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Health Monitoring Of Structure By NDT And Analysis & Research

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ABSTRACT

We are building the structures rapidly in the area where there is requirement of the structures. Every structure has its own service life. Every structure is designed by assuming its life of existence. Some of the structures gets more life than expected and some gets fail in achieving its life. Any technology or material has its limitation to withstand. Many of the structures of R.C.C. are located in Seismic prone area. The structures gets damaged due to earthquake and the structures which becomes old should be checked that whether it has the strength of existence or not. The structures should be audited timely for the safety of the human life as well as for the nearby structures.

The structures can be checked by various methods of Non-Destructive Test (Rebound Hammer Test, Ultrasonic Pulse Velocity Method, Pulse Echo Method, Probe Penetration Test or Windsor Probe Test, Ground Penetration Radar Method, Carbonation Test, Half Cell Potential Meter Test) and Destructive Test. Rebound Hammer Test of Non-Destructive Test is used in this paper to check the strength of an institutional building. After auditing the structure, this paper aims to improve the life of structure. Different techniques of Retrofitting is given to the structural member which is unsafe. By applying the retrofitting, the structure can be made safe.

***Keywords*- NDT method, Non Destructive Test, Rebound Hammer Test,Retrofitting, Structural Audit.**

I. INTRODUCTION

The standard life of R.C.C. framed structure is considered to be in the range of 50-60 years approximately depending upon the use and the importance of the structure. But it has been observed that many of the buildings completing just 50% of their life in coastal areas found to be in distressed condition and this needs the evaluation of the strength of the building so that appropriate remedial action can be taken to improve performance of the building depending upon the extent of deterioration of the structure.

Structure may also get damaged due to fire, earthquake, explosion, etc. there could be loss of strength and reduction in area of cross section due to fire depending on intensity of fire, temperature, duration of fire and size of the structural member. Stability of such member becomes critical. It is imperative to measure residual strength and assess stability by NDT means.

Earthquake effects could prevail on all members calling resistance to deformation and distortions by way of ductility and toughness available with them. The resulting distress is more pronounced at beam column junction, shear and flexural zones due to excessive deflection and deformations exhibited by way of surface and deeper penetrated cracks. In such cases there isa loss of integrity and stability of the structure. NDT is the only means to assess the extent of cracks and to decide whether any structural damage has occurred. This decision will help to undertake appropriate restoration or improvement strategy i.e. whether to go for simple grouting or strengthening of the member.

Due to explosion, structure is suddenly loaded by way of impact forces. The structure may get heated up under high temperature generated by explosion and burn partially and deform when it is under loads. Visible damage may immediately help to decide for replacement of the member. But an invisible damage, which has distressed the structure, needs assessment for integrity, loss of strength and stability. Assessment through NDT can guide for reuse of the structure.

The Non Destructive Testing is being fast, easy to use at site and relatively less expensive can be used for:

- To test actual structure instead of representative cube samples.
- To test any number of points and at any location.
- Quality control and quality assurance management tool
- To assess the structure for various distressed conditions
- Damage assessment due to fire, chemical attack, impact, age etc.
- To detect cracks, voids, fractures, honeycombs and week locations
- To monitor progressive changes in properties of concrete & reinforcement.
- To assess overall stability of the structure
- Monitoring repairs and rehabilitation systems
- Scanning for reinforcement location, stress locations.

In the recent years significant advances have been made in Non-destructive Testing techniques, equipment's and methods.

There are occasions when the various performance characteristics of concrete in a structure are required to be assessed. In most of the cases, an estimate strength of concrete in the structure is needed although parameters like overall quality, uniformity etc., also become important. The various methods that can be adopted for in-situ assessment of strength properties of concrete depend upon the particular aspect of the strength in question.

In this paper an institutional building is taken into account and various sections are checked by the use of Rebound Hammer. The aim of this paper is to give different retrofitting techniques to make the structure safe.

The different structural member like beam, column and slab are taken out into consideration. The plastering of these are removed approximately 10 x 10 (in mm). By using Rebound Hammer different reading are taken out. With the help of these readings the strength of the structural member is sorted out. If the strength is more than the required strength then the member is safe and if not then the member is to be given proper remedy in the form of retrofitting.

II. LITERATURE REVIEW

Bhavar Dadasaheb [1]Many parts of the country have suffered earthquake in last three decades. In coastal part of South India faced T-sunami. In first three earthquakes it was found that many of damaged structures were built in non-engineered masonry techniques. Unreinforced masonry structures are the most vulnerable during an earthquake. Normally they are designed for vertical loads and since masonry has adequate compressive strength, the structures behave well as long as the loads are vertical. When such a masonry structure is subjected to lateral inertial loads during an earthquake, the walls develop shear and flexural stresses. The strength of masonry under these conditions often depends on the bond between brick and mortar (or stone and mortar), which is quite poor. This bond is also often very poor when lime mortars or mud mortars are used. A masonry wall can also undergo failure in-plane shear, if the inertial forces are in the plane of the wall. Shear failure in the form of diagonal cracks is observed due to this. However, catastrophic collapses take place when the wall experiences out-of-plane flexure. This can bring down a roof and cause more damage. Masonry buildings with light roofs such as tiled roofs are more vulnerable to out-of-plane vibrations since the top edge can undergo large deformations. It is always useful to investigate the behavior of masonry buildings after an earthquake, so as to identify any inadequacies in earthquake resistant design. Studying types of masonry construction, their performance and failure patterns helps in improving the design and detailing aspects.

Pravin B. Waghmare [2]concluded thatfor the open ground storey frame, retrofitting by means of introducing RC structural wall in the open ground storey, offers the maximum strength (frequency) and ductility. Although the initial stiffness of the brick masonry infilled specimen is more than that of the other specimen, at higher displacement levels, and the RC structural wall specimens gave better stiffness. Introducing the RC structural wall in the open ground storey gives the most desirable behavior for the two dimensional frame from the points of view of strength, stiffness ductility and frequency profile.

Vijay Kumar and Venkatesh Babu [3]concluded that many guidelines are reviewed regarding seismic rehabilitation of school, office, hospital and apartment buildings. Some of the researchers discussed the various seismic retrofitting and strengthening methods for existing building. The following methods are carried out by most of the researchers which are concrete jacketing of columns of ground floor, brick masonry infill in the ground floor, X and V bracing, shear wall, FRP of beams and columns. All these topics require further research, and it is essential for seismic retrofitting of reinforced concrete structures.

Amritha and Anju Paul [4]concluded that the analysis and designing of an existing old structure which was actually designed for seismic zone II as per the previous code i.e. IS 1893: 1984 and redesigning the structure as per the revised code i.e. IS 1893: 2002 for seismic zone III. Columns are found to be the deficient member and are to be retrofitted so as to achieve ductile performance. The most suitable retrofitting technique i.e. use of FRP wrapping is suggested for the retrofitting of the deficient columns.

Giuseppe Oliveto and Massimo Marletta[5]concluded that the retrofitting of buildings vulnerable to earthquakes and briefly describes the main traditional and innovative methods of seismic retrofitting. Examples drawn from the professional, editorial and research activity of the senior author are used to illustrate the problems in a simple way. Among all the methods of seismic retrofitting, particular attention is devoted to the method which is based on stiffness reduction. This method is carried out in practice by application of the concept of springs in series, leading in fact to base isolation. One of the two springs in series represents the structure and the other represents the base isolation system. The application of the concept to two buildings in Eastern Sicily concludes the presentation. The enhanced resistance of the buildings to the design earthquake clearly shows the effectiveness of the method, while a generally improved seismic performance also emerges from the application. In conclusion it is hoped that the material presented in this paper will be useful in increasing the understanding of the earthquake engineering problem and of seismic retrofitting.

Nikhil R. Jagtap [6]concluded that strengthening and enhancement of performance of existing structure so that structure can perform well when subjected to additional loads over it. The present work deals with NDT on existing structural elements/determination of load and moment carrying capacity of structural elements before and after extension, method applied for strengthening of structure ,design of the existing structural elements such as R.C.C beams and columns according to the load carrying capacity required.

Patil S.R., Prof. Sayyed G.A[7]concluded thatthe defects of structural members are due to combined effects of carbonation, corrosion & effect of continuous drying and wetting. The result of visual survey prompt us to conclude the distress is wide spread and is an ongoing process and so needs to be stopped at this stage so as to avoid complete collapse of the structure. The condition of the building appears to be quite bad and major structural distress is observed in some of the columns and beams of the external walls. Micro Concrete Repairs to R.C.C. Column, Beam, etc. In terms of two restoration of extensive damages in R.C.C. micro concrete: micro concrete is a very high strength mix design concrete, its factory made product. its dry powder in grey color more like cement constitutes cement as a one component & other's graded fine aggregate, additive in powder form & free flowing agent, because of this micro concrete can placed in less thickness & mix. Material can travel in narrow gape & having self-leveling properties, so that it provides very smooth & uniform finish. Strength equivalent to 35 m concrete can be achieved in only three day setting / placing time. After overnight setting de shuttering is possible.

III. METHODOLOGY

POINTS OBSERVED AND VARIOUS REMEDIES GIVEN AFTER CONDUCTING DETAILED STRUCTURAL AUDIT OF THE INSTITUTIONAL BUILDING:-

01) The R.C.C column's strength during NDT rebound hammer tests have indicated them to be below M10 grade, at a few locations. At few locations, the grade of concrete strength is inadequate to even withstand the current load and the RCC Framed structure might be under composite action.

- **Provide jacketing to columns, wherever required to increase its load bearing capacity.**
- **Provide I- section supports at intermediate position between two columns underneath floor beams, to reduce columns on existing columns**
- **It is strongly recommended NOT to carry out any further construction on above storey, i.e. on thisU.G+2 structure.**

02) Percolation of rain water through parapet wall's top is taking place, which is deteriorating the surface inside-out.

- **There is a need to provide coping on the parapet wall to prevent ingress and percolation of rain water.**

03) The water proofing done on the roof has peeled off and shrubs have grown over the surface, leading to logging of rain-water during monsoon.

- **These shrubs, plants must be removed and old waterproofing mortar layer peeled off and grit re-waterproofing is required to prevent percolation of rain water.**

04) Dampness in wall member due to seepage percolation of water from slab.

- **Find cause source and fill in with adhesives/sealants.**

05) Due to seepage of water, the beam has undergone spalling of concrete and the reinforcement have corroded.

- **The affected area must be treated by providing waterproofing treatment.**

06) The floor beam's structural stability is under suspicion, as the strength of concrete is quite low, then the desired values.

- **Attention is required. I-section support should be provided at the mid-span of the beams.**
- **Also it is recommended not to dump any heavy machinery or install new water tanks in its place.**
- **It is also recommended to replace the existing syntax water tank base platforms with new ones.**

07) The handrail of the staircase is unstable due to weakened support to it.

- **Strengthen the posts at waist slab and wall joints, by welding and concreting.**

08) The main reinforcement of slab is exposed due to careless drilling of holes in slab for passing drain pipes, the holes are not yet filled back with concrete.

- **It is strongly recommended to refill the holes with fresh concrete.**

09) One of the column supporting the side stair's of building is subjected to spalling of concrete, and the strength of concrete is quite low.

- **Clean and replace the column and stairs.**

10) The outlet pipes of roof rain water drainage have broken down leading to chlorination of adjoining concrete surface.

- **New P.V.C. roof water drainage pipes to be fixed.**

11) The Chajja's have vertically deflected and their reinforcement is exposed.

12) Wide and narrow cracks can be observed and spalling of concrete to a large extent has occurred. Hair cracks are present almost everywhere in the structure.

- **The affected cracks should be widened and filled up with cement slurry..**

13) The gap between the door frames and walls has widened at many instances.

- **Fill in the gap with cementing agent.**

14) The plinth protection has slide away and shrubs are grown from the structure and columns plaster cracked and peeled off.

- **The plinth protection need prompt repairs. Refilling with P.C.C in the gaps must be carried out.**

15) Carbonation and Chlorination has taken place over First Floor Chajjas.

- **Scrub off the scum and repaint the surface, with epoxy based exterior paint.**

16) Trees have sprouted into the plinth protection

Remove the trees and repair the plinth protections.

17) The Chajjas have vertically deflected and their reinforcement is exposed.

- **Repair chajjas by grouting and where situation is beyond repairable condition, replace there with new chajjas. Refer attached drawings for details.**

18) Unwanted twigs, bushes and shrubs have grown over walls near the first floor region.

- **Remove these twigs, bushes and shrubs. Then conduct chemical treatment to burn off their roots. Seal the surface and paint it.**

19) Crack due to uneven settlement of underlying members.

- **Fill in the cracks through grouting, after widening the cracks.**

20) Wide and narrow cracks can be observed and spalling of concrete to a large extent has occurred. Hair cracks are present almost everywhere in the structure.

- **The affected cracks should be widened and filled up with cement slurry.**

21) The rainwater outlet pipe in the front is absent, dampness and cracks in the walls above it are worsening, plants are growing over it.

- **Clean the affected area and provide outlet pipe to avoid further loss.**

22) The plaster from R.C.C slab is falling out, at a few locations. This might lead to serious accidents.

- **Remove the bulged out plaster surface.**
- **Carryout hacking on the concrete surface and then provide thin layer of putty or and paint.**

23) The porch slab has deep cracks along the length. The plaster and the concrete spalling can be observed. The cantilever porch has also undergone deflection

- **Remove existing concrete and by using bonding agent repair joints.**

IV. DAMAGED STRUCTURALMEMBER AND RETROFITTING:

FIGURES:

Spalling of Concrete and Excessive Deflection Of chajja

Slab plaster is fallen out and reinforcement is visible

TABLE:The rebound hammer readings of some members are shown in the table:

Sr. No.	Location	Orientation H : Horizontal V : Vertical	Concrete Compressive Strength (fck) as per Rebound Hammer Test in MPa
01	Column – 01	H	23.3
02	Column – 02	H	16.2
03	Column – 03	H	20.3
04	Column – 11	H	Grade is less than M10
05	Column – 18	H	Grade is less than M10
06	Column – 19	H	Grade is less than M10
07	Column – 20	H	Grade is less than M10
08	Column – 21	H	Grade is less than M10
09	Floor Beam – 01	H	18.9
10	Floor Beam – 02	H	13.7
11	Floor Beam – 03	H	Grade is less than M10
12	Floor Beam – 09	H	Grade is less than M10
13	Floor Beam – 24	H	Grade is less than M10
14	Floor Beam – 29	H	Grade is less than M10
15	SLAB – 01	V	25.9
16	SLAB – 02	V	Grade is less than M10
17	SLAB – 08	V	14.7
18	SLAB – 14	V	Grade is less than M10

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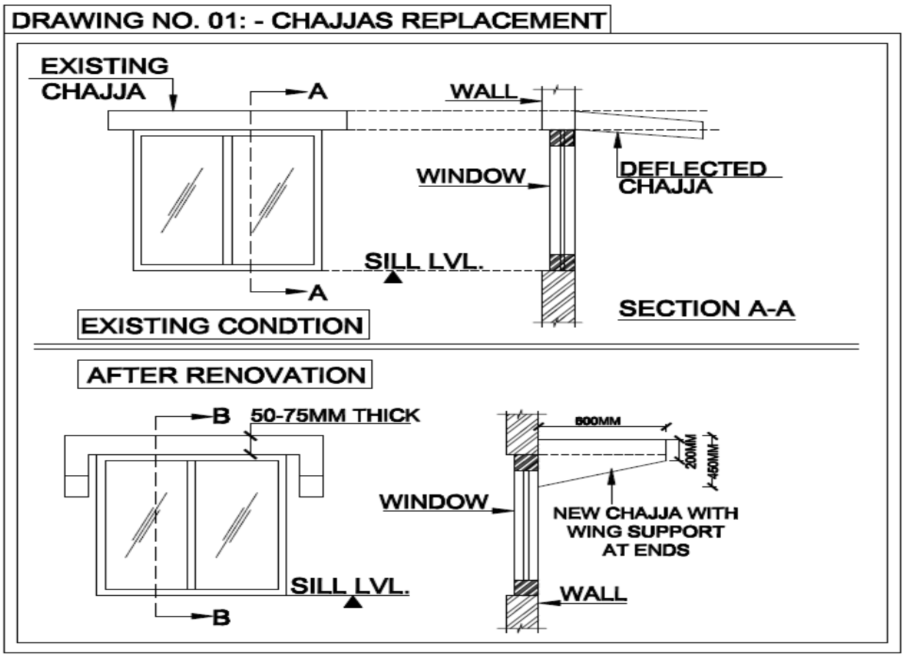
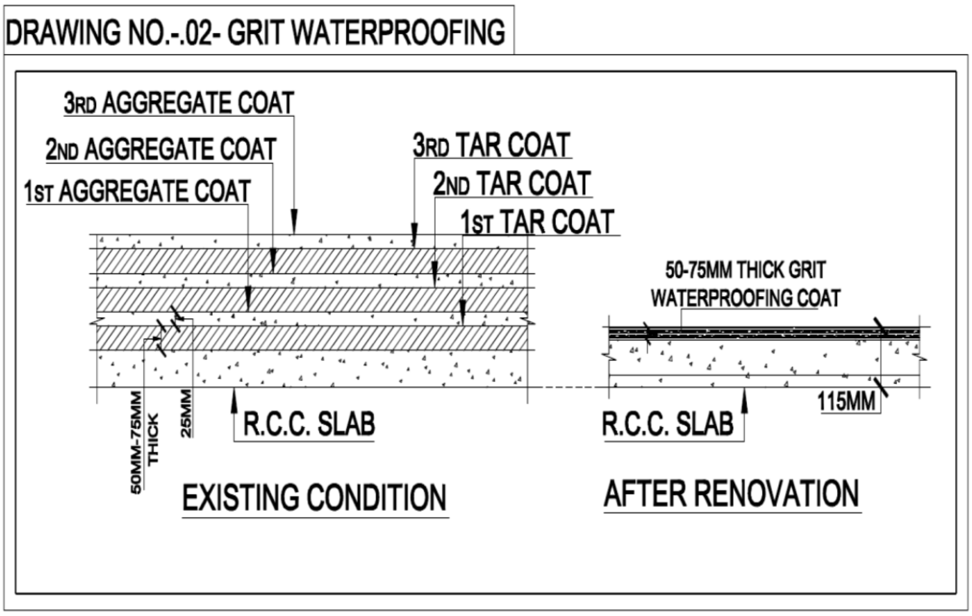
Retrofitting of various members:





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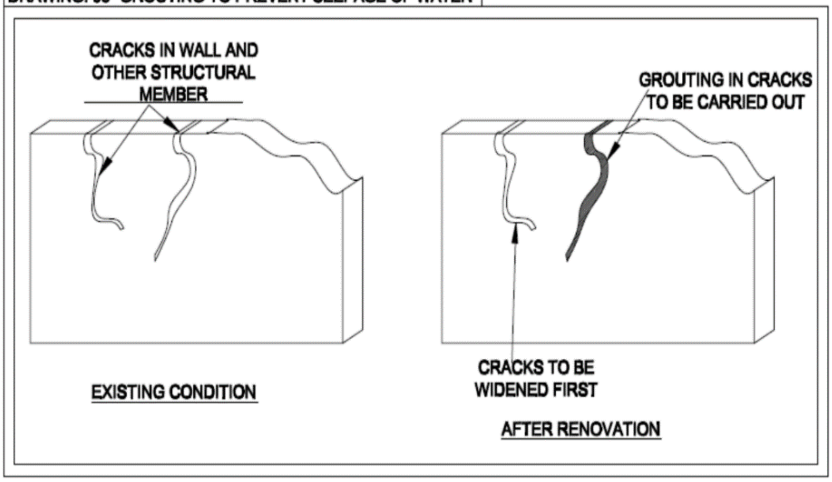
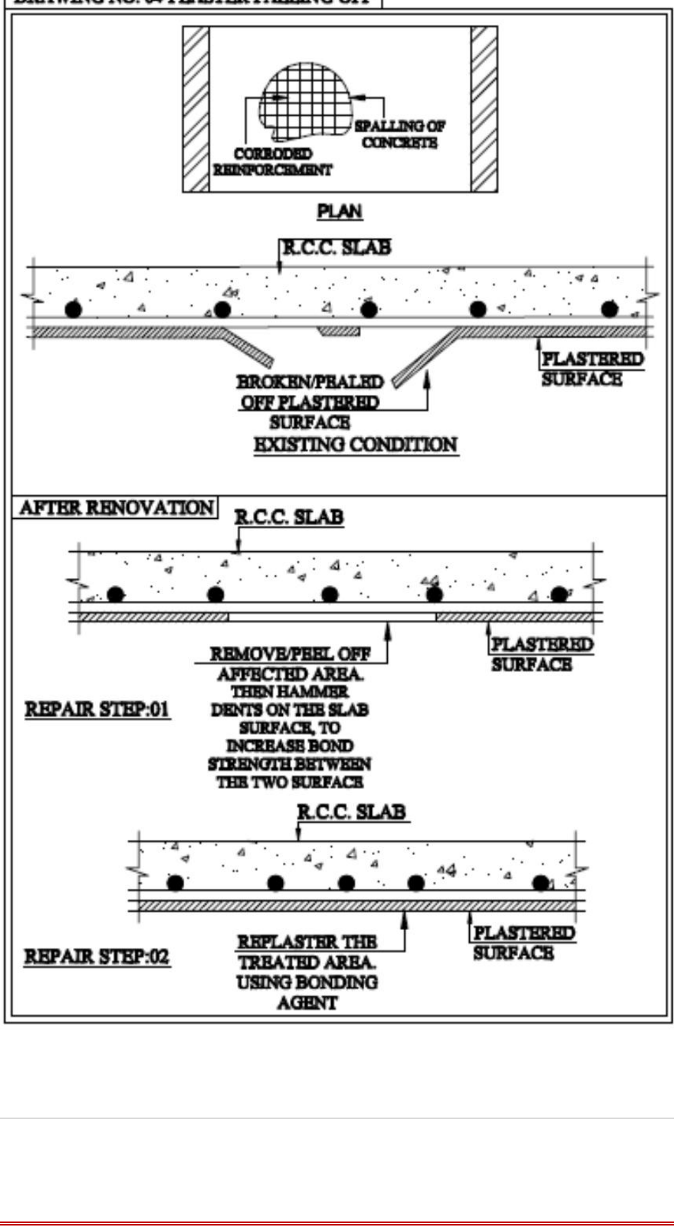
DRAWING. 03- GROUTING TO PREVENT SEEPAGE OF WATER



DRAWING NO. 04 PLASTER FALLING OFF



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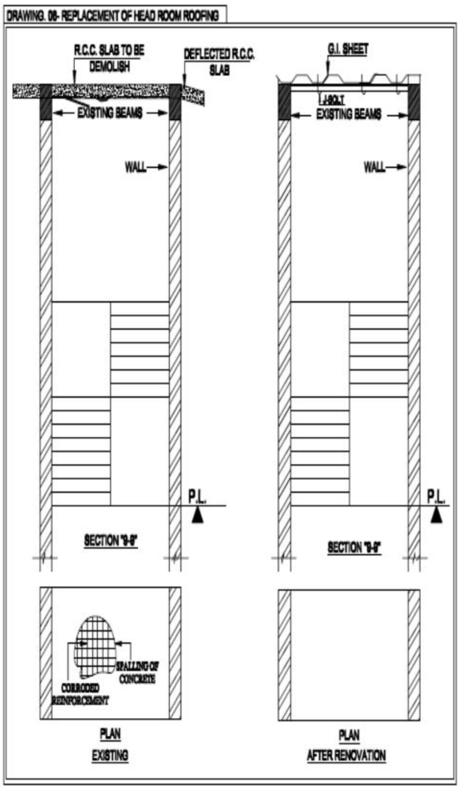
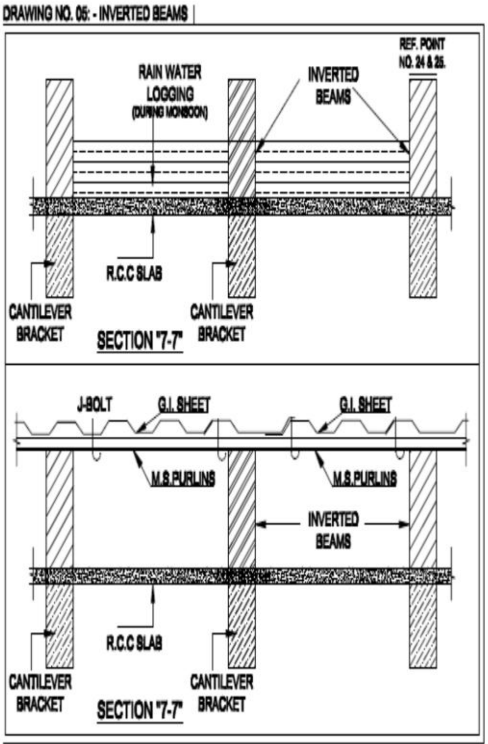
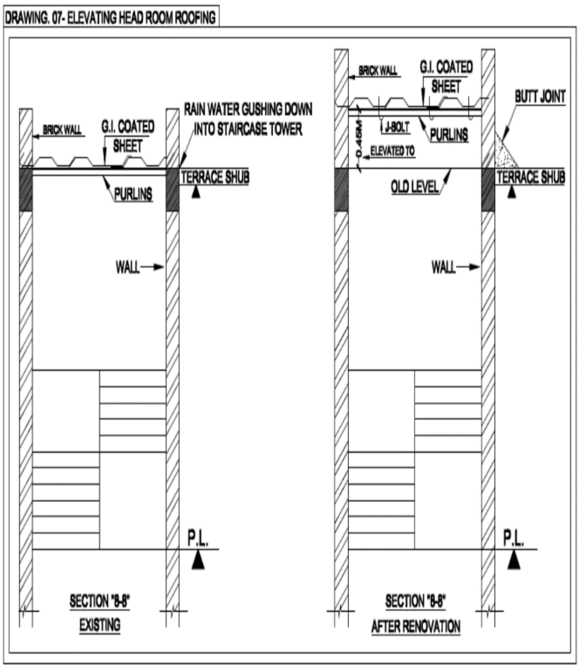
DRAWING. 08- REPLACEMENT OF HEAD ROOM ROOFING



DRAWING NO. 05: - INVERTED BEAMS





IV. CONCLUSION

From the N.D.T. Rebound Hammer test report, it is concluded that the structure is within safe limits and retrofitting is provided with the different suggestions to the members which are not safe and which are damaged.The report is based only on NDT, visual inspection of the assessable area and the data provided by the client. In the absence of design data and structural drawings, the resistance to seismic forces cannot be assessed.Overall the Structure is safe to meet its current functional requirement.

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