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INFLUENCE OF TAMPING ON COMPRESSIVE STRENGTH OF CONCRETE

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ABSTRACT

Concrete compaction significantly influences the strength, durability, and overall performance of concrete by reducing air voids and improving density. This study evaluated the effect of manual tamping and mechanical vibration on the compressive strength of M25, M30, and M35 concrete grades using 150 mm × 150 mm × 150 mm cube specimens designed according to IS 10262:2019. Specimens were compacted using 15, 25, and 35 tamping's per layer or mechanical vibration for 15 seconds per layer, cured for 28 days, and tested using a Compression Testing Machine (CTM). Results showed that for M25 concrete, 25 tamping's achieved the highest manual compressive strength (41.48 MPa), while mechanical vibration produced superior strengths for M30 (41.92 MPa) and M35 (46.37 MPa). Overall, moderate manual tamping provided satisfactory compaction, but mechanical vibration consistently reduced air voids and achieved higher compressive strength, particularly for higher-grade concrete, highlighting the importance of proper compaction in ensuring optimum concrete performance.

KEYWORDS: ***Concrete Compaction, Tamping, Mechanical Vibration, Compressive Strength, Mix Design, M25, M30, M35.***

1. INTRODUCTION

Concrete is one of the most widely used construction materials due to its strength, durability, and versatility, and its performance largely depends on factors such as mix design, material quality, curing, and especially compaction. Proper compaction removes entrapped air, increases density, and enhances compressive strength, while inadequate compaction can cause voids, honeycombing, and reduced durability. This study investigates the influence of different compaction methods, including manual tamping (3 layers × 15, 25, and 35 strokes) and mechanical vibration, on the compressive strength of M25, M30, and M35 concrete mixes designed according to IS 10262:2019. The research addresses the lack of clarity regarding the optimum level of manual tamping and compares its effectiveness with mechanical vibration under laboratory conditions. Concrete cubes are cast, cured for 28 days, and tested using a Compression Testing Machine (CTM) to evaluate compressive strength. The study aims to identify the most effective compaction method, analyse its effect on different concrete grades, and provide guidance for improving quality control and reducing structural deficiencies in both laboratory and field construction practices.

2. LITERATURE REVIEW

Concrete technology has advanced significantly, with research emphasizing the importance of proper compaction in improving the strength, durability, and overall performance of concrete. Compaction removes entrapped air, increases density, and enhances the bond between cement paste and aggregates, while inadequate or excessive compaction can lead to air voids, honeycombing, porosity, and segregation, bleeding, and reduced compressive strength. Previous studies show that even a 1% increase in air voids can reduce compressive strength by about 5–6%. Manual tamping is commonly used for laboratory testing and small-scale construction, with its effectiveness depending on the number of tamping strokes, consistency, and operator skill, whereas mechanical vibration is widely preferred in modern construction because it provides better consolidation, removes entrapped air more effectively, and generally produces higher compressive strength when properly controlled. The effectiveness of both methods is also influenced by factors such as water-cement ratio, workability, aggregate size, grading, and mix design, with standards such as IS 10262:2019 and IS 456:2000 providing guidance for proper concrete production. Although existing literature confirms the advantages of mechanical vibration, limited research has quantitatively compared different manual tamping levels (15, 25, and 35 strokes) with vibration across multiple concrete grades (M25, M30, and M35) under identical conditions. Therefore, this study addresses this research gap by systematically evaluating the influence of varying tamping levels and mechanical vibration on the compressive strength of concrete to identify the optimum compaction method.

3. MATERIALS USED

3.1 Cement

Cement acts as a binding material in concrete. It reacts with water and forms a paste that binds aggregates together.

3.2 Fine Aggregate (Sand)

Fine aggregate fills the voids between coarse aggregates and improves the workability of concrete. Locally available river sand was used in this study.

3.3 Coarse Aggregate

Coarse aggregate forms the major portion of concrete and contributes significantly to its strength.In this study, **20 mm nominal size crushed aggregate** was used

3.4 Water

Water is an essential component in concrete, required for hydration of cement and workability of the mix.In this study, **filtered drinking water** was used. Water used satisfied the requirements of IS standards and was free from harmful substances like oils, acids, alkalis, and salts.

Table 1 Properties of Materials

Material	Property	Value
Cement	Specific Gravity	3.15
Fine Aggregate	Specific Gravity	2.65
	Water Absorption	1.0%
Coarse Aggregate	Specific Gravity	2.74
	Water Absorption	0.5%
Water	Quality	Potable

4. MIX DESIGN

The concrete mix designs for M25, M30, and M35 grades were carried out in accordance with IS 10262:2019 and IS 456:2000 to achieve the required strength, durability, and workability under severe exposure conditions using OPC cement, 20 mm crushed angular coarse aggregate, Zone II fine aggregate, and a slump of 75 mm. The target mean strengths were calculated as 31.6 MPa, 38.25 MPa, and 43.25 MPa for M25, M30, and M35, respectively, with water-cement ratios of 0.50, 0.48, and 0.44. The corresponding cement contents were 384 kg/m^3, 399 kg/m^3, and 435 kg/m^3, while the water content was maintained at approximately 192 kg/m^3. Aggregate proportions were determined based on specific gravity, water absorption, and IS recommendations, and necessary adjustments were made for dry aggregate conditions by modifying aggregate quantities and increasing the mixing water to compensate for absorption. The final mix proportions were established in saturated surface dry (SSD) condition and subsequently adjusted for field conditions, ensuring that all mixes satisfied the requirements for strength, workability, and durability before being used for casting concrete specimens.

5. EXPERIMENTAL PROCEDURE

The experimental investigation was conducted under controlled laboratory conditions to evaluate the effect of manual tamping and mechanical vibration on the compressive strength of M25, M30, and M35 concrete. Concrete was batched by weight and manually mixed using the designed proportions, after which it was placed into clean, oil-coated 150 mm × 150 mm × 150 mm steel cube moulds in three equal layers. Each layer was compacted using one of four methods: 15 tamping's, 25 tamping's, 35 tamping's, or mechanical vibration for 15 seconds per layer. After casting, the cube surfaces were levelled, labelled, and left undisturbed for 24 hours before demoulding. The specimens were then immersed in water for 28 days to ensure proper curing and strength development. Following curing, the cubes were cleaned, dried, and tested for compressive strength using a Compression Testing Machine (CTM), where the maximum failure load was recorded and the compressive strength was calculated by dividing the load by the cross-sectional area of the cube (22,500 mm^2). Three specimens were prepared for each combination of concrete grade and compaction method, resulting in a total of 36 cubes, and the average strengths were used to compare the influence of different compaction techniques on concrete performance.

Figure 5.1: Mixing of Concrete

Figure 5.2: Preparation of Cube Moulds

Figure 5.3: Pouring the Concrete into the Moulds

Figure 5.4: Compaction by Tamping Rod

Figure 5.5: Compaction using Vibrator

Figure 5.6: Giving Id’s for cubes after compaction.

Figure 5.7: Curing of Concrete Cubes

Figure 5.8: Conducting Compression Test on CTM

6. RESULTS AND DISCUSSION

This chapter presents the results of the compressive strength tests conducted on M25, M30, and M35 concrete cubes to evaluate the effect of different compaction methods, namely manual tamping and mechanical vibration. The findings are presented through tables and graphs, followed by a detailed discussion of the observed trends and variations. The experimental results are analyzed to compare the effectiveness of each compaction method and to identify the most suitable technique for achieving optimum compressive strength in each concrete grade.

Table 2 Average Strength for M25 Grade

Method	Average Strength (MPa)
15 Tampings	28.59
25 Tampings	41.48
35 Tampings	33.04
Vibration	38.67

Table 3 Average Strength for M30 Grade

Method	Average Strength (MPa)
15 Tampings	33.48
25 Tampings	39.85
35 Tampings	35.85
Vibration	41.92

Table 4 Average Strength for M35 Grade

Method	Average Strength (MPa)
15 Tampings	41.78
25 Tampings	44.00
35 Tampings	41.48
Vibration	46.37

able 5 Combined Comparison Table

Grade	15T	25T	35T	Vibration
M25	28.59	41.48	33.04	38.67
M30	33.48	39.85	35.85	41.92
M35	41.78	44.00	41.48	46.37

GRAPHICAL REPRESENTATION

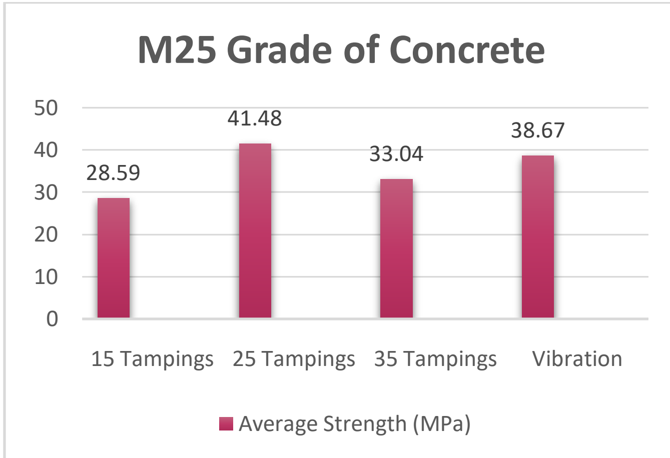

Figure 1: M25 Strength vs Compaction

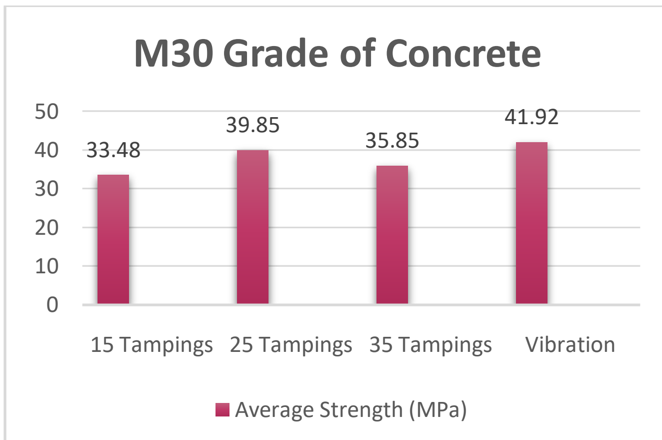

Figure 2: M30 Strength vs Compaction

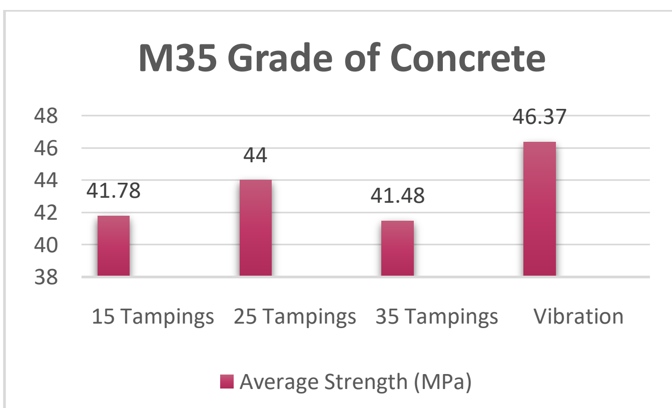

Figure 3: M35 Strength vs Compaction

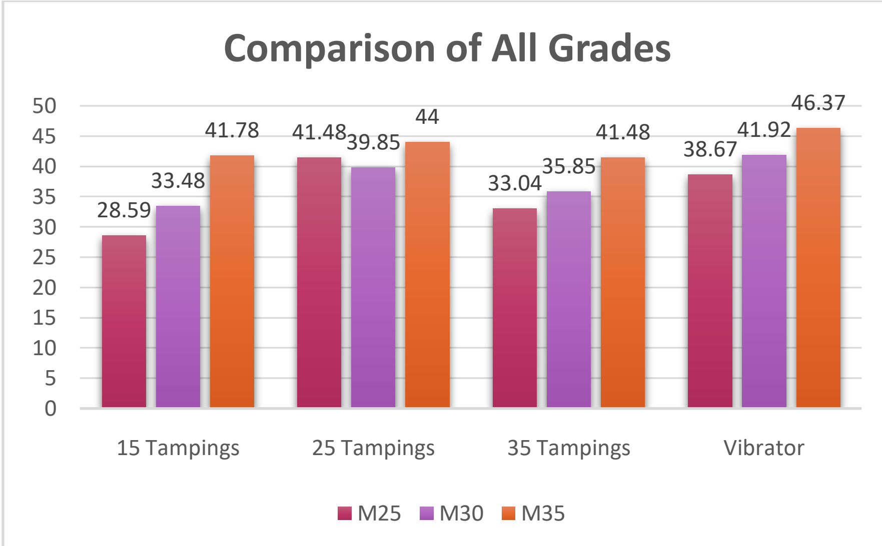

Figure 4: Comparison of All Grades

The experimental results demonstrate that compaction plays a vital role in improving the compressive strength of concrete. For M25 grade concrete, strength increased with an increase in tamping up to an optimum level, while excessive tamping reduced strength due to possible segregation and disturbance of the concrete matrix. In M30 and M35 grades, mechanical vibration produced higher and more consistent strength compared to manual tamping, indicating better compaction efficiency. The variations in results were mainly due to factors such as inconsistency in hand mixing, aggregate moisture variations, operator-dependent manual tamping, entrapped air voids, and minor testing errors. Overall, the study shows that proper compaction reduces air voids, improves concrete density, and enhances strength and durability. Moderate tamping provided satisfactory results, but mechanical vibration was found to be the most effective method, especially for higher-grade concrete requiring better compaction. The findings confirm that selecting a suitable compaction method is essential for achieving the desired quality and performance of concrete.

CONCLUSIONS

The experimental study on M25, M30, and M35 grades of concrete concludes that compaction method and degree significantly affect the compressive strength of concrete. Proper compaction reduces air voids, improves density, and enhances strength and durability. For M25 grade concrete, moderate manual compaction with 3 layers × 25 tampings provided the highest strength, showing that an optimum level of tamping is required to achieve effective compaction without segregation. For M30 and M35 grades, mechanical vibration produced higher and more consistent compressive strength compared to manual tamping, indicating the need for efficient compaction in higher-grade concrete. Excessive tamping was found to reduce strength due to possible segregation and disturbance of the concrete structure. Overall, mechanical vibration was identified as the most effective compaction method for achieving improved and uniform compressive strength across all concrete grades.

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