Chapter 11 Other Port Facilities

[Ministerial Ordinance] (Items Necessary for Other Port Facilities)

Article 57

The items necessary for the performance requirements for fixed and mobile facilities for passenger boarding, waste disposal sites, beaches, and plazas and green spaces as specified in this Chapter by the Minister of Land, Infrastructure, Transport and Tourism and other requirements shall be provided by Public Notice.

[Public Notice] (Other Port Facilities)

Article 94

The items to be specified by Public Notice under Article 57 of the Ministerial Ordinance concerning the performance requirements for fixed facilities for passenger boarding, waste disposal sites, beaches, and plazas and green spaces shall be as provided in the following Article through Article 98.

1 Fixed Passenger Boarding Facilities

[Ministerial Ordinance] (Performance Requirements for Fixed Passenger Boarding Facilities)

Article 53

The provisions of Article 51 apply mutatis mutandis to the performance requirements for fixed passenger boarding facilities.

[Public Notice] (Performance Requirements for Fixed Passenger Boarding Facilities)

Article 95

(1) The provisions of Article 93 (excluding Item (vi)) apply mutatis mutandis to the performance requirements for fixed passenger boarding facilities depending on the types of the facilities.

(2) In addition to the provision of the preceding paragraph, the performance requirements for fixed passenger boarding facilities shall be such that the risks of losing the integrity of members and stability of foundation sections under variable situations, in which the dominating actions are level 1 earthquake ground motions, surcharge loads or winds, shall be equal to or less than the threshold level.

[Interpretation]

15 Other Port Facilities

(1) The performance criteria of fixed passenger boarding facilities (Article 53 of the Ministerial Ordinance and the interpretation related to Article 95 of the Public Notice)

The performance requirements for fixed passenger boarding facilities under a permanent state in which the dominating action is self-weight, or under variable situations in which the dominating actions are level 1 earthquake ground motions, surcharges or winds shall be serviceability. The performance verification items and standard indexes to determine the limit values with respect to the actions shall be as shown in **Attached Table 15-1**. In **Attached Table 15-1**, the standard index to determine the limit values for the soundness of members and the stability of foundation sections shall be appropriately set when carrying out the performance verification of the members and the foundation sections, respectively.

Attached Table 15-1 Performance Verification Items and Standard Indexes to Determine Limit Values of Fixed Passenger Boarding Facilities under Their Respective Design States (Except in Accidental Situations)

Ministerial Ordinance			Public Notice			Performance requirements	Design situation			Verification item	Standard index to determine limit value
Article	Paragraph	Item	Article	Paragraph	Item		Situation	Dominating action	Non-dominating action		
53	–	–	95	–	–	Serviceability	Permanent	Self-weight	Surcharge, earth pressure, water pressure	Soundness of member	–
							Variable	Level 1 earthquake ground motion [Surcharge] [Wind]	Self-weight, surcharge, earth pressure, water pressure (Self-weight, earth pressure, water pressure) (Self-weight, surcharge, earth pressure, water pressure)	Soundness of member Stability of foundation	–

*[ ] means an alternative dominating action to be assessed as a design state.
*( ) means an alternative non-dominating action to be assessed in accordance with the dominant actions.

The performance verification of fixed passenger boarding facilities can be carried out with reference to **Part III, Chapter 10, 2 Mobile Facilities for Passenger Boarding**.

2 Waste Disposal Sites

[Ministerial Ordinance] (Performance Requirements for Waste Disposal Sites)

Article 54

1 The performance requirements for waste disposal sites shall be such that the requirements specified by the Minister of Land, Infrastructure, Transport and Tourism are satisfied so as to appropriately dispose of waste materials and protect disposal sites.

2 The provisions of Article 16 apply mutatis mutandis to the performance requirements for waste disposal sites.

[Public Notice] (Performance Criteria of Waste Disposal Sites)

Article 96

1 The provisions of Article 39 apply mutatis mutandis to the performance criteria of waste disposal sites.

2 In addition to the provision of the preceding paragraph, the performance criteria of waste disposal sites shall be such that the sites are appropriately arranged and have the dimensions necessary to prevent washing out of the waste materials by waves, storm surges, design tsunamis, etc. in consideration of the environmental conditions to which the facilities are subjected.

[Interpretation]

15 Other Port Facilities

(2) Performance criteria of waste disposal sites (Article 54 of the Ministerial Ordinance and the interpretation of Article 96 of the Public Notice)

The required performance criteria and interpretation for seawalls shall be applied to those for waste disposal sites.

2.1 General

(1) The definitions of waste differ depending on whether the reference is made to the **Waste Disposal and Public Cleansing Act** (Act No. 137 of 1970, hereinafter referred to as the "Waste Disposal Act") or the **Act for the Prevention of Marine Pollution and Maritime Disasters** (Act No. 136 of 1970, hereinafter referred to as the "Marine Pollution Prevention Act"). The main difference in the definitions between the two acts is that earth and sand are not reflected in the Waste Disposal Act, but they are in the Marine Pollution Prevention Act. In this code, waste subject to the Waste Disposal Act, as well as earth and sand subject to the Marine Pollution Prevention Act, is collectively defined as waste. In the Marine Pollution Prevention Act, the definition of waste does not include the type of earth and sand which is sufficiently managed by contractors and has a quality considered acceptable as reclamation materials (refer to the Circular Notice of the Transport Minister's Secretariat, No. 289 of 1972 "Concerning the implementation of the Marine Pollution Prevention Act"). The Marine Pollution Prevention Act is applicable to the waste discharged from ships to the sea.

(2) In the Waste Disposal Act, waste is classified into: general waste; the industrial waste specified in (1) to (6), (a), Item 3, Article 6 of the **Enforcement Ordinance of the Waste Disposal Act** (hereinafter referred to as "stable-type industrial waste"); the industrial waste specified by (c), Item 14, Article 7 of the **Enforcement Ordinance of the Waste Disposal Act** (hereinafter referred to as "controlled-type industrial waste"); and the industrial waste specified in (1) to (5), (c), Item 3, Article 6 and (1) to (6), (a), Item 3, Article 6-5 of the **Enforcement Ordinance of the Waste Disposal Act** (hereinafter referred to as "shielding-type industrial waste").

(3) In the Marine Pollution Prevention Act, dredged soil is classified into: hazardous dredged soil specified in Items 4 and 5, Paragraph 2, Article 5 of the **Enforcement Ordinance of the Marine Pollution Prevention Act**; and special, designated and other dredged soil (hereinafter referred to as "general dredged soil") specified in Item 1, Paragraph 1, Article 5 of the **Enforcement Ordinance of the Marine Pollution Prevention Act**.

(4) Depending on the types of waste subject to landfill disposal, waste disposal sites are classified into: stabilized waste disposal sites for the disposal of stabilized waste and general dredged soil; controlled-type waste disposal sites for

the disposal of general waste and controlled-type waste; and strictly controlled-type waste disposal sites for the disposal of strictly controlled-type waste.

(5) Waste disposal sites are constructed not only for the landfill disposal of waste, but also for the land use after the disposal operation. Therefore, the areas and layouts of landfill sites and landfill methods shall be determined based on the demands for land use and constraints in cases where waste disposal is subjected to the Waste Disposal Act.

(6) After the abolition of final disposal sites, controlled-type waste disposal sites are maintained as port facilities. However, waste disposal sites still need to maintain their water impermeability, and there are cases where groundwater levels in landfilled areas need to be controlled. Thus, the facility layouts of final disposal sites shall be assessed while taking into consideration not only the land use, but also the maintenance after the abolition of the final disposal sites. In addition, it is desirable to assess the facility layouts in close collaboration with the environmental sections in charge of waste disposal.

(7) There has been no practical example of waste disposal sites constructed in areas other than sea areas and it is expected that almost all waste disposal sites will be constructed in sea areas in the future. Thus, the waste disposal sites discussed in this code shall be those to be constructed in sea areas. Therefore, the characteristics of waste disposal sites are such that ① they shall be constructed with due consideration to the actions of waves and earthquake ground motions, and ② revetments and seepage control work shall be stabilized with properly controlled levels of retained water in the case of controlled-type waste disposal sites.

2.2 Purposes and Types of Waste Disposal Sites

(1) The purposes of constructing waste disposal sites are to develop sea area waste disposal sites and to protect the sites and hinterlands from storm surges, tsunamis and waves. These purposes shall be valid even after landfilled areas are used for other land use.

(2) The environmental safety and compatibility of waste disposal sites shall be achieved not only by their performance as revetments, but also by how adequately they manage waste for disposal. Thus, it is necessary to assess how to manage waste for disposal in close collaboration with the authorities who manage the waste.

2.2.1 Stabilized Waste Disposal Sites

(1) Stabilized waste disposal sites are facilities that enable the disposal of stabilized industrial waste and general dredged soil. They do not require construction permits for final disposal sites based on the Waste Disposal Act.

(2) Stabilized waste disposal sites shall have the function of preventing waste in landfill sites from being washed out.

(3) Waste which is subject to the Waste Disposal Act and which is to be disposed of at stabilized waste disposal sites shall conform to the landfill disposal standards specified in the Waste Disposal Act.

2.2.2 Controlled-Type Waste Disposal Sites

(1) Controlled-type waste disposal sites are facilities that enable the disposal of general waste (excluding specially-controlled general waste) and controlled-type industrial waste. Controlled-type waste disposal sites for waste under the Waste Disposal Act are subject to construction permits for final disposal sites based on the Waste Disposal Act and the technical standards in the Waste Disposal Act (the **Ministerial Ordinance Prescribing the Technical Standards concerning the Final Landfill Sites of General Waste and Industrial Waste** (Ordinance of the Prime Minister's Office and the Ministry of Health and Welfare No. 1 of 1977), hereinafter referred to as the "Ministerial Ordinance for Final Disposal") until confirmation of the abolition of the final landfill sites based on the Waste Disposal Act. In addition, controlled-type waste disposal sites shall be managed as designated areas under the Waste Disposal Act even after the confirmation of the closure of the landfill sites (refer to (5)). The laws and regulations applicable to controlled-type waste disposal sites corresponding to each stage of life are summarized in **Fig. 2.2.1**.

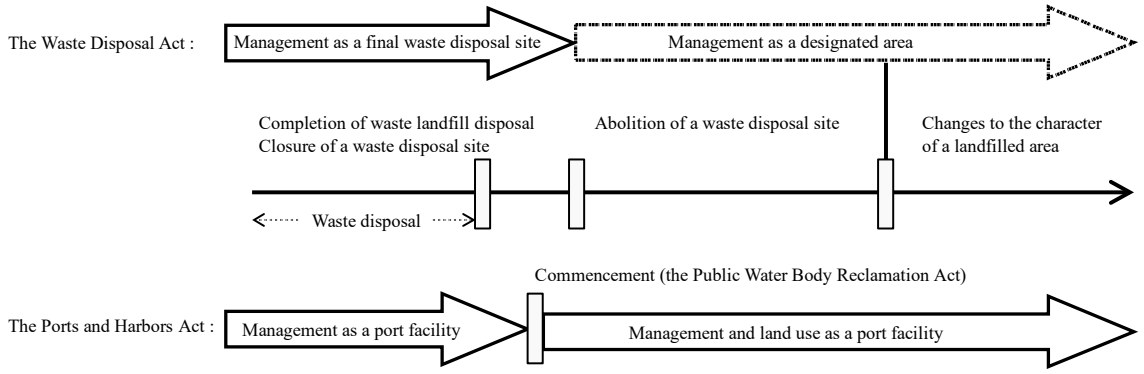

Fig. 2.2.1 The Laws and Regulations Applicable to Controlled-Type Waste Disposal Sites for Waste Subject to the Waste Disposal and Public Cleansing Act (Modification of the Literature[2])

(2) Controlled-type waste disposal sites shall have the required water impermeability to keep retained water in waste landfill sites from leaking out, in addition to preventing waste in landfill sites from being washed out. It is preferable that water impermeability be ensured through the introduction of a fail-safe concept. Here, the fail-safe concept means the introduction of at least one of the following measures: double seepage control structures where water impermeability can be maintained by either one of the structures when the other is damaged; water level control to keep hydraulic gradients in a direction opposite to the directions of external leakages; confirmation of water impermeability through inspections and monitoring; and ensuring prompt restorability of damage.

(3) Waste which is subject to the Waste Disposal Act and which is to be disposed of at controlled-type waste disposal sites shall conform to the landfill disposal standards prescribed in the Waste Disposal Act depending on the types of waste.

(4) After the landfill of waste is completed under the Waste Disposal Act at controlled-type waste disposal sites, notifications shall be made accordingly and landfill sites shall be closed in accordance with the Ministerial Ordinance for Final Disposal. Then, the final disposal sites shall obtain approval for abolition based on confirmation that the sites conform to the abolition standards prescribed in the Ministerial Ordinance for Final Disposal.

(5) The landfilled areas of the final disposal sites which are abolished based on (4) above are normally registered as designated areas subjected to Article 15-17 of the Waste Disposal Act. Then, the preliminarily approval of prefectural governors shall be required for any possible changes to the character of the landfilled areas along with the construction or improvement of port facilities. As reference, the following literature summarizes the notification items and procedures in cases where notifications are not required and the specific contents of the enforcement standards: the **Enforcement Guidelines concerning Changes in the Character of Landfilled Areas of Final Disposal Sites**[3] (Notice of Waste Management Division, Waste Management and Recycling Department, Ministry's Secretariat, Ministry of the Environment No. 050606001, Industrial Waste Management Division, Waste Management and Recycling Department, Ministry's Secretariat, Ministry of the Environment No. 050606001 of June 6, 2005). In particular, when constructing pile foundations penetrating the bottom impervious layers for the intensive land use of landfilled areas, refer to the **Guidelines for the Intensive Land Use of Controlled-Type Sea Area Final Disposal Sites in Ports and Harbors (Draft): For the Construction of Foundation Piles Penetrating Bottom Impervious Layers**.[4]

(6) When utilizing landfilled areas before getting approval for the abolition of final waste disposal sites, it is necessary to follow the maintenance standards in the Ministerial Ordinance for Final Disposal and to refer to the literatures introduced in (5) above.

2.2.3 Strictly Controlled-Type Waste Disposal Sites

(1) Strictly controlled-type waste disposal sites are facilities that primarily enable the disposal of strictly controlled-type industrial waste. For the disposal of waste subject to the Waste Disposal Act, strictly controlled-type waste disposal sites are subject to construction permits for final disposal sites based on the Waste Disposal Act and the Ministerial Ordinance for Final Disposal.

(2) Because the waste to be disposed of contains harmful substances, strictly controlled-type waste disposal sites need to have structures that can completely isolate landfill sites from the outside. However, this code refrains from any

further comments on strictly controlled-type waste disposal sites as there have been no cases of the construction of such sites in port and harbor areas.

2.3 Fundamentals of Performance Verification

(1) The performance verification of revetments of waste disposal sites can be carried out with reference to **Part III, Chapter 4, 14.6 Performance Verification**.

(2) Unlike the revetments of protective facilities for harbors, the purpose of revetments of waste disposal sites is to provide the site to accept waste; such revetments usually have a long landfilling period and often remain in a structurally unstable state for a long period of time before the areas behind revetments are landfilled. Therefore, it is necessary to pay particular attention to ensuring structural safety during construction. One of the most effective approaches is to give priority to waste dumping behind the revetments so that sufficient structural stability is achieved early by balancing the actions in the front and back of the revetments.

(3) It is necessary to give due consideration to waste disposal methods so as to reduce earth pressure acting on the back side of revetments of waste disposal sites and thereby achieving cross-sectional stability of the revetments of waste disposal sites after the completion of waste landfill operations.

(4) There may be cases where the future land use of landfilled areas requires waste disposal sites to ensure certain soil bearing capacities. In such cases, it is necessary to give due consideration to the types of waste to be accepted for landfill and the acceptance methods.

(5) Revetments of waste disposal sites shall have structures which can prevent waste from being washed out into sea areas, not only under variable and permanent action situations, but also against the actions of level 2 earthquake ground motions; provided, however, that this provision shall not apply to stabilized waste disposal sites for the disposal of general dredged soil.

2.4 Performance Verification

(1) The performance verification of revetments of controlled-type waste disposal sites can be carried out as follows the case for revetments with reference to **Part III, Chapter 4, 14.6 Performance Verification**, or by the following procedures.

(2) Rapid implementation of landfill disposal near revetments of controlled-type waste disposal sites may cause cohesive soil ground to undergo circular slip failures, thereby impairing the functions of revetments of the controlled-type waste disposal sites. Therefore, due consideration shall be given to the setting of areas and rates of landfill disposal when relying on the increase in foundation strength due to consolidated drainage to achieve structural stability.

(3) The following are the requirements for seepage control work applied to controlled-type waste disposal sites as specified in the Ministerial Ordinance for Final Disposal.

① **For cases where no seepage control work is required (Item 5(a), Paragraph 1, Article 1 of the Ministerial Ordinance for Final Disposal)**

Seepage control work is not required in cases where there exists a continuous layer (impervious layer) with a thickness of 5 m or more and a permeability factor of $k = 1 \times 10^{-7}$ m/s (1×10^{-5} cm/s) or less at the bottom and sides of the landfill area.

② **For cases where no impervious layer exists on the entire underground surface of a landfill area (Item 5(a)(1), Paragraph 1, Article 1 of the Ministerial Ordinance for Final Disposal)**

The Ministerial Ordinance for Final Disposal stipulates that seepage control work in cases where no impervious layer exists shall fulfill the following requirements (called surface seepage control work), or shall have seepage control effects equivalent to or greater than the surface seepage control work. In addition, the Ministerial Ordinance for Final Disposal sets a provision on the protection of surface seepage control work with light-blocking, nonwoven cloth in the case of possible degradation of water sealing sheets due to exposure to sunlight.

(a) Seepage control work with water sealing sheets laid on cohesive soil layers having a thickness of 50 cm or more and a permeability factor of $k = 1 \times 10^{-8}$ m/s (1×10^{-6} cm/s) or less

(b) Seepage control work with water sealing sheets laid on the surfaces of watertight asphalt concrete having a thickness of 5 cm or more and a permeability factor of $k = 1 \times 10^{-9}$ m/s (1×10^{-7} cm/s) or less

(c) Seepage control work with double water sealing sheets having intermediary protection layers made of nonwoven cloth or synthetic resin in between and laid on the surfaces of nonwoven cloth.

③ For cases where an impervious layer exists on the entire underground surface of a landfill area (Item 5(b), Paragraph 1, Article 1 of the Ministerial Ordinance for Final Disposal)

The Ministerial Ordinance for Final Disposal stipulates that seepage control work in cases where an impervious layer exists shall fulfill the following requirements or shall have seepage control effects equivalent to or greater than the seepage control work. In addition, the seepage control work shall be constructed so as to reach the impervious layer.

(a) Seepage control work constructed in a manner that injects chemicals into the ground down to an impervious layer so that the ground has a Lugeon value of 1 or less when the chemicals solidify.

(b) Seepage control work with a continuous wall having a thickness of 50 cm or more and a permeability factor of $k = 1 \times 10^{-8}$ m/s (1×10^{-6} cm/s) or less installed to an impervious layer.

(c) Seepage control work with steel sheet piles (only those provided with impermeable joints) driven to an impervious layer.

(d) Seepage control work satisfying the requirements in (a) to (c) of ② above.

(4) For inland waste disposal sites, it is often the case that water sealing sheets are used to ensure sufficient seepage control performance at their bottom layers. However, for waste disposal sites located in coastal areas in Japan, it is often the case that cohesive soil below the bottom layers is used to ensure sufficient seepage control work as stated in (3). Therefore, it is necessary to confirm whether cohesive soil layers equivalent to the impervious layers exist adjacent to the bottoms of the disposal sites located in water areas and to confirm whether the cohesive soil layers have seepage control capabilities equivalent to those of the cohesive soil layers specified in the Ministerial Ordinance for Final Disposal.

Whether the seepage control capabilities of specific layers are equivalent to those of cohesive soil layers can be evaluated by their permeation time, which can usually be calculated by the **equation** (**2.4.1**).

$$t = \frac{L^2}{kh} \tag{2.4.1}$$

where

t : the permeation time (s)

L : the permeation distance (thickness of a layer) (m)

k : the permeability factor (m/s)

h : the water level difference in a layer (as shown in **Fig. 2.4.2**) (m)

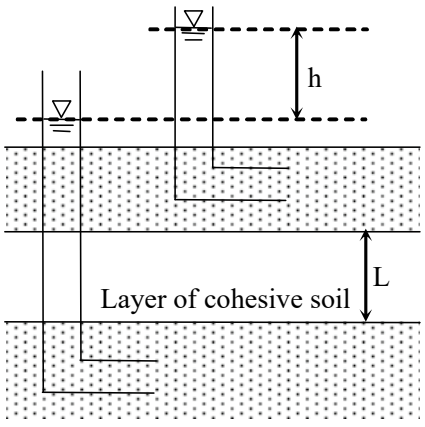

Fig. 2.4.2 Permeation Distance and Water Levels

When calculating a thickness (permeation distance) to achieve the permeation time equivalent to that of an impervious layer (with a thickness of 5 m or more and a permeability factor of $k = 1 \times 10^{-7}$ m/s (1×10^{-5} cm/s) or less) using the **equation (2.4.1)**, a cohesive soil layer with a permeability factor of $k = 1 \times 10^{-8}$ m/s (1×10^{-6} cm/s) is required to have a calculated thickness of 1.6 m or more. The layer thicknesses and continuity of impervious layers shall be confirmed through boring surveys. Layer thicknesses are preferably determined in consideration of allowances for possible inhomogeneity or uneven layer boundaries in cohesive soil layers and possible reductions in layer thicknesses due to deformation or consolidation settlement along with landfill disposal.

(5) Because controlled-type waste disposal sites are provided with seepage control work as specified in the Ministerial Ordinance for Final Disposal and face water areas at their outer sides, they cause water-level differences between the water areas at their outer sides and the retained water at their inner sides. Furthermore, tidal actions at the outer sides cause water-level differences to fluctuate. In contrast, rainwater accumulated in disposal sites at the inner sides needs to be treated (purified) and drained. In order to prevent retained water from leaking out from water area disposal sites, it is preferable to keep the water-levels of retained water lower at the inner sides. However, in the case of seepage control work using water sealing sheets, keeping high water-levels of retained water at the inner sides is considered to be effective in stabilizing the sheets (curbing the lift force on the sheets) until the stability of the seepage control work is improved with the progress of landfill disposal behind the revetments. Thus, it is preferable to appropriately set control water-levels with due consideration to the contradictory conditions. Furthermore, in the case of temporary increases in the water-levels of retained water as a result of abnormal rainfalls or overtopping waves due to storm surges and high waves, it is preferable to ensure the stability of controlled-type waste disposal sites by appropriately setting water-levels in abnormal situations. For the contents of the maintenance of retained water during the time until the abolition of the final disposal sites, refer to the **Collection of the Technical Information on the Abolition of Water Area Final Disposal Sites**.[5)]

(6) The design working life of controlled-type waste disposal sites shall be determined through comprehensive evaluations of the number of years until the retained water inside the sites has reached the abolition standards specified in the Ministerial Ordinance for Final Disposal (Paragraph 3 of Article 1, or Item 3, Paragraph 3 of Article 2), as well as the importance of the facilities, surrounding environments, economic efficiency and land use plans.

(7) The land developed by landfill disposal at controlled-type waste disposal sites may require a long period of time until the landfilled waste has been stabilized to a level satisfying the abolition standards. In addition, controlled-type waste disposal sites may require special considerations in design and construction while depending on the technologies to be used for facilitating early use of the land. In such cases, refer to the **Collection of the Technical Information on the Early Stabilization of Controlled-Type Water Area Final Disposal Sites in Ports and Harbors**.[6)]

(8) Controlled-type waste disposal sites maintain seepage control performance even after the abolition of the waste disposal sites, and, therefore, there may be cases where the controlled-type waste disposal sites are destabilized with the levels of retained water exceeding the control water-levels due to rainfall. Thus, the performance verification of controlled-type waste disposal sites shall include the confirmation of their structural safety with retained water kept at the maximum possible levels after the abolition of the waste disposal sites.

(9) For the performance verification and construction of controlled-type waste disposal sites, refer to the **Manual for the Design, Construction and Maintenance of Controlled-Type Waste Disposal Sites**.[1)]

(10) In a tsunami-resistant design for assessing the stability of the waste disposal sites designated as facilities prepared for accidental incidents with respect to design tsunamis and tsunamis with intensities exceeding the design tsunamis, refer to the **Guideline for Tsunami-Resistant Design of Breakwaters**[7)] and the **Guideline for Tsunami-Resistant Design of Seawalls (Parapet Walls) in Ports**.[8)]

[References]

1) Waterfront Vitalization and Environment Research Foundation: Manual for the Design, Construction and Maintenance of Controlled-Type Waste Disposal Sites, 2008 (in Japanese)

2) Endoh, K. and Oda, K.: Lecture,Current Status and Future of Sea Area Disposal Site, 7 Future Developability of Sea Area Disposal Site, Geotechnical engineering magazine, Vol. 61, No. 9, pp.49-56, 2013 (in Japanese)

3) Technicaal Committee on Enforcement Guidelines concerning Changes in the Character of Landfilled Areas of Final Disposal Sites: Enforcement Guidelines concerning Changes in the Character of Landfilled Areas of Final Disposal Sites, Ministry of the Environment, 2005 (in Japanese)

4) Technical Committee on Early Stabilization and Intensive Land Use of Controlled-Type Sea Area Final Disposal Sites: Guidelines for Intensive Land Use of Controlled-Type Sea Area Final Disposal Sites in Ports and Harbors (Draft): For the Construction of Foundation Piles Penetrating Bottom Impervious Layers, 2017 (in Japanese)

5) Expert meeting on abolished of sea area disposal sites: Technical information document for closure or abolished of sea area final disposal sites, 2014 (in Japanese)

6) Technical Committee on Early Stabilization and Intensive Land Use of Controlled-Type Sea Area Final Disposal Sites: Technical Information Document for Early Stabilization of Controlled-Type Water Area Final Disposal Sites in Ports and Harbors, 2017 (in Japanese)

7) Ports and Harbours Bureau, Ministry of Land, Infrastructure, Transport and Tourism: Guideline for Tsunami-Resistant Design of Breakwaters, 2013 (in Japanese)

8) Ports and Harbours Bureau, Ministry of Land, Infrastructure, Transport and Tourism: Guideline for Tsunami-Resistant Design of Seawalls (Parapet Walls) in Ports, 2013 (in Japanese)

3 Beaches

[Ministerial Ordinance] (Performance Requirements for Beaches)

Article 55

1 The performance requirements for beaches shall be as prescribed respectively in the following items to facilitate the development of port and harbor environments:

(1) Beaches shall satisfy the requirements specified by the Minister of Land, Infrastructure, Transport and Tourism so as to contribute to the development of port and harbor environments.

(2) Beaches shall be capable of maintaining a stable state over a long term against variable waves and water flows.

2 In addition to the provisions of the preceding paragraph, the beaches which are utilized by an unspecified large number of people shall satisfy the requirements specified by the Minister of Land, Infrastructure, Transport and Tourism so as to ensure the safety of beach users.

[Public Notice] (Performance Criteria of Beaches)

Article 97

1 The performance criteria of beaches shall be as prescribed respectively in the following items:

(1) Beaches shall be appropriately located with the necessary dimensions to ensure the safe and comfortable use by visitors and to contribute to the enhancement of good port environments.

(2) The risk of losing the stability of the beach profile and plan shape shall be equal to or less than the threshold level in a variable situation in which the dominating actions are variable waves and water flows.

2 In addition to the provisions in the preceding paragraph, beaches which are utilized by an unspecified large number of people shall be provided with the dimensions required for securing the safety of the users by taking into consideration the environmental conditions to which the facilities are subjected, and the usage conditions.

[Interpretation]

15. Other Port Facilities

(3) The performance criteria of beaches (Article 55 of the Ministerial Ordinance and the interpretation related to Article 97 of the Public Notice)

Serviciability shall be the performance requirement of beaches under the external forces including waves and water flows. The performance verification items and standard indexes to determine limit values with respect to the actions shall be as shown in **Attached Table 15-2**. In **Attached Table 15-2**, the standard index to determine the limit values for the stability of beaches shall be appropriately set when carrying out their performance verification.

Attached Table 15-2 Performance Verification Items and Standard Index to Determine Limit Values of Beaches under the Respective Design States

Ministerial Ordinance			Public Notice			Performance requirements	Design state			Verification item	Standard index to determine limit value
Article	Paragraph	Item	Article	Paragraph	Item		State	Dominating action	Non-dominating action		
55	1	2	97	1	2	Serviceability	Variable	Variable waves, water flows	–	Stability of beach shapes	–

3.1 General

(1) Beaches are classified depending on the grain size compositions of sediment: those composed of mud, sand or gravel, and those with exposed bedrock or rocky coasts. Depending on the positional relationships with the tidal zones and beach profiles, beaches are also classified into backshores and foreshores. Furthermore, depending on the ecosystems, such as vegetation, beaches are classified into seagrass meadows and coral reefs. The typical cross section of a beach is shown in **Fig. 3.1.1**.

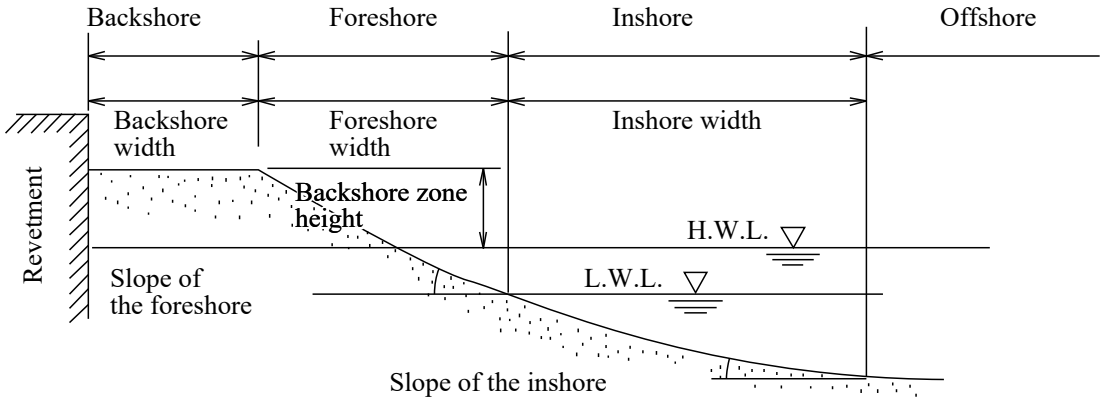

Fig. 3.1.1 Example of the Cross Section of a Typical Beach

(2) Tidal flats are beaches which have flat topography with sandy mud sediment exposed at low tide[1)] and often form complex and valuable natural environments as a result of a mix of various factors such as the repetition of exposure and submergence of bottom sediment, fluctuations in saline concentrations due to river inflow, and geographical deformation due to waves and currents. Other beaches, called shallow waters, have geography similar to tidal flats, except for the depths which range approximately 10 m without the exposure of bottom sediment. Seagrass meadows are shallow sea areas in which large sea algae and seagrass grow densely to form colonies. These colonies are found in water areas with depths ranging from tens of centimeters to tens of meters. Coral reefs are topographic features that are formed by hermatypic organisms such as coral.

(3) Beach nourishment is defined as artificially supplying sand along the shores to develop or restore the beaches. Artificially nourished beaches shall be developed with grain sizes and slopes which are appropriately set. In the cases of artificially nourished beaches where continuous nourishment cannot be expected, jetties and detached breakwaters are preferably installed to stabilize the shapes of the beaches.

(4) Generally, beaches include not only artificially nourished beaches, but also those that are naturally developed. Here, beaches refer to artificially nourished beaches and natural beaches with artificial maintenance or restoration.

3.2 Purposes of Beaches

(1) As shore protection facilities, sand beaches are developed for the purposes of protecting shores from damage due to tsunamis, storm surges, waves and other fluctuations of seawater or ground, and promoting the development and preservation of shore environments as well as the proper public use of shores, thereby contributing to the conservation of national land. The main purpose of such beaches is shore protection. In contrast, beaches are also developed as port environment development facilities for the purpose of developing comfortable living spaces with waterfront amenities. Thus, the main purposes of such beaches include not only shore protection, but also safe and comfortable use by public visitors and the preservation of natural environments.

(2) Beaches provide visitors with waterfront amenities in the form of recreation spaces for collecting shellfish in addition to swimming and fishing, sports spaces for beach volleyball, etc., work spaces for agriculture and fisheries, and natural experiences as well as educational spaces.

(3) The functions of beaches to preserve natural environments include the creation of habitats for a wide variety of organisms by creating favorable environments for them to live and grow, the facilitation of water quality purification through the physical and biological actions of beaches, and the production of marine species supported by the primary production of organic substances.

(4) In addition to providing visitors with waterfront amenities, beaches have functions to alleviate the flow rates of overtopping waves by damping the energy of incident waves through wave breaking and preventing the scouring of dike toes.

3.3 Fundamentals of Performance Verification

(1) Similar to beaches as port environment development facilities, sand beaches as shore protection facilities are defined in **Paragraph 1, Article 2 of the Coast Act**. These two types of beaches are facilities on shorelines and have similar shapes. They also have many features in common with respect to stability against waves. Thus, the performance verification of beaches can be carried out with reference to the **Technical Standards and Commentaries for Shore Protection Facilities**[2] and the **Planning and Design Manual for Zonal Shore Protective Complexes**.[3]

(2) Each beach has one or more functions for waterfront amenities, create habitats for living organisms, purify water quality, and produce marine species. Because some of these functions are complementary to each other and others are contradictory, the examination of beach development shall start by setting the appropriate objectives. When setting objectives, it is important to understand the past relationships between the natural environments and the lives of local people. Such an understanding is useful for consultations with the parties concerned and for examining and deciding plans based on sharing concepts concerning nature. In addition, it requires particular attention so that these functions are affected by the stability and maturity of the ecosystems and environmental fluctuations.

3.4 Topography of Beaches

(1) With regard to long-term topographical changes at beaches, it can be said that constructed beaches are stable in the long term if the beach profiles immediately after their nourishment are stable with respect to the dominant waves. Although short-term topographical changes are affected mainly by the phenomenon of littoral drift in cross-shore directions, this phenomenon has remained unexplained. Therefore, it is necessary to examine the appropriate measures, such as an examination of stabilization measures by means of jetties and detached breakwaters, the selection of grain sizes of sand in accordance with the characteristics of waves, and the replenishment for eroded sand. The shapes of the initial shorelines shall be close to those of stabilized beaches as a result of the actions of waves in relation to the arrangements of jetties and detached breakwaters.

(2) In addition to the topography, the materials to be used for beach nourishment are important factors that affect beach performance and stability and must be selected carefully. When examining the development of beaches involving beach nourishment, due consideration shall be given to the fact that the grain size compositions of the sand used for beach nourishment affect not only the stability and cross-sectional profiles of the beaches, but also the satisfaction of beach users and the habitats of the organisms living there. Furthermore, due consideration shall be given to the selection of materials for beach nourishment so as to prevent the sediments from being washed out and adversely affecting the surrounding water areas.

(3) When developing plans to install stone structures in tidal flats or rocky shores, it is necessary to give sufficient consideration to placing them appropriately to ensure the safety of users and the stability of the structures.

(4) Jetties and detached breakwaters are preferably positioned in a manner that ensures the stability of the shapes of the beaches and allows for sufficient tidal exchanges to prevent the deterioration of water quality. When utilizing beaches for swimming, they shall be provided with jetties or detached breakwaters to prevent generation of strong and complex currents, such as rip currents, which cause incidents for swimmers. In addition, when installing jetties and detached breakwaters, it is necessary to pay attention to the following items to prevent these structures from degrading the landscape.

① Expanding the crown widths of the detached breakwaters to reduce their crown heights or submerging them and thereby preventing them from blocking views of the ocean.

② Positioning the detached breakwaters as far from the beach as possible so that beach users do not feel pressured.

③ Using masonry or stone-cladded jetties to create a greater sense of harmony with the surrounding landscape.

④ Providing planting on jetties to enrich ocean views.

Expanding the intervals between the jetties to the extent possible to create a greater sense of openness.

(5) Regarding the topography of beaches, it is necessary to carry out performance verification for the shapes (widths, elevations and lengths) of beaches and grain sizes. The performance verification can be carried out with reference to the **Technical Standards and Commentaries for Shore Protection Facilities**.[2] In addition, the structural details of the beach topography can be set with reference to the following methods.

① **Crown heights and widths of backshores**

The crown height of the backshore shall be determined based on measurements taken at the sites or at similar coasts located near the sites, or with the proposed estimation formulas.[1), 4), 5)] The crown widths of backshores shall be determined taking into consideration the shorelines' amount of short-term regression during high wave periods estimated by using numerical calculations or historical data.

② **Slopes of the foreshore**

The slopes of foreshores, one of the essential dimensions of beaches, shall be determined by the proposed estimation formulas,[1),4), 5)] or based on measurements taken at the sites or at similar coasts located near the sites, taking into consideration the differences in grain sizes and the wave conditions. In general, tidal flats have milder bottom slopes than sandy beaches (refer to **Fig. 3.4.1**).

③ **Sediment grain sizes**

Sediment grain sizes affect not only the stability and cross-shore beach profiles,[1), 4), 5)] but also the degrees of satisfaction among beach users, the distribution of the habitats of organisms, environment purification functions and permeability (water retention characteristics).[1), 5)] Thus, the grain size distribution of the sediment shall be appropriately determined taking into consideration these factors.

(6) In the verification of the topographical stability of beaches, it is necessary to predict the short- and long-term changes of shorelines, or the changes in water depths and the sediment transport rates by using the appropriate numerical calculations or estimation formulas, taking into consideration the wave control and sediment movement control effects of jetties and detached breakwaters.[2), 4)] The methods for predicting the deformation of beaches include empirical engineering methods, hydraulic model experiments and numerical simulations. For details regarding these methods, refer to **Part II, Chapter 2, 7.6 Estimation of Beach Deformation**. Because the degrees of beach deformation are largely affected by local characteristics, it is necessary to comprehensively evaluate as much local information as possible. Thus, it is preferable to predict beach deformation by combining at least two prediction methods.

(7) In addition to littoral drift control with structures such as jetties and detached breakwaters, there are two other methods for maintaining beaches. One is the sand bypass method, which allows sediment accumulated on the upstream side of coastal structures to flow continuously to the downstream side. The other is the sand back pass method, which transfers sediment to eroded areas at the upstream side of coastal structures.

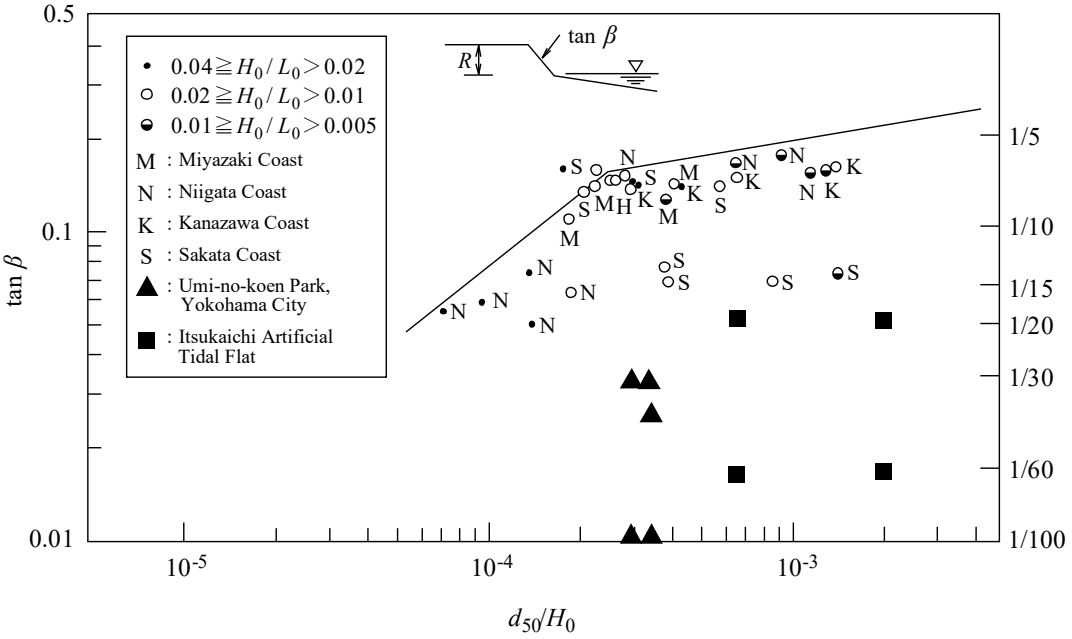

Fig. 3.4.1 Relationship between Seabed Slopes and Sediment Grain Sizes[4)]
(Where: tanβ is a Seabed Slope; d_{50} is the Median Grain Size; and H_0 is the Deepwater Wave Height)

3.5 Waterfront Amenities

(1) The function of beaches to provide visitors with waterfront amenities shall be appropriately evaluated, giving due consideration to the frequency of their use for swimming, shellfish gathering and other purposes.

(2) Beaches are preferably provided with planting and resting areas at the appropriate locations according to their purposes. When examining planting, it is necessary to perform sufficient analyses, taking into consideration the fact that coastal areas are subjected to special environmental conditions such as strong winds, salt water splashes and saline soils. For the determination of planted areas, the selection of tree types and construction and maintenance methods for planting work, refer to the **Design and Construction Manual for the Arrangement of Garden Plants on Port Green Belts**.[6)] Resting areas on beaches, including the necessary component facilities such as benches, trees, shaded areas, public water fountains, hand-wash stations and public restrooms, shall be installed with due consideration to user safety and comfort. In addition, because resting areas are component elements comprising the landscape, it is preferable to arrange them in consideration of their harmonization with the surrounding facilities and vegetation. Furthermore, considering that resting areas do not function individually but collaboratively with the surrounding green zones and facilities, it is preferable to examine the sizes and layouts of the resting areas in consideration of these factors.[7)]

(3) Based on the fact that the main purpose of beaches is human use, it is necessary to give sufficient consideration to ensuring user safety to avoid accidents due to the deformations of beaches. When renovating existing beaches, it is necessary to examine the renovation of facilities based on the collection and organization of materials related to the use conditions of the beaches and conditions that may generate water accidents as well as the extraction of potential problems with the existing facilities. Once a newly constructed or restored beach is opened for public use, it is necessary to conduct periodic patrols and inspections to confirm that the safety measures are functioning properly. In particular, it is important to take measures to prevent sand outflows from nourished beaches, which may cause collapses or create cavities that cannot be recognized from the surface, and to continuously check for and monitor phenomena that may affect user safety by conducting periodic patrols and inspections after the beach is opened for public use.

(4) Beaches provide spaces where people can relax and enjoy recreational activities. However, the safety of beach users is occasionally threatened by tidal waves, storm surges and tsunamis. Therefore, beaches shall be provided with emergency communication equipment, as needed, such as alarm equipment and telephones to allow beach users to evaluate their own safety.

(5) Beaches preferably enable use by visitors such as physically disabled and elderly persons as well as infants who require additionally greater care for their safety than healthy adults. Thus, beaches and adjacent parking lots shall be developed with due consideration to the safe use of all people.

3.6 Conservation of Natural Environment

(1) Beaches have functions to conserve natural environments including those for creating habitats for organisms, purifying seawater and producing marine species. Because some of these functions are complementary to each other while others are contradictory, the examination of beach development shall start with setting the appropriate objectives. Setting objectives based on understanding the relationships between the natural environments and the lives of local people in the past is useful when consulting with the parties concerned and conducting examinations and deciding plans based on sharing concepts about nature.

(2) Depending on the ecosystem, beaches are classified into seagrass beds, tidal flats and coral reefs. For the functions required for each ecosystem and the importance of these types of beaches for conserving natural environments, refer to the following items.[8)]

① **Seagrass beds**

Seagrass beds are shallow coastal sea areas in which large seaweed and seagrass grow densely to form colonies. These colonies are found in water areas with depths ranging from tens of centimeters to tens of meters. Some fish and shellfish use seaweed and seagrass, which make up seagrass beds, as spawning sites. Seaweed and seagrass also have an effect of reducing sea water currents so they contribute to stabilizing sediment and act as nurseries for juvenile fish. Seagrass beds function as feeding grounds for marine species; i.e., abalone and turban shells feed on seaweed and seagrass, and black rockfish and rock trout feed on small sea animals breeding in seagrass beds. In addition, seaweed and seagrass purify seawater in a manner that absorbs nitrogen and phosphorus, which cause eutrophication, as well as act as blue carbon ecosystems in a manner that increase the net carbon dioxide absorption amount with the carbon dioxide concentration in water reduced as a result of photosynthesis of seaweed and seagrass, and also allows organic substances to be stored in bottom sediment.[9)]

The formation of seagrass beds is subjected to not only the characteristics of sea bottoms that will become nursing grounds but also physical factors such as external forces due to waves, biochemical factors such as the balance between photosynthesis rates and oxygen consumption, and biological factors related to herbivorous animals. For example, seaweed beds which are the seagrass beds on sandy mud sea bottoms have constraints from cross-shore directions as shown in **Fig. 3.6.1**.[10)]

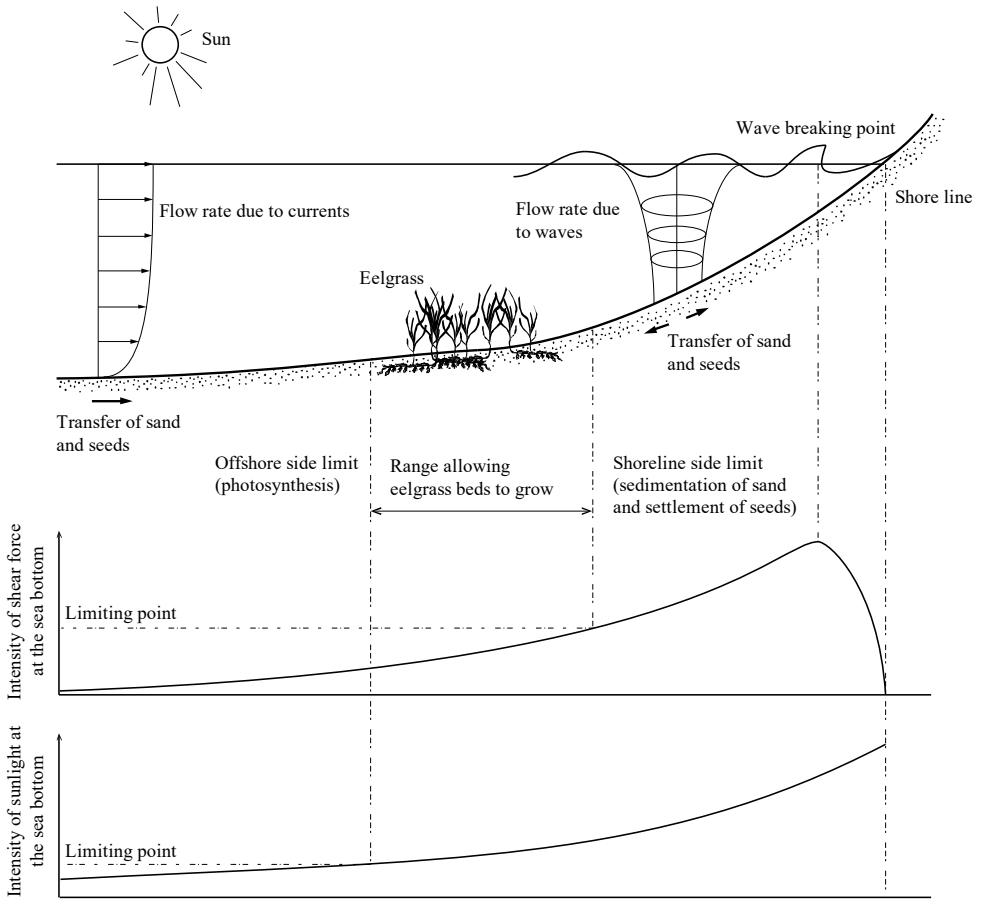

Fig. 3.6.1 Cross-Shore Directional Range of Seaweed Beds That Allows Colonies to Grow

② Tidal flats

Tidal flats are water areas with sandy mud sediment, which is repeatedly exposed and submerged along with the tidal fluctuation of ebb and flood, on mild seabed slopes. Natural tidal flats are developed as a result of the balance among the actions of tides, waves and rivers. Because of the environmental diversity produced by the topography and tides, tidal flats allow a wide variety of organisms to make their habitats, including benthic species such as clams and sand worms, as well as benthic algae, aquatic organisms, plankton, fish and birds. Material cycles enhanced by the activities of these organisms enable the tidal flats to serve several functions including purifying the seawater through filtration of the bivalves and producing marine species through the vigorous activities of the primary producers (such as algae and plankton-producing organic substances through photosynthesis). In addition, tidal flats are important for the habitats of rare species such as amphioxus, lingula and limuli, which maintain their primitive forms (species which used to flourish and have widespread habitats but currently survive in only a few locations), and endemic species such as eel gobies and mudskippers (species which make their habitats only in specific areas).

Tidal flats can be formed only when the local topographic conditions and surrounding environments (locational conditions) allow sandy mud to deposit. Flat topography dissipates wave energy, thereby creating calm water areas. The surrounding rivers create brackish environments with a supply of sediments as well as nutrients. Because of these specific topographic and environmental conditions, tidal flats can nurture biodiversity, enhance the productivity of marine species, and maintain smooth material cycle, thereby fulfilling their unique functions. (Refer to **Fig. 3.6.2**.)

When developing tidal flats, it is necessary to examine the foundation to maintain their topography and measures to prepare habitable environments for organisms and enhance the migration and settlement of the organisms. In this regard, refer to the Ecohabitat chart and Optimal design for Biodiversity and Topographical Stability of Tidal Flats.[11a)11b)] Here, the term “topographical stability” includes fluctuations that maintain specific ranges (dynamic stability) and cyclic fluctuations (rhythmic stability).

For foreshore and estuarine tidal flats in which the dominant actions are waves and currents, the widths, backshore crown heights and foreshore slopes are determined in consideration of stability with respect to the waves and currents. In determining these dimensions, the following basic items can be used as references.

(a) The crown heights of backshores shall generally be set at H.W.L or more.

(b) The crown heights of backshores and the slopes of foreshores shall be determined based on actions due mainly to waves with a special focus on maintaining the stability of the topography of the tidal flats by avoiding situations where the foreshores and backshores are subjected to frequent exposure to large waves.

(c) The slopes of outer tidal flats are remarkably mild and, therefore, cannot be determined primarily by waves.

(d) For estuarine tidal flats, it is necessary to examine the stability of bottom sediment with respect to water currents.

(e) For muddy tidal flats, it is necessary to keep them as flat as possible with sufficiently long foreshore sections for the stability of the foundations.

(f) The foreshore sections of foreshore tidal flats may have the topography of flat sections combined with bars and troughs. There may be cases where benthic organisms (shells and sand worms) make their habitats on the sea bottoms below M.W.L.[12)]

In the case of lagoon tidal flats where peripheral environments are of importance, the elevations, slopes and vegetation shall be determined while taking into consideration the exchange of seawater and the maintenance of water quality. In determining these dimensions, the following basic items can be used as references.

(a) The exchange of seawater with the surrounding water areas is required to maintain the water environment including water levels, salinity, nutrients and dissolved oxygen, and the habitats of organisms including the provision of larvae and migration of organisms.

(b) Seawater can be exchanged through channels and training jetties, and water gates can be used to control the volume of seawater to be exchanged. It is preferable to examine the water balance while taking into consideration freshwater inflow, seawater exchange, evaporation, rainfalls, overflow and underground seepage.

(c) Depending on the species, birds show different preferences in terms of water depths and bottom slopes for their feeding grounds. (Snipes and plovers prefer water areas with a depth of approximately 0.5 m or less.)[13)] Because water retention characteristics and the hardness of sediments in tidal flats have a close relationship with the habitat conditions and biological activities of organisms, it is preferable to appropriately evaluate and consider these factors.[14), 15)]

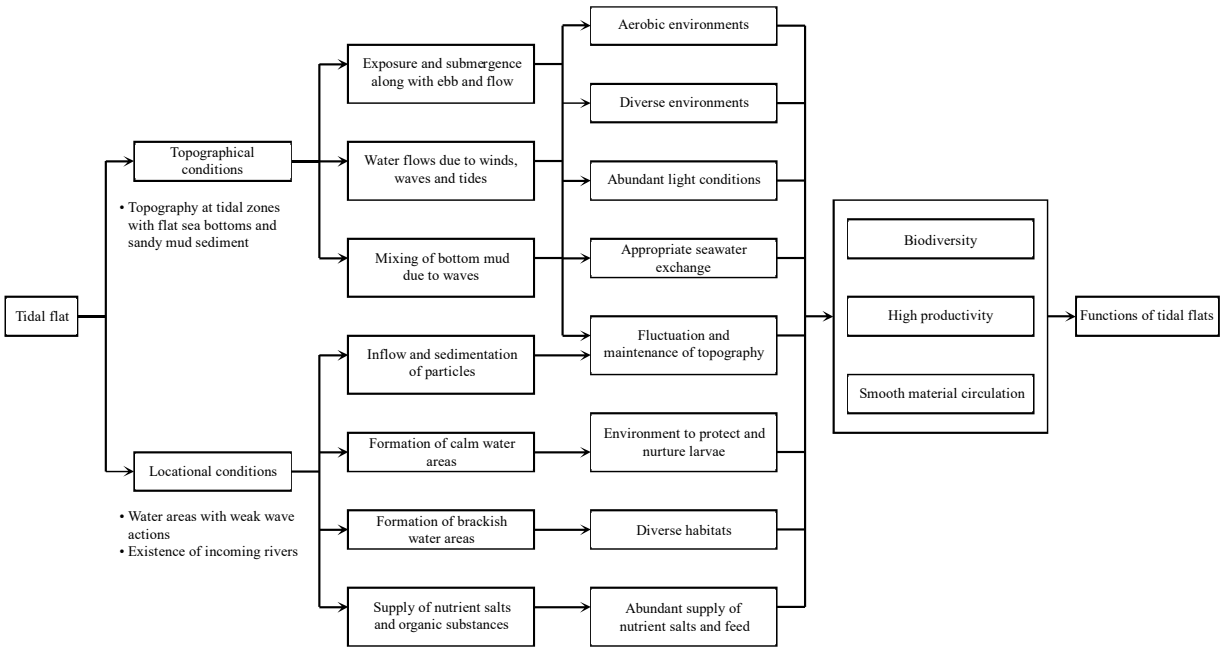

Fig. 3.6.2 Topographical and Environmental Conditions (Locational Conditions) Supporting the Functions of Tidal Flats[1)]

③ Coral reefs

Coral reefs are topography formed mainly by cnidarian hermatypic coral. In Okinawa, coral reefs extend across a wide range, from a few hundred meters to a few kilometers from the shoreline. Some coral reefs have the topography of reef lagoons, reef ridges and reef slopes, which include seaweed beds and sand beds (refer to **Fig. 3.6.3**). Live coral communities, which have high organism production owing to the actions of zooxanthella cohabiting in coral, can be found mainly in reef lagoons and reef ridges. Coral reefs generate diverse environments capable of cultivating many marine species, and, therefore, have functions to create habitats for organisms and purify seawater as is the case with tidal flats. Because of their topographical characteristics, some coral reefs contribute to shore protection in the form of living breakwaters which block high waves due to typhoons and beaches with sand generated from foraminiferal shells and the bones of dead coral. Particularly in remote islands surrounded by coral reefs in the southern part of Japan, it is important to preserve the functions of the coral reefs to attenuate waves and generate sand and gravel from coral and foraminiferal shells for the conservation of national land.

The growth of hermatypic coral, which is indispensable for the formation of coral reefs, is subjected not only to the growth conditions of coral itself but also to the growth conditions of symbiotic zooxanthella. The important growth conditions of coral include waves, the widths of reef lagoons, and networks with other coral reefs. The important growth conditions of symbiotic zooxanthella include light, turbidity, water temperature and water depths. (Refer to **Fig. 3.6.3**.)

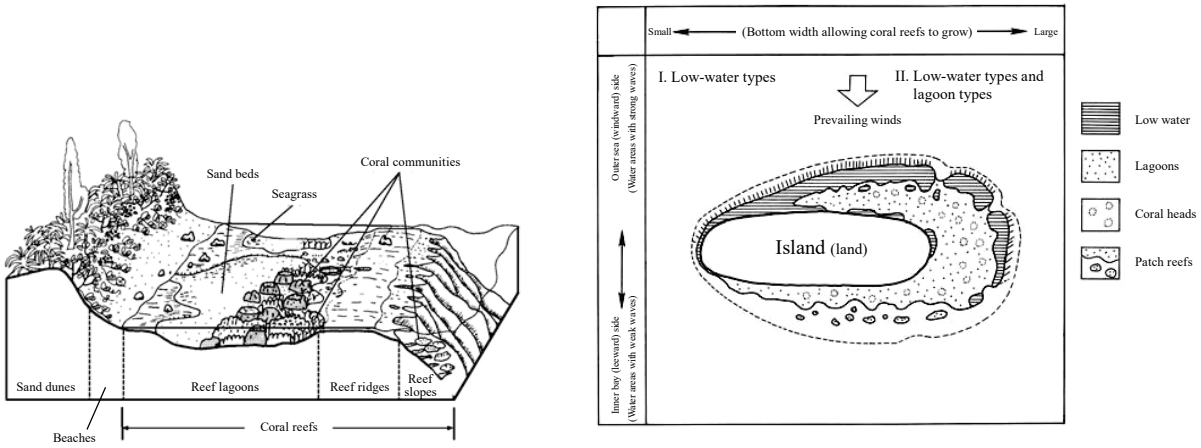

Fig. 3.6.3 Topography and Formation Factors for Coral Reef
(Left: Cross-Sectional Topography; Right: Planar Topography)[16)]

(3) The ecosystems of beaches comprise the ground and substances (topography, sediment and materials) which form the foundations of ecosystems and organisms which grow and make their habitats on the foundations. Thus, when examining the development of beaches, it is important to make assessments from various perspectives with respect to the stability of the ground and substances as well as the appropriate reproduction, migration, inhabitation and predation of organisms so as to enhance the functions according to the respective ecosystems as listed below.

① Stability of ground and substances

(a) Topographical conditions: topography, water depths and slopes

(b) Hydrographic conditions: waves, tides and tidal currents

(c) Meteorological conditions: winds and rainfalls

(d) Sediment and ground conditions: grain sizes, specific gravity and water contents

(e) Hydrological conditions: river discharges and supply of suspended matters

② Appropriate reproduction, migration, inhabitation and predation of organisms

(a) Water quality conditions: water quality

(b) Sediment conditions: sediment and organic accumulation amounts

(c) Biological conditions: migration, use of habitats depending on life cycles, food webs and biological networks

(d) Meteorological conditions: temperature and insolation

(4) When implementing monitoring surveys to evaluate the functions of the ecosystems, it is preferable to examine the scope, frequency and items of monitoring surveys taking into consideration the fluctuation of ecological functions depending on the surrounding environments.

(5) The performance verification of beaches with respect to the preservation of the natural environments can be used not only for the determination of whether the beaches satisfy the performance requirements at the time of verification, but also as part of the adaptive management method (**Fig. 3.6.4**) that incorporates the implementation of continuous monitoring surveys and the feedback of survey results. The adaptive management method is a functional system for achieving both individual and comprehensive goals through improvements in the construction and maintenance methods while taking into consideration fluctuations in the natural environments and changes in social requirements.[17), 18)]

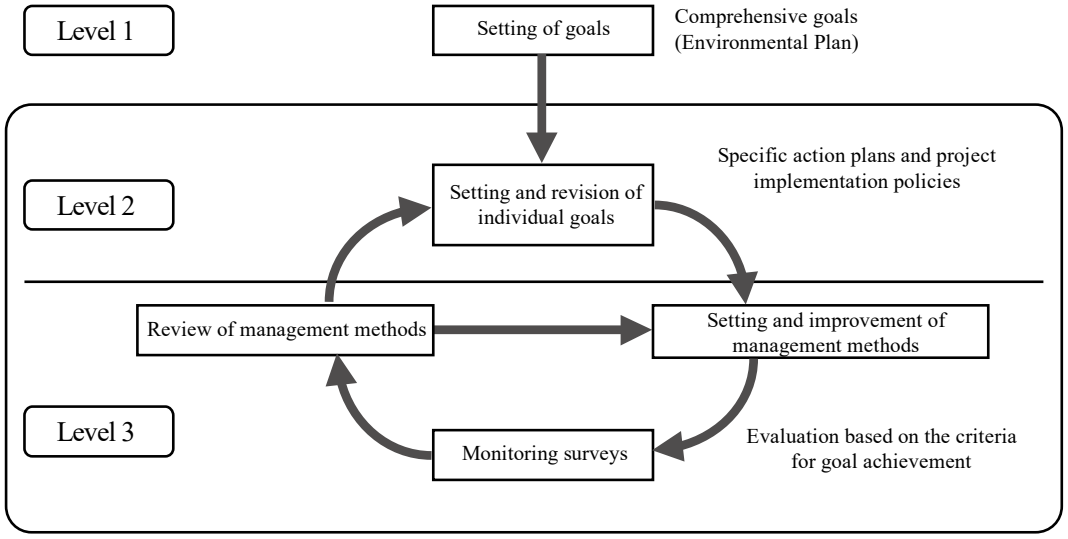

Fig. 3.6.4 Performance Verification through Feedback from Monitoring Survey Results to Achieve Comprehensive Goals[17), 18)]

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4 Green Spaces and Plazas

(English translation of this section from Japanese version is currently being prepared.)

5 Passenger Building

5.1 General

(English translation of this section from Japanese version is currently being prepared.)

5.2 Performance Verification

(English translation of this section from Japanese version is currently being prepared.)

5.3 Ancillary Facilities

(English translation of this section from Japanese version is currently being prepared.)