CONSTRUCTION QUALITY AUDIT OF UNDER CONSTRUCTION CGEWHO HOUSING PROJECT (PH-III)

KOLKATA, WEST BENGAL

By

Umesh Kumar Sharma, Professor

Department of Civil Engineering

Indian Institute of Technology Roorkee

Roorkee, 247667

(April 2025)

Contents

List of Tables

List of Figures

1.0 INTRODUCTION

1.1 Overview

The Department of Civil Engineering at the Indian Institute of Technology (IIT) Roorkee was requested by the Director (T) of CGEWHO to conduct a periodic construction quality audit for the under-construction CGEWHO Housing Project in Kolkata. Professor Umesh Kumar Sharma from the Department of Civil Engineering, IIT Roorkee, accepted this assignment and submitted a proposal to undertake the work in accordance with the consultancy rules and guidelines of IIT Roorkee. Upon acceptance of the proposal by the Director of CGEWHO, the project was officially awarded to IIT Roorkee.

The first stage construction audit of the building was carried out on March 22 and 23, 2025, by a team from IIT Roorkee. During the audit, the CGEWHO staff accompanied the IIT Roorkee team throughout the investigation. This report presents the details of the audit, including observations recorded during site inspections and testing, along with the corresponding inferences drawn.

1.2 Scope of Work

The scope of the audit work assigned to IIT Roorkee involved:

- Periodic visit to the site, twice in a year (as per site requirement) to guide and implement quality control/assurance measures, to ensure soundness of the structures, finishing works and provisioning, efficiency, and functionality of all services.
- Co-relation between civil structural, plumbing, electrical, and all other service drawings so that no mis-matching occurs during the execution of the project.

As per the defined scope, the team from IIT Roorkee visited the site and conducted a thorough assessment of the current construction status. The assessment included:

a) A visual inspection to identify any construction defects, distress, or anomalies.
b) Non-destructive testing (NDT) to evaluate the in-situ quality, structural integrity, and durability of the constructed members.
c) Verification of built components to ensure compliance with structural drawings.

The findings and recommendations presented in this report are based on the extent of construction completed at the time of assessment. Any deviations that may arise in later stages of construction fall outside the scope of this report. It is also important to note that IIT Roorkee's engagement in this project was strictly for technical advisory purposes as outlined above, and this report is not intended for any legal use.

1.3 Structure Details

The CGEWHO Housing Project consists of three blocks: Block 1, Block 2, and Block 3.

- Block 1 is divided into two zones—Pile Zone and Non-Pile Zone—based on the type of foundation provided.
- Block 2 serves as the parking block.
- Block 3 is further subdivided into three parts based on construction progress and expansion joints provided.

The referenced structure utilizes the MIVAN construction technique, where reinforced concrete (RC) elements are cast monolithically, reducing the number of joints and improving structural integrity. The detailed construction status of each block is illustrated in **Figure 1**.

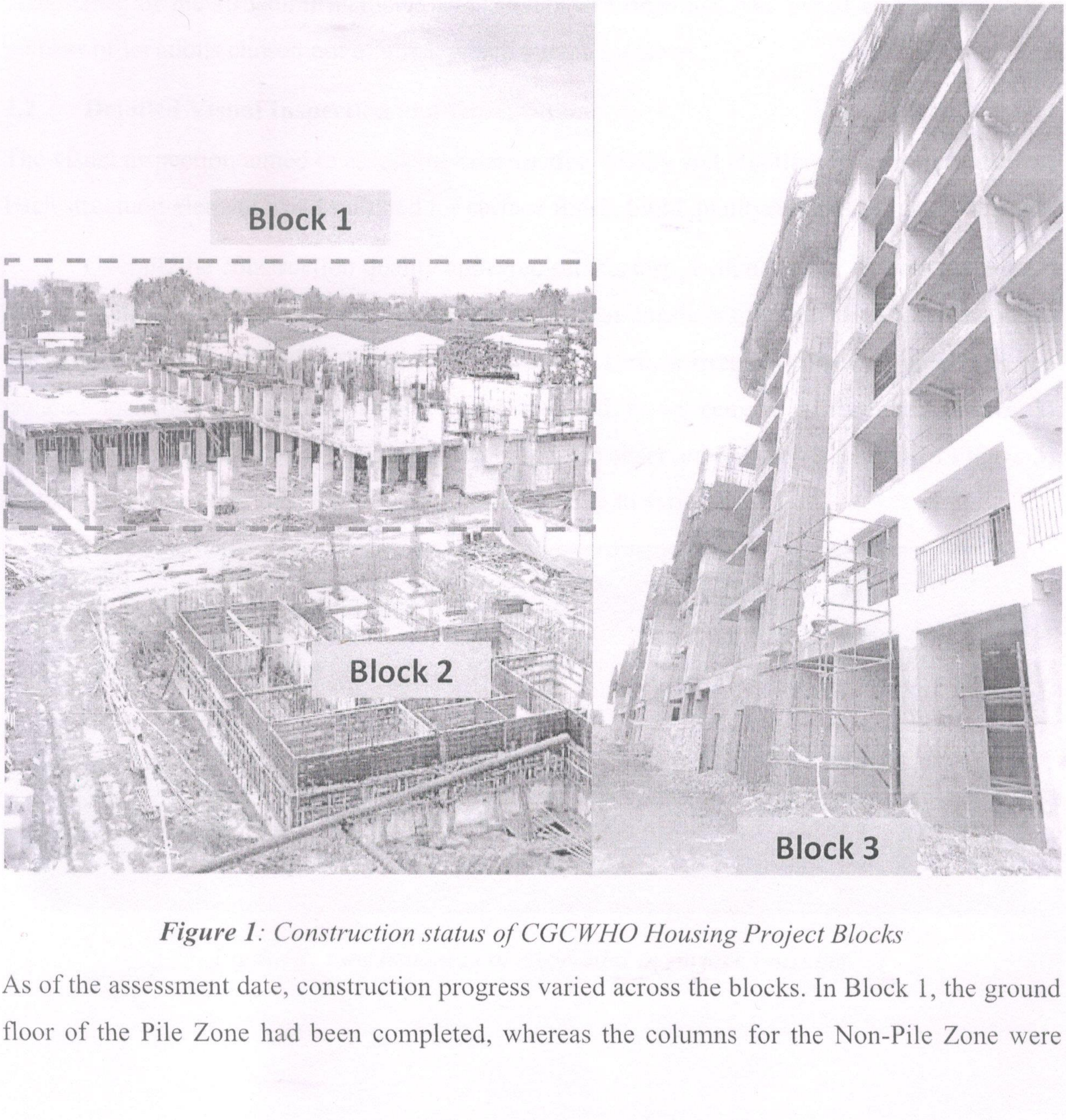

***Figure 1**: Construction status of CGCWHO Housing Project Blocks*

As of the assessment date, construction progress varied across the blocks. In Block 1, the ground floor of the Pile Zone had been completed, whereas the columns for the Non-Pile Zone were constructed in February. In Block 2, the foundation work was already completed, and the plinth beam construction was in progress. In Block 3, progress was recorded at different levels—Part 1 had reached the sixth floor, Part 2 had been cast up to the fourth floor, and Part 3 had progressed up to the second floor.

2.0 IN-SITU INVESTIGATIONS AND OBSERVATIONS

2.1 Overview

A detailed in-situ testing of the structural components of the buildings was conducted that included visual inspection, distress mapping, in-situ NDT, and extraction of samples to test the chemical makeup of concrete in the laboratories of IIT Roorkee. The nature and number of in-situ tests were planned on site based on the visual inspection and the extent of construction. It shall be noted that NDT investigations were performed on members that were at least 28 days old. However, compliance of the structural members against standard drawings was tested at a representative number of locations chosen out of already constructed members.

2.2 Detailed Visual Inspection and Observation

The visual inspection aimed to assess the construction quality and identify any structural distress. Each structural element was examined for surface finish, build quality, and signs of any defects.

Overall, the construction quality appeared satisfactory, with no major defects observed in the completed structural elements. The surface finish was consistent, and no significant anomalies were identified across the buildings. However, minor surface irregularities were noted at a few isolated locations, which had already been rectified using cement mortar (see **Figure 2**). Additionally, isolated instances of honeycombing were observed in Block 3 (shown in **Figure 3**). Necessary instructions and advice were given at the site to avoid them.

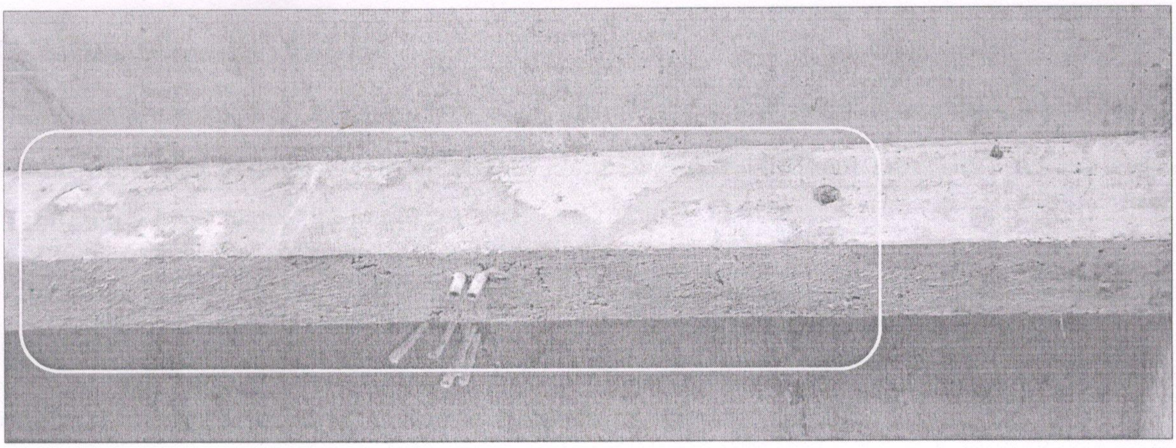

***Figure 2**: Few Instances of Anomalies in surface finishing*

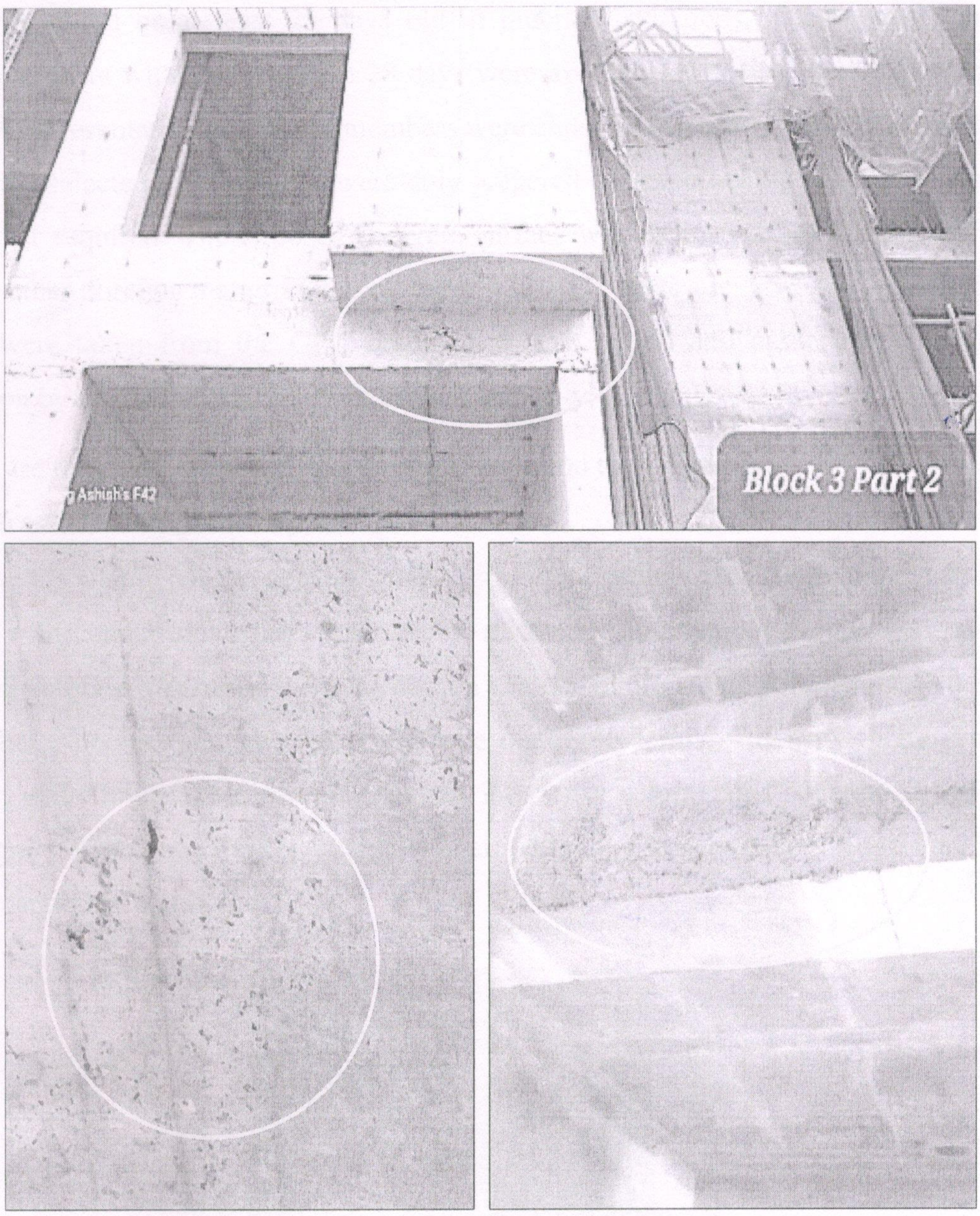

Figure 3: Honeycombing issues at isolated locations in Block 3

2.3 Non-destructive Testing

NDT's were performed on the structural components of the buildings. Some samples of hardened concrete were also acquired from structural elements for subsequent laboratory testing at IITR. The following NDT were carried out:

(i) Ultrasonic pulse velocity (UPV) test was conducted to ascertain the homogeneity quality, and integrity of concrete,

(ii) Rebound hammer test on concrete to ascertain the surface quality,

(iii) Sampling and testing of concrete samples to determine the chemical makeup of the concrete (Chloride content and pH).

It should be noted that the non-destructive tests only give reliable results when concrete is adequately matured or at least 28 days old in practical situations. Those newly constructed structural members with age less than 28 days were avoided for testing due to their inadequate maturity. A representative number of members were chosen from the mature members to perform NDT. All the selected test locations were duly prepared by smoothening the concrete surface, if and wherever required. The exposed concrete surface was cleaned of all loose material, dust, debris, or other foreign matter. The results of the NDT tests are given in **Appendix I**. Grid markings were taken from the GFC drawings in this regard and made available during the investigation by the CGEWHO housing project authority.

Following are the details of the non-destructive tests and their findings:

2.3.1 Ultrasonic Pulse Velocity Test

The UPV test is widely used to assess the homogeneity of concrete, detect internal defects such as cracks and voids, and evaluate the overall quality of concrete in reference to standard requirements. The method involves measuring the transmission velocity of ultrasonic pulses through the concrete mass. Higher velocities indicate better concrete quality in terms of density, homogeneity, and uniformity, while lower velocities may suggest inferior or delaminated concrete. A typical UPV test in progress is shown in **Figure 1,** and the interpretation criteria based on IS 516 Part 5 Section-1 are summarized in **Table 1**.

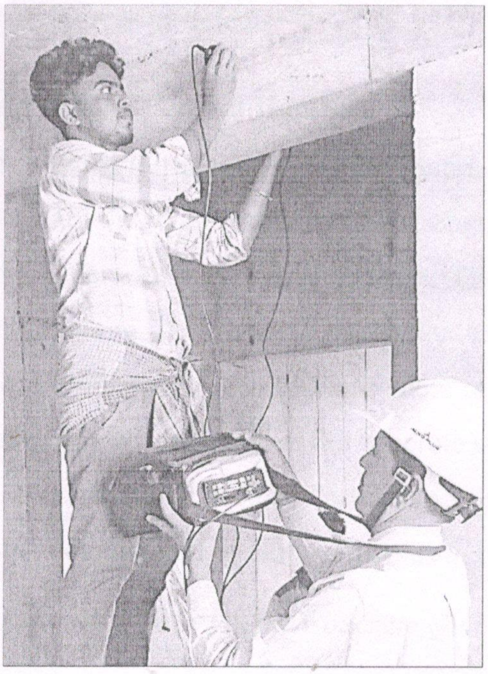

Figure 4: *Typical view of Ultrasonic Pulse Velocity Test in Progress*

Table 1: *Classification of the quality of concrete-based pulse velocity as per amendment no. 1 in IS 516 part-5 section-1*

S. No.	Pulse velocity, km/s	Concrete Quality Grading
For concrete (≤M25)		
1	Below 3.50	Doubtful
2	3.50-4.50	Good
3	Above 4.50	Excellent
For concrete (>M25)		
4	Below 3.75	Doubtful
5	3.75-4.50	Good
6	Above 4.50	Excellent

According to project documentation, M30-grade concrete has been used in the ongoing construction. The test results indicate that the concrete quality at all tested locations falls within the "good" to "excellent" range, with UPV values varying between 3.78 km/s and 4.58 km/s, and an average value of 4.14 km/s. Although minor overestimation of UPV readings may occur due to residual moisture in the concrete, the overall values confirm the sound quality of the concrete. These findings align with the visual inspection, where the concrete elements were observed to be mostly free from any noticeable distress or defects.

2.3.2 Surface Hardness Test using Rebound Hammer

The rebound hammer test was carried out using an N-type (Schmidt make) rebound hammer of impact energy 2.25 N-m to ascertain the relative quality and strength of in-situ concrete. **Figure 2** shows a typical surface hardness test in progress at the site. The rebound hammer used was calibrated as per the recommendations of *IS 516: Part 5: Sec 4: (2020)*. During the rebound hammer tests, a minimum of ten number of readings were taken at every test location. Care was taken to avoid visible locations of coarse aggregate in the concrete surface for the hammer impact. The criterion given in **Table 2** is generally used for estimating the quality of concrete in new structures and for identifying the delaminated or damaged areas in old concrete structures.

Table 2: *Rebound Number Criterion for Concrete Quality and condition*

S. No.	Average Rebound	Quality and condition of concrete near surface
1	>40	Very Good
2	30-40	Good
3	20-30	Fair
4	<20	Poor and delaminated

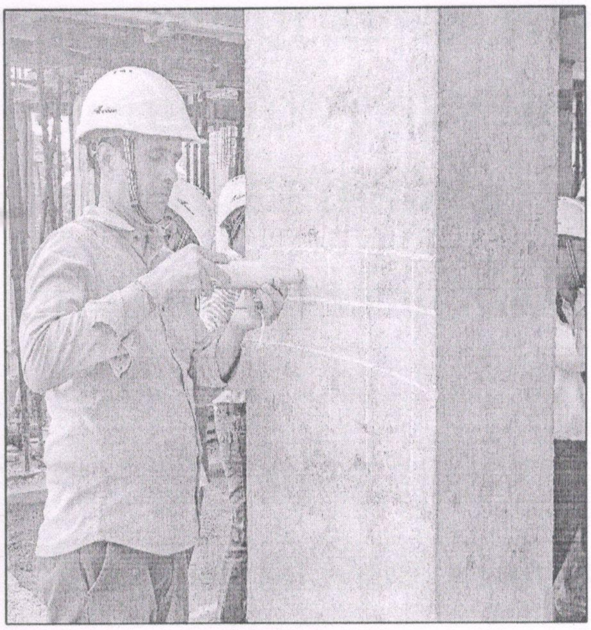

Figure 5: *Typical view of Rebound Hammer Test in Progress*

Since construction was very new, negligible carbonation is expected. This makes rebound hammer test a reliable indicator of concrete surface quality. In the present case, the rebound hammer values vary between 38 to 52, indicating good to very good concrete surface quality. Such a high value also exhibits that concrete was free from patches or delamination.

2.3.4 Chloride Content & pH Tests

For reinforced concrete structures, *IS: 456-2000*, specifies an upper limit of 0.6 kg/m³ for chloride content to ensure durability. Additionally, concrete is inherently alkaline, with sound concrete typically exhibiting a pH between 12 and 14, which helps maintain the passivation layer around reinforcement and prevents corrosion.

A total of fourteen concrete powder samples were collected from selected locations across the buildings to assess chloride content and pH levels. These samples were carefully sealed in polythene pouches and transported to the Department of Civil Engineering laboratories at IIT Roorkee for chemical analysis. Chloride content was determined following the guidelines of *IS 14959 (Part 2)-2001*.

The test results indicate that chloride levels in the concrete were negligible at the time of testing, with an average value below the permissible limit of 0.6 kg/m³, confirming that the concrete does not pose an immediate durability risk due to chloride-induced corrosion. Additionally, the pH of the concrete samples averaged 12.31, indicating adequate alkalinity, which is essential for maintaining reinforcement passivation and long-term durability.