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Performance Investigation of Rebound Hammer Testing within a Non-Destructive Testing System for Structural Concrete Evaluation

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Abstract: ***This study uses the Schmidt Rebound Hammer method to evaluate precast concrete components of the Annex Building at IIT Madras in a non-destructive manner. In order to ascertain the concrete's structural sufficiency and compliance to the designated design grade, the examination attempts to evaluate the concrete's in-situ quality, surface hardness, and indicative compressive strength. To assess the consistency and general state of the concrete components, rebound measurements were methodically documented and examined. The study emphasizes the value of rebound hammer testing as an effective and trustworthy method for the initial evaluation of existing reinforced concrete structures.***
Keywords: Schmidt Rebound Hammer Testing, Non-Destructive Evaluation, In-situ Concrete Assessment, Precast Structural Elements, Compressive Strength Estimation, Surface Hardness Measurement, Structural Condition Appraisal, Concrete Quality Verification

I. INTRODUCTION

Non-destructive testing (NDT) is a method used in the construction industry to examine the properties of materials, structures, or components without putting them in danger. It is highly useful for assessing the quality and strength of concrete, steel, and other building materials without breaking them. NDT is used to find any holes, cracks, weaknesses, or defects in a structure. It is beneficial to know the actual condition of the materials and to make sure the structure is safe. Additionally, it serves to guarantee that building projects are finished accurately and in compliance with quality standards.

NDT provides crucial information on the condition and quality of building materials without inflicting any harm. It helps determine the compressive strength of concrete, which is essential for assessing a structure's capacity to support loads. NDT techniques can also be used to locate and measure voids or cracks in concrete or other materials that aren't always visible on the surface. It can also assess the strength of the link between different materials, such as steel reinforcement and concrete. NDT methods can also find hidden internal flaws, which helps engineers carry out preventive maintenance or repair actions before serious damage occurs. NDT is very helpful in structural evaluation and construction because of several advantages. It saves money because testing doesn't need damaging or breaking the existing structure. Additionally, by conserving time, this speeds up and increases the effectiveness of the inspection process. NDT is essential to the planning of repairs and maintenance because it provides accurate information on the condition of materials and buildings. It also improves building and infrastructure safety by identifying potential issues early on, before they get worse. Additionally, NDT is very important for monitoring the state of older buildings, ensuring their stability, and extending their usable life.

II. METHODOLOGY

Rebound hammer testing [1] is one non-destructive method commonly employed on concrete structures to evaluate the concrete's surface hardness and indirect compressive strength. The rebound hammer works on the basis of the rebound of a spring-loaded plunger that hits the concrete surface. After hitting the surface, the plunger bounces back, and the degree of rebound indicates how hard the concrete surface is. Concrete with a lower rebound value is weaker than concrete with a higher rebound value. The reading is recorded using the scale on the hammer body. This test is used to assess the state of an existing concrete structure since it is quick,

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simple, and economic. It is used in a variety of buildings, including walls, slabs, beams, and columns. The surface of the concrete should be dry, clean, and smooth. Testing should be done in the center of a 300 × 300 mm chalk grid that has been marked beforehand. At least ten readings of a single element are required, and the average value is considered. During testing, rebound hammers are softly driven while being held perpendicular to the concrete surface. When the trigger is released, the hammer hits the surface, and we record the rebound number. The manufacturer's graph or chart or the IS code are then used to convert the rebound number into an estimated compressive strength. It is necessary to take precautions like surface should be appropriately calibrated, the hammer should not be excessively wet or rough, and the plunger should not be pressed in the same location more than once. Additionally, plaster or small particles should be taken out of the testing area. The hammer's angle matters whether the test is conducted uphill or downward. Direction, a correction factor ought to be used.

The Schmidt rebound hammer shown in Fig.1. The graph shown below In Fig.2 is for the conversion based on the compressive strength and the rebound number given on the instrument.



Fig.1: Schmidt Rebound Hammer. [7]

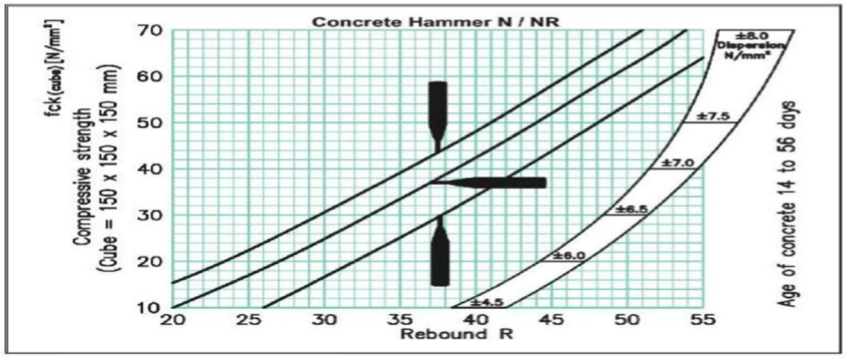


Fig. 2: Conversion based on the compressive strength and the rebound number. [8]

Table. 1: Quality of Concrete for different values of rebound number. [1]

Average Rebound Number	Quality of Concrete
>40	Very good hard layer
30 to 40	Good layer
20 to 30	Fair
<20	Poor concrete
0	Delaminated

The quality of concrete for different values of rebound number is analysed by above fig 2.

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III. OBJECTIVE OF THE WORK

Evaluation of the quality and strength of concrete of walls at Annex Building, IIT Madras Fig.3 is carried out to achieve the following objectives:

Rebound Hammer test is to estimate the surface compressive strength and hardness of Concrete in a quick and non-destructive manner.



Fig. 3: View of the Venue.

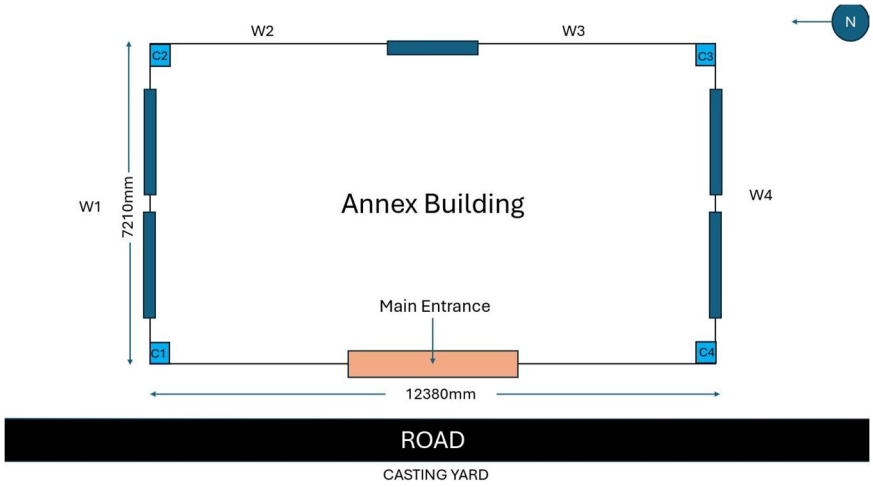


Fig. 4: The diagrammatic layout of the building. The figure above is provided to clarify the nomenclature of the elements, which will be referenced in subsequent sections. All dimensions are in mm.

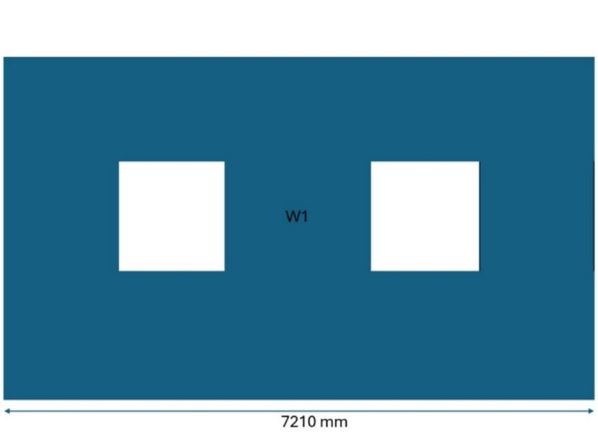


Fig. 5: Side View of Wall (W1).

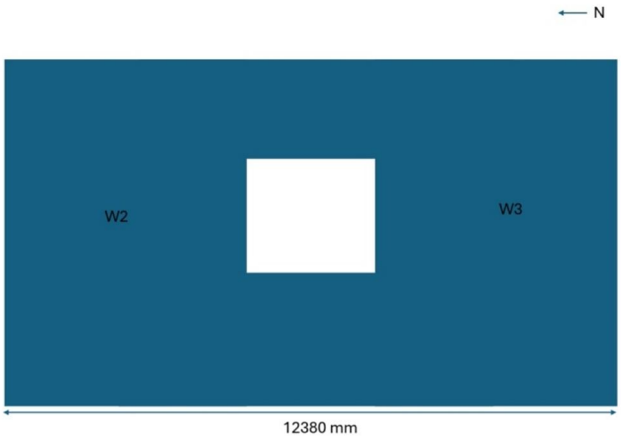


Fig. 6: Side View of Wall (W2).

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IV. PROBLEM STATEMENT

Reliable non-destructive testing techniques that can precisely represent in-situ material performance are needed for the evaluation of concrete quality in precast structural elements that are currently in use. The Schmidt Rebound Hammer's suitability for assessing the state and indicative strength of the precast concrete put in the Annex Building at IIT Madras is not sufficiently clear. It is difficult to confirm whether the concrete still satisfies the required levels of strength and consistency in the absence of a methodical assessment. By critically analyzing the efficacy of rebound hammer testing as a method for assessing the structural integrity and quality of the precast parts, this study aims to close this gap.

V. EXPERIMENTAL ASSESSMENT

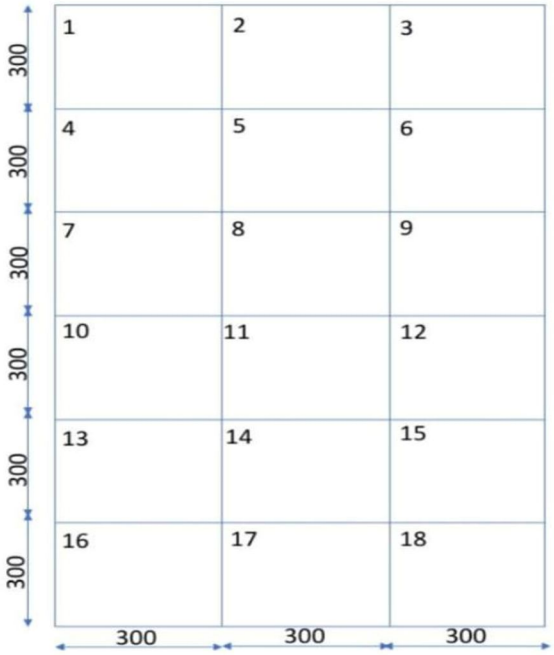


Fig. 7: Grids on Wall (W1).



Fig. 8: Making Grids on Wall.

Table. 2: Result of Rebound Hammer Test on Wall (W1).

Result of Rebound Hammer Test				
Rebound Number (N)			Average Rebound Number (N)	Compressive Strength (N/mm²)
39	39	36	42	44
41	45	42		
41	41	43		
41	39	45		
45	45	46		
46	45	45		

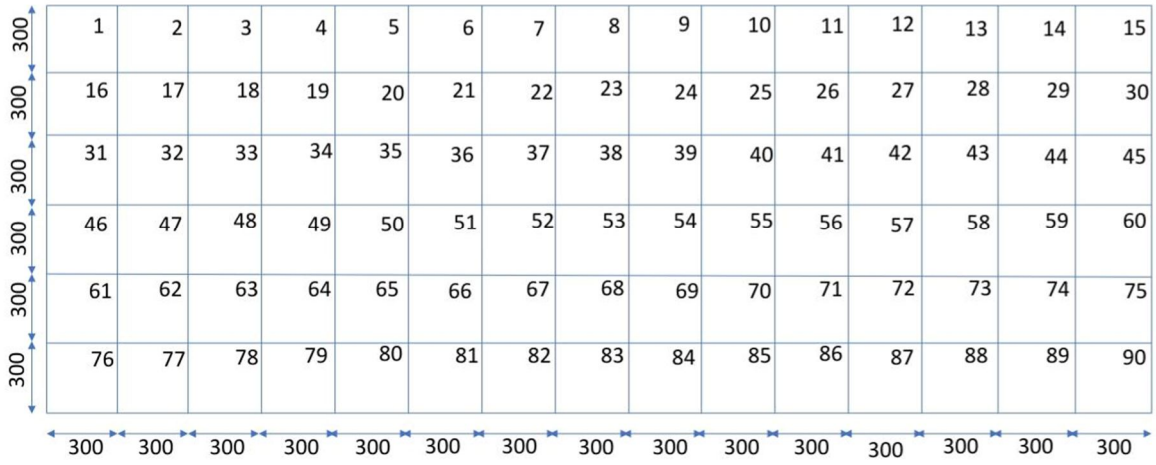


Fig. 9: Grids on Wall (W2).

Table. 3: Result of Rebound Hammer Test on Wall (W2).

Result of Rebound Hammer Test						
Rebound Number (N)					Average Rebound Number (N)	Compressive Strength (N/mm²)
50	50	47	51	51	50	62
48	49	49	51	50		
52	47	50	50	50		
48	49	51	51	49		
48	52	55	49	49		
51	50	50	50	49		
52	51	50	49	49		
52	50	50	51	49		
51	49	52	50	49		
53	50	52	50	51		
49	50	48	51	47		
51	47	49	48	49		
51	49	49	49	50		
51	50	51	52	50		
50	51	50	50	51		
48	52	48	49	49		
50	51	49	49	45		
49	48	48	50	51		

VI. ANALYSIS OF VALUES OF SCHMIDT REBOUND HAMMER TEST

Table. 4 : Categorizing walls based on Rebound Hammer Test results.

Wall Number	Quality of Concrete
W1	Very good hard layer
W2	Very good hard layer

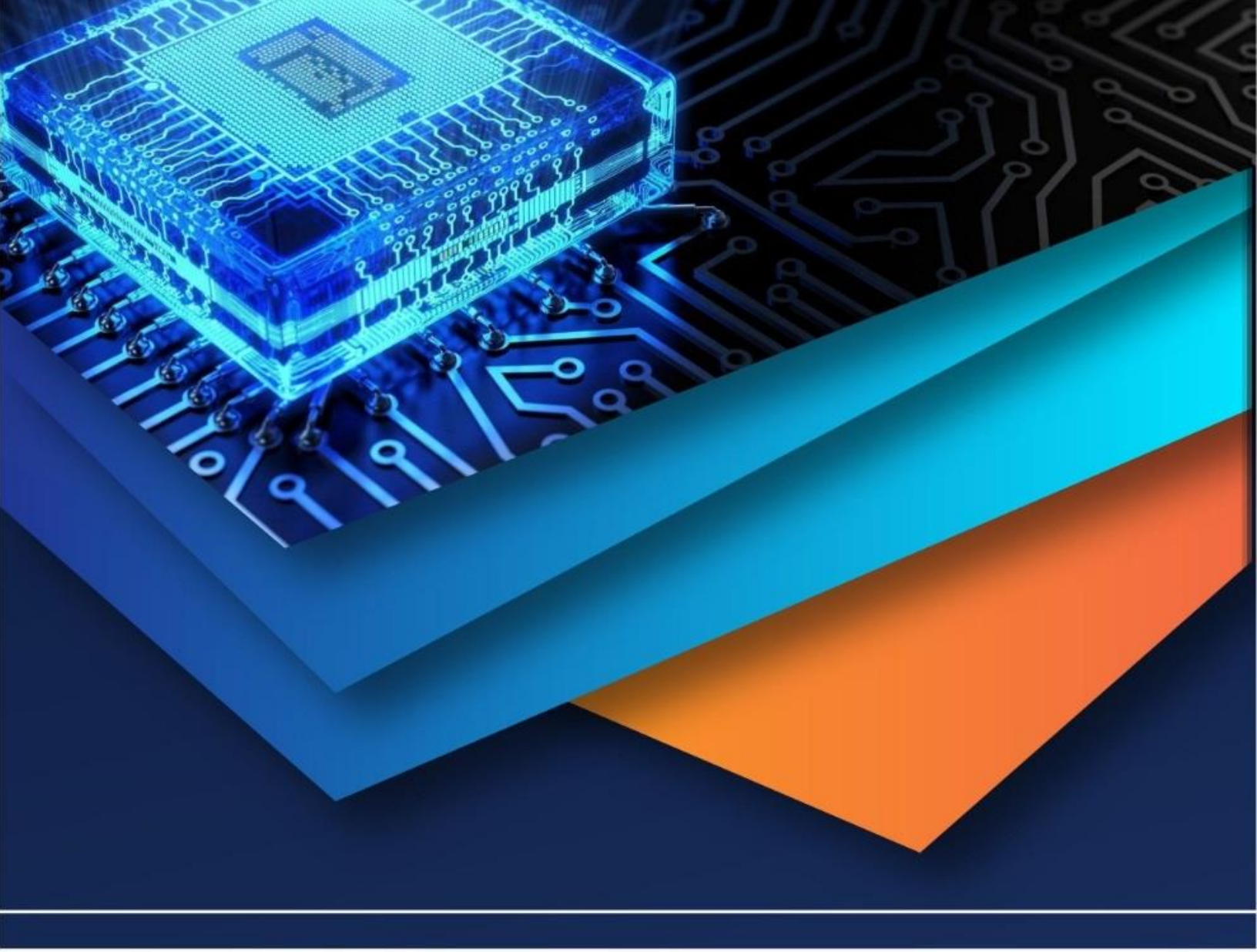
VII. CONCLUSION

The analysis of the Schmidt Rebound Hammer test results for the precast elements in the Annex Building at IIT Madras indicates that the average rebound value corresponds to an estimated surface compressive strength of approximately 46 Mpa. This value aligns well with the expected performance for M50 grade concrete used in the structure. Overall, the test results confirm that the in-situ concrete quality remains within the acceptable range, demonstrating adequate strength, uniformity, and satisfactory performance of the structural elements.

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