

# Advancement of port construction and maintenance management

## 1. Outline of Studies and Activities

Event	Research background	Research	Results and policy reflection
<p>Since 2000 (Increase in port facilities that are more than 50 years old, increased maintenance and management costs, etc.)</p> <p>2012 Sasago Tunnel Accident</p>	<ul style="list-style-type: none"> <li>■ Aging port infrastructure, etc., and the need for strategic maintenance and management, etc.</li> <li>■ Need for precise implementation of preventive maintenance measures for port infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>Advancement of maintenance and management of port facilities</b> <ul style="list-style-type: none"> <li>• Study on the life cycle cost estimation of port facilities (2010-)</li> <li>• Study on the design methodology based on maintenance and management (2014)</li> <li>• Study on the repair design method for port concrete structures (2015)</li> <li>• Study on the evaluation method for effective utilization of existing port facilities (2016-2018)</li> <li>• Study on effective maintenance management of port facilities (2013-)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>○ <b>Guidelines for Inspection and Diagnosis of Port Facilities (2014) and other guidelines</b></li> <li>○ <b>Release of life cycle cost (LCC) calculation program for port facilities (2013)</b></li> <li>○ <b>Release of an information provision system that contributes to decisions on inspections and repairs (2019)</b></li> <li>○ <b>Revision of the Technical Standards and Commentary for Port and Harbor Facilities (Chapter 2, 3 Construction, 4 Maintenance and Management) (2018)</b></li> <li>○ <b>Development and revision of the standards for ICT construction at ports and harbors</b> <ul style="list-style-type: none"> <li>Bathymetric Survey Manual (Dredging) (2017, 2018, 2019),</li> <li>Workmanship Control Manual (Dredging) (2017, 2018, 2019), etc.</li> </ul> </li> <li>○ <b>Development and revision of BIM/CIM utilization guidelines (2019)</b> <ul style="list-style-type: none"> <li>• Creating generic objects</li> </ul> </li> <li>○ <b>Development of design and construction guidelines for improving the safety of large-scale temporary works and other facilities in port construction (2017)</b></li> </ul>
<p>Since the late 1990s (Decrease in the number of construction firms and construction workers)</p> <p>2011 The Great East Japan Earthquake (Increase in construction investment)</p> <p>2020 Global spread of COVID-19</p>	<ul style="list-style-type: none"> <li>■ Need for DX (digital transformation) and other initiatives against the backdrop of labor shortages and the COVID-19 pandemic</li> <li>■ Need for initiatives in port construction in light of ICT (information and communication technology), automation, and digitalization</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>Promotion of ICT construction and BIM/CIM utilization for port facilities</b> <ul style="list-style-type: none"> <li>• Study on the promotion of i-construction in the port sector (2016-)</li> <li>• Study on improving the safety of construction in the port sector (2014-2017)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>○ <b>Development and revision of BIM/CIM utilization guidelines (2019)</b> <ul style="list-style-type: none"> <li>• Creating generic objects</li> </ul> </li> <li>○ <b>Development of design and construction guidelines for improving the safety of large-scale temporary works and other facilities in port construction (2017)</b></li> </ul>
<p>2001 Green Purchasing Act (Act on the Promotion of Procurement of Eco-Friendly Goods and Services by the State and Other Entities)</p> <p>2005 Enactment of the Quality Assurance Act (Act on Promoting Quality Assurance in Public Works)</p> <p>2014, 2019 Partial revision of the Quality Assurance Act</p>	<ul style="list-style-type: none"> <li>■ Need for further quality assurance efforts in public works</li> <li>■ Need for initiatives to reduce environmental impact in public works, etc.</li> <li>■ Need to address the aging of work vessels</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>Promotion of public procurement and quality assurance of port construction</b> <ul style="list-style-type: none"> <li>• Study on the cost estimation standard for ports and harbors (2001-2004)</li> <li>• Study on maintenance and improvement of port construction technology (2005-2006)</li> <li>• Study on the application of the general evaluation bidding method in the field of port construction (2003-2005)</li> <li>• Study on the promotion of quality assurance in the port and harbor field (2006-)</li> <li>• Study on eco-friendly goods and services for reducing the environmental load of ports and airports (2003-)</li> <li>• Development of environmental assessment technology for social infrastructure in the port sector (2010-2012)</li> <li>• Study on the activity status and basic information of work vessels for determining countermeasures against aging of work vessels (2014-2016)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>○ <b>Revision of the Guidelines for Application for Competitive Eligibility Screening</b></li> <li>○ <b>Development and revision of various procedures</b> <ul style="list-style-type: none"> <li>• Revision of the Performance Grading Standards for Contracted Construction Work (2013)</li> <li>• Guidelines for the Bidding Methods for Port and Airport Work (2015)</li> <li>• Revision of the Performance Evaluation Standards for Contracted Work (2020)</li> </ul> </li> <li>○ <b>Re-evaluation of procurement items specified in the Basic Policy on the Promotion of Procurement of Eco-Friendly Goods and Services (2012)</b></li> <li>○ <b>Revision of the Guidelines for Recycling in Port and Airport Development (2015, 2018)</b></li> </ul>

As with other infrastructures, port facilities also require strategic maintenance management and appropriate implementation of preventive maintenance measures against the backdrop of an increasing number of aging facilities. In addition, the recent development of information and communication technology (ICT) and automation, as well as digitalization, the labor shortage, and the COVID-19 pandemic have made it necessary to address ICT construction and DX (digital transformation), etc., and we have conducted research related to these issues. It has also become necessary to provide further quality assurance, reduce the environmental load of public works projects, and take measures against aging work vessels.

#### ■Advancement of maintenance and management of port facilities

**(Background/Issues)** As port facilities that were intensively developed during the period of rapid economic growth continue to age, it is necessary to promote systematic and strategic maintenance and management with limited budgets and personnel. Therefore, we needed to develop a system that could be used as a reference for port managers to efficiently determine future maintenance and management costs and the timing of repairs, etc.

**(Research Outline and Results Implementation)** Based on the results of inspection and diagnosis of port facilities, we analyzed the deterioration trend, compiled the results in a NILIM Technical Note, and reflected them in the Technical Standards and Commentary on Port and Harbor Facilities (Chapter 2-4 Maintenance and Management) and other documents. In addition, a practical system for estimating the life cycle costs and determining the timing of inspections and repairs was developed and published on the NILIM website.

#### ■Promotion of ICT construction and BIM/CIM utilization for port facilities

**(Background/Issues)** In the construction industry, labor shortages are a serious issue, and the Ministry of Land, Infrastructure, Transport and Tourism (MILT) has implemented the “i-Construction” initiative to improve the productivity of the entire construction production system. In addition, the outbreak of COVID-19 triggered an urgent need to accelerate the construction of a resilient economic structure, including the shift to a noncontact, remote working style. In order to promote these efforts and address the above issues, it was necessary to formulate standards and make improvements based on the trial project.

**(Research Outline and Results Implementation)** Through questionnaire surveys and on-site verifications in ICT trial works and CIM trial projects, data analysis and evaluation were conducted to improve the work efficiency mainly in the design and construction phases. The results were reflected in the formulation and revision of various standards, such as the manual for bathymetric surveying using multibeam echo sounding (dredging section), the workmanship management manual using 3D data (dredging section), and the BIM/CIM utilization guidelines for ports, based on discussions by the ICT Introduction Study Committee for Ports and Harbors and inquiries to related parties for their opinions. The results were reflected in the development and revision of various standards.

#### ■Promotion of public procurement and quality assurance of port construction

**(Background/Issues)** Since the Act on Promoting Quality Assurance in Public Works came into effect in April 2005, the bidding and contracting system has been improved and reformed, including the expansion of the application of general competitive bidding and the comprehensive evaluation method, and further efforts to ensure quality have been required.

In addition, for eco-friendly goods, etc. in the port and airport sector, the “Basic Policy on the Promotion of Procurement of Eco-Friendly Goods and Services” has been formulated based on the Green Purchasing Act (Act on Promotion of Procurement of Eco-Friendly Goods and Services by the State and Other Entities), which requires the selection of eco-friendly goods and services and the provision of information necessary for their procurement in order to promote procurement.

**(Research Outline and Results Implementation)** Analytical studies have been conducted on bidding and contracting results,

efficiency of construction, and examination and evaluation (comprehensive evaluation method, competitive eligibility screening, and performance grading) based on the policy for public procurement initiatives and the history of improvements in the system. The results were reflected in the revision of various guidelines, such as the Guidelines for Application for Construction Competition Qualification Screening and the Performance Grading Criteria for Contracted Work.

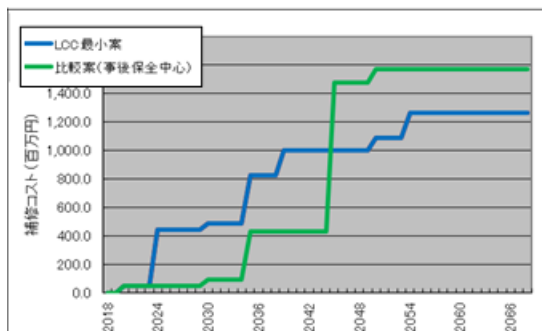
In addition, in the survey on eco-friendly goods, the selection and review of specified procurement items have been studied, and information on the use track record and quality performance of recycled materials have been collected, organized, and studied. The results were reflected in the revision of the Guidelines for Recycling in Port and Airport Development.

## 2. Main Research Results

### ■Advancement of maintenance and management of port facilities

- Using the results of the inspection and diagnosis of port facilities, we examined the improvement of accuracy in predicting the deterioration of mooring facilities, and analyzed the hollowing out of port facilities and the deformation trend of the side walls of the main body of the wave dissipating block covered breakwater.
- We have developed a calculation program that enables even nonexperts in charge of port structures to easily calculate life cycle costs by simply inputting the inspection and diagnosis results (deterioration information). Moreover, an information provision system that contributes to decisions on inspections and repairs has been developed.

【LCC計算結果(全部材)】



Life cycle cost calculation results

#### Information to enter

- Basic facility information (facility name, construction year, survey year, etc.)
- Inspection and diagnosis results (degree of deterioration, measurement results)

#### Calculation

#### Information to be output

- Deterioration location information, etc.
- Repair period
- Life cycle cost information
- Evaluation and points to note

Overview of information provision system

### ■Promotion of ICT construction and BIM/CIM utilization for port facilities

- Through the field verification, we confirmed that the measurement performance (density of acquisition points) in multibeam echo sounding can be optimized and the swath angle (range of sound wave irradiation) and overlap ratio (ratio of overlapping sound wave irradiation) can be relaxed in the calculation of dredged material volume and water depth measurement for port and harbor construction. In addition, we studied ways to simplify the documents to be submitted, and developed a noise processing program using AI technology.
- Based on the CIM modeling work, a draft of the BIM/CIM utilization guidelines (ports and harbors) was prepared, and a library providing 3D prototype models and generic objects for port facilities was also created.

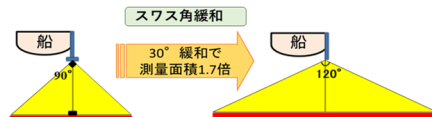
(Optimization of acquisition point density for multibeam echo sounding)

【現行 (H30)】

計測性能 (取得点密度)	① 1.0m平面格子に3点以上 ② 達成率90%以上 ③ ただし、3点未満の平面格子が連続してはならない
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【改定 (H31)】

計測性能 (取得点密度)	① 1.0m平面格子に3点以上 ② 達成率99%以上
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(Relaxation of swath angles and overlap rates)

【現行 (H31)】

スワス角	90°
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【改定 (R2)】

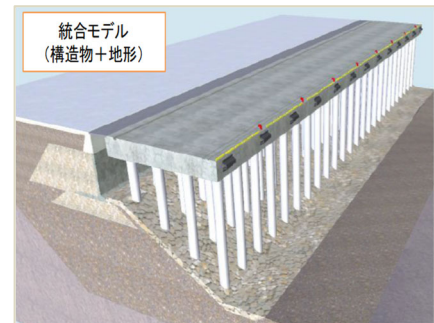
スワス角	90°~120° (広げる)
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【現行 (R2)】

重複率	100%
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【改定案】

重複率	20% (ラップを小さく)
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Reflecting the results of the study on narrow multibeam in manuals and other documents

Prototype model of port facilities (pier)

## ■Promotion of public procurement and quality assurance of port construction

- We conducted an analysis of the general evaluation bidding system and bidding contract results for port construction and operations, as well as a trial analysis for the next competitive eligibility screening. Furthermore, we prepared a trial draft of the performance evaluation standards for contracted works and contracted services, and proposed revisions based on the results of the opinion inquiry.
- In order to select new specified procurement items in the field of ports and airports, technical studies were conducted on characteristics related to environmental load reduction and characteristics other than the environmental load reduction (strength, durability, quality of functions, etc.) of the items to be proposed. In addition, we examined the contents to be reflected in the organization of procurement results and comprehensive evaluation of recycled materials in the field of ports and airports, and prepared a draft revision of the recycling guidelines accordingly.

Recycling guideline revision points (2018)  
(Updated technical evaluation has improved the evaluation for the following six materials)

材 料	用 途
鉄鋼スラグ二次製品(浚渫土改質材)	埋立材
フライアッシュ (JIS 灰/非JIS 灰)	コンクリート用細骨材
クリンカアッシュ	サンドコンパクションパイル材、盛土材等、埋立材
石炭灰二次製品(石炭灰造粒物)	サンドコンパクションパイル材
フェロニッケルスラグ	コンクリート用粗骨材
破碎瓦	裏込材、裏埋材、埋立材

## 3. List of Related Reports and Technical Documents

### ■Advancement of maintenance and management of port facilities

- NILIM Technical Note No. 837 <http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn837.htm>
- NILIM Technical Note No. 918 <http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn918.htm>
- NILIM Technical Note No. 932 <http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn932.htm>
- NILIM Technical Note No. 933 <http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn933.htm>
- NILIM Technical Note No. 1023 <http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn1023.htm>
- NILIM Technical Note No. 1043 <http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn1043.htm>

### ■Promotion of ICT construction and BIM/CIM utilization for port facilities

- NILIM Technical Note No. 1022 <http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn1022.htm>
- NILIM Technical Note No. 1024 <http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn1024.htm>

- 3) NILIM Technical Note No. 1066 <http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn1066.htm>
- 4) NILIM Technical Note No. 1067 <http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn1067.htm>
- 5) NILIM Technical Note No. 1079 <http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn1079.htm>
- 6) NILIM Technical Note No. 1087 <http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn1087.htm>
- 7) NILIM Technical Note No. 1102 <http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn1102.htm>
- 8) NILIM Technical Note No. 1103 <http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn1103.htm>

**■Promotion of public procurement and quality assurance of port construction**

- 1) NILIM Technical Note No. 651 <http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn651.htm>
- 2) NILIM Technical Note No. 919 <http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn919.htm>
- 3) NILIM Technical Note No. 957 <http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn957.htm>

#### 4. Future Outlook

In order to achieve a 20% increase in construction site productivity by FY2025, we need to continue conducting hearings and on-site inspections related to improving the efficiency of ICT-enabled construction work, and consider revising various standards based on these findings. It is also necessary to expand the provision of generic objects and analyze the BIM/CIM utilization guidelines in order to shift to the use of BIM/CIM in all public works projects, except small-scale ones, by FY2023.

In addition, it is necessary to continue implementing measures to upgrade the support tools for maintenance management by providing information, etc., in response to the further aging of port facilities, and provide further quality assurance and reduce the environmental load in public works.