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Effect of formwork material on surface hardness of concrete

Rushikesh Kolte
rushikolte.1707@gmail.com
Pimpri Chinchwad College of Engineering,
Pune, Maharashtra

Aniket Malwade
aniket.malwade3@gmail.com
Pimpri Chinchwad College of Engineering,
Pune, Maharashtra

Avinash Sawant
sawantavinash02@gmail.com
Pimpri Chinchwad College of Engineering,
Pune, Maharashtra

Kartik Roge
kartikroge7115@gmail.com
Pimpri Chinchwad College of Engineering,
Pune, Maharashtra

Renuka Purohit
purohit.renu@gmail.com
Pimpri Chinchwad College of Engineering,
Pune, Maharashtra

ABSTRACT

The study emphasizes the effects of the formwork material that imparts a characteristic surface hardness to the concrete. Concrete cubes were cast of the M20 grade in different mould material like Cast Iron, Shuttering Plywood and Timber. The effect of these materials was studied by using the Rebound Hammer Test to find the Rebound numbers which depend on the surface hardness of the concrete. The results obtained are explained in the following statistical form. It can be concluded that each formwork material imparts a characteristic surface hardness to the concrete.

Keywords: *Rebound Hammer Test, Surface Hardness, Formwork Material.*

1. INTRODUCTION

Concrete is the one of the most widely used material in the world and hence continuous research is being done on the subject. Though the traditional way of the casting of concrete is done by using shuttering plywood, it is quite visible that the present market has seen an up rise in the use of the new material as formwork for their various advantages. Few such materials are Cast Iron, P.V.C., Mild Steel, Timber, and Aluminum, which are being efficiently used in a lot of constructional concreting process. These materials vary in their properties hence it is important to see if they have any specific role to play in altering the physical properties of the concrete cast in them. Cast Iron is the standard mould material recommended for laboratory level studies and Shuttering Plywood is the most commonly used material in India for concreting formwork. Timber is an additional material that has been considered for the research work. Rebound hammer test is one of the most widely used Non-Destructive methods for assessing the compressive strength of concrete. It is easy to operate and understand and hence is the primary way of assessing concrete properties. Rebound Hammer Test (IS 13311 Part 2: 1992) is capable of determining the surface hardness of concrete based on the Rebound number obtained from it. As per the IS 13311 Part 2: 1992, the rebound number depends on a number of influencing factors which include the type of cement, type of aggregate, surface condition and moisture content of concrete, curing, and age of concrete and carbonation of the surface. The Indian Standard nowhere mentions the influence of the formwork material on the rebound number but the American Standard (C805-97) and British Standards (BS 1881 Part 202-806) have included it.

1.1 Advantages of Rebound Hammer Test

a) It is simple to use and no special experience is needed to conduct the test.
b) It establishes uniformity of properties of concrete.

c) The equipment is inexpensive.
d) To assess the likely compressive strength of the concrete, the test is carried out without any destruction of the structure.

1.2 Objectives of the Study

The main objective of this study is to find the effect of the formwork material on the surface hardness of concrete.
For this various material like Cast Iron, Shuttering Plywood and Timber were used to fabricate moulds to cast 150mmX150mmX150mm cubes of concrete. These cubes were to be tested for Rebound Hammer Test and Compression Strength Test and then the results were analyzed.

2. STUDY AND METHODOLOGY

The study consists of selecting the different formwork material and casting of the concrete cubes.

2.1 Materials

The materials used are Ordinary Portland Cement (53 Grade) conforming to IS 12269, aggregate brought from Moi, Pune, Maharashtra (INDIA). The testing of properties of both types of aggregate was done as shown in Table 1.

Table-1: Properties of aggregates

Properties	Coarse Aggregate (20mm)	Fine Aggregate (Crushed Sand)
Specific Gravity	2.99	2.77
Water Absorption	0.38%	0.88%

2.2 Mix Proportion of Concrete

The concrete mix design was prepared using IS 456:2000 and IS 10262:1982 and shown in Table 2.

Table 2: Mix Proportion for M20 grade

Parameters	Quantity
Cement (kg)	38.45
Fine Aggregate (kg)	94.02
Coarse Aggregate (kg)	140.64
Water (kg)	19.61
W/C	0.51

2.3 Casting and Curing of Sample

The concrete specimen of 150 mm cube were cast in different formwork material like Cast Iron, Shuttering Plywood and Timber and wet cured for 28 days and surface dried for 3 days for Rebound Hammer Test and then wet cured again for 1 day and then surface dried for Compressive Strength Test.
The test procedure is as follows:

1. Ten samples in each formwork material were cast; around 30 cubes were cast.
2. The cubes were cast using the mix proportion as shown in Table 2.
3. At the time of casting, mixing was done using a concrete batch mixer in which all ingredients were added.
4. Moulds were kept in air for 24 hours so that the concrete is properly set and then cubes were taken out of the moulds which were then cured in water tanks for 28 days.
5. After curing, the cubes are taken out and kept in air for 3 days so that the surface gets dried.
6. The samples are then tested for Rebound number by following Indian Standards (IS 13311 Part 2:1992).
7. The cubes were again cured for a period of 1 day and then surface dried for some time to carry out compression strength test.

3. RESULTS

All the readings of Rebound Hammer Test and Compressive Strength Test were plotted together to get the results.

1) Readings of Rebound Hammer Test for all 10 cubes cast in different formwork material are shown in Table 3. (The results are the average of 18 rebound readings where 9 readings were taken on both accessible faces of the sample cube)
2) The comparison of Rebound numbers for cubes cast in different formwork material is shown in Figure 1.
3) The results of the Compression Strength Test for all the cubes are shown in Table 4.
4) Correlation curve between Rebound Number and Compressive Strength, for cubes cast in all formwork material, is shown in Figure 2.

Table 3: Rebound Hammer Test Results

Cast Iron	Shuttering Plywood	Timber
24.37	24.36	26.5
25.45	25.7	29.45
23.5	24	27.5
26.78	23.8	29.5
27.33	24.5	29.58
25	26.67	24.44
25.44	25.94	28.78
25.22	28.11	28.27
25.89	24.89	28.27
26.38	24.89	28.03

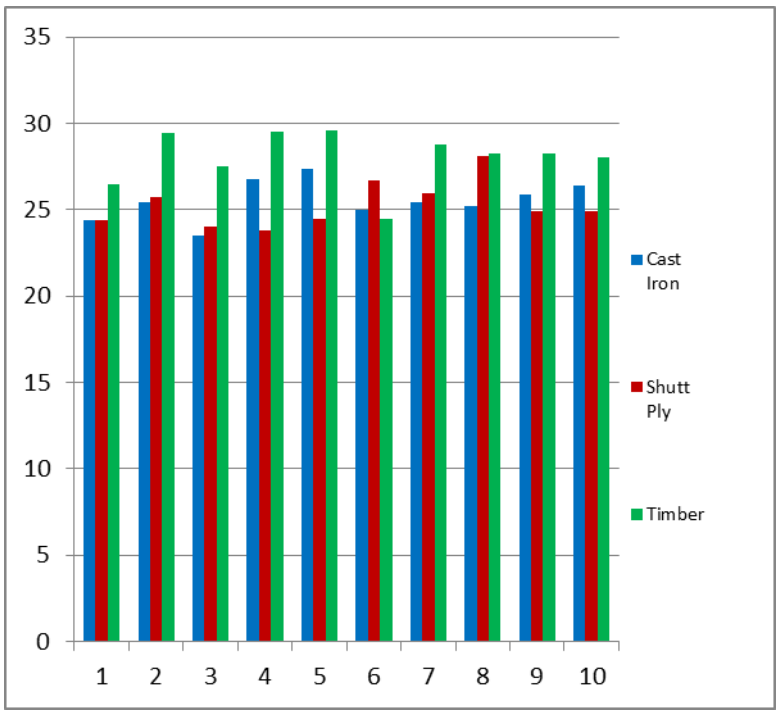

Figure-1: Comparison of Rebound Numbers
(On Y-axis: Rebound Number
On X-axis: Cube Samples)

Table-4: Compression Strength Test results (in kN)

Cast Iron	Shuttering Plywood	Timber
475	559.2	534.8
496	584.5	590.6
491.2	553.7	579.1
602	466.3	606.2
625.3	584.5	643.4
527.2	599.5	393.4
599.8	561.8	485.2
590.1	641.2	478.3
614.6	498.3	477.5

649.7	496.1	532.06

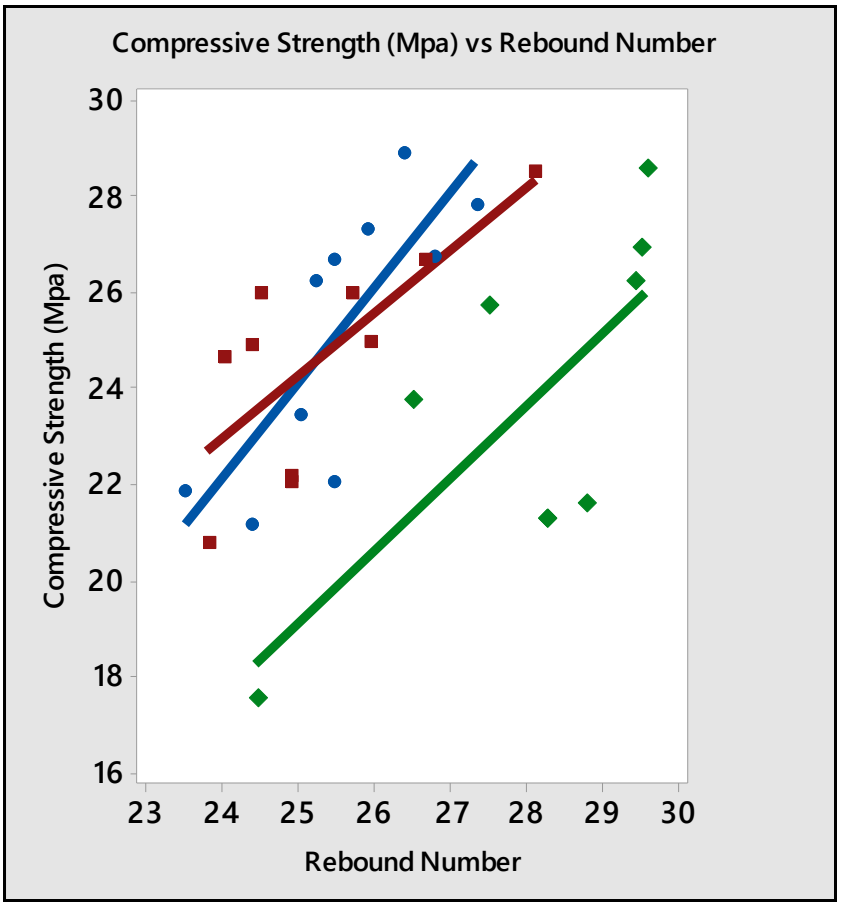

Figure-2: Correlation curve between Compressive Strength and Rebound Number

	Cast Iron
	Shuttering Plywood
	Timber

4. CONCLUSION

From the experimental study, we can derive the following conclusions:

1) From Figure-1, it can be concluded that the rebound numbers are varying for the same concrete which was cast in different formwork material. Hence it is evident that the formwork materials impart a characteristic surface hardness to the concrete.
2) Figure 1 also indicates that the rebound numbers obtained on Cast Iron and Shuttering Plywood cubes are approximately same but the cubes obtained from Timber moulds have around 9% higher Rebound numbers. This shows that Timber imparts a comparatively higher surface hardness. The assumed reason for such variation is that Timber soaks the water present in concrete (while casting) and hence reduces the Water-Cement ratio which gives higher surface hardness than other materials.
3) It is also evident from Figure-2 that the correlation curve for Timber casted concrete is on the lower side i.e. the compressive strength attained by concrete is also lower than that of other materials. The reason for the reduction in strength of compressive strength of concrete is a reduction of water-cement ratio and hence proves the assumption to be correct.

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