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A BRIEF STUDY OF CRACKING IN CONCRETE AND ITS PREVENTION

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Abstract - *Concrete is one of the most used, most durable and most lasting products used in construction which we will find around us. But with the pros comes some cons as well. Means if not used properly then one cannot take full benefits out of this raw material, hence proper placement of the concrete is utmost important in any construction work. Otherwise one has to face issues related to cracking, its durability as well as its strength. Here we are going to discuss issues related to the cracking of concrete. A building part develops cracks when its strength falls short of the externally applied loads.*

Key Words: Cracking, deflection, microcracks, crack width, stress-strain, Poisson's ratio.

1. INTRODUCTION

Cracking is a serious problem in concrete. Due to its various physical and chemical properties it is prone to cracking. Though cracking cannot be totally removed but it can be reduced to an extent that its visibility is on microscopic level. Cracking affects the overall efficiency of the structure whether it is related to sound insulation or aesthetics or some other.

In IS: 456, it is given that limit state of serviceability covers below two main parameters

i) Deflection

ii) Cracking

Discussing about cracks, there are mainly two types of cracks

a) Structural cracks

b) Non-structural cracks

Non-structural cracks are not dangerous from the safety point of view resulting due to lack of proper joint detailing or bad workmanship or shrinkage of concrete due to temperature changes and also these lies on the outer part of the structures and not really related to the core. Whereas structural cracks are those resulting due to defects in designs or construction or some reinforcement corrosion or some other problem which affects the structure negatively and should be given immediate attention. However there are some design parameters given under codes to follow and check whether the cracks are under control or need to be dealt with some technical knowhow.

Mainly cracks can be broadly classified as

1) Fine …..... if crack width <0.1mm
2) Thin…….if crack width 0.1-0.3mm
3) Medium…if crack width 0.3-0.7mm
4) Wide……..if crack width 0.7-2.0mm
5) Very wide…if crack width >2.0mm

The widths of cracks vary between large limits and pre assessment of absolute maximum width is not possible or very difficult in many cases. Generally, the width of cracks should not be above 0.3mm. At places where cracking in the tensile areas is dangerous due to the exposure to the effects of the weather or regularly exposed to moist environment or in touch of soil or ground water, an above limit of 0.2mm is advised for the maximum width of cracks. For places and areas which are treated under severe category, the surface width of cracks should not be above 0.1mm.generally.

The crack width can be controlled and governed by adequate detailing of reinforcement. A more number of smaller diameter bars which are placed and properly distributed in tension zone lessen the width of crack more adequately than the larger diameter bars of the same area.

The limit state of serviceability for such crack width and detailing is discussed in IS: 456. It is stated "Cracking of concrete should not adversely affect the appearance or durability of the structure, the acceptable limits of cracking would vary with the type of structure and environment." Where specific attention is required to limit the designed crack width to a particular value, crack width calculation may be done using formula given in IS: 456 and SP 25 (1984). To check whether the crack width is not large, any of the two methods are used-

i) Bar spacing controls

ii) Crack width calculations

Using any of the above methods, the cracking can be controlled upto a certain limit. Both of these methods are discussed in IS Codes and should be referred for crack width calculations.

1.1 Understanding crack mechanism

It has been found in studies that the crack formations are closely related with the tensile and compressive loadings on the concrete. Whenever there is a restraint to movement due to dimensional changes because of internal stresses, cracks occur. Internal stresses can be tensile, compressive or shear. Taking compressive case, before loading starts, volumetric changes occur in cement resulting in cracks on mortar and aggregate boundary. Till the load applied is under 30 percent of the compressive strength of the concrete, these boundary cracks do not go beyond the boundary but when the load is increased above this limit, cracks are formed throughout the concrete. Further increasing the compressive load above 70 percent, these cracks travel even deeper in the concrete and keep going further with the increasing load. This keeps going till the concrete finally fail and collapse. In case of tensile load, this upper limit is of 60 percent of the tensile strength of concrete.

Microcracking is not very dangerous for the concrete generally but these microcracks may accumulate and may travel deeper thus creating problems for the structure. Some researchers say if microcracking occurs before the loading is initiated, cracks will not be affecting the strength but however this applies only to the case of least water cement ratios as the prior loading cracks formed will increase when met with the shrinkage cracks. Studies of Stress-strain graphs have shown that beginning of major cracks relates accordingly with the Poisson's ratio of concrete. Cracks increases with increase in Poisson's ratio.

2. CAUSES OF CRACKING

Some of the main causes held responsible can be listed as-

- High water cement ratio
- Loss from concrete surface
- Rapid setting
- Structure settlement
- Corrosion in steel
- Weathering
- Improper structure usage
- Poor maintenance
- Increase in loading
- Bad quality of materials used
- Improper concrete mix
- Bad placing techniques or inadequate vibration
- Unskilled labor
- Concrete movement
- Design defects
- Chemical attacks
- Thermal stresses generation
- vegetation

As there is a very famous saying that prevention is always better than cure therefore let's look into some main reasons responsible for cracking and their prevention.

 # MORE WATER IN CONCRETE: - Mostly water used for concrete mix has an amount more than needed for hydration although water required to gain strength after hydration of the cement is in small amount. Since the main use of water is to achieve workability but with the increasing water amount strength decreases and later results in cracking due to the evaporation of the excess water. Shrinkage is the reason behind cracking either plastic shrinkage or drying shrinkage.

 # FAST DRYING OF CONCRETE: - Concrete changes its state due to hydration which normally takes days and weeks to complete. If done rapidly by any means, it may lead to cracking. Also for it to go on smoothly curing should be done properly. 7-10 days of proper curing period should be given so that proper strength is achieved.

 # QUALITY OF CONCRETE: - Concrete is available in different grades and the appropriate grade should be used as per the requirement.

 # LESSER CONTROL JOINTS: - These joints help in controlling the location of the cracks. Joints should be kept same as that of the slab depth and spacing not more than 2-3 times of the concrete thickness. Structural cracks are mainly dealt with proper joint control.

 # RICHER MIX: - High cement ratio will lead to greater drying shrinkage. Thus comparatively more volume of aggregates will have lesser shrinkage but keeping in mind the necessary strength against loading is achieved in the provided cement percentage in the concrete.

3. PREVENTION

Though there are technical methods for reducing the cracks but better way out is to give proper preventions so that the need for later cures is not raised. Hence some measures for its prevention can be listed as: -

i) Decreasing water cement ratio. Lower the water, higher the strength and hence lesser the cracks. This ratio should not exceed 0.5. With changing temperature and moisture, concrete expands and shrinks and shrinkage pulls the slab apart thus showing as cracks on surface.

ii) Curing should be done for sufficient time and no hurry should be made as rapid loss of water from surface may lead to cracks. Rapid drying may increase the crack possibility largely.

iii) Proper vibration and placing should be done.

iv) Adequate compaction has to be done to avoid settlement of the soil beneath and thus avoiding cracks. If concrete is poured over soft ground, it can be cracked even with the movement of the delivery vehicle used for bringing concrete.

v) Appropriate amount of cement and quality materials should be used to avoid cracks. Lesser cement will lead to cracking in the same way as low grade materials will. If low grade aggregates they should be well graded and increased size may lead to lesser shrinkage.

vi) Providing control joints at regular intervals as it gives a control where the crack should occur. However it should be well planned and checked whether the concrete cracks at that particular point only

vii) Proper finishing of the surface is also desired using good techniques. Over doing should be avoided as may lead to bleeding.

viii) Lastly remains the application of certain admixtures or sealers to prevent cracks. There are now different types of coatings available for reinforcement and concrete to protect them against liquid penetration.

4. CONCLUSIONS

Thus in the concluding paragraph, we can say cracking may occur anywhere in concrete but if above given preventions and causes are kept in mind, it may lead far better results and much lesser visible cracks and hence a better safer and stronger structure. Cracking is overlooked may result in big and hazardous accidents also. This article covers all the basics reasons and their preventions that need to be taken care of in construction process on a small or medium level.

With the growing technology, there are many post construction methods available for the crack removal or healing. Also they are now some special types of concretes discovered such as "*Self healing concrete*" that themselves repair and heal the cracked portions, thus saving a lot of money, energy and time for post methods. There are polymer composites available to improve resistance against wearing, compressive strength, impermeability, durability as well as chemical attacks resistance. And if not above mentioned admixtures or polymers are used in initial phase then there are many repair techniques to be followed at a later stage like stitching, sealing, routing and grouting. Though with the help of all above techniques cracks can be covered up even at later stage but again it is always focused to adopt prevention rather than looking for cures afterwards.

REFERENCES:

[1] IS 456:2000, "Indian Standard Plain and Reinforced Concrete-Code of Practices", *Bureau of Indian Standards*, New Delhi.

[2] SP 25(1984),"Handbook on causes and prevention of cracks in buildings", *Bureau of Indian Standards*, New Delhi.

[3] DR.H.J.SHAH, "Reinforced concrete volume I", sixth edition, Charotar publishing house.

[4] ACI Committee report 224R-1990