WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Study on Causes and Prevention of Cracks in Building

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ABSTRACT

Building cracks are the most prevalent issue that may arise in any sort of concrete construction, such as beams, columns, and so on... As a result, it's critical to comprehend the reason and preventive steps. Although concrete cracks cannot be completely avoided, they may be reduced by utilizing appropriate materials and building techniques, as well as addressing design factors. However, with time, different fractures emerge on various structural and non-structural sections of the building due to certain erroneous procedures done during construction or due to some unavoidable circumstances. There are cracks that must be detected at the right time so that suitable care may be taken of them. This document discusses many causes and preventative methods.

Keywords: Crack, Concrete, etc

INTRODUCTION

Cracks are the common problem which occur in the any type of building structure. Cracks occur due to several reasons which are poor workmanship, improper design, due to low quality material, improper construction. Cracks in plain and reinforced concrete possess a challenging to civil engineers from the six decades. Cracking is the initial sign of distress of the structure baring other forms of distress and deterioration like deformation, surface deposits and construction defects etc. causing damage to structural strength, durability and serviceability. The effects of freeze-thaw alongside chloride ingress in the presence of cracks present ideal circumstances to promote the premature deterioration of the concrete material. The presence of cracks leads to poor durability and a shorter service life of the structure. The successful repair of cracks would reduce the deterioration effects resulting in a longer service life. Prolonging the service life defers the rehabilitation or replacement of the bridge and the government sectors responsible for the management of multiple bridges would experience economic benefits. The result of a longer service life is also indicative of a sustainable practice. Cracks can be treated as a cancer in the R.C.C structure which in its preliminary stage is up to a certain extent but as the time passes it becomes non curable in the later stage. Repairs can be treated only if the root cause is identified. If the cause is properly identified, satisfactory repairs can be performed and improvement and durability of the structure is ensured. Cracks that occur before hardening, primarily due to settlement, construction movements, and excessive evaporation of water, are called plastic cracks. Plastic cracking that can be predominantly eliminated through close attention to the mixture design, material placement, and curing. Cracks that occur after the concrete has hardened may be due to variety of reasons. These may be due to mechanical loading, thermal gradients, moisture and incompatibility due to chemicals reactions.

Cracks can be basically divided into two predominant companies: -

1) Structural cracks: Structural cracks are shaped due to faulty design, faulty construction which closely risks the protection of building. Examples of structural cracks are the cracks in beam, column, slabs and footings.

2) Non-Structural cracks: Non-Structural cracks are the end result of induced stresses in constructing materials and due to internal forces developed because of variant in moisture content material, temperature version, crazing and so on. Examples of Non-Structural cracks are cracks on parapet.

OBJECTIVE

- To study the various types of cracks in concrete
- To study causes of cracks in concrete.
- To study the prevention of cracks in concrete.
- To study the techniques to repair and filling up crack sin concrete.

LITERATURE REVIEW

3.1 Rishabh Pathak, Deepak Rastogi concluded from their research on **"Case Study on Cracks in Public Buildings and their"** cracks are inherent and detrimental elements of building detailed investigation should be carried out regularly to ensure the accessibility and serviceability of the building. For rehabilitation of cracks, it is important to understand thecausesandthetypesofcracksappearedinthestructure.Thispapershortlydescribesthecausesand types of cracks and their remedial measures. Non-destructive testing methods are used to access the strength of the structure at a first instance to know the actual state of the structure whether it will be serviceable/workable or to be demolished. Few case studies were conducted at different public buildings at Gwalior M.P. Political science, economic and archaeological blocks of Jiwaji University. Moti Mahal building. NITM (Nagaji institute of

Technology and Management building. Which were reported cracks and they were in suspension to whether it will work or should be demolished. The purpose of this study is to determine the position ofstructurewhetheritisfurtherserviceableornotandsecondly,ifweusethesamebuildinghowitwill be repaired.

3.2 Pooja Nama, Ankush Jain, Rajat Srivastava and Yash Bhatia has come to an end from their research on **"Study on Causes of Cracks & its Preventive Measures in Concrete Structures"** The problem of cracking in building is becoming a difficult puzzle for engineers nowadays. Cracking is an unavoidable response of any structure while designers are trying to eliminate many of the causes of cracking and design tolerance for other factors. We all want our building structurally safe but it is not so easy. Some faulty steps during construction and some unavoidable reasons different type of cracks starts to appear on various structural and non- structural parts of the building. So, timely identification of such cracks and adopting preventive measure are essential. There pair materials and repair technique are different depending upon forms of cracks according to their positions in structure. Some types of cracks seriously need attention as they are structurally hazardous. In this paper, we will discuss about the problem engineers are facing i.e., of cracking after construction and what preventive measures should betaken along with the techniques to cure crack.

3.3 Shivani More, Tejas Hirlekar realize from their research **'on causes, prevention, repair and maintenance of cracks in building '**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 under taken 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. No tall the cracks developed are harmful but there is 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.

3.4 P Velumani, K Mukilan, G Varun, S Divakar, R Muhil Doss and P Ganesh kumar have concluded from their research on **"Analysis of cracks in structures and buildings"**Analyzing and identifying cracks is the most vital step in the construction process. Them annual crack detection process will take longer and will be subjectively assessed by the inspectors. This research provides a conceptual base for the image processing methodology for the automated identification and examination of cracks. This model uses the Gray Intensity Correction Method Min Max Gray Level Differentiation (M2GLD) for Image Improvement and the Otsu Image Linearization Process. The experimental results how is that the combination of the M2GLD method and the Otsu test will effectively detect crack defects in digital images. This model can therefore be a useful tool for building construction agencies and structural maintenance engineers.

CASE STUDY

For a better understanding, some cases are taken at Priyadarshini college of engineering, Nagpur. PCE is new institute which is started in 1990and it has world class Infrastructure. Some parts of the structure in this building have started showing cracks at various locations all across the campus which leads to the decrease in the durability as well as strength of the structure. Cracks generated in the Jyotiba College of Physical Education building, Dept. of Mechanical & Electrical Engg. Building has many different reasons which are responsible for the structural and non-structural cracks. In the month of February 2022, the academic building along with hostel and mess of the University were inspected carefully and each type of cracks were photographed and recorded for further reasoning. These cracks are categorized on the basis of-

a) Thin - less than 1mm in width
b) Medium - 1 to 2mm in width
c) Wide - more than 2mm in width

Case Study 1:
Name of Building: Jyotiba College of Physical Education, Nagpur
Location: Nagpur

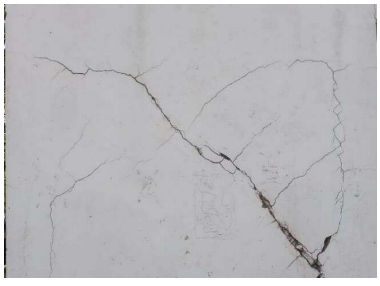

Fig no. 1
Crack on wall
Type-Non-Structural crack
Shape – Diagonal
Width- 2mm
\Length- 1200mm
Cause- Foundation Settlement

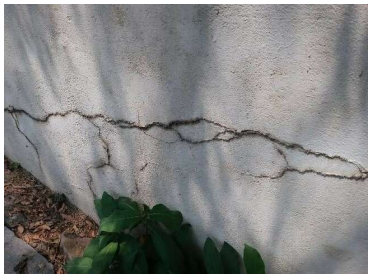

Fig no. 2
Crack on Staircase
Type- Structural crack
Shape - Horizontal
Width-3mm
Length-840mm
Cause- Due to settlement of brick wall

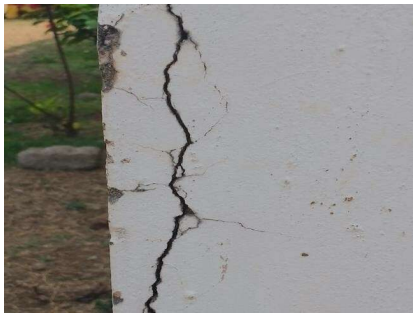

Fig no. 1
Crack on Column
Type- Structural Crack
Shape - Vertical
Width-2mm
Length-420mm
Cause-Due to clear cover

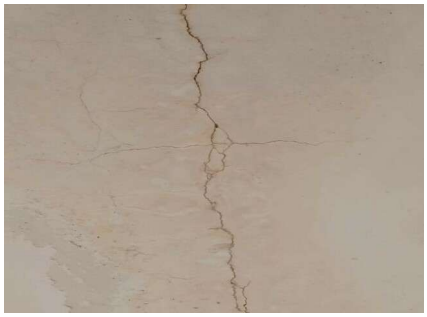

Fig no. 2
Crack on Slab
Type- Structural Crack
Shape - Vertical
Width-1mm
Length-1000mm
Cause- Due to improper curing and thermal variation

Case Study 2
Name of Building: Priyadarshini College of Engineering, Nagpur (Dept of Mechanical & Electrical Engineering)

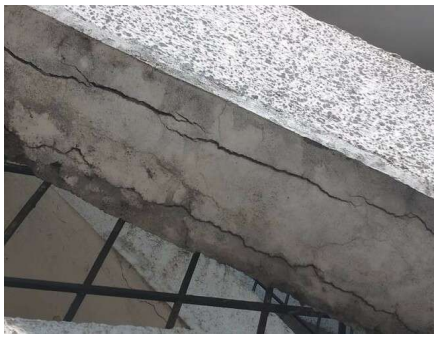

Fig no. 1
Crack on Column
Type- Structural Crack
Shape - Vertical
Width-2mm
Length-420mm
Cause-At the bottom developed

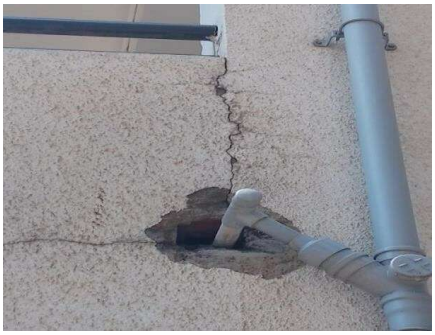

Fig no. 2
CrackonSlab
Type- Structural Crack
Shape - Vertical
Width-1mm
Length-1000mm
Cause- Due to plumbing operation tensile and flexural stresses

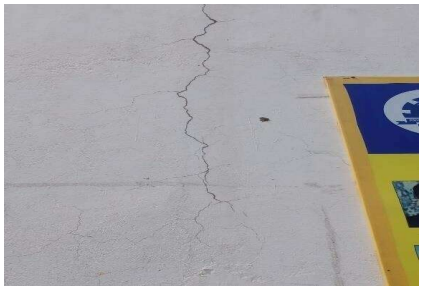

Fig no. 1
Crack on Column
Type- Structural Crack
Shape - Vertical
Width-2mm
Length-420mm
Cause-Thermal variation

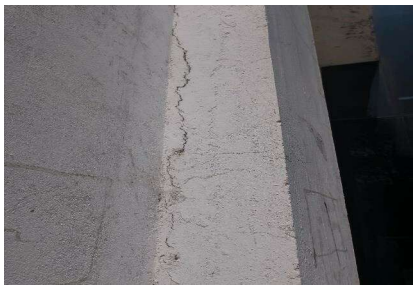

Fig no. 2
Crack on Slab
Type- Structural Crack
Shape - Vertical
Width-1mm
Length-1000mm
Cause- Due to improper joint between wall and column

CAUSES & ITS PREVENTIVE MEASURES

A. Elastic Deformation

It occurs when a material strains under stress. When two materials (having different elastic properties) built together under the effect of load then different shear stresses in these materials create cracks at the junction. Dead and live loads are the main cause of elastic deformation in any structural components of a building. Preventive Measures: Create slip joints under the support of concrete slab on walls. Provide horizontal movement joints between the top of brick panel and reinforced cement concrete beam/slab.

B. Thermal Movement

Most materials expand when they are heated, and contract when they are cooled. The expansion and contraction with changes in temperature occur regardless of the structure's cross-sectional area. It is one of the most potent causes of cracking in buildings which need attention. Preventive Measures: Joints should be constructed like construction joints, expansion joints, control joints and slip joints. The joints should be planned at the time of design and be constructed carefully.

C. Chemical Reaction

Chemical reactions may occur due to the materials used to make the concrete or materials that come into contact with the concrete after it has hardened. Concrete may crack with time as the result of slowly developing expansive reactions between aggregate containing active silica and alkalis derived from cement hydration, admixtures or external sources. Preventive Measures: If sulphate content in soil exceeds 0.2 percent or in ground water exceed 300 ppm, use very dense concrete and either increase richness of mix to 1:1/5:3 and to prevent cracking due to corrosion in reinforcement it is desirable to specify concrete of richer mix for thin sections in exposed locations.

D. Shrinkage

Most of the building materials expand when they absorb moisture from atmosphere and shrink when they are dry. Shrinkage can be of plastic or dry. The factors causing shrinkage in cement concrete and cement mortar and their preventions are as following. 1) Excessive Water: The quantity of water used in the mortar mix can cause shrinkage. Vibrated concrete has less quantity of water and lesser shrinkage than manually compacted concrete. Preventive Measures: Use minimum quantity of water required for mixing cement concrete or cements mortar according to water cement ratio. Cement concrete is never allowed to work without mechanical mix and vibrator. 2) Quantity of Cement: As a general rule, the richer the mix is, the greater the shrinkage/drying will be. Preventive Measures: Do not use excessive cement in the mortar mix.

E. Foundation Movement and Settlement of Soil

Shear cracks in buildings occur when there is large differential settlement of foundation and it may be either due to the following reasons:

- Unequal bearing pressure under different parts of the structure Rajat Srivastava
- Bearing pressure on soil being in excess of safe bearing strength of the soil
- Low factor of safety in the design of foundation
- Local variation in the nature of supporting soil Preventative Measure: The design of foundation should be based on sound engineering principles and good practice.

F. Earthquake

Crack may occur due to sudden shift in lower layer of the earth. The voids in the earth might have suddenly collapsed and be filled with soil from the above. Many geological events can trigger earth movements but is continuous movement. Preventive Measures: Construct the foundation of buildings on firm ground while doing construction. Tie up the building with connecting beams at foundation level, door level and roof level.

G. Vegetation

Fast growing trees in the area around the walls can sometimes cause cracks in walls due to expansive action of roots growing under the foundation. The cracks occur in clay soil due to moisture contained by roots. Preventive Measure: Do not grow trees too close to the building. Remove any saplings of trees as soon as possible if they start growing in or near of walls.

H. Poor Construction practices

There is a general lack of good construction practices either due to ignorance, carelessness, greed or negligence. For a healthy building it is absolutely necessary for the construction agency and the owner to ensure good quality materials selection and good construction practices. Preventive Measure: Proper monitoring and use of good quality of materials is required at the time of construction

TECHNIQUES TO CURE CRACK

A. Epoxy injection

Epoxy injection is an economical method of repairing non-moving cracks in concrete walls, slabs, columns and piers as it is capable of restoring the concrete to its pre-cracked strength. The technique generally consists of establishing entry and venting ports at close intervals along the cracks, sealing the crack on exposed surfaces, and injecting the epoxy under pressure.

B. Routing and sealing

In this method, the crack is made wider at the surface with a saw or grinder, and then the groove is filled with a flexible sealant. This is a common technique for crack treatment and it is relatively simple in comparison to the procedures and the training required for epoxy injection. It can be done on vertical surfaces and curved surface

C. Stitching

This method is done to provide a permanent structural repairs solution for masonry repairs and cracked wall reinforcement. It is done by drilling holes on both sides of the crack, cleaning the holes and anchoring the legs of the staples in the holes with a non-shrink grout.

D. Drilling and plugging

This technique is only applicable when cracks run in reasonable straight lines and are accessible at one end. This method is mostly used to repair vertical cracks in retaining walls.

E. Gravity Filling

Low viscosity monomers and resins can be used to seal cracks with surface widths of 0.001 to 0.08 in. by gravity filling. High molecular weight methacrylate, urethanes, and some low viscosity epoxies have been used successfully.

F. Dry packing

It is the hand placement of a low water content mortar followed by tamping or ramming of the mortar into place and also helps in producing intimate contact between the mortar and the existing concrete.

G. Polymer impregnation

Monomer systems can be used for effective repair of some cracks. A monomer system is a liquid consisting of monomers which will polymerize into a solid. The most common monomer used for this purpose is methyl methacrylate.

CONCLUSION

Finally, it can be stated that if sufficient care and oversight are given, crack development may be avoided, and if crack formation does occur, appropriate steps can be taken to treat it. Epoxy-based resins are one of these resins, and when utilised appropriately to cure cracks, epoxy treatment outperforms damaged components. This work is divided into four sections. The first paper provides background information about cracks. The second section discusses the causes of cracks, such as why cracks originate and the many factors that contribute to crack formation. The third section discusses how to avoid cracks by preventing them from forming. The fourth section explains what treatment options are available for treating cracks. We have derived our whole project with all the proofs determined with facts and figures, calculated and proposed every single answer by our thorough research and hard work.

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