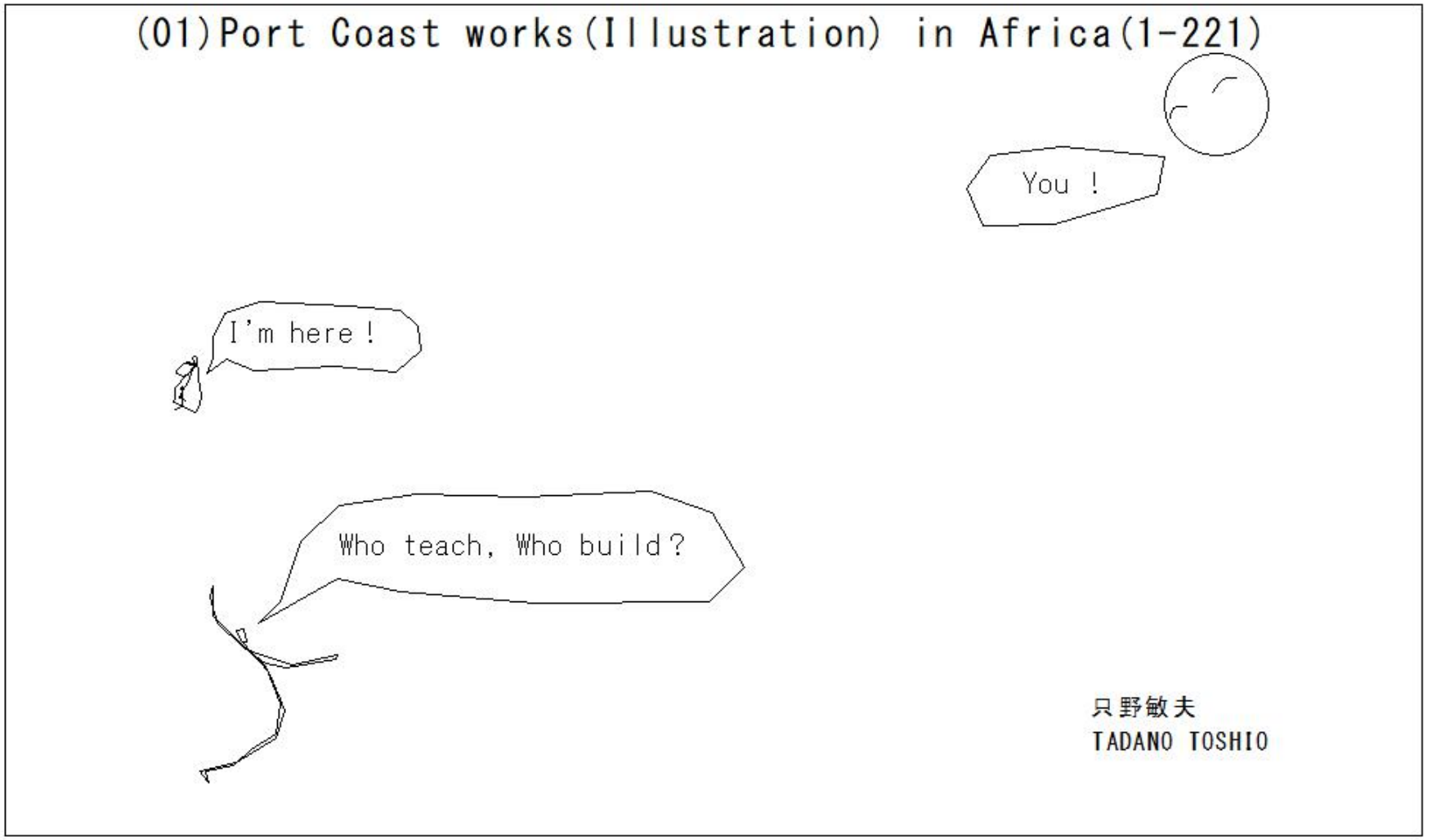
(01)Port Coast works(Illustration) in Africa(1-221)



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只野敏夫
Tadano Toshio

(P1)Port Coast	Port Coast
(P2)Port Coast	Port Coast
(P3)Port Coast（Underwater construction）	Underwater construction
(P4)Port Coast（Underwater concrete）	Underwater concrete
(P5)Port Coast（cutting/welding）	cutting/welding
(P6)Port Coast（Sea work boat）	Sea work boat
(P7)Port Coast（Sea work platform）	Sea work platform
(P8)Tide level and Symbol	Tide level and Symbol
(P9)Port Coast（port）	port
(P10)Port Coast（Basics of port planning）	port planning
(P11)Port Coast（Basics of port planning）	port planning
(P12)Port Coast（Basics of port planning）	port planning
(P13)Port Coast（Basics of port planning）	port planning
(P14)breakwater	breakwater
(P15)breakwater	breakwater
(P16)breakwater(Sloped breakwater)	breakwater(Sloped breakwater)
(P17)breakwater(Sloped breakwater)	breakwater(Sloped breakwater)
(P18)breakwater(Sloped breakwater)	breakwater(Sloped breakwater)
(P19)breakwater(upright breakwater)	breakwater(upright breakwater)
(P20)breakwater(upright breakwater)	breakwater(upright breakwater)
(P21)breakwater(upright breakwater)	breakwater(upright breakwater)
(P22)breakwater(composite breakwater)	breakwater(composite breakwater)
(P23)breakwater(composite breakwater)	breakwater(composite breakwater)
(P24)breakwater(Wave-dissipating block covering)	Wave dissipating block covering
(P25)breakwater(Wave-dissipating block covering)	Wave-dissipating block covering
(P26)breakwater(Breakwater design)	breakwater(Breakwater design)
(P27)breakwater(Breakwater design-Top height)	breakwater(Top height)
(P28)breakwater(Breakwater design-Top width)	breakwater(Top width)
(P29)breakwater(Breakwater design-Height of the top of the rubble mound(riprap))	breakwater(rubble mound(riprap))
(P30)breakwater(Breakwater design-Thickness of the rubble mound(riprap))	breakwater(rubble mound(riprap))
(P31)breakwater(Gradient slope of the rubble mound(riprap))	breakwater(rubble mound(riprap))
(P32)breakwater(Breakwater design-Filling material)	breakwater(Filling material)
(P33)breakwater(Breakwater stability)	Breakwater stability
(P34)breakwater(Breakwater stability)	Breakwater stability

(P35)breakwater(Breakwater stability)	Breakwater stability
(P36)breakwater(Breakwater stability)	Breakwater stability
(P37)breakwater(Breakwater stability)	Breakwater stability
(P38)breakwater(Breakwater stability-Soil bearing capacity)	Breakwater stability
(P39)breakwater(Breakwater stability-For soft ground)	Breakwater stability
(P40)breakwater(Breakwater stability-Settlement)	Breakwater stability
(P41)breakwater(Construction-Foundation work)	breakwater(Construction）
(P42)breakwater(Construction-Main body work)	breakwater(Construction）
(P43)breakwater(Concrete block construction (composite breakwater))	composite breakwater
(P44)breakwater(Caisson (composite breakwater))	Caisson (composite breakwater)
(P45)breakwater(Caisson (composite breakwater))	composite breakwater
(P46)Mooring facility	Mooring facility
(P47)Mooring facility(Caisson quay)	Mooring facility(Caisson quay)
(P48)Mooring facility(L-shaped block quay)	Mooring facility(L-shaped block quay)
(P49)Mooring facility(Cellular block quay)	Mooring facility(Cellular block quay)
(P50)Mooring facility(Cast-in-place concrete quay)	Mooring facility(Cast-in-place concrete quay)
(P51)Mooring facility(sheet pile quay)	Mooring facility(sheet pile quay)
(P52)Mooring facility(sheet pile quay)	Mooring facility(sheet pile quay)
(P53)Mooring facility(Stability of steel sheet pile type quay)	Mooring facility
(P54)Mooring facility(Stability of steel sheet pile type quay)	Mooring facility
(P55)Mooring facility(Construction of steel sheet pile type quay)	Mooring facility
(P56)Mooring facility(Construction of steel sheet pile type quay)	Mooring facility
(P57)Mooring facility(Construction of steel sheet pile type quay)	Mooring facility
(P58)Mooring facility(Construction of steel sheet pile type quay)	Mooring facility
(P59)Mooring facility(Construction of steel sheet pile type quay)	Mooring facility
(P60)Mooring facility(Construction of steel sheet pile type quay)	Mooring facility
(P61)Mooring facility(Construction of steel sheet pile type quay)	Mooring facility
(P62)Mooring facility(Pile type pier)	Mooring facility(Pile type pier)
(P63)Mooring facility(Floating pier:pontoon)	Mooring facility(Floating pier:pontoon)
(P64)Mooring facility(Dolphin (mooring bundle pile))	Mooring facility(Dolphin (mooring bundle pile))
(P65)Mooring facility(Sea bass)	Mooring facility(Sea bass)
(P66)Mooring equipment(Fender construction)	Mooring equipment(Fender construction)
(P67)Mooring equipment(Mooring pillar)	Mooring equipment(Mooring pillar)
(P68)Mooring equipment(Car stop)	Mooring equipment(Car stop)

(P69)Dredging work	Dredging work
(P70)Dredging work(Pump dredger)	Dredging work(Pump dredger)
(P71)Dredging work(Bucket dredger)	Dredging work(Bucket dredger)
(P72)Dredging work(Grab dredger)	Dredging work(Grab dredger)
(P73)Dredging work(Dipper dredger)	Dredging work(Dipper dredger)
(P74)Dredging work(Dredger selection)	Dredging work(Dredger selection)
(P75)Dredging work(Calculation of dredged soil volume)	Dredging work(dredged soil volume)
(P76)Dredging work(Slope gradient)	Dredging work(Slope gradient)
(P77)Dredging work(Extra excavation)	Dredging work(Extra excavation)
(P78)Dredging work(Landfill)	Dredging work(Landfill)
(P79)Dredging work(Direct Landfill)	Dredging work(Direct Landfill)
(P80)Dredging work(Landfill method by soil transportation)	Dredging work(Landfill soil transportation)
(P81)Dredging work(How to transport and reclaim mountain soil)	Dredging work(How to transport)
(P82)Dredging work(Calculation of the amount of land for reclamation work)	Dredging work(reclamation work)
(P83)Dredging work(Calculation of landfill settlement amount)	Dredging work(settlement amount)
(P84)Dredging work(Calculation of landfill settlement amount)	(P84)Dredging work(settlement amount)
(P85)Dredging work(Calculation of landfill settlement amount-Yield)	(P85)Dredging work(landfill settlement)
(P86)Dredging work(Placement of sand discharge pipe)	(P86)Dredging work(Placement -discharge pipe)
(P87)Dredging work(How to lay a sand discharge pipe)	(P87)Dredging work(lay discharge pipe)
(P88)Dredging work(Measures to take in case of the sand discharge pipe becomes clogged)	Dredging work(pipe becomes clogged)
(P89)Dredging work(spillway)	Dredging work(spillway)
(P90)Dredging work(reclamation in water area)	Dredging work(reclamation in water area)
(P91)coast(coastal embankment)	coast(coastal embankment)
(P92)coast(Coastal construction)	coast(Coastal construction)
(P93)coast(sea waves)	coast(sea waves)
(P94)coast(wave changes)	coast(wave changes)
(P95)coast(wave properties)	coast(wave properties)
(P96)coast(wave pressure)	coast(wave pressure)
(P97)coast(wave pressure of breaking waves)	coast(wave pressure of breaking waves)
(P98)coast(drift sand)	coast(drift sand)
(P99)coast(drift sand)	coast(drift sand)
(P100)coast(drift sand)	coast(drift sand)
(P101)coastal embankment	coastal embankment
(P102)coastal embankment	coastal embankment

(P103)coastal embankment(Coastal seawall)	coastal embankment(Coastal seawall)
(P104)coastal embankment(Slanted type)	coastal embankment(Slanted type)
(P105)coastal embankment(upright type)	coastal embankment(upright type)
(P106)coastal embankment(composite type)	coastal embankment(composite type)
(P107)coastal embankment(Embankment shape)	coastal embankment(Embankment shape)
(P108)coastal embankment(Normal line)	coastal embankment(Normal line)
(P109)coastal embankment(Slope)	coastal embankment(Slope)
(P110)coastal embankment(crown height)	coastal embankment(crown height)
(P111)coastal embankment(crown width)	coastal embankment(crown width)
(P112)coastal embankment(Embankment construction)	Embankment construction
(P113)coastal embankment(Foundation work)	coastal embankment(Foundation work)
(P114)coastal embankment(Foundation work)	coastal embankment(Foundation work)
(P115)coastal embankment(Foundation work)	coastal embankment(Foundation work)
(P116)coastal embankment(Foundation work)	coastal embankment(Foundation work)
(P117)coastal embankment(Surface slope Covering (Coating) work)	Surface slope Covering (Coating) work
(P118)coastal embankment(Surface slope Covering (Coating) work)	Surface slope Covering (Coating) work
(P119)coastal embankment(Stone-slope type)	Stone-slope type
(P120)coastal embankment(Concrete block pitching type)	Concrete block pitching type
(P121)coastal embankment(Concrete covered type)	Concrete covered type
(P122)coastal embankment(Upright type)	Upright type
(P123)coastal embankment(Gravity type buttress type)	Gravity type buttress type
(P124)coastal embankment(Wave return work)	Wave return work
(P125)coastal embankment(Wave return work)	Wave return work
(P126)coastal embankment(Masonry type/stone pitching type)	Masonry type/stone pitching type
(P127)coastal embankment(Concrete block pitching type)	Concrete block pitching type
(P128)coastal embankment(Concrete Covering (Coating) work)	Concrete Covering (Coating) work
(P129)coastal embankment(Asphalt Covering (Coating) work)	Asphalt Covering (Coating) work
(P130)coastal embankment(Concrete frame(crib) type work)	Concrete frame(crib) type work)
(P131)coastal embankment(foot protection)	coastal embankment(foot protection)
(P132)coastal embankment(Drainage works)	coastal embankment(Drainage works)
(P133)coastal embankment(Foot protection works)	Foot protection works
(P134)coastal embankment(Foot protection works)	Foot protection works
(P135)coastal embankment(Foot protection works)	Foot protection works
(P136)coastal embankment(Foot protection works)	Foot protection works

(P137)coastal embankment(Wave dissipation works)	Wave dissipation works
(P138)coastal embankment(deformed precast concrete block)	deformed precast concrete block
(P139)coastal embankment(Hudson Formula)	Hudson Formula
(P140)coastal embankment(How to stack deformed precast concrete blocks)	deformed precast concrete blocks
(P141)coast(Erosion countermeasures)	Erosion countermeasures
(P142)coast(Erosion countermeasures-causes of erosion)	Erosion countermeasures
(P143)coast(Erosion countermeasures-jetty)	jetty
(P144)coast(Erosion countermeasures-Classification of jetty)	jetty
(P145)coast(Erosion countermeasures-jetty-upright)	jetty-upright
(P146)coast(Erosion countermeasures-jetty-composite type)	jetty-composite type
(P147)coast(Erosion countermeasures-jetty-permeability)	jetty-permeability
(P148)coast(Erosion countermeasures-jetty-Impermeable structure)	jetty-Impermeable structure
(P149)coast(Erosion countermeasures-offshore breakwater)	offshore breakwater
(P150)coast(Erosion countermeasures-offshore breakwater)	offshore breakwater
(P151)coast(Erosion countermeasures-off shore breakwater)	off shore breakwater
(P152)coast(Erosion countermeasures -off shore breakwater)	off shore breakwater
(P153)coast(Erosion countermeasures -off shore breakwater)	off shore breakwater
(P154)coast(Erosion countermeasures -Beach nourishment)	Beach nourishment
(P155)coast(Erosion countermeasures -Beach nourishment)	Beach nourishment
(P156)coast(Erosion countermeasures -tombolo)	tombolo
(P157)coast(breakwater embankment)	breakwater embankment
(P158)coast(offshore breakwater)	offshore breakwater
(P159)coast(Beach nourishment)	Beach nourishment
(P160)coast(jetty)	jetty
(P161)coastal embankment(Slanted(sloped-canted) type・Upright type）	Slanted(sloped-canted) type・Upright typ
(P162)coastal embankment(composite type）	composite type
(P163)coastal embankment	coastal embankment
(P164)coastal embankment	coastal embankment
(P165)coastal embankment(Beach nourishment)	Beach nourishment
(P166)coastal embankment(offshore embankment works)	offshore embankment
(P167)coastal embankment(stone pitching breakwater)	stone pitching breakwater
(P168)coastal embankment(rock-filled breakwater)	rock-filled breakwater
(P169)port(apron)	apron
(P170)port(protective facility of harbor)	protective facility of harbor

(P171)caisson breakwater
(P172)Concrete block breakwater
(P173)Composite breakwater
(P174)Breaking wave levee
(P175)dredging(Pump dredger)
(P176)dredging(Bucket dredger)
(P177)dredging(Grab dredger)
(P178)dredging(Dipper dredger)
(P179)progressive wave
(P180)artificial reef
(P181)fetch length
(P182)wind duration
(P183)riprap work
(P184)rubble-mound breakwater
(P185) Covering and foundation work
(P186)cellular block breakwater
(P187)cellular sheet pile
(P188)fetch
(P189)upright breakwater
(P190)special bank
(P191)jetty
(P192)two jetties
(P193)Parapet
(P194)reflection wave
(P195)groyne net
(P196)groyne net
(P197)groyne wood
(P198)breakwater
(P199)windbreak
(P200)Floating Pier
(P201)Concrete joint
(P202)Coastal embankment
(P203)Detached pillar
(P204)jetty

caisson breakwater
Concrete block breakwater
Composite breakwater
Breaking wave levee
dredging(Pump dredger)
dredging(Bucket dredger)
dredging(Grab dredger)
dredging(Dipper dredger)
progressive wave
artificial reef
fetch length
wind duration
riprap work
rubble-mound breakwater
Covering and foundation work
cellular block breakwater
cellular sheet pile
fetch
upright breakwater
special bank
jetty
two jetties
Parapet
reflection wave
groyne net
groyne net
groyne wood
breakwater
windbreak
Floating Pier
Concrete joint
Coastal embankment
Detached pillar
jetty

(P205)Mooring Facilities（dolphin）	Mooring Facilities（dolphin）
(P206)Tombolo	Tombolo
(P207)Sheet piles mooring shore	Sheet piles mooring shore
(P208)Flow of port construction	Flow of port construction
(P209)Flow of port construction	Flow of port construction
(P210)Flow of port construction	Flow of port construction
(P211)Flow of port construction	Flow of port construction
(P212)Flow of port construction	Flow of port construction
(P213)Flow of port construction	Flow of port construction
(P214)approach wave	approach wave
(P215)tsunami	tsunami
(P216)detached breakwater	detached breakwater
(P217)bucket dredger	bucket dredger
(P218)wharf	wharf
(P219)drift sand	drift sand
(P220)Coastal erosion	Coastal erosion
(P221)Formation of a tombolo	Formation of a tombolo

(P84)Dredging work(Calculation of landfill settlement amount)	(P84)Dredging work(settlement amount)
(P85)Dredging work(Calculation of landfill settlement amount-Yield)	(P85)Dredging work(landfill settlement)
(P86)Dredging work(Placement of sand discharge pipe)	(P86)Dredging work(Placement -discharge pipe)
(P87)Dredging work(How to lay a sand discharge pipe)	(P87)Dredging work(lay discharge pipe)
(P214)approach wave	approach wave
(P169)port(apron)	apron
(P180)artificial reef	artificial reef
(P129)coastal embankment(Asphalt Covering (Coating) work)	Asphalt Covering (Coating) work
(P154)coast(Erosion countermeasures -Beach nourishment)	Beach nourishment
(P155)coast(Erosion countermeasures -Beach nourishment)	Beach nourishment
(P159)coast(Beach nourishment)	Beach nourishment
(P165)coastal embankment(Beach nourishment)	Beach nourishment
(P174)Breaking wave levee	Breaking wave levee
(P14)breakwater	breakwater
(P15)breakwater	breakwater
(P198)breakwater	breakwater
(P157)coast(breakwater embankment)	breakwater embankment
(P33)breakwater(Breakwater stability)	Breakwater stability
(P34)breakwater(Breakwater stability)	Breakwater stability
(P35)breakwater(Breakwater stability)	Breakwater stability
(P36)breakwater(Breakwater stability)	Breakwater stability
(P37)breakwater(Breakwater stability)	Breakwater stability
(P38)breakwater(Breakwater stability-Soil bearing capacity)	Breakwater stability
(P39)breakwater(Breakwater stability-For soft ground)	Breakwater stability
(P40)breakwater(Breakwater stability-Settlement)	Breakwater stability
(P26)breakwater(Breakwater design)	breakwater(Breakwater design)
(P22)breakwater(composite breakwater)	breakwater(composite breakwater)
(P23)breakwater(composite breakwater)	breakwater(composite breakwater)
(P41)breakwater(Construction-Foundation work)	breakwater(Construction）
(P42)breakwater(Construction-Main body work)	breakwater(Construction）
(P32)breakwater(Breakwater design-Filling material)	breakwater(Filling material)
(P29)breakwater(Breakwater design-Height of the top of the rubble mound(riprap))	breakwater(rubble mound(riprap))
(P30)breakwater(Breakwater design-Thickness of the rubble mound(riprap))	breakwater(rubble mound(riprap))
(P31)breakwater(Gradient slope of the rubble mound(riprap))	breakwater(rubble mound(riprap))

(P16)breakwater(Sloped breakwater)	breakwater(Sloped breakwater)
(P17)breakwater(Sloped breakwater)	breakwater(Sloped breakwater)
(P18)breakwater(Sloped breakwater)	breakwater(Sloped breakwater)
(P27)breakwater(Breakwater design-Top height)	breakwater(Top height)
(P28)breakwater(Breakwater design-Top width)	breakwater(Top width)
(P19)breakwater(upright breakwater)	breakwater(upright breakwater)
(P20)breakwater(upright breakwater)	breakwater(upright breakwater)
(P21)breakwater(upright breakwater)	breakwater(upright breakwater)
(P217)bucket dredger	bucket dredger
(P44)breakwater(Caisson (composite breakwater))	Caisson (composite breakwater)
(P171)caisson breakwater	caisson breakwater
(P186)cellular block breakwater	cellular block breakwater
(P187)cellular sheet pile	cellular sheet pile
(P92)coast(Coastal construction)	coast(Coastal construction)
(P91)coast(coastal embankment)	coast(coastal embankment)
(P98)coast(drift sand)	coast(drift sand)
(P99)coast(drift sand)	coast(drift sand)
(P100)coast(drift sand)	coast(drift sand)
(P93)coast(sea waves)	coast(sea waves)
(P94)coast(wave changes)	coast(wave changes)
(P97)coast(wave pressure of breaking waves)	coast(wave pressure of breaking waves)
(P96)coast(wave pressure)	coast(wave pressure)
(P95)coast(wave properties)	coast(wave properties)
(P101)coastal embankment	coastal embankment
(P102)coastal embankment	coastal embankment
(P163)coastal embankment	coastal embankment
(P164)coastal embankment	coastal embankment
(P202)Coastal embankment	Coastal embankment
(P103)coastal embankment(Coastal seawall)	coastal embankment(Coastal seawall)
(P106)coastal embankment(composite type)	coastal embankment(composite type)
(P110)coastal embankment(crown height)	coastal embankment(crown height)
(P111)coastal embankment(crown width)	coastal embankment(crown width)
(P132)coastal embankment(Drainage works)	coastal embankment(Drainage works)
(P107)coastal embankment(Embankment shape)	coastal embankment(Embankment shape)

(P131)coastal embankment(foot protection)	coastal embankment(foot protection)
(P113)coastal embankment(Foundation work)	coastal embankment(Foundation work)
(P114)coastal embankment(Foundation work)	coastal embankment(Foundation work)
(P115)coastal embankment(Foundation work)	coastal embankment(Foundation work)
(P116)coastal embankment(Foundation work)	coastal embankment(Foundation work)
(P108)coastal embankment(Normal line)	coastal embankment(Normal line)
(P104)coastal embankment(Slanted type)	coastal embankment(Slanted type)
(P109)coastal embankment(Slope)	coastal embankment(Slope)
(P105)coastal embankment(upright type)	coastal embankment(upright type)
(P220)Coastal erosion	Coastal erosion
(P43)breakwater(Concrete block construction (composite breakwater))	composite breakwater
(P45)breakwater(Caisson (composite breakwater))	composite breakwater
(P173)Composite breakwater	Composite breakwater
(P162)coastal embankment(composite type）	composite type
(P172)Concrete block breakwater	Concrete block breakwater
(P120)coastal embankment(Concrete block pitching type)	Concrete block pitching type
(P127)coastal embankment(Concrete block pitching type)	Concrete block pitching type
(P121)coastal embankment(Concrete covered type)	Concrete covered type
(P128)coastal embankment(Concrete Covering (Coating) work)	Concrete Covering (Coating) work
(P130)coastal embankment(Concrete frame(crib) type work)	Concrete frame(crib) type work)
(P201)Concrete joint	Concrete joint
(P185) Covering and foundation work	Covering and foundation work
(P5)Port Coast（cutting/welding）	cutting/welding
(P138)coastal embankment(deformed precast concrete block)	deformed precast concrete block
(P140)coastal embankment(How to stack deformed precast concrete blocks)	deformed precast concrete blocks
(P216)detached breakwater	detached breakwater
(P203)Detached pillar	Detached pillar
(P69)Dredging work	Dredging work
(P71)Dredging work(Bucket dredger)	Dredging work(Bucket dredger)
(P73)Dredging work(Dipper dredger)	Dredging work(Dipper dredger)
(P79)Dredging work(Direct Landfill)	Dredging work(Direct Landfill)
(P75)Dredging work(Calculation of dredged soil volume)	Dredging work(dredged soil volume)
(P74)Dredging work(Dredger selection)	Dredging work(Dredger selection)
(P77)Dredging work(Extra excavation)	Dredging work(Extra excavation)

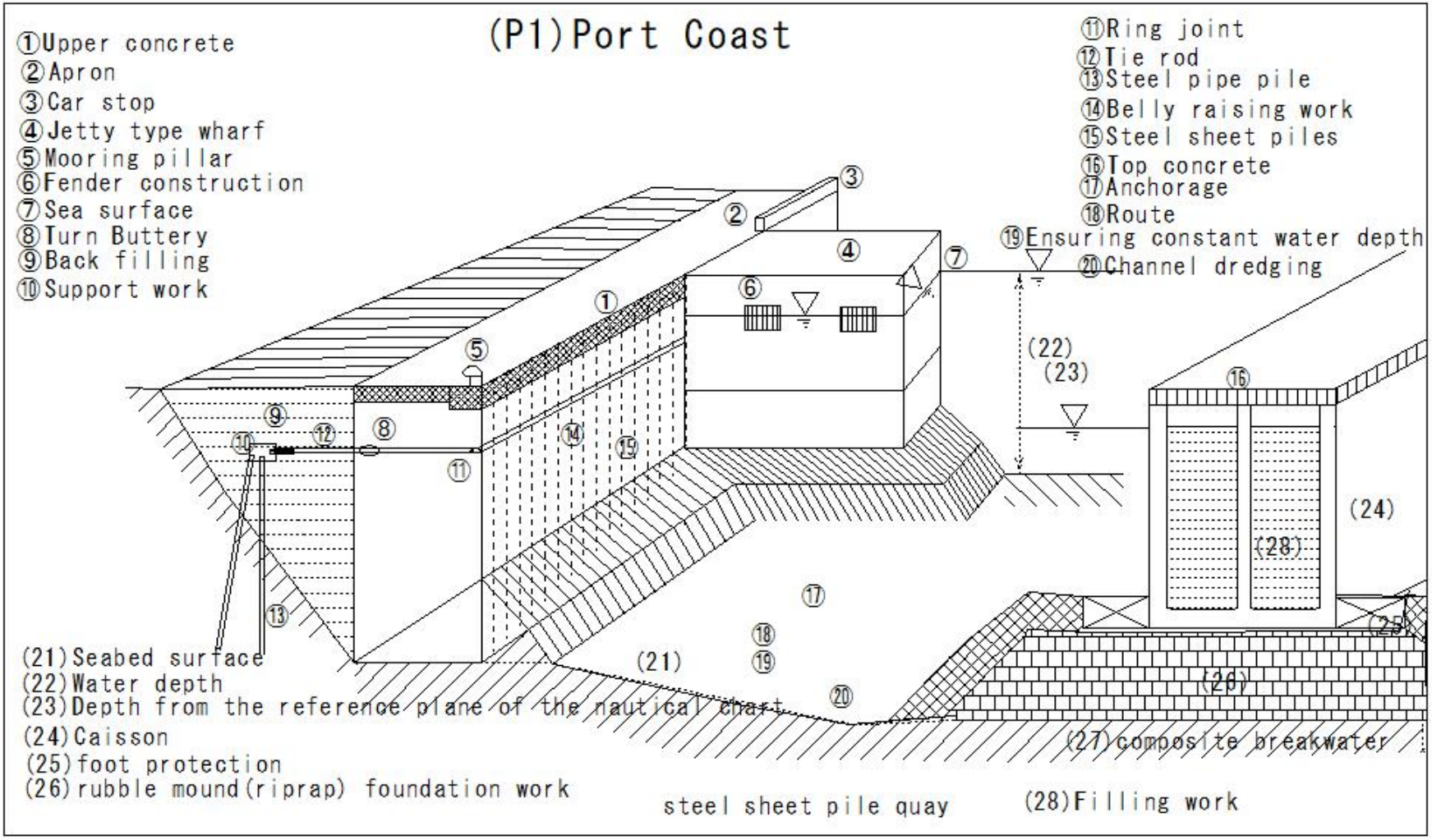
(P72)Dredging work(Grab dredger)	Dredging work(Grab dredger)
(P81)Dredging work(How to transport and reclaim mountain soil)	Dredging work(How to transport)
(P80)Dredging work(Landfill method by soil transportation)	Dredging work(Landfill soil transportation)
(P78)Dredging work(Landfill)	Dredging work(Landfill)
(P88)Dredging work(Measures to take in case of the sand discharge pipe becomes clogged)	Dredging work(pipe becomes clogged)
(P70)Dredging work(Pump dredger)	Dredging work(Pump dredger)
(P90)Dredging work(reclamation in water area)	Dredging work(reclamation in water area)
(P82)Dredging work(Calculation of the amount of land for reclamation work)	Dredging work(reclamation work)
(P83)Dredging work(Calculation of landfill settlement amount)	Dredging work(settlement amount)
(P76)Dredging work(Slope gradient)	Dredging work(Slope gradient)
(P89)Dredging work(spillway)	Dredging work(spillway)
(P176)dredging(Bucket dredger)	dredging(Bucket dredger)
(P178)dredging(Dipper dredger)	dredging(Dipper dredger)
(P177)dredging(Grab dredger)	dredging(Grab dredger)
(P175)dredging(Pump dredger)	dredging(Pump dredger)
(P219)drift sand	drift sand
(P112)coastal embankment(Embankment construction)	Embankment construction
(P141)coast(Erosion countermeasures)	Erosion countermeasures
(P142)coast(Erosion countermeasures-causes of erosion)	Erosion countermeasures
(P188)fetch	fetch
(P181)fetch length	fetch length
(P200)Floating Pier	Floating Pier
(P208)Flow of port construction	Flow of port construction
(P209)Flow of port construction	Flow of port construction
(P210)Flow of port construction	Flow of port construction
(P211)Flow of port construction	Flow of port construction
(P212)Flow of port construction	Flow of port construction
(P213)Flow of port construction	Flow of port construction
(P133)coastal embankment(Foot protection works)	Foot protection works
(P134)coastal embankment(Foot protection works)	Foot protection works
(P135)coastal embankment(Foot protection works)	Foot protection works
(P136)coastal embankment(Foot protection works)	Foot protection works
(P221)Formation of a tombolo	Formation of a tombolo
(P123)coastal embankment(Gravity type buttress type)	Gravity type buttress type

(P195)groyne net	groyne net
(P196)groyne net	groyne net
(P197)groyne wood	groyne wood
(P139)coastal embankment(Hudson Formula)	Hudson Formula
(P143)coast(Erosion countermeasures-jetty)	jetty
(P144)coast(Erosion countermeasures-Classification of jetty)	jetty
(P160)coast(jetty)	jetty
(P191)jetty	jetty
(P204)jetty	jetty
(P146)coast(Erosion countermeasures-jetty-composite type)	jetty-composite type
(P148)coast(Erosion countermeasures-jetty-Impermeable structure)	jetty-Impermeable structure
(P147)coast(Erosion countermeasures-jetty-permeability)	jetty-permeability
(P145)coast(Erosion countermeasures-jetty-upright)	jetty-upright
(P126)coastal embankment(Masonry type/stone pitching type)	Masonry type/stone pitching type
(P68)Mooring equipment(Car stop)	Mooring equipment(Car stop)
(P66)Mooring equipment(Fender construction)	Mooring equipment(Fender construction)
(P67)Mooring equipment(Mooring pillar)	Mooring equipment(Mooring pillar)
(P205)Mooring Facilities（dolphin）	Mooring Facilities（dolphin）
(P46)Mooring facility	Mooring facility
(P53)Mooring facility(Stability of steel sheet pile type quay)	Mooring facility
(P54)Mooring facility(Stability of steel sheet pile type quay)	Mooring facility
(P55)Mooring facility(Construction of steel sheet pile type quay)	Mooring facility
(P56)Mooring facility(Construction of steel sheet pile type quay)	Mooring facility
(P57)Mooring facility(Construction of steel sheet pile type quay)	Mooring facility
(P58)Mooring facility(Construction of steel sheet pile type quay)	Mooring facility
(P59)Mooring facility(Construction of steel sheet pile type quay)	Mooring facility
(P60)Mooring facility(Construction of steel sheet pile type quay)	Mooring facility
(P61)Mooring facility(Construction of steel sheet pile type quay)	Mooring facility
(P47)Mooring facility(Caisson quay)	Mooring facility(Caisson quay)
(P50)Mooring facility(Cast-in-place concrete quay)	Mooring facility(Cast-in-place concrete quay)
(P49)Mooring facility(Cellular block quay)	Mooring facility(Cellular block quay)
(P64)Mooring facility(Dolphin (mooring bundle pile))	Mooring facility(Dolphin (mooring bundle pile))
(P63)Mooring facility(Floating pier:pontoon)	Mooring facility(Floating pier:pontoon)
(P48)Mooring facility(L-shaped block quay)	Mooring facility(L-shaped block quay)

(P62)Mooring facility(Pile type pier)	Mooring facility(Pile type pier)
(P65)Mooring facility(Sea bass)	Mooring facility(Sea bass)
(P51)Mooring facility(sheet pile quay)	Mooring facility(sheet pile quay)
(P52)Mooring facility(sheet pile quay)	Mooring facility(sheet pile quay)
(P151)coast(Erosion countermeasures-off shore breakwater)	off shore breakwater
(P152)coast(Erosion countermeasures -off shore breakwater)	off shore breakwater
(P153)coast(Erosion countermeasures -off shore breakwater)	off shore breakwater
(P149)coast(Erosion countermeasures-offshore breakwater)	offshore breakwater
(P150)coast(Erosion countermeasures-offshore breakwater)	offshore breakwater
(P158)coast(offshore breakwater)	offshore breakwater
(P166)coastal embankment(offshore embankment works)	offshore embankment
(P193)Parapet	Parapet
(P9)Port Coast（port）	port
(P1)Port Coast	Port Coast
(P2)Port Coast	Port Coast
(P10)Port Coast（Basics of port planning）	port planning
(P11)Port Coast（Basics of port planning）	port planning
(P12)Port Coast（Basics of port planning）	port planning
(P13)Port Coast（Basics of port planning）	port planning
(P179)progressive wave	progressive wave
(P170)port(protective facility of harbor)	protective facility of harbor
(P194)reflection wave	reflection wave
(P183)riprap work	riprap work
(P168)coastal embankment(rock-filled breakwater)	rock-filled breakwater
(P184)rubble-mound breakwater	rubble-mound breakwater
(P6)Port Coast（Sea work boat）	Sea work boat
(P7)Port Coast（Sea work platform）	Sea work platform
(P207)Sheet piles mooring shore	Sheet piles mooring shore
(P161)coastal embankment(Slanted(sloped-canted) type・Upright type）	Slanted(sloped-canted) type・Upright typ
(P190)special bank	special bank
(P167)coastal embankment(stone pitching breakwater)	stone pitching breakwater
(P119)coastal embankment(Stone-slope type)	Stone-slope type
(P117)coastal embankment(Surface slope Covering (Coating) work)	Surface slope Covering (Coating) work
(P118)coastal embankment(Surface slope Covering (Coating) work)	Surface slope Covering (Coating) work

(P8)Tide level and Symbol	Tide level and Symbol
(P156)coast(Erosion countermeasures -tombolo)	tombolo
(P206)Tombolo	Tombolo
(P215)tsunami	tsunami
(P192)two jetties	two jetties
(P4)Port Coast（Underwater concrete）	Underwater concrete
(P3)Port Coast（Underwater construction）	Underwater construction
(P189)upright breakwater	upright breakwater
(P122)coastal embankment(Upright type)	Upright type
(P24)breakwater(Wave-dissipating block covering)	Wave dissipating block covering
(P137)coastal embankment(Wave dissipation works)	Wave dissipation works
(P124)coastal embankment(Wave return work)	Wave return work
(P125)coastal embankment(Wave return work)	Wave return work
(P25)breakwater(Wave-dissipating block covering)	Wave-dissipating block covering
(P218)wharf	wharf
(P182)wind duration	wind duration
(P199)windbreak	windbreak

(P1)Port Coast



(P2)Port Coast

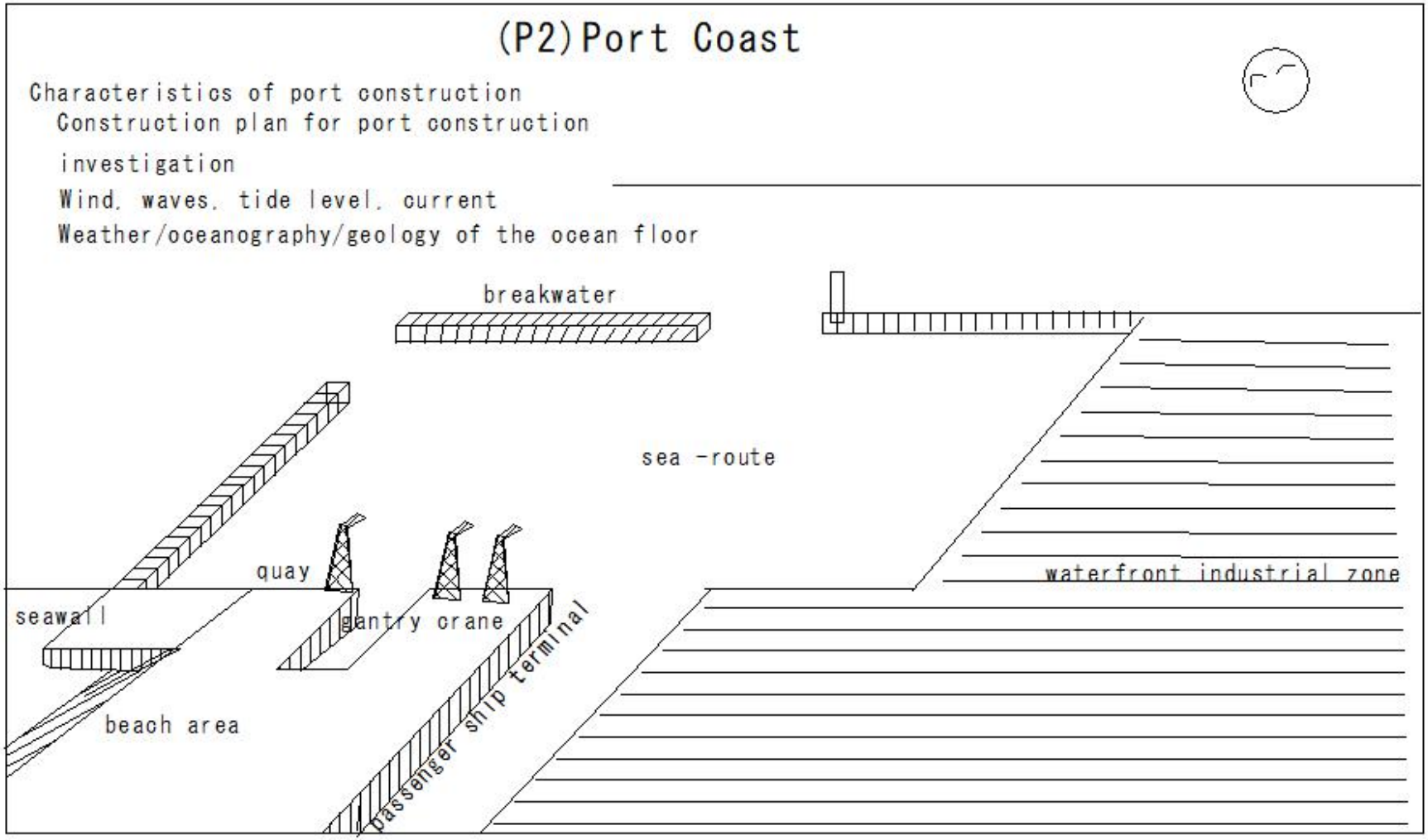
Characteristics of port construction

Construction plan for port construction

investigation

Wind, waves, tide level, current

Weather/oceanography/geology of the ocean floor



(P3)Port Coast（Underwater construction）

(P3)Port Coast (Underwater construction)

Characteristics of port construction

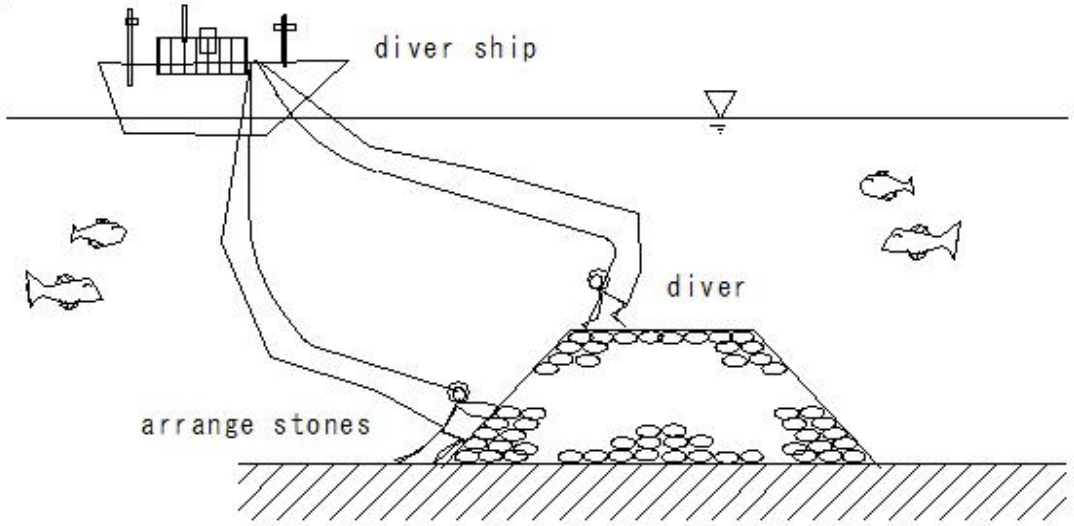
①Underwater construction

①Diving work

underwater construction

Working under high pressure

Diving disease - caution



(P4)Port Coast（Underwater concrete）

(P4)Port Coast (Underwater concrete)

Characteristics of port construction

①Underwater construction

②Underwater concrete

Prevention of material separation

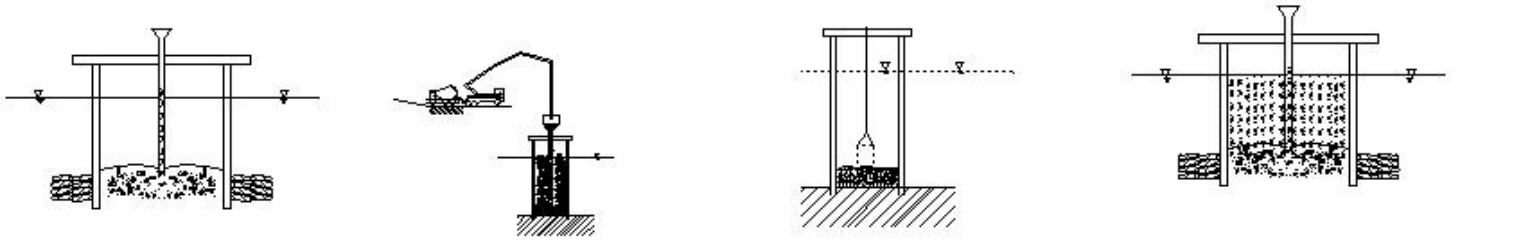
Quality of construction - influence on strength

Tremie pipe method

Pre-packed construction method

bagged concrete

Underwater non-separable concrete



① Tremie ② Concrete pump ③ Open bottom box ④ Prepact concrete

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(P5)Port Coast（cutting/welding）

(P5)Port Coast (cutting/welding)

Characteristics of port construction

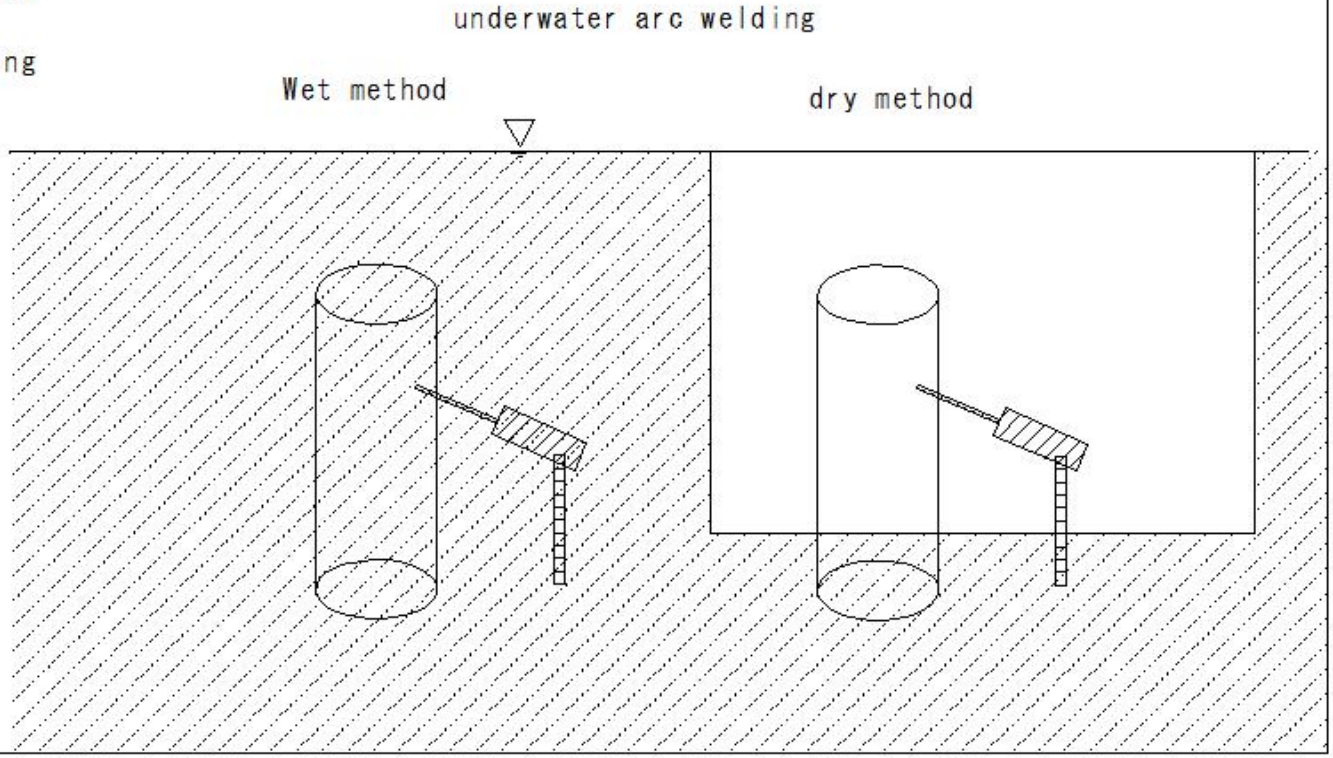
①Underwater construction

③Underwater cutting/welding

underwater gas cutting

arc oxygen cutting

underwater arc welding



(P6)Port Coast（Sea work boat）

(P6)Port Coast (Dredger)

Characteristics of port construction

shore work boat

①Types of work boats

②Dredger

③Grab, dipper, bucket, pump, rock crusher

④Structure construction vessel

⑤Crane, pile driving, concrete mixer

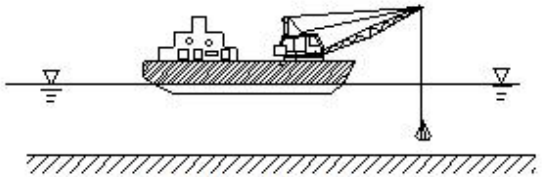
⑥Investigation and supervision vessel

⑦Surveying/boring/supervision

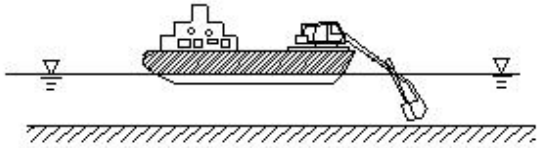
⑧Other ships

⑨Tugboat/earth transport/anchor lifting boat

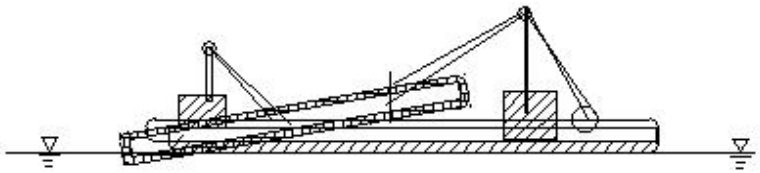
Pump dredger



Grab dredger



Dipper dredger



Bucket dredger

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(P7)Port Coast（Sea work platform）

(P7)Port Coast (Sea work platform)

Characteristics of port construction

Sea work platform

①Sea work platform for civil engineering work

②Anchor fixed type

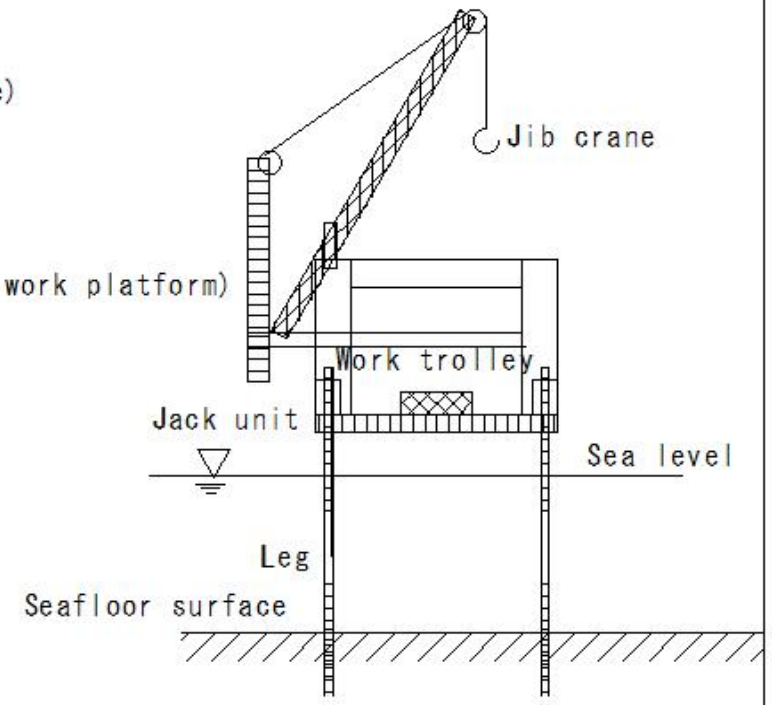
③Floating type (conventional work boat type)

④River-submerged type (half-river type)

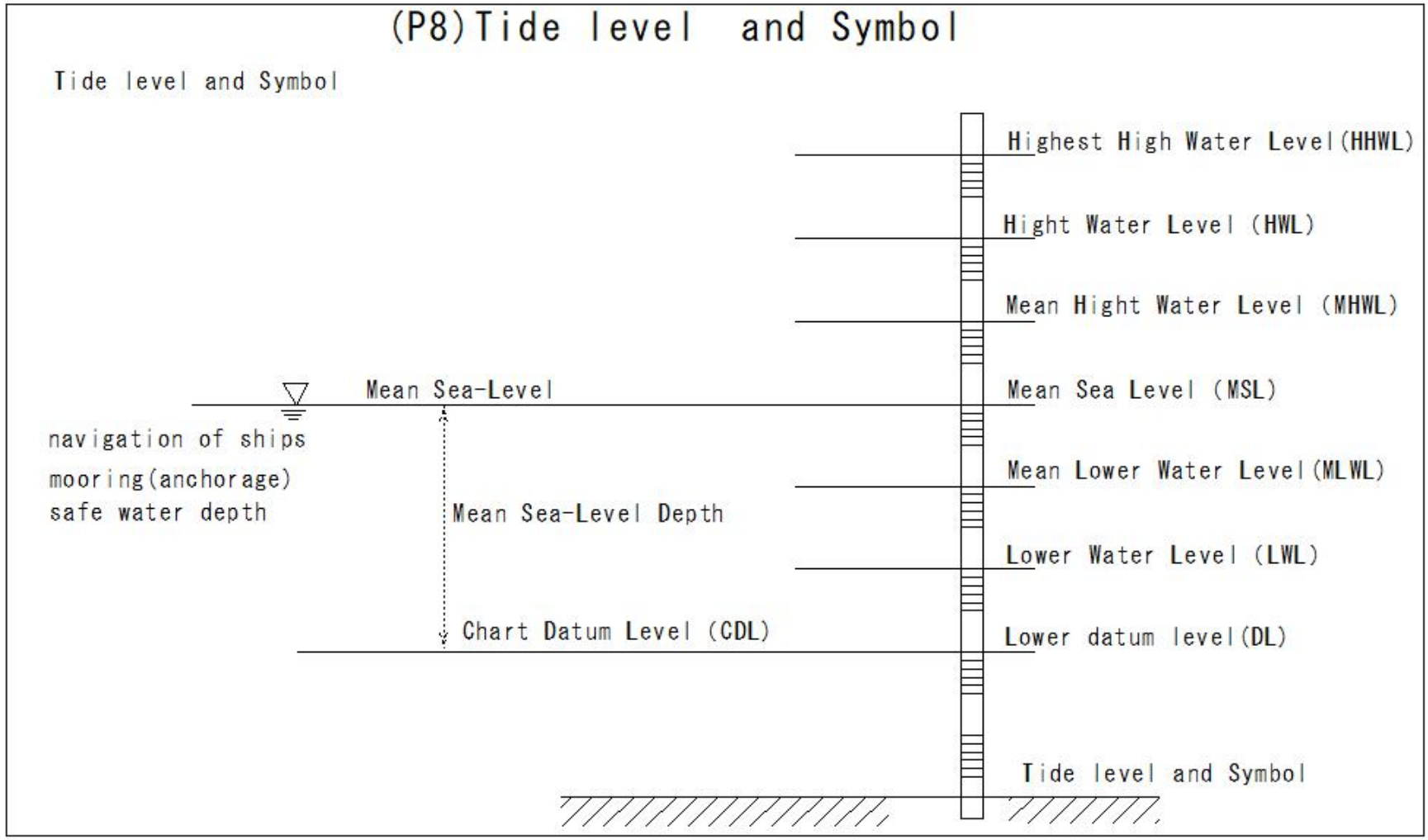
⑤Self-lifting type

⑥Jacket type (steel pipe frame structure)

⑦Leg elevating type (self-lifting offshore work platform)



(P8)Tide level and Symbol



(P9)Port Coast（port）

(P9)Port Coast (port)

Characteristics of port construction

Basics of port planning

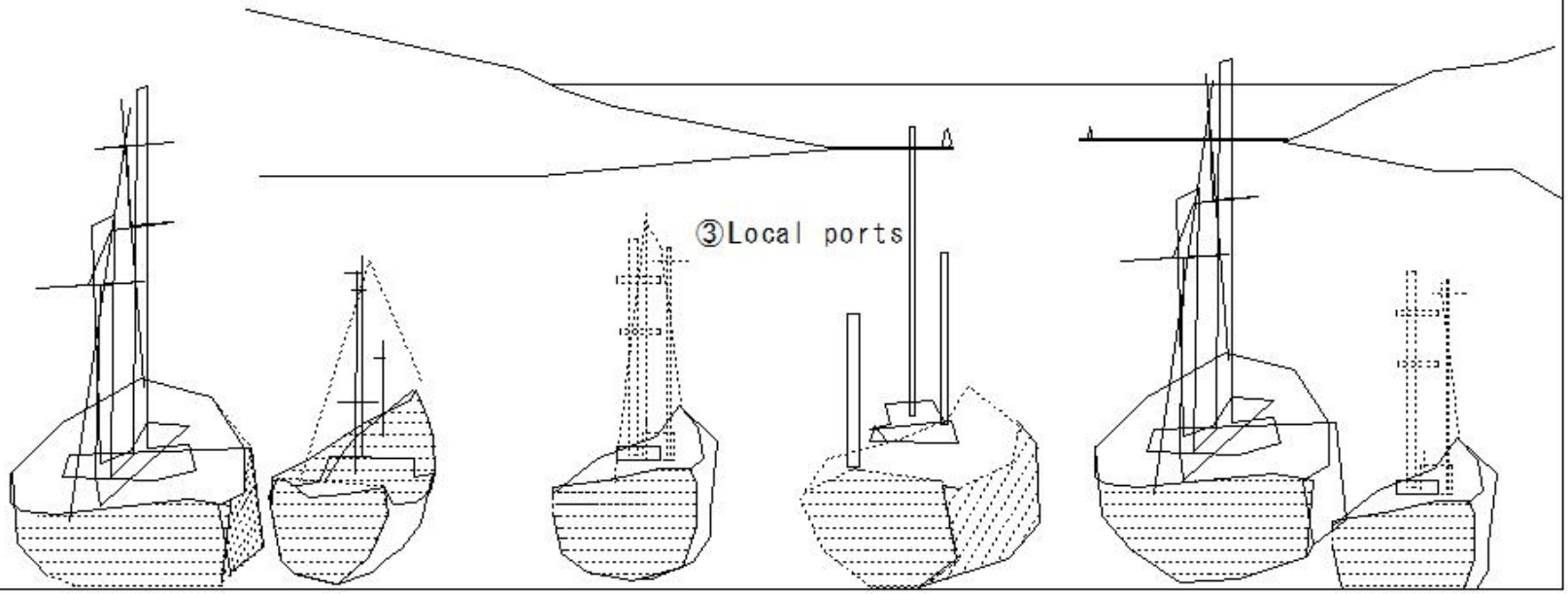
①Type of port

①Specific important ports: Trade

②Important ports

③Local ports

④Evacuation port: For evacuation of small ships



(P10)Port Coast（Basics of port planning）

(P10)Port Coast (Basics of port planning)

Characteristics of port construction

Basics of port planning

②Basics of port planning

①Basics of port planning

②Efficient

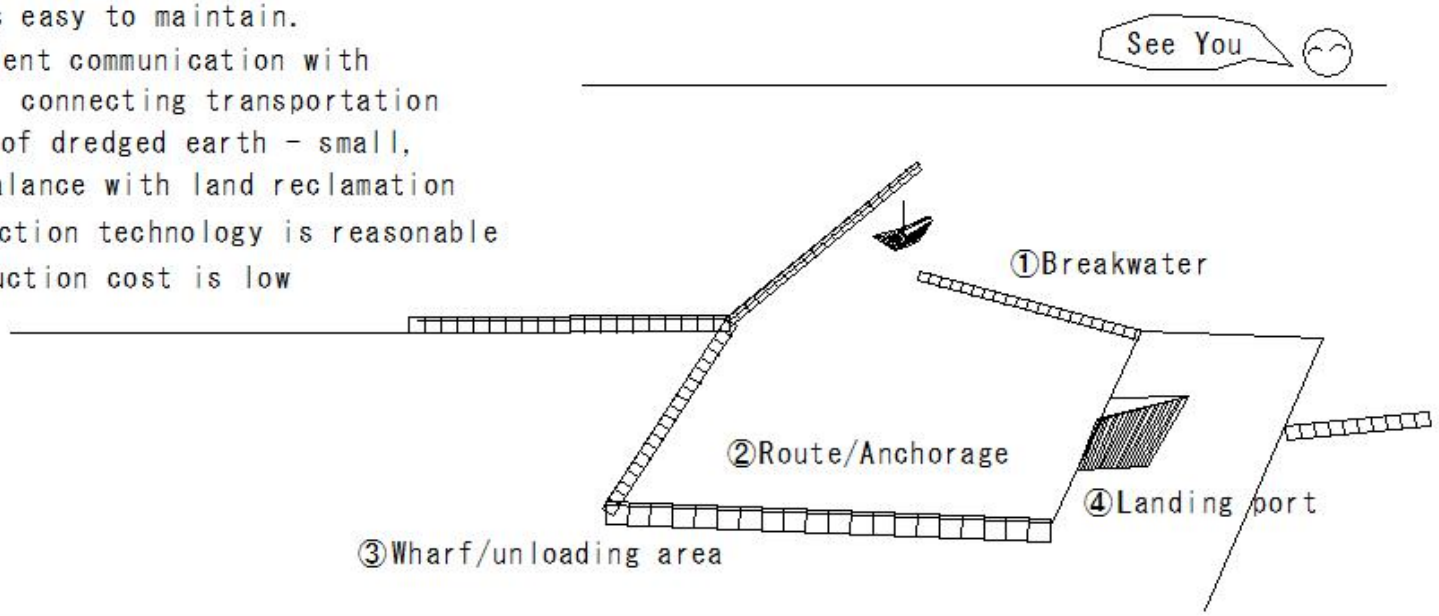
③Good use of land in the back

④The pier has a good operating rate and is easy to maintain.

⑤Sufficient communication with connecting transportation

⑥Amount of dredged earth - small, good balance with land reclamation

⑦Construction technology is reasonable construction cost is low



(P11)Port Coast（Basics of port planning）

(P11)Port Coast (Basics of port planning)

Characteristics of port construction

Basics of port planning

②Basics of port planning

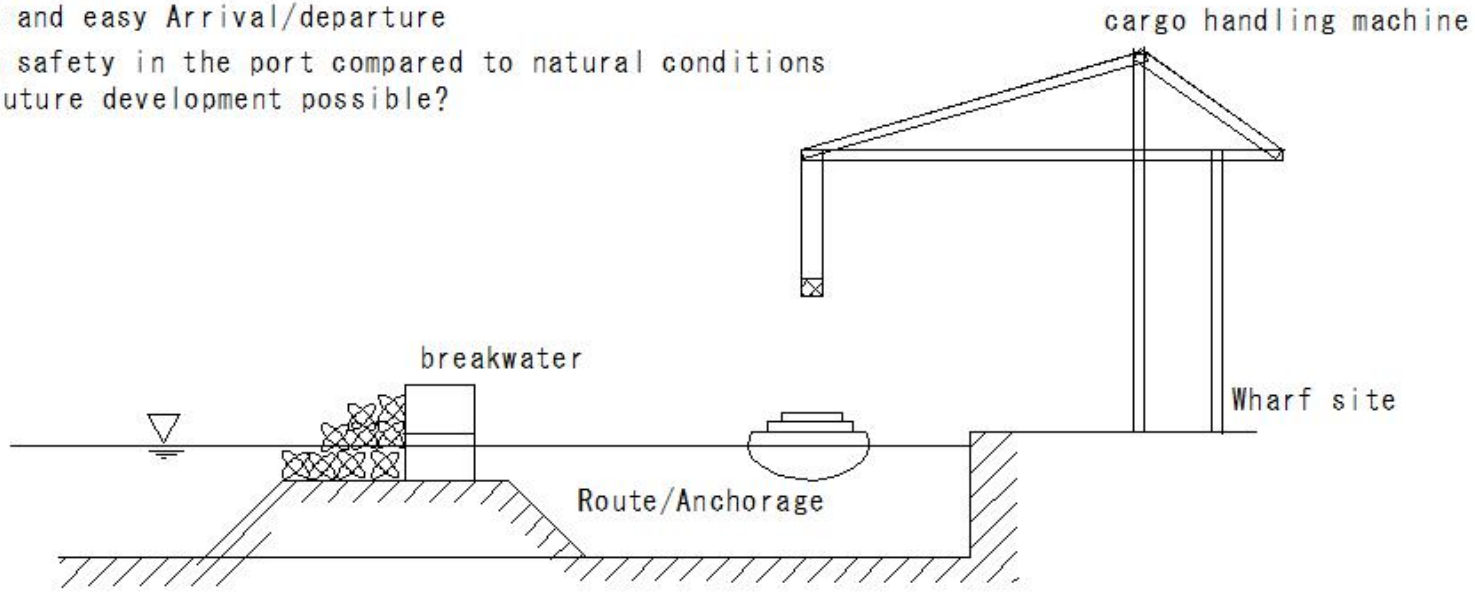
①Basics of port planning

⑧Highly safe

⑨Safe and easy Arrival/departure

⑩High safety in the port compared to natural conditions

⑪Is future development possible?



(P12)Port Coast（Basics of port planning）

(P12)Port Coast (Basics of port planning)

Characteristics of port construction

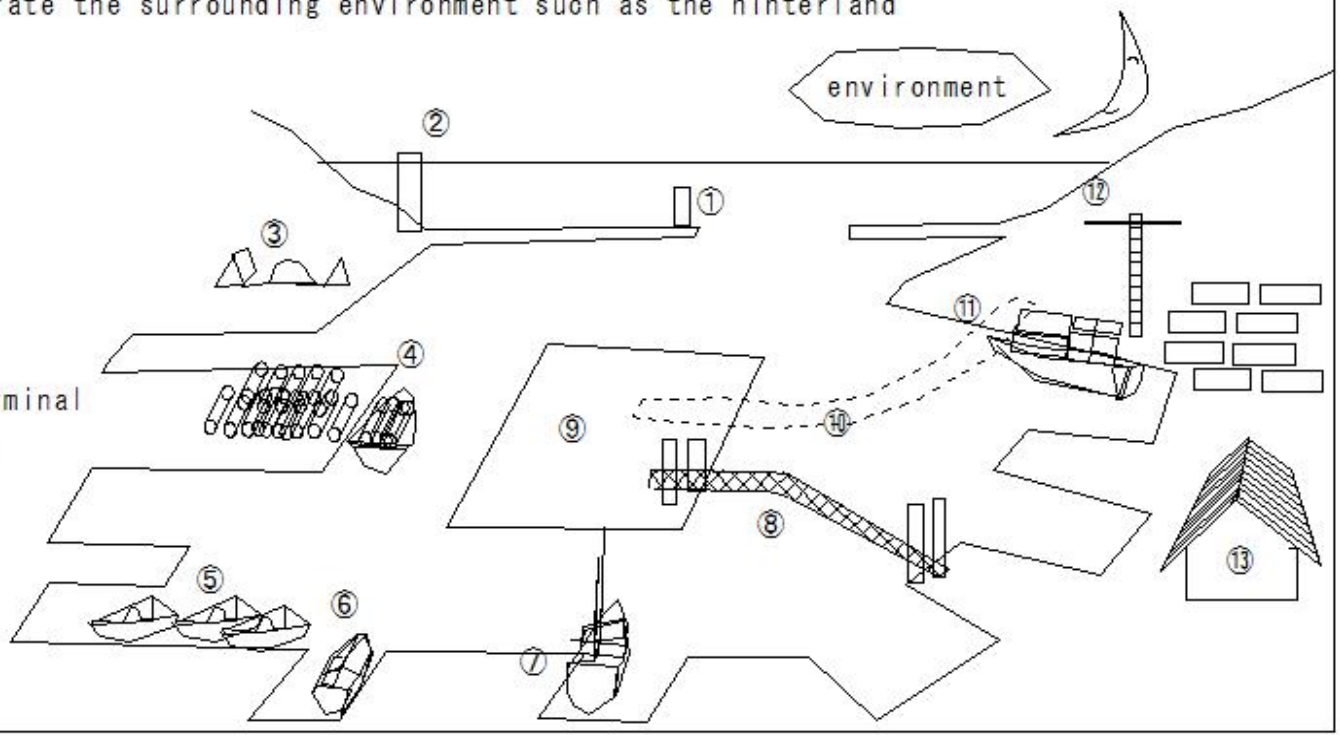
Basics of port planning

②Basics of port planning

⑫Good environmental conditions

⑬Do not deteriorate the surrounding environment such as the hinterland

①Lighthouse
②Signal station
③Marine Park
④Timber wharf
⑤Marina
⑥Ferry pier
⑦Passenger ship terminal
⑧Connecting bridge
⑨Artificial island
⑩Undersea tunnel
⑪Container wharf
⑫Gantry crane
⑬Warehouse



(P13)Port Coast（Basics of port planning）

(P13)Port Coast (Basics of port planning)

Characteristics of port construction

Basics of port planning

②Basics of port planning

⑭Layout plan

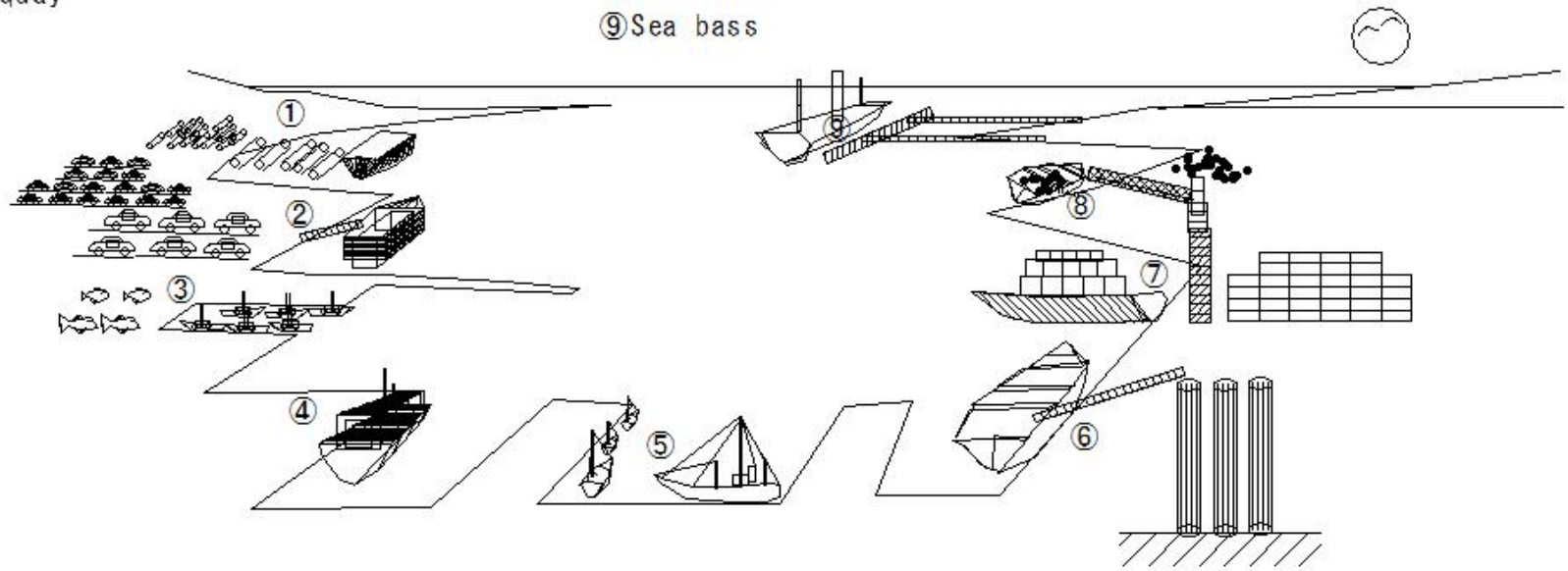
port facilities

breakwater

sea -route

quay

①Timber wharf
②Car wharf
③Fish port
④Passenger ship terminal
⑤Marina
⑥Grain wharf
⑦Container wharf
⑧Coal wharf
⑨Sea bass



(P14)breakwater

(P14)breakwater

breakwater

Types and characteristics of breakwaters

Calmness in the port

Maintaining water depth

Protecting ships, port facilities, and hinterlands from waves, tsunamis, storm surges, etc.

Safety and smoothness of ship navigation, berthing, and cargo handling

Upright breakwater

Concrete block breakwater

rock-filled breakwater

Block masonry breakwater

C1328 C1326 C1244 C1126

(P15)breakwater

(P15)breakwater

breakwater

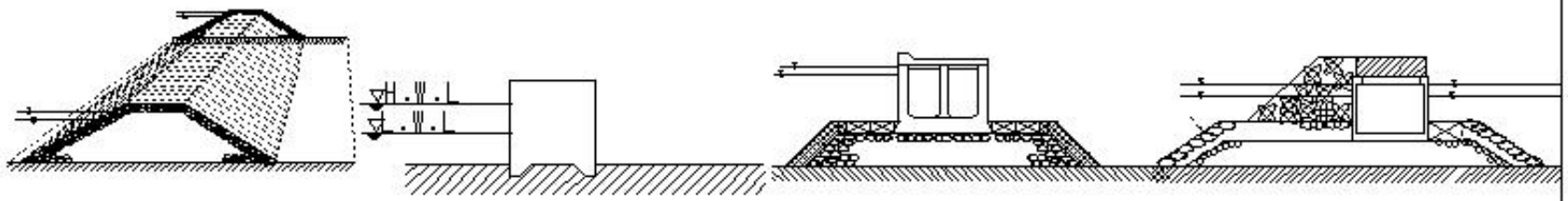
Types and characteristics of breakwaters

①Sloped breakwater

②Upright breakwater

③composite breakwater

④Wave-dissipating block covering breakwater



①Sloped breakwater ②upright breakwater ③composite breakwater ④Wave-dissipating block covering breakwater

P16 P19 P22 P23

(P16)breakwater(Sloped breakwater)

(P16)breakwater(Sloped breakwater)

breakwater

Types and characteristics of breakwaters

①Sloped breakwater

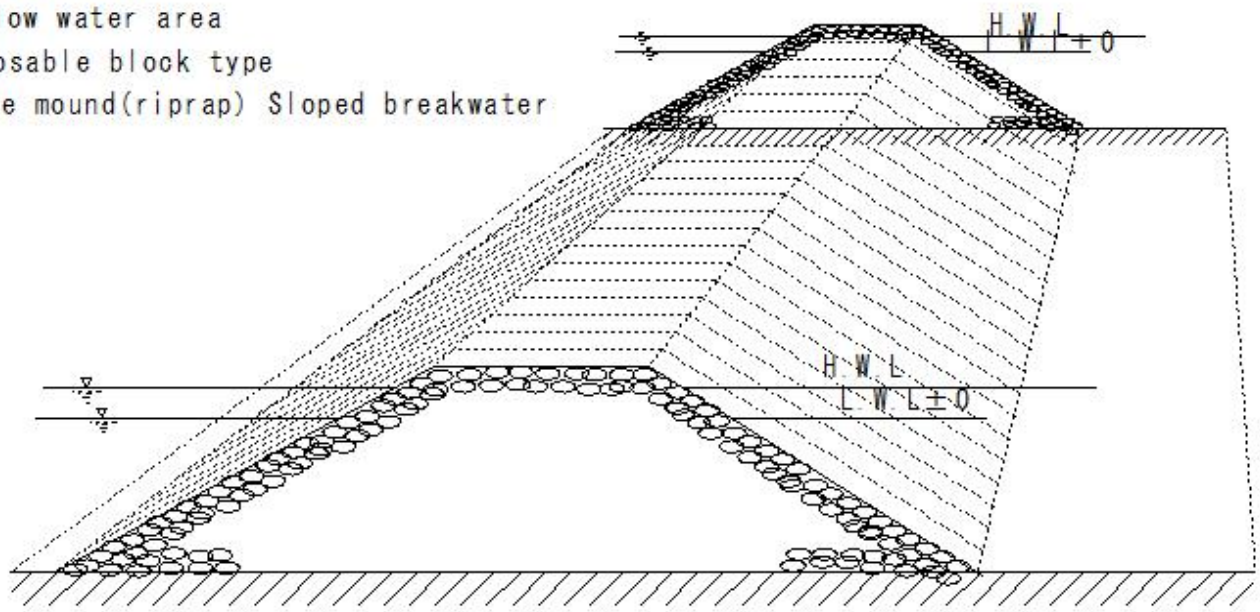
rough stone

Concrete block

shallow water area

disposable block type

rubble mound(riprap) Sloped breakwater



①Sloped breakwater

(P17)breakwater(Sloped breakwater)

(P17)breakwater(Sloped breakwater)

breakwater

Types and characteristics of breakwaters

①Sloped breakwater

Strong Points

①Not affected by unevenness of the seabed ground

Suitable for soft ground

②Reflected waves -few

Do not disturb the nearby sea surface

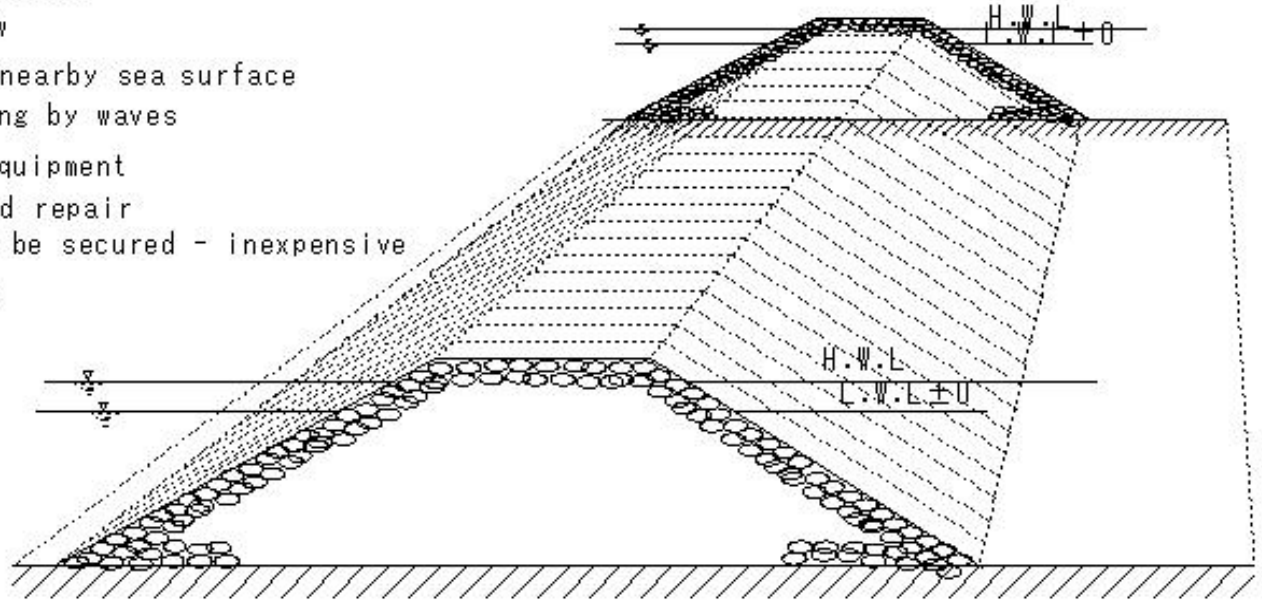
③Adaptable to scouring by waves

④Easy construction equipment

Easy to maintain and repair

⑤Stone materials can be secured - inexpensive

Construction - fast



①Sloped breakwater

(P18)breakwater(Sloped breakwater)

(P18)breakwater(Sloped breakwater)

breakwater

Types and characteristics of breakwaters

①Sloped breakwater

Strong Points

weak point

① Large amount of materials required

② Directly - subject to breaking wave pressure

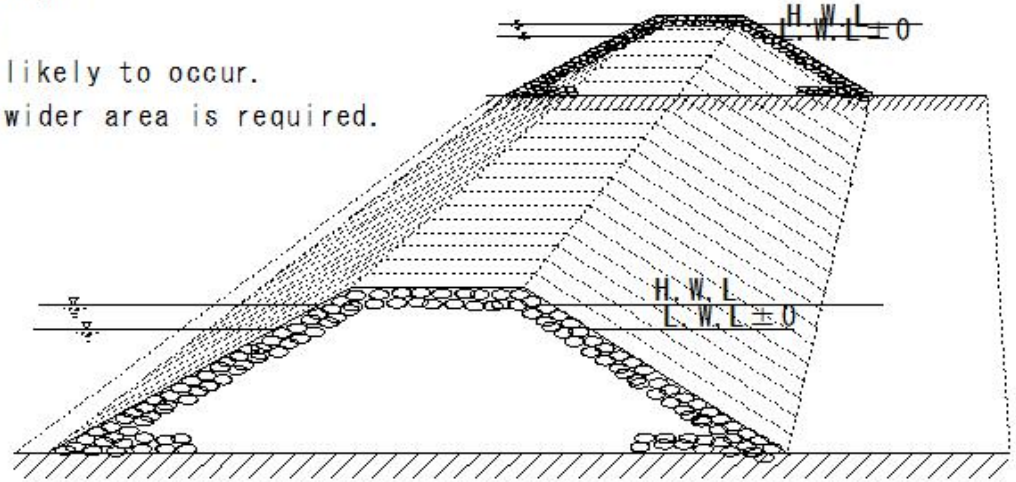
Surface layer - scattering of covering stones is likely to occur

Maintenance and repair costs are high

③ Areas affected by drifting sand

Sedimentation within the port is likely to occur.

④ As the water depth increases, a wider area is required.



①Sloped breakwater

(P19)breakwater(upright breakwater)

(P19)breakwater(Upright breakwater)

breakwater

Types and characteristics of breakwaters

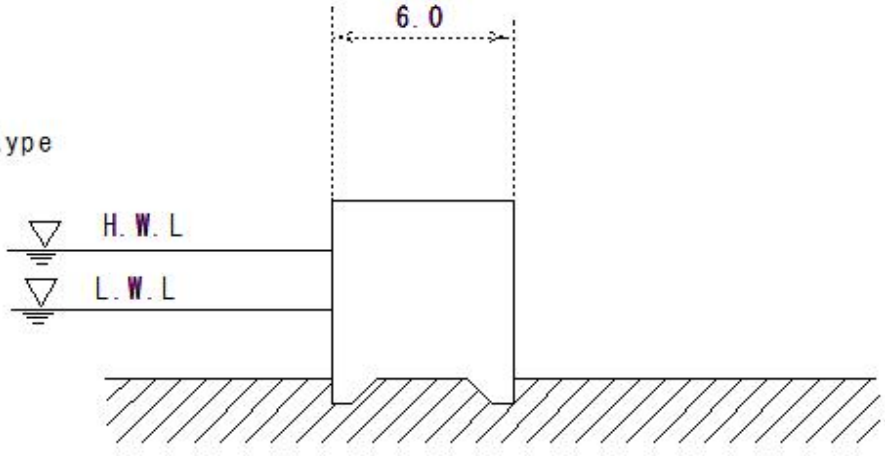
②upright breakwater

caisson type

block type

cellular block type

concrete single block type



②upright breakwater

The ground is hard and there is no scouring caused by waves.

caisson upright

(P20)breakwater(upright breakwater)

(P20)breakwater(Upright breakwater)

breakwater

Types and characteristics of breakwaters

②upright breakwater

①Advantages of upright breakwater

・Entire levee body - strong against wave force

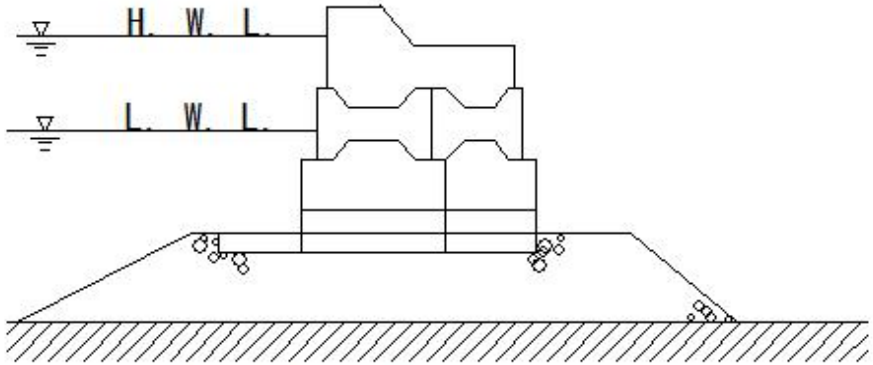
・Cheap filling material - savings in construction costs

・Base width -Narrow but good

・Caisson type - manufactured on land

Quality/construction management - sure

Offshore construction days -can be shortened



②upright breakwater

C1326

(P21)breakwater(upright breakwater)

(P21)breakwater(Upright breakwater)

breakwater

Types and characteristics of breakwaters

②upright breakwater

②upright breakwater

②Disadvantages of upright breakwater

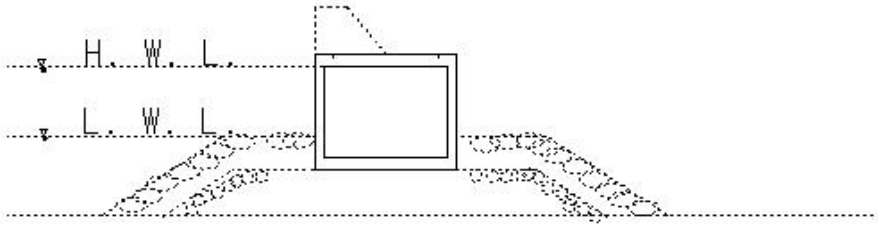
・Wall body - direct seabed ground - installation - bottom reaction force increases

・Front surface of the wall - Vertical - Blocks waves - Wave energy is concentrated in the front

Easy to cause soil scouring

- Requires solid foundation ground

・Caisson production equipment: Various equipment - large amount of construction costs required



②upright breakwater

(P22)breakwater(composite breakwater)

(P22)breakwater(composite breakwater)

breakwater

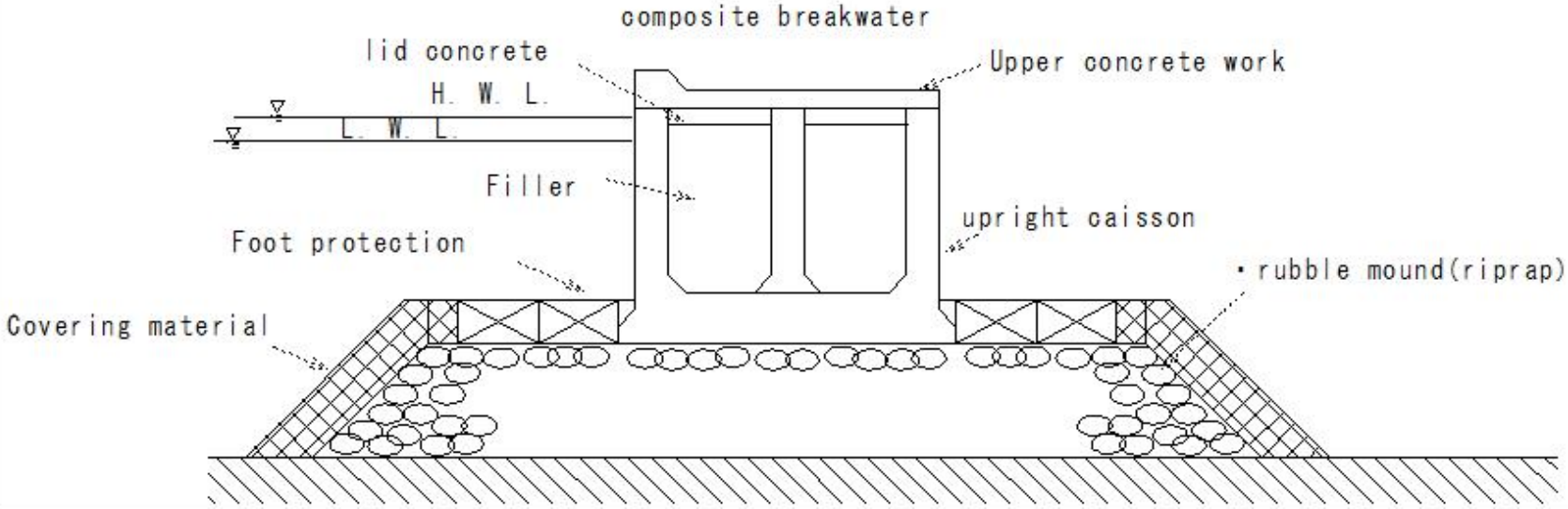
Types and characteristics of breakwaters

③composite breakwater

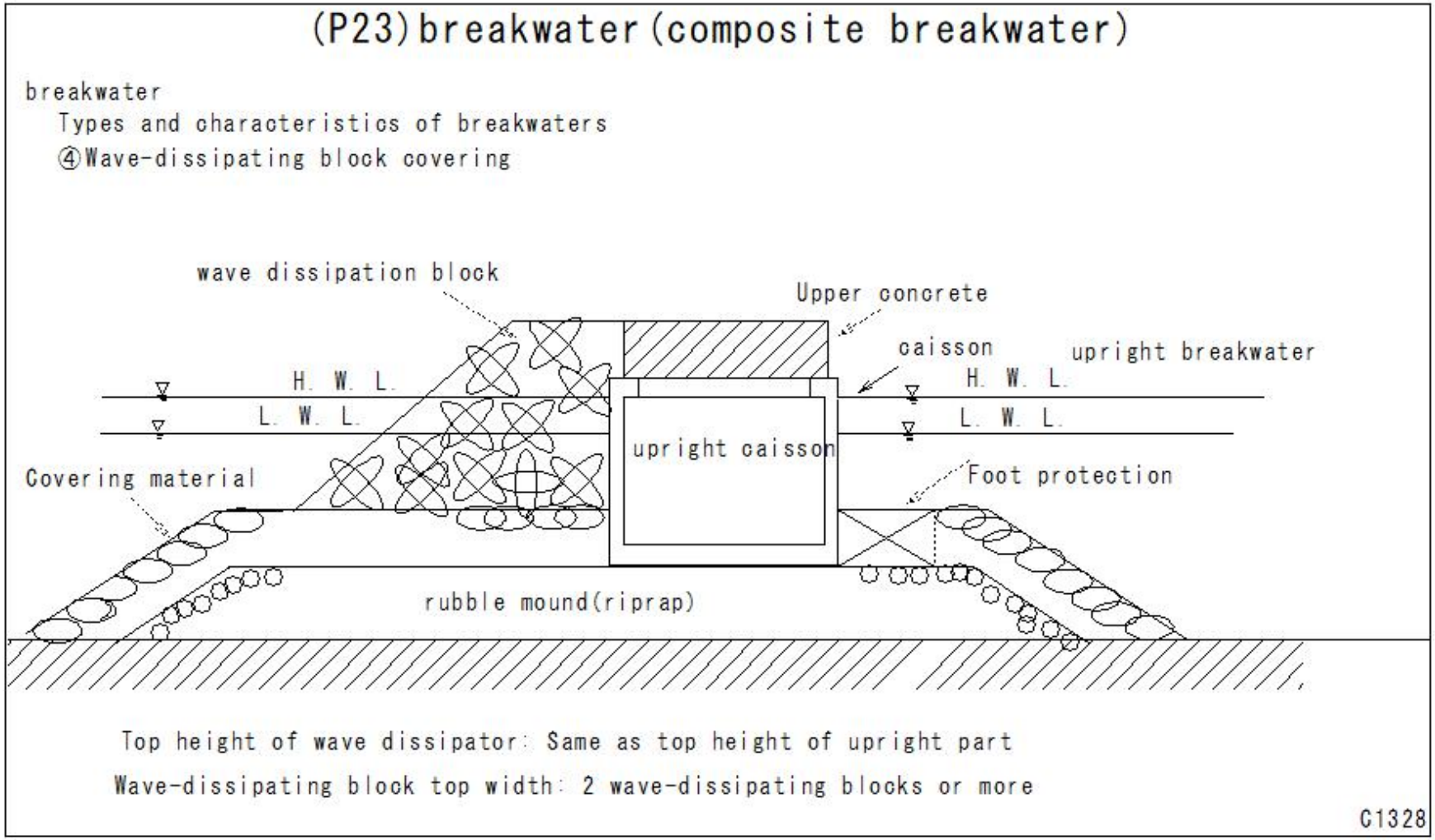
- Slanted + Upright
- rubble mound(riprap)
- Upright part: caisson, concrete block, cellular block

type

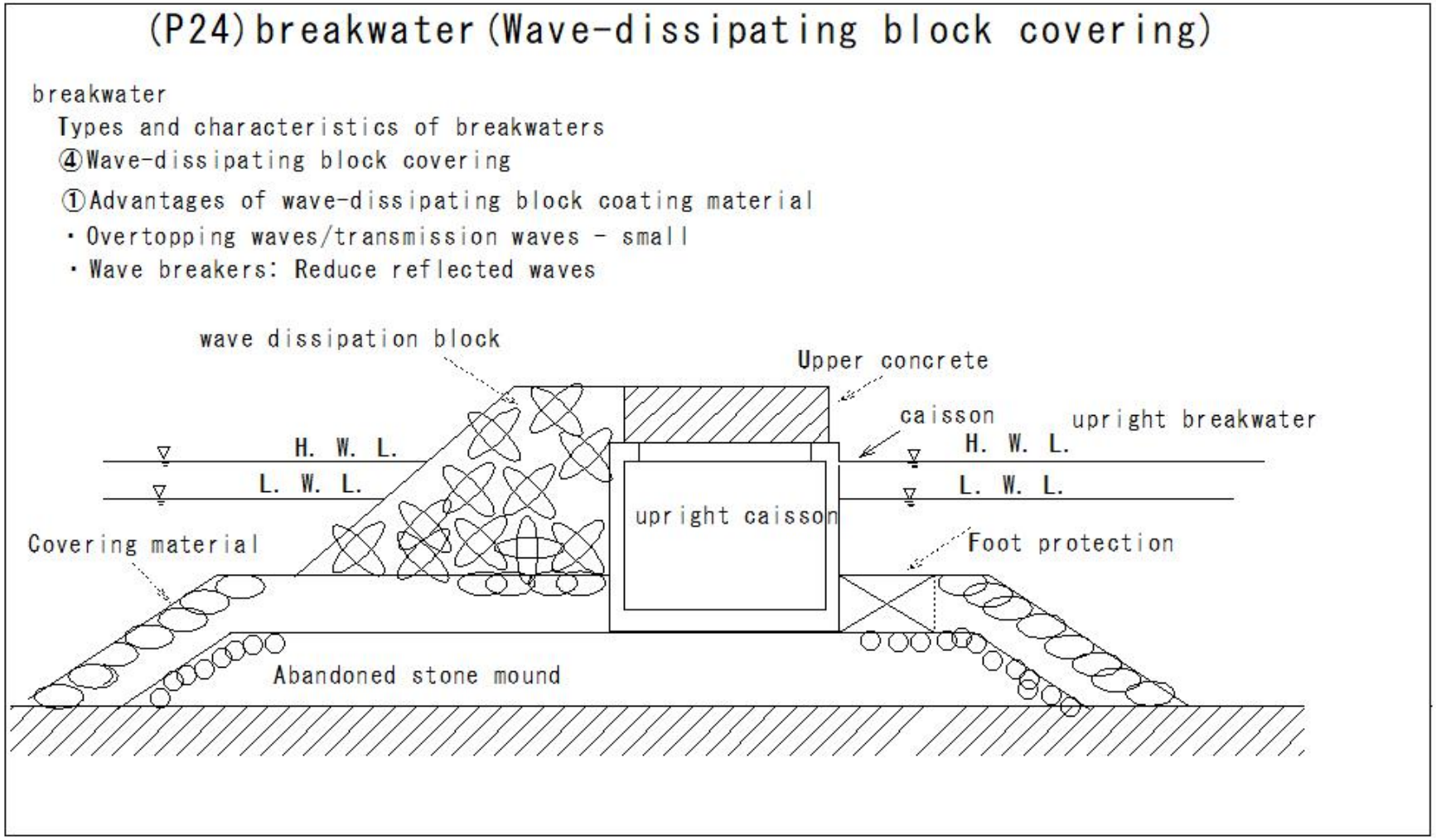
- Caisson type, block type, cellular block type, concrete single block type



(P23)breakwater(composite breakwater)



(P24)breakwater(Wave-dissipating block covering)



(P25)breakwater(Wave-dissipating block covering)

(P25)breakwater(Wave-dissipating block covering)

breakwater

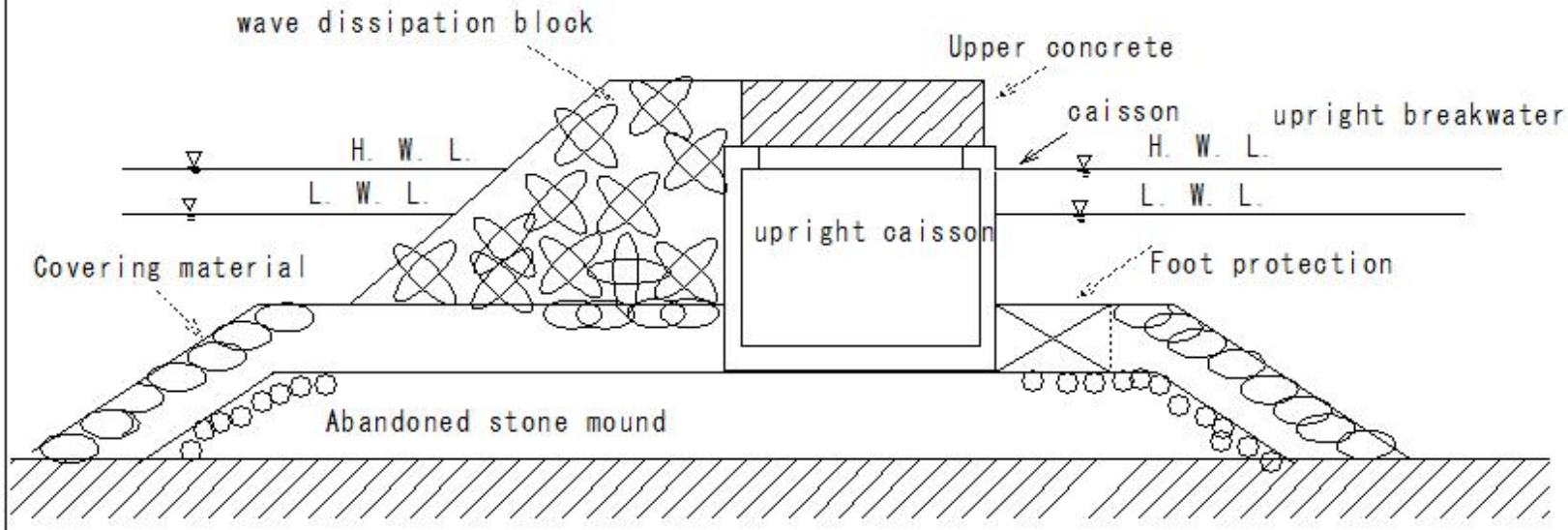
Types and characteristics of breakwaters

④Wave-dissipating block covering

②Disadvantages of wave-dissipating block coating material

・Wave-dissipating block manufacturing equipment:

A large amount of construction cost for various equipment



(P26)breakwater(Breakwater design)

(P26)breakwater(Breakwater design)

breakwater

Breakwater design

・Quiet level inside the breakwater

Wind, tide level, waves, water depth, ground condition, flow, drifting sand - investigation and design

design order

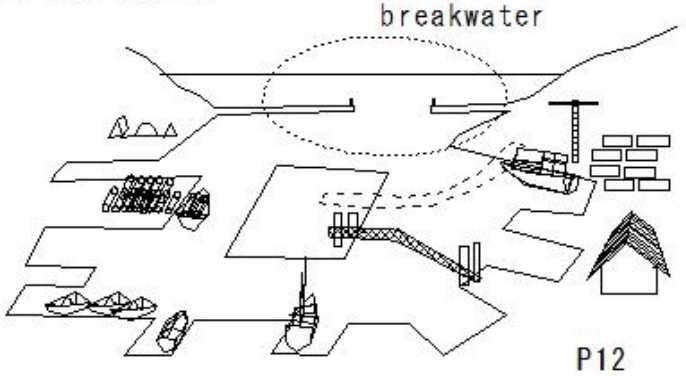
① Determine design conditions

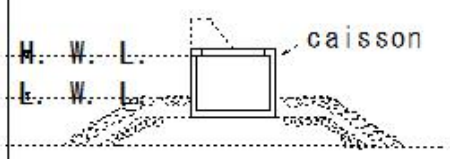
② Assumption of cross section

③ Calculation of external force

④ Stability calculation

⑤ Cross section determination

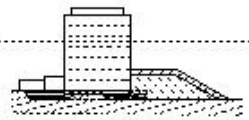




C1328

C1326

C1244



C1126

(P27)breakwater(Breakwater design-Top height)

(P27)breakwater(Breakwater design-Top height)

breakwater

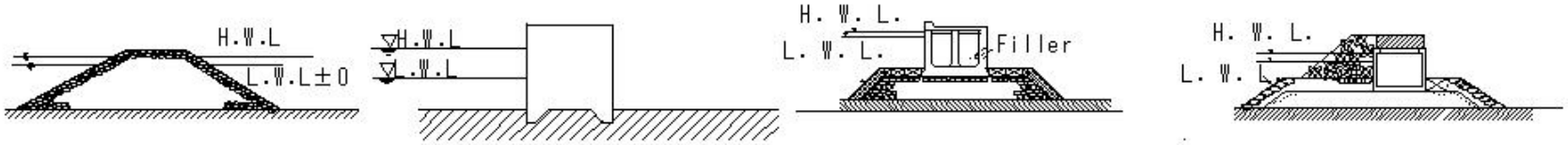
Breakwater design

①Top height

Average high tide level +0.6H (1/3)

①Sloped breakwater ②upright breakwater ③composite breakwater

④Wave-dissipating block covering



P16 P19 P22 P23

(P28)breakwater(Breakwater design-Top width)

(P28)breakwater(Breakwater design-Top width)

breakwater

Breakwater design

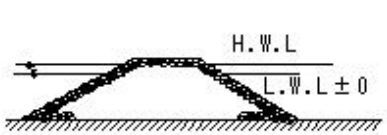
②Top width

Wave pressure calculation: sufficient width

3 or more blocks

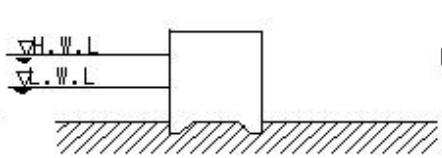
5-7m

①Sloped breakwater



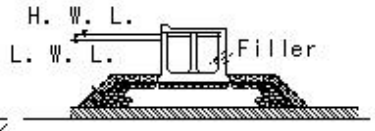
P16

②upright breakwater



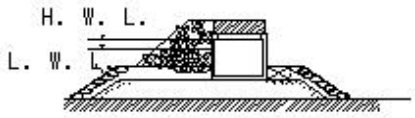
P19

③composite breakwater



P22

④Wave-dissipating block covering



P23

(P29)breakwater(Breakwater design-Height of the top of the rubble mound(riprap))

(P29)breakwater(Breakwater design-Height of the top of the rubble mound(riprap))

breakwater

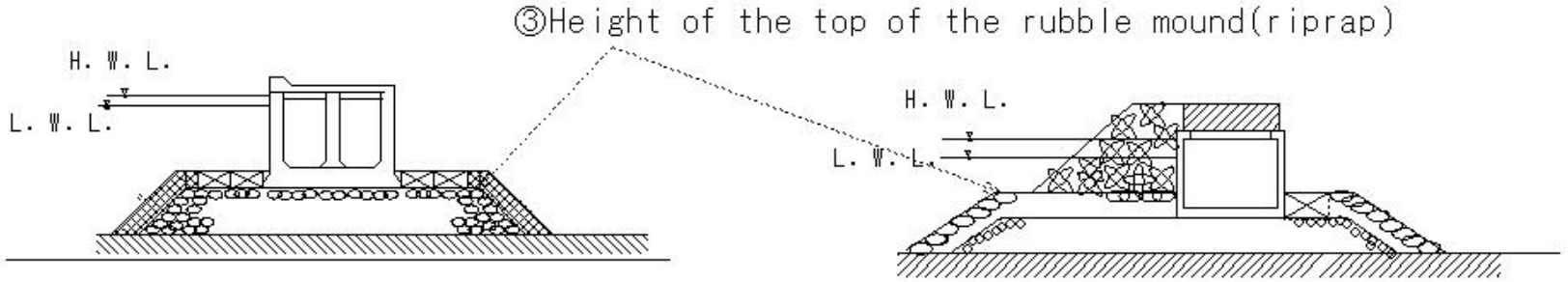
Breakwater design

③Height of the top of the rubble mound(riprap)

Water depth at which caisson can be installed

③composite breakwater

④Wave-dissipating block covering



P22

P23

(P30)breakwater(Thickness of the rubble mound(riprap))

(P30)breakwater(Thickness of the rubble mound(riprap))

breakwater

Breakwater design

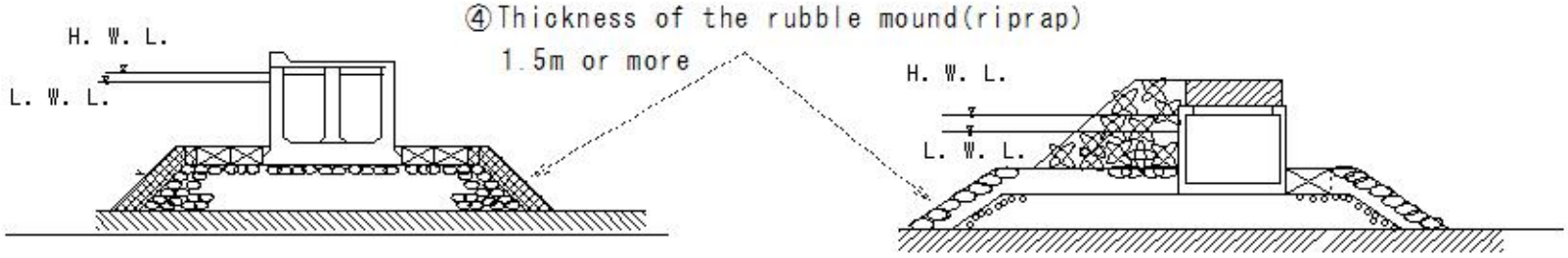
④Thickness of the rubble mound(riprap)

Widely distributes the load of upright parts on the ground

Level the ground on which the upright part will be installed

③composite breakwater

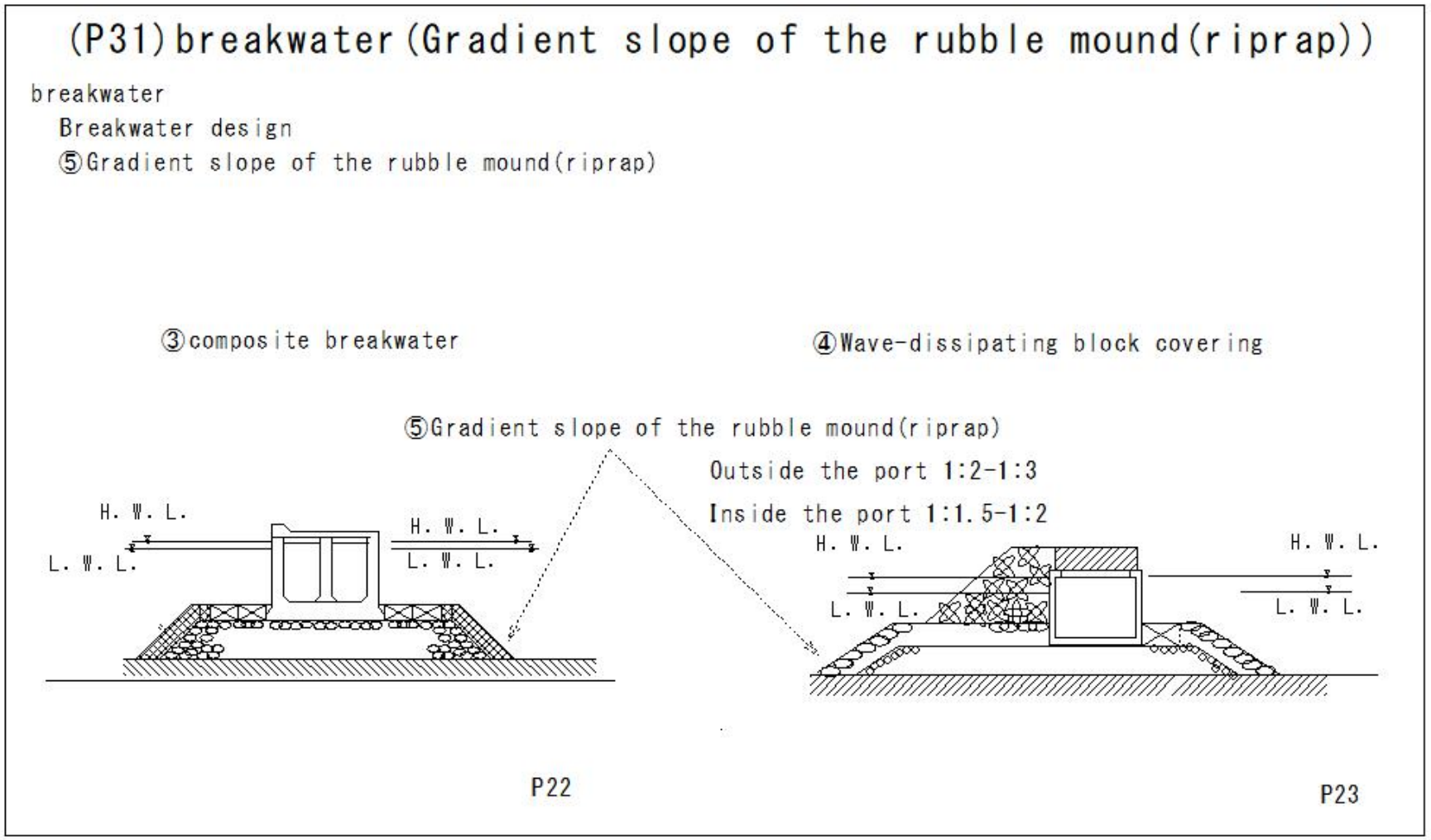
④Wave-dissipating block covering



P22

P23

(P31)breakwater(Gradient slope of the rubble mound(riprap))



(P32)breakwater(Breakwater design-Filling material)

(P32)breakwater(Breakwater design-Filling material)

breakwater

Breakwater design

⑥Filling material

dead weight of caisson

Embankment stability

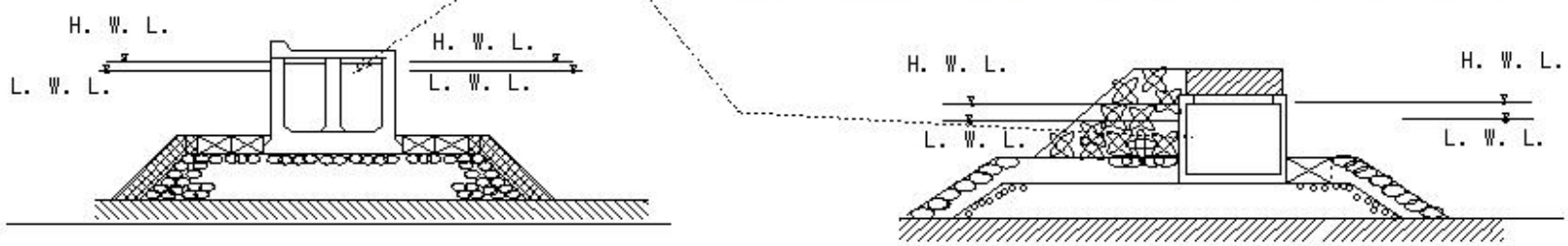
③composite breakwater

④Wave-dissipating block covering

⑥Filling material

Sand, gravel, gravel, concrete with a poor mix

Sand, gravel, gravel: covered with concrete blocks



P22

P23

(P33)breakwater(Breakwater stability)

(P33)breakwater(Breakwater stability)

breakwater

Breakwater stability

external force

① Wave power-wave power of overlapping waves and breaking waves

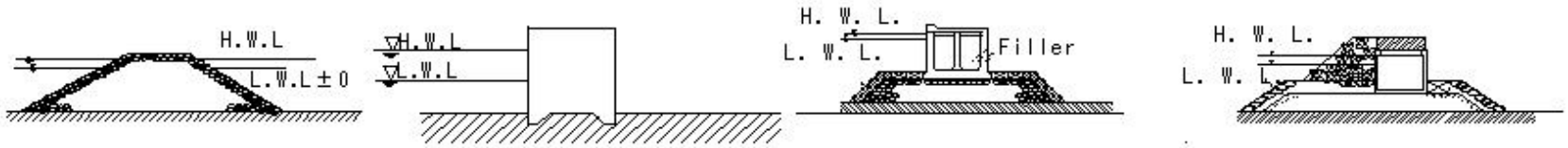
② Hydrostatic pressure - case of a difference between the static water level inside and outside the breakwater

③ Buoyancy force -force acting below the still water surface, including uplift force

④ Self weight - weight of embankment body

⑤ Earthquake force -force acting on the levee body during an earthquake

①Sloped breakwater ②upright breakwater ③composite breakwater ④Wave-dissipating block covering



P16 P19 P22 P23

(P34)breakwater(Breakwater stability)

(P34)breakwater(Breakwater stability)

Breakwater stability

① Stability calculation

① Sliding of embankment body

Fs=(f/W)/p

Fs: Safety factor (Standard safety factor is 1.2 at all times, 1.0 or more during earthquakes)

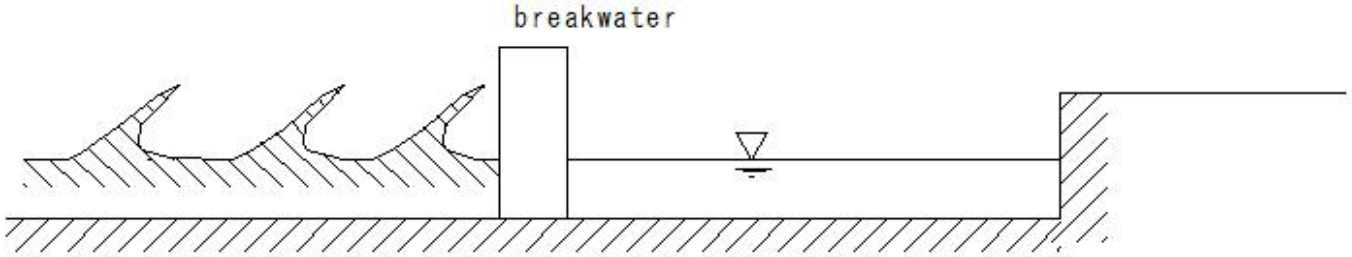
P: Horizontal resultant force of external forces (wave pressure resultant force) (t)

f: Coefficient of friction with the bottom of the embankment

W: Vertical resultant force on the bottom of the embankment
(embankment weight (t) after subtracting buoyancy, etc.)

case of the water depth is less than twice the wave height,
wave breaking pressure Hiroi formula (P = 1.5wH)

case of the water depth is less than twice the wave height,
it is considered a duplicate wave, and the Sunflue formula



(P35)breakwater(Breakwater stability)

(P35)breakwater(Breakwater stability)

breakwater

Breakwater stability

① Stability calculation

Wave height: H=3.5m

Embankment body unit weight w = 2.0t/?3

Seawater unit weight w=1.0t/m3

Friction coefficient: f=0.8(t/m2)

breakwater

Design wave height (H) = 3.5m

The water depth in front of the embankment body is less than twice the wave height.

Hiroi's formula

p=1.5wH(t/m2)

=1.5×1.0×3.5

=5.25(t/m2)

P=p×10.0m (levee body height)=52.5(t/m)

W=10.0m×10.0m×(2.0t/m3 (unit weight of levee body) - 1.0t/m3 (unit weight of seawater))

=100.0(t/m)

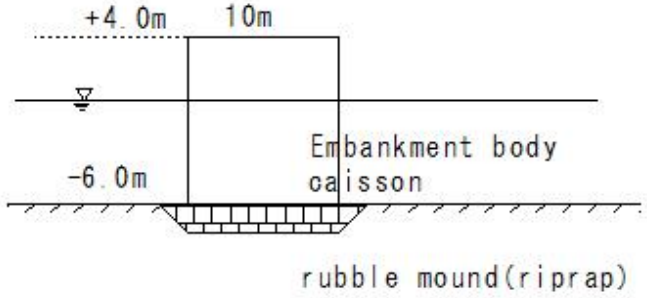
The height of the top of the embankment body is 4.0m.

Less than 1.25H

Due to buoyancy acting on the entire cross-sectional area of the dam body subtract buoyancy

Fs=(0.8×100.0(t/m)/52.5(t/m))=1.52>1.2

Safe against sliding



(P36)breakwater(Breakwater stability)

(P36)breakwater(Breakwater stability)

breakwater

Breakwater stability

② Overturning of the embankment body

Fs=Wt/Pl

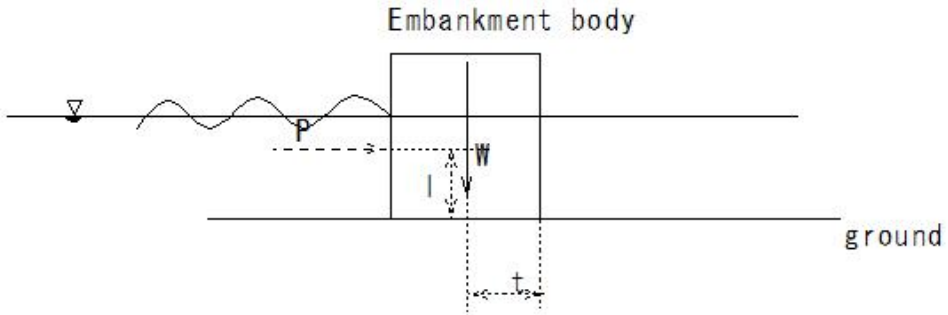
Fs: Safety factor (safety factor is always 1.2 or more)

P: Horizontal resultant force of external forces (wave pressure resultant force) (t)

l: Height from the lower end of the embankment body to the line of action of the horizontal resultant force of external forces (m)

W: Vertical resultant force (embankment weight minus buoyancy, etc.) (t)

t: Distance from the rear end of the bottom of the embankment body to the line of action of the vertical resultant force (m)



(P37)breakwater(Breakwater stability)

(P37)breakwater(Breakwater stability)

breakwater

Breakwater stability

② Overturning of the embankment body

Fs=Wt/Pl

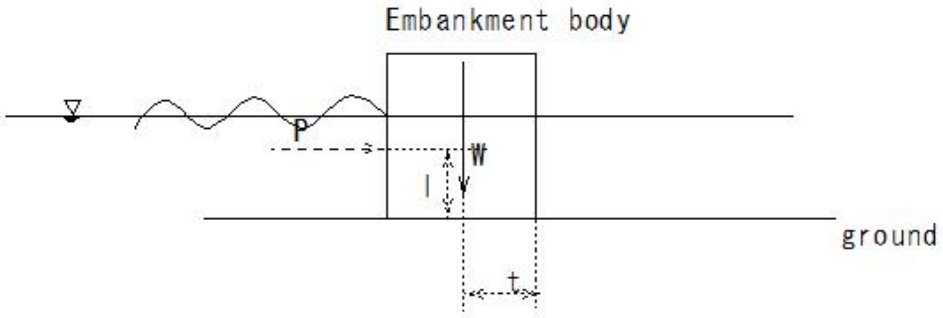
Fs: safety factor of 1.2 or more

P: Horizontal resultant force of external forces (wave pressure resultant force) (t)

l: Distance from the rear end of the bottom of the embankment body to the line of action of the horizontal resultant force of external forces (m)

W: Vertical resultant force (embankment weight minus buoyancy, etc.) (t)

t: Distance from the rear end of the bottom of the embankment body to the line of action of the vertical resultant force (m)



(P38)breakwater(Breakwater stability-Soil bearing capacity)

(P38)breakwater(Breakwater stability-Soil bearing capacity)

breakwater

Breakwater stability

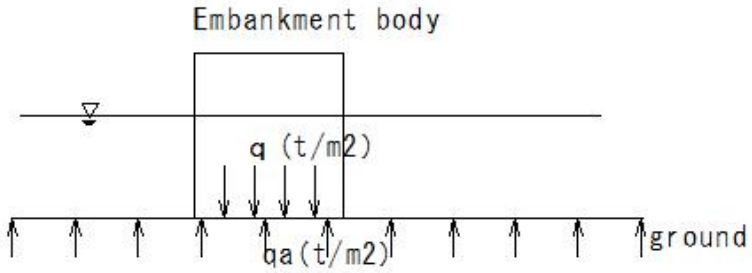
③Soil bearing capacity

Fs=qa/q

Fs: Safety factor of 1.0 or more

q: Load strength transmitted to the ground (t/m2)

qa: Allowable bearing capacity of the ground (t/m2)



P35

(P39)breakwater(Breakwater stability-For soft ground)

(P39)breakwater(Breakwater stability-For soft ground)

breakwater

Breakwater stability

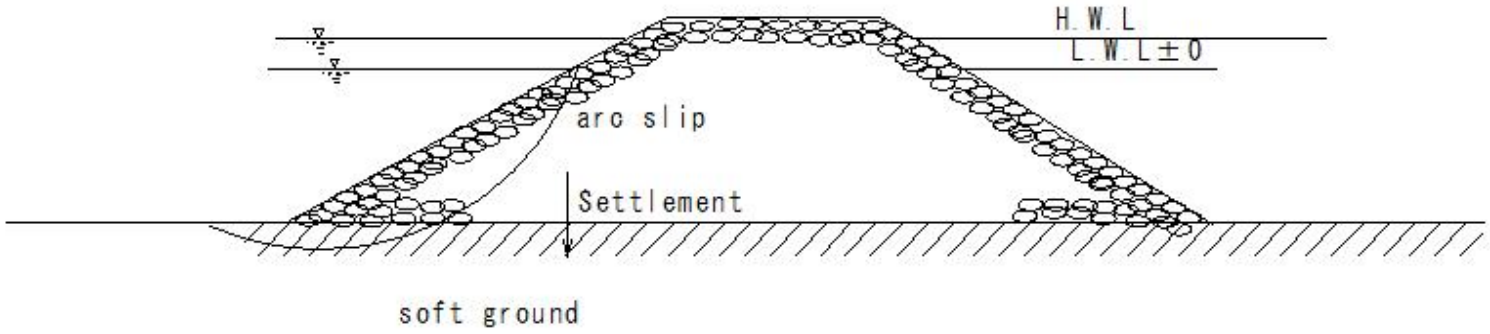
④For soft ground

against the levee body

arc slip

Examine Settlement

①Sloped breakwater



P36

(P40)breakwater(Breakwater stability-Settlement)

(P40)breakwater(Breakwater stability-Settlement)

breakwater

Causes of breakwater Settlement

① Encroachment due to the weight of rubble mound(riprap) and discarded blocks

② scouring by waves

③ Compression/consolidation of the embankment body itself

④ Consolidation of foundation ground and lateral moving

During construction

20-30% increase in quantity

extremely soft ground

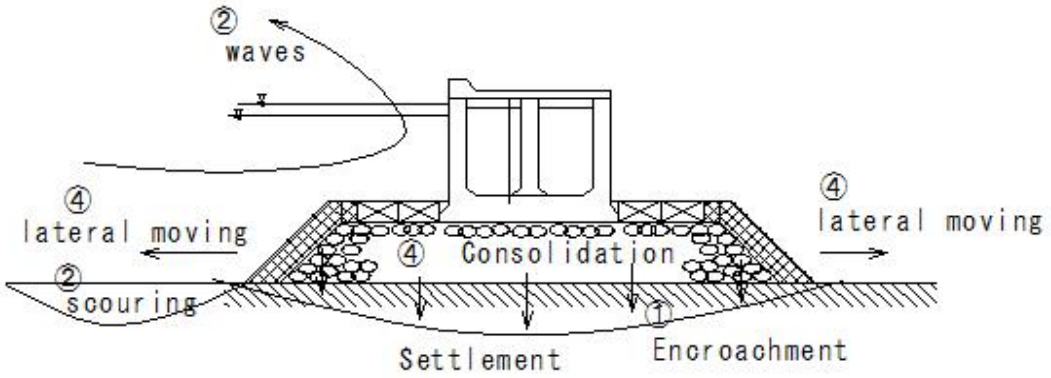
Replacement method

sand drain

sand compaction pile

mattress

Measures to reduce the amount of rubble mound(riprap)



(P41)breakwater(Construction-Foundation work)

(P41)breakwater(Construction-Foundation work)

breakwater

Construction of breakwater

①Foundation work

・For bedrock

In the case of bedrock

Uneven land adjustment

case of the foundation is good

Creating a rubble mound(riprap)

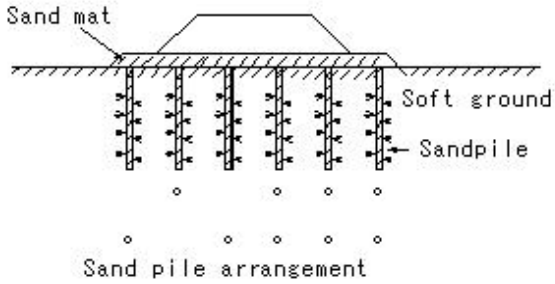
In case of soft ground

Replacement method

sand drain

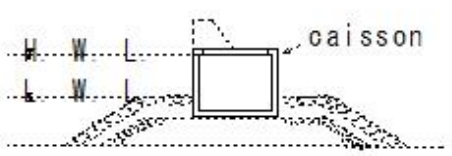
sand compaction pile

mattress



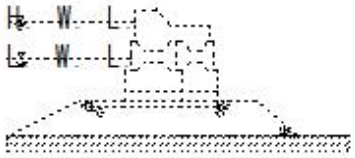
Sand pile arrangement

F232



Upright breakwater

C1328

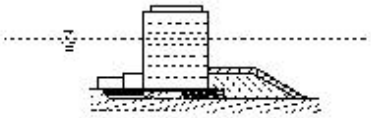


Concrete block breakwater

C1326

rock-filled breakwater

C1244



Block masonry breakwater

C1126

(P42)breakwater(Construction-Main body work)

(P42)breakwater(Construction-Main body work)

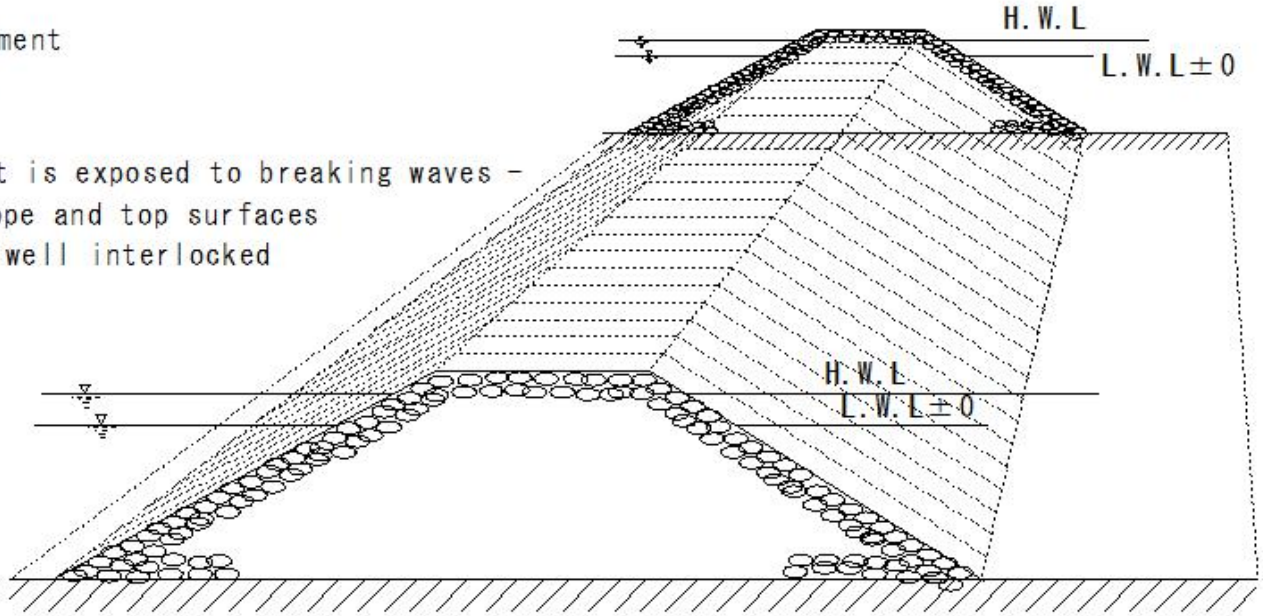
breakwater

Construction of breakwater

②Main body work

① rubble mound(riprap) (slope)

In the case of a slope
dumped at sea
Embankment body Settlement
Anticipate scattering
20-30% premium
Embankment surface that is exposed to breaking waves -
the stones on the slope and top surfaces
are well interlocked



① rubble mound(riprap) (slope)

(P43)breakwater(Concrete block construction (composite breakwater))

(P43)breakwater(Concrete block construction (composite breakwater))

breakwater

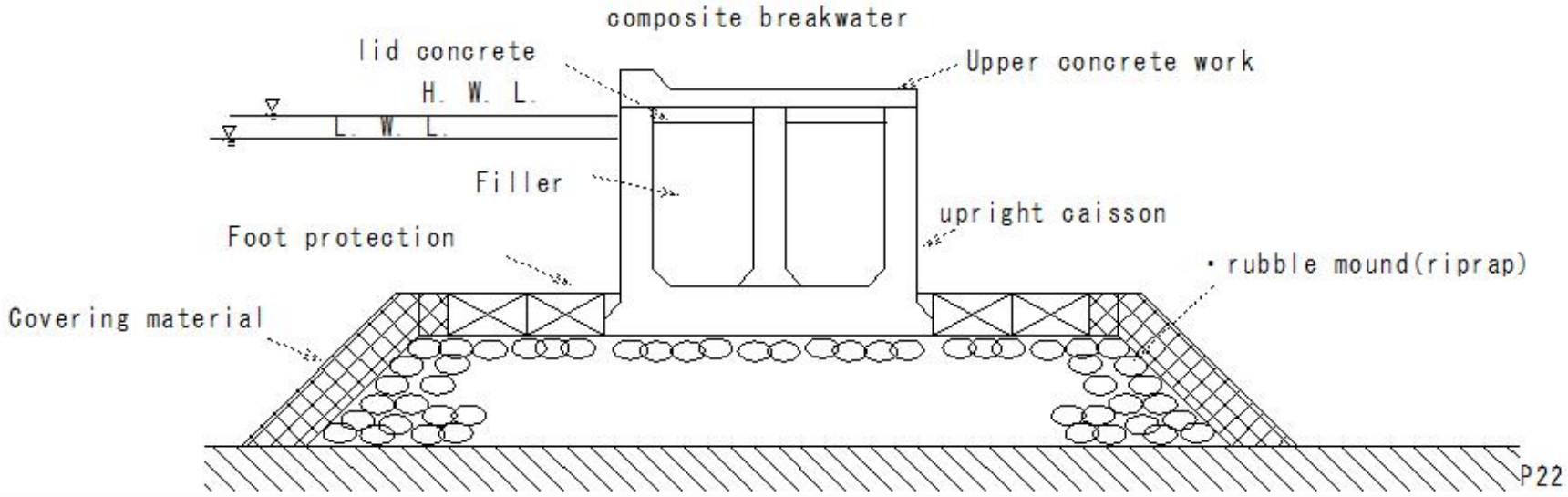
Construction of breakwater

②Concrete block construction (composite breakwater)

20-30t block

Installed on rubble mound(riprap) by crane ship

Avoid vertical joints



(P44)breakwater(Caisson (composite breakwater))

(P44)breakwater(Caisson (composite breakwater))

breakwater

Construction of breakwater

③Caisson (composite breakwater)

rubble mound(riprap) section (mound)

Water depth at which caisson can be installed

advantages

Strong against wave force

Produced on land

Construction - sure

Offshore construction days -can be shortened

Filling material - can be used

Construction costs - savings

disadvantages

caisson yard

large crane ship

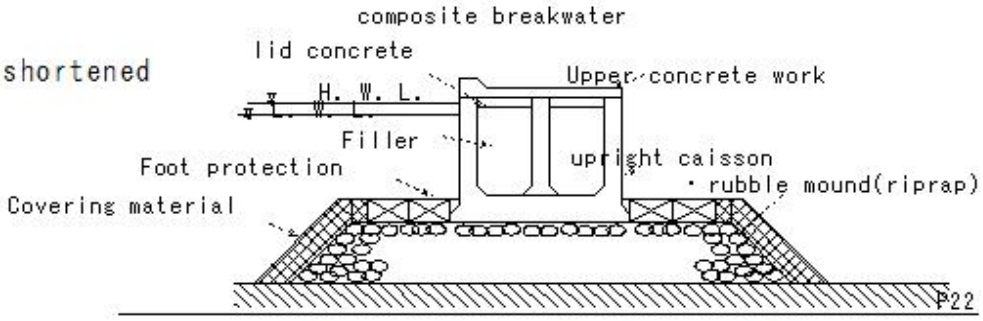
Block production equipment

Diverse equipment

Construction methods-various

Construction management -complex

Installation crown height of caisson - above average high tide level



③Caisson (composite breakwater)

(P45)breakwater(Caisson (composite breakwater))

(P45)breakwater(Caisson (composite breakwater))

breakwater

Construction of breakwater

③ Construction order of caisson (composite breakwater)

① Caisson production

caisson yard dock

② Temporary caisson placement

water injection

③ Caisson levitation

towing

④ Caisson installation

Water injection Water level difference is within 1.0m

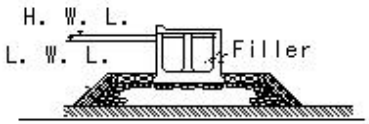
⑤ Caisson filling work

sand, concrete, stone

⑥ Lid concrete

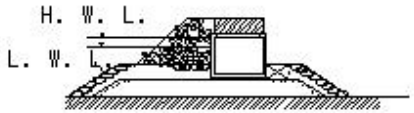
cut the side wall and edge

③composite breakwater



P22

④Wave-dissipating block covering

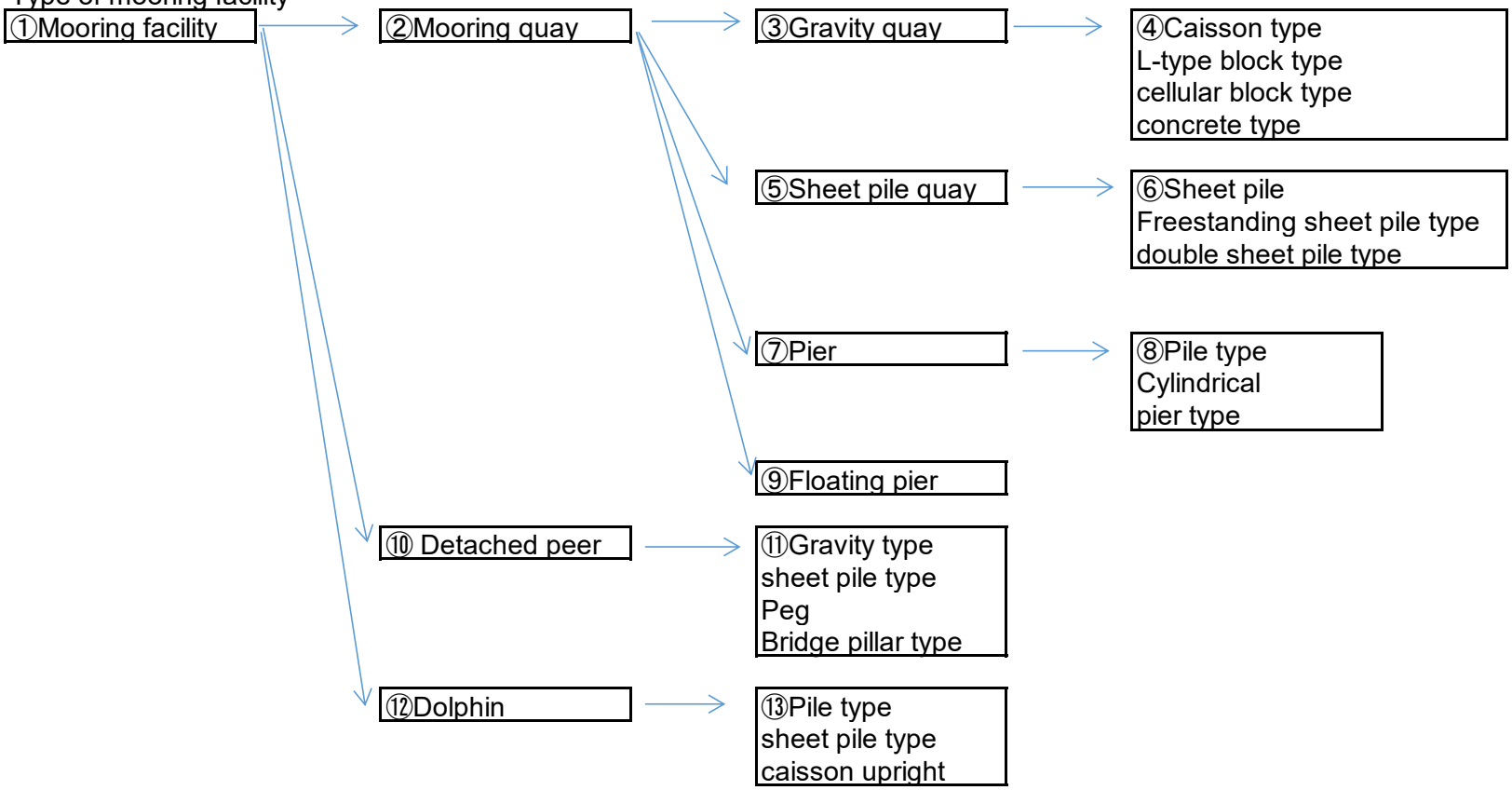


P23

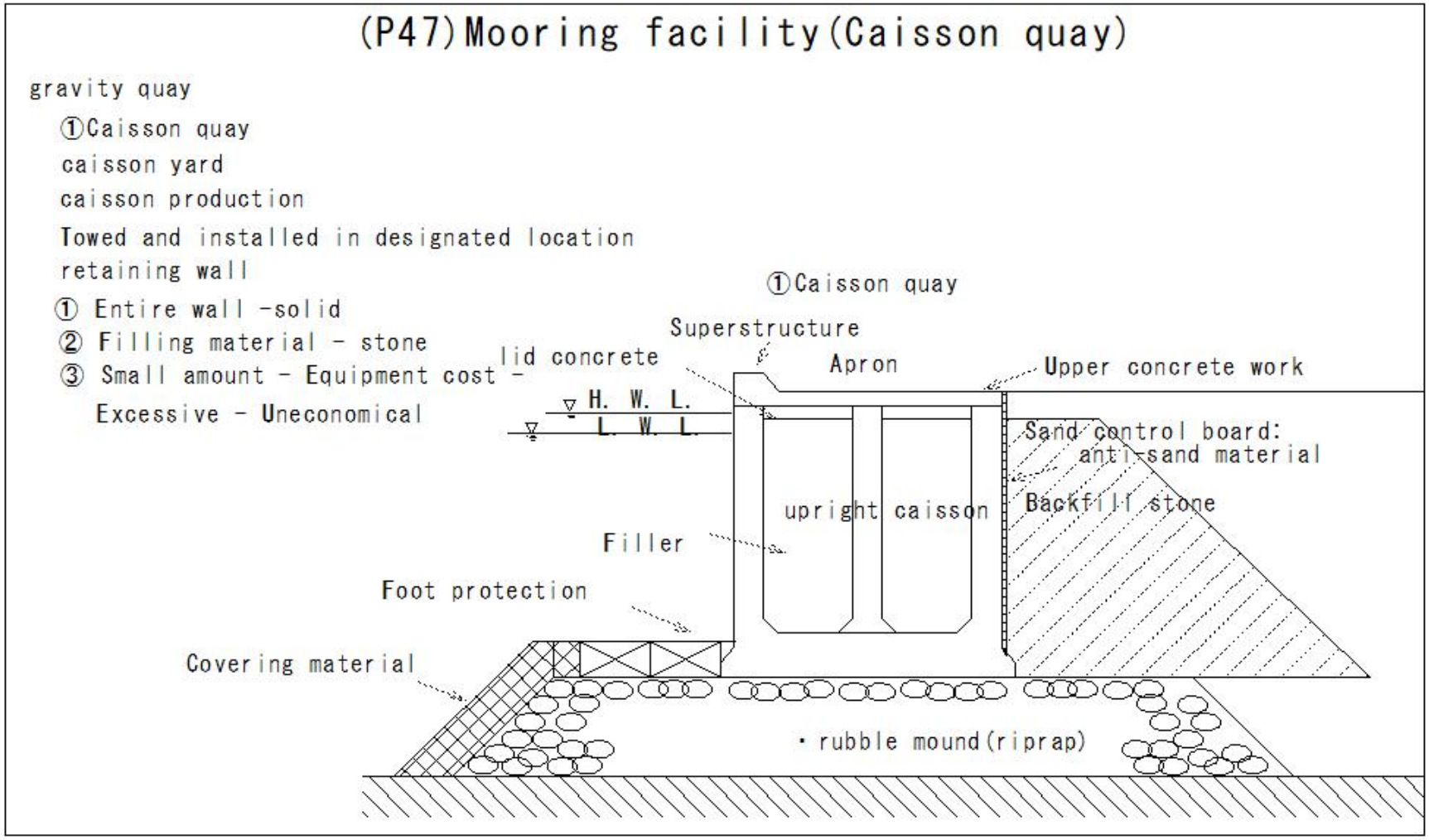
(P46)Mooring facility

(P46)Mooring facility
Mooring facility

Type of mooring facility



(P47)Mooring facility(Caisson quay)



(P48)Mooring facility(L-shaped block quay)

(P48)Mooring facility(L-shaped block quay)

gravity quay

②L-shaped block quay

Land - L-shaped block - production

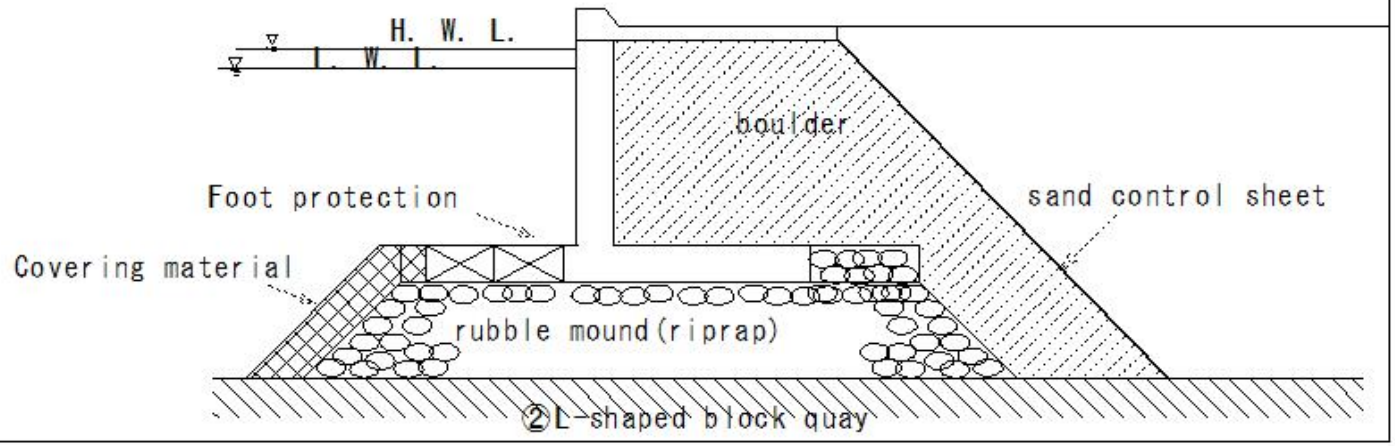
Block Weight of backfill material -
Resistance to external force

①Economical if the water is shallow

②After installing the L-shaped block
Unstable before backfilling

③the wall thickness is thin, in case of the wall shifts,
the backfill earth and sand will flow out.

④No need for large equipment



(P49)Mooring facility(Cellular block quay)

(P49)Mooring facility(Cellular block quay)

Cellular block quay

Made of steel and reinforced concrete, hollow frames are stacked and filled.

wall structure

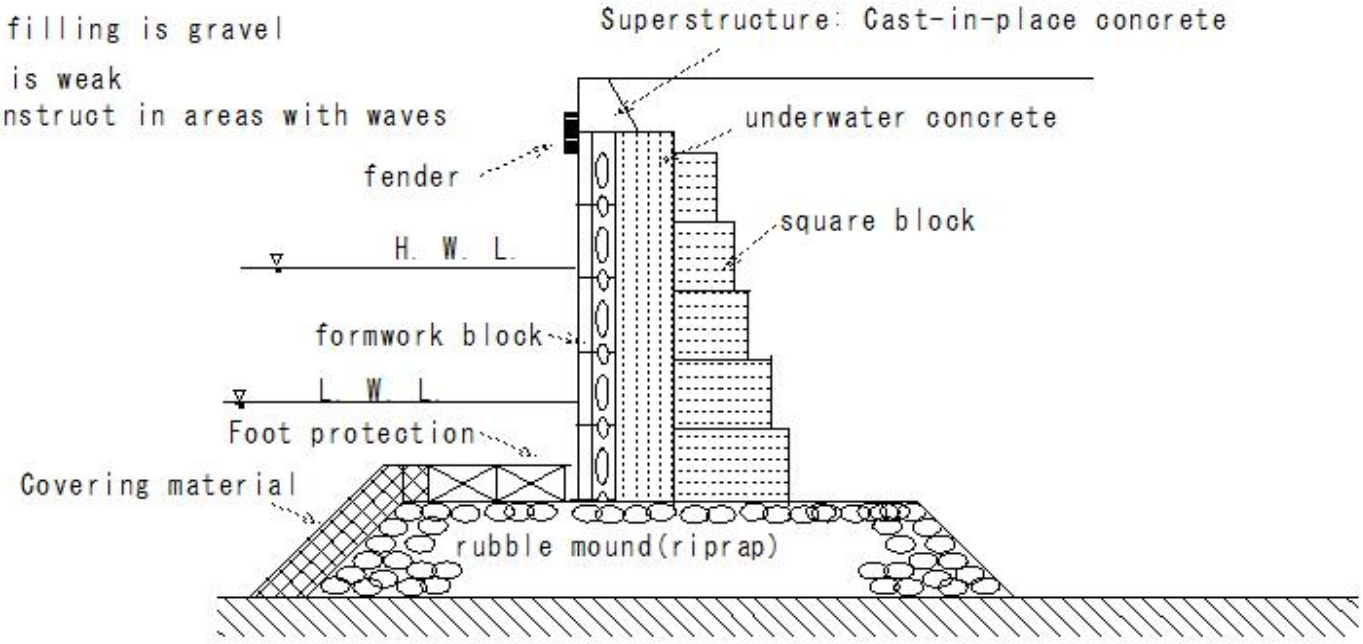
①Equipment - Easy

②Wall

③case of the filling is gravel

Wall integrity is weak

Difficult to construct in areas with waves



Cellular block quay

(P50)Mooring facility(Cast-in-place concrete quay)

(P50)Mooring facility(Cast-in-place concrete quay)

Cast-in-place concrete quay

Assemble formwork on good foundation ground by underwater concrete etc.

Build walls directly on site

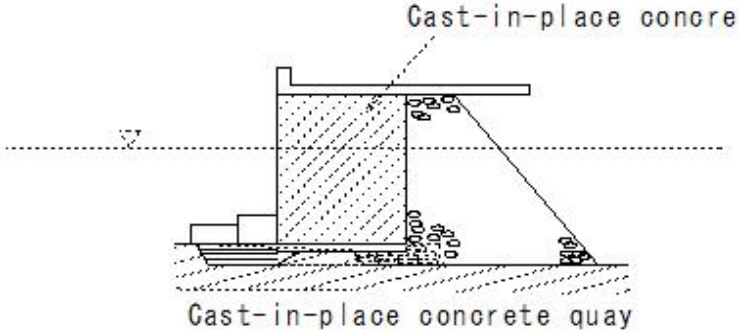
①Free shape and excellent integrity as a wall

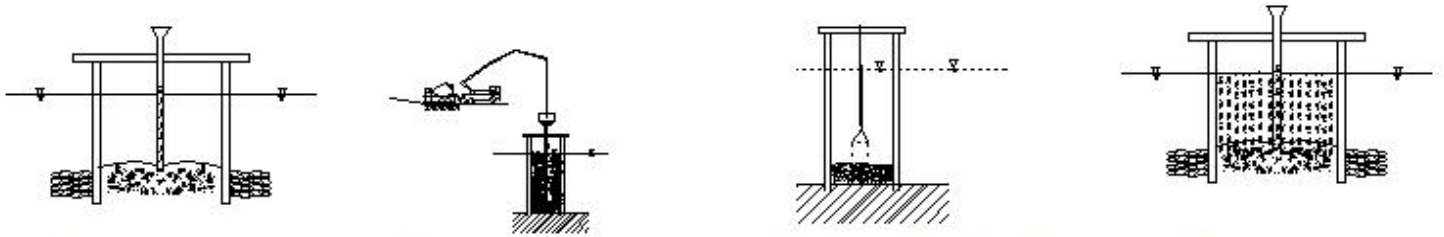
②Frictional resistance on the bottom is large

③Difficult to construct in areas with waves

④No need for large equipment

⑤It becomes uneconomical in case of a lot of underwater construction.





① Tremie ② Concrete pump ③ Open bottom box ④ Prepact concrete

C1422

(P51)Mooring facility(sheet pile quay)

(P51)Mooring facility(sheet pile quay)

Characteristics of steel sheet pile type quay

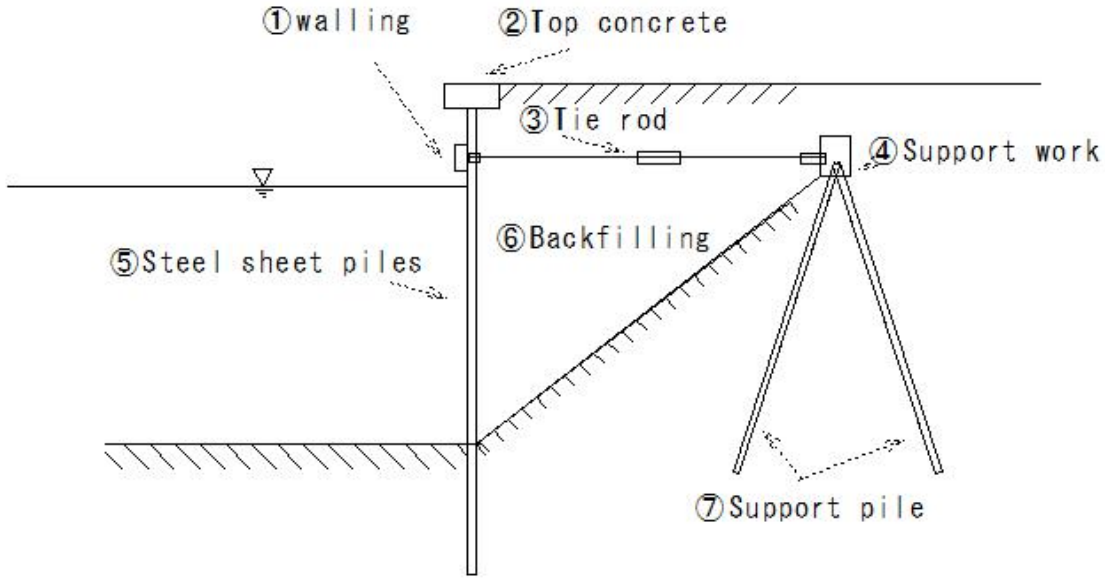
Normal sheet pile quay

Strong Points

① Construction equipment - easy

② No underwater construction required, so construction can be completed in a short period of time

③The wall is lightweight, highly elastic, and strong against earthquakes.



(P52)Mooring facility(sheet pile quay)

(P52)Mooring facility(sheet pile quay)

Characteristics of steel sheet pile type quay

Normal sheet pile quay

disadvantages

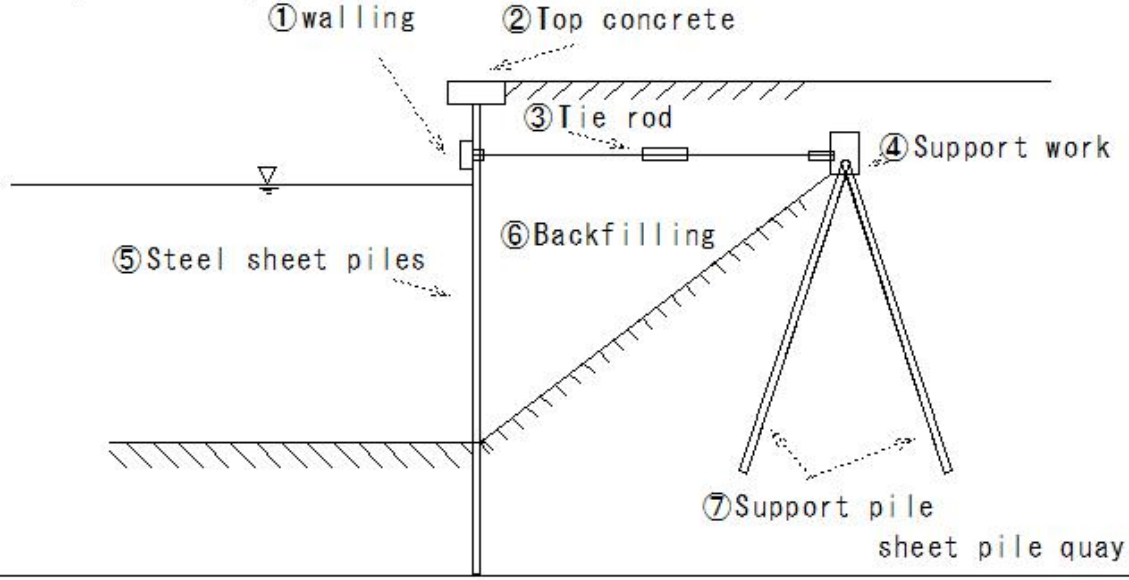
①Steel sheet piles are prone to corrosion

②Poor durability

③Apply cathodic protection

④in case of the ground is deep, after driving the sheet pile

Vulnerable to waves until preliminary work is carried out



(P53)Mooring facility(Stability of steel sheet pile type quay)

(P53)Mooring facility(Stability of steel sheet pile type quay)

Stability of steel sheet pile type quay

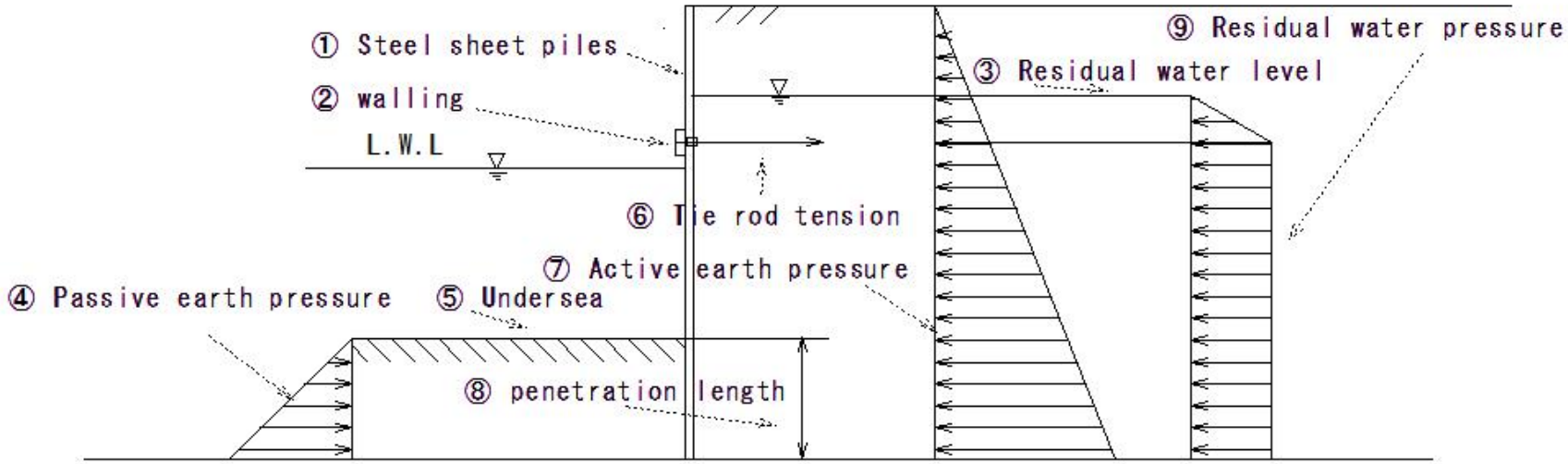
①Active earth pressure

②Residual water pressure

③Passive earth pressure

For main earth pressure and residual water pressure

Maintain balance with passive earth pressure and tie rod tension



(P54)Mooring facility(Stability of steel sheet pile type quay)

(P54)Mooring facility(Stability of steel sheet pile type quay)

Stability of steel sheet pile type quay

① Tie rod installation position

Position slightly above L.W.L

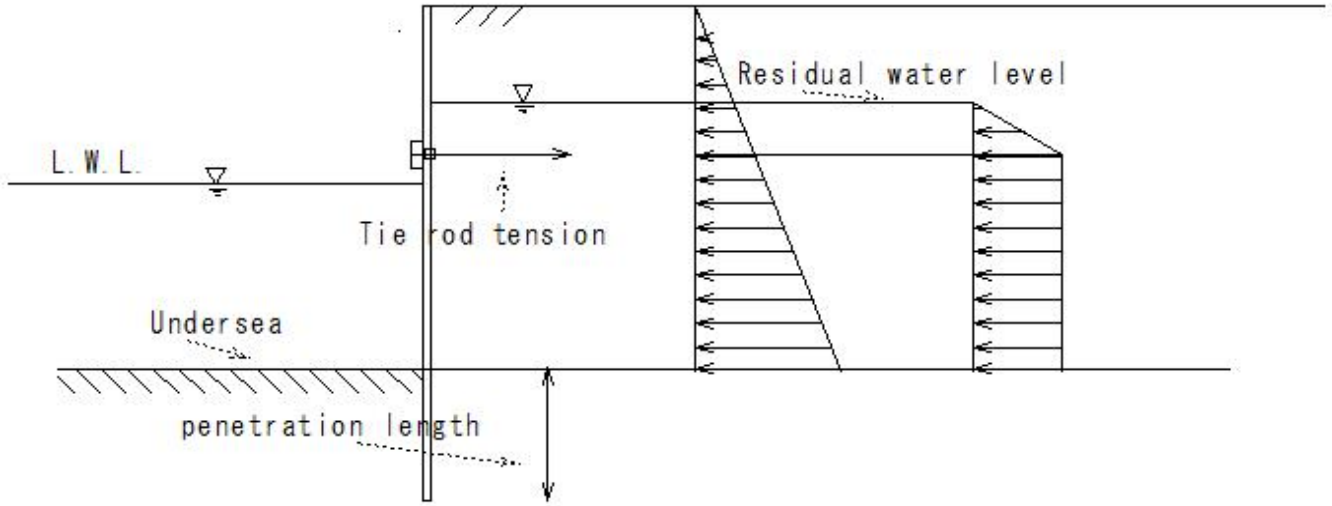
② penetration length of engineered sheet pile

The safety factor is 1.5 for sandy soil.

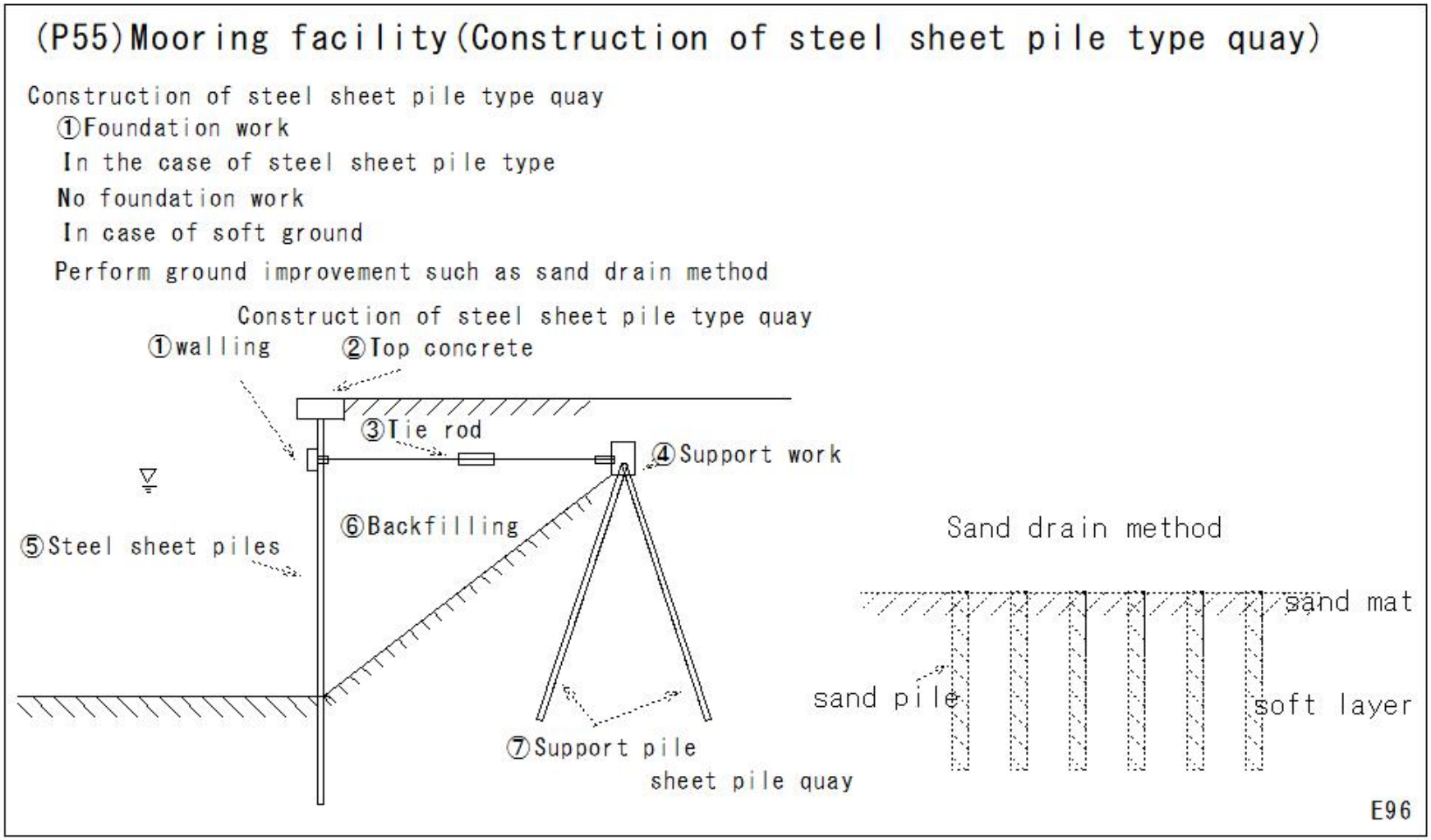
Cohesive soil is 1.2

③ Cross section of steel sheet pile

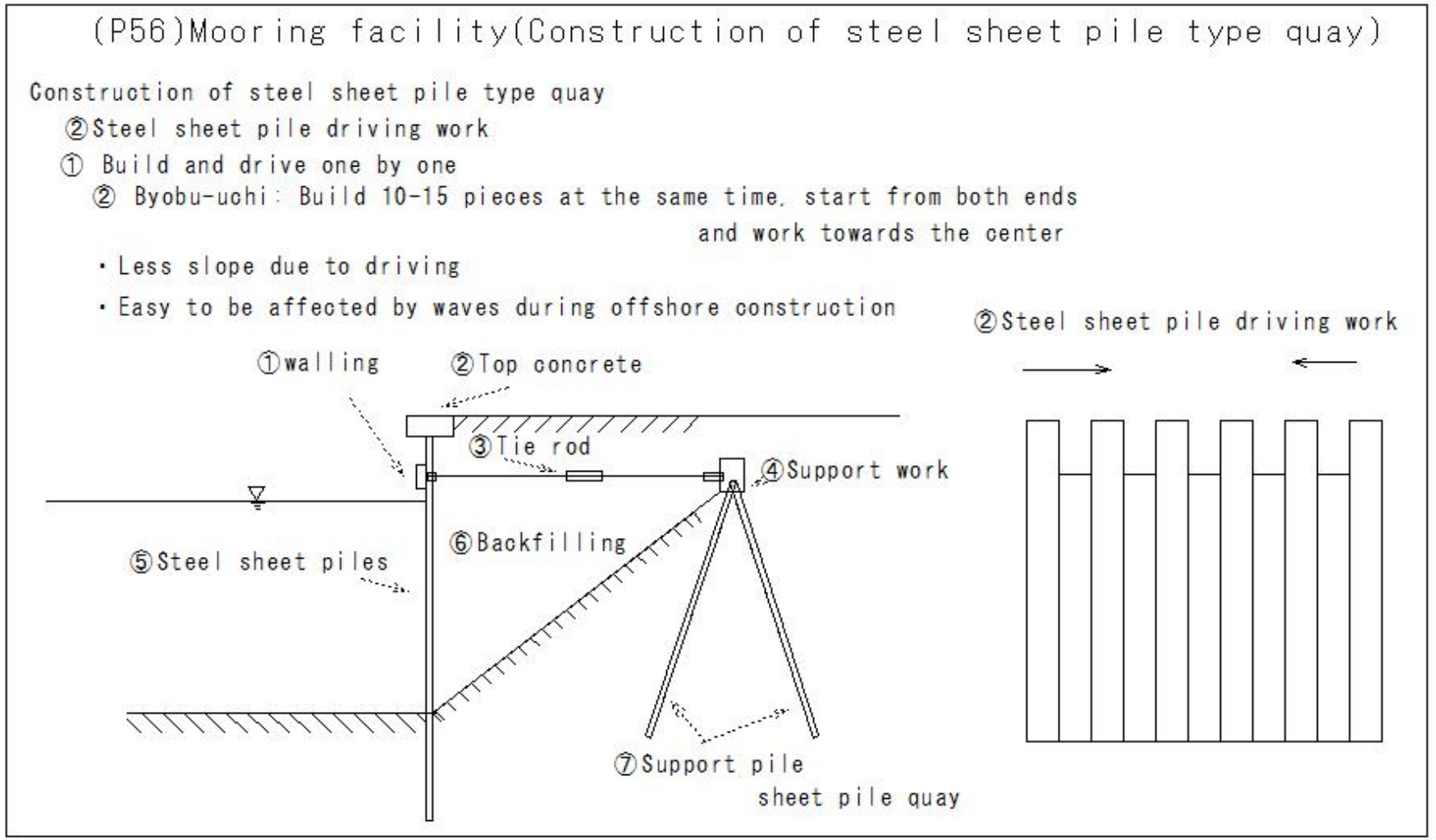
U-shape and Z-shape for sheet pile type quay



(P55)Mooring facility(Construction of steel sheet pile type quay)



(P56)Mooring facility(Construction of steel sheet pile type quay)



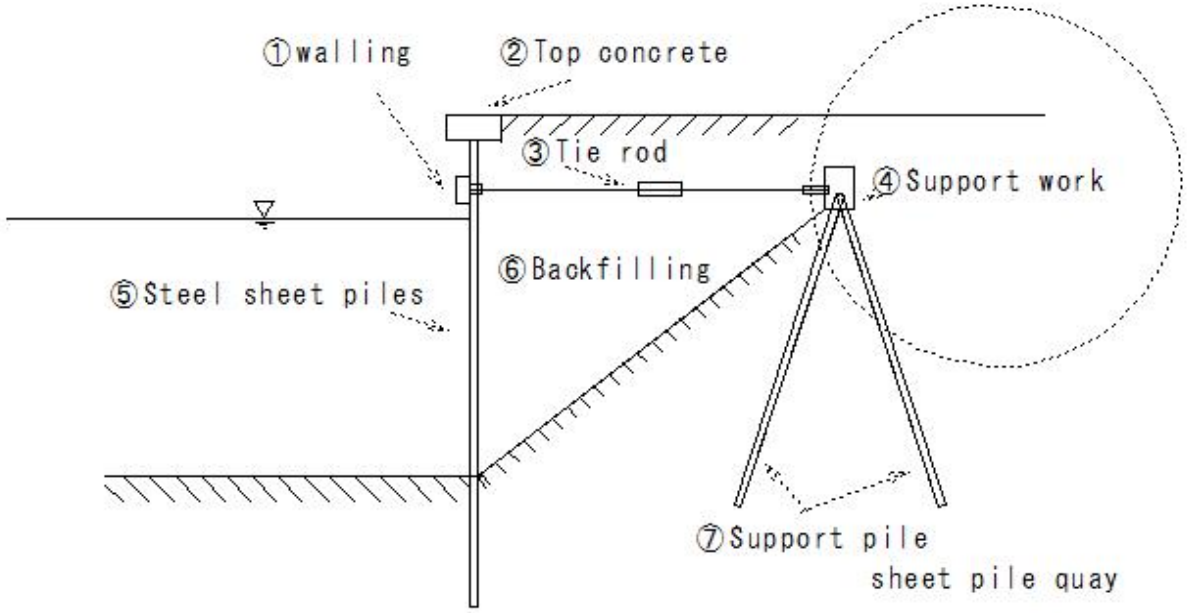
(P57)Mooring facility(Construction of steel sheet pile type quay)

(P57)Mooring facility(Construction of steel sheet pile type quay)

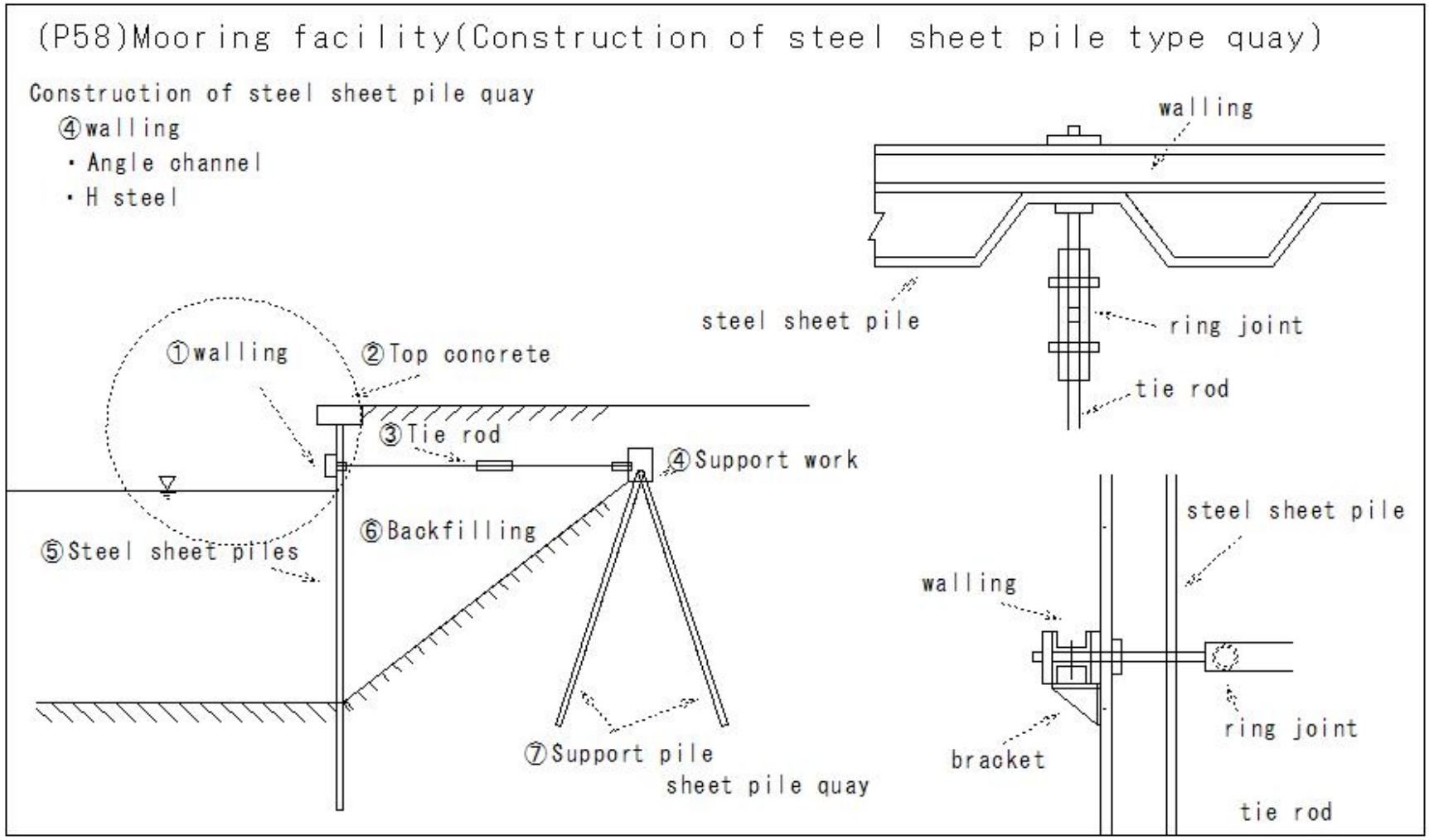
Construction of steel sheet pile quay

③Support work

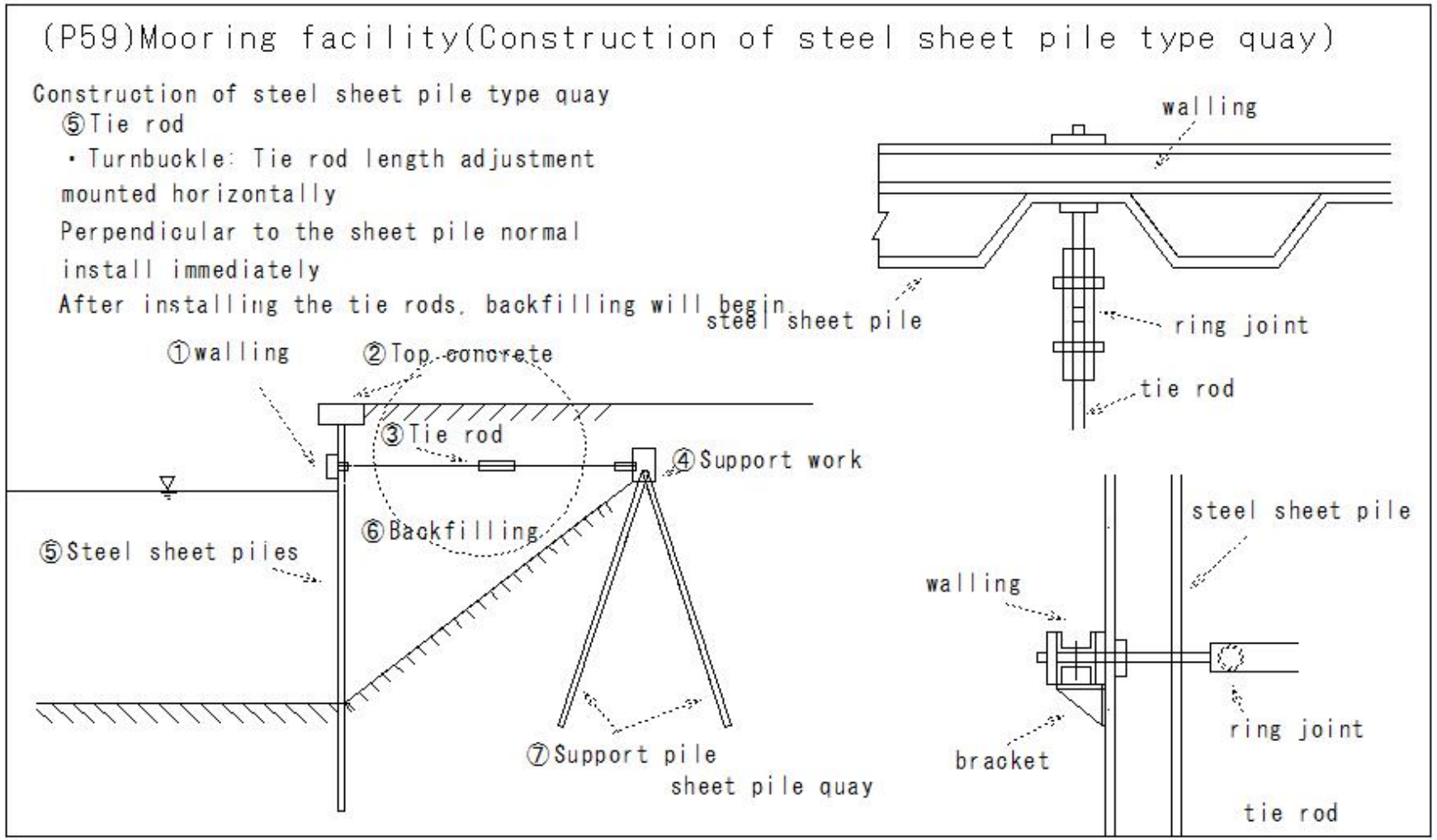
- Straight pile
- Slanted pile
- Resist the tension of the tie rod



(P58)Mooring facility(Construction of steel sheet pile type quay)



(P59)Mooring facility(Construction of steel sheet pile type quay)



(P60)Mooring facility(Construction of steel sheet pile type quay)

(P60)Mooring facility(Construction of steel sheet pile type quay)

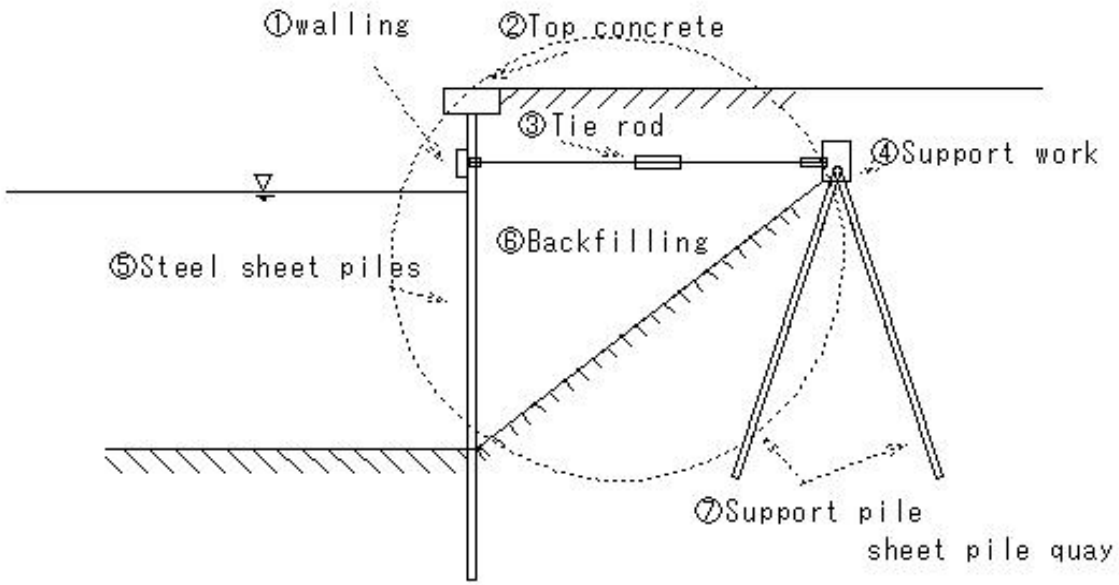
Construction of steel sheet pile type quay

⑥Backfilling

・After tie rod installation

Perform backfilling on the front side of the copy plate.

・Practical backfilling of the back of steel sheet piles



(P61)Mooring facility(Construction of steel sheet pile type quay)

(P61)Mooring facility(Construction of steel sheet pile type quay)

Construction of steel sheet pile type quay

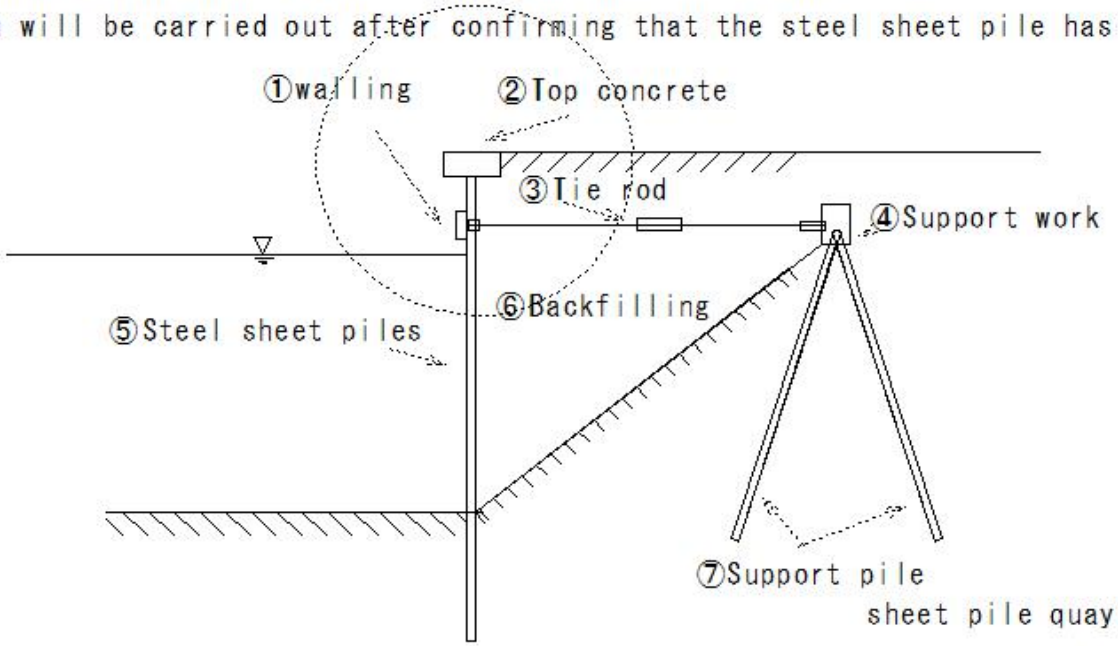
⑦Top concrete

・Corrected unevenness of steel sheet pile normal line

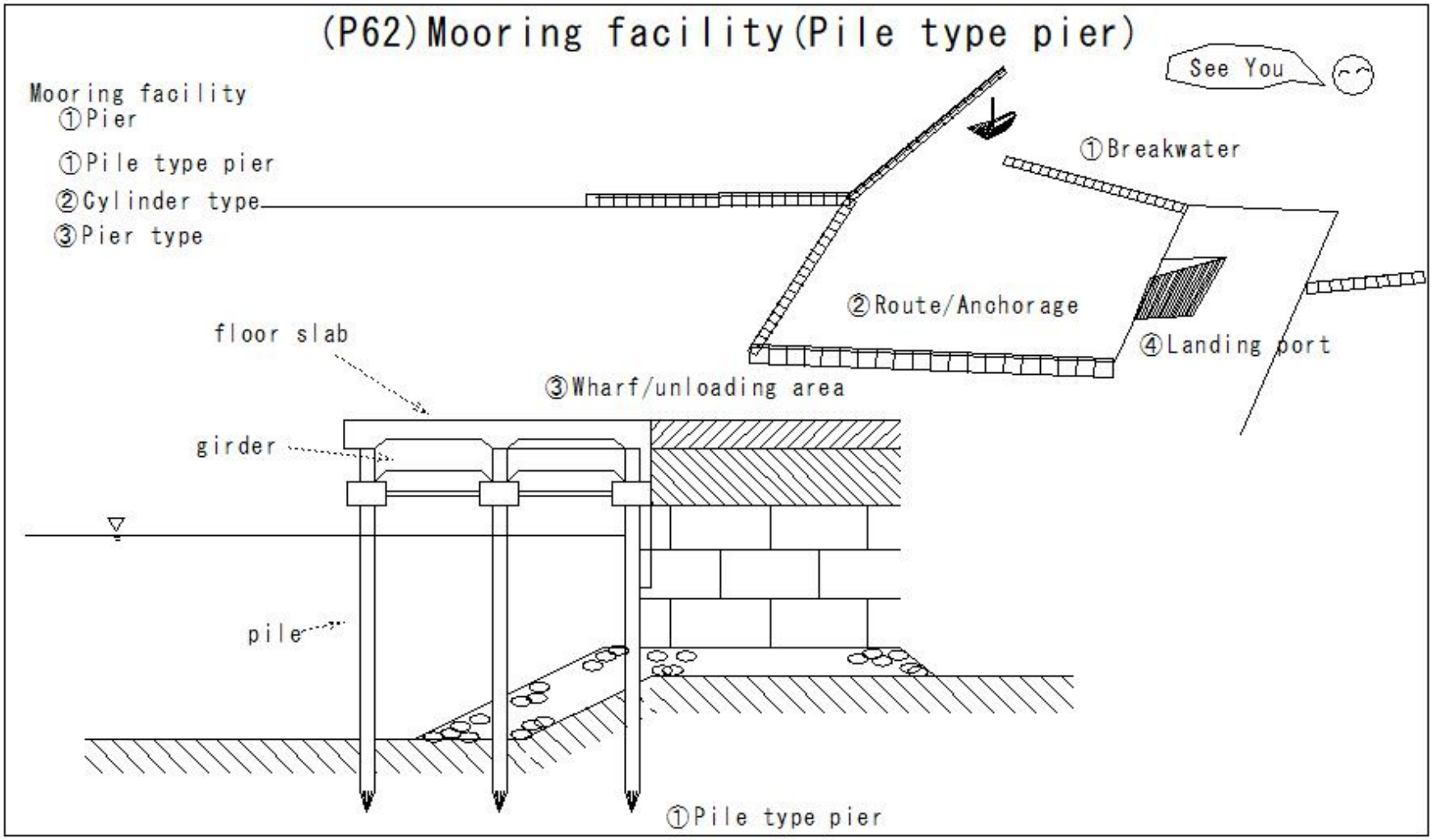
・Place the upper concrete

・After all dredging and backfilling of the front surface is completed

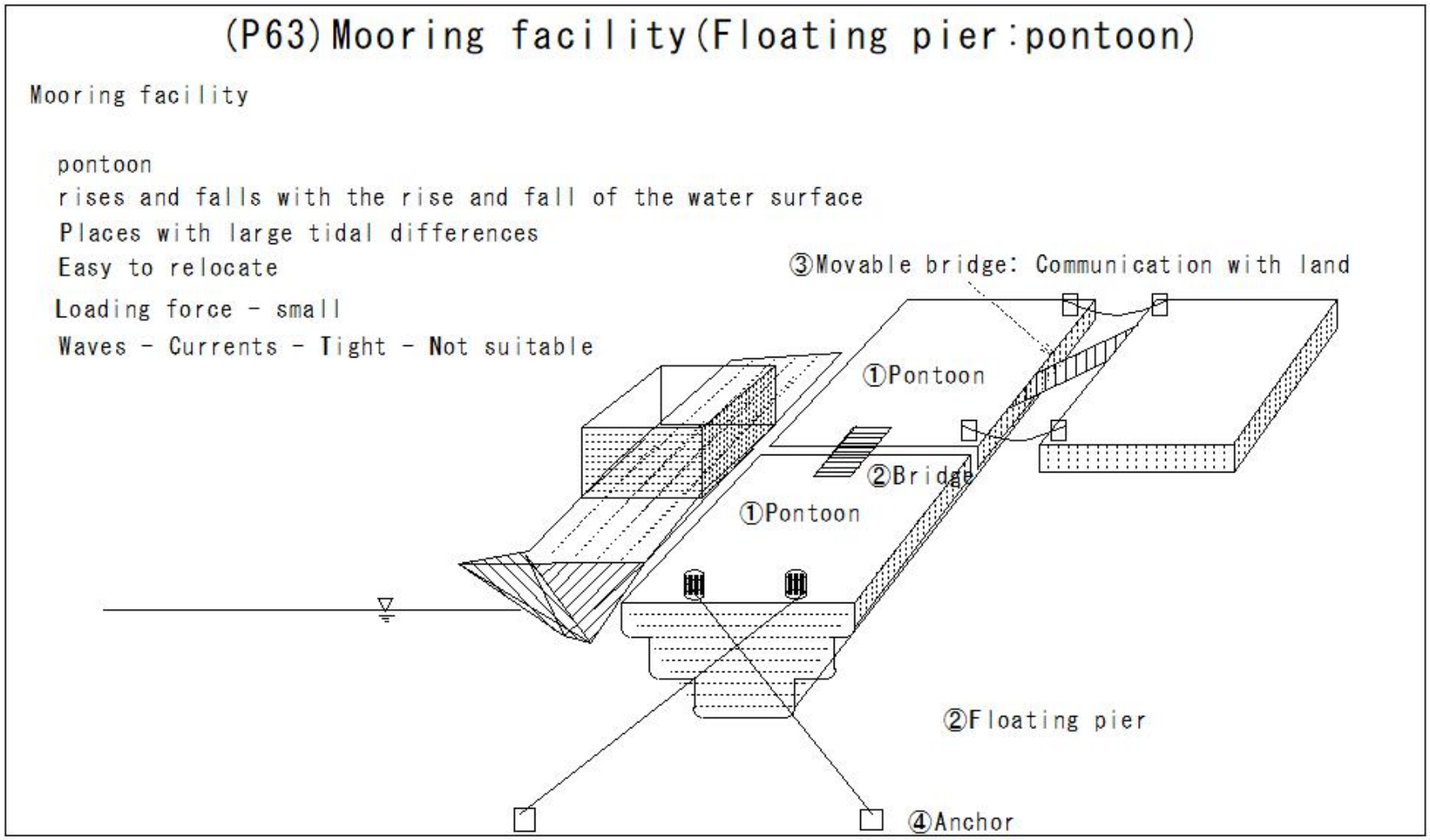
・Construction will be carried out after confirming that the steel sheet pile has been displaced



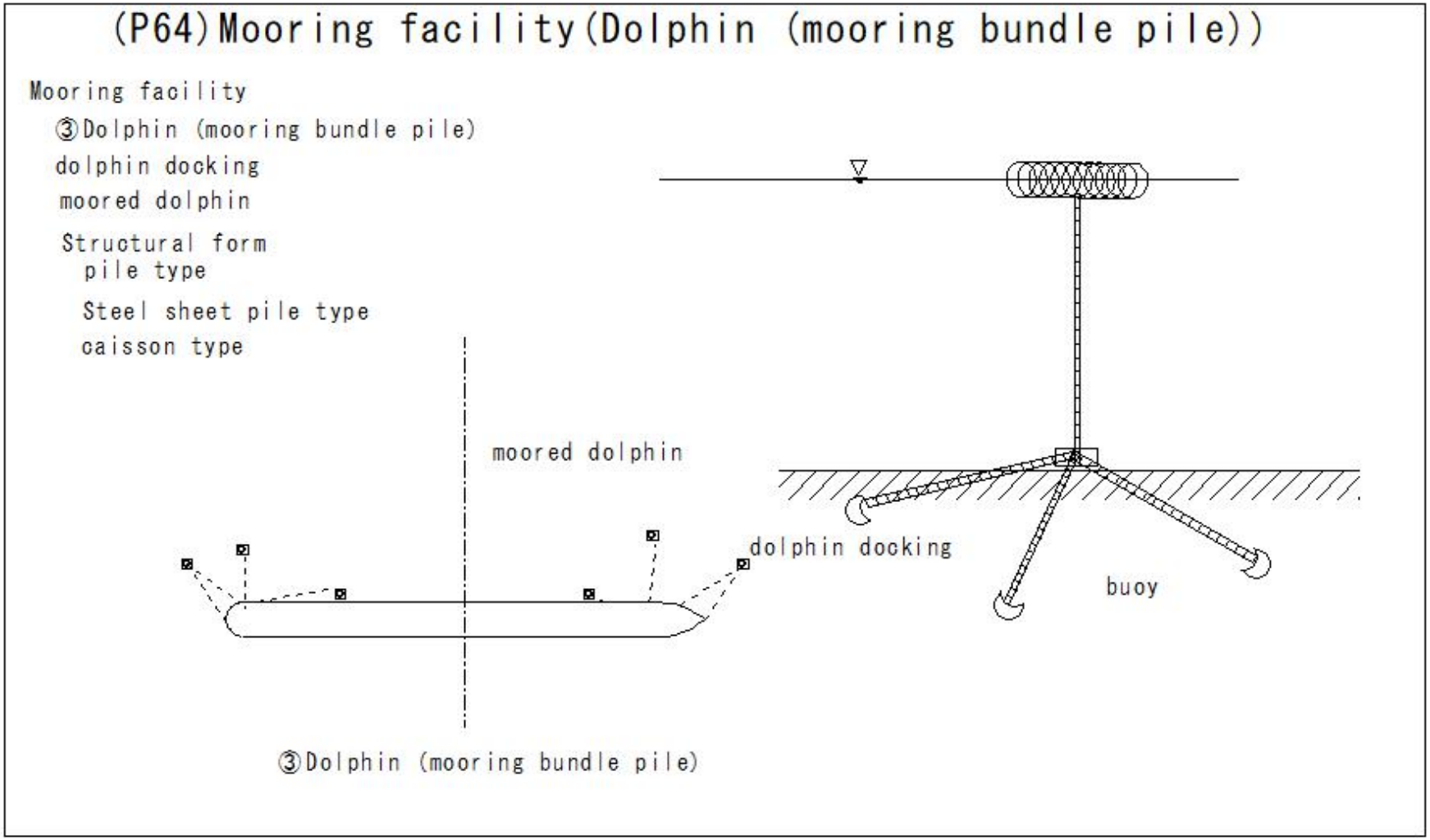
(P62)Mooring facility(Pile type pier)



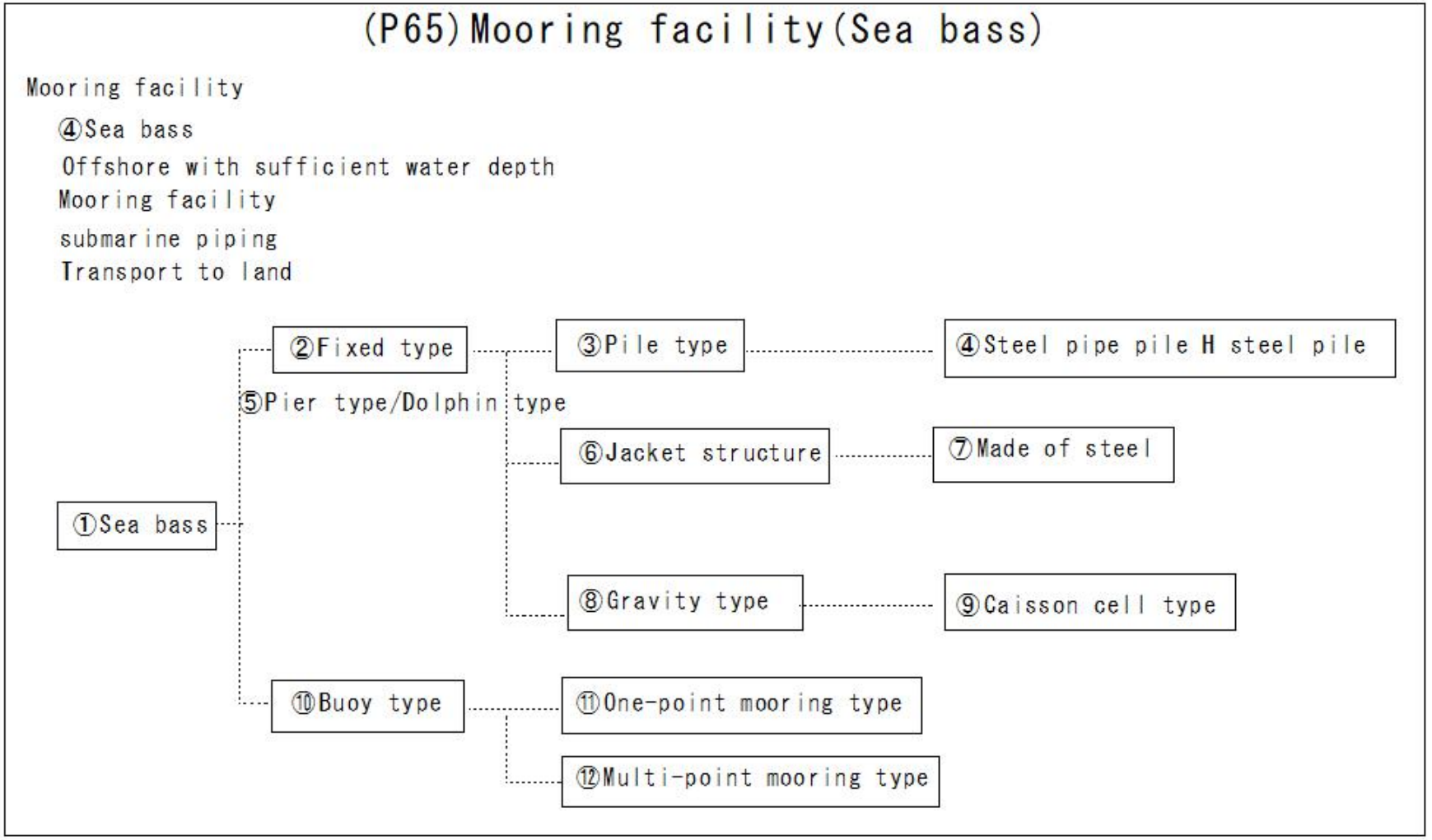
(P63)Mooring facility(Floating pier:pontoon)



(P64)Mooring facility(Dolphin (mooring bundle pile))



(P65)Mooring facility(Sea bass)



(P66)Mooring equipment(Fender construction)

(P66)Mooring equipment(Fender construction)

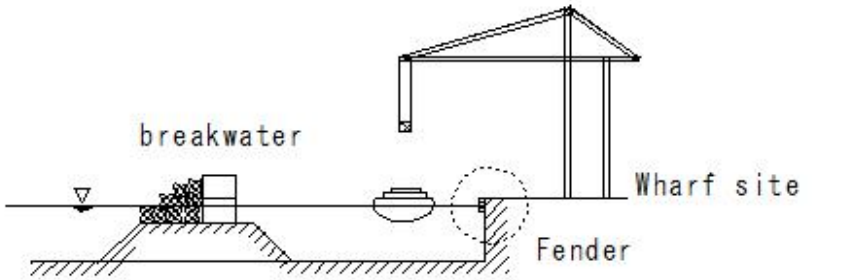
Mooring equipment

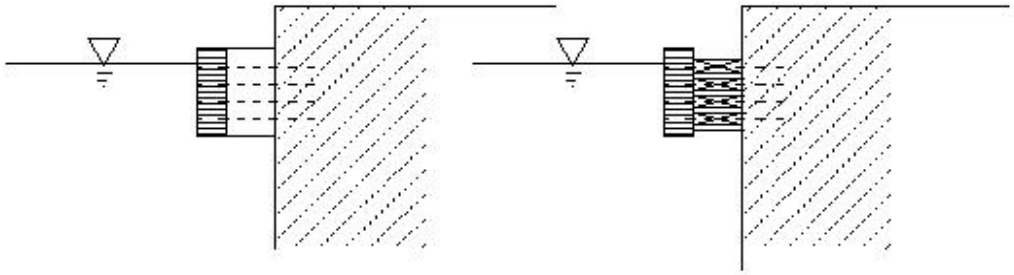
①Fender construction

Shock device in case the ship berths

rubber fender

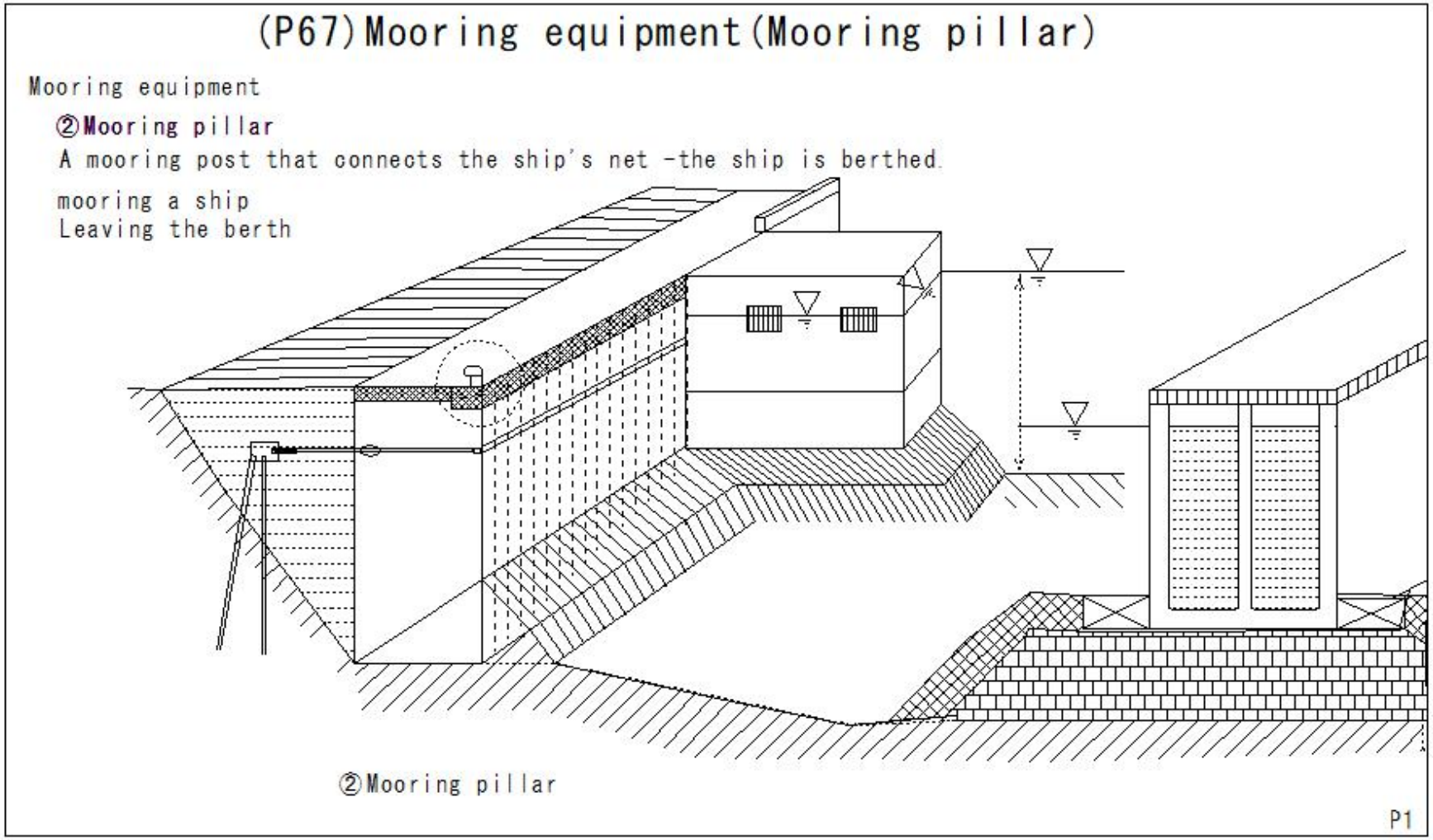
5-20m interval



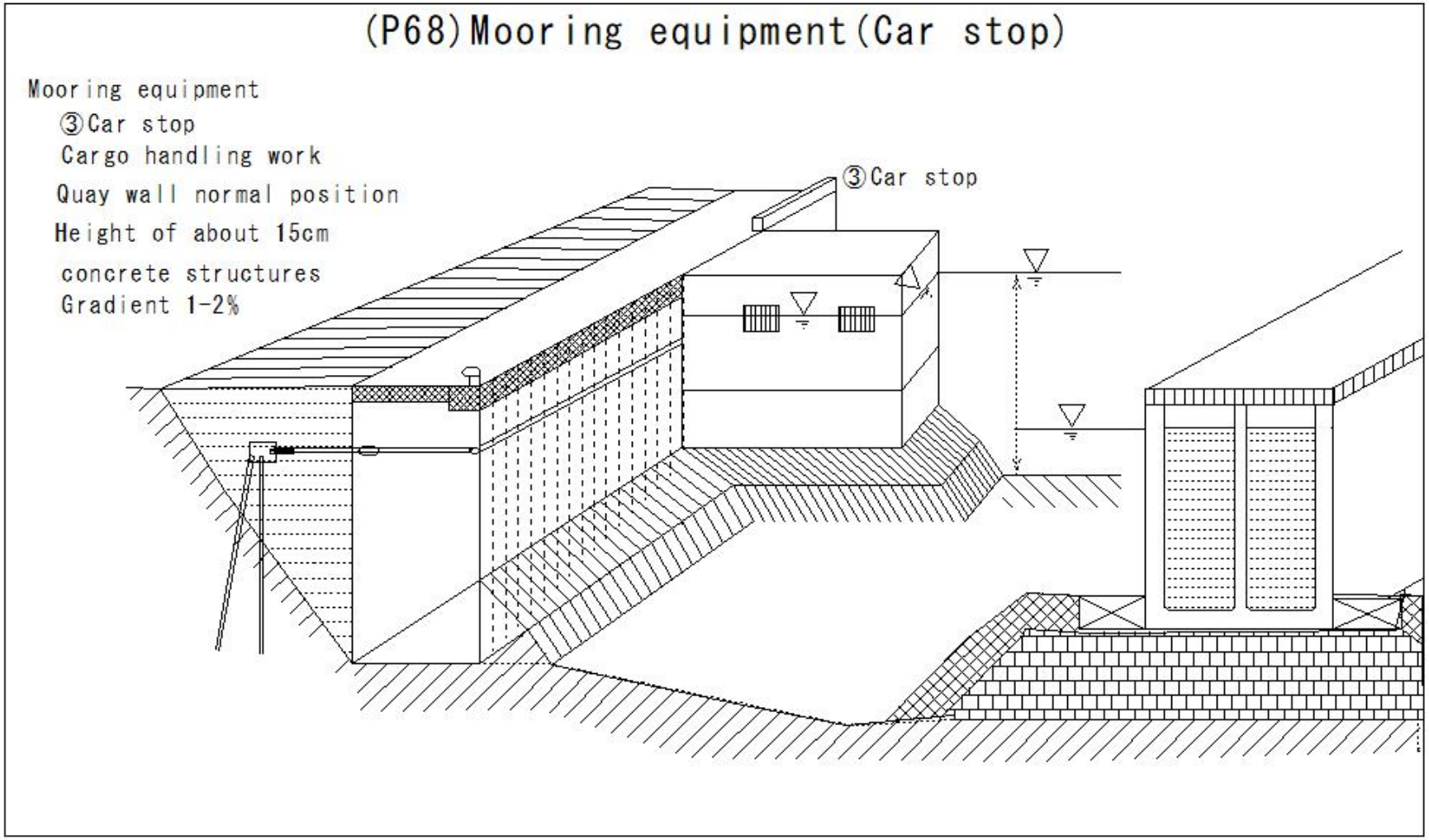


①Fender construction

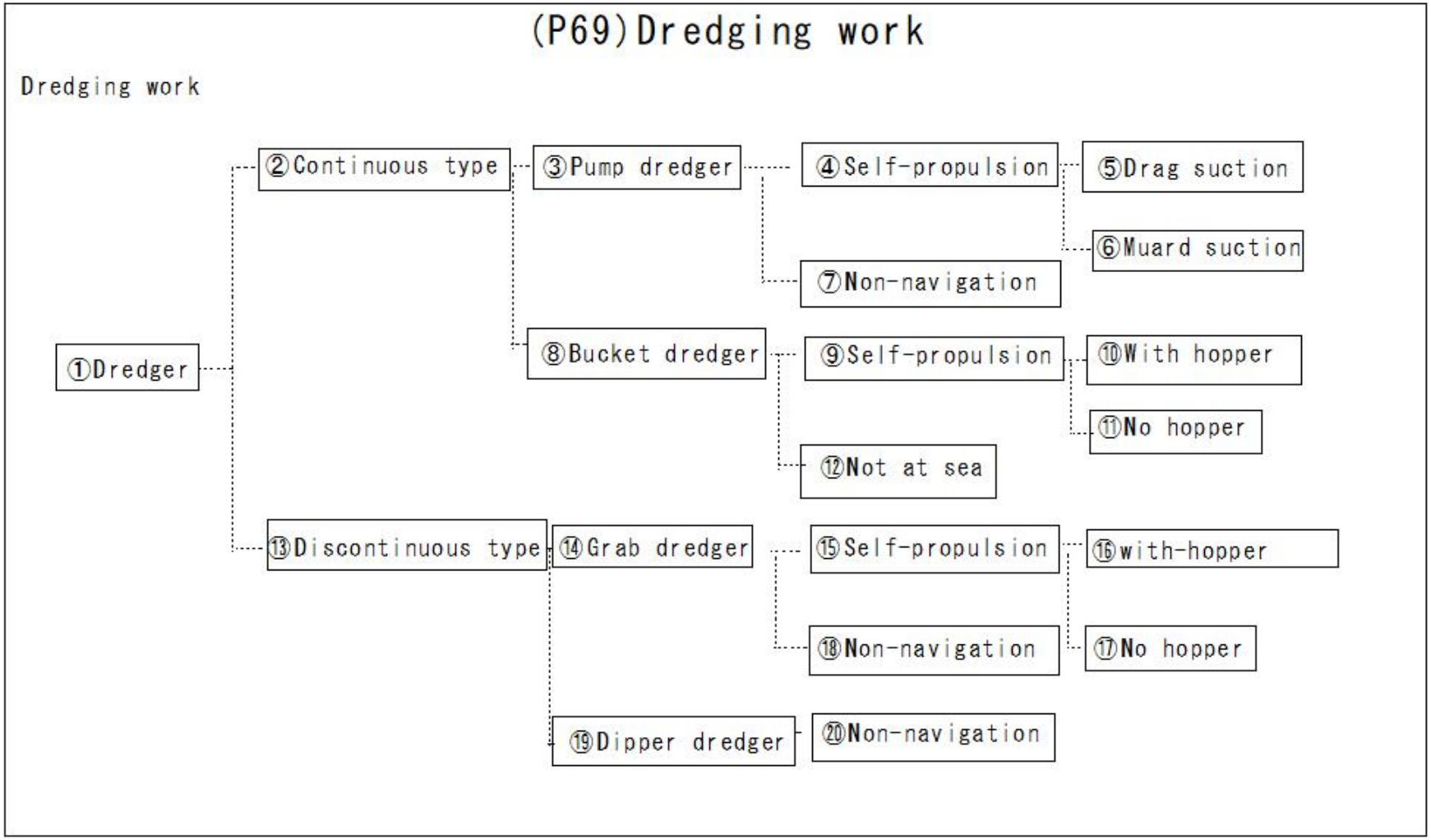
(P67)Mooring equipment(Mooring pillar)



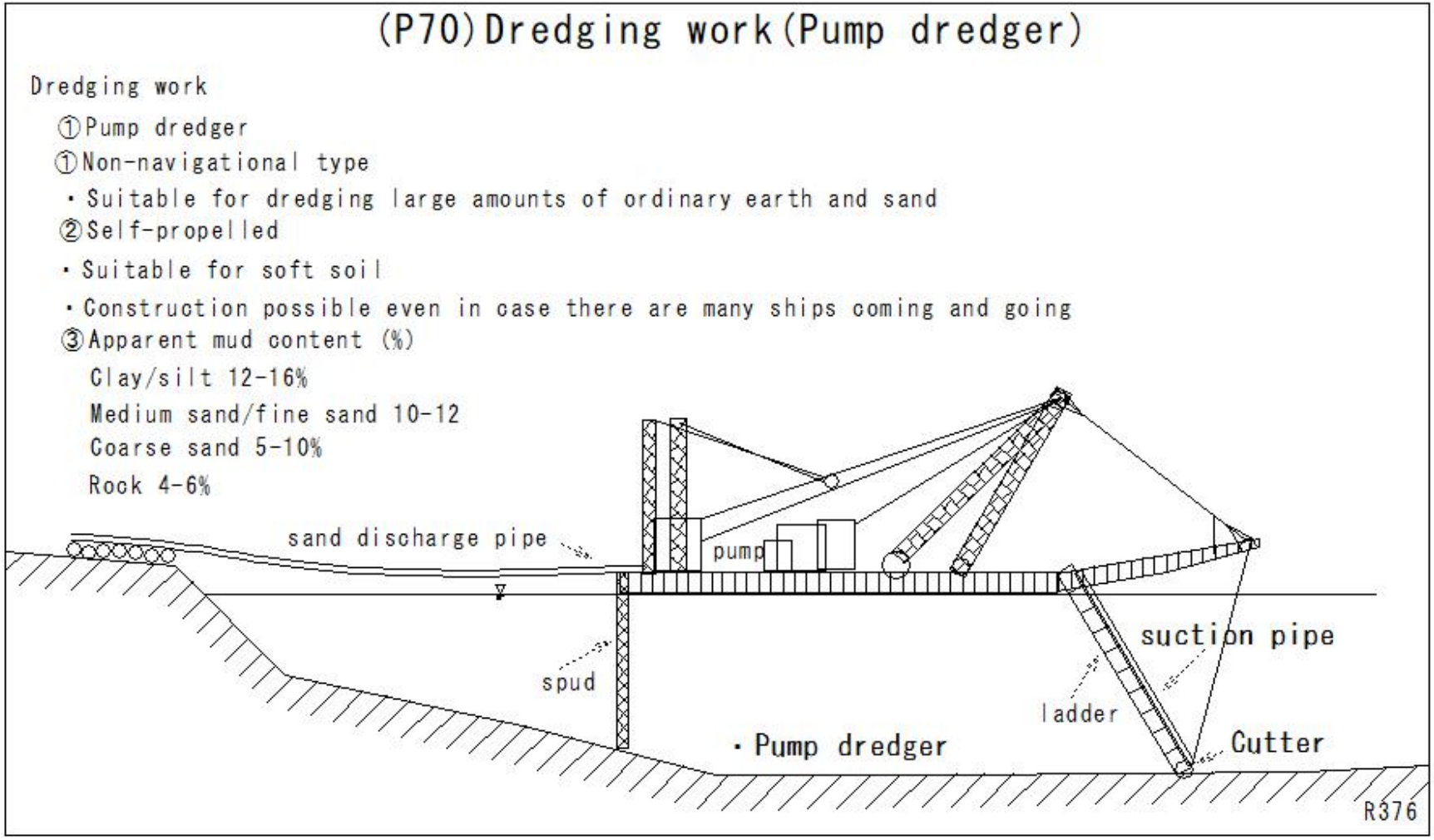
(P68)Mooring equipment(Car stop)



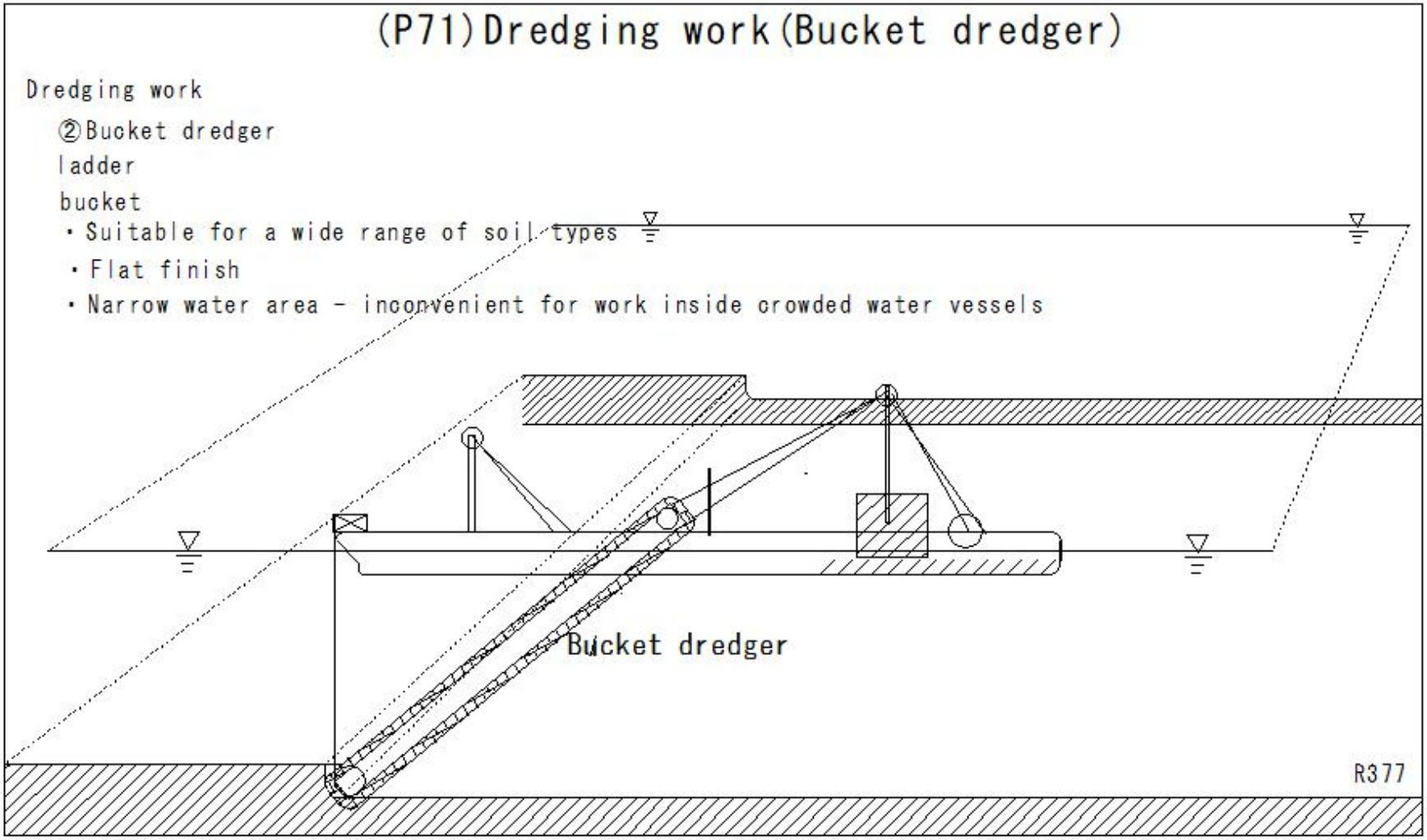
(P69)Dredging work



(P70)Dredging work(Pump dredger)



(P71)Dredging work(Bucket dredger)



(P72)Dredging work(Grab dredger)

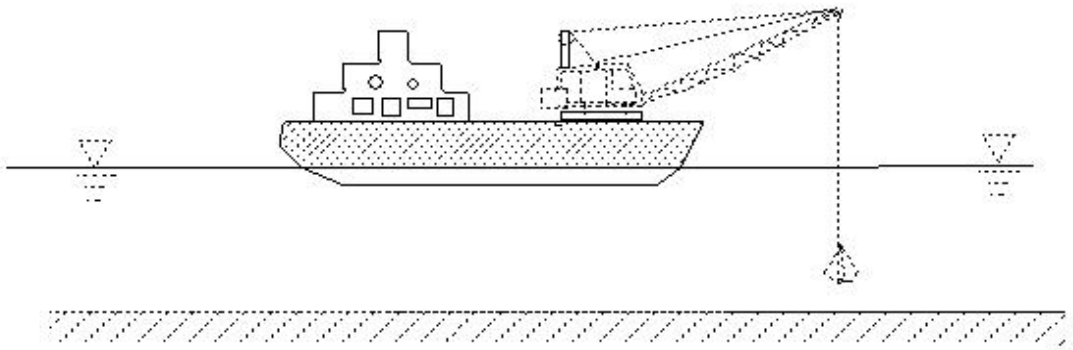
(P72)Dredging work(Grab dredger)

Dredging work

③Grab dredger

jib crane

- Small-scale routes
- Suitable for excavating the floor of breakwaters and quays.
- Soil quality is suitable for earth, sand, and gravel.
- Not limited by dredging depth
- Able to work in narrow spaces



Grab dredger

R26

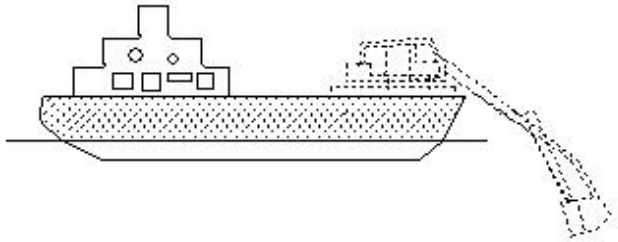
(P73)Dredging work(Dipper dredger)

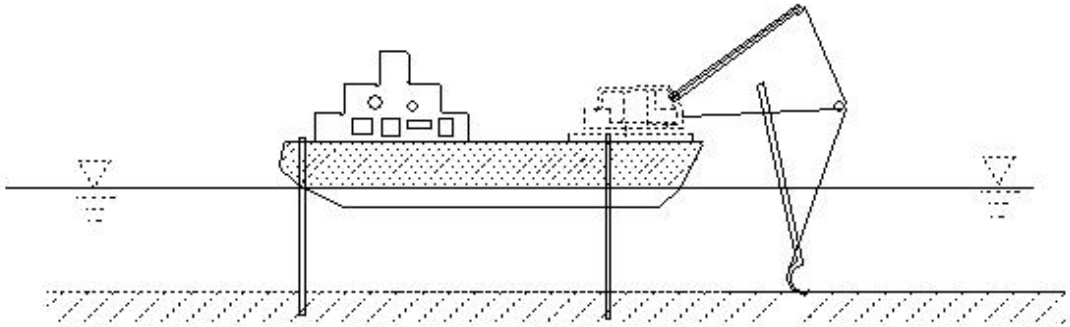
(P73)Dredging work(Dipper dredger)

Dredging work

④Dipper dredger

- Suitable for hard ground
- Soft rock dredging
- Removal of obstacles on the bottom of the water
- Can be operated even in narrow work surfaces





Dipper dredger

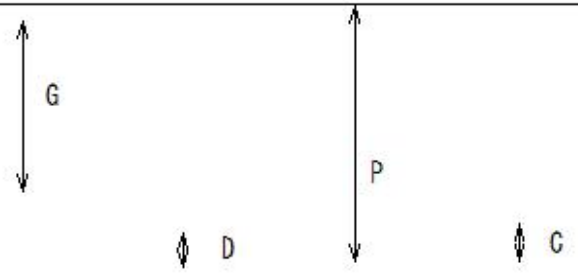
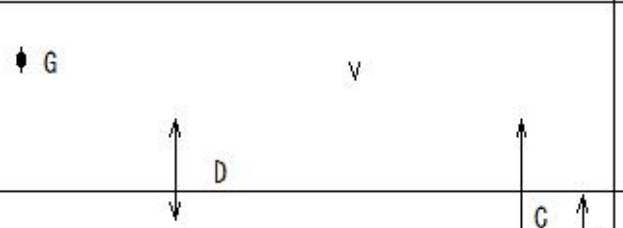
R379

(P74)Dredging work(Dredger selection)

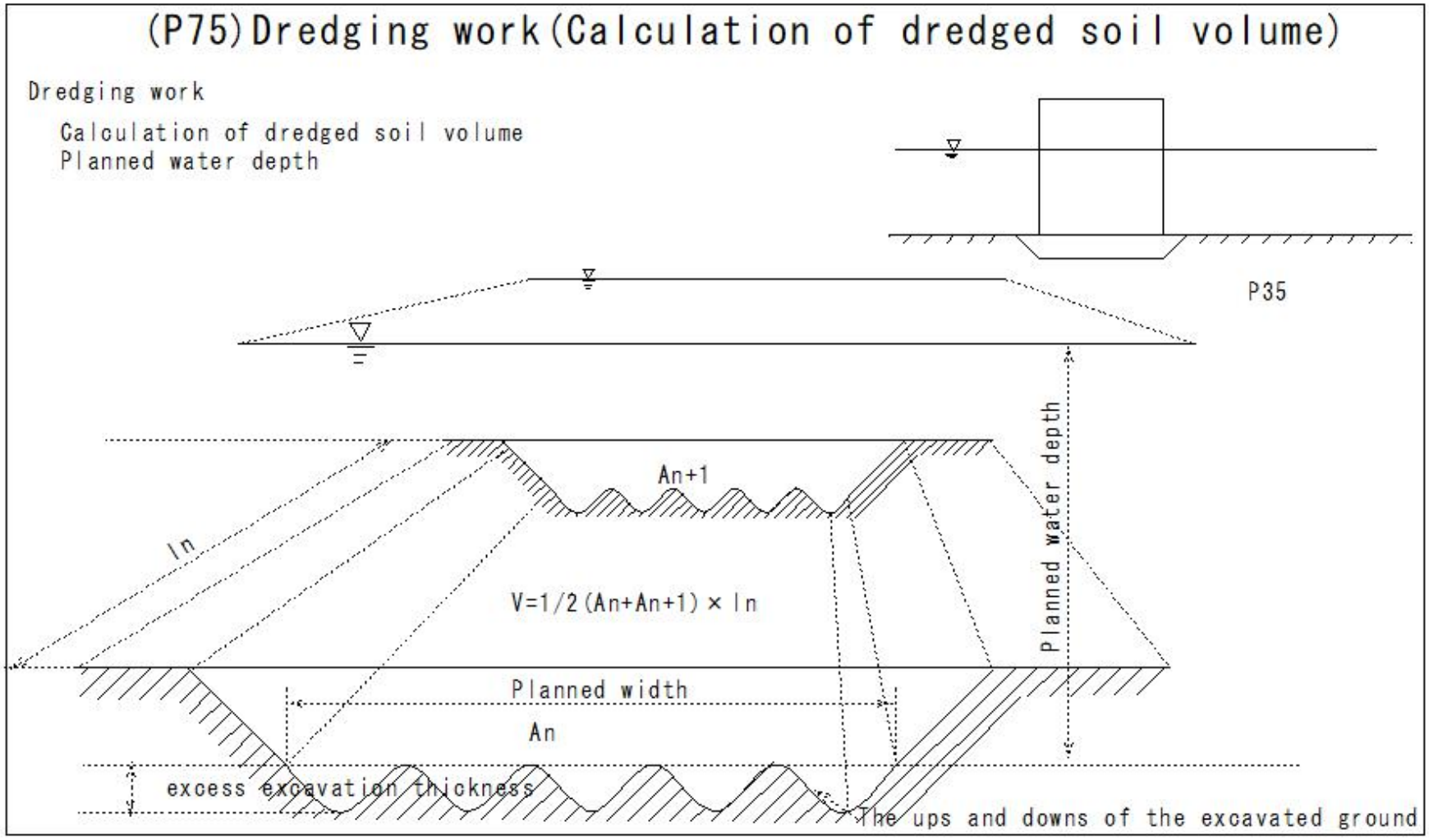
(P74)Dredging work(Dredger selection)

Dredger selection
Excavation/Transportation/Disposal
Selecting the most suitable work boat
①Selection based on soil quality

G: Grab ship
D: Dipper ship
P: Pump ship
C:rock crusher
B:blasting

①Selection based on soil quality				
②Classification	③Condition	④N value	⑤Applicable ship types	⑥Remarks
⑦Sediment	⑧Soft N=less than 10 ⑨Medium quality N=10-20 ⑩Hard N=20-30 ⑪Hardest N=30 or more			
⑫Soil mixed with gravel	⑬Soft N=less than 30 ⑭Hard N=30 or more			
⑮Bedrock	⑯Soft dipper ship possible ⑰Hard, dipper ship impossible			

(P75)Dredging work(Calculation of dredged soil volume)



(P76)Dredging work(Slope gradient)

(P76)Dredging work(Slope gradient)

Dredging work

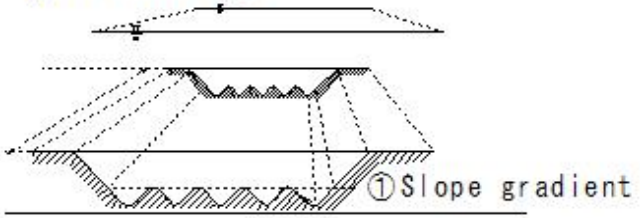
Calculation of dredged soil volume

①Slope gradient

Dredging work: Excavation to maintain a certain area and a certain water depth

After dredging, select slope

Gradient 1-2%



P75

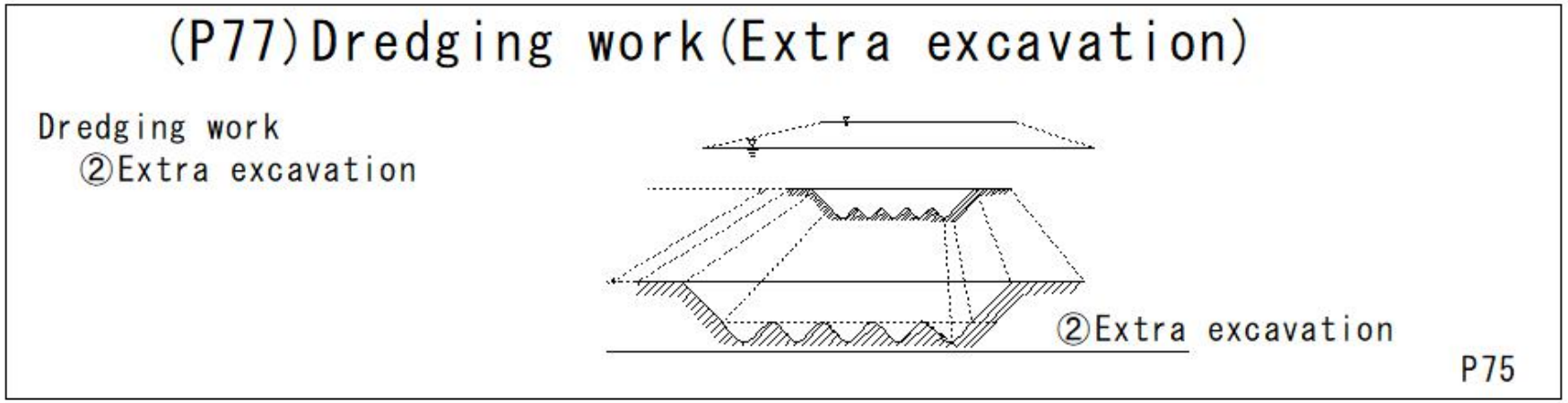
slope gradient		
①Soil quality		
②Classification	③N value	④Slope
⑤Clay soil	⑨ Less than 4 Soft	3.0－5.0
	⑩ 4－20 Medium quality	1.5-3.0
	⑪ 20－40 Hard	1.0－1.5
⑥Sandy soil	⑫ Less than 10 Soft	2.0－4.0
	⑬ 10－50 Medium hard	1.0-2.0
⑦Gravel		1.0-1.5
⑧Bedrock		1

(P77)Dredging work(Extra excavation)

(P77)Dredging work(Extra excavation)
Dredging work
Calculation of dredged soil volume
② Extra excavation
・The remains of the dredging moat have ups and downs.
There are differences depending on soil quality and dredging method.
To ensure the planned water depth
Dredging deeper than the planned water depth

Extra excavation

①soil quality	②Dredger	③Extra carving thickness by water depth (cm)		
		④-Less than 5.5m	⑤－5.5m－－9.0m	⑥－9.0m or more
⑦Sediment	⑧Pump	30	40	60
	⑨Grab	30	40	50
	⑩Dipper	30	40	50
⑪Bedrock	⑫Determined by boring	30		



(P78)Dredging work(Landfill)

(P78)Dredging work(Landfill)

Dredging work

Landfill

Landfill method

Securing flat land in coastal areas

Land is created by filling in earth and sand in coastal waters and shallow waters near river mouths.

Crown height of reclaimed land: 1.5-2.0 m above average high tide level

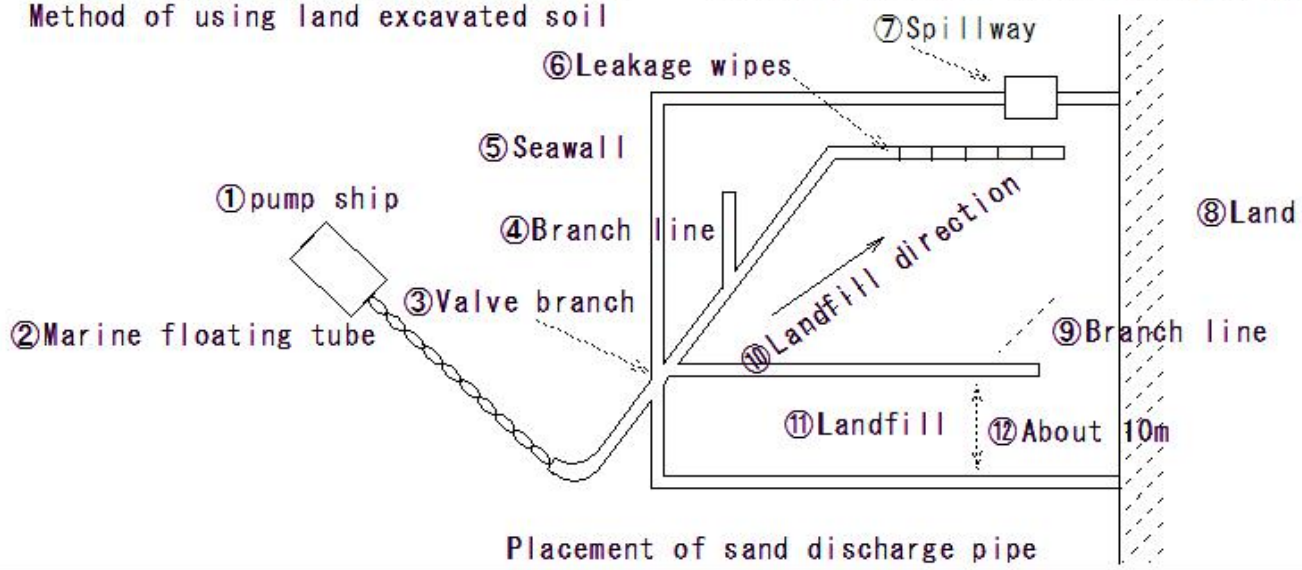
・Use of seabed dredged soil

・Dump truck/belt conveyor from land

Method of using land excavated soil

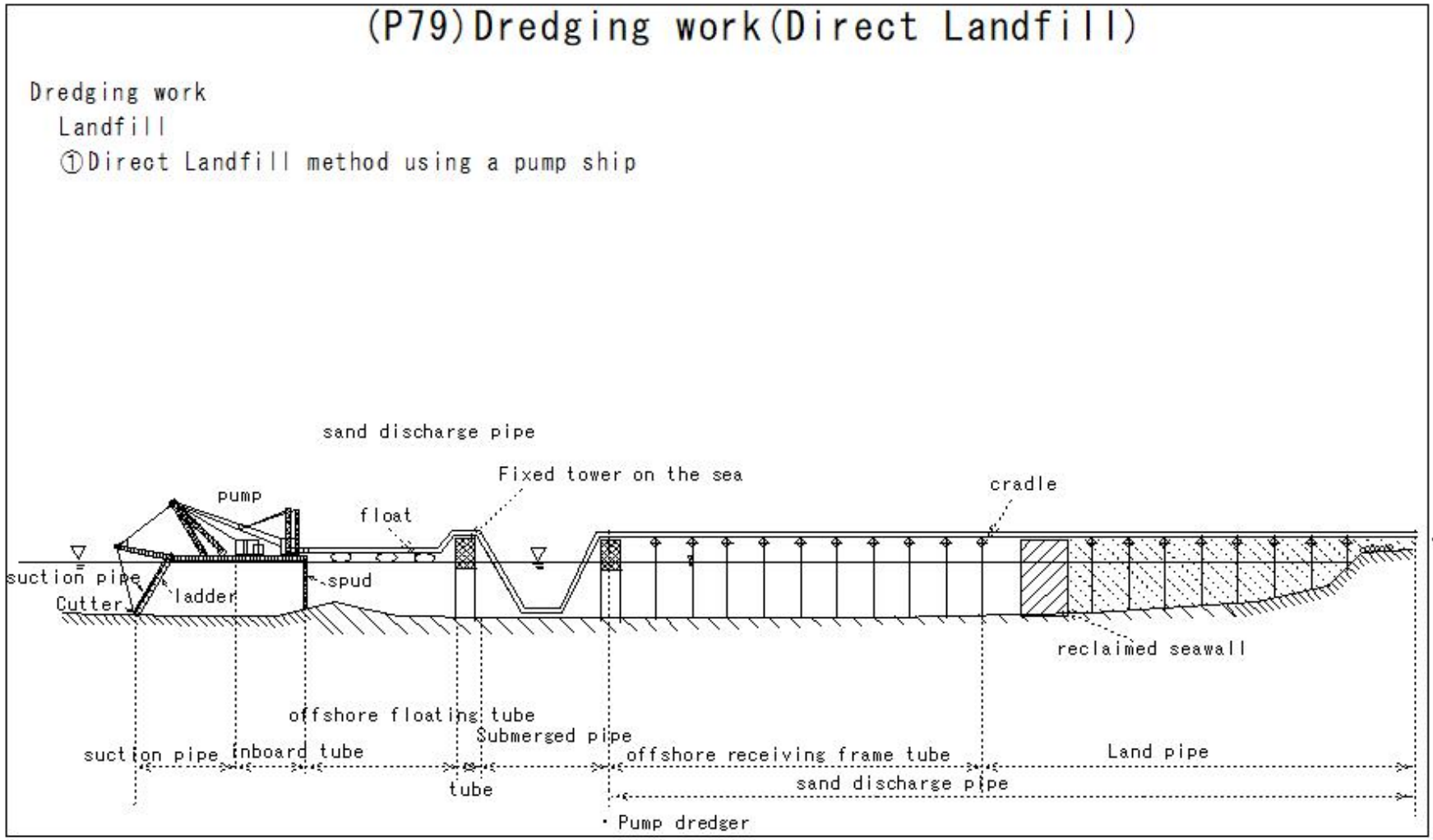
Landfill piping diagram

①Direct drainage method using a pump ship

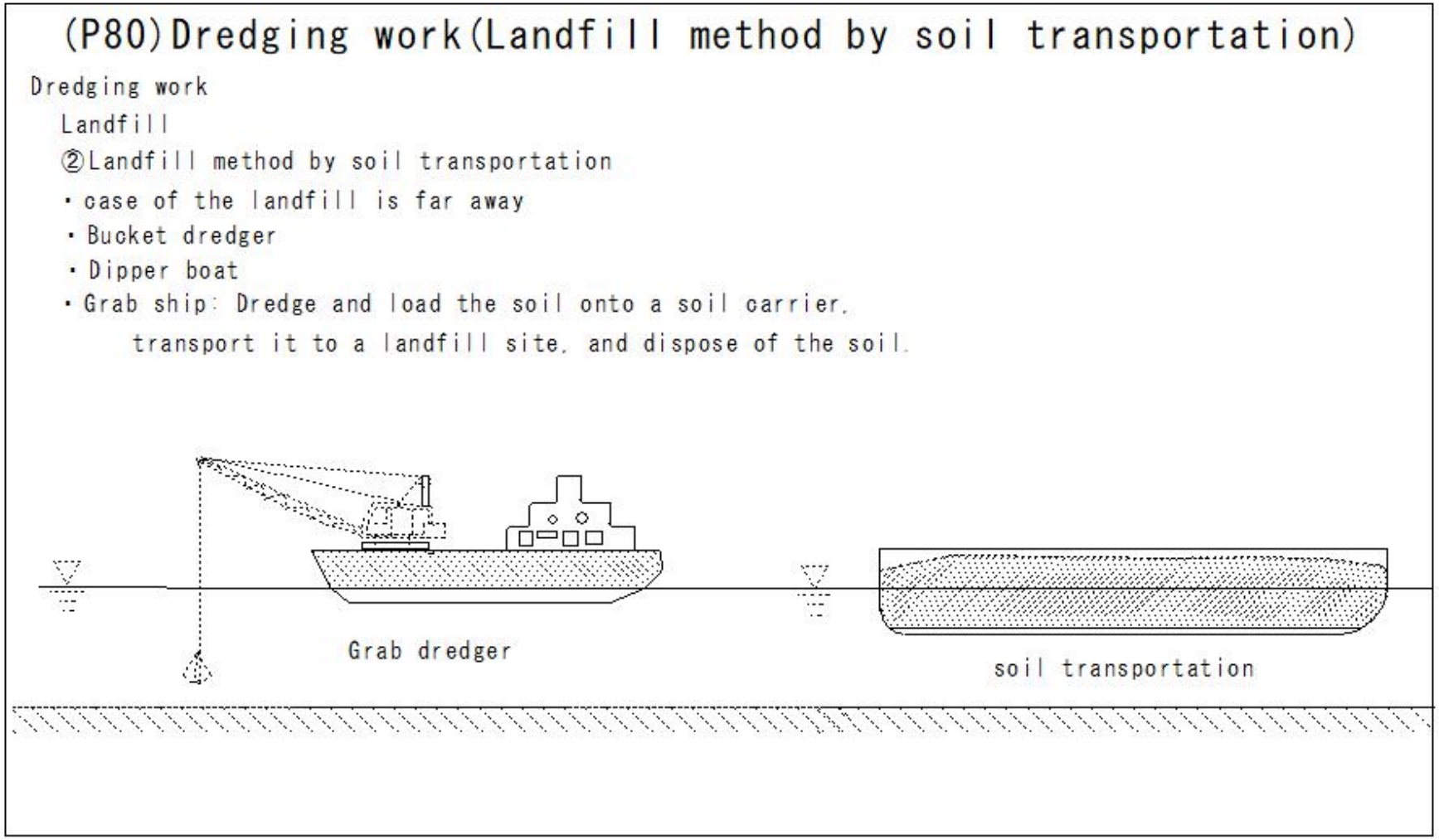


Placement of sand discharge pipe

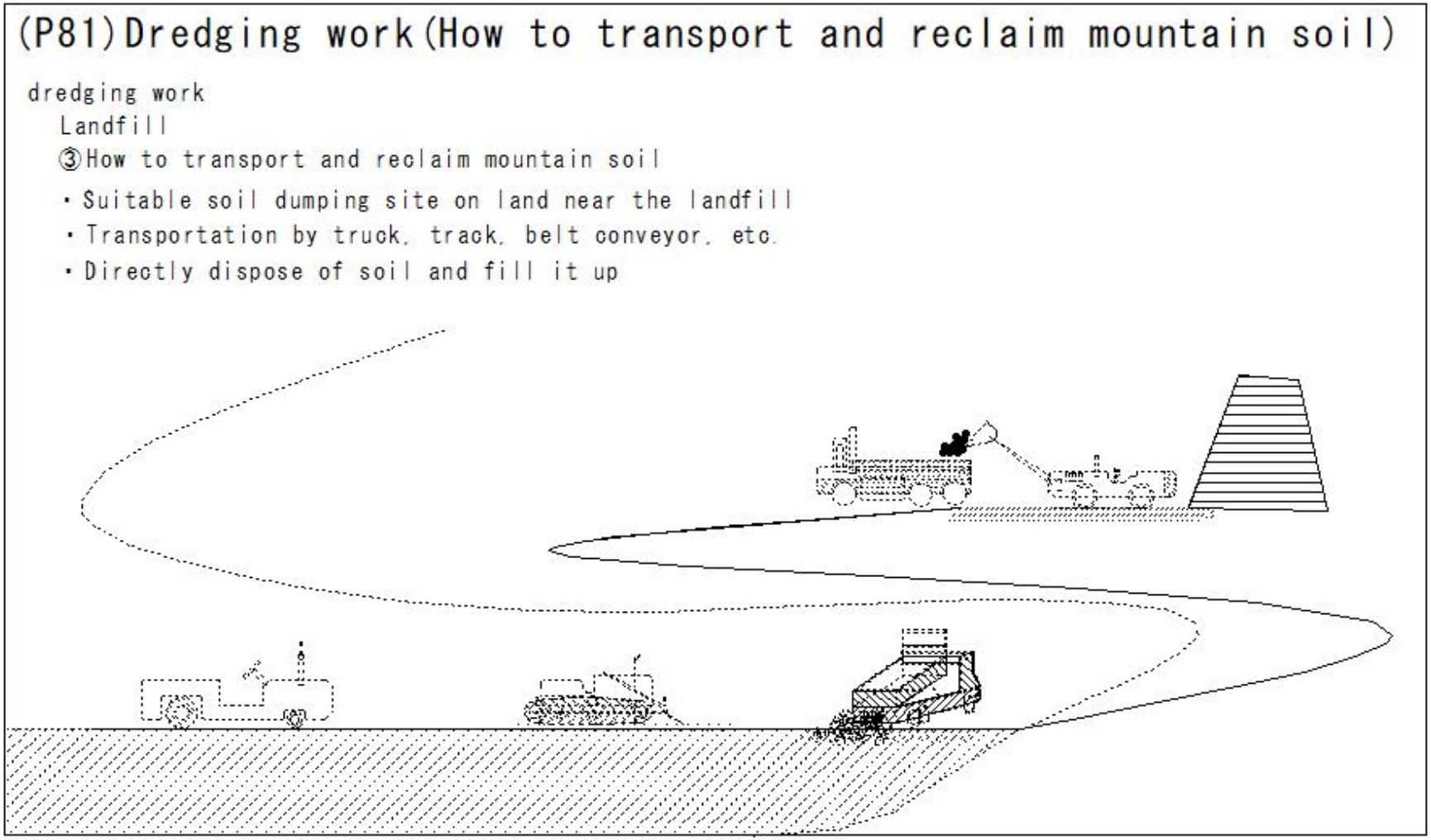
(P79)Dredging work(Direct Landfill)



(P80)Dredging work(Landfill method by soil transportation)



(P81)Dredging work(How to transport and reclaim mountain soil)



(P82)Dredging work(Calculation of the amount of land for reclamation work)

(P82)Dredging work(Calculation of the amount of land for reclamation work)

dredging work

①Calculation of the amount of land for reclamation work

V=Vo/p

V: Landfill volume (m3)

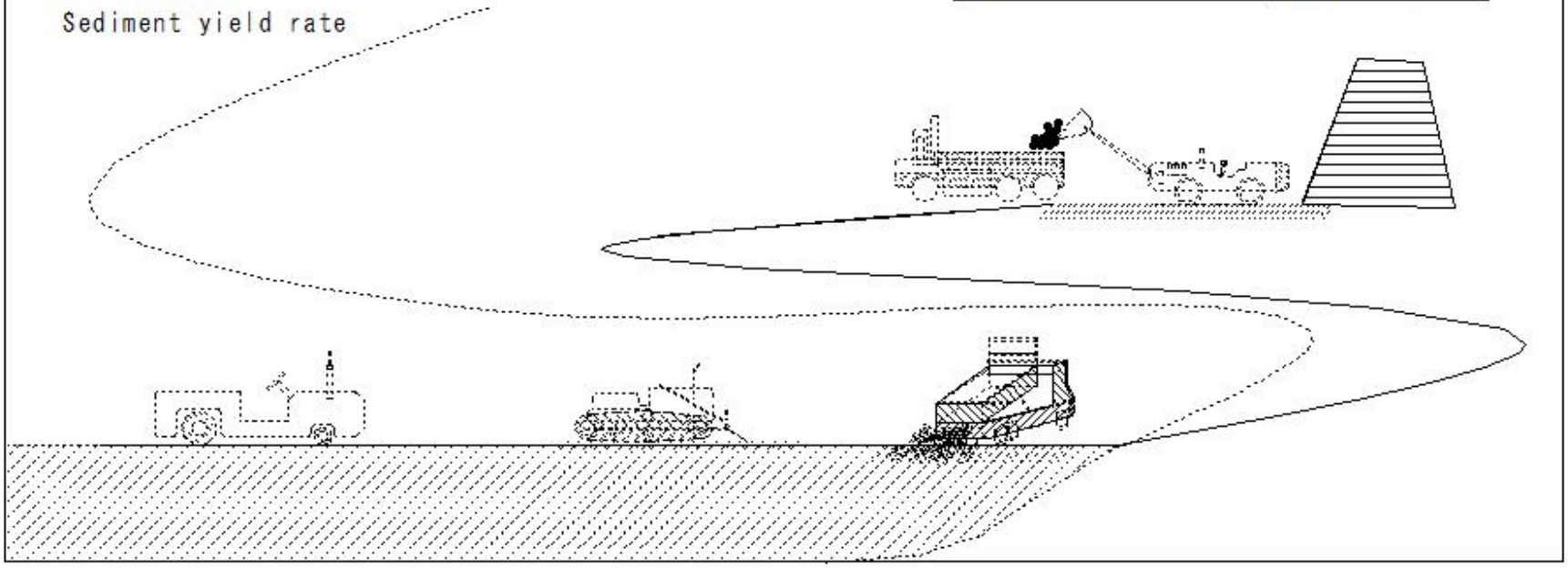
Vo: Landfill volume (including surplus) (m3)

p: Average yield rate of reclaimed soil

pump dredger

Sediment yield rate

Sediment yield rate	
Soil quality	Yield rate(%)
①Gravel/Coarse sand	95-100
②Middle sand	90-95
③Fine sand	70-90
④Silt	70 or less



(P83)Dredging work(Calculation of landfill settlement amount)

(P83)Dredging work(Calculation of landfill settlement amount)

dredging work

②Calculation of landfill settlement amount

・Settlement amount

・Settlement of the original ground: soil quality, porosity ratio, compression index, layer thickness

・Settlement of reclaimed layer: Subsidence due to shrinkage

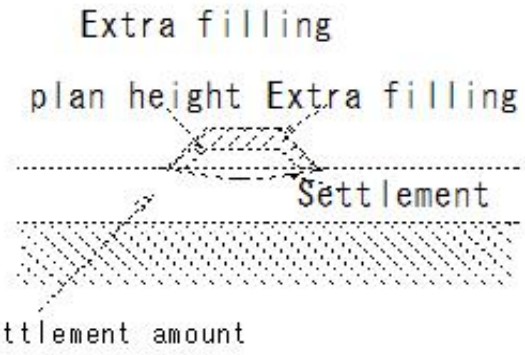
Gravel/sand: The coarser the particle size, the less

Silt/clay: Fine grain size - large amount of settling

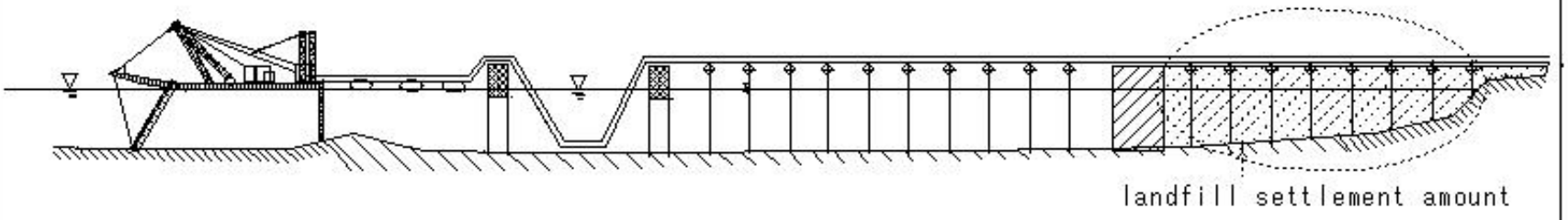
Regarding the layer thickness of the landfill

Gravel/sand: 1-3%

Silt/clay: 15%



E81



(P84)Dredging work(Calculation of landfill settlement amount)

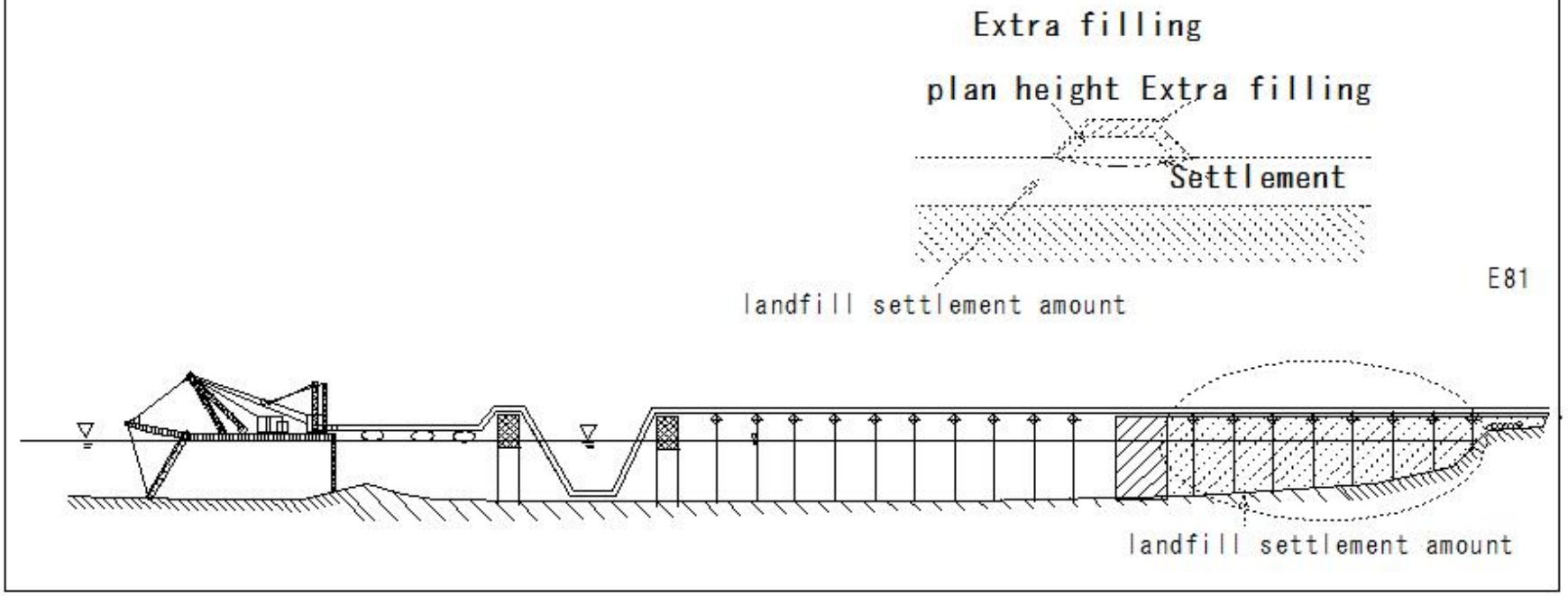
(P84)Dredging work(Calculation of landfill settlement amount)

Dredging work

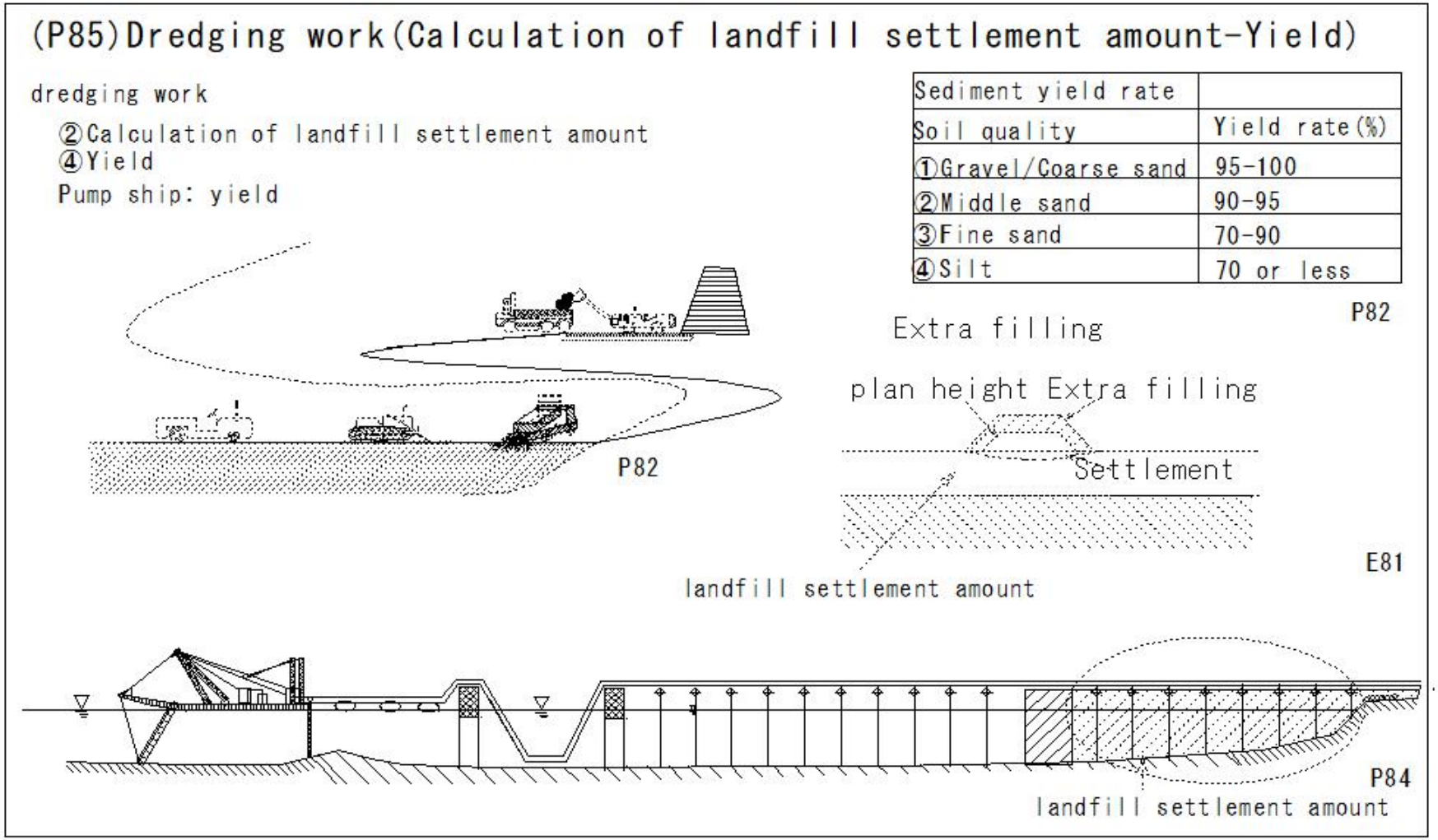
②Calculation of landfill settlement amount

③Extra filling

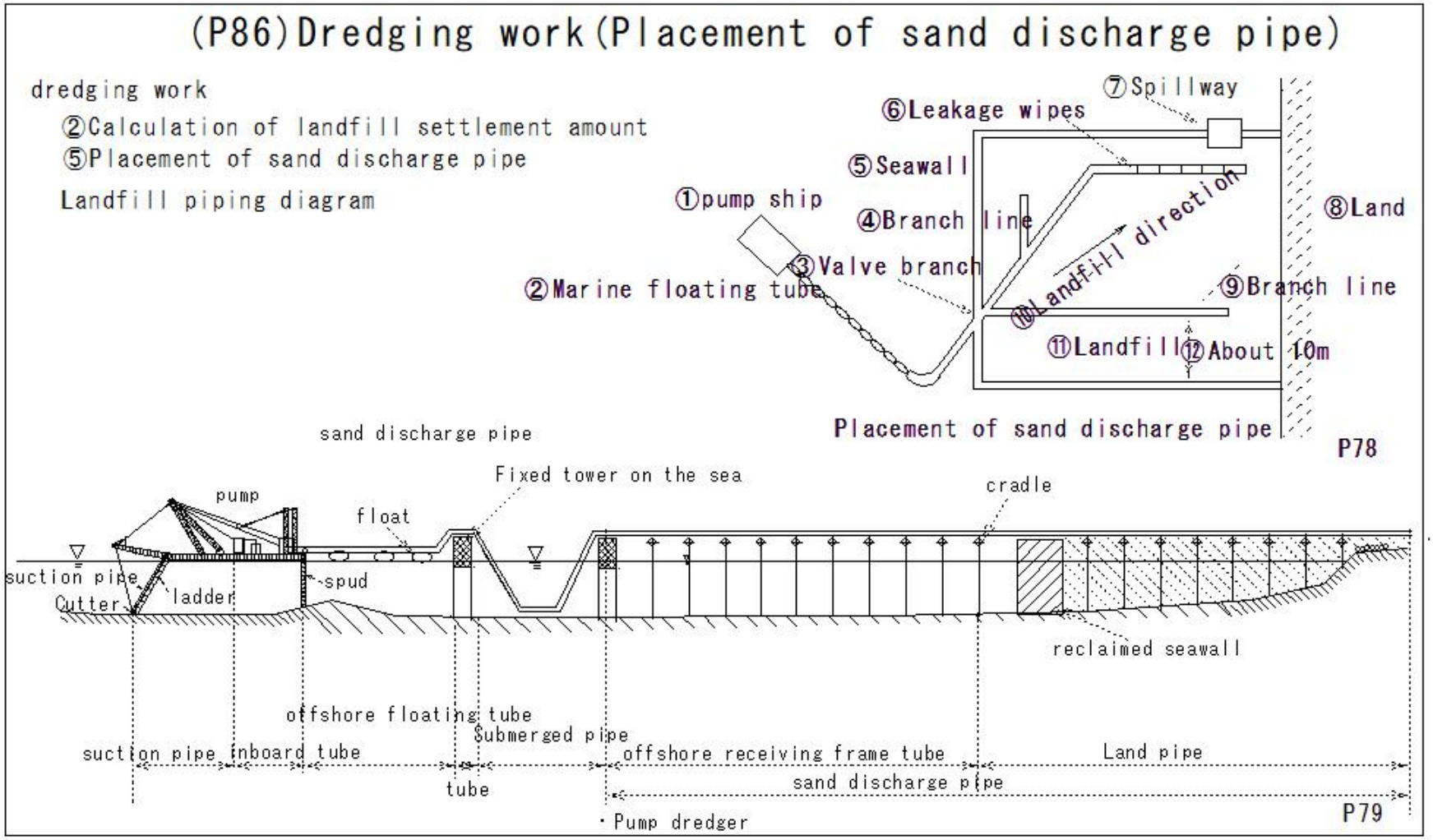
- Smoothing out the unevenness of the reclaimed land surface
- Short-term Settlement
- About 10-15cm



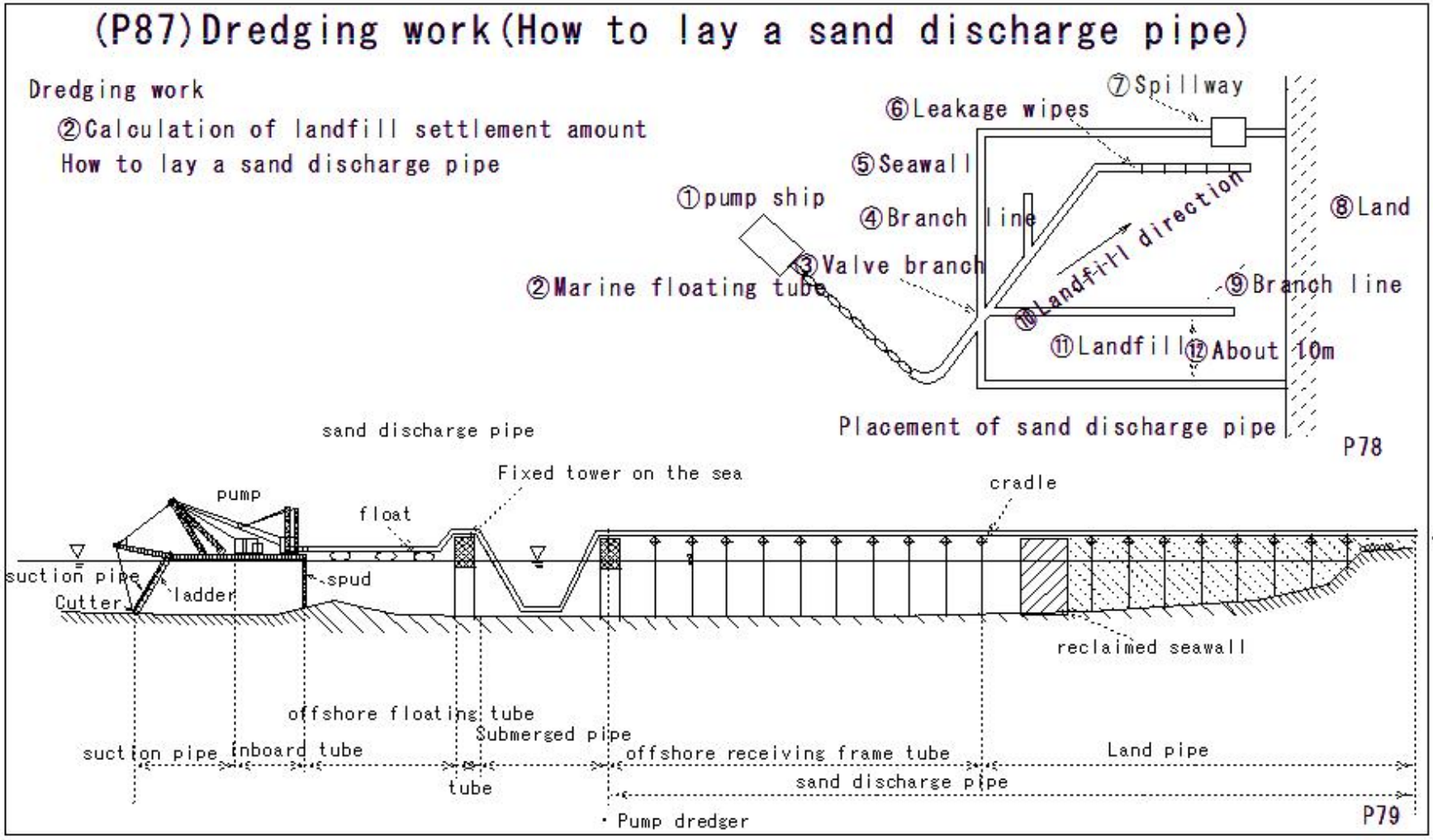
(P85)Dredging work(Calculation of landfill settlement amount-Yield)



(P86)Dredging work(Placement of sand discharge pipe)



(P87)Dredging work(How to lay a sand discharge pipe)



(P88)Dredging work(Measures to take in case of the sand discharge pipe becomes clogged)

(P88)Dredging work(Measures to take in case of the sand discharge pipe becomes clogged)

dredging work

②Calculation of landfill settlement amount

⑥Measures to take in case of the sand discharge pipe becomes clogged

causes

① Long discharge distance

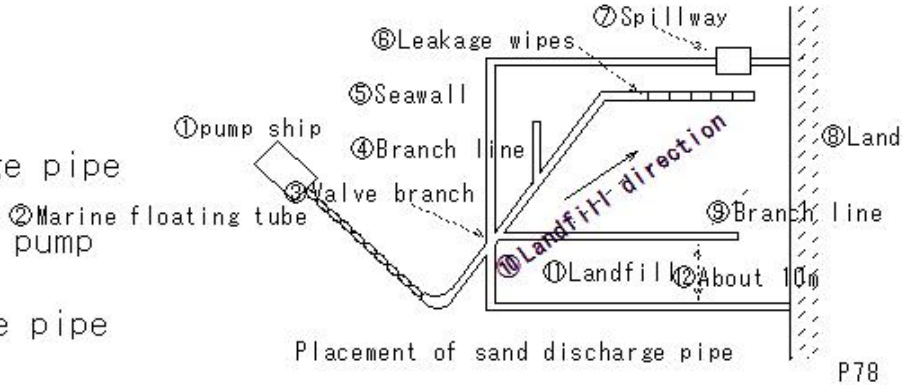
② Insufficient flow velocity in the sand discharge pipe

countermeasure

① Increase the rotation speed of the pump

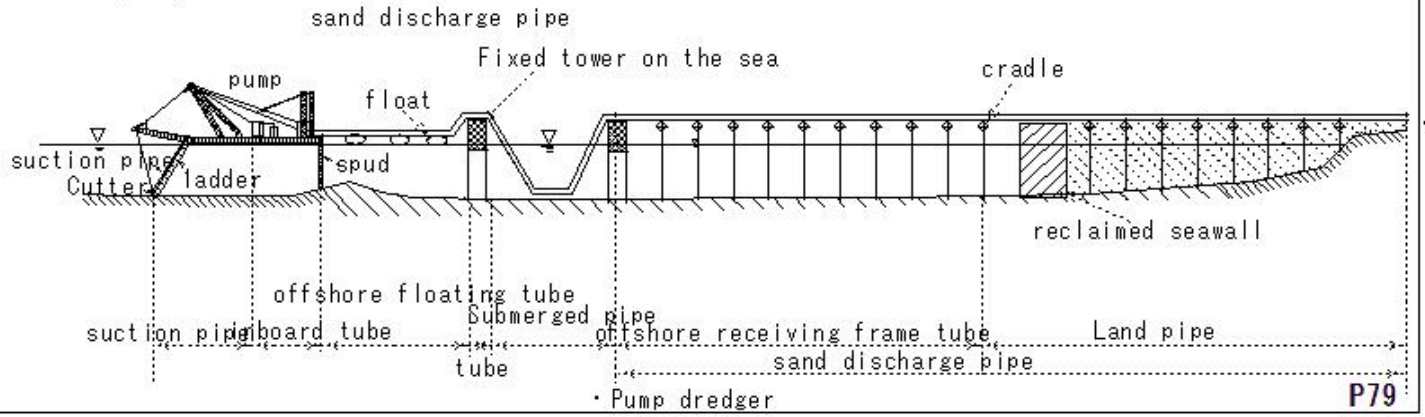
② Reducing the diameter of the sand discharge pipe

③ Install a booth pump on the way



Placement of sand discharge pipe

P78



P79

(P89)Dredging work(spillway)

(P89)Dredging work(spillway)

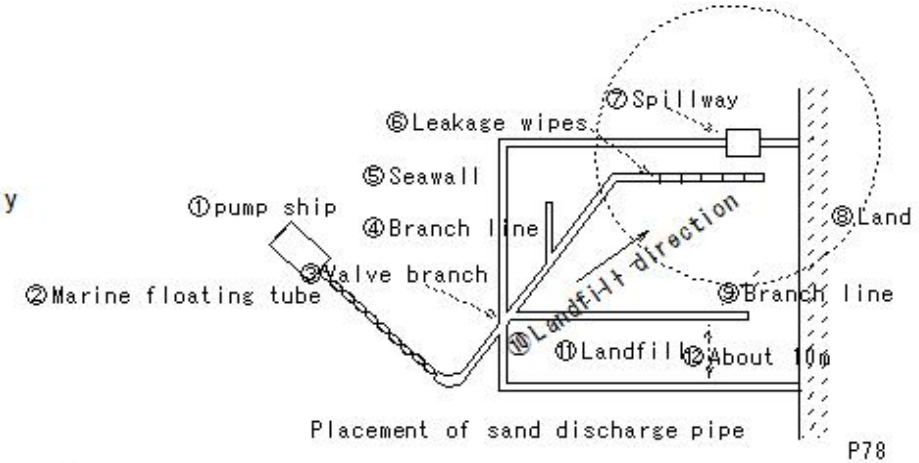
⑦spillway

- Overflow type
- basin type

Muddy water coming out of the sand pipe -

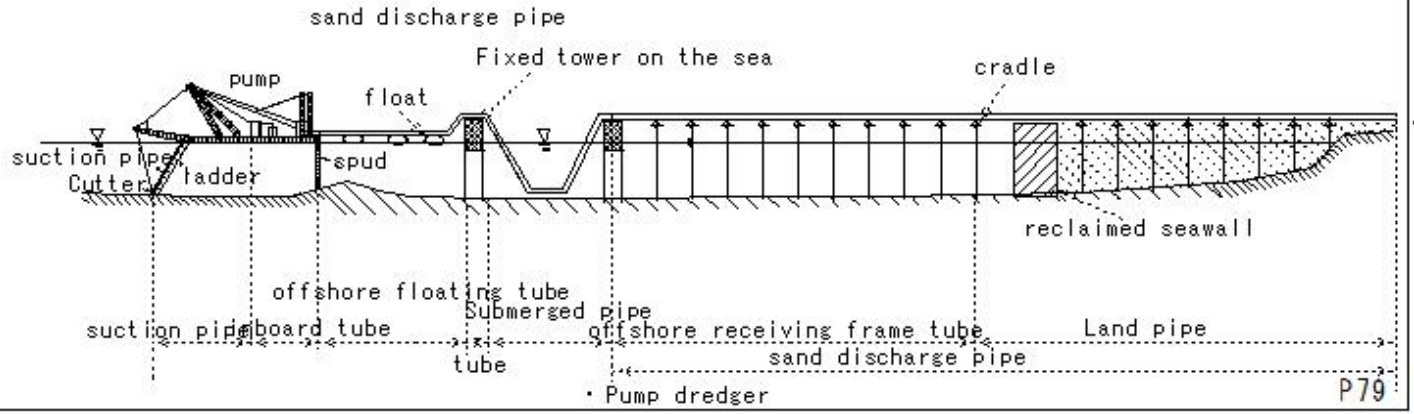
Sediment settling in the reclaimed land

Discharged into the ground from the spillway



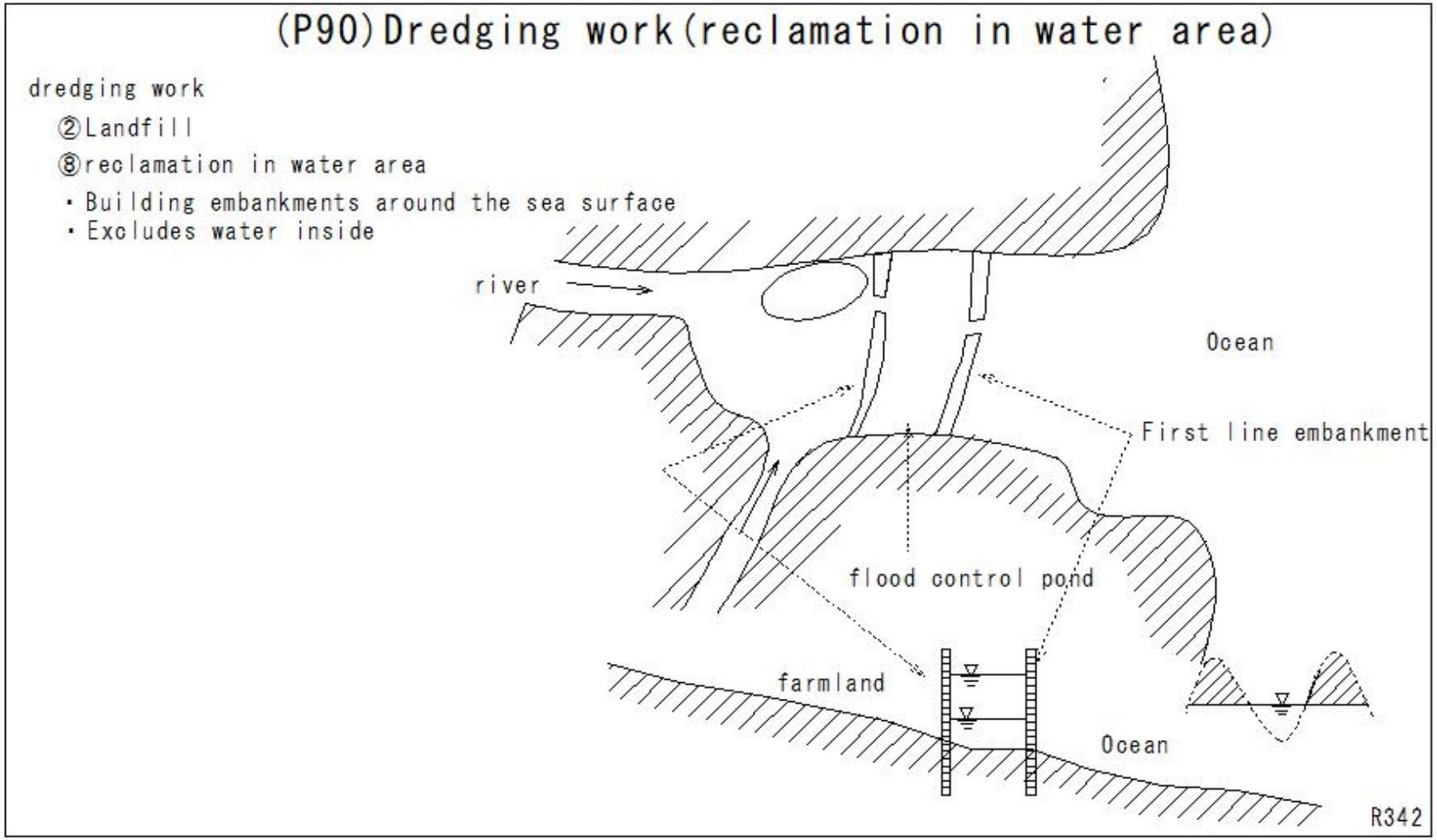
Placement of sand discharge pipe

P78

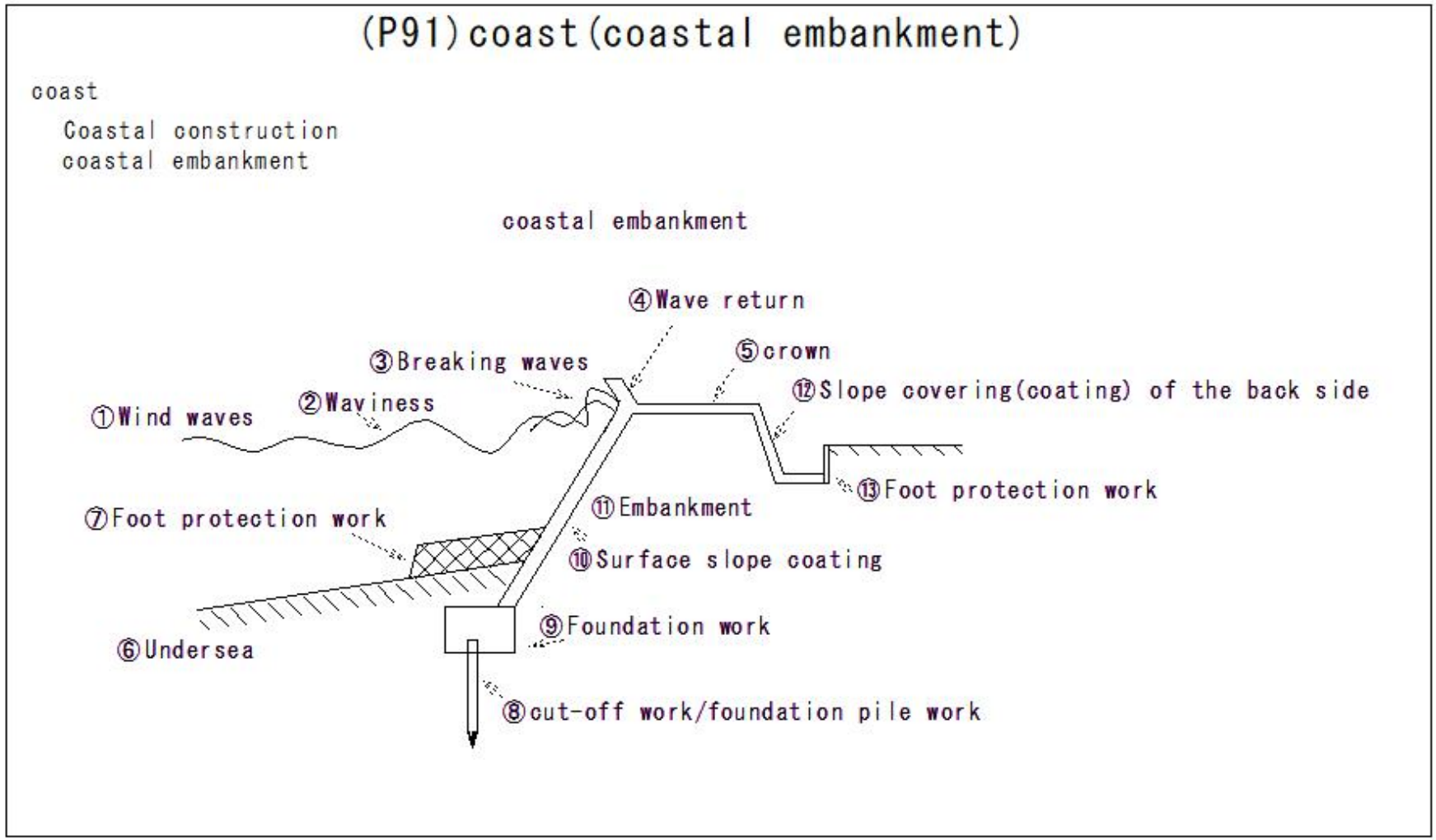


P79

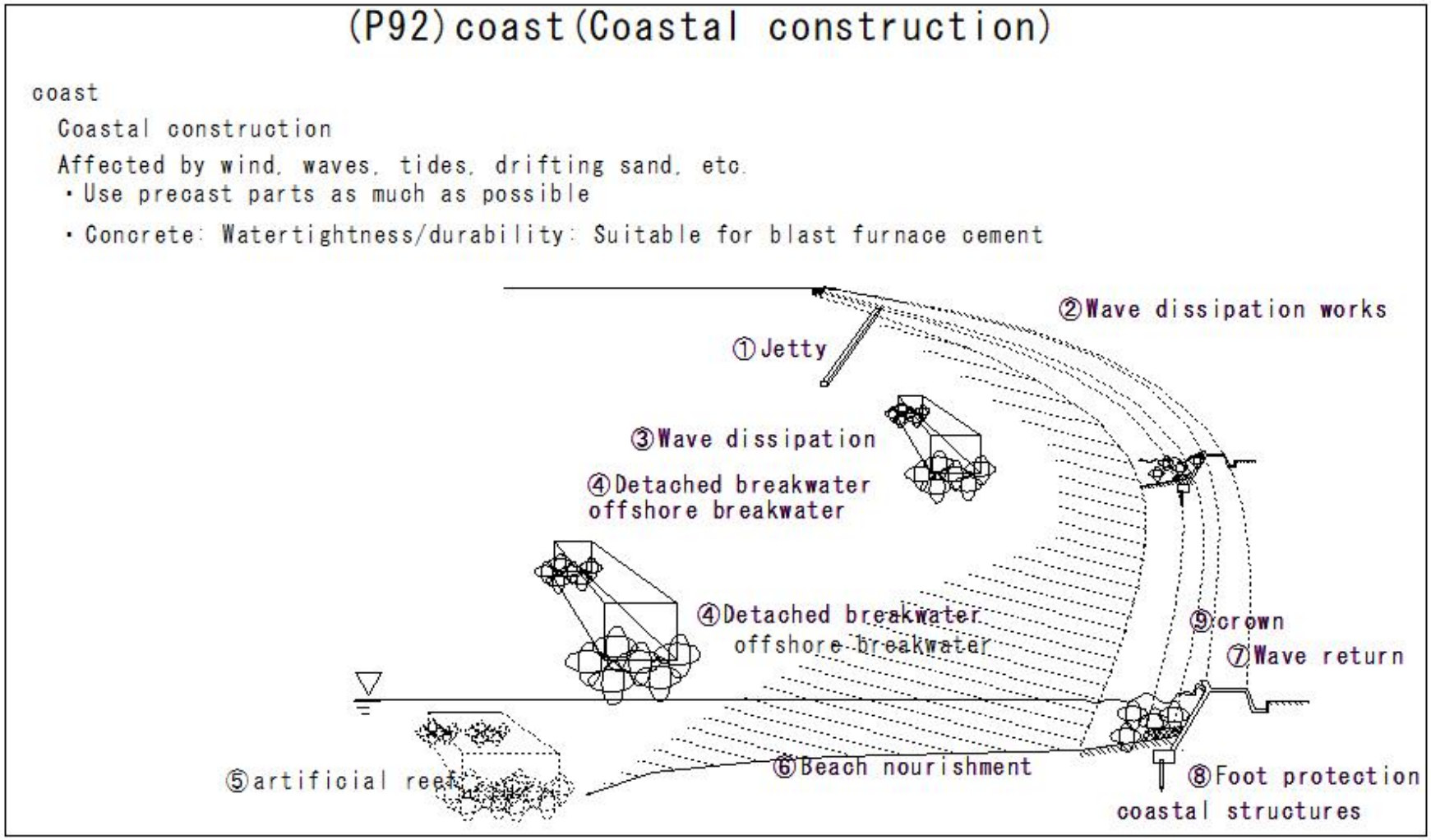
(P90)Dredging work(reclamation in water area)



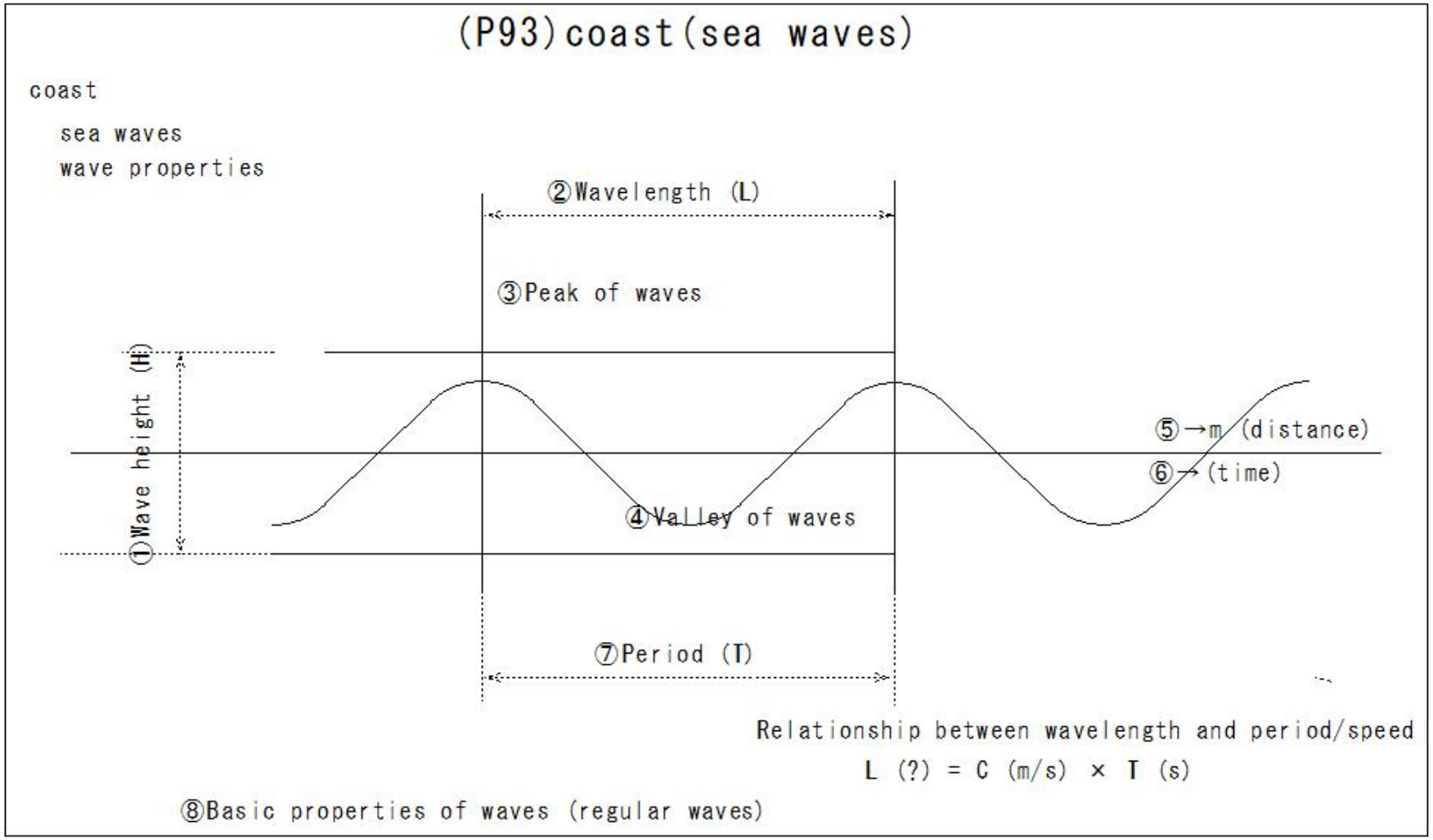
(P91)coast(coastal embankment)



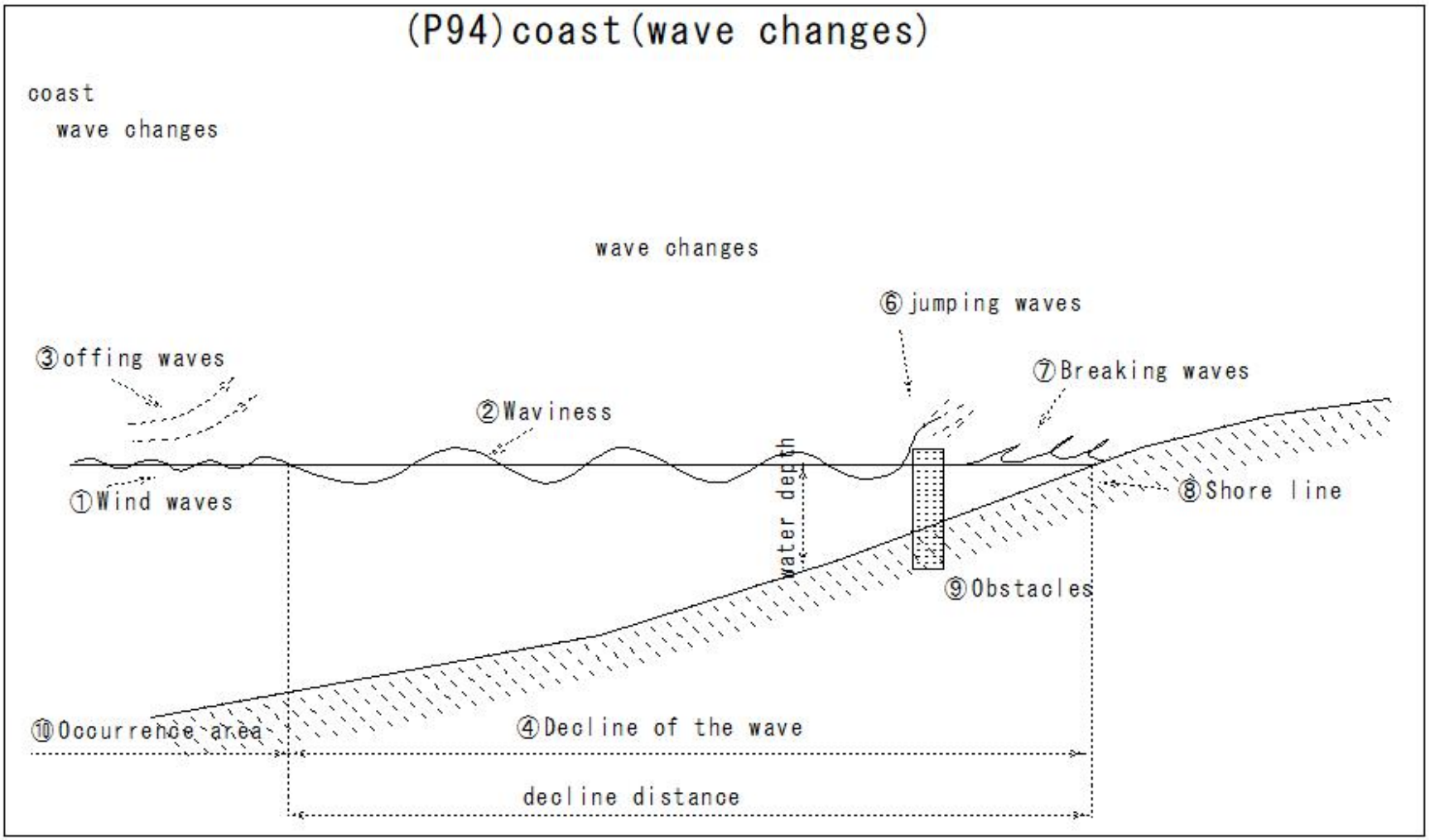
(P92)coast(Coastal construction)



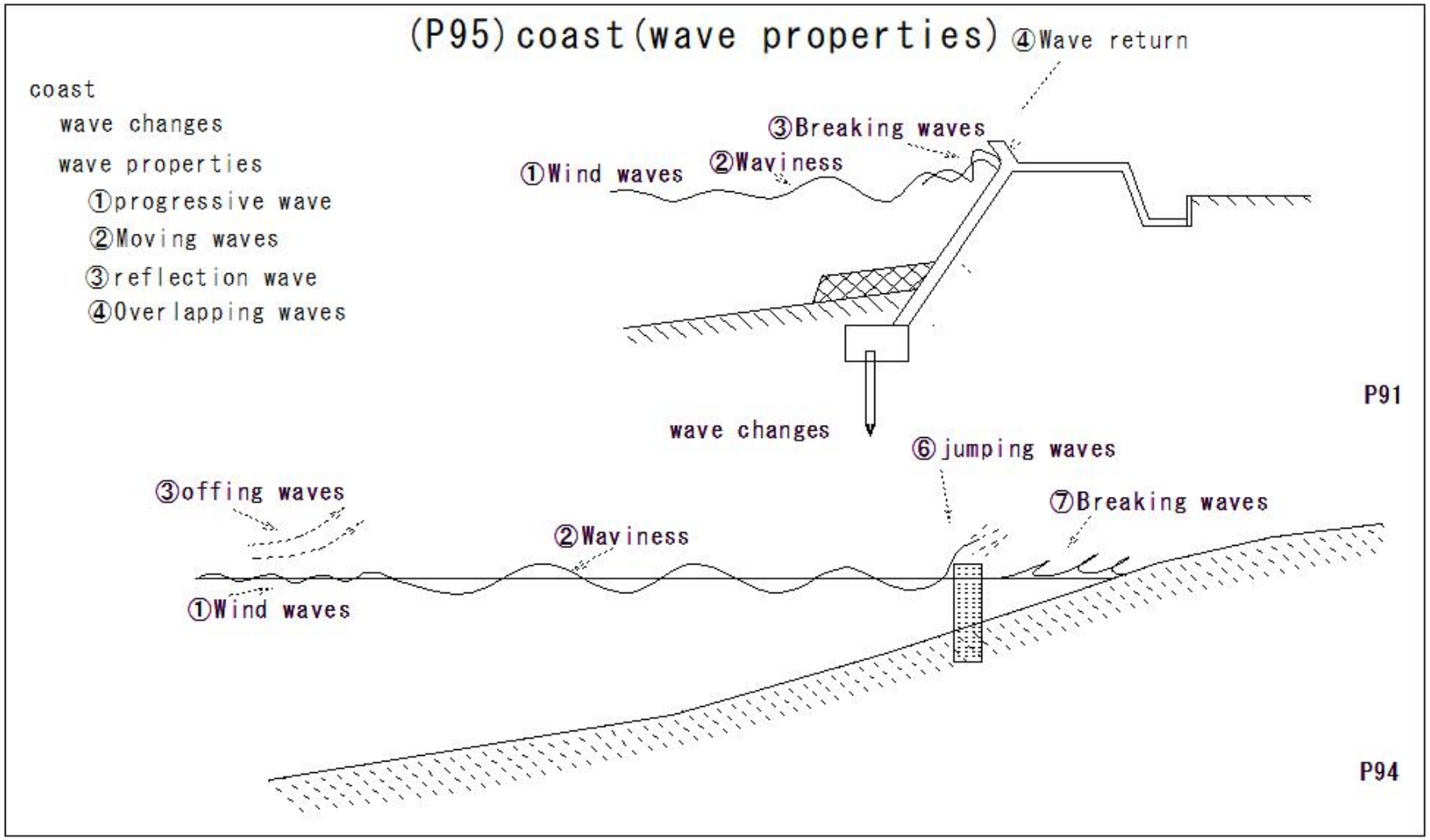
(P93)coast(sea waves)



(P94)coast(wave changes)



(P95)coast(wave properties)



(P96)coast(wave pressure)

(P96)coast(wave pressure)

coast

wave changes

wave pressure

・Wave force acting on coastal structures

・in case of the water depth of the structure is more than twice the wave height: Overlapping waves

・in case of the water depth of the structure is less than twice the wave height: breaking waves

①Wave pressure of overlapping waves

Water depth is more than twice the wave height

case of waves cannot be avoided

Sainflow simplified formula

$p1=(p2+\omega h)((H+ho)/(h+H+ho))$

$p2=\omega H/(\cosh \cdot kh)$

p: Overlapping wave pressure (t/m2)

H: Wave height (m)

L: Wavelength (m)

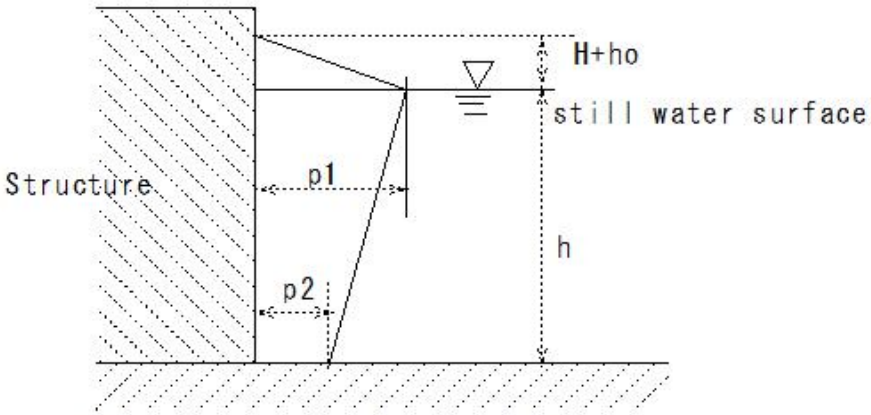
H+ho: Wave height as overlapping wave (m)

ω: Unit volume weight of seawater (t/m3)

h: Water depth (m)

$ho:((\pi H\hat{}2)/L)\cosh \cdot kh$

$k=2\pi/L$



①Wave pressure of overlapping waves

(P97)coast(wave pressure of breaking waves)

(P97)coast(wave pressure of breaking waves)

coast

wave changes

wave pressure

②wave pressure of breaking waves

in case of the water depth is less than twice the wave height,
it is calculated as breaking waves.

(HIROI formula)

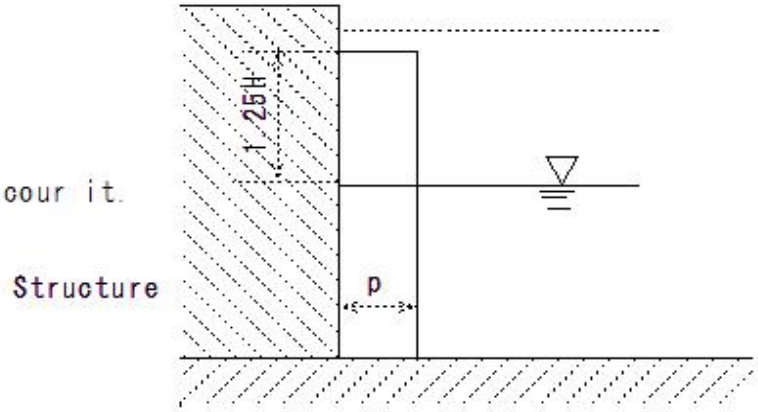
$p=1.5wH$

p: Crushing pressure (t/m3)

ω: Unit volume weight of seawater (t/m3)

H: Wave height (m)

in case of the waves evade,
lift up the sand on the ocean floor and scour it.



②wave pressure of breaking waves

in case of the waves evade, lift up the sand on the ocean floor and scour it.

(P98)coast(drift sand)

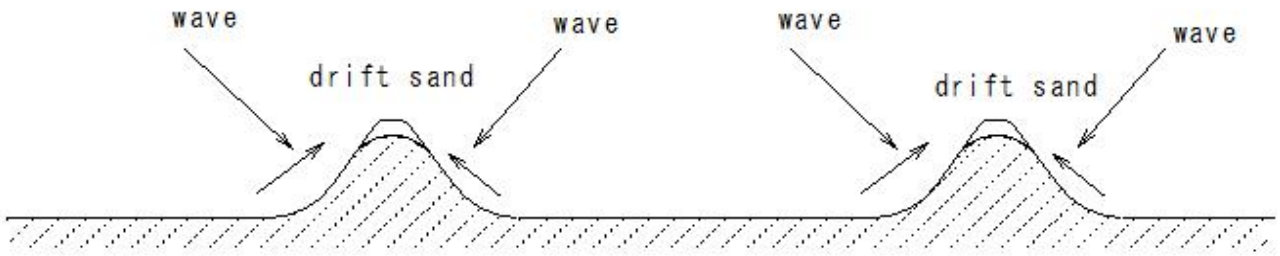
(P98)coast(drift sand)

coast

wave changes

drift sand

・A phenomenon in which sediment on the sea floor is moved by the action of waves and currents on the coast.



Deformation of the sandy beach

(P99)coast(drift sand)

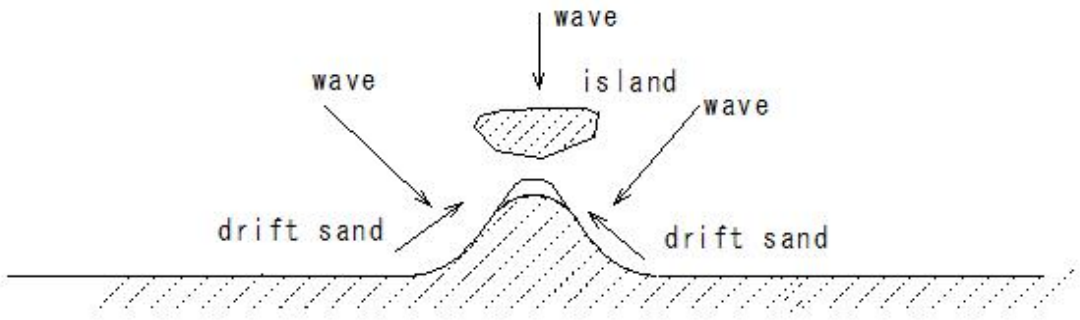
(P99)coast(drift sand)

coast

wave changes

drift sand

・A phenomenon in which sediment on the sea floor is moved by the action of waves and currents on the coast.



Tomboro

Deformation of the sandy beach

(P100)coast(drift sand)

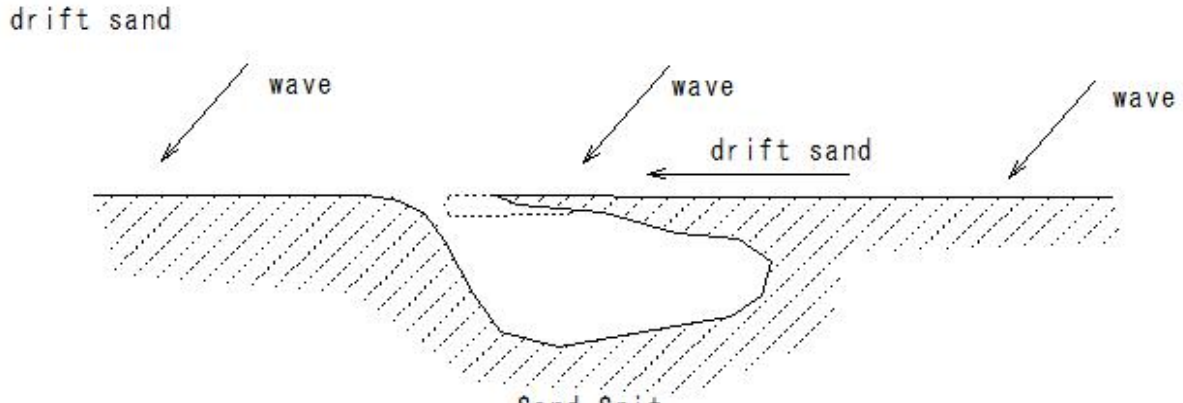
(P100)coast(drift sand)

coast

wave changes

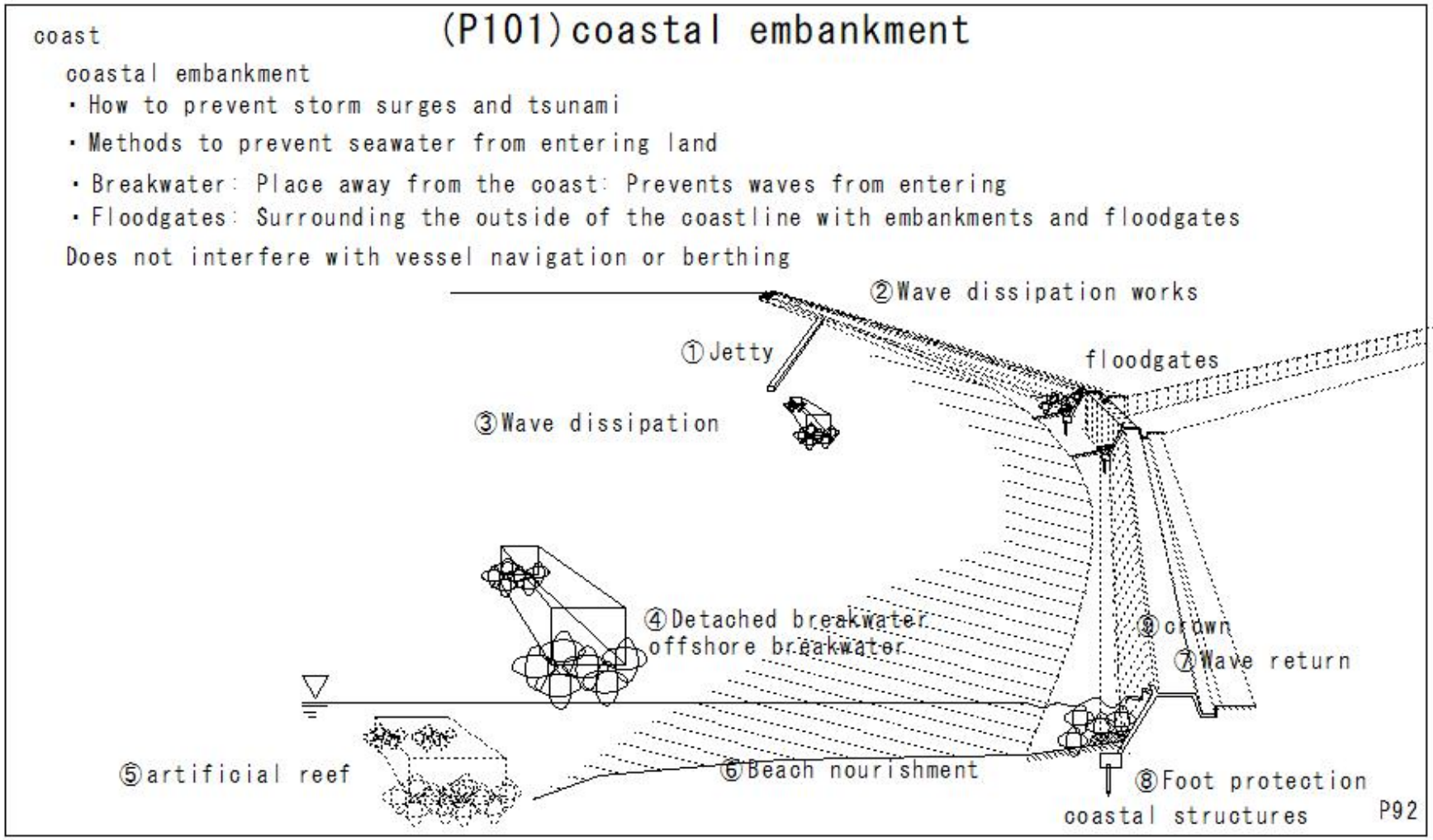
drift sand

・A phenomenon in which sediment on the sea floor is moved by the action of waves and currents on the coast.



Deformation of the sandy beach

(P101)coastal embankment



(P102)coastal embankment

(P102)coastal embankment

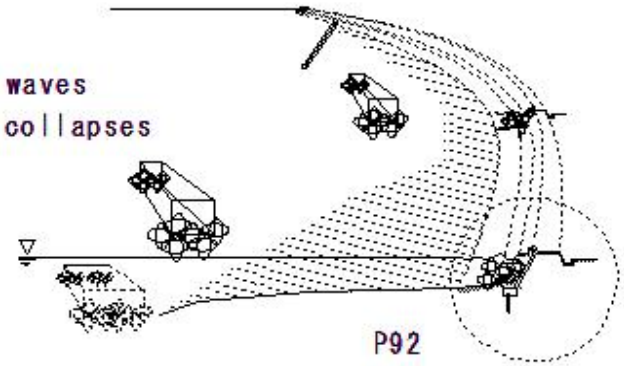
coast

coastal embankment

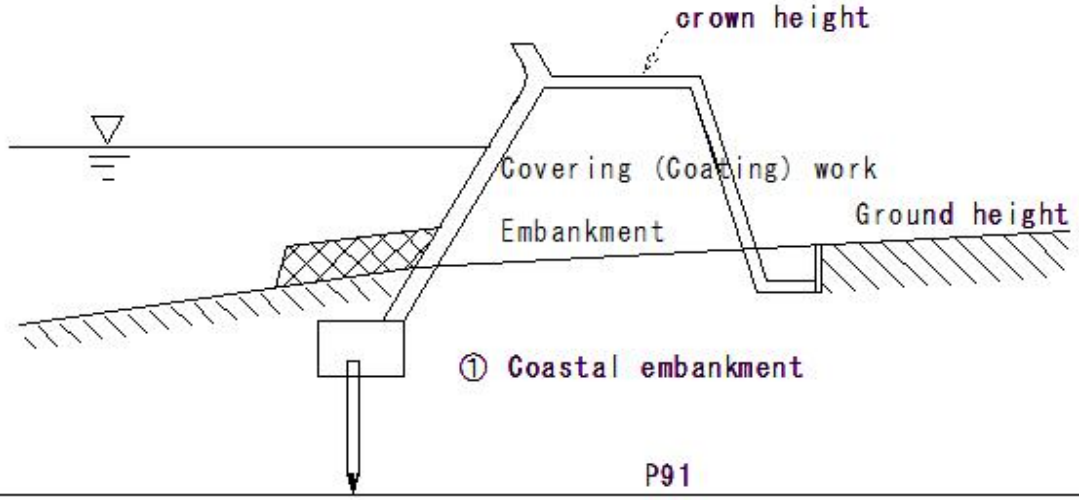
seawall

- Preventing scouring caused by tsunamis, storm surges, and waves
- Destination caused by overtopping waves: Preventing beach collapses
- Prevention of land collapse
- Erosion prevention

① Coastal embankment

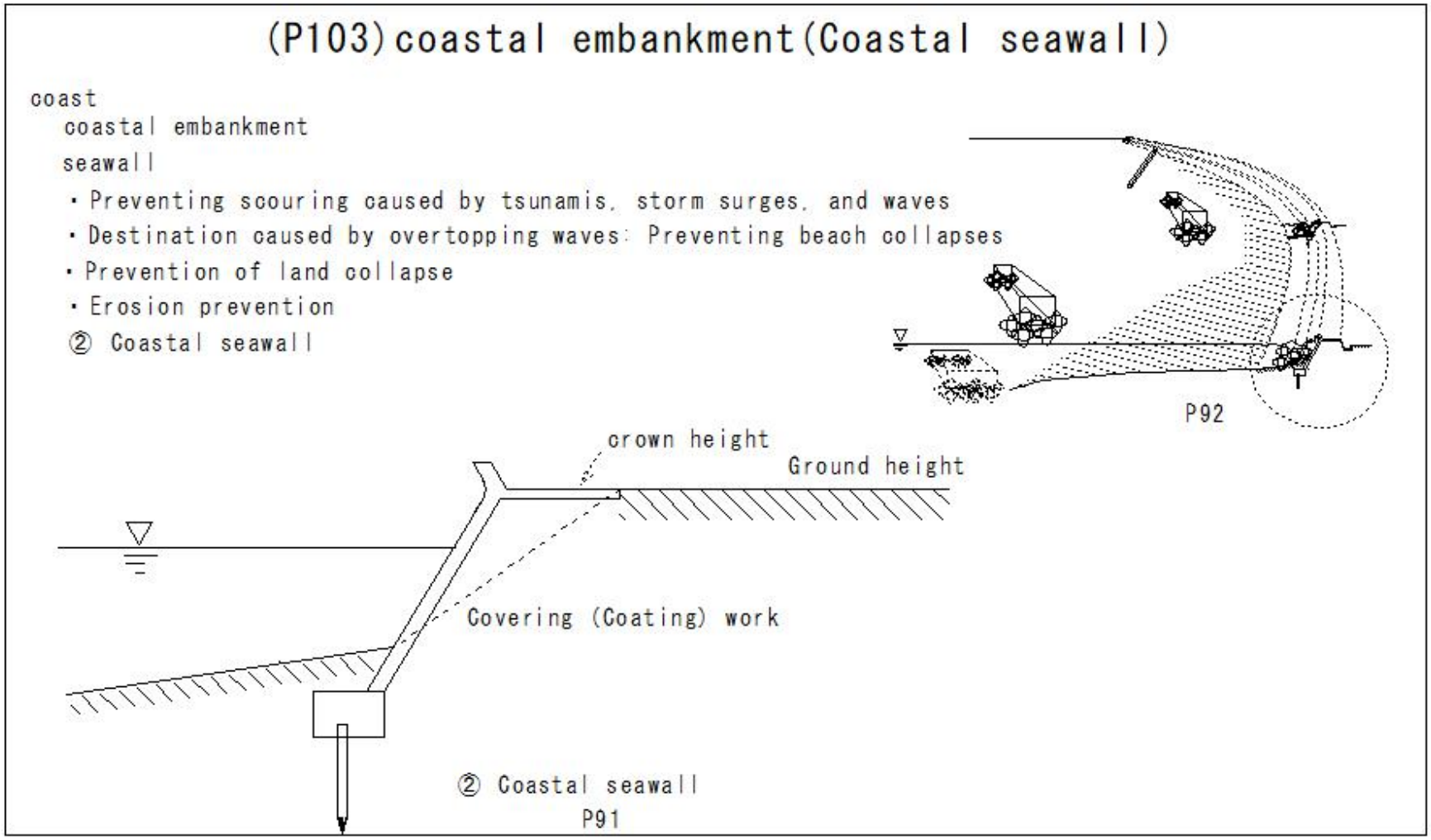


P92



P91

(P103)coastal embankment(Coastal seawall)



(P104)coastal embankment(Slanted type)

(P104)coastal embankment(Slanted type)

coast

coastal embankment

Model

By material used

①Slanted(sloped ・canted) type

Looser than 10%

Concrete block type

Concrete Covering (Coating) type

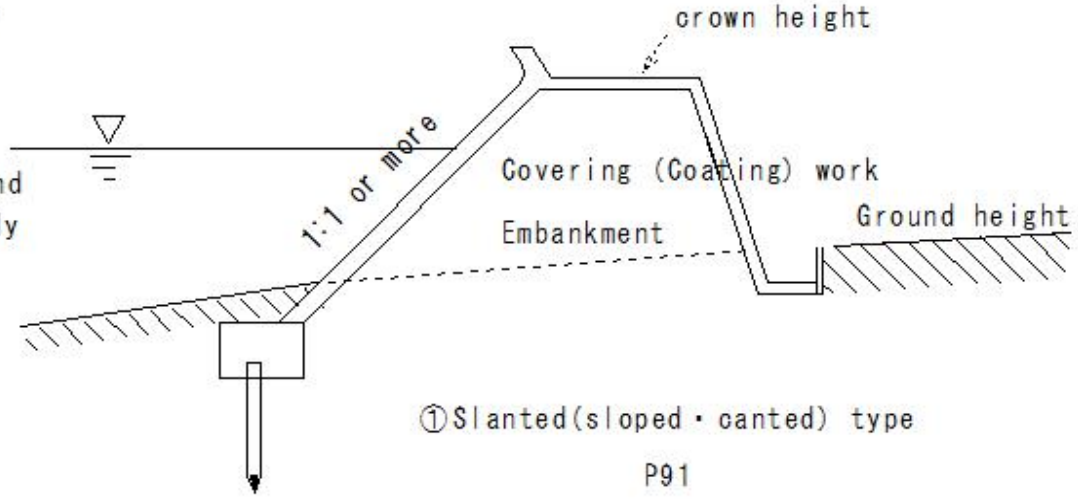
1:1 or more

・Suitable for soft ground

・Easy to construct

・A large amount of earth and sand on the embankment body

・Easy to be washed away



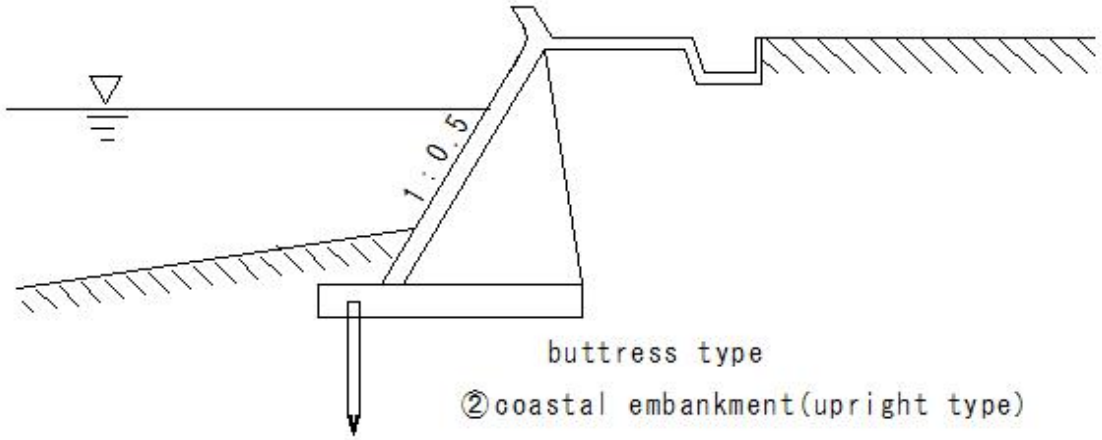
①Slanted(sloped・canted) type

P91

(P105)coastal embankment(upright type)

(P105)coastal embankment(upright type)

coast
- coastal embankment
- Model
- By material used
- ②coastal embankment(upright type)
- 10% steep
- masonry type
- concrete block construction
- gravity type



buttress type

②coastal embankment(upright type)

・Suitable for areas with good foundation ground

(P106)coastal embankment(composite type)

(P106)coastal embankment(composite type)

coast

coastal embankment

Model

By material used

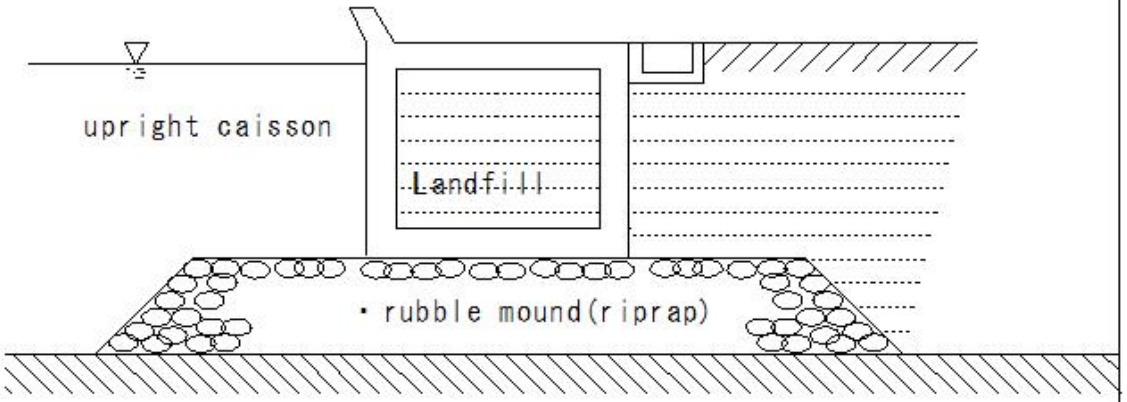
③composite type

Upper part (10% steeper)

Lower part (10% looser)

Upper part: Upright type (free-standing type)

Lower part slanted type (saved stone)



advantages of sloping and upright types

・For deep water, the lower part is tilted

・The ground is relatively weak and the water is deep

③composite type

(P107)coastal embankment(Embankment shape)

(P107)coastal embankment(Embankment shape)

coast

coastal embankment

Embankment shape

① Normal line

② Surface slope

Gravity type・・・ Vertical ~ 1:1

Masonry type・・・ 1:0.3～1:1

Concrete covered type・1:1～1:3

③Back slope

stone Masonry type・・・・・・1:0.3～1:1

Concrete block type...1:1~1:2.5

Concrete covered type・・・1:1～1:2

Asphalt covering type・・・1:2～1:3

④crown height

・Considering tide level, wave launch height, and overtopping amount

Estimate the amount of Settlement

⑤Top width

Slanted(sloped・canted) type...3m

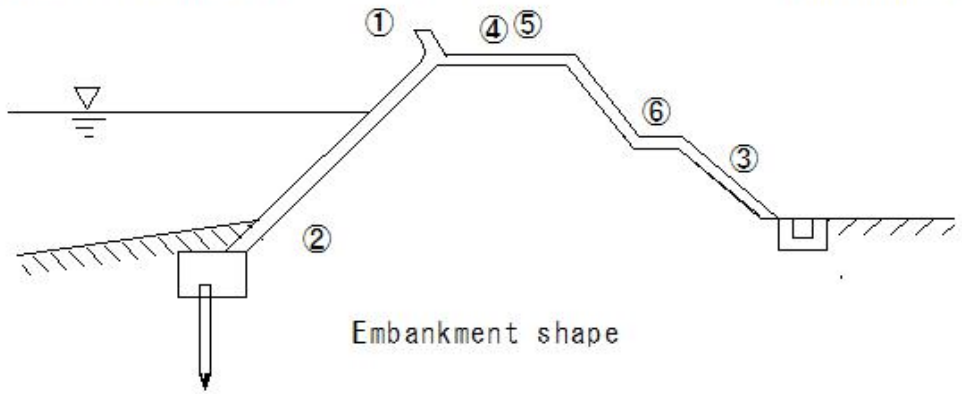
Upright gravity type...1m

⑥berm width

in case of the height is 5m or more

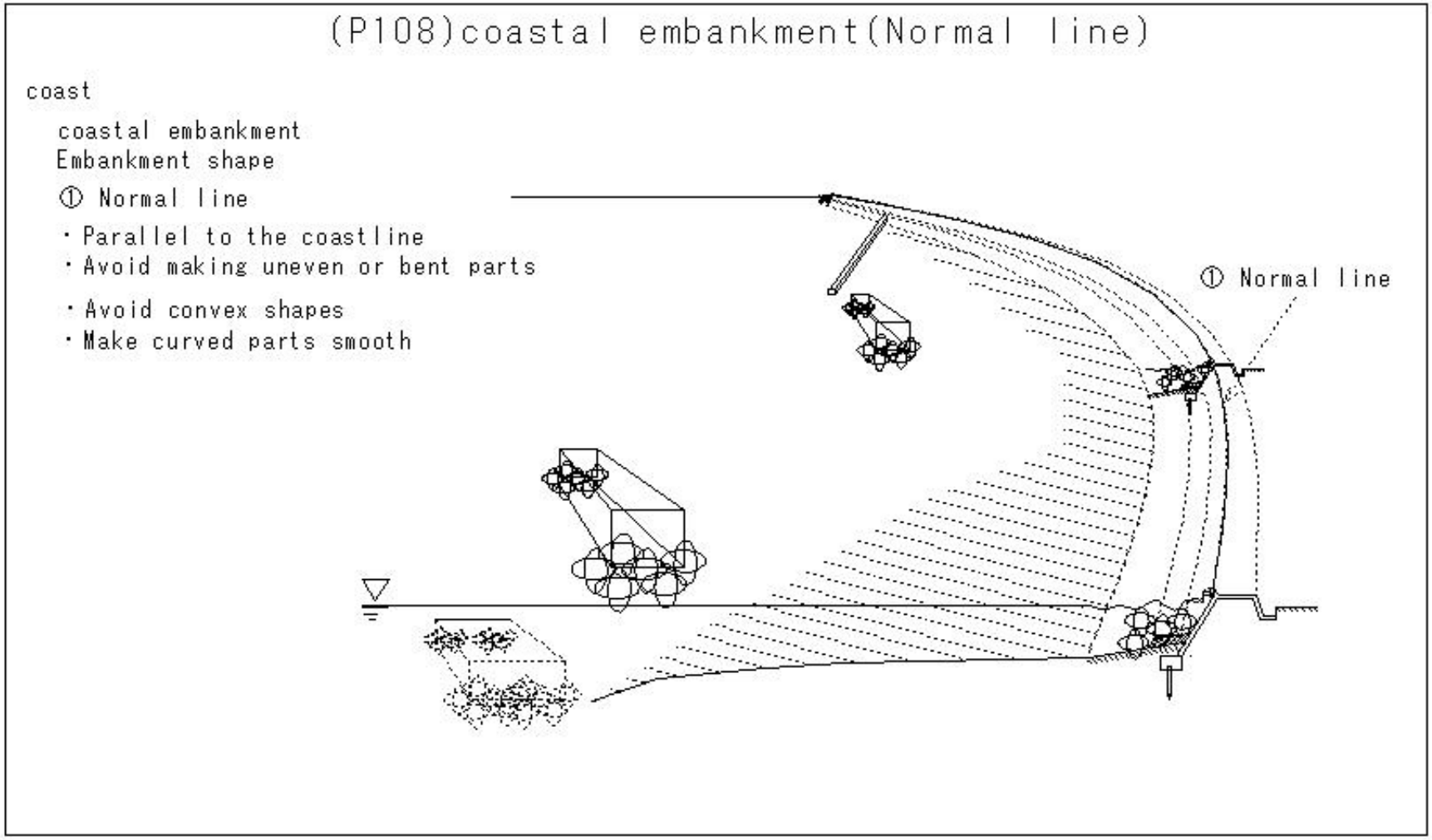
Provided every 2-3 meters lowered...

...1.5 meters or more



Embankment shape

(P108)coastal embankment(Normal line)



(P109)coastal embankment(Slope)

(P109)coastal embankment(Slope)

coast

coastal embankment

Embankment shape

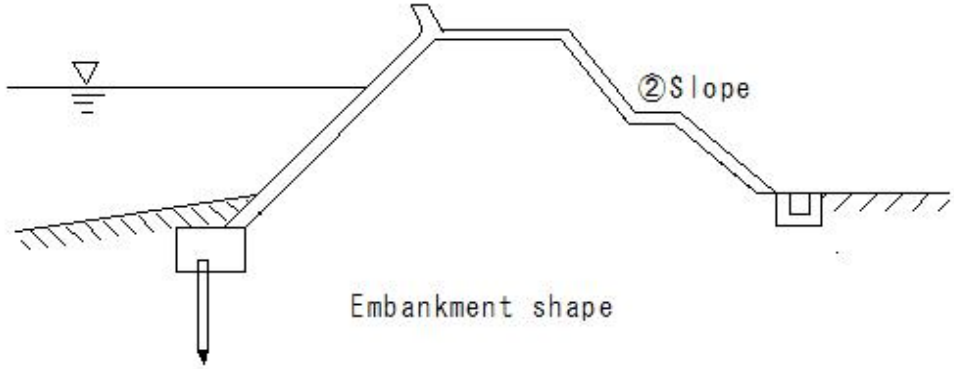
②Slope

back slope

Direct height 5m or more

Set up a (berm)small step 2-3 meters down from the top.

berm(Small step)width 1.5m or more



Embankment shape

(P110)coastal embankment(crown height)

(P110)coastal embankment(crown height)

coast

coastal embankment

Embankment shape

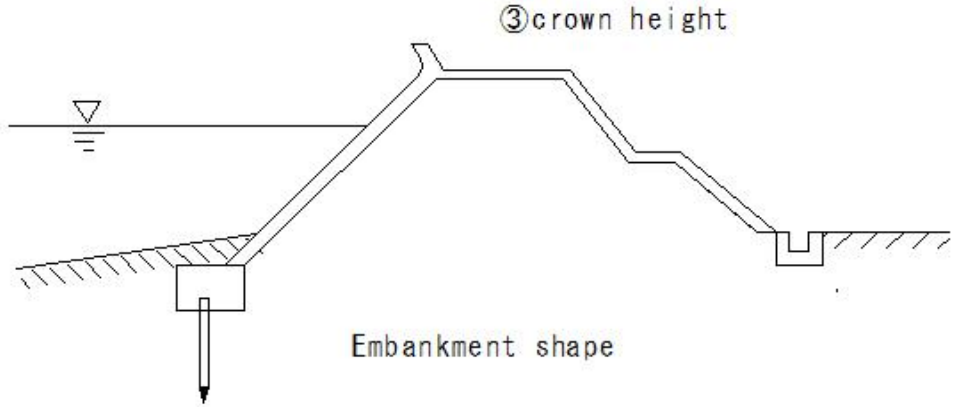
③crown height

・Prevention of storm surge, tsunami, etc.

・Protect the territory

・Considering tide level, wave launch height, and overtopping amount

Anticipate Settlement



(P111)coastal embankment(Top width)

(P111)coastal embankment(crown width)

coast

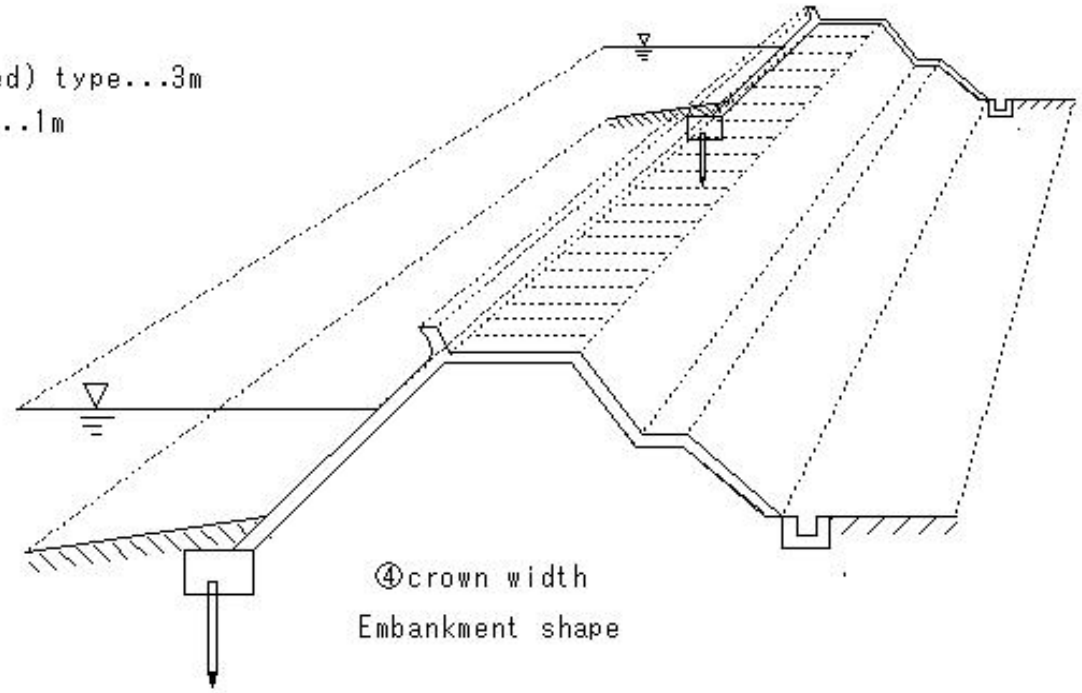
coastal embankment

Embankment shape

④crown width

Slanted(sloped・canted) type...3m

Upright gravity type...1m



(P112)coastal embankment(Embankment construction)

(P112)coastal embankment(Embankment construction)

coast

coastal embankment

Embankment construction

- Embankment work
- Foundation work
- Foot protection work
- Covering (Coating) work on the surface
- crown covering (Coating) work
- Back Covering (Coating) work

important points

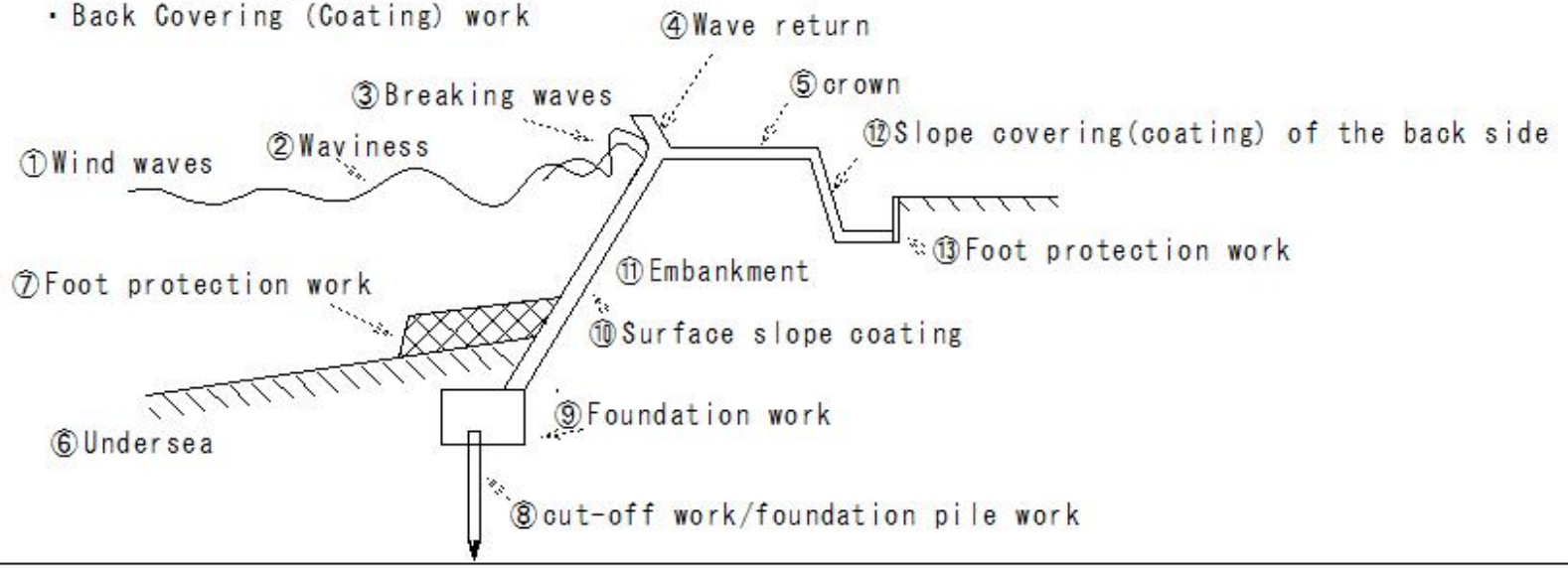
①Embankment: Thoroughly compact

②Extra banking

③After embankment

equip cover the crown and back edges

to prevent erosion from overtopping waves.

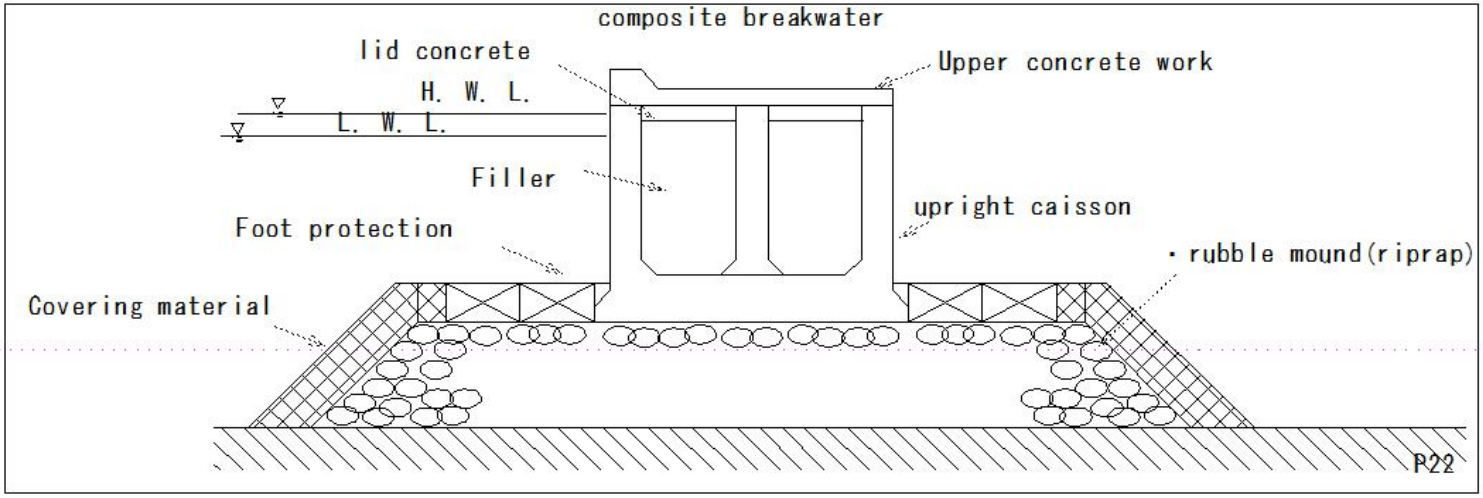


P91

(P113)coastal embankment(Foundation work)

(P113)coastal embankment(Foundation work)
coast
coastal embankment
Embankment construction
②Foundation work
Types and characteristics of foundation work

kinds	Features
①Cast-in-place concrete foundation	①Good quality ground, widely used
②Concrete block foundation	②in case of the water is relatively deep and concrete pouring is not possible
③rubble mound(riprap)/stone block foundation	③case of the ground is soft and the water is deep
④Pile driving foundation	④Used in combination with concrete foundation, concrete pile, Use of steel pipe sheet piles
⑤Cellular block basics	⑤ Construction costs are high if the water is deep and the ground is of good quality.
⑥Well, caisson foundation	⑥ Construction costs are high if the water is deep and the ground is of good quality.
⑦Sand foundation	⑦Used for soft ground
⑧Replacement basics	⑧Replace with sand or gravel on soft ground

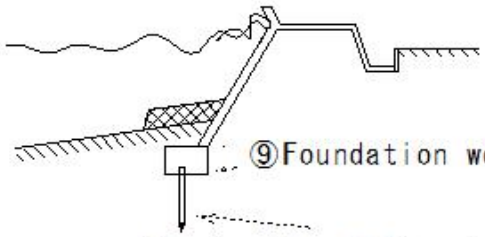


(P114)coastal embankment(Foundation work)

(P114)coastal embankment(Foundation work)

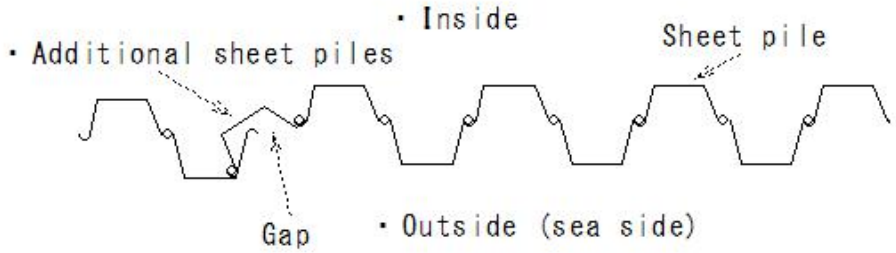
coast

coastal embankment
Embankment construction
②Foundation work
・Highly permeable foundation ground -
Water stoppage using sheet piles
Prevent water leakage from the bottom
Precautions for sheet pile construction
①Water stop work: Sheet pile joints
・Make sure to mesh well and use highly watertight materials
②Sheet pile construction: gaps and holes become defects
③Gap treatment
・Misalignment of sheet pile joints
・Replacement
・Overlapping and hitting inside
④End point of foundation sheet pile
Add 1-2m extra from foundation work



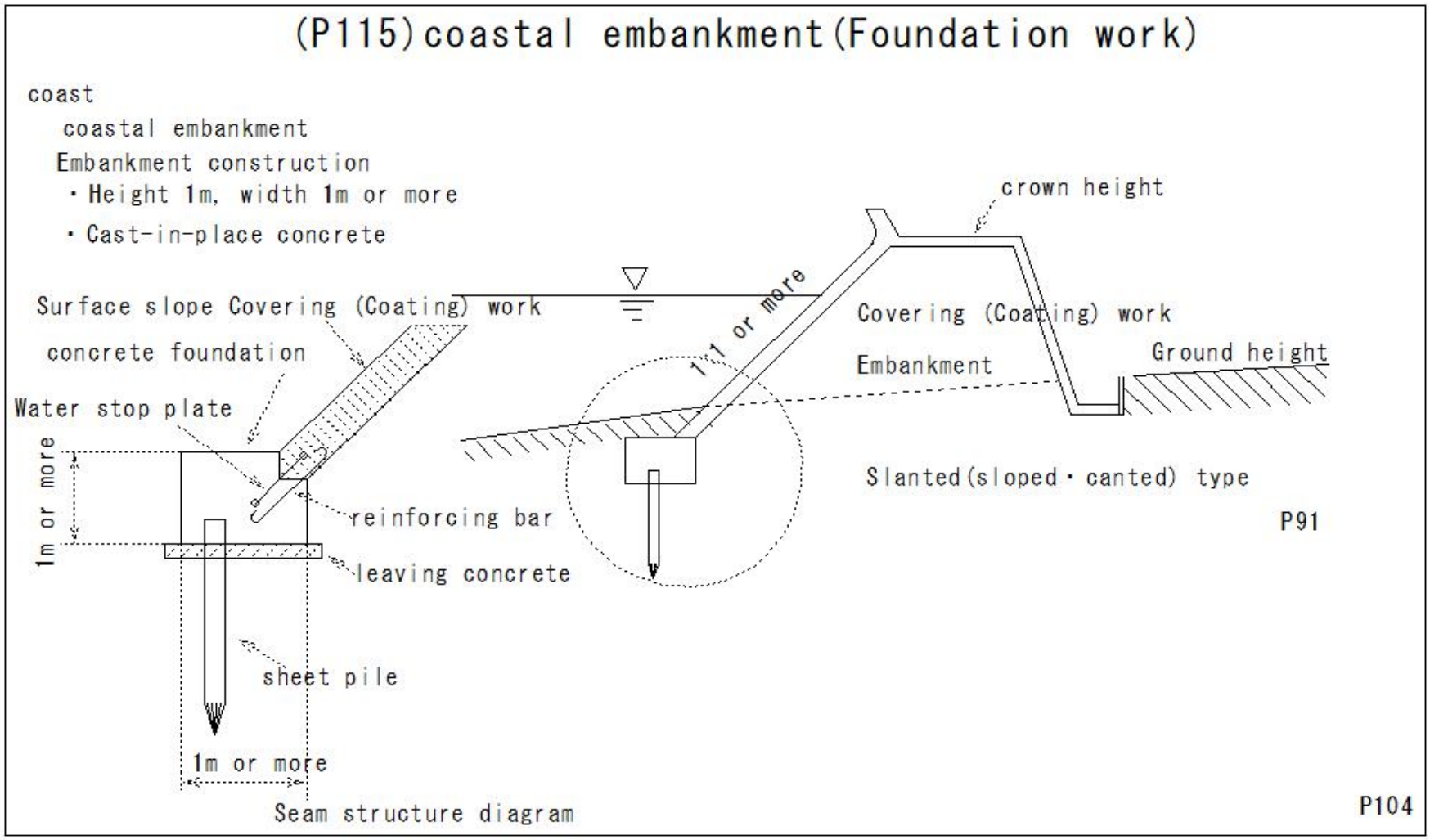
⑧cut-off work/foundation pile work

P91

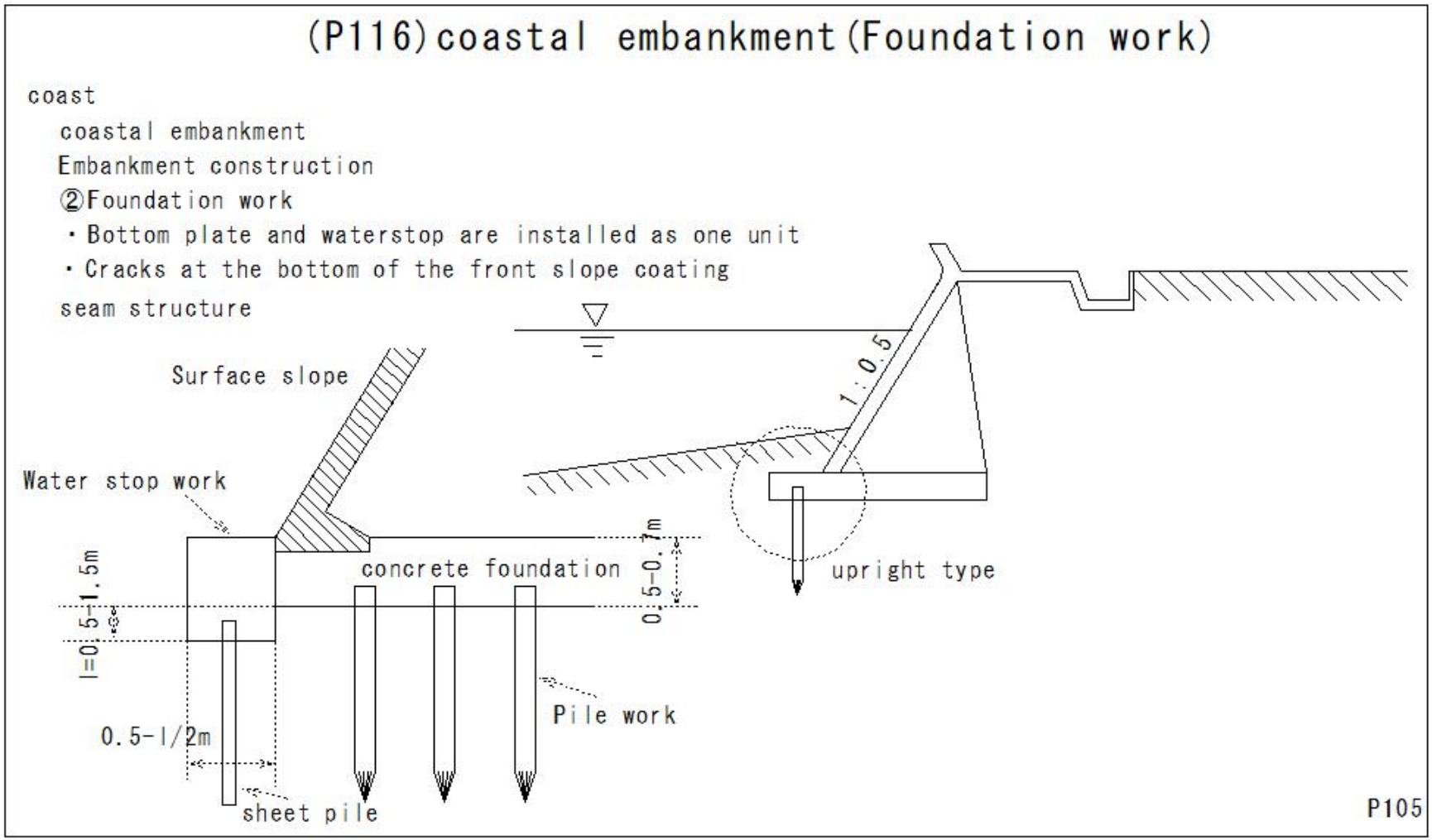


③Gap treatment

(P115)coastal embankment(Foundation work)



(P116)coastal embankment(Foundation work)



(P117)coastal embankment(Surface slope Covering (Coating) work)

(P117)coastal embankment(Surface slope Covering (Coating) work)

coast

coastal embankment

Embankment construction

③Surface slope Covering (Coating) work

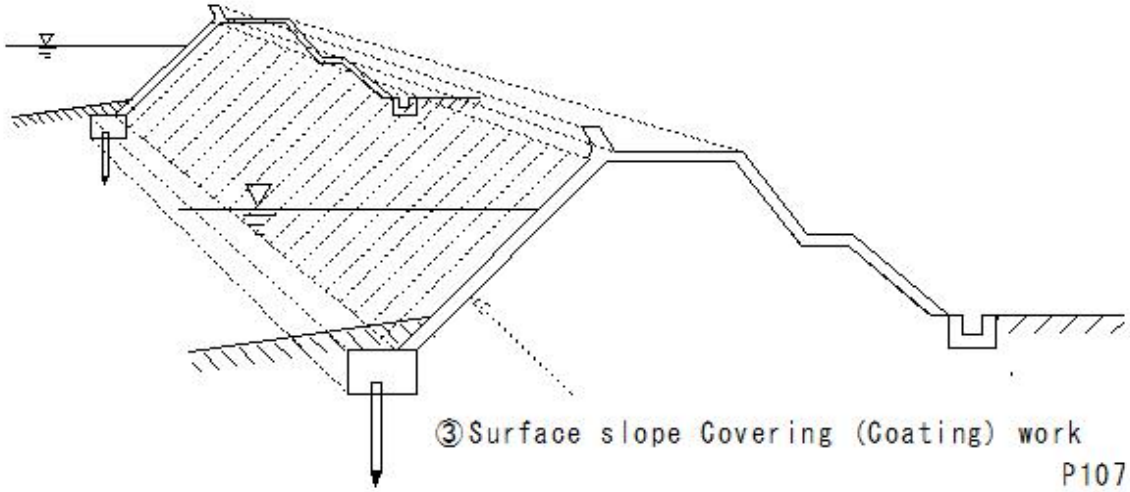
・Protect the embankment body

・Preventing storm surges and waves

Resistant to wave penetration and abrasion

・Preventing levee body sediment from flowing out

・in case of changing the slope, it must be done smoothly



③Surface slope Covering (Coating) work

P107

(P118)coastal embankment(Surface slope Covering (Coating) work)

coast
coastal embankment
Embankment construction
③ Surface Covering (Coating) work
Surface slope Covering (Coating) work type and standard structure
1 format
2 standard structure
①Slanted(sloped・canted) type
②Stone-pitching type
・The length of the building stone is 35cm or more
・Backfill thickness: 30cm or more
③Concrete block tension type
・Block thickness: 50cm or more
・Backfill thickness: 30cm or more
④Concrete covered type
⑤Flat type
・Concrete thickness standard 50cm
・Backfill concrete construction
⑥Step type
・Minimum concrete thickness 50cm
・Height of stairs: around 20-30cm
⑦slope frame type
・Frame material thickness: Width 20-40cm, height 30-50cm
・The frame is reinforced concrete
・The spacing between the ribs is 1-3 m. Attach Haunch.
・Use stone or concrete blocks for filling.
⑧Upright type
⑨stone masonry type
・mortar masonry
・The length of the building stone is 35cm or more
・Backfill thickness: 10cm or more
・Backfill thickness: 50cm or more
⑩Concrete block type
・Same as stone masonry type
⑪Gravity type buttress type
・Minimum wall thickness: unreinforced concrete, 50 cm or more
Reinforced concrete 30cm or more
・buttress type spacing 3m standard

(P119)coastal embankment(Stone-slope type)

(P119)coastal embankment(Stone-slope type)

coast

coastal embankment

Embankment construction

slope protection

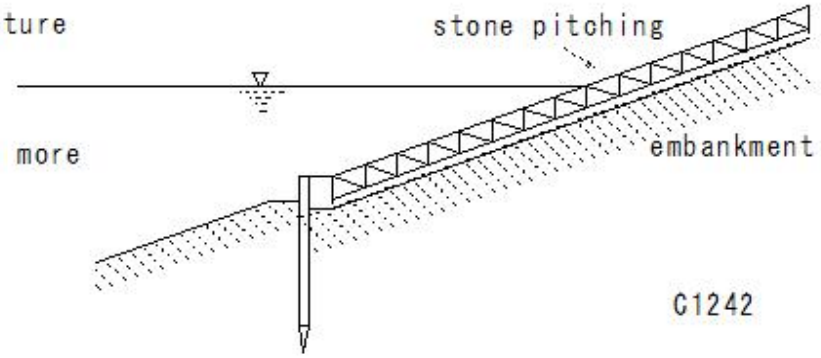
③Surface slope coating

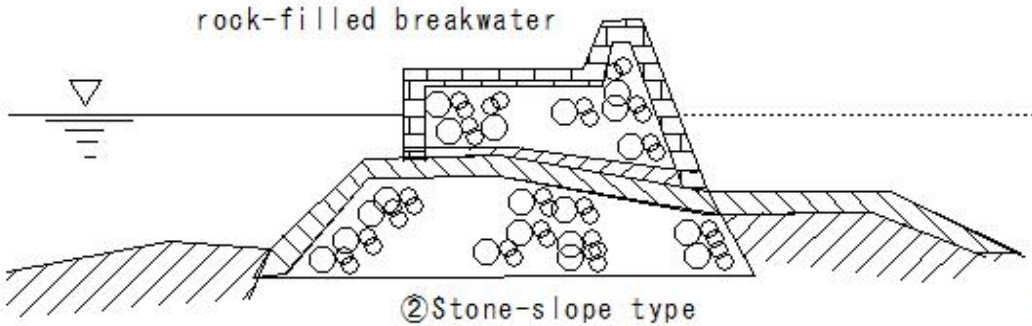
Surface slope coating type and standard structure

①Slanted type

②Stone-slope type

- The length of the building stone is 35cm or more
- Backfill thickness: 30cm or more
- Easy construction
- Places with small waves
- Locations where uneven settlement occurs





(P120)coastal embankment(Concrete block pitching type)

(P120)coastal embankment(Concrete block pitching type)

coast

coastal embankment

①Slanted(sloped・canted) type

③Concrete block pitching type

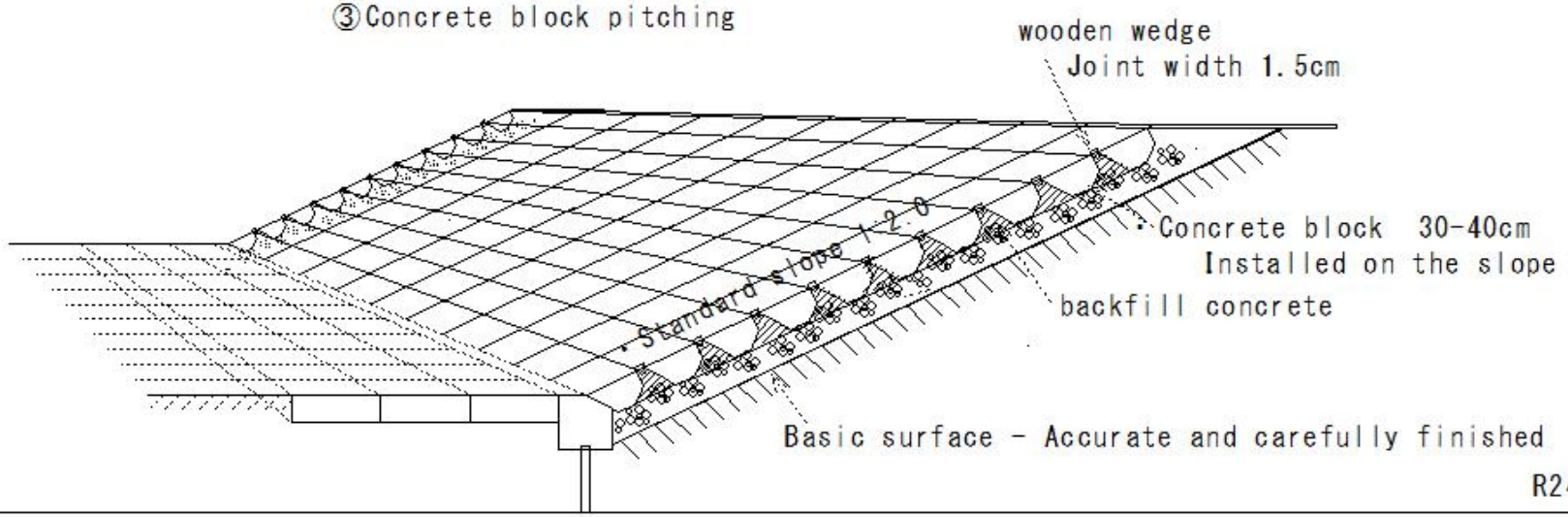
・Block thickness: 50cm or more

・Backfill thickness: 30cm or more

・Consideration of measures to prevent sandy beaches from collapsing

・Slope 1:3 or less

・Tip of block: Push into the ground



R244

(P121)coastal embankment(Concrete covered type)

(P121)coastal embankment(Concrete covered type)

coast

coastal embankment

①Slanted(sloped・canted) type

④Concrete covered type

⑤Flat type

・Concrete thickness standard 50cm

・Backfill concrete construction

⑥Step type

・Minimum concrete thickness 50cm

・Height of stairs: around 20-30cm

⑦slope frame type

・Frame material thickness:
Width 20-40cm, height 30-50cm

・The frame is reinforced concrete

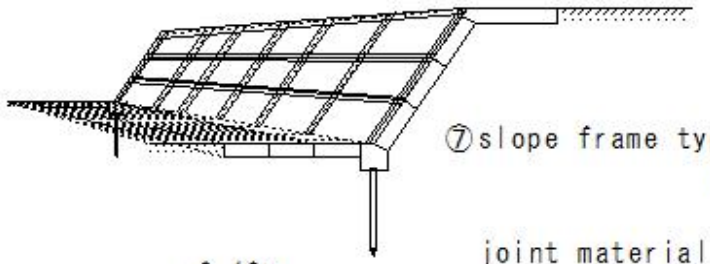
・The spacing between the ribs is 1-3 m.
Attach Haunch.

・Use stone or concrete blocks for filling.

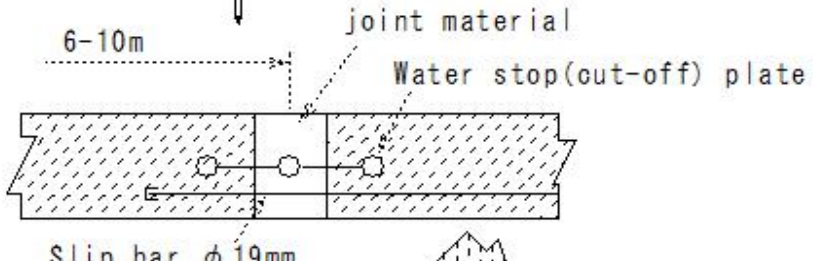
・6-10m interval

・Insert Water stop(cut-off)
slip bar joint material

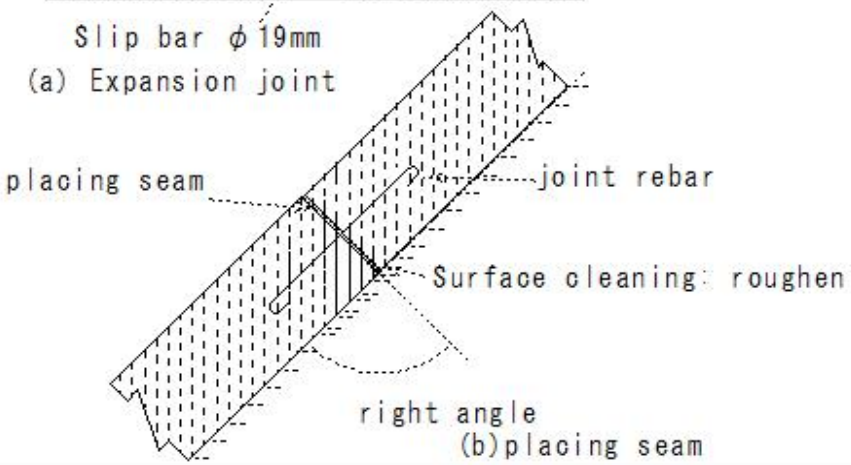
・Preventing suction



⑦slope frame type
R237



(a) Expansion joint



(b)placing seam

(P122)coastal embankment(Upright type)

(P122)coastal embankment(Upright type)

coastal embankment

⑧Upright type

⑨Masonry type

・mortar masonry

・The length of the building stone is 35cm or more

・Backfill thickness: 10cm or more

・Backfill thickness: 50cm or more

⑩Concrete block type

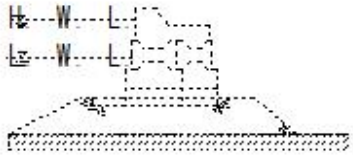
・Same as stone masonry type

・Strong durability

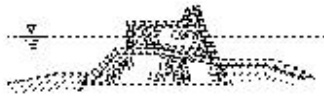
・Construction - Easy

・Dry work possible during low tide

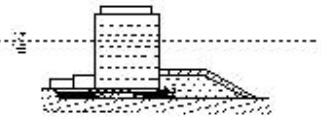
・Places with large wave force - Weak points of the embankment body



C1326



C1244



C1126

(P123)coastal embankment(Gravity type buttress type)

(P123)coastal embankment(Gravity type buttress type)

coast

coastal embankment

⑧Upright type

⑪Gravity type buttress type

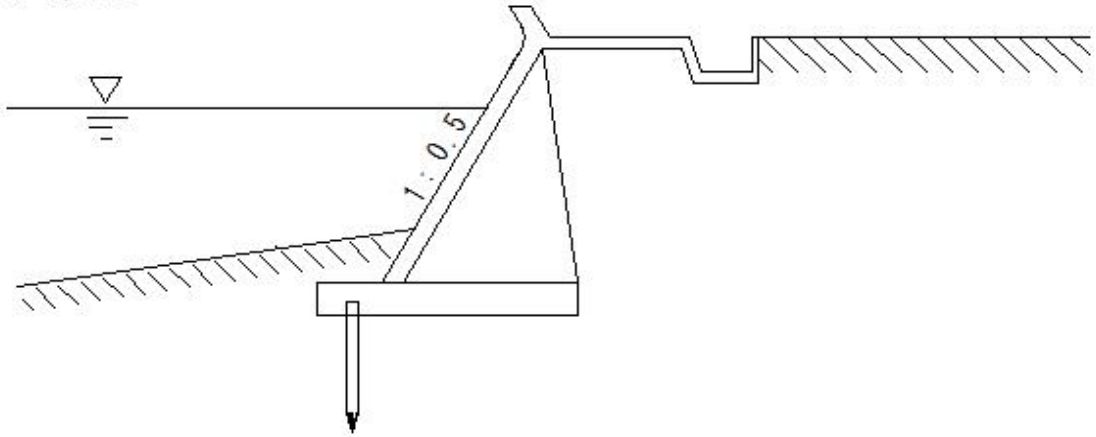
・Minimum wall thickness: unreinforced concrete, 50 cm or more

・Minimum wall thickness: unreinforced concrete, 50 cm or more

Reinforced concrete 30cm or more

・buttress wall spacing 3m standard

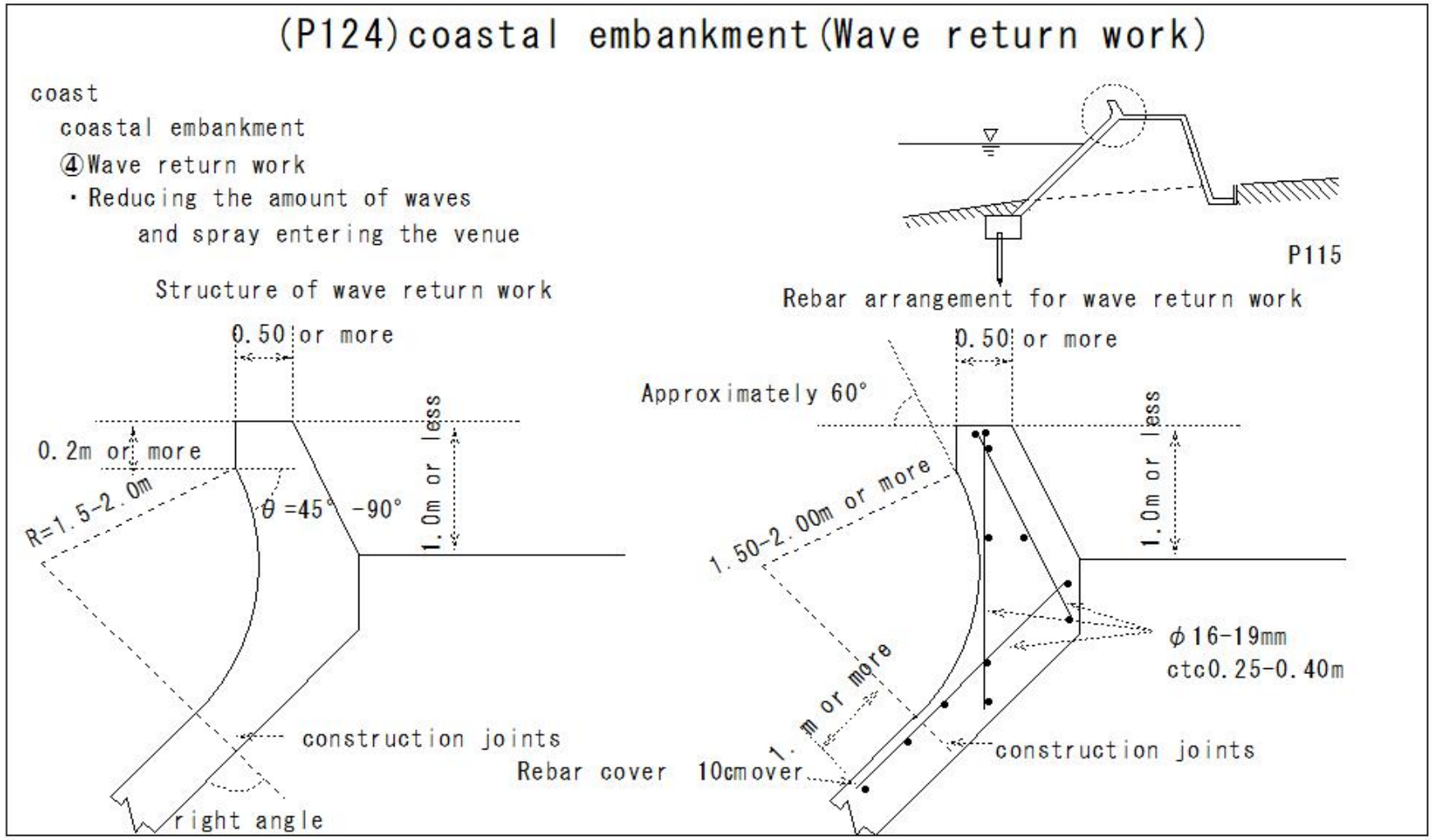
・Expansion joints 6-10m apart



⑪Gravity type buttress type

P105

(P124)coastal embankment(Wave return work)



(P125)coastal embankment(Wave return work)

(P125)coastal embankment(Wave return work)

coast

coastal embankment

⑤crown cladding and back re-cladding

・Covering (Coating) work to prevent levee body sediment from being washed away by overtopping seawater

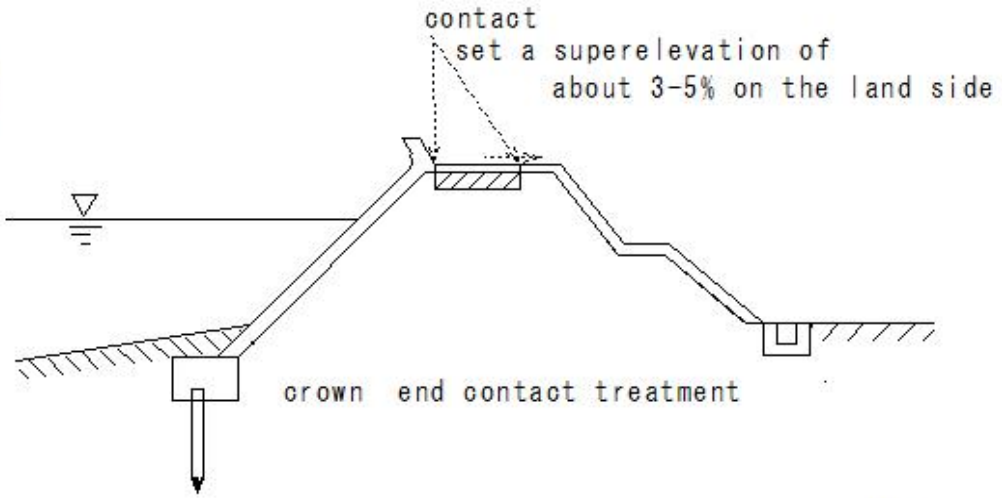
・Concrete type

・Asphalt type

・Concrete block type

・Same as stone masonry type

Structure that can adapt to shrinkage and deformation of embankment



P107

(P126)coastal embankment(Masonry type/stone pitching type)

(P126)coastal embankment(Masonry type/stone pitching type)

coast

coastal embankment

⑤crown Covering (Coating) work

Standard structure for crown Covering (Coating) work and back Covering (Coating)

format

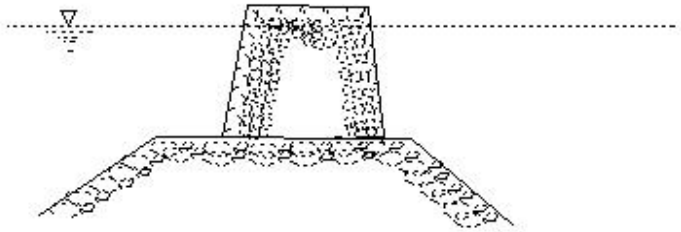
standard structure

①Masonry type/stone pitching type

・Building stone, abutment length 30cm or more

・Regarding backfilling, follow the method for covering the front surface with Covering (Coating) work

Stone pitching breakwater



C1243

(P127)coastal embankment(Concrete block pitching type)

(P127)coastal embankment(Concrete block pitching type)

coast

coastal embankment

⑤crown Covering (Coating) work and back slope covering

Standard structure for crown Covering (Coating) work
and back Covering (Coating) work

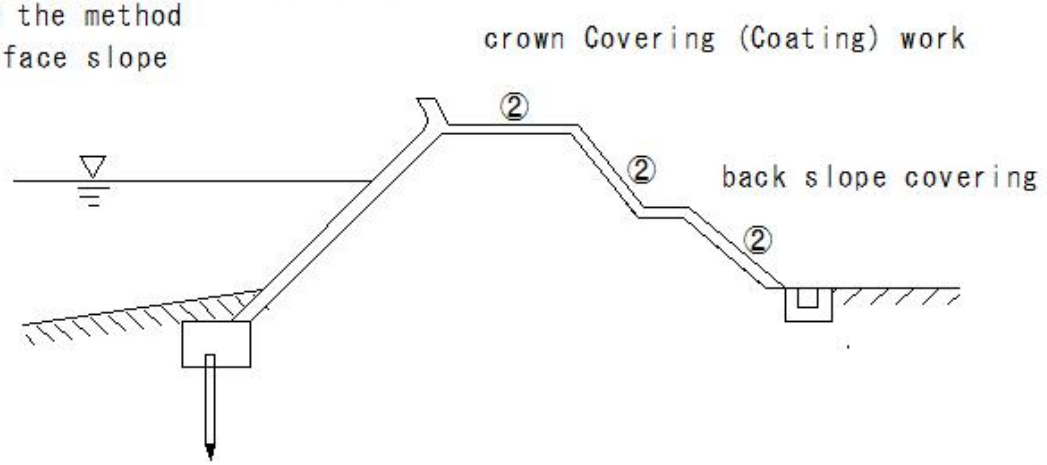
format

standard structure

②Concrete block pitching type

・Block side length 30cm or more, thickness 10cm or more

・Regarding backfilling, follow the method
for covering the front Surface slope



P107

(P128)coastal embankment(Concrete Covering (Coating) work)

(P128)coastal embankment(Concrete Covering (Coating) work)

coast

coastal embankment

⑤crown Covering (Coating) work and back slope covering

Standard structure for crown Covering (Coating) work
and back Covering (Coating) work

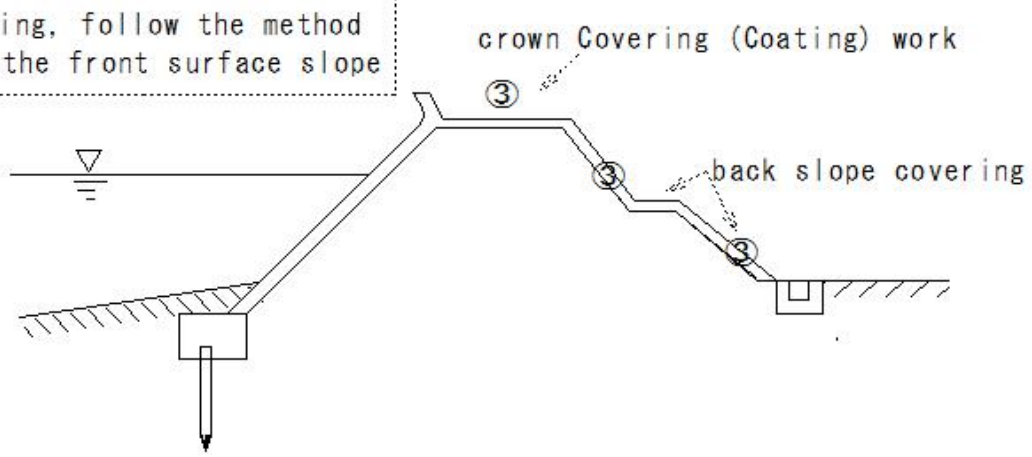
format

standard structure

③Concrete Covering (Coating) work

・Concrete thickness: approximately 20cm

・Regarding backfilling, follow the method for covering the front surface slope



P107

(P129)coastal embankment(Asphalt Covering (Coating) work)

(P129)coastal embankment(Asphalt Covering (Coating) work)

coast

coastal embankment

⑤crown Covering (Coating) work and back slope covering

Standard structure for crown Covering (Coating) work
and back Covering (Coating) work

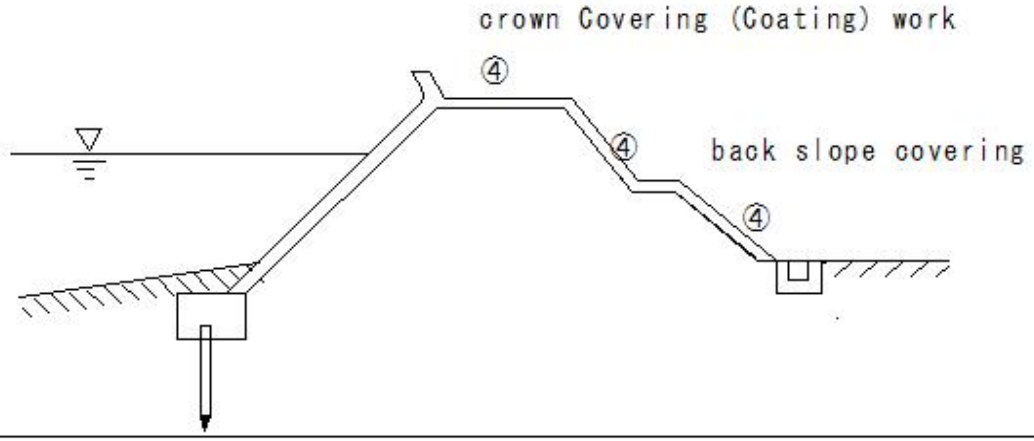
format

standard structure

④Asphalt Covering (Coating) work

・Compaction method Asphalt thickness 6cm or more

・Foundation crushed stone thickness approximately 20cm



P107

(P130)coastal embankment(Concrete frame(crib) type work)

(P130)coastal embankment(Concrete frame(crib) type work)

coast

coastal embankment

⑤crown Covering (Coating) work and back slope covering

Standard structure for crown Covering (Coating) work and back Covering (Coating) work

format

standard structure

⑤Concrete frame(crib) type

・Frame material thickness: Width 20-40cm, height 30-50cm

・The frame is reinforced concrete structure

・Spacing between frames: about 2-3m

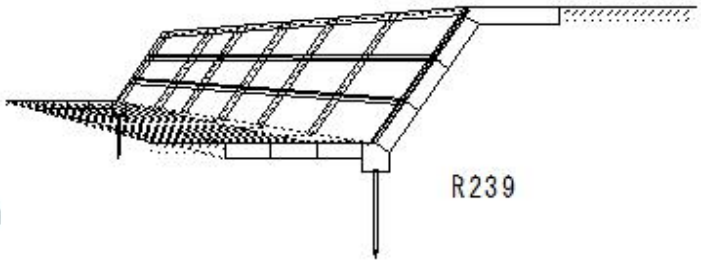
・Concrete filling

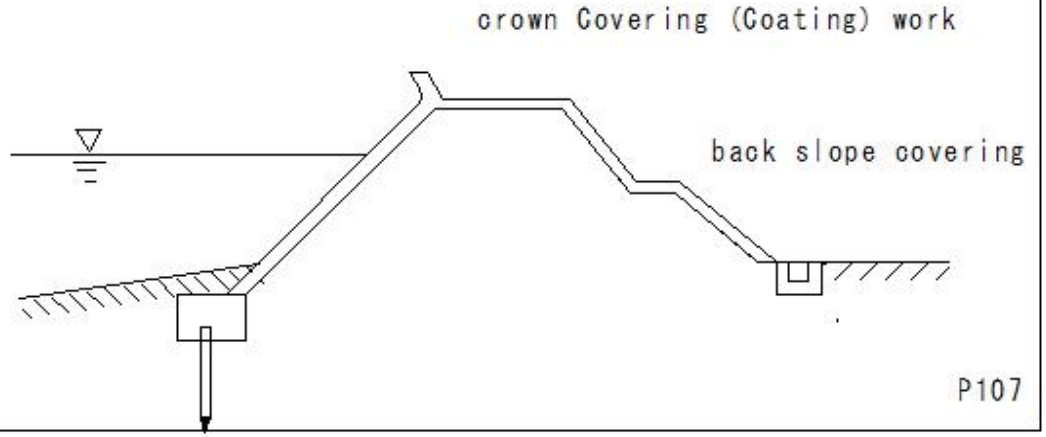
asphalt covering

stone pitching

block pitching

⑤Concrete frame(crib) type





P107

(P131)coastal embankment(foot protection)

(P131)coastal embankment(foot protection)

coast

coastal embankment

⑥foot protection

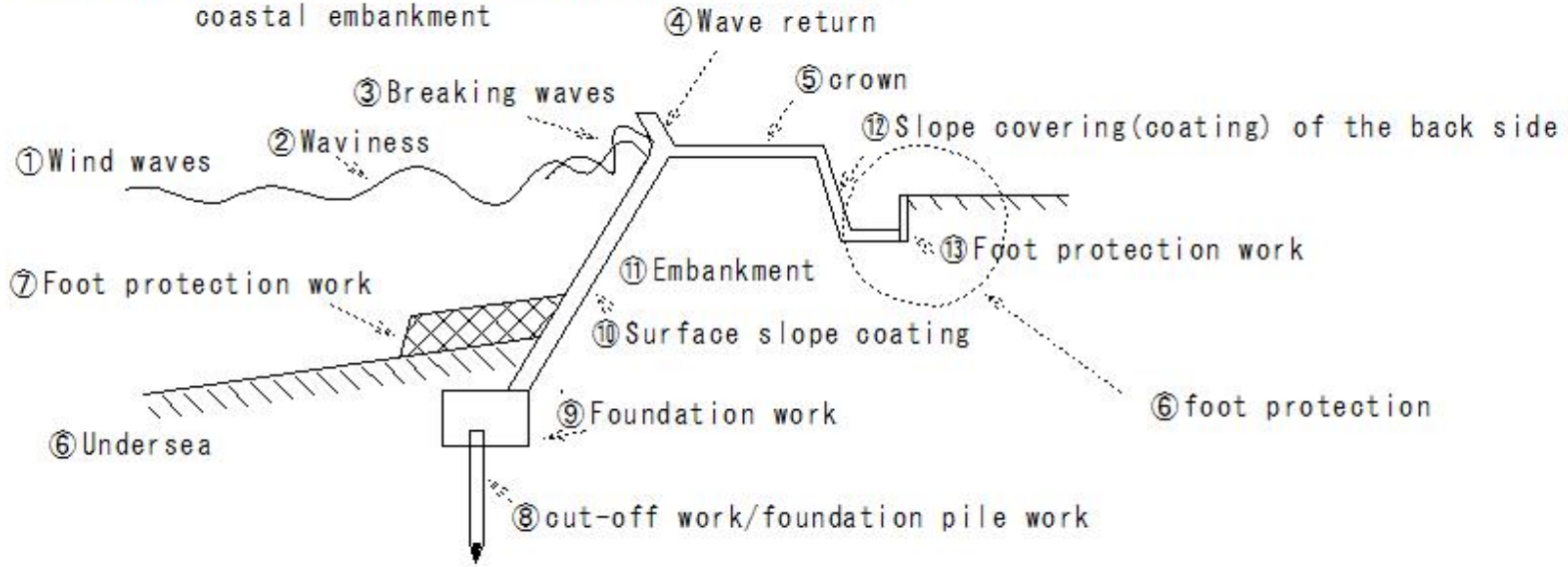
foot protection and drainage works Unit: mm

Approximately 0.3m

・Preventing back slope movement and Settlement

・Protects toe of slope

・Foundation work for back slope Covering (Coating) work



(P132)coastal embankment(Drainage works)

(P132)coastal embankment(Drainage works)

coast

coastal embankment

⑦Drainage works

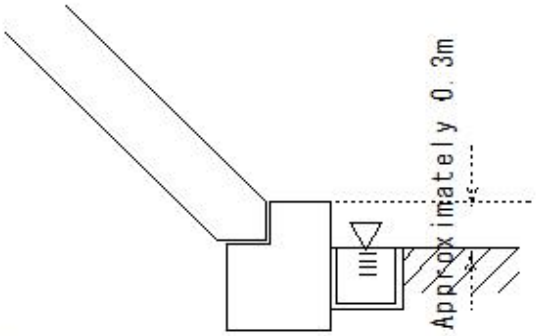
・crown of embankment

・Back slope

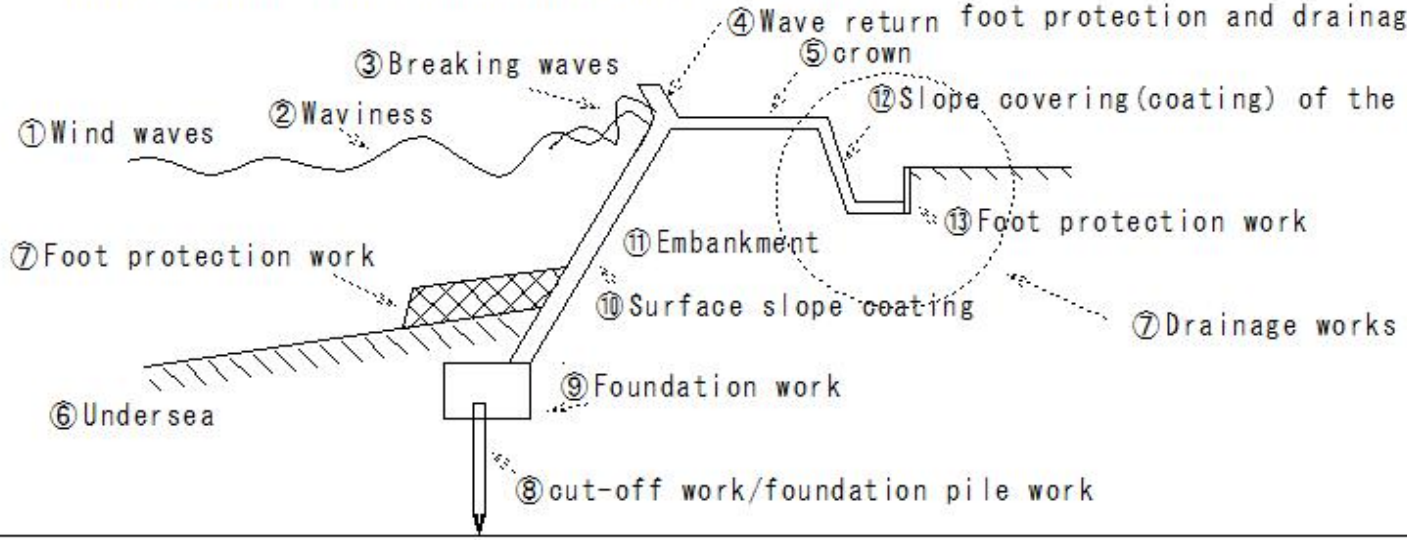
・Purpose of discharging overtopping waves and spray

・Overtopping waves - drainage works - sluices discharged into the sea

・foot protection work and drainage work are separated.



foot protection and drainage works Unit: mm



(P133)coastal embankment(Foot protection works)

(P133)coastal embankment(Foot protection works)

coast

coastal embankment

⑧Foot protection work

(a) in case of using stones of the same weight

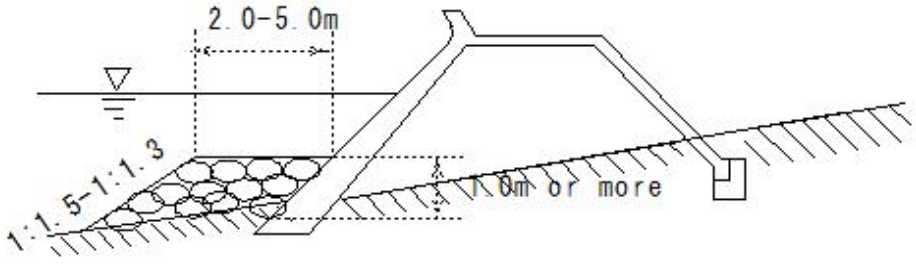
・Bottom part of surface slope Covering (Coating) work

Installed in front of foundation work

・Protects the foundation of the embankment from scouring by waves

・Protection of joints between foundation work and surface slope coating work

・Separate ties with covering work and foundation work



(a) in case of using stones of the same weight

⑧Foot protection work

(P134)coastal embankment(Foot protection works)

(P134)coastal embankment(Foot protection works)

coast

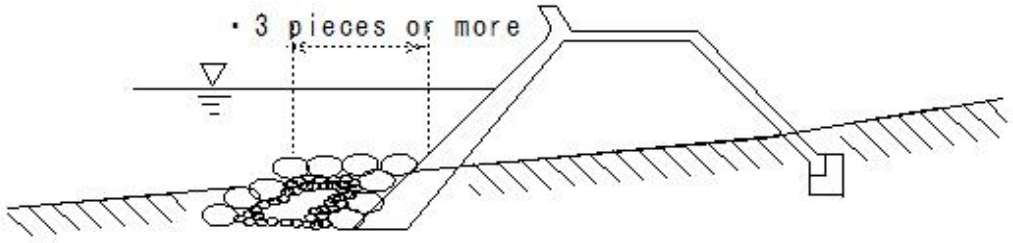
coastal embankment

⑧Foot protection work

(b)： in case of using filled stones

・Bottom part of surface slope coating
Installed in front of foundation work
・Protects the foundation of the embankment
from scouring by waves
・Protection of joints between foundation work
and surface slope coating work
・Separate ties with covering work and foundation work

・Dig more than 1.0m near the shoreline.
use larger ones on the outside



・1/10-1/20 of the surface layer

⑧Foot protection work

(b)： in case of using filled stones

(P135)coastal embankment(Foot protection works)

(P135)coastal embankment(Foot protection works)

coast

coastal embankment

⑧Foot protection work

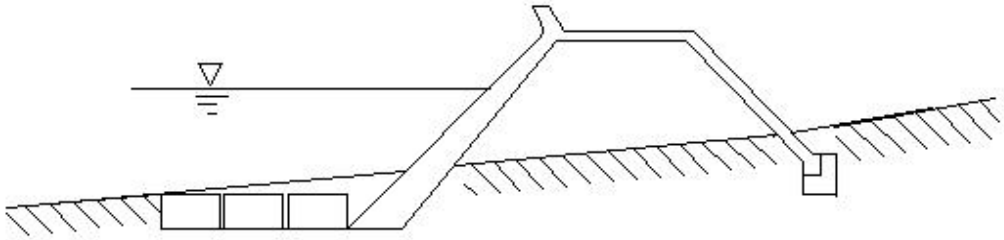
(c): in case of using concrete blocks

・Bottom part of surface slope coating
Installed in front of foundation work

・Protects the foundation of the embankment from scouring by waves

・Protection of joints between foundation work and surface slope coating work

・Separate ties with covering work and foundation work



⑧Foot protection work

(c): in case of using concrete blocks

(P136)coastal embankment(Foot protection works)

(P136)coastal embankment(Foot protection works)

coast

coastal embankment

⑧Foot protection work

(d): in case of using deformed precast concrete blocks mattress method

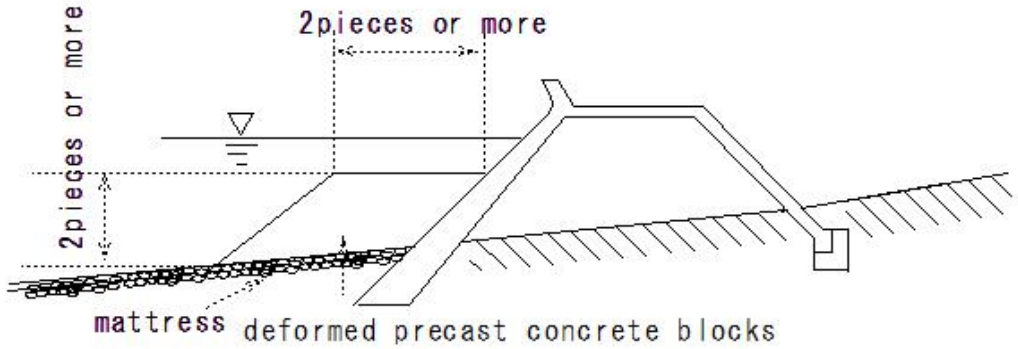
・Bottom part of surface slope coating

Installed in front of foundation work

・Protects the foundation of the embankment from scouring by waves

・Protection of joints between foundation work and surface slope coating work

・Separate ties with covering work and foundation work



⑧Foot protection work

(d): incase of using deformed precast concrete blocks

(P137)coastal embankment(Wave dissipation works)

(P137)coastal embankment(Wave dissipation works)

coast

coastal embankment

Wave dissipation works

Foot protection

- Launch height of waves
- Amount of overtopping waves
- Reduced impact wave breaking pressure
- Constructed in front of the embankment
- Reduced wave energy
- Reducing wave pressure and launch height
- Uses deformed precast concrete blocks

surface roughness

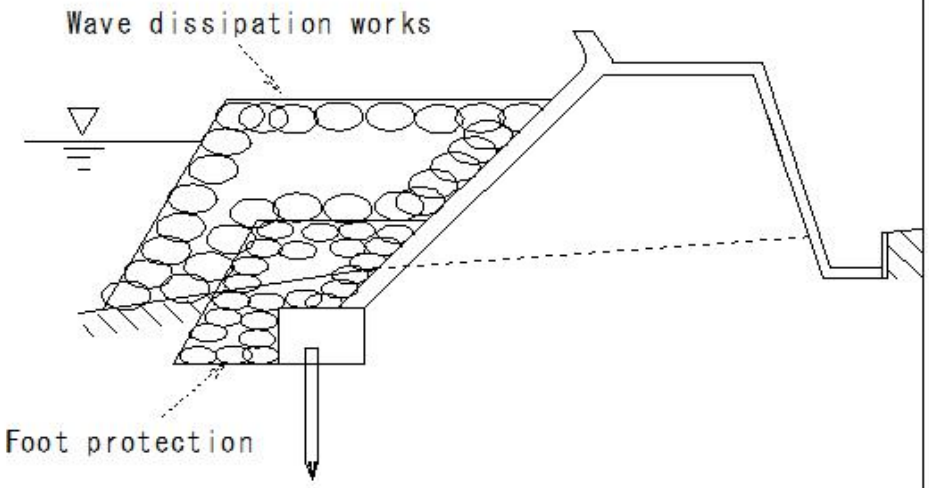
internal void

Reduces wave energy

Appropriate weight and stability required

Blocks interlock with each other

to resist waves.



P91

Wave dissipation works

(P138)coastal embankment(deformed precast concrete block)

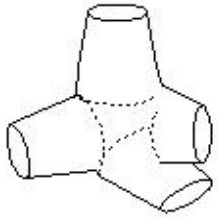
(P138)coastal embankment(deformed precast concrete block)

coast

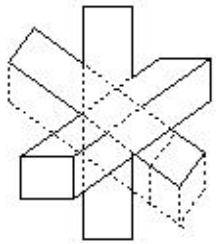
coastal embankment

①deformed precast concrete block

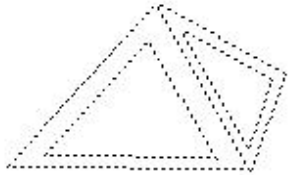
a:Tetra pot



b: Hexapod block



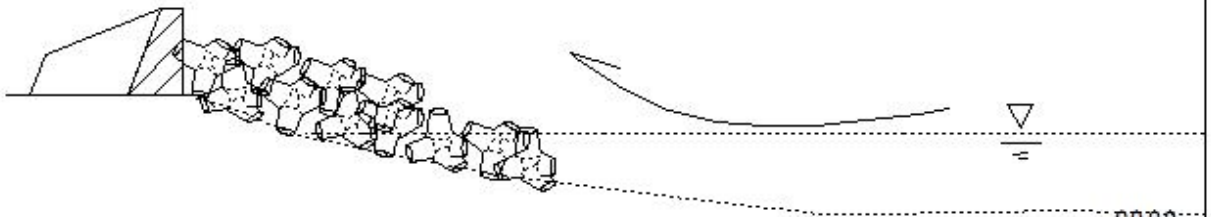
c: hollow triangular block



ports and coasts

stability against wave dissipation and wave force

breakwaters, detached embankments, consolidation work, etc.



C982

(P139)coastal embankment(Hudson Formula)

(P139)coastal embankment(Hudson Formula)

coast

coastal embankment

②Hudson Formula

Formula for determining stable weight of deformed precast concrete block for wave dissipation

$W=rrH^3/(Kv(rr/wo-1)^3\cot\alpha)$

W: Block (t) (about 1-20t)

rr: Air unit volume weight of block (t/m3)

H: Wave height (m)

Kv: block constant

wo: Unit volume weight of seawater (t/m3)

α: Angle between the slope and the horizontal

(P140)coastal embankment(How to stack deformed precast concrete blocks)

(P140)coastal embankment(How to stack deformed precast concrete blocks)

coast

coastal embankment

③How to stack deformed precast concrete blocks

・Layer stacking: dry construction

Installation - time consuming

Stability - good

・Random stacking

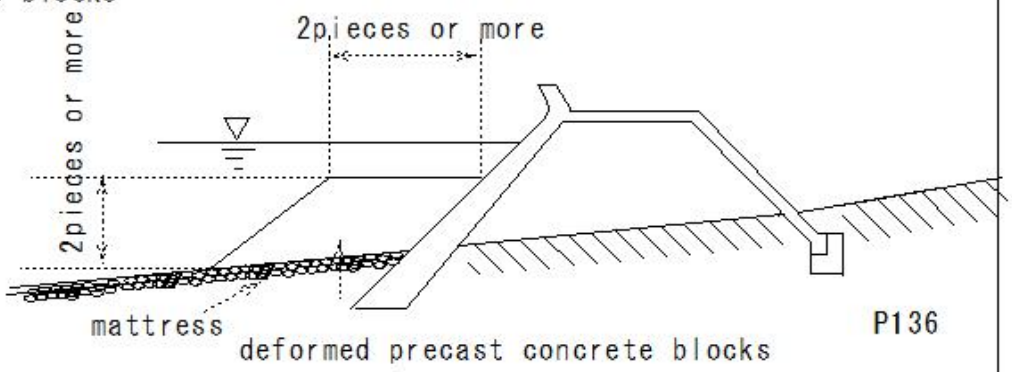
Underwater construction possible

Easy to install

Stability - poor

Lots of voids

on sandy ground

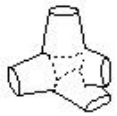


Lay out stones and mats(rubble mound(riprap))

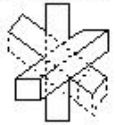
・crown width of wave-deformed precast concrete blocks:
2 or more rows of blocks

・Places with large water depth in front:
3-5 rows or more

a:Tetra pot



b: Hexapod block



c: hollow triangular block

C982

(P141)coast(Erosion countermeasures)

(P141)coast(Erosion countermeasures)

coast

Erosion countermeasures

beach

①Coastline: Boundary line between land and sandy beach

②Beach: Sandy beach from the coastline to the average low tide level

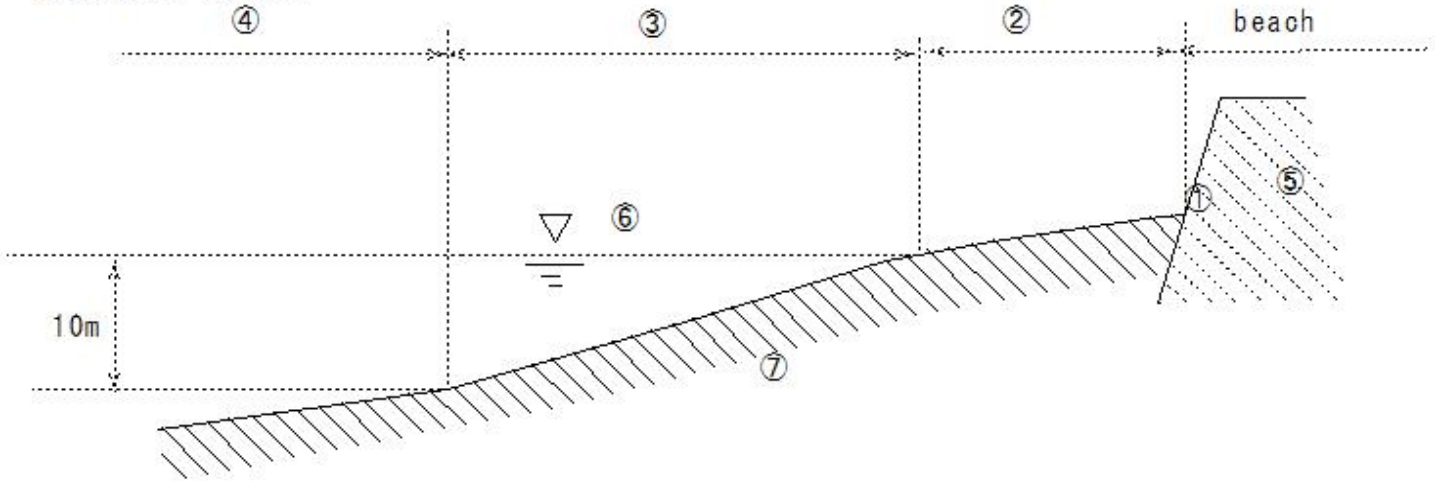
③Outer beach: From the average low tide level to a point approximately 10m deep

④offing beach: Water depth of 10 meters or more where breaking waves do not occur

⑤Land

⑥Average low tide surface

⑦Coastal sandbar



(P142)coast(Erosion countermeasures-causes of erosion)

(P142)coast(Erosion countermeasures-causes of erosion)

coast

Erosion countermeasures

causes of erosion

①Ground Settlement: Ground fluctuations due to consolidation subsidence, etc.

②Due to the construction of dams through geological and flood control land works

The amount of sediment discharged from the estuary has decreased dramatically.

Estuaries are eroded by waves and currents

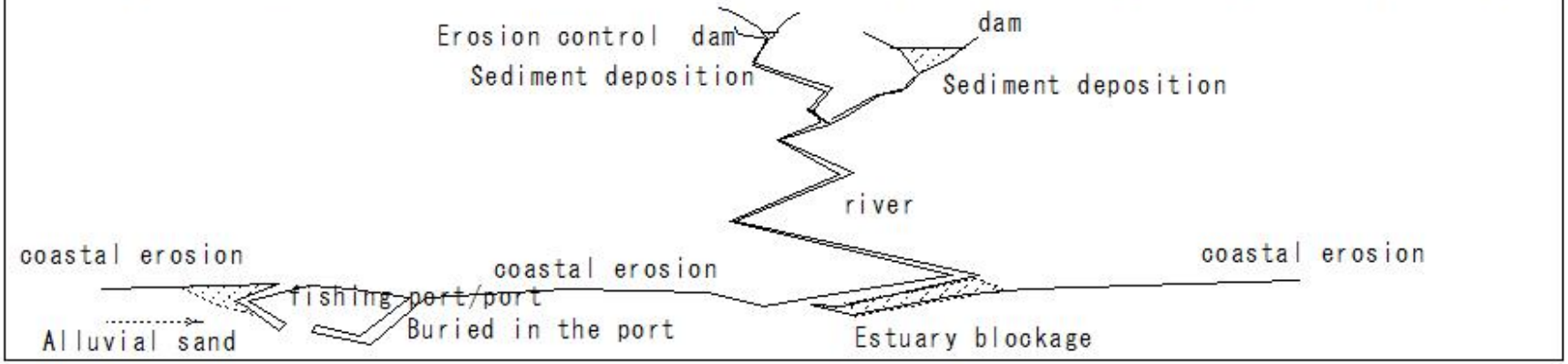
③Due to construction of erosion control works

Coastal sand drift is prevented

The coast on the lower side of drifting sand is eroded.

④A structure was built on the coast

Temporary erosion occurs in case of waves and currents change the shape from before construction.



(P143)coast(Erosion countermeasures-jetty)

(P143)coast(Erosion countermeasures-jetty)

coast

Erosion countermeasures

jetty

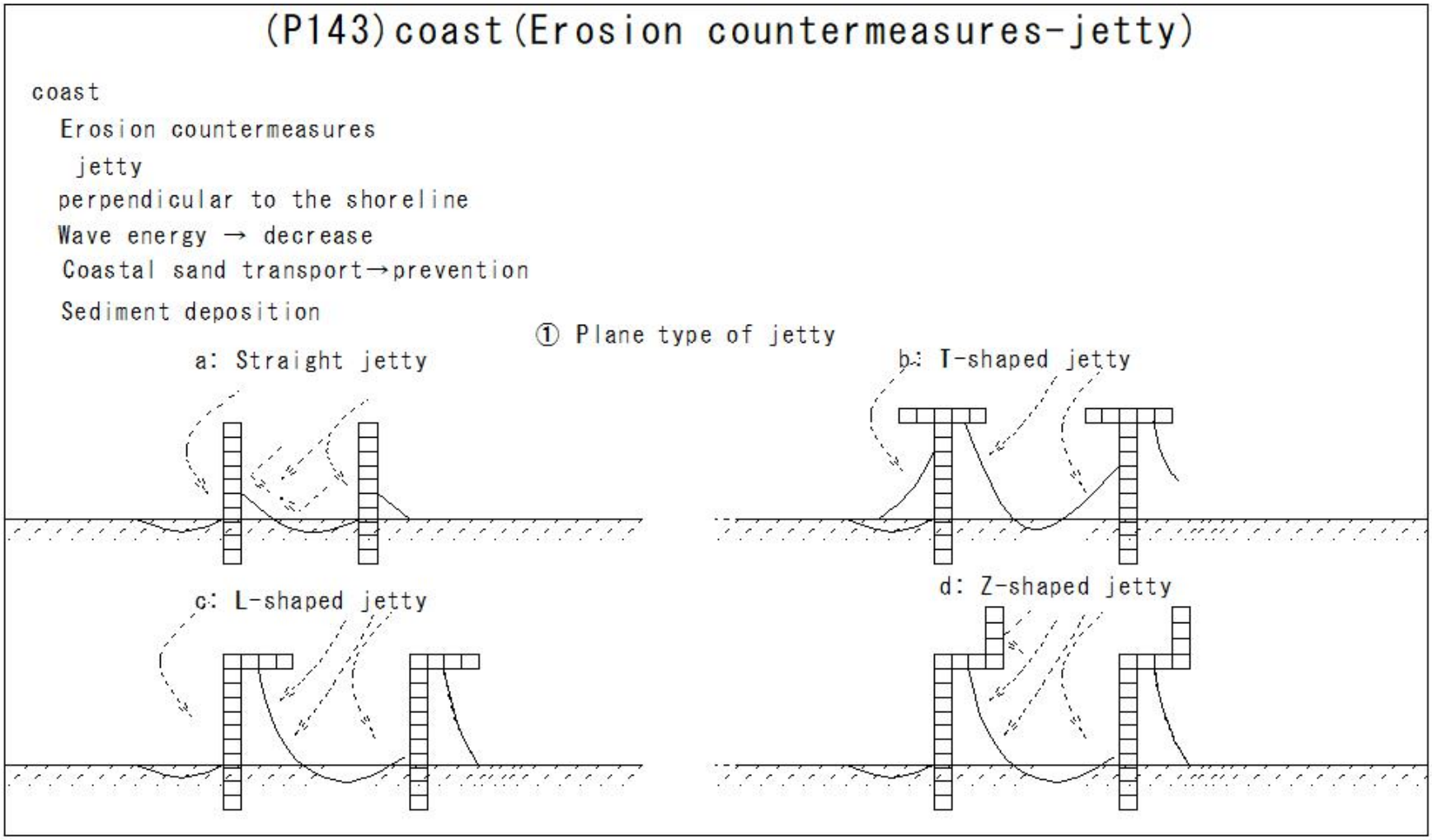
perpendicular to the shoreline

Wave energy → decrease

Coastal sand transport→prevention

Sediment deposition

① Plane type of jetty

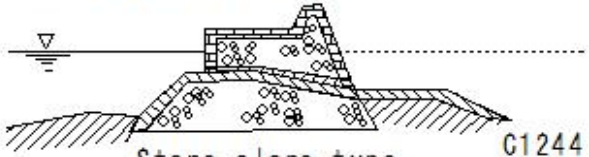


(P144)coast(Erosion countermeasures-Classification of jetty)

(P144)coast(Erosion countermeasures-Classification of jetty)

coast
Erosion countermeasures
jetty
②Classification by cross-sectional shape
slope-Slanted type
slope gradient-Looser than 10%
By material used-Stone-Stone-pitching type, rubble mound(riprap) block type

rock-filled breakwater

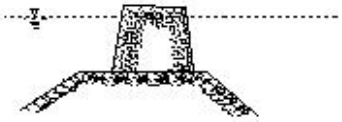


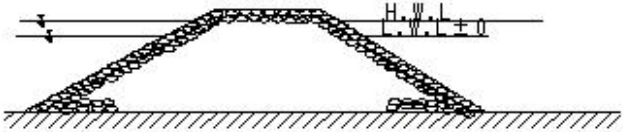
Stone-slope type

C1244

P119

Stone pitching breakwater





Sloped breakwater

slope-Slanted type
Classification of jetty

P16

P126

(P145)coast(Erosion countermeasures-jetty-upright)

(P145)coast(Erosion countermeasures-jetty-upright)

Coastal erosion control works

Erosion countermeasures

②Classification by cross-sectional shape

jetty

slope-upright

slope gradient-steeper than 10%

By material used

masonry type

concrete block type

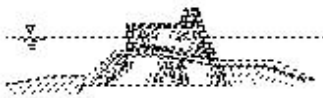
caisson upright

Cellular block quay

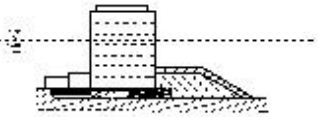
well type

stone crushing method

C1326



C1244



C1126

(P146)coast(Erosion countermeasures-jetty-composite type)

(P146)coast(Erosion countermeasures-jetty-composite type)

Coastal erosion control works

Erosion countermeasures

②Classification by cross-sectional shape

jetty

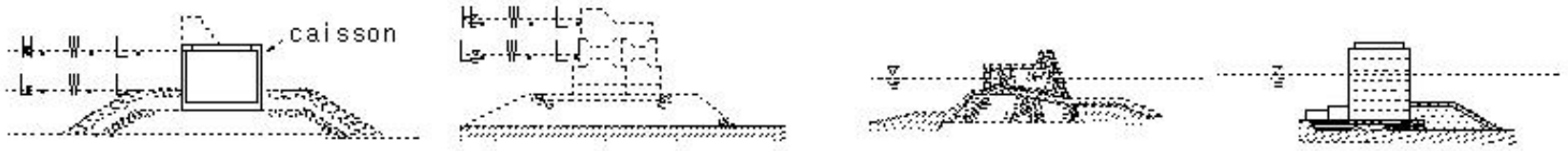
composite type

Upper part (steeper than 10%)

Lower part (10% looser)

Upper part: Upright type (free-standing type)

Lower part slanted type (rubble mound riprap, etc.)



C1328 C1326 C1244 C1126

(P147)coast(Erosion countermeasures-jetty-permeability)

(P147)coast(Erosion countermeasures-jetty-permeability)

Coastal erosion control works

Erosion countermeasures

③Classification by permeability

a: permeability type, structure that allows some drifting sand to pass through

・Same rough stone, deformed precast concrete block, rubble mound

stone crib wall type

rubble mound(riprap) block type

kinds

permeability jetty

Strong Points

・Foundation work -easy and economical

・Wave pressure - less waves Reflected waves - less

・Elevation/reinforcement - Easy, diversion - Possible

・Less influence of uneven settlement

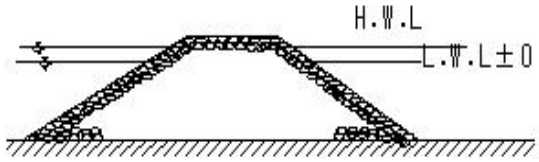
Disadvantages

・Easy to Settlement

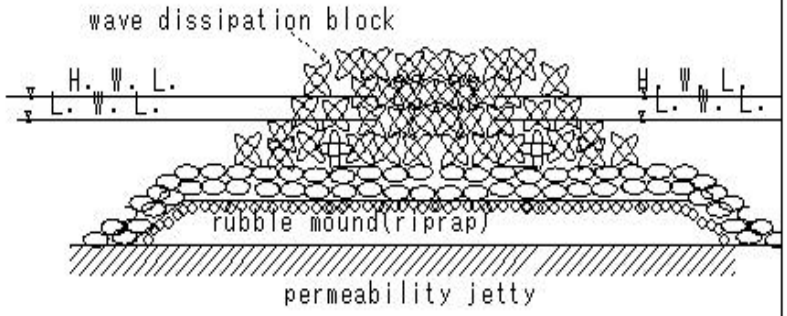
・Shredding wave prevention ability - small

・Small waves - penetrate

・in case of erosion or scour is expected



permeability jetty P16



(P148)coast(Erosion countermeasures-jetty-Impermeable structure)

(P148)coast(Erosion countermeasures-jetty-Impermeable structure)

Coastal erosion control works

Erosion countermeasures

③Classification by transparency

b: Impermeable structure that does not allow drift sand to pass through.

Masonry type・・・・・・・・・・ 1:0.3～1:1

concrete block type

caisson type

cellular block type

well type

Strong Points

・Crushing wave prevention ability - large

・Foundation /frame-independence

Disadvantages

・Wave pressure - received a lot

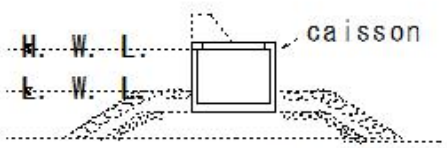
・Reflected waves - much

・Elevation/Reinforcement/Diversion - Difficult

・Vulnerable to uneven Settlement

jetty

Upright jetty

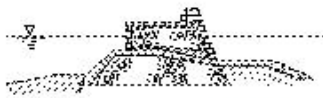


C1328

Concrete block jetty

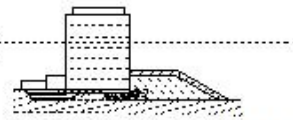
C1326

rock-filled jetty



C1244

Block masonry jetty



C1126

(P149)coast(Erosion countermeasures-offshore breakwater)

(P149)coast(Erosion countermeasures-offshore breakwater)

Coastal erosion control works

Erosion countermeasures

②Offshore embankment works

offshore breakwater

tombolo phenomenon

10－100m

coast

・Wave dissipation wave height - decay

construction of beaches

・the energy of incident waves-decay

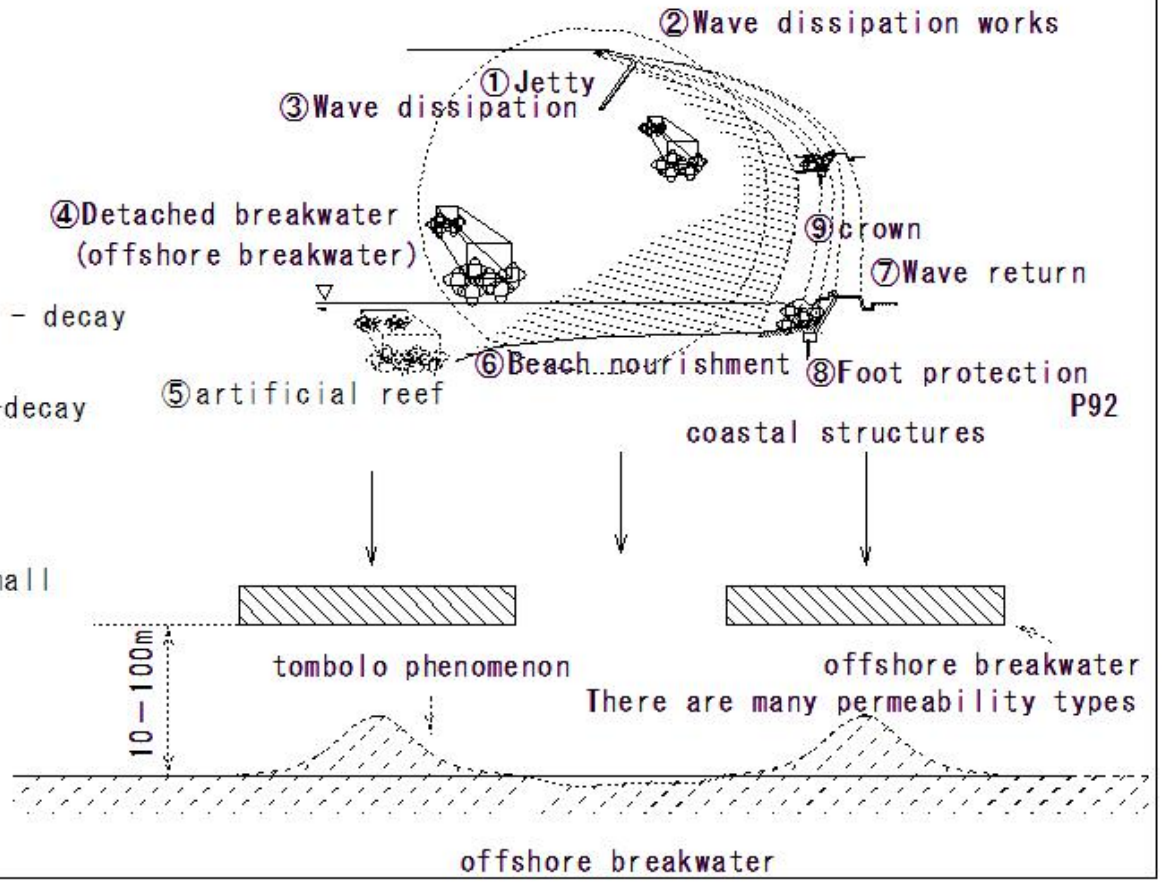
・offshore flow - Prevent

・Wave height- decay

・Waveform slope - small

・Coastal current velocity - small

・Generates a tombolo



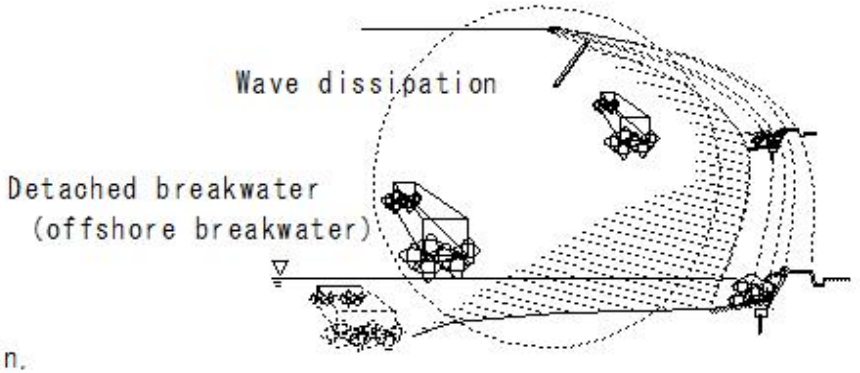
(P150)coast(Erosion countermeasures-off shore breakwater)

(P150)coast(Erosion countermeasures-off shore breakwater)

Coastal erosion control works

Erosion countermeasures

②Off shore breakwater works

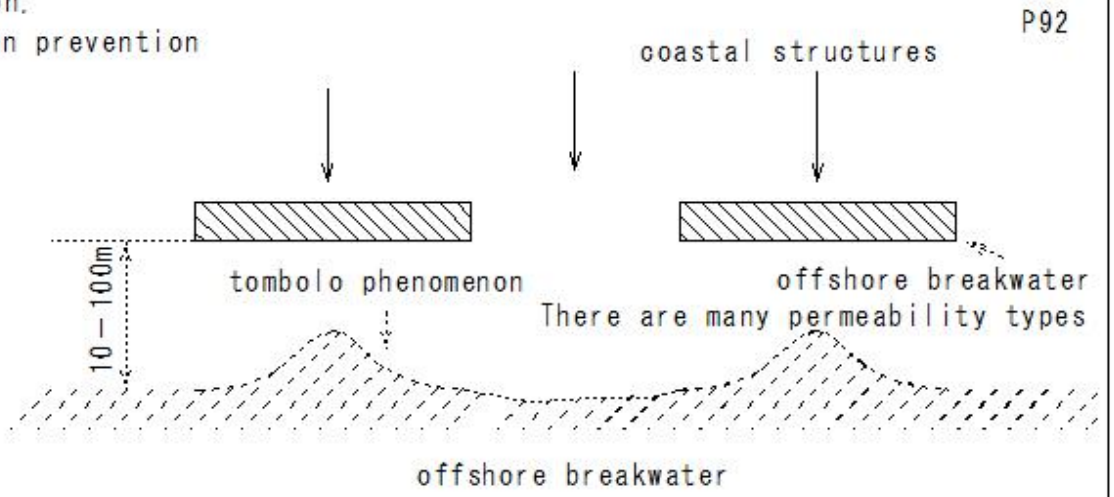


①Classification by plane shape

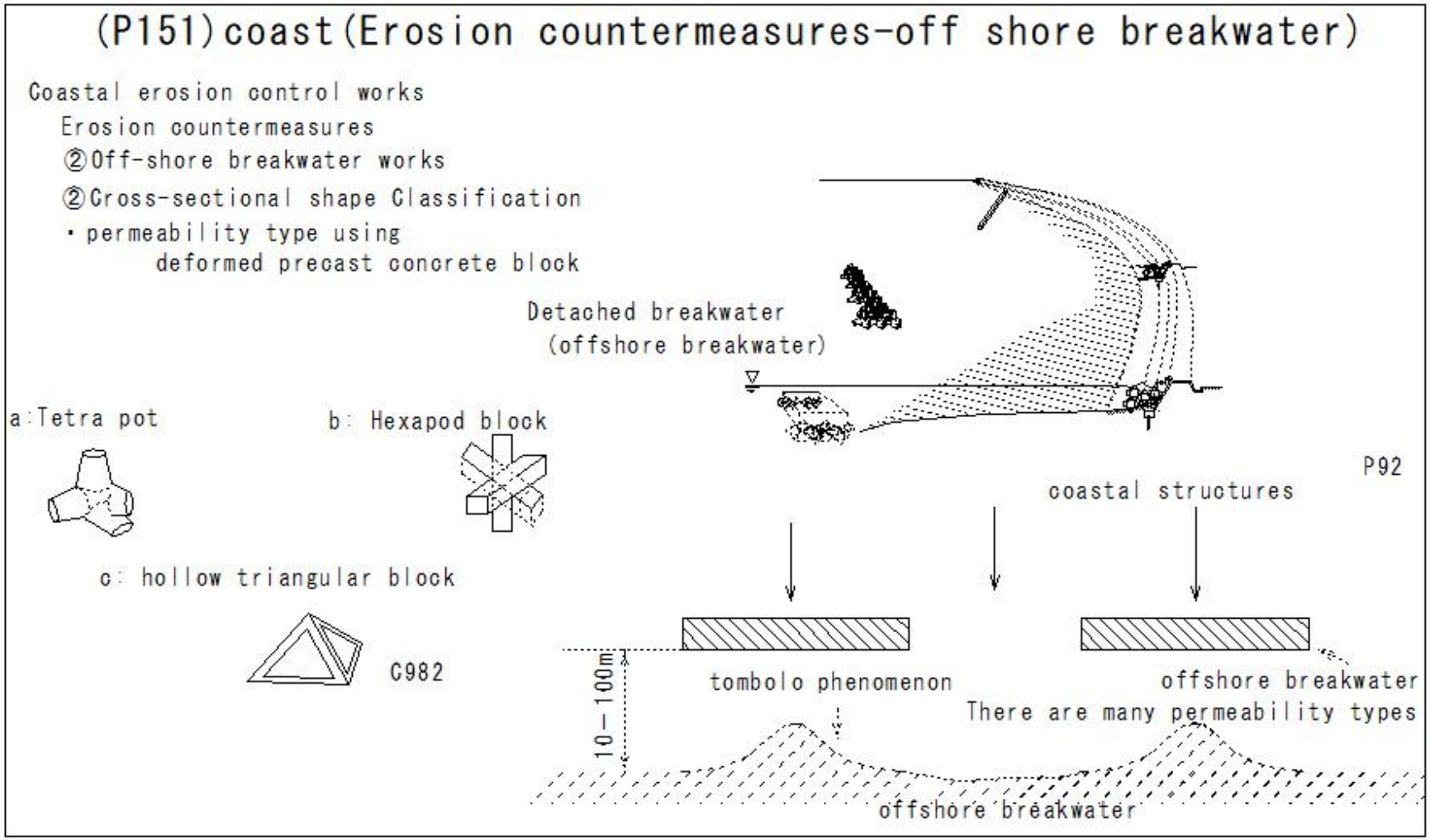
・Continuous type: wave dissipation, wave attenuation, wave intrusion prevention

・Discontinuous type: Tomboro

P92



(P151)coast(Erosion countermeasures-off shore breakwater)



(P152)coast(Erosion countermeasures -off shore breakwater)

(P152)coast(Erosion countermeasures -off shore breakwater)

Coastal erosion control works

Erosion countermeasures

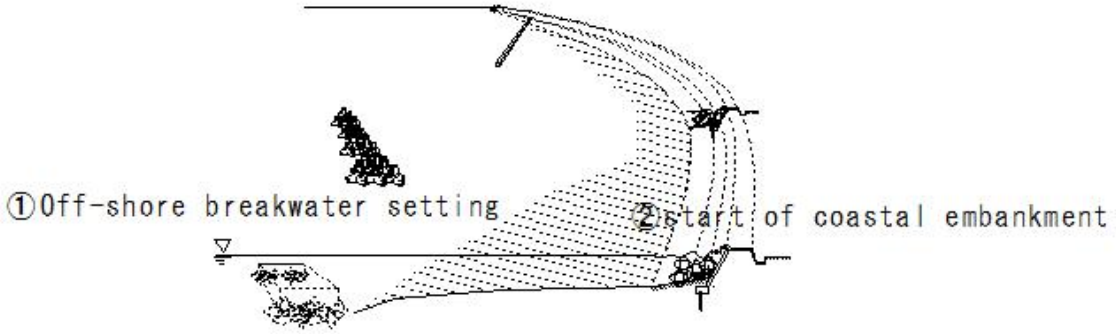
②off shore breakwater works

③Adoption of detached breakwater

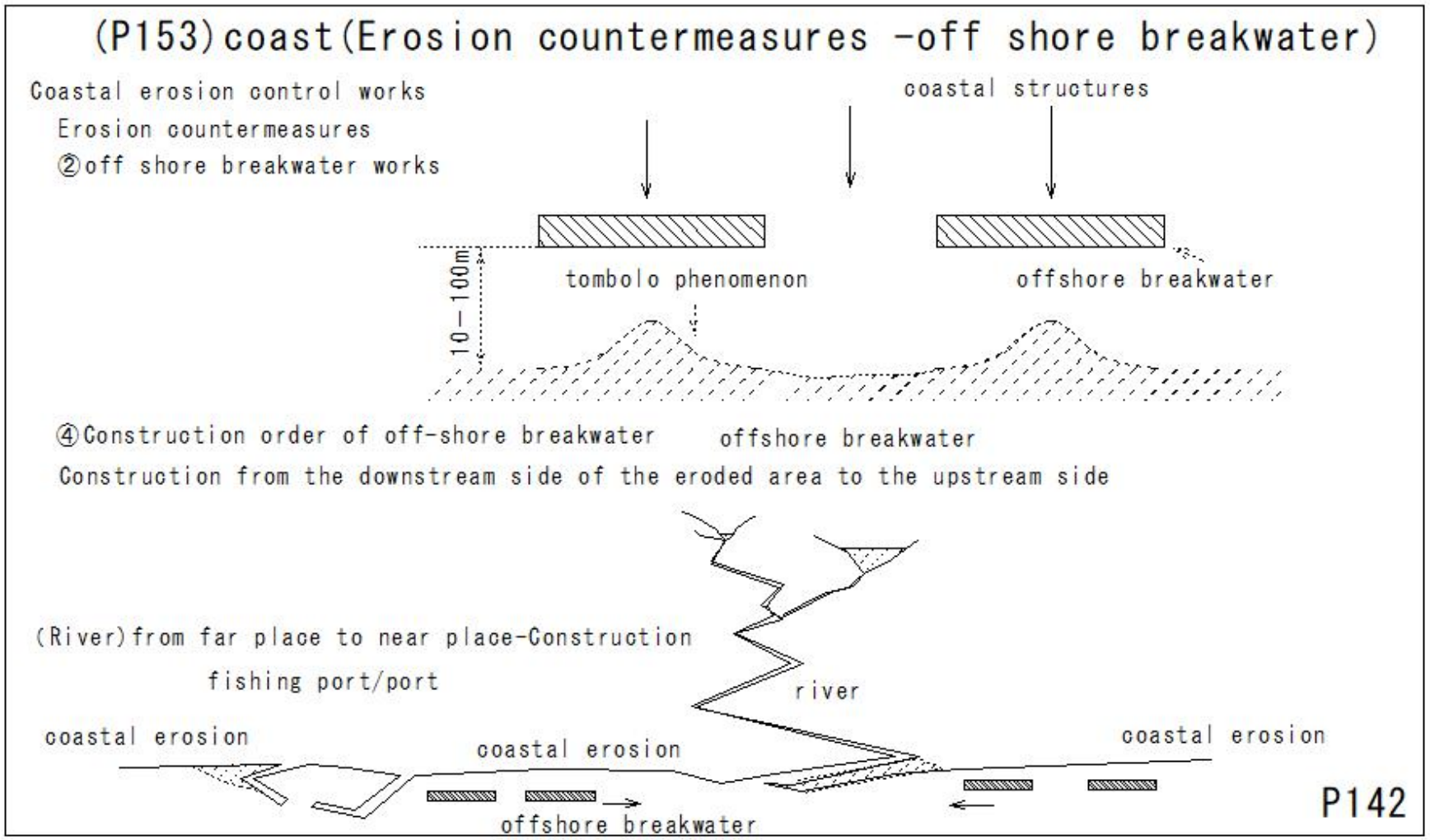
・The direction of drifting sand is inconsistent

in case of the movement of drift sand is much

①Off-shore breakwater setting →②start of coastal embankment



(P153)coast(Erosion countermeasures -off shore breakwater)



(P154)coast(Erosion countermeasures -Beach nourishment)

(P154)coast(Erosion countermeasures -Beach nourishment)

Coastal erosion control works

Erosion countermeasures

③Beach nourishment

・Artificial sand supply

・Coastal erosion prevention

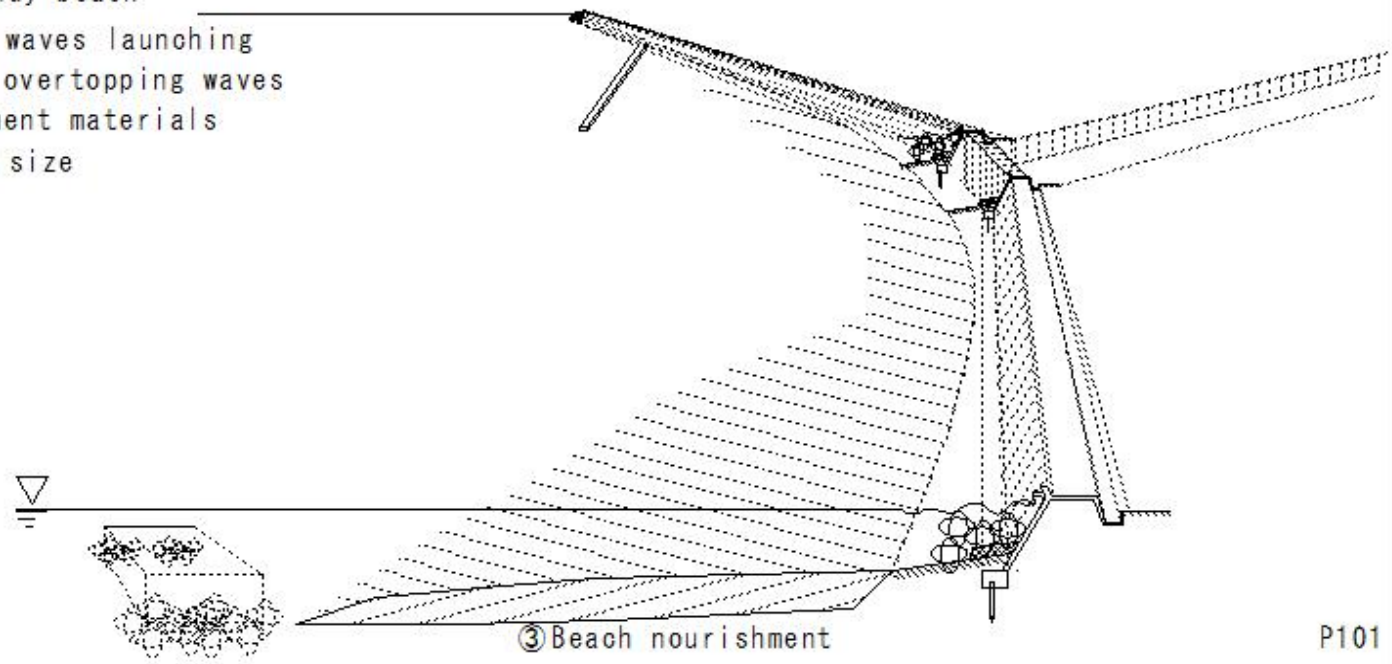
・Creating a sandy beach

・Prevention of waves launching

・Prevention of overtopping waves

①Beach nourishment materials

・Large grain size



③Beach nourishment

P101

(P155)coast(Erosion countermeasures -Beach nourishment)

(P155)coast(Erosion countermeasures -Beach nourishment)

Coastal erosion control works

Erosion countermeasures

③Beach nourishment

②Construction method

kinds

seabed sand

beach sand

river sand

mountain sand

Sediment sampling method

drag line

pump dredging

grab dredging

Method of using land excavated soil

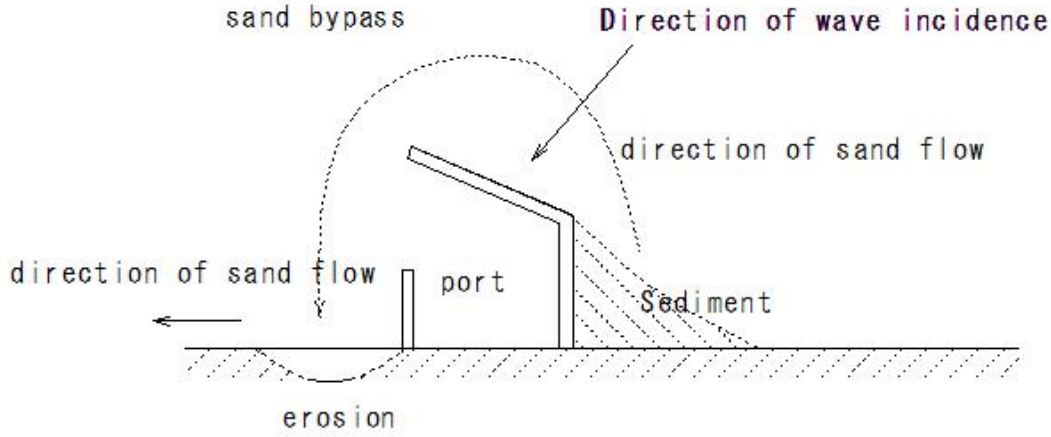
Transportation method

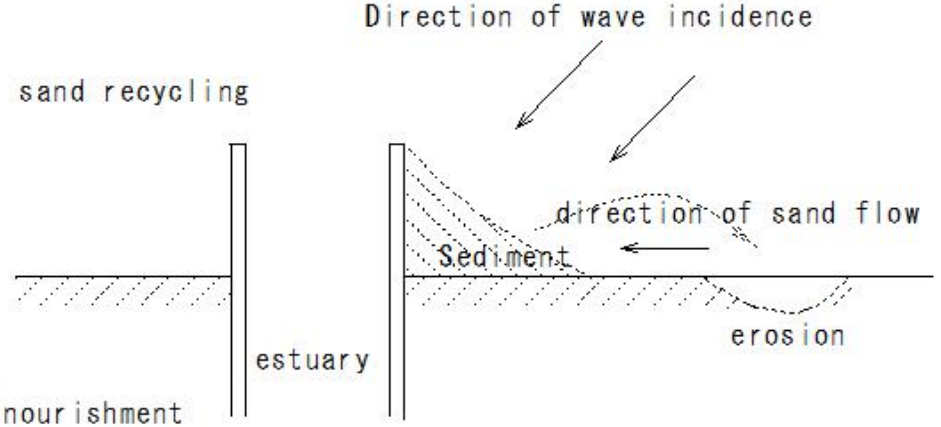
pipe

Soil transportation-truck-belt conveyor

Input method

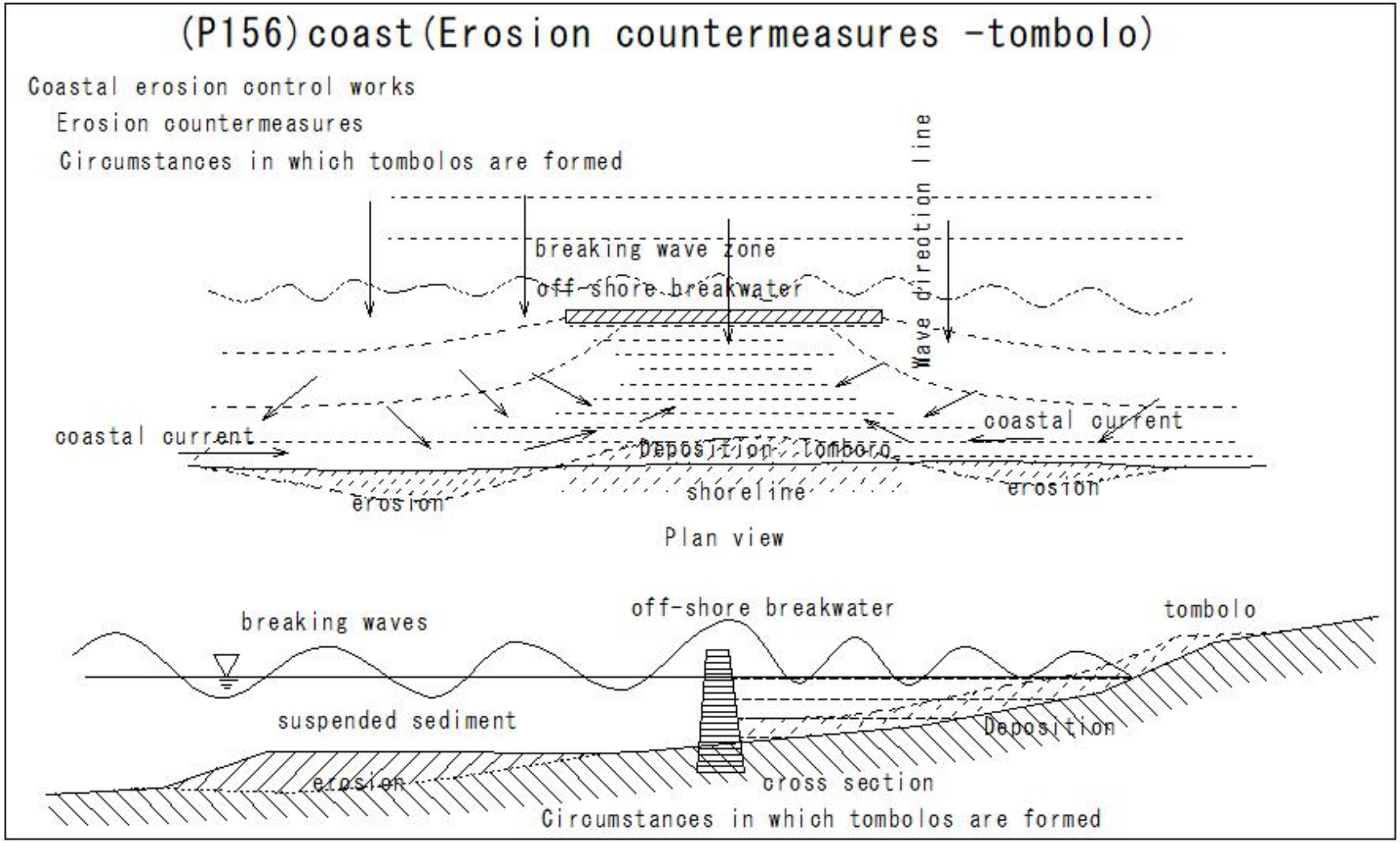
Temporary disposal-pump dredging



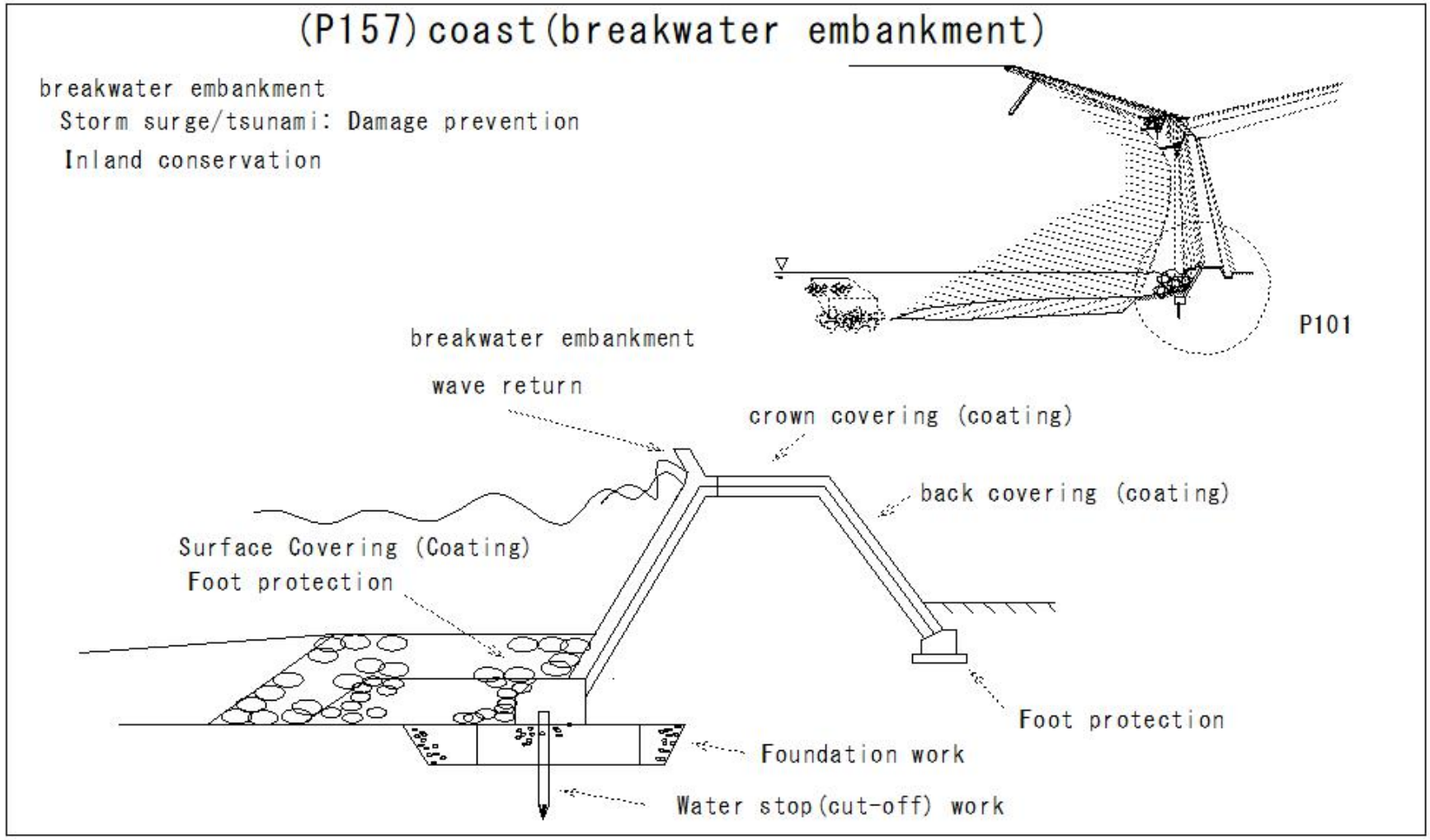


③Beach nourishment

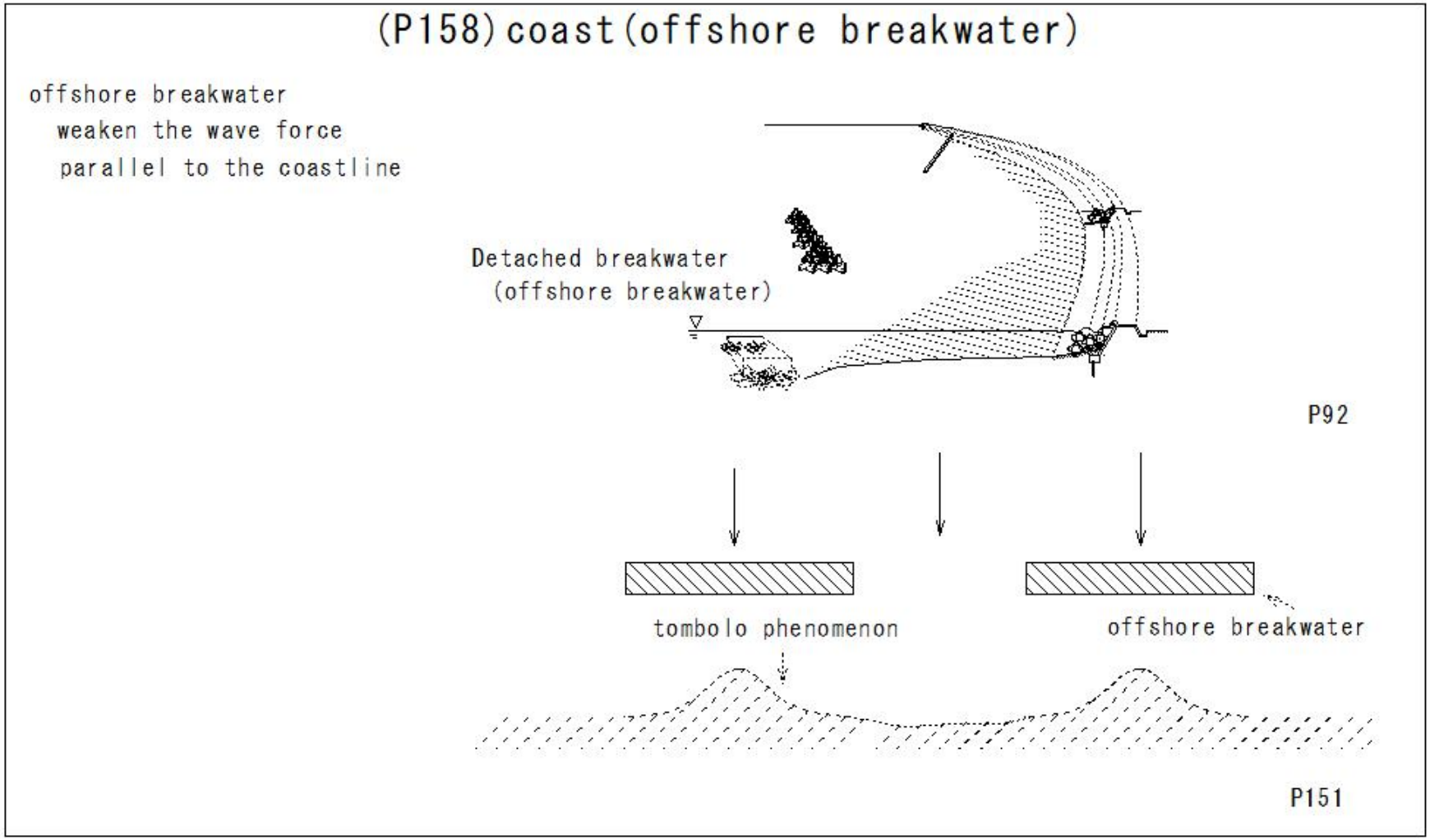
(P156)coast(Erosion countermeasures -tombolo)



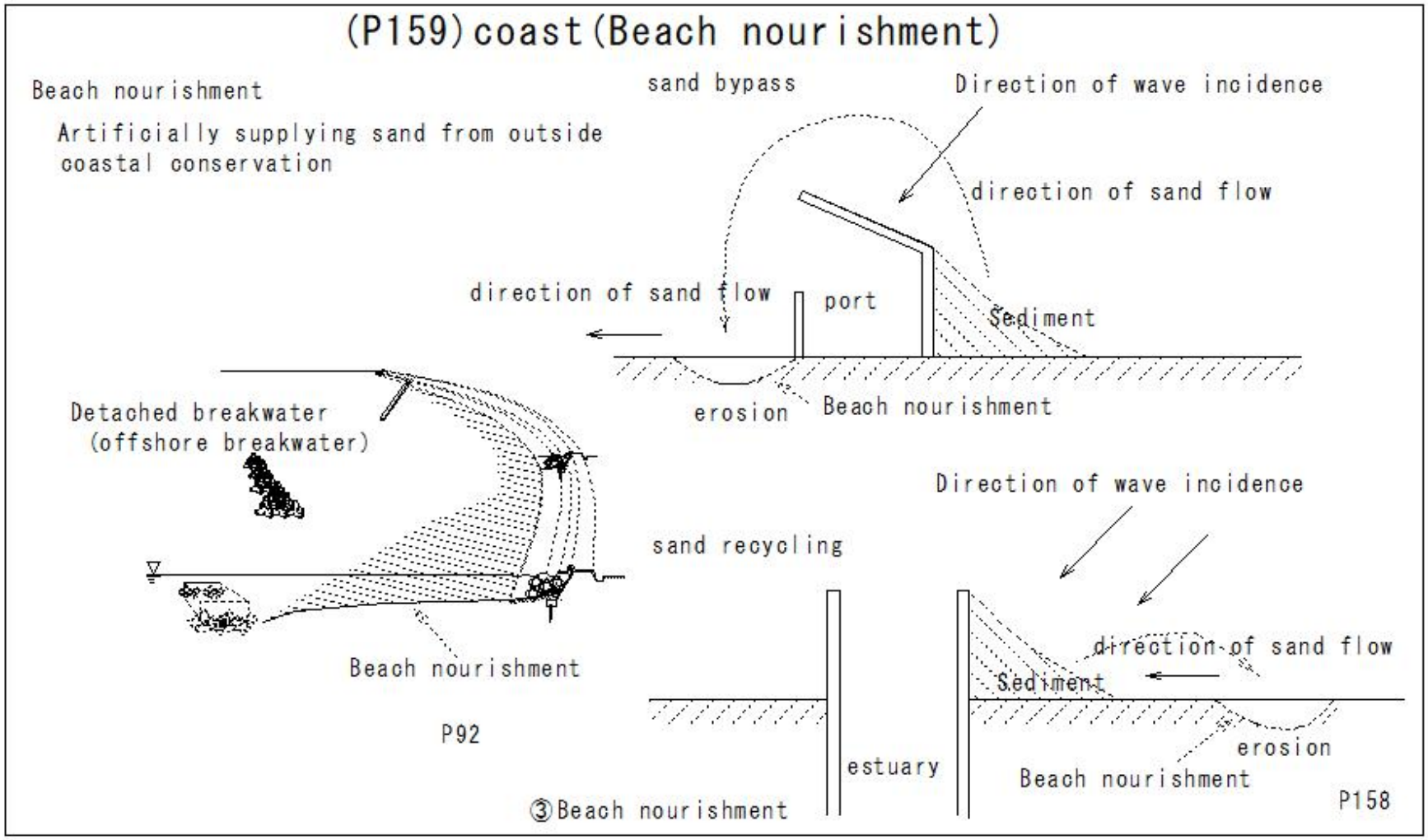
(P157)coast(breakwater embankment)



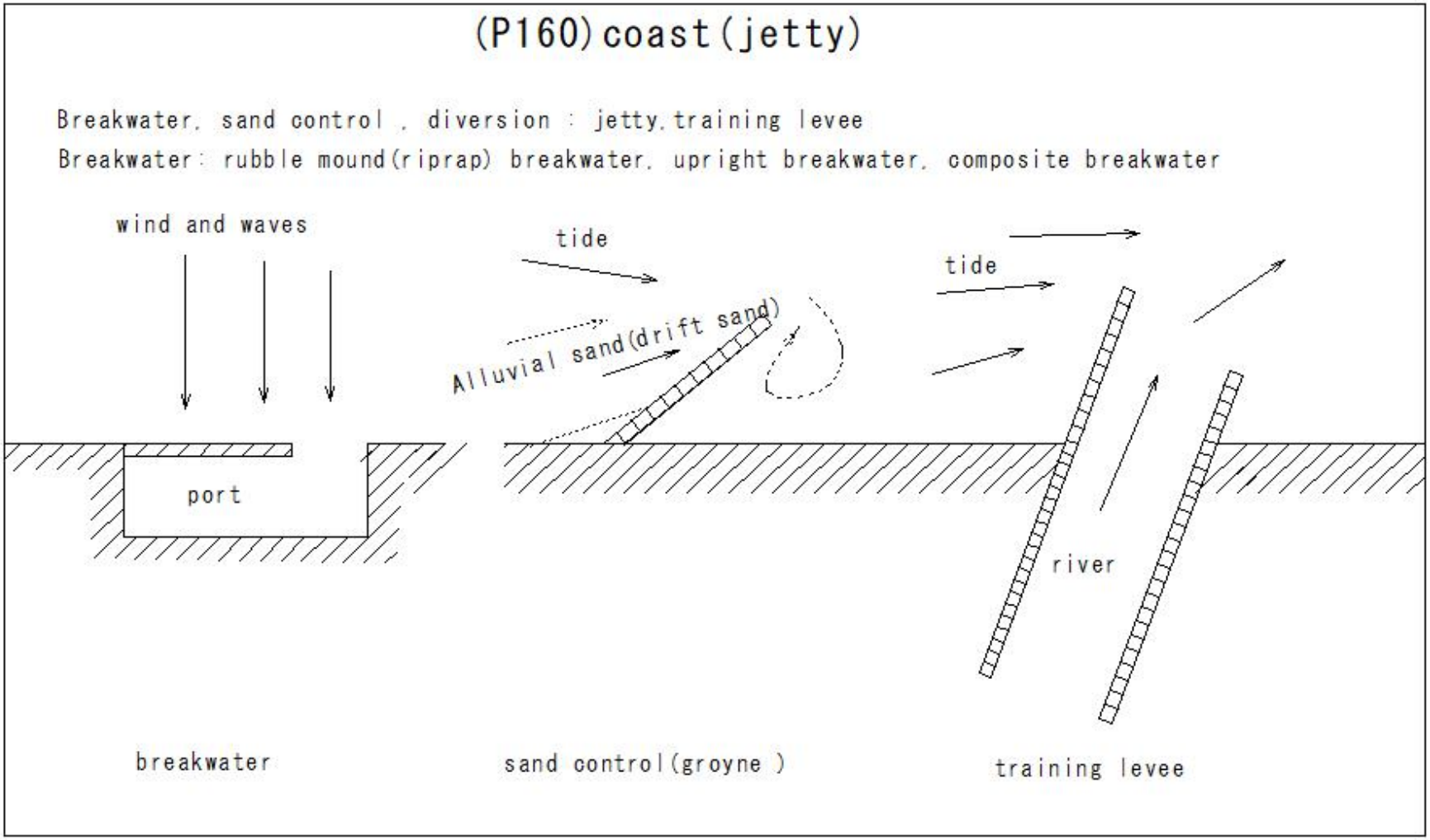
(P158)coast(offshore breakwater)



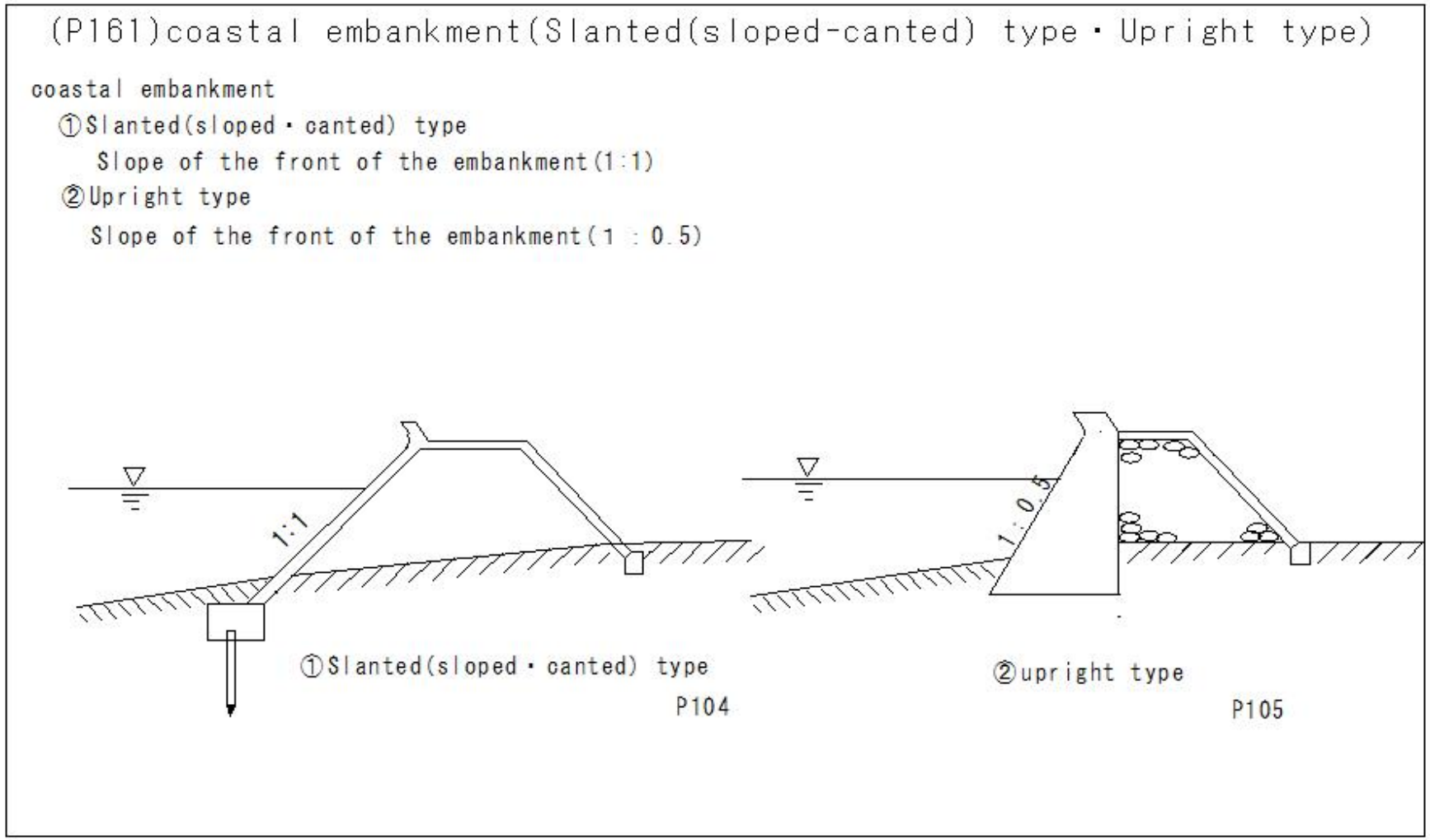
(P159)coast(Beach nourishment)



(P160)coast(jetty)



(P161)coastal embankment(Slanted(sloped-canted) type・Upright type）



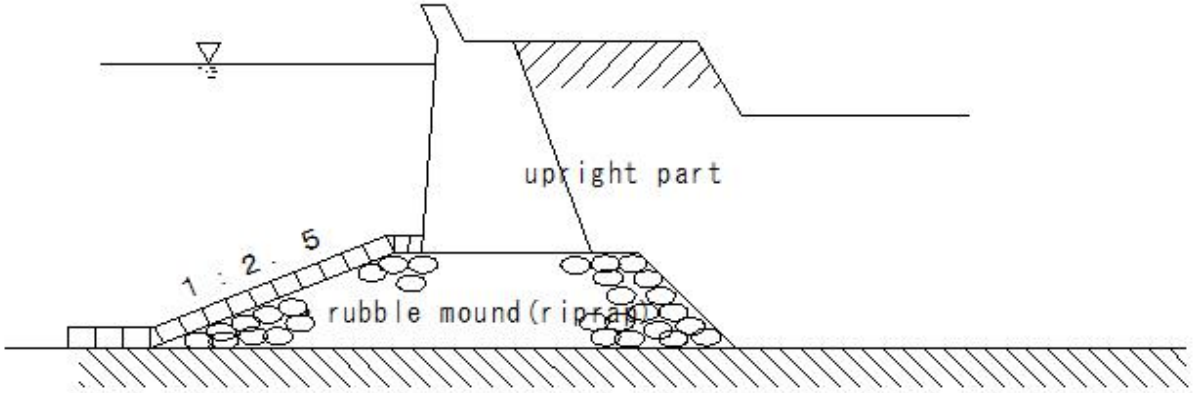
(P162)coastal embankment(composite type）

(P162)coastal embankment(composite type)

coastal embankment

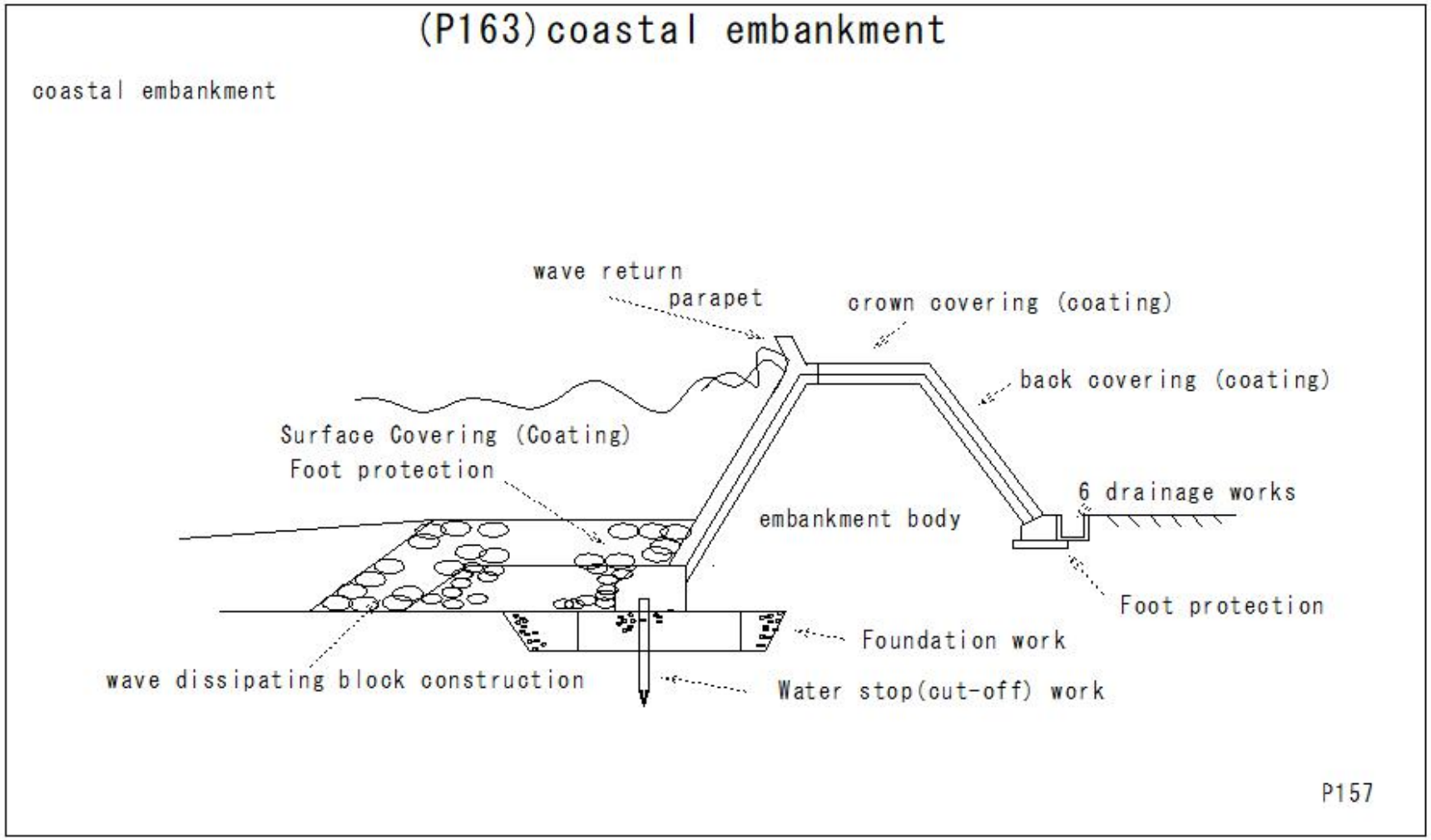
③composite type

Slope of the front of the embankment

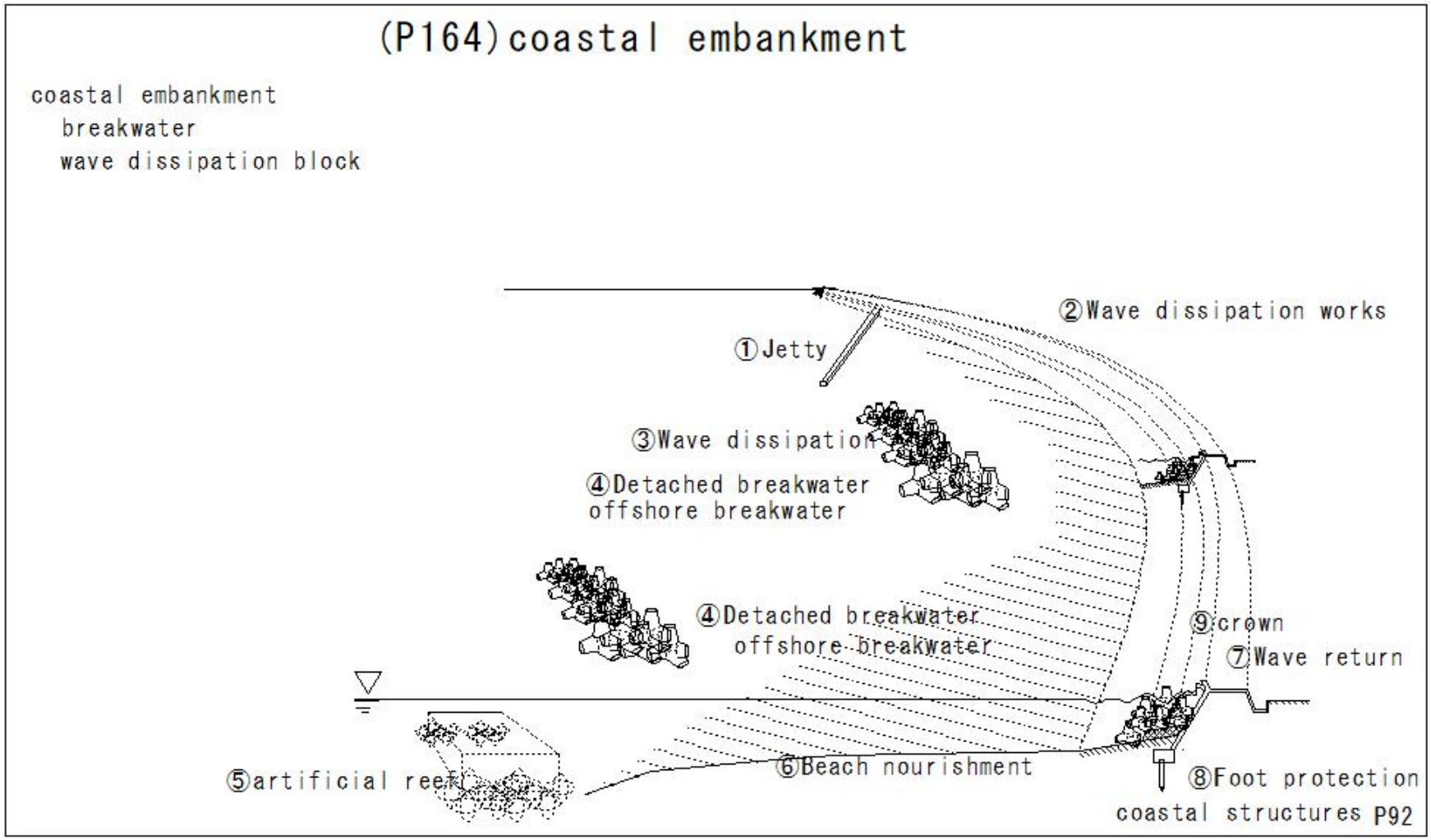


③composite type

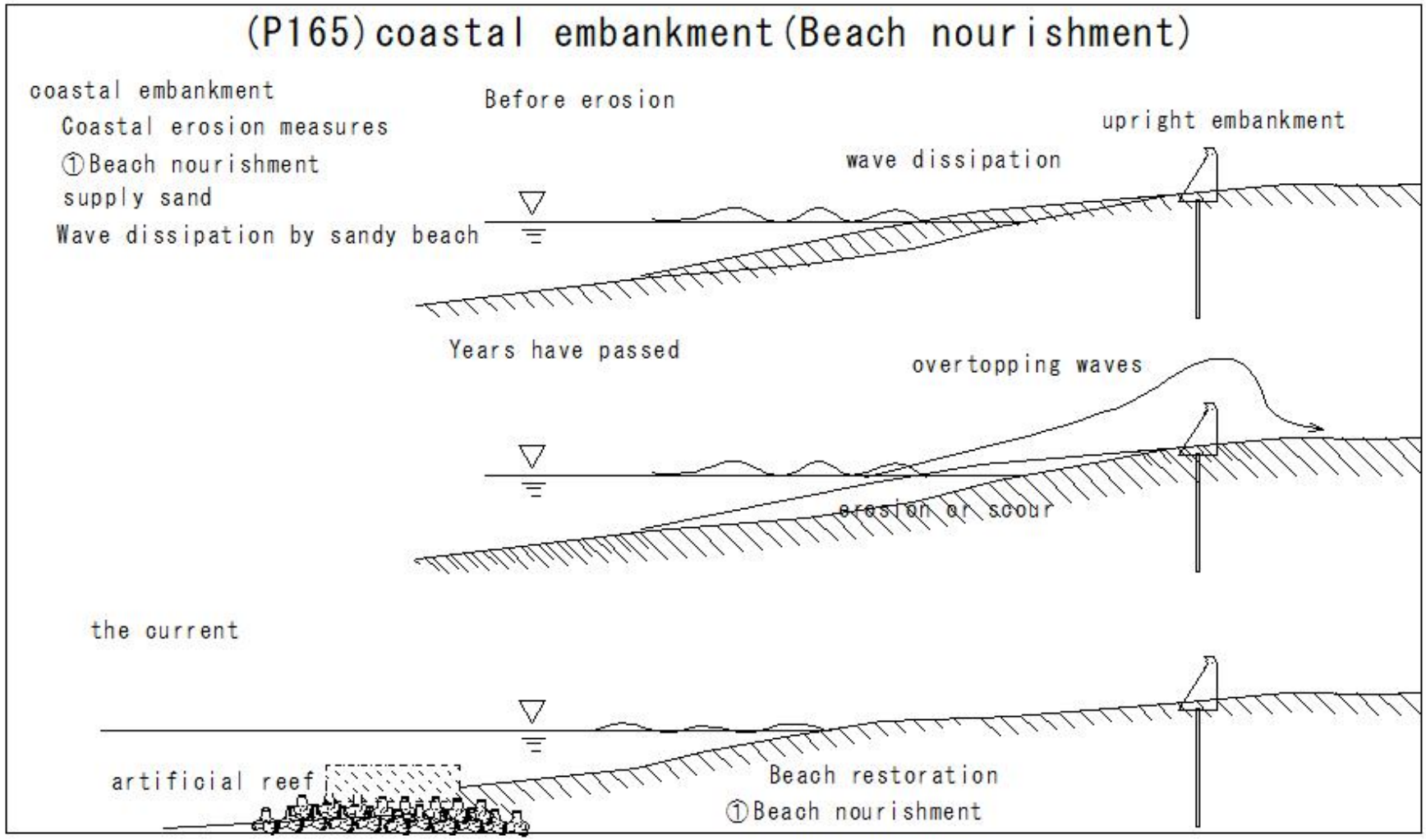
(P163)coastal embankment



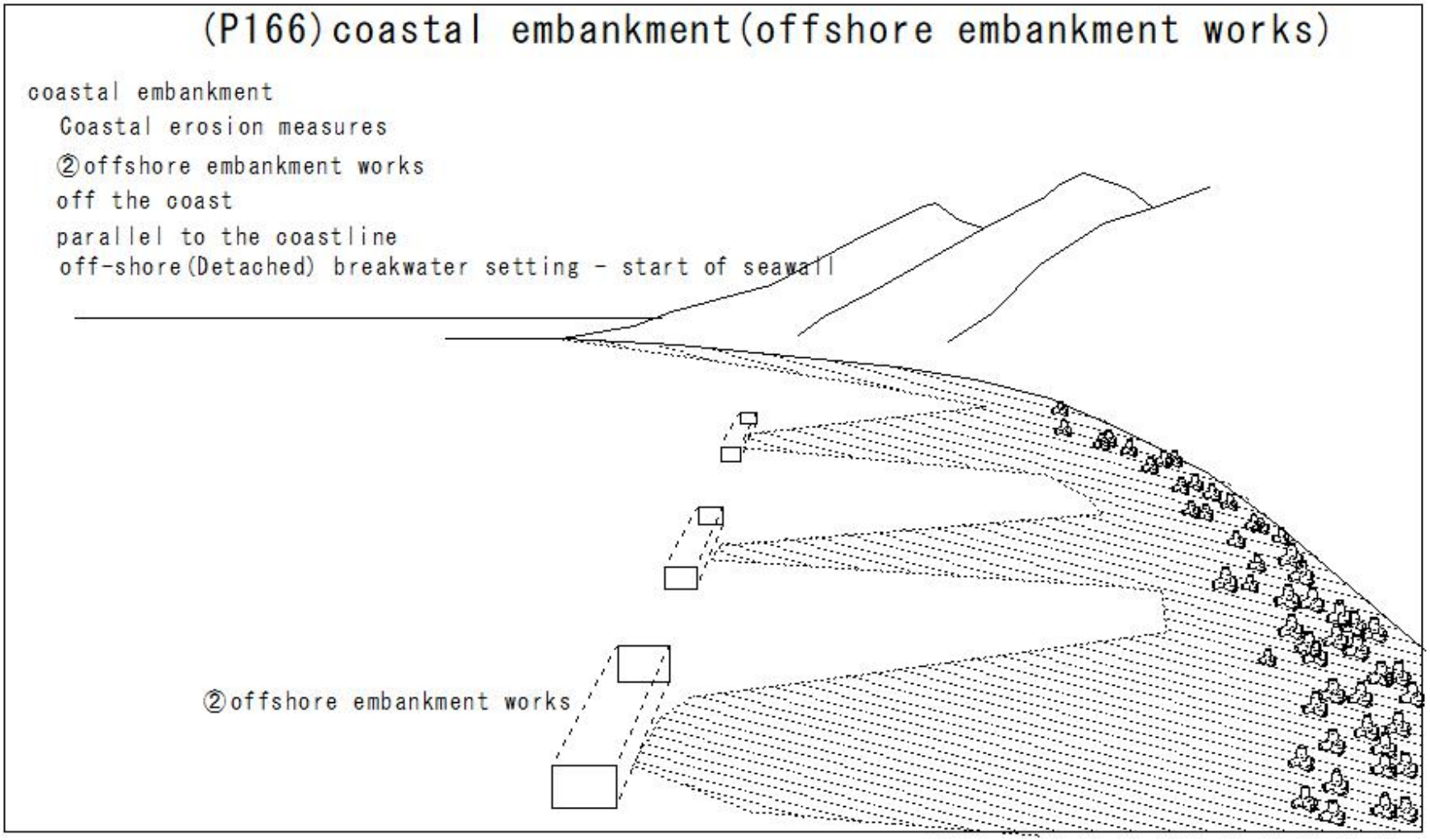
(P164)coastal embankment



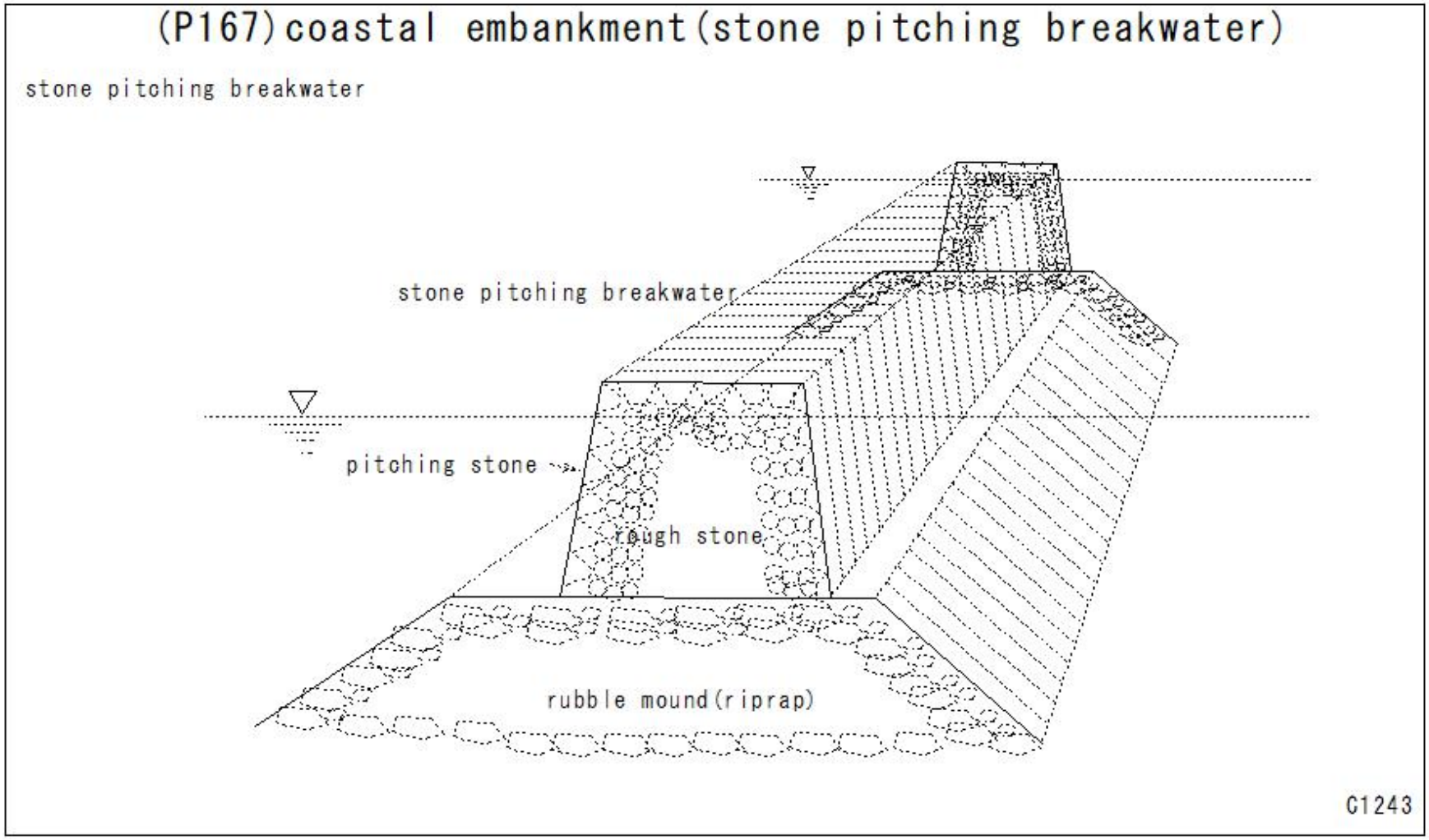
(P165)coastal embankment(Beach nourishment)



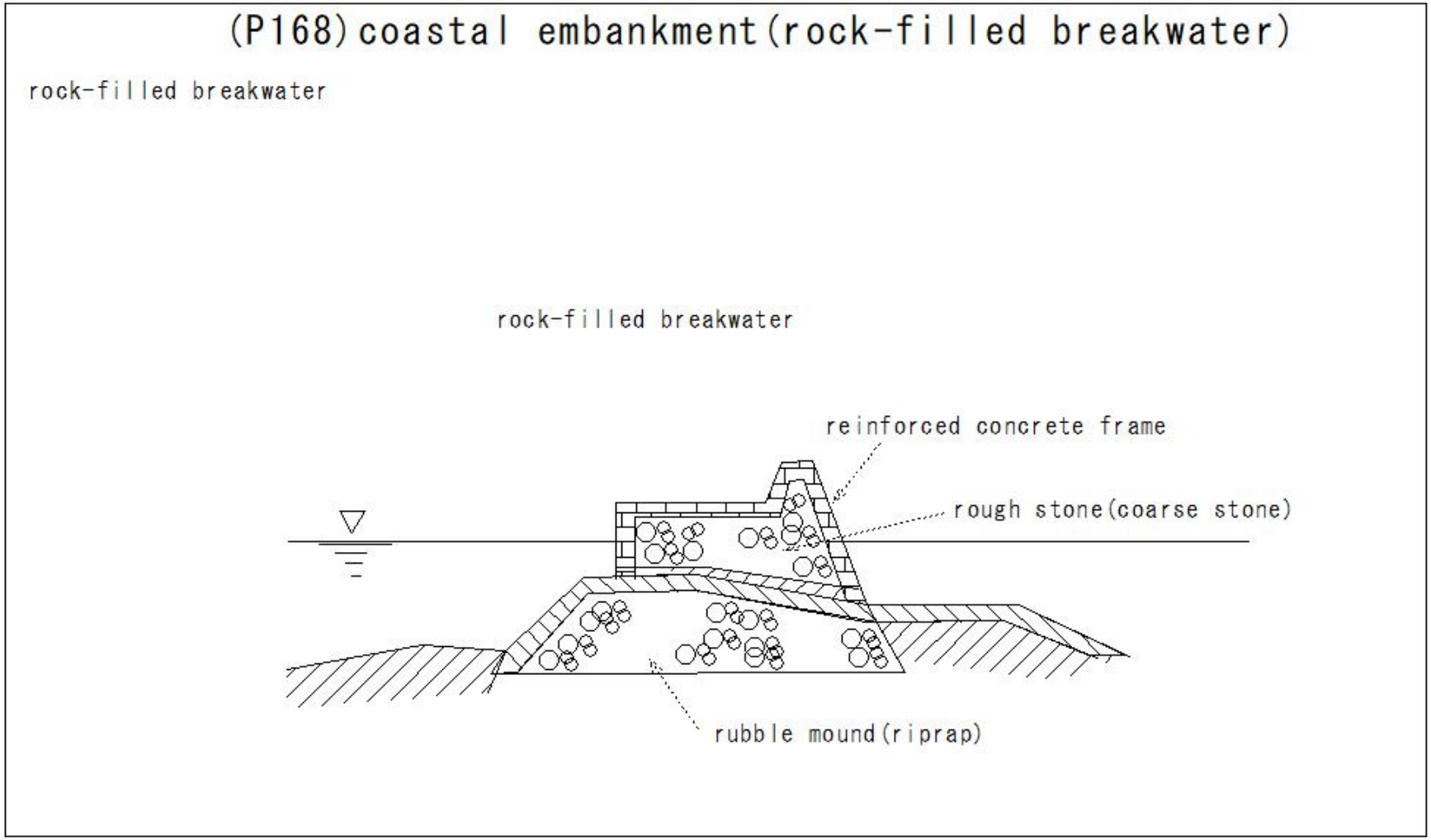
(P166)coastal embankment(offshore embankment works)



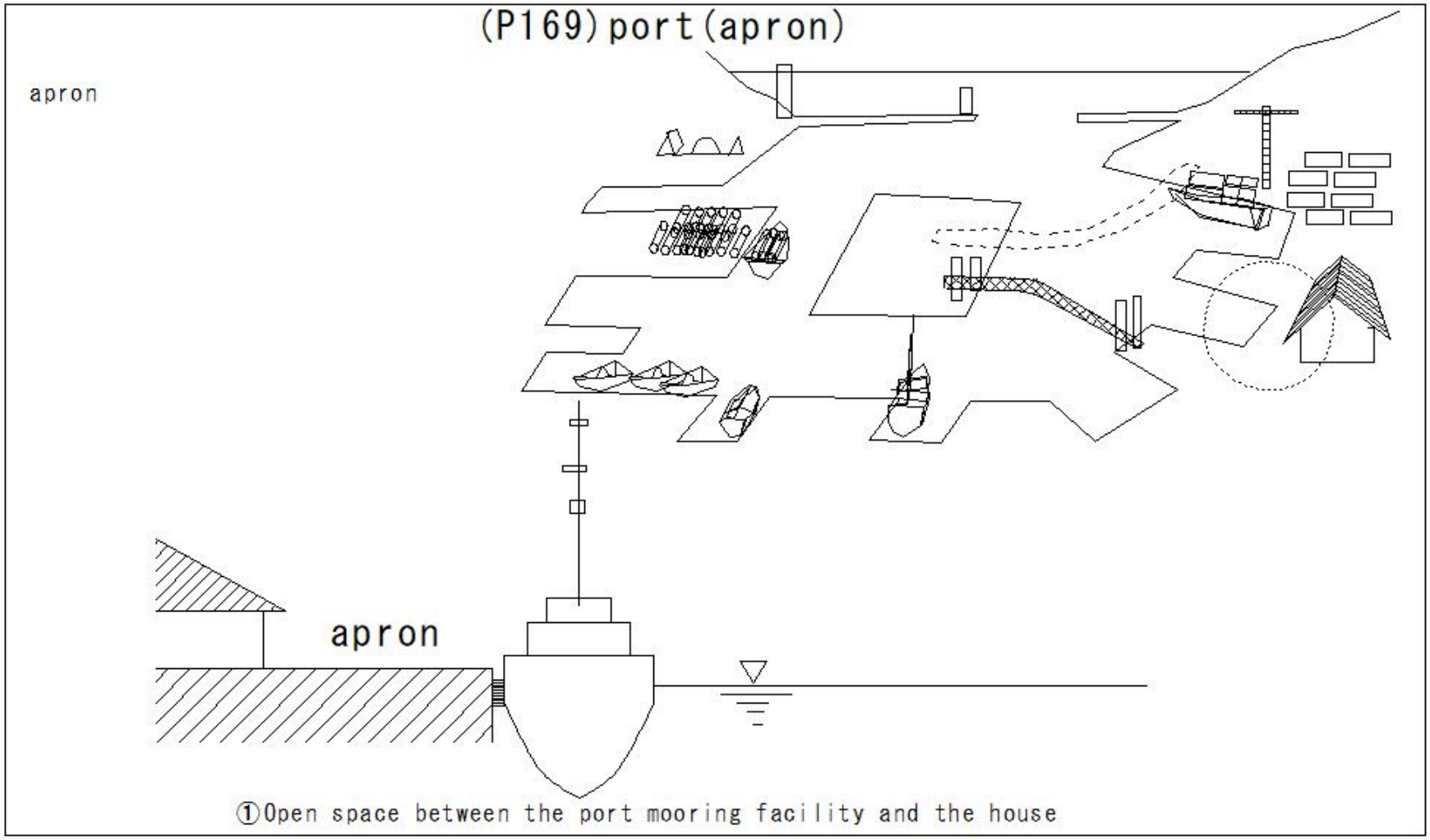
(P167)coastal embankment(stone pitching breakwater)



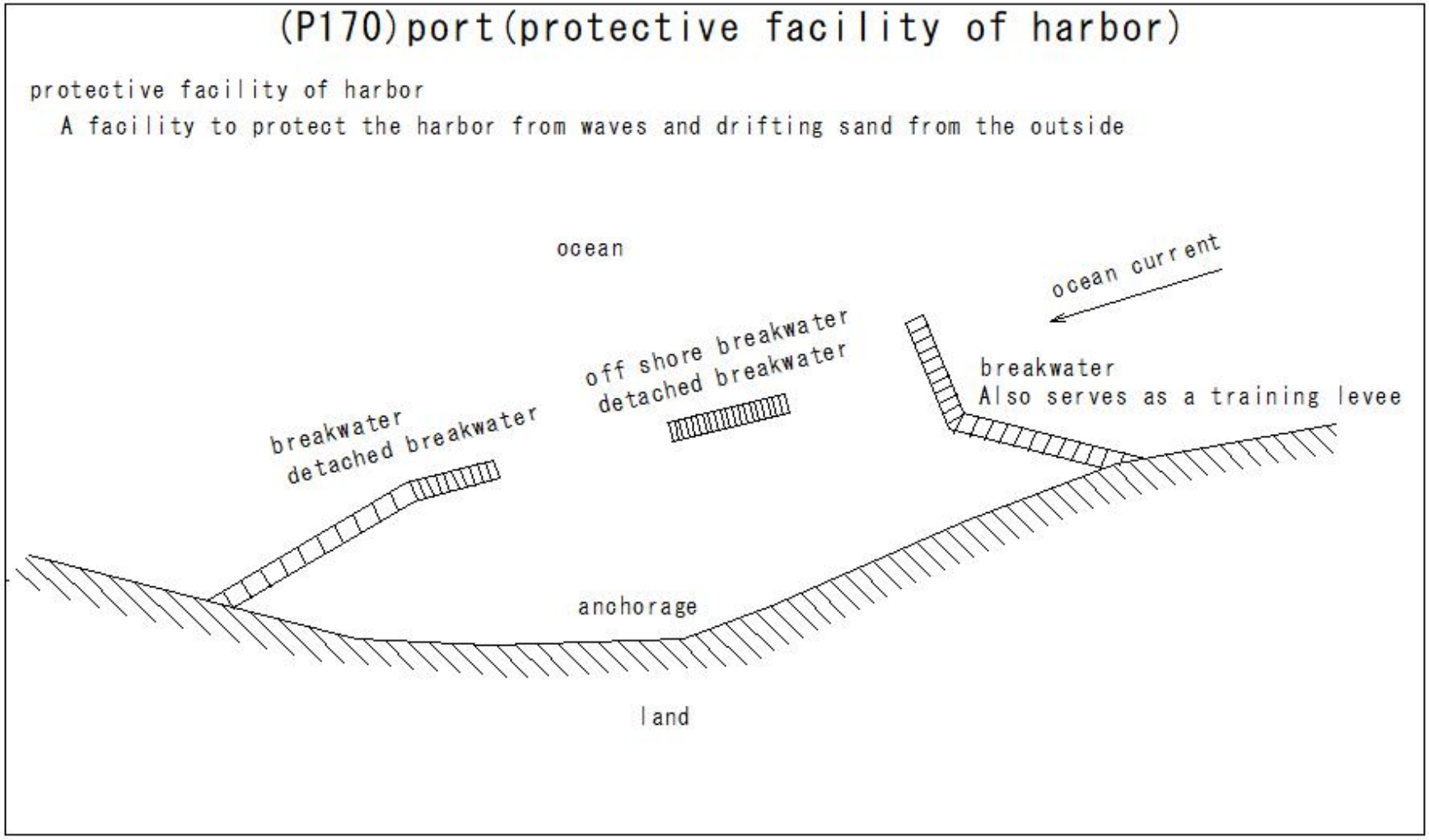
(P168)coastal embankment(rock-filled breakwater)



(P169)port(apron)



(P170)port(protective facility of harbor)



(P171)caisson breakwater

(P171)caisson breakwater

caisson breakwater

①build a caisson in the caisson yard on land.

②Stones carried by stone carriers (gut ships) are thrown into the ocean floor, and divers level the stones to create a foundation.

③Transport the caisson using a tugboat, fill the cavity with water, submerge it, and set it on the foundation.

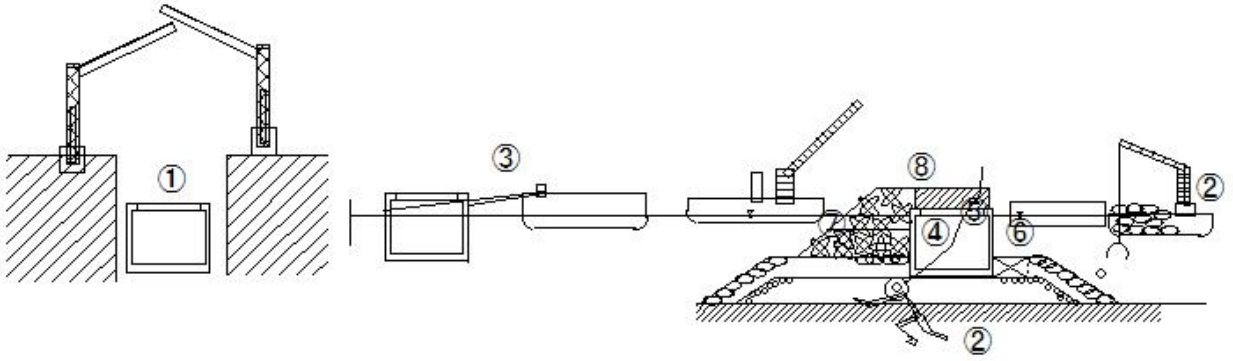
④Pour sand into the caisson

⑤Cover the top with concrete. (lid concrete)

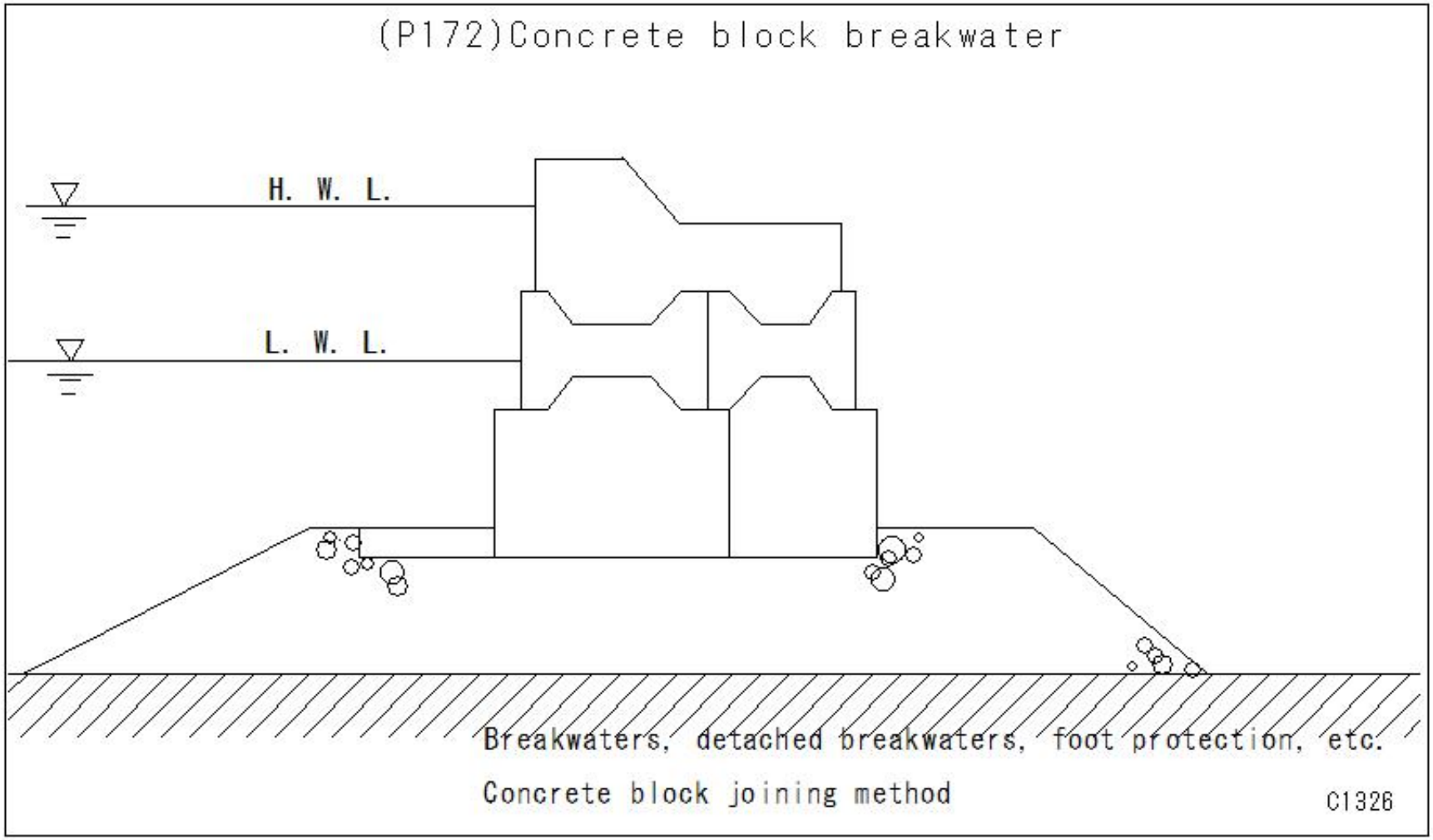
⑥Strengthen the base of the caisson with covering stones and foot protection blocks.

⑦Set up the wave-dissipating block (tetrapod).

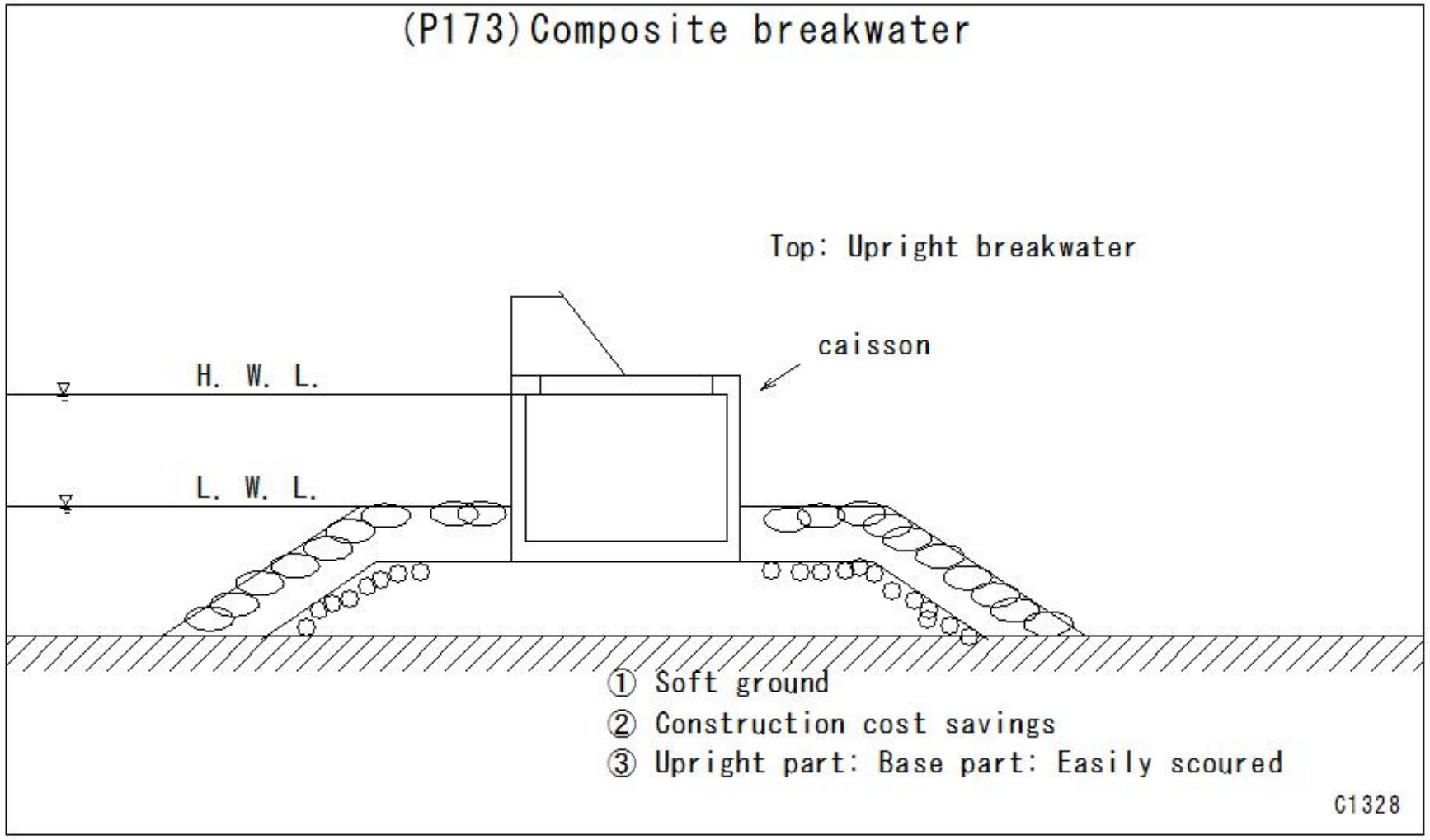
⑧Pour concrete on top of the caisson. (upper concrete)



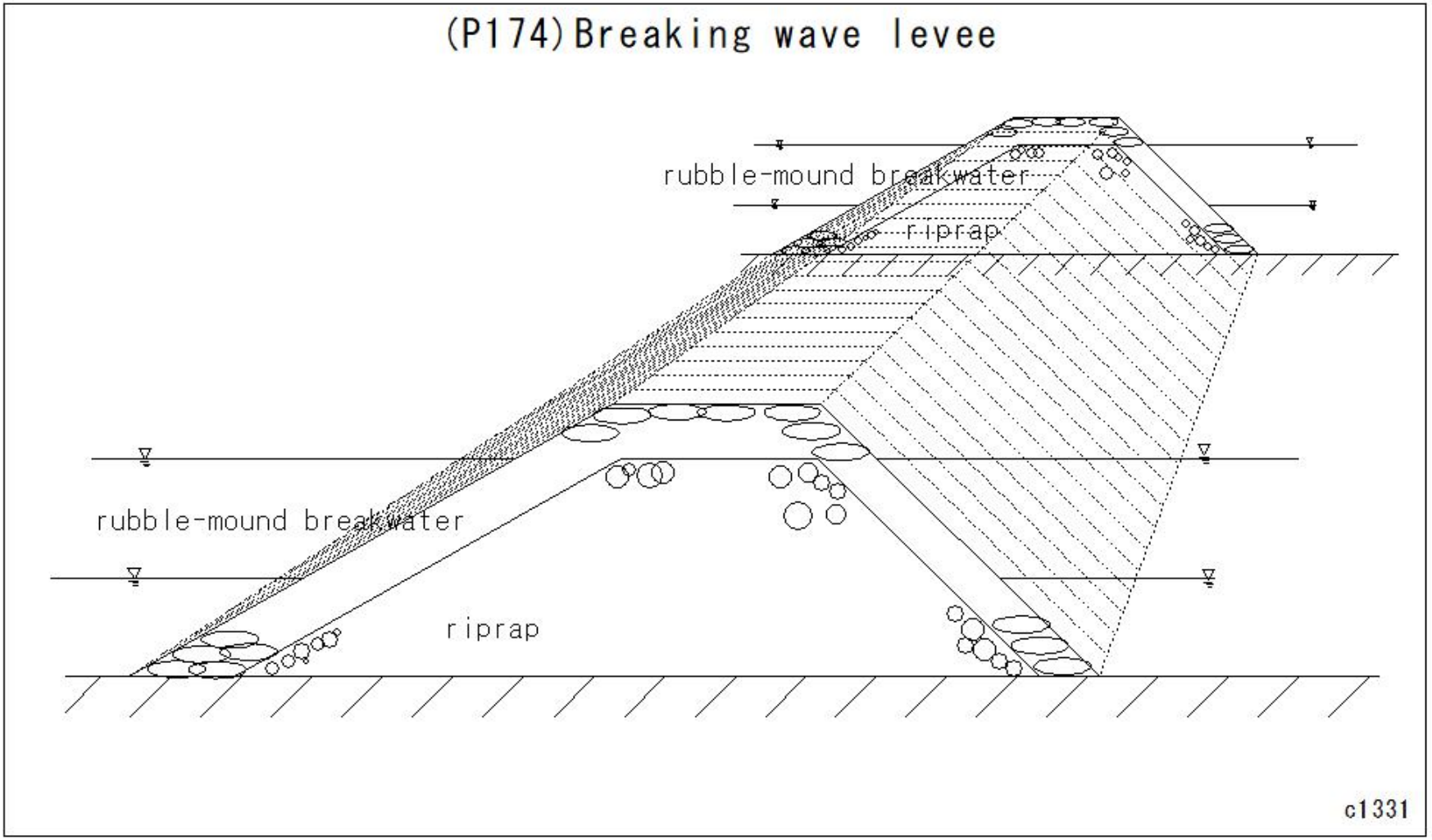
(P172)Concrete block breakwater



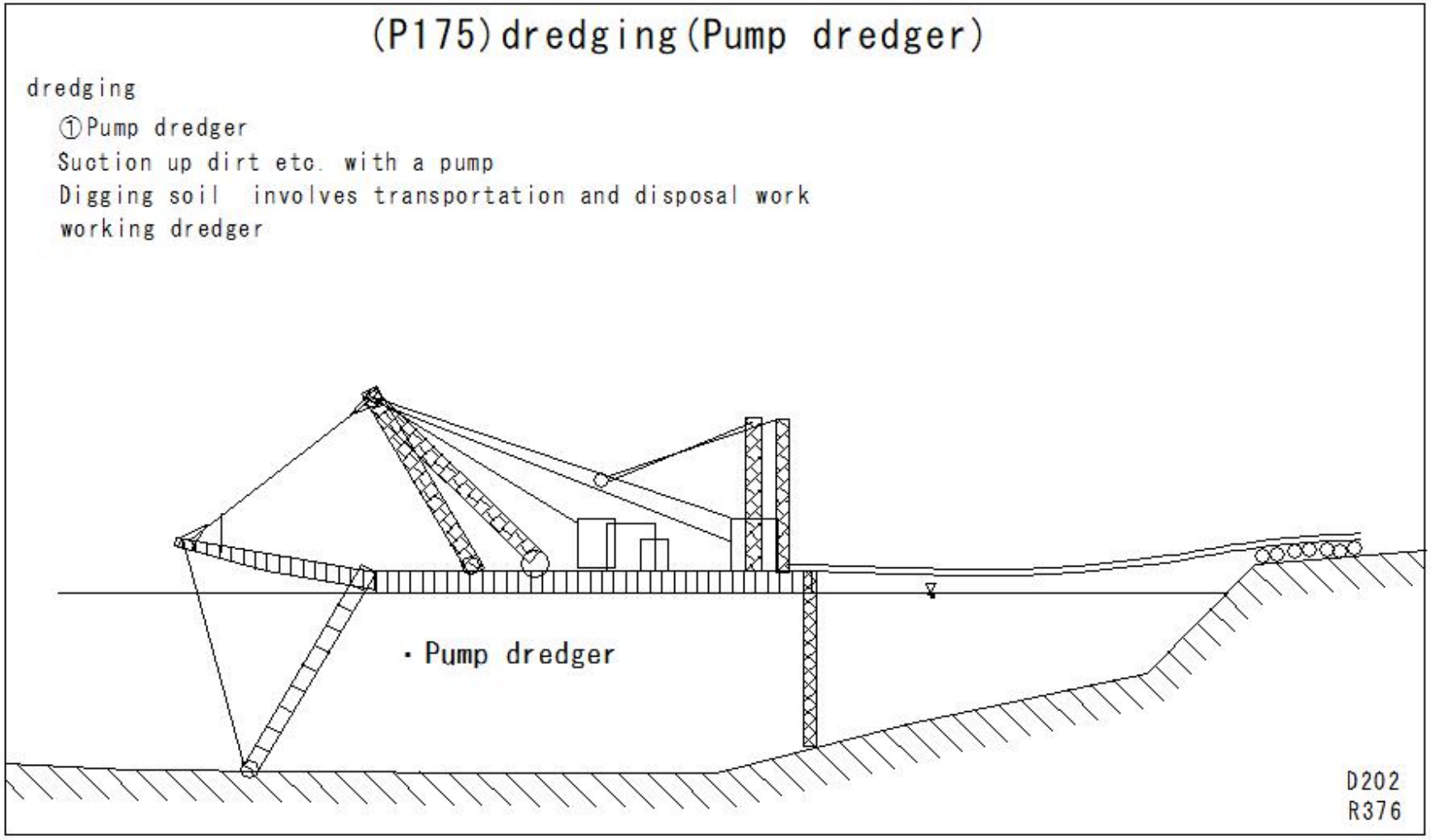
(P173)Composite breakwater



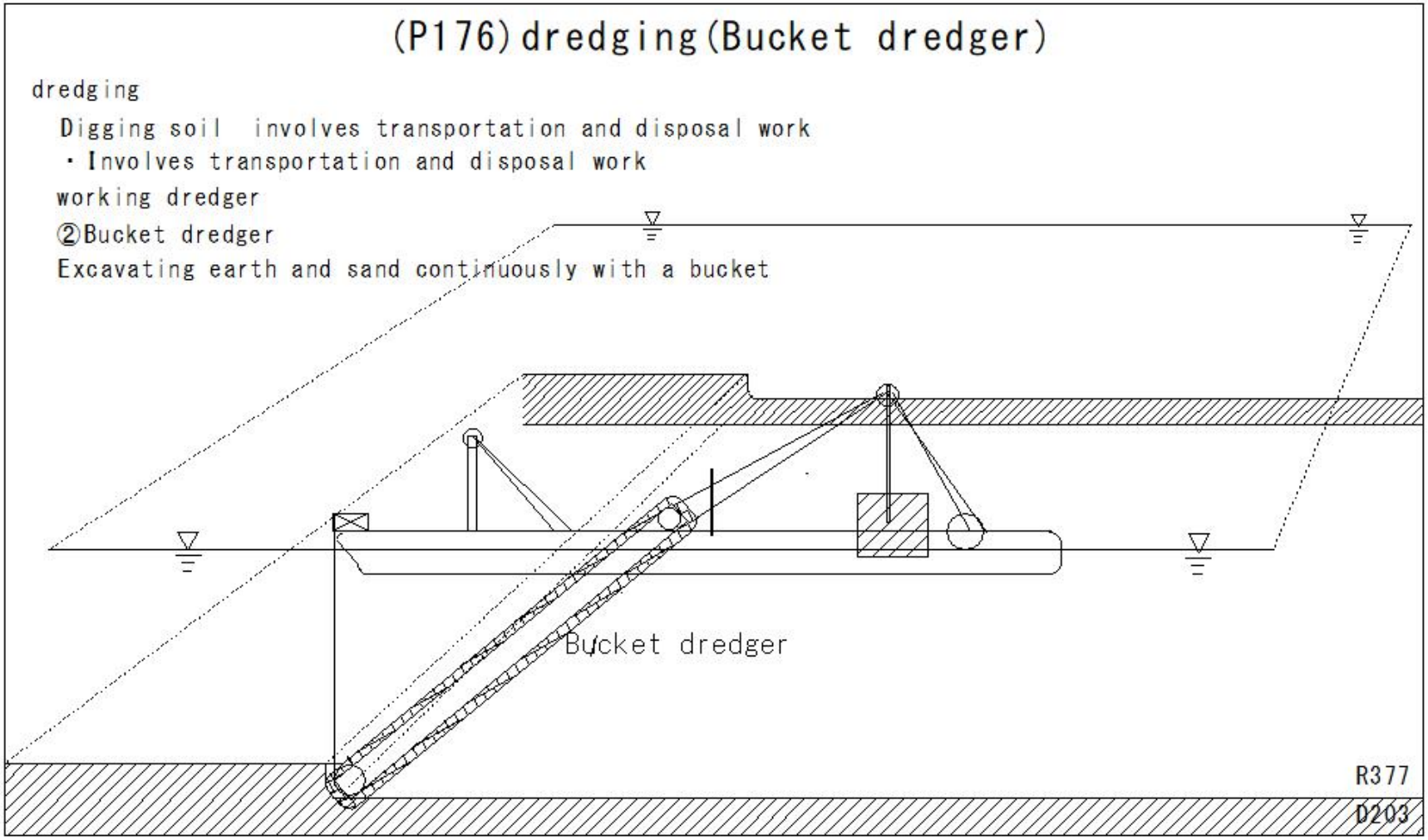
(P174)Breaking wave levee



(P175)dredging(Pump dredger)



(P176)dredging(Bucket dredger)



(P177)dredging(Grab dredger)

(P177)dredging(Grab dredger)

grab dredger

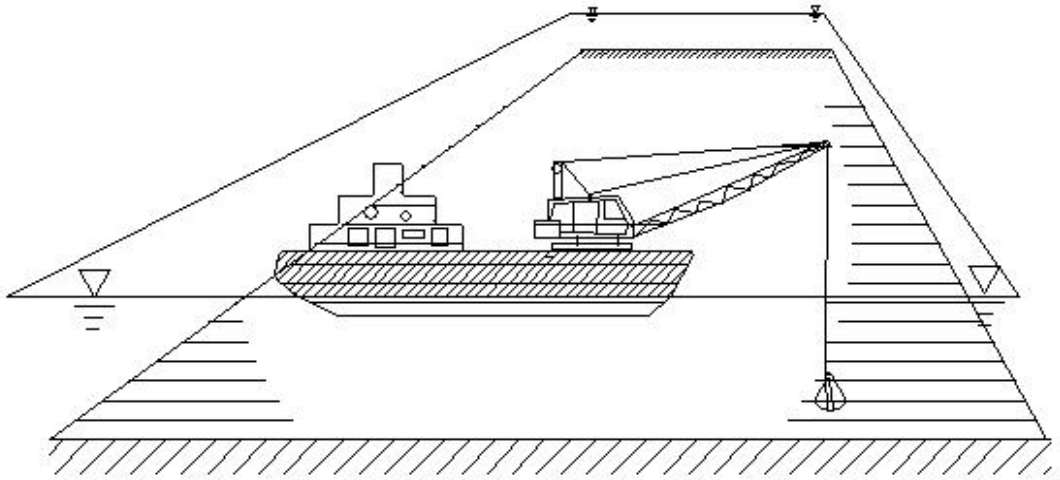
Digging soil involves transportation and disposal work

・Involves transportation and disposal work

working dredger

③Grab dredger

excavating with a grab bucket



Grab dredger

R378
D204

(P178)dredging(Dipper dredger)

(P178)dredging(Dipper dredger)

dredging

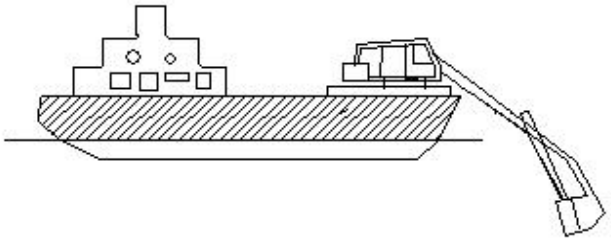
Digging soil involves transportation and disposal work

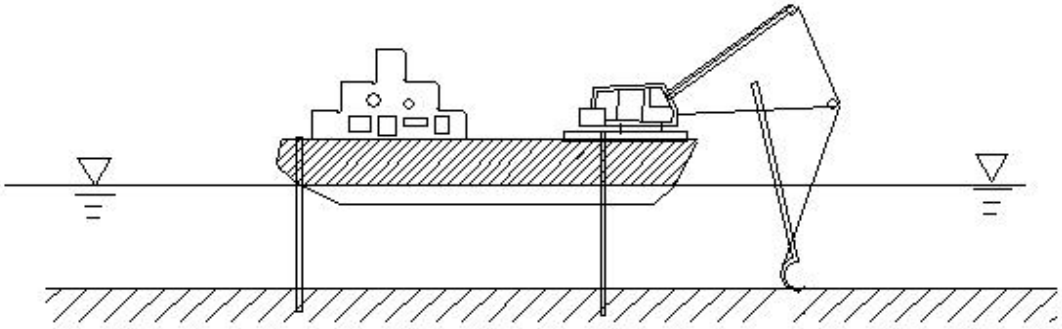
・Involves transportation and disposal work

working dredger

④Dipper dredger

Excavating hard soil with a dipper





Dipper dredger

R379
D205

(P179)progressive wave

(P179)progressive wave

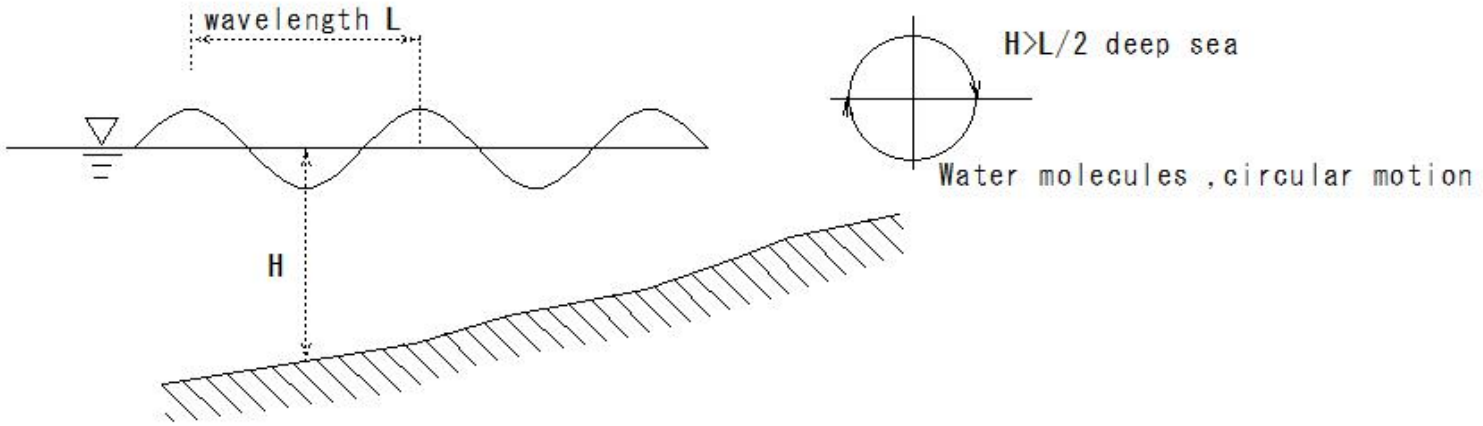
progressive wave

Waves are deeper than 1/2 of the wavelength

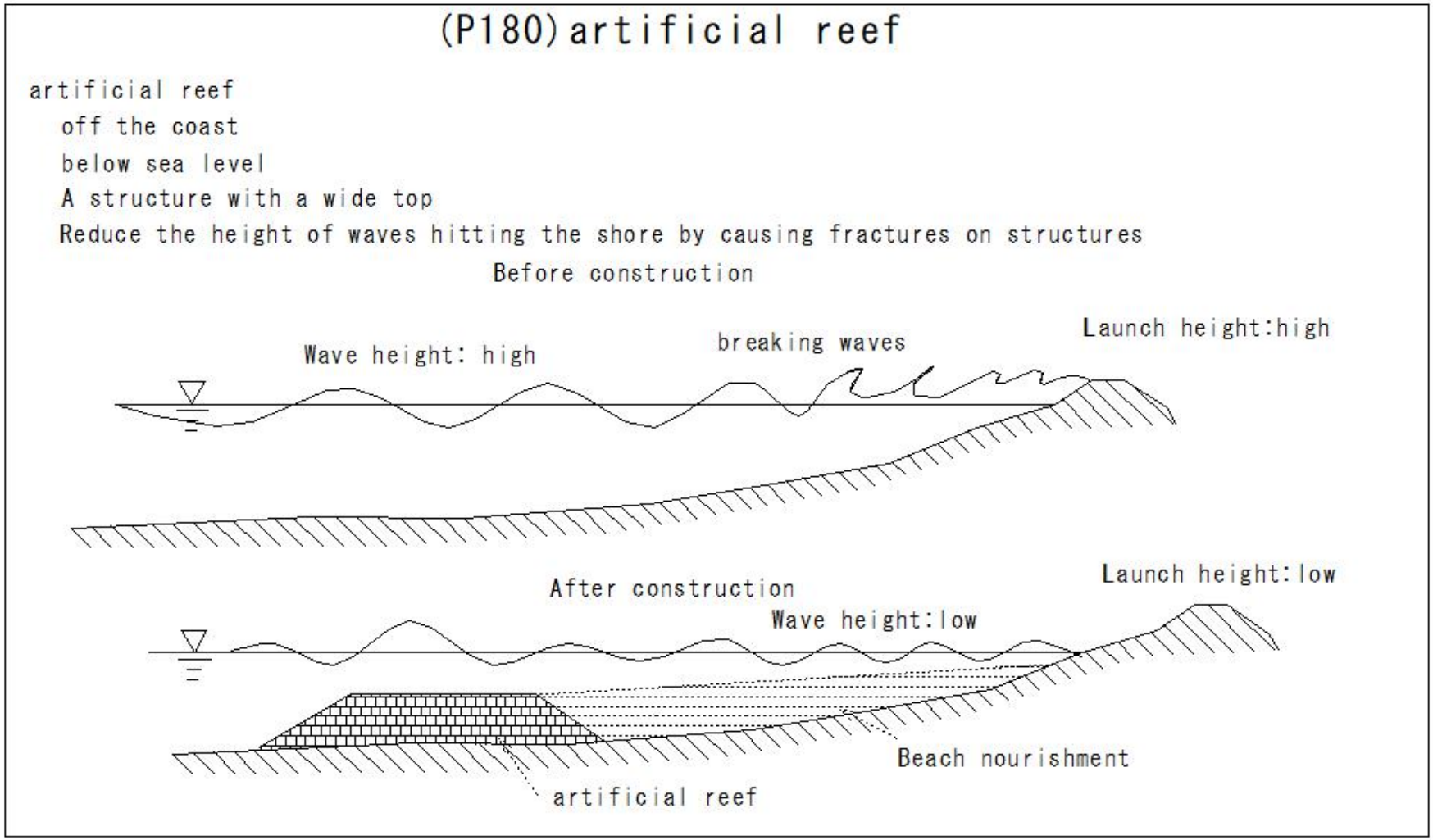
water molecules move in a circle

water molecules do not move forward

Only the shape of the wave moves in the direction of travel.



(P180)artificial reef

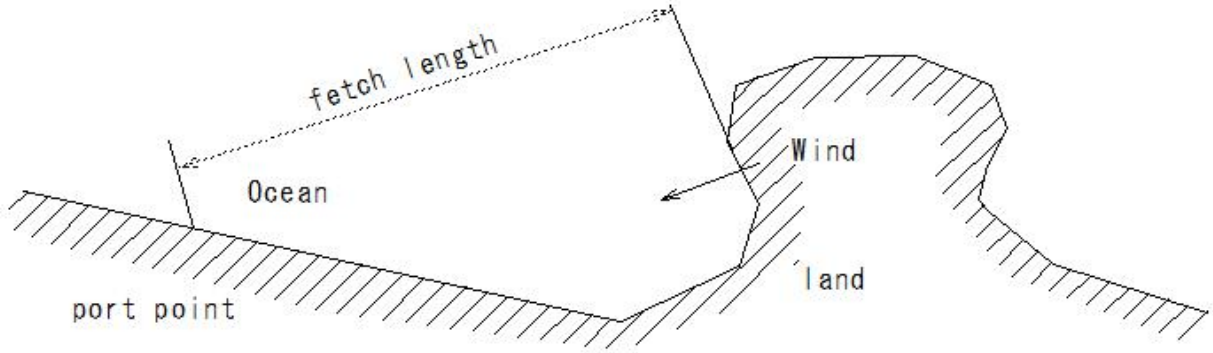


(P181)fetch length

(P181)fetch length

fetch length

Distance to the opposite shore in the windward direction



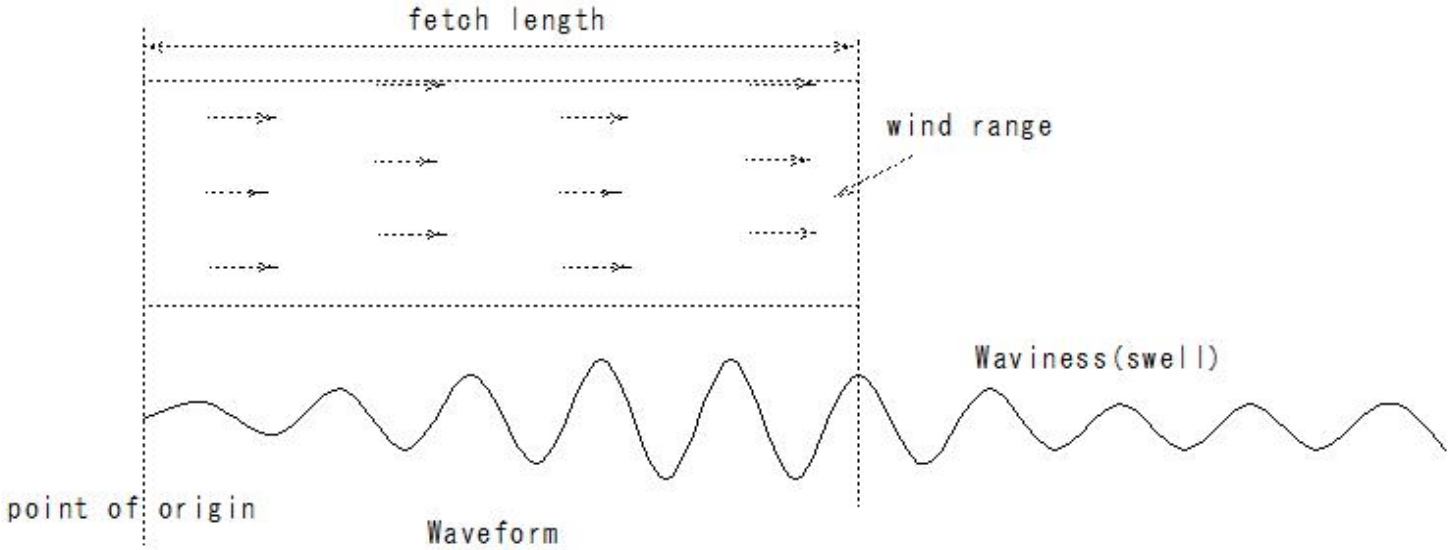
(P182)wind duration

(P182)wind duration

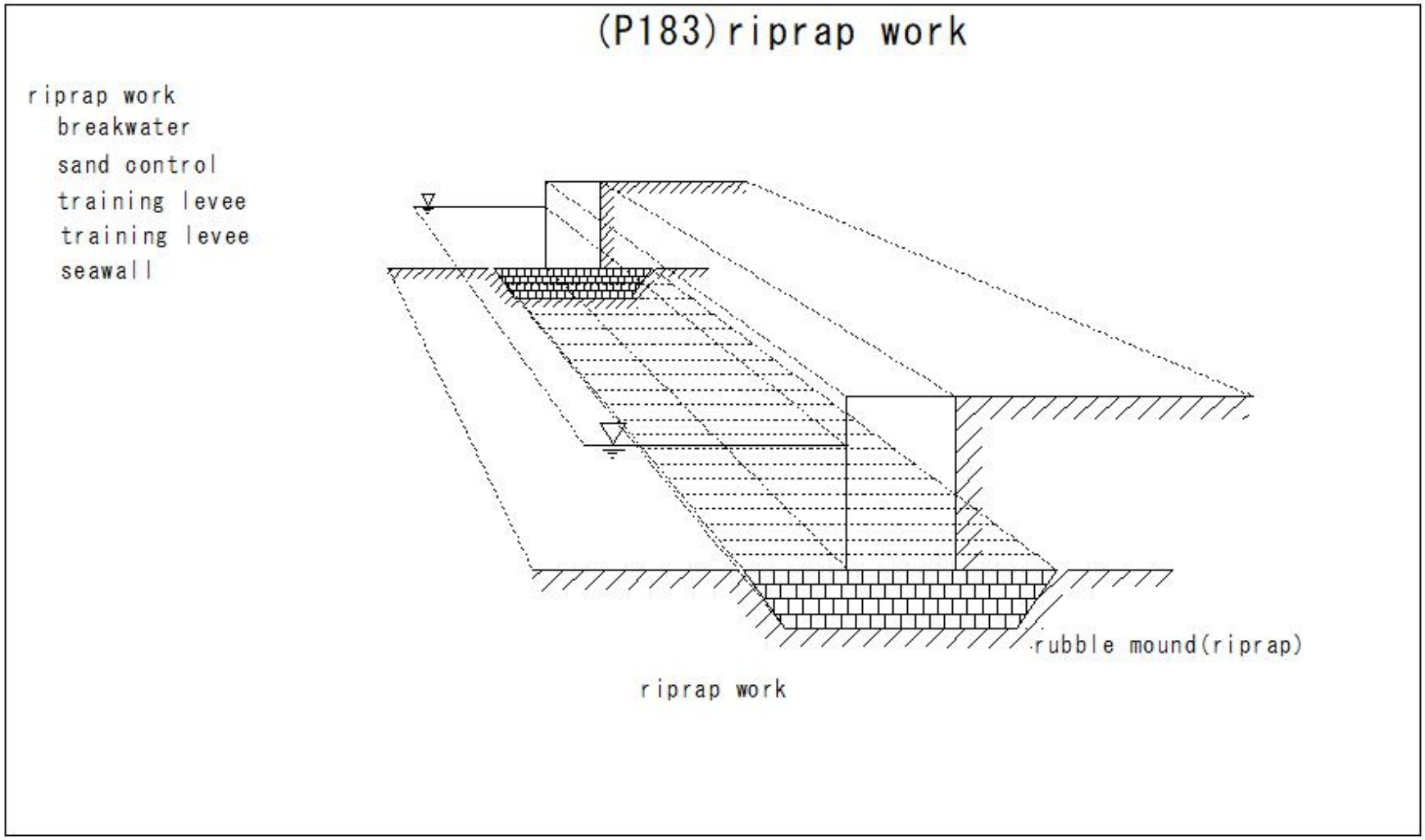
wind duration

waves developed by the wind

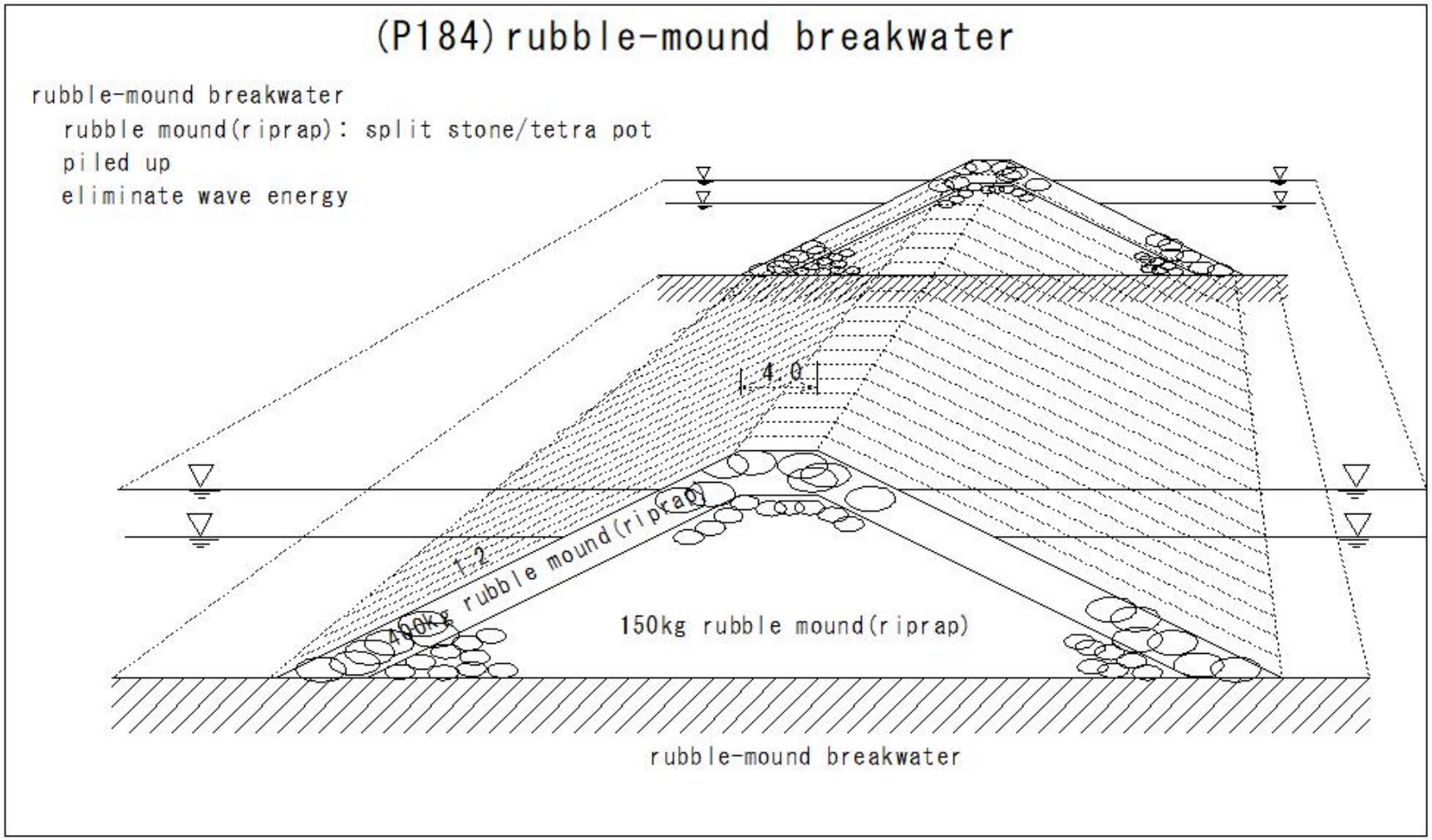
It occurs and develops within a wind region that continues to blow for a certain period of time.



(P183)riprap work



(P184)rubble-mound breakwater



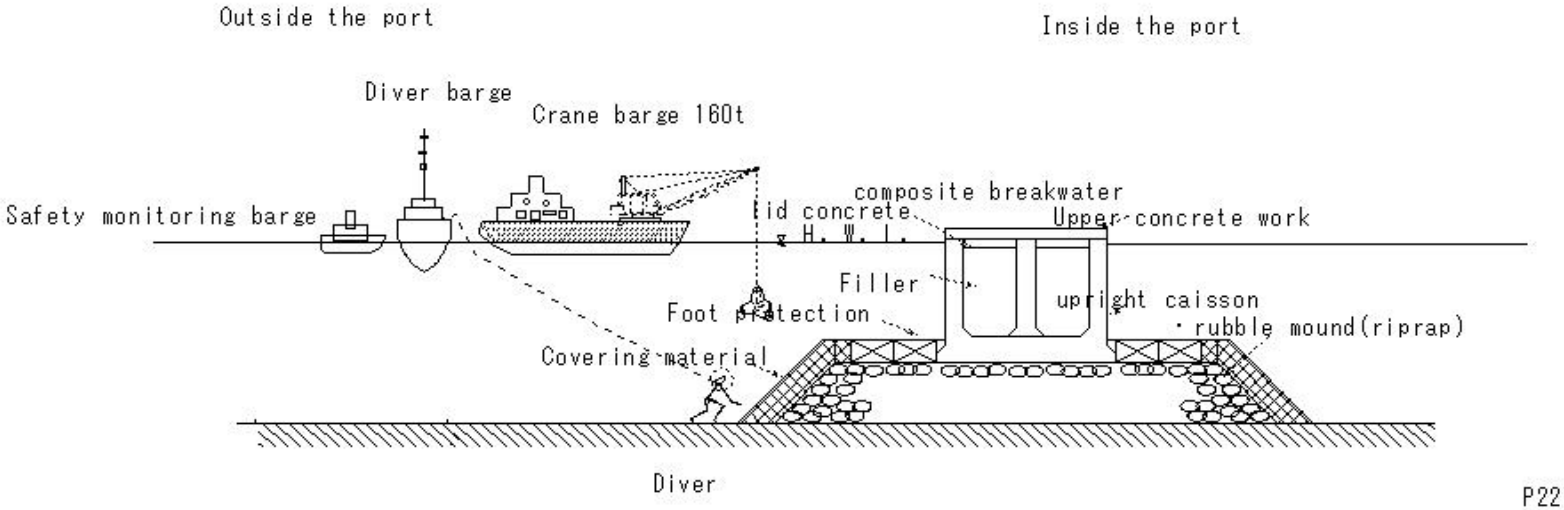
(P185) Covering and foundation work

(P185) Covering and foundation work

Covering and foundation work

Covering and foundation work (installation of foundation blocks and covering blocks,

introduction and leveling of covering stones)



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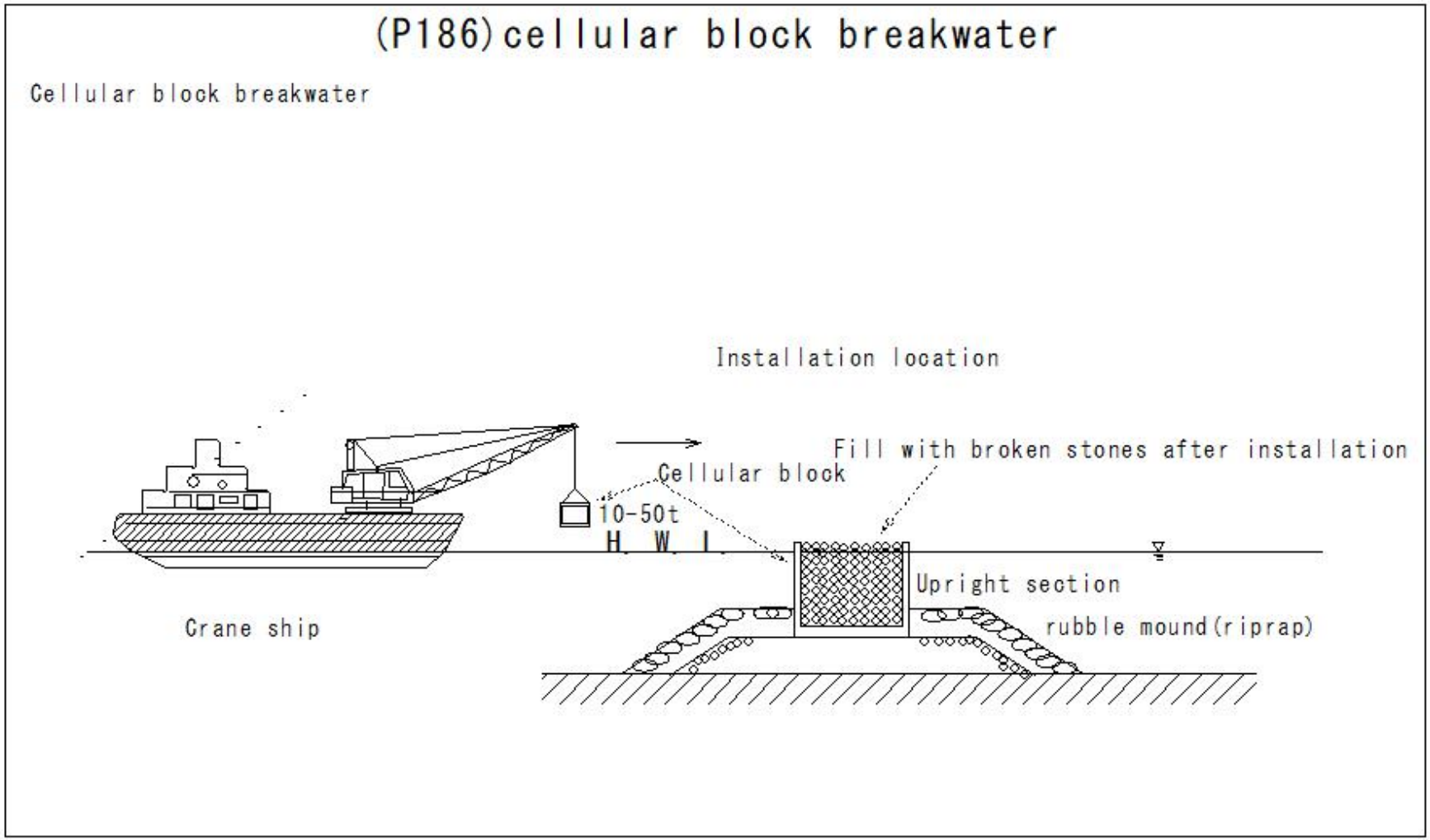
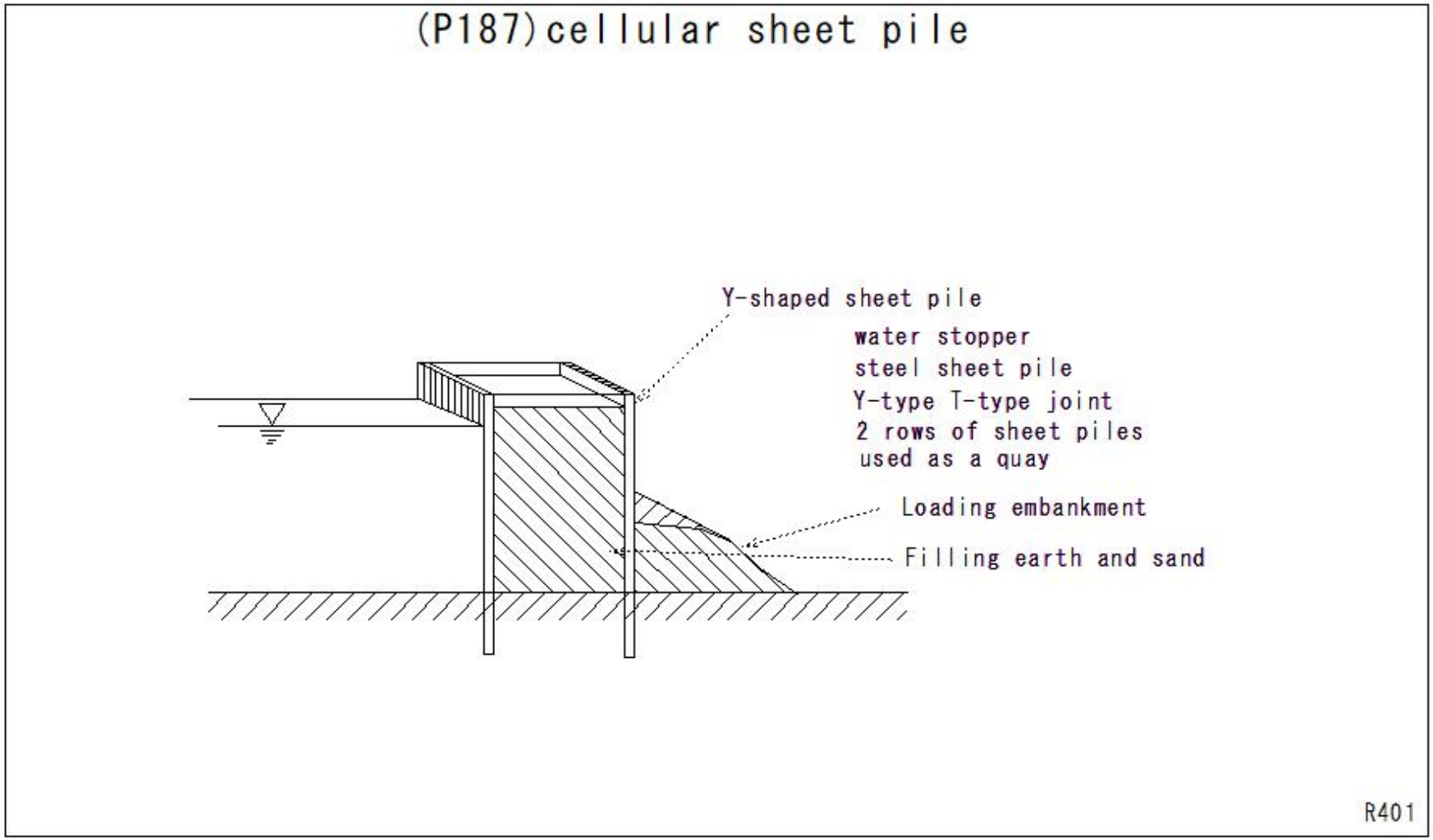
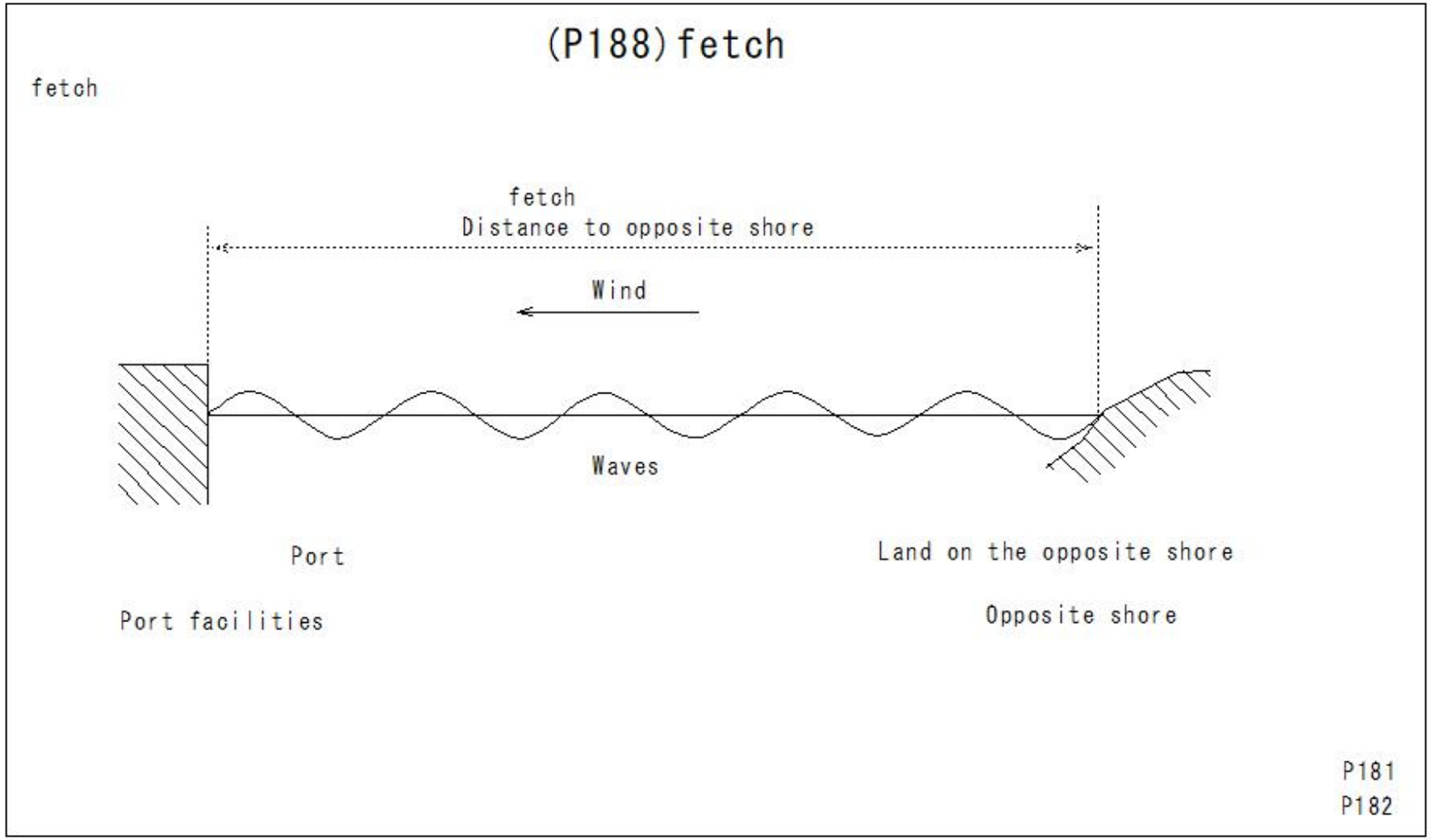
(P186)cellular block breakwater



(P187)cellular sheet pile



(P188)fetch


(P188)fetch
fetch
fetch
Distance to opposite shore
Wind
Waves
Port
Land on the opposite shore
Port facilities
Opposite shore
P181
P182

(P189)upright breakwater

(P189)upright breakwater

Upright breakwater

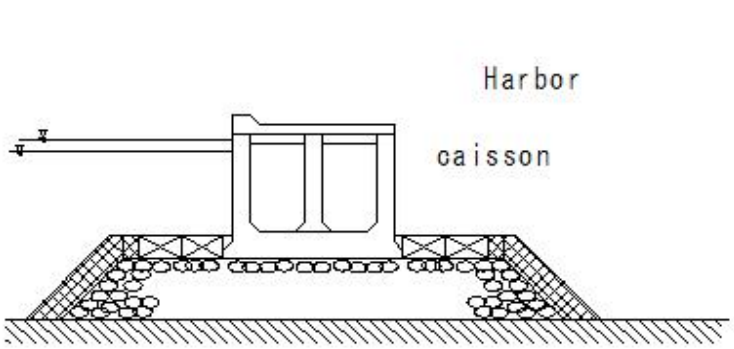
Prevent waves from entering

Installed upright from the seabed

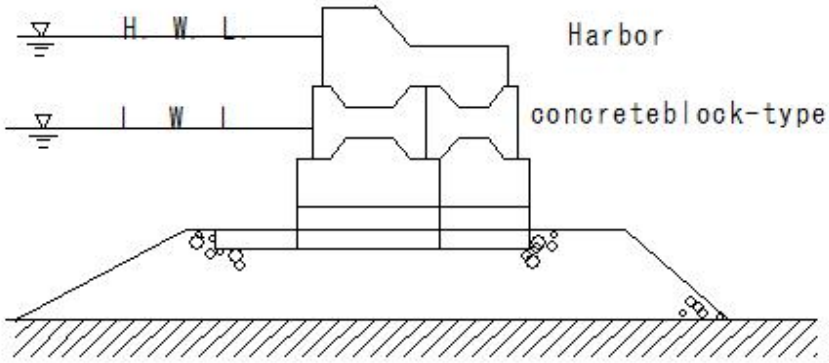
Places where the ground is strong

Lots of reflected waves

upright breakwater



P22



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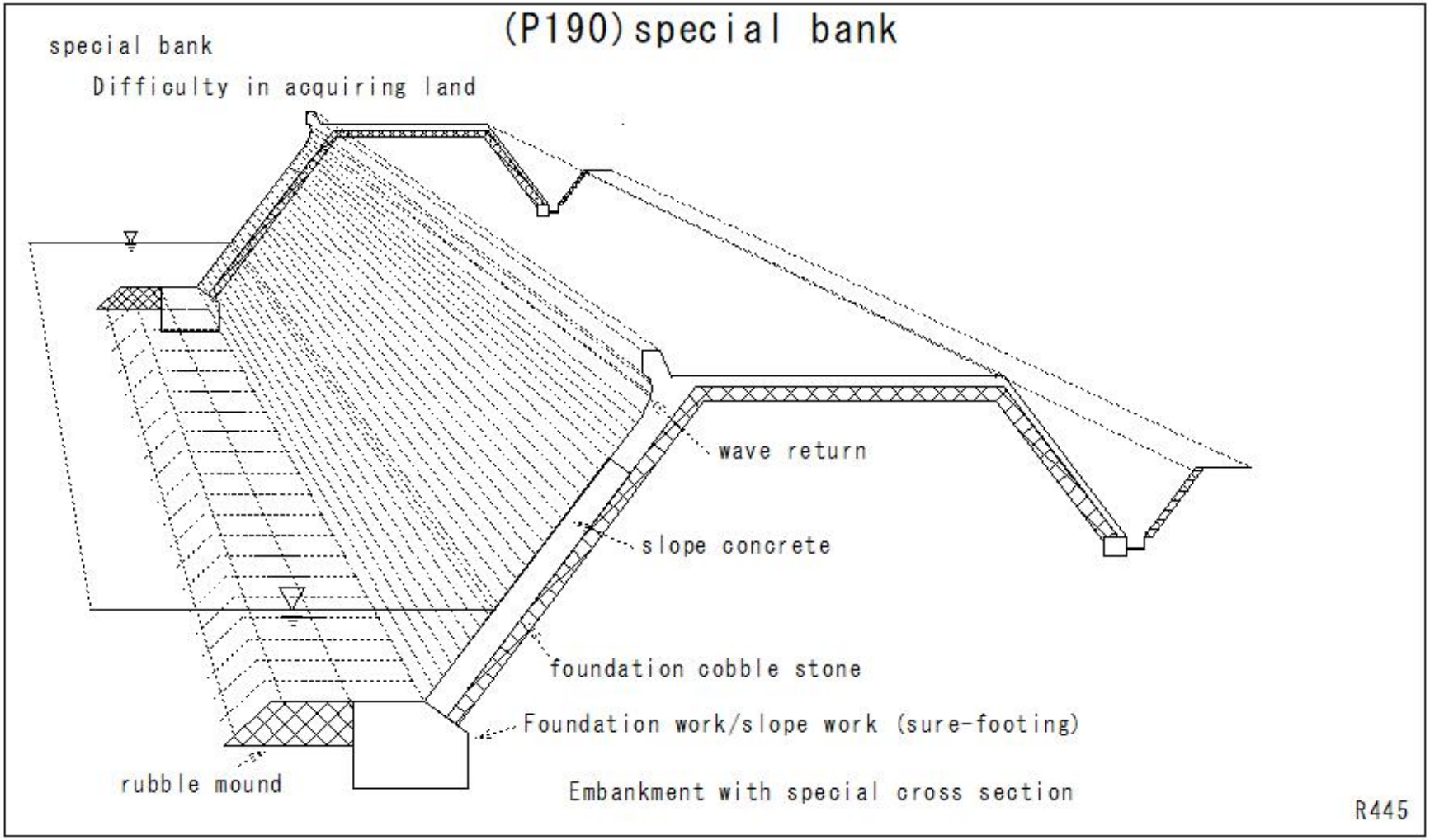
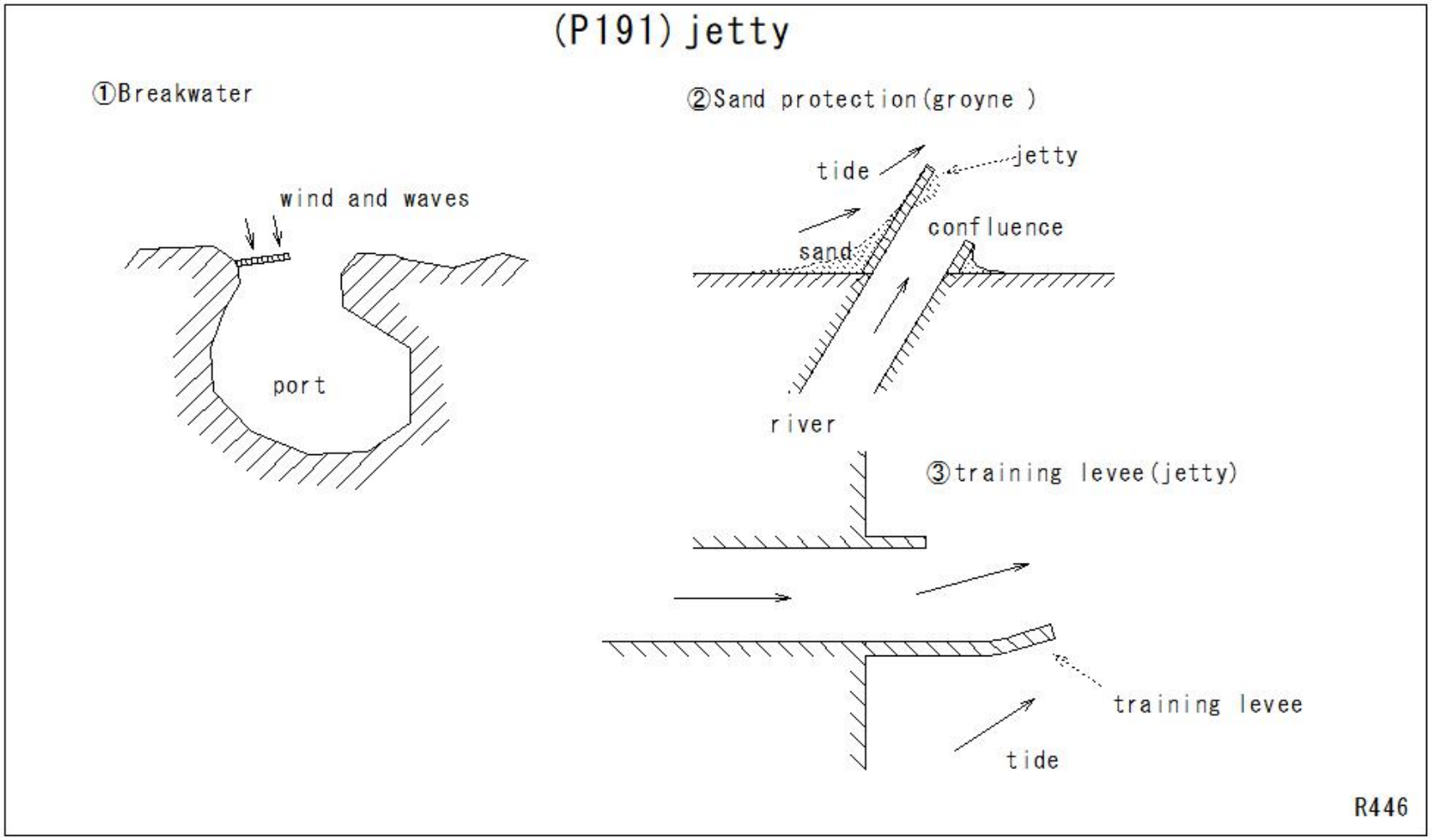
C1326

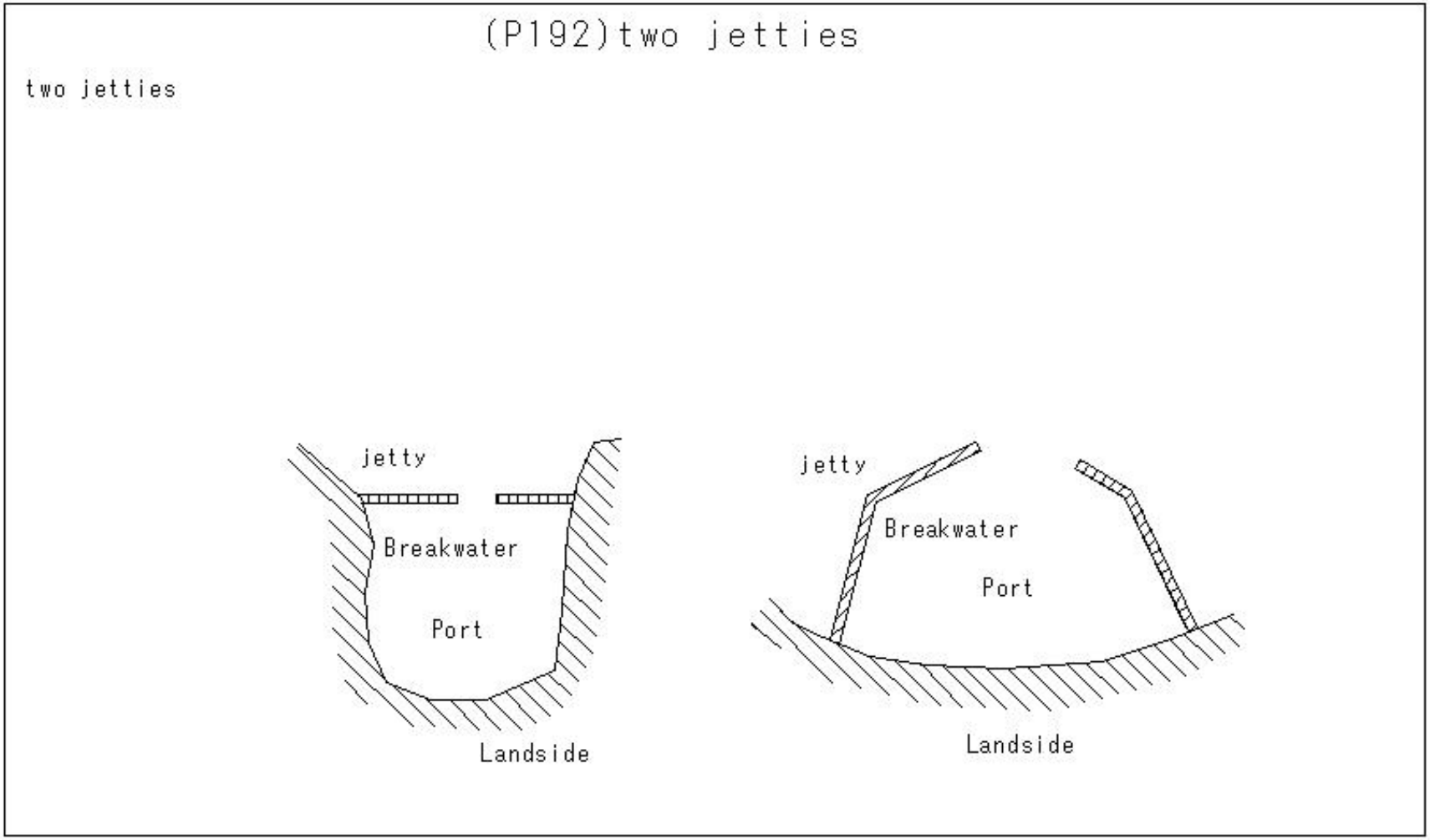
(P190)special bank



(P191)jetty


(P191) jetty
①Breakwater
wind and waves
port
②Sand protection(groyne)
tide
jetty
confluence
sand
river
③training levee(jetty)
training levee
tide
R446

(P192)two jetties



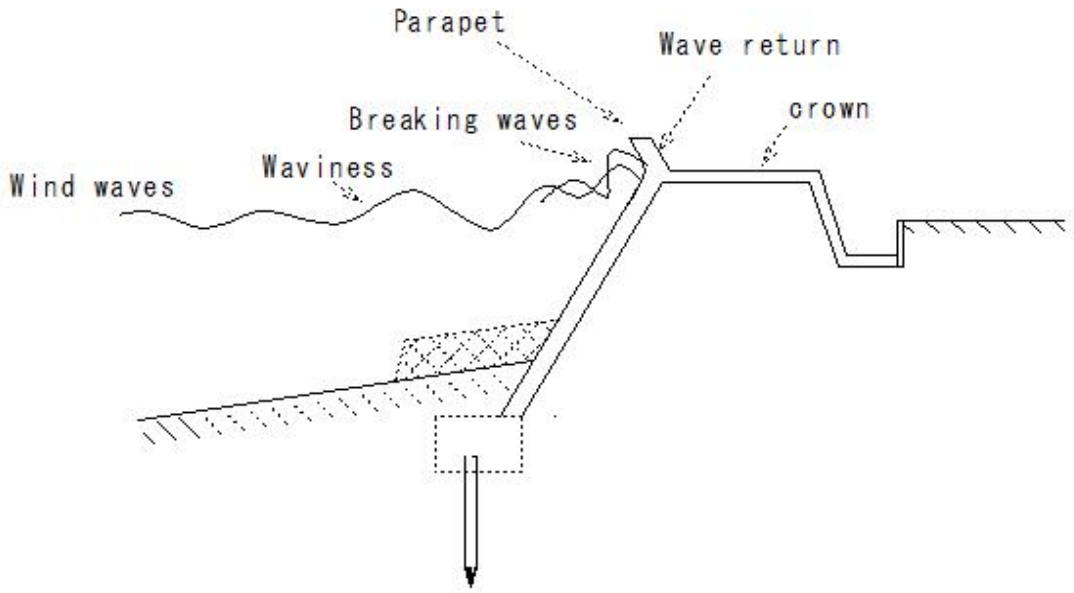
(P193)Parapet

(P193)Parapet

Parapet

Surf-breaking structure

Breakwater crown



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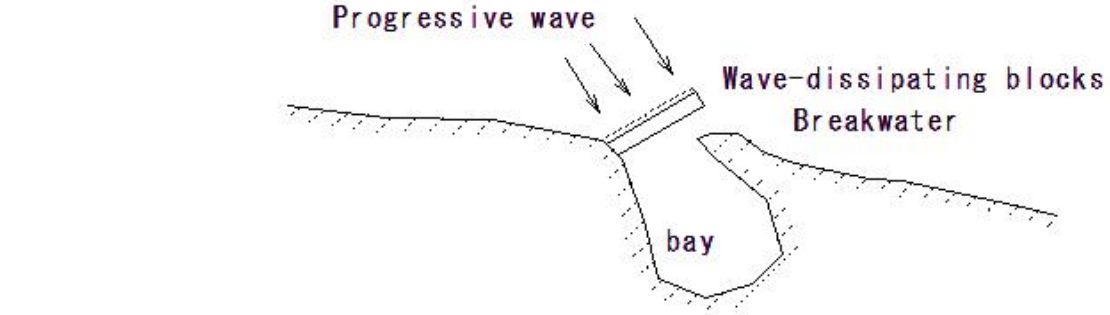
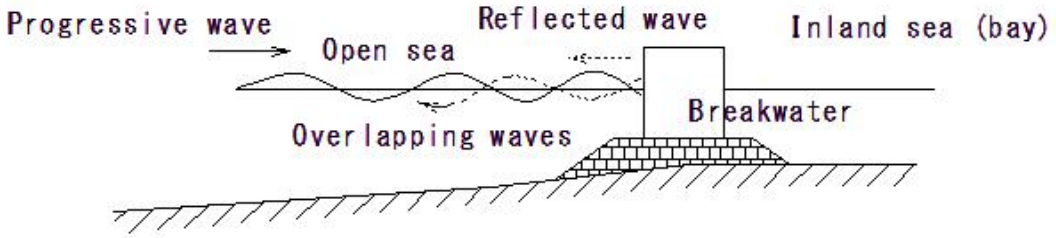
(P194)reflection wave

(P194)reflection wave

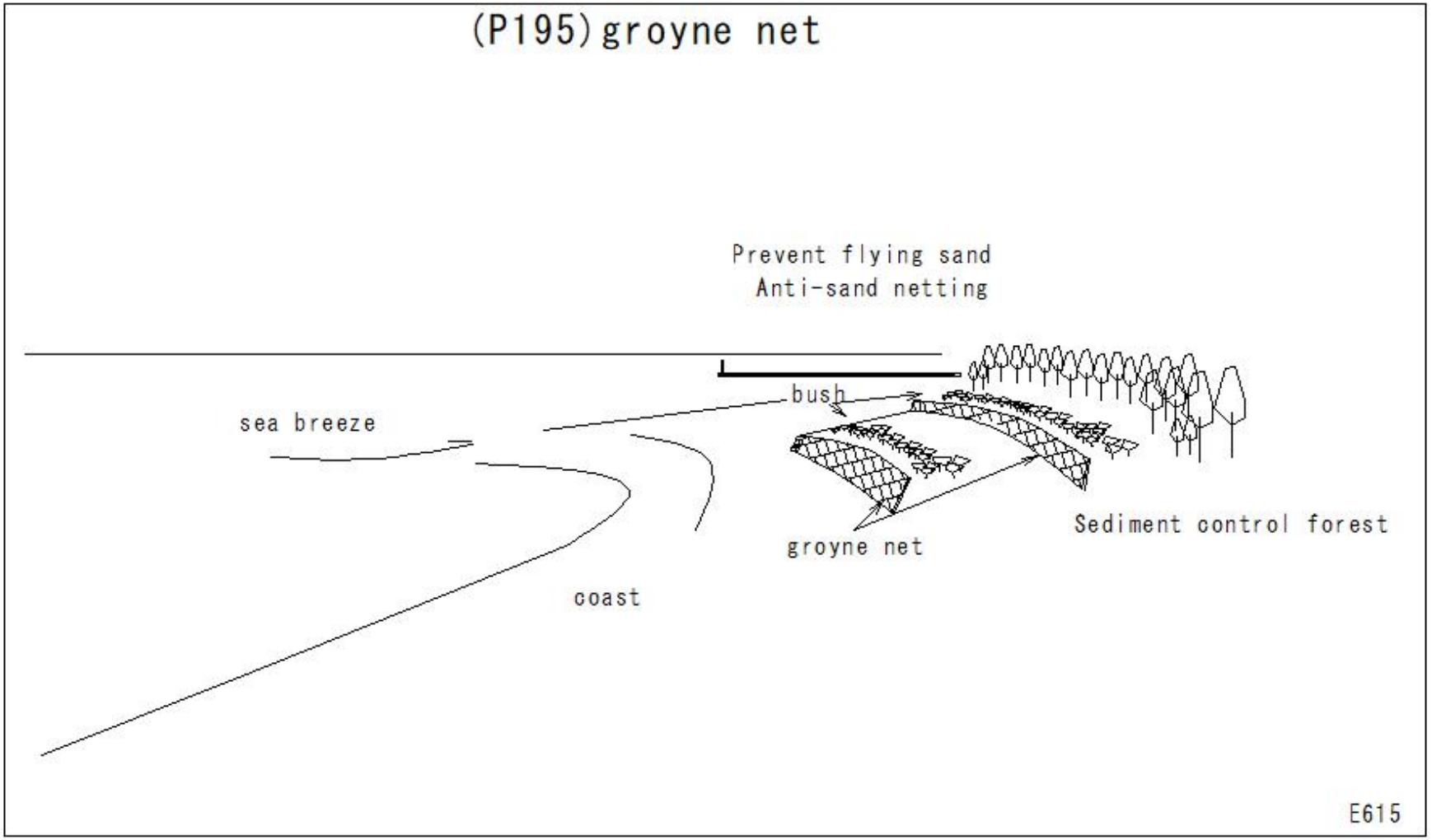
reflection wave

- Progressive waves
- Waves collide and move in the opposite direction
- Outside the breakwater
- Progressive and reflected waves become overlapping waves
- Disturbing the sea area
- Cover with wave-dissipating blocks to reduce reflected waves

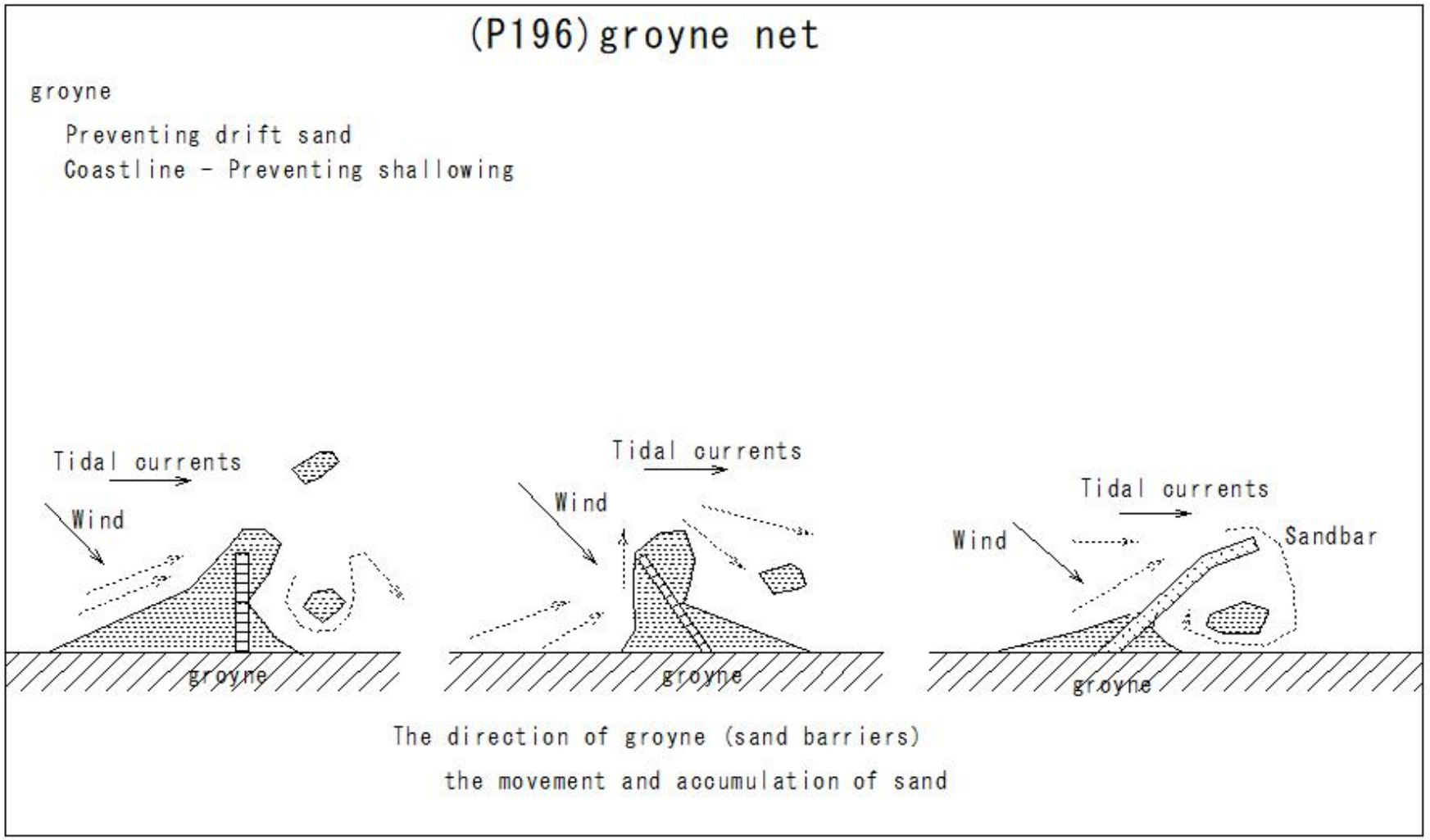




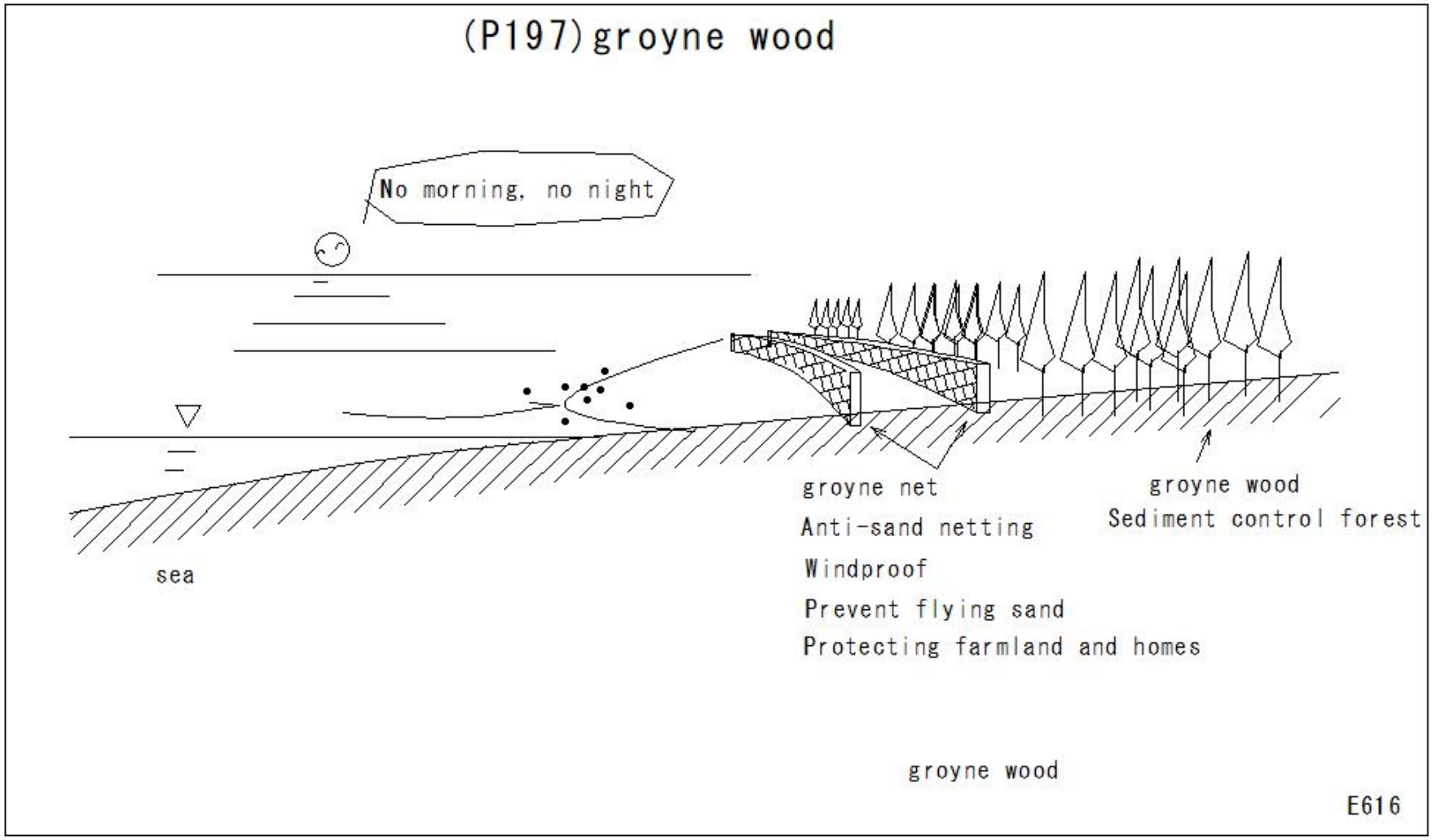
(P195)groyne net



(P196)groyne net



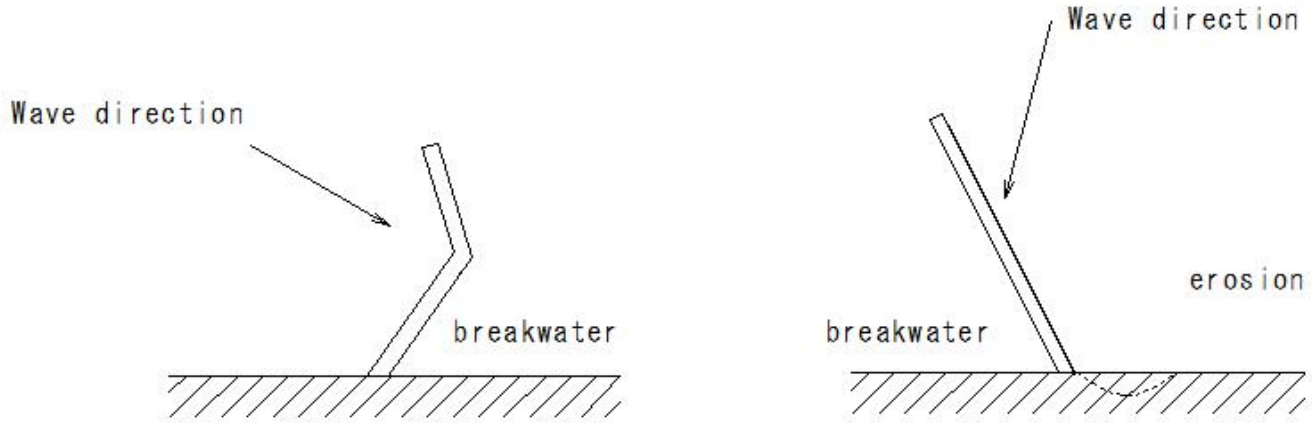
(P197)groyne wood



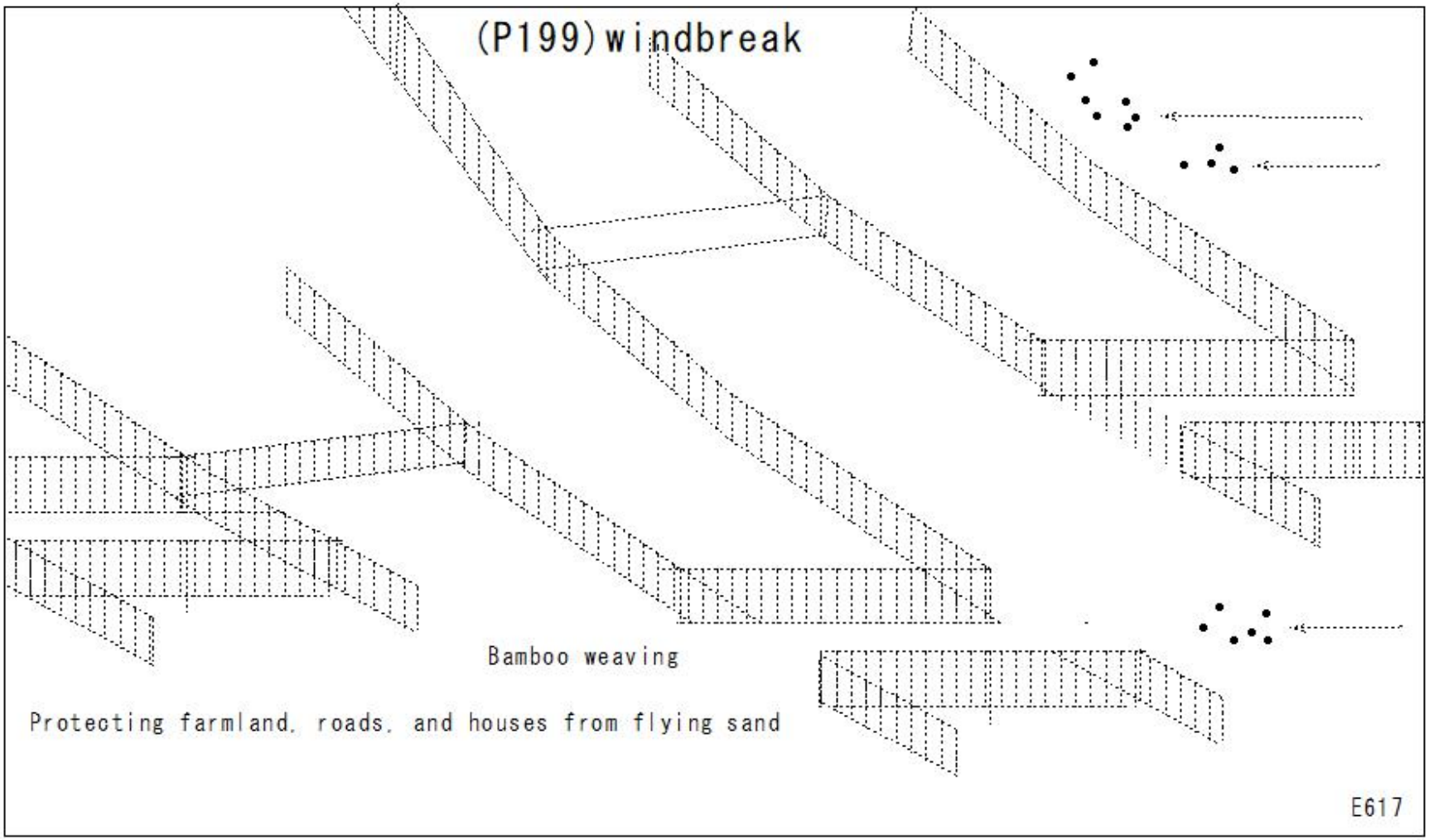
(P198)breakwater

(P198)breakwater

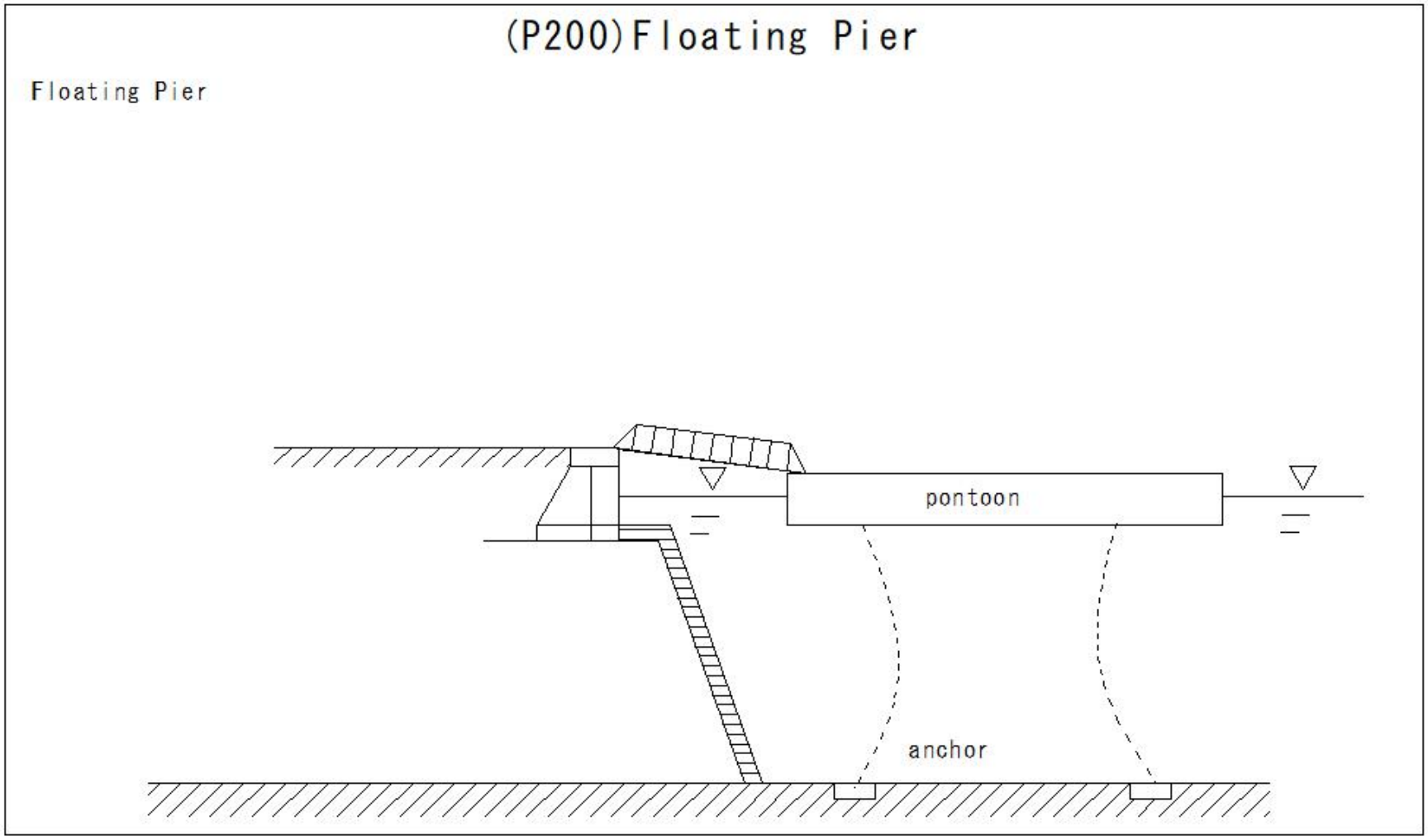
breakwater
Port Facilities
Protects from the waves of the open sea



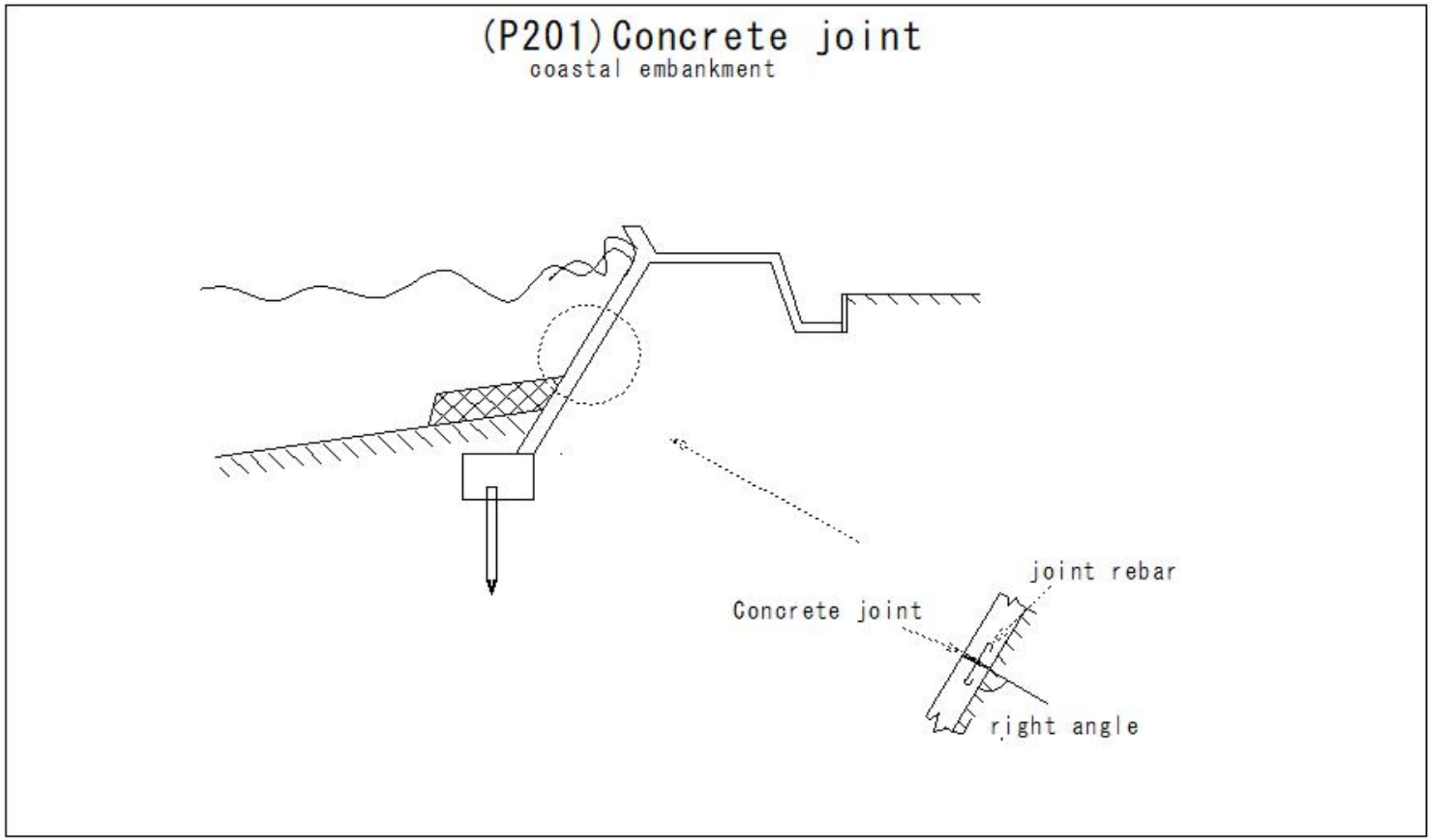
(P199)windbreak



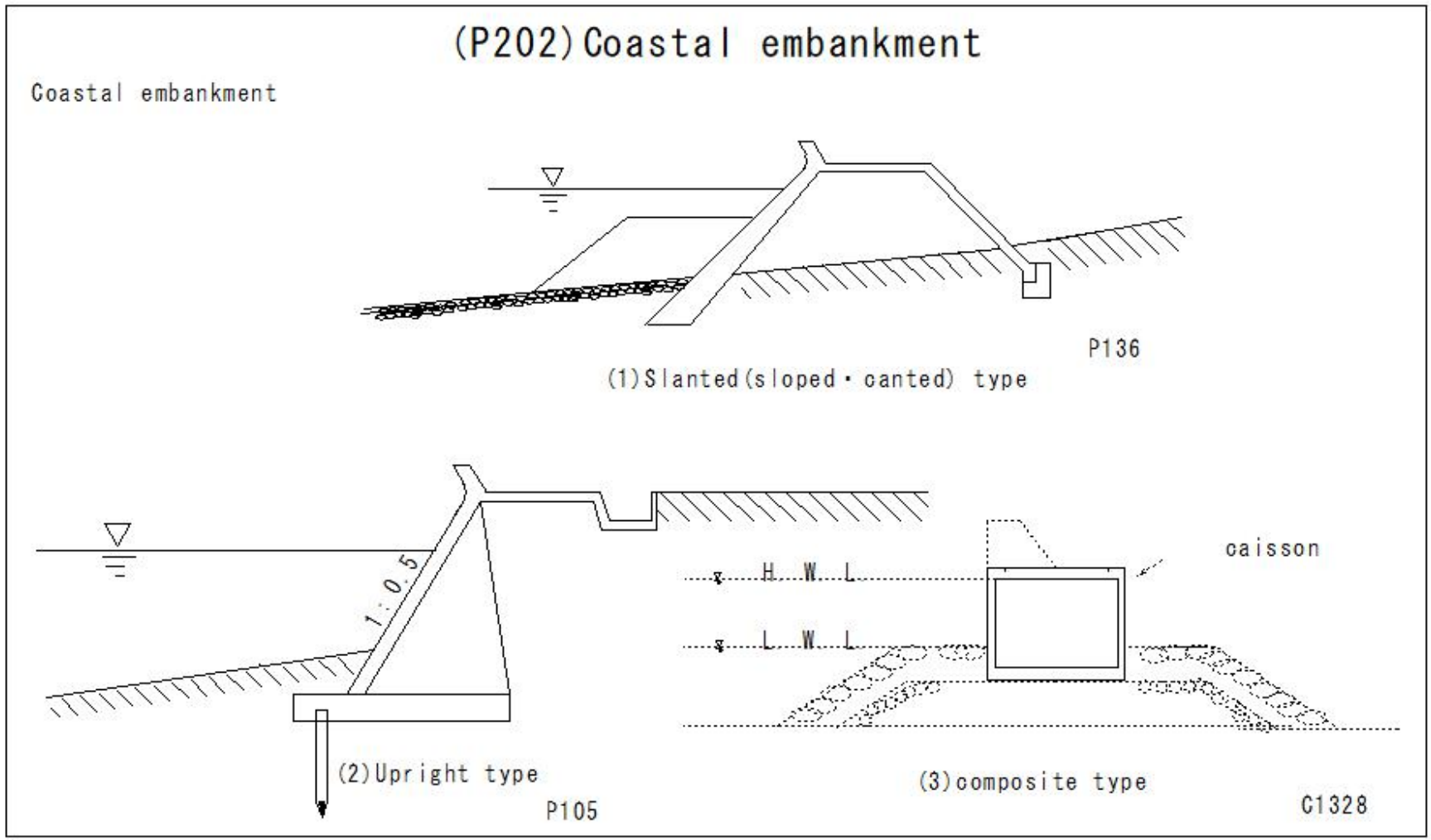
(P200)Floating Pier



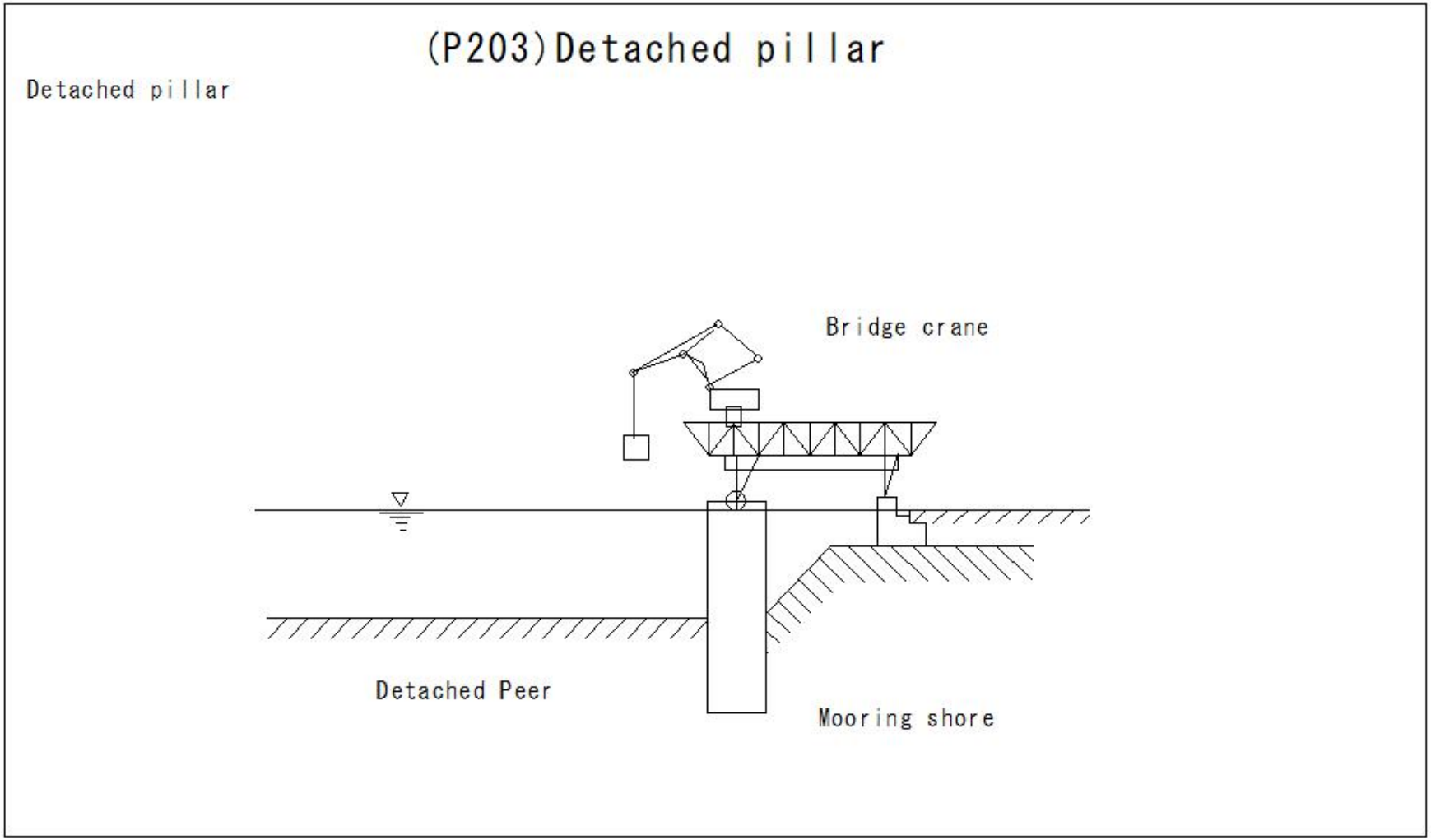
(P201)Concrete joint



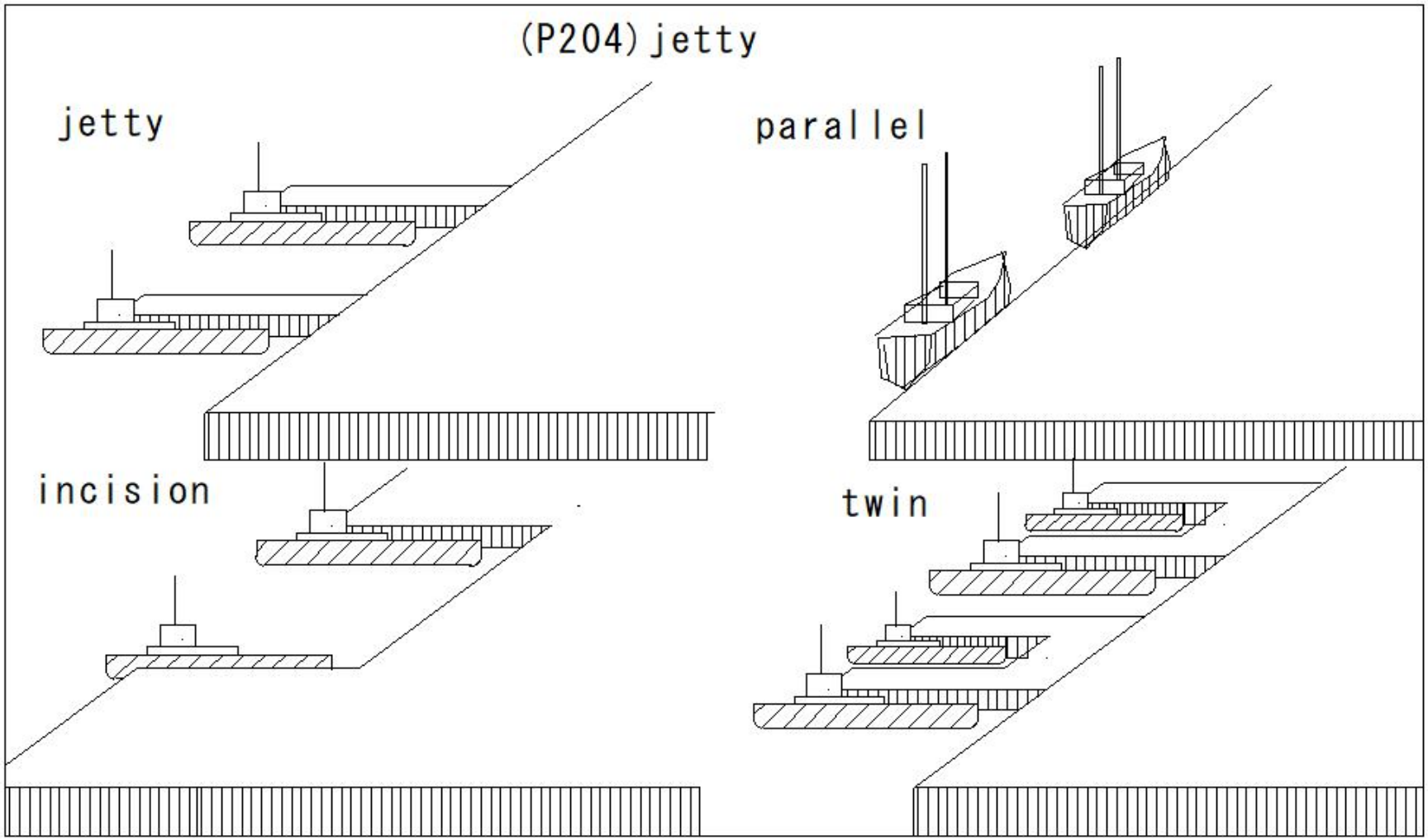
(P202)Coastal embankment



(P203)Detached pillar

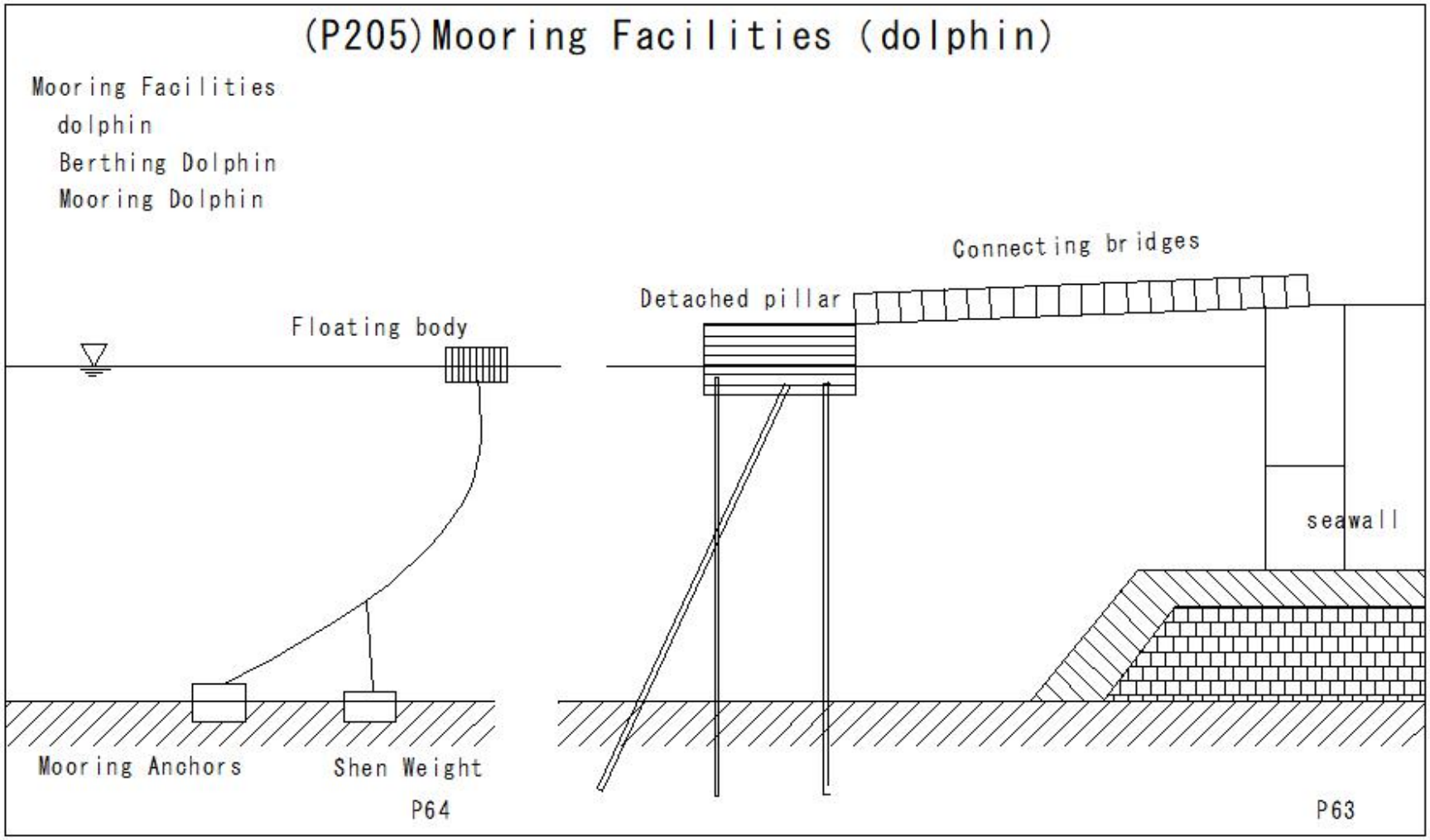


(P204)jetty

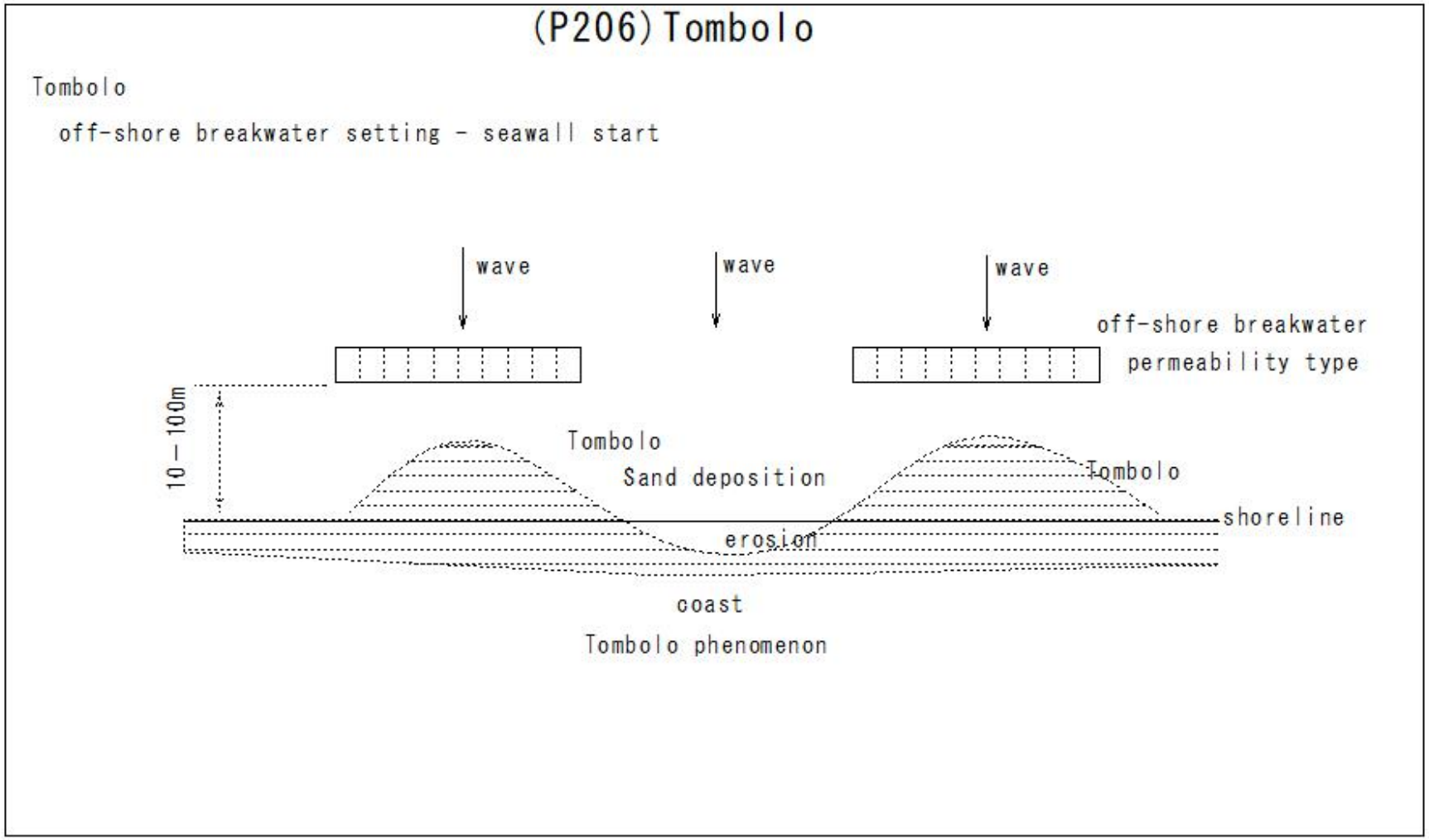


(P205)Mooring Facilities (dolphin)

Mooring Facilities
dolphin
Berthing Dolphin
Mooring Dolphin



(P206)Tombolo

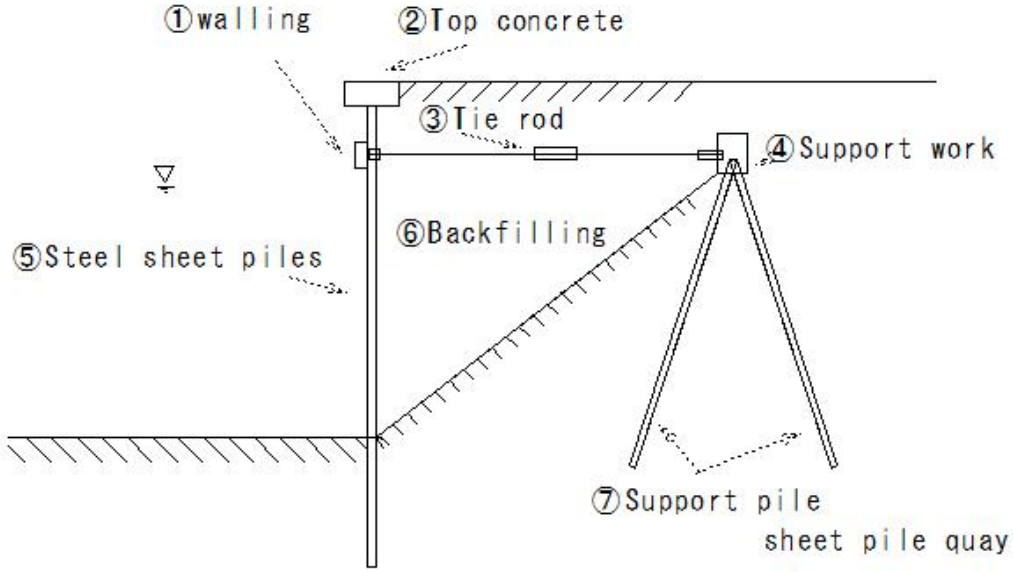


(P207)Sheet piles mooring shore

(P207)Sheet piles mooring shore

Sheet piles mooring shore

After the tie rod is installed, it is applied to the backfill work.



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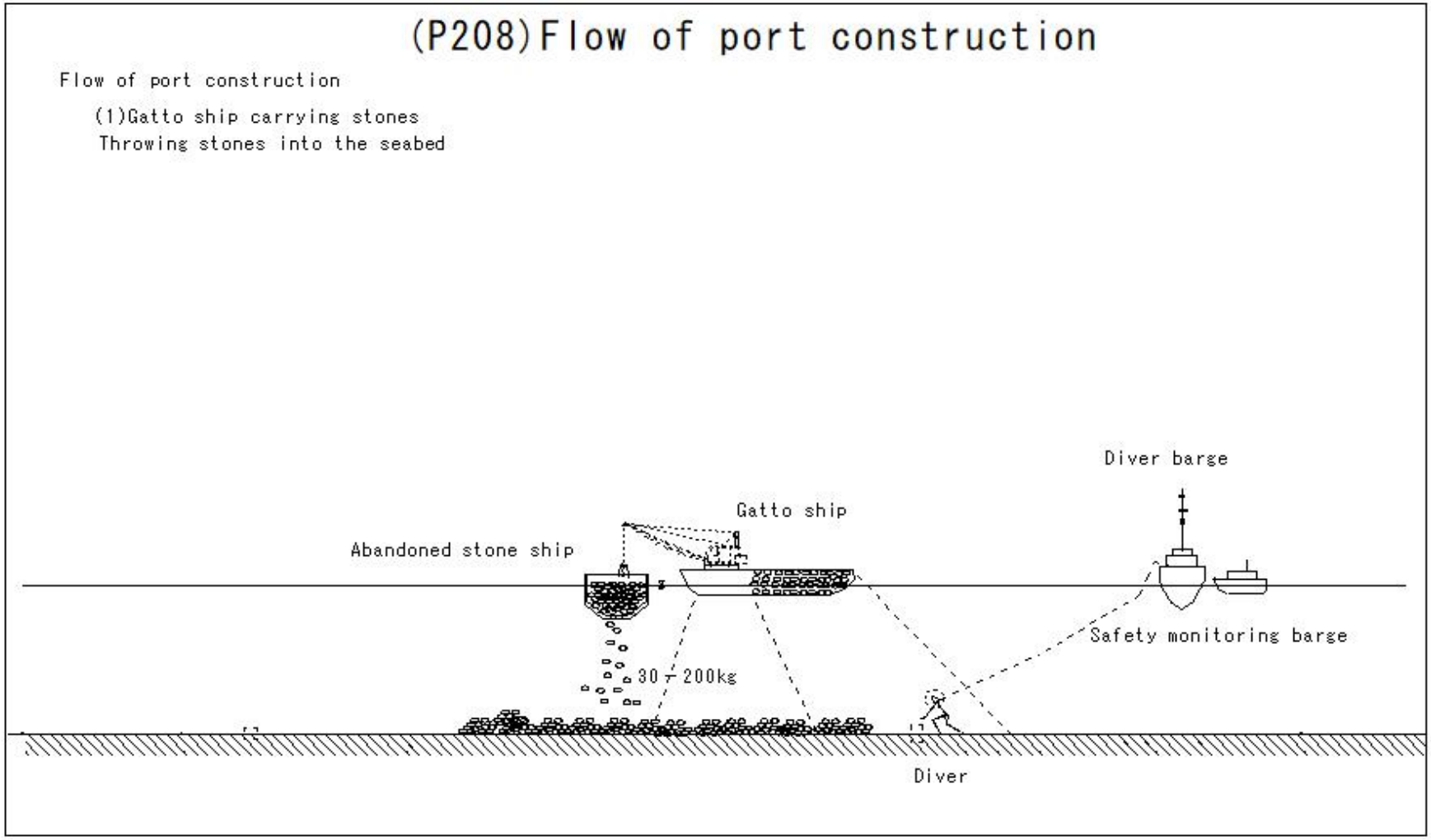
(P208)Flow of port construction

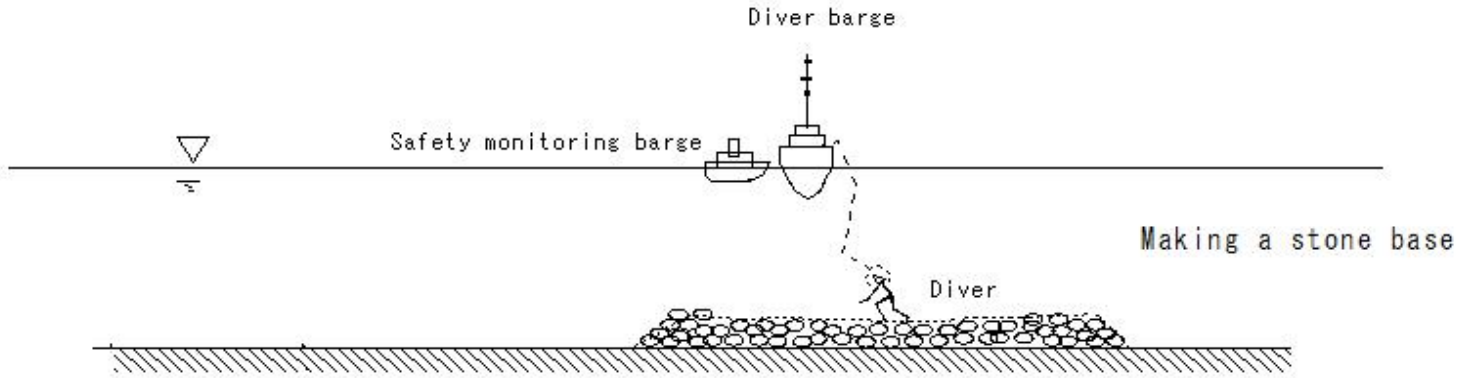


(P209)Flow of port construction

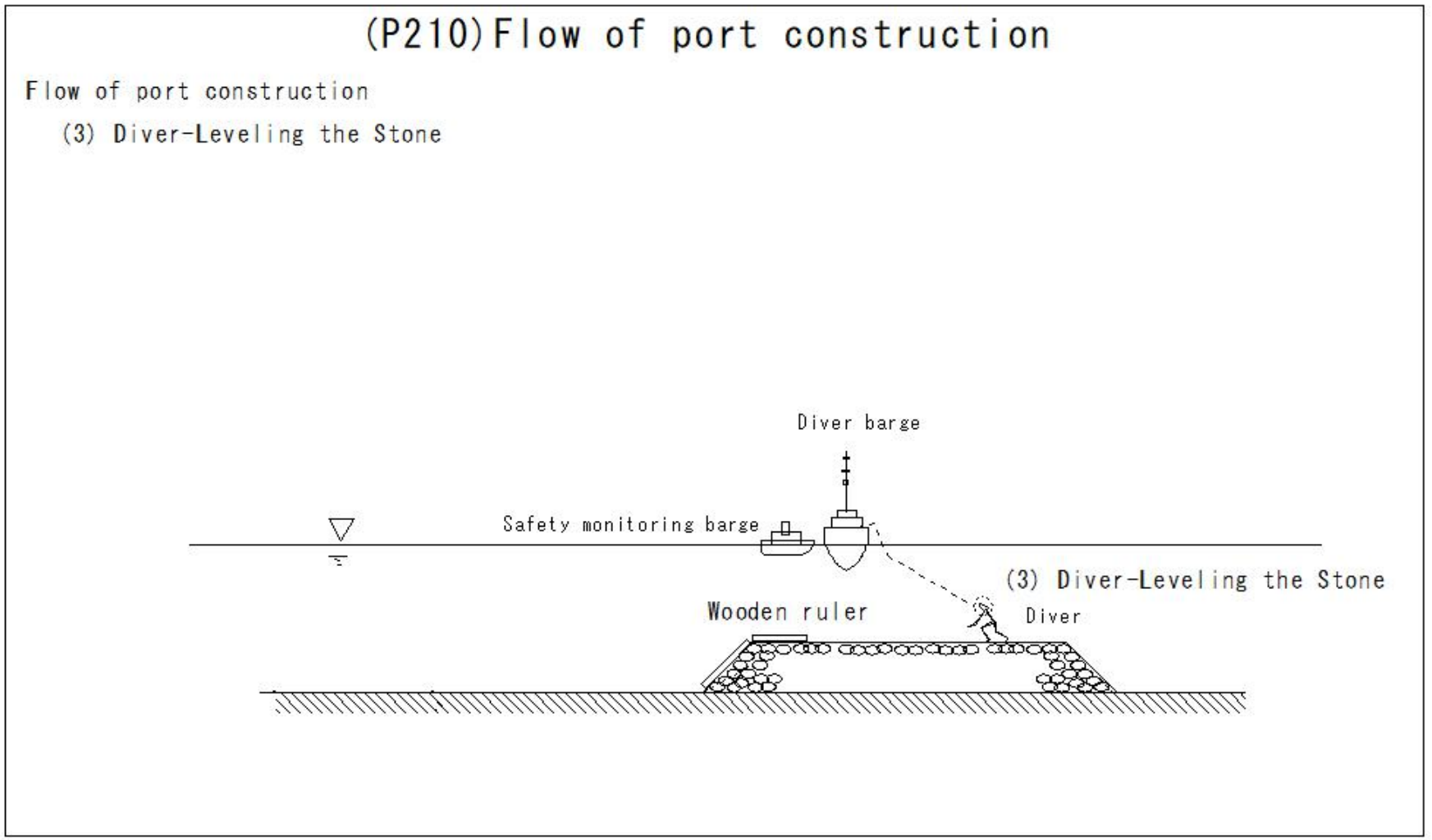
(P209)Flow of port construction

Flow of port construction

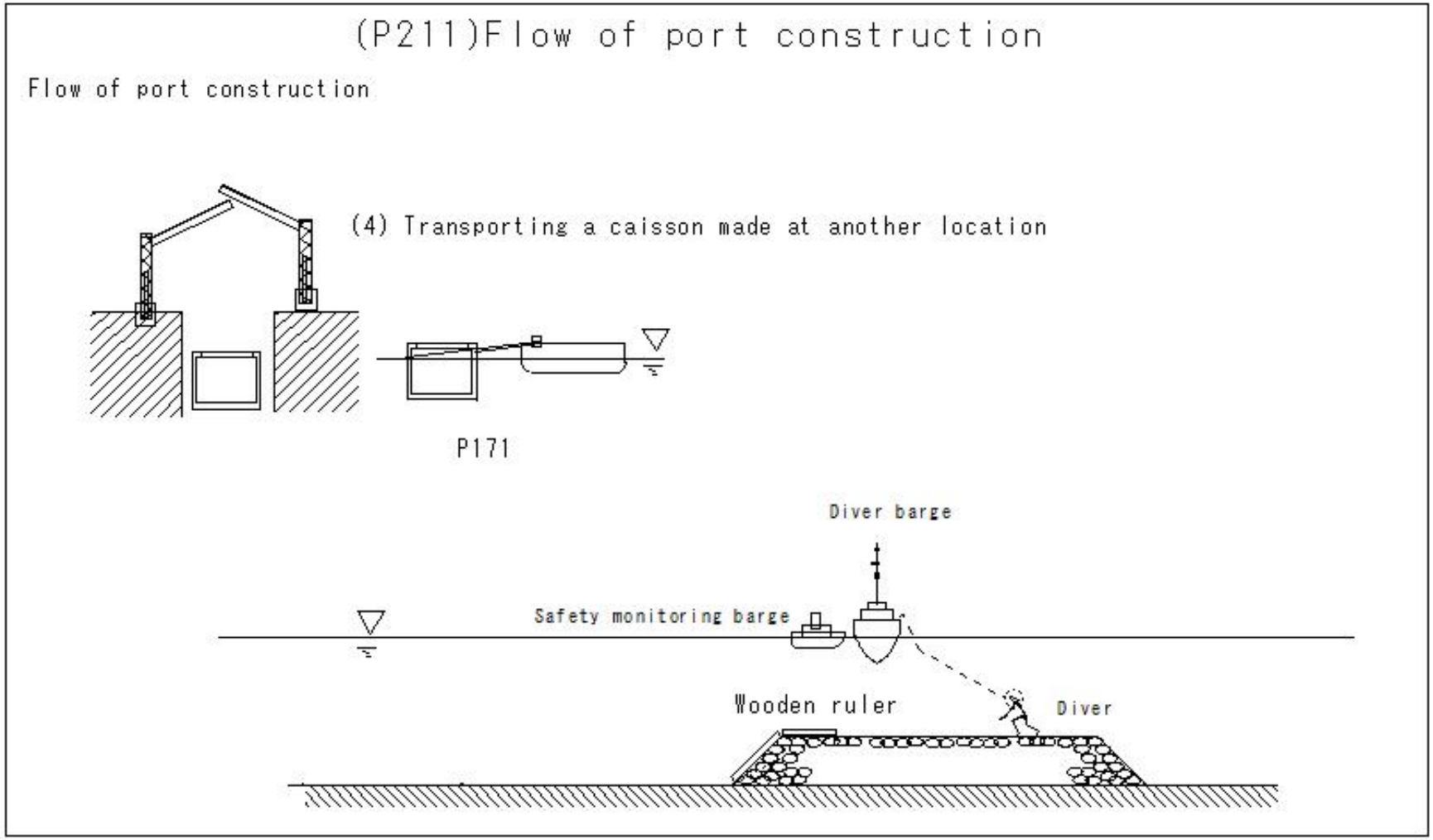
(2) Stones are laid flat by divers.



(P210)Flow of port construction



(P211)Flow of port construction

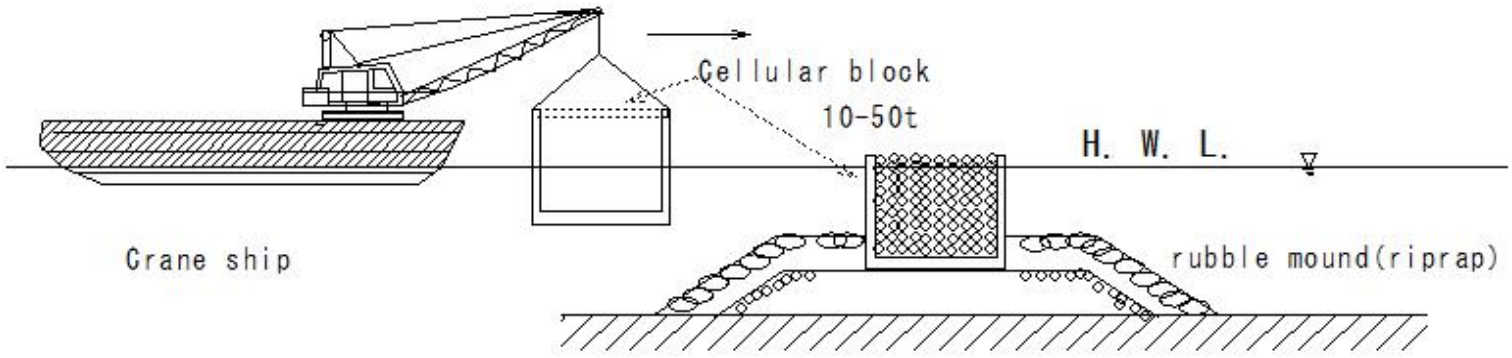


(P212)Flow of port construction

(P212)Flow of port construction

Flow of port construction

(5) Hanging the caisson on the caisson shipLay on the foundati on stone



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(P213)Flow of port construction

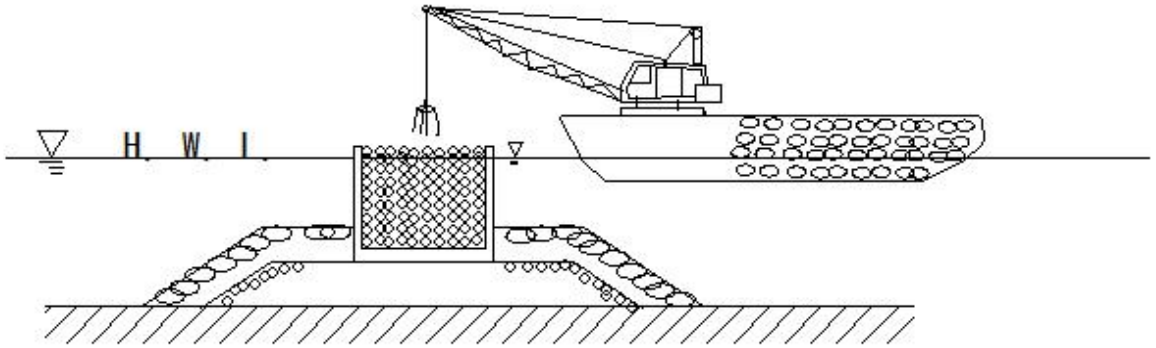
(P213)Flow of port construction

Flow of port construction

(6) Put stones in the caisson

Make the caisson heavier and immobile

- Cover with concrete



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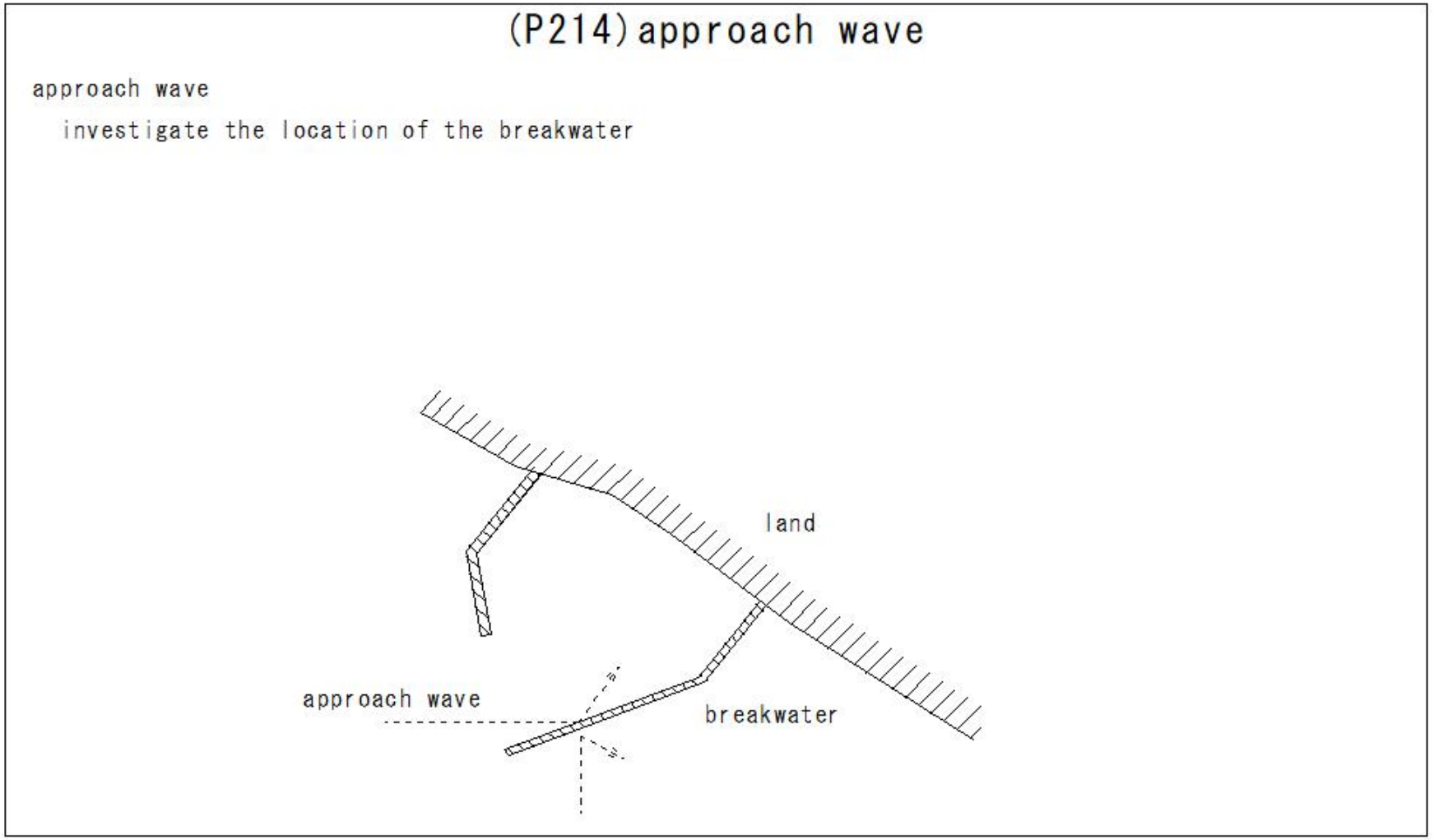
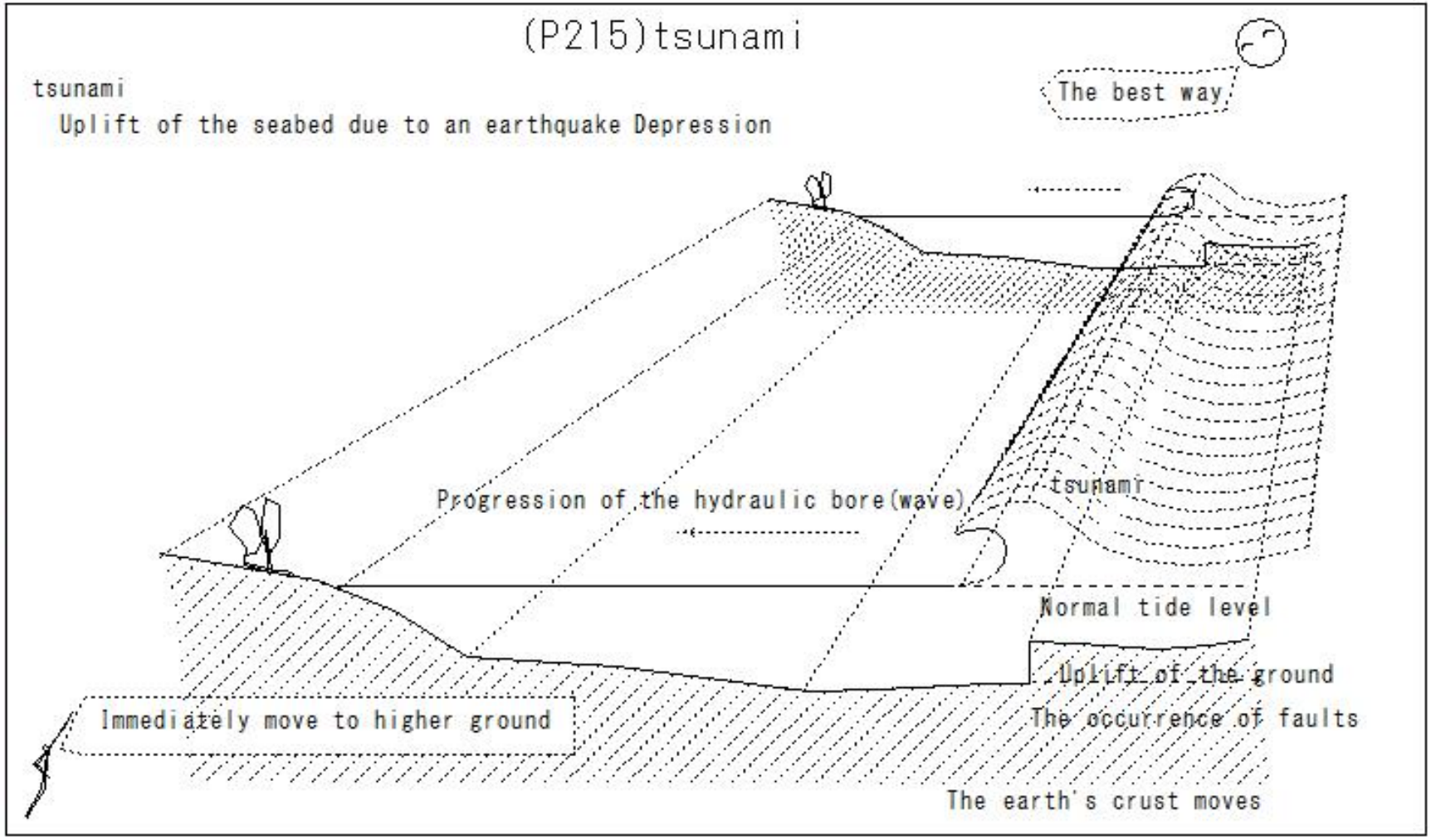
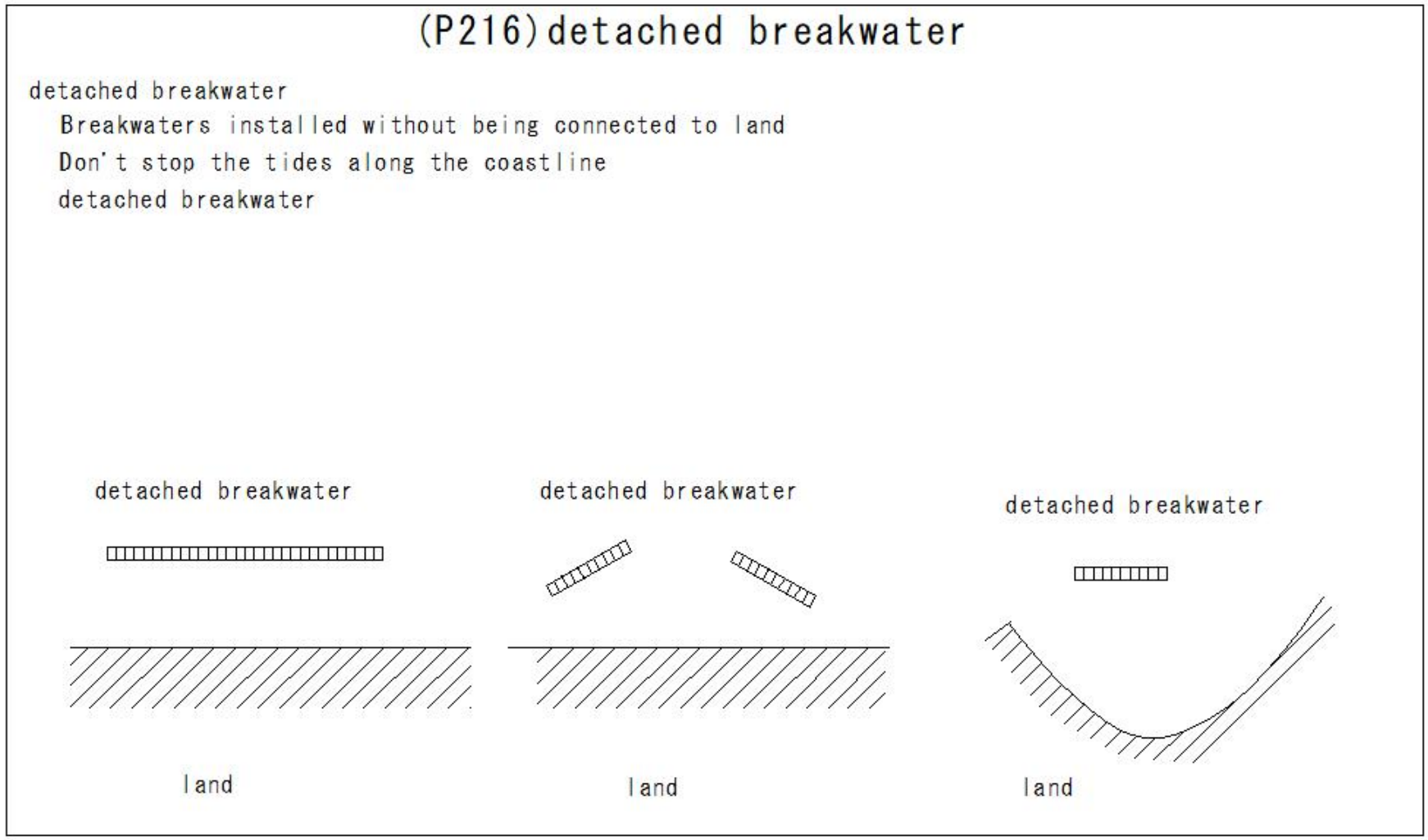
(P214)approach wave



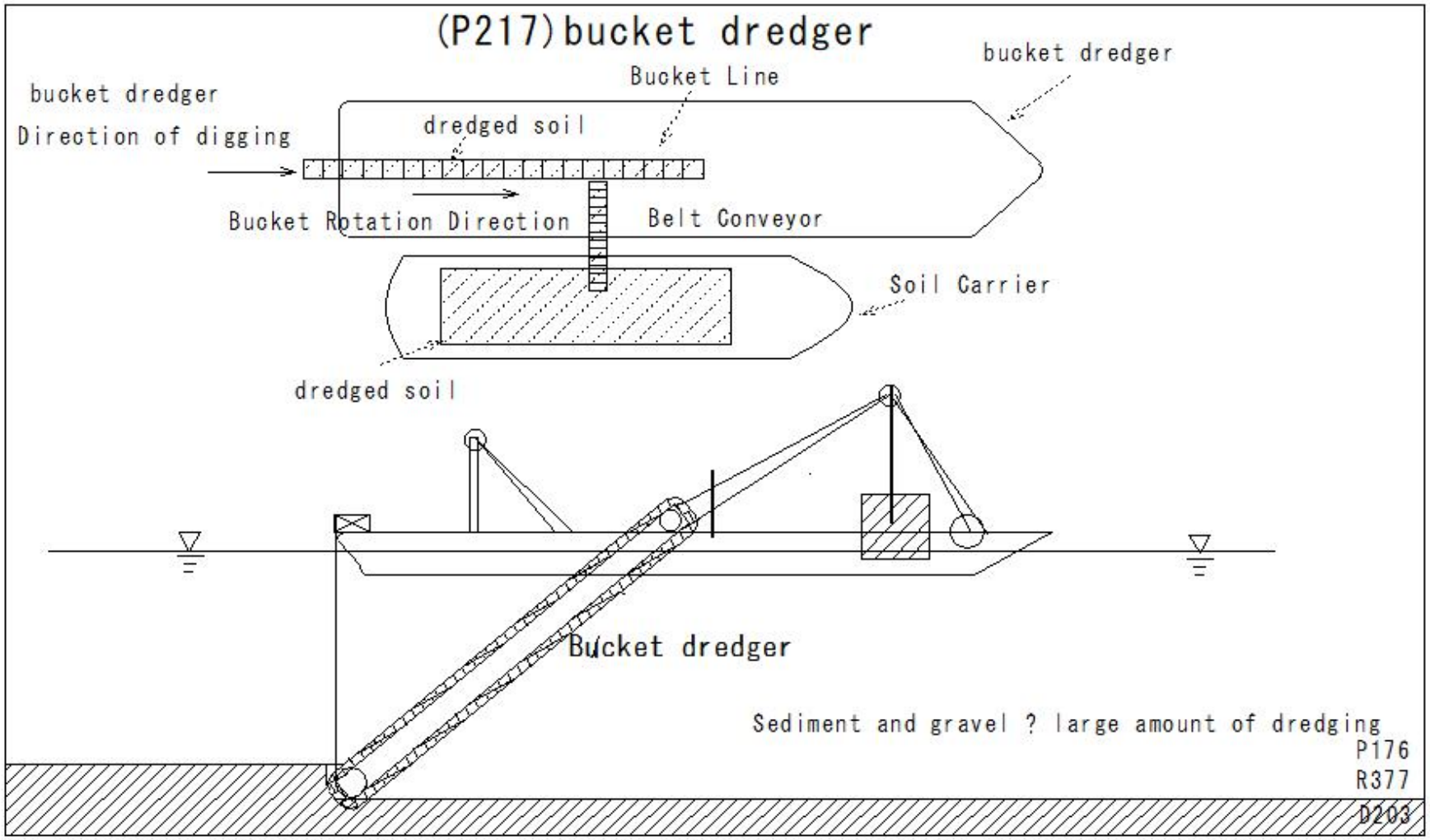
(P215)tsunami



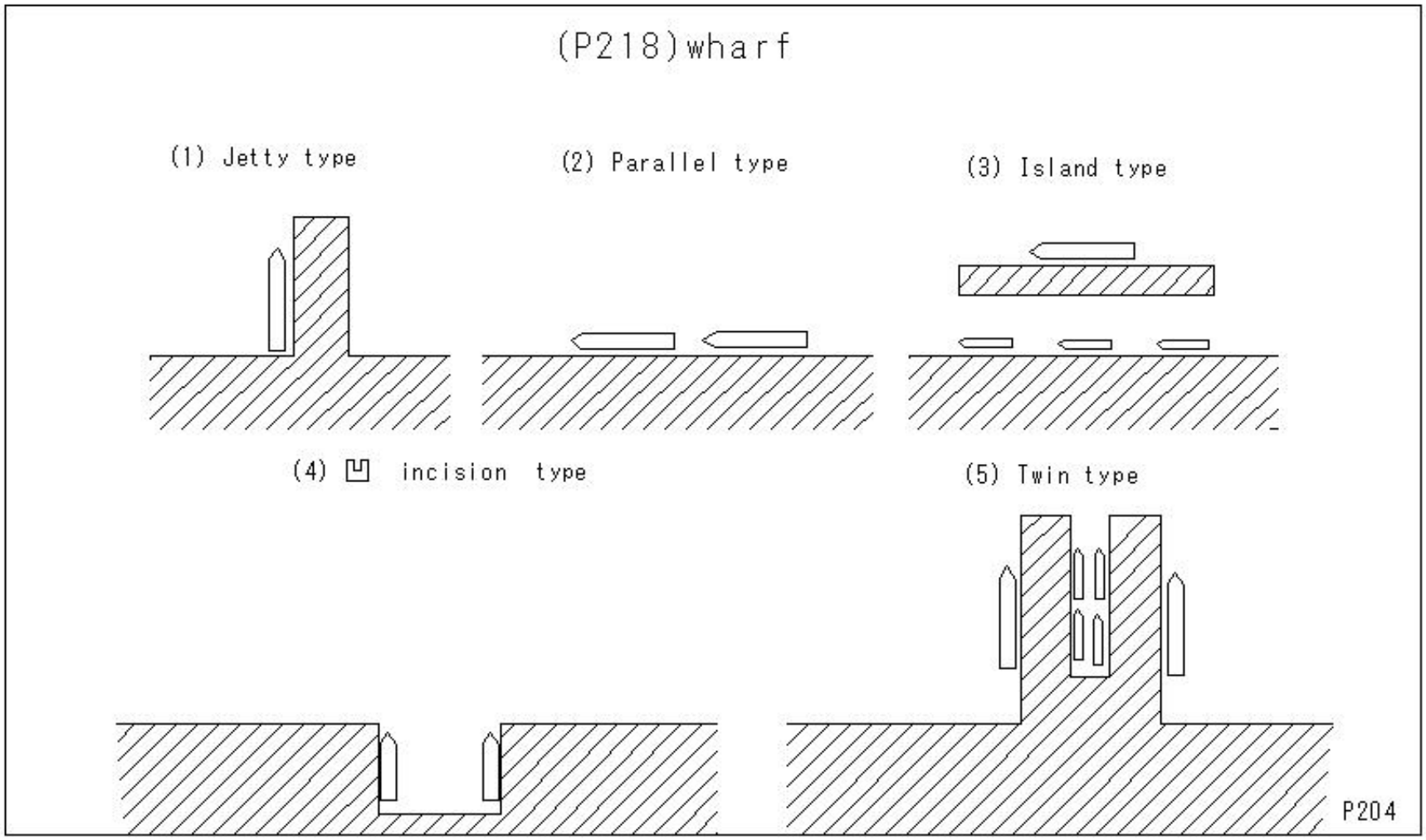
(P216)detached breakwater



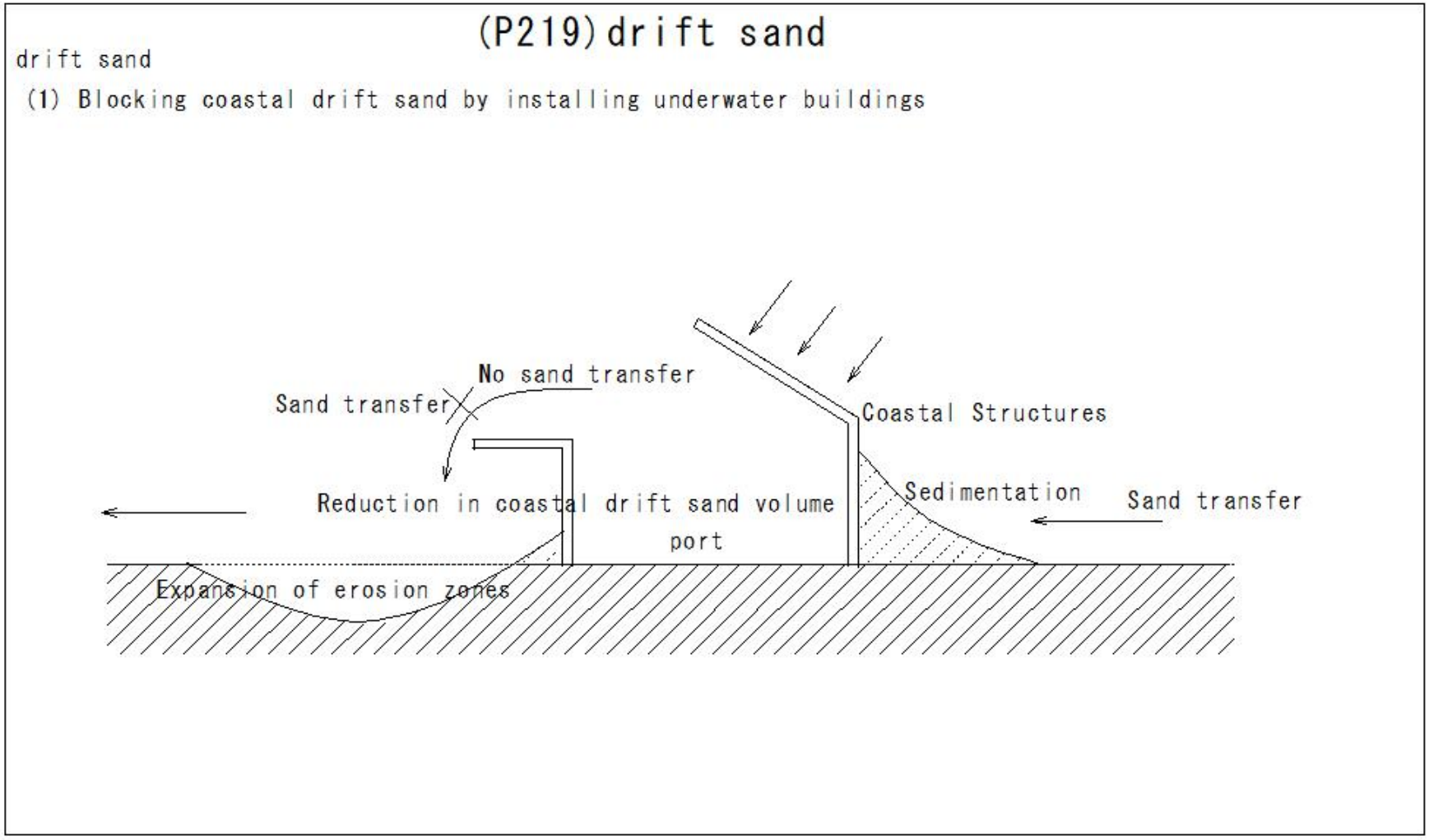
(P217)bucket dredger



(P218)wharf


(P218)wharf
(1) Jetty type
(2) Parallel type
(3) Island type
(4) 凹 incision type
(5) Twin type
P204

(P219)drift sand

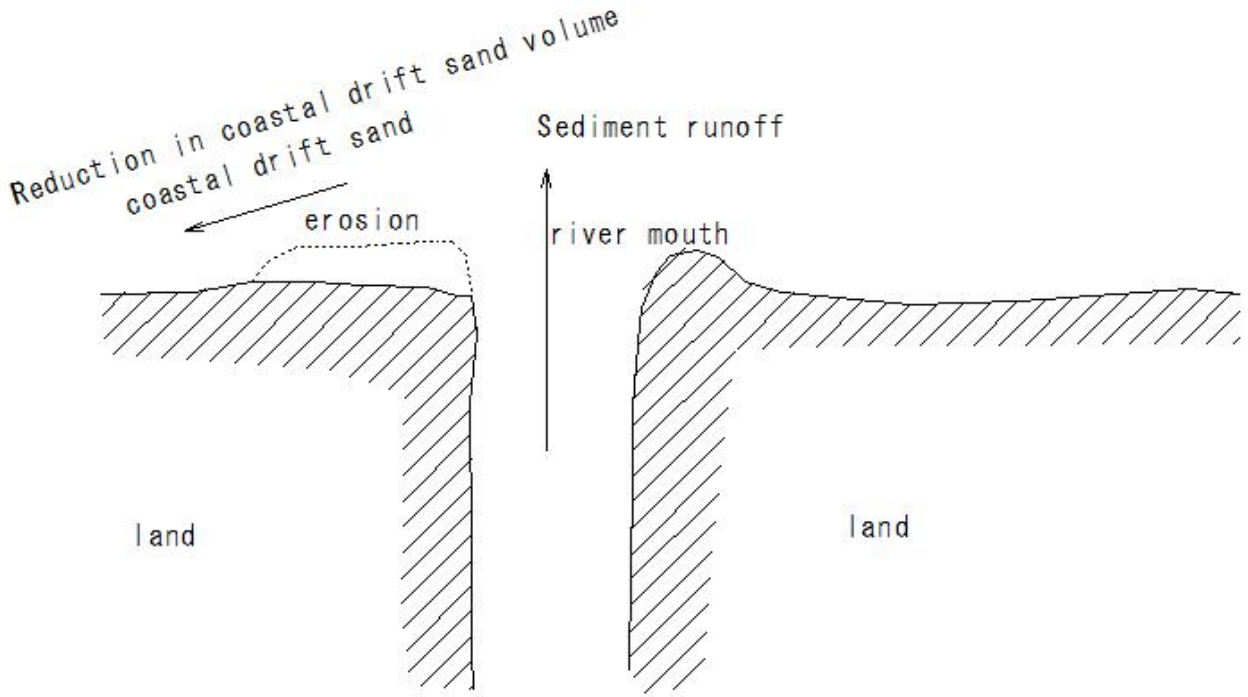


(P220)Coastal erosion

(P220)Coastal erosion

Coastal erosion

(2) Decrease in the amount of sediment supplied from rivers and other sources



(P221)Formation of a tombolo