Research on Evaluation Technology of Lock Chamber Wall

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Abstract. Under the influence of natural and human factors, most hydraulic structures will be damaged. Therefore, an index parameter system is proposed to reflect the surface integrity of lock chamber wall, durability and strength, etc. Meanwhile, the corresponding testing technology and testing methods for the use of all necessary indicators are made. On the basis of this, researches of evaluation technology are carried out to determine whether the wall surface needs to be repaired. According to the processing requirements and regulations to repair and reinforce it.

Introduction

After years of operation under the influence of natural and human factors, the structure, materials function of most of locks and other hydraulic structures vary degrees of damage. Phenomena of concrete aging and severely damaged, concrete surface cracking, erosion and water seepage are more common.

There are more than 100 navigation locks in Jiangsu, many of which are built 50 years ago or built in the 1980's, mostly designed in low standard and having serious aging damage. What's more, with the increase in size and frequency of operation of the ship, the lock chamber wall suffered severe wear and serious cracking.

At present, the detection and grade assessment of lock chamber are mainly based on "Technical Specification for Detection and Assessment of Harbour and Marine Structures"(JTJ302-2006) and "Safety Identification Regulations of Locks"(SL214-98)[1], lacking the specification for inspection and evaluation of lock chamber. Jiazheng Li believed that the positive evaluation of the locks should start with overall reliability and evaluate the structure and operation of the various structural components respectively[2]. Hangzhou Wang proposed lock buildings and structures reliability assessment based primarily on national and sectoral peremptory norms and carry out from the three aspects of safety, durability and serviceability requirements[3].

In addition, the evaluation methods of concrete structure are mainly divided into two categories[4-7]. The first kind of evaluation methods analyses the internal stress and deformation theory of the structure, studies the mechanical, physical and chemical of the damage, so as to determine whether the structure to reach the ultimate bearing capacity. The second kind of evaluation methods analyses the inspection data of engineering and structural components, studys on the reason of the structure damage, establishes index system and judges the aging degree of structure.

Therefore, it is necessary to propose the index system parameters which can reflect the wall surface integrity, durability and strength with modern testing techniques and analysis methods. So that the research on evaluation technology can be carried out on the basic of this to provide a basis for judging and evaluating whether the lock chamber wall needs to be repaired. And according to the technology, we are able to treat the damaged lock chamber wall structure to restore the function of use and improve the overall reliability of the navigation locks.

In summary, the researches on the detection and evaluation of lock chamber, especially the lock chamber wall are rare. This paper reasonably selects the critical indicators of detection and evaluation by using the reliability of the lock chamber wall as the overall goal and combining the structural characteristics and operational environment of it. According to relevant documents to make research on evaluation technology and on the basis of the processing requirements to repair and reinforce it.

Selection of Detection and Evaluation Indicators

The lock chamber walls are usually reinforced concrete structure. Current detection of reinforced concrete structures typically includes visual inspection, crack inspection, measuring the depth of concrete carbonation, chloride content analysis, internal defect inspection of concrete and concrete strength evaluation, as well as reinforced protective layer thickness inspection, steel corrosion rate analysis. Under normal conditions of use, the durability of concrete is closely related to environment and concrete quality. Lock chambers are vulnerable to the impact of ships and water erosion. Phenomena of wear, erosion and cracking are more common. Thus, according to the lock chamber wall structure characteristics and the environment, reasonably determining the critical detection and evaluation indicators is an important part of the study.

We took the defects of appearance, concrete strength and durability as the index to evaluate. The defects of appearance includes surface cracks, peeling, deteriorated appearance due to steel corrosion and wear. The concrete strength of chamber wall surface includes concrete compressive strength, tensile strength and shear strength. The durability of chamber wall includes concrete internal defects, carbonation depth, thickness of concrete cover and extent of steel corrosion.

Research on Evaluation Methodology Lock Chamber Wall

The result of testing will be divided into A,B,C and D four levels (Table 1) in reference to "Safety Identification Regulations of Locks"(SL214-98), "Technical Specification for Detection and Assessment of Harbour and Marine Structures"(JTJ302-2006), "Control Standards of Concrete Quality in Waterway"(JTS202-2-2011), other existing norms and related articles. Then requirements for the processing of repair and reinforcement can be done by relevant specification (Table 2).

Table 1. Grade estimation for lock chamber wall testing project

Test items		Grade			
		A	B	C	D
The defects of appearance	Surface cracks	No cracks	The local has slight corrosion cracks. Crack width is less than 0.3[mm]	More corrosion cracks or reticular cracks. Crack width is between 0.3[mm] to 1.0[mm]	A large area of corrosion cracks, which take on net structure. Crack width is greater than 1.0[mm]
	Peeling	No peeling	Locally hollowing in small area	Locally peeling. The area of flaking and hollowing is less than 30% of area of zone	A large area of peeling. The area of flaking and hollowing is more than 30% of area of zone

	Deteriorated appearance due to steel corrosion	No deterioration	Local rust on concrete surface	More rut. The range of steel corrosion is wide	Universal rut, most or all of the steel surface corroded. The cross-sectional area of the steel is reduced
	Wear	No wear	Slight surface wear	Abrasion depth is 1~2 [mm]	Abrasion depth is 2~3 [mm]
Concrete strength	When the concrete strength is less than C25, repair and reinforcement are needed. Concrete compressive strength should be greater than 45.1[MPa] after repair. Tensile strength should be greater than 4.08[MPa] and the shear strength should be greater than 15.2[MPa]				
Durability	Concrete internal defects	The inner parts of concrete are complete and uniform	Small cracks inside the concrete, a little unevenness	Large cracks inside the concrete, the phenomenon of Honeycomb	Internal concrete crushing. The phenomenon of Honeycomb is relatively common. There are some voids
	Carbonation depth[mm]	<0.7	0.7~1.2	1.2~1.5	>1.5
	Thickness of concrete cover	Concrete cover thickness of chamber wall above water, in water level fluctuation zone and in underwater zone should be respectively greater than 40mm, 40mm and 35mm			
	Extent of steel corrosion	Electric potential is greater than -150[mV]. Slightly corroded steel, corrosion pits or local corrosion	Electric potential is between -150 ~ -220 [mV]. Slightly corroded steel, corrosion pits or local corrosion	Electric potential is between -220 ~ 350[mV]. Comprehensive steel corrosion	Electric potential is less than -350[mV]. severely steel corrosion

According to the indicators above for the lock chamber wall, the test results can be obtained on the basis of Table 2.

Table 2. Structure evaluation classification and processing requirements for lock chamber wall

Grade	The classification standard	Processing requirements
A	The deterioration degree conforms to grade A standard requirement. The durability meets the requirements of design life.	Do not take measures
B	The deterioration degree conforms to grade B standard requirement. The durability fails to meet the requirements of design life. The structural damage has not affected the carrying capacity.	Repair measures in a timely manner
C	The deterioration degree conforms to grade C standard requirement. The durability fails to meet the requirements of design life. The structural damage has affected the carrying capacity.	Take immediate repair and reinforcement measures
D	The deterioration degree conforms to grade D standard requirement. The durability fails to meet the requirements of design life. The structural damage is severe.	Repair and reinforcement measures depending on the condition or scrapped

Conclusions

In this paper, taking the defects of appearance, concrete strength and durability as the indicators to evaluate, according to the criterion of evaluation and processing, provides the judgement and evaluation basis for the lock chamber wall. The evaluation technology has a strong operability for the evaluation for the lock chamber wall.

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