Initiative to Study Climate Change Adaptation Actions for Ports and Harbors

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1. Introduction

Climate change is a urgent global challenge, which requires concrete and concerted action. Port facilities in Japan are an essential infrastructure that supports people's lives and economic activities. Furthermore, being located on the waterfront, they are inevitably susceptible to the effects of changes in sea levels and ocean waves resulting from climate change. In consideration of the importance of port facilities, the Transport Policy Council released a report in August 2020 entitled "Future Direction for Comprehensive Disaster Prevention and Mitigation Measures for Ports which Combine Hard and Soft Measures." In the meantime, scientific insights on climate change have accumulated, as represented by the report "Climate Change in Japan 2020" released in December 2020 by the Japan Meteorological Agency and the Ministry of Education, Culture, Sports, Science and Technology. Against this backdrop, the "Technical Committee on Climate Change Adaptation Implementation for Ports and Harbors," which is chaired by Dr. ISOBE Masahiko, professor emeritus at Kochi University of Technology and the University of Tokyo, has been studying the implementation of measures to cope with climate change at port facilities. Following the deliberations of this committee, a partial revision is to be made in April 2024 on the Technical Standards for Port and Harbor Facilities to integrate adaptation measures to address climate change. This paper is intended to introduce adaptation measures for climate change at ports and harbors.

2. Assessment of climate change impact on high-water levels and ocean waves

(1) Growing severity of the impacts of climate change

In September 2021, the Intergovernmental Panel on Climate Change (IPCC) released a summary of its Sixth Assessment Report for policymakers. The report recognized that human activities had unequivocally caused the warming of air, ocean, and land areas, and it points out that even if net zero emissions is achieved in the future, further global warming is inevitable due to past greenhouse gas emissions. In particular, CO2 emissions are still rapidly increasing, and current progress and timeframes for achieving global net zero emissions are not clear. Therefore, countermeasures for climate change must include both mitigation and adaptation measures.

(2) Forecasts for high-water levels and ocean waves at port facilities which take into account the effects of climate change

Forecasts for high-water levels and ocean waves that take into account climate change are vital for designing adaptation measures at port facilities. To this end, prediction calculations for future climate patterns were made according to the two scenarios of global warming of 2°C and global warming of 4°C using the Database for Policy Decision-Making for Future Climate Change (d4PDF). The respective calculations were made according to the six cases of the model sea surface temperature (SST). The calculation method used an

empirical typhoon model that incorporated atmospheric pressure and wind velocity, with these two factors being corrected for pressure bias via a quantile mapping method. Based on these, a nonlinear long-wave equation was used to calculate high-water levels, and the third-generation wave model Wave Watch 3 was used to calculate ocean waves.

Figure 1 presents examples of probable sea level deviations under the present climate (past testing) and in the future (future testing) for Tokyo Bay in the warming scenario of 2°C (given as an average of the 6 SSTs).

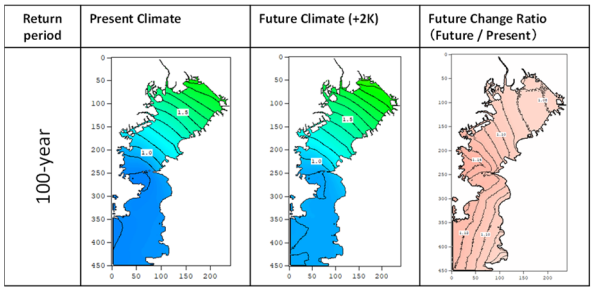

Fig. 1: Examples of probable sea level deviations (Tokyo Bay, under the 2°C warming case)

Calculations were also made for Ise Bay and Osaka Bay[1], to summarize the spatial average of the probability of sea level deviations in each sea area (see **Table 1**), and the probable wave height indicated as an average of representative points (see **Table 2**).

In addition to these sea areas, efforts are being made to calculate future change ratios for sea level deviations and wave heights for all sea areas in Japan. These results are to be released once they have been completed.

Table 1: Spatial average of future change ratio in sea level deviations

Bay	100-year Return Period			50-year Return Period
	Mean	10%tile	90%tile	Mean
Tokyo Bay	1.10	1.03	1.15	1.09
Ise Bay	1.07	1.03	1.10	1.03
Osaka Bay	1.06	0.99	1.13	1.05

Table 2: Future change ratio in wave heights indicated as an average of representative points

Bay	50-year Return Period		
	Mean	10%tile	90%tile
Tokyo Bay	1.02	0.98	1.06
Ise Bay	1.00	0.98	1.03
Osaka Bay	1.04	0.97	1.08

3. Partial revision of the Technical Standards for Port and Harbor Facilities

(1) Revision of notification

As climate change adaptation measures, the clause "in consideration of meteorological conditions and future prospects" for wind, sea levels and waves has been newly incorporated in the notification that specifies the details of the Technical Standards for Port and Harbor Facilities.

(2) Two approaches to ensure required performance

The Standards and Guide to the Standards propose two different approaches to ensure required performances[2] as a specific design approach for addressing the impacts of future climate change.

Conditions, including various water levels (such as average sea level and abnormal water level), high-water level, and residual water level, should be set in consideration of anticipated changes that may occur over time during the design working life of the facilities subject to the Technical Standards to ensure their required performance during their working life. Also, the facilities subject to the Technical Standards must be designed to factor in such changes so that they can fulfill their required performance during their design working life. In consideration of these requirements, "proactive adaptation measures," which address changes at an early stage of the design working life and "flexible adaptation measures," which address changes in a step by step manner within the design working life, have been presented as ways for handling anticipated temporal changes during the design working life. In applying adaptation measures to facilities subject to the Standard, or other port facilities, it is not the

case that only a single approach can be used. The two approaches can be applied in combination as needed, according to the usage situation and structural characteristics, etc., of each facility.

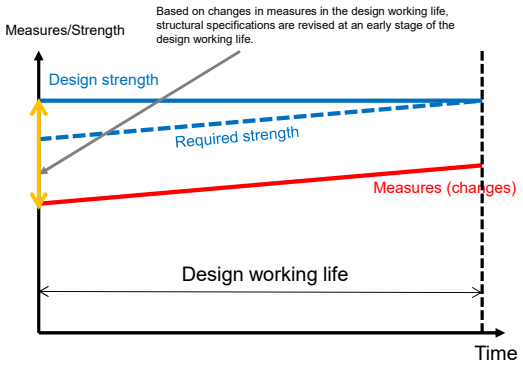

Fig. 2: Proactive adaptation measures

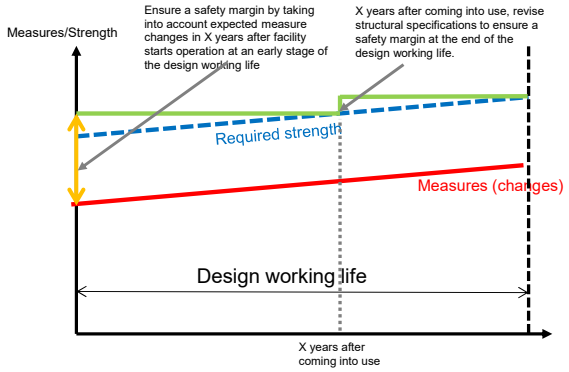

Fig. 3: Flexible adaptation measures

4. Conclusion

The 2024 fiscal year marks the first year of specific efforts being implemented to address climate change issues at ports and harbors. NILIM intends to properly address technical issues that are ports and harbors are being confronted with.

☞For more information:

1) Technical Note of NILIM, No. 1266, p 132
https://www.ysk.nilim.go.jp/kenkyuseika/pdf/ks1266.pdf
2) Technical Note of NILIM, No. 1281, p 24
https://www.ysk.nilim.go.jp/kenkyuseika/pdf/ks1281.pdf