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REPAIR, RESTORATION AND STRENGTHENING OF BUILDING

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ABSTRACT
It has become a major challenge to select right techniques, materials, and procedures for the repair of a building structure. Recently developed innovative techniques of the structural repairs have many advantages. Some guidelines for the selection of materials for repair work like fiber reinforced polymer, Epoxy resins, Quick-setting cement mortar has been discussed in this paper. The selection of materials for the repair is generally depend on many factors like requirement of repair and the financial resources, the suitability of materials and their applicability in the repair of damaged part of structures. For the successful repair, strengthening and restoration of damaged structures use of innovative and standard repair materials with good workmanship and appropriate technique, and proper control on quality during implementation are the only key factors.

INTRODUCTION
For the maintenance of reinforced concrete structures and buildings, it requires periodic inspection. In that case there is very little awareness in civil engineers and other discipline. As a result, many of the times due importance is not given to the repair and maintenance of the building. But now a day it has become necessary to give more attention towards the repair and maintenance of old and damaged building structure. Hence, in depth requirement has been generated for structural repair, restoration and strengthening of RCC structures. New and innovative techniques have been developed in the repairs of concrete structures. In India there are large numbers of old existing buildings which are deteriorated because of their use, their age and may be due to fully consumption of their design life. For such a deteriorated structures it requires repair with proper material and proper technique. The cost of repair for any deteriorated building structures could be in lakhs of rupees. To avoid any kind of accident of such deteriorated buildings, repair works should be carried out at regular time so that the building will be serviceable upto its full serviceable life. For any recreational activity of structure it required strengthening of structural elements.
Causes of deterioration of the building structures:

- Selection of Site and its development errors
- Errors in design
- Errors in construction
- Deficiencies in material
- Errors in operation

REPAIR, RESTORATION AND STRENGTHENING:

The underlying concepts in the three operations are stated below:

i. REPAIRS
The main aim of repairs is to bring back the aesthetics of the building so that it starts working and the functioning of building precisely. It includes the following:
(i) Patching up of defects such as cracks and fall of plaster.
(ii) Repairing doors, windows, replacement of glass panes.
(iii) Checking and repairing plumbing services.
(iv) Re-building non-structural walls
(v) Re-plastering of walls as required.
(vi) Rearranging disturbed roofing tiles.
(vii) Relaying cracked flooring at ground level.

ii. RESTORATION

The restoration of the structure is done after the damage of the structure. In the process of restoration mainly the strength of the structure is restored. The restoration of the structure is done when there is clear evidence that the damage occurred is due to a phenomenon which is not likely to occur again and the strength restored is enough considering the safety of the occupants. The main objective of the restoration is to carryout structural repairs and to make the structural elements enough to bear the loads coming on them and transfer all loads safely. The process of restoration may involve cutting portions of the elements and reconstructing them or strengthening them by adding more structural materials so as to achieve the original strength of structure.

The process of restoration of the structure could involve inserting temporary underpinning, supports etc.

Some of the common steps used in restoration of the building structure are listed below:

(i) Portions of cracked walls and piers are to be removed and rebuilding them with richer mortar. In that non shrinking mortar should be preferably used.

(ii) Reinforcing mesh should be placed on both sides of the cracked walls; spikes or bolts are used to hold the mesh on wall.

(iii) Epoxy materials are also injected which are strong in tension so as to fill up cracks in walls, beams and columns etc.

Structural repairs and architectural repairs should be carried prior or simultaneously so that the total planning of work could be done in coordination manner and wastage will be avoided.

iii. STRENGTHENING OF EXISTING BUILDINGS

The behaviour of old existing buildings is affected by their structural inadequacies, degradation of material due to age of the building, and the structural or non structural change carried out during the life of the structure such as making new doors and windows, construction of any part which induces dissymmetry in the plan and elevation, etc. The possibility of substituting the old buildings with new earthquake resistant buildings is generally neglected because of social and economical reasons, historical and artistic view. The complete replacement or rehabilitation of old buildings in the given area could also result in destroying a number of social and human links. Strengthening means an improvement in the building structure over the original strength of the building. After the damage and evaluation of the building it indicates that the strength available in the structural members before the damage was insufficient and only restoration of strength in the structure alone will not be sufficient for the future damages may be due to same or different reasons.

Generally the objectives of strengthening the structure are as below:

i. To increase the strength of building, by providing extra reinforcement or by increasing the number of walls and columns.
ii. To provide unity to the whole building structure by providing connections in its resisting elements, in this way the inertia forces generated by vibration of the building can be transferred to the members that have the ability to resist these inertia forces. Some of important aspects are the connections between walls and foundations, roofs or floors and walls, and also between intersecting walls.
iii. To eliminating some features that are sources of weakness or that producing concentration of stresses in some of members. e. g. asymmetrical distribution of resisting members, large openings in walls without a proper peripheral reinforcement.
iv. To avoid the possibility of brittle failure by proper reinforcement and connection in between of resisting members.

REPAIR MATERIALS

The most common material in the repair of damages are of various types including cement and steel. In most of situations non-shrinking cement or an admixture like aluminium powder in the ordinary Portland cement is admissible. Steel can be required in many forms, like bolts, channels, angles, rods. For providing temporary supports and scaffolding timber and bamboo are the most commonly used, and they are required in the form of sleepers, planks, rounds etc. There are other methods of repair also which gives good results in repair and strengthening works.

i. SHOTCRETE

Shotcrete is a method in which combination of sand and Portland cement are applied on the required area. This sand and cement is mixed pneumatically and then conveyed in dry state itself to the nozzle of a pressure gun, where water gets mixed and the hydration takes place just before to the expulsion. By this technique the material bonds perfectly to prepared surface. While application on irregular or curved surfaces, its high strength and good physical characteristics, make it an ideal means to achieve added structural capability in walls and other elements of building. With this there are some of minor restrictions to the technique as clearance, thickness, direction of application etc.

ii. EPOXY RESINS

Epoxy resins are excellent binding agents which are used as repair material. The use of epoxy resins gives high strength in the repair works. Epoxy resins are composed of chemicals with proportions which when changed gives results as per requirement. These epoxy components are mixed just prior to their application. The product formed by the addition of epoxy resin has low viscosity and it can be injected in small cracks also. The epoxy resins having higher viscosity could be used for the purpose of surface coating or for filling the larger cracks or holes also. The strength of epoxy mixture depends upon the temperature of curing. Lower the temperature higher will be the strength achieved.

iii. EPOXY MORTAR

In case of larger void spaces, epoxy resins of either low viscosity or higher viscosity are combined with sand or aggregate to form epoxy mortar. This mixture of epoxy mortar has much higher strength than the Portland cement concrete. Thus the mortar is not a stiff material for replacing reinforced concrete. It has also been reported that the epoxy is a combustible material. Therefore the epoxy material is not used alone. The epoxy mortar formed from mixing of sand and aggregates gives a heat sink for heat generated and with this it also provides increase in modulus of elasticity.

iv. GYPSUM CEMENT MORTAR

Gypsum cement mortar has very limited use regarding its structural application. This gypsum cement mortar has lowest strength at the failure among other materials of repair.

v. QUICK-SETTING CEMENT MORTAR

This quick setting cement mortar was actually manufactured for the use as a repair material for reinforced concrete floors that are adjacent to steel blast furnaces. This mortar is a non-hydrous magnesium phosphate cement with two components, a liquid and a dry; these are mixed in similar way of Portland cement concrete.

vi. MECHANICAL ANCHORS

Mechanical type of anchors gives wedging action to provide anchorage. Some of the anchors provide shear and tension resistance both. In the purpose of achieving strength these type of manufactured anchors are used. Alternatively for chemical anchors bonded in drilled holes polymer adhesives are used.

CONCLUSION

- There should be keen observation where we had applied protective coatings.
- It is essential to carry out the periodic maintenance of structures.
- Each repair technique and repair material is suitable only for the its particular application for which it is prepared.
- Honey combing and bug hole like surface defects requires immediate repairs.
- To restore the durability and serviceability of building the damaged part of structures should be repaired on priority basis however; structures affected by corrosion of reinforcement need special treatment to care of corrosion besides restoration of strength.
- Before repairs & rehabilitation of damaged structures it is essential to carryout detailed condition assessment of the building with non destructive and destructive tests so that suitable remedial measures and repair techniques could be employed.

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