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Strength Evaluation, Repair & Retrofitting of RC Structure

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Abstract:- Non-Destructive Testing (NDT) could be a wide cluster of study techniques utilized in science and trade to judge the properties of a cloth, part or system while not inflicting injury, as a result NDT doesn't for good alter the article being inspected, it's an extremely valuable technique that may save each cash and time in product analysis, troubleshooting, and analysis. By definition, non-destructive testing is that the testing of materials, for surface or internal flaws or scientific discipline condition, while not busy bodied with the integrity of the fabric or its suitableness for service. A certain degree of ability is needed to use the techniques properly so as to get the most quantity of data regarding the merchandise, with resultant feedback to the assembly facility. Non-destructive Testing isn't simply a technique for rejecting substandard material; it's conjointly associate assurance that the purportedly sensible is nice. The technique uses a range of principles there's no single methodology around that a recorder could also be engineered to satisfy all needs altogether circumstances.

***Keywords*:-** *NDT, UPV, Rebound Hammer, Retrofitting.*

I. INTRODUCTION

The basic technique of proving whether or not concrete complies with the specification is to check its strength by means that of cubes or cylinders made of samples of recent concrete. It should be noted that non-compliance by one take a look at specimen or perhaps by cluster, doesn't essentially mean that the concrete from that the take a look at specimens have been created is inferior thereto such. This necessitates NDT on the concrete within the structure. In NDT, the event has taken place to such associate extent that it's currently thought-about as a prevailing technique for evaluating existing concrete structure with relation to their strength, durability, investigation of crack depth, microcracks and progressive deterioration are studied by this technique heavy their structural integrity.

The aim of this project is to elaborate; however, the NDT is finished victimization numerous strategies like supersonic Pulse rate take a look at, Rebound Hammer and Profometer for mensuration concrete strength that's wide employed in the structural field. the most motive of those tests is to find and establish flaws in materials, live its dimension and estimate its strength moreover on decide whether or not there's a desire for retrofitting. Retrofitting is that the method of improvement of existing structures like buildings, monuments, heritage structures to form them a lot of unaffected by the seismic activity and different natural calamities.

II. CASE STUDY

BUILDING DETAILS:
KASTEL APARTMENT BUILDING LOCATED AT NO. 5, CORNWELL ROAD, LANGFORD GARDENS, RICHMOND TOWN, BANGALORE - 560025.

Fig 1:- Case Study Building

Problems faced in the building

1) Crushed columns
2) Structural cracks on walls

Fig 2:- Crushed Columns

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III. METHODOLOGY

➢ *Ultrasonic Pulse Velocity*

The portable ultrasonic non-destructive digital indicative technique (PUNDIT) is associate degree equipment for non-destructive analysis of concrete quality. The instrumentality consists of a try of transducers (probes) of various frequencies, electrical generator, and electrical temporal arrangement device and cables. it's wont to live the coordinated universal time of ultrasonic pulses within the take a look at specimen by putting transducers, from that the rate is computed. a group of UPV readings is used for additional interpretations of structural concrete.

No.	Pulse Velocity By cross probing (km / sec)	Concrete Quality Grading
1.	Above 4.5	Excellent
2.	3.5 to 4.5	Good
3.	3.0 to 3.5	Medium
4.	Below 3.0	Doubtful
Note: In case of "doubtful" quality it may be necessary to carry out further tests.		

Table 1:-Velocity Criterions for Concrete Grading (I S: 13311 (Part 1): 1992

➢ *Rebound Hammer.*

Hardness is the main factor associated with concrete. The Schmidt rebound hammer is basically a surface hardness test with little apparent theoretical relationship between the strength of concrete and the rebound number of the hammer. The only known instrument to be related to the rebound (impact) principle for concrete testing is the Schmidt hammer, which weighs about 1.8 kg and is suitable for both laboratory and field work.

REBOUND NUMBER	ESTIMATED COMPRESSIVE STRENGTH RANGE (N/mm^2)
22 to 26	10 to 14
26 to 30	14 to 18
30 to 34	18 to 22
34 to 36	22 to 26
36 to 42	26 to 34
42 to 46	34 to 36

Table 2

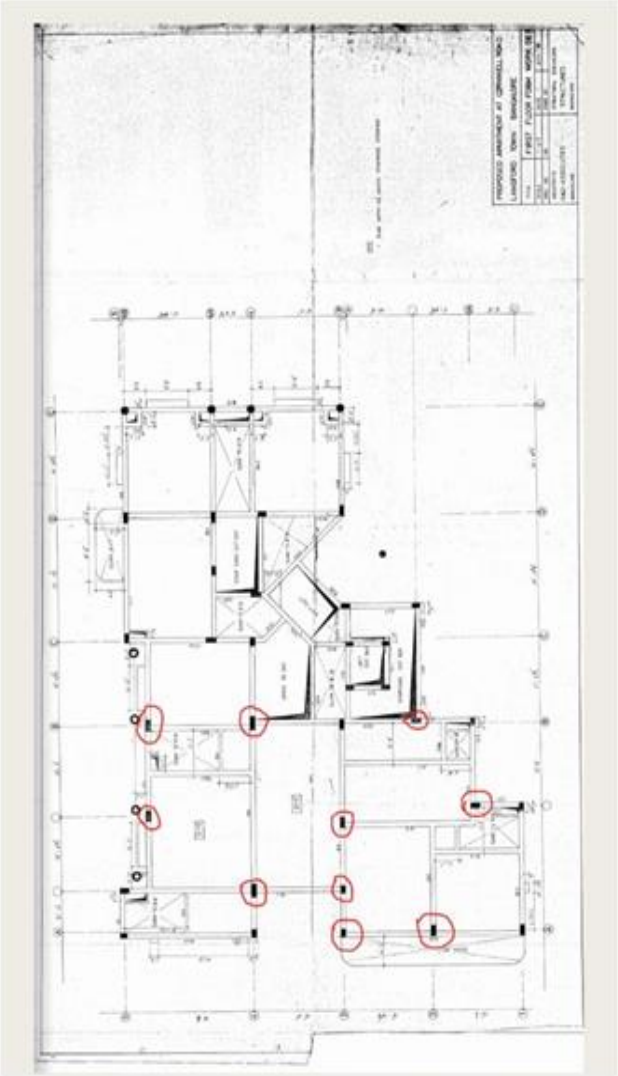

FIG 3: Basement Layout plan indicating Columns that were tested for strength evaluation.

FIG 4: UPV Test by Direct Method for Column F3.

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FIG 5: Google location
https://www.google.co.in/maps/place/Kastel+Apartments/@12.9628178,77.596145,17z/data=!4m8!1m2!2m1!1skastel+apartments+langford+!3m4!1s0x3bae15ed142bedb7:0xb0309f1b522f8964!8m2!3d12.9632594!4d77.5986946!10m3!1e1!2e18!4e2?hl=en

FIG 6: Rebound hammer test on Slab.

IV. RESULTS

Sl. No	Structural Members	Position	Ultrasonic Pulse Velocity in km/sec	Average Velocity km / sec	Concrete Quality Grading as Per IS – 13311- PART-1 Remarks Ref chart 1-2
1	Column A1	Top Middle Bottom	3.73 3.83 3.71	3.75	Good
2	Column A3	Top Middle Bottom	3.53 3.89 3.99	3.80	Good
3	Column F3	Top Middle Bottom	3.96 3.83 3.81	3.86	Good
4	Column G5	Top Middle Bottom	3.53 3.64 3.71	3.62	Good
5	Column G3	Top Middle Bottom	3.15 3.21 3.20	3.20	Medium
6	Column B3	Top Middle Bottom	3.78 3.72 3.52	3.67	Good
7	Column G1A	Top Middle Bottom	3.30 3.45 3.35	3.36	Medium
8	Beam B26	Top Middle Bottom	3.81 3.81 3.89	3.83	Good
9	Beam B6	Top Middle Bottom	3.83 3.73 3.56	3.70	Good
10	Beam B5	Top Middle Bottom	3.75 3.51 3.65	3.63	Good
11	Slab G5-F5 F4(F)	a1 - b1 a2 - b2 a3 - b3 a4 - b4 a5 - b5 a6 - b6	3.50 3.52 3.61 3.67 3.88 3.70	3.64	Good

Table 3:- Ultra-Sonic Pulse Velocity
Floor Level - Basement Floor Level
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Sl. No	Structural Members	Position	Rebound Hammer Number	Average Rebound hammer Number	Probable Strength Of Concrete in N/mm^2	Remarks
1	Column A1	Top Middle Bottom	34 34 32	34	20-22	
	Column	Top	34			
2	A3	Middle	34	34	20-22	
		Bottom	36			
3	Column F3	Top Middle Bottom	34 34 34	34	20-22	
4	Column G5	Top Middle Bottom	34 36 34	34	20-22	
5	Column G3	Top Middle Bottom	29 27 26	28	16-18	Less than the permissible limits (+/- 25% as per IS 13311)
6	Column B3	Top Middle Bottom	36 34 34	34	20-22	
7	Column G1A	Top Middle Bottom	31 26 26	27	16-18	Less than the permissible limits (+/- 25% as per IS 13311)
	Beam	1	32			
8	B26	2	34	34	20-22	
		3	34			
	Beam	1	34			
9	B6	2	34	34	20-22	
		3	32			
10	Beam B5	1 2 3	34 34 32	34	20-22	
		a1 - b1	34			
11	Slab G5-F5 F4(F)	a2 - b2 a3 - b3 a4 - b4 a5 - b5	34 32 32 34	34	20-22	
		a6 - b6	36			

Table 4:- Rebound Hammer Test
Floor Level**:** Basement Floor Level
IS: 13311 (Part 2):1992

V. CONCLUSION

From the Non-Destructive tests performed to assess the quality of the structure it has been concluded that

- From the outcomes of the Ultrasonic Pulse Velocity Test and Rebound Hammer test, the estimated compressive strength of RC columns and beams was found to be between **20.0 N/sq.mm - 22.0 N/sq.mm except for the two Columns** (**G3, G1A**) that had lesser compressive strength of **16-18 N/sq.mm.**
- The quality of concrete in the slabs and beams were found to be with in the permissible limits as prescribed by IS 13311(part1, part2).
- To enhance the strength for the above particular two columns, Concrete jacketing had been proposed as a retrofitting measure.

It was concluded based on the outcomes of the feasibility study, retrofitting measures suggested for the building is feasible, after strengthening the structurally deficient columns which are identified. On implementing retrofitting measures effectively (column jacketing, grouting) the building was rendered safe and normal**.**

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