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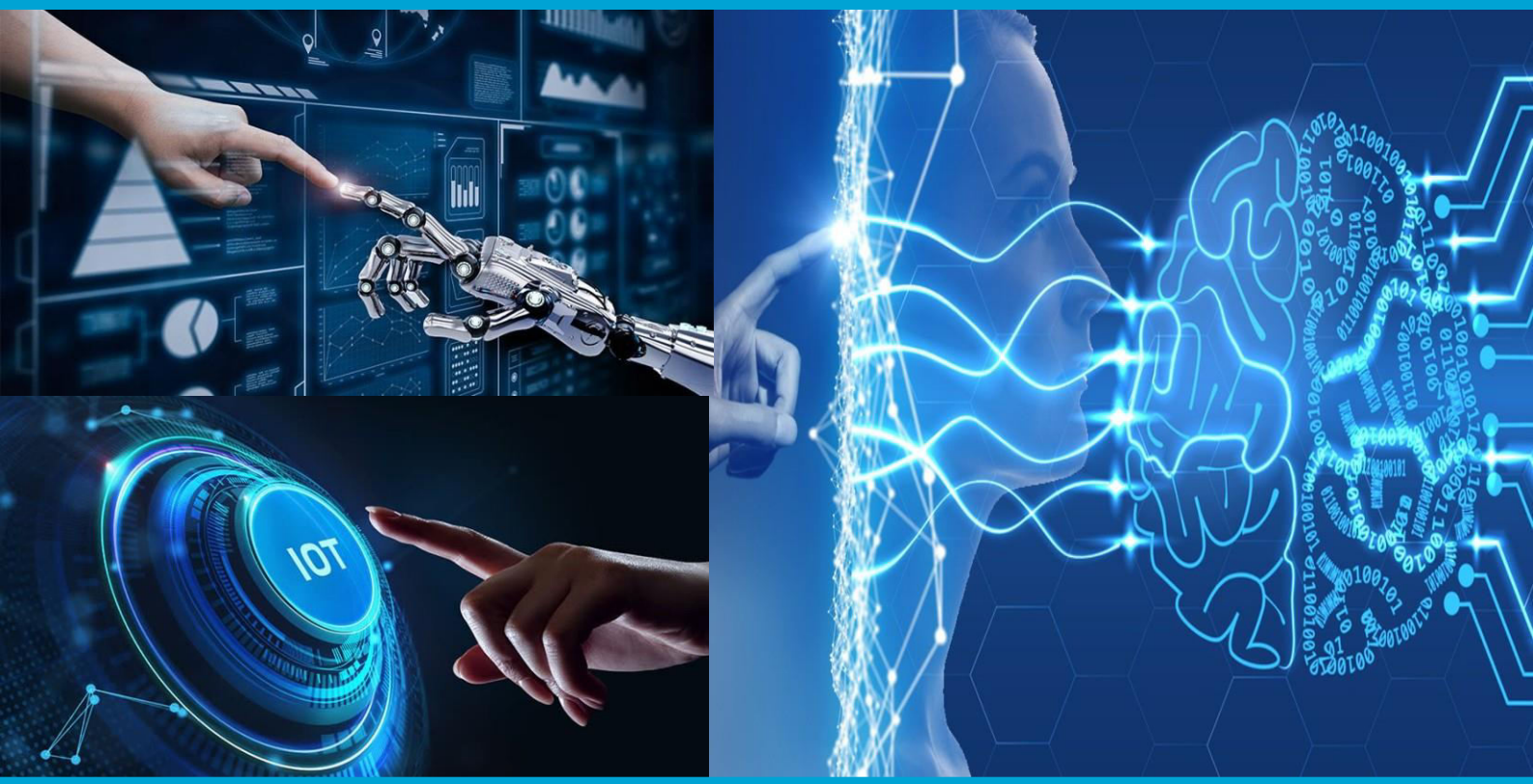

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Case Study of Cracks and Its Repairing Techniques

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ABSTRACT: In concrete buildings subjected to real-world service conditions all around the world, cracking is a frequent issue. In reality, it is quite difficult to locate concrete constructions that are free of cracks. Cracks appear as a result of concrete deterioration, corrosion of the reinforcement bars, mistakes in the construction and design, as well as the effects of temperature and shrinkage. To overcome calamities caused by nature, soil failure during construction, design flaws, and inadequate joints that lead to the development of cracks. Depending on the mix composition, exposure environment, hydration rate, and curing circumstances, concrete can experience early age cracking. The strength and durability of the structures are significantly decreased by the crack. When choosing the best course of action to address the early-age cracking issue in concrete, it is crucial to properly understand the causes and effects of cracking. This case study will assist in determining the main reasons for and effects of concrete cracking. Based on the types of cracks and their locations in the structure, different restoration methods and materials are used. Some types of fractures require immediate care because they pose a threat to the structure. In some circumstances, restoration efforts might result in more severe issues and prolong the effects to greater structural deterioration and cracking. In this assignment, we've spoken about the different kinds of cracking and the appropriate restoration methods.

KEYWORDS–Case study, Cracking,Repair techniques.

I. INTRODUCTION

A crack is the result of the breaking or fracturing of concrete into two or more portions, whether completely or partially. It reduces the structure's durability and compromises the structural safety and integrity of the wall. Buildings often have cracks. Cracks appear as a result of concrete deterioration, corrosion of the reinforcement bars, mistakes in the construction and design, as well as the effects of temperature and shrinkage. The first and most frequent cause of crack development is a stress component that exceeds its strength component. This can be attributed to externally applied loads (forces) like dead, live, wind, or seismic loads, foundation settlement, or stresses that develop internally as a result of thermal movements, moisture changes, and/or chemical action, among other things. Most structures develop cracks at some point throughout their useful lives. The emergence of cracks is a sign that there is trouble with the structure of the building. Often, the cracking doesn't matter much, and after it's been determined that it's static, all that's needed to fix it is some filler or new pointing. However, a fracture might be the initial indication of a serious flaw that could jeopardize the building's usability or stability.

II. CLASSIFICATION OF CRACKS

The cracks can be classified into two major types based on the deterioration of the concrete and location of crack in the building. These can failure due to both man-made and environmental effects.

2.1 Structural cracks:

Inadequate construction locations, overloading, or inadequate soil bearing can create structural fissures. Even while these cracks might not immediately let in water, you can be sure that they will eventually. Any delay in problem-solving will only result in new issues. Repairs will become more costly and difficult. Only a skilled repairman ought to take care of the issue. A knowledgeable foundation repair contractor should address structural faults as soon as feasible. On the slab, column, and beam, structural fissures developed.

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2.2 Non-Structural cracks:

They can develop gradually as a result of climatic fluctuations, thermal movement, hydrostatic pressure, and moisture exposure. Some fissures develop as people age. Well, a lot of these elements are universal and natural. Cosmetic cracks are typically shallow and less severe than structural ones. The crack injection technique is frequently employed to fix them. They typically survive a long time when corrected. You should only be concerned if water begins to leak through them. When this occurs, mould development may result.

2.3 Types of cracks based on nature of cracks:

- Plastic shrinkage concrete cracks.
- Expansion concrete cracks.
- Heaving concrete cracks.
- Settling concrete cracks.
- Concrete cracks caused by overloading the slab.
- Concrete cracks caused by premature drying.

STRUCTURAL	NON-STRUCTURAL
• Incorrect design • Faulty construction • Overloading • Non-uniform soil settlement	• Internally induced stress • Non-uniform thermal changes. • Shrinkage of building materials. • Inadequate curing.

III. SYSTEMATIC APPROACH TO REPAIR

The systematic approaches to repair the cracks are as follows

- Visual inspection
- NDT and partial NDT
- Need for repair
- Expected life of repair
- Selection and evaluation of repair material
- Budget of repairing
- Limitation / constraints in repairing

3.1Visual inspection:

It is typically one of the first steps in evaluation of a concrete structure. Visual inspection can provide a wealth of information that may lead to positive identification of the cause of observed distress. Before performing a detailed visual inspection, the investigator should develop and follow a definite plan to maximize the quality of the record data. Visual inspection has the obvious limitation that only visible surface can be inspected. Internal defects go unnoticed and no quantitative information is obtained about the properties of the concrete. For these reasons, a visual inspection is usually supplemented by one or more of the other NDT methods.

3.2NDT and partial NDT:

NDT stands for Non-Destructive Testing. It refers to an array of inspection methods that allow inspectors to evaluate and collect data about a material, system, or component without permanently altering it. While NDT methods are typically associated with industrial use cases, like inspecting weak points in a boiler used at an oil refinery, uses in medicine are actually some of the most common. For example, an expecting mother getting an ultrasound to check on the health of her baby would be considered an NDT use case, as would getting an X-ray or MRI to learn more about an injury. But it's important to note that NDT does not necessarily require the use of special tools, or any tools at all. Here are the top reasons NDT is used by so many companies throughout the world.

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IV. REPAIRING TECHNIQUES

- Bonding with epoxies
- Routing and sealing
- Stitching
- External stressing
- Blanketing
- Grouting
- Autogenous healing
- Jacketing
- Pneumatically applied mortar
- Pre-packed concrete
- Replacement of concrete
- Dry pack
- Overlays
- Epoxy resin
- Protective surface treatment

4.1 Stitching techniques:

The tensile strength of a cracked concrete section can be restored by stitching in a manner similar to sewing cloth. Any desired degree of strengthening can be accomplished but it must be noted that strengthening also tends to stiffen the structure locally. Stitching the crack will tend to cause its migration elsewhere in the structure. For this reason strengthening the adjacent areas of cracks have to be made to take care of additional stresses. More over the stitching dog should be of variable length, orientated and so located that the tension transmitted across the crack does not devolve on a single plane of the section but is spread over an area, Strengthening of the adjacent sections of concrete may consist of external reinforcement embedded in a suitable overlay material. Where there is a leakage of water problem, the crack should be sealed as well as stitched so that stitches are not corroded. Stress concentrations occur at the ends of the cracks; hence the spacing of the stitching dogs should be reduced at such locations. The stress concentrations at each ends of the cracks can be relieved by drilling holes near them. Wherever possible both sides of cracks have to be stitched to prevent bending action on dogs due to movements of the structure. In bending members it is possible to stitch one side of the crack but this should be the tension side of the section where movement is originating. If the member is in a state of axial tension then a symmetrical placement of the dogs is a must. If the stitching is to supplement the strength of the existing section, the deformation must be compatible. The dogs must be grouted with a non- shrink or expandable mortar so that they have a tight fit thus the movement of the crack will cause the simultaneous stressing of both old and new sections. The holes for the legs of the dogs should be filled with grout. The dogs are thin and long and to cannot take much of compressive force. The dogs must be stiffened and strengthened by encasement in an overlay or some similar means. Instead of steel rods or flats used us dogs, the same

be replaced with ferro-cement which is made effective using chicken mesh or chicken mesh in conjunction with welded mesh as the case may be, Employment of cement mortar 1:2 or 1:2:5 with a water cement ratio of 0.45 is recommended for protecting the steel reinforcement mesh.

4.2Epoxy resins:

These are organic compounds that create robust, chemically resistant structures with high adhesive qualities when they are activated with the right hardening agents. They serve as binders or adhesives to join damaged concrete pieces or adhere fresh concrete patches to existing surfaces. This substance will not melt, flow, or bleed after being solidified. After mixing, the epoxy should be carefully placed into the pot.

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V. CASE STUDY

5.1 Corrosion crack in a column located at thiruvalluvarillam boys hostel (ACGCET), karaikudi.

Fig-1 Corrosion crack in column

Type of crack: Corrosion crack in the column.
Cause of corrosion: Inadequate bond between concrete and steel bars are the cause of corrosion of reinforcement in concrete columns. It is also due to the reason of not providing proper cover over the reinforcement.
Repairing techniques:

- Encasement (or) enlargement of the column cross section. (Jacketing)
- Cathodic protection to stop reinforcing steel corrosion
- Chloride extraction to retard the reinforcing steel corrosion.
- Addition of shear collars to increase the shear capacity of intermediate floors.
- The application of a protection system to prevent future corrosion.

5.2 Flexural crack in the slab in tiruvalluvarboys hostel.

Type of crack: Flexural cracks on slab.
Cause of corrosion: External load results in direct and bending stresses, causing flexural, bond and diagonal tension cracks. Immediately after the tensile stress in the concrete exist its tensile strength, internal micro cracks propagating to the external fibre zones of the concrete element.

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Repairing techniques:

- The use of embedded CFRP reinforcement through the stirrups is a very promising, practical and sufficient method of repairing especially in corroded steel R.C. beams as it could increase the beam capacity after repairing and also could be easy in construction as the concrete cover in most corroded beams has already been spalled out.

- The use of embedded CFRP reinforcement prohibited any concrete cover delamination could occur using near surface mounted method.
- The use of embedded FRP rods is an effective technique to enhance the flexure capacity of R.C. beams. An increase in capacity by 33.33% with respect to the control beam could be obtained.
- The preloading levels have very minor effect in the enhancement capacity of R.C. beams, as beams preloaded to 50% and 70% show a decrease in enhancement level by 4.2% compared with strengthened beam without preloading which could be neglected.
- Removing the concrete cover, embedding the FRP bars and then re-casting the concrete cover again decrease the load carrying capacity of strengthened beam compared with the beams cast with the existing FRP strengthening bars by about 11% which is also very small ratio and could be neglected.
- All beams failed in flexure; therefore, the embedded FRP rods are an effective method to avoid the brittle failure for strengthening beams using FRP and de-bonding of CFRP bars compared to near surface mounted technique.

VI. CONCLUSION

The study's findings suggest that while it is impossible to guarantee against cracking, efforts can be made to reduce its occurrence. It also suggests that not all types of cracks require the same level of attention, and that the potential causes of cracks can be managed if proper consideration is given to the materials and construction methods to be employed. After thorough investigation and analysis of the parameters of the existing cracks, new repair methods are used. We conducted multiple studies to determine how to lessen the impact of cracks by using contemporary techniques like epoxy injection. By using outdated methods, it is impossible to manage the effect of fractures in a building. In the end, our results were more modest than the previous ones.We come to the conclusion that all types of structures can utilise these contemporary approaches at a reasonable price.

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