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REPAIR AND REHABILITATION OF STRUCTURES

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Abstract: Reinforced cement concrete (RCC) as a construction material has come into use for the last one century. In India, RCC has been used extensively in the last 50-60years.During this period, we have created large number of infrastructural assets in terms of buildings, bridges, sports stadium etc., which are lifeline for the civilized society. These have been created with huge investment of resources. We cannot even dream of recreating such assets out of limited national resources. It is there more essential to maintain them in functional condition. Since, deterioration of RCC is a natural phenomenon and has started exhibiting in large number of structures, a systematic approach is needed in dealing with such problems. Identification of the causes of deterioration and consequent repair/rehabilitation strategy at optimum cost needs a scientific evaluation and solution.

Concrete constructions require proper care in the form of regular maintenance If buildings remain for several years without proper attention then, various factors like water stagnation, paint peeling, plaster break- off, fungus growth, cracking of external surfaces will affect the building. Penetration of moisture into reinforced concrete components promotes corrosion process and further damages the concrete cover.

It has been observed that the deterioration phenomena of RCC are not realized by majority of practicing civil engineers. As a result, the factors considered necessary for durability of RCC buildings are many times not given due importance during construction and/or during maintenance. The durability provisions have been given emphasis in the revised Code of Practice on Plain and Reinforced Concrete' (IS: 456-2000). In the international scenario also, deterioration of CC had been drawing attention of the practicing civil engineers for quite some time. They have accordingly, made certain advancement in the field of protection, repairs, rehabilitation, strengthening and retrofitting of the existing RCC structures taking advantage of the advancement in the materials science, more particularly the polymer science. The knowledgeas UPV, rebound hammer, pH, carbonation, corrosion test, delamination, and cover metre tests were undertaken.

Index Terms **– introduction, methodology,future sope, delamination.**

I. INTRODUCTION

Large stocks of existing structures and infrastructure are deteriorated with use and time and might have passed their design life and require retrofitting and rehabilitation. The cost of retrofitting various infrastructures is estimated in the lakhs of rupees. To overcome the ill effects caused by these deteriorated buildings Repair and Rehabilitation works are carried out from time to time.

Many of the existing structures were designed to codes that have since been modified and upgraded. Change in use or higher loads and performance demands require modifications and strengthening of structural elements.

Concrete construction is generally expected to give trouble free service throughout its intended design life. However, these expectations are not realized in many constructions because of structural deficiency, material deterioration, unanticipated over loadings or physical damage. Premature material deterioration can arise from a number of causes, the most common being when the construction specifications are violated or when the facility is exposed to harsher service environment than those expected during the planning and design stages. Physical damage can also arise from fire, explosion as well as from restraints, both internal and external, against structural movement. Except in extreme cases, most of the structures require restoration to meet its functional requirements by appropriate repair techniques.

The human body becomes deteriorated upon ageing. To a certain extent, the problem can be remedied by taking necessary preventive steps at the appropriate time. This is exactly the case with buildings. As time passes, the condition of buildings also becomes deteriorated. Unless corrective measures are taken, it may so happen that the safety of the building itself may be jeopardized.

There are other factors that necessitate renovation. These are accidents, environmental factors, alteration to structures, etc. The construction associated with already-constructed structures is called renovation. Some people call the process of rehabilitation "Forensic Engineering." The role of the engineer is just like that of a doctor trying to diagnose the disease of a patient and then recommending corrective treatment. Maintenance of constructed structures includes preventive care, repairs, and rehabilitation.

II. METHODOLOGY OF REPAIR AND REHABILITATION FOR SLAB/WALL CRACKS

- Stitching
- Routing and sealing
- Resin injection
- Drilling and plugging
- Grouting
- Overlays

2.1) Stitching:

Stitching involves drilling holes on both sides of the crack and grouting in U- shaped metal units with short legs (staples or stitching dogs) that span the crack . Stitching may be used when tensile strength must be reestablished across major cracks. The stitching procedure consists of drilling holes on both sides of the crack, cleaning the holes, and anchoring the legs of the staples in the holes, with either a non-shrink grout or an epoxy resin-based bonding system.

In this technique, the crack is bridged with U-shaped metal units called stitching dogs before being repaired with a rigid resin material. A non- shrink grout or an epoxy resin based adhesive should be used to anchor the legs of the dogs. Stitching is suitable when tensile strength must be reestablished across major cracks. Stitching dogs should be of variable length and orientation.

a) Repair Steps:

Step 1: Mark and Drill holes on both sides of the cracks.

Step 2: Chase a Groove between the drilled holes.

Step 3: Insert U-shaped M.S bars in the holes and span across the crack.

Step 4: Grouting the holes with either epoxy or non-shrink grout.

b) Benefits of Cracked Stitching:

Quick, simple, effective and permanent.

The grout combination provides an excellent bond within the substrate.

Masonry remains flexible enough to accommodate natural building movement.

Non-disruptive structural stabilization with no additional stress.

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2.2) Routing and Sealing:

Routing and sealing of cracks can be used in conditions requiring remedial repair and where structural repair is not necessary. This method involves enlarging the crack along its exposed face and filling and sealing it with a suitable joint sealant . This is a common technique for crack treatment and is relatively simple in comparison to the procedures and the training required for epoxy injection. The procedure is most applicable to approximately flat horizontal surfaces such as floors and pavements. However, routing and sealing can be accomplished on vertical surfaces (with a non-sag sealant) as well as on curved surfaces (pipes, piles and pole).

a) **Features:**

- This is the simplest and most common method of crack repair.
- It can be executed with relatively unskilled labor and can be used to seal both fine pattern cracks and larger isolated cracks.
- This involves enlarging the crack along its exposed face and sealing it with crack fillers.
- Care should be taken to ensure that the entire crack is routed and sealed.

Routing and sealing is used to treat both fine pattern cracks and larger, isolated cracks. A common and effective use is for waterproofing by sealing cracks on the concrete surface where water stands, or where hydrostatic pressure is applied. This treatment reduces the ability of moisture to reach the reinforcing steel or pass through the concrete, causing surface stains or other problems.

The sealants may be any of several materials, including epoxies, urethanes, silicones, polysulfide, asphaltic materials, or polymer mortars. Cement grouts should be avoided due to the likelihood of cracking. For floors, the sealant should be sufficiently rigid to support the anticipated traffic. Satisfactory sealants should be able to withstand cyclic deformations and should not be brittle.

The procedure consists of preparing a groove at the surface ranging in depth, typically, from 1/4 to 1 in. (6 to 25 mm). A concrete saw, hand tools or pneumatic tools may be used. The groove is then cleaned by air blasting, sandblasting, or water blasting, and dried. A sealant is placed into the dry groove and allowed to cure. A bond breaker may be provided at the bottom of the groove to allow the sealant to change shape, without a concentration of stress on the bottom.

The bond breaker may be a polyethylene strip or tape which will not bond to the sealant. Careful attention should be applied when detailing the joint so that its width to depth aspect ratio will accommodate anticipated movement.

2.3) Resin injection:

Cracks as narrow as 0.002in (0.05 mm) can be bonded by the injection of epoxy. 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. Epoxy injection has been successfully used in the repair of cracks in buildings, bridges, dams, and other types of concrete structures. However, unless the cause of the cracking has been corrected, it will probably recur near the original crack. If the cause of the cracks cannot be removed, then two options are available

One is to rout and seal the crack, thus treating it as a joint, or, establish a joint that will accommodate the movement and then inject the crack with epoxy or other suitable material. With the exception of certain moisture tolerant epoxies, this technique is not applicable if the cracks are actively leaking and cannot be dried out. Wet cracks can be injected using moisture tolerant materials, but contaminants in the cracks (including silt and water) can reduce the effectiveness of the epoxy to structurally repair the cracks.

The use of a low-modulus, flexible adhesive in a crack will not allow significant movement of the concrete structure. The effective modulus of elasticity of a flexible adhesive in a crack is substantially the same as that of a rigid adhesive because of the thin layer of material and high lateral restraint imposed by the surrounding concrete. Epoxy injection requires a high degree of skill for satisfactory execution, and application of the technique may be limited by the ambient temperature.

a) Repair Steps:

i) Clean the cracks: The first step is to clean the cracks that have been contaminated; to the extent this is possible and practical. Contaminants such as oil, grease, dirt, or fine particles of concrete prevent epoxy penetration and bonding, and reduce the effectiveness of repairs. Preferably, contamination should be removed by vacuuming or flushing with water or other specially effective cleaning solutions.

The grout key prevents transverse movements of the sections of concrete adjacent to the crack. The key will also reduce heavy leakage through the crack and loss of soil from behind a leaking wall. If water-tightness is essential and structural load transfer is not, the drilled hole should be filled with a resilient material of low modulus in lieu of grout. If the keying effect is essential, the resilient material can be placed in a second hole, the fiat being grouted.

2.4) Grouting

a) **Portland cement grouting:**

Wide cracks, particularly in gravity dams and thick concrete walls, may be repaired by filling with Portland cement grout. This method is effective in stopping water leaks, but it will not structurally bond cracked sections. The procedure consists of

1) cleaning the concrete along the crack.
2) Installing built-up seats (grout nipples) at intervals astride the crack
3) Sealing the crack between the seats with a cement paint, sealant, or grout.
4) Flushing the crack to clean it and test the seal and,
5) then grouting the whole area.

Grout mixtures may contain cement and water or cement plus sand and water, depending on the width of the crack. However, the water-cement ratio should be kept as low as practical to maximize the strength and minimize shrinkage. Water reducers or other admixtures may be used to improve the properties of the grout. For small volumes, a manual injection gun may be used and for larger volumes, a pump should be used. After the crack is filled, the pressure should be maintained for several minutes to insure good penetration.

2.5) Overlays:

Slabs containing fine dormant cracks can be repaired by applying an overlay, such as polymer modified Portland cement mortar or concrete, or by silica fume concrete. Slabs with working cracks can be overlaid if joints are placed in the overlay directly over the working cracks. In highway bridge applications, an overlay thickness as low as 1-1/4 in. (30 mm) has been used successfully. Suitable polymers include styrene butadiene or acrylic latexes. The resin solids should be at least 15 percent by weight of the Portland cement, with 20 percent usually being optimum.

FUTURE SCOPE

- In the scope of insulation and sealing, the materials and the installation method must be considered respecting the parameters of the climate where the structure is found, luminescence, skill and know-how of the team and the budget destined for its execution. One of the important points is the roof, where the greatest loss of energy occurs in a building.

•For foundation structures, durability is a critical item. Water and excessive soil moisture are factors that generate recurring structural and maintenance problems. Protecting the building through an internal and external waterproofing system may keep the foundation dry, extending its service life.

- The walls and floors in rehabilitation depend on factors such as the weather and the availability of the material on site .There is a wide range of materials ranging from wood to high efficiency systems such as the Structural Insulated Panel (SIP).Each system has unique characteristic, durability, energy efficiency and cost. Thus, it is the responsibility of the people involved to identify the characteristics necessary to better serve the building. One must remember that it is always possible to combine local alternative solutions, such as the use of mud and hay bale with traditional solutions such as masonry brick.

•The patios, balconies and decks are spaces of external interaction in a building, where there is a better circulation of air. In rehabilitation, the spaces unprotected against external agents must be made of materials suitable for this purpose. One should be aware of the influence of the external area on the internal elements of the rehabilitated building, as these spaces can become openings in the building for the entrance of water, dust, biological agents, among others.

- The choice for an adequate lighting is a relevant factor in the electrical system of a rehabilitated building. Harnessing the external lighting when possible and installing efficient equipment generate a lower cost in energy consumption.
- Old buildings often waste water through inefficient fittings, leaks and long pipes. In addition to repairing, replacing the sanitary ware with modern accessories, implement water reuse techniques and flow control valves increase the efficiency of water consumption.

•The heat air conditioning HVAC system that reduces air infiltration and maintains pressure uniformity requires appropriate designs for better energy utilization and installation method in rehabilitated buildings. The compatibility of new components with the existing ones is one of the challenges of this system, that is, it requires specific design and adaptation in order not to affect other construction systems.

III. CONCLUSION

Based on the results obtained from the study the following conclusions made are as follows,

- Periodic maintenance of structures is essential.
- Each and every problem should be properly analyzed and then the appropriate repair methods undertaken.
- Primary design of the building reflects its performance in long run.
- Each repair technique is suitable only for the particular application for which it is meant for.
- Cost should not be significant planning factor in rehabilitation though it is a deciding factor.
- Due to moisture, walls get patch off and brick walls losses its strength, so the mentioned repair works for bricks and plaster of walks is well recommended.
- Due to some adverse conditions cracks will form in walls and slab which disturbs the functioning of structure, so the earlier mentioned methods are very useful for repair of cracks and rehabilitation of

structure.

- RCC structure gets deterioted due to corrosion of steel ultimately which improper functioning results of structure so in above mentioned methods like RCC jacketing, Plate Bonding Guniting/Shortcrete etc., are very useful in rehabilitation of structures.

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