Comoon Quality Faults and Prevention Measures of shiplock culvert

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Abstract: By analysing formation mechanism of concrete crack on shiplock culvert, the concrete mixture designing, the concrete raw material testing, the additive agent performance testing and the concrete prototype observation are researched combining a typical three lines shiplock in Jiangsu Province. A series of prevention measures of concrete crack are put forward from the aspect as design, construction and maintenance.

Introduction

The culvert is the most important part of ship lock engineering, whichconsists of mass concrete structure with a complex section structure and big volume. The cross section changed parts of ship lock culvert produced different levels of cracks, and this problem has become one of common quality faults in Jiangsu ship lock engineering construction.

The cause of lock culvert concrete cracks

The internal temperature of mass concrete structures can rise to more than 60℃due to hydration heat accumulation is not easy to send out, then the temperature stress caused by different temperature between inside and outside easy to make concrete cracks. In addition, tensile stress of external load,shrinkage of concrete hardening and contraction stress are main factors which cause concrete cracks. The cracks are not only influence the integral force of structure, but also affects the seepage control and durability of structures, shorten the service life of the building. According to the statistics of shiplock culvert, cracks usually appear in about two weeks after concrete pouring. External cracks, internal cracks and penetrating cracks all have varying degrees of existence. Typical fractures of lock culvert are shown in Fig1.

Fig.1 Typical fractures of lock culvert

culvert construction techniques and crack control measures

Setting post-poured strip

Setting post-poured strip on the concrete easy to cause cracks, which can release shrinkage stress and reduce the probability of cracking on culvert concrete. The culvert crack often appears in exterior arc section which cross section changes greatly. According to this, post-poured strip are set up both upstream and downstream sides in Huai-anshiplock. The concrete observation of post-poured strip profile is shown in Fig2.

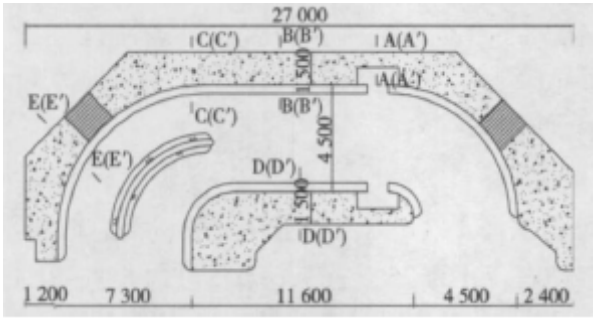

Fig.2 Observation section and arrangement diagram of culvert post-poured strip

Settingcrack-prevention steel bar

Reasonable setting crack-prevention steel bar can enhance the local tensile strength of concrete and reduce the probability of cracking. According to this, crack-prevention steel bars are set up on Huai-yin lock and Huai-an lock of Jiangsu Province.

Choosing appropriate additive and admixture

(1) Mixing fly ash in concrete can reduce the unit consumption，reduce the heat of hydrationanddelay the time of exothermic peak. Mixing fly ash in concrete can improve crack resistance, durability and workability of concrete.

(2)Mixing HLC-I concrete anticrack and antiseepage agent can make a micro expansion in concrete. Under the restrained of rebar, it is forming a 0.2 to 0.7Mpa preloading stress in concrete, which delay the contraction time of silicon hardeningand increased tensile strength of silicon.

The temperature control technology

Thermocouples were buried in concrete structure of Huai-anshiplock culvert to master temperature change in the process of concrete pouring and curing, in order to guide concrete pouring and maintenance in future work. In process of low temperature construction should ensure that concrete warehouse temperature is not lower than 5℃,and high temperature construction should ensure that concrete warehouse temperature is not higher than 30℃.Through the temperature monitoring, it can also analyse the origin cause of culvert cracks, which serve a reference for design and construction of shiplock culvert.

Fracture monitoring and analysis of Huai-an shiplock

Lock culvert is a three-dimensional empty container structure, which has a stronger internal binding force and a complex constraint relationship.Because it is easy to generate concrete cracks under the action of temperature and shrinkage stress, then the post-poured strip were set on arc segment of culvert. In order to research actual effects of post-poured strip, post-poured strip were

set on right side of culvert and not set on left side, crack-prevention steel bar were set on both side and anticrack and antiseepage agent were added in concrete. Choosing A-A,B-B,C-C,D-D and E-E as monitoring section of right side. Choosing A'-A',B'-B',C'-C',D'-D' and E'-E' as monitoring section of right side. The strain gauge, pressure gauge and temperature gauge were buried in structurefor comparative observation. The monitoring section diagram is shown in Fig.3.

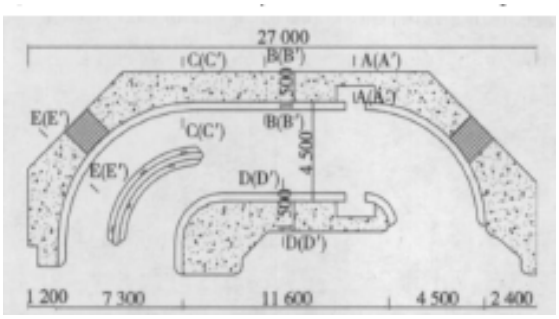

Fig.3 The monitoring section diagram

crack occurrence and experience summary of Huai-an lock culvert

The downstream culvert of Huai-an lock took measures of setting post-poured strip, crack-prevention steel bars and fly ash, which appeared eight cracks totally, seven of cracks wider than 0.2mm and the cumulative length reached 29 meters. The upstream culvert of Huai-an lock took the same measures as downstream, in addition, mixing concrete anticrack and antiseepage agent, which only appeared three cracks and crack width less than 0.2 mm. Fracture statistics of Huai-an lock are shown in Tab.1 and Tab.2.

Tab.1 Upstream culvert fracture statistics of Huai-an lock

Number	Crack Width/mm	Crack Length/m
1	0.11	1.6
2	0.15	0.8
2	0.18	2.1

Tab.2 Downstream culvert fracture statistics of Huai-an lock

Number	Crack Width/mm	Crack Length/m
1	0.38	8.5
2	0.25	2.5
2	0.53	3.5
4	0.42	3.5
5	0.56	3.8
6	0.24	6.5

The crack control measures have an obvious effect, especially mixing HLC-I concrete anticrack and antiseepage agent. According to observation, except downstream head of Huai-an lock, the rest of cracks present characteristics of that crack shrink or disappear. In concrete curing period, water and agent react to form crystalfillingcracks, which make cracks thinner or disappear.

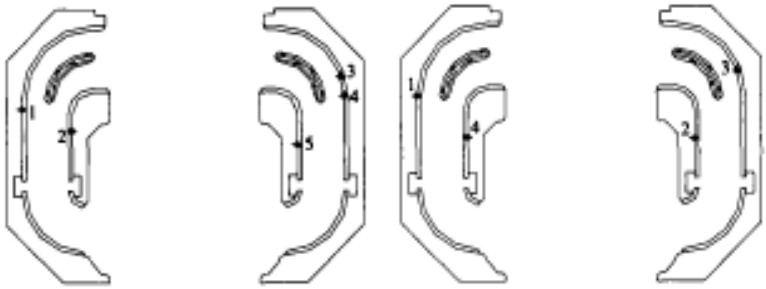

Fig4. Plan sketch of ship lock culvert

Setting post-poured strip on lock culvert can significantly reduce constraint stress within a certain range, but because the particularity of culvert structure, the setup of them cannot disconnect the structures completely, then the reduction of restraint stress is limited.

Summary

Most of chamber wall are variable cross-section structure and chamber cracks are common faults of shiplock. Huai-an lock chamber adopt set anti-cracking reinforcement fabric, control placing temperature of concrete, strengthen maintenance measures and extend moisture curing time of lock chamber, which have been achieved a good results. It follows that measures of setting anti-cracking reinforcement fabric, mixing concrete anticrack and antiseepage agent, strengthen temperature control and maintenance management can minimize the occurrence of culvert cracks, and gives effective prevention and control on common faults of shiplock engineering.

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