Centre of Excellence on
Technologies for
Low Carbon & Lean
Construction

Marsh Cone Test — Guidelines for the Method of Testing and Analysis

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Technologies for Low – Carbon and Lean Construction (TLC2)

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Marsh Cone Test — Method of Testing and Analysis

1 SCOPE

1.1 This guideline specifies the procedure for determining the flow properties of the superplasticized cement paste, for both field and laboratory, by determining the time of efflux of a specified volume of fluid hydraulic cement grout through a standardized Marsh cone.

1.2 The test method can also be used for determining the saturation dosage of the superplasticizer by evaluating the flow properties of the superplasticized cement paste and mortar using Marsh cone test.

1.3 It is for use with cement paste, and mortar containing fine aggregate passing through 4.75 mm sieve.

NOTES

When carrying out these tests, prevent skin contact with fresh cement paste and mortar by wearing suitable protective clothing, gloves, masks and footwear. If wet cement enters the eye, immediately wash it out thoroughly with clean water and seek medical treatment without delay. Wash fresh cement paste and mortar off the skin immediately.

2 REFERENCES

2.1 The standards listed in Annex A contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A. Additional references are also included in the annex.

3 TERMINOLOGY

3.1 For the purpose of this guideline, the definitions given in IS 9103: 1999, IS 4031: 1996, IS 4845: 1968, IS 269: 2015, IS 6461 (Part 1): 2024, and the following important terminologies apply:

Admixture, a material other than water, aggregates, cementitious material, and fiber reinforcement that is used as an ingredient of a cementitious mixture to modify its properties in the fresh, hardening and hardened state and that is added to the batch before, after or during its mixing.

Chemical admixture, an admixture in the form of a liquid, suspension, or water-soluble solid added to the cementitious mixture to modify or improve the properties.

High Range Water-reducing admixture or Superplasticizers, a water-reducing admixture capable of producing more reduction of water content imparting high workability when tested in accordance with specification IS 9103: 1999 and meeting the other relevant requirements of specification IS 9103: 1999.

Mineral admixture, this term has been used to refer to different types of water insoluble, finely divided materials such as pozzolanic materials, and supplementary cementitious materials. These materials are not similar, and it can not be group them under a single term. The name of the specific material should be used, for example, use "pozzolan," "slag cement," "pozzolana" as is appropriate.

Normal Water-reducing admixture, admixture that either increases the workability of freshly mixed cement paste, mortar or concrete without increasing the water content or that maintains the workability with a reduced amount of water.

4 SAMPLING AND TEST CONDITIONS

4.1 The samples of the cement shall be taken according to the requirements of IS 3535:1986 (see 2.1) and the relevant standard specification for the type of cement being tested. The representative sample of the cement selected as above shall be thoroughly mixed before testing. The samples of superplasticizer will be selected based on IS 9103: 1999.

4.2 TEMPERATURE AND HUMIDITY

4.2.1 The temperature of the moulding room, dry materials and water shall be maintained at 27 ± 2°C. The relative humidity of the laboratory shall be 65 ± 5 percent.

5 SIGNIFICANCE AND USE

5.1 This test method is applicable for the determination of the fluidity of various cement grout mixtures with different types and dosages of the superplasticizers. The time for the efflux of a specified volume of the grout from a standardized Marsh cone is measured as the flow time in seconds for various mixes.

The test gives the fluidity of the paste in terms of the flow time; higher the flow time, lower is the fluidity of the paste. The fluidity of the paste increases with increase in

dosage of the superplasticizer until it reaches the saturation dosage. The saturation point is the dosage beyond which further addition of the superplasticizer does not increase fluidity significantly but can produce segregation. The saturation dosage can be taken as the optimum superplasticizer dosage for a given cement paste. The test can also be used to determine the loss of fluidity with time, and the cement-mineral admixture-superplasticizer compatibility.

6 GENERAL

6.1 Ordinary Portland cement - The cement to be used in the test shall conform to IS: 269-2015.

6.2 Water reducer/ High Range water reducer/ Superplasticizer - The water reducer/ high range water reducer/ superplasticizer to be used in the test shall conform to IS: 9103:1999.

6.3 Sand - The sand to be used in the test shall conform to IS: 2386: 1963.

6.4 Water - The water to be used in the test shall conform to IS: 456-2000.

7 APPARATUS

7.1 Marsh cone: A non-corroding metal cone with a nozzle of diameter of 8 mm or 10 mm is generally used for cement paste. and 12 mm diameter can be used for mortar. The dimensions of a recommended Marsh cone is shown in Figure 1.

7.2 Graduated glass cylinders - Receiving glass cylinders of 1000 ml capacity. The permissible variation on these cylinders shall be ± 1 ml. The main graduation lines of the cylinders shall be in circles and shall be numbered. The graduation lines may be omitted for the lowest 5 ml.

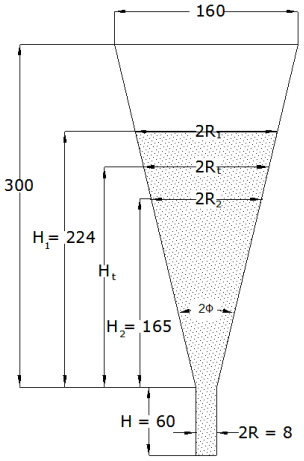
7.3 Ring stand for supporting the Marsh cone in a vertical steady position over the receiving container.

7.4 Level, carpenter’s or similar.

7.5 Stop watch, least reading of not more than 0.2 s.

7.6 Mixer for preparing the paste or mortar in the test shall shall be an electrically driven mechanical mixer imparting both planetary and arevolving motion to the mixer paddle. The mixer shall have three controlled speeds, slow speed, medium and high speed revolving the paddle at a rate ranging from 140 ± 10 rpm to 280 ± 10 rpm. The electric motor shall be at least 124 W (1⁄6 hp).

7.7 Balance - The balance shall conform to IS 4031-6 (1998) and to the following requirements: The permissible variation of balance in use at a load of 1000 g shall be ± 1.0 g. The permissible variation on new balance shall be one-half of this value. The sensibility reciprocal shall be not greater than twice the permissible variation.



R, H - Radius and length of nozzle

R_1, H_1 - Radius of the free surface and height of fluid in the cone at the initial moment

R_t, H_t - Radius of the free surface and height of fluid in the cone at any time t

R_2, H_2 - Radius of the free surface and height of fluid in the cone at the final moment

φ – Angle between the axis and the generator of the cone

Figure 1. Typical Geometry and dimensions (in millimetres) of the Marsh cone.

8 Calibration of the Apparatus

8.1 Place the Marsh cone in a vertical and steady manner over the receiving container with the support of the ring stand. Level the top to ensure the verticality. Check the inside of the cone to ensure that the cone is devoid of any deposits of grout.

8.2 Close the outlet of the nozzle with a finger. Pour 1000 ml of the water into the cone. After checking the level of water surface to the mark of 1000 ml, wait for 30 seconds. Then start the stopwatch and simultaneously remove the finger to allow the water to drain through the nozzle of diameter 8 mm and stop the watch at the first break in the continuous flow of water. If the time indicated by the stop watch is 5 ± 0.2 s, the Marsh cone is calibrated and can be used for testing the grout. Periodical calibration of the Marsh cone is required for accuracy.

9 PREPARATION OF TEST SAMPLES

9.1 The test sample of approximately 1500 ml should be a representative of the paste or mortar in the mixer.

9.2 While sampling and testing, the raw materials and water for the preparation of the grout should be kept at a temperature of 23± 2°C so that the temperature of the grout is within the same limit. A consistent procedure as mentioned below should be used for the preparation of the grout. Use a mortar mixer (1/6 hp) with a B-flat beater with low speed (with shaft speed of 139 rpm and planetary speed of 61 rpm) for the preparation of the paste.

9.3 Mix the cement with or without mineral admixture/supplementary cementitious materials (SCMs) and 70 % of the water required together in the mixer for one minute. After that, add the superplasticizer and the remaining water to the cement paste. Mix the paste for 2 minutes at the same speed. Stop and scrap the sides of mixer bowl 15-30 seconds. Again, mix the paste for 2 minutes so that the total mixing time is 5 minutes.

9.4 The dosage of the superplasticizer should be represented as the solid content of the superplasticizer to the cement content or binder content by weight (sp/c or sp/b) %. Deduct the water content of the superplasticizer from the water added, if liquid superplasticizer is used.

10 Marsh Cone Test Procedure

10.1 Moisten the inside of the Marh cone with water one minute before pouring the grout. Close the nozzle with finger. In the recommended test procedure, pour an initial volume of 1000 ml of paste into the cone until the grout surface touches the point gauge or the marked level of 1000 ml. Start the stop watch and simultaneously remove the finger and measure the time required for 500 ml of it to flow out, which is represented as the flow time for the test sample. The remaining paste can be collected in the disposal container. The test has to be completed within 1 minute after pouring the grout into the cone. The test can be repeated for different grouts with various dosages of the superplasticizers.

10.2 The test has to be repeated thrice for the grout with the specific dosage of the superplasticizer, and the difference between at least two tests having flow time within ± 2 s of their average shall be made for each grout mixture.

10.3 The test for flow time shall be made within 1 min of taking of the grout from the mixer or transmission line. When grout is being used over a significant period of time, the flow time may be determined at selected intervals to demonstrate that the consistency is suitable for the work.

11 CALCULATION

11.1 Determination of the saturation dosage of the superplasticizer: Prepare Marsh cone flow time curve of pastes with sp/c (%) as X-axis and log (flow time, sec) as Y-axis. In the method of objective determination of the saturation dosage of the superplasticizer is to calculate the internal angle (α) corresponding to each data point and the superplasticizer dosage corresponding to an internal angle of 140°±10° is taken as the saturation dosage. Interpolation is used to determine the dosage when there are no data points corresponding to that range of angles. This criterion is proposed based on several tests on superplasticized cement pastes.

Note

The Marsh cone test can be used to study the flow behaviour of superplasticized cement paste only for continuous flow. It can not be used for discontinuous flow. The Marsh cone test can also be used to study the loss of fluidity with time, the fluidity of cement mortar, optimization of cement paste with mineral admixtures and incompatability between cement and superplasticizer.

12. EXPRESSION OF RESULTS

12.1 Report the following information: Sample details such as identification of materials in the sample, the proportions, and whether the sample is laboratory-prepared or taken from the field, testing conditions, type of mixer used. Average flow time to nearest 0.2 s and time interval from completion of mixing at which the test was made. Plot sp/c or sp/b (%) v_s log (flow time, sec) and report the saturation dosage of the superplasticizer for different mixes.

ANNEX A

LIST OF REFERRED ARTICLES AND STANDARDS

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