

# Non-Destructive Quality Evaluation of Rural Sanitation Construction Works

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**Abstract:** Ensuring construction quality in rural infrastructure projects is essential for achieving long-term durability, structural safety, and efficient use of public resources. With the rapid expansion of development works in rural regions, there is a growing requirement for systematic monitoring and technical evaluation of executed projects. This study highlights the findings obtained from independent quality inspections carried out on selected rural construction works under the mission. The investigation involved field-based assessment of concrete performance using Non-Destructive Testing (NDT) methods, particularly the rebound hammer test, along with detailed visual examination of workmanship quality, material application, and adherence to specified construction guidelines. The study emphasizes that maintaining construction standards in rural areas is often challenging because of inadequate technical monitoring, inconsistent workmanship skills, and limited availability of quality materials. Deficiencies in construction practices can significantly affect the strength, functionality, and lifespan of infrastructure facilities, resulting in higher repair costs and reduced service efficiency. Therefore, establishing effective quality assurance mechanisms is vital for improving the reliability and sustainability of rural infrastructure projects and for ensuring that development schemes provide safe, durable, and beneficial assets to the community.

**Keywords:** Durability, Non destructive test, quality inspections

## I. INTRODUCTION

Rural infrastructure development plays a vital role in improving living standards, public health, and socio-economic growth. Government-led initiatives such as the Swachh Bharat Mission have significantly accelerated the construction of sanitation and allied infrastructure in rural areas across India. While the scale of implementation has been extensive, ensuring consistent construction quality remains a major challenge, particularly in remote and resource-constrained regions. Inadequate quality control can result in premature deterioration of structures, reduced serviceability, and inefficient utilization of public resources.

Quality construction is essential for achieving durability, safety, and long-term functionality of rural infrastructure. However, rural construction projects often face limitations such as lack of skilled manpower, insufficient technical supervision, variability in material quality, and non-adherence to standard construction practices. These factors increase the risk of structural deficiencies, which may compromise both performance and sustainability. Therefore, systematic quality assessment and monitoring are crucial to verify compliance with prescribed standards and to identify potential shortcomings at early stages.

Non-destructive testing methods provide efficient means for assessing construction quality without damaging existing structures. Among these methods, the rebound hammer test is widely used for rapid in-situ evaluation of concrete surface hardness and indicative compressive strength. When combined with visual inspection of workmanship, curing practices, and material usage, it offers meaningful insight into overall construction quality. The involvement of independent third-party consultants improves transparency, accountability, and reliability of assessments. This study



examines third-party quality inspections of rural construction works integrating rebound hammer testing with systematic site observations to evaluate construction standards, identify common deficiencies.

## II. METHODS AND MATERIAL

The study followed a structured methodology to assess the quality of rural construction works through the application of non-destructive evaluation techniques. The rebound hammer test was used as the principal testing method, along with comprehensive visual inspections and on-site observations. This methodology facilitated the evaluation of concrete quality without affecting the integrity of the existing structures, making it highly appropriate for rural field investigations.

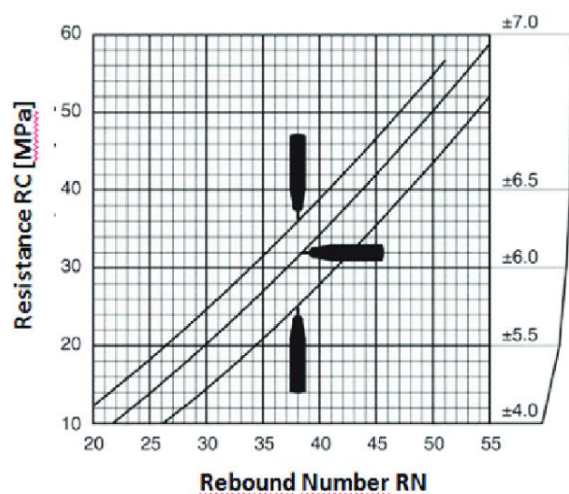
The rebound hammer testing procedure was performed in accordance with applicable Indian Standard guidelines. Before conducting the test, the concrete surfaces were properly cleaned to eliminate dust, loose particles, and surface deposits to obtain accurate and consistent readings. Test points were identified on structural elements such as soak pit slabs while avoiding edges, cracked portions, and honeycombed or deteriorated areas. Several rebound readings were recorded at each location, and their average value was considered to reduce variations caused by surface unevenness. The rebound index values were then correlated with standard reference charts to estimate the probable compressive strength of concrete.

Apart from the non-destructive testing procedure, detailed visual inspections were also undertaken to examine the quality of workmanship, adequacy of curing, surface appearance, alignment, and the overall condition of the construction works.

All test results and observations were systematically recorded and analyzed to identify variations in concrete quality across different locations. The involvement of an independent third-party inspection team ensured unbiased evaluation and adherence to quality assurance protocols. The combined use of rebound hammer testing and visual inspection provided a comprehensive assessment of construction quality and highlighted areas requiring corrective measures to improve the durability and sustainability of rural infrastructure.

Rebound hammer testing was adopted as a non-destructive method to evaluate the in-situ quality of hardened concrete. A Schmidt rebound hammer (Type N) was used to measure the surface hardness of concrete elements. Before testing, the surface was prepared by removing dust, laitance, and irregularities to obtain consistent results. The hammer was positioned normal to the concrete surface, and multiple impacts were applied at each location. Rebound numbers obtained from individual impacts were averaged after eliminating abnormal values. The mean rebound index was then converted into an estimated compressive strength using standard reference chart as given below:

Figure I: Resistance Determination chart



**III. RESULTS AND DISCUSSION**

Rebound hammer testing was performed on soak pit structures to evaluate the in-place condition of hardened concrete in a non-destructive manner. The procedure was followed as per IS 516 (Part 5/Sec 4):2020, Non-Destructive Testing of Concrete – Rebound Hammer Test. Test locations were carefully selected on accessible and properly prepared concrete surfaces, and several impact readings were taken at each location to minimize random errors. The rebound indices obtained were averaged after excluding inconsistent values and were subsequently used to derive indicative compressive strength values through standard reference correlations. The findings reflect the general consistency and quality of concrete in soak pits, while also indicating the influence of on-site construction practices, curing adequacy, and material handling on concrete performance under rural field conditions. For the upper slab of the soak pit, rebound hammer readings should be obtained from locations that truly represent the quality of the concrete. The test points should be selected on the exposed top surface of the slab, avoiding edges, corners, cracks, and areas showing surface defects. Measurements should be taken at a safe distance from slab boundaries and away from reinforcement to prevent localized effects on rebound values. Several impact readings, generally eight to ten, should be distributed uniformly over the slab area, with preference given to central and mid-span regions. The concrete surface should be clean, dry, and smooth before testing. Irregular or inconsistent readings should be excluded, and the mean rebound number should be used for further assessment.

TABLE II: Rebound Hammer result Details

Site No.	Site & Number of Soak Pits	Average Value (N/mm <sup>2</sup> )	Compressive Strength (N/mm <sup>2</sup> )	Quality of Concrete
1	Chikhali (6 No.s)	23	20	Fair
2	Manoli, Ghatanji (7 No.s)	23.23	20	Fair
3	Akola Bazar (7 No.s)	19.23	20	Poor
4	Tiwasa (4 No.s)	23.23	20	Fair
5	Kotha Kalamb (8 No.s)	22.28	20	Fair

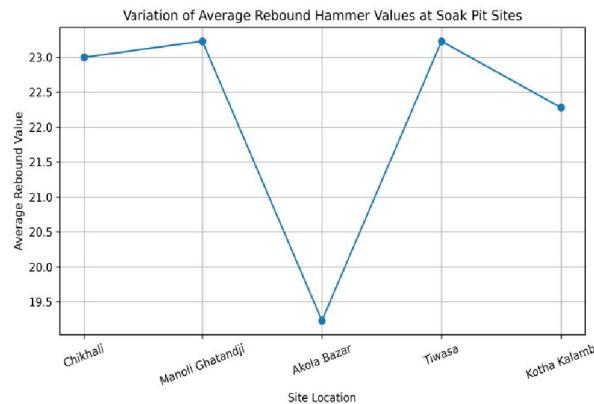


Figure III: recognition of quality of concrete



The line graph illustrates the variation in average rebound hammer values measured on the upper slabs of soak pits constructed at different project locations. The rebound hammer test was used to assess the surface hardness of concrete and to obtain an indicative measure of in-situ concrete quality without causing damage to the structure. The plotted values correspond to five sites, namely Chikhali, Manoli (Ghatandji), Akola Bazar, Tiwasa, and Kotha Kalamb, allowing a comparative evaluation of concrete performance across locations.

The graph shows that Chikhali, Manoli (Ghatandji), and Tiwasa recorded similar rebound numbers, ranging between 23 and 23.23. These values indicate fair-quality concrete for M20 grade and suggest that basic construction practices such as batching, placement, and curing were reasonably maintained at these sites. Kotha Kalamb also exhibits a rebound value above 22, reflecting comparable concrete quality with only minor fluctuations, which may be attributed to differences in site conditions or workmanship. A significant deviation is observed at Akola Bazar, where the rebound value drops to approximately 19.23. This comparatively lower value reflects reduced surface hardness and points towards possible deficiencies in curing, compaction, or material control during construction. The pronounced dip in the graph at this location highlights non-uniformity in concrete quality across the surveyed sites.

#### IV. CONCLUSION

The present study concludes that the overall quality of construction observed in rural infrastructure projects is generally satisfactory, as reflected by the results obtained from non-destructive testing. The rebound hammer test results indicate that most soak pit structures exhibit fair concrete quality, suggesting acceptable workmanship, material selection, and curing practices at site level. These findings highlight that construction quality is being given due importance even in rural areas, contrary to the earlier perception of poor execution in such regions. Over the past five years, rural development activities across the country have accelerated significantly, with large-scale implementation of sanitation, housing, and basic infrastructure projects. The pace of development is expected to further increase in the coming years, making quality assurance an essential component of sustainable rural growth. The test results demonstrate that concrete quality and structural performance are increasingly being prioritized in rural construction works, contributing to improved durability and service life of infrastructure assets.

The application of non-destructive testing techniques, particularly the rebound hammer test, has proven to be an effective tool for rapid quality assessment under field conditions. Such methods offer immediate results without causing damage to the structure, making them highly suitable for third-party inspections and routine monitoring in rural projects. The ease of execution, minimal equipment requirements, and quick interpretation of results enable inspectors to evaluate multiple structures efficiently. Overall, the integration of non-destructive testing with regular site inspections can significantly enhance quality control mechanisms, ensuring that rural infrastructure development remains both robust and sustainable in the long term.

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