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Decision Making for Retrofitting in Existing RCC Structures

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***Abstract:** In order to assess the condition of the RCC structure, a thorough evaluation was performed. The evaluation determined the structural condition, the need for repair or maintenance and provided an indication as to the safety and expected remaining service life of the structure. The testing consisted of:*

1) *A visual inspection of the exterior exposed elements to determine if there were any obvious signs of distress, deflection or deterioration in the structure.*
2) *The inspection of the structure to determine the condition of the structure. This is essential as we found that the structure can appear to be in a very good condition from outside, but could be suffering from extreme structural distress from inside.*
3) *Selective concrete/steel removal to examine the condition of the underlying reinforcing steel.*
4) *Materials testing to determine steel/concrete compressive strength, carbonation, chloride content.*

Objectives of the overall investigation:

The overall objective of the investigation carried out for the structure is to obtain an up to date account of the health condition of the structure so that appropriate repair measures can be taken up to make up for the damages sustained. Keeping this in view the basic objectives of the investigation formulated are as given below.

a) *To assess the existing condition of the structural elements.*
b) *To determine the extent of damages in the structure, so as to undertake suitable remedial measures for rehabilitation of the structure.*

Planning and Survey and Methodlogy

Walk over survey: First and foremost activity in a condition survey and structural investigation, especially in distressed superstructure, is a walk over survey or systematic visual inspection so as to gather readily available information about the structure in question. Further, careful visual observation of typical crack pattern and the nature of the spalling can furnish valuable information regarding the distresses. This in turn provides an idea about the degree of damage encountered in the concrete and hence the extent of repair required. A systematic visual observation has been recorded in this investigation and the findings are presented in later part of this report.

Selection of tests: Tests are selected on the basis of the requirements of the overall objectives of the investigation and the observations made during a quick walk over survey. In this investigation, following in-situ and laboratory tests were considered necessary for achieving the overall objectives stated earlier for the structure. Various Test were Conducted for the evaluation of the Structure:

METHODLOGY

1. *Visual Survey*
2. *Test Plan*
3. *Sample and Data Collection*
4. *Structure Stability Analysis & Retrofitting*

I. INTRODUCTION

The Existing structure is a Group Housing Society situated in Sector 6, Dwarka, New Delhi 110075.

Condition health assessment of Group Housing Society situated in Sector 6, Dwarka, New Delhi by using Visual Inspection & Non-destructive testing. This report pertains to the stated safety appraisal & health assessments.

In order to assess the condition of the RCC structure, a thorough evaluation was performed. The evaluation determined the structural condition, the need for repair or maintenance and provided an indication as to the safety and expected remaining service life of the structure.

A. Primary Evaluation

1) A visual inspection of the exterior exposed elements to determine if there were any obvious signs of distress, deflection or deterioration in the structure.

2) Selective concrete removal to examine the condition of the underlying reinforcing steel.

In-Situ and laboratory testing is perform to determine concrete homogeneity, compressive strength & condition of steel and RCC structure.

B. Walk Over Survey

First and foremost activity in a condition survey and structural investigation, especially in distressed superstructure, is a walk over survey so as to gather readily available information about the structure in question. Further, careful visual observation of the nature of the crack & spalling can furnish valuable information regarding the distresses. A systematic visual observation has been recorded in this investigation and the findings are presented in later part of this report.

Visual survey of the structural members and documenting the damage if any with the help of photographs

Visual Survey and Testing

II. TEST PLAN

A. Selection of Tests

On behalf of primary evaluation further In-situ and laboratory testing was selected to know the nature of the Crack, Spalling, Compressive Strength, Cover etc. As per surface condition, test locations were decided to cover the secondary evaluation of overall structure.

B. Secondary Evaluation

The various Non-Destructive Tests proposed to be carried out for condition survey of the structure are listed below:

1) *Ultrasonic Pulse Velocity Test as per IS:* 13311 (Part-1)-1992 for ascertaining the quality of concrete, soundness and density of concrete.
2) *Rebound Hammer Test:* For determining the estimated compressive strength of concrete and uniformity of concrete in terms of surface hardness as per IS 13311 (Part-2)- 1992.
3) *Carbonation Test as per BS EN:* 14630 Measurement of carbonation depth by phenolphthalein spray test at selected locations on RCC members of the structures covered under the study to see the depth of carbonation.
4) *Core Extraction:* IS: 516, concrete extraction for exact in-situ compressive strength evaluation of concrete, grade and fck value of concrete.
5) *Chloride content as per IS:* 456: 2000,IS: 14959 (Part 2) – 2001, B.S. 5328, ACI 201.2R-92
6) PH Test on Concrete sample to determine the acidic or alkaline nature of concrete
7) *Tensile Strength Analysis of existing Steel Members:-* To analyze the tensile strength of existing steel members/steel bar; how much tensile strength has been lost by member during the corrosion along with time.
8) *Structural Drawings Preparation:* Preparation of structural drawings with complete RCC details, section sizes and steel percentage by using profometer or GPR based scanner, it will give detailed cover depth and existing protecting layer of steel rebar, diameter of steel and number of steel bar.
9) *Structure Analysis:* To Analysis for additional one floor as per IS 456:2000,IS 800:2007 and IS 1893 in Seismic Zone.
10) *Retrofitting Design:* Design the retrofitting methodology to increase the load carrying capacity of the structure as per IS 13935-2009.

C. Number of Tests Performed

1) Ultrasonic Pulse Velocity-14 Nos
2) Rebound Hammer Test- 40 Nos.
3) Cover Meter & RCC Scanning- 3Nos.
4) Carbonation, Core, pH Test- 3 Nos.
5) Crack Pattern Analysis- 10 Nos.

III. TEST PROCEDURE & RESULTS

A. Ultrasonic Pulse Velocity

1) Purpose

Although there is no fundamental relationship between pulse velocity and strength, an estimation of strength can be obtained by correlation. The method has perhaps a greater potential for comparing known sound concrete with affected concrete.
Ultrasonic pulse velocity is a means of assessing variations in the apparent strength of concrete.
The quality gradation of concrete can be appraised at best qualitatively as `excellent', `good', `medium' or `doubtful'. The meanings of the term `excellent', `good', `medium' and `doubtful' are based on ultra sonic pulse velocity measured at site and are as per the nomenclature of IS 13311(part-1): 1992. To strike balance between the reliability, speed and damage to structure, core test have to be used to establish a correlation between rebound number index and the estimated in-situ strength with the USPV test results in the investigation.

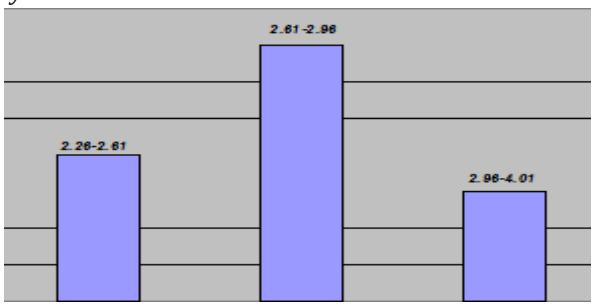
2) Objective of Testing

Ultrasonic pulse velocity test is used to establish the following:
Homogeneity of concrete
Presence of cracks voids, honeycombing and other imperfections
Changes in the structure of concrete which may occur with time.
Quality of one element of concrete in relation to another i.e. comparative quality analysis and gradation of concrete.
The values of dynamic elastic modulus of the concrete.

3) References

BS 6089:1981 and BS 1881:Part203
IS 13311:Part1:1992
ASTM: C597-83.

4) Results of Ultrasonic Pulse Velocity Test



Total No. of Test Location/ Results/samples	Min.	Max.	Mean	Mode	Median	Standard Deviation S/P
14	2.26	4.01	2.86	#N/A	2.72	0.54

*Note: Total no of test sample = Sum of frequency

B. Rebound Hammer Test

1) Purpose: This test gives a measure of the surface hardness of the concrete surface. Although there is no direct relationship between this measurement of surface hardness and strength, an empirical relationship exists. Rebound hammer is the best known methods of comparing the concrete in different parts of a structure and indirectly assessing concrete strength. The rebound hammer should be considered as a means of assessing variations of strength within a structure rather than an accurate means of assessing the strength.

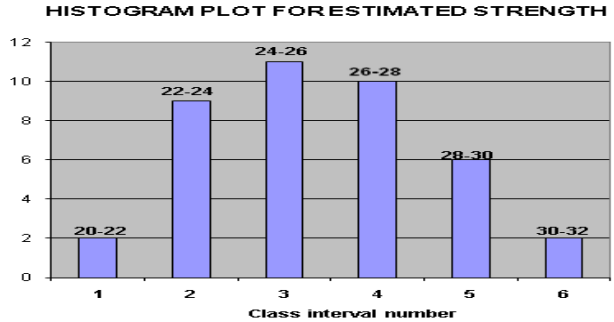
2) Objective of Testing

Rebound hammer test is performed to determine the following:
Surface hardness
Uniformity of concrete over the structure
Grade of concrete
Estimated strength which is derived from establishing a relationship between in-situ core strength and rebound number.

3) References

BS 6089:1981 and BS 1881:Part 202,
IS13311(Part2):1992
ASTM C 805-02

4) Results of Rebound Hammer Test



Total No. of Test Location/ Results/samples	Min.	Max.	Mean	Mode	Median	Standard Deviation S/P
40	20	32	26	25	26	2.94

*Note: Total no of test sample = Sum of frequency

C. Cover And Carbonation Test

1) *Carbonation Depth:* Concrete cover layer acts as a good protective layer for the reinforcement. When whole Protective layer/cover depth is carbonated as per carbonation (B.S 4248) deterioration of structure will fall in deterioration period with linear rate. So full carbonated cover depth removal is mandatory to protect the steel bar from further corrosion and we have to increase the thickness of cover depth to protect the steel from futuristic corrosion.

2) *Results of Cover and Carbonation Test*

Sr. No.	Sample Identification/Location	Cover (mm)	Remark	Carbonation Depth (mm)	Remark
1	F.W.OPD:- GROUND FLOOR(Column)	40	Sufficient cover depth	50	Up To Cover
2	F.W.,HALL:-FIRST FLOOR(Column)	45	Sufficient cover depth	60	Up To Cover
3	F.W.,C.W.,L.F.-FIRST FLOOR(Slab)	25	Sufficient cover depth	35	Up To Cover
Cover Depth (IS: 456 2000) :-Minimum required cover depth for Beam :30mm ,Column: 40mm, Slab: 15 ±5mm R.C.C wall in contact with water 45 ±10mm & for general R.C.C wall 20mm ± 5mm					
Carbonation (BS EN 14630: 2006): - If depth of carbonation is greater than cover depth, then incubation period is over; degradation rate will be accelerated.					

Whole Protective layer is carbonated in present case. Carbonation depth is greater than depth of cover

D. Core Drilling Method For In-Situ Compressive Strength Analysis Of Concrete Core In Lab

1) *Purpose*

This test is known as a confirmatory test to get the idea about the compressive strength of the existing concrete. Core compressive strength is the best known methods of getting the in-situ concrete compressive strength in different parts of a structure at present time and indirectly assessing the fck value of concrete.

2) *Objective*

Compressive strength (Grade) of concrete
fck value of concrete
Estimated strength which is derived from establishing a relationship between in-situ core strength and rebound number.

3) *References*

IS516:1959
IS1199:1959
IS456:2002

4) *Results of Core Cutting Test*

Sr.No	Identification mark/Serial No	Dia of core (d in mm)	Core Length (l in mm)	l/d ratio	Loading surface area (m2)	Failure load (kN)	Cylindrical compressive strength (MPa)	Correction factor	Equivalent cube strength (MPa)
1	F.W.OPD:- GROUND FLOOR(Column)	65	85	1.31	0.00332	54.52	16.42	0.9308	19
2	F.W.,HALL:-FIRST FLOOR(Column)	65	76	1.17	0.00332	43.58	13.13	0.9169	15
3	F.W.,C.W.,L.F.-FIRST FLOOR(Slab)	65	65	1.00	0.00332	38.50	11.60	0.9000	13
Codal Procedure: Cylindrical compressive strength (MPa) = Failure load (kN)/ Loading surface area (m2 = Π.d2/4) Correction factor = IS Code 516:1959 Page no 12 fig 1, Equivalent cube strength (MPa) = Cylindrical compressive strength * 1.25, Concrete construction should be considered structurally adequate if average of three cores from questionable region/sections is equal to or exceed the 85% of specified strength as per ACI 318.									
Interpretation of concrete core test results :- The Equivalent cube compressive strength obtained for the cores ranges from 13 MPa to 19 MPa Average 16 MPa and in-situ strength of concrete is in the range of M 16									
Grade of Concrete: M 16									

E. Chemical Test

Generally cast-in chlorides are chemically bound within the cement matrix and don't migrate through the concrete, while chlorides in-grassed are substantially free to move and diffuse through the pore solution into cement matrix and leads to corrosion in RCC. It is important to note that whether free chloride ions are leading to chloride-induced corrosion of the reinforcement or not.

Chloride (water soluble) % mass of concrete (IS: 14959 (Part 2) – 2001, B.S. 5328)

Results of Chemical Test

Sr. No./Location		Chemical Analysis of Concrete			
Sr. No.	Sample Identification	Chloride (%)	Impression	pH Value	Impression
1	F.W.OPD:- GROUND FLOOR(Column)	0.022	Low	10	Alkaline
2	F.W.,HALL:- FIRST FLOOR(Column)	0.024	Low	9.5	Alkaline
3	F.W.,C.W.,L.F.- FIRST FLOOR(Slab)	0.045	Low	9.5	Alkaline

F. Corrosion Analysis On The Basis Of Half-Cell Potential Test Results

Permeability of concrete has an inverse relationship with the concrete cover depth and is directly related to the corrosion of the reinforcement. The tendency of any metal to react with an environment is indicated by the potential it develops in contact with the environment. In reinforced concrete structures, concrete acts, as an electrolyte and the reinforcement will develop a potential depending on the concrete environment, which may vary from place to place. The schematic diagram for reinforcement corrosion mechanism is shown below:

ASTM C876 standard provides information on the probability of reinforcement corrosion based on measured HCP values. The difference in voltage between the reinforcing steel and the current source can be correlated to the amount of corrosion.

Non Destructive Testing at Military Hospital, Mathura			
SL. No.	Sample Identification	Mean Value (mV)	Risk to Corrosion of Steel
Ground Floor			
1	P.R.R.W. (Column)	-324	Uncertain
2	P.R.R.W. (Slab)	-368	High
First Floor			
3	Cor. Common Wash Room (Slab)	-357	High
Half Cell Potential(ASTM C876-91):-Low Risk ? More positive than-200mV; Uncertain Risk in range:- 350mV to -200mV; High Risk : More negative than -350mV			

At most of locations steel are suffering from 95% risk of corrosion which clearly shows that risk of active corrosion is high which is not under permissible range. So we can say that reinforcement has lost its tensile strength due to corrosion.

G. Structural Stability Analysis For

MILITARY HOSPITAL FAMILY WING BUILDING

USING NON DESTRUCTIVE TECHNIQUE TESTS RESULTS AND INTERPRETATIONS

1) *Method Of Structural Adequacy Analysis And Design Parameters:* The seismic safety of a reinforced concrete building will depend upon the initial architectural and structural configuration of the total building, the quality of the Structural analysis, design and reinforcement detailing of the building frame to achieve stability of elements and their ductile performance under severe seismic lading. Proper quality of construction and stability of the infill walls and partitions are additional safety requirements of the structure as a whole. Any weakness left in the structure, whether in design or in construction will be fully revealed during the postulated maximum considered earthquake for the seismic zone 4 in the earthquake code IS: 1893.

2) *Assumptions in static analysis*

The basic assumptions in static analysis methodology are as follows:-

a) The behavior of the structure is assumed to be perfectly linear and deformations are small
b) All joints are rigid
c) The members are subjected to axial, flexural and shear deformations
d) The force deformation relationship remains linear during the entire load regime.
e) Plinth beams are assumed

3) *Mathematical Modeling :* The structure is idolized as a 3-D space frame model. The beams and columns are considered as members. The floor slab load is given on beam members. The brick wall is used as a filler wall and is not casted monolithically with structure; hence this load is also given on beam members. The columns are assumed to be fixed at the foundation level.

4) *Loads for Superstructure and Sub Structural Elements*

a) Grade of Concrete: M15 (As per NDT Test)
b) Steel: Fe415
c) Slab thickness: 150mm
d) Density of Concrete: 25kN/m³
e) Density of Brick: 20kN/m³
f) Ground floor to First floor level height = 3.65m
g) Live load on other floors: 4kN/m²,
h) Live load on roof : 1.5 kN/m²,
i) Dead Loads:
j) Floor load: 4.75kN/m² (all dead load included in it like tiles, False ceiling and others)
k) Top Floor load: 6.35kN/m² (all dead load included in it like top profile, False ceiling and others)

5) *Materials properties data for static analysis: (as given in test certificates of reports)*

a) Concrete

- Concrete grade: Grade of concrete: M 15
- Static modulus of elasticity : $5000\sqrt{fck}$
- Poisson's ratio : 0.17
- Unit weight of R.C.C: 25 kN/m3
- P.C.C: nominal mix of 1:4:8

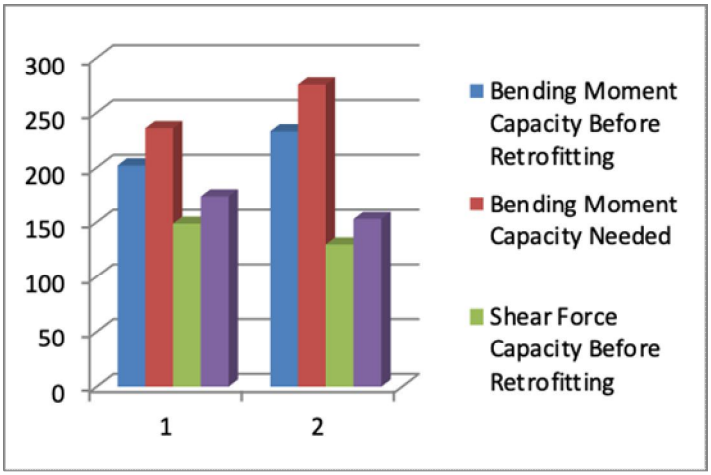
b) Reinforcement Steel

- Yield strength Fy: 415 N/mm2
- Conforming to IS 1786 -1985
- Static modulus of elasticity : 2 x 105 N/mm2

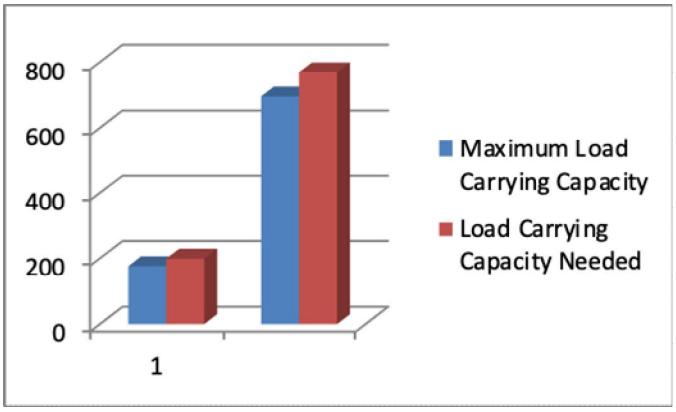
6) *Load Combinations:* Combination of Loads considered in analysis: The structural design has been carried out in accordance with the provisions of the codes IS 456 – 2000 and IS 1893 – 2002 for Normal design conditions

H. Analysis Summary

1) Beams Analysis Results



2) Columns Analysis Results



3) Foundations Analysis Results: During Analysis the foundation size are found to be insufficient as per the SBC soil report. Hence need to be retrofit.

I. Retrofitting Methodology

1) For Columns

a) Removal of loose concrete from the member so as to prevent from the deterioration or de-bonding issues that entire loose particle from the concrete should remove around 25-50mm from all the sides of columns. After removal of loose concrete entire surface should be wetted by spraying water. Propped the slab during chipping by hydraulic jacts at 1 @1sqm each.

b) After the removal of the loose mass of concrete for surface preparation the existing reinforcement is exposed to the atmosphere which is treated with the anti-corrosive treatment to avoid corrosion in the steel.

c) Based on the design aspect additional reinforcement is added to concrete with maintaining of proper alignment and cover with a lap length of 50Xdia of bar= 1 meters.

d) After anti-corrosive treatment to existing reinforcement, the Nito Bond EP Chemical is applied to the old concrete to prepare a bond between the old and new placed concrete.

e) After the application of the nito bond ep the the ties and shear connector should be laid as per design.

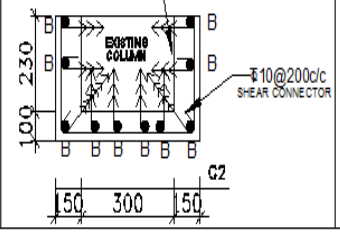
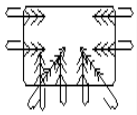
f) After the placing if ties and shear connector immediately shuttering is fixed, the shuttering is carried out to provide the desired shape and size to the structure after jacketing.

g) Pouring of Concrete is carried as per required thickness based on design aspect, and proper part that pouring should be done and also to be compacted properly by manual condition using needle vibrators.

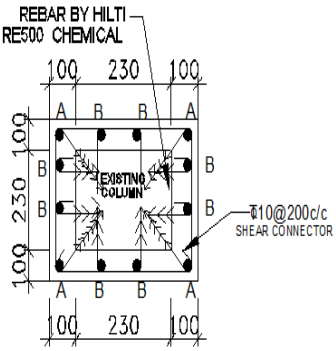
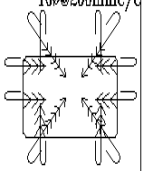
h) Once the pouring done after period it should be de-shutter the joints of the shuttering occurs in column it should be filled with cement mortar layer.

i) For imparting durability water should be properly cured to casting surface that it should achieve strength. At suitable intervals curing of the surface to be done.

COLUMN STRENGTHENING SCHEDULE FOR EXTERIOR COLUMN

LEVEL / MIX / COLUMN MARK	COLUMN SIZE (230mmx300mm) M25(PPC,A20+10,WATER PROOFING)	Fe550	TIES Fe550
C2	REBAR BY HILTI RE500 CHEMICAL 	FOUNDATION LVL. TO TERRACE LVL. B 10-16 ϕ	RINGS-8ϕ@150mmC/C SHEAR CONNECTOR- 10ϕ@200mmC/C 

COLUMN STRENGTHENING SCHEDULE FOR INTERIOR COLUMN

LEVEL / MIX / COLUMN MARK	COLUMN SIZE (230mmx230mm) M25(PPC,A20+10,WATER PROOFING)	Fe550	TIES Fe550
C1	REBAR BY HILTI RE500 CHEMICAL 	FOUNDATION LVL. TO TERRACE LVL. A 4-20 ϕ B 8-16 ϕ	RINGS-8ϕ@150mmC/C SHEAR CONNECTOR- 10ϕ@200mmC/C 

2) For Beams

a) Removal of loose concrete from the member so as to prevent from the deterioration or de-bonding issues that entire loose particle from the concrete should remove below upto 25mm from beams junction. After removal of loose concrete entire surface should be wetted by spraying water. Propped the slab during chipping by hydraulic jacks at 1 @1sqm each.

b) After the removal of the loose mass of concrete for surface preparation the existing reinforcement is exposed to the atmosphere which is treated with the anti-corrosive treatment to avoid corrosion in the steel.

c) Based on the design aspect additional reinforcement is added to beam with maintaining of proper alignment and cover with a lap length of 50Xdia of bar= 1 meters.

d) After anti-corrosive treatment to existing reinforcement, the Nito Bond EP Chemical is applied to the old concrete to prepare a bond between the old and new placed concrete.

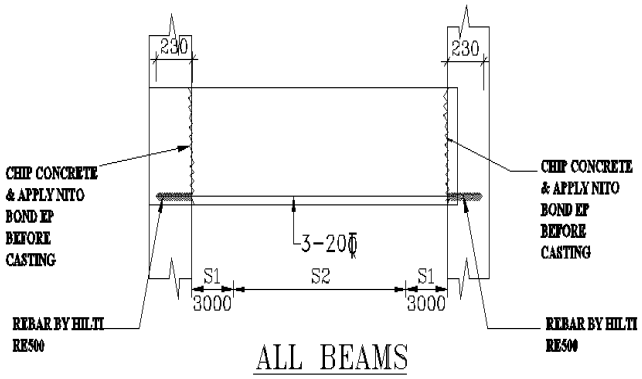
e) After the application of the nito bond ep the the ties and shear connector should be laid as per design.

f) After the placing if ties and shear connector immediately shuttering is fixed, the shuttering is carried out to provide the desired shape and size to the structure after jacketing.

g) Pouring of Concrete is carried as per required thickness based on design aspect, and proper part that pouring should be done and also to be compacted properly by manual condition using needle vibrators.

h) Once the pouring done after period it should be de-shutter he joints of the shuttering occurs in column it should be filled with cement mortar layer.

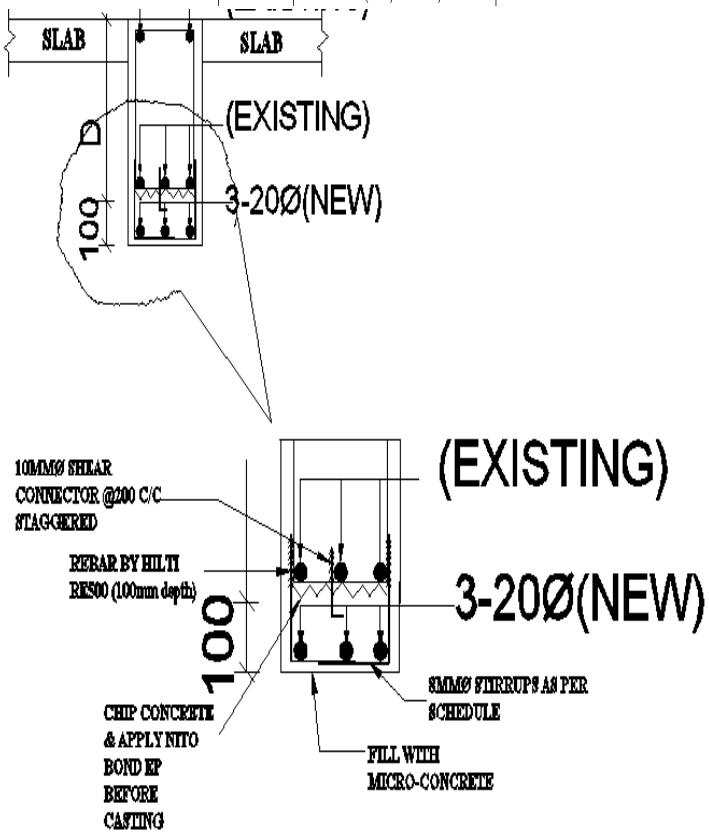
i) For imparting durability water should be properly cured to casting surface that it should achieve strength. At suitable intervals curing of the surface to be done.



ALL BEAMS

(STIRRUPS SCHEDULE)

MARK	DESCRIPTION
S1	8 Ø -(2L)@4"c/c
S2	8 Ø -(2L)@6"c/c



3) For Foundations

a) Removal of loose concrete from the member so as to prevent from the deterioration or de-bonding issues that entire loose particle from the concrete should remove around 50-75mm from all the sides of foundation. After removal of loose concrete entire surface should be wetted by spraying water.

b) After the removal of the loose mass of concrete for surface preparation the existing reinforcement is exposed to the atmosphere which is treated with the anti-corrosive treatment to avoid corrosion in the steel.

c) Based on the design aspect additional reinforcement is added to concrete.

d) After anti-corrosive treatment to existing reinforcement, the Nito Bond EP Chemical is applied to the old concrete to prepare a bond between the old and new placed concrete.

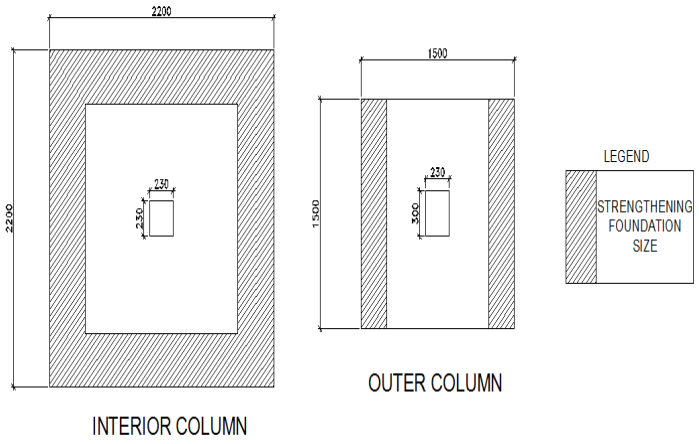
e) After the application of the nito bond-ep the ties and shear connector should be laid as per design.

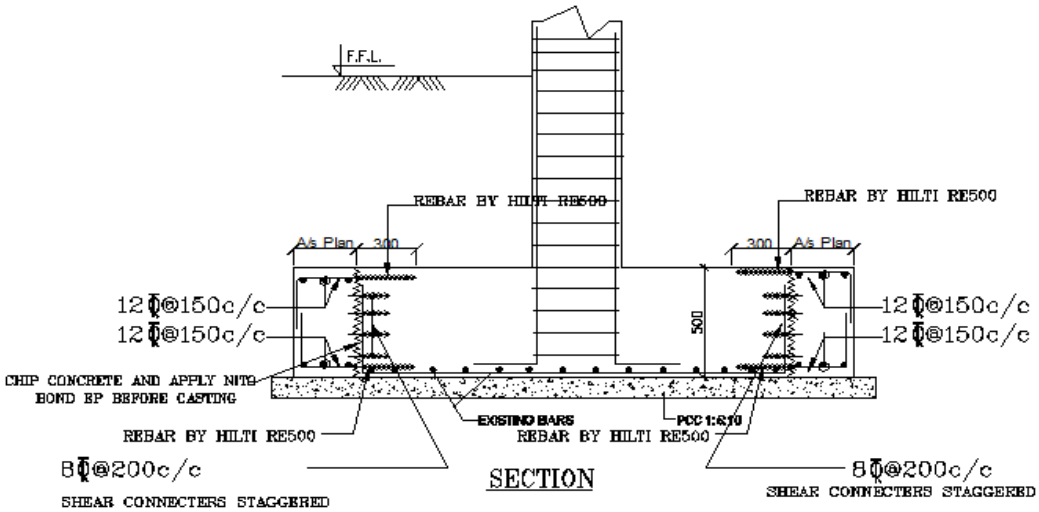
f) After the placing if ties and shear connector immediately shuttering is fixed, the shuttering is carried out to provide the desired shape and size to the structure after jacketing.

g) Pouring of Concrete is carried as per required thickness based on design aspect, and proper part that pouring should be done and also to be compacted properly by manual condition using needle vibrators.

h) Once the pouring done after period it should be de-shutter the joints of the shuttering occurs in column it should be filled with cement mortar layer .

i) For imparting durability water should be properly cured to casting surface that it should achieve strength. At suitable intervals curing of the surface to be done.





4) For Slabs

a) Concrete Removal and Surface preparation

The general procedure for marking area to prepare the surface of spalled area for carrying out repairs

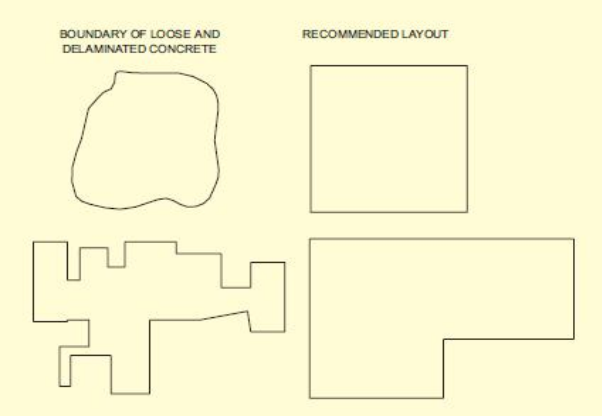
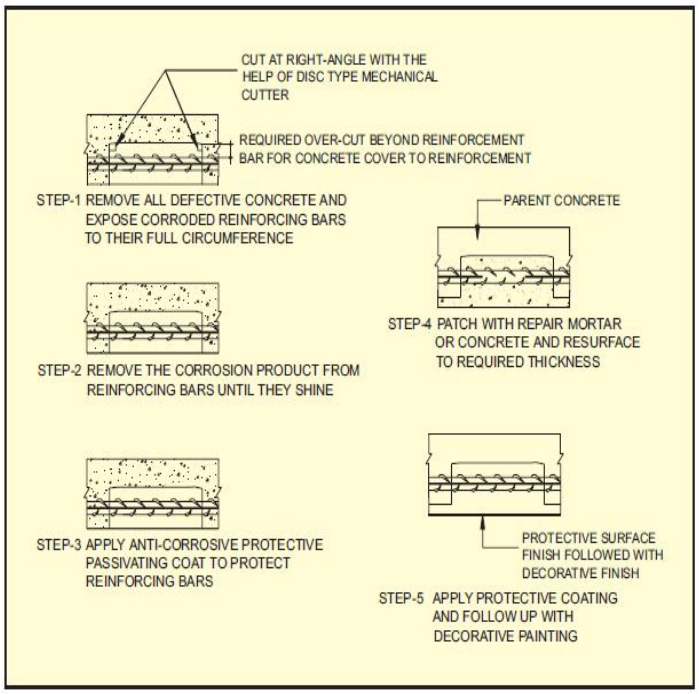


Fig Recommended Layout of Surface Repairs.

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.



The process of Surface preparation is illustrated stepwise (Step 1 to 3) in Fig. 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.

b) Apply Bonding Coat and Repair Application: Polymer Modified Cement Mortars are used for repairs on old hardened concrete for repairing defects on exposed concrete surface only.

REFERENCES

Codes:
[1] IS516:1959
[2] IS1199:1959
[3] IS456:2002
[4] BS 6089:1981 and BS 1881:Part203
[5] IS 13311:Part1:1992
[6] ASTM: C597-83.
[7] IS: 14959 (Part 2)

BIOGRAPY

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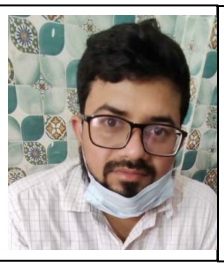

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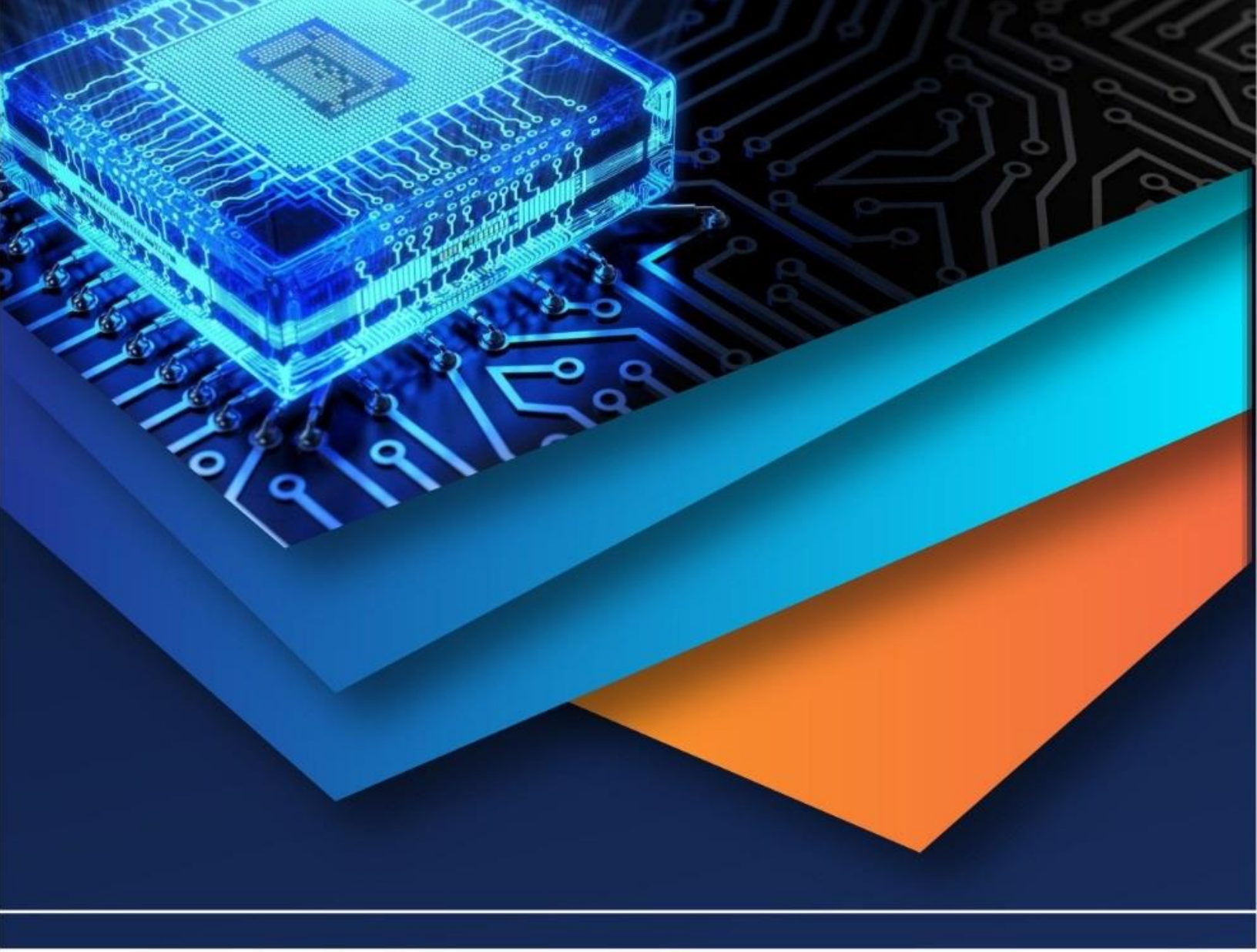

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