Chapter 6 : Inspection of Cracks Due to Heat of Hydration of Cement

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Chapter 6  Inspection of Cracks Due to Heat of Hydration of Cement

6.1 General
(1) The inspection shall be carried out under the supervision of the owner of the structure or his agent.
(2) The inspection shall be carried out by appropriate methods at the appropriate stages of the construction process with adequate judgment in order to satisfy the performance requirements of the concrete members in the structure.
(3) The inspection for DEF cracks shall be done at the timing and using the method and the criteria predetermined appropriately.
(4) Remedial measures shall be implemented if the DEF crack prevention and thermal crack control targets are judged not to have been achieved based on the results of the inspection.

Important revisions of the section 6.1
The scope of cracks for the inspection is specified as “Cracks Due to Heat of Hydration of Cement” including “DEF cracks”.
The clause (4) is modified to express clearly the viewpoint of the judgement based on the achievement of the target of control of cracking.
The technical background of section 6.1

The various causes can be assumed for cracks observed on the concrete structures. The inspection of cracks of the structures can be carried out without identifying the causes of the cracks. However, crack inspection without identifying the causes of the cracks can be not valid and can lead mistakes for the judgement of the cracks. The best window of time for the inspection for the cracks due to heat of hydration of cement is dependent on the cause of the cracks. Therefore, the timing and the method for the inspection shall be determined appropriately considering the mechanism of cracking due to heat of hydration of cement.

The method of inspection and the inspection criteria have to be established beforehand to perform the inspection adequately.
6.2 Inspection Methods

6.2.1 Inspection Methods of Thermal Cracks

6.2.2 Inspection Methods of DEF Cracking

Important revisions of the section 6.2

Inspection methods are different between thermal cracks and DEF cracking. Therefore the inspection methods are shown each other.
6.2 Inspection Methods
6.2.1 Inspection Methods of Thermal Cracks
(1) When the target is to prevent thermal cracking, the presence or absence of cracks is the inspection criterion. When the target is to control thermal crack widths, the inspection criterion is crack width.
(2) The inspection shall be performed when the internal temperature of the member reaches equilibrium with the ambient temperature.
(3) The measuring method for the crack width shall be determined in advance of the inspection.
(4) Measurement of thermal crack widths shall be recorded with a minimum resolution of 0.05 mm.

Important revisions and additional information of the section 6.2.1
The crack width and numbers can be varied with daily temperature change even after the internal temperature of the member reaches equilibrium with the ambient temperature. The measured crack width and numbers can affect the inspection result. Therefore the time of inspection should be agreed.
JCI Guidelines for Control of Cracking of Mass Concrete 2016

Temperature

Concrete Temperature

ambient temperature

equilibrium

Period for the inspection
Temperature

Crack Width

The time for the inspection should be decided.

1 Day
6.2 Inspection Methods

6.2.1 Inspection Methods of Thermal Cracks

(1) When the target is to prevent thermal cracking, the presence or absence of cracks is the inspection criterion. When the target is to control thermal crack widths, the inspection criterion is crack width.

(2) The inspection shall be performed when the internal temperature of the member reaches equilibrium with the ambient temperature.

(3) The measuring method for the crack width shall be determined in advance of the inspection.

(4) Measurement of thermal crack widths shall be recorded with a minimum resolution of 0.05 mm.

Important revisions and additional information of the section 6.2.1

When measuring the crack width, the crack width shall be measured perpendicular to the direction of cracking. Each thermal crack shall be measured in several places where the crack width is considered to be wide, and the maximum of those measurements should be used as the crack width. Measurements should not be taken where the edges of the crack are chipped or not well defined.
Perpendicular to the crack

Direction of crack width measurement
Method of crack width measurement

Measurements should not be taken where the edges of the crack are chipped or not well defined
6.2.2 Inspection Methods of DEF Cracking
The inspection for DEF cracking is carried out by checking the maximum temperature measured at the verification point of the constructed concrete member as well as the concrete materials and mixture proportions. The verification point should be determined taking into consideration the contact condition of water at the surface of the concrete member.

Important revisions and additional information of the section 6.2.2
Visual observation of DEF cracks is desirable. However, it is normally impossible to detect DEF cracks during inspection for thermal cracks induced by the heat of hydration of cement. There is no inspection method available to predict DEF cracks by now. In the Guidelines, it is determined that inspection shall be carried out to verify the maximum temperature, materials, and mixture proportions of the concrete, such as alkali content and sulfur trioxide content, which affect DEF cracks. In the Guidelines, it is deemed that the threshold value is not dependent on the moisture condition of concrete; however, the verification point of the maximum temperature in concrete can vary with the penetration depth of water into concrete. If the concrete is subjected to intermittent water supply, the maximum temperature at the surface of the concrete member shall be verified. In the case where water supply into concrete is possible, the maximum temperature at the center of the concrete member shall be verified.
6.3 Judgement of Achievement of Target and Countermeasures

(1) The timing of the inspection and the method of identification of cracks that are considered to be caused by thermal stress shall be agreed between the owner and the contractor of the structure.

(2) When the target is to prevent thermal cracking, the result of the inspection is judged to be acceptable if thermal cracking is not observed. However, even though thermal cracks are observed, the result can be judged to be acceptable if the width of the cracks is 0.05 mm or less.

(3) When the target is to control crack width, the result of the inspection is judged to be acceptable if the width of the observed thermal cracks is equal to or smaller than the limit value.

Important revisions and additional information of the section 6.3
It is thought that thermal stress induced by the heat of hydration of cement does not increase significantly after the temperature of the concrete structure reaches equilibrium with the ambient temperature. Therefore, the cause of the cracks that are observed after the equilibrium temperature is reached is thought to be other than thermal stress. The cause of cracks that are observed before the equilibrium temperature is reached is mainly thermal stress; however other factors may be involved.
6.3 Judgement of Achievement of Target and Countermeasures

(4) When the target is to prevent DEF cracks, the result is judged to be acceptable if the maximum temperature at the surface or the center of the concrete member does not exceed the critical value, which is dependent on the amount of alkali and SO3 content.

(5) If the target is judged not to have been achieved, the cause of the crack shall be identified through consultation between the owner and the contractor of the structure.

(6) Appropriate countermeasures shall be taken, considering the importance of the structure, the effects of thermal cracks on the performance of the structure, the presence or absence of defects, the cost of repair, etc.

Important revisions and additional information of the section 6.3

It is known that DEF cracks do not occur at the completion of the structure. Therefore, whether the target of prevention of DEF cracks is achieved shall be judged by verifying that the measured maximum temperature does not exceed the critical temperature, which is dependent on the alkali and SO3 content for DEF.
Thank you for your kind attention