DEPARTMENT OF CIVIL ENGINEERING

ASSAM ENGINEERING COLLEGE

JALUKBARI, GUWAHATI - 781 013, ASSAM

सत्यमेव जयते

Ref : .... Date : ....

Ref.No. CAEC-CON(CE)/OTH/2020/3043 Date:04-03-2020

SCHOOL BUILDING SAFETY CERTIFICATE

It is to certify that **Kaziranga English Academy** at Garoghuli Road, Garoghuli, P.O.-Garchuk, AHOM GAON, Guwahati, Assam-781035 is in sound, safe and stable condition. The structure of school is R.C.C Type Building and material used is as per norms and specifications. The building is earthquake resistance. The building is safe from all points of view. This Certificate is provided To Whom It May Concern

Date:04-03-2020
Place: Guwahati

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DEPARTMENT OF CIVIL ENGINEERING
ASSAM ENGINEERING COLLEGE
JALUKBARI, GUWAHATI - 781 013, ASSAM

Ref : CAEC/SM/2017/2044

Date : ....

REPORT ON QUALITY ASSURANCE OF THE KAZIRANGA ENGLISH ACADEMY AT GOG GAON GAROGHULI, RANI, GUWAHATI

Date of report issued on 4th February 2017

Client: **KAZIRANGA ENGLISH ACADEMY, GOG GAON GAROGHULI, RANI, GUWAHATI**

It will be required to conduct non-destructive tests viz. rebound hammer test and ultrasonic pulse velocity test to assess the quality of the different structures. Accordingly these tests were conducted at few locations of the different structural members.

1. NON-DESTRUCTIVE TESTING (NDT) OF CONCRETE

The following non-destructive quality control tests were conducted at the site to assess the quality of the tested structures.

2. REBOUND HAMMER TEST

The Rebound Hammer test is a simple and convenient test for assessing the compressive strength of in-situ concrete by non-destructive technique. The Bureau of Indian Standards specifies methods of test by rebound hammer in IS: 13311 – 1992 (Part 2) Non-destructive testing of concrete by rebound hammer.

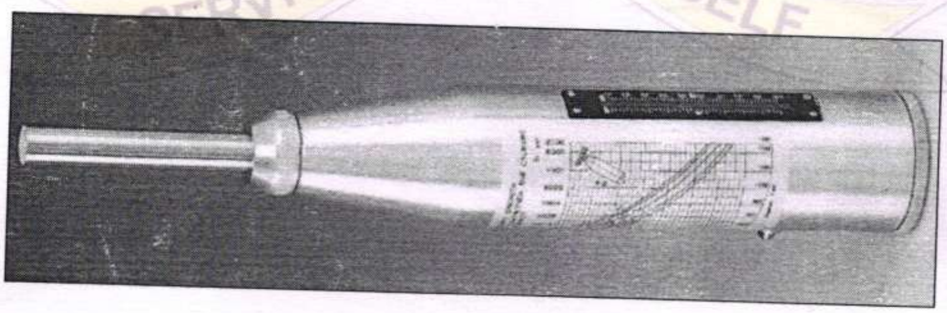

Fig. Rebound Hammer

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Sl No	Structure	Method	Pulse velocity (km/sec)	Concrete Quality as per IS
.25	Beam	Direct	3.54	Good
26	Beam	Direct	3.71	Good
27	Beam	Direct	3.64	Good
28	Beam	Direct	3.52	Good
29	Slab	Indirect	3.65	Good
30	Slab	Indirect	3.54	Good
31	Slab	Indirect	3.52	Good
32	Slab	Indirect	3.60	Good
33	Slab	Indirect	3.71	Good
34	Slab	Indirect	3.59	Good
35	Slab	Indirect	3.52	Good
36	Slab	Indirect	3.75	Good

REMARKS

After extensive non-destructive testing it is observed that quality of concrete of all the structural elements is found to be good and the compressive strength is found to be satisfactory.

It is found that the school building is structurally sound. The overall work of the completed project had been found to be satisfactory.

Report issued by

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The results of ultrasonic pulse velocity tests at different locations are tabulated in table 2.

Table 2: Test Results of Ultrasonic Pulse Velocity - School Building

Sl No	Structure	Method	Pulse velocity (km/sec)	Concrete Quality as per IS
1	Column	Direct	3.82	Good
2	Column	Direct	3.54	Good
3	Column	Direct	3.88	Good
4	Column	Direct	3.83	Good
5	Column	Direct	3.81	Good
6	Column	Direct	3.65	Good
7	Column	Direct	3.63	Good
8	Column	Direct	3.55	Good
9	Column	Direct	3.66	Good
10	Column	Direct	3.70	Good
11	Column	Direct	3.50	Good
12	Column	Direct	3.55	Good
13	Column	Direct	3.69	Good
14	Column	Direct	3.68	Good
15	Column	Direct	3.79	Good
16	Beam	Direct	3.72	Good
17	Beam	Direct	3.68	Good
18	Beam	Direct	3.65	Good
19	Beam	Direct	3.65	Good
20	Beam	Direct	3.68	Good
21	Beam	Direct	3.75	Good
22	Beam	Direct	3.58	Good
23	Beam	Direct	3.52	Good
24	Beam	Direct	3.53	Good

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Sl No	Location	Position	Observed Rebound No.	Avg. Corrected Rebound No.	Comp. Strength of Concrete (N/mm^2)
12	Column 12	Horizontal	32, 30, 32, 31, 30, 29	30.7	**26.20**
13	Column 13	Horizontal	30, 31, 34, 32, 30, 31	31.3	**27.00**
14	Column 14	Horizontal	31, 32, 34, 32, 34, 32	32.5	**29.40**
15	Column 15	Horizontal	32, 32, 30, 34, 32, 30	31.7	**27.80**
16	Column 16	Horizontal	33, 34, 32, 32, 30, 28	31.5	**27.40**
17	Column 17	Horizontal	32, 32, 31, 30, 32, 30	31.2	**26.80**
18	Column 18	Horizontal	30, 29, 32, 31, 32, 31	30.8	**26.40**
19	Column 19	Horizontal	31, 31, 32, 30, 34, 33	31.8	**28.00**
20	Beam 1	Horizontal	31, 31, 32, 30, 35, 34	32.2	**28.80**
21	Beam 2	Horizontal	32, 30, 32, 31, 30, 33	31.3	**27.00**
22	Beam 3	Horizontal	29, 32, 33, 36, 30, 32	32.0	**28.40**
23	Beam 4	Horizontal	30, 32, 31, 30, 33, 35	31.8	**28.00**
24	Beam 5	Horizontal	31, 30, 32, 31, 30, 31	30.8	**26.40**
25	Beam 6	Horizontal	34, 35, 32, 30, 30, 31	32.0	**28.40**
26	Beam 7	Horizontal	31, 32, 30, 30, 34, 34	31.8	**28.00**
27	Beam 8	Horizontal	34, 32, 30, 30, 35, 34	32.5	**29.40**
28	Beam 9	Horizontal	32, 31, 30, 30, 32, 34	31.5	**27.40**
29	Slab Panel 1	Upward	38, 37, 37, 34, 36, 34	36.0	**27.40**
30	Slab Panel 2	Upward	35, 38, 35, 36, 34, 37	35.8	**26.60**
31	Slab Panel 3	Upward	35, 36, 37, 37, 35, 34	35.7	**26.40**
32	Slab Panel 4	Upward	37, 36, 35, 35, 36, 34	35.5	**26.30**
33	Slab Panel 5	Upward	35, 34, 36, 36, 36, 34	35.2	**25.70**
34	Slab Panel 6	Upward	35, 38, 37, 36, 39, 35	36.7	**28.40**
35	Slab Panel 7	Upward	34, 36, 36, 37, 37, 36	36.0	**27.40**

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Table1: Velocity Criterion Velocity Criterion for Concrete Quality Grading (IS 13311 (Part 1 -1992)

Sl No	Pulse Velocity by Cross Probing (Km/Sec)	Concrete Quality
1.	Above 4.5	Excellent
2.	3.5 to 4.5	Good
3.	3.0 to 3.5	Medium
4.	Below 3.0	Doubtful

The table above gives indication of quality of concrete in terms of materials and mix proportions used, uniformity, incidence or absence of internal flaws, cracks and segregation, level of workmanship employed etc.

4. RESULTS OF TESTS PERFORMED ON DIFFERENT STRUCTURAL MEMBERS

The results of rebound hammer tests at different locations are tabulated in table 1.

Table 1.: Test Results of Rebound Hammer-School Building

Sl No	Location	Position	Observed Rebound No.	Avg. Corrected Rebound No.	Comp. Strength of Concrete (N/mm^2)
1	Column 1	Horizontal	30, 32, 30, 30, 34, 32	31.3	**27.00**
2	Column 2	Horizontal	31, 32, 30, 33, 35, 30	31.8	**28.00**
3	Column 3	Horizontal	37, 30, 30, 31, 32, 34	32.3	**29.00**
4	Column 4	Horizontal	32, 31, 30, 33, 32, 34	32.0	**28.40**
5	Column 5	Horizontal	33, 30, 32, 31, 33, 30	31.5	**27.40**
6	Column 6	Horizontal	30, 32, 33, 34, 34, 31	32.3	**29.00**
7	Column 7	Horizontal	29, 30, 34, 33, 32, 31	31.5	**27.40**
8	Column 8	Horizontal	30, 32, 31, 32, 30, 32	31.2	**26.80**
9	Column 9	Horizontal	33, 32, 30, 31, 34,33	32.2	**28.80**
10	Column 10	Horizontal	32, 32, 30, 31, 30, 31	31.0	**26.80**
11	Column 11	Horizontal	30, 31, 34, 30, 32, 34	31.8	**28.00**

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$v = L / T$, where v is the longitudinal pulse velocity, L is the path length, T is the time taken by the pulse to traverse that length.

3.1. Equipment for pulse velocity test

The equipment consists essentially of an electrical pulse generator, a pair of transducers, an amplifier and an electronic timing device for measuring the time interval between the initiation of a pulse generated at the transmitting transducer and its arrival at the receiving transducer. Two forms of electronic timing apparatus and display are available, one of which uses a cathode ray tube on which the received pulse is displayed in relation to a suitable time scale, the other uses an interval timer with a direct reading digital display.

3.2. Applications

Measurement of the velocity of ultrasonic pulses of longitudinal vibrations passing through concrete may be used for the applications of (i) the homogeneity of the concrete, (ii) the presence of cracks, voids and other imperfections, (iii) changes in the structure of the concrete which may occur with time, (iv) the quality of the concrete in relation to standard requirements.

3.3. Interpretation of results

The ultrasonic pulse velocity through concrete depends on its density and modulus of elasticity. This in turn, depends on the materials and mix proportions used in concrete as well as the method of placing, compaction and curing of concrete. For characterisation of quality of concrete in terms of the ultrasonic pulse velocity, Table 2 of IS 13311 (Part 1) : 1992 may be followed which is reproduced below :

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The rebound number **N** obtained from the test gives an estimate of the hardness i.e. compressive strength of the material under test. The rebound number **N** is correlated to the compressive strength **W** of the material by standard nomograms specified for the particular instrument used by the manufacturer. The value of **W** is an approximate one, and its value may lie within a range of $\mathbf{W} \pm \Delta$, where Δ is the dispersion value for **W** (as read out from the nomogram referred above). The value of **N** depends upon the angle α at which the test is performed. Nomograms are given for various values of α. By choosing the appropriate curve, the corresponding compressive strength is to be estimated.

2.1. Methodology of Testing

The tests have been performed on exposed surfaces at various locations of the structures. At a particular location, five numbers of readings were recorded. The average of these readings is taken as the representative reading for that location. The test is performed by holding the hammer perpendicular to the surface to be tested and procedures as specified in IS 13311–1992 (Pt.2) are followed.

3. ULTRASONIC TESTING

A pulse of longitudinal vibrations is produced by an electro-acoustical transducer, which is held in contact with one surface of the concrete under test. When the pulse generated is transmitted into the concrete from the transducer using a liquid coupling material such as grease or cellulose paste, it undergoes multiple reflections at the boundaries of the different material phases within the concrete. A complex system of stress waves develops, which include both longitudinal and shear waves, and propagates through the concrete. The first waves to reach the receiving transducer are the longitudinal waves, which are converted into an electrical signal by a second transducer. Electronic timing circuits enable the transit time T of the pulse to be measured. Longitudinal pulse velocity v (in km/s or m/s) is given by:

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