

A REVIEW ON CAUSES, PREVENTION, REPAIR AND MAINTENANCE OF CRACKS IN BUILDING (RESIDENTIAL AND COMMERCIAL)

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Abstract - Cracking is the most difficult and puzzling problem for the engineers today. Many designers are trying to eliminate the problems of cracking, but cracking is unavoidable response of any structure. Since cracks are the most common type of problem in buildings, It is very necessary to understand the causes and remedial measures required to be undertaken for preventing cracks, As cracks in various types of building structures cannot be eliminated completely but can be prevented and controlled by using adequate materials which enhances the properties of the structure and also adopting required changes in design criteria. Due to some faulty designs and other unavoidable factors cracks start developing on various structural and non-structural parts of the building. Hence, timely measures should be adopted to prevent and control cracks and its formation. Not all the cracks developed are harmful but there are some type of cracks which can be severely structurally hazardous. In this paper we will discuss about several problems engineers are facing, why and how the cracks are formed? And how these cracks can be prevented and controlled.

Keywords: Cracking, structurally hazardous, structural, non-structural, faulty designs, unavoidable response, causes and remedial measures.

1. INTRODUCTION:

Nowadays there is limited or reduced availability of resources for new constructions due to which civil engineers have tendency to rely on existing structures and extending the life span of the same structures. Due to this, the difficulties caused are:-

- 1) More repair and maintenance is required on existing structure.
- 2) New technologies and experiments have to be adopted to maintain and improve existing structures and also new structures that have to be developed.

Cracking is the most common phenomenon and is often the most misunderstood when one sees crack in wall or any other part of structure, the person immediately assumes that something is wrong. This is not true always. Cracks can be primarily of many types. Active

cracks are the ones which keep on growing over in a particular direction. Other types of cracks called as Inactive cracks also called as Dormant cracks which are initially not so dangerous but if left unrepaired can cause damage in the long-run.

Cracks are mostly developed due to deterioration of concrete and due to corrosion of reinforcement provided due to faulty design and poor construction or by many other factors like temperature and shrinkage properties.

Cracks can be primarily divided into two main groups:-

- 1) **Structural cracks:** Structural cracks are formed due to faulty design, faulty construction which heavily risks the safety of a building. Examples of structural cracks are the cracks in beam, column, slabs and footings.
- 2) **Non-Structural cracks:** Non-Structural cracks are the result of induced stresses in building constituents and due to internal forces developed due to variation in moisture content, temperature variation, crazing etc. Examples of Non-Structural cracks are cracks on parapet wall, drive-way etc.

2. CAUSES :

Principal causes of the occurrence of cracks in the buildings are as follows:-

2.1) Moisture variation:

Building materials majorly have pores in their burnt clay bricks, mortar, some stones etc. These materials expand on absorbing moisture and contract or shrink on drying. These movements are cyclic in nature and are caused due to increase or decrease in the pore water pressure, extent of these movements also depends on molecular structure of a material. The various effects of moisture changes are:-

- a) Initial shrinkage.
- b) Reversible movement.

Thermal movement:

This is one of the most important causes of cracking in building. Thermal movement largely depends on several factors such as variation in temperature, co-efficient of thermal expansion and other physical properties of the components. Thermal variation in the internal walls and internal floors of the building are not much and thus do not cause much cracking. It is majorly the external walls and the roofs which are exposed to several physical factors and are subjected to substantial thermal variation that are liable to cracking.

2.2) Changes due to chemical reaction:

Due to expansive reactions between aggregates consisting of silica and alkali, concrete may crack. This alkali-silica reaction gives rise to a swelling gel, which absorbs water from other parts of concrete. This phenomenon of expansion results in cracks in the building.

2.3) Cracking caused due to vegetation :

Availability of vegetation in the vicinity of walls can cause cracks in the wall due to expansion of roots growing across and under the foundation. Tree roots spread on all the sides above the ground and when trees are in the vicinity of wall, this should always spark a suspicion.

2.4) Poor repair and maintenance:

After a certain period of time every structure needs to be repaired and maintained. Some structures do not need a very early look while some may need a very look into their deterioration problems. It is always better and wise to identify problems before they cause any damage.

2.5) Movement due to settlement of foundation:

Whenever a structure is built the left over dig is subsequently backfilled. This dig is filled unless the backfill material is properly compacted, this will eventually settle over time. This process of settling will cause poured concrete to settle. Various other factors resulting in the settlement of foundation are variation in moisture content below and across the foundation, decay of organic particles and load of the structure.

2.6) Faulty specification and poor structural design:

Every structure loses its durability over a period of time or during the time of preparation of specification for concrete, other materials. During the design of any structure every designer and architect must take into consideration the environmental aspects of the site. It is most important to also take into consideration the geotechnical factors for determination of soil type, type of foundation required, grade of concrete and steel required etc. In addition to faulty specifications, improper skills, lack of experience of contractor, unskilled workers ultimately gives rise to the deterioration of building or any structure.

2.7) Corrosion of Reinforcement :

The reinforcement steel is well protected by a properly designed and constructed concrete, this physical barrier of concrete has low permeability and high density. The cover of concrete around the reinforcement steel provides a chemical protection and this steel is safe and will not undergo corrosion as long as concrete around it is not pervious and does not allow chemicals to penetrate within the area. When the concrete around the steel is alkaline and have high pH value the corrosion of steel will not occur when a structure is well designed and structured excellent protection to reinforcement steel is provided by concrete. In cases, where the structure is not properly designed there is no excellent protection provided by the concrete to the reinforcing steel. This, in the long run has caused severe damage to the concrete structures resulting in the loss of bond, durability, stiffness and ultimately loss of strength in the whole structure takes place.

3. REMEDIES:

As the saying goes "prevention is better than cure" we must always find ways to avoid the problems caused by cracking by adopting adequate materials and techniques, proper design and effective specifications and supervision. The preliminary things that should be taken care of to avoid the phenomena of cracking are as follows.

- Drying shrinkage is one of the most important factors that majorly cause cracking. Hence , several chemical admixtures should be put to use to reduce the amount of drying shrinkage.
- Also some synthetic fibres that may help in the reduction of drying shrinkage must be put to use.
- Proper repair maintenance and construction of expansion and contraction joints should be done so

that the effect of variation in temperature is neutralized.

- Keep a track of the review of mixed design in order to ensure that maximum size course aggregate, is used which will help to minimize the water content used in the mix.
- Keep a track of the review of mixed design to ensure that lowest possible water content is used in the mix for workability purposes.
- Also ensure that the contractor is quite familiar with the design and technique of using different materials and equipment's during mixed designs.

The various remedial and preventive measures that should be undertaken to cure crack are listed below:

3.1) Use of fine aggregates:

Use of aggregates which are too fine and largely contains too much of clay or silt, not graded well should be avoided. The permissible percentage of clay and silt in fine aggregate should not be more than 3%.

3.2) Use of coarse aggregates:

The allowable permissible size of coarse aggregate should be decided as per job requirements. Also for concrete work coarse aggregates used should be well graded so as to obtain high durability and density. The fine content in coarse aggregate should not exceed 3%.

3.3) Stitching:

Stitching is a process of drilling of holes on both the sides of crack in which grouting is done with the help of U-shaped metal units that covers the crack. When cracks are formed the tensile strength is comparatively lost, in order to gain this lost tensile strength stitching is used, along with the drilling of holes, this process also involves cleaning the holes and filling the holes with the grout having enormous bonding strength.

3.4) Dry packing:

It is the process of placing of low moisture content mortar which is further followed by tamping the placed mortar into a particular area and also helps in producing a close bond and contact between the concrete and the mortar.

3.5) Injection of Epoxy:

This method is very useful for repairing dormant or non-moving cracks in slabs, walls, columns and piers. It is considered as one of the most economical methods and

is very much capable of maintaining the compactive strength of concrete. Pumping of epoxy in vertical cracks should be in such a way that epoxy should start entering the lowest elevation until the level of epoxy reaches the level of entry port above. This process is repeated until the crack has been completely filled with epoxy. In case of filling of horizontal crack, the process of injecting of epoxy starts from one end of the crack to the other end of the crack in the same way. Due to maintenance of required pressure, the crack is filled.

3.6) Plugging and drilling:

This process consists of drilling through the full length of crack and filling or grouting it in the shape of a key. This technique is majorly applicable when orientation of cracks is in the form of straight lines, and are accessible at one end. This method is mostly used for repairing vertical cracks in retaining walls. Generally, a hole of 50-75mm diameter should be drilled in this process.

3.7) Sealing and routing:

This method is preferably used in conditions which require repair and maintenance and where repair of structures is not necessary. In this process the crack is enlarged along its face which is exposed, which is followed by filling with a suitable sealant. This is the common and the most economical technique as compared to other procedures like epoxy injection. Though routing and sealing can be done on vertical surfaces as well as on the curved surfaces it is mostly applicable to flat horizontal surfaces such as slabs, pavements.

3.8) Sealing cracks with gravity filling:

Resins and monomers having comparatively low viscosity can be widely used to seal cracks by gravity filling. Urethanes having high molecular weight and some low viscosity epoxies have been successfully used previously. This process typically consists of cleaning the surface by water blasting or air blasting through this method it is practically understood that lower the viscosity of the filling the finer the cracks can be easily filled.

3.9) Impregnation of polymer:

The most commonly used monomer in this method is methyl methacrylate. This system is highly used for effective repair of some cracks. The monomer system used in this is a liquid monomer which will eventually polymerize into solid.

4. CONCLUSION:

Cracks may occur due to several reasons as discussed above. The formation of cracks cannot be completely eliminated nor completely stopped but several measures can be undertaken to prevent their consequences. Several prevention factors should be taken care of during actual construction process itself. Lack of careful observations and lack of attentiveness can lead to a cause for deterioration in the building in the long-run, which ultimately leads to the failure of structure. Through this research work we came to a conclusion that it is impossible to find ways against cracking yet attempts can be made to minimize the formation and development of cracks in the structure. By observing several cracks and tendency of cracking we also concluded that not all type of cracks require same level of attention. Taking into consideration proper repair and maintenance, adequate construction materials, proper techniques, the potential causes of crack can be minimized to a large extent. Out of the several preventive and remedial measures of cracking discussed above the most appropriate method should be adopted for different types of cracks for gaining the most effective and efficient structure as a whole.

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