Chapter 7 Cargo Sorting Facilities

1 General

[Ministerial Ordinance] (General Provisions)

Article 41

1 The performance requirements for cargo sorting facilities shall be such that the requirements specified by the Minister of Land, Infrastructure, Transport and Tourism are satisfied in light of geotechnical characteristics, meteorological characteristics, sea states and other environmental conditions, as well as the conditions of cargo handling.

2 The performance requirements for cargo sorting facilities shall be such that the facilities have stability against self-weight, waves, earthquake ground motions, surcharges, winds, etc.

[Ministerial Ordinance] (Necessary Items concerning Cargo Sorting Facilities)

Article 44

The items necessary for the performance requirements for cargo sorting facilities as specified in this Chapter by the Minister of Land, Infrastructure, Transport and Tourism and other requirements shall be provided by the Public Notice.

[Public Notice] (Cargo Sorting Facilities)

Article 81

The items to be specified by the Public Notice under Article 44 of the Ministerial Ordinance concerning the performance requirements for cargo sorting facilities shall be as provided in the following Article through Article 84.

1.1 General

(1) This chapter can be applied to the performance verification of cargo sorting facilities.

(2) For the performance verification of cargo sorting areas, refer to **References 1)** to **3)**.

[References]

1) Fujino, S. and Y. Kawasaki: Port Planning, New Series Civil Engineering 81, Giho-do Publishing, pp.135-138, 1981 (in Japanese)

2) Nakayama, S.: Port Engineering, Sankai-do Publishing, pp.36-37, 1985 (in Japanese)

3) Civil Engineering Handbook, Part 37, Port and harbours, Giho-do Publishing, pp.1620-1621, 1989 (in Japanese)

2 Stationary Cargo Handling Equipment and Rail-Mounted Cargo Handling Equipment

[Ministerial Ordinance] (Performance Requirements for Cargo Handling Equipment)

Article 42

1 The performance requirements for stationary cargo handling equipment and rail-mounted cargo handling equipment (hereinafter referred to as "cargo handling equipment") shall be such that the requirements specified by the Minister of Land, Infrastructure, Transport and Tourism are satisfied so as to ensure the safe and smooth sorting of cargo and to prevent interference with the mooring or berthing and unberthing of ships.

2 In addition to the provisions of the preceding paragraph, the performance requirements of the cargo handling equipment cited in the following items shall be as prescribed respectively in those items:

(1) "The performance requirements for cargo handling equipment (excluding petroleum cargo handling equipment, liquefied petroleum gas cargo handling equipment and liquefied natural gas cargo handling equipment, which is referred to as "petroleum cargo handling equipment, etc." in the following item)" shall be such that damage due to self-weight, Level 1 earthquake ground motions, surcharges, winds and other actions shall not adversely affect the continuous use of the cargo handling equipment or impair its function.

(2) "The performance requirements for petroleum cargo handling equipment, etc." shall be such that damage due to the self-weight of equipment, Level 1 earthquake ground motions, winds, the self-weight and pressure of petroleum, liquefied petroleum gas and liquefied natural gas and other actions shall not adversely affect the continuous use of the petroleum cargo handling equipment, etc. or impair its function.

(3) "The performance requirements for cargo handling equipment installed at high earthquake-resistance facilities" shall be such that damage due to Level 2 earthquake ground motions and other actions shall not affect restoration through minor repair works of the functions of the equipment.

[Public Notice] (Performance Criteria for Cargo Handling Equipment)

Article 82

1 The performance criteria of cargo handling equipment shall be as prescribed respectively in the following items in consideration of the type of cargo handling equipment:

(1) Cargo handling equipment shall be arranged appropriately and provided with the necessary dimensions in consideration of the design ships, types and volumes of cargo, structure of the mooring facilities, and condition of cargo handling.

(2) In order to protect the environment surrounding the facilities, cargo handling equipment shall be provided with functions appropriate for the prevention of dust, noise and other hazards as necessary.

2 In addition to the provisions specified in the preceding paragraph, the performance criteria for rail-mounted cargo handling equipment for the use of loading and unloading ships shall be such that the rail-mounted cargo handling equipment is provided with the appropriate functions to prevent runaway due to winds.

3 In addition to the provisions in the paragraph (1), the performance criteria for petroleum cargo handling equipment, liquefied petroleum gas cargo handling equipment and liquefied natural gas cargo handling equipment shall be as prescribed respectively in the following items:

(1) Under a permanent situation in which the dominating action is self-weight, the risk of impairing the integrity of structural members shall be equal to or less than the threshold level.

(2) Under a variable situation in which the dominating actions are Level 1 earthquake ground motions, winds or the weight and pressure of petroleum, liquefied petroleum gas or liquefied natural gas, the risk of impairing the integrity of structural members and losing structural stability shall be equal to or less than the threshold level.

(3) Appropriate measures shall be taken to enable petroleum cargo handling equipment, liquefied petroleum gas cargo handling equipment and liquefied natural gas cargo handling equipment to be transferred from the mooring facilities of the ships in the event of an emergency situation without issue.

4 In addition to the provision in the paragraph (1), the performance criteria for cargo handling equipment to be installed at high earthquake-resistance facilities shall be such that the degree of damage owing to the action, under accidental situation in which the dominating action is Level 2 earthquake ground motions, is equal to or

less than the threshold level.

[Interpretation]

13 Cargo Sorting Facilities

(1) Performance criteria for cargo handling equipment

① **Petroleum cargo handling equipment** (Article 42 paragraph 2 item 1 of the Ministerial Ordinance and the interpretation related to Article 82 paragraph 3 of the Public Notice)

a) Here, petroleum cargo handling equipment, liquefied petroleum gas cargo handling equipment and liquefied natural gas cargo handling equipment (only those using loading arms) are called "petroleum cargo handling equipment."

b) The performance requirements of petroleum cargo handling equipment in a permanent state in which the dominating action is the self-weight of equipment, and in a variable situation in which the dominating actions are Level 1 earthquake ground motions, winds or the weight or pressure of petroleum and other materials (such as liquefied petroleum gas and liquefied natural gas) shall be serviceability. The performance verification items and standard indexes to determine limit values with respect to the actions shall be as shown in **Attached Table 13-1**. In the performance verification of petroleum cargo handling equipment, it is necessary to appropriately set the standard indexes to determine the limit values.

Attached Table 13-1 Performance Verification Items and Standard Indexes to Determine the Limit Values of Petroleum Cargo Handling Equipment under the Respective Design States (Excluding Accidental Situations)

Ministerial Ordinance			Public Notice			Performance requirements	Design situation			Verification item	Standard index for determining the limit value
Article	Paragraph	Item	Article	Paragraph	Item		Situation	Dominating action	Non-dominating action		
42	2	1	82	3	1	Serviceability	Permanent	Self-weight	Wind, earth pressure and surcharge	Soundness of members	–
					2		Variable	Level 1 earthquake ground motions [Wind] [Self-weight and pressure of petroleum and other materials*1]	Self-weight, earth pressure and surcharge	Soundness of members, stability of the structure	–

* [ ] means alternative dominating actions to be studied as design states.

*1: The term "other materials" means liquefied petroleum gas and liquefied natural gas.

c) In **Attached Table 13-1**, the performance verification of the members of petroleum cargo handling equipment shall be carried out by appropriately setting the limit value with respect to their soundness. In addition, the performance verification of the structures of petroleum cargo handling equipment shall be carried out by appropriately setting the performance criteria with respect to stability depending on the structural types.

② **Cargo handling equipment installed at high earthquake-resistance facilities** (Item 1, Paragraph 2, Article 42 of the Ministerial Ordinance and Interpretation related to Paragraph 4, Article 82 of the Public Notice)

The performance requirements of cargo handling equipment installed at high earthquake-resistance facilities in an accidental situation in which the dominating action is Level 2 earthquake ground motions shall be restorability. The performance verification items and standard indexes to determine the limit values with respect to the actions shall be as shown in **Attached Table 13-2**. In **Attached Table 13-2**, the term "damage" is used for performance verification items as a comprehensive expression for the verification items which differ depending on the types, structures and structural types of cargo handling equipment. In the performance verification of cargo handling equipment, it is necessary to appropriately set the standard indexes to determine the limit values.

Attached Table 13-2 Performance Verification Items and Standard Indexes to Determine the Limit Values of Cargo Handling Equipment Installed at High Earthquake-Resistance Facilities 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		
42	2	1	82	4	–	Restorability	Accidental	Level 2 earthquake ground motion	Self-weight and earth pressure	Damage	–

2.1 General

(1) In the Ports and Harbor Act, cargo handling equipment as port facilities is classified into stationary cargo handling equipment and rail-mounted cargo handling equipment, which are cargo sorting facilities, and movable cargo handling equipment, which are movable facilities. In this Chapter, stationary, rail-mounted, and movable cargo handling equipment are collectively called "cargo handling equipment."

(2) Cargo handling equipment as port facilities means equipment which is used for cargo handling work and which includes stationary, rail-mounted and mobile cranes, as well as unloaders, conveyors, forklifts, bulldozers, tractors, straddle carriers, reach stackers, log loaders and loading arms, but excludes on-board equipment and vehicle boarding facilities for roll-on/roll-off (RORO) ships. For movable cargo handling equipment, refer to **Part III, Chapter 10, 1 Movable Cargo Handling Equipment**.

(3) The purpose of introducing cargo handling equipment in ports is to achieve laborsaving, fast and safe cargo handling operation. The selection of the types, structures and capabilities of cargo handling equipment is preferably made by sufficiently considering the design ships and types, shapes, volumes and particulars of the cargo, as well as the relationship with the yard facilities located behind them and the modes of secondary transportation.

(4) The cargo handling equipment to be installed in cargo sorting areas or mooring facilities shall have the optimal structures, capabilities and placements for the usage patterns of those areas and facilities, and will ensure structural safety, as well as the functions adequate to prevent public hazards such as dust and noise, and smooth and safe cargo handling operation.

(5) When installing cargo handling equipment, it is necessary to ensure that the areas where cargo handling equipment travels, turns or moves up and down do not obstruct buildings and electric wires, and that the cargo handling equipment is prevented from making accidental contact with ships traveling alongside or leaving the facilities, or ships being moored at berths.

(6) The cargo handling equipment and the ancillary facilities for cargo handling equipment (such as electric equipment, rails and ditches) are preferably installed so as not to reduce the safety of ships traveling alongside the facilities or leaving berths.[1)]

(7) In the case of possible cargo handling operation without using cargo handling equipment, it is preferable to examine the locations and structures of the cargo sorting facilities so as not to prevent smooth and safe execution of cargo sorting operation.

(8) Because bulk cargo operation is likely to produce noise and dust, cargo handling equipment for bulk cargo shall be equipped with dust and noise prevention measures as standard practice. In particular, as a general rule, explosion-proof measures are required for equipment handling inflammable dust.

(9) Related laws, regulations and guidelines

① The International Standards, regulations and guidelines related to cargo handling equipment are as follows:

(a) Cranes-Design principles for loads and load combinations-Part1: General (ISO 8681-1, 2012)

(b) **Cranes-principles for seismic ally resistant design** (ISO 11031, 2016)

(c) The **Safety Ordinance for Cranes** (Ordinance of the Ministry of Labour No. 34 of 1972)

(d) The **Structural Standards for Cranes** (Public Notice of Ministry of Labour No. 134 of 1995)

(e) The **Structural Standards for Mobile Cranes** (Public Notice of Ministry of Labour No. 135 of 1995)

(f) The **Structural Standards for Derricks** (Public Notice of Ministry of Labour No. 55 of 1962)

(g) **Cranes-Design Principles for Loads and Load Combinations** (JIS B 8831, 2004)

(h) **Calculation Standards for Steel Structures of Cranes** (JIS B8821, 2013)

(i) **Cranes-Anchoring devices for in-service and out-of-service conditions. Part1: General** (JIS B 8828-1, 2013)

(10) For basic information on cargo handling equipment in ports, refer to the **Directory of Port Cargo Handling Machinery**.[2)]

2.2 Container Cranes

2.2.1 General

(1) Container cranes are a type of rail-mounted cargo handling equipment installed at mooring facilities to directly transfer containers between the container ships and mooring facilities.

(2) Container cranes shall have structures complying with the items to be considered in accordance with the characteristics of ports and the safety standards for cranes as based on the **Industrial Safety and Health Act**.

2.2.2 Fundamentals of Performance Verification

(1) In the performance verification of container cranes, the **Structural Standards for Cranes** can be used as a reference except for the items to be specifically required in accordance with the characteristics of ports.

(2) The items to be specifically required in accordance with the characteristics of ports are shown in **Part III, Chapter 7, 2.2.3 Performance Verification of Earthquake Resistance** and **Part III, Chapter 7, 2.2.4 Appropriate Functions to Prevent Runaway Due to Winds**.

(3) The terms regarding the loads applied to structures such as the actions of self-weight, Level 1 earthquake ground motions, surcharges and winds shall be appropriately replaced by the terms specified in **Structural Standards for Cranes**, **Article 8 (Types of Loads to Be Used for Calculations)**. (Refer to **Commentaries for Structural Standards for Cranes and Other Equipment**[3)].)

(4) Although the design of container cranes is normally carried out after or parallel to the design of the mooring facilities, the process of ensuring the performance requirements of the container cranes is subjected to the ensuring of the performance requirements of the mooring facilities on which the container cranes are to be installed. Thus, in the performance verification of the container cranes, it is necessary to ensure that the mooring facilities are designed based on the design conditions including the actions of the container cranes on the mooring facilities.

2.2.3 Performance Verification of Earthquake Resistance

(1) Points of caution when carrying out the verification of earthquake resistance of container cranes

① Earthquake-resistant performance of container cranes in consideration of mooring facilities

Because container cranes for the use of loading and unloading container ships function in tandem with the mooring facilities, the earthquake resistance of the container cranes shall also be verified integrally with the mooring facilities. During the occurrence of an earthquake, the container cranes and mooring facilities interact with each other. For example, the deformation of mooring facilities due to an earthquake may expand the rail spans and cause damage to the container cranes.[4)] Therefore, the verification of earthquake resistance of both container cranes and mooring facilities shall be carried out with due consideration to such interactions. In cases where the rail spans are expected to be expanded to a length larger than the allowable elastic deformation ranges for leg sections, the container cranes need to be provided with the adequate mechanisms, if necessary, to keep any possible damage to the crane bodies within the levels that satisfy the predetermined performance requirements.

② Prevention of uplift of the leg sections of container cranes and earthquake-resistant performance of members

The members of container cranes shall be prevented from damage due to Level 1 earthquake ground motions, which may adversely affect the continued use of the container cranes. The members of container cranes installed at earthquake-resistance facilities shall be prevented from damage due to Level 2 earthquake ground motions, which may adversely affect the restoration of functions through minor repair work.

Rail-mounted container cranes have a high risk of receiving damage to their leg sections when subjected to uplift of the leg sections due to earthquakes. Thus, in order to fulfill the required serviceability, rail-mounted container cranes shall be basically prevented from uplift of the leg sections. Furthermore, in order to fulfill the required restorability, in the case of seismically isolated container cranes, the leg sections shall be basically prevented from complete uplift, though uplift in a state where some wheel flanges contact with rails is allowed.

The performance verification of the uplift of leg sections and members of the container cranes shall be carried out based on the predetermined natural periods and damping constants of the container cranes. For example, although the natural periods in cross-shore directions of container cranes that do not have seismic isolation mechanisms vary depending on the sizes and types of the container cranes, they approximately range from 1.5 to 3 seconds.[5)] In contrast, the natural periods of the container cranes with seismic isolation mechanisms are about 4 seconds. Based on these natural periods, the performance of the seismic isolation mechanisms for container cranes is often set so as to enlarge the damping constants.

When the predominant periods of earthquake ground motions at the container crane installation locations are close to the natural periods of the container cranes and the damping constants of the container cranes are small, the container cranes are likely to undergo uplift of the leg sections and receive damage to the members as a result of the generation of large responses. In such cases, modifying the container cranes so that they have natural periods that are not close to the dominant periods of earthquake ground motions is considered to be an effective measure to improve earthquake resistance. In addition, the application of seismic isolation or vibration control mechanisms to container cranes is an effective measure to reduce response acceleration and thereby prevent the uplift of leg sections and damage to members. However, it shall be noted that large earthquakes are likely to have longer dominant periods than small or medium-sized earthquakes due to the effect of the non-linear behavior of surface layers.

For details regarding the performance verification of container cranes, refer to the descriptions about performance verification of the respective facilities in this book, **Guideline for the Earthquake Resistant Design of Container Cranes**,[6)] and **Reference 7)**.

(2) Fundamentals of performance verification of container cranes in respect to Level 1 earthquake ground motions

The performance verification of container cranes in respect to Level 1 earthquake ground motions can be carried out according to the procedure shown in **Fig. 2.2.1**.

① Setting of Level 1 earthquake ground motions

Level 1 earthquake ground motions can be set based on **Part II, Chapter 6, 1.2 Level 1 Earthquake Ground Motions Used in the Performance Verification of Facilities**, which can be downloaded from the homepage of the National Institute for Land and Infrastructure Management (http://www.ysk.nilim.go.jp/kakubu/kouwan/sisetu/sisetu.html).

② **Calculation of the maximum response acceleration of container cranes**

(a) In the cases of mooring facilities other than piled piers, the earthquake ground motions at rail installation positions can be obtained by calculating the time history of ground surface acceleration according to **Part II, Chapter 6, 1.2.3 Earthquake Response Calculation of Surface Ground**. The earthquake response calculation may be one-dimensional earthquake response calculation with respect to the ground at the rear of the mooring facilities. Then, the maximum response acceleration of container cranes needs to be calculated with the calculated earthquake ground motions input into container cranes modeled as lumped mass systems.

(b) In the case of piled piers, because the dynamic interaction between the piled piers and container cranes needs to be considered, piled piers and container cranes are modeled as dual lumped mass systems. Next, the time history of ground acceleration at levels $1/\beta$ below the virtual ground surfaces of the piled piers can be calculated according to **Part II, Chapter 6, 1.2.3 Earthquake Response Calculation of Surface Ground**. Then, the maximum response acceleration of container cranes needs to be calculated with the calculated time history of ground acceleration input into the dual lumped mass systems. For the virtual ground surfaces and $1/\beta$, refer to **Part III, Chapter 5, 5.2.2 Setting of Basic Cross Sections**. The concept of the calculation model of a dual lumped mass system is shown in **Fig. 2.2.2**, where k is the equivalent stiffness of piles on 1 block of a piled pier; m is the mass of the 1 block of the superstructure; c is the damping constant; k_c is the equivalent stiffness of the container crane; m_c is the mass of the container crane; and c_c is the damping constant of the container crane. The equivalent stiffness is obtained by converting the stiffness of all the piles on 1 block of the piled pier into springs of a lumped mass system and the stiffness of all the legs of the container crane into additional springs of a lumped mass system as shown in **Fig. 2.2.2**.

(c) In both cases of (a) and (b) above, for the vibratory characteristics, the natural periods shall be adjusted to those of the actual container cranes. The damping constants of the container cranes may be set at 1 to 3% if individual data is not available. In cases where seismic isolation mechanisms are expected to be introduced, lumped mass systems need to have the appropriate stiffness and damping constants corresponding to the mechanisms. When the specific dimensions of the container cranes are unknown, the vibratory characteristics can be set at levels acceptable for the manufacturers of the container cranes.

③ **Examination of whether the leg sections of the container cranes undergo uplift**

(a) Whether or not the leg sections of the container cranes undergo uplift can be examined through the seismic coefficient method in a manner that calculates values (hereinafter referred to as the "design value of seismic coefficient") by dividing the maximum response acceleration of the container cranes by gravitational acceleration, and applies the loads obtained by multiplying the vertical static loads of the container cranes by the design value of seismic coefficient to the container cranes in a horizontal direction.

(b) When it is determined that the leg sections of the container cranes are subjected to uplift, it is necessary to change the dimensions of the container cranes and go back to procedure ② above, or review the determination results through dynamic response analyses. In the latter case, analyses can be made according to (3) below with the introduction of a seismic isolation mechanism as needed. When it is determined that the leg sections are not subjected to uplift, the performance verification can proceed to ④ below.

④ **Verification of stresses on members**

(a) When the design value of seismic coefficient is not more than 0.2, container cranes conforming to the **Structural Standards for Cranes** are considered to satisfy the performance requirements in respect to Level 1 earthquake ground motions at ports.

(b) When the design value of seismic coefficient is larger than 0.2, the performance verification shall be carried out with respect to the stresses on members through the methods specified in the **Structural Standards for Cranes** with the loads obtained by multiplying the vertical static loads of the container cranes by the design value of seismic coefficient applied to the container cranes in a horizontal direction. If any members fail the performance verification, it is necessary to change the members concerned and go back to procedure ② above. If no members fail, the performance verification can be completed.

(c) When designing container cranes, the following analysis results of the values obtained by dividing the least horizontal loads causing members to have stresses larger than those allowable by the vertical static loads of container cranes (hereinafter referred to as "crane limit seismic coefficient") can be used as a reference. The analysis was conducted in a manner that applies static horizontal loads to actual container cranes designed in accordance with the **Structural Standards for Cranes**. According to the analysis results, in many cases, the crane limit seismic coefficient ranges from 0.20 to 0.29 depending on the characteristics of the container cranes (based on the most critical among the various situations such as a suspension or operation situation). The analysis result above indicates that when the design value of seismic coefficient is larger than 0.20 to 0.29, the container cranes designed only based on the **Structural Standards for Cranes** may not satisfy the performance requirements in respect to Level 1 earthquake ground motions. In additional analyses of crane limit seismic coefficient using the actual container cranes having a crane limit seismic coefficient of 0.20 to 0.25, it was found that partial reinforcement, such as the changes in cross sectional dimensions of diagonal or horizontal members between crane legs, can increase the crane limit seismic coefficient to a level larger than 0.25. Thus, even container cranes having a design value of seismic coefficient of 0.20 to 0.25 can be reinforced through the modification of members to a level which satisfies the performance requirements in respect to Level 1 earthquake ground motions.

However, when the design value of seismic coefficient is larger than 0.25, there may be cases where partial reinforcement does not help the container cranes satisfy the predetermined performance requirements. In such cases, dynamic response analyses can be employed with reference to (3) below with the introduction of seismic isolation mechanisms as needed.

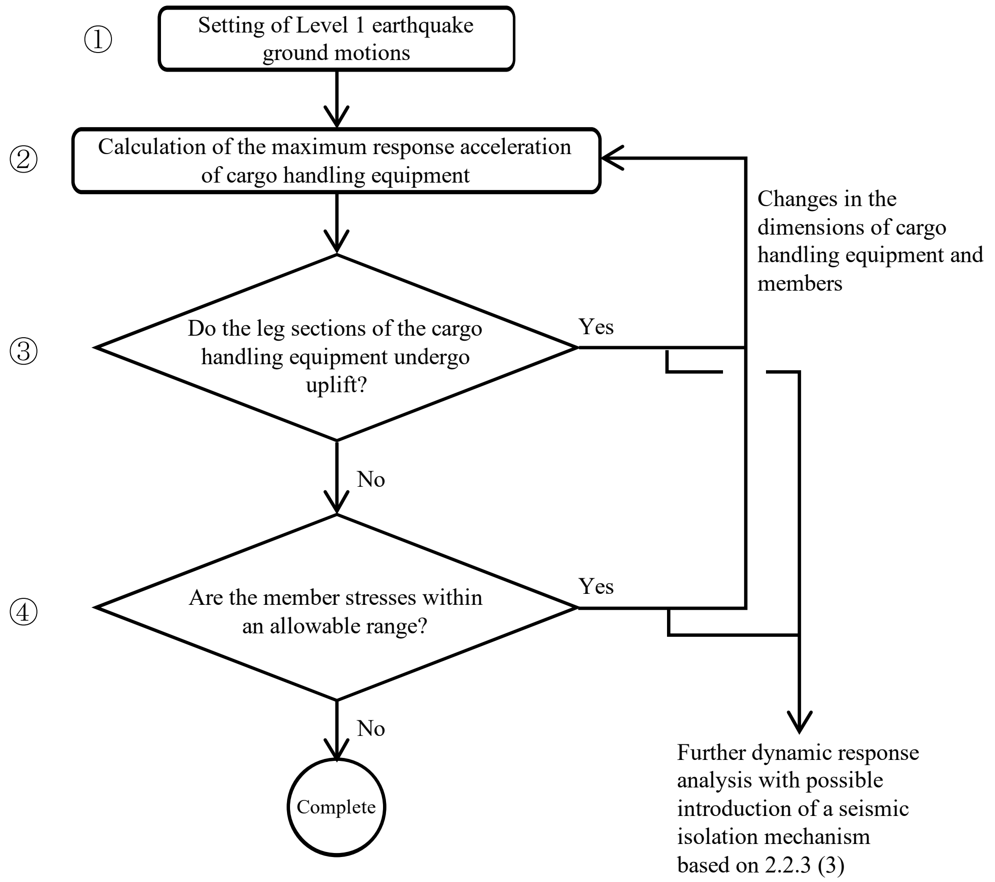

Fig. 2.2.1 Flowchart of Performance Verification of Container Cranes in Respect to Level 1 Earthquake Ground Motions

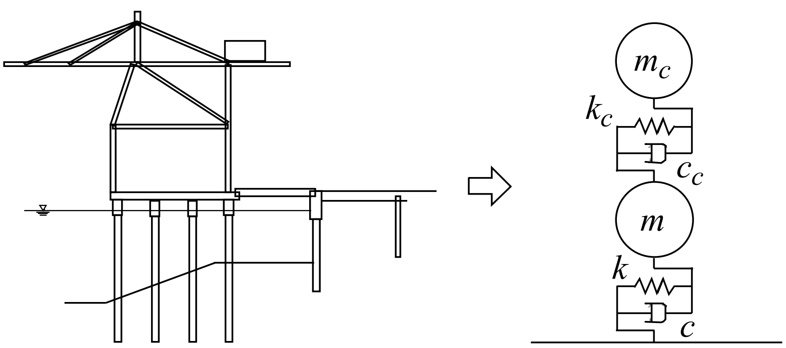

Fig. 2.2.2 Concept of the Calculation Model of the Dual Lumped Mass System of Piled Piers and Container Cranes

(3) Fundamentals of performance verification of container cranes in respect to Level 2 earthquake ground motions

The performance verification of container cranes in respect to Level 2 earthquake ground motions can be carried out by the following procedures.

① **Setting of Level 2 earthquake ground motions**

Level 2 earthquake ground motions can be set with reference to **Part II, Chapter 6, 1.3 Level 2 Earthquake Ground Motions for the Performance Verification of Facilities**.

② **Input earthquake ground motions for container cranes**

The input earthquake ground motions for container cranes can be obtained by calculating the time history of ground surface acceleration at rail installation positions through seismic response analyses of the ground and structures. Examination of the dynamic interactions between container cranes and mooring facilities, if necessary, shall be carried out by using lumped mass models capable of reproducing the natural periods with proper combinations of mass and stiffness, the damping constants, and the gravity center positions of the container cranes. In the case of seismic isolated container cranes, the calculation models shall have characteristics acceptable for the manufacturers of the container cranes concerned.

③ **Examination of uplift of the leg sections, member stresses and seismic isolation mechanisms of container cranes**

The performance verification of container cranes in respect to Level 2 earthquake ground motions shall be carried out for the uplift of leg sections, member stresses and the necessity of seismic isolation mechanisms through dynamic response analyses or other means. For the performance verification of seismic isolation mechanisms, it is necessary to confirm that the response values of loads and displacement are equal to or less than those allowable for planned seismic isolation mechanisms.

In addition, depending on the types of mooring facilities and rail foundations, Level 2 earthquake ground motions may cause rail spans to fluctuate. In such cases, seismic isolation mechanisms can effectively absorb the fluctuation of rail spans in accordance with elastic deformation of the leg sections of the container cranes. For example, when the elastic deformation range of the leg sections of a container crane having a rail span of 30.5 m is about 200 mm, as shown in **Fig. 2.2.3** (which is used here only as reference since different container cranes have different elastic deformation ranges of leg sections), the seismic isolation mechanism can increase the allowable displacement of the rail span to about 500 mm with the displacement stroke of a of about 300 mm (which is also used here only as reference since different seismic isolation mechanisms have different strokes). However, it is necessary to confirm that the increased displacement due to seismic isolation mechanisms does not cause the container cranes to collide with any ships.

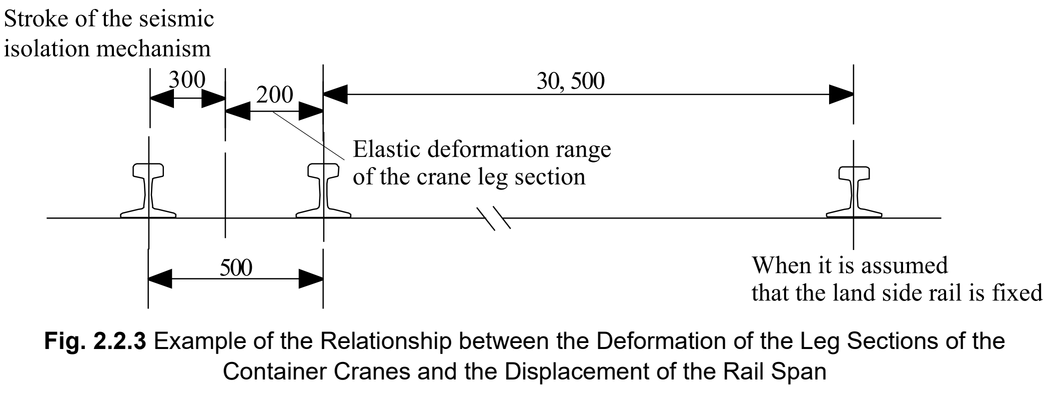

Fig. 2.2.3 Example of the Relationship between the Deformation of the Leg Sections of the Container Cranes and the Displacement of the Rail Span

Note: The seismic isolation mechanisms mentioned in this section are those which have been commercialized at this time. When applying newly developed technologies to the container cranes concerned, the performance verification shall be carried out in compliance with this section.

2.2.4 Appropriate Functions to Prevent the Runaway of Container Cranes Due to Winds

(1) Container cranes shall have buffer stops and power engines having output enabling the container cranes to be moved even against winds of predetermined intensity as appropriate functions to prevent them from running away due to winds.

It is also preferable that container cranes be provided with buffer stop-related devices, which can be used as runaway prevention measures, and vane anemometers to appropriately monitor wind conditions.

For more information, refer to the **Operational Regulations to Prevent the Runaway of Container Cranes**.[8)]

(2) Buffer stops

The **Structural Standards for Cranes, Article 41 (Buffer Stops)** stipulates that buffer stops shall have the capability to resist wind loads equivalent to a wind speed of 60 m/s. Buffer stops include anchors and other related devices, such as rail cramps. In **Cranes-Anchoring devices for in-service and out-of-service conditions, Part 1: General (JIS B 8828-1: 2013)**, rail cramps are required to have the capability to resist wind loads equivalent to a wind speed of 35 m/s.

(3) Buffer stop-related devices

Buffer stop-related devices are devices to be used as measures to prevent the runaway of container cranes, and include brakes, rail brakes and crane stoppers. Examples of rail brakes and crane stoppers are shown in **Figs. 2.2.4** and **2.2.5**, respectively.

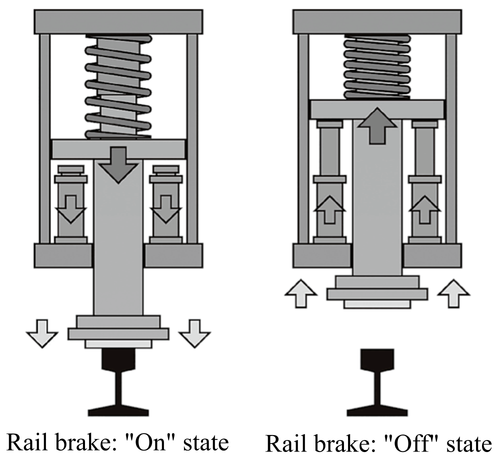

Fig. 2.2.4 Rail Brakes

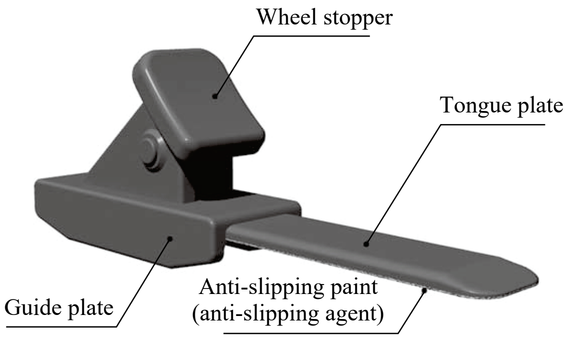

Fig. 2.2.5 Crane Stopper

(4) Power engines

The **Structural Standards for Cranes, Article 42 (Power Engines)** stipulates that container cranes shall be provided with power engines having output enabling the container cranes to be moved against winds of 16 m/s.

(5) Vane anemometers

Vane anemometers are preferably installed at locations not affected by container cranes in order to be used for determining the suspension of cargo handling operation, the implementation of measures to prevent the runaway of rail-mounted cargo handling equipment, and the resumption of cargo handling operation.

(6) Prevention of the overturning of container cranes due to winds

Measures to prevent the overturning of container cranes due to winds shall conform to the **Structural Standards for Cranes, Article 15 (Stability)**.

2.3 Unloaders

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

2.3.1 General

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

2.3.2 Fundamentals of Performance Verification

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

2.3.3 Performance Verification of Earthquake Resistance

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

2.3.4 Appropriate Functions to Prevent the Runaway of Unloaders Due to Winds

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

2.4 Loading Arms (Stationary Cargo Handling Equipment)

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

2.4.1 General

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

2.4.2 Fundamentals of Performance Verification

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

2.4.3 Performance Verification

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

2.5 Rubber Hoses for Petroleum Transportation (Stationary Cargo Handling Equipment)

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

2.5.1 General

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

2.5.2 Performance Verification

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

2.6 Petroleum, LPG and LNG Conduit Pipes (Stationary Cargo Handling Equipment)

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

2.6.1 General

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

2.6.2 Performance Verification

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

2.7 Maintenance of Stationary Cargo Handling Equipment and Rail-Mounted Cargo Handling Equipment[9), 10), 11)]

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

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3 Cargo Sorting Areas

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

3.1 General

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

3.2 Cargo Sorting Areas for Timber

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

3.3 Sorting Facilities for Marine Products

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

3.4 Sorting Facilities for Hazardous Cargoes

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

3.5 Container Terminal Areas

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

4 Sheds

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

4.1 General

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