STRUCTURAL AUDIT OF 30 YEAR OLD SCHOOL BUILDING AND ITS STRENGTHENING

[1]Monis Azhar Ansari, [2]Shrikant Solanke, [3]Aashish Soni

[1]Research Scholar, [2] Assistant Professor, [3]Structural Engineer
[1]Department of Civil Engineering,
[1]G.H.Raisoni College of Engineering, Nagpur, (Maharashtra), INDIA.

Abstract- Structural audit belongs to two test which is Destructive and Non-Destructive test. We will conclude Non-Destructive test which is in form of Rebound Hammer test and Ultrasonic Pulse velocity test. To know the building strength and structural stability of structure, we can used Non-Destructive testing. Generally structural audit is carried on old building to avoid structural accident. Non-Destructive testing is help for improving life of structure and safety parameter. We present study in this paper is structural audit of 30 years old school building, that structural age is 30 years old, now this building is found to be weak in structural point of view. We should be carried testing this building. The testing is used on this building is Non-Destructive test, Rebound Hammer test. After testing according to their Non-Destructive test result.

Key words: Structural audit, NON-Destructive testing, STAAD Modelling, Structural plan, Demand to capacity ratio, Repair and retrofit.

1. INTRODUCTION

Rescue checks are common health condition, when doctors examine patients, they conduct rescue tests. A structural audit helps determine the condition of old buildings. The Audit helps with projects planning and testing of all the hazardous area, critical areas and building. Immediate attention is needed. This includes a basic analysis of forests that are still alive and weak, structural space and wind perception. If the bldg. if the consumer has been converted from domestic to commercial or individual, this should leads to this change.

1.1 Mandatory for Structural Testing

Structural audit is carried out in order to

- To extend the life of structure.
- Recognize the expected building situation and life.
- For design accuracy.
- Recommend rehabilitation techniques.
- To highlight areas damages and reconstruct quickly.
- For structural tests reports required by the city government and other agencies.

Structural audit involves over and done with inspection of the building which involves:

Noting all detectable cracks, underlining dangerous zone of cracks. Identification of damage. Carrying out crucial NDT, Suggesting helpful processes.

1.2 Project Objective

- First building inspection.
- Preparation of building architecture plans, structural plans for buildings.
- Visual investigation to damage detection.
- Conduct non-destructive test
- Determination of the buildings actual endurance.
- Suggestions for corrective actions.

2. METHODOLOGY

Preliminary research of the building

↓

Preparation of Architectural plan of The building

↓

Performance of Non-Destructive Test of building

↓

Modelling of building by using STAAD-PRO V8i Software

↓

Suggesting corrective measure

Fig 2.1 Methods for Analysis

3. INSPECTION AND BUILDING DETAILS

Fig 3.1 Sidhheshwar School

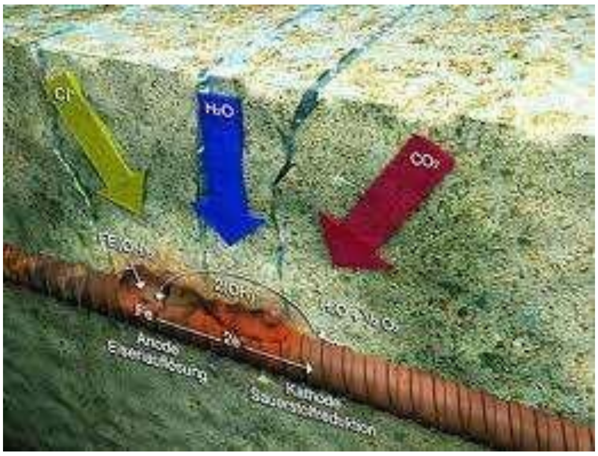

Fig 3.2 Reinforcement Expose in Cantilever Slab

4. NON DESTRUCTIVE TESTIING

Hammer deflection test is a concrete Non-Destructive testing method that provides a useful and accelerated signal for the compressive strength of concrete. The impact hammer is also called as Schmidt hammer, which contents a spring controlled mass that glides on the piston in the tube lining.

NDT tests are important when checking complaints from bridges, highways, building etc. with NDT users can define the following object properties.

4.1 Classification of NDT Techniques.

1: Non Destructive Tests for Concrete

- Hammer Rebound Test
- Ultrasound Pulse Test

4.2 Rebound Hammer

(a) Measuring the possible compressive quality of cement with the support of proper co-relations amongst bounce back list and compressive quality.
(b) Measuring of concrete consistency.

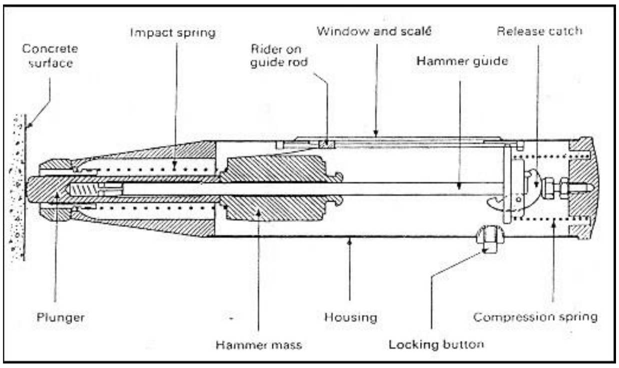

Fig 4.1 Components of Rebound hammer test

Test Method:

1. Use the grind stone to smooth the test surface.
2. Do some hammer test effects on this smooth and hard surface before choosing the size you would appreciate. Check the test consistency of test foundation.
3. Make sure all settings are acceptable.
4. Then placed the hammer perpendicular to the test surface. Press the concrete test hammer to the surface at medium speed until the effect is triggered. Note that the piston generates a discount when set. It is therefore recommended to hold the rebound perpendicular to the test surface hammer with both hands, before performing a collision.

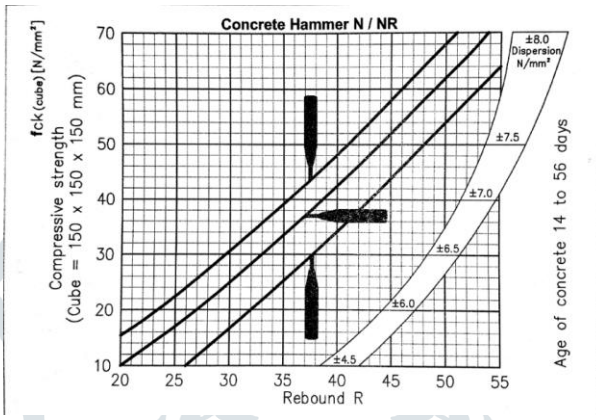

Fig 4.2 Rebound No. Vs. Compressive Strength

4.3 Ultrasonic Pulse Velocity Test

4.3.1 Introduction

The U.P.V method has been used successfully more than 75 years to calculate concrete superiority. This method is often used to detect internal gaps and other defects and changes in cement, for example, B. harm because of forceful concoction atmosphere as well as freezing and thawing. The pulse method can indeed be the N.D.T method, because power uses mechanical wave that result in the loss of the presence of the solid components being tested. Devices as are tested often repeatedly tested an equivalent area, which is valuable for observing certain inward basic changes over significant stretches of time.

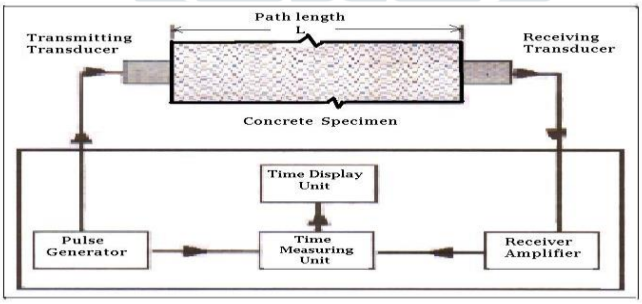

Fig.4.3 Schematic Diagram of Ultrasonic Pulse Velocity Method

4.3.2 Apparatus

According to IS13311 (Part 1):1992, the contraption for U.P.V estimation be going to comprise of the accompanying

1) Electric heartbeat generator
2) Amplifier
3) Electronic synchronization gadget
4) Sensors -one sets

Fig.4.4 Ultrasonic Pulse Velocity Testing Instrument

5. RESULTS

5.1 REBOUND HAMMER TEST

5.1.1. Pre Strengthening Test Results

Table 5.1: Rebound Hammer Test Result

SR. NO.	DESCRIPTION	REBOUND NO.									AVG.	REMARK
GROUD FLOOR												
1.	Column C1	24	28	20	18	24	26	22	28	20	24	
2.	Column C2	30	22	26	26	22	20	20	20	18	23	
3.	Column C4	22	22	26	20	20	24	22	26	28	24	
4.	Column C7	24	24	26	28	22	20	24	30	22	25	
5.	Column C8	18	26	20	20	28	24	20	22	22	23	
6.	Column C10	26	28	24	22	22	24	28	22	24	25	
7.	Column C11	28	22	22	26	26	28	20	22	22	24	
8.	Column C13	30	26	22	26	24	24	20	18	22	24	
9.	Column C16	20	20	20	18	26	24	24	20	22	22	
10.	Column C17	28	22	22	26	26	28	20	22	22	24	
11.	Column C18	30	30	26	22	24	24	20	18	22	24	
12.	Column C19	20	20	20	18	26	24	24	20	22	22	
13.	Column C22	24	24	22	24	26	26	20	24	22	24	
14.	Column C23	30	28	24	24	26	26	20	28	22	26	
15.	Beam No. B1	26	28	24	26	24	26	22	24	28	25	
16.	Beam No. B2	24	20	24	26	22	24	28	24	22	23	
17.	Beam No. B3	20	18	18	20	22	24	22	26	30	22	
18.	Beam No. B4	18	22	22	26	26	20	30	28	28	24	

19.	Beam No. B5	26	22	20	28	26	20	30	22	20	24	
20.	Beam No. B6	26	22	20	18	24	26	24	22	28	23	
21.	Slab No. S1	18	20	20	20	28	20	26	24	26	22	
22.	Slab No. S2	22	22	20	20	18	20	30	22	30	23	
23.	Slab No. S3	18	22	20	22	24	18	24	26	28	22	
24.	Slab No. S4	26	18	22	20	24	18	22	28	30	23	
FIRST FLOOR												
25.	Column C1	24	24	20	20	24	26	20	26	28	24	
26.	Column C2	20	22	20	26	28	24	20	28	26	24	
27.	Column C3	26	22	24	28	22	24	22	28	26	25	
28.	Column C5	28	20	26	28	28	22	22	24	24	25	
29.	Column C6	28	26	24	24	24	26	22	26	28	25	
30.	Column C9	30	28	30	24	26	26	26	24	28	27	
31.	Column C12	20	24	28	22	20	24	20	18	18	22	
32.	Column C14	20	20	22	24	24	24	22	22	22	22	
33.	Column C15	24	20	22	26	22	26	26	22	24	24	
34.	Column C16	22	20	28	24	26	22	24	26	20	24	
35.	Column C17	26	22	18	26	22	20	18	18	24	22	
36.	Column C18	24	24	26	18	20	22	26	20	24	23	
SECOND FLOOR												
37.	Column C19	22	20	24	24	24	24	22	20	20	22	
38.	Column C20	26	20	24	24	20	20	22	18	22	25	
39.	Column C21	24	24	20	20	18	18	26	24	22	22	
40.	Column C24	26	22	18	26	22	20	18	18	24	22	
41.	Column C25	24	24	26	18	26	20	22	26	20	23	
42.	Column C26	26	22	18	26	22	20	18	18	24	22	

5.1.2 Post Strengthening Test Results

Table 5.2: Rebound Hammer Test after Strengthening Result

SR. NO.	DESCRIPTION	REBOUND NO.									AVG.	REMARK
GROU D												
1.	Column C1	36	36	34	32	34	30	32	38	28	33	
2.	Column C2	40	42	38	34	38	32	36	28	30	35	
3.	Column C4	32	26	34	28	32	30	36	30	34	31	
4.	Column C7	34	32	36	30	28	26	34	26	30	31	
5.	Column C8	36	32	34	38	36	30	28	26	24	31	
6.	Column C10	36	38	30	34	28	26	22	24	30	30	
7.	Column C11	28	30	28	34	26	30	32	38	28	30	
8.	Column C13	38	26	32	28	34	28	30	32	34	31	
9.	Column C16	38	30	32	34	28	36	30	24	30	31	
10.	Column C17	38	34	38	34	32	40	42	38	32	33	
11.	Column C18	30	28	30	34	32	32	34	36	38	35	
12.	Column C19	40	38	42	36	42	42	38	36	30	36	
13.	Column C22	34	30	28	30	28	30	34	28	30	32	
14.	Column C23	30	34	30	28	30	34	28	30	32	32	
15.	Beam No. B1	40	38	26	32	36	30	32	34	36	33	
16.	Beam No. B2	28	36	34	32	28	30	34	36	32	36	
17.	Beam No. B3	34	30	32	28	40	26	30	32	38	34	
18.	Beam No. B4	28	32	26	30	38	32	34	30	32	30	
19.	Beam No. B5	36	34	28	22	36	34	30	32	28	36	
20.	Beam No. B6	30	38	34	36	38	34	40	32	38	33	
21.	Slab No. S1	28	24	32	28	30	36	30	28	30	29	
22.	Slab No. S2	36	34	38	28	24	26	28	30	36	34	
23.	Slab No. S3	30	34	32	28	36	30	28	26	30	30	
24.	Slab No. S4	36	30	32	28	30	34	36	28	30	35	
FIRST FLOOR												
25.	Column C1	36	38	32	38	36	38	40	30	28	27	
26.	Column C2	36	36	34	32	34	30	32	38	28	35	
27.	Column C3	40	42	38	34	38	32	36	28	30	36	
28.	Column C5	32	26	34	28	32	30	36	32	34	29	

29.	Column C6	34	32	36	30	28	26	34	26	30	32	
30.	Column C9	36	32	34	38	36	30	28	26	24	35	
31.	Column C12	36	38	30	34	28	26	22	24	30	36	
32.	Column C14	28	30	28	34	26	30	32	38	28	29	
33.	Column C15	38	26	32	28	34	28	30	32	34	32	
34.	Column C16	34	32	36	30	28	26	34	26	30	33	
35.	Column C17	36	32	34	38	36	30	28	26	24	29	
36.	Column C18	28	30	28	34	26	30	32	38	28	34	
SECOND FLOOR												
37.	Column C19	30	32	28	36	38	36	34	32	30	31	
38.	Column C20	34	32	36	30	28	26	34	26	30	27	
39.	Column C21	36	3	34	38	36	30	28	26	24	36	
40.	Column C24	36	38	30	34	28	26	22	24	30	29	
41.	Column C25	28	60	28	34	26	30	32	38	28	32	
42.	Column C26	30	38	34	36	38	34	40	32	38	33	

5.1.3 INTERPRETATION OF RESULTS

Table 5.3: Rebound Hammer Test Result

Sr. No.	Description	No. of Points	Rebound Hammer Test			
			Max.	**Min.**	**Average**	**Probable Compressive Strength (MPa)**
GROUND FLOOR						
1.	Before Repair	126	27.77	18.88	23.33	15.00
	After Repair	135	28.22	18.89	23.56	17.00
FIRST FLOOR						
2.	Before Repair	126	23.50	15.56	19.53	10.00
	After Repair	90	25.11	18.67	21.89	14.00
SECOND FLOOR						
3.	Before Repair	126	24.9	16.9	20.89	12.00
	After Repair	54	28.4	19.5	24.01	17.00

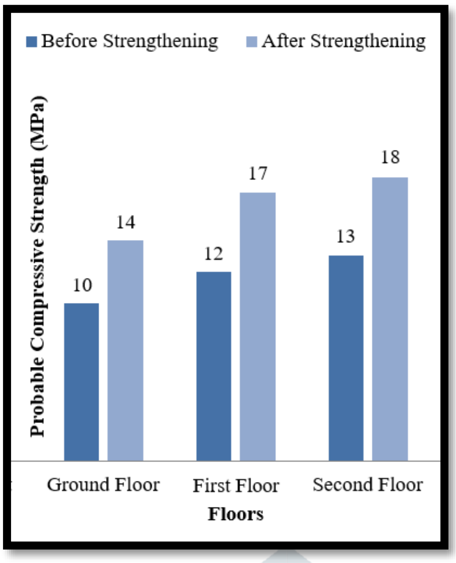

Fig. 5.1 Comparison of Compressive Strength

5.2 ULTRASONIC PULSE VELOCITY TEST

5.2.1 PRE STRENGTHENING TEST RESULTS

Table 5.4: Ultrasonic Pulse Velocity Test Result

Sr. No.	Description	Type of Methods	No. of points.	Transit Time (T) in Micro Seconds	Path Length (L) in mm	Velocity V= L/T in Km/Sec	Corrected Factor Reading
GROUND FLOOR							
1.	Column C1	Direct	06	90.9	230	2.53	2.53
2.	Column C2	Direct	08	91.2	250	2.74	2.74
3.	Column C4	Direct	06	92.6	250	2.70	2.70
4.	Column C7	Semi Direct	06	195.1	169.70	0.87	1.87
5.	Column C8	Direct	06	76.4	230	3.01	3.01
6.	Column C10	Direct	09	292.7	600	2.05	2.05
7.	Column C11	Direct	06	120.8	250	2.07	2.07
8.	Column C13	Direct	06	271.7	250	0.92	0.92
9.	Column C16	Direct	09	94.3	230	2.44	2.44
10.	Column C17	Direct	07	72.3	230	3.18	3.18
11.	Beam B1	Direct	04	53.5	170	3.18	3.18

12.	Beam B2	Direct	04	59.0	160	2.71	2.71
13.	Beam B3	Direct	03	52.6	170	3.23	3.23
14.	Beam B4	Direct	04	44.9	170	3.79	3.79
15.	Beam B5	Direct	04	70.4	150	2.13	2.13
16.	Beam B6	Direct	04	43.4	150	3.46	3.46
17.	Slab S1	Indirect	06	102.0	200	1.96	2.96
18.	Slab S2	Indirect	06	7.78	200	2.57	3.57
19.	Slab S3	Indirect	12	76.3	200	2.62	3.26
FIRST FLOOR							
20.	Column C1	Indirect	04	250.0	200	0.08	1.80
21.	Column C2	Indirect	04	160.0	200	1.25	2.25
22.	Column C3	Indirect	04	165.3	200	1.21	2.21
23.	Column C5	Indirect	04	196.1	200	1.02	2.02
24.	Column C8	Indirect	04	183.9	200	1.15	2.15
25.	Column C9	Indirect	04	163.9	200	1.22	2.22
26.	Column C12	Indirect	03	83.6	230	2.75	2.75
27.	Column C14	Indirect	05	110.0	230	2.575	2.75
28.	Column C15	Indirect	05	151.5	200	1.32	2.32
29.	Column C18	Direct	06	86.8	230	2.65	2.65
SECOND FLOOR							
30.	Column C19	Indirect	10	139.9	200	1.43	2.43
31.	Column C20	Indirect	12	102.6	200	1.95	2.95
32.	Column C21	Indirect	15	109.9	522	1.82	2.82
33.	Column C22	Direct	08	80.4	230	2.86	2.86
34.	Column C23	Indirect	09	102.6	200	1.95	2.95
35.	Column C24	Indirect	05	129.9	200	1.54	2.54
36.	Column C25	Indirect	09	183.5	200	1.09	2.09

Sr. No.	Description	Type of Methods	No. of points.	Transit Time (T) in Micro Seconds	Path Length (L) in mm	Velocity V= L/T in Km/Sec	Corrected Factor Reading
GROUND FLOOR							
1.	Column C1	Direct	04	146.6	450	3.07	3.07
2.	Column C2	Direct	04	88.5	230	2.60	2.60
3.	Column C4	Direct	03	61.3	230	3.75	3.75
4.	Column C7	Semi Direct	04	107.0	200	1.87	2.87
5.	Column C8	Direct	04	114.3	200	1.75	2.75
6.	Column C10	Direct	04	67.8	230	3.39	3.39
7.	Column C11	Direct	04	203.4	600	2.95	2.95
8.	Column C13	Direct	04	78.8	230	2.92	2.92
9.	Column C16	Direct	04	83.0	230	2.77	2.77
10.	Column C17	Direct	04	71.7	230	3.21	3.21
11.	Beam B1	Direct	04	109.9	200	1.82	2.82
12.	Beam B2	Direct	04	115.8	300	2.59	3.59
13.	Beam B3	Direct	05	122.0	200	1.64	1.64
14.	Beam B4	Direct	04	104.2	200	1.92	2.92
15.	Beam B5	Direct	04	109.9	200	1.82	2.82
16.	Beam B6	Direct	04	132.5	200	1.51	2.51
17.	Slab S1	Indirect	04	113.6	200	1.76	2.76
18.	Slab S2	Indirect	04	121.2	200	1.65	2.65
19.	Slab S3	Indirect	04	133.3	200	1.50	2.50
FIRST FLOOR							
20.	Column C1	Indirect	04	107.5	200	1.86	2.86
21.	Column C2	Indirect	04	122.0	200	1.64	2.64
22.	Column C3	Indirect	04	107.5	200	1.86	2.86
23.	Column C5	Indirect	04	111.1	200	1.80	2.80
24.	Column C8	Indirect	04	90.5	200	2.21	3.21
25.	Column C9	Indirect	04	110.5	200	1.81	2.81

26.	Column C12	Direct	04	126.6	200	1.58	2.58
27.	Column C14	Direct	04	120.5	200	1.66	2.66
28.	Column C15	Indirect	04	111.1	200	1.80	2.80
29.	Column C18	Direct	04	92.2	200	2.17	3.17
20.	Column C1	Indirect	04	107.5	200	1.86	2.86
SECOND FLOOR							
30.	Column C19	Indirect	04	84.0	200	2.38	3.38
31.	Column C20	Indirect	04	101.0	200	1.98	2.98
32.	Column C21	Indirect	04	85.8	200	2.33	3.33
33.	Column C22	Direct	04	103.1	200	1.94	2.94
34.	Column C23	Indirect	04	100.0	200	2.00	3.00
35.	Column C24	Indirect	04	89.7	200	2.23	3.23
36.	Column C25	Indirect	04	111.1	200	1.80	2.80

5.2.2 POST STRENGTHENING TEST RESULTS

Table 5.5: Ultrasonic Pulse Velocity Test after Strengthening Result

5.2.3 INTERPRETATION OF RESULTS

Table 5.6: U.P.V Test Result

Sr. No.	Description	No. of Points	Ultrasonic Pulse Velocity (Km/Sec)		
			Max.	Min.	Average
GROUND FLOOR					
1.	Before Repair	69	2.91	0.97	1.94
	After Repair	52	3.75	2.60	3.18
FIRST FLOOR					
2.	Before Repair	43	2.75	1.80	2.28
	After Repair	56	3.21	2.50	2.86
SECOND FLOOR					
3.	Before Repair	68	3.82	2.03	2.93
	After Repair	24	3.38	2.80	3.09

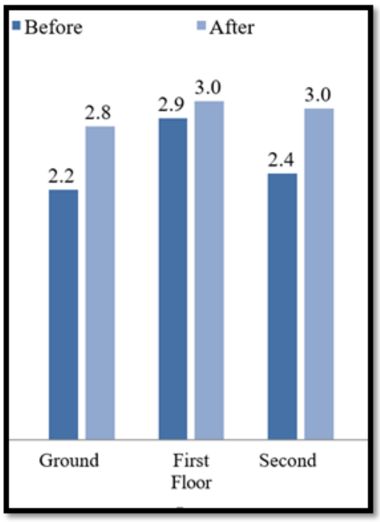

Fig. 5.2 Comparison of U.P.V Test Results

6. CONCLUSION:

Significant technical solutions are expected to assess correct estimation. Misunderstanding is conceivable if the contact is fail. For instance, now and again it is absurd to expect to distinguish bar that have high corrosion activity with respect to low concrete. However, substandard concrete may appear that may explain the growing problem with the pillar. The poor quality concrete leads to corrosion due to moisture and oxygen approaching the reinforcement.

If the difference in the properties of concrete affects the test outcomes (particularly in inverse headings), then the person using this method won't be happy with the investigation and evaluation of the necessary properties. Then, instead of using individual functions, you can get more stable results using advanced function. For example, increase the moisture content of concrete increases U.P.V, but reduces the number of cracks. Later, the joint use of two technologies reduces the number of errors caused by the evaluation of concrete using one technology. I tried for this amount of rebound and U.P.V. This was completed with real immutability. Inaccurate, the equation requires preliminary data for a particular material in the instruction to get reliable and expected results.

Schmidt hammer offer a modest, easy and fast way to find sign of solid quality. However, a precision of ±15 to ±20 % is only feasible for samples and samples under conditions where a calibration curve is known. The results is factor such as surface softness, sample size and shape, concrete moisture, type of cement and gross inertia and the degree of surface carbonization.

In short, it can be said that pulse frequency experiments have very good potential for solid control, especially by starting consistency and identifying breaks and imperfections. Its utilization in anticipating quality is significantly more restricted due to many variables the affect the relationship between intensity and heart rate.

7. FUTURE SCOPE OF WORK:

- To determine Structural Stability, it is important to assess the state of each building or RCC structure.
- The building is not fortified to install cement slurry i.e. Epoxy mortar and Fine Cement, RCCcoating required.
- We also offer a steel casing to strengthen the Building.
- Carbon packing is also a major reinforcing agent.

8. REFRENCES:

1. I.H SHAH:" Structural audit of RCC Building" 2008

2. National disaster management division:" Condition assessment of the building and seismic up gradation"

3. Central Public Works Department (CPWD), Government of India, New Delhi" CPWD Handbook on Repair and Rehabilitation of RCC Structures", Published 2002.

4. Dr.G.S,Suresh" Seismic performance and evaluation "

5. B.H Chafekar,O.F.Kadam "Structural Audit" International Journal Of Civil And Structural Engineering Research (IJCSER), Vol. 1, Issue 1, Published 2013

6. Guwahati Metropolitan Development Authority Bhangagarh, Guwahati-781005:" DETAILED PROCEDURE OF TECHNICAL SAFETY AUDIT "Published 2012

7. M.Rodriegies" Repair and strengthening of existing building for earthquake resistance "Published 1988

8. List of Indian Standards for Non Destructive Testing

9. Indian Standard SEISMIC EVALUATION AND STRENGTHENING OF EXISTINING REINFORCED CONCRETE BUILDINGS — GUIDELINES IS15988:2013

10. Patil S.R, Prof Sayyed "Structural audit" IOSR Journal of Mechanical and Civil Engineering (IOSR- JMCE) e-ISSN : 2278-1684, p-ISSN : 2320–334X PP 60-64,Published 2015

11. K.R Sonawane,Dr A.W Dhawale "Structural audit case study of RCC building in Nasik"Indian journal of research,ISSN- 2250-1991,VOL 4,issue 6,Published 2015