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Importance of Controlling Cracks in a Structure

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Abstract

The main aim of this study is to discuss some of the very common causes of cracks in concrete and their preventive measures as cracks can also be called as the braking or fracturing of concrete in two or more parts or we can say it as the separation which can be both complete as well as incomplete separation, cracks in concrete is said to be that inherent feature in concrete which can't be fully prevented but can be controlled up to some extent. As this phenomenon of incomplete or complete separation of concrete is very common, so to ensure the durability of the structure, engineers and researchers are making their efforts in finding the causes and their remedial measures and to overcome such problems various new techniques of healing of cracks in concrete were introduced with time among those, healing of concrete with synthetic polymers such as epoxy treatments are very common but on the other hand such epoxy treatments are very harmful to the environment as well as to the human health, due to those certain limitations, the use of bacterial concrete is focused (Kadian, 2018). As bacterial concrete is a special type of concrete which has the ability to heal itself whenever cracks appears on the surface of concrete, in formation of bacterial concrete, bacteria's such as bacillus subtilis JC3 is the most commonly used soil bacterium which instigates the precipitation of calcite (Kadian & Pannu, Durability Performance of Bacterial Concrete, 2018) when the concrete surface comes into the contact with moisture. Apart from this, the most important aspect of this study is to find the causes of cracks and observing carefully its characteristics such as shape, size, depth and the behavior of the crack.

Keywords: *Cracks, Bacterial Concrete, Drying Shrinkage, Stresses, Structural Failure.*

Introduction

It is a very well known fact that the concrete is the most widely and commonly used construction material in the world which has certain limitations as well such as weal tensile and shear strength, Therefore, tensile and shear stresses from a very minor magnitude can cause cracking, as the cracks in structural components are not always due to the structural inadequacy, overloading or due to the faulty construction. As many internal stresses are induced in the structure on the account of the chemical reactions, deformations due to elasticity, movements due to the thermal factors and changes in moisture etc. All such factors are responsible for the dimensional changes in the structure and whenever movement due to these changes is restricted that resistance between the different parts or layers of the structure induces stress and when such induced stresses exceeds the limit strength of the material, cracking happens on the surface of concrete whereas percolation of such cracks also leads to a number of problems such as the movement of moisture as well as the deleterious substances into the structure causing deterioration of the cement-concrete mixture and also corrosion into the reinforcement (Kadian, A Study on Importance of Bacterial Cement Composites , 2019). These cracks are generally classified into thin and thick cracks depending upon the properties of the building material used and other various causes, As thin cracks appeared on the surface of concrete even in a large number are considered as less threatening or dangerous to the structure as compared to fewer wider cracks, not all but in most cases self-healing bacterial concrete could be the required solution due to its ability to heal itself by sealing the cracks with the calcium carbonate crystals. In bacterial concrete the process of MICP (Microbiologically Induced Calcite Precipitation) is a series of complex biochemical reactions including concomitant precipitation of bacillus subtilis, urease and high pH. In this process, an alchophilic soil micro-organismbacillus subtilis plays an important role by producing urease which hydrolyze the urea to ammonia, increasing the pH in the surroundings which in turn induces

precipitation of calcium carbonate, mainly in the form of calcite (Kadian M. , 2018). Keeping above in view, various causes, preventions and precautions for investigation and controlling the cracks are enumerated in this study.

Literature Review

Researchers are continuously working on the causes and remedies of cracks and various other advance techniques which can be adopted for the better future of construction industry (Kashyzadeh. R. Kazem et al.2012) describes the importance, why every civil engineer should know about the cracking in the structure, (Kadian & Pannu, A Study of Durability Properties of Bacterial Concrete, 2018) in this study states that the bacterial concrete refers to a new generation of concrete in which selective cementation by microbiologically-induced CaCO3 precipitation has been introduced for remediation of micro cracks.

(Sayed.Mohd.Mehndi et al.2014) explains about the different techniques for evaluating the cracks such as ultrasonic testing and crack compacting. (kadian, 2018) said MICP (Microbiologically Induced Calcite Precipitation)system is considered for the study by utilizing Bacillus Subtilis and its nutrients which later acts as the food for the microorganisms or bacteria's such as Sodium Bi-Carbonate (NaHCO3), Ammonium Carbonate (NH4CL), Calcium Chloride Dehydrate (CaCl2). Generally, they are mixed in a proportion of 1:2.5:5, Liquid form of Bacillus Subtilis is also added to the proportion (35 ml approx.) with the cell concentration of approximately 100cells/ml. The tests are performed on a cubical concrete section of 150mmx150mmx150mm for calculating and testing the compressive and tensile strength. As a result, it is found that there is a considerable increase in the strength and quality of concrete with added bacteria's/ Bacillus Subtilis.

(Thaguna G. , 2014) stated that the cracks may or may not have direct impact on the building related to the structural issues but it may facilitates the activities which can lead to some serious problems.

(Kadian A. , Bending Concrete: Balanced, Under-Reinforced and Over-Reinforced Beam Sections, 2018) in his paper stated while working in laboratory performing tests regarding the strength of concrete and occurrence of cracks at different loads and other factors if satisfactory results are not obtained or the quality example fails to give appropriate results additional testing of concrete setup is required and when studied deeply at microscopic level, various changes in concrete properties are observed such as electrical and acoustical properties even leading to the complete failure of the structure (Singh & Kadian, 2018). (B.B.Gamit et al., 2014) classifies the structural and non-structural cracks in a structure with their causes and remedies.

(Kumar & Killemsetty, 2014) in their study on control of cracks in a structure through visual identification and inspection explains about the visual inspection of cracks and classifying them with respect to various parameters by taking case study of an institutional building. (Kadian A. , Effects of MICP in Self-Healing of Bacterial Concrete , 2019) For self-healing of cracks in concrete, due to its highly alkaline nature, the bacteria's to be added in the concrete mix in the initial stages must follow certain criteria, such as the longer survival durations with the ability of forming spores as well as the potential to withstand the mechanical as well as environmental forces.

Crack Controlling Measures

• To avoid cracks in any structural brick work on the account of initial expansions, a minimum period of 7 to 14 days is recommended.

• Rich cement mortar in masonry should be used to minimize the shrinkage cracking.

• Plaster work should be avoided until the masonry becomes completely dry after proper curing.

• While flooring, the floor should be laid in small alternate panels or by using other materials such as glass strips or aluminum closely in a grid pattern, to render the shrinkage cracks.

• For cracks at ceiling level in cross walls, slip joints should be used between the slabs and its

supporting walls as well as between the slab and the cross walls.

• For cracks at the base of the parapet walls where thermal coefficient of concrete is twice than that of the brickwork and drying shrinkage is 3 to 4 times that of brick masonry, the concrete used for slab should be 1:1:6 (1 cement:1 lime:6 sand) and good bond must be ensured between the concrete and the masonry.

Crack Controlling Techniques

The following are some of the important crack curing techniques**:**

(i) Epoxy Treatments

Using epoxy treatments for non-movable cracks is the most economical method, for such purposes epoxy injections are used such for cracks in concrete wall, slabs and columns etc. Epoxy treatments using epoxy injections have the ability to restore the concrete up to its pre-concrete strength. This technique generally includes sealing of cracks on the outside exposed surface of concrete and injecting the epoxy under pressure.

(ii) Stitching Technique

This crack curing technique named as stitching involves drilling of holes in the both sides of the cracks, which after cleaning are anchored on the legs of the staples in the holes with a non-shrinkage grout. This technique is generally adopted at places where permanent structural repair solutions are needed for masonry repairs and cracked wall reinforcements.

(iii) Routing and Sealing

Routing and Sealing crack curing technique involves widening of cracks on the surface with a saw or grinder and filling the grove with the flexible sealant. Generally, it is one of the most common techniques adopted for the purpose because of its simple procedures as compared to other techniques such as epoxy treatments which requires skilled labor. Routing and Sealing can be done on vertical and curved surfaces.

(iv) Dry Packing

Dry Packing is the simplest of all other crack-curing techniques which involves placement of thick mortar with low water content by hand followed by the tamping or ramming of the mortar into its right position.

(v) Drilling and Plugging

This technique is mostly used to repair vertical cracks on the retaining walls generally running in a straight line whose only one end is accessible.

(vi) Polymer Impregnation

Polymer Impregnation crack curing technique involves a monomer system i.e. a liquid containing monomers which later polymerize into the solid form. Most commonly used monomers in Polymer Impregnation is Methyl-Methacrylate**.**

Conclusions

In the above study we have discussed some of the common causes and curing techniques for cracks along with previous attempts made by the researchers in their respective studies, and concluded that some preventions taken initially during the construction can do much of its job of preventing cracks, sometimes lack of knowledge, unavailability of skilled labor or un-attentiveness can be a cause for damage in the structure in its coming future which if remains unattended, depending on its severity can also lead to complete structural failure, Cracks occurs due a number of reasons as discussed earlier in the paper, their occurrence cannot be stopped but particularly prevented by adopting preventing measures on time to minimize the level of consequences as the potential causes for cracks can be controlled if proper attention is given to the quality of the construction material and the used technique.

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