NDT ON RESPOSE CHARACTERISTCS OF COMPRESSIVE STRENGTH IN A ELECTRONIC IMPACT HAMMER FOR CONCRETE

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ABSTRACT

This work describes for development of electronic impact hammer of the non - destructive for compressive strength measurement of concrete. There is test method for rebound number, it is used most plentifully in safety inspection of the infrastructure. This electronic impact hammer, it solved the problem of Schmidt hammer. It acquires the reliability which is excellent existing Schmidt hammer compared to. The electronic impact hammer measurement data is acquired from the detection coil the velocity which and a degree of acceleration response waveform; it will be able to measure the compressive strength of the concrete. From the NDT, following conclusions are described; it is development for accurate measure of the compressive strength of the concrete which it is electronic impact hammer.

Keywords: Electronic impact hammer, Compressive strength, Velocity, NDT, Response

1. Study Background

When diagnosing and confirming structures to maintain, manage and check their destruction and damage, there were non-destructive test methods widely used recently. As for Non-Destructive Concrete Compressive Strength Measurement out of a variety of non-destructive test methods, there are generally typical kinds of methods, such as Rebound Method, Ultrasound Method and Elastic Wave Method and so on. Out of the

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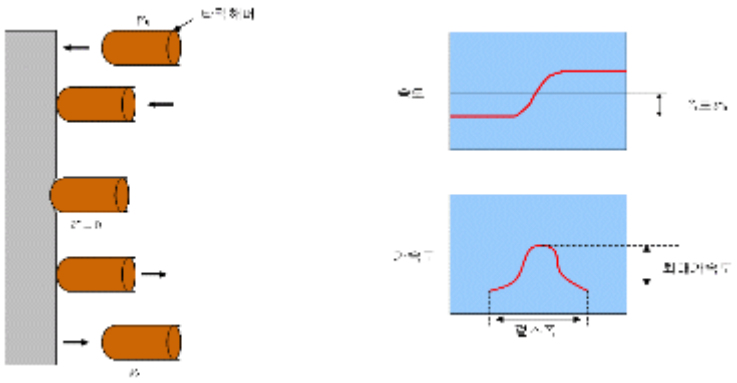

Fig. 1 Impact process and its response process+

various kinds of methods, the most representative method is Rebound Method, and a variety of measuring equipments for the strength of concrete are widely used in applying Rebound Method. Fig. 1 shows the process the impact and its response. The measuring device for the strength of concrete, using Rebound Method, is used for the safe diagnosis for structures most widely in Korea, and it can be used conveniently and easily in actual construction sites. The measuring equipment takes advantages of the fact that rebounds can vary depending on the strength of concrete, so that it has a defect of being influenced according to the surface condition and hammering condition. However, It is universalized most representatively out of all the equipments using other measuring methods, as a non-destructive method used to measure the compressive strength of structures.[1)]

2. Electronic Impact Response Controller

2.1 Introduction

Concrete Compressive Strength Measurement with Rebound Number Method is a rebound test hammer method using the hammering energy obtained by hammering the surface of concrete, and it is a method to measure the compressive strength of concrete to measure the rebound value by striking the surface of concrete with a hammer with fixed energy and measure the compressive strength of concrete by applying the measurement equation to the rebound value. Since it is easy to use the method, it is

widely used, but it still has a problem that differences of the compressive strength value of concrete take place due to the direction, power, speed of hammering, the sincerity of a measurer and the age and humidity condition of concrete and so on.

Therefore, by controlling such elements as the power, direction and speed of a measurer hammering the surface of concrete in the existing rebound test method to get rid of uncertain elements likely to occur during the test, it is needed to develop an electronic hammering response controller and secure the reliability of evaluation on the compressive strength of concrete by decrease the deviation taking place during the measurement. Accordingly, this study attempted to compare two evaluations of strength by the existing Schmidt hammer and the non-destructive electronic hammering response controller developed for the reliability evaluation of the compressive strength of concrete.

2.2 Design of the Equipment

Impact Response Controller basically consists of Impact Hammer and Data Logger, and measured values obtained by hammering the surface of concrete with Impact Hammer is confirmed by Data Logger through the process of collection and calculation. In addition, there are some additional devices adding to the equipment, such as a connector, to transmit the dat to the computer so that it may confirm and analyze the measured values. The standard equipment of Impact Response Controller consists of the following devices shown as Fig 2.

(a) Impact Hammer (b) Data Logger (c) Electronic detection sensor

Fig. 2. Electronic Impact Hammer and sensor

3. Comparative Analysis of the Compressive Strength of Concrete

3.1 Design of Concrete Specimen

This study produced concrete specimen for the experiment. It was used with aggregate of 25mm, and the combination ratio was as follow in Table 1 to produce concrete specimen.

Table 1. Experimental specification of concrete combination

Combination Name / Combination Intensity	Gmax (mm)	W/C	S/a (%)	Unit Weight(kg/m^3)					Slump (cm)	Air (%)	Actual Compressive Strength
				W	C	S	G	AE Plasticizer			
40 Mpa	25	57.5	46.0	171	297	828	998	cx 0.5%	17.5	4.2	39.8 Mpa
50 Mpa	25	52.0	45.0	177	340	787	988	cx 0.5%	17.0	4.7	48.3 Mpa
60 Mpa	25	43.0	48.0	157	365	850	938	cx 0.75%	10.5	3.8	67.6 Mpa

The size of concrete specimen was produced on the basis of 200×200×200 mm to secure the distance length between corners and between striking points as suggested by foreign regulations or guidelines about rebound degree tests.

When affected a lot by the cure temperature of concrete and the moisturizing during the cure, the management of the compressive strength of concrete at the moment is based on Standard Cure Specimen, that is, the result of the compression experiment of cylinder-shaped standard specimen cured for 28 days in the water of 20±3□. Accordingly, the standard specimen used for this experiment was cured in water, and after 28 days it was managed till the compression intensity experiment under dried cure inside the laboratory. The compressive intensity of concrete was 40 MPa, 50 MPa and 60 MPa in producing concrete specimen respectively, and the actual compression intensity, as shown in Table 1, was 39.8 MPa, 48.3 Mpa and 67.6 Mp when checking the compression intensity by destroying three pieces of specimen with each intensity.

3.2 Experiment of the Compression Intensity of Concrete

The measurement of concrete rebound number was conducted by using the electronic impact hammer developed in this study as well as two kinds of concrete test hammers, KAMEKURA R-7500 and PROCEQ DIGI-2000, generally and widely used in actual construction sites.

As for the hammering position, by referring to the existing studies arguing that rebound degree varies around the corner and foreign standard about the distance length between striking points, 16 intersecting points were established by making lines at intervals of 30mm from a position 55mm off each corner. On the basis of those intersecting points, in the manner of striking points judged to obtain favorable values, where there were no rough surface or aggregate, 10 points on both the frontal and back sides were struck, and the rest left and right sides were also struck 10 times. By regarding each average value of the rebound degree of 20 points obtained by striking both the frontal and back sides and the right and left sides as the final rebound degree, the experiment could obtain two values of rebound degree for each standard specimen.

Table 2. Rebound number comparison for concrete strength

Equipment / Number / Intensity / Concrete	Front and back side			Right and left side		
	R-7500	Digi-2000	Electronic impact hammer	R-7500	Digi-2000	Electronic impact hammer
	Case I-1	Case I-2	Case I-3	Case II-1	Case II-2	Case II-3
39.8 MPa	36.65	37.65	42.00	36.55	38.65	41.00
48.3 MPa	50.55	50.70	51.00	52.66	51.85	53.00
67.6 MPa	54.25	55.55	67.00	56.30	55.30	73.00

As shown in the Table 2 and Fig 3, the rebound number of each test hammer was compared according to the actual compression intensity of concrete specimen. When comparing the value of rebound number measuring the frontal and back sides and the right and left sides with each test hammer, the minimum rebound number was 36.55

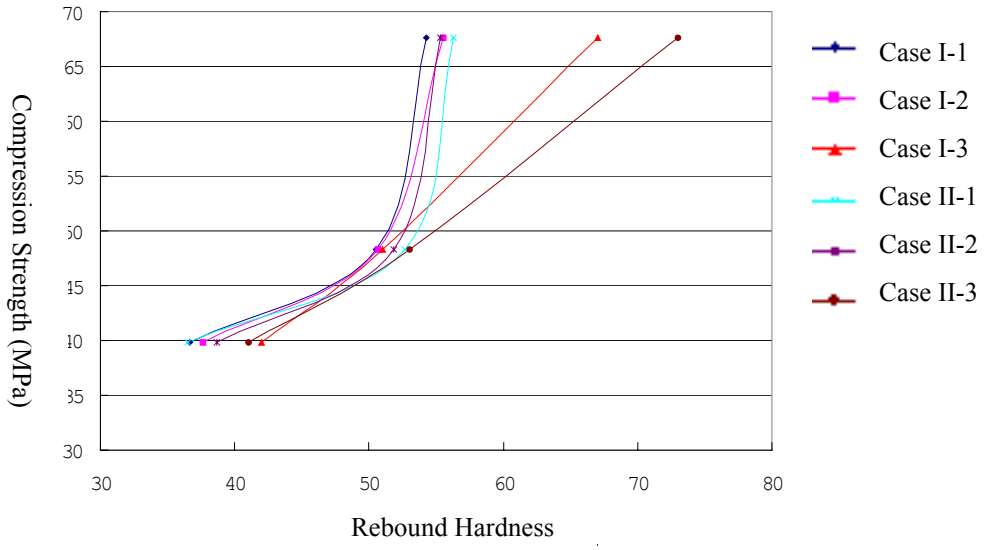

Fig. 3. Comparison of Rebound Number for Concrete Strength

with R-7500 test hammer, and the maximum rebound number was 42 with the electronic impact hammer in the case that the intensity of concrete specimen was 39.8MPa. Secondly, in the case that the intensity of concrete specimen was 48.3MPa, the minimum rebound number was 50.55 with R-7500, while the maximum rebound number was 53 with the electronic impact hammer. Finally, in the case that the intensity of concrete specimen was 67.6MPa, the highest intensity, the minimum rebound number was 54.25 with R-7500, while the maximum rbound number was 73 with the electronic impact hammer.

As a result of investigating, it was expected that the higher the intensity of concrete specimen was, the higher rebound number should increase, but actually over a certain point of intensity, it was found that the rebound number of test hammers failed to increase as much as the actual intensity of concrete. Also, it was found that the electronic impact hammer showed a steady increase of rebound number even though the intensity increased, compared to the other two commercialized products.

4. Conclusion

This study carried out a comparative experiment on the rebound number between the existing concrete test hammers and the newly developed electronic impact hammer to evaluate the reliability of Electronic Impact Response Equipment. When conducting a comparative experiment with each test hammer, threre was a tendency to increase the rebound number as concrete had more intensity, but it was found that the existing test hammers showed almost no change in the rebound number of concrete with over 50 MPa.

As conclusions, the electronic impact hammer developed in this study was found to show a steady increase of the value of rebound number even if the intensity increased. By conducting further studies constantly with more specimen and on-site experiments in the future, it is anticipated that a comparative experiment will be carried out to measure the compressive strength of concrete with high intensity as well as increase the reliability of the electronic impact hammer.

Reference

1. Korea Concrete Institute, “Non-Destructive test and Safe Diagnosis of Concrete Structures”, Gimundan, 2001

2.. V.M. Malhotra, N.J.Carino, "Handbook on Nondestructive Testing of Concrete" CRC press, 1991

3. ASTM C 805-02 "Standard Test Method for Rebound Number of Hardness Concrete" Annual Book of ASTM standard, Vol.04.02, 2003