Study on Causes & Control of Cracks In A Structure

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Abstract- *Our main aim of the project is to know the causes and preventive measures of cracks in buildings. A crack is a complete or incomplete separation of concrete in two or more parts by breaking or fracturing. It is a inherent feature in concrete which cannot be prevented but controlled and reduced. Structural Cracks are a common occurrence in all types of buildings. To ensure the longevity of the structure, engineers are often required to look into their causes and carry out suitable repairs and remedial measures. For repairs and remedies to be effective, it is essential that the engineer should have a proper understanding of various causes of occurrence of cracks. For investigating the causes it is necessary to observe carefully the location, shape, size, depth, behavior and other characteristics of the cracks, and to collect information about specifications of the job and time of construction. It is also necessary for the engineer to keep track of when the cracks first came to notice.*

Keywords- Cracks, Shrinkage, Structural Failure, Stresses, Grouting

I. INTRODUCTION

The cracks in building components which are not due to structural inadequacy, faulty construction & overloading. The commonly used building material namely masonry, concrete, mortar etc. are weak in tension and shear. Therefore the stresses of even small magnitude causing tension and shear stresses can lead to cracking. Internal Stresses are induced in the building components on account of thermal movements, moisture change, elastic deformation, chemical reactions etc. All these phenomenon causes dimensional changes in the building components, and whenever this movement is restraint due to interconnectivity of various member, resistance between the different layers of the components etc., stresses are induced and whenever these stresses (tensile or shear) exceed the strength of material cracking occurs.Depending upon the cause and certain physical properties of building material these cracks may be wide but further apart or may be thin but more closely space. As a general rule, thin cracks even though closely spaced and greater in number, are less damaging to the structures and are not so objectionable from aesthetic and other considerations as fewer number of wider cracks. Keeping above in view, in the subsequent chapters the various precautions and the preventive measures for mitigating the non-structural cracks, or containing them in less damaging fine cracks has been enumerated in detail.

II. LITERATURE REVIEW

Some researchers already worked on related topics of causes and remedies of cracks such as Study type of cracks in construction and its controlling done by [Kazem Reza Kashyzadeh and Neda Aghili Kesheh 2012], it shortly describes about what every civil engineer should know about face of the building i.e. cracking. Causes and evaluation of cracks done in concrete structure by [Sayed Mohd Mehndi et al. 2014], they explained about the evaluation of cracks that can be done by different technique like Crack Compactor and by ultrasonic Testing.

Building cracks-causes and remedies by [Grishma Thagunna 2014], from this research it is found that building cracks has direct and indirect impacts and building cracks do not cause structural problem in direct way but it facilitates the activities which ultimately cause the problem. Prevention & repair of cracks in concrete structures by [B.B.Gamit et al. 2014], they broadly classified about the structural and non structural cracks that occurs in building along with their causes and remedy.

Study on control of cracks in a structure through Visual Identification & Inspection [Kishor Kunal and Namesh Killemsetty 2014], they talk about how visual inspection of cracks can be helpful in order to identify and categorize them with respect to various parameters by taking case study of an institutional building.

Confined masonry is one of the most widely used construction systems in Latin America, Europe and Asia. Where, the masonry system performed satisfactorily during past earthquakes. The system has been in use for decades; however, not much experimental work has been done for the evaluation of behavior of confined masonry. In Pakistan, confined masonry construction is popularly used after October 08, 2005 Kashmir earthquake through the affected area. In this

chapter an attempt has been made to present typical properties of masonry materials used in Pakistan in section
The data presented here represent mainly N-W.F.P. However, data of bricks and steel bars is collected from Material Laboratory of Department of Civil Engineering and is supposed to cover much larger area than N-W.F.P. The failure mechanism of the confined masonry is discussed in section 2.3. The behavior of confined masonry buildings during past earthquakes in Latin American and Asian countries is presented

III. METHODOLOGY

The commonly observed crack pattern in building can be group as, cracks in:

- Walls,
- RCC members,
- Renderings and plasters,
- Concrete and terrazzo floors, and
- Roof terrace

Each of these has been covered in this chapter along with preventive measures and feasibility of repairs in specific cases. However, main emphasis is given on prevention of cracks, as in many cases there may be no satisfactory method of repairing the cracks after they have appeared.

3.1 Cracks in walls

Cracks in walls can be further grouped as:

- In masonry structure
- In RCC frame structure
- In free standing walls

3.1.1 In masonry structure:

Commonly observed cracks in masonry structures are :

(i) **Cracks at ceiling level in cross walls:** In load bearing structures, where a roof slab undergoes alternate expansion and contraction due to temperature variation, horizontal cracks may occur (shear cracks) in cross walls, due to inadequate thermal insulation or protective cover on the roof slab. To prevent such cracks, the following measures may be adopted

a) Slip joint (Para 3.4.9) should be introduced between slab and its supporting wall, as well as between slab and cross walls.

b) The slab should either project for some length from the supporting wall or the slab should bear only on part width of the wall (fig. 18 & 23). On the inside, wall plaster and ceiling plaster should be made discontinuous by a groove about 10 mm in width.

(ii) Cracks at the base of a parapet wall: An instance of very frequent occurrence of thermal cracks in buildings is the formation of horizontal crack at the support of a brick parapet wall or brick-cum-iron railing over an RCC cantilevered balcony. Factors, which contribute to this type of cracking, are:

a) Thermal coefficient of concrete is twice that of brickwork and thus differential expansion and contraction cause of horizontal shear stress at the junction of the two materials.

b) Drying shrinkage of concrete is 3 to 4 times that of brick masonry.

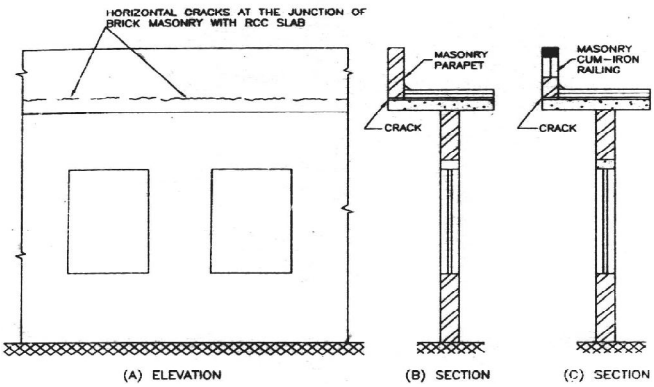
c) Parapets are generally built over the concrete slab before the latter undergone its drying shrinkage fully, and

d) Parapet or railing does not have much self-weight to resist horizontal shear force at its support caused by differential thermal movement and differential drying shrinkage.

The following measures may be adopted to reduce the severity of such cracking.

a) Concrete for slab should be of low shrinkage and low slump.
b) Construction of masonry over the slab should be deferred as much as possible (at least one month) so that concrete undergoes some drying shrinkage before construction of parapet.
c) Mortar for parapet masonry should be 1 cement: 1 lime: 6 sand and a good bond should be ensured between masonry and concrete.
d) Plastering on masonry and RCC work should be deferred as much as possible (at least one month) and made discontinuous at the junction by providing V groove in plaster. This way the cracks if they occur, will get concealed behind the groove and will not be conspicuous. Alternatively, a 10 cm. Wide strip of metal mess or lathing may be fixed over the junction to act as reinforcement for plaster.

e) .In case of brick-cum-iron railing, cracks could be avoided by substituting the brickwork (of which there are only a few courses) with a low RCC wall, supporting RCC railing.



Horizontal cracks at the base of brick masonry parapet (or masonry cum iron railing) supported on a projecting RCC slab.

iii) Horizontal cracks in the topmost story below slab level: These cracks are due to deflection of slab and lifting up of edge of the slab, combined with horizontal movement in the slab due to shrinkage. These cracks appear a few months after construction and are more prominent if the span is large. These cracks are mostly confined to the top most storey because of light vertical load on the wall due to which, end of slab lifts up without encountering much restraint. In the lower stories, lifting of the corners is prevented by the vertical load of the upper stories. Sometimes horizontal cracks develop in the topmost storey of a building at the corners, due to lifting of the slab at corners on account of deflection of slab in both directions. These cracks could be avoided by providing adequate corner reinforcement in the slabs. When large spans cannot be avoided, defection of slabs or beams could be reduced by increasing depth of slabs and beams so as to increase their stiffness. Adoption of special bearing arrangement (fig. 18 & 23) and provision of groove in plaster at the junction of wall and ceiling will be of some help in mitigating the cracks.

IV. CONTROLLING MEASURES

To avoid cracks in brickwork on account of initial expansion, a minimum period varying from 1 week to 2 weeks is recommended by authorities for storage of bricks after these are removed from Kilns.

- Shrinkage cracks in masonry could be minimized by avoiding use of rich cement mortar in masonry and by delaying plaster work till masonry has dried after proper curing and has undergone most of its initial shrinkage.
- Use of precast tiles in case of terrazo flooring is an example of this measure. In case of in-situ/terrazo flooring, cracks are controlled by laying the floor in small alternate panels or by introducing strips of glass, aluminum or some plastic material at close intervals in a grid pattern, so as to render the shrinkage cracks imperceptibly small.

V.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 methacrylates, 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.

VI.CONCLUSIONS

This paper is divided into four parts. First part comprises of basic introduction about cracks and about the previous attempts which are made by the research scholars, second part contains the case study, visual identification of cracks and causes with preventive measures and third part contains techniques to cure crack. The potential causes of crack can be controlled if proper consideration is given to construction material and technique to be used. If we focus on the major causes to cracks in our building and take their preventive measures initially, we will able to minimize the problem of cracking in our structure.

From the above case study we have concluded that some preventions could be taken care of during the construction process itself. Any lack of attentiveness can lead to a cause for damage in the building in its future, which can also lead to the failure of structure. Cracks may occur due to various reasons, as discussed earlier. The occurrence of cracks cannot be stopped but particular measures can be taken to restrict them to reduce the level and degree of consequences

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