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Field Identification of Bricks by Rebound Hammer Test

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The present study is aimed to establish the non-destructive rebound hammer test for identification of bricks. An N-type rebound hammer with impact energy 2.207 N-m was used for testing different types of bricks and the ranges of rebound number were determined for each category. Ranges of rebound number for 1st class, 2nd class and 3rd class brick were found to be 24.10 - 31.40, 17.30 - 20.40 and 11.80 - 14.30 respectively.

Keywords: Field test of brick; Non-destructive test; Rebound hammer.

1. INTRODUCTION

The common types of bricks available in the construction sector of Bangladesh are namely the “1st class brick”, “2nd class brick” and “3rd class brick”. In a construction site, the type of brick is usually identified by visual inspection of color, shape and metallic sound by hammering. As suggested by Aziz (1995), a good brick should not permit marking on its surface by nail, it should make metallic sound when striking with a hammer and two of such bricks should not be broken when dropped from a height of 6 feet in the form of a tee (T). All these field test would identify 1st class brick but as the tests are mostly depends on visual and hearing ability of the inspecting personnel, the outcomes of such tests may vary person to person. Moreover, these field tests do not define specific barriersamong 1st class, 2nd class and 3rd class bricks. The most accurate way to distinguish the categories is testing them under a compression testing machine. Compressive strength of brick can define its category. But such test involves heavy equipment, laboratory provision and sufficient time. Moreover, the samples under test are destroyed in such test. Non-destructive tests, on the other hand, preserves integrity of sample under test, takes a very little time and involves portable, simple and handy equipment. That why non-destructive test are popular for field test of engineering

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materials. Rebound hammer test, also known as Schmidt hammer test developed by Earnest Schmidt is one of the most popular non-destructive tests. The test involves a device known as Schmidt hammer or rebound hammer that uses a spring and measures the hardness of surface using the rebound principle (Cemex USA Technical Bulletin, 2008). The rebound hammer test is well recognized and it is codified in ASTM C805.This test was primarily developed for estimating compressive strength of concrete only and manufacturers of such rebound hammers provide calibrated curves only for concrete strength. One can estimate compressive strength of concrete from its rebound number using the calibrated curves. There is no way for estimating strength of brick or other materials in similar manner due to the unavailability of calibrated curves. But, however, identification of brick may be possible using rebound hammer following the principle that, a good quality brick must possess a higher rebound number. It is possible to establish a range of rebound number for 1st class brick by testing a series of sample and so for 2nd class and 3rd class bricks. Objective of the present study is to find out those ranges so that the bricks can be classified more accurately within a very short time without breaking them.

2. LITERATURE REVIEW

Acceptability and accuracy of rebound hammer test is evaluated in several research works and studies. An investigation made by Sanchez and Tarranza (2014) concluded that the Schmidt Hammer Test is fairly reliable for estimating strength existing concrete structures. Fair accuracy of strength estimation was also claimed by Rubene and Vilnitis (2014) who performed a series tests on reinforced concrete wall. However, the test is for estimation purpose only and it does not give actual strength. A study showed that rebound number readings are sensitive to near-surface properties and influenced by surface smoothness, age of concrete, moisture content, carbonation, presence of aggregates, presence of air voids and steel reinforcement, temperature, and calibration of the rebound hammer (Cemex USA Technical Bulletin, 2008). Therefore, rebound hammers should be used with caution. Another important consideration was stated by American Concrete Institute as, if the specimen is small, any movement under the impact will lower the rebound readings and in such cases the specimen has to be fixed or backed up by a heavy mass (ACI 228.1 R-03, 2003).

In recent years, several research works were carried on the application of rebound hammer test for bricks and stones. Researchers found the method suited for testing bricks. McCann and Forde (2011) reviewed the applicability of non-destructive tests on masonry structures. Brozovsky (2012) performed rebound hammer test on lime sand bricks and honeycomb

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bricks and he summarized that the test method is usable in practice for lime sand bricks but in case of honeycomb bricks special considerations need to be taken into account. He performed another research using a combination of ultrasonic pulse method and rebound hammer method (SonReb) and found that that the combined SonReb method was fairly applicable for determination of compressive strength of bricks built in existing masonry structures (Brozovsky, 2014). Recently a study on different types of bricks and stones carried by Aliabdo and Elmoaty (2012) established an exponential model for correlation between rebound number and compressive strength. All the studies indicate the acceptability of rebound hammer test for bricks and therefore, the concept of present study is justified.

3. METHODOLOGY

For this study, sample bricks were collected from local brick fields. An N-type classic concrete rebound hammer with impact energy 2.207 N-m was used for rebound hammer test. Test method is discussed in this section.

3.1 SAMPLE PREPARATION

Total thirty (30) samples of brick(conventional size:$240mm \times 115mm \times 70mm$), ten (10) from each category, i.e. 1st class, 2nd class and 3rd class were collected from two brick fields located in the district of Dinajpur, Bangladesh. Test surfaces of the bricks were smoothened using the abrasive stone available with the rebound hammer accessories. Samples from each category were marked with numbers 1 to 10. The samples were kept firmly attached with a concrete column so that they cannot move during test.

3.2 REBOUND HAMMER TEST

The rebound hammer test was performed by keeping the hammer in horizontal alignment. Ten rebound number readings were taken for each sample and recorded in a table.

3.3 CALCULATION OF AVERAGE REBOUND NUMBER

Average of the ten readings recorded for a particular sample was calculated. As stated in the user manual, if some readings lie at a distance of 5 units or more from the average, those readings were disregarded and the average was revised excluding the distant readings. Same calculation was made for all the thirty samples.

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4. RESULTS and DISCUSSION

Calculationsfor average rebound numbers and revised averages (if applicable) for 1st class, 2nd class and 3rd class brick are presented in Table-1, Table-2 and Table-3.

Table-1 Calculation of average rebound number for 1st class brick

Sample No.	Observed Rebound Number (RN)										Average RN	Revised Average RN rejecting the distant values	Mean Rebound Number
	1	2	3	4	5	6	7	8	9	10			
1	23	25	27	**19***	24	26	27	26	23	27	24.70	25.34	26.68
2	27	22	26	24	24	23	27	23	27	27	25.00	25.00	
3	25	24	26	24	28	24	26	26	22	26	25.10	25.10	
4	24	27	22	25	22	24	26	27	26	23	24.60	24.60	
5	32	34	29	30	32	34	29	31	32	31	31.40	31.40	
6	34	34	29	29	29	29	27	33	30	27	30.10	30.10	
7	29	30	31	**34***	30	25	26	25	25	27	28.20	27.56	
8	22	22	27	27	27	22	22	26	22	24	24.10	24.10	
9	28	27	**21***	28	26	27	31	26	24	25	26.30	26.89	
10	28	25	29	25	25	24	25	28	29	29	26.70	26.70	

*Distant reading excluded in revised average calculation

The table shows that the range of rebound number for 1st class brick is from 24.10 to 31.40 with a mean rebound number of 26.68. Therefore, a brick can said to be 1st class brick if it possesses an average rebound number above 24.

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Table-2 Calculation of average rebound number for 2nd class brick

Sample No.	Observed Rebound Number (RN)										Average RN	Revised Average RN rejecting the distant values	Mean Rebound Number
	1	2	3	4	5	6	7	8	9	10			
1	20	19	24	18	16	21	15	21	18	22	19.40	19.40	18.85
2	21	19	21	21	22	21	22	17	20	20	20.40	20.40	
3	20	21	19	22	19	19	15	19	15	18	18.70	18.70	
4	16	18	19	15	21	18	18	18	15	15	17.30	17.30	
5	15	23	19	18	18	19	22	23	21	19	19.70	19.70	
6	23	23	20	23	15	16	21	15	22	16	19.40	19.40	
7	21	**24***	15	19	16	21	15	15	21	15	18.20	17.56	
8	16	22	21	19	15	22	16	21	21	18	19.10	19.10	
9	19	18	18	18	17	20	15	19	17	18	17.90	17.90	
10	19	19	18	18	20	18	19	19	21	19	19.00	19.00	

. *Distant reading excluded in revised average calculation

The range of rebound number for 2nd class brick is therefore found to be from 17.30 to 20.40 with a mean rebound number of 18.85.

Table-3 Calculation of average rebound number for 3rd class brick

Sample No.	Observed Rebound Number (RN)										Average RN	Revised Average RN rejecting the distant values	Mean Rebound Number
	1	2	3	4	5	6	7	8	9	10			
1	11	12	15	15	15	18	17	14	11	15	14.30	14.30	13.39
2	10	15	14	16	14	11	12	13	10	13	12.80	12.80	
3	13	12	13	13	11	15	14	10	11	12	12.40	12.40	
4	14	17	10	13	12	14	13	16	11	14	13.40	13.40	
5	13	13	10	11	10	10	13	14	12	12	11.80	11.80	
6	11	15	16	15	15	15	13	14	12	15	14.10	14.10	
7	14	15	13	13	15	12	16	15	15	11	13.90	13.90	
8	13	17	17	16	13	13	14	14	13	10	14.00	14.00	
9	13	14	14	15	17	14	16	15	12	13	14.30	14.30	
10	14	13	12	11	11	12	16	15	13	12	12.90	12.90	

The table shows that, the range of rebound number for 3rd class brick is from 11.80 to 14.30 with a mean rebound number of 13.39.

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5. CONCLUSION

The study revealed that, rebound numbers for different types of bricks vary in between 11.80 to 31.40 depending on their quality. The ranges of rebound number established in this research can conveniently be used for identifying 1st class, 2nd class and 3rd class bricks at a construction site. However, as the rebound hammer method estimates the strength of materials, the test result should be used for inspection purpose only. To obtain exact strength, crushing strength test of brick is recommended. Moreover, the ranges established in this study are applicable for conventional local bricks$(240mm \times 115mm \times 70mm)$ manufactured in Bangladesh. For special bricks like perforated bricks, hollow bricks etc. and for the bricks with different size and shape, similar studies are required to establish the ranges for that particular type of brick.

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