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METHOD OF TEST FOR DETERMINING SETTING TIME OF CONCRETE BY PENETRATION RESISTANCE

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Indian Standard

METHOD OF TEST FOR DETERMINING SETTING TIME OF CONCRETE BY PENETRATION RESISTANCE

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Indian Standard

METHOD OF TEST FOR DETERMINING SETTING TIME OF CONCRETE BY PENETRATION RESISTANCE

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 8 July 1976, after the draft finalized by the Cement and Concrete Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Information obtained from the penetration resistance test for setting of concrete can provide useful guidance to the engineer at site regarding removal of formwork, maximum permissible time lapse between placement of successive layers of concrete and such other operations, where assessment of the degree of hardening of the concrete is necessary. The method may be used for determining the effects of variables, such as temperature, cement, concrete mix proportions and admixtures, upon the time of setting and hardening characteristics of concrete. It may be used as a part of performance specifications to determine compliance with specified time of setting requirements and will also be useful in the laboratory for comparative studies of above aspects.

0.2.1 The method is suitable only for those cases where required information on the above aspects can be obtained from the tests on the mortar fraction of the concrete. Since the hardening of concrete is a gradual process, any definition of setting time will necessarily be arbitrary. The temperature of storage of specimens employed in this test is to be selected by the user.

0.3 The Sectional Committee responsible for the preparation of this standard has taken into consideration, the practices followed in this country in conducting the test for determining setting time of concrete by penetration resistance. Due weightage has also been given to the need for international co-ordination among the standards and practices prevailing in different countries of the world.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance

with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers the method for determining the setting time of concrete with slump greater than zero, by testing mortar sieved from the concrete mixture.

1.2 In this method of test, the initial setting time and the final setting time are the time intervals required for the mortar sieved from the concrete mixture to reach the prescribed penetration resistance after the initial contact of cement and water.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Initial Setting Time — The elapsed time, after initial contact of cement and water, required for the mortar (sieved from the concrete) to reach a penetration resistance of 3·43 N/mm^2 (35 kgf/cm^2).

2.2 Final Setting Time — The elapsed time, after initial contact of cement and water, required for the mortar (sieved from the concrete) to reach a penetration resistance of 26·97 N/mm^2 (275 kgf/cm^2).

3. APPARATUS

3.1 Containers for Mortar Specimens — Rigid, watertight, non-absorptive, non-oiled containers, either cylindrical or rectangular in cross-section, with minimum lateral dimension 150 mm and height at least 150 mm.

NOTE — The container for the mortar from the concrete mixture shall provide enough mortar surface for the undisturbed reading of penetration resistance.

3.2 Penetration Resistance Apparatus — Spring reaction-type apparatus, graduated from 50 N (5 kgf) to 600 N (60 kgf) in increments of 10 N (1 kgf) or less; or hydraulic reaction-type apparatus with pressure gauge of 700 to 900 N (70 to 90 kgf) capacity, graduated in increments of 10 N (1 kgf) or less. Indications of actual needle loads by these apparatus shall be accurate to 10 N (1 kgf). Removable needles of 645, 323, 161, 65, 32 and 16 mm^2 bearing areas shall be provided. Each needle shank shall be scribed peripherally at a distance of 25 mm above the bearing face. The length of the 16 mm^2 needle shall be not more than 90 mm to minimize bending.

NOTE — The spring reaction-type apparatus shall be recalibrated periodically.

*Rules for rounding off numerical values (*revised*).

3.3 Pipette — Pipette or suitable instrument for drawing off free water from the surface of the test specimens.

3.4 Tamping Rod — Round, straight, steel rod 16 mm in diameter and approximately 600 mm in length, having the tamping end rounded to a hemispherical tip, of 16 mm diameter.

4. PREPARATION OF MORTAR SPECIMENS

4.1 From the concrete mixture under test, select a representative sample of concrete of sufficient volume to provide enough mortar to fill the test container, or containers, to a depth of at least 140 mm.

4.2 Remove essentially all of the mortar from the sample of concrete by sieving it through a 4·75-mm IS sieve onto a non-absorptive surface.

4.3 Thoroughly remix the mortar by hand on the non-absorptive surface and place it in the container, or containers in layers of 50 mm each, and compact by rodding each layer. Rod the specimen by means of the tamping rod held so as to penetrate the mortar with the round end. Rod the mortar once for each 6·5 cm^2 of top surface area of the specimen and distribute the strokes uniformly over the cross-section of the specimen. After completion of the rodding, tap the sides of the containers lightly with the tamping rod to close voids left by the tamping rod and to further level the surface of the specimen. Upon completion of specimen preparation, the mortar surface shall be at least 13 mm below the top edge of the container to provide space for the collection and removal of bleeding water and to avoid contact between the mortar surface and the protective covering specified in **5.1**.

5. STORAGE OF MORTAR SPECIMENS

5.1 Store and maintain the specimens at the temperature, selected for testing the specimens. To prevent excessive evaporation of moisture, keep the specimens covered and protected with a suitable tight-fitting, water-impermeable cover for the duration of the test, except when bleeding water is being removed or penetration tests are being made. The specimens shall be shielded from the sun.

6. NUMBER OF SPECIMENS

6.1 At least three separate batches shall be made for each test condition. One rate of hardening test shall be made on each batch. An equal number of batches for each condition shall be made on any given day. When it is impossible to make at least one test for each variable on a given day, the mixing of the entire series of batches shall be completed in as few days as possible and one of the mixtures shall be repeated each day as a standard of comparison.

7. PROCEDURE

7.1 Remove bleeding water from the surface of the mortar specimens just prior to making a penetration test by means of a pipette or a suitable instrument. To facilitate collection of bleeding water, tilt the specimen carefully to an angle of about 12° from the horizontal by placing a block under one side 2 minutes prior to removal of the bleeding water.

7.2 Insert a needle of appropriate size, depending upon the state of hardening of the mortar, in the penetration resistance apparatus and bring the bearing surface of the needle into contact with the mortar surface. Gradually and uniformly apply a vertical force downward on the apparatus until the needle penetrates the mortar to a depth of 25 mm as indicated by the scribe mark. The time required to penetrate to the 25 mm depth shall be approximately 10 seconds. Record the force required and the time of application, measured as elapsed time after initial contact of cement and water. In subsequent penetration tests take care to avoid areas where the mortar has been disturbed by previous tests. The clear distance between two needle impressions shall be at least two diameters of the needle being used, but not less than 13 mm. The clear distance between any needle impression and the side of the container shall be not less than 25 mm.

7.3 Make penetration tests at hourly intervals for normal mixtures and normal temperatures, the initial test being made after an elapsed time of 3 to 4 h. For accelerated mixtures or high temperatures, it may be advisable to make the initial test after an elapsed time of 1 or 2 h and subsequent tests at $\frac{1}{2}$ h intervals. For low-temperature conditions or retarded concrete mixtures, the initial penetration test may be deferred for an elapsed time of 4 to 6 h, and perhaps longer. Subsequent tests may be made at intervals of 1 h, unless the rate of increase in penetration resistance indicates that shorter intervals are desirable.

7.4 Not less than six penetration resistance determinations shall be made in each rate of hardening test and the time intervals between penetration resistance determinations shall be such as to give a satisfactory rate of hardening curve, as indicated by equally spaced points. Continue the tests until one penetration resistance of at least 26·97 N/mm^2 (275 kgf/cm^2) is reached.

8. CALCULATION

8.1 Calculate the penetration resistance, in N/mm^2 (kgf/cm^2), as the force required to cause a 25 mm depth of penetration of the needle divided by the area of the bearing face of the needle.

9. PRECISION

9.1 The range of three results of properly conducted tests by the same operator with the same machine using similar materials on different days

shall not exceed 84 minutes, and the average setting times for two sets of tests each consisting of three similar batches shall not depart more than 20 minutes from the average of the two.

10. REPORT

10.1 The report shall include the following:

a) *Data on Concrete Mixture* — Type and proportions of cement, fine aggregate, coarse aggregate (including maximum size and grading of aggregates), and the ratio of net water content to cement content;

b) Name, nature, and percentage of active ingredients by mass of cement, of any admixture used;

c) Air content of fresh concrete and method of determination;

d) Consistency of concrete as determined by the slump or other test for consistency;

e) Temperature of mortar after sieving;

f) Record of ambient temperature during the test period; and

g) Date of test.

10.2 Curves — For each variable and condition of concrete as specified in **6**, the results from each of three or more rate of hardening tests shall be plotted separately, showing penetration resistance in N/mm^2 (kgf/cm^2) as the ordinate and elapsed time in hours and minutes as the abscissa, where 3·5 MN/m^2 (35 kgf/cm^2) and 1 hour are represented by not less than 13 mm.

10.3 Time of Setting — Times of initial and final setting as defined in **2.1** and **2.2** shall be calculated by averaging the elapsed times, determined from the curves plotted in accordance with **10.2** at which penetration resistances of 3·43 N/mm^2 (35 kgf/cm^2) and 26·97 N/mm^2 (275 kgf/cm^2) respectively, are reached. Times of setting shall be reported in hours and minutes to the nearest minute.

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