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Experimental Investigation of Concrete Block Walls Compressive Strength Using a Non-Destructive Test

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Abstract. The non-destructive test is an inexpensive measure of surface hardness that is used to determine the theoretical relationship between the strength of hardened concrete block walls and the rebound number of the hammer. This study analyzed the compressive strength of concrete block walls a building using a non-destructive test. Data was collected using the impact method (Schmidt rebound hammer) on three sides of the building concrete block walls. The standard experimental procedure for impact method was followed and the analysis of the result was presented through tables and figure. The result shows that the Rebound value (R) of the three sides for the concrete block walls (R) were 17.21N/mm^2 (CBW1), 15.01 N/mm^2 (CBW2) and 16.1N/mm^2 (CBW3). The average compressive strength for all the CBW tested in relation to the rebound value (R) is 16.1N/mm2, which shows that the compressive strength of the concrete block walls is within the stipulated minimum compressive strength of 12.5 N/mm^2 for load-bearing concrete block work, using Ordinary Portland Cement and suitably graded fine and coarse aggregate in accordance to BSEN1971-1 2011. The study indicated that a non-destructive test using Schmidt rebound hammer is suitable for testing of building structures because it does not compromise the performance of component or structure being investigated and it's quality. The study concluded that the structure tested using the non-destructive test is safe and suitable for habitation

Keywords: Non-Destructive; Concrete Block Wall; Rebound Value; Compressive Strength.

1 Introduction

Concrete block is a standard size rectangular block multipurpose building product that is mostly used as load-bearing walls of a building. It is used with other construction material like concrete columns, tie beam or when built with integral steel reinforcing. In Nigeria, the concrete block walls are used as freestanding walls and loading bearing structure because of its affordability and simplicity. Over 90% of Masonry walling units of housing structure provided was constructed using concrete blocks. Its utility value comparing to its cost and its adaptability climatic factors make it a good material for

building work [1]. This makes concrete blocks vital material in building construction work [2]In meeting the need of the building, concrete blocks can be produced through mechanical vibrating moulding machine or manually process of production [3].In the production of concrete blocks, the durability and strength of the concrete block before and during use is not considered. Although the standards organization of Nigeria has provided specifications for its production and usage. In many parts of the country, concrete blocks are produced devoid of reference to any requirement or its usage specifications [4]. Odeyemi [5] opined that concrete blocks strength increases with density in its hardened state. The concrete block as a load bearing wall support other building as such its strength could be determined using a non-destructive test in accordance to [6] that stipulated minimum compressive strength of 12.5N/mm^2 for load-bearing concrete block walls. The non-destructive test is majorly carried out on component of building a structure without affecting the structure itself before, during or after usage [7]. The non-destructive test is performed on a structure using an apparatus called the Schmidt rebound hammer, and the test does not compromise the envisioned performance of any component or structure being investigated and it's quality [8]. Yüksel [9] opined that in determining the compressive strength of any part of a building structure, the non-destructive testing is ideal because of its easiness. Although, using the non-destructive test to determine the concrete block strength is not expensive, there are standard processes that need to be followed to attain better results using the rebound hammer [10]. Conversely, [11] state that a non-destructive test causes less damage to building walls. Aydin [8] state that the result of a non-destructive test using a Schmidt rebound hammer dependent upon the type of surface finish and its preparation, the degree of saturation, carbonation, and temperature. The study of [12] further shows that result of Schmidt hammer test on concrete block walls is affected by so many factors which include aggregate type, mix ratio, type of hammer, testing area, honey-comb, and scaling, and rough texture. Yilmaz [13] observed that the use of the non-destructive test to determine the concrete block walls strength is affected by factors such as; type of aggregate use, area of testing, method of construction, direction of testing, and state of the surface to be tested. Nevertheless, [14] opined that using the non-destructive test on concrete block walls is of no importance if its results are not meeting the expected result from part tested. This study investigates the compressive strength of concrete block walls in relation to the rebound value (R) using a non-destructive impact method (Schmidt rebound hammer).

2 Methods and Procedure

The experimental procedure for this research was carried out in accordance with [6]. The load-bearing concrete block walls to be tested were carefully selected and the tested points were prepared and smoothened using a grindstone. The rebound hammer was pushed against the test surface at a reasonable speed with a fixed amount of energy against the concrete block walls, positioned horizontally to and against the test surface and until an impact is initiated. 25 impacts values were recorded on each concrete walls tested. Minimum of 12 impact values was taking from values for each concrete block

wall sampled. The average rebound value (ARV) for 10 impacts which is the minimum values that can be taken for evaluation in accordance with [15] and [16] was calculated and the rebound value (R) determined. The compressive strength for the concrete block walls sampled was analyzed in relation to the rebound values. The study makes use of the following equipment, apparatus, and tools: Schmidt rebound Hammer, grinding stone, measuring tape in carrying out its experiment procedure. The safety procedure for the research was in line with the finding of [17].

3 Results

Table 1. Analysis of Rebound value for the CBW 1

S/N	Sample (mm)	No of Impact	Rebound value (N/mm²)	Deductions (N/mm²)
1	Concrete Block wall of 250x250x450mm with plaster and screed of 25mm thickness	1	15.75	15.75
		2	16.69	16.69
		3	15.45	Lowest value
		4	18.65	18.65
		5	16 85	16.85
		6	16.75	16.75
		7	18.45	18.45
		8	17.95	17.95
		9	16.35	16.35
		10	19.55	Highest value
		11	18.24	18.24
		12	16.23	16.23
			Total	171.91

Average rebound value (ARV) = $\frac{\text{Sum of the total value}}{\text{Number of Impact}}$

$$R = \frac{171.91}{10} = 17.2 \text{ N/mm}^2$$

Table 2. Analysis of Rebound value for the CBW2

S/N	Sample (mm)	No of Impact	Rebound value (N/mm²)	Deductions (N/mm²)
2	Concrete Block wall of 250x250x450mm with plaster and screed of 25mm thickness	1	14.55	14.55
		2	17.45	17.45
		3	14.45	Lowest value
		4	17.65	17.65
		5	16 .85	16. 85
		6	15.75	15.75

	7	17.45	17.45
	8	15.85	15.85
	9	17.15	17.15
	10	17.50	17.50
	11	16.78	16.78
	12	17.87	Highest value
		Total	150.13

Average rebound value (ARV) = $\frac{\text{Sum of the total value}}{\text{Number of Impacts}}$

$R = \frac{150.13}{10} = 15.01 N/mm^2$

Table 3. Analysis of Rebound value for the CBW3

S/N	Sample (mm)	No of Impact	Rebound value (N/mm^2)	Deductions (N/mm^2)
3	Concrete Block wall of 250x250x450mm with plaster and screed of 25mm thickness	1	15.65	15.65
		2	15.95	15.95
		3	16.45	16.45
		4	15.45	15.45
		5	17.35	17.35
		6	15.85	15.85
		7	18.45	Highest value
		8	15.95	15.95
		9	13.45	Lowest value
		10	16.36	16.35
		11	17.03	17.03
		12	16.87	16.87
			Total	162.91

Average rebound value (ARV) = $\frac{\text{Sum of the total value}}{\text{Number of Impacts}}$

$R = \frac{162.92}{10} = 16.29 N/mm^2$

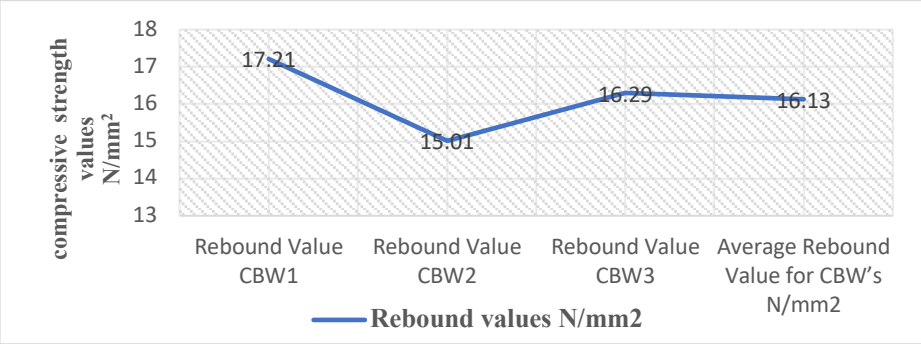

Fig.1: Analysis of compressive strength for concrete block walls in relations to the rebound values

4 Discussion

Non-destructive test was carried out on CBW1 of 250x250x450mm with plaster and screed of 25mm thickness. The rebound values after impact were recorded taking at least 12 readings out of 25 impacts that was carried out on the tested concrete block wall. For accuracy, the lowest (15.45N/mm^2) and the highest rebound value (19.55N/mm^2) was deducted, and the average rebound value (ARV) for the 10 rebound values was calculated. The result shows that the Rebound value (R) for CBW1 is 17.2 N/mm^2.

Non-destructive test was carried out on CBW2 of 250x250x450mm with plaster and screed of 25mm thickness. The rebound values after impact were recorded taking at least 12 readings out of 25 impacts that were carried out on the tested concrete block wall. For accuracy, the lowest (14.45N/mm^2) and the highest rebound value (17.87N/mm2) was deducted, and the average rebound value (ARV) for the 10 rebound values was calculated. The result shows that the Rebound value (R) for CBW2 is 15.01N/mm^2.

Non-destructive test was carried out on CBW3 of 250x250x450mm with plaster and screed of 25mm thickness. The rebound values after impact were recorded taking at least 12 readings out of 25 impacts that were carried out on the tested concrete block wall. For accuracy, the lowest (13.45N/mm^2) and the highest rebound value (18.45N/mm^2) was deducted, and the average rebound value (ARV) for the 10 rebound values was calculated. The result shows that the Rebound value (R) for CBW3 is 16.29 N/mm^2 .

The compressive strength result for the three load-bearing block walls in a specific relationship with the rebound value (R) is shown in figure 1. The result showed compressive strengths of 17.21N/mm² (CBW1), 15.01N/mm² (CBW2), and 26.45N/mm² (CBW3), and average compressive strength in relation to the rebound value (R) is16.1N/mm² for all CBW tested using the Schmidt rebound hammer.

The findings of this study agreed with [18] that stipulated that the minimum compressive strength of an existing load bearing wall above the damp-proof course should be 12.5 N/mm^2 for load-bearing block work.

5 Conclusions

This study investigates the compressive strength of concrete block walls in relation to the rebound value (R) using a non-destructive impact method (Schmidt rebound hammer). From the result of the study, the compressive strength values of the concrete block walls tested in relation to the rebound values (R) were 17.21N/mm² (CBW1), 15.01N/mm² (CBW2), and 16.29N/mm² (CBW3). The average compressive strength for all the CBW tested in relation to the rebound value (R) is 16.13N/mm2, which shows that the compressive strength of the concrete block walls is within the stipulated minimum compressive strength of 12.5 N/mm2 for load-bearing concrete block work, using Ordinary Portland Cement and suitably graded fine and coarse aggregate in accordance to [18]. The study indicated that a non-destructive test using Schmidt rebound hammer is suitable for testing of building structures because it does not compromise the performance of component or structure being investigated and its quality. The study concluded that the structure tested using the non-destructive test is safe and suitable for habitation. The limitation of this research is that there is little existing literature on this study area. Future research work can be carried out on existing concrete floors and columns using the Schmidt rebound hammer.

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