# Detection and Rectification of Internal Cracks In Flexural Members

**R. Subha Priya[1], S. Yamini Roja[2]**
[1]Dept of Civil Engineering
[2]Assistant Professor, Dept of Civil Engineering
[1, 2] Sri Ramakrishna Institute of Technology, Coimbatore, India

***Abstract-*** *The existence of internal cracks in a flexural member can maximise the number of flow paths connecting each other. These paths may allow harmful substances and thus makes the reinforcement to corrode. As flexural members provides a great support to the building, it is mandatory to detect and rectify the internal cracks in it. The present paper describes the crack propagation analysis with different methods to detect cracks and provides up with different possible solutions.Crack propagation analysis is done in consideration with fracture mechanics of concrete. This paper also reviews literatures relating to detection of cracks using conventional methods and using sensors. Crack propagation analysis is carried out using any of the following methods (i) Linear Elastic Fracture Mechanism, (ii) Boundary Element Method, (iii) Finite Element Method.*

***Keywords***- internal cracks, crack propagation analysis, fracture mechanics, stress intensity factor, flexural member.

## I. INTRODUCTION

Crack is a fracture or discontinuation in a structural element. Generally cracks are classified into structural and non – structural cracks. **Structural Cracks in Concrete** are formed due to incorrect design, faulty construction or overloading and these cause damages to a building and their inmates. **Non - Structural Cracks in Concrete**are caused mostly due to stresses induced internally in building materials. These cracks do not affectthe building but creates an impression of faulty work or give a feeling of instability.

Internal cracks in building components are caused by Compressive stress, tensile stress, Shear stress.Cracks in flexural members are caused due to insufficient positive reinforcement, insufficient negative reinforcement, retraction of concrete and shear.

Cracks in concrete are caused due to following factors.

1. The main cause of cracks in concrete is expansion and contraction during setting of concrete. Volume changes and stresses due to shrinkage are independent of any external load applied.
2. Cracks develop in smaller sections which areattached to the larger section this is because of differential expansion and contraction.
3. Continuous contraction and expansion or alternate wetting and drying are a result of gradual disintegration of poor concrete.
4. Rapid drying happens due to hot weather, high speed winds or absorption of water from concrete by wooden formworks also cause cracks in concrete.
5. Loose form work leads to cracks in concrete.
6. Concentration of tensile reinforcement at square openings or re-entrant angles causes cracks.
7. Micro cracks on the tension phase of a reinforced concrete member is impossible to exclude due to poor tensile strength of concrete when compared with steel andthe member cracks when steel reinforcement takes its load.
8. Unequal shrinkage of the surface concrete causeshair cracks in the reinforced concrete member.

The conventional crack propagation approach is based on the singular stress portions at the crack tip expressed by stress intensity factors. The influence of the non-singular stress portions is neglected in the short crack stage described by the slit tip stress intensity factor, but possibly taken into account in subsequent crack propagation stages.

The theory of Linear Elastic Fracture Mechanics (LEFM)was developed using a stress intensity factor (K) which is determined by stress analysis andis expressed as a function of stress and crack size.
The elements of fracture mechanics are in the form of a triangle having 3 critical parameters located at each apex: working stress, fracture toughness and critical flaw size. If any two of the three parameters are known, the third one can be calculated.

Finite element methods (FEM) is a numerical method which provides approximate solutions of mathematical problems that are usually formulated so as to provide an idea

of some aspects of physical reality. A finite element method is classified by a variation formulation, a discretization strategy, one or more solution algorithms and post-processing procedures.

## II. LITERATURE REVIEW

**Arun Mohan, Sumathi Poobal** "Crack detection using image processing: a critical review and analysis" Cracks on the concrete surface are one of the earliest indications of degradation of the structure.Since the manual approach depends on the specialist's knowledge and experience. So, automated crack detection based on image is proposed as a replacement. Literature provides different techniques to automatically identify the crack and its depth using image processing techniques.It is concluded that the camera type image for the analysis with better segmentation algorithm like threshold technique and reconstructable feature extraction technique for the thorough damage analysis.

**Matthew M. Torok, Mani Golparvar-Fard, Kevin B. Kochersberger "**Image-Based Automated 3D Crack Detection for Post-disaster Building Assessment" this a report on the system which helps to identify the defects in critical building elements before responders must enter a structure could save lives. In this paper we propose such a system, centred on an image-based three-dimensional (3D) reconstruction method and a new 3D crack detection algorithm. The image-based method is to analyse the surface damages along with the capable of detecting the defects.

**F. Qin, Z. Z. Cen, T. C. Fung**"A Boundary element analysis of Quasi - Brittle Solids containing Cracks**"**The behaviour of a single crack is analysed first. The obtained information is then used to predict the overall behaviour of the cracked solids. The relationship between the overall response of the cracked solids and the growth of wing cracks is established numerically. Finally, a gypsum square plate containing orderly distributed cracks is analysed to illustrate the adequacy and efficiency.

**Samy Mezhoud, Pierre Clastres, Hacéne Houari; and Mouloud Belachia**"Field Investigations on Injection Method for Sealing Longitudinal Reflective Cracks" This paper is study for the process of proposed for sealing longitudinal cracks (LCs) that had appeared on the surface of a newly constructed highway with composite pavement. The main issue of the procedure was to restore the structural integrity of the affected areas and enclose the cracks to prevent water ingress.The solution clearly demonstrates the effectiveness of such treatment and its competitive cost for repairing the pavement by strengthening the existing structure using injection.

**Giovanni Formica, Franco Milicchio**"Crack growth propagation using standard FEM". This paper is part of research lines providing numerical methods for structural capability related to an evolving crack length in 2D linear-elastic fracture mechanics of isotropic materials. This results proves the accuracy of our strategy in comparison with both experimental numerical and outcomes.

**M. K. Ramezani, J. Purbolaksono, A.Andriyana, S.Ramesh, N.A.Mardi**"Analysis of surface cracks in round bars using dual boundary element method" A closed-form solution for stress intensity factors (SIFs) of a semi-elliptical surface crack in round bars subjected to torsional loading using the dual boundary element method are presented in this paper. The results revealed that the Stress Intensity Factor was strongly affected by both the crack size and crack shape.

**Stephen Jiménez, Ravindra Duddu**"On the evaluation of the stress intensity factor in calving models using linear elastic fracture mechanics" here the comparison of LEFM model-predicted stress intensity factors (SIFs) against numerically computed . SIFs using the finite element method and the displacement correlation methodnin conjunction.Our simulation results indicate the basal boundary condition significantly influences the SIF at the crevasse tips. We find that the existing calving models using LEFM are not generally accurate for evaluating SIFs in grounded glaciers or floating ice shelves. To conclude, we recommend using the displacement correlation method for SIF evaluation in real glaciers and ice shelves with complex geometries and boundary conditions.

**Annette Beedholm, Rasmussen, Jakob Fisker, LarsGerman Hagsten**"Cracking in Flexural Reinforced Concrete Members" The system of cracks developing in reinforced concrete is in many aspects essential when modelling structures in both serviceability- and ultimate limit state. The results of the approach is in overall good agreement with the observed tests and captures the pronounced size effect associated with flexural cracking in which the crack spacing and crack widths are approximately proportional to the depth of the member.

**Vidmantas JOKU BAITIS, Linas JUKNEVICIUS** "Critical depth of normal cracks in reinforced concrete beams of rectangular cross-section" The propagation of cracks in flexural reinforced concrete beams is investigated extensively, but such research is usually limited to the serviceability stage. The state of tensile reinforcement of flexural reinforced

concrete structures could be examined by observing the properties of normal cracks which are the result of stress state in the cross section.

**D.Kumar, K.Tamilvanan** "Study and Analysis of Structural Cracks and Rectifying by Innovative Method" his deals with the repairs and remedies to be effective, it is essential that the engineer should have proper understanding of various causes of cracking. From the above study it is concluded that Microbial technology has proved to be better than other conventional technologies because of its self-healing abilities, eco- friendly nature and increase in durability of various building materials. The other methods for repairing cracks increase the crack width later due to the presence of moisture in freshly laid concrete.

## III. CONCLUSION

The present study reveals the accurate method for detection of internal cracks. Cracks on the concrete surface are one of the earliest indications for the degradation of the structure. Internal cracks are generally caused by overloading. These cracks are identified either with image processing sensors or with conventional crack propagation methods. Numbers of remedies are available for sealing cracks in a flexural member. By proper choice of sealants or fillers those cracks are rectified. It is concluded that Structural repairs are generally repaired using epoxy resins and flexible sealants restrict future movement of cracks.

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