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A Study on Non-Destructive Testing of Government Polytechnic Jehanabad Building Using Rebound Hammer

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Abstract: ***In recent years, innovative NDT methods, which can be used for the assessment of existing structures, have become available for concrete structures. The purpose of establishing standard procedures for non-destructive testing (NDT) of concrete structures is to qualify and quantify the material properties of in-situ concrete without intrusively examining the material properties. There are many techniques that are currently being research for the NDT of materials today. This study presents the compressive strength of a Non-Destructive Testing (NDT) investigation conducted on the Government Polytechnic Jehanabad building using the Rebound Hammer Test.***

The primary objective was to assess the surface hardness and estimate the in-situ compressive strength of concrete structural members without causing any physical damage. Concrete compressive strength is one of the most important concrete requirements that can be used to decide if the concrete is structurally acceptable or not. Compressive strength of concrete depends on age of concrete, moisture content, surface carbonation etc. This study provides valuable insights into the current condition of the institution's structure and highlights the importance of regular NDT assessments.

Keywords: Moisture content, in-situ concrete, Concrete compressive strength, Surface carbonation, Rebound Hammer Test, Non-Destructive Test.

I. INTRODUCTION

The durability and strength of concrete structures are critical factors in ensuring the safety and serviceability of buildings throughout their lifespan. Traditional methods of assessing concrete strength often involve destructive testing, which is not feasible for existing structures in use. In this context, Non-Destructive Testing (NDT) techniques provide valuable tools for evaluating structural integrity without causing any damage to the elements being examined.

Among various NDT methods, such as Visual Testing (VT), Ultrasonic Testing (UT), Radiographic Testing (RT), Magnetic Particle Testing (MT), and Liquid Penetration Testing (PT). The Rebound Hammer Test is one of the most widely used due to its simplicity, portability, cost-effectiveness, and ability to give quick results. The test provides a measure of the surface hardness of concrete, which can be correlated with its compressive strength.

This study focuses on conducting a rebound hammer test on the structural elements of the Government Polytechnic Jehanabad building, with the objective of assessing the in-situ compressive strength and overall condition of the building. As the building is used for academic purposes and has been in service for several years, ensuring its structural health is essential for safety and long-term performance.

The outcomes from this research will help in understanding the current condition of the building's concrete and assist in planning any necessary maintenance or rehabilitation. The results also demonstrate the relevance and practicality of NDT methods in evaluating existing structures.

II. NEED AND SCOPE OF STUDY

A. Need For Study

The structural safety and reliability of educational institutions are of paramount importance, especially in government-owned infrastructures like the Government Polytechnic Jehanabad. As buildings age, there is an increasing need to assess their structural health without causing damage or disruption to their functioning. In such cases, Non-Destructive Testing (NDT) methods like the Rebound Hammer Test play a vital role.

Conducting this study not only ensures the safety of students and staff but also supports the efficient planning of repair and renovation works. Moreover, it contributes valuable data for future structural audits and promotes the practical application of NDT techniques in real-life infrastructure management.

B. Scope And Objectives Of Present Study

The scope of this study focuses on assessing the in-situ compressive strength and surface hardness of concrete used in the Government Polytechnic Jehanabad building using the Rebound Hammer Test, a well-known non-destructive testing (NDT) method. This study aims to:

1) Evaluate the quality and uniformity of concrete across different structural elements of the building (e.g., columns, beams, and slabs).
2) Determine whether the concrete in the existing structure meets the required strength parameters for long-term safety and durability.
3) Provide a cost-effective, quick, and non-invasive method of assessing the structural health of old buildings without causing any damage.
4) Offer baseline data that can be used for future maintenance, retrofitting, or renovation planning by the concerned authorities.

The main objectives of the present study are;

- Estimating the in-situ compressive strength.
- Estimating the uniformity and homogeneity.
- Estimating the quality in relation to standard requirement.
- Detection of presence of cracks, voids and other defects.
- Condition of reinforcement steel with respect to corrosion.

III. METHODOLOGY

A. Rebound Hammer

The Rebound Hammer, commonly known as the Schmidt Hammer developed by Ernst Schmidt in the 1950s, is a portable, spring-driven mechanical device used in the non-destructive testing (NDT) of concrete structures. It is designed to assess the surface hardness of concrete and provide an estimate of its compressive strength based on rebound values. The rebound hammer test offers several advantages, including its simplicity, portability, and non-destructive nature. It can be performed on-site, requiring minimal preparation and no sample extraction. The test provides valuable information about the condition of concrete structures, aiding in the evaluation of their structural integrity, durability and overall quality.

Primary objective of the rebound hammer test is to estimate the compressive strength of concrete by correlating the rebound index with the actual strength. By comparing the rebound values obtained from the test with established calibration curves or conversion tables, the compressive strength of the concrete can be approximated. This information is crucial for assessing the load-bearing capacity ,safety, and performance of concrete structures. Furthermore, the rebound hammer test can also be used to assess the uniformity and quality of concrete. It enables inspectors and engineers to identify areas of potential concern, such as variations in strength or the presence of voids, cracks, or other defects. This allows for targeted investigations and appropriate measures to be taken for the repair or maintenance, based on the specific findings.

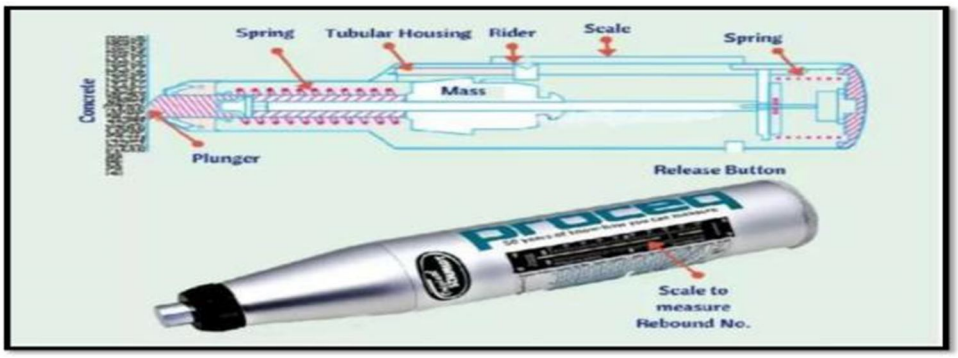

Fig. 1: Rebound Hammer

1) Principle

Rebound hammer test method is based on the principle that the rebound of an elastic mass depends on the hardness of the concrete surface against which the mass strikes. The operation of the rebound hammer is shown in figure-1. When the plunger of rebound hammer is pressed against the concrete surface, the spring controlled mass in the hammer rebounds. The amount of rebound of the mass depends on the hardness of concrete surface. Thus, the hardness of concrete and rebound hammer reading can be correlated with compressive strength of concrete. The rebound value is read off along a graduated scale and is designated as rebound number or rebound index. The compressive strength can be read directly from the graph provided on the body of the hammer.

B. Procedure Of Rebound Hammer Test

The process involves holding the hammer perpendicular to the surface, striking it, and reading the rebound number on the scale. This value is then correlated with the concrete's compressive strength using a calibration chart. Multiple readings are taken at different locations and averaged to provide a more accurate assessment. Following is the procedure of RHT :

1) Surface Preparation - Clean the surface of the concrete where the test is to be performed. Ensure it is dry, smooth, and free from dust, grease, or loose particles. Avoid testing on rough, honeycombed, or cracked areas.

2) Positioning the Hammer - Hold the rebound hammer perpendicular (90°) to the concrete surface .The plunger should be pushed firmly against the concrete without tilting. Ensure firm contact without any gaps.

The Various positioning of rebound hammer is :

POSITION	ANGLE (°)	DIRECTION OF TEST	SURFACE TYPES
Vertical Upward	+90°	Hammer Facing Upward	Ceiling & Beam
Horizontal	0°	Hammer held Horizontal	Walls & Column
Vertical Downward	-90°	Hammer Facing Vertical	Floor

Table1: Position of Rebound Hammer in Test

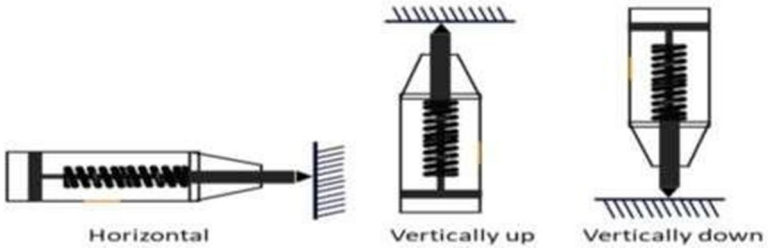

Fig.2: Position of Rebound Hammer

Note : For different position of hammer value of compressive strength will vary as per calibration chart.

3) Taking Readings - Press the test hammer plunger at exactly right angles to the surface of the concrete being tested. After impact read the rebound value. Take a minimum of Three rebound readings around each point of observation. Take avg. of these values.

4) Data Interpretation - Use the average rebound number to estimate the compressive strength of concrete using rebound index

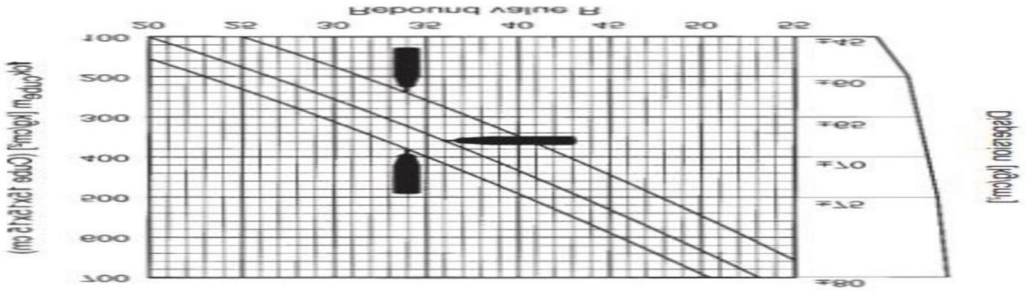

Fig. 3: Rebound Index

- Considering 10 kg/cm^2 = 1 N/mm^2
- The quality of concrete can be determine by following table:

Average rebound no.	Quality of Concrete
>40	Very good
30-40	Good
20-30	Fair
<20	Poor

Table 2: Concrete quality as per rebound no.

- Neglecting the avg. rebound value in decimal form by considering nearest value:

Ex- 30.33- 30
30.66 – 31

C. Test Location
Government Polytechnic Jehanabad
Sultanpur, Makhdumpur, Jehanabad – 804405
Bihar, India

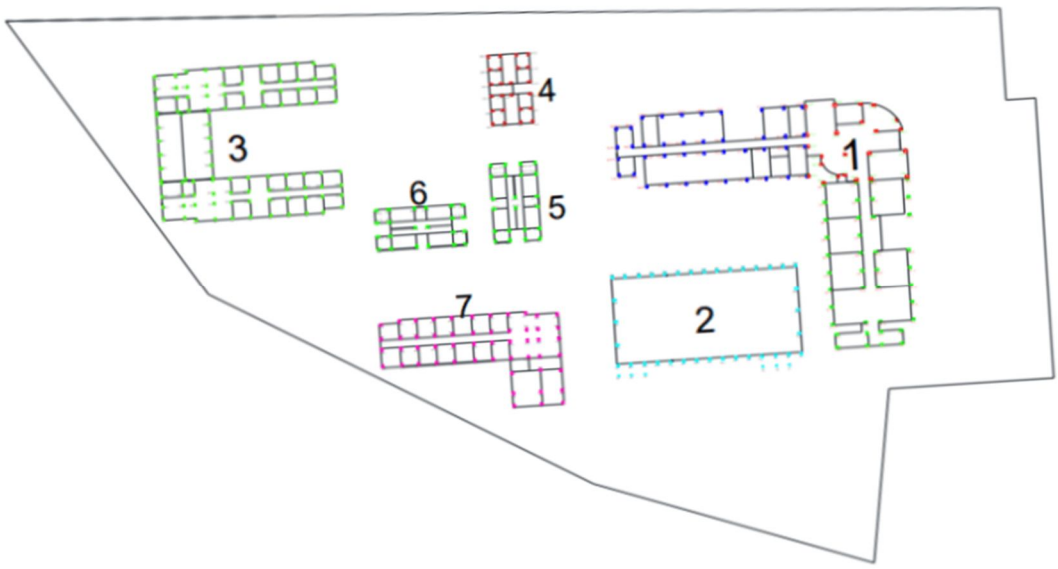

Fig. 4: Plan of Govt. Polytechnic Jehanabad

Govt. Polytechnic jehanabad building includes:
1– ACADEMIC BUILDING
2– WORKSHOP
3– BOY'S HOSTEL
4– PRINCIPAL / LECTURER QUARTER (BLOCK - A)
5– SUPPORTING STAFF QUATER (BLOCK - C)
6– TECHNICAL STAFF QUARTER (BLOCK - B)
7– GIRL'S HOSTEL

IV. RESULT & ANALYSIS

1-Academic Building				
Sr. No.	Column No.	Rebound no.	Average	Compressive Strength in N/mm²
1	C1	29,36,38	34	32
2	C2	29,33,40	34	32
3	C6	28,34,42	35	34
4	C10	32,42,44	40	42
5	C11	34,45,49	43	48
6	C16	30,37,46	38	39
7	C17	25,32,35	31	26
8	C24	20,29,29	26	18
9	C25	17,36,41	31	26
10	C27	27,35,36	33	30
11	C30	27,33,35	32	28
12	C31	22,31,39	27	20
13	C35	30,32,38	33	30
14	C38	27,32,41	33	30
15	C39	24,37,34	32	28
16	C41	24,29,38	30	25
17	C42	30,37,41	36	35
18	C49	30,36,39	35	34
19	C50	25,40,41	35	34
20	C51	30,38,45	38	39
21	C52	32,38,45	37	37
22	C58	24,33,36	31	26
23	C59	32,31,32	32	28
24	C60	25,33,36	31	26
25	C67	29,34,42	35	34
26	C71	31,38,36	35	34
27	C75	29,32,30	30	25
28	C81	22,34,40	32	28
29	C85	30,32,38	33	30
30	C93	32,37,44	38	39
31	C97	28,32,34	31	26
32	C102	32,37,44	38	39

Table 3: Report of Academic Building

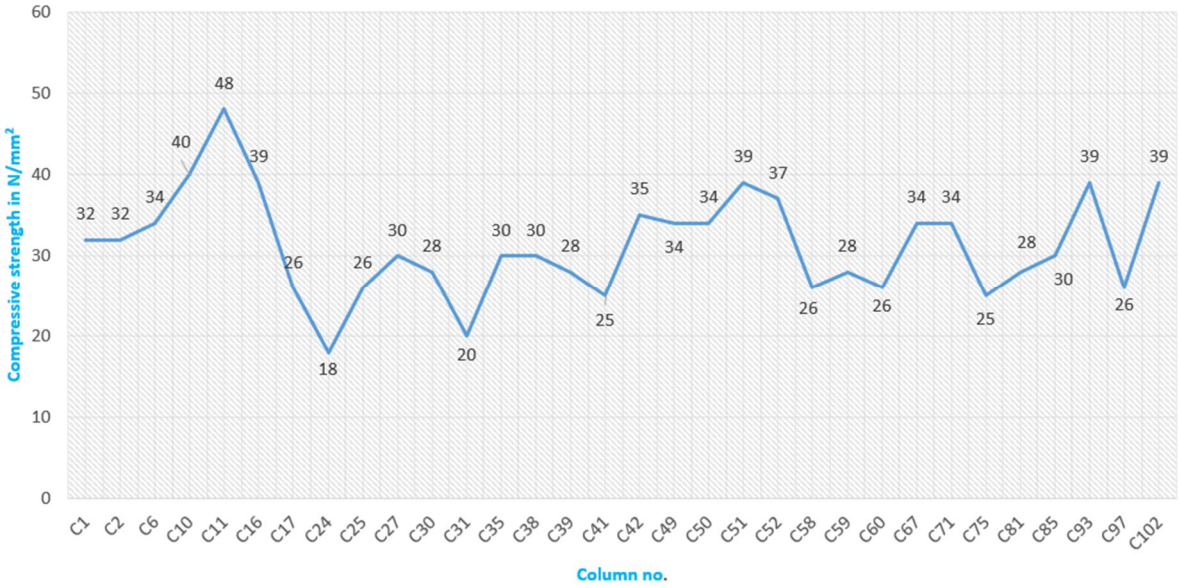

Fig. 5: Strength Graph of Academic Building

2-WORKSHOP				
Sr. No.	Column No.	Rebound no.	Average	Compressive Strength in N/mm²
1	C1	26,30,35	30	25
2	C2	26,29,32	29	23
3	C3	26,31,34	30	25
4	C4	27,34,39	33	30
5	C5	28,30,33	30	25
6	C6	26,30,34	30	25
7	C8	29,33,36	33	30
8	C9	26,31,35	31	26
9	C10	30,30,32	31	26
10	C11	30,34,37	33	30
11	C12	26,31,38	32	28
12	C13	30,34,39	34	32

Table 4: Report of Workshop

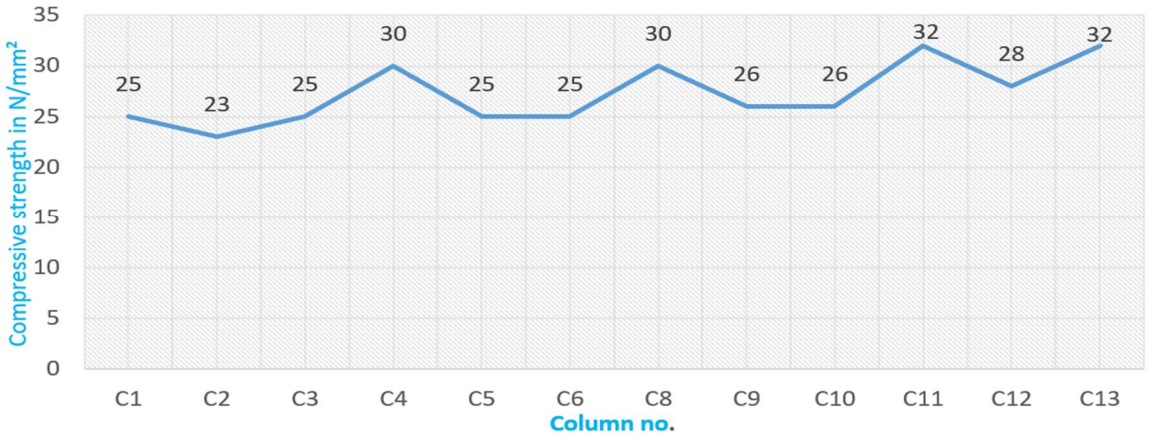

Fig. 6: Strength Graph of Workshop

3-BOY'S HOSTEL				
Sr. No.	Column No.	Rebound no.	Average	Compressive Strength in N/mm²
\ 1	C1	32,44,47	41	44
2	C12	22,29,35	29	23
3	C23	29,32,37	33	30
4	C34	30,36,40	35	34
5	C40	31,37,42	37	37
6	C41	36,42,47	42	46
7	C58	38,42,50	43	48
8	C75	32,44,47	41	44
9	C76	26,34,40	33	30
10	C77	33,43,46	41	44
11	C89	33,42,47	41	44
12	C90	32,38,43	38	39
13	C91	34,45,43	41	44

Table 5: Report of Boy's Hostel

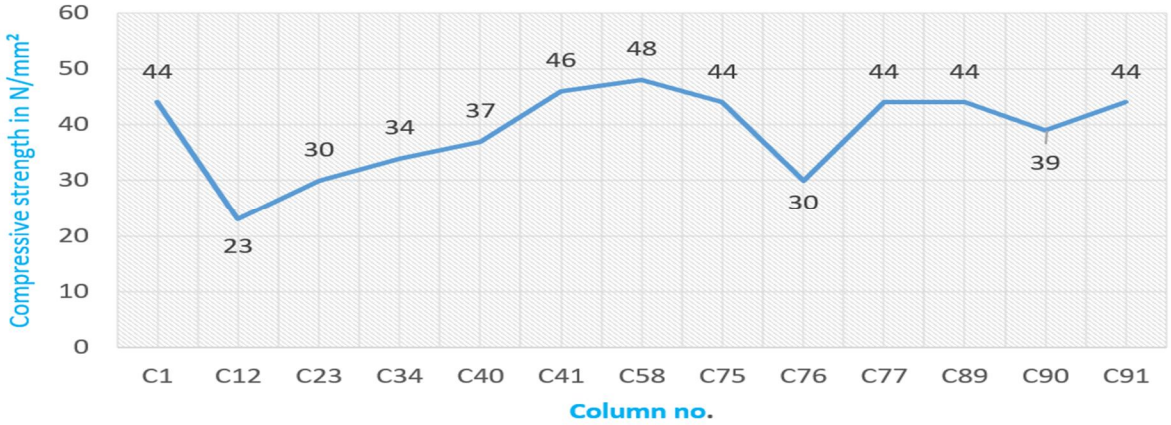

Fig. 7: Strength Graph of Boy's Hostel

4-PRINCIPAL / LECTURER QUARTER (BLOCK - A)				
Sr. No.	Column No.	Rebound no.	Average	Compressive Strength in N/mm²
1	C1	28,38,41	36	35
2	C4	25,29,37	30	25
3	C24	28,32,46	35	34
4	C21	24,32,38	31	26

Table 6: Report of Principal / Lecturer Quarter (Block - A)

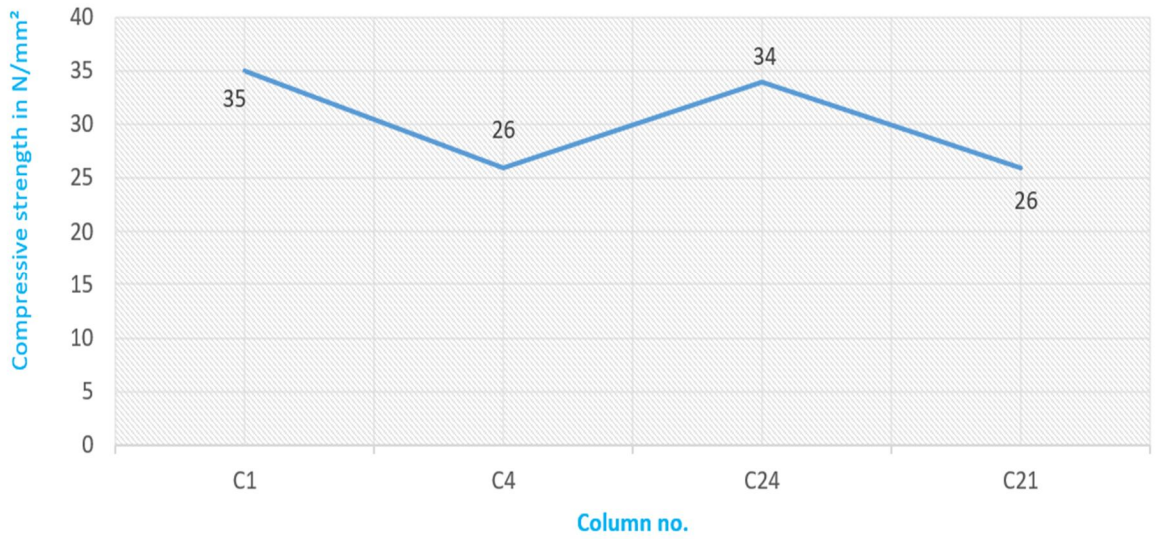

Fig. 8: Strength Graph of Principal / Lecturer Quarter (Block-A)

5-TECHNICAL STAFF QUARTER (BLOCK - B)				
Sr. No.	Column No.	Rebound no.	Average	Compressive Strength in N/mm²
1	C1	29,39,44	37	37
2	C6	28,35,42	35	34
3	C17	26,34,38	33	30
4	C22	29,33,45	36	35

Table 7: Report of Technical Staff Quarter (Block - B)

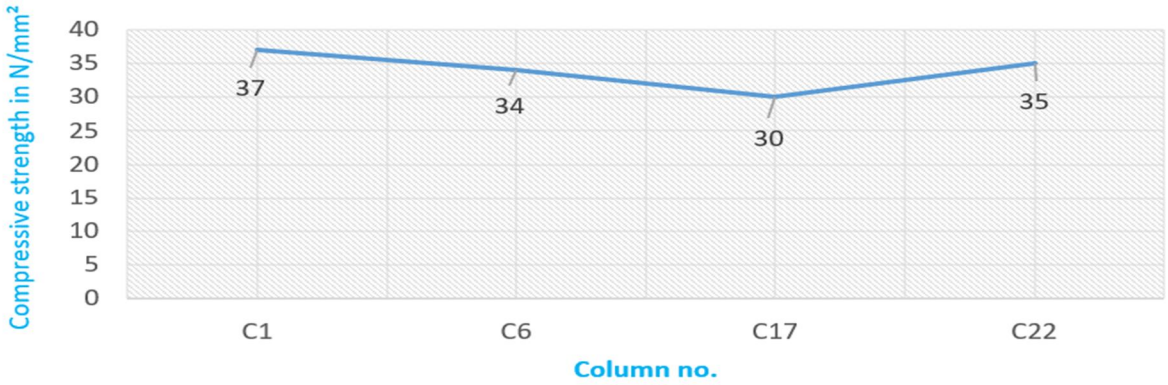

Fig 9: Strength Graph Technical Staff Quarter (Block - B)

6-SUPPORTING STAFF QUARTER (BLOCK - C)				
Sr. No.	Column No.	Rebound no.	Average	Compressive Strength in N/mm²
1	C11	24,36,41	34	32
2	C14	29,33,34	32	28

Table 8: Report of Supporting Staff Quarter (Block - C)

Fig10: Strength Graph Supporting Staff Quarter (Block - C)

V. CONCLUSION

The rebound value of the Column varies between 26 to 43 along the Horizontal direction. The Corresponding to these Rebound Values, Compressive Strength of Concrete Columns varies between 18 MPa to 48 MPa. In this study we found that 8 columns having rebound value greater than 40 which shows very good harden quality concrete and 48 columns having rebound value 31- 40 which shows good quality concrete. However, 11 columns exhibited rebound value between 20 to 30, indicating fair quality of concrete. Based on the results of the non-destructive testing conducted, particularly the Rebound Hammer Test, it can be concluded that the overall condition of the Government Polytechnic Jehanabad building is structurally good. Most of compressive strength values observed fall within the acceptable range as per IS 13311 (Part 2): 1992 standards, indicating that the concrete quality is satisfactory. No major signs of defects or structural distress were observed during the inspection.

Therefore, the building is deemed fit for continued occupancy and use. However, periodic inspection and routine maintenance are recommended to ensure long-term durability and safety.

VI. ACKNOWLEDGMENT

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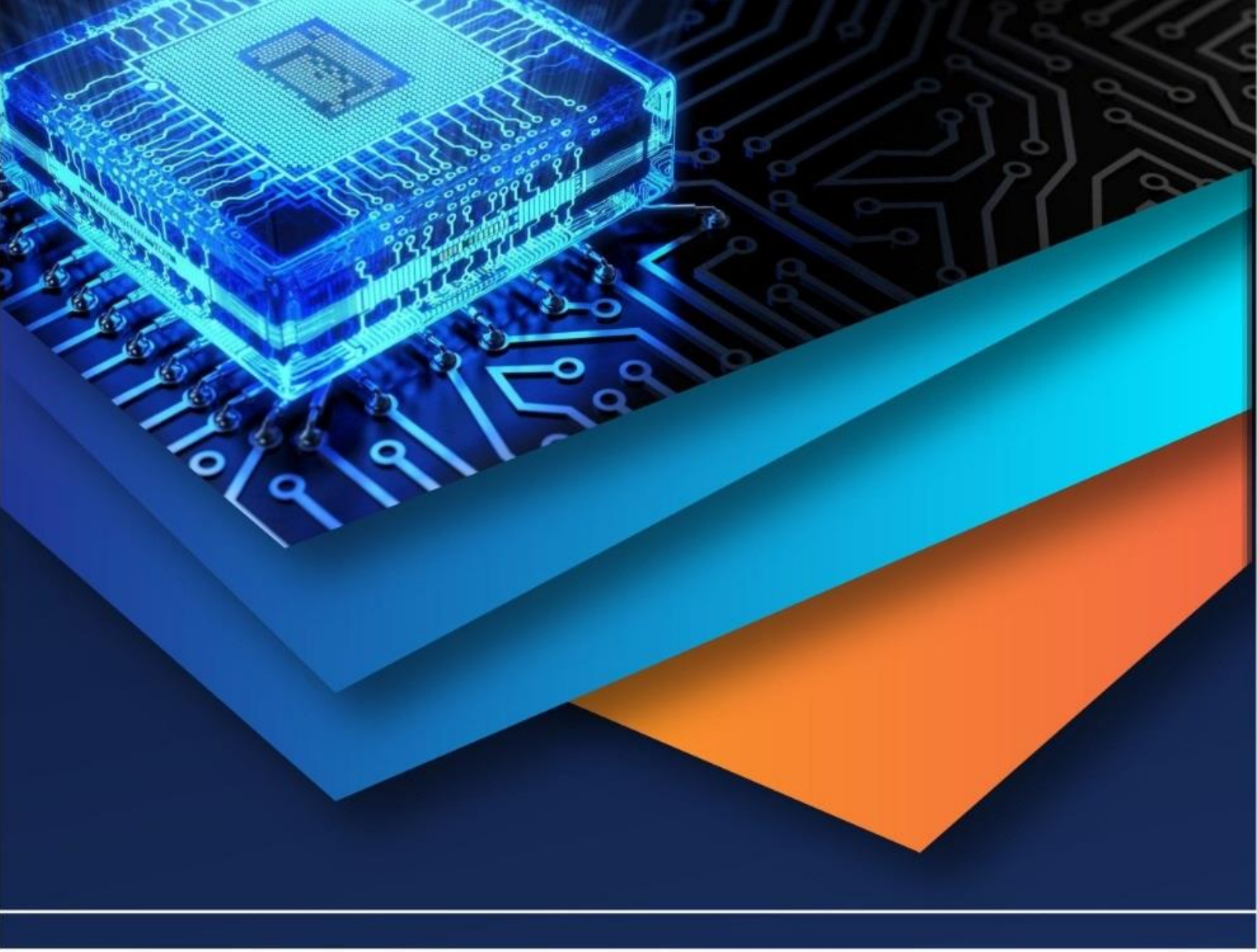

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