Diagnosis process for the assessment and the refurbishing of port and maritime existing structures

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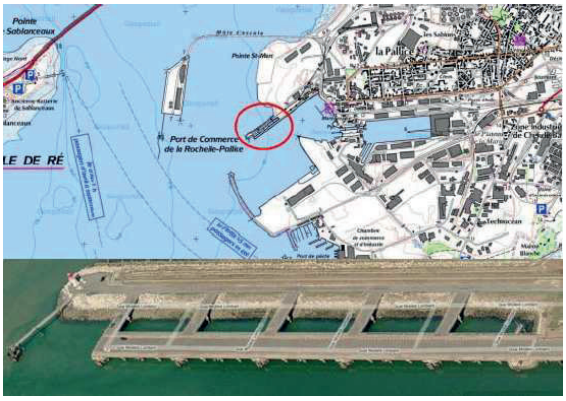
Summary

The managers of maritime port structures have to face several issues: ageing of structures, environmental risks, maintenance, adaptation to new equipments and new vessels. The assessment of structures condition is therefore a critical element to help managers make the proper decisions to ensure a continuous exploitation and to avoid exploitation losses. This assessment is done through a diagnosis which aims to gather the objective elements to make the proper choices. After a general presentation, the diagnosis issues are illustrated by the presentation of real studies on a grain dock in La Rochelle and an oil wharf in Guadeloupe Island. In each of these studies, managers' issues are exposed, and the means and methods used to address them are presented. The conclusions of these diagnoses are then commented, with a focus on linking these specific cases to broader issues and pointing on the difficulties for the assessment and refurbishing of old structures.

Keywords: maritime port structures; concrete; steel; ageing; diagnosis; non-destructive tests; monitoring; assessment.

1. The issues of diagnosis for maritime port structures

Because of its long maritime history, France owns a large patrimony of maritime port structures. These structures are scattered along over 6 000 km coastline and thus exhibit an important diversity. These are exposed to a large variety of environmental conditions which vary from polar climate to tropical, and which include seismic and cyclonic risks. The port infrastructures' managers have to ensure an optimal serviceability while minimizing maintenance costs and exploitation interruptions. Moreover, the existing infrastructures often have to bear new equipment, increasing tonnages and comply with the requirements of a regulatory framework in perpetual evolution.



Modere Lombard grain dock

To illustrate these issues, we have chosen to present two examples: a grain dock in La Rochelle and an oil wharf in Guadeloupe. In the first case, the manager has had to engage diagnosis studies to examine the conditions and the feasibility of the implementation of a new crane on an old dock. In the second case, the condition, the performances and the compliance of an old structure had to be determined in order to examine the possibilities of a life span extension and to recommend refurbishing and repair solutions.

https://doi.org/10.2749/222137813806521423 Distributed by structurae

2. Diagnosis programs

The diagnosis program for Modere Lombard grain dock was established considering existing archives, discussions with the port manager and on-field preliminary visit. The program consisted in a complete detailed inspection, a verification of several geometrical data on specific parts, considered as relevant from a structural point of view and a verification of the durability characteristics of the reinforced concrete, because of both environmental conditions and defects observed during a preliminary visit.

Unlike the Modere Lombard dock diagnostic program which was elaborated by specialists, diagnosis elements for Jarry oil wharf were defined in the technical terms of the tender. These elements consisted in a complete detailed inspection, metal thickness measurements, a verification of the concrete filling of the piles by local drilling, a verification of the global geometry and of the deflection of the longitudinal beams, a dimensional control of structural elements and of steel reinforcements characteristics to validate input data, a verification of the durability parameters for the reinforced concrete, a verification of the performances of structural elements through numerical computing using on field observations and measurements, and a verification of the resistance to earthquakes and to cyclones, in terms of compliance with actual standards.

3. Results summary

Diagnosis of the Modere Lombard grain dock revealed only material defects on precast concrete secondary elements; these defects consisted in chloride induced corrosion. Thus, in the short term, the feasibility of the replacement of the actual crane by a 380 tons gantry was demonstrated conditional to the repair of these concrete defects. In the longer term, the economical and technical feasibility of the implementation of a protection system on the main beams (dechloration, cathode protection) and an efficient preventive maintenance program were recommended.

Several severe structural and material defects were found on the Jarry oil wharf. Moreover, the structure did not meet the requirements concerning operating solicitations, earthquakes and cyclones. Thus, additional investigations were recommended to complete the diagnosis and to define a refurbishing program which will ensure optimal compliance to actual standards and will enhance the lifespan. As the refurbishing of this structure imposes already heavy works, the manager has first to redefine his needs in terms of operation duration and service level and then to choose between different solutions, including replacement of the structure. However, as the Jarry oil wharf needs to be operational until the refurbishing, limitation of access and tonnage as well as continuous monitoring of the main beams deflections were recommended to prevent partial ruin and associated exploitation losses.

4. Discussion

The two cases presented here illustrate the gain and the difficulties of diagnosis for ancient structures, these studies being engaged in the frame of projects as development, service level enhancement or extension of lifespan.

These studies combine investigations on “structural behaviour” and “material durability” and compliance verifications with actual regulation standards, often more restrictive than the ones which have been used when the structures were built.

While diagnosis provides objective elements of response on the consequences of proved non compliances, for instance partial or total ruin, appearance of severe degradations, lowering of service level, the forensic engineering and risk-based management methods may provide a complementary help to the manager who faces difficulties in making the proper choices technically, strategically and financially.

In all cases, the existence of an organized preventive maintenance program which comprises the periodic assessment of relevant parameters characterizing the status and functioning of structures is essential in order to define optimal diagnosis programs, to limit the residual unknown data and to establish recommendations that facilitate the selection then the implementation of adapted solutions to the problems posed.