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Autor: Yokota, Hiroshi / Matsubuchi, Satoru

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Recent Experience of Upgrading Berthing Facilities in Japan

Hiroshi YOKOTA
Chief
Port and Harbour Research Inst.
Yokosuka, Japan

Satoru MATSUBUCHI
Research Engineer
Port and Harbour Research Inst.
Yokosuka, Japan

Hiroshi Yokota, born 1955, received his Dr. Eng. degree from Tokyo Institute of Technology. He has been a chief of Structural Mechanics Laboratory since 1997.

Satoru Matsubuchi, born 1960, received his civil engineering degree from the Nippon University. He is engaged in the research on the design of port and harbour structures.

1. Introduction

While berthing facilities in Japan have been designed with 30 to 50 years of design life spans, approximately 15 or more facilities begin to be upgraded every year before reaching their intended life spans. Most of such upgraded facilities faced the problems associated with insufficient water depth in front of the berth, ageing of materials, lack of cargo handling spaces, containerisation, and so on. This was because they have been designed to service comparatively small vessels and have been equipped with less sophisticated and lighter cargo handling equipment.

To understand the actual upgrading measures to such less valuable port facilities, a nationwide survey has been undertaken and 90 examples have been collected. These examples were analysed with focus on timing, structural and design details, and reasons for upgrade. Beside the upgrade analysis, maintenance and major repair costs before and after upgrading were also analysed and estimated. It is getting more important to estimate the life-cycle cost to decide future maintenance strategy including repair, rehabilitation, upgrade, or demolition. This paper presents the analytical results of upgrade and life-cycle cost of berthing facilities in Japanese ports.

2. Examples of upgrading existing berthing facilities

Among all berthing facilities with more than -4m depth in Japan, a total of 90 facilities in 48 ports upgraded after 1988 were surveyed and collected. Figure 1 shows the time of upgrade after initial construction with the description of structural types. The age group of 20 to 29 years after initial construction showed the largest numbers of upgraded cases and sheet-pile bulkheads accounted for the majority of the upgraded structures. Among all upgraded examples, those upgraded before 30 years after construction were 52% of gravity type structures, 58% of piled platforms, and 76% of sheet-pile bulkheads. It can be concluded that steel structures have more possibility to be upgraded than concrete structures because of possible cause of corrosion. About 30% were taken the reason for meeting the requirements on physical conditions such as loss of strength and large deformation. For functional reasons such as enlargement of vessels and shortage of cargo handling areas was about 55% of all.

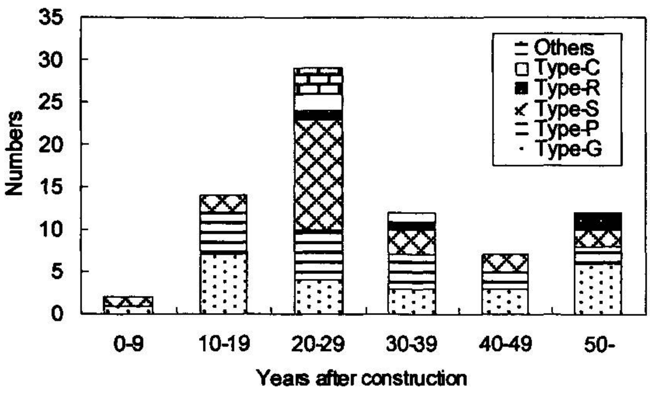

Fig. 1 Timing of upgrading after initial construction

3. Life-cycle Cost Estimation and Evaluation

The relationship between operational years after construction and the average annual maintenance cost is shown in Figure 2. The maintenance cost began to appear after 15 years and increased with operational year. There were two groups

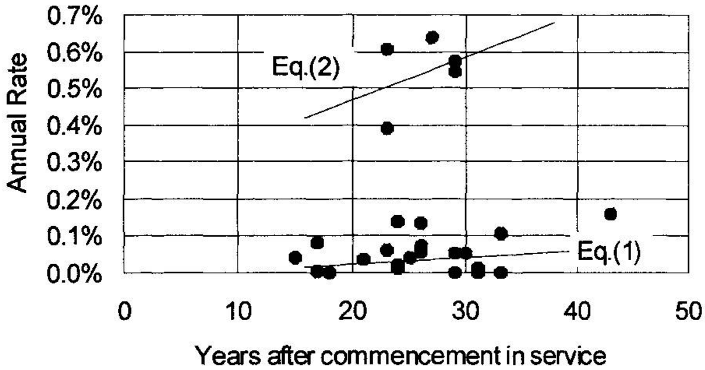

Fig. 2 Annual cost ratio of normal maintenance

of the relationship: higher cost rate and lower cost rate. The higher cost tended to appear in well maintained facilities. The best fit lines, though there are much varied, for maintenance cost was proposed.

4. Life-Cycle Cost and Maintenance Strategy

The life cycle maintenance for port facilities was based on 1)Evaluation of present structural performance and function and 2) Remaining life to be required. When the estimated remaining life is longer than the initial design life, there would be no countermeasures at the time of consideration. In other cases, however, countermeasure to extend the life of facilities should be taken and this should be done according to the life-cycle cost estimation if available.

On the basis of the maintenance strategy, three scenarios were considered here. Scenario 1: leaving this condition until the stress ratio reached 0.9 and after that very high quality countermeasures such as petrolatum and protection cover for steel and resin lining for concrete deck would be installed. Scenario 2: repairing or strengthening to some extent such as reinforced concrete covering for steel and replacement of deteriorated part of concrete and the same corrosion rate would be expected. Scenario 3: installing countermeasures enable to decrease the corrosion rate. The required life was set to be 60 years after construction and normal maintenance happened after 15 years. Steel piles and concrete deck were considered to need countermeasure at 40 years and 30 years after construction respectively.

Figure 3 shows the life-cycle cost calculation with the three scenarios. Scenario 3 gave the most economical results at the end of life span. Accumulating cost data and establishing its database will enable to provide more accurate cost estimation. Life-cycle cost estimation is one of the sophisticated decision support tool for establishing maintenance strategies for port facilities. The life-cycle cost estimation was proposed for providing a prospective answer for future maintenance strategy.

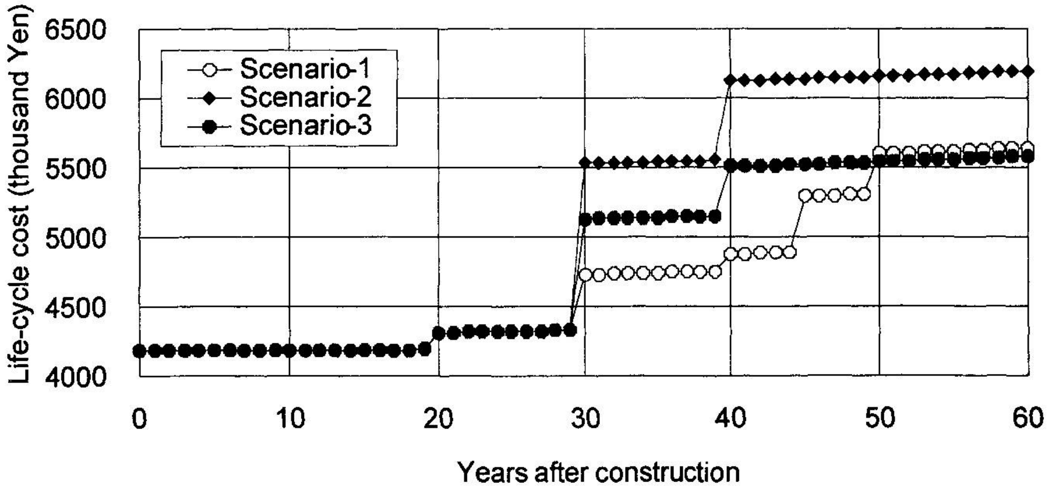

Fig. 3 Life-cycle cost calculation with three scenarios