

STUDY, PREVENTION AND REPAIR OF CRACKS IN BUILDING

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ABSTRACT: Generally, there is no building construction with zero cracks. It's a very common and unavoidable problem in any concrete construction structure. Cracks affect structural safety as well as the beautiful and artistic appearance of any construction. Everyone wishes their construction or building to be crack free, but it is not an easy task or almost impossible. Various types of cracks start to appear on the non-structural and structural part of any construction. These cracks are the result of some unwanted or faulty steps taken during construction. Sometimes, cracks can be a serious concern about the safety of any construction. Cracks do not risk the safety directly, but they encourage some acts which cause major safety problems. Therefore, it is very important to detect cracks before they create any serious safety issue and take preventive measures. However, cracks cannot be completely prevented, but can be controlled by using adequate materials and techniques. The present paper analyses reasons of cracks formation and provides some techniques and measures that can prevent cracks and related issues.

KEYWORDS: Cracks, techniques, Repair, Grouting.

I.INTRODUCTION

A crack is a complete or incomplete separation of concrete into two or more parts, produced by breaking or fracturing. The crack in concrete is an inherent feature, which cannot be completely prevented but can only be controlled and minimized. Concrete being a material having very low tensile strength, readily cracks when such tensile stress beyond the tensile strength of concrete occur in structure.

An engineer should have a sound knowledge of all the facts of concrete technology i.e. of the behavior of construction materials, construction techniques, and types of crack likely to occur, their causes and respective remedial measure. In short treatment of cracks involves detection, diagnosis and remedy. Cracks also occur due to settlement, temperature, shrinkage effect, poor construction practice etc.

Types of cracks:

Cracks may be divided in two categories:

1. Structural cracks
2. Non-structural cracks

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(a) Structural cracks:

Structural cracks may arise due to various reasons such as incorrect design, overloading of the structural components, overloading of the soil on which the building is constructed or other similar factors. Structural cracks endanger the stability of the building and may be difficult to be rectified. Extensive cracks of foundations walls, beams, columns or slabs etc, are examples of structural cracks.

(b) Non- structural cracks:

Non- structural cracks are generally due to internal forces developed in the buildings on account of change in the size of building components, due to moisture variation, temperature variations, the effect of gases, liquid and solids on the building components. The non-structural cracks can be repaired provided the reasons for cracks are identified and suitable remedial measures are taken to prevent their reoccurrence.

II. LITERATURE REVIEW

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

1. Moisture changes,
2. Thermal variations,
3. Elastic deformation,
4. Creep,
5. Chemical reaction,
6. Foundation movement and settlement of soil, and
7. Vegetation.

1. Moisture Changes:

As a general rule, most of the building materials having pores in their mortar, burnt clay bricks, some stones, timber, etc. expand on absorbing moisture and shrink on drying. these movements are reversible, that is study on control of cracks in a structure through visual identification & inspection Cyclic in nature and is caused by increase or decrease in the inter-pore pressure with moisture changes, extent of movement depending on molecular structure and porosity of a material. The various effects of moisture changes:

1. Reversible Movement
2. Initial Shrinkage

The various causes of initial shrinkage are:

1. Cement Content
2. Water content
3. Aggregates

4. Use of accelerators
5. Curing
6. Presence of excessive fines
7. Humidity
8. Composition of cement
9. Temperature

2. Movement due to Thermal Variations:

It is a well-known phenomenon of science that all materials, more or less, expand on heating and contraction cooling. Magnitude of movement, however, varies for different materials depending on their molecular structure and other properties.

Factors affecting the thermal movement are:

1. Colour and Surface Characteristics
2. Thermal Conductivity
3. Provision of an Insulating or Protective Layer.
4. Internally Generated Heat

3. Movement due to Elastic Deformation:

Structural components of a building such as walls, columns, beams and slabs, generally consisting of materials like masonry, concrete, steel, etc, undergo elastic deformation due to load in accordance with Hook's law, the amount of deformation depending upon elastic modulus of the material, magnitude of loading and dimensions of the components. This deformation, under circumstances such as those mentioned below, causes cracking in some portions:

1. When walls are unevenly loaded with wide variations in stress in different parts, excessive shear strain is developed which causes cracking in walls.
2. When a beam or slab of large span undergoes excessive deflection and there is not much vertical load above the supports, ends of beam/slab curl up causing cracks in supporting masonry.
3. When two materials, having widely different elastic properties, are built side by side, under the effect of load, shear stress is set up at the interface of the two materials, resulting in cracks at the junction. (Institution, Design and installation of joints in buildings, 1968)

4. Movement due to creep:

Some building items, such as concrete, brickwork and timber, when subjected to sustained loads not only undergo instantaneous elastic deformation, but also exhibit a gradual and slow time-dependent deformation known as creep or plastic strain. The latter is made up of delayed elastic strain which recovers when load is removed, and viscous strain which appears as permanent set and remains after removal of load. (Institution, Code of practice for plain and reinforced concrete, 2000)

5. Movement due to chemical reaction:

Certain chemical reactions in building materials result in appreciable increase in volume of materials, and internal stresses are set up which may result in outward thrust and formation of cracks. The materials involved in reaction also get- weakened in strength. Commonly occurring instances of this phenomenon are: sulphate attack on cement products, carbonation in cement-based materials, and corrosion of reinforcement in concrete and brickwork, and alkali-aggregate reaction.

6. Foundation movement and settlement of soil:

Shear cracks in buildings occur when there is large differential settlement of foundation either due to unequal bearing pressure under different parts of the structure or due to bearing pressure on soil being in excess of safe bearing strength of the soil or due to low factor of safety in the design of foundation. Buildings Study on control of cracks in a structure through Visual Identification & Inspection constructed on shrinkable clays (also sometimes called expansive soils) which swell on absorbing moisture and shrink or drying as a result of change in moisture content of the soil, are extremely crack prone and special measures are necessary to prevent cracks in such cases.

7. Cracking due to vegetation:

Existence of vegetation, such as fast-growing trees in the vicinity of compound walls can sometimes cause cracks in walls due to expansive action of roots growing under the foundation. Roots of a tree generally spread horizontally on all sides to the extent of height of the tree above the ground and when trees are located close to a wall; these should always be viewed with suspicion.

III.CASE STUDY

For a better understanding, some cases are taken at Vaibhav Hostel. It is new Hostel which is started in 2018 and it has world class Infrastructure. Some parts of the structure in this building have started showing cracks at various locations all across the building which leads to the decrease in the durability as well as strength of the structure. Cracks generated in the academic building, hostel and mess has many different reasons which are responsible for the structural and non-structural cracks. In the month of April 2022, the building along were inspected carefully and each type of cracks were photographed and recorded for further reasoning. These cracks are categorized on the basis of –

Thin - less than 1mm in width

Medium - 1 to 2mm in width

Wide - more than 2mm in width



Figure 1: Case Study



Figure 2: Case Study



Figure 3: Case Study

Causes for the occurrence of cracks:

The importance causes responsible for occurrence of the cracks are:

1. Structural deficiency resulting from design deficiency or construction deficiency and overloading.
2. Settlement of ground
3. Temperature and Shrinkage effects.
4. Cracks due to faulty workmanship and poor construction practice.

IV. METHODOLOGY

Repair of Cracks:

The repair of cracks can be achieved with the following techniques:

1. By epoxy-injection grouting
2. By routing and sealing
3. By flexible sealing
4. By stitching
5. By providing additional reinforcement
6. By drilling and plugging
7. By prestressing steel
8. By grouting
9. Dry packing
10. Overlays
11. Autogenous healing
12. Surface coatings

Here we will discuss about most popular repair technique of cracks such as grouting:

Crack Repair by Grouting:

Based on the grouting material used, there are two methods:

1) Portland cement Grouting:

Wide cracks in gravity dams and thick concrete walls can be repaired by filling the Portland cement grout in cracks. This method is proved effective in preventing water leakage, but will not structurally bond cracked sections. In this method the very first step is cleaning the concrete along the crack by using air jetting or water jetting, then grout nipples at suitable intervals is installed, then sealing is done between the seats with sealant, then the crack should be flushed to clean it and test the seal and then grouting the whole area. To improve the properties of the grout, water reducers or admixtures may be used.

2) Chemical Grouting:

Chemicals used for grouting are silicates, urethanes and acrylamides. Two or more chemicals are combined to form a gel, a solid precipitate or foam as opposed to cement grouts that consists of suspensions of solid particles in a fluid. Chemical grouts can be used in moist environments and in very fine fractures. But with some limits of control of gel time.

V.CONCLUSION

This paper is divided into four parts. First part comprises of basic introduction about cracks and second part contains literature review and third is case study and fourth one about techniques to cure. The potential causes of crack can be controlled if proper consideration is given to construction material and techniques to be used. If we focus on the major causes to cracks in our building and take their preventive measures initially, we will minimise the problem of cracking in our structure. Therefore, we used grouting method for our case and that seems too very fair enough.

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