Health Monitoring of Building through Crack Analysis

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Abstract:
Health monitoring of building through crack Analysis provides a useful tool for ensuring integrity and safety, detecting the evolution of damage, and estimating performance deterioration of civil infrastructures. A number of civil infrastructures under construction have greatly motivated and promoted development. In today's modern world, the development is at its peak. Due to increasing development, thousands of new buildings, tunnels, bridges, expressways, and many challenging and complex structure are being made day by day for suiting the increasing needs of people. The development is also seen in the new materials and techniques used in construction methods. Due to this increasing construction of vast structures, the analysis of structures has also become a major challenge as maintaining the integrity of the structure is of utmost importance.

Keywords: Structural Health, Monitoring, Cracks, Analysis, Technique,

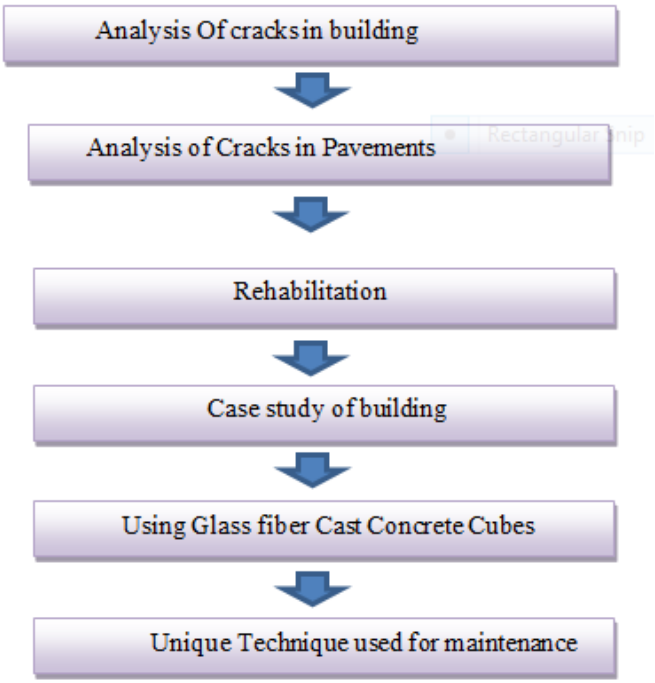
1. INTRODUCTION

A building crack may be complete or incomplete separation of concrete into two or more parts produced by breaking or fracturing. A building crack is a common occurrence. A component of crack in building develops when stress in the component exceeds its strength Cracks are of two type structural and non structural categories. The structural ones are due to faulty design, faulty construction or overloading which may endanger safety of buildings. The non structural cracks are due to internal stresses. The stresses which are Internally induced in building components lead to dimensional changes and whenever there is a restraint to movement as is generally the case cracking occurs. Cracks are one kind of problem of concrete construction as it affects the building artistic , building structure as it destroys the wall's integrity, affects the structure safety even reduce the durability of structure. Cracks are developed due to deterioration of concrete or corrosion of reinforcement bars, due to improper bonding between steel and concrete, faulty construction or inappropriate selection of constituent material and by temperature and shrinkage effects

2. LITERATURE REVIEW

1 Prof.A. Morassi (2001) did a study which deals with detecting a single crack in a vibrating rod from the knowledge of damage induced shifts in a pair of natural frequencies. The crack is simulated by an equivalent linear spring connecting the two segments of the bar. The analysis is based on an explicit expression of the frequency sensitivity to damage and enables non-uniform bars under general boundary conditions to be considered. The inverse problems generally ill-posed, because even if the system is not symmetrical, cracks indifferent locations can still produce identical changes in a pair of natural frequencies. In spite of this, it is found that there are certain situations concerning uniform rods in which the effects of the non-uniqueness of the solution may be considerably reduced by means of a careful choice of the data.The theoretical results are confirmed by a comparison with dynamic measurements on steel rods with a crack. Some of
the results are also valid for cracked beams in bending.
2 K.Sambasivarao (2014)did a study which shows the importance of the beam and its engineering applications is obvious, and it undergoes different kinds of loading. Such loading may cause cracks in the beam. Crack depth and location are the main parameters for the vibration analysis of such beams. These cracks and their locations effect on the shapes and values of the beam frequency. So it become very important to monitor the changes in the response parameters of the beam to access structural integrity, performance and safety.
3 CheeKian Teng (2012) done a research to find out inexpensive and efficient SHM method utilizing Wireless Sensor Network (WSN) is helping to facilitate the selection of the bridges that require maintenance. The changes to structural properties (i.e. stiffness) caused by damage (i.e. corrosion) will change the structural responses (i.e. acceleration responses) to ambient motions. Modal analysis algorithms applied to the vibration responses acquired through WSN provide the modal properties (i.e. natural frequency, modal shape and damping ratio) that will change

3. METHODOLOGY



4. CRACKS REPAIRS TECHNIQUE IN BUILDING

1) Repair Cracks on RCC Surface

- Clean cracked portion and apply guniting
- The cracked portion should be widen gently and be cleaned of all loose materials. Fill the cracked portion by pressure grouting or 'guniting'. The material for such grouting can be epoxy or cement (with suitable admixture).
- Apply epoxy and finish the surface

Epoxy has more strength and adhesion than cement and can go into very thin cracks as fine as 0.1 mm. The surface should be finished according to adjacent area on the wall

2) Repair Cracks in Floor

- Remove loose material and apply mortar
- Create V shape groove in cracked portion and remove all loose material by washing and brushing. Fill in the groove with polymer modified mortar (for wide cracks) or with polymer modified cement grout (for thin cracks).
- Remove cracked panel or material
- If there are many cracks in the floor, remove cracked panels and old materials.
- Prepare the surface and lay new panel
- Clean the panel by washing and brushing. Prepare floor material according to the existing floor and lay new panel.

3) Repair cracks in bricks/diagonal cracks-

- Remove broken bricks
- Before doing any repair of cracks, make sure that the cracks are stabilized and are not widening further. Remove broken bricks by scratching cement mortar from the joints gently.
- Prepare the surface
- All loose material should be cleaned from the portion by brushing and washing. Wet the surface 24 hours before application of new plaster.
- Fix new bricks thoroughly
- Lay fresh cement mortar with coarse sand in 1:4 and fix new bricks. Fill all joints around bricks with mortar tightly with the help of iron tools.
- Do curing and finishing
- The repaired surface should be kept moist up to 7 days. When surface is dry, it should be finished according to adjoining area.

4) Repair Cracks in Masonry Walls

Two types of cracks are seen in masonry walls i.e.
A. Crack in mortar joints of walls.
B. Crack in bricks/Diagonal Cracks
A) Repair cracks in mortar joints of walls-

- Remove mortar
- The mortar should be removed from cracked joint with the help of iron tools at least up to 25 mm depth. All loose material should be cleaned from cracked portion.
- Wet the surface and apply cement mortar
- Cracked portion must be kept moist at least for 24 hours before doing repair. Fill in the joints with cement mortar of coarse sand in 1:4.
- Do curing and finishing
- After filling the joints with cement mortar, keep the repaired surface wet at least for 3 days. After drying the surface, finish the repaired area according to the adjoining area.

5) Repair Fine cracks

- Apply surface water proof coating on the entire area having very fine cracks (especially on roof) where filling /sealing of each individual crack is not possible.
- Do proper curing of repaired area at least for 3 days.

5. CRACKS REPAIRS TECHNIQUE IN PAVEMENTS

- (A)Epoxy injection-
  As narrow as 0.002 in. (0.05 mm) can be bonded by the injection of epoxy. The technique generally consists of establishing entry and venting ports at close intervals along the cracks, sealing the crack on exposed surfaces, and injecting the epoxy under pressure. Epoxy injection has been successfully used in the repair of cracks in buildings, bridges, dams, and other types of concrete structures. However, unless the cause of the cracking has been corrected, it will probably recur near the original crack. If the cause of the cracks cannot be removed, then two options are available. One is to rout and seal the crack, thus treating it as a joint, or, establish a joint that will accommodate the movement and then inject the crack with epoxy or other suitable material. Epoxy materials used for structural repairs should conform to ASTM C 881 (Type IV). ACI 504R describes practices for sealing joints, including joint design, available materials, and methods of application. Epoxy injection requires a high degree of skill for satisfactory execution, and application of the technique may be limited by the ambient temperature.
- The general procedures involved in epoxy injection are as follows
  - Clean the Cracks
  - Seal the Surfaces
  - Install the entry and venting ports- three methods are in

- General use-
  a. Fittings inserted into drilled holes
  b. Bonded flush fitting
  c. Interruption in seal
  - Mix the Epoxy
  - Inject the Epoxy
  - Remove the Surface Seal

- (B) Routing and sealing-
  Routing and sealing of cracks can be used in conditions requiring remedial repair and where structural repair is not necessary. This method involves enlarging the crack along its exposed face and filling and sealing it with a suitable joint sealant. This is a common technique for crack treatment and is relatively simple in comparison to the procedures and the training required for epoxy injection. The procedure is most applicable to approximately flat horizontal surfaces such as floors and pavements. However, routing and sealing can be accomplished on vertical surfaces (with a non-sag sealant) as well as on curved surfaces (pipes, piles and pole).

- (C) 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 as shown in Fig 3.3 (Johnson 1965). Stitching may be used when tensile strength must be reestablished across major cracks (Hoskins 1991). Stitching a crack tends to stiffen the structure, and the stiffening may increase the overall structural restraint, causing the concrete to crack elsewhere. Therefore, it may be necessary to strengthen the adjacent section or sections using technically corrected reinforcing methods. Because stresses are often concentrated, using this method in conjunction with other methods may be necessary

Conclusion-

Cracks in the concrete structures are early signs of distress which have to be diagnosed properly otherwise the repair of same crack takes place again and again causing loss of time and money. The structural cracks need more attention than non structural cracks. The repair materials and methodology are different depending upon types of cracks, their locations such as joints, structural members etc. and conditions such as dry or moist. A through and logical evaluation of the current condition of a concrete structure is the first step in any repair project.

Regular inspection and monitoring is essential to detect problems with concrete structures. The structures should be inspected a minimum of once per year. It is important to keep written records of the dimensions and extent of deterioration as scaling, disintegration, efflorescence, honeycombing, erosion, spalling, popouts, and the length and width of cracks. Structural cracks should be monitored more frequently and repaired if they are a threat to the stability of the structure. Photographs provide invaluable records of changing conditions. All maintenance and inspection records should be kept.

6. REHABILITATION

- In recent years, rehabilitation has been the subject of extensive research due to increased spending on building work and repair of built works. In all cases, it is absolutely essential to carry out methods of strengthening or repair of structural elements, and that following an inspection analysis and methodology of a correct diagnosis. The reinforced concrete columns are important elements in building structures. They support the vertical loads and provide bracing against the horizontal loads. The different results obtained revealed a considerable gain in bearing capacity failure of reinforced sections cladding concrete, metal bracket, steel plates and a slight improvement to the section reinforced with fabric FRP. The use of FR does not affect the weight of the structures, but the use of different techniques like cladding increases the weight of elements rehabilitated and therefore the weight of the building which requires resizing foundations.
- The need of structural repairs can arise from any of the following:

- Faulty design of the structure
- Improper execution and bad workmanship
- Extreme weathering and environmental conditions
- High degree of chemical attack
- Ageing of the structure

7. Making Concrete Cube Using Glass Fibre

Aim:

Making concrete cube and give test on UTM & observe cracks.

Equipment:

Sample tray, Tower or steel float, compacting bar, mould, curing tank, spanner, scoop, cleaning rays.

The total 6 cubes measuring 150x150mm should be cast, 3 cubes for 7 days, 3 cubes for 28 days testing should be used.

Procedure:

- Take random samples from the mix in a ghamela, fibre white while concreting.
- pour concrete in the cubes in 3 layers.
- Compact each layer with @ 35 Nos of strokes with the tamping red. 4) Finish the top surface by trowel after 5) compaction of the last layer.
- Each specimen should be taken from different locations of the proposed.

concreting.

- After 24 hours, remove the specimen from the mould.
- While removing, take care to avoid breaking of the edges.
- Submerge the specimen in clean, fresh water until the time of testing...
- Test 3 specimens for 7 days & 3 specimens for 28 days curing.

Material Required for making cubes:

Cube size: 150x150x150 mm
Volume of cube: 0.15x0.15x0.15m
1 cube of volume: 3.375x10-3

6 cube volume = 6x3.375x10-3
= 0.02025m3
Dry volume = 1.54x0.02025m3
=0.0312m3

Use of concrete grade = M20 (1:1.5:3)
= 0.0312
1+1.5+3
=5.672x10-3

- Cement volume = 1x5.672x10-3
  = 5.672x10-3
- cement (Kg) = 5.672x10-3 x 1440
  =8.2kg
- Sand Quantity = 1.5x5.672x10-3
  = 8.508x10-3x1750
  = 15 Kg
- Aggregate Quantity = 3x5.672x10-3
  =0.0170m3
  =0.0170x1550
  = 26.37 Kg
- Fiber Glass =35 gram

- Cement = 8.2Kg
- Sand = 15Kg
- Aggregate = 26.37 Kg
- Fiber Glass = 34 gram

Test Report

DATE	SAMPLE 1(KN)	SAMPLE 2(KN)	SAMPLE 3(KN)	AVERAGE	LOAD	AREA (MM)	COMPRESSIVE STRENGTH(N/MM²)
6-4-22	615.6	620.7	746.4	660.9	660.9	225	29.37
27-4-22	942	880	1065	962.3	962.3	225	42.77

Conclusion: By using fiber glass in concrete compressive strength are increase by 213.85% as compare to normal compressive strength.(Use M20 grade of concrete)

6. CONCLUSION

In this project, we had studied various types of cracks reason behind formation of cracks, cracks formed in building, pavement etc.
Also we studied at the time of construction what prevention we need to take, to avoid future cracks ad increase life of structure and make structure more safe . Although we can't prevent occurrence of cracks in buildings We can repair cracks by applying various method like chemical application our using rehabilitation techniques depending upon the severity of the cracks and percentage of damage to building.
These these project we lernt that use of proper construction method can reduce formation of cracks.

7. REFERENCE

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