asphalt

Types of petroleum asphalt

③ Asphalt for waterproofing

Uses: Roofing material, underground structure joint material



(H389)Pavement work(Asphalt-Properties of asphalt)

(H389)Pavement work(Asphalt-Properties of asphalt)

Pavement

Asphalt

Properties of asphalt

Asphalt: Easily affected by temperature

Changes from solid to liquid as temperature rises

Properties vary depending on the origin of crude oil and manufacturing method

○Properties required for paving asphalt

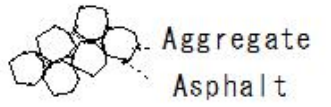
①Good adhesion of aggregate

Does not peel off

・Good quality materials

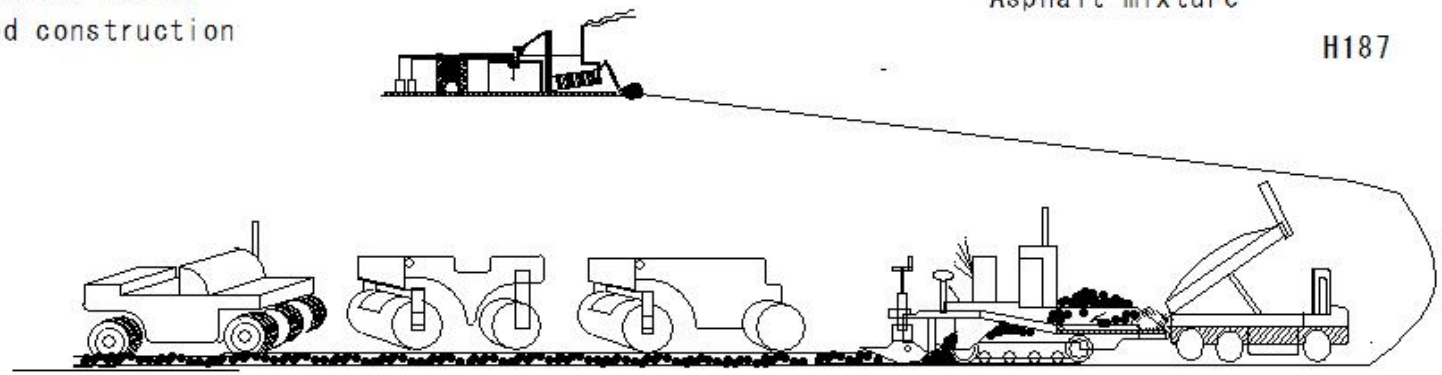
・Good mix design

・Good construction



Asphalt mixture

H187



(H390)Pavement work(Asphalt-Properties of asphalt)

(H390)Pavement work(Asphalt-Properties of asphalt)

Pavement

Asphalt

Properties of asphalt

Asphalt: Easily affected by temperature

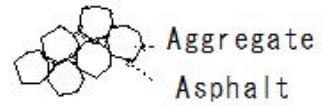
Changes from solid to liquid as temperature rises

Properties vary depending on the origin of crude oil and manufacturing method

○Properties required for paving asphalt

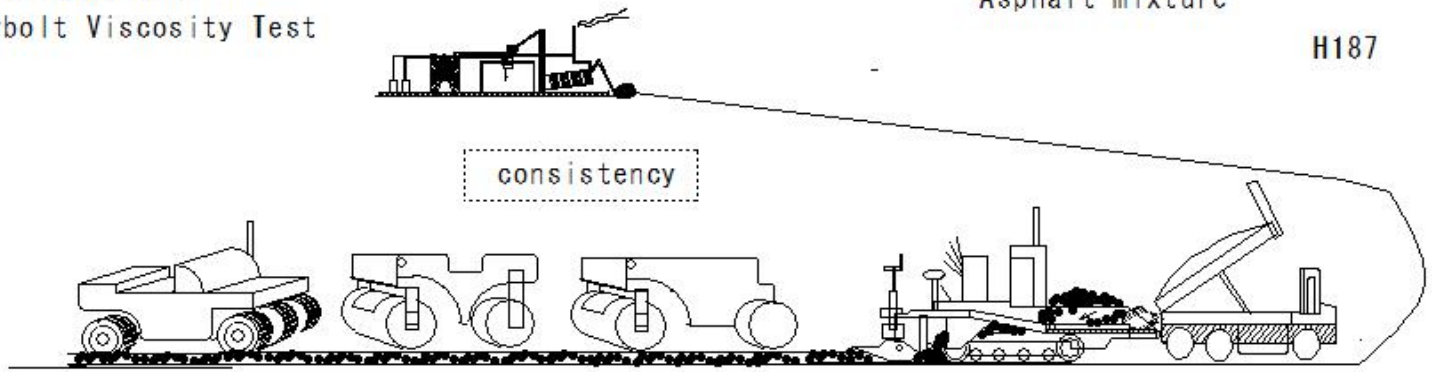
② Appropriate consistency

- Penetration test
- Softening point test
- Elongation test
- Saybolt Viscosity Test



Asphalt mixture

H187



(H391)Pavement work(Asphalt-Properties of asphalt)

(H391)Pavement work(Asphalt-Properties of asphalt)

Pavement

Asphalt

Properties of asphalt

Asphalt: Easily affected by temperature

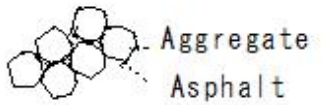
Changes from solid to liquid as temperature rises

Properties vary depending on the origin of crude oil and manufacturing method

○Properties required for paving asphalt

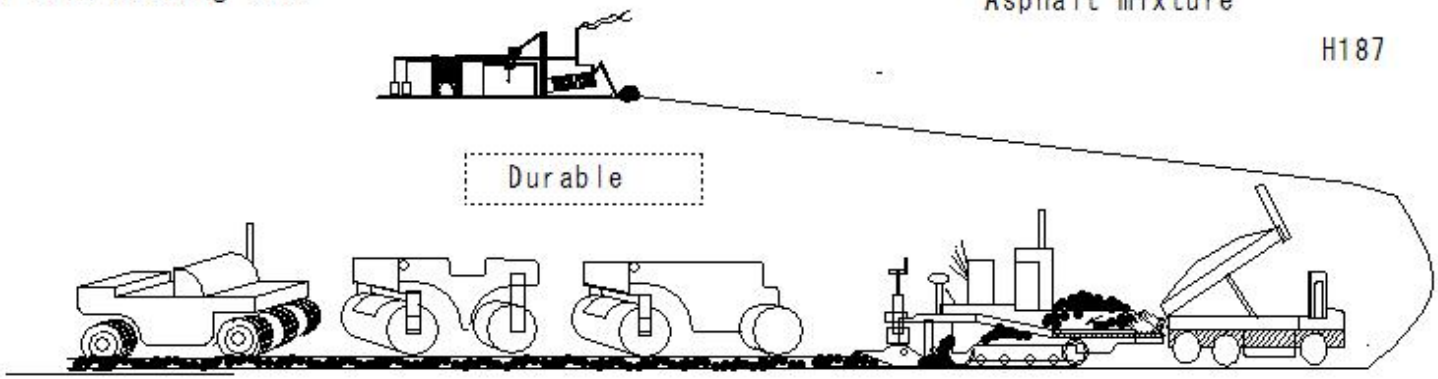
③ Durable and does not harden or deteriorate

- Evaporation test
- Penetration ratio test after evaporation
- Thin film heating test



Asphalt mixture

H187



(H392)Pavement work(Properties of asphalt-Specific gravity)

(H392)Pavement work(Properties of asphalt-Specific gravity)

Pavement

Asphalt

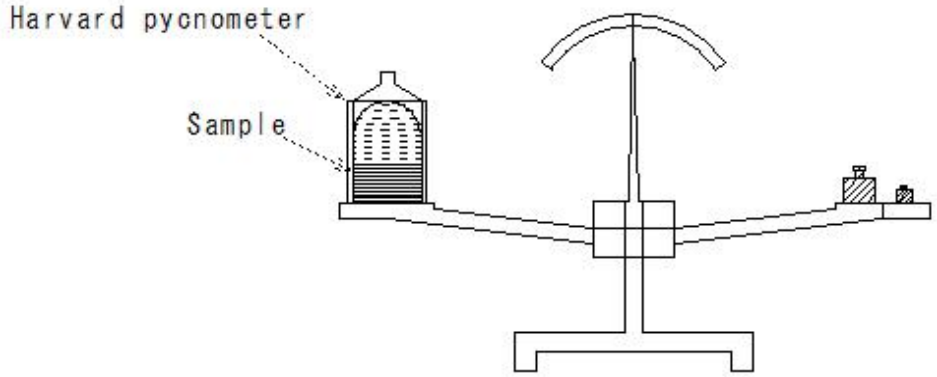
Properties of asphalt

○Specific gravity

Weight of asphalt at 25℃

Ratio to the weight of the same volume of water at 25℃

Specific gravity: 1.01-1.05



Specific gravity of asphalt

(H393)Pavement work(Properties of asphalt-Penetration)

(H393)Pavement work(Properties of asphalt-Penetration)

Pavement Asphalt Properties of asphalt

Asphalt

Asphalt properties

○Penetration

Asphalt hardness

Depth to which a specified needle penetrates into the asphalt

Hard asphalt: Penetration small

Soft asphalt: Penetration large

①Purpose: Whether or not the hardness is suitable for the intended use

②Unit: Expressed as the length of penetration of a standard needle into the test material

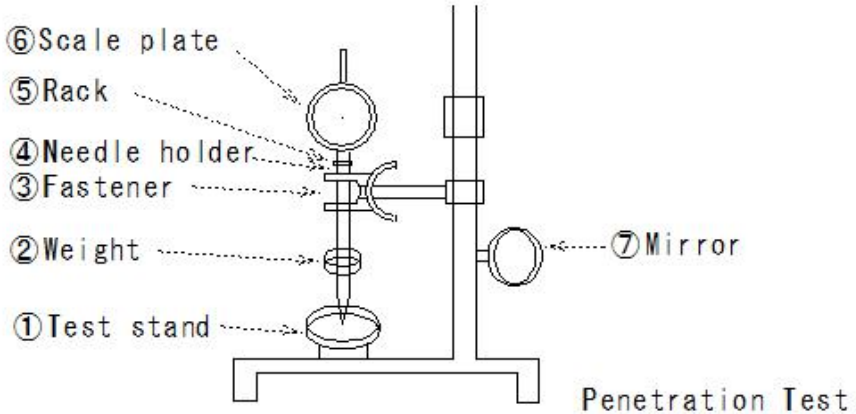
Unit - Penetration amount of 0.1 mm is considered to be penetration 1

③Test conditions

Test load 100g

Test temperature 25℃

Penetration time 5 seconds



Penetration Test

(H394)Pavement work(Properties of asphalt-Softening point)

(H394)Pavement work(Properties of asphalt-Softening point)

Pavement Asphalt Properties of asphalt

Asphalt

Asphalt properties

○Softening point

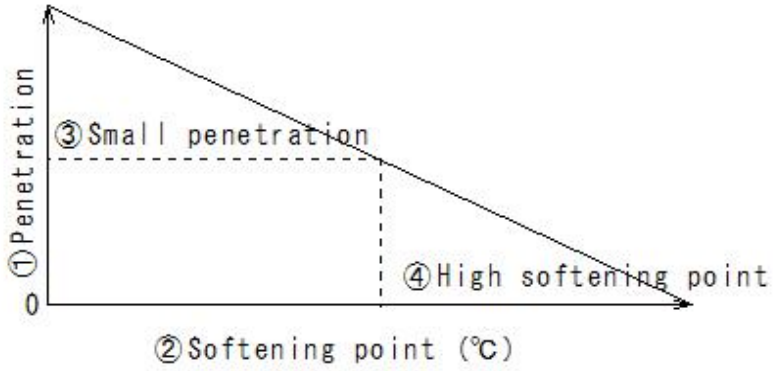
Asphalt is easily affected by temperature changes

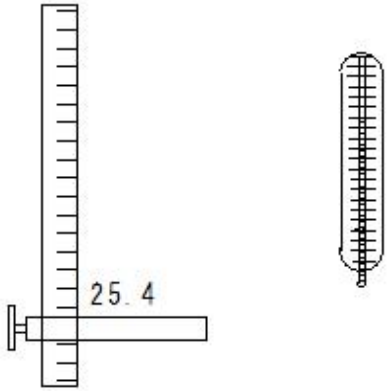
in case of the temperature rises, it becomes softer

and changes from semi-solid to liquid

The softening point of asphalt for paving is 40-60℃

Asphalt: Steel ball, temperature when it hangs down 25.4mm





(H395)Pavement work(Properties of asphalt-Elongation)

(H395)Pavement work(Properties of asphalt-Elongation)

Pavement

Asphalt

Asphalt properties

○Elongation

Asphalt: Tensile property (ductility)

Elongation test: Pull both ends of the sample at a constant speed
The length (cm) the sample is stretched before it breaks

Things related to elongation

・Asphalt's bonding strength and ease of stretching

・Good or bad adhesion to aggregate

・Flexibility of pavement

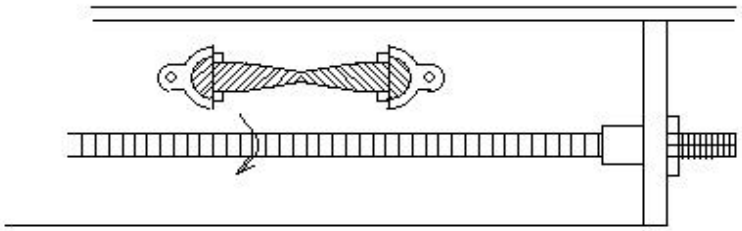
Test temperature: 15℃, 25℃

Straight asphalt: Elongation - large

Blown asphalt: small

Elongation tester: Stretch the sample
at a speed of 5±0.25cm per minute

Read the length of the sample in case of
it breaks to within 0.5cm



Asphalt Elongation Test

(H396)Pavement work(Properties of asphalt-Flash point)

(H396)Pavement work(Properties of asphalt-Flash point)

Pavement

Asphalt

Asphalt properties

○Flash point

Bitumen - Heating - Ignition

Minimum temperature - Flash point

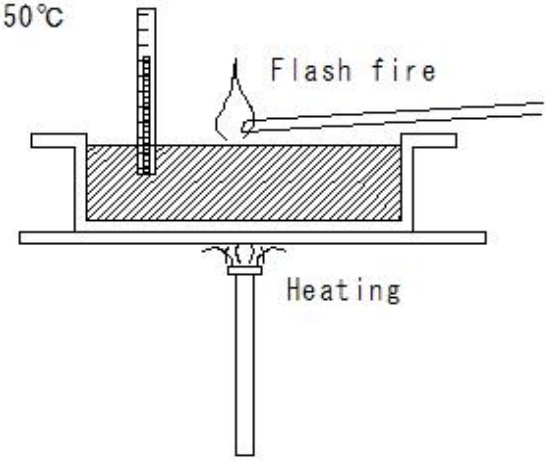
Predicting risk during heating work

・Flash point of asphalt for paving: 260-330℃

・Flash point of asphalt for paving: 3-6℃ higher than the flash point

・Heating temperature during construction: Around 150℃

・Asphalt becomes brittle if heated too much



Flash point Test

(H397)Pavement work(Properties of asphalt-Evaporation amount (%))

(H397)Pavement work(Properties of asphalt-Evaporation amount (%))

Pavement

Asphalt

Asphalt properties

○Evaporation amount (%)

・Paving asphalt: Heat-melted and used
in case of kept for a long time, some of it evaporates and hardens

・Evaporation test

(H398)Pavement work(Properties of asphalt-Viscosity)

(H398)Pavement work(Properties of asphalt-Viscosity)

Pavement

Asphalt

Asphalt properties

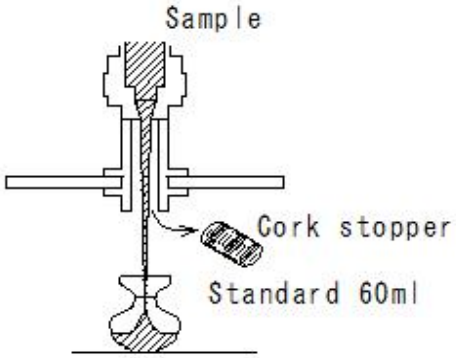
○Viscosity

・Easily affected by temperature

・Easily affected by temperature

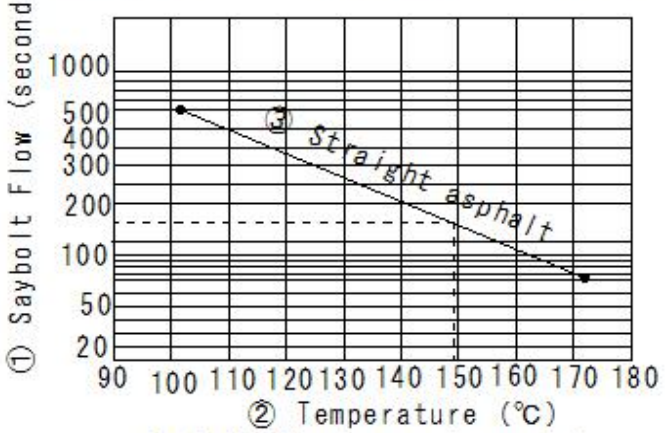
・Low temperature - Hard to flow

・Viscosity - degree - viscosity



Saybolt Flow test (seconds):

④ Asphalt temperature-viscosity diagram



Saybolt Flow test (seconds):
Viscosity of asphalt at high temperatures

(H399)Pavement work(Petroleum asphalt emulsion)

(H399)Pavement work(Petroleum asphalt emulsion)

Pavement

Petroleum asphalt emulsion

・Petroleum asphalt dispersed as fine particles in water containing emulsifiers and stabilizers to make it liquid brown

・No need to heat

・Spray on aggregates on the road surface at room temperature

・Use by mechanically mixing with aggregates

・Emulsion-Asphalt coating-Aggregate surface-Aggregate bond

Petroleum asphalt emulsion (cationic (K) anionic (A)

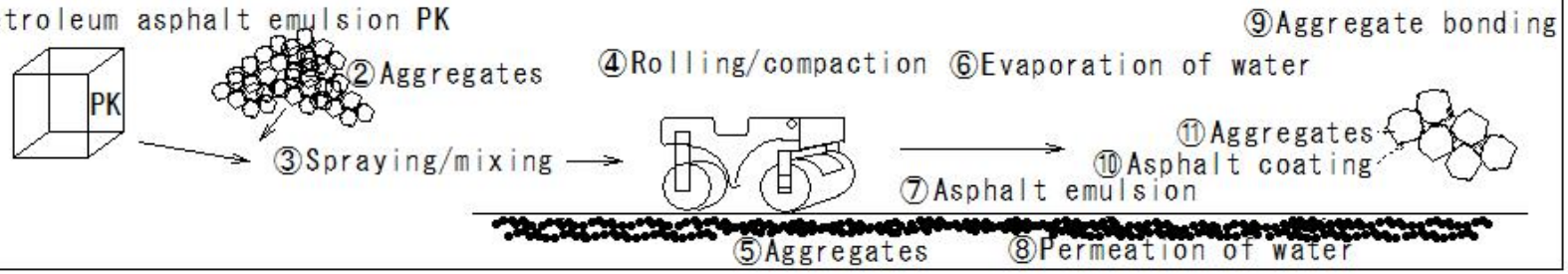
・Good permeability

・Does not re-emulsify with rainwater or other water

・Strong bonding with aggregates

・For permeation (P)-PK, PA

・For mixing (M)-MK, MA



(H400)Pavement work(Petroleum asphalt emulsion)

(H400)Pavement work(Petroleum asphalt emulsion)

Pavement

Petroleum asphalt emulsion

Standards for petroleum asphalt emulsion

①Type/symbol	②PK, PA				③MK, MA		
④Item	1	2	3	4	1	2	3
⑤Engler degree (25℃)	3-15		1-6			3-40	
⑥Sieve residue (1190μm)%	below0.3						
⑦Adhesion degree	over 2/3(only PK)				-		
⑧Aggregate coating degree (40℃, 5 minutes)	over 2/3(only PA)				-		
⑨Mixability of coarse aggregate	-				Uniformity	-	
⑩Mixability of dense aggregate	-					Uniformity	-
⑪Mixability of soil-mixed aggregate	-						below 5(MK) below 2(MA)
⑫Particle charge	Positive (PK, MK) Negative (PA, MA)						

(H401)Pavement work(Petroleum asphalt emulsion)

(H401)Pavement work(Petroleum asphalt emulsion)

Pavement

Petroleum asphalt emulsion

Standards for petroleum asphalt emulsion

	①Type/symbol	②PK,PA				③MK,MA		
	④Item	1	2	3	4	1	2	3
	⑬Evaporation residue (%)	over 60		over 50		over 57		
⑭Residue	⑮Penetration (25℃)	100-200	150-300	100-300	60-150	60-200		60-300
	⑯Elongation (15℃) (cm)	over 100				over 80		
	⑰Ethane trichloride solubles (%)	over 98				over 97		
	⑱Storage stability (5 days) (%)	below 5						
	⑲Freezing stability (-5℃)	-	①	-				
	⑳Main uses	②	③	④	⑤	⑥	⑦	⑧

①No coarse particles or lumps

②For warm season penetration and surface treatment

③For cold season penetration and surface treatment

④For prime coat and cement stabilization layer curing

⑤Tack coat

⑥For mixing coarse aggregate

⑦For mixing dense aggregate

⑧For mixing soil-mixed aggregate

(H402)Pavement work(Cutback asphalt)

(H402)Pavement work(Cutback asphalt)

Pavement

○Cutback asphalt

Straight asphalt with a penetration of 60-150

adds an appropriate volatile solvent to reduce viscosity and improve fluidity

①Straight asphalt: Asphalt components in crude oil -Penetration 60-150
Cannot be applied at room temperature

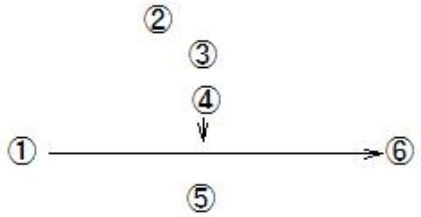
②Cutback oil

③Oil spill oil Oil spill with a spill range of 140-360℃

④Mixing

⑤Cutback asphalt-Improved fluidity

⑥Cutback asphalt-Penetration 80-250
Same as asphalt emulsion Can be applied at room temperature

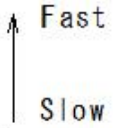


Types of cutback asphalt

①RC Cutback with gasoline fraction

②MC Cutback with kerosene fraction

③SC Cutback with heavy oil fraction



Evaporation of cutback oil

Cutback oil has a content of 10-45% by weight

(H403)Pavement work(Cutback asphalt)

(H403)Pavement work(Cutback asphalt)

Pavement work

○Standards for cutback asphalt

①Type	RC				MC			
②Grade	70	250	800	3000	70	250	800	3000
③Flash point: open tag type (℃)	over 30				over 40	over 65		
④Kinematic viscosity (60℃)	70－140	250－500	800-1600	3000-6000	70－140	250－500	800-1600	3000-6000
⑤Fractional distillation test (volume (%) of total distillate up to 360℃)								
Up to 190℃	over 10	-	-	-	-	-	-	-
Up to 225℃	over 50	over 35	over 15	-	-	-	-	-
Up to 260℃	0ver 70	over 60	over 45	over 25	over 20	over 15	-	-
Up to 316℃	over 85	over 80	over 75	over 70	over 65	over 60	over 45	over 15
⑥Distillation residue (volume at 360℃) (%)	over 55	over 65	over 75	over 80	over 55	over 65	over 75	over 80
⑦Distillation residue test								
⑧Penetration (25℃)		80－250				80－250		
⑨Elongation (15℃)		over 100				over 100		
⑩Ethane trichloride solubles (%)		over 99.5				over 99.5		
⑪Moisture (%)		below 0.2				below 0.2		

(Japan Road Association standard)

(H404)Pavement work(Paving tar)

Paving work

○ Paving tar

Paving tar standards	A						B					C		
⓪ Type	1	2	3	4	5	6	1	2	3	4	5	1	2	3
① Equivalent viscosity temperature (EVT) (℃)	-12～-2	-2～8	8－16	16－24	24－32	32－40	-12～-2	-2～8	8－16	16－24	24－32	32－40	40－50	50－60
② Specific gravity (25℃/25℃)	1.10－1.25				1.15－1.30		1.10－1.25				1.15－1.30	1.15－1.30		
③ Moisture (%)	1 or less			1 or less			1 or less		1 or less			1 or less		
④ Toluene insolubles (for dehydrated sample) (%	20 or less				25 or less		20 or less				25 or less	25 or less		
⑤ Naphthalene content (for dehydrated sample) (%)	4 or less					3 or less	4 or less					3 or less		
⑥ Acidic oil content (for dehydrated sample) (%)	3 or less					2 or less	3 or less					2 or less		
⑦ Fractional distillation test (for dehydrated sample) (%)														
⑧ Distillate volume and weight up to 170℃ (%)	-						3 or less				1or less	1 or less		
⑨ Distillate volume and weight up to 220℃ (%)	5-30		2-20		1-15		-					-		
⑩ Distillate volume and weight up to 270℃ (%)	35 or less		25 or less				35 or less		25 or less			25 or less	15 or less	5 or less
⑪ Distillate volume and weight up to 300℃ (%)	45 or less		35 or less				45 or less		35 or less			35 or less	20 or less	10 or less
⑫ Softening point of 300℃ distillation residue (Ring and Ball method) (℃)	35-60						25－50			35－60		35－60		
⑬ Flash point (tag open type) (℃)	40 or more				60 or more							-		
⑭ Creepland method (℃)	-						90 or more				100 or more	100 or more		
⑮ Foaming test	-						-				Passed	Passed		

（JIS K 2472）

(H405)Pavement work(Modified asphalt)

(H405)Pavement work(Modified asphalt)

Pavement work

Modified asphalt

①Modified asphalt is petroleum asphalt that has been modified by adding polymers and natural asphalt.

②It is used to improve various properties of asphalt mixtures (flow resistance, abrasion resistance, peeling resistance, adhesion to aggregate, deflection compliance.

Semi-blown asphalt

Rubber-containing asphalt

Thermoplastic resin-containing asphalt

Flow resistance measures for heavy traffic roads

Asphalt for waterproofing work

(H406)Pavement work(Modified asphalt)

(H406)Pavement work(Modified asphalt)

Pavement

Modified asphalt

Asphalt for waterproofing

Rubber-containing asphalt

Straight asphalt with synthetic and natural rubber added (rubber content 2.5-5%)

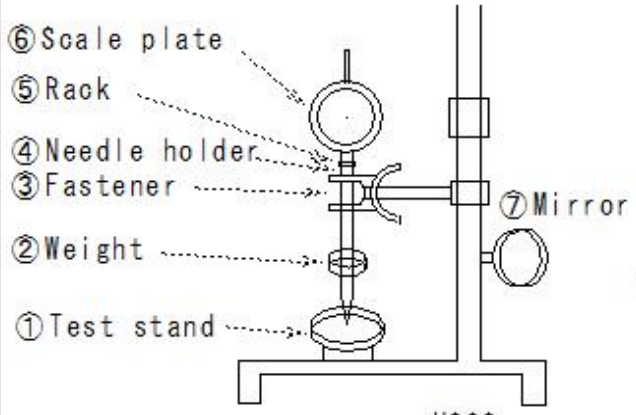
① Less affected by temperature changes

② Excellent adhesion to aggregate

③ Penetration 60-80 Softening point 48-56℃ Elongation (7℃) 20cm or more

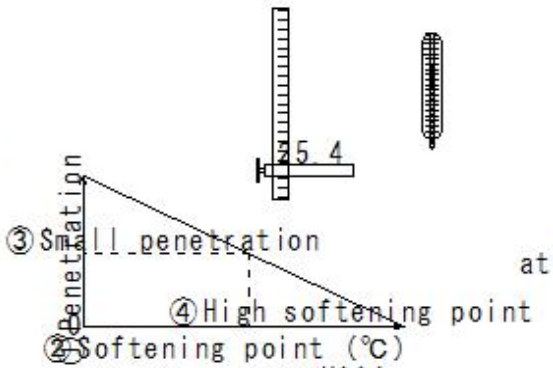
④ Penetration 80-100 Softening point 46-54℃ Elongation (7℃) 50cm or more

Penetration Test



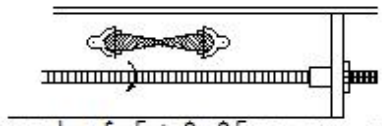
H393

Softening point



H394

Asphalt Elongation Test



at a speed of 5±0.25cm per minute

Asphalt Elongation Test

H395

(H407)Pavement work(Modified asphalt)

Pavement

○Modified asphalt

○Asphalt for waterproofing

①Type

②Use

③Softening point (℃)

④Penetration (25℃) (1/10mm)

⑤Evaporation mass change rate (%)

⑥Flash point (℃)

⑦Ethane trichloride soluble content (%)

①Type	②Use	③Softening point (℃)	④Penetration (25℃) (1/10mm)	⑤Evaporation mass change rate	⑥Flash point (℃)	⑦Ethane trichloride soluble content (%)
①Type 1	①	85 or more	25－45	1 or less	250 or more	98 or more
②Type 2	②	90 or more	20－40	1 or less	270 or more	98 or more
③Type 3	③	100 or more	20－40	1 or less	280 or more	95 or more
④Type 4	④	95 or more	30－50	1 or less	280 or more	92 or more

（JIS K 2207）

①Type 1 Used for indoor and underground structural parts under moderate temperature conditions during and after construction

Normal temperature sensitivity

Soft

②Type 2 Used for gentle slope walking roofs in general areas

Low temperature sensitivity

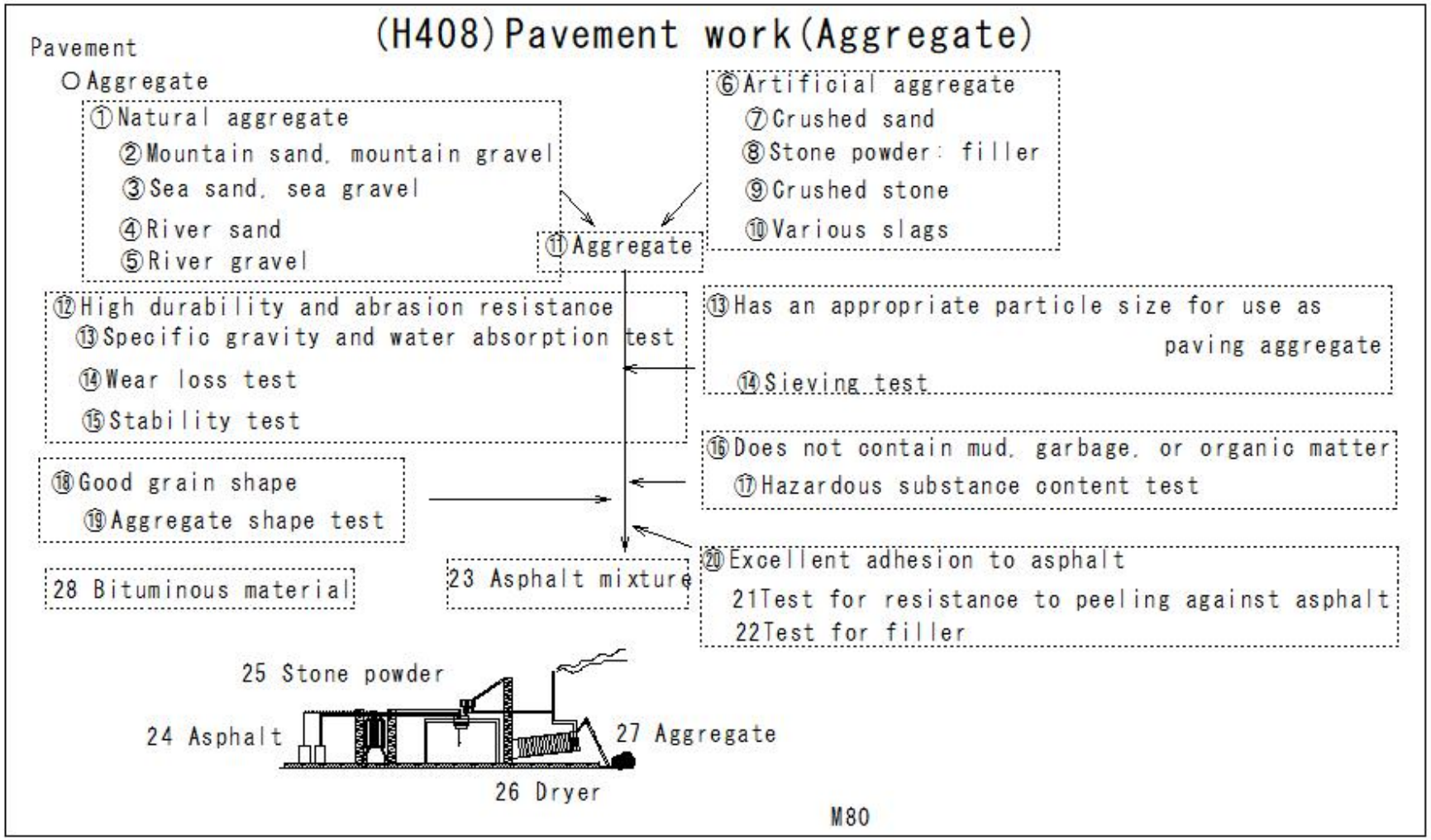
③Type 3 Used for exposed roofs in general areas or roofs with relatively high temperatures

Low temperature sensitivity

④Type 4 Used for roofs and other parts in general areas as well as cold areas

Especially low temperature sensitivity, relatively soft

(H408)Pavement work(Aggregate)



(H409)Pavement work(Aggregate-Types of aggregates)

(H409)Pavement work(Aggregate-Types of aggregates)

Paving work

○ Types of aggregates

Aggregates for paving

Coarse aggregate: Aggregates that pass through a 2.5 mm sieve

Fine aggregate: Aggregates that pass through a 2.5 mm sieve and are stopped by a 74 μm (0.074 mm) sieve

Filler (stone powder): Mineral powder that passes through a 74 μm sieve

① Types of aggregates for paving Aggregates

② By classification and place of origin		③ Classification by size		
		④ Coarse aggregate	⑤ Fine aggregate	⑥ Filler
⑦ Aggregates for paving	⑧ Natural aggregate	⑨ River gravel ⑩ Mountain gravel ⑪ Sea gravel	⑫ River sand ⑬ Mountain sand ⑭ Sea sand	
	⑮ Artificial aggregat	⑯ Crushed stone ⑰ Slag	⑱ Crushed sand	⑲ Stone powder

(H410)Pavement work(Aggregate-Required properties for aggregate)

(H410)Pavement work(Aggregate-Required properties for aggregate)

Pavement

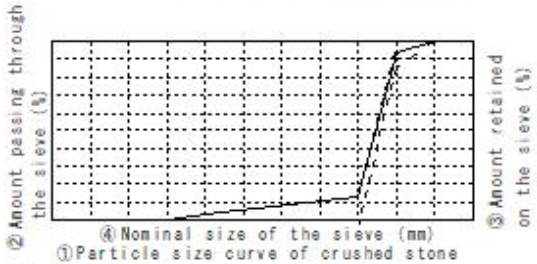
Required properties for aggregate

Asphalt concrete

Aggregate ratio: 75% or more

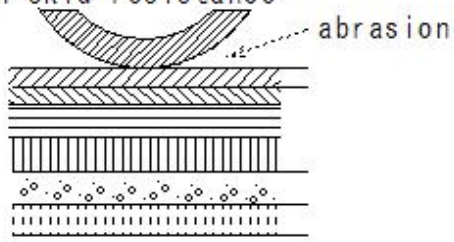
Uniform material

① Appropriate particle size for paving aggregate



② High durability and abrasion resistance

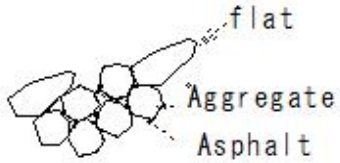
High skid resistance



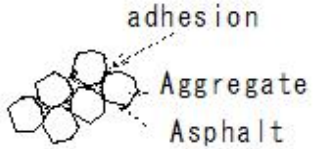
③ Does not contain harmful amounts of mud, garbage, organic matter, etc.

Asphalt mixture

④ Does not contain flat or elongated particles



⑤ in case of mixed with asphalt, has excellent adhesion to asphalt



Asphalt mixture

(H411)Pavement work(Aggregate-Aggregate size and classification)

Pavement work
Aggregate size and classification
Aggregate: Coarse aggregate - crushed stone, gravel
Fine aggregate - sand, crushed sand
Grain size: The degree to which large and small aggregate particles are mixed

Grain size of crushed stone for roads
④ Weight percentage of material passing through the sieve

① Name	② Grain size range (mm)	③ Nominal size of sieve (mm)	100	80	60	50	40	30	25	20	13	5	2.5	1.2
⑤Single-grain crushed stone	⑥ S-80 (No. 1)	80-60	100	85-100	0-15									
	⑦ S-60 (No. 2)	60-40		100	85-100	-	0-15							
	⑧ S-40 (No. 3)	40-30				100	85-100	0-15						
	⑨ S-30 (No. 4)	30-20					100	85-100	-	0-15				
	⑩ S-20 (No. 5)	20-13							100	85-100	0-15			
	⑪ S-13 (No. 6)	13-5								100	85-100	0-15		
	⑫ S-5 (No. 7)	5-2.5									100	85-100	0-25	0-5
⑬ Crusher run	⑭ C-40	40-0				100	95-100	-	-	50-80	-	15-40	5-25	
	⑮ C-30	30-0					100	95-100	-	55-85	-	15-45	5-30	
	⑯ C-20	20-0							100	95-100	60-90	20-50	10-35	

JIS Z 8801 Standard sieve Compatible with 101.6mm, 76.2mm, 63.5mm, 50.8mm, 38.1mm, 31.7mm, 25.4mm, 19.1mm, 12.7mm, 4760μ, 2380μ, 1190μ

(H412)Pavement work(Aggregate-Aggregate size and classification)

Pavement work

Aggregate size and classification

Aggregate: Coarse aggregate - crushed stone, gravel

Fine aggregate - sand, crushed sand

Grain size: The degree to which large and small aggregate particles are mixed

Grain size of crushed stone for roads

④ Weight percentage of material passing through the sieve

① Name	② Grain size range (mm)	③ Nominal size of sieve (mm)	50	40	30	25	20	13	5	2.5	0.4	0.074
⑤ Particle size adjusted crushed stone	⑥M-40 ⑦M-30 ⑧M-25	40-0 30-0 25-0	100	95－100 100	- 95－100 100	- - 95－100	60－90 60－90 -	- - 55－85	30－65	20－50	10－30	2－10

JIS Z 8801 standard sieve: 50.8mm, 38.1mm, 31.7mm, 25.4mm, 19.1mm, 12.7mm, 4760μ, 2380μ, 420μ, 74μ

(H413)Pavement work(Aggregate-Aggregate size and classification)

vement work

Aggregate size and classification
Aggregate: Coarse aggregate - crushed stone, gravel
Fine aggregate - sand, crushed sand
Grain size: The degree to which large and small aggregate particles are mixed

Grain size of crushed stone for roads
④ Weight percentage of material passing through the sieve

① Name	② Grain size range (mm)	③ Nominal size of sieve (mm)	5	2.5	0.6	0.3	0.15	0.074
⑤ Screening	⑥F-2.5	2.5－0	100	85-100	25-55	15-40	7-28	0-20

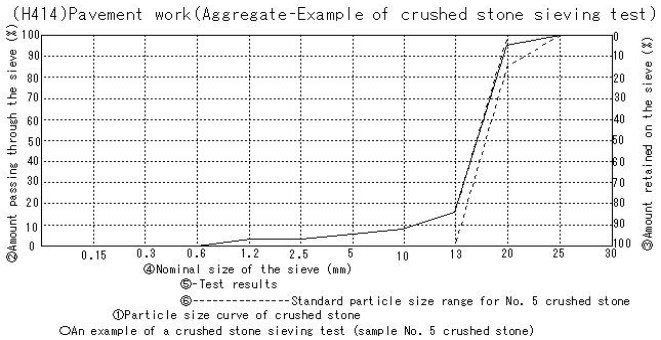
JIS Z 8801 Standard sieve 4760μ, 2380μ, 590μ, 297μ, 149μ, 74μ

(H414)Pavement work(Aggregate-Example of crushed stone sieving test)

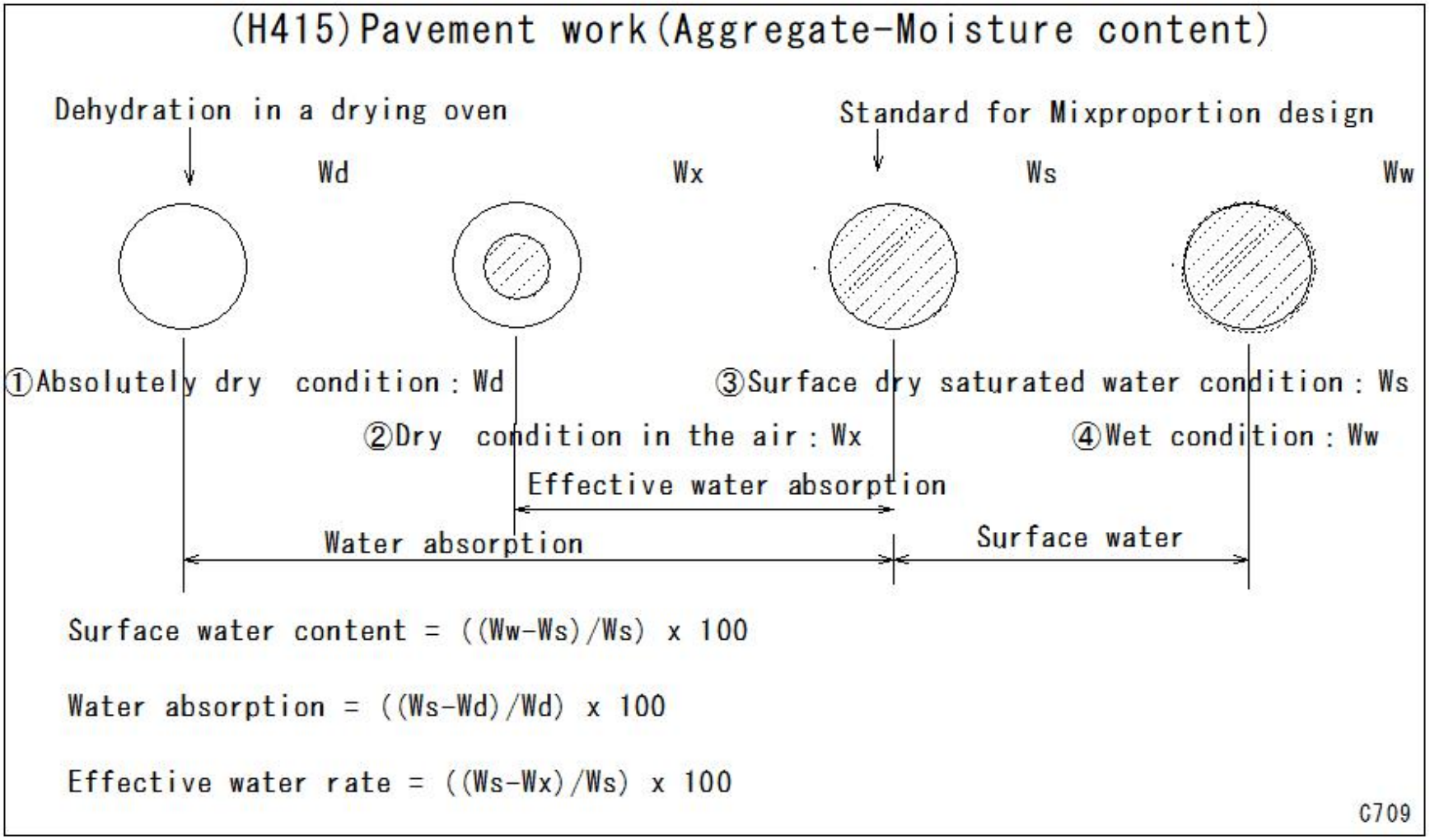
Pavement work

○ Example of crushed stone sieving test (sample No. 5 crushed stone)

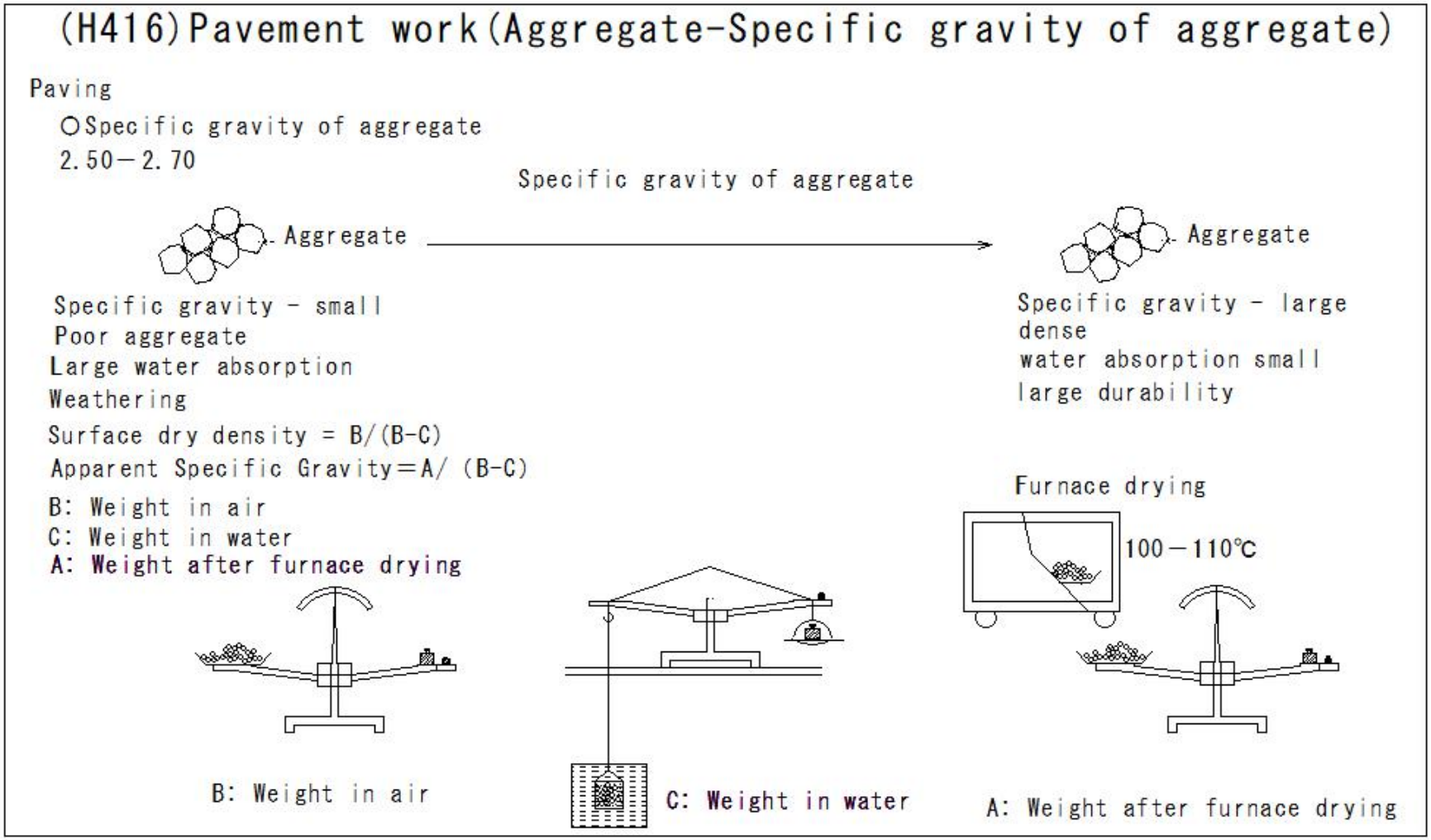
① Nominal dimension of sieve (mm)	② Cumulative amount of the amount remaining in each sieve		③ Amount to stay in each sieve		④ Amount passed through sieve	
(mm)	(g)	(%)	(g)	(%)	(%)	
25	0	0	0	0	100	
20	275	5	275	5	95	
13	4309	85	4034	80	15	
10	4710	93	401	8	7	
5	4860	96	150	3	4	
2.5	4960	98	100	2	2	
1.2	5010	99	50	1	1	
0.6	5030	100	20	1	0	
0.3	5045	100	15	0	0	
0.15	5057	100	12	0	0	
0.074	5062	100	5	0	0	
saucer	5075	100	13	0	0	
sum	-	-	5075	100	-	
Maximum	20					



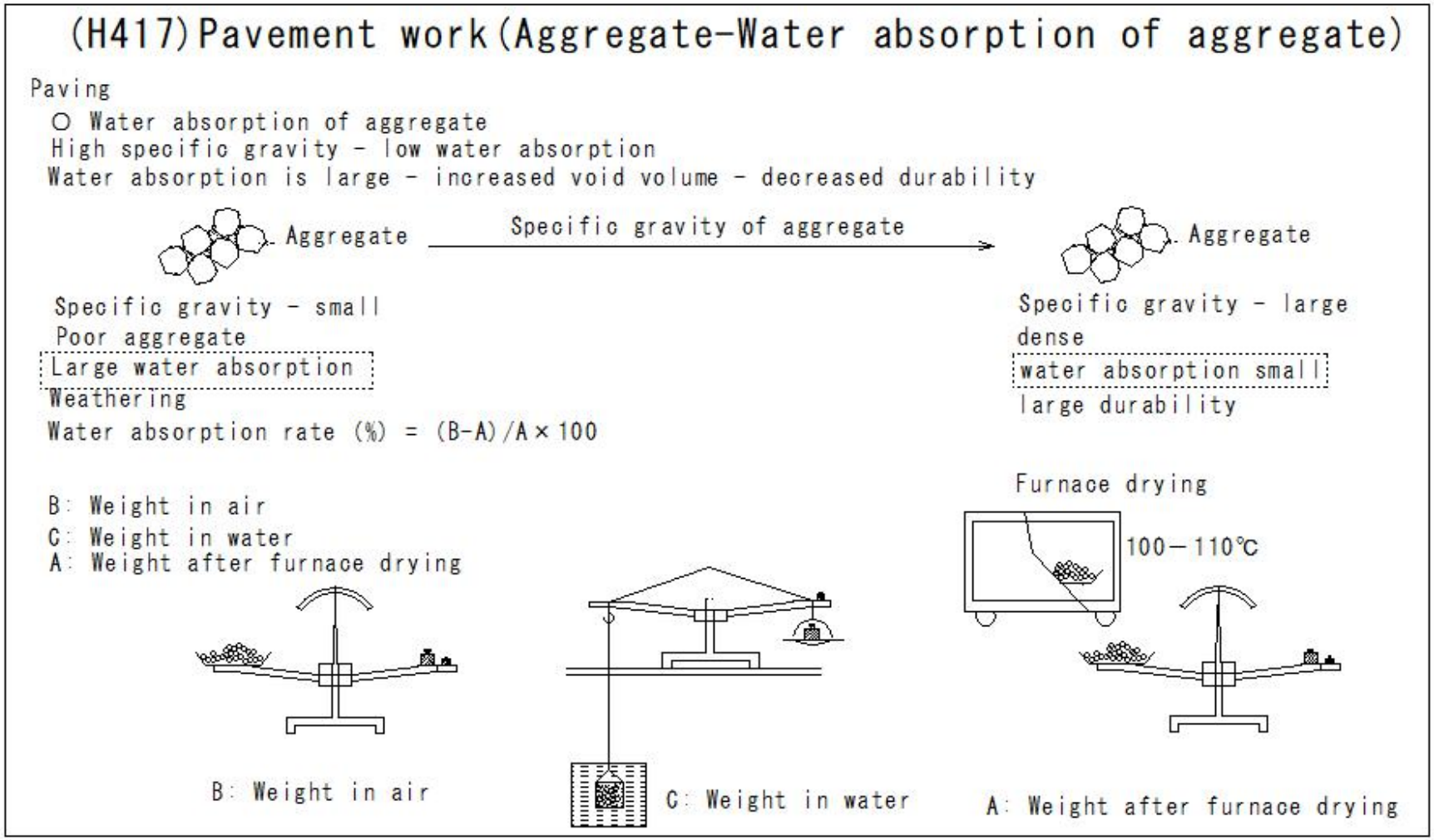
(H415)Pavement work(Aggregate-Moisture content)



(H416)Pavement work(Aggregate-Specific gravity of aggregate)



(H417)Pavement work(Aggregate-Water absorption of aggregate)



(H418)Pavement work(Aggregate-Unit volume weight of aggregate)

(H418)Pavement work(Aggregate-Unit volume weight of aggregate)

Paving work

○Unit volume weight of aggregate

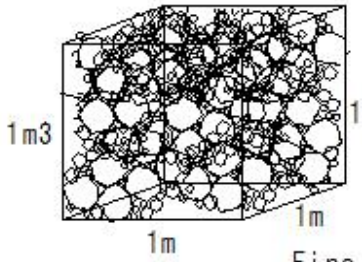
Air-dried weight of 1 m3 aggregate (kg)
Affected by aggregate specific gravity and grain size

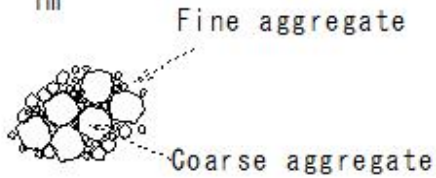
Affected by degree of compaction and moisture content

①Approximate unit volume weight

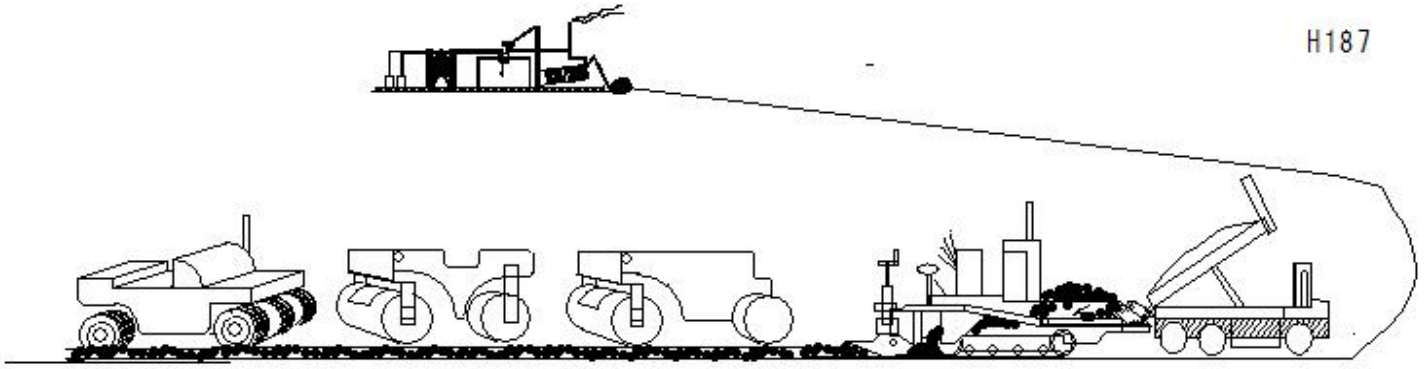
②Fine aggregate...1450-1700 kg/m3

③Coarse aggregate...1500-1850 kg/m3





H187



(H419)Pavement work(Aggregate-Abrasion resistance of aggregate)

(H419)Pavement work(Aggregate-Abrasion resistance of aggregate)

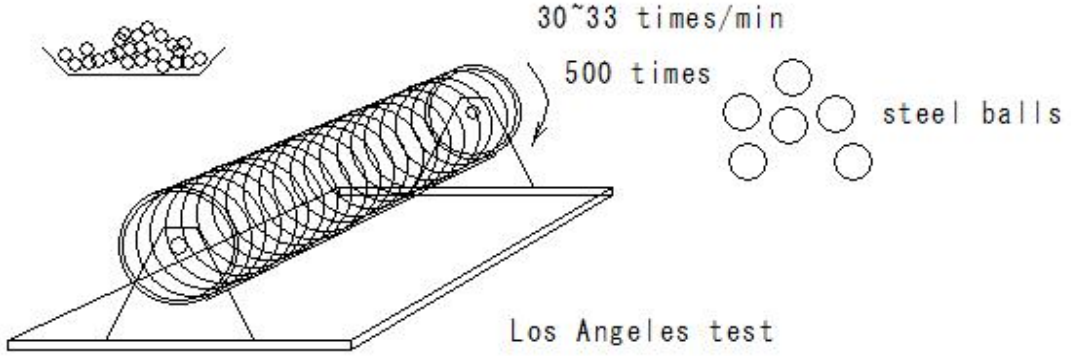
Pavement work

○Abrasion resistance of aggregate

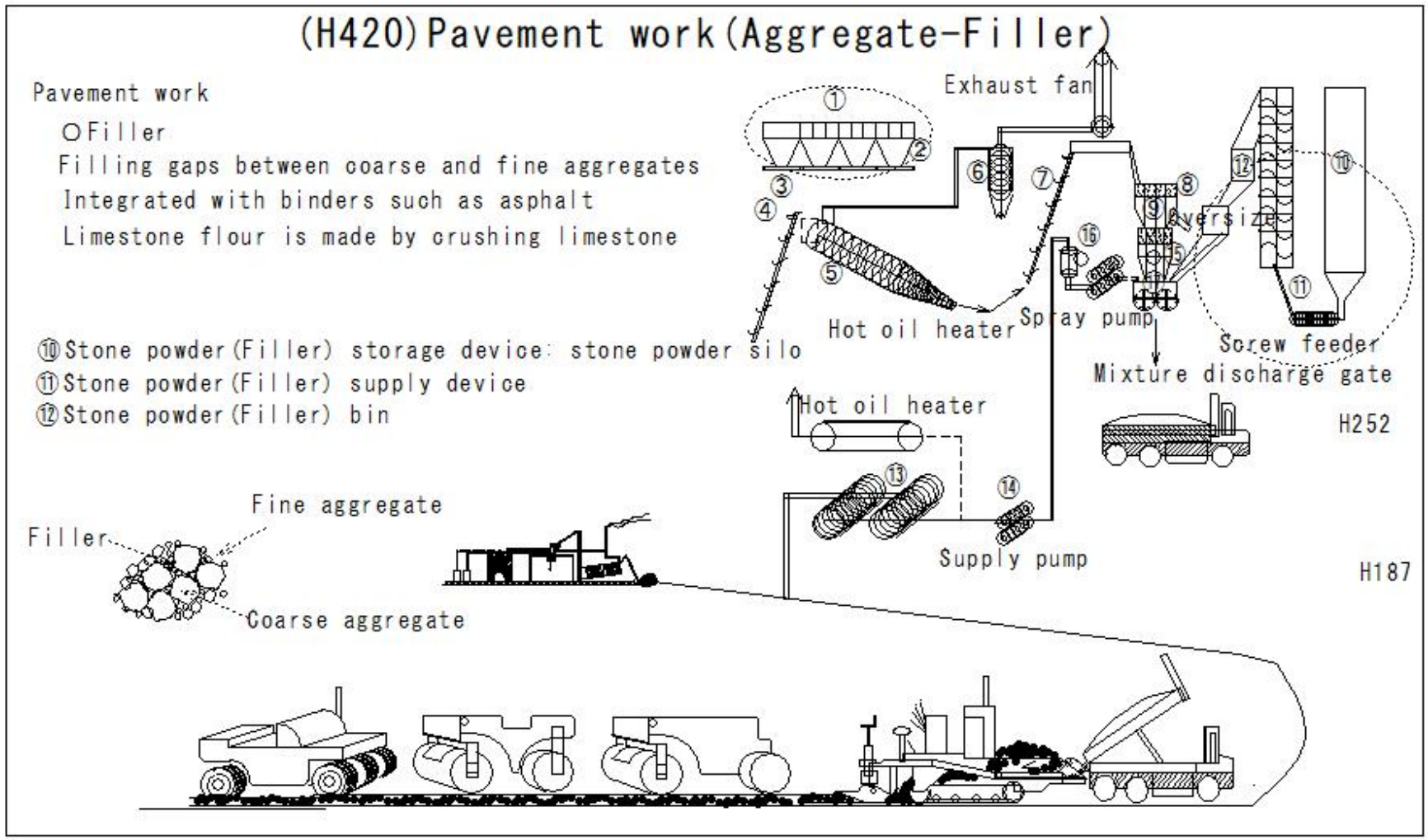
Aggregate used in surface and base asphalt concrete

Wear loss: 30% or less

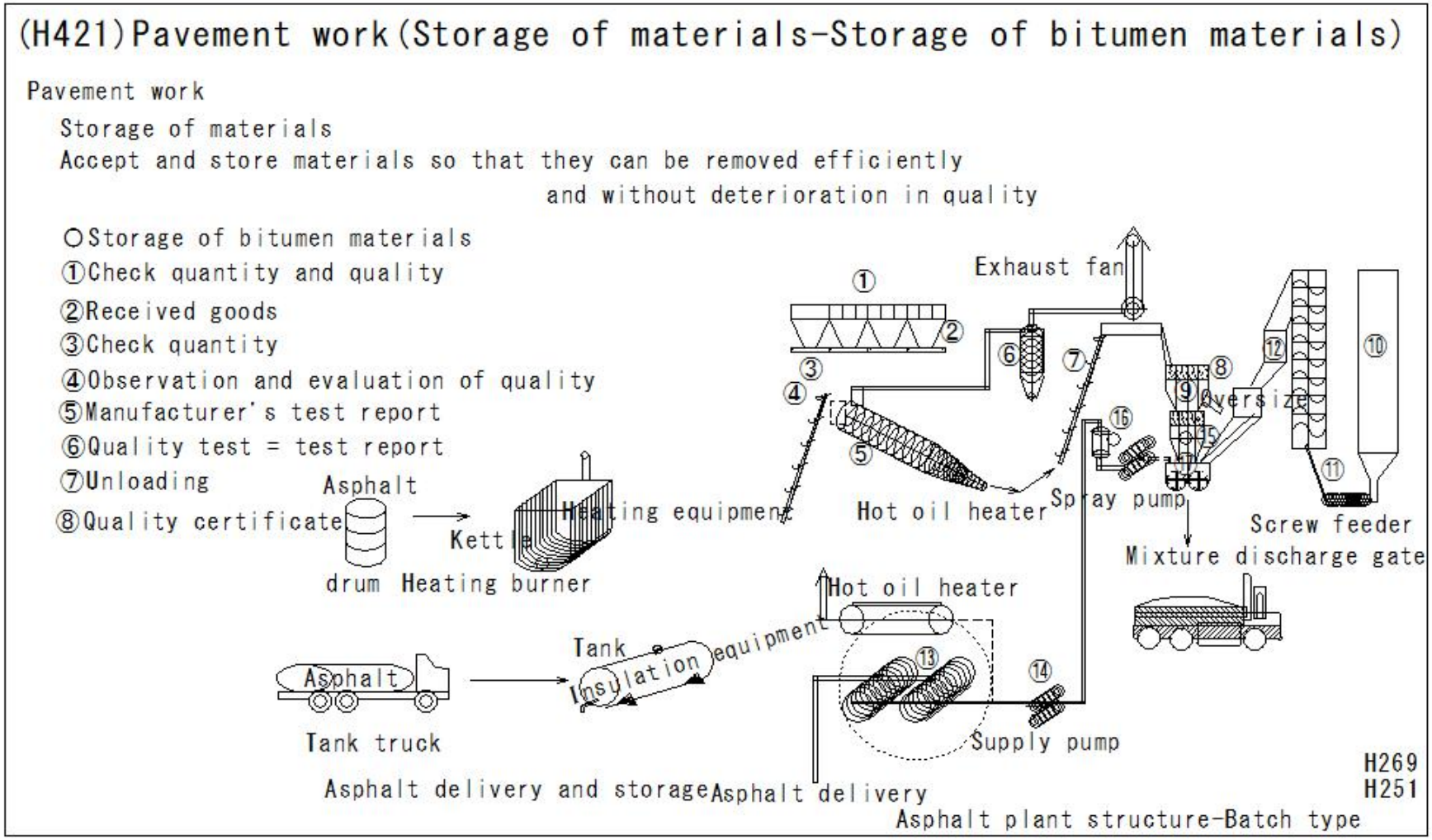
Los Angeles test	
②Items	③Conditions
④Particle size of sample	5－15mm
⑤Weight of sample	5000±10ｇ　（5－10mm… 2500±10ｇ、10－15mm… 2500±10ｇ）
⑥Number of steel balls	8 pcs
⑦Total weight of steel balls	3330±20ｇ
⑧Rotational speed of test machine	30~33 times/min
⑨Rotational speed of test machine	500 times



(H420)Pavement work(Aggregate-Filler)



(H421)Pavement work(Storage of materials-Storage of bitumen materials)



(H422)Pavement work(Storage of materials-Aggregate storage)

(H422)Pavement work(Storage of materials-Aggregate storage)

Pavement work

Storage of materials

○ Aggregate storage

① Store by grain size

② No. 6

③ Label grain size

④ No. 7

⑤ Sand

⑥ Sheet

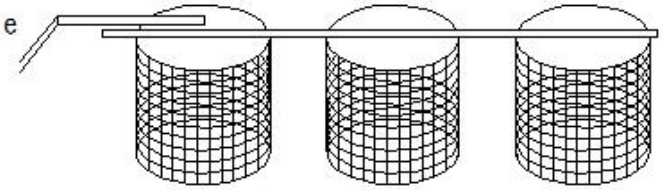
⑦ Drainage

⑧ Observe and evaluate quality
in case of abnormalities are found, test

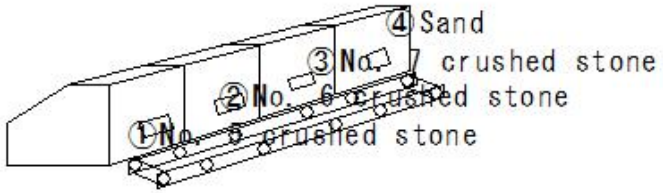
⑨ Store and label by type and grain size

⑩ Cover with sheet to prevent dirt, mud,
and rainwater from entering

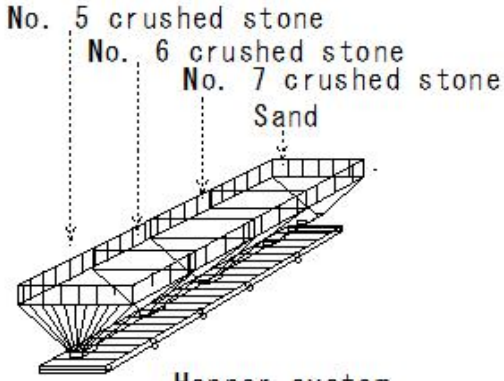
⑪ Consider drainage at aggregate storage area



Silo method H254



Bulkhead method H252



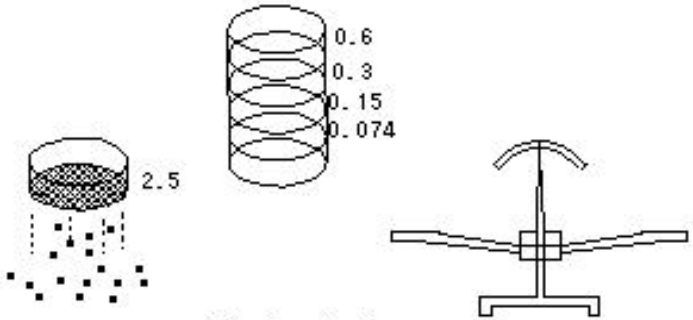
Hopper system H253

(H423)Pavement work(Mixture)

(H423)Pavement work(Mixture)

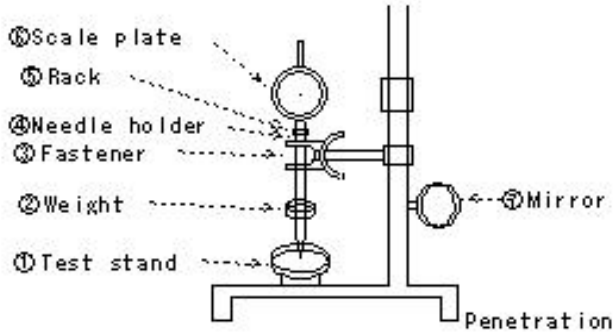
Pavement work
Mixture

①Aggregate test



Sieving Test

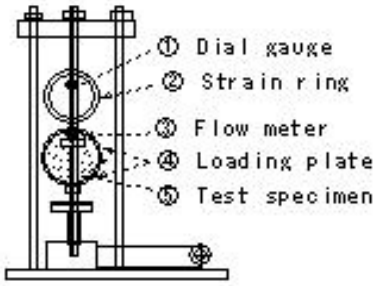
②Asphalt test



Penetration Test

H393

③Mixture test (Marshall test)



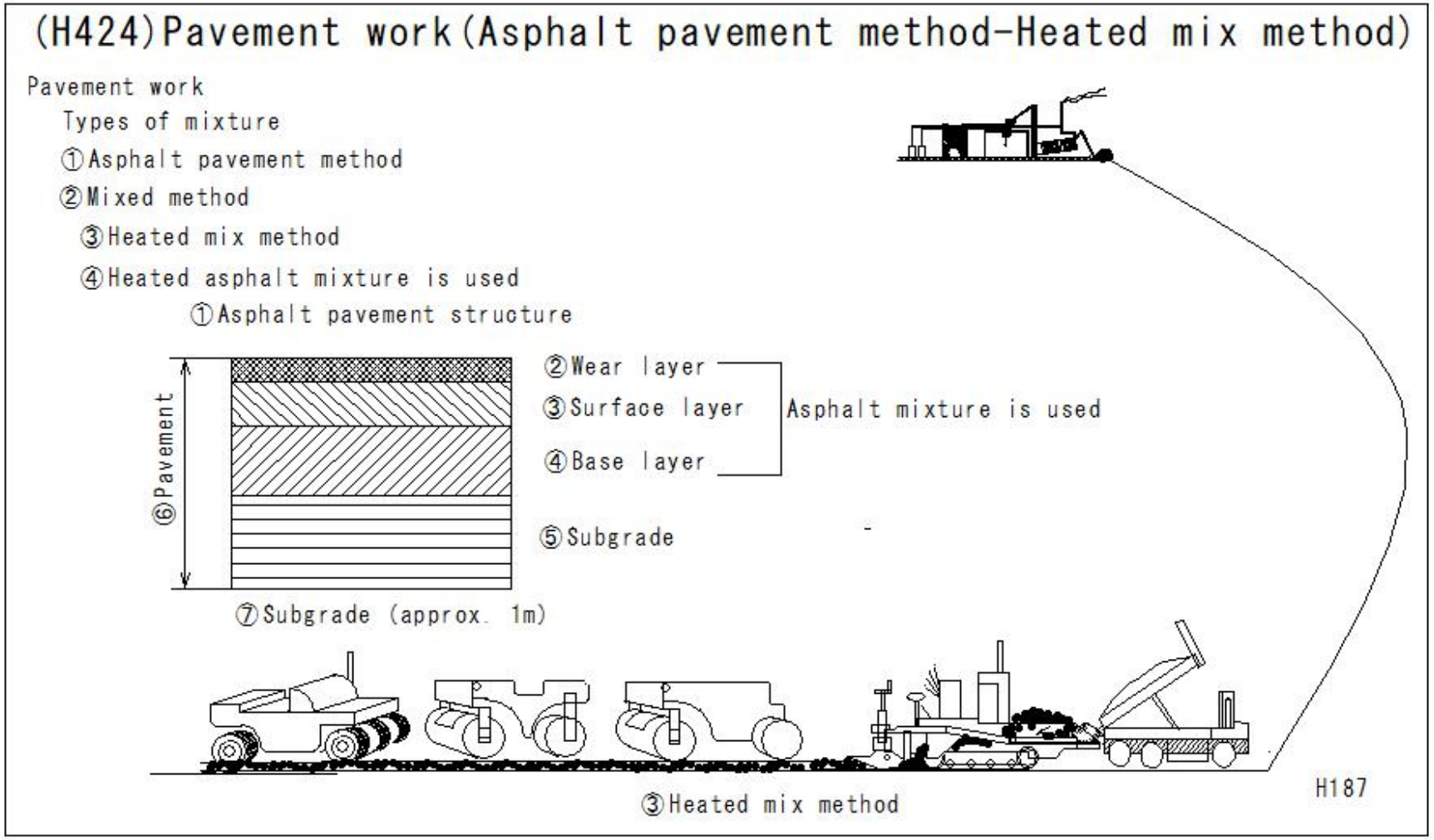
Marshall testing machine

H70
H287

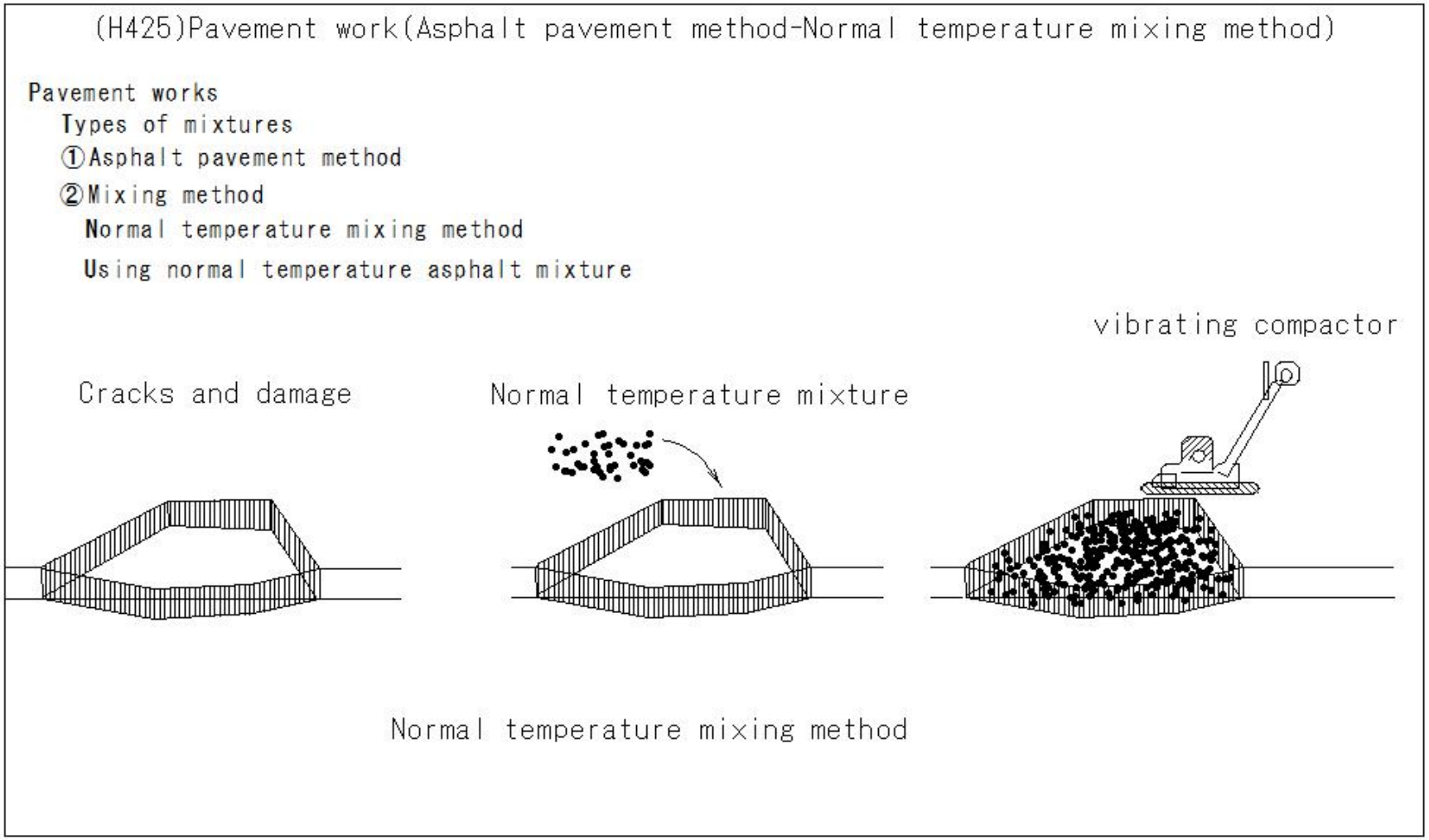
④Mixture determination

①Field mix	(%)
②Crushed stone No. 6	
③Crushed stone No. 7	
④Screenings	
⑤Coarse sand	
⑥Fine sand	
⑦Stone powder (Filler)	
⑧Asphalt	

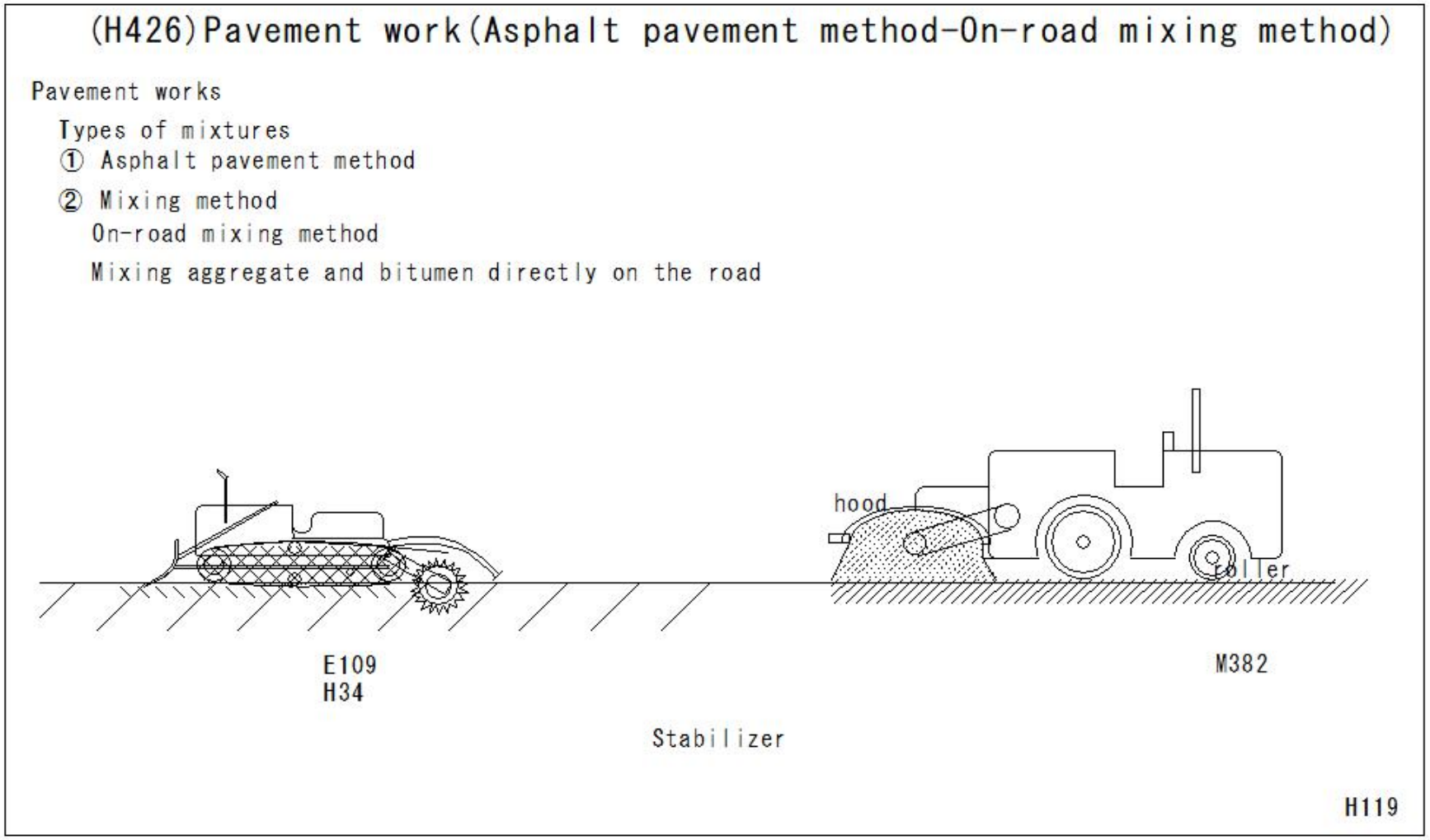
(H424)Pavement work(Asphalt pavement method-Heated mix method)



(H425)Pavement work(Asphalt pavement method-Normal temperature mixing method)



(H426)Pavement work(Asphalt pavement method-On-road mixing method)



(H427)Pavement work(Asphalt pavement method-Permeation method)

(H427)Pavement work(Asphalt pavement method-Permeation method)

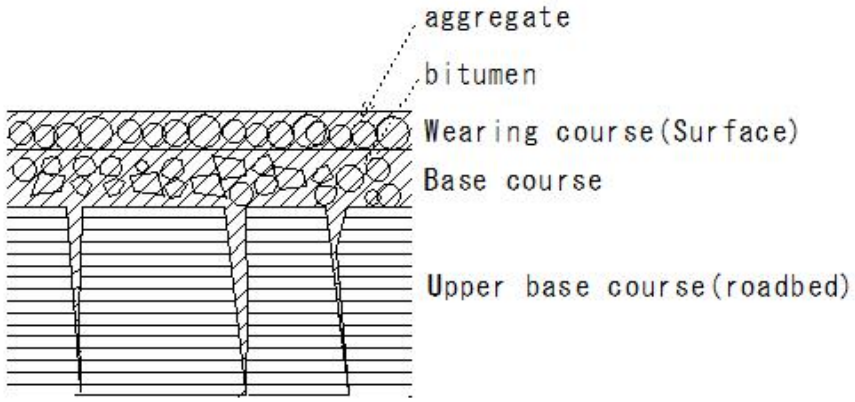
Pavement works

Types of mixtures

② Mixing method

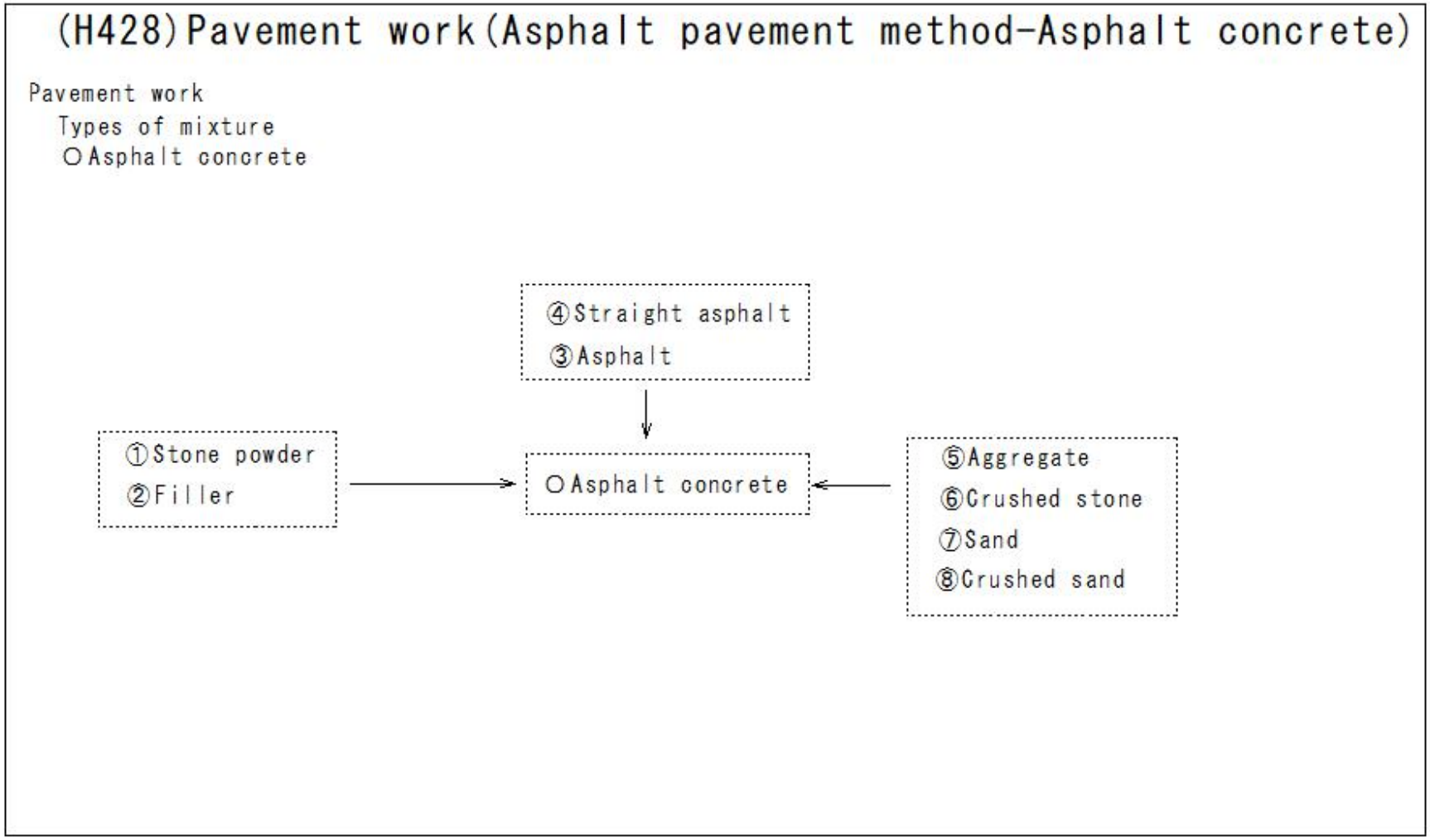
Permeation method:

Spread aggregate over the surface and sprinkle bitumen to allow it to permeate



Permeation method

(H428)Pavement work(Asphalt pavement method-Asphalt concrete)



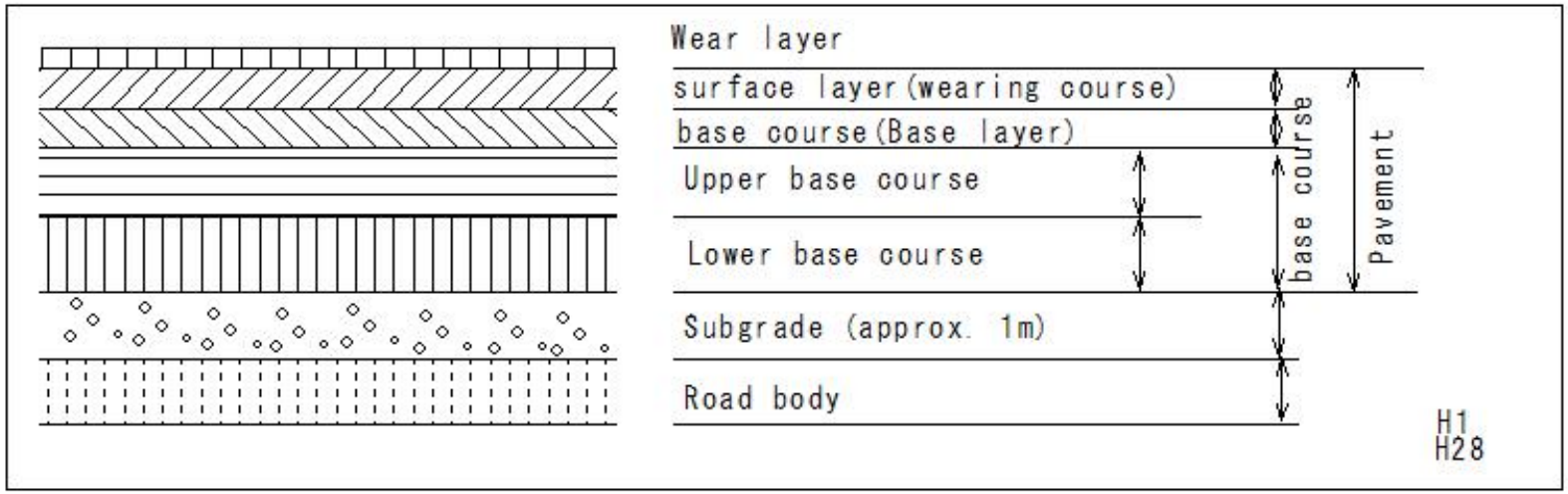
(H429)Pavement work(Type of mixture)

(H429)Pavement work(Type of mixture)

Pavement work　　Type of mixture

①Area		②General area	③Snowy area
④Use			
⑥Surface layer		①Coarse-grained asphalt concrete (20) ②Dense-grained asphalt concrete (20, 13) ③Fine-grained asphalt concrete (13) ④Dense-grained gap asphalt concrete	⑤Dense-grained asphalt concrete (20F, 13F) ⑥Fine-grained gap asphalt concrete (13F) ⑦Fine-grained asphalt concrete (13F) ⑧Dense-grained gap asphalt concrete (13F)
⑦Wear layer	⑧For wear		⑥Fine-grained gap asphalt concrete (13F) ⑦Fine-grained asphalt concrete (13F)
	⑨For slip prevention	⑨Open-grained asphalt concrete (13)	

④⑧Mixtures are used for the surface layer, which also has a slip prevention effect.



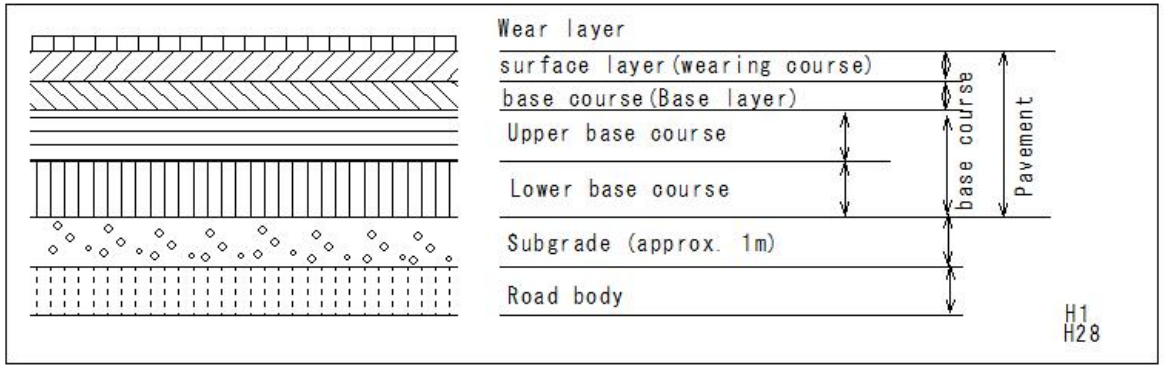
(H430)Pavement work(Type of mixture)

(H430)Pavement work(Type of mixture)

Pavement work　　Type of mixture

①Area		②General area	③Snowy area
④Use			
⑥Surface layer		①Coarse-grained asphalt concrete (20) ②Dense-grained asphalt concrete (20, 13) ③Fine-grained asphalt concrete (13) ④Dense-grained gap asphalt concrete	⑤Dense-grained asphalt concrete (20F, 13F) ⑥Fine-grained gap asphalt concrete (13F) ⑦Fine-grained asphalt concrete (13F) ⑧Dense-grained gap asphalt concrete (13F)
⑦Wear layer	⑧For wear		⑥Fine-grained gap asphalt concrete (13F) ⑦Fine-grained asphalt concrete (13F)
	⑨For slip prevention	⑨Open-grained asphalt concrete (13)	

④⑧Mixtures are used for the surface layer, which also has a slip prevention effect.



Notes on selecting mixtures

① Use ① for the base layer

② in case of there is a lot of heavy traffic, use a mixture with a large maximum particle size such as ②⑤

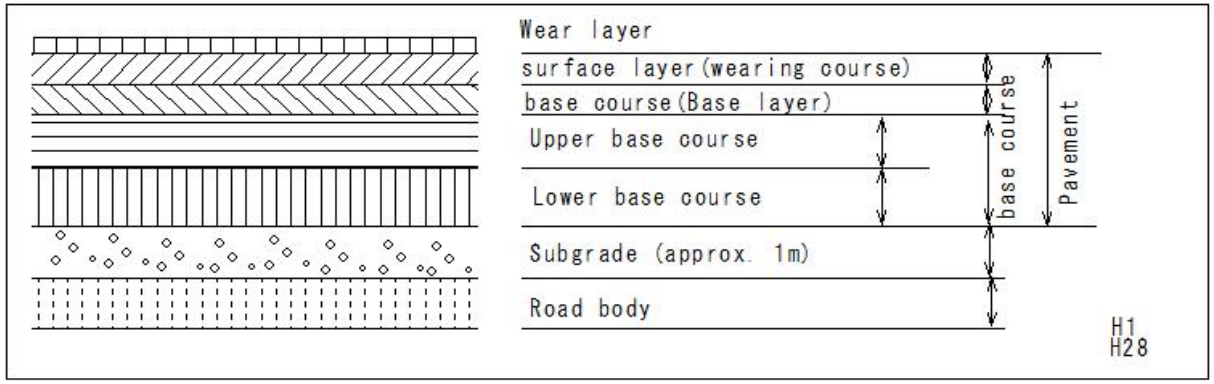
③ For paving with low traffic volume, emphasis on durability, sidewalks, bicycle paths, etc. - ③⑦

(H431)Pavement work(Type of mixture)

(H430)Pavement work(Type of mixture)

Pavement work		Type of mixture	
①Area		②General area	③Snowy area
④Use			
⑥Surface layer		①Coarse-grained asphalt concrete (20) ②Dense-grained asphalt concrete (20, 13) ③Fine-grained asphalt concrete (13) ④Dense-grained gap asphalt concrete	⑤Dense-grained asphalt concrete (20F, 13F) ⑥Fine-grained gap asphalt concrete (13F) ⑦Fine-grained asphalt concrete (13F) ⑧Dense-grained gap asphalt concrete (13F)
⑦Wear layer	⑧For wear		⑥Fine-grained gap asphalt concrete (13F) ⑦Fine-grained asphalt concrete (13F)
	⑨For slip prevention	⑨Open-grained asphalt concrete (13)	

④⑧Mixtures are used for the surface layer, which also has a slip prevention effect.



Notes on selecting mixtures

④ Use ⑨ in case of placing an abrasion layer with emphasis on slipperiness,
and ④ in case of considering durability and providing a surface layer with anti-slip properties.

⑤ Use ② for the surface layer when placing an abrasion layer on top of the surface layer in areas with heavy snowfall.

(H432)Pavement work(Type of mixture-Standard mix ratio for mixture)

Pavement work
Type of mixture

Standard mix ratio for mixture

	①Type of mixture	①	②	②	③	④	⑤	⑤	⑥	⑦	⑧	⑨
	②Finished thickness	4-6	3-5	3-5	3-5	3-5	3-5		3－5	3－4	3－5	3-4
	③Maximum grain size (mm)	20	20	13	13	13	20	13	13	13	13	13
④Percentage of passing weight (%)	25	100	100				100					
	20	95－100	95－100	100	100	100	95－100	100	100	100	100	100
	13	70－90	75－90	95－100	95－100	95－100	75－95	95－100	95－100	95－100	95－100	95－100
	5	35－55	45－65	55－70	65-80	35－55	52－72		60－80	75－90	45－65	23－45
	2.5	20－35	35－50		50－65	30－45	40－60		45－65	65－80	30－45	15－30
	0.6	11－23	18－30		25－40	20－40	25－45		40－60	40－65	25－40	8－20
	0.3	5－16	10－21		12－27	15－30	16－33		20－45	20－45	20－40	4－15
	0.15	4－12	6－16		8－20	5－15	8－21		10－25	15－30	10－25	4－10
	0.074	2－7	4－8		4－10	4－10	6－11		8－13	8－15	8－12	2－7
	⑤Amount of asphalt (%)	4. 5－6	5－7		6-8	4. 5－6. 5	6－8		6－8	7. 5－9. 5	5. 5－7. 5	3. 5－5. 5
	⑥Asphalt penetration				40－60 60－80 80－100							

⑦The amount of asphalt is expressed as a weight percentage of the total mixture

①Coarse-grained asphalt concrete (20)
②Dense-grained asphalt concrete (20, 13)
③Fine-grained asphalt concrete (13)
④Dense-grained gap asphalt concrete
⑤Dense-grained asphalt concrete (20F, 13F)
⑥Fine-grained gap asphalt concrete (13F)
⑦Fine-grained asphalt concrete (13F)
⑧Dense-grained gap asphalt concrete (13F)
⑨Open-grained asphalt concrete (13)

(H433)Pavement work(Type of mixture-Definition of asphalt concrete)

Pavement works
Types of mixtures
Definition of asphalt concrete

① Composition	② Types	③ Composite grading		④ Notes
		⑮ Passing through 2.5 mm sieve (%)	⑯ Passing through 0.6 mm sieve (%)	
⑤ Coarse aggregate	⑨ Coarse-grained asphalt concrete	(20—35)		
⑥ Fine aggregate	⑩ Dense-grained asphalt concrete	(35－50)		
⑦ Filler	⑪ Dense-grained gap asphalt concrete	(30－45)	20－40	⑱ Discontinuous grading
⑧ Asphalt heated mix	⑫ Fine-grained asphalt concrete	(50－80)		
	⑬ Fine-grained gap asphalt concrete	(45－65)	40－60	⑲ Discontinuous grading
	⑭ Open-grained asphalt concrete	(15－30)		

(H434)Pavement work(Mixture properties-General properties)

(H434)Pavement work(Mixture properties-General properties)

Pavement works

Mixture properties

Asphalt mixture

General properties

Asphalt mixtures Conditions

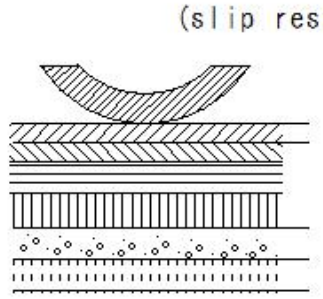
① Not prone to wave or rut deformation (stability)

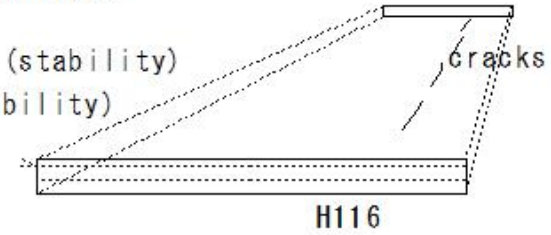
② Not prone to cracking (flexibility)

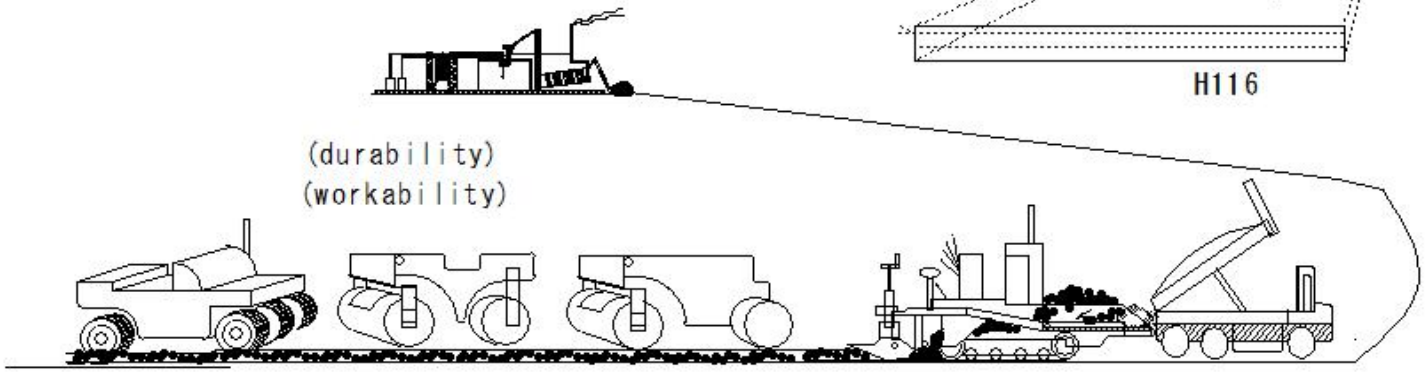
③ Not prone to slipping on the road surface (slip resistance)

④ Not brittle, water resistant, and not prone to wear (durability)

⑤ Easy to construct (workability)







(H435)Pavement work(Mixture properties-General properties)

(H435)Pavement work(Mixture properties-General properties)

Pavement works

Mixture properties

Asphalt mixture

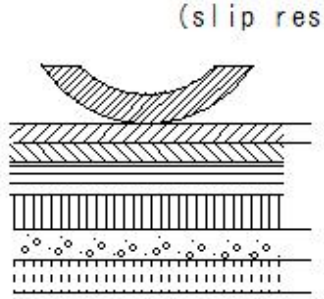
General properties

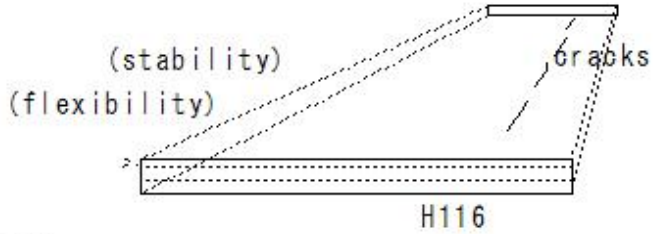
①Stability

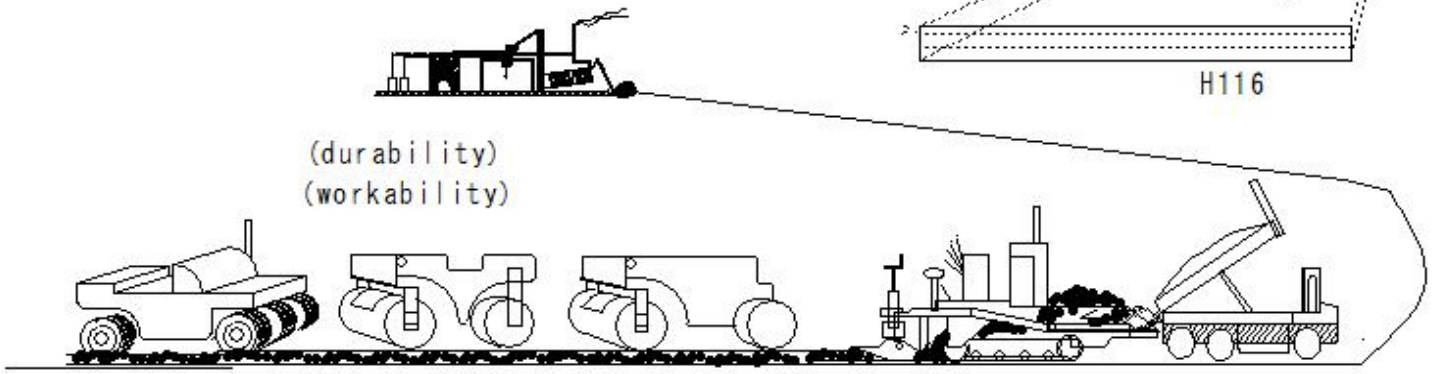
Mixture - The load of traffic vehicles causes it to flow and deform like waves at high temperatures

Resistance to such deformation

Depends on the amount of asphalt, and in case of there is too much, stability is compromised







(H436)Pavement work(Mixture properties-General properties)

(H436)Pavement work(Mixture properties-General properties)

Pavement works

Mixture properties

Asphalt mixture

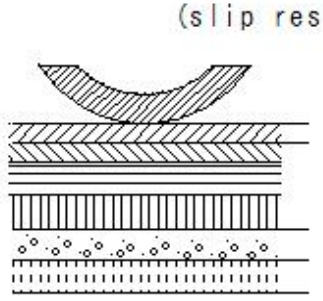
General properties

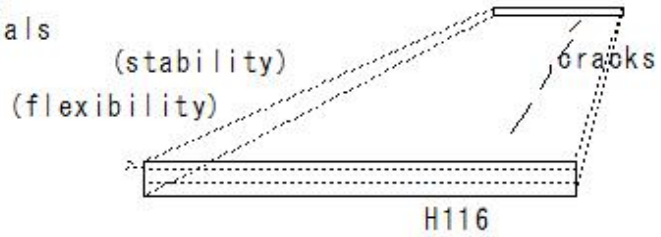
②Flexibility

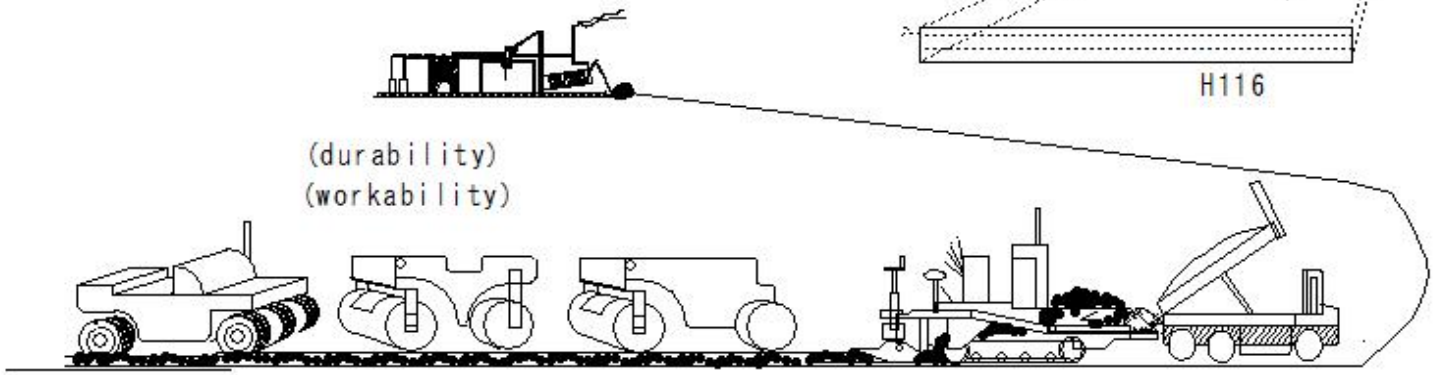
・Pavement works Mixture properties ②Flexibility The property of the mixture to adapt to deformations in the roadbed and subgrade and resist cracking ・The more asphalt

・The more asphalt there is, the greater the flexibility

・Significantly affected by the properties of the materials used and the aggregate granularity







(H437)Pavement work(Mixture properties-General properties)

(H437)Pavement work(Mixture properties-General properties)

Pavement works

Mixture properties

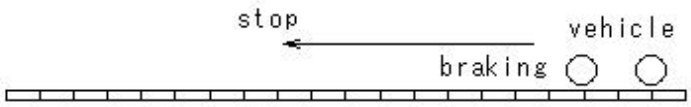
Asphalt mixture

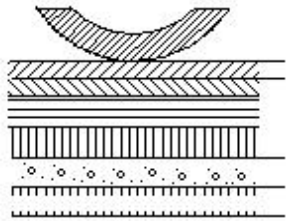
General properties

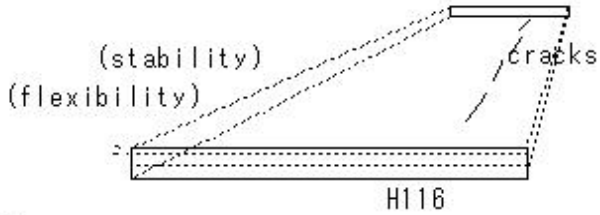
③ Slip resistance

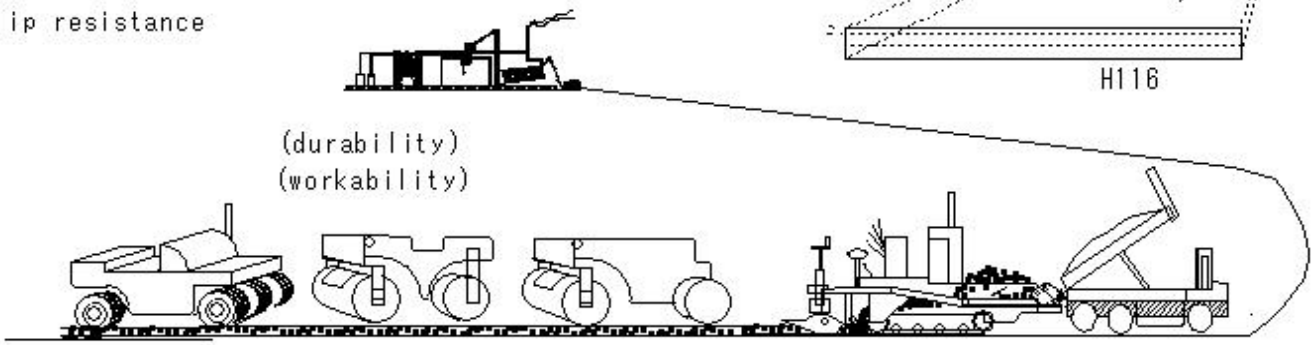
・Refers to the surface ability of the mixture to provide enough friction to stop a vehicle within an appropriate distance when braking

・The more asphalt there is, the more quickly it becomes slippery

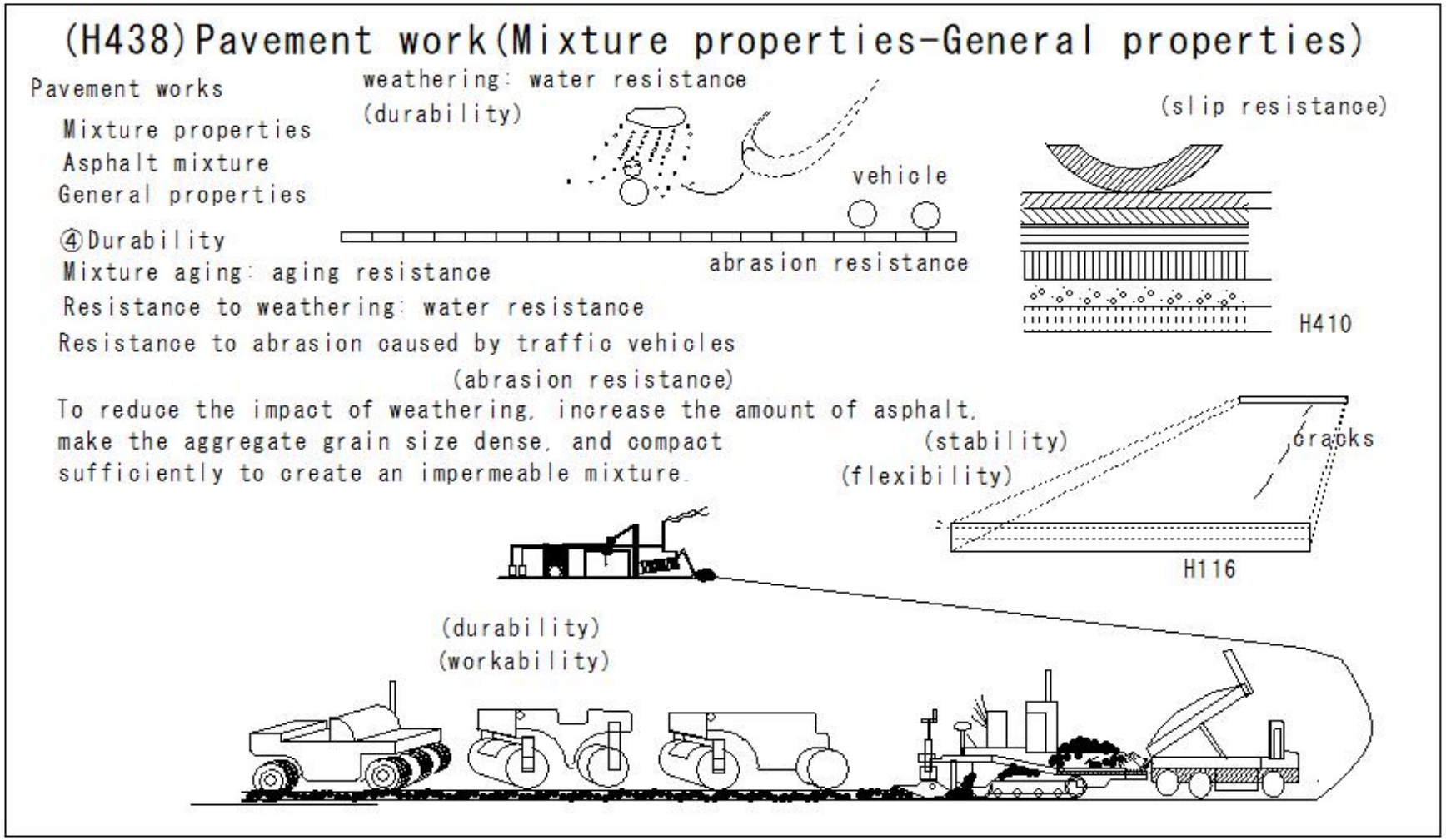








(H438)Pavement work(Mixture properties-General properties)



(H439)Pavement work(Mixture properties-General properties)

(H439)Pavement work(Mixture properties-General properties)

Pavement works

Mixture properties

Asphalt mixture

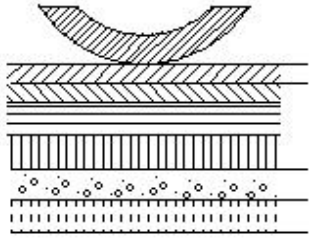
General properties

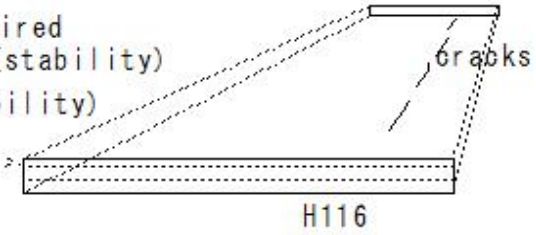
⑤ Workability

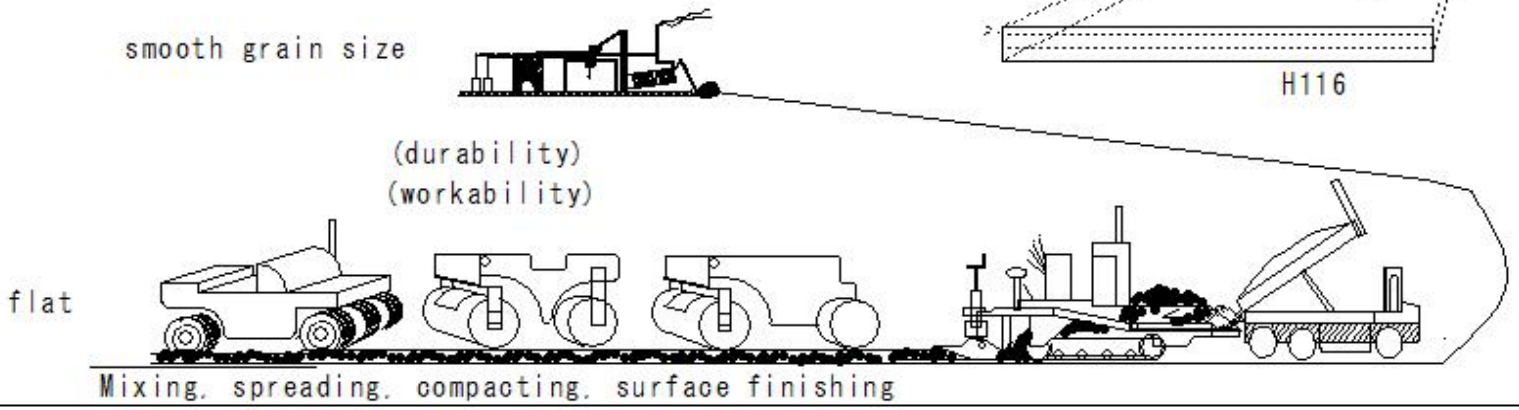
Mixing, spreading, compacting, surface finishing, etc. are easy

The properties of the mixture are such that it does not separate and can be made uniform and flat

To improve workability, a mixture with a small maximum particle size and smooth grain size is required





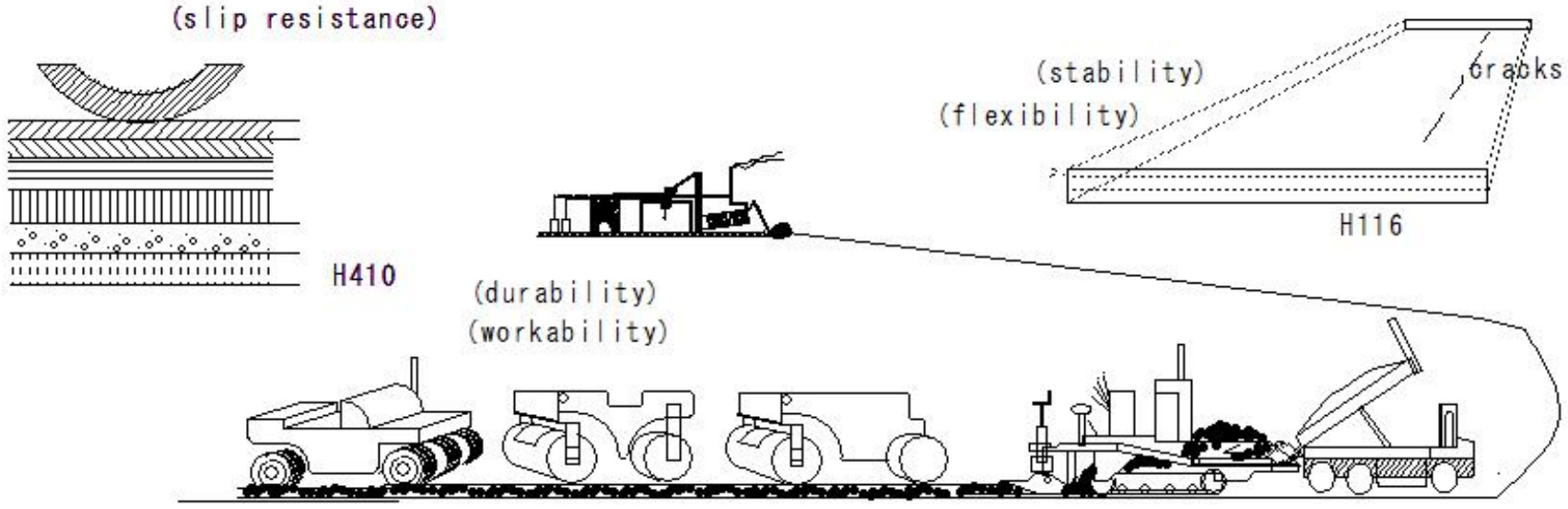


(H440)Pavement work(Mixture properties-General properties)

Pavement works

Comparison of mixture properties

①Properties	②Stability	③ Flexibility	④Slip resistance	⑤Durability	⑥ Workability
⑦Types					
①Coarse-grained asphalt concre	Excellent	Small	Large	Slightly good	Easy to construct
②Dense-grained asphalt concret	Excellent	Slightly large	Slightly large	Excellent	Easy to construct
③Fine-grained asphalt concrete	Slightly excellent	Slightly large	Slightly large	Excellent	Easy to construct
④Open-grained asphalt concrete	Slightly inferior	Small	Large	Inferior	Slightly to construct



(H441)Pavement work(Mixture properties-Tests on mixtures)

(H441)Pavement work(Mixture properties-General properties)

Pavement works

Tests on mixtures

①Types and purposes of tests

	①Types and purposes of tests	②Purpose
③Mixture design	④Density measurement ⑤Stability test	①Determine the optimum amount of asphalt in the mixture ②Check the type and density of aggregates
⑥Quality control	⑦Density measurement ⑧Extraction test ⑨Aggregate grain size test ⑩Stability test	①Is the amount of asphalt mixed as designed? ②How much aggregate variation is there? ③Is the mixture sufficiently compacted?

(H442)Pavement work(Mixture properties-Tests on mixtures)

(H442)Pavement work(Mixture properties-Tests on mixtures)

Pavement works

Tests on mixtures

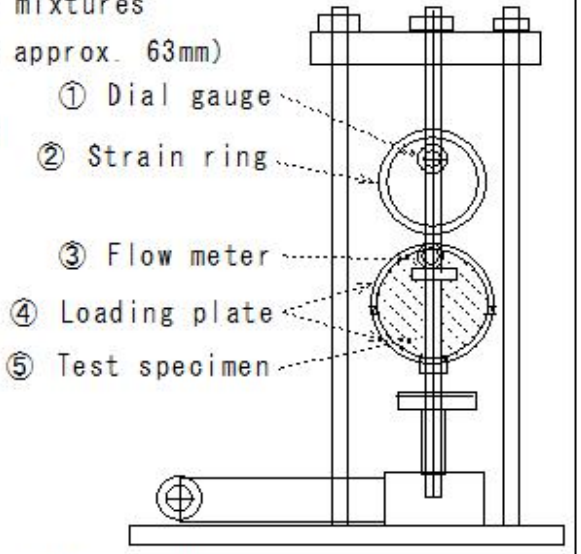
○Stability test

Asphalt mixture

Based on past experience, it is sufficient if the strength (stability) is greater than a certain limit

○Marshall stability test

- Maximum aggregate particle size: 25mm or less - used for heated mixtures
- Cylindrical mixture specimen (diameter approx. 100mm, thickness approx. 63mm)
- Two loading plates
- Specified temperature (60℃) Specified loading speed: 50mm/1min
- Maximum load (stability): specimen breaks
- Measure the corresponding deformation (flow value)



H70 Marshall testing machine

(H443)Pavement work(Mixture properties-Tests on mixtures)

(H443)Pavement work(Mixture properties-Tests on mixtures)

Pavement works

Tests related to mixtures

○Standard values for Marshall tests

①Variation in stability and flow values

②Test procedures

③Variation in aggregate during sample preparation

④Inaccurate measurement of aggregate and asphalt (sensitivity of scale)

⑤Variation in mixing of asphalt mixture (mixing temperature, time)

⑥Aggregate separation when placed in mold

⑦Variation in compaction temperature and compaction time

⑧Effect of handling when removing from mold

⑨Variation in time for leaving specimens

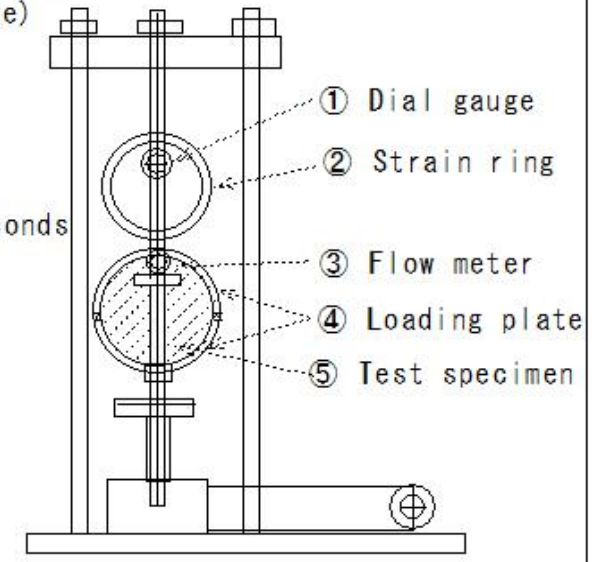
⑩Variation in time for soaking in 60℃ water tank: within 30 seconds

⑪Uneven stability measurement time (perform within 30 seconds)

⑫Contamination of loading plate: amount of grease applied

⑬Timing of taking flow meter and contamination of guide rod

○Standard values for Marshall tests



Marshall testing machine

H70

(H444)Pavement work(Mixture properties-Tests on mixtures)

(H444)Pavement work(Mixture properties-Tests on mixtures)

Pavement works

Tests related to mixtures

○Standard values for Marshall tests

① Variation in stability and flow values

⑭ Mixture composition

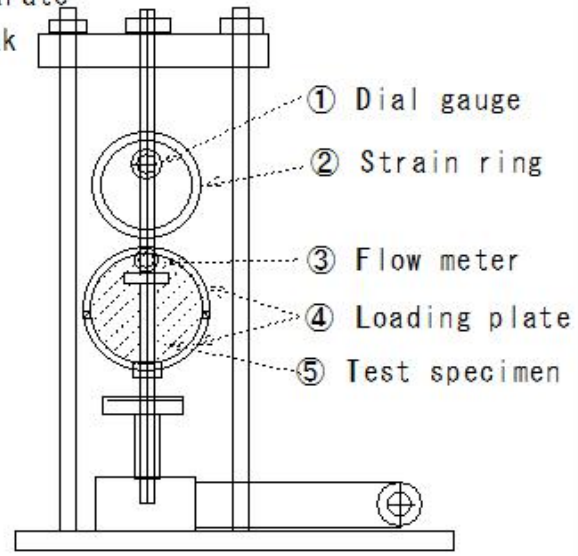
⑮ Mixtures with large maximum dimensions: Aggregates easily separate

⑯ Mixtures using soft stone and flat aggregates: Aggregates break

⑰ Mixtures using aggregates with high water absorption:
Differences occur in the amount of asphalt absorbed

⑱ Mixtures with a lot of filler: Mixing is prone to unevenness

○Standard values for Marshall tests



Marshall testing machine

H70

(H445)Pavement work(Mixture properties-Tests on mixtures)

(H445)Pavement work(Mixture properties-Tests on mixtures)

Pavement works

Tests related to mixtures

○Standard values for Marshall tests

① Variation in stability and flow values

⑲Mechanism of test machine

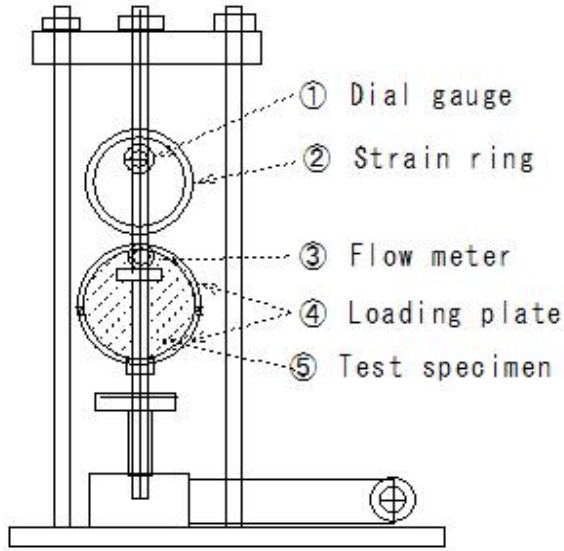
⑳Deformation of strain ring and dial gauge play

(21)Insufficient motor capacity (V-belt tension)

(22)Playback of flow meter

(23)Effect of high and low voltage on motor

○Standard values for Marshall tests



Marshall testing machine

H70

(H446)Pavement work(Mixture properties-Tests on mixtures)

(H446)Pavement work(Mixture properties-Tests on mixtures)

Pavement works

Tests on mixtures

○Standard values　for Marshall tests

①Type of mixture	①	②	③	④	⑤	⑥	⑦	⑧	⑨
②Number of tamping times: C traffic or more	75	75	75	75	50	50	50	50	75
②Number of tamping times: B traffic or less	50	50	50	50	50	50	50	50	50-80
③Void ratio (%)	3－7	3－6	3－6	3－7	3－5	3－5	2－5	3－5	-
④Saturation (%)	65－85	70－85	70－85	65－85	75－85	75－85	75－90	75－85	-
⑤Stability (kg)	500or more	500or more	500or more	500or more	500or more	500or more	350or more	500or more	350or more
⑥Flow value (1/100 cm)	20－40	20－40	20－40	20－40	20－40	20－40	20－30	20－40	20－40

①Coarse-grained asphalt concrete (20)
②Dense-grained asphalt concrete (20, 13)
③Fine-grained asphalt concrete (13)
④Dense-grained gap asphalt concrete
⑤Dense-grained asphalt concrete (20F, 13F)
⑥Fine-grained gap asphalt concrete (13F)
⑦Fine-grained asphalt concrete (13F)
⑧Dense-grained gap asphalt concrete (13F)
⑨Open-grained asphalt concrete (13)

(H447)Pavement work(Asphalt mixture mix design)

(H447)Pavement work(Asphalt mixture mix design)

Pavement work

Mixture mix

○Asphalt mixture mix design

Marshall stability test

Mix design procedure

a: Specific gravity and water absorption test

b: Tests for wear, stability, harmful substance content, etc.

①Aggregate used

②Particle size test

③Calculation of aggregate mix

④Determining aggregate mix

⑤Aggregate calculation

⑥Preparation of Marshall specimen

⑦Measurement of specimen density

⑧Marshall stability test

⑨A Calculated amount of asphalt

⑩ Viscosity test

⑪ Specific gravity test

⑫ General properties

⑬ Penetration test

⑭ Softening point test

⑮ Elongation test

⑯ Evaporation amount test

⑰ Flash point test

⑱ Calculation of characteristic values

⑲ Measured density

⑳ Theoretical maximum density

㉑ Asphalt volume ratio

㉒ Void ratio

㉓ Saturation

㉔ Stability measurement

㉕ Flow value

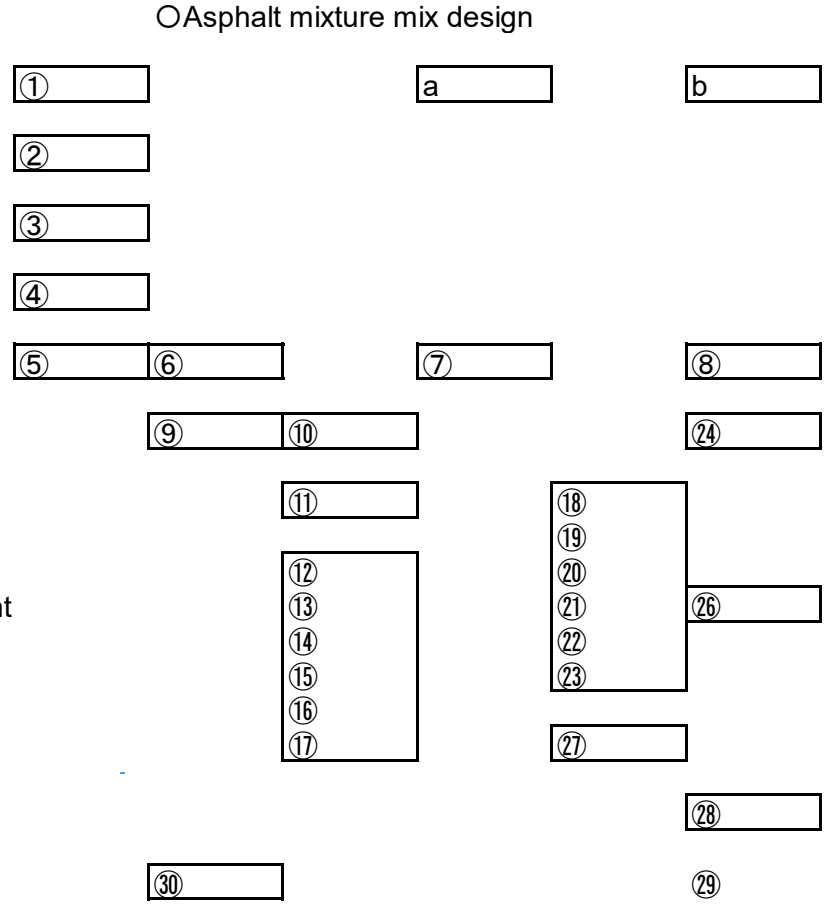
㉖ Drawing

㉗ Comparison of standard values

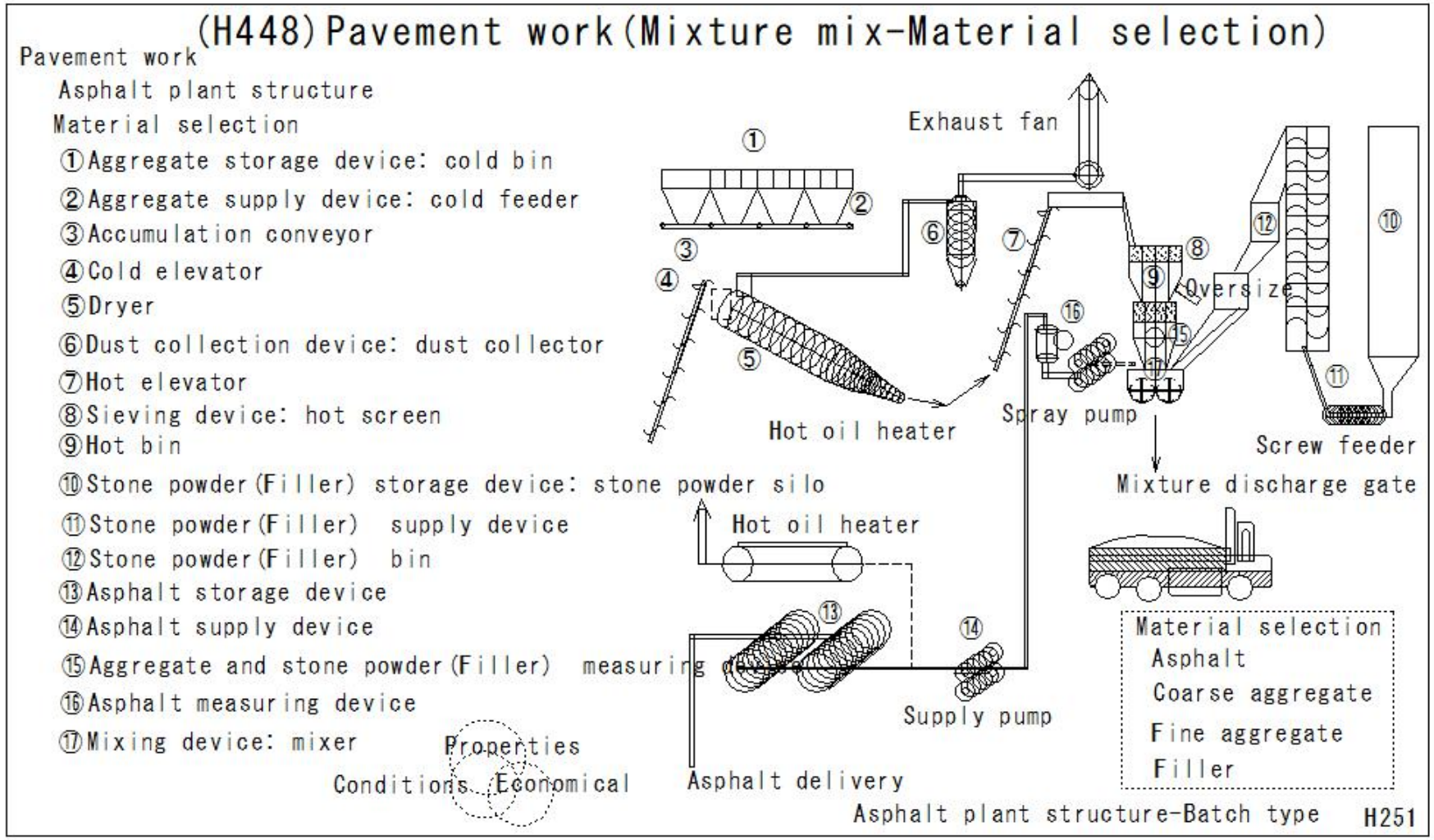
㉘ Determination of design asphalt amount

㉙ Actual mix

㉚Asphalt used



(H448)Pavement work(Mixture mix-Material selection)



(H449)Pavement work(Material selection-Asphalt)

(H449)Pavement work(Material selection-Asphalt)

Pavement work

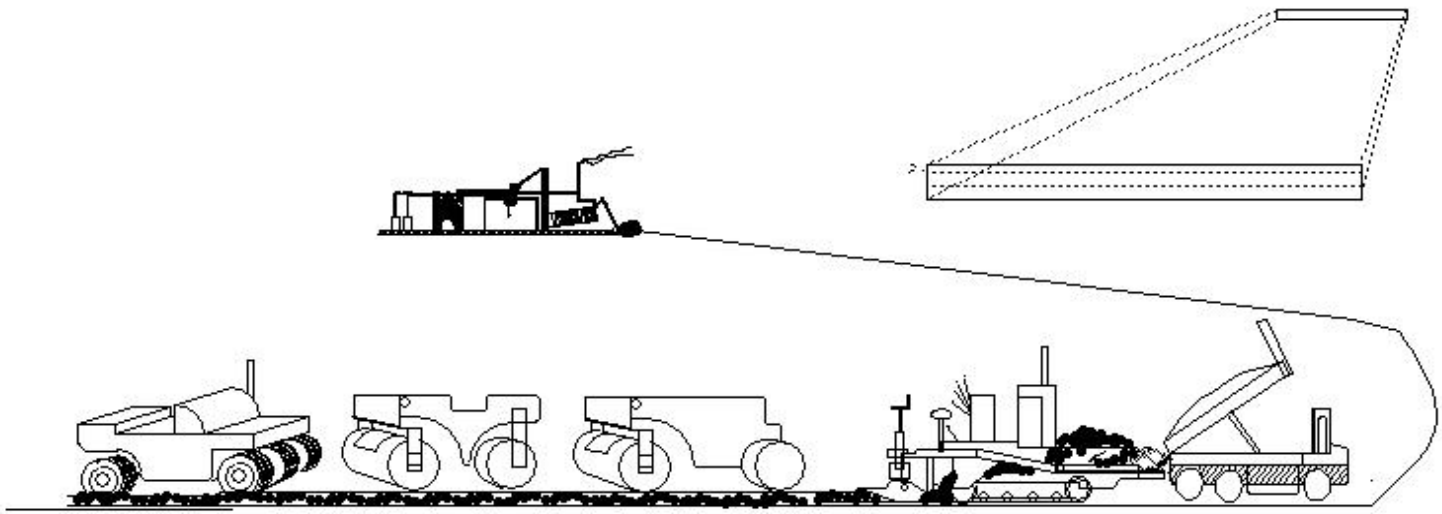
○Selection of materials

Mixture materials

○Asphalt

Penetration 60-150

Straight asphalt is used



(H450)Pavement work(Material selection-Aggregate)

(H450)Pavement work(Material selection-Aggregate)

Pavement work

○Selection of materials

Mixture materials

○Aggregate

Coarse aggregate - crushed stone - local product

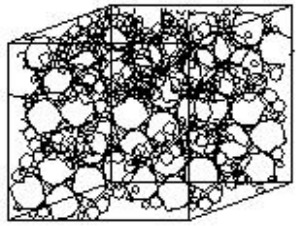
Fine aggregate - river sand, crushed sand (screenings)

Mixture of coarse and fine sand

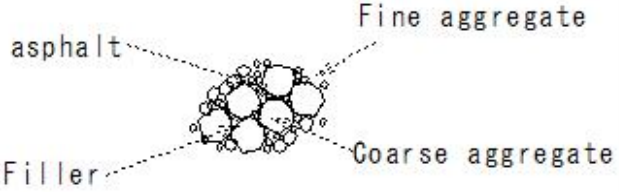
Filler: limestone stone powder

Function of filler

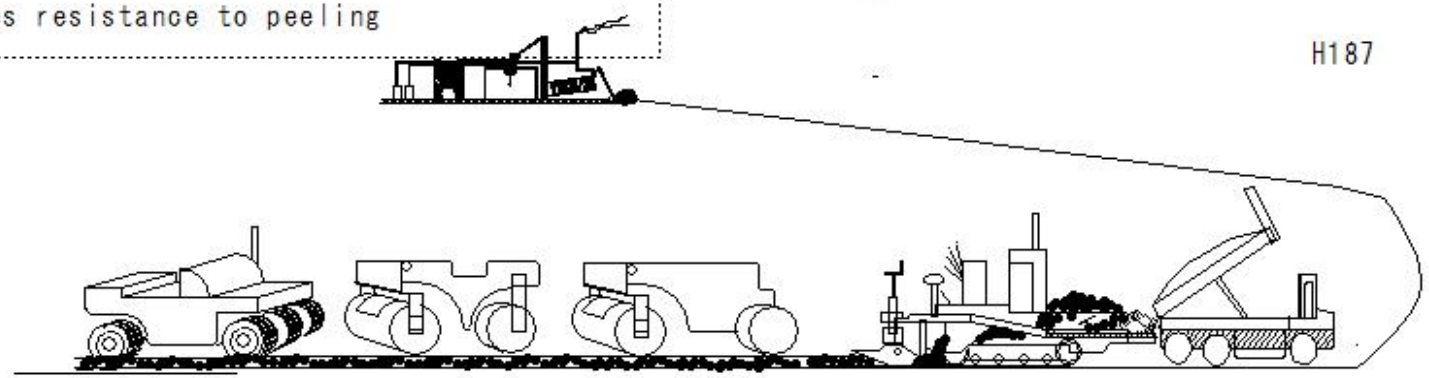
- Improves the viscoelastic properties of asphalt
- Fills gaps between coarse and fine aggregates
- Reduces temperature sensitivity
- Increases resistance to peeling



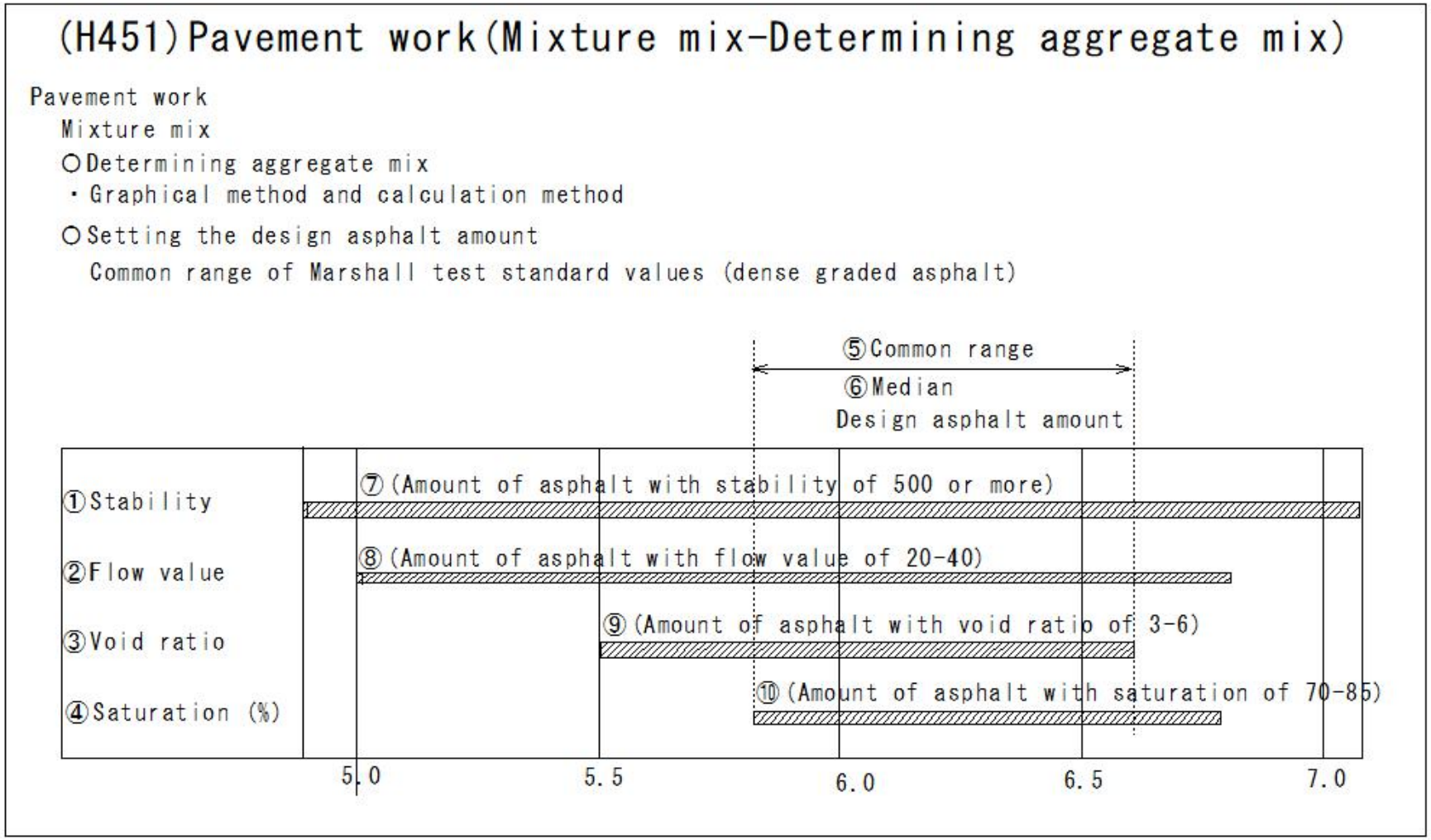
H418



H187



(H451)Pavement work(Mixture mix-Determining aggregate mix)



(H452)Pavement work(Mixture mix-Determining aggregate mix)

(H452)Pavement work(Mixture mix-Determining aggregate mix)

Pavement works

Mixture mix

○Determining the mix

①Factor　　Factors that affect the properties of the mixture

⑧Characteristics	②Maximum particle size	③Aggregate with many corners	④Amount of fine sand	⑤Amount of stone powder	⑥Asphalt penetration	⑦Aggregate porosity
⑨Stability	+	+		+	-	-
⑩Flow value	-	-		+	+	+
⑪Porosity		+	+	-		+
⑫Saturatio		-	-	+		
⑬Aggregate		+	+	-		
⑭Constructibility	-	-		-	+	+

(H453)Pavement work(Mixture mix-Asphalt test results)

(H453)Pavement work(Mixture mix-Asphalt test results)

Pavement work

Mixture mix

Asphalt test results

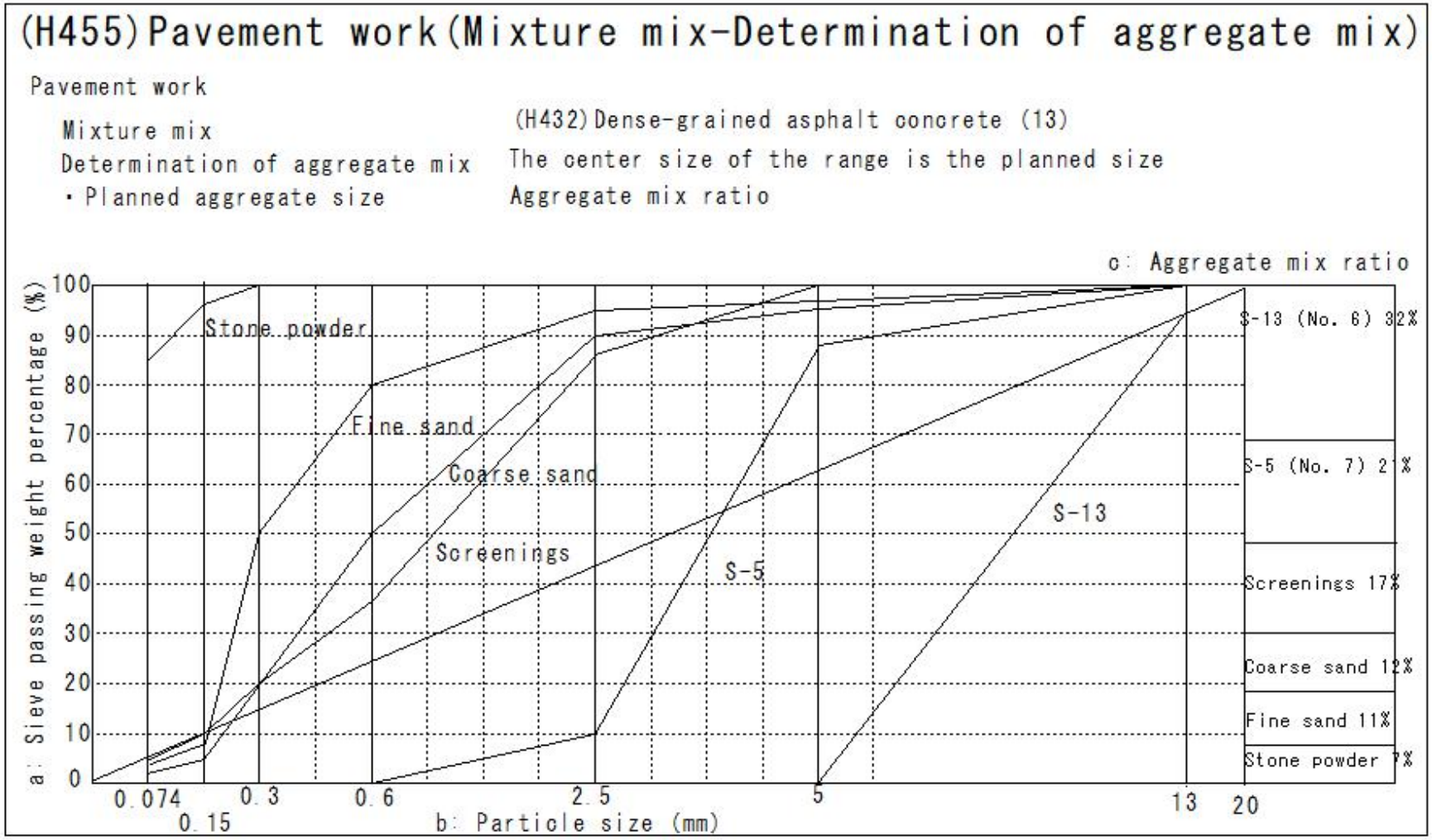
①Product name	② Specific gravity (25℃/25℃)	③ Penetration (25℃ 100g 5sec)	④ Softening point (℃)	⑤Flash point (℃)	⑥ Elongation (15℃) cm	⑦ Evaporation amount (%)	⑧ Penetration after evaporation (%)	⑨Saybolt-Flour viscosity (sec)		
								140℃	160℃	180℃
⑩Straight asphalt 60/80	1.030	72	46.5	300	140	0.01	92	175	77	40

(H454)Pavement work(Mixture mix-Aggregate test results)

(H454)Pavement work(Mixture mix-Aggregate test results)
Pavement work
Mixture mix
Aggregate test results

①Type of aggregate		②Coarse aggregate		⑤Fine aggregate			⑨Filler
		③S-13 (No. 6)	④S-5 (No. 7)	⑥ Screenings	⑦Coarse sand	⑧Fine sand	⑩Stone powder
⑪Sieve passing weight percentage (%)	20㎜	100					
	13	98	100		100	100	
	5	0	87	100	97	99	
	2.5		10	86	90	95	
	0.6		0	34	50	80	
	0.3			19	20	49	100
	0.15			11	4	9	98
	0.074			5	1	2	83
⑫Apparent specific gravity		2.74	2.741	2.713	2.640	2.658	2.710
⑬Water absorption rate (%)		0.9	1.3	1.4	0.9	1.2	0.1
⑭Origin							

(H455)Pavement work(Mixture mix-Determination of aggregate mix)



(H456)Pavement work(Mixture mix-Calculation of composite grading)

Pavement work

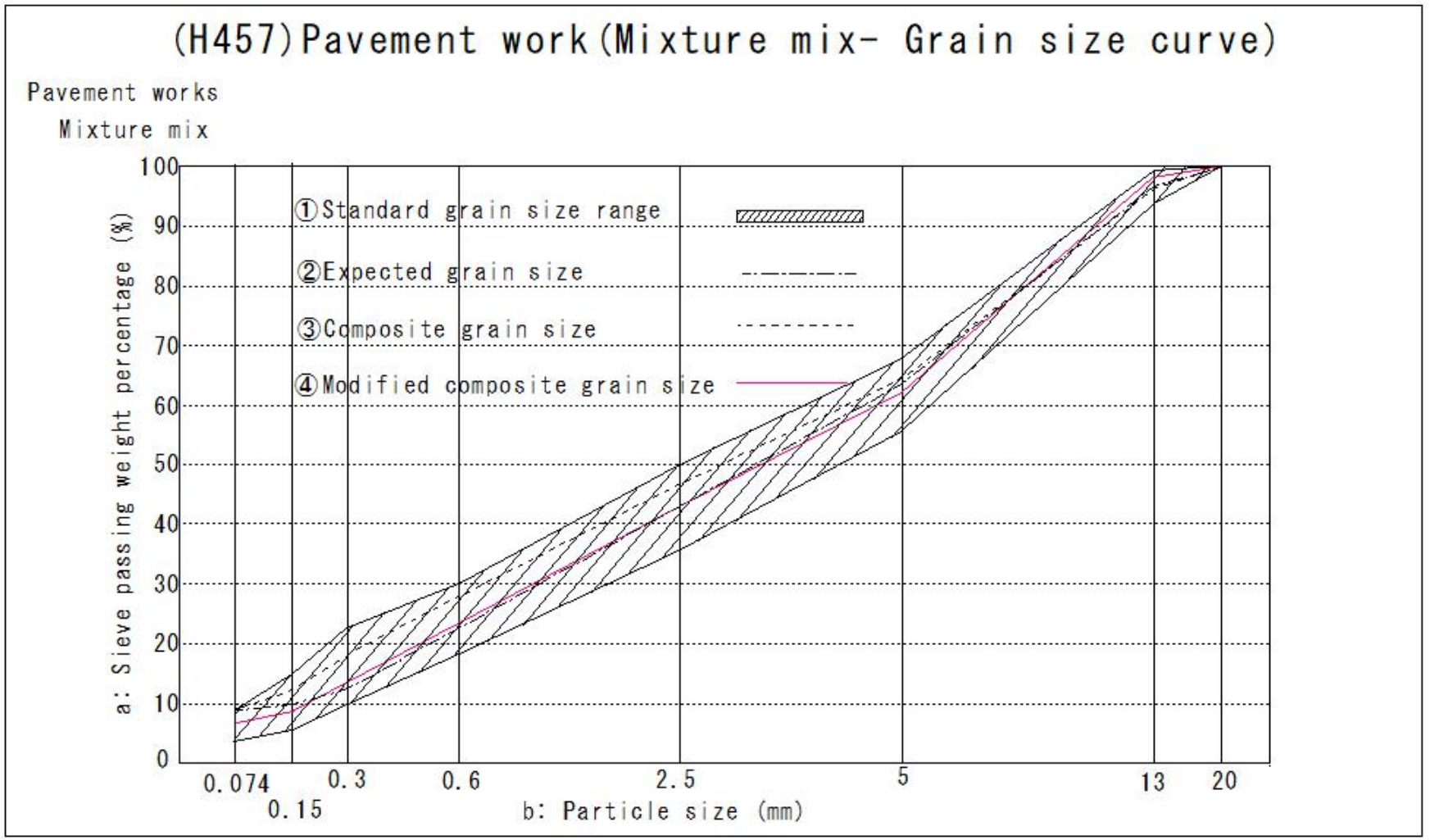
Mixture mix

Calculation of composite grading

①Type of aggregate	③	④	⑥	⑦	⑧	⑩	⑥Mixing ratio of each aggregate						⑦ Composite grading	⑧ Expected grading
②Mixing ratio (%) (A)	32	21	17	12	11	7	(A)×(B)							
③Corrected mixing ratio (A)'	34	21	17	12	10	6	(A')×(B)							
④Passing percentage (%) ⑤Nominal sieve size (mm)	B						③	④	⑥	⑦	⑧	⑩		
20㎜	100						32(34)	21	17	12	11(10)	7(6)	100(100)	100
13	98	100		100	100		31.4(33.3	21	17	12	11(10)	7(6)	99.4(99.3	95-100
5	0	87	100	97	99			18.3	17	11.6	10.9(9.9)	7(6)	64.8(62.8	63
2.5		10	86	90	95			2.1	14.6	10.8	10.5(9.5)	7(6)	45(43)	43
0.6		0	34	50	80				5.8	6	8.8(8)	7(6)	27.6(25.8	24
0.3			19	20	49	100			3.2	2.4	5.4(4.9)	7(6)	18(16.5)	16
0.15			11	4	9	98			1.9	0.5	1(0.9)	6.9(5.9)	10.3(9.2)	11
0.074			5	1	2	83			0.9	0.1	0.2(0.2)	5.8(5)	7(6.2)	6

③ S-13 (No. 6) 32%
④ S-5 (No. 7) 21%
⑤ Fine aggregate
⑥ Screenings 17%
⑦ Coarse sand 12%
⑧ Fine sand 11%
⑨ Filler
⑩ Stone powder 7%

(H457)Pavement work(Mixture mix- Grain size curve)



(H458)Pavement work(Mixture mix- Determined mix ratio and composite grading)

(H458)Pavement work(Mixture mix- Determined mix ratio and composite grading)

Pavement work

Mixture mix

Determined mix ratio and composite grading

Type of aggregate						Mixing ratio (%)		
Coarse aggregate	S-13 (No. 6)					34		
	S-5 (No. 7)					21		
	Screenings					17		
Fine aggregate	Coarse sand					12		
	Fine sand					10		
Filler	Stone powder					6		
Sieve size (mm)	20	13	5	2.5	0.6	0.3	0.15	0.074
Composite grading	100	99.3	62.8	43	25.8	16.5	9.2	6.2

(H459)Pavement work(Mixture mix- Determination of the design asphalt amount)

(H459)Pavement work(Mixture mix- Determination of the design asphalt amount)

Pavement work

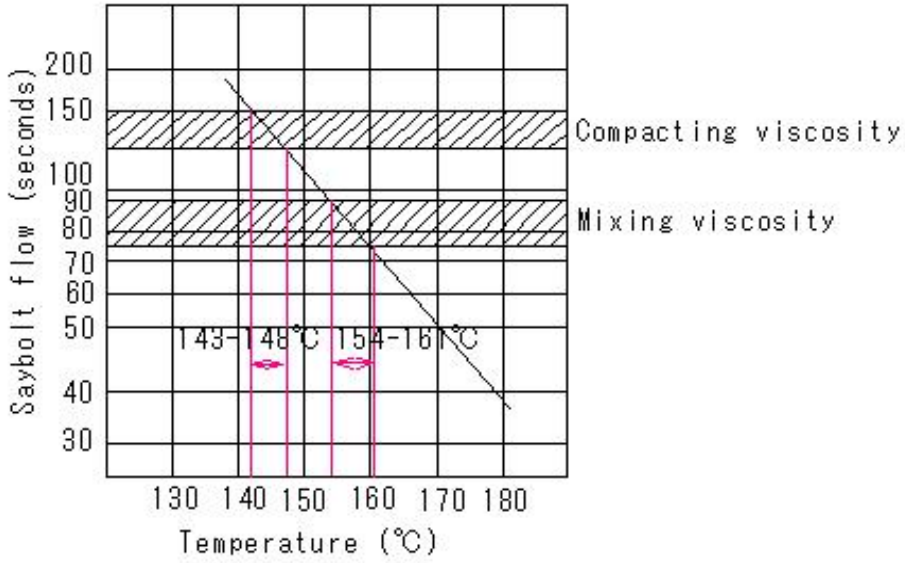
Mixture mix

Determination of the design asphalt amount

(H432) Asphalt amount range - 5.0-7.0%

Prepare 3 specimens using asphalt amounts of 5.0, 5.5, 6.0, 6.5, and 7.0%

Prepare specimens and stability test - conform to Marshall stability test method



Temperature-viscosity relationship of asphalt used

(H460)Pavement work(Mixture mix- Determination of the design asphalt amount)

(H460)Pavement work(Mixture mix- Determination of the design asphalt amount)

Pavement work

Mixture mix

Determining the amount of asphalt designed

Trial compaction results

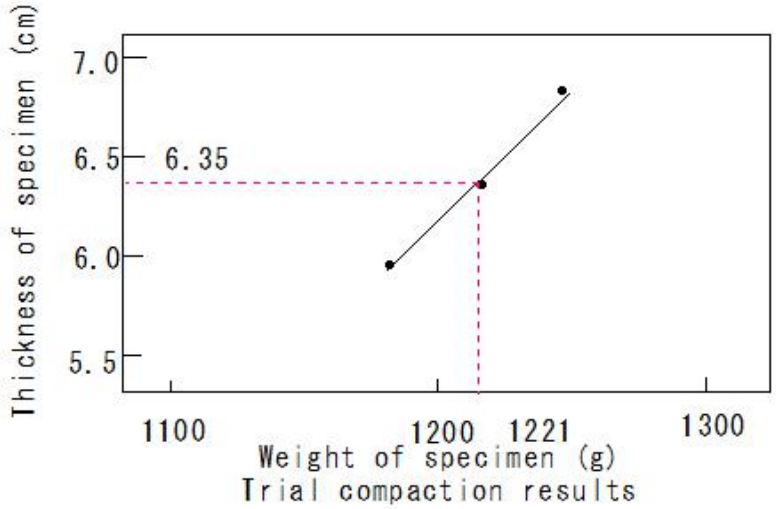
① Creation of specimen

Using 6% asphalt

Trial compaction with three aggregate weights of 1200g, 1150g, and 1100g

Aggregate weight per standard specimen to achieve the specified thickness

1221 × 0.94 = 1148 ≒ 1150g



(H461)Pavement work(Mixture mix- Amount of material required for one test piece)

(H461)Pavement work(Mixture mix- Amount of material required for one test piece)

Pavement work

Mixture mix

Determining the amount of asphalt designed

Amount of material required for one test piece

Materials Test piece (g)

Type	Aggregate mix ratio (%)	5.0%	5.5%	6.0%	6.5%	7.0%
S-13 (No. 6)	34	391	391	391	391	391
S-5 (No. 7)	21	241.5	241.5	241.5	241.5	241.5
Screenings	17	195.5	195.5	195.5	195.5	195.5
Coarse sand	12	138	138	138	138	138
Fine sand	10	115	115	115	115	115
Stone powder	6	69	69	69	69	69
Aggregate weight	-	1150	1150	1150	1150	1150
Amount of asphalt	-	60.5	66.9	73.4	79.9	86.6
Mixture weight	-	1210.5	1216.9	1223.4	1229.9	1236.5

(H462)Pavement work(Mixture mix- Calculating the theoretical maximum density)

(H462)Pavement work(Mixture mix- Calculating the theoretical maximum density)
Pavement work
Mixture mix
Determining the amount of asphalt designed
Calculating the theoretical maximum density

Calculating the theoretical maximum density

Type of aggregate	Mix ratio	Specific gravity of	B/C
A	B	C	D
S-13 (No. 6)	34	2.74	12.409
S-5 (No. 7)	21	2.741	7.661
Screenings	17	2.713	6.266
Coarse sand	12	2.64	4.545
Fine sand	10	2.658	3.762
Stone powder	6	2.71	2.214

ΣD=K=36.857

Specific gravity of dry aggregate = 100/K = 2.713

Asphalt mixing	Specific gravity of	E/F	K（100－E）／100	G＋H	Theoretical
E	F	G	H	I	J
5.0	1.030	4.854	35.014	39.868	2.508
5.5	1.030	5.340	34.830	40.170	2.489
6.0	1.030	5.825	34.646	40.471	2.471
6.5	1.030	6.311	34.461	40.772	2.453
7.0	1.030	6.796	34.277	41.073	2.435

(H463)Pavement work(Mixture mix-Marshall stability test results)

Determination of the design asphalt amount　　Marshall stability test results

A: Test piece No.	B: Asphalt mixture ratio (%)	C: Thickness (cm)	D: Weight (g) in air	E: Weight (g) in water	F: Volume (cm3)	G: Density (g/cm3): Actual measurement	H: Density (g/cm3): Theoretical	I: Asphalt volume ratio (%)	J: Porosity (%)	K: Saturation (%)	L: Stability (kg)	M: Flow value (1/100 cm)
A	B	C	D	E	F	G	H	I	J	K	L	M
					D-E	D/F		B×G/(Specific gravity of asphalt)	100-100×G/H	I/(I+J)		
1	5.0	6.28	1198	688.7	509.3	2.352					1156	29
2	5.0	6.24	1193.4	680.3	503.1	2.352					1088	26
3	5.0	6.32	1201.4	690.6	510.8	2.352					1037	25
(average)						(2.352)	(2.508)	(11.4)	(6.2)	(64.8)	(1094)	(27)
4	5.5	6.22	1181.3	683.7	497.6	2.374					1105	28
5	5.5	6.28	1198.1	692.6	505.5	2.37					1122	28
6	5.5	6.23	1184.2	685.6	498.6	2.375					1088	28
(average)						(2.373)	(2.489)	(12.7)	(4.7)	(73)	(1105)	(28)
7	6.0	6.23	1197.7	695.7	502.0	2.386					1275	38
8	6.0	6.28	1216.4	707.4	509.0	2.39					1207	31
9	6.0	6.22	1197	693.9	503.1	2.379					1105	34
(average)						(2.385)	(2.471)	(13.9)	(3.5)	(79.9)	(1196)	(34)
10	6.5	6.29	1211.9	704.4	507.5	2.388					1190	40
11	6.5	6.26	1203.8	698.2	505.6	2.381					1088	37
12	6.5	6.27	1212.3	706.1	506.2	2.395					1122	37
(average)						(2.388)	(2.453)	(15.1)	(2.6)	(85.3)	(1133)	(38)
13	7.0	6.27	1207.8	701.0	506.8	2.383					1071	42
14	7.0	6.35	1217.6	704.3	513.3	2.372					1071	46
15	7.0	6.28	1207.7	700.7	507.0	2.382					1020	45
(average)						(2.379)	(2.435)	(16.2)	(2.3)	(87.6)	(1054)	(44)

(H464)Pavement work(Mixture mix-Characteristic values of the specimen)

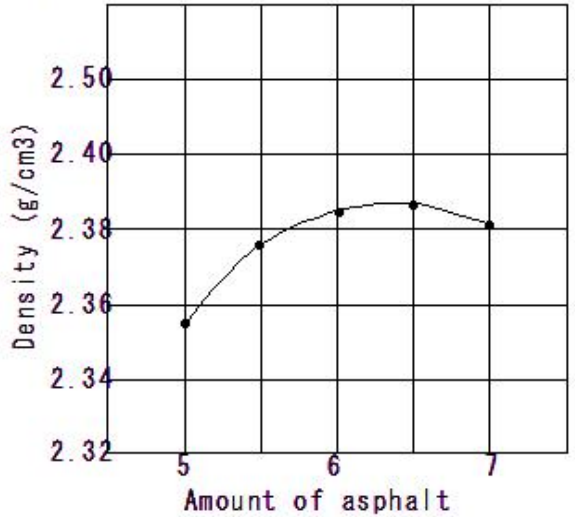
(H464)Pavement work(Mixture mix-Characteristic values of the specimen)
Pavement work
Mixture mix
Determination of the design asphalt amount
○Marshall stability test results
Characteristic values of the specimen

Asphalt mixture ratio (%) / Characteristic value	5.0	5.5	6.0	6.5	7.0
Density (g/cm3): Actual measurement	2.352	2.373	2.385	2.388	2.379
Density (g/cm3): Theoretical	2.508	2.489	2.471	2.453	2.435
Asphalt volume ratio (%)	11.4	12.7	13.9	15.1	16.2
Porosity (%)	6.2	4.7	3.5	2.6	2.3
Aggregate porosity (%)	17.6	17.4	17.4	17.7	18.5
Saturation (%)	64.8	73	79.9	85.3	87.6
Stability (kg)	1094	1105	1196	1133	1054
Flow value (1/100 cm)	27	28	34	38	44

(H465)Pavement work(Mixture mix-Determining the amount of asphalt designed)

(H465)Pavement work(Mixture mix-Determining the amount of asphalt designed)

Pavement work
Mixture mix
Determining the amount of asphalt designed
○Amount of asphalt and properties of the mixture
Density (g/cm3)

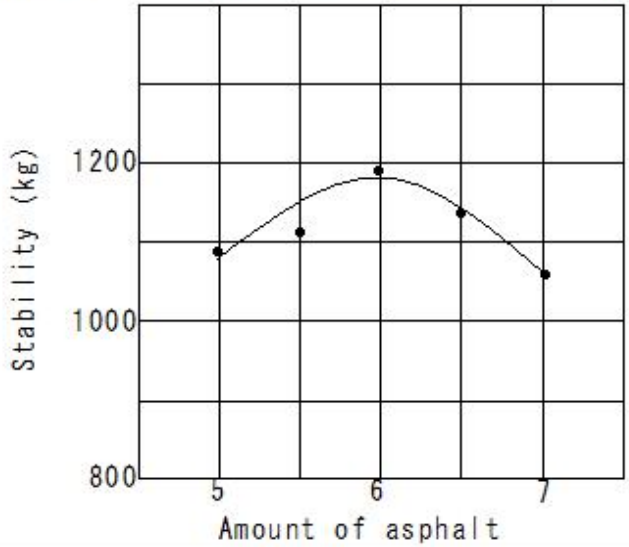


	Asphalt mixture ratio (%)	5.0	5.5	6.0	6.5	7.0
	Characteristic value					
○	Density (g/cm3): Actual measurement	2.352	2.373	2.385	2.388	2.379
	Density (g/cm3): Theoretical	2.508	2.489	2.471	2.453	2.435
	Asphalt volume ratio (%)	11.4	12.7	13.9	15.1	16.2
	Porosity (%)	6.2	4.7	3.5	2.6	2.3
	Aggregate porosity (%)	17.6	17.4	17.4	17.7	18.5
	Saturation (%)	64.8	73	79.9	85.3	87.6
	Stability (kg)	1094	1105	1196	1133	1054
	Flow value (1/100 cm)	27	28	34	38	44

(H466)Pavement work(Mixture mix-Determining the amount of asphalt designed)

(H466)Pavement work(Mixture mix-Determining the amount of asphalt designed)

Pavement work
Mixture mix
Determining the amount of asphalt designed
○Amount of asphalt and properties of the mixture
Stability (kg)

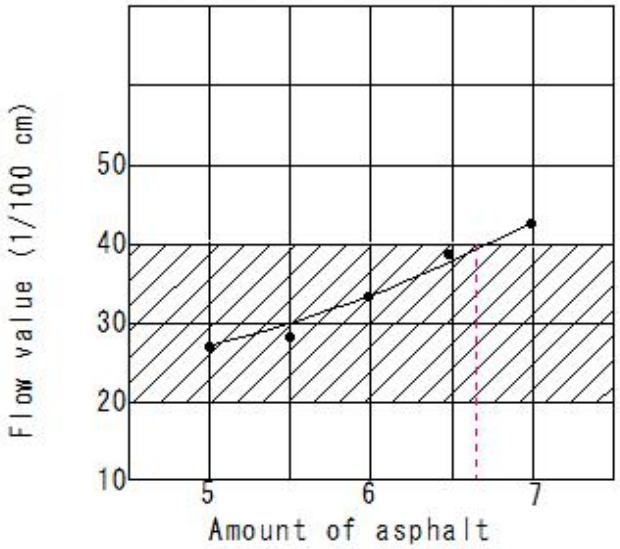


	Asphalt mixture ratio (%)	5.0	5.5	6.0	6.5	7.0
	Characteristic value					
	Density (g/cm3): Actual measurement	2.352	2.373	2.385	2.388	2.379
	Density (g/cm3): Theoretical	2.508	2.489	2.471	2.453	2.435
	Asphalt volume ratio (%)	11.4	12.7	13.9	15.1	16.2
	Porosity (%)	6.2	4.7	3.5	2.6	2.3
	Aggregate porosity (%)	17.6	17.4	17.4	17.7	18.5
	Saturation (%)	64.8	73	79.9	85.3	87.6
○	Stability (kg)	1094	1105	1196	1133	1054
	Flow value (1/100 cm)	27	28	34	38	44

(H467)Pavement work(Mixture mix-Determining the amount of asphalt designed)

(H467)Pavement work(Mixture mix-Determining the amount of asphalt designed)

Pavement work
Mixture mix
Determining the amount of asphalt designed
○Amount of asphalt and properties of the mixture
Flow value (1/100 cm)

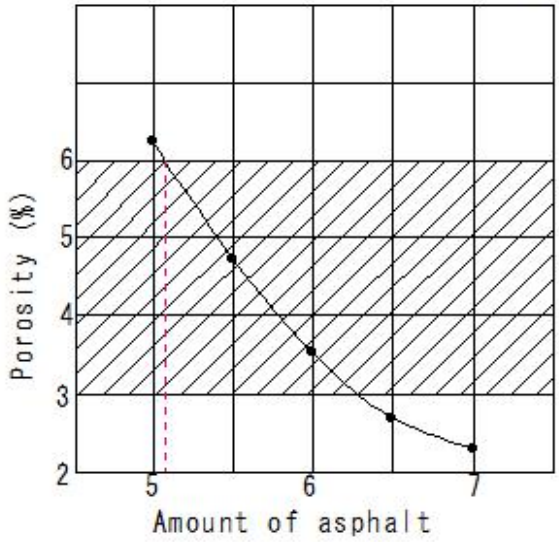


	Asphalt mixture ratio (%)	5.0	5.5	6.0	6.5	7.0
	Characteristic value					
	Density (g/cm3): Actual measurement	2.352	2.373	2.385	2.388	2.379
	Density (g/cm3): Theoretical	2.508	2.489	2.471	2.453	2.435
	Asphalt volume ratio (%)	11.4	12.7	13.9	15.1	16.2
	Porosity (%)	6.2	4.7	3.5	2.6	2.3
	Aggregate porosity (%)	17.6	17.4	17.4	17.7	18.5
	Saturation (%)	64.8	73	79.9	85.3	87.6
	Stability (kg)	1094	1105	1196	1133	1054
○	Flow value (1/100 cm)	27	28	34	38	44

(H468)Pavement work(Mixture mix-Determining the amount of asphalt designed)

(H468)Pavement work(Mixture mix-Determining the amount of asphalt designed)

Pavement work
Mixture mix
Determining the amount of asphalt designed
○Amount of asphalt and properties of the mixture
Porosity (%)

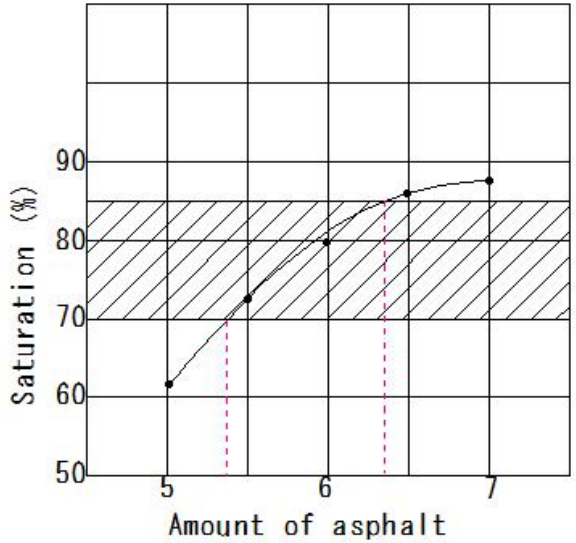


	Asphalt mixture ratio (%)	5.0	5.5	6.0	6.5	7.0
	Characteristic value					
	Density (g/cm3): Actual measurement	2.352	2.373	2.385	2.388	2.379
	Density (g/cm3): Theoretical	2.508	2.489	2.471	2.453	2.435
	Asphalt volume ratio (%)	11.4	12.7	13.9	15.1	16.2
○	Porosity (%)	6.2	4.7	3.5	2.6	2.3
	Aggregate porosity (%)	17.6	17.4	17.4	17.7	18.5
	Saturation (%)	64.8	73	79.9	85.3	87.6
	Stability (kg)	1094	1105	1196	1133	1054
	Flow value (1/100 cm)	27	28	34	38	44

(H469)Pavement work(Mixture mix-Determining the amount of asphalt designed)

(H469)Pavement work(Mixture mix-Determining the amount of asphalt designed)

Pavement work
Mixture mix
Determining the amount of asphalt designed
○Amount of asphalt and properties of the mixture
Saturation (%)



	Asphalt mixture ratio (%)	5.0	5.5	6.0	6.5	7.0
	Characteristic value					
	Density (g/cm3): Actual measurement	2.352	2.373	2.385	2.388	2.379
	Density (g/cm3): Theoretical	2.508	2.489	2.471	2.453	2.435
	Asphalt volume ratio (%)	11.4	12.7	13.9	15.1	16.2
	Porosity (%)	6.2	4.7	3.5	2.6	2.3
	Aggregate porosity (%)	17.6	17.4	17.4	17.7	18.5
○	Saturation (%)	64.8	73	79.9	85.3	87.6
	Stability (kg)	1094	1105	1196	1133	1054
	Flow value (1/100 cm)	27	28	34	38	44

(H470)Pavement work(Mixture mix-Determining the amount of asphalt designed)

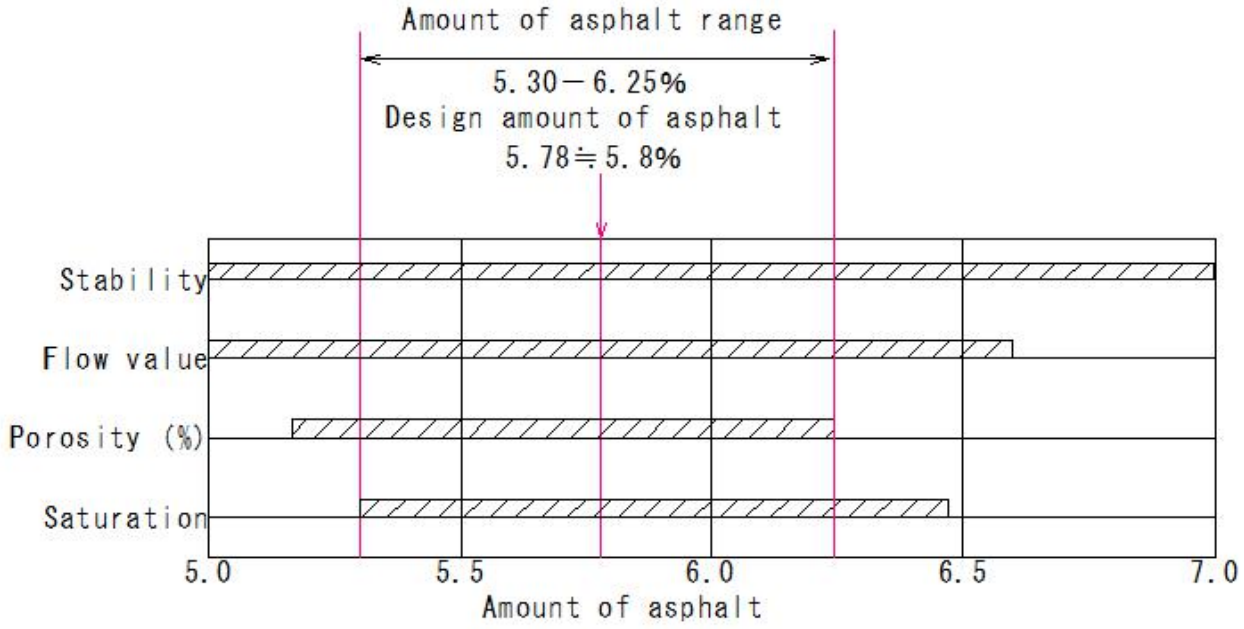
(H470)Pavement work(Mixture mix-Determining the amount of asphalt designed)

Pavement work

Mixture mix

Determining the amount of asphalt designed

○Amount of asphalt and properties of the mixture



Determining the amount of designed asphalt

(H471)Pavement work(Mixture mix-Determining the amount of asphalt designed)

(H471)Pavement work(Mixture mix-Determining the amount of asphalt designed)

Pavement work

Mixture mix

Determining the amount of asphalt designed

○Amount of asphalt and properties of the mixture

Mixture properties	Standard range	Asphalt amount within the standard range (%)
Stability (kg)	Over 500	Pass
Flow value (1/100 cm)	20－40	5.00-6.65
Porosity (%)	3-6	5.10-6.25
Saturation degree (%)	70-85	5.30-6.45
Asphalt amount		5.8

(H472)Pavement work(Mixture mix-Determining the amount of asphalt designed)

(H472)Pavement work(Mixture mix-Determining the amount of asphalt designed)

Pavement work

Mixture mix

Determining the amount of asphalt designed

○Amount of asphalt and properties of the mixture

Mixture properties at the design asphalt amount

Design asphalt amount 5.8% -(H446)

Range of standard values for Marshall stability test

Mixture properties at the design asphalt amount

Compacted density (g/cm3)	2.381
Stability (kg)	1190
Flow value (1/100 cm)	32
Porosity (%)	3.8
Saturation degree (%)	77.9

(H473)Pavement work(Mixture mix-Determining the amount of asphalt designed)

(H473)Pavement work(Mixture mix-Determining the amount of asphalt designed)

Pavement work

Mixture mix

Determining the amount of asphalt designed

Field Mixing

Materials		Mix ratio
Coarse aggregate	S-13 (No. 6)	32.0
	S-5 (No. 7)	19.8
Fine aggregate	Screenings	16.0
	Coarse sand	11.3
	Fine sand	9.4
Filler	Stone powder	5.7
Asphalt		5.8