Ports and Harbours Bureau, Ministry of Land, Infrastructure, Transport and Tourism (MLIT)
National Institute for Land and Infrastructure Management, MLIT
Port and Airport Research Institute

TECHNICAL STANDARDS AND COMMENTARIES FOR PORT AND HARBOUR FACILITIES IN JAPAN

THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN

2009

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Foreword

This book is a translation of "*the Technical Standards and Commentaries for Port and Harbour Facilities in Japan*" (hereinafter called "the Technical Standards"), which summarizes the ministerial ordinance and public notice articles as well as the related commentaries and technical notes in connection with the "Technical Standards for Port and Harbour Facilities" established by Japan's Ministry of Land, Infrastructure, Transport and Tourism (MLIT) based on the provisions of the Port and Harbour Law. This translation has been made with the approval of the authors including the Ports and Harbours Bureau of MLIT, National Institute for Land and Infrastructure Management (NILIM; also a part of MLIT), and the Port and Airport Research Institute (PARI; an Independent Administrative Institution).

Japan is an island nation with few underground resources. The country comprises approximately 6,800 islands, and has an area of 380,000 square kilometers and a total coastline of 34,000 km. For this reason, industry, which supports the nation's economy, has been located in coastal areas with ports and harbors for convenience in importing raw materials and exporting products. Given these conditions, Japan has constructed, improved and modernized approximately 1,100 ports and harbors as well as approximately 3,000 fishing ports during the past one and a half centuries. Because 99% of trade now depends on ports and harbors, they play a particularly important role in Japan.

Japan was a closed country for about 220 years, from the early 17th century until the mid-19th century. Following the Meiji Restoration of 1868, modernization progressed rapidly. During the modernization period, young Japanese engineers learned from experienced engineers invited to Japan from abroad, and constructed modern ports and harbors, such as the Ports of Yokohama and Kobe.

The first Japanese manual on port and harbor technology was released in 1943 and was subsequently revised a number of times. Under the 1974 revision of the Ports and Harbours Law, "the Technical Standards for Port and Harbour Facilities" are provided in the form of ministerial ordinances. The first edition of the present "Technical Standards" was published by the Japan Port and Harbour Association in 1979 and it has been revised three times as of this writing. An English-language edition of the "Technical Standards" was first published in 1980, and was revised and reissued in 1991 and 2002 corresponding to the revisions of the Japanese "Technical Standards."

Because many ports and harbors in Japan face the open sea, a considerable number of ports are exposed to waves with heights exceeding 10m. Furthermore, many Japanese ports and harbors have been constructed on thick strata of cohesive soil deposited on the sea bottom. Because Japan is also one of the world's most earthquake-prone nations, the facilities of ports and harbors are exposed to severe natural disasters of earthquakes and tsunamis. Many efforts for technical development have been undertaken to enable construction of port and harbor facilities that are both safe and economical under these difficult natural conditions. As a result of these efforts, it is fair to say that Japan possesses the world's most advanced level of technology for wave-resistant design, earthquake-resistant design of port and harbor facilities, and countermeasures for soft ground.

The 2007 edition of "the Technical Standards," in addition to incorporating the most advanced technology, has fully incorporated the approach based on "performance-based design" in response to worldwide demands that the national standards be based on "performance criteria," as advocated in the TBT Agreement (Agreement on Technical Barriers to Trade). "The Technical Standards" are consistent with the following international standards, and represent a compilation of Japan's world-class knowledge in connection with technology for ports and harbors:

ISO2394 General principles on reliability for structures,

ISO23469 Bases for design of structures – Seismic actions for designing geotechnical works,

ISO21650 Actions from waves and currents on coastal structures.

The system of technical standards in Japan is structured with “ministerial ordinances” and “public notices” which specify concrete methods in connection with “the Technical Standards” that port and harbor facilities must satisfy based on the Ports and Harbours Law. They are supplemented with the “commentaries” and “technical notes” on those ordinances and public notices. Basically, this structure is followed in the English edition. Although there are duplications in various parts of the explanation, the reader is asked to understand that such duplications reflect the structure of the Standards in the Japanese version. "Some description on the performance-based design and the partial factor and system reliability" are included in Annexes as an aid for the reader’s understanding.

Because technology in respective countries has been developed to conform to the conditions in each country, there may be aspects of the content of “the Technical Standards” which are difficult for persons from other countries to understand. For parts which can not be clearly understand, we recommend that the reader refer to the reference literature for a more detailed explanation of the contents. Those with a keen interest in the subject may also inquire of the relevant offices of the above-mentioned Ports and Harbours Bureau (MLIT), NILIM, and PARI.

It is our sincere hope that “the Technical Standards” will contribute to the development of ports and harbors worldwide and to progress in port and harbor technology.

October 2009

Dr. GODA Yoshimi, Dr. TAKAHASHI Shigeo, Dr. YAGYU Tadahiko, and Dr. YAMAMOTO Shuji
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Acknowledgement

The publisher, Overseas Coastal Area Development Institute of Japan, sincerely appreciates the persons listed below for their contributions in editing, translating and publishing this Technical Standards.

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Abbreviations

Abbreviations	English term
ANSI	American National Standards Institute
API	American Petroleum Institute
ASTM	American Society for Testing and Materials
CBR	California Bearing Ratio
CD	Consolidated Drained
CDL	Chart Datum Level
CIQ	Customs, Immigration and Quarantine
CU	Consolidated Undrained
DOL	Deviation of Out Liar
DT	Displacement Tonnage
DWT	Dead Weight Tonnage
FCL	Full Container Load
FLIP	Finite Element Analysis Program for Liquefaction Process
FRP	Fiber Reinforced Plastic
GPS	Global Positioning System
HWOST	High Water of Ordinary Spring Tide
HWL	Mean Monthly-highest Water Level
IHO	International Hydrographic Organization
IMO	International Maritime Organization
IPCC	International Panel on Climate Change
ISO	International Organization for Standardization
JPI	Japan Petroleum Institute
JSCE	Japan Society of Civil Engineers
LCL	Less than Container Load
LWL	Mean monthly-lowest Water Level
LWOST	Low Water of Ordinary Spring Tide
MIR	Minimum Rate of Residual Correction Coefficient
MLIT	Ministry of Land, Infrastructure, Transport and Tourism
MRI	Meteorological Research Institute
MSL	Mean Sea Level
NILIM	National Institute for Land and Infrastructure Management
NOWPHAS	National Ocean Wave Information Network for Ports and Harbours
OCDI	Overseas Coastal Area Development Institute of Japan
PARI	Port and Airport Research Institute
PC	Prestressed Concrete
PHC	Prestressed Hightension Concrete
PHRI	Port and Harbour Research Institute

PIANC	World Association for Waterborne Transport Infrastructure
RC	Reinforced Concrete
REC	Residue of Correlation Coefficient
RI	Radio Isotope
RWL	Residual Water Level
SALM	Single Anchor Leg Moring
SCP	Sand Compaction Pile
SI	International System of Unit
SRC	Steel Framed Reinforced Concrete
SMB	Sverdrup-Munk-Bretshneider
TP	Mean Sea Level of Tokyo Bay, Tokyo Peil
UU	Unconsolidated Undrained
VLCC	Very Large Crude Carrier
WTO	World Trade Organization

Symbols

Symbols	**Definitions**
A	sectional area (m^2)
A_p	sectional area of pile points (m^2)
A_s	total surface area of a pile (m^2)
B	width (m), ship breadth (m)
C	wind coefficient, center of buoyancy
C_c	compression index
C_D	drag coefficient
C_L	lift coefficient
C_M	coefficient of inertia force
C_m	coefficient of virtual mass
C_u	undrained shearing strength (kN/m^2)
C_v	coefficient of consolidation (cm^2/min)
c	cohesive force (kN/m^2)
c_0	undrained shearing strength of original ground (kN/m^2)
c_d	design value of soil cohesive force (kN/m^2)
D	embedded depth of a foundation (m), pile diameter (mm), depth of waterway (m)
D_e	effective diameter of a drain pile (mm)
D_r	relative density
D_w	diameter of a drain pile (mm)
d	load draft (m), grain size of soil particle (mm)
E	Young's modulus of a pile (kN/m^2)
E_f	berthing energy of a ship ($kN \cdot m$)
EI	flexural rigidity ($kN \cdot m^2$)
e	void ratio
f	coefficient of friction, frequency (Hz)
f'_c	compressive strength of concrete (N/mm^2)
f_d	design value of angle of shearing resistance (°)
G	shearing rigidity ($kN \cdot m^2$)
GT	Gross Tonnage (t)
g	gravitational acceleration (m/s^2)
H	wave height (m), wall height (m)
H_0	deepwater wave height (m)
H'_0	equivalent deepwater wave height (m)
$H_{1/10}$	highest one-tenth wave height (m)
$H_{1/3}$	significant wave height (m)
H_b	breaking wave height criterion (m)
H_D	wave height for design verification (m)

H_i	incident wave height (m)
H_t	transmitted wave height (m)
H_{max}	maximum wave height (m)
h	water depth (m), thickness of layer (m)
h_c	crown height of breakwater above water level (m)
I	moment of inertia of pile sectional area (m^4)
K	coefficient of earth pressure
K_a	coefficient of active earth pressure
K_0	coefficient of earth pressure at rest
K_d	diffraction coefficient
K_r	refraction coefficient
K_P	coefficient of passive earth pressure
K_s	shoaling coefficient
K_t	coefficient of wave transmission
k	seismic coefficient, coefficient of permeability (cm/s)
k'	equivalent seismic coefficient
k_{CH}	coefficient of lateral subgrade reaction (N/cm^3)
k_h	seismic coefficient for design verification
L	wave length (m), embedded length of a pile (m)
L_0	deepwater wave length (m)
L_{pp}	perpendicular length (m)
M	moment ($kN \cdot m$), metacenter
m_v	coefficient of volume compressibility (m^2/kN)
N	N value (Number of blows in 30cm thick of soil by Standard Penatration Test), number of waves
N_q, N_r	coefficient of bearing capacity
N_S	stability number of armor blocks
n	stress sharing ratio, ratio of Young's modulus
P	acting force (kN)
P_B	buoyancy (kN)
P_H	horizontal wave force (kN)
P_U	uplift pressure (kN)
P_V	vertical force (kN)
p_0	overburden pressure (kN/m^2)
p_1, p_2, p_3	intensity of wave pressure (kN/m^2)
p_u	uplift pressure acting underneath bottom of vertical wall (kN)
Q	longshore sediment transport rate (m^3/s)
q	surcharge load (kN/m^2), water volume (cm^3/s), sediment transport rate per unit width ($m^3/m/s$)
q_u	unconfined compression strength (kN/m^2)
r_s	density of soil particle (t/m^3)
R_{fk}	characteristic value of circumference resistance of a pile (kN)

S	settlement (cm)
S_{max}	parameter representing the degree of directional spreading of wave energy
$S(f)$	frequency spectrum of waves
S_r	relative density of rubble stone against water
t	time (s,m,h,d,y), thickness (mm)
T	period (s), tensile strength (kN), tractive force (kN)
$T_{1/3}$	significant wave period (s)
U	consolidation rate (%), wind velocity (m/s), current velocity (m/s)
V	volume (m^3), velocity (m/s), vertical force (kN)
V_p	divergent wave velocity (m/s)
V_s	transverse wave velocity (m/s)
W	weight of wall body (kN), width of waterway (m)
w	unit weight of soil (kN/m^3), width of crack (mm)
wl	tide level (m)
Z	section modulus (m^3)
α	sensitivity factor
β	angle of incident wave (°), inverse of distance between virtual ground surface and virtual fixed point (m^{-1})
δ	friction angle on a wall (°)
Δ_p	increment of pressure (kN/m^2)
φ	angle of shearing resistance (°)
γ	partial factor, unit weight (kN/m^3)
γ'	unit weight in water (kN/m^3)
γ_b	member factor
γ_i	structure factor
γ_w	unit weight of sea water (kN/m^3)
η^*	height of 0 wave pressure above water level (m)
λ_1, λ_2	coefficient of wave pressure correction
μ	static friction coefficient
θ	angle of a slope (°), slope angle of slip failure (°)
ρ	density (t/m^3)
ρ_a	air density (t/m^3)
ρ_d	dry density (t/m^3)
ρ_0, ρ_w	density of sea water (t/m^3)
σ_y	bending yield stress of steel member (N/mm^2)
τ	shearing stress (kN/m^2)
ψ	perimeter length of a pile (mm)

Contents

Part II Actions and Material Strength Requirements