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Review Paper on the Effectiveness of Retrofitting of Beam Subjected To Corrosion and Spalling of Concrete

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Abstract -*This paper aims to study the effectiveness of retrofitting on beams subjected to spalling due to corrosion of rebars using steel mesh. Corrosion of steel reinforcement is one of the main durability problems faced by reinforced concrete infrastructures worldwide. This paper explains about various repair materials that can be used for retrofitting. These repair materials will act as a strong bonding agent to have a better and effective bonding between the existing concrete and the new concrete cover to be provided. The lost area of steel due to corrosion is compensated using steel wire meshes, steel plates or steel angles over the repair material and the cover concrete can be provided. From the various studies it was observed that, the full strength could not be achieved in repairs but an adequate strength can be achieved when compared to that of damaged beam with corroded bars and spalling of concrete.*

***Key Words*: Repair material, durability, bonding agent, effective, steel reinforcement, worldwide**

1.INTRODUCTION

Deterioration in the form of spalling is very common in the concrete covers of R.C. structures, especially when they are exposed to aggressive environmental conditions. Spalling occurs most commonly because of corrosion in the reinforcement bars. Such corrosion is often accelerated by a lack of adequate cover. Retrofitting reduces the vulnerability of damage of existing structure. Retrofitting is the process of addition of new features to older buildings, heritage structures, bridges etc. Retrofitting reduces the vulnerability of damage of existing structure. For the purpose of assessment, damages may generally be classified as: a total or partial collapse,cracking (including pattern cracking), spalling of cover concrete leading to size reduction, due to corrosion of reinforcing steel.

A spalling in the concrete surface may be the result of localized distress or the symptom of a more widespread distress in the concrete element. Causes of spalls include: corrosion of reinforced steel impact, vibration, etc., excessive deflection, buckling, twisting, distortion, etc. Reinforcing steel that has been placed too close to the surface of the concrete –that is, with less cover- or that has been exposed by spalling (due to distress), erosion, or cracking, can corrode, or rust easily. The presence of salt –rich moisture adds to the rate of deterioration due to accelerated oxidation of steel. The parameters which influence the corrosion process are: the cover thickness,quality of concrete in the cover region, environmental conditions, pH value, chloride level in concrete and presence of cracks.

The repair materials required for RCC elements are:

(i) coatings to inhibit corrosion
(ii) bonding agents for adhering old concrete (substrate) to new,
(iii) repair material for building the lost cover. There are different types of bonding agents and repair materials for concrete, produced by a lot of companies available in the market.

They are broadly classified as cement based, polymer based and epoxy based. Each category has its own context of use, and procedures for application, finishing and curing. A variety of repair materials has be discussed by various authors mainly wire meshes [1], steel angles [3], reinforced concrete layer and steel plates [4], Styrene-Butadiene Rubber (SBR) [5], advanced patch repair mortars, that is, a free flowing self compacting mortar (FFSCM) and a polymer modified cementitious mortar (PMCM) [6], cement grout, ferrocement with mortar, sprayed concrete or shotcrete, fibre reinforced polymer (FRP) and sprayed fibre reinforced polymer [6] and epoxy material [8].

Various repair materials are selected based on availability, durability, economical feasibility, strength, weight changing properties and general performance. The major advantages of retrofitting are improved comfort greater building durability, resistivity, higher resale value and indoor environmental quality.

2. LITERATURE REVIEW

Mohandas et al. (2016) [1], studied the suitability of using wire mesh for the purpose of strengthening the RC flexural members by conducting experimental works. New technique of strengthening system using wire mesh with a view to improve sectional properties and subsequent flexural strength of RC beams is adopted. FRP materials are not used for strengthening works practically because of their high weight to strength ratio. The experimental results indicate that RC beams strengthened with steel wire

mesh is an easy technique for strengthening of existing flexural members.

Ezz-Eldeen et al. (2015) [3], studied the strengthening and retrofitting of reinforced concrete beams completely damaged due to flexural failure. The strengthening technique consists of seven steel wire mesh with and without additional longitudinal steel angles. The strength has almost doubled.

Elhamed et al. (2015) [2], studied the use of jacketing of steel wire mesh with steel plates for retrofitting and strengthening of damaged beams that has completely failed (severe deformations).

Bashandy (2013) [4], studied the efficiency of strengthening reinforced concrete beams using some valid strengthening materials and techniques. Using concrete layer, reinforced concrete layer and steel plates are investigated in this research. The effectiveness varies based on the thickness of the materials used.

Radhakrishnan et al. (2012) [5], studied the details of an experimental investigation on the performance of Styrene – Butadiene Rubber (SBR) as a concrete repair material in tropical climatic conditions.

Kabir et al. (2010) [6], studied the problems in repair works and possible solutions were presented. These include removal of unsound concrete, preparation of concrete bonding surfaces, cleaning and/or replacement of reinforcing steel, surface inspection, and, finally, the selection of right repair materials. This paper presents a study on the structural performance of R C beams repaired using two advanced patch repair mortars i.e., a free flowing self compacting mortar (FFSCM) and a polymer Modified cementitious mortar (PMCM).

Obaydullah et al. (2006) [7], studied the causes of deterioration of concrete as well as repairing by using cement grout, mortar, concrete, sprayed concrete or shotcrete, epoxy, ferrocement with mortar, Fiber Reinforced Polymer (FRP) Sprayed Fiber Reinforced Polymer (SFRP) and the techniques of applying of these materials and also some resin based materials for bonding agent between interface of old concrete and new concrete are reported.

Camille et al. (2005) [8], conducted experimental study of epoxy repairing of cracks in concrete. It was found that the cracks caused a reduction in compressive strength, whereas the epoxy system, when properly applied restored the compressive strength.

Soudki et al. (2002) [9], obtained the results of a multi-phase experimental program undertaken to investigate the viability of using externally bonded fiber reinforced polymer (FRP) laminates to rehabilitate corrosion-damaged reinforced concrete beams.

Suresh Chandra Pattanai [10] stated that polymer modified concrete is a free flowing, self-levelling, self-compacting and high early strength material which can be effectively used for structural strengthening of deteriorated RCC members of column and beam especially in an aggressive environment. Polymer modified concrete strengthens the RCC structural members and makes it highly durable repair. Selection of appropriate polymer based repair materials and their use for durable structural repairs of beams under tropical climate still awaits more investigations.

3. CONCLUSION

In summary, a comprehensive literature review was performed in order to gain a better insight about the effectiveness of retrofitting of beam subjected to corrosion and spalling of concrete. Some of the researchers discussed the various retrofitting and strengthening methods for existing structures. The various materials discussed are wire meshes [1], steel angles [3], reinforced concrete layer and steel plates [4], Styrene-Butadiene Rubber (SBR) [5], advanced patch repair mortars, that is, a free flowing self compacting mortar (FFSCM) and a polymer modified cementitious mortar (PMCM) [6], cement grout, ferrocement with mortar, sprayed concrete or shotcrete, fibre reinforced polymer (FRP) and sprayed fibre reinforced polymer [6] and epoxy material [8].

Styrene butadiene (SBR) latex, which is compatible with cementitious compounds, is a copolymer. This type of latex shows good stability in the presence of multivalent cat-ions such as calcium (Ca 2+) and aluminium (Al 3+), and is unaffected by the addition of relatively large amounts of electrolytes (e.g., CaCl 2). Polymer modified concrete can show significant improvement in durability and bonding properties, leads the material to attain higher toughness or “ductility”. Among all polymer composites, Styrene Butadiene rubber latex (SBR) performs well in augmenting the mechanical behaviors of the conventional concrete. It is proved that, the resistance of the concrete to impact loading is enhanced by the use of SBR latex [8].

It is studied that, the failures which will be observed in repaired beams with reduced area of tension reinforcement due to corrosion will not be by spalling off of repaired portion but the failures will be similar to that of control specimen, that is by under reinforced flexural failure. But de-lamination will occur towards the end of loading. From

the studies it was observed that, the full strength could not be achieved in repairs but an adequate strength can be achieved when compared to that of damaged beam with corroded bars and spalling of concrete.

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