Review of Cracks Rehabilitation and Retrofitting

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ABSTRACT

Occurrence of various crack patterns in the building during construction, after completion when it is subjected to super imposed load or during the service life, is a common phenomenon. A building component develops cracks whenever the stress in the components exceeds its strength. Stress in the building component could be caused by externally applied forces, such as dead, live, wind or seismic loads, foundation settlement etc. or it could be induced internally due to thermal movements, moisture changes, elastic deformation, chemical action etc. Cracks in buildings could be broadly classified as structural and nonstructural cracks. These occur due to incorrect design, faulty construction or overloading and these may endanger the safety of a building.

Keywords---- Concrete, Reinforcement, Carbondioxide

I. INTRODUCTION

The decision to repair or replace a structure or its component can be taken only after consideration of likely service life of the structure is established based on the technical & economic evaluations. Once a decision, based on preliminary investigations, is taken to carry out the repairs, proper diagnosis, identification & extent of distress in structural members has to be correctly assessed. A detailed methodology should be developed, which should include available

Methods of repair & Repair materials

Thus, a repair strategy can be adopted, keeping the objective in view. This shall be based on evaluation and available alternative methods of repair & material. Priorities should be assigned to Repair of structural defects to ensure safety of the structure and Protection of the structure from further deterioration.

The selected method of repair should achieve one or more of the following objectives:
- Reinstall the structural integrity of the member by restoring or increasing its strength & stiffness.
- Prevent the ingress of distress promoting agents such as moisture, chlorides and Carbon dioxide to improve durability.
- Maintaining the aesthetics/appearance of concrete surface.

Concrete Removal and Surface Preparation

The general procedure for marking area to prepare the surface of spalled area for carrying out repairs is illustrated in Prior to preparation of concrete surfaces, exposed reinforcement should be inspected for access clearance, cross-sectional area and location. Reinforcing bars must be further exposed if the remaining concrete is de-bonded from the reinforcing steel. Removal must be continued to completely expose the bar if more than half of a reinforcing bar perimeter has been exposed. For completely exposed reinforcing bars, a minimum average clearance of 25 mm or nominal maximum size of aggregate plus 5mm, whichever is greater, must be provided between the reinforcing bar and surrounding concrete. A structural engineer should be consulted if the cross-sectional area of an individual bar has been reduced by 15 percent or more or if two adjacent bars have been reduced by 10 percent or more. Out-of-plane and loose reinforcement should be secured in its design location.

The process of Surface preparation is illustrated stepwise (Step 1 to 3) in Fig. 6.16. The general procedure in preparing concrete and reinforcement surfaces for optimum bonding is to sandblast the surfaces and then remove dust and debris by air blasting, low-pressure water blasting, or brooming. If the damage is due to corrosion, a suitable coating may be considered after removal of total rust from its surface to protect the exposed reinforcing steel. Final inspection of the prepared area including...
remedying any deficiencies should be completed just prior
to batching the repair material.

II. APPLY BONDING COAT AND
REPAIR APPLICATION

These shall be carried out as per the repair
method/system selected based on engineering judgment
considering various options available as under:
- Filling of cracks with cement and/or resin based
gROUT
- Injecting grout into a mass of dry aggregate.
- Poured concrete
- Pre-packed concrete
- Dry packing
- Sprayed concrete (shotcrete), etc
- Repair and Strengthening Methods/Systems be in
three groups
  - Materials
  - Methods
  - Systems

Repairs using Mortars:
Mortar repairs are the most common form of
repairs being resorted to in the field without knowing the
limitations of such repairs in structural
rehabilitation/strengthening.

A variety of mortars are available for carrying out
repairs of a structure, these are explained with their
limitations and areas of application in the following
subsections:

Repair/Rehabilitation Strategies:
A number of options are available for giving a
relief to a distressed structure, which could cover any of
the following:
- Reduction of dead/live loads
- Repair/strengthening of Columns, beams and slabs
- Improving the compressive strength of concrete.
- Attending to Cracks and joints
- Improving the masonry structure to be able to
resist earthquake forces
- Providing protective cover against the aggressive
deteriorating chemicals

Stress Reduction:
The reduction is another method of providing
relief to the distressed
Structure. This can be achieved by Reducing dead load and
live loads;
- Replacing heavy solid partitions with lightweight
partitions
- Enlarging openings by removing filler walls;
- Reducing numbers of stories;
- Changing the building use to a lower
classification of loading;
- Span reduction of beams by providing struts etc;
  Installation of shear movement joints in a
continuous spans at points of zero moment.

Foundation: The methods are explained earlier section

Base Isolation:
Seismic forces are transmitted to the structure due
to ground motion caused by the seismic activity. In this
method, structure is isolated from ground motionby
inserting elastomeric isolators. Most of the energy input
from the earth due to seismic activity is absorbed due to
isolators movement and thus the building is protected from
damage. This method is of significance where it is not
possible to make structural/architectural alterations in the
superstructure heritage value. The essential requirement of
this method is availability of sufficient space all-round the
building for movement of the superstructure and high cost.

III. STRUCTURAL REPAIRS TO RCC
COLUMNS, BEAMS AND SLABS

CASE-I:
Crack Repair and Protective Coating for less
damaged structural members like minor/hair cracks or
spalling from beams and columns, where carbonation
depth in cover concrete has not reached reinforcement
level.

Step-1: Measures shall be taken to ensure that no
seepage/leakage etc. affects the RCC columns/beams.

Step-2: The plaster/finishes over the RCC columns/beams
shall be removed. Chipping of existing plaster
manually from masonry or concrete surface using chisel
and hammer and disposal of debris within a lead of 50 m
complete. The concrete surface exposed, spalled and loose
cover concrete removed, cracks marked after close
examination on the surface of concrete. Whereas the good
surface of concrete shall be hacked and roughened for
receiving the repair as per relevant item Mixing and
applying bonding coat, excluding cost of material, on
prepared non-metallic surface of parent material

A. Acrylic polymer modified cementitious bond coat @
2.2 Kg cement per sqm. of surface area with specified
proportion of polymer admixed (Rate shall include cost of
cement)

B. SBR polymer modified cementitious bond coat @ 2.2
kg cement per sqm of surface area with specified
proportion of polymer admixed (Rate shall include cost of
cement)

C. Approved epoxy adhesive.

Step-3: Wherever loose/spalled cover concrete is
removed, it shall be repaired with polymer modified
cement mortar, done up in layers as per nomenclature of
items Mixing and applying bonding coat, excluding cost of
material, on prepared non-metallic surface of parent
material

A. Acrylic polymer modified cementitious bond coat @
2.2 Kg cement per sqm. of surface area with specified
Repair to Damaged Columns/Beams/Slabs where the RCC column of stresses due to load coming over it as noticed shall be sealed by injection grouting through nipples fixed along the crack line as per nomenclature of Providing and inserting 12mm dia Aluminium/ galvanized iron injection nipples along crack lines or honeycomb area, including:

(i) Drilling holes of required diameter up to depths from 40mm to 80mm or half the thickness of member (whichever is less), at required spacing but not exceeding the thickness of member or 300 mm

(ii) Making grooves of size 12mm x 12mm along the crack line.

(iii) Making the crack dust free by blowing compressed air and then washing with water.

(iv) Sealing the distance between the injection nipples with approved putty (Polymer modified cement mortar/polyester putty/epoxy putty) etc and allow it to cure.

(v) If cementitious grout material proposed to be used, washing and saturating the cracked surface with water by pumping from top most nipple and down wards complete. (The rate shall include all material, labour and all operations above. The cost of grout material shall be paid separately on the basis of actual quantity consumed.)

Step-5: Over the prepared surface of RCC columns/beams, 6 mm thick 1:3 cement sand plaster shall be applied with polymer modified cement slurry bond coat (item no. 3.2) within 24 hours of injection grouting.

Step-6: Cement plaster shall be cured strictly as per the nomenclature and of items Wet curing of shotcreted or plastered surface or RCC work as per specifications by keeping it continuously wet for a minimum period of seven days. With regular sprinkling of water by keeping the surface continuously wet.

B Using pre-tested and approved water based concrete curing compound

a) Using non-pigmented wet curing compound

Step-7: After RCC columns/beams are cured and completely dried, a protective coating shall be applied over it for protecting the reinforcement and concrete against environmental aggressive chemicals in accordance

CASE-II:-
Repair to Damaged Columns/Beams/Slabs where carbonation depth of concrete has reached reinforcement level:

(i) Shotcreting

Stepwise sequence of methodology to be adopted is given hereunder

Step-1:
Prop and support the structure in order to relieve the RCC column of stresses due to load coming over it as per the nomenclature of items Propping and supporting the structural members and its adjoining areas with steel props (adjustable or as required), bracings, steel/timber runners etc to relieve the structural member of the required load coming over it as per the pattern.

A (a) Steel Prop of up to 5 MT Capacity and up to 3.2 m height

(b) Extra for every additional height of 0.3 M or part thereof

B (a) Extra for steel prop (adjustable or as required) for having additional capacity of 2 MT or part thereof beyond 5 MT and up to 3.2 m height

(b) Extra for every additional height of 0.3 M or part thereof

Step-2:

Remove plaster and finishes all around the distressed RCC columns. Thereafter remove loose, cracked and spalled concrete to expose the rusted reinforcement as per the nomenclature Chipping of existing plaster manually from masonry or concrete surface using chisel and hammer and disposal of debris within a lead of 50 m complete

Step-3:

Remove concrete all around the reinforcement in order to get average 25 mm air gap all around i/c behind the reinforcement & clean the reinforcement of concrete and rust by appropriate methods as per nomenclature Chipping of existing plaster manually from masonry or concrete surface using chisel and hammer and disposal of debris within a lead of 50 m complete

Step-4:
Put additional reinforcement wherever the reinforcement diameter has been reduced by more than 15% with the necessary overlap or welding with the existing reinforcement as per the nomenclature and of items Providing and placing in position Micro-concrete, which shall be cemented based prepacked single component, chloride free, non-shrink, free flow, self compacting, ready to use after mixing water in specified proportion obtained from approved manufacturer as per specification and directions

Step-5:
Fix shear key bars of appropriate diameter at specified spacings in both directions over the surface to be covered with repair materials as per the nomenclature of items

Step-6:
Apply appropriate passivating and bond coat over the reinforcement and prepared RCC surface as per the nomenclature of items. Shotcrete the RCC column within the time limit specified as pot life of the epoxy or tacking period of slurry as per the nomenclature and of items. The necessary shuttering as specified in specifications of shotcreting shall be used for ensuring the desired thickness and shape of the columns.

Step-7:
6 mm thick finishing coat with cement sand plaster 1:3(1cement:3fine sand) (of least possible thickness) if felt...
necessary, shall be applied within 48 hours of application of shotcreted repair.

Step-8:
Wet curing shall be done over the finished surface of the shotcrete for a minimum period of 7 days as per the nomenclature and of items in subhead 6 of Chapter 8 and relevant specifications in Chapter 9.

Step-9:
After RCC columns/beams are cured and completely dried, a protective coating shall be applied over it for protecting the reinforcement and concrete as per the nomenclature.

V. CONCLUSIONS

1. Poor quality of RCC.
2. Inadequate and permeable cover concrete.
3. Excessive chloride content in concrete.
4. Inadequate level of maintenance.
5. Improper workmanship of external finish.

REPAIR METHODS

1. Improvement and repair to Civil Services
a) Replace the broken/ damaged drainage and water pipes.
   b) Replace the worn out GI pipelines.
   c) Relocating of service lines from garbage chute to protect them from damage.

2. Structural Repairs
   A) Slabs
      Provide alternate structural system comprising of RSJ’s spaced at about 1.00 Metre to support RCC slabs
   B) RCC Beams
      Carry out structural Repairs to RCC beams
   C) RCC Columns
      Carry out structural Repairs to RCC columns
   D) RCC Parapet Wall
      The wall to be reconstructed by using super plasticizer admixed concrete of mix 1:1.5: 3 with w/c ratio not exceeding 0.45.

Non Structural Repairs
   a) Remove the vegetation growth from roof and other places to avoid further deterioration of building.
   b) Routine maintenance defects to be attended to.
   c) Concealed service pipes to be shifted to external face of walls.

REFERENCES