UNIT-1

INTRODUCTION

- ✓ Cracks in the building are of common occurrence in a building
- ✓ It is due to exceeding stress in a building components
- ✓ Causes of the cracks are mainly by increase in live load and dead load, seismic load etc.,

Classification of cracks

Cracks can be classified into two categories viz.,

- ✓ **Structural cracks**
- ✓ **Non-structural cracks**

Structural cracks

- it arises due to incorrect designs, overloading of structural components
- Expenses cracking of foundation walls, beams and columns or slab etc.,

PHOTO OF STRUCTURAL CRACKS

Non structural cracks

They are due to internal forces developed in materials due to moisture variations, temperature variation, crazing, effects of gases ,liquids etc.,

They can be broadly classified into vertical, horizontal, diagonal, smoothened cracks

PHOTO OF NON STRUCTURAL CRACKS

DIRECTION OF THE CRACKS

- ➢ Vertical
- ➢ Horizontal
- ➢ Diagonal
- ➢ Straight
- ➢ Toothed
- ➢ Variable and irregular

WIDTH OF CRACKS

It can be measured through instrument and tell-tale signs.

The changes in the length of the cracks should be noted.

Cracks measuring devices

CAUSES OF CRACKS

Major causes of cracks

- ✓ Movements of the ground
- ✓ Over loading
- ✓ Effect of gases, liquids and solids
- ✓ Effect of changes of temperature
- ✓ General causes such as vibrations

Movements of grounds

- ❑ Due to mining subsidence, land slips, earthquakes, moisture changes due to shrinkable soils.

Overloading

- ❑ Overloading of the building
- ❑ Overloading of the building parts results in cracks

Overloading forced may be due to

- ✓ External (excessive wind/snow loads)
- ✓ Internal (from heavy machinery etc.,)

Effects of gases, liquids and solids

Gases

- ✓ Only gases like Co_2 (carbon dioxide) is likely to produce cracks.
- ✓ It causes Carbonation of porous cement products
- ✓ Leads into an overall shrinkage crazing cracks

Liquids

- ✓ Water is the most commonly used liquid when not taken care it can be hazardous
- ✓ Construction water i.e., that in the utilization of water during the construction process

Effects of water

Physical(i.e. due to change in water content)

Chemical (directly or indirectly affecting other

materials) General vibrations

Vibrations can cause cracks in buildings only when their amplitude of vibrations are high.

Apart from vibrations caused due to earthquakes, the vibrations caused due to heavy machinery, traffic, sonic booms are also responsible for the occurrence of cracks in buildings.

THERMAL MOVEMENT

All materials expand on heat and contract on cool.

Thermal movement in components of structure creates cracks due to tensile of shear stresses

One of the most potent causes of cracking in buildings and need attention

GENERAL PRECAUTION TO AVOIDING CRACKS

- ➢ Before laying up foundation, the type of foundation to be used should be decided based on the safe bearing capacity of soil.
- ➢ Providing R.C deep beam or an involved T-beam with adequate reinforcements to withstand the stress due to differential ground movements. This method is expensive
- Construction operations such as cutting for roads drainages etc., close to the structures should be avoided this will results in reduction of soil moisture with consequent shrinkage of soil beneath the foundation of the structure.
- In buildings close to the water courses are noticed in many places

PLACING OF CONCRETE

Concrete should not be placed in heavy rains unless suitable shelter is provided.

To avoid segregation, concrete should not be dropped from a height of more than 1m. Working

on freshly laid concrete should be avoided

- While placing the concrete in R.C.C members the alignment of formwork should not be disturbed.

- Concrete should be laid continuously to avoid irregular and unsightly lines.
- Internal surface of the forms either steel or wood should have even surfaces and should be oiled so that the concrete may not stick to it

MATERIAL QUALITY

Aggregate should be hard, sound, durable, non-absorbent and capable of of developing good bond with mortar.

Water shall be clean and free from alkaline and acid materials and suitable for drinking purposes.

TEST TO BE CARRIED OUT

Slump test to be carried out for the control of addition of water and workability.

Consistency of concrete should also be tested.

A slump of 7.5 to 10cm may be allowed for building work

LAYING TECHNIQUE AND CURING METHOD

Concrete should be laid in layers and should be compacted while laying with wooden tamping rods or with mechanical vibrators until a dense concrete is obtained

After two hours of laying concrete, when the concrete has begun to harden, it shall be kept damp by covering with wet gunny bags or wet sand for 24 hours

Evaluation of cracks

To determine the effects of cracks in the building.

First the cracks location and extent should be noted down for the adopting suitable methods of repair and the future problems due to that cracks.

Crack widths should be measured to the accuracy of 0.001 in (0.025mm) using a crack comparator.

Movements should be recorded with movement sensors.

Based on the reports from the location and width the suitable methods is adopted

Crack as narrow as 0.002 in can be bonded by the injection of epoxy.

Epoxy injection can alone be used to restore the flexural stiffness.

For water retaining structure cracks it can be repaired by the autogenous healing.

Repairing of cracks

Routing and sealing.

Stitching.

Additional reinforcement.

Gravity filling

Grouting

Dry

packing

Polymer impregnation

Routing and sealing

Routing and sealing of cracks can be used in conditions requiring remedial repair and where structural repair is not necessary.

Routing and sealing is used to treat both fill pattern cracks and larger, isolated cracks.

The sealants may be any of several materials, including epoxies, urethanes, silicones, polysulfide, asphaltic materials, or polymer mortars

Process of routing and sealing

stitching

Stitching involves drilling holes on both sides of the crack and grouting in U-shaped metal units with short legs (staples or stitching dogs) that span the crack.

Stitching a crack tends to stiffen the structure, and the stiffening may increase the overall structural restraint.

The stitching procedure consists of drilling holes on both sides of the crack, cleaning the holes, and anchoring the legs of the staples in the holes, with either a non shrink grout or an epoxy resin-based bonding system

Figure showing stitching

Additional reinforcements

- ✓ Conventional reinforcement-Cracked reinforced concrete bridge girders have been successfully repaired by inserting reinforcing bars and bonding them in place with epoxy .
- ✓ This technique consists of sealing the crack, drilling holes that intersect the crack plane at approximately 90^{o} ,filling the hole and crack with injected epoxy and placing a reinforcing bar into the drilled hole

Prestressing steel-Post-tensioning is often the desirable solution when a major portion of a member must be strengthened or when the cracks that have formed must be closed.

Adequate anchorage must be provided for the prestressing steel, and care is needed so that the problem will not merely migrate to another part of the structure

Fig showing additional reinforcements

grouting

Portland cement grouting-Wide cracks, particularly in gravity dams and thick concrete walls, may be repaired by filling with portland cement grout.

This method is effective in stopping water leaks, but it will not structurally bond cracked sections.

Gravity filling

Low viscosity monomers and resins can be used to seal cracks with surface widths of 0.001 to 0.08 in. (0.03 to 2 mm) by gravity filling.

High-molecular-weight methacrylates, urethanes, and some low viscosity epoxies have been used successfully.

The lower the viscosity, the finer the cracks that can be filled.

Dry packing

Drypacking is the hand placement of a low water content mortar followed by tamping or ramming of the mortar into place, producing intimate contact between the mortar and the existing concrete.

Polymer impregnation

Monomer systems can be used for effective repair of some cracks. A monomer system is a liquid consisting of monomers which will polymerize into a solid.

The most common monomer used for this purpose is methyl methacrylate.

The procedure consists of drying the fracture, temporarily encasing it in a watertight (monomer proof) band of sheet metal, soaking the fractures with monomer, and polymerizing the monomer

conclusion

The discussion on our project mainly focused on the cracks deals with failure due to improper settlement of foundation and poor construction.

By the following discussed remedies and instruction what we have concentrated helps to reducing the cracks and move on to the next level in the construction.

Content

Introduction

Deterioration of reinforced concrete structure due to corrosion of steel is a cause of global concern.

The losses due to corrosion every year run in to millions of rupees and any solution to this universal problem of corrosion has a direct bearing economy of the country.

It is estimated that about 30 to 40% of steel produce each year is used to replace corroded material.

Main objective of rehabilitation in the construction industry to reinstate rejuvenate strengthen and upgrade existing concrete structure.

Various causes which needs rehabilitation of a building are such as environment degradation, design inadequacies, poor construction practices, lack of maintenance, increase in load, unexpected seismic loading condition in addition to corrosion induced distress.

Why rehabilitation

The chief aim of rehabilitation is to restore a prematurely distressed building back to it's original standard and to improve the facilities depending upon the needs and the technological advances.

In the field of building construction, after rehabilitation the building is expected to give a trouble free service up-to it's expected life.

What is rehabilitation

There is basic difference between the words "repair and rehabilitation". The word repair normally indicates small and petty repairs more or less cosmetic, which are not of structural significance.

A building is said to require rehabilitation, when structural stability and safety of building and occupant is in danger.

Basic advantage of rehabilitation on repair-

1. Repair building required frequent repair again because these are up to small extent and less durable so the expenditure spent on repair required more. The life of rehabilitated building is comparatively more than that of a repair building and economical too.
2. In repair what we apply is plaster only that does not last long hence leads leakage in pipe line, terrace, therefore there is corrosion in reinforcement of RCC structure but in rehabilitation we can approach the problem by the identification of main culprits responsible for deterioration. Plastering is nothing but the waste of money only. So rehabilitation is effective than repair.

Causes of distress

1. Design deficiency:
    1. underestimation of loads, deflection, shear forces and moments
    2. environmental condition for durability neglected wrongly specifying concrete grade, maximum water to cement ratio and minimum cement content
    3. Poor detailing especially at beam and column junction
    4. fault analysis and earth quake & wind forces not considered at all
2. Material deficiency:
    a. Poor quality cement
    b. Poor quality steel
    c. Contaminated water
    d. Contaminated aggregates

3. Construction deficiency:

    a. inadequate cover of concrete to steel reinforcement

    b. use of poor quality cover blocks

    c. poor formwork and staging

    d. poor preparation of construction joints

4. chemical/environmental attacks:

a. moisture and chloride attack

b. carbonation

c. sulphate attacks

d. thermal variation, hot and cold cycles

e. erosion

f. biological(insects and fungus) attacks

5. Natural causes:

a. earth quakes

b. floods

c. fires

6. Mechanical causes-

a. over loading

b. fatigue

c. impact

7. Foundation problem-

a. failure of load bearing strata

b. soil consolidation

c. soil shrinkage and swelling

d. ground movement

8. Manmade causes-

a. blasting

b. poor and no maintenance

Cracks in buildings and it's components

Cracks in

column Cracks

in slabs

Cracks in beam

Philosophy of rehabilitation

Inspection

Systematic detailed inspection is the key to success of any rehabilitation scheme and is done to achieve the following objectives.

1. Preparation of complete defect catalogue
2. Evaluate the existing (safety and serviceability) condition of the building and assess the possible rate of future
3. Decide further course of action

Items needed during inspection-

1. Completion drawing for detailing
2. Mason's tool kit- plumb bob, hammer, chisel, punch etc.
3. Measuring instrument- steel tap, scale, ladder, torch, safety belt etc.
4. Labour
5. Details of repairs

Common remedies

1. Jacketing of column-

Jacketing (provision of additional cross section) is done to strengthen column by removing loose concrete and treating the reinforcement with protection treatment like providing shear anchor of 10mm–12mm diameter with a spacing 20–30cm c/c and then concreting is done (M25).

Polymer modified concrete which have good bonding quality and flexural strength, can be used.

2. Patch repairing by polymer mortar-

Patching is done by removing loose concrete and rust of reinforced. Sometimes extra reinforcement is also provided. after removal of rust a bond coat is applied evenly in order to attain sufficient strength between old concrete and new polymer mortar then polymer mortar is applied which is prepared by weight (one part of polymer latex liquid, 5 part of cement and 15 part of quartz sand). Mortar is applied by hand by pressing it to the damaged or cracked surface.

Column jacketing

3. Repairing of toilet block and GI pipe line-

To avoid leakage problem from toilet, they should be made water proof. for this the seats are broke and cleaned then the surface is applied with suitable polymer coating. After this a coating of 20 mm thick plaster in cm 1:3 with w/c ratio of 0.4 provided. And joints between the seats are sealed with polymer mortar.

Pipes which are leaked should be replaced.

4. Grouting-

Grouting is used to repair deep structural cracks by injecting grout material like cement grout or resin. It is very effective method for repairing RCC or masonry structure. admixture are added to reduce shrinkage problem of cement grout so that it can reach upto the deepest crack in the structure and fill the pores.

5. Shotcreting-

Shotcreting is a technique to achieve better structural capability for walls an other elements. In this method mortar or concrete is conveyed at a high velocity onto a receptive surface by the application of compressed air for moving concrete. the cement, sand mix and water are kept in separate containers, which are connected to a nose pipe. Compressed air is forced into these containers through a motor.

FIBER REINFORCED POLYMER COMPOSITE

Fiber reinforced polymer (FRP) is a composite material made by combining two or more materials to give a new combination of properties.

It is composed of fiber and matrix, which are bonded.

In this case, the reinforcing fiber provides FRP composite with strength and stiffness, while the matrix gives rigidity and environmental protection.

Formation of Fiber Reinforced Polymer Composite

- A fiber is a material made into a long filament with a diameter generally in the order of 10 mm.
- The main functions of the fibers are to carry the load and provide stiffness, strength, thermal stability, and other structural properties in the FRP.

To perform desirable functions, the fibers in FRP composite must have-

1. High Modulus of Elasticity for use as reinforcement;
2. High Ultimate Strength;
3. Low variation of strength among fibers;
4. High Stability of their strength during handling; and

5. High Uniformity of diameter and surface dimension among fibers.

Matrix

Matrix material is a polymer composed of molecules made from many simpler and smaller units called monomer.

The matrix must have a lower modulus and greater elongation than those of fibers, so that fibers can carry maximum load.

Made from Metal, Polymer or Ceramic

Some Ductility is Desirable

TYPES OF FRP

MATERIALS USES

To strengthen the structures due to:-

1) Loading Increase

- Increasing the Live Load in warehouses
- Increased traffic volume on Bridges
- Installation of Heavy machinery in Industrial Building
- Vibrating Structures
- Change of Building utilization

2) Damage to Structural parts

- Ageing of Construction material
- Steel Reinforcement corrosion
- Vehicle Impact
- Fire
- Earthquakes

3) Serviceability Improvement

- Decrease of Deformation
- Stress reduction in steel reinforcement

- ❑ Crack width reduction

4) Change in Structural System

- ❑ Removals of walls or columns
- ❑ Removal of slab section for openings

5) Design or Construction Defects

- ❑ Insufficient reinforcement
- ❑ Insufficient Structural Depth

advantages

Low in weight

Available in any Length, no joints

required Low overall thickness

Easy to transport

Laminate Intersections are simple

Economical application- no heavy handling and installation equipment

Very high strength

High modulus of elasticity

Outstanding fatigue resistance

High alkali resistance

No corrosion

conclusion

1. With careful planning and close supervision, expected result can be achieved.
2. We can protect many buildings having historic, cultural, monumental, archeological importance by rehabilitation.
3. Can save lot of money by rehabilitation.
4. Rehabilitation increases the life of building and any type of structure.
5. FRP gives the