

New Design Proposal for Simplified Maintenance of Open-type Wharf

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Summary

Reinforced concrete (RC) members consisting of superstructure of open-type wharf are exposed to harsh marine conditions, resulting in early degradation of the structures due to chloride-induced deterioration. In such conditions, appropriate maintenance works are required to secure durability and safety of the members, while repair works to the superstructure cannot avoid setting up temporary scaffolds under the superstructure. In addition, working time is strictly limited due to interference of terminal operations, tidal actions and poor working conditions. Consequently, repair works to deteriorated RC superstructure, inevitably suspending terminal operations, are costly over a service and incur significant beneficial loss.

The authors have proposed a “replaceable” slab as a new design concept of RC members for simplified maintenance of the superstructures of open-type wharf. A precast RC slab connected to the beams by the proposed joint system is to be easily removed during the service period. When critical deterioration is detected in the slab during services, the slab is to be removed and replaced by a new intact one. A replaceable slab can avoid repair works with temporary scaffolds under the slab, resulting in reduction of maintenance costs without suspension of terminal operations.

In this paper, structural performance of a 2-way slab connected by the proposed joint system was investigated with various structural details and concrete types through loading tests in order to secure a feasibility of the replaceable slab concept. The loading test of the slab under negative bending moment was also conducted. Based on the results, the design method of the replaceable slab was discussed in this paper. One trial calculation on Net Present Value (NPV) revealed that the replaceable slab system would be cost-effective compared to the conventional one.

Keywords: replaceable slab; open-type wharf; structural performance; joint; NPV

1. Introduction

Port structures are generally affected by harsh marine conditions. Material deterioration and damage to structural components are likely to occur throughout a structure's service period. Open-type wharf is a typical structure commonly found in Japan, which is used in both container and bulk terminals. The maintenance of this kind of wharf may pose a certain problems. The steel pipe piles that support the superstructure of a wharf are normally protected by corrosion-prevention system, such as cathodic protection and surface coating. The reinforced concrete superstructure, however, is constantly exposed to severe chloride attack, resulting in quick deterioration of the concrete members and consequently affecting structural performance and durability. In Japan, most wharves need repair works only a few decades after completion, because durability of RC in design had not been considered appropriately.

When carrying out repairs to a superstructure, it is usually necessary to erect temporary scaffolds under the superstructure. Naturally, the time available to work under the superstructure is limited because of the interference of tidal change and wave action. The narrow clearance under the superstructure and high humidity also mean that working conditions are also far from ideal. In combination, these factors can make it necessary to suspend terminal operations. Consequently,