Temperature Field Monitoring of *Mass Concrete of I-Shaped Bearing Platform*

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Abstract. According to the monitoring project of the arch bridge of Ma Zhang Dam, with the mass concrete of its I-shaped bearing platform as the analysis object, the temperature sensor is set up in the construction process, and the temperature field changes in the bearing platform are monitored in real time, and the internal change law of the mass concrete temperature field is measured. The results show that the highest temperature of 1# with 2.5m high I-shaped platform appears at 27h after full warehouse, which is 70.4℃; the highest temperature of 2# appeared at 17h after full storage, which was 65.5 ℃, exceeding the limit of 5℃. Therefore, the cooling cycle water pipe is set up in the construction process, the cooling measures are taken in time, and the cracks are not appeared in the platform, which provides a certain basis for the construction of the mass concrete in the future.

1. Background

Cement will generate a large amount of hydration heat during the condensation process. Because the concrete is an adiabatic material, the hydration heat generated can't be released in time, resulting in the continuous increase of the internal temperature of the mass concrete and the formation of the internal and external temperature difference. When the temperature difference is too large, the temperature stress of concrete will be greater than the ultimate tensile strength of concrete, resulting in cracks in concrete.

In the construction of the bridge in the summer, the casting temperature is high. If we do not take proper cooling, heat preservation measures and crack resistance measures in concrete pouring process, it is easy to cause temperature cracks in mass concrete. Therefore, according to the local climate conditions, it is particularly important to adopt reasonable and effective temperature control measures by studying the variation law of mass concrete temperature field.

In order to master the change and development of the hydration heat of concrete inside the large volume concrete of the bridge platform in Ma Zhang Dam, it provides the basis for the construction parties to adjust the temperature control measures and maintenance schemes, and avoids the excessive temperature gradient and humidity changes of concrete, thus effectively controlling the production of concrete temperature cracks, so the temperature in the mass concrete of the 1# and 2# pier platform is monitored. The Ma zhang dam bridge is a new urban road bridge in Suijiang County. The main bridge is 60m concrete filled steel tube tied arch. The section size of 1# and 2# pier platform is 2.5m I-shaped section with 2.5m height. The whole 1 casting is completed and the strength grading of concrete is C30. The layout of the bridge and the position of the cap are shown in Figure 1.
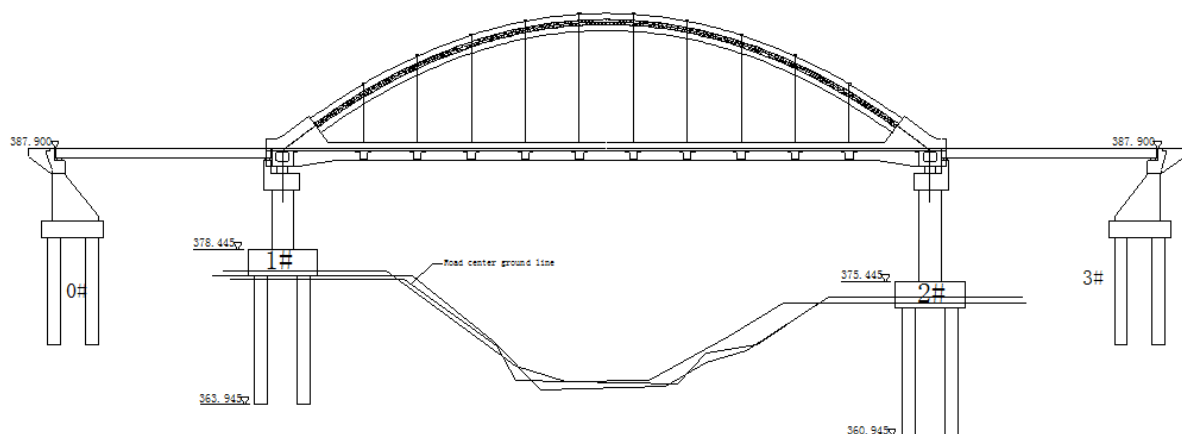
Figure 1. 1#and2# platform map

2. Monitoring scheme

During the construction of mass concrete of the bearing platform, the following 4 temperature control values are determined by monitoring   the temperature of mixture placing to mould, the central temperature of concrete pouring, and the surface temperature of concrete pouring and the ambient temperature：   A- Temperature rising value of concrete pouring；B-Temperature difference of inside and surface ；C-the descending speed of temperature ；D- Temperature difference between surface of concrete pouring body and atmosphere.

The casting temperature is monitored 2 times, and the other indicators are monitored 4 times a day, at 9:00, 13:00，18:00 and 24:00；then determine the following 4 temperature control values:

When A (on the basis of the temperature of mixture placing too mold) exceeds 50℃, B is more than 50℃, C is more than 2 ℃/d, D is more than 20℃, early warning is carried out to adjust concrete pouring procedures, cooling measures and maintenance methods in time.

According to the construction plan, the concrete of 1# and 2# pier platform is completed by one-stage pouring. Based on the regulation of<Code for Construction of Mass Concrete> (GB 50496-2009), the monitoring points of the central temperature and surface temperature of the concrete pouring body are arranged on the half axis of the symmetrical axis of each layer of pouring body. The schematic diagram of temperature measurement points for 1# and 2# pier bearing platform is shown in figure 2, and the monitoring instruments and equipment required are shown in table 1.
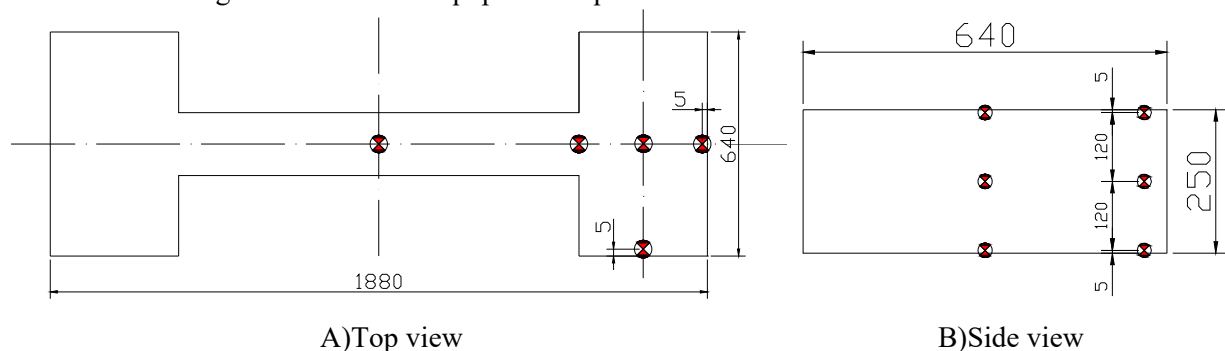

A)Top view   B)Side view

Figure 2. Layout of temperature monitoring point in the bearing platform of Ma Zhang Dam Bridge

Table1. Instrument and equipment summary sheet

No.	Instrument name	Specifications	Wire length /m
1	Temperature sensor	JMT-36B	22
2	Temperature sensor	JMT-36B	15
3	Temperature sensor	JMT-36B	10
4	Comprehensive test instrument	JMZX-3001	
5	Hub box	20 path	

3. Monitoring results of temperature field

1# bearing platform temperature monitoring results are shown in Figure 3. The main results of monitoring are as follows:

1)The highest internal temperature is 70.4℃, which appears in full warehouse after 27H.

2)The maximum temperature difference between inside and surface is 30.2℃, and the maximum difference between inside and surface temperature appears in full warehouse after 87H. The total length of time between inside and outside temperature difference exceeds 25 ℃ is 62H.

3)The maximum descending speed of temperature is 12.9 ℃ /d, The maximum descending speed of temperature appears at 50H after full storehouse, the total length of time when the descending speed of temperature exceeds 2 /d is 50H.
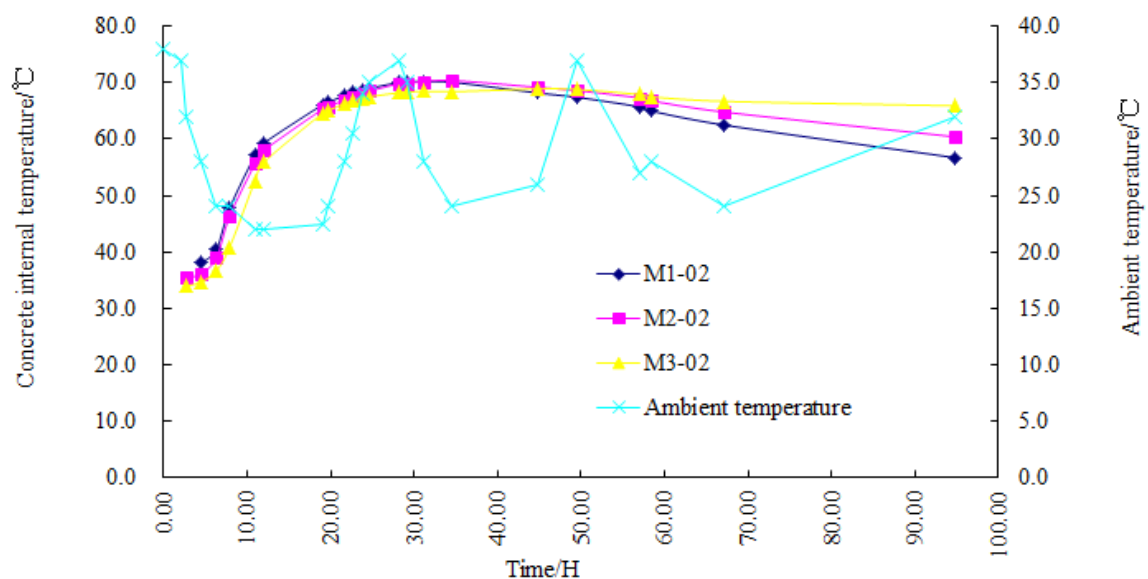

Figure3. Internal temperature change curve of 1# platform

2# bearing platform temperature monitoring results are shown in Figure 5. The main conclusions of the monitoring are as follows:

1)The highest internal temperature is 65.5℃, which appears in full warehouse after 17h;

2)The maximum temperature difference between inside and surface is 26.4℃, and the maximum difference between inside and surface temperature appears in full warehouse after 29h. The total length of time between inside and outside temperature difference exceeds 25 ℃ is 2h.

3)The maximum descending speed of temperature is 16.9℃ /d, The maximum descending speed of temperature appears at 28h after full storehouse, the total length of time when the descending speed of temperature exceeds 2 /d is 120h.

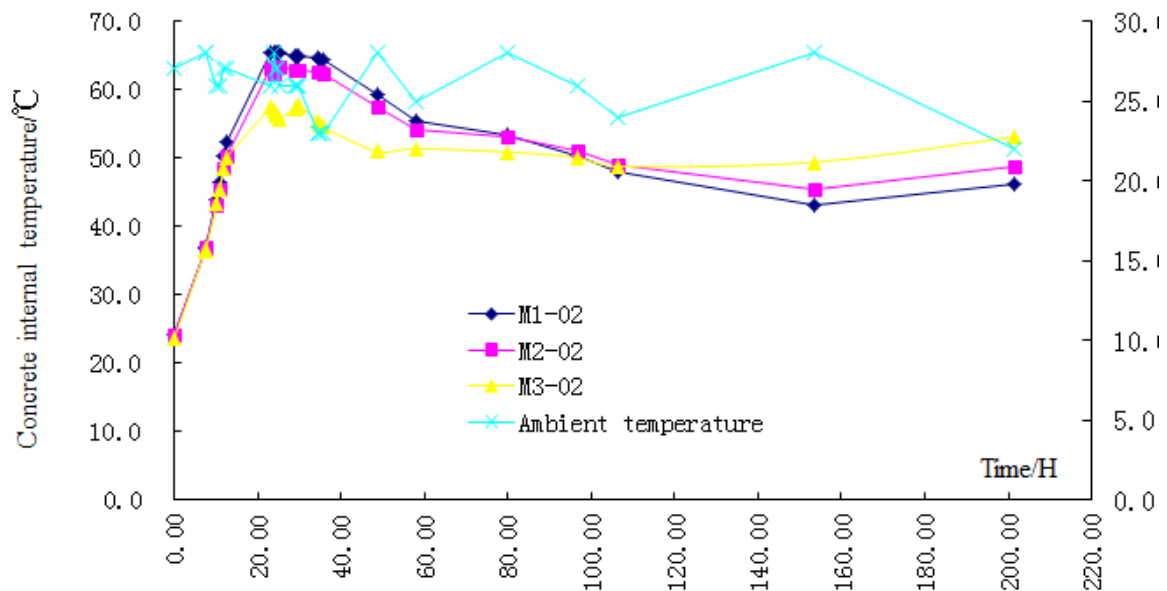
Figure 4. Internal temperature change curve of 2# platform

The cumulative temperature rise of 12h has reached 20℃, and the cooling water has started；When the temperature of full warehouse 25h reached 40℃, the internal cooling was accelerated；when 45h starts to cool down, slowly reduce the speed of cooling water, until it no longer passes through the water, and the temperature gradually decreases. During the heating process, when the temperature difference between the inside and surface is greater than 30 degrees, during the heating process, when the temperature difference between the inside and outside is greater than 30 degrees, while taking the internal cooling down, we can take external insulation measures and appropriately reduce the temperature difference between the inside and surface.

4. Conclusions

1) In the 2.5m height I-shaped bearing platform, the highest temperature of 1# appears at 27h after full storehouse, at 70.4 ℃, the highest temperature of 2# appears at 17h after full storehouse, which is 65.5 ℃, all over the 50℃. The cooling measures must be taken to provide a certain basis for the construction of large volume concrete in the future.

2) The inside and surface temperature difference of 1# and 2# bearing platform exceeds the standard requirement of 25 C after a full warehouse. Therefore, it is particularly important to reduce the temperature difference. At last, there is no crack in the bearing platform, which shows that the method of set up cooling water pipe is effective, but it is very important to grasp the speed and the time.

References
 [1] GB50496-2012. *Code for construction of mass concrete.* National standards of People's Republic
       of China.

[2] QIN   Yu;ZHANG Qiu- xin;YU   Yi. *Temperature Control Techniques for Massive Concrete of Intermediate Pylon Pile Cap of Pingtang Bridge*[J].. World Bridge2018(46-02).

[3] Mohammad Tahersima,Paul Tikalsky,Roshan Revankar.*An experimental study on using a mass radiant floor with geothermal system as thermal battery of the building*[J]. Building Energy Efficiency,2018,46(04):39.

[4] Chao Li. *Optimization of Cooling Pipes Inside Mass Concrete Bridge Pile Cap*[A].Proceedings of 2017 International Seminar on Social Science and Humanities Research (Session 2)[C]. 2017:6.

[5] ZHU Wen,CHEN Yang,LI Fangxian.*Design and Preparation of High Elastic Modulus Self-compacting Concrete for Pre-stressed Mass Concrete Structures*[J].Journal of Wuhan University of Technology(Materials Science),2016,31(03):563-573.

[6] [4]Munishi Fred Abel,ZHANG Shengdong,LI Minying.*Spatial Thermal Crack Control in Mass Concrete*[J]. Structural Engineer,2012,28(06):54-59.

[7] HOU Jing-peng, XIONGJie, Y UAN Yong. *Controlling and in-site monitoring temperature in mass concrete*. Concrete2004(05).

[8] Gajda J, *Controlling Temperature in Mass Concrete, Concrete Interna-tional*, 2002, 1, pp59-62.

[9] ACI Committee 207, "*Effects of Restraint , Volume Change , and Rein-forcement on Cracking of Mass Concrete (ACI 207.2R-95)*" .