Causes, Prevention and Repair of Cracks in a Building

[1]Prof. (Dr.) C.P Sharma, [2]Er. Arshid Ul Hassan, [3]Umar Sani Mohammed, [4]Adamu Shehuddeen Baba, [5]El-Hussain Rabiu, [6]Komal Shankar Shushant

[1]Professor and Head, [3,4,5,6]Students of Civil Engineering Department of Civil Engineering, Nims University, Jaipur, Rajasthan, India.

ABSTRACT - Cracks in building are a common occurrence. It affects the stability and appearance of buildings. So, it is important to understand the cause of cracks and the effective measures should be taken for prevention. Though cracks in concrete cannot be prevented entirely but they can be prevented by using proper material and technique of construction and considering criteria. Sometimes water penetrates through cracks in building and cause severe damage to building. There are many reason of occurrence of cracks like moisture, thermal movement, elastic deformation, chemical reaction, foundation movement, vegetation and earthquake. We all dream of a house structurally safe and aesthetically beautiful but it is not so easy. So, timely identification of such cracks and adopting preventive measures is essential. In this paper, we will discuss about the methodology for prevention and repair of cracks in building. This research paper also gives information about result of Rebound Hammer Test and Ultrasonic Pulse Velocity Test for determining strength of concrete. Because strength of concrete is also an influencing factor for repairing cracks in building. So, we can say if crack repair is assumed to be building of structure then this paper can be assumed as foundation of it.

Keywords- Crack, Structural Failure, Concrete, Causes, Prevention, Repair Technique, Epoxy, Grouting

I. INTRODUCTION

Cracks are the most common problem that occurs in any type of concrete structure such as, beams, columns, etc. A building component develops cracks whenever stress in the component exceeds its strength. Stress in a building component could be caused by externally applied forces such as, dead, live, wind or seismic loads and internal forces such as, moisture changes, thermal movements and chemical reaction. There are numerous causes of cracking in concrete, but most instances are related more too concrete specifications and construction practices than by stresses due to induced forces. Cracks are classified in two categories: Structural Cracks and Non-Structural Cracks. Structural cracks are occur due to incorrect design, faulty construction or over loading. These may endanger the safety of a building. Non-Structural cracks are mostly due to the internally induced stresses in building materials and these generally do not directly result in structural weakness. When concrete becomes older cracks become causes of leakages and seepages and give entree to the moisture, oxygen, chloride etc. and other aggressive chemicals and gases into the concrete causing serious degradation of the structure. Cracking are early indication of failure of structure. Light weight concrete shrinks more.

Depending on width of crack, these are classified into Thin (less than 1 mm in width), Medium (1mm to 2mm in width) and Wide (greater than 2mm). According to IS: 456(2000), the surface width of crack should not exceed 0.3mm in members where cracking is not harmful and does not have any serious adverse effects upon the preservation of reinforcing steel, nor upon the durability of structures. In the members where cracking in tensile zone is harmful either because they are exposed to moisture or in contact of soil or ground water, an upper limit of 0.2mm is suggested for maximum width of crack.Cracks in the building is a universal problem faced throughout the world. Building components develops cracks whenever stress in the components exceeds its strength. Stress in the building components could be caused by externally applied forces such as dead, live, wind, seismic loads or foundation settlement or could it be induced by internally due to temperature variations, moisture changes and chemical actions.Cracks affects the building's artistic look and it destroys the wall integrity, affects the safety of structure and even reduces the durability of structure.

II. SIZE OF CRACKS

1) Hairline cracks: less than 0.1mm in width. No repair action is required. Methodology for Prevention and Repair

 DOI : 10.35291/2454-9150.2020.0640

of Cracks in Building (GRDJE/ Volume 3 / Issue 3 / 010) All rights reserved by www.grdjournals.com 53

2) Fine cracks: up to 1mm in width. Easily treated using normal decoration.

3) Cracks easily filled: up to 5mm in width. It can be masked by suitable linings.

4) Cracks that require opening up: 5-15mm in width. External brickwork may need repointing or in some cases, to be replaced

5) Extensive damage: widths of 15-25mm. It requires breaking-out and replacement of wall section

6) Structural damage: widths greater than 25mm. Structure becomes unstable and requires major repair works

III. SHAPE OF CRACKS

The various shapes of cracks are: vertical, horizontal, stepped, diagonal, straight, toothed, variable and irregular. Cracks can also be uniform type or non-uniform type. Stepped cracks tend to follow the lines of horizontal or vertical joints in buildings. A diagonal cracks indicate that structural settlement is happening, possibly due to upheaval at foundation level or some other from slippage. Vertical cracks may indicate that structural components such as bricks or blocks have failed and so can be a sign of significant stresses within the building structure. Horizontal cracks may indicate that an element such as a wall is failing and this may present a safety concern.

IV. CAUSES OF CRACKS

The common causes of cracks in building are: permeability of concrete, thermal movement, corrosion of reinforcement, chemical reaction, moisture changes, creep, foundation movement, soil settlement, shrinkage, elastic deformation, overloading, environmental stresses like nearby trains, earthquakes, faulty design, bad quality materials, poor construction practices, weather effects, lots of wear and tear, poor structural design, poor specification, poor maintenance, poor workmanship, etc.

V. TYPES OF CRACK

Generally cracks can be divided into two types : Structural cracks and Non-structural cracks.

a). Structural Cracks :

Structural cracks may rise due to various reasons such as incorrect design, overloading of the structural components. Structural cracks endanger the stability of the building and may be diffcult to be rectified[3].

Table No.1 Structural Cracks Formed On Beam, Column,Slab

BEAMS	COLUMNS	SLABS
Flexure Cracks	Horizontal Crack	Flexure Cracks
Shear Cracks	Diagonal Crack	Shrinkage Cracks
Torsional Cracks	Corrosion Crack	Corrosion Crack

b) Non-structural cracks(Hair cracks):

Non-structural cracks are generally due to internal forces developed in the building materials due to moisture variation, temperature changes and suitable remedial measures can be taken to control it. Cracks may appreciably vary in width from very thin hair crack barely visible to naked eye to gaping crack. Depending upon the crack width , the cracks are classified as :

∑ Thin Crack -less than 1 mm in width. ∑ Medium Crack -1 to 2 mm in width.

∑ Wide Crack -more than 2 mm in width.

∑ Crazing -Occurrence of closely spaced fine cracks at the surface of a material is called crazing.Crazing is the development of a network of fine random cracks on the surface of concrete or mortar caused by shrinkage of the surface layer.

Thin Crack

Medium Crack

Wide Crack

VI. CAUSES OF CRACKS

There are several causes of cracks in a building. Som of these are:

6.1 Land Subsidence

In some countries land subsidence can be a problem as a result of mining operations. Coal or other minerals are removed leaving a void deep below the surface, the land eventually collapses and this may cause severe damage to buildings above.

In Bali we can probably forget land subsidence, there is not a lot of coal mining going on. In the more steeply sloping areas of Bali there are major problems with landslides. In many places paddy fields have been “sculptured” into the hillsides with steep slopes between them. If it rains a lot or a watercourse gets diverted onto the land it may well collapse.

6.2 Loss of Trees

Trees are very effective in stabilising the ground. The removal of trees in many parts of Indonesia has considerably increased the incidence of landslides. This is also a serious problem in Bali. I get into the countryside a lot and it is noticeable that the insatiable demand for

 DOI : 10.35291/2454-9150.2020.0640

carving wood has meant the quite worrying loss of tree cover and land stability on the Island.

6.3 Landslips

In Bali landslips are very common on higher sloping land. Usually caused by heavy rain or where streams have eroded land or, believe it or not, where someone starts digging out soil from the block next door. I saw a block of land once where the landowner had dug soil out to a depth of 4 metres right up to the boundary wall. Great to have a neighbour like that!

6.4Earthquakes

There are, of course, other causes of cracks in buildings .... earthquakes for instance. We do get earthquakes in Bali from time to time and there is always the potential for a big one. Don't be scared of this – just be prepared. There are some very clear lessons to be learned from the Yogya earthquake and I will look at these another time. For the time being all we need to understand is that your house should be well designed by someone who knows what they are doing.

VII. METHODOLOGY

A. 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

Here we will discuss about most popular repair technique of cracks such as epoxy-injection method and grouting.

- **Crack Repair By Epoxy-injection Method**

Epoxy compounds are having very well compressive, tensile and bond strength. They can be used for preparing repair mortars but if used as bonding/binding materials for concrete i.e. epoxy concrete, the cost is prohibitive. Cracks as narrow as 0.05 mm can be bonded by the injections of epoxy. It is excellent material for repairing cracks because they have very good properties such as resistant against water penetration, resistant to crack formation and their very good adhesive properties. This method has been successfully used in the repair of cracks in building, bridges, and other types of concrete structures.

- **Crack Repair by Grouting**

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

Portland Cement and 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.

Chemical Grouting

Chemicals used for grouting are silicates, urethanes and acrylomides. 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.

VIII. PREVENTIVE MEASURES AGAINST CRACKS

- Build in movement joints as construction proceeds. Spacing between these joints should never exceed 15m in unreinforced walls.
- Use slip planes - these enable elements of the construction to slide in relation to each other to help reduce stress in the adjacent materials.
- Carefully consider the design and positioning of movement joints and slip planes to ensure they don't affect the stability of the wall or any of its functions.
- Seal and properly protect movement joints and slip planes on external walls to prevent water penetration.
- Ensure fixings and services don't interfere with the performance of the movement joints or slip planes.

Finishes should be broken at the joints and slip planes and any fixings and fittings should not tie across the joints.

- You may need to provide movement joints at more frequent intervals in external walls with openings or else the masonry above and below the opening may need to be reinforced to restrain movement.
- Pay particular attention to long low horizontal panels of masonry, such as those under windows.

REFERENCE

[1] Concrete Evaluation and Repair Techniques Sep 2012
[2] Pirro, R. (2012). "Concrete Evaluation and Repair Techniques." Professional lecture, Sept. 2012.
[3] Concrete Evaluation and Repair Techniques Sep 2012
[4] Grishma Thagunna. "Building cracks – Causes and Remedies". 3rd World Conference on Applied Sciences, Engineering and Technology at Basha Research Centre.
[5] Robert T. Ratay. "Structural Condition Assessment".
[6] FIP Guide. "Repair and Strengthening of Concrete Structures", Thomas Telford.
[7] Chung, H.W. 1981. "Epoxy Repair of Bond in Reinforced Concrete Members", Journal, American Concrete Institute, Proceedings, Vol. 78, No. 1, pp. 79-

 DOI : 10.35291/2454-9150.2020.0640