

The Study on Early Cracking Mechanism of Cast-in-place Reinforced Concrete Plate

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Abstract: The early age cracking of cast-in-place reinforced concrete plate has been a common phenomenon in engineering; however, the theoretical research on this kind of problems develops far behind the engineering practice on the early cracking of cast-in-place reinforced concrete plate. So it is necessary to explore the early cracking of concrete research problems from various aspects at present.

1. Introduction

From the early deformation of cast-in-place reinforced concrete plate of 25 cm and the constraints suffered by it and other aspects, combining research methods of theoretical analysis and numerical simulation, more in-depth and systematic studies on the causes and formation mechanism of early cracks of cast-in-place plate on the basis of the existing knowledge, the dominant factor of clearly early cracking is clarified with exploration of early cracking mechanism. Through the simulation calculation and analysis to explain the deformation of temperature and the contribution made by deformation and shrinkage to the stress development contribution, the stress change law of early cast-in-place reinforced concrete plate cracking, mechanism and characteristics of cracking formation are greatly studied.

In our country, there is less quantitative study on the early cracking of cast-in-place slab. About the simulated calculation of early temperature cracks calculation of 19 centigrade, the traditional method does not take the effect of temperature on the hydration speed and concrete physical and mechanical properties of thermal reaction into consideration. Due to the complexity of the shrinkage and creep, simulated calculation on the stress of early age of at least 5 years mostly used estimation methods, such as shrinkage of equivalent temperature range being 43%, uniformly contraction happening to assumed structure of 7 kinds, but concrete shrinkage and uniform temperature change of equivalent have different the effects on the structure with different shrinkage stress and equivalent temperature stress, especially for the thin-wall structure of the cast-in-place reinforced concrete plate, it will cause a great deviation in 4 centigrade. This study will consider the influence of temperature on cement hydration reaction rate, of the humidity on shrinkage and deformation and the development law of elastic modulus with the passing of time and beneficial influence on creep.

2. The Basic Theory of Cracks of Concrete Early Deformation

The early volume deformation of concrete. Early volume deformation of concrete generally refers to the deformation without any load; its main feature is time-varying (Time-dependent)(Varying from 6 a.m. to 5 p.m.). Early deformation is the most direct reason of early cracking, which is the source for early cracking. The early deformation mainly includes shrinkage deformation, temperature deformation and creep. Shrinkage embraces plastic shrinkage when the concrete has not yet solidified self-shrinkage due to water hydration and drying shrinkage caused by dispersion and loss of water under dry circumstances. The use

condition of comparable concrete and pouring concrete shows that due to the pump, high fluidity of concrete, the general commodity concrete slump are larger than that of water cement. For example, to guarantee the ratio between water and cement, increasing the dosage of water ash. Therefore, it can make concrete contraction appear cracks in hardening stage; although the current commodity concrete used a certain amount of fly ash, from the actual observation, the problem hasn't been solved completely. Pouring concrete in the high temperature in the summer season, due to water evaporation, it is easy to cause the shrinkage crack of concrete. This is because the concrete slab water evaporation at the surface is much faster than that in the inner surface, the shrinkage of concrete is subjected to internal concrete, As a result, it is easy to produce plastic cracking.

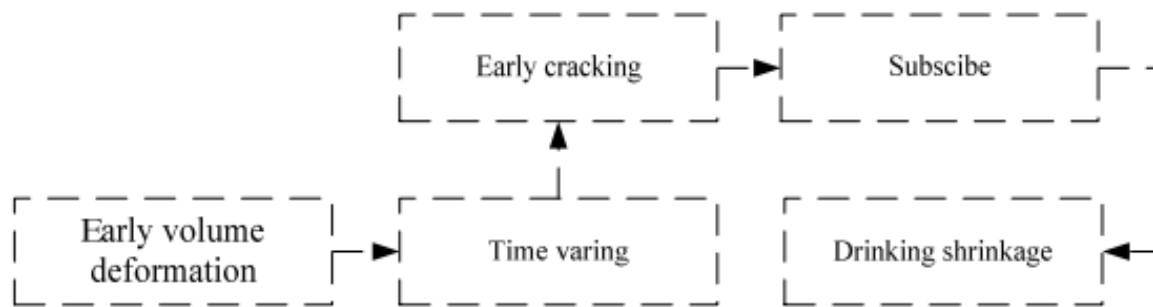


Fig.1 Shrinkage due to water hydration

The micro structure of concrete. The core of modern material science is the relationship between the structure and properties (Kumar Mehta 1986). About the structure and properties of concrete material composition and the research on some issues, such as elastic modulus, shrinkage, research strength, creep, cracking, durability and other issues of knowledge of mutual relationship of some important properties of concrete is the essential foundation. Before the discussion of early volume deformation percent up to 9%, the microstructure of cement stone and concrete should be firstly understood. The amount of water needed for the hydration of cement concrete is only about 25% of cement weight (i.e., water cement ratio of 0.25), but due to the concrete pouring operation, people often need more times than the water effect. These excess moisture evaporate would cause volume shrinkage, which is called humidity shrinkage. At the same time, water and cement will also cause the volume shrinkage, which is called self-shrinkage. These two kinds of contracts of humidity shrinkage is particularly prominent, which is related to shrinkage and cement varieties, dosage, mixing water, aggregate specifications, about the vibration compacting and curing conditions. Concrete shrinkage cracks in the construction of common plastic shrinkage include the settlement shrinkage crack, dry shrinkage crack.

Analysis of calculation results of early humidity field of cast-in-place slab. As can be seen from the calculation results, humidity conduction is very slow. After 10 days, the humidity of cast-in-place reinforced concrete plate is 10% and the region of changes is only confined to 2 cm of the surface, 2.5 cm after 14 days, 3.5 cm after 28 days. The change rate of humidity showed a tendency of smaller change rate when changing inwards. Although compared with the temperature conduction, the conduction of humidity is very slow in the interior concrete, after a period of time, the changes of the surface area of the humidity field is quite clear, the humidity field in the surface still has formed strong gradient of moisture even after 14 days. In the thickness of 3cm, concrete humidity sharply dropped from 99.28% to 77.54% of the surface with an average humidity change of about 7.2% per cm. Inconsistence with the in homogeneity in the internal and external humidity changes will lead to inconsistence of internal and external deformation, thus forming a constraint on the internal structure to the surface which is very easy to cause the surface tensile stress and thereby cause surface cracking.

Table.1 Shrinkage due to water hydration

Shrinkage	Hydration %	Percent %
Humidity	2.5	10
Change	99.2	9.3
Moisture	77	80
Temperature	35	2

3. Study on early anti cracking design method of cast-in-place reinforced concrete plate

China has a large number of engineering practices in the concrete cast-in-place reinforced concrete plate, and gained a lot of valuable experience in the completed engineering. However, the main achievements (forming the standard) still concentrate on the anti-crack design of deformation cracks of cast-in-place reinforced concrete plate of early crack (including the cracks caused by some factors, such as temperature up to 24 degrees, humidity and soil deformation). It is difficult to find the perfect accepted design method of this kind of structure in the current domestic specification and various design reference books. Engineering staff without any regular rules on engineering design attempts to seek a simple and effective calculation method to guide the present concrete structure of 45 layers.

3.1 The empirical formula and the correction coefficient

At present, the research method for this problem can be divided into two categories: one category conducts calculation and analysis based on the empirical formula and the coefficient correction that the calculation process is simple and easy for engineering practice. Relevant experts and scholars also present some calculation method according to the study with 4 times. As for the influential factors of calculation method, consideration of each method is very decentralized, which makes the existing research results fail to form a unified standard or file. It brought some difficulties for the engineering design personnel in the practical application.

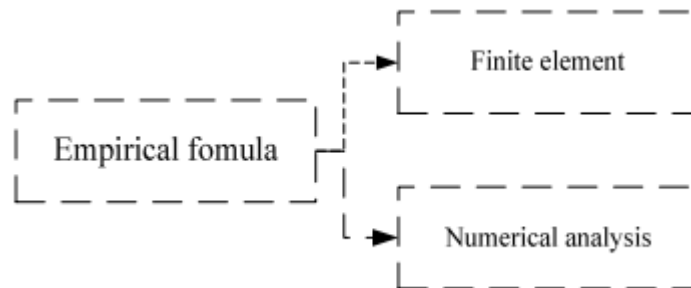


Fig.2 The existing research results of unification

3.2 The numerical analysis method

Another kind is by using the numerical analysis methods, such as the finite element method to conduct research; the result is more accurate but also has some unfavorable aspects. The present finite element method is hardly to accurately predict an early crack. Some design units often use structure analysis software (ANSYS PKPM) or use the finite element program structure to calculate the internal force by 28%. But the stress calculation doesn't have any guidance to the reinforcement. What's more, it is difficult to apply the finite element calculation into the building structure and form of complex structure, so this application is not very extensive.

4. Conclusion

In summary, at present, there still exists a certain gap between the analyzing methods and calculation design methods and the settlement of problems. Necessary theory research work on the mechanism of the early cracks of cast-in-place plate and exploration of developing laws of early deformation crack and update and improvement of anti-cracking design simplified calculation method have become the problem needed to be urgently resolved for the revealing of the cast-in-place concrete floor cracking. The early age cracking of cast-in-place reinforced concrete plate level quantitative prediction and control of engineering structure is of great theoretical significance.

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