

AN EXPERIMENTAL STUDY OF REPAIR AND REHABILITATION OF STRUCTURE

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Abstract - The paper presents an experimental study of Repair and Rehabilitation of Heritage Buildings. In current scenario of Building Research, Repair and Rehabilitation plays a vital role as it serves important in building applications. It acts as an inevitable solution in maintaining the Integrity of Structures, in case of Heritage structures. Repair and Rehabilitation of heritage buildings has become a concern of greater importance over the world, notably in the developed countries. The major defects reported are discussed and a suitable and economical solution for a particular defect is identified by a tradeoff between cost, lifetime and adaptability of the solution.

1. Introduction

Repair and Rehabilitation is an Art of Civil Engineering work which enables to extend the service life of a structure. Repair and Rehabilitation is defined as the process of achieving the original state of structure when it undergoes any sort of defects or deterioration or destruction. Restoration of structure is an ultimate aim of Repair and Rehabilitation where it plays a major role by maximizing the functional utility of the structure.

Repair and Rehabilitation technique is also used to modify a structure to meet new functional and other requirements. Many structures may need Repair and Rehabilitation for one of the following reasons

1. Deterioration due to Environment effect.
2. New functional or loading requirements entering modifications to a structure.
3. Damage due to accidents.

Repair and Rehabilitation includes several systematic approaches that are lined up with various strategies to promote a desired level in attaining maximum life of the structure. Generally, life of a

structure depends on geography of location, Building material, Technology and Workmanship. Geography of location includes various aspects such as type of strata, water table, earthquake or wind or cyclone or flood or snow, pollutant, landslide and tree location with respect to building. Building materials includes cement, lime, fine sand, coarse sand, quality of water, bamboo or wood, brick. Technology includes various aspects such as architectural design, construction methods, and quality practices. Finally one of the major factor workmanship includes various aspects such as structural work, finishing work, waterproofing work, maintenance of building. The basic process flow employed in Repair and Rehabilitation includes identification of the building that should be rehabilitated, history of the building, preliminary survey which includes preliminary tests that are performed, identification of problems, and suitable solution for the problem which should be feasible to the building topography conditions.

- Selection building or model creation
- Data collection
- Identification problem
- Selection of suitable solution for problem

- Feasible or not

Flowchart-1: Process of Repair and Rehabilitation

concrete can be made from sand consisting of rounded grains as good as form that in which the grains or granular.

Cement of 53 grades is used for experimental work. Initial and final setting time of the cement was 30 minutes and 600 minutes.

Fine aggregate

The fine aggregate used was locally available river sand without any organic impurities and conforming to IS: 383 – 1970. The fine aggregate was tested for its physical requirements such as gradation, fineness modulus, specific gravity and bulk density. A concrete can be made from sand consisting of rounded grains as good as form that in which the grains or granular.

Coarse Aggregate

Coarse aggregate for structures consists of material within the range of 5mm to 150mm size. Rocks having water absorption value greater than 3% or specific gravity of less than 2.5 are not considered suitable for mass concrete. However, in practice mixes of same workability for round shaped aggregates required less water than angular shaped aggregates.

Water

Water is an important ingredient of concrete as it activity participates in the chemical reaction with cement and potable water available in laboratory with pH value of not less than 6.5 and not more than 8.5, conforming to the requirement of IS 456 2000 were used for mixing concrete and curing the specimen. The water which is fit for drinking should be used for making concrete.

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

1. Materials

Cement

aluminum 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.

- 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.
- 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. **GYP SUM 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 is used. Alternatively, for chemical anchors bonded in drilled holes' polymer adhesives are used.

2. Experimental Work

Rebound Hammer test

Rebound Hammer test is a Non-destructive testing method of concrete which provide a convenient and rapid indication of the compressive strength of the concrete. The rebound hammer is also called as Schmidt hammer that consist of a spring controlled mass that slides on a plunger within a tubular housing. The operation of rebound hammer is shown in the fig.1. When the plunger of rebound hammer is pressed against the surface of concrete, a spring controlled mass with a constant energy is made to hit concrete surface to rebound back. The extent of rebound, which is a measure of surface hardness, is measured on a graduated scale. This measured value is designated as Rebound Number (rebound index). A concrete with low strength and low stiffness will absorb more energy to yield in a lower rebound value.



Figure 1. Rebound Hammer Test

Sl. No	Specimen	Compressive strength in/		
		Normal	Rebound no	Comparison
1	Specimen 1	8	30	Fair
2	Specimen 2	6	40	Good
3	Specimen 3	13	30	Fair
4	Specimen 4	15	20	Poor

Compression Test on Concrete

Compression test is the most common test conducted on harden concrete, partly because it is an easy test to perform, and partly because most of the desirable characteristics properties of concrete are qualitatively related to its compressive strength.

The compressive test is carried out on specimen cubical or cylindrical in shape. Sometimes, the compression strength of concrete is determined using parts of a beam tested in flexure. The end parts of beam are left intact after failure in flexure and since the beam is usually of square crosssection, this part of the beam could be used to find out

the compressive strength.

Figure 2. Compressive test on concrete

Sl. No	Specimen	Compressive strength in/		
		Normal	After repair	Comparison
1	Specimen 1	7.1	10	High
2	Specimen 2	5.77	12	High
3	Specimen 3	12.44	15.00	High
4	Specimen 4	8	13.00	High

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