

## 1.2 REPAIR

### Repair

Repair is the technical aspect of rehabilitation. It refers to the modification of a structure, partly or wholly which is damaged in appearance or serviceability.

**The following factors to be considered repair of concrete structures:**

The cause of damage

Type, shape and function of the structure

The capabilities and facilities available with builders

The availability of repair materials

### Stages of concrete repair

Repair of concrete structures is carried out in the following stages:

Removal of damaged concrete

Pre treatment of surfaces and reinforcement

Application of repair material

Restoring the integrity of individual sections and strengthening of structure as a whole

#### a) Removal of damaged concrete

Prior to the execution of any repair, one essential and common requirement is that the deteriorated or damaged concrete should be removed.

Removal of defective concrete can be carried out using tools and equipment the types of which depend on the damage.

Normally, removal of concrete can be accomplished by hand tools, or when that is impractical because of the extent of repair, it can be done with a light or medium weight air hammer fitted with a spade shaped bit.

Care should be taken not to damage the unaffected concrete portions.

For cracks and other narrow defects, a saw-toothed bit will help achieve sharp edges and a suitable undercut.

#### b) Pre treatment of surfaces and reinforcement

The preparation of a surface/pretreatment for repair involved the following steps:

Complete removal of unsound material.

Undercutting along with the formation of smooth edges

Removal of the cracks from the surface.

Formation of a well defined cavity geometry with rounded inside corners.

Providing, rough but uniform surface for repair.

The cleaning of all loose particles and oil and dirt out of the cavity should be carried out shortly before the repair. This cleaning can be achieved by blowing with compressed air, hosing with water, acid etching, wire brushing, scarifying or a combination. Brooms or brushes will also help to remove loose material.

### c) Application of repair materials

After the concrete surface has been prepared, a bonding coat should be applied to the entire cleaned exposed surface.

It should be done with minimum delay.

The bonding coat may consist of bonding agents such as cement slurry, cement sand mortar, epoxy, epoxy mortar, resin materials etc.

Adequate preparation of surface and good workmanship are the ingredients of efficient and economical repairs.

### Repair procedure

A repair procedure may be selected to accomplish one or more of the following objectives:

To increase strength or restore load carrying capacity

To restore or increase stiffness

To improve functional performance

To provide water tightness

To improve durability

To prevent access of corrosive material to reinforcement

### Types and classification of repair

#### Types of repair:

Cosmetic treatments on surfaces

Partial replacement of surface and subsurface material

Additional of reinforcements and bonding materials to strengthen the element

Total replacement of the structural element

### Classification of repair -Repair requirements

1. Superficial                - Cement mortar bonding by trowelling
2. General                    - Non structural or minor structural restoring cover to rebar's
3. Principal                - Significant loss of concrete strength; shotcreting for slab and beam, Jacketing for columns etc
4. Major                      - Demolition and recasting

## Methods of Repairs

The following considerations are to be taken care of and observed:

Determination of extent, location and width of cracks

Classification of cracks as structural and non-structural

### Dormant cracks:

Dormant cracks are caused by some event in the part, which is not expected to recur. They remain constant in width, and may be repaired by filling them with a rigid material.

### Active cracks:

Do not remain constant in width, but open and close as the structure is loaded, or due to thermal and hydra changes in the concrete.

### Growth cracks:

Increase in width becomes the original reason for their occurrence persists.

### Applications:

The repair of cracks can be achieved with the following techniques:

Resin injection

Routing and Sealing

Stitching

External stressing

Bonding

Blanketing

Overlays

Dry pack

Vacuum impregnation

Polymer impregnation

## Durability of concrete Repair

Findings and recommendations may be grouped into three categories:

1. Durable Repair Design
2. Durable repair application and
3. Evaluation of the repairs

### 1. Durable Repair Design

#### Modulus of elasticity and strength of repair material:

The repair material selected should have as similar modulus of elasticity as the substrate as possible.

**Coefficient of thermal expansion of repair material:**

The repair material selected should have as similar as coefficient of then expansion as the substrate as possible.

**Shrinkage and creep of repair material:**

The repair material selected should have shrinkage properties that are as low as possible.

**2. Durable Repair Application:****Preparation of the repaired surface**

The first step in the repair to be carried out is the removal of the damaged concrete.

Commonly used methods in-situ include: sand blasting, chipping with jack hammers, and hydro demolition among which, the last is highly recommended. A sound surface if adequate roughness can be created by this method.

**Bonding agents:**

Use of polymer bonding agents is not recommended as their modulus of elasticity is substantially different from that of the substrate. However, use of a cementitious bonding agent with a low water/cement ratio may be considered.

**Curing of Repair Material:**

Excessive loss of water may result in higher shrinkage (Plastic and drying) and cause debonding failure of the repair material at an earlier age. Therefore, specification of proper curing after completion of the repair is very important. Curing time should be atleast the same as that adopted for usual concrete practice.

**3. Evaluation of the Repairs****Behavior of the interfacial transition phase**

Defects such as micro-cracks and pores may be formed within this phase caused by the differential movements between the substrate and repair material. Thus the mechanical properties and durability of this phase should be evaluated after the completion of the repair work.

**Behavior of the repaired structure:**

Differential movements between the repair material and the substrate may result in the cracking of the repair material. The fatigue resistance of the interface between the repair material and substrate may also be evaluated by cyclic loading test of representative samples.