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Rehabilitation & Retrofitting Work For Old R.C.C Members

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ABSTRACT

Retrofitting is usually the prepared option for quality improvement (as compared with redevelopment) to increase the attractiveness and economic life of existing older buildings. Several methods are available, each with different advantages and disadvantages.

Concrete does not always behave as we would like, some of the undesirable behavior can be seen as disintegration, spalling, cracking, leakage, wear, deflection, or settlement. Developing effective repair strategies requires an understanding of what caused he undesirable behavior. Understanding the cause allows the repair strategy to address both the cause and the effect (behavior). The result is, long lasting repair.

Building consists 4 floors of existing building at Chennai has been taken for the project. The third floor of above said buildings total area is 460m^2. has been analyzed (total numbers of column-20, beam-31, and slab-11).

The concrete column made grid is placed at every 0.1m,0.3m,0.5m (horizontally) & 0.3m,0.6m,0.9m,etc….(vertically). Like wise to beam the grid points placed at 0.125m, 0.425 (vertically) & 0.20m (horizontally).

Ultrasonic Pulse Velocity (UPV) test carried out, to assess the homogeneity, integrity and uniformity of the concrete on the selected columns and beams. Based on the velocity variation test the affected or corroded members are determined (out of 20 column 8 columns are affected, out of 31 beams 8 beams are affected, out of 11 slabs 4 slabs(based on visual inspection) are affected).

By the analyzing results based on the measurements of velocity variation"v" km/sec is plotted by graph. Based on the graph result, the velocity below 3 km/sec (as per as BIS 13311/part-1) of the concrete member low strength & need to be retrofitting and strengthening.

The concrete member has been strengthening by guniting (shotcrete) process. Based on this process the detailed estimate has been done for the retrofitting work. The total cost arrived is **Rs.4,47,200.00.**

Keyword: retrofitting, guniting, Rehabilitation.

CHAPTER – 1

INTRODUCTION

1.1 GENERAL

Concrete does not always behave as we would like, some of the undesirable behavior can be seen as disintegration, spilling, cracking, leakage, wear, deflection, or settlement. Developing effective repair strategiesrequires an understanding of what caused he undesirable behavior. Understanding the cause allows the repair strategy to address both the cause and the effect (behavior). The result is successful, long lasting repair.

A variety of factors influence concrete behavior. These factors include design, materials, construction, service loads, service conditions, and exposure conditions. Most of the observed behavior is combination of these factors working together.

Retrofitting is usually the prepared option for quality improvement (as compared with redevelopment) to increase the attractiveness and economic life of existing older buildings. Several methods are available, each with different advantages and handicaps (Jones Lang Meghraj Research team 2007).

1.2 BACKGROUND

The art of construction slowly developed in to a science of construction technologyover the centuries. The skill of man developed further and he could make so many complex, beautiful monuments and intricate structures in addition to magnificent residential accommodations. The examples are old Forts, TajMahal, Lake Palace, Kutab Minar, Golden Temple and many other structures.

Concrete repair which began with the first concrete placement came of age as the nineteen sixties, seventies, and eighties.

Today concrete repair is a major industry supporting the needs of virtually every concrete structure.Each structure requires routine repair and maintenance, ranging from simple protective coatings to repair of spilling concrete to strengthening of under design components.

Concrete repair is a complex process, presenting unique challenges very different from those experienced in the field of new concrete construction.

Concrete repair must successfully integrate new materials with old materials, forming a composite capable of enduring the exposures of use, the environment, and time.

1.2 NEED FOR THE STUDY

- Building which are designed considering gravity loads only, all other loads also taken for load consideration to avoid.
- Lack of timely revisions of codes of practice.
- Lack of understanding by the designer.
- Improper planning and mass distribution on floors.

1.3 SCOPE OF THE STUDY

- To increasing the knowledge about the retrofitting work to the peoples.
- To give corrosion protection awareness.
- To create healthy buildings in future.

1.4 OBJECTIVE OF THE STUDY

The specific objectives of the studies are,

- To Analysis the existing structure.
- To Repair the structure by guniting (Shot Crete).
- To Extend or increasing the life of the structure.

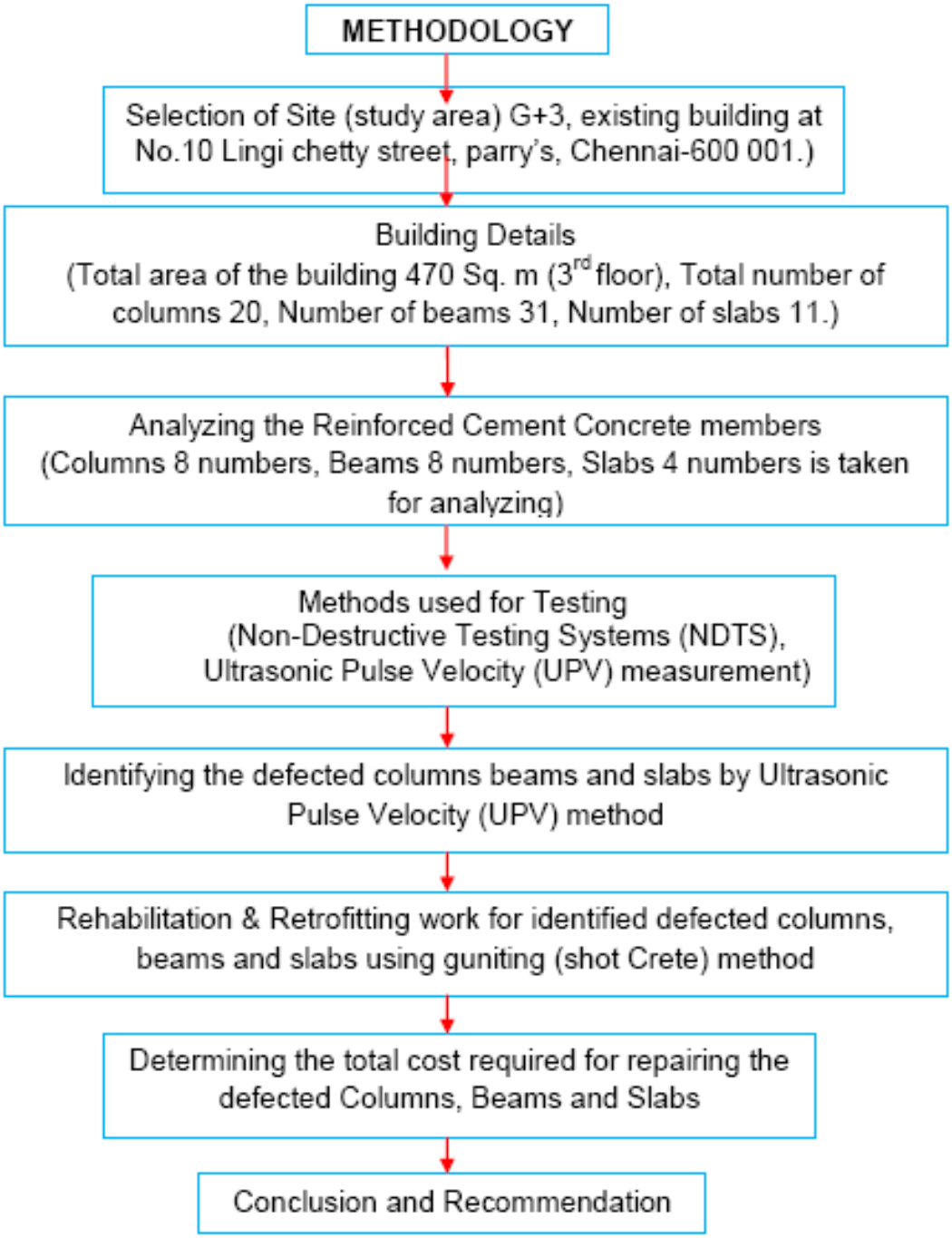
CHAPTER – 3

EXPERIMENTAL AND METHODS

3.1 REHABILITATION & RETROFITTING

The damaged structure or unused structure is modified as a good used structure is called rehabilitation and using technique is called retrofitting.

3.2 METHODOLOGY FLOW CHART



3.3 SELECTION OF SITE (STUDY AREA)

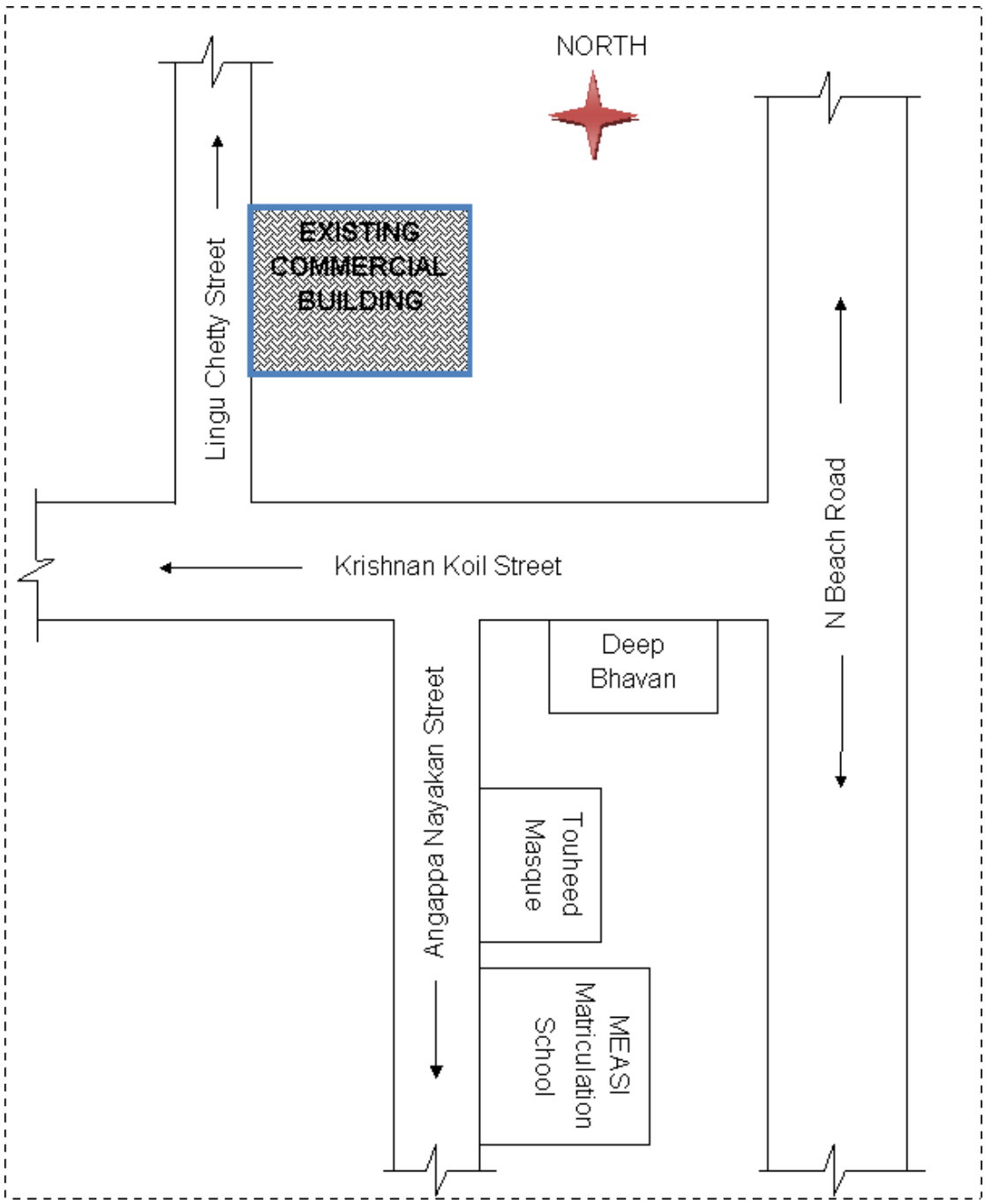


Fig: 3.1 Sketch showing the study area

3.4 AFFECTED COLUMNS, BEAMS AND SLABS

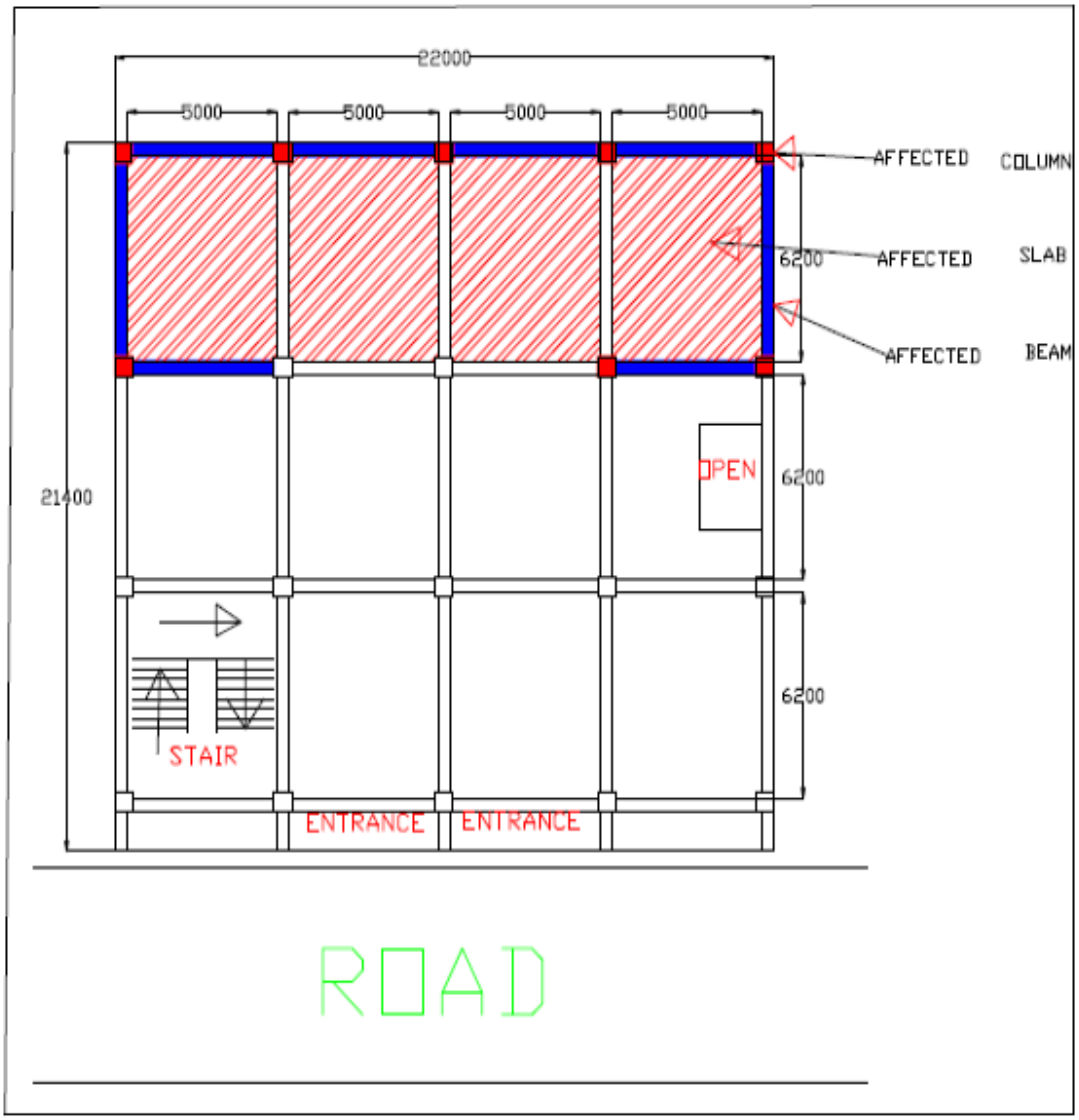


Fig: 3.2 Sketch showing the affected columns, beam and slabs of the existing building

3.5 ANALYSING METHOD

Ultrasonic Pulse Velocity (UPV) test is basically a wave propagation test and consists of transmitting Ultrasonic Pulses of 50 – 60 kHz frequency through a concrete medium and measuring the travel time of Ultrasonic Pulses for known or measured length.

To conduct Ultrasonic Pulse Velocity (UPV) measurement on the test carried out, to assess the homogeneity, integrity and uniformity of the concrete on the selected columns,and beams.

After conducting the above measurement, (UPV) on selected columns a detailed report consisting of the methodology adopted for UPV and findings has been presented below.

3.5.1 NON-DESTRUCTIVE TESTING SYSTEMS (NDTS)

- Ultrasonic Pulse Velocity (UPV) measurement

3.5.1.1 ULTRASONIC PULSE VELOCITY (UPV) MEASUREMENTS

Ultrasonic Pulse Velocity (UPV) test is basically a wave propagation test and consists of transmitting Ultrasonic Pulses of 50 – 60 kHz frequency through a concrete medium and measuring the travel time of Ultrasonic Pulses for known or measured length. The length divided by time gives the velocity which can be indirectly correlated to concrete quality. Based on correlation graphs, approximate estimation of concrete compressive strength can also be made with a variation of $\pm$ 20%. UPV values can also be suitably interpreted to assess the condition with regard to its homogeneity, integrity, identification of presence of voids, cracks, etc. in concrete and relative quality between or within members.

In this investigation UPV values have been interpreted to make a qualitative assessment with regard to any loss of integrity due to age of concrete.

3.6 WAYS OF MEASURING PULSE VELOCITY

- Direct Transmission
- Semi – direct Transmission
- Indirect or Surface transmission

Direct Transmission	- When opposite faces of a member are accessible (e.g. North – South or East – West) - Sketch – I.
Semi – direct Transmission	- When two adjacent sides of a member are accessible (e.g. North – East, North – West, South - East, South - West)- Sketch –II.
Indirect or Surface Transmission	- When only one side of member is accessible – Sketch – III.

Fig: 3.3: Column testing by directs transmission

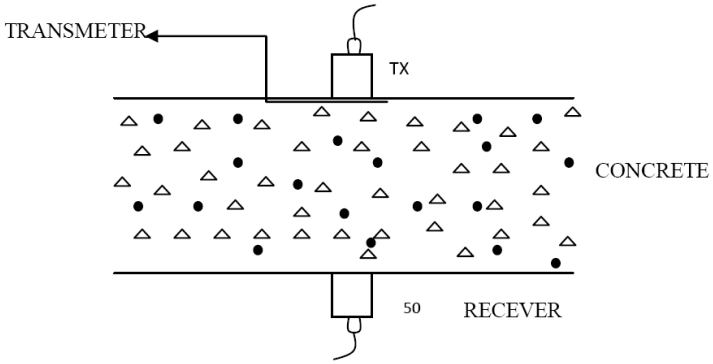


Fig. 3.4 Direct transmission

3.6.1 DIRECT TRANSMISSION

The direct transmission method is generally preferred since the maximum energy of the pulse is being directed at the receiving and this gives maximum sensitivity. In this investigation, this method is only used.

3.7 UPV MEASUREMENT TEST AT SITE (PROCEDURE)

Before taking UPV measurements in the columns, the selected columns on which grid points (200 x 300mm) were marked opposite faces (North – South or East to West faces) of the columns, the grid points are used for UPV measurement, the grid points dressed with carbarandum stone and cleaned in order to have smooth surface to contact the transducers surface properly with concrete surface, in order to have a steady reading. The transducers were kept on the opposite faces (direct method used) on the both surfaces grid points were applied small quantity of grease to obtain a perfect acoustic coupling. After ensuring that the readings obtained in the instrument remained steady and constant, that reading was noted and recorded. This procedure was repeated on all the grid points. The grid pattern is clearly mentioned in each drawing.

The general guidelines for quality assessment of concrete on UPV values "V" km/sec are given below:

"V" km/sec are given below as per as BIS 13311/Part – I

Table 3.1 Velocity range & Condition of concrete

S.No	Velocity range	Condition of concrete
1	"V" Greater than 4.50 km/sec	Excellent quality
2	"V" in the range of 3.50 to 4.50 km/sec	Good
3	"V" in the range of 3.00 to 3.50 km/sec	Medium
4	"V" Less than 3.00 km/sec	Doubtful

The analysis and interpretation of test results have been carried out in this Investigation on the base of above said guidelines (Table 3.1).

CHAPTER 4

4.1 RESULTS

Ultrasonic Pulse Velocity (UPV) test in this method, the ultrasonic pulse is produced by the instrument which travels through a known distance (L) in the concrete and is received at the other end. An electronic timing circuit enables the measurement of transit time (T) of the pulse. The velocity is given by V=L/T in Km/sec. The underlying principle of assessing the quality of concrete is that comparatively higher velocities are obtained, when the quality of concrete in terms of density, homogeneity and uniformity, is not good.

4.2 RESULTS IN GRAPH

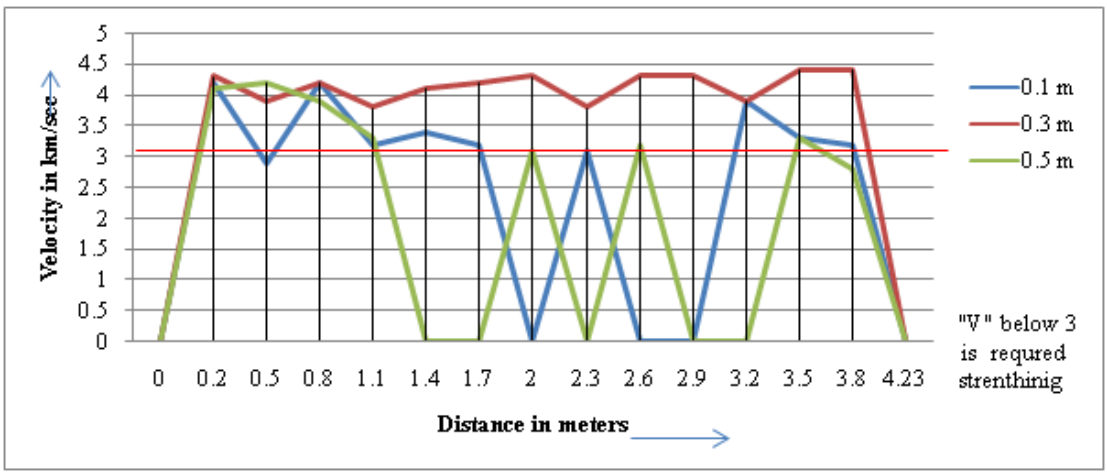
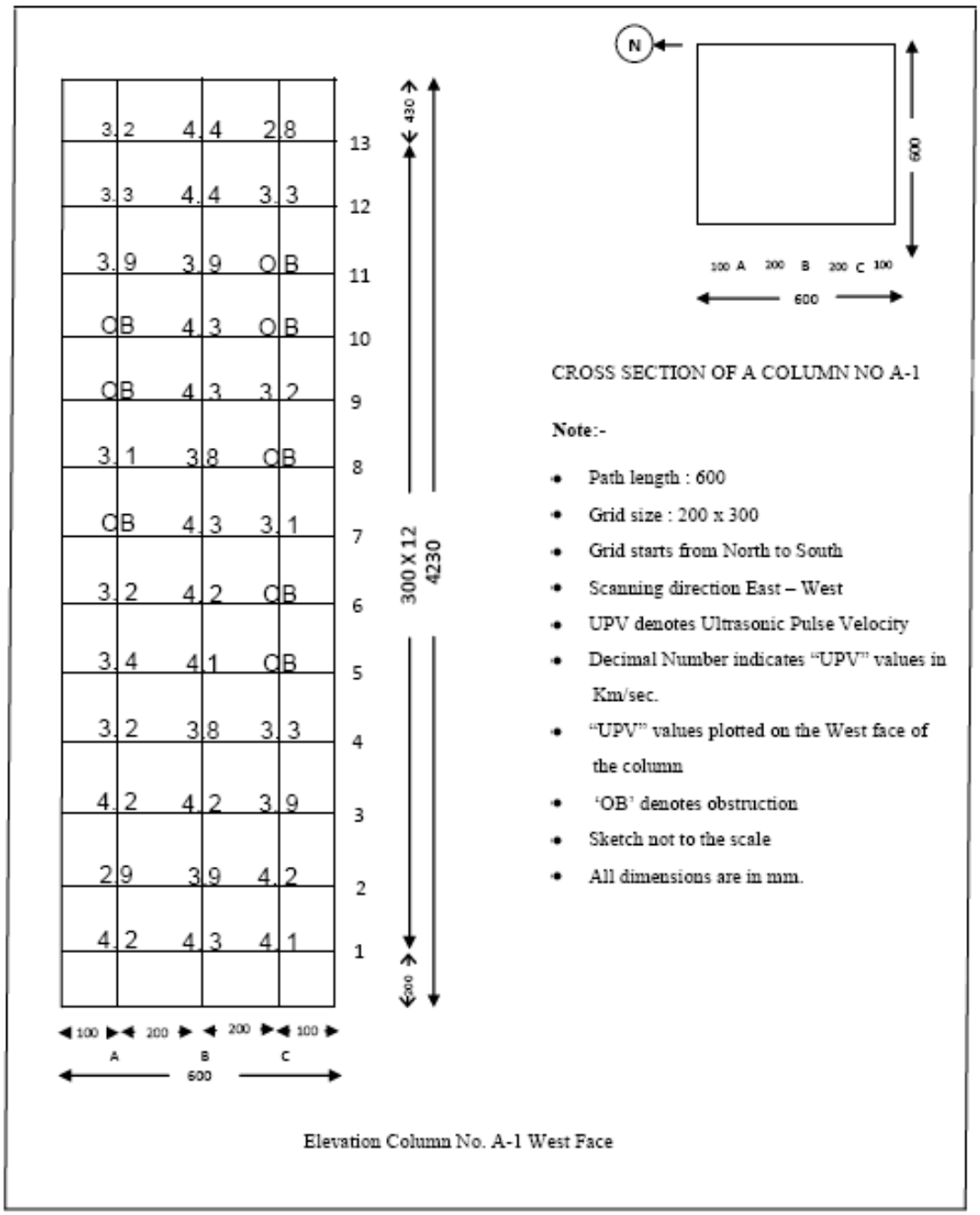


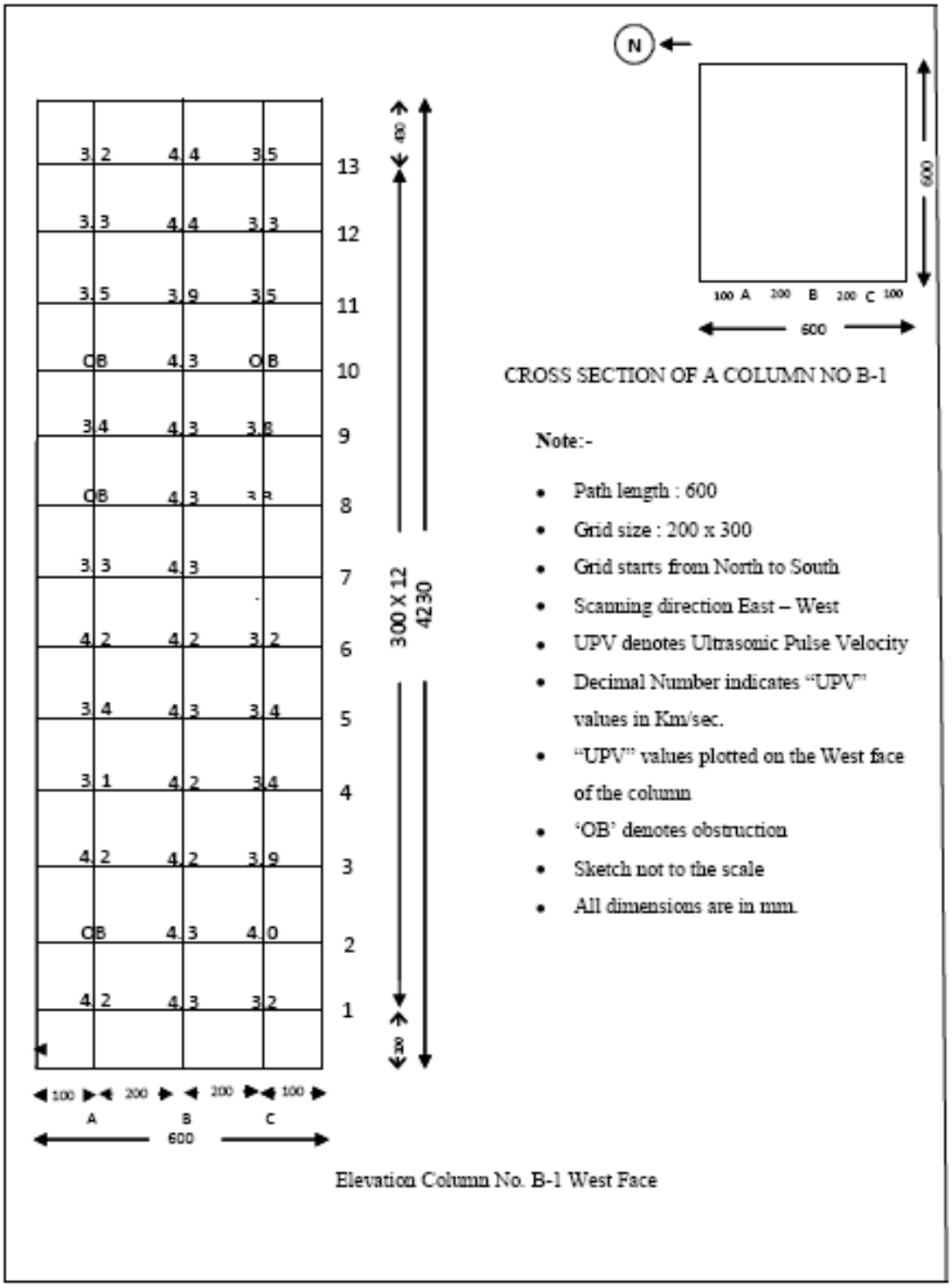
Fig: 4.1: Velocity variation at column A-1

The graph shows the variation of velocity in the particular column (column A-1) - (Figure 4.1) at the points 0.1m,0.3m,0.5m, respectively, the height of the grid point is 0.3m at each point.

The velocity variation in first layer that is 0.1m (blue) and third layer that is at 0.5m (green) shows the obstruction and low strength .Similarly the velocity in the particular column i.e. Column A-2, A-3,A-4, A-5 has been analyzed.



Elevation Column No. A-1 West Face


N
600
100 A 200 B 200 C 100
600
CROSS SECTION OF A COLUMN NO B-1
Note:-
Path length : 600
Grid size : 200 x 300
Grid starts from North to South
Scanning direction East – West
UPV denotes Ultrasonic Pulse Velocity
Decimal Number indicates "UPV" values in Km/sec.
"UPV" values plotted on the West face of the column
'OB' denotes obstruction
Sketch not to the scale
All dimensions are in mm.
3.2 4.4 3.5
3.3 4.4 3.3
3.5 3.9 3.5
OB 4.3 OB
3.4 4.3 3.8
OB 4.3
3.3 4.3
4.2 4.2 3.2
3.4 4.3 3.4
3.1 4.2 3.4
4.2 4.2 3.9
OB 4.3 4.0
4.2 4.3 3.2
13
12
11
10
9
8
7
6
5
4
3
2
1
400
300 X 12
4230
300
100 200 200 100
A B C
600
Elevation Column No. B-1 West Face

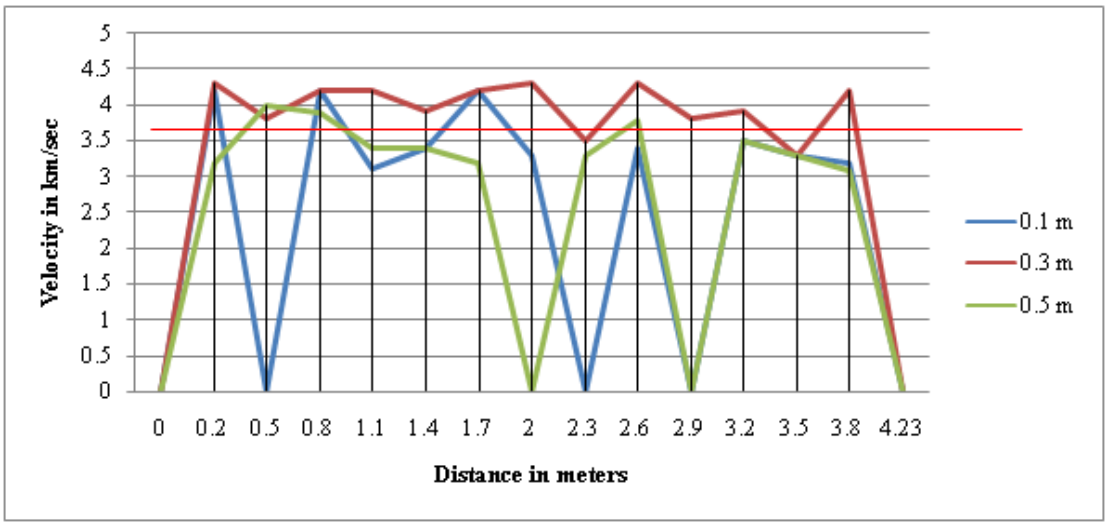
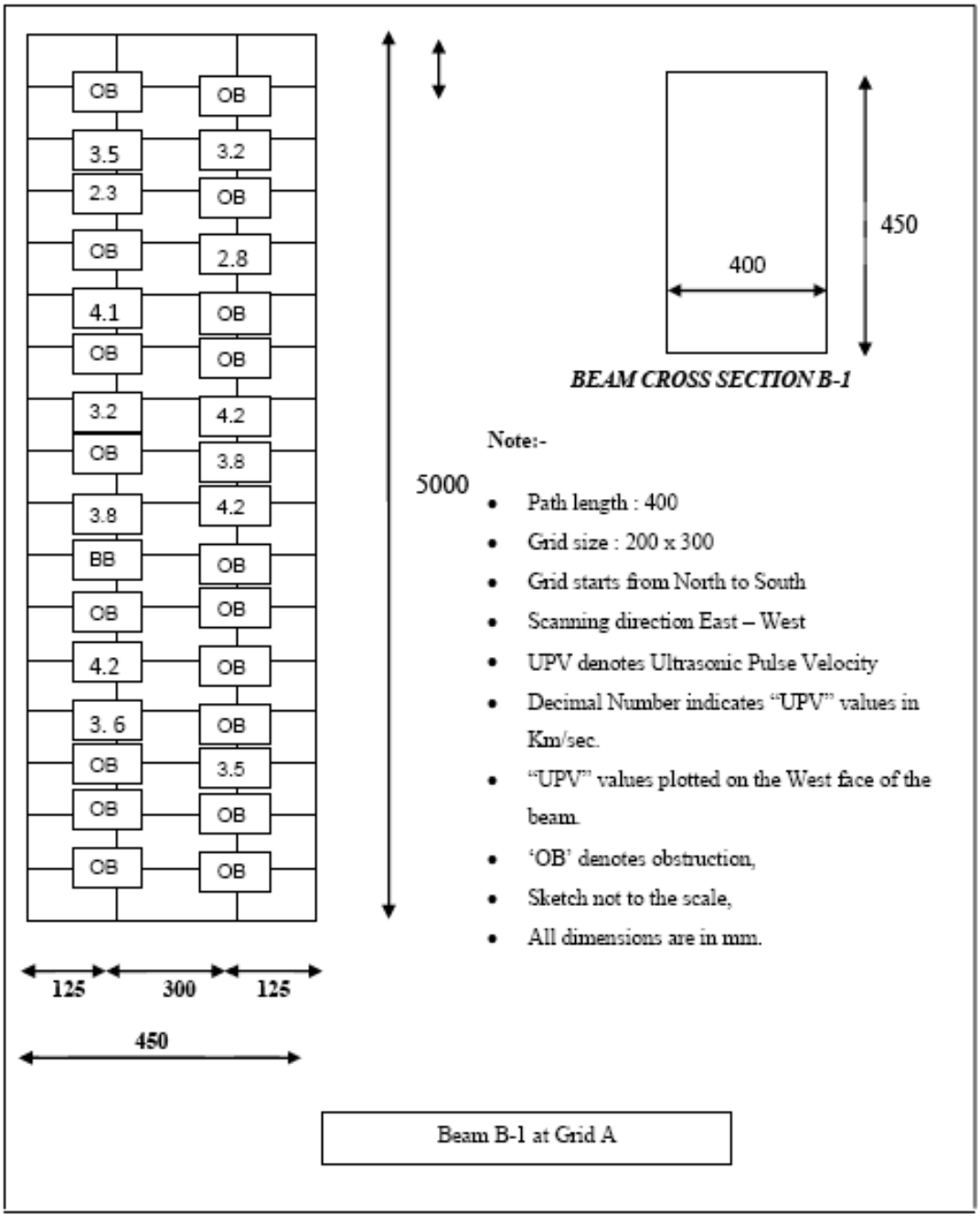


Fig: 4.2 velocity variation at column B-1

The graph shows the variation of velocity in the particular column (column B-1)- (Figure 4.2) at the points 0.1m, 0.3m, 0.5m, respectively the height of the grid point is 0.3m at each point. The velocity variation in first layer that is 0.1m (blue) and third layer that is at 0.5m (green) shows the obstruction and low strength.

The velocity variation in second layer that is at 0.3m (red) is good and safe. The velocity "V" below 3 km/sec is indicate low strength and should be required special attention for repair and retrofitting. Similarly the velocity in the particular column i.e. Column B-2, B-3,B -4, B-5 has been analyzed.

4.3 BEAM GRAPHS



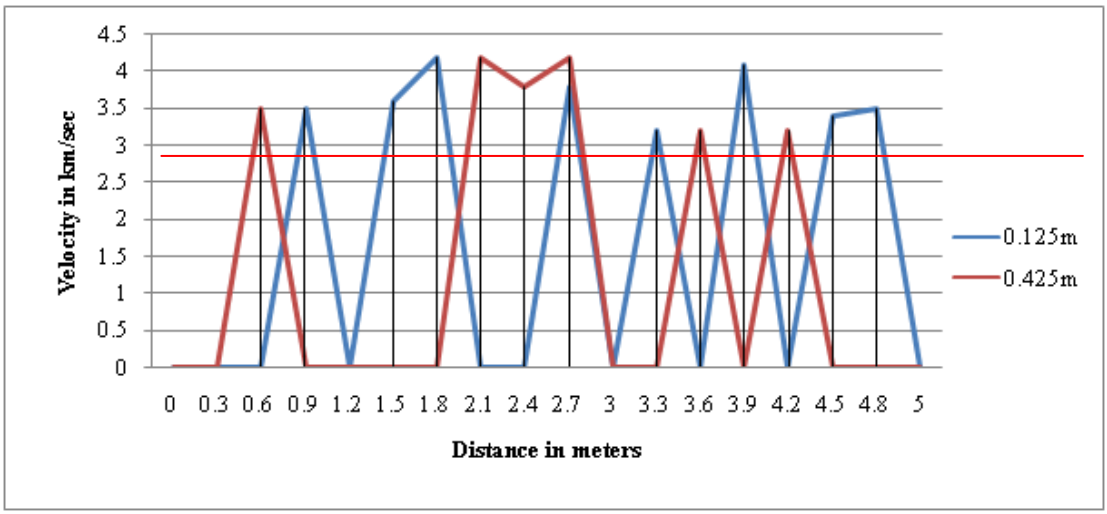


Fig: 4.3 Velocity variations at beam 1 at grid A

The graph shows the variation of velocity in the particular column - beam 1 at grid A (Figure 4.3) at the points 0.125m, 0.425m, respectively the height of the grid point is 0.3m at each point. The velocity variation in first layer that is 0.1m (blue) and third layer that is at 0.5m (green) shows the obstruction and low strength.

The velocity variation in second layer that is at 0.3m (red) is good and safe. The velocity "V" below 3 km/sec is indicate low strength and should be required special attention for repair and retrofitting. Similarly the velocity variation at bean 1 at grid A, beam 2 at grid A, beam 3 at grid A, beam 4 at grid A, beam 5 at grid B, beam 6at grid B, and velocity variation at corner beam 7 at A1 to B1, Velocity variation at corner beam 8 at grid A5 to B5, has been analyzed.

4.4 TYPES OF REPAIR MATERIALS

The basic materials of construction (such as steel, cement, concrete, bricks, stones, timber, paints, etc.) can all be used for repair work. The present text describes mainly repair materials other than basic construction materials.

Depending upon requirements, properties and use, the repair materials can be broadly categorized into following groups:

- Anti corrosion coatings
- Adhesives/Bonding Aids
- Repair Mortars
- Curing compounds
- Joints Sealants
- Grouts
- Waterproofing Systems for Roofs
- Special Concretes

- Migratory Corrosion Inhibitor
- Protective coatings
- Materials for special applications

4.5 REPAIR METHOD GUNITE/SHOTCRETE

Gunite is a cementitious repair material that is pneumatically applied to concrete surfaces. Shotcrete or gunite is mortar or concrete conveyed through a pressure line and pneumatically at a high velocity on to a damaged or worn out prepared surface. It has the advantages of requiring no formwork, self compacting and monolithic joints. Using specially graded aggregates and guniting equipment, 28- day equivalent cube strengths in excess of 50 N/mm^2 can be obtained. Reinforced gunite can be obtained by pinning the reinforcement to old surfaces and then guniting. Gunite lining are usually reinforced with steel bar fabric (Welded mesh) and the distribution steel may be more than that provided in the original concrete. Normally, gunite would have a w/c ratio of about 0.5, though w/c ratio up to 0.33can is used. Several types of fibers and additives are added to the gunites to improve its properties and performance.

4.5.1 DRYMIX SHOTCRETE

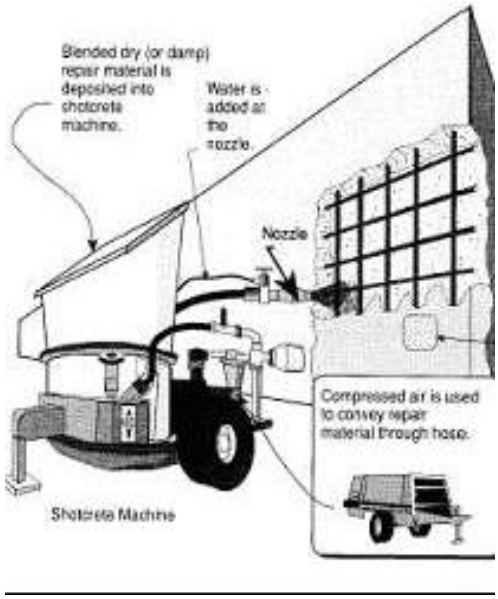


Fig: 4.17 Pumping technique

4.4.1.1 FORM AND PUMP TECHNIQUE

The form and pump repair method is a two step process of constructing formwork and pumping repair material into the cavity confined by formwork and existing concrete. The form and pump technique allows use of different materials. Repair

materials are mixed and pumped into the cavity. When the cavity is full, pump pressure is exerted into the form causing the repair material to consolidate and make contact with existing concrete surfaces

4.4.1.2 SURFACE REPAIR OF VERTICAL LOCATION (COLUMN)

One of the most common methods of surface repair of vertical and overhead location is placement of formwork and casting of repair material into the prepared cavity. The repair material must be of low shrinkage and necessary flow ability. Roding or internal vibration is necessary to remove air and provide intimate contact for placing concrete substrate. In some applications complete filling of the cavity may be difficult. In those cases a final step of dry packing the remaining cavity works well.

4.4.1.3 SURFACE REPAIR OF OVERHEAD LOCATION (BEAM)

There are many techniques available to restore damaged or deteriorated concrete structures. Each surface repair techniques offer advantages and limitations depending upon the conditions of the repair project. Form a pump technique is relatively new method which has been developed as a viable alternative to Shotcrete (gunite), hand placement and grouted preplaced aggregate techniques.

Problems associated with Dry mix Shotcrete

- Presence of voids due to encapsulated rebound
- Shrinkage cracking caused by high cement concrete ,improper curing or excessive water control

Dry mixing involves premixing of binders and aggregates which are fed into special mechanical feeder metering the premixed materials into a hose. The mix is jetted out along with compressed air from a nozzle connected to the hose having a water ring outfitted to it. This mix is injected to the repair spot. The resultant hardened properties include increased flexural, compressive strengths and more durability.

4.5 ESTIMATION

4.5.1 DETAILED MEASUREMENT AND CALCULATION OF QUANTITIES

Item no	Particulars	Nos	Length "m"	Breadth "m"	Height Or Depth "m"	Quantity Sq.mt
1.	Concrete repair surface:					
	Columns	1x8	2.40	_	4.23	81.22
	Beams	1x6	5.00	1.30	_	39.00
	Beams	1x2	6.20	1.30	_	16.12
	Slabs	1x4	6.20	5.00	_	124.00
						260.34

4.5.2 GUNITING WORK WITH CEMENT MORTAR 1:3 –Rate for 1m^2

Particulars	Quantity	Rate per	Unit	Amount
Cement	35 g	7.50	Kg	262.50
Sand	2.7 Cu.ft	40.00	Cu.ft	100.00
Chemicals	0.175 Lts	360.00	Lts	63.00
Weld Mesh	1m^2	95.00	m^2	95.00
Labour charges	1m^2	900.00	m^2	900.00
Other charges	_	_	_	300.00
			Total	**1720.50**

RATE FOR 1M^2 -1720.00

4.5.3 DETAILED ESTIMATE WITH COSTING

Sl.No.	Particulars	Qty	Unit	Rate Rs.	Amount Rs.
1.	Providing Repair by gunting work including , a) Chipping and removing loosely held concrete at honey combed area. b) Cleaning the steel rods with steel wire brush to remove the rust and splash the concrete surface with water to clean the surface. c) Additional steel shall be introduced by tied or welding. a) Applying a coat of anti corrosive coating like "Zentrifix KMH" manufactured by "MC bauchemie" India Pvt. Ltd, to all the old and new Reinforcements. e) fixing of weld mesh of 2" x 2" at the top of reinforcement around columns and beams. f) Providing gunting with cement and sand at 1:3 mix ratio (1 cement: 3 sand) using gun with compressor for a thickness of 30 to 40 mm (Maximum) and curing the same and all complete.	260	m^2	1720.00	4,47,200.00
				TOTAL	**4,47,200.00**

CHAPTER – 5

5.1 SUMMARY

Thousands of buildings are constructed every year. Though initially these buildings are built stronger and carefully, but maintenance is necessary to sustain serviceability. Serviceability depends on durability. Durability of building structures is one of the greatest challenges that building technologists face today. One ton steel is lost every 14 seconds due to corrosion alone in RCC in India. Durability is the property of a structure to give a satisfactory performance and service for design life with minimum maintenance. American Concrete Institute (ACI) defines durability of concrete as its ability to resist weathering chemical attack, abrasion or any other process of deterioration under service conditions.

Normally, Concrete provides adequate protection to embedded steel, provided there is enough cover to steel and the concrete is also sufficiently impermeable. Durability of concrete or RCC is affected by its strength, and other properties such as air content, permeability, water tightness, and volumetric stability. Type of concrete materials and their proportions, construction practices and exposure conditions also affect durability of the structures.

5.2 CONCLUSION

- Periodic maintenance of structures is essential.
- Each and every problem should be properly analyzed and then the appropriate repair, methods undertaken.
- Primary design of the building reflects its performance in long run.
- Each repair technique is suitable only for the particular application for which it is meant for.
- Form and Pump technique which has become the alternative for grouting, guniting nowdays is also cost effective in large scale operations.
- Cost should not be significant planning factor in rehabilitation though it is a deciding factor.