Water works Q & A II

1. In the design of watermain, the normal practice is to use ductile iron for pipe size less than 600mm and to use steel for pipe size more than 600mm. Why?

For watermain pipe size less than 600mm, ductile iron is normally used because internal welding for steel pipes below 600mm is difficult to be carried out. Moreover, it requires only simple jointing details which allow for faster rate of construction. For watermain pipe size above 600mm, steel pipes are recommended because steel pipes are lighter than ductile iron pipes for the same material strength and therefore the cost of steel pipes is less than that of ductile iron pipes. In addition, in areas of difficult access the lighter mild steel pipes pose an advantage over ductile iron pipes for easy handling.

2. What is the difference between air chamber and surge tank?

Air chambers and surge tanks are normally installed in watermain to ease the stress on the system when valves or pumps suddenly start up and shut down. A surge tank is a chamber containing fluid which is in direct contact with the atmosphere. For positive surge, the tank can store excess water, thus preventing the water pipes from expansion and water from compression. In case of downsurge, the surge tank could supply fluid to prevent the formation of vapour column separation. However, if the surge pressure to be relieved is very large, the height of surge tank has to be designed to be excessively large and sometimes it is not cost-effective to build such a chamber. On the contrary, a air chamber can be adopted in this case because air chamber is a enclosed chamber with pressurized gases inside. The pressure head of gas inside the air chamber is the component to combat the hydraulic transient. However, air chamber has the demerits that regular maintenance has to be carried out and proper design of pressure level of gas has to be conducted.

3. When designing a water storage tank, should movement joints be installed?

In designing water storage tanks, movement joints can be installed in parallel with steel reinforcement. To control the movement of concrete due to seasonal variation of temperature, hydration temperature drop and shrinkage etc. two principal methods in design are used: to design closely spaced steel reinforcement to shorten the spacing of cracks, thereby reducing the crack width of cracks; or to introduce movement joints to allow a portion of movement to occur in the joints.

Let's take an example to illustrate this. For 30m long tanks wall, for a seasonal variation of 35 degree plus the hydration temperature of 30oC, the amount of cracking is about 8.8mm. It can either be reduced to 0.3mm with close spacing or can be absorbed by movement joints. Anyway, the thermal movement associated with the seasonal variation of 35oC is commonly accounted for by movement joints.

For water-retaining structure like pumping stations, the crack width requirement is even more stringent in which 0.2mm for severe and very severe exposure is specified in BS8007. It turns out to a difficult problem to designers who may choose to design a heavy reinforced structure. Obviously, a better choice other than provision of bulky reinforcement is to allow contraction movement by using the method of movement joints together with sufficient amount of reinforcement. For instance, service reservoirs in Water Supplies Department comprise grids of movement joints like expansion joints and contraction joints.

4. Why do BS8007 specify the allowable crack width of water retaining structure as 0.2mm for severe or very severe exposure?

For crack width less than 0.2mm, it is assumed that the mechanism of autogenous healing will take place in which the crack will automatically seal up and this would not cause the problem of leakage and reinforcement corrosion in water retaining structure.

When the cracks are in inactive state where no movement takes places, autogenous healing occurs in the presence of water. However, when there is a continuous flow of water through these cracks, autogenous healing would not take place because the flow removes the lime. One of the mechanisms of autogenous healing is that calcium hydroxide (generated from the hydration of tricalcium silicate and dicalcium silicate) in concrete cement reacts with carbon dioxide in the atmosphere, resulting in the formation of calcium carbonate crystals. Gradually these crystals accumulate and grow in these tiny cracks and form bonding so that the cracks are sealed. Since the first documented discovery of autogenous healing by the French Academy of Science in 1836, there have been numerous previous proofs that cracks are sealed up naturally by autogenous healing. Because of its self-sealing property, designers normally limit crack width to 0.2mm for water retaining structures.

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