2. APPARATUS

2.1 Mould — The mould shall conform to IS : 516-1959*.

2.2 Mould Cover Plate — Each mould shall be provided with a flat steel cover plate, rigid enough so as to avoid distortion during use and of dimensions such that the plate completely covers the top edge of the mould.

2.3 Curing Tank

2.3.1 The curing tank shall be constructed from any material of suitable strength that will resist the effects of corrosion. The internal dimensions of the tank shall be adequate to accommodate the required number and size of the test specimens such that test specimens can be easily removed.

2.3.2 The tank shall contain sufficient water and be controlled so that the temperature of the water around the specimens immersed in the tank is maintained at the desired level at all times except for a period not exceeding 15 minutes immediately after the immersion of a freshly made specimen into the tank.

2.3.3 A typical diagrammatic layout of a tank suitable for accelerated curing of test specimens is given in Fig. 1.

3. PREPARATION OF TEST SPECIMENS

3.1 The preparation of test specimen including sampling of materials, preparation of materials, proportioning, weighing, mixing, testing for workability, choice of the size of test specimens, compacting, and capping of specimen shall be in accordance with IS: 516-1959*, if tests are intended to draw correlation curve between the results from compressive strength tests on specimens cured by normal curing method and accelerated curing method.

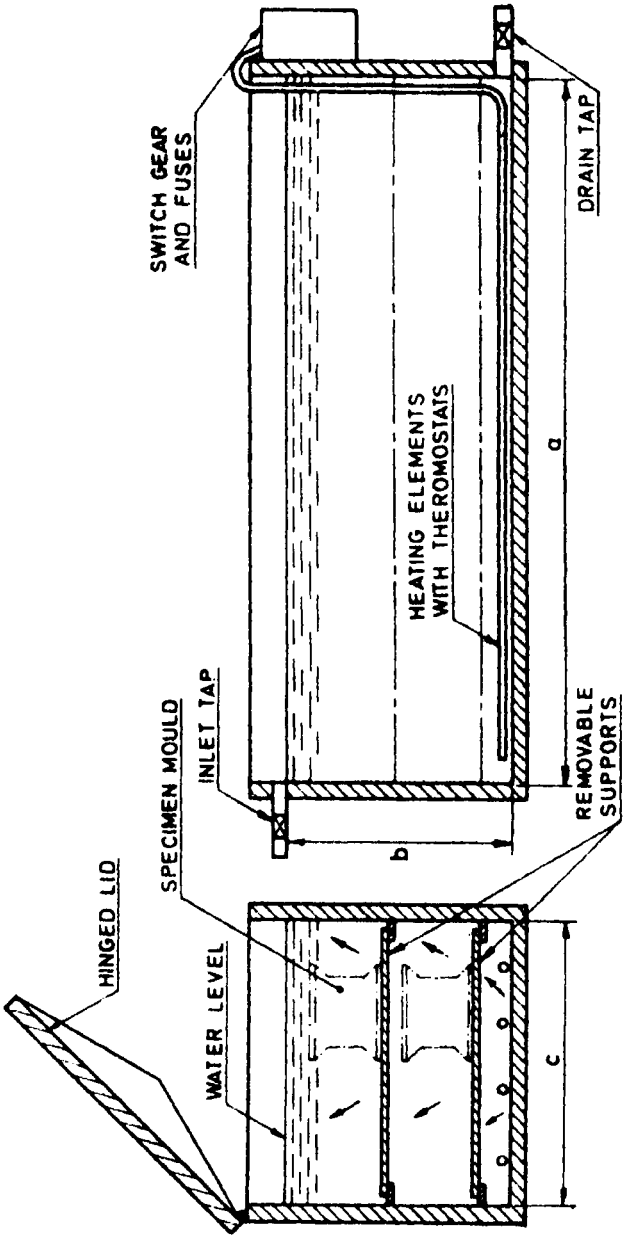
3.2 If the tests are intended for control purposes, sampling shall be done in accordance with IS : 1199-1959† and choice of the size of test specimens, compacting, and capping of specimen shall be in accordance with IS : 516-1959*.

3.3 Immediately after moulding, each specimen shall be covered with a steel plate thinly coated with mould oil to prevent adhesion of concrete.

4. ACCELERATED CURING BY WARM WATER METHOD

4.1 After the specimens have been made, they shall be left to stand undisturbed in their moulds in a place free from vibration at a temperature

*Methods of tests for strength of concrete.
†Methods of sampling and analysis of concrete.



NOTE — The dimensions *a*, *b* and *c* of curing tank suitable for accommodating twelve, 150 mm cubes are 1·60 m, 0·50 m and 0·65 m respectively.

FIG. 1 DIAGRAMMATIC LAYOUT OF SUITABLE CURING TANK

of 27 ± 2°C for at least one hour, prior to immersion in the curing tank. The time between the addition of water to the ingredients and immersion of the test specimens in the curing tank shall be at least 1½ hours but shall not exceed 3½ hours.

4.2 The specimens in their moulds shall be gently lowered into the curing tank and shall remain totally immersed at 55 ± 2°C for a period of not less than 19 hours 50 minutes. The specimens shall then be removed from the water, marked for identification, removed from the moulds and immersed in the cooling tank at 27 ± 2°C before the completion of 20 hours 10 minutes from the start of immersion in the curing tank. They shall remain in the cooling tank for a period of not less than one hour.

NOTE — For control purposes, the above time tolerances may be relaxed and an appropriate correction factor applied.

5. ACCELERATED CURING BY BOILING WATER METHOD

5.1 After the specimens have been made, they shall be stored in a place free from vibration, in moist air of at least 90 percent relative humidity and at a temperature of 27 ± 2°C for 23 hours ± 15 minutes from the time of addition of water to the ingredients.

5.2 The specimens shall then be gently lowered into the curing tank and shall remain totally immersed for a period of 3½ hours ± 5 minutes. The temperature of the water in the curing tank shall be at boiling (100°C) at sea level. The temperature of water shall not drop more than 3°C after the specimens are placed and shall return to boiling within 15 minutes.

NOTE — In confined places the temperature of the water may be kept just below the boiling point to avoid excessive evaporation.

5.3 After curing for 3½ hours ± 5 minutes in the curing tank, the specimen shall be removed from the boiling water, removed from the moulds and cooled by immersing in cooling tank at 27 ± 2°C for 2 h.

6. TESTING

6.1 The specimens shall be tested in accordance with IS : 516-1959*.

6.2 In the warm water method specimens shall be tested while still wet, not more than 2 hours from the time of immersion in the cooling tank.

6.3 In the boiling water method, the age at the time of test shall be $28\frac{1}{2}$ hours ± 20 minutes.

*Methods of tests for strength of concrete.

7. CALCULATION

7.1 The calculation of compressive strength shall be done in accordance with IS : 516-1959*.

8. REPORT

8.1 The following information shall be included in the report on each test specimen :

a) Identification mark (including the size and type) of test specimens and date of casting;
b) Date and time of test and age of specimen;
c) Particulars of concrete from which test specimen was made;
d) Method of compaction;
e) Size of specimen;
f) Mass of specimen;
g) Defects, if any, in specimen;
h) Time of adding water to concrete materials;
j) Time of making test specimen;
k) Time of immersion of test specimen into curing tank;
m) Time of removal of test specimen from curing tank;
n) Time of immersion of test specimen into cooling tank;
p) Time of removal of test specimen from cooling tank;
q) Thermographic record of temperature of water in curing tank;
r) Maximum load at crushing;
s) Compressive strength; and
t) Description of fractured face.

9. PRECAUTIONS

9.1 The following precautions shall be taken :

a) The curing tank shall be cleaned and the water renewed periodically so as to prevent accumulation of detritus which may impair the heating or circulating system.

b) The use of boiling water imposes the need for safety measures to prevent scalding or eye-burns, resulting from sudden escape of steam, upon opening the cover. Also care shall be exercised when immersing the specimens to avoid splashing of hot water.

*Methods of tests for strength of concrete.

c) Strict attention shall be given to the protection and storage of the specimens during the initial period of curing.

d) Suitable safety devices and indicators shall be provided with the set up. A separate panel or switch-board shall be provided incorporating the thermograph and related heating equipment controls.

10. INTERPRETATION OF RESULTS

10.1 Since strength requirements in existing specifications are not based upon accelerated curing, results from this method in checking the compliance of specified strengths at later ages shall be applied with great caution.

10.2 The results can be used in rapid assessment of variability for process control and signalling the need for indicated adjustments.

10.3 The magnitude of the strength values from strength tests is influenced by the specific combination of materials. Therefore the use of the results from either conventional tests at any arbitrary age or those from this method shall be supported by experience or correlations developed for the existing local conditions and materials (*see* Appendix A).

APPENDIX A

(*Clauses* 0.5 *and* 10.3)

CORRELATION OF RESULTS FROM COMPRESSIVE STRENGTH TESTS ON SPECIMENS CURED BY NORMAL AND ACCELERATED CURING METHODS

A-1. Accelerated curing of concrete hastens the process of hydration of cement and as a result, a substantial proportion of the strength to be attained in 28 days under normal curing conditions is achieved within a shorter time. The rate and extent of hydration of cement under a particular curing regime depend mainly upon the chemical composition of cement, water-cement ratio and mix proportions, which are considered to be important parameters in the correlation of results from compressive strength tests on specimens cured by accelerated curing method and normal curing method.

The accelerated curing regime, in itself, is another variable in that the higher temperature employed may alter the morphology of the hydration products apart from thermally activating the chemical reactions of hydration of cement.

A-2. The variability arising from the curing regime to be adopted, is eliminated by standardizing them, as is done in this standard. Figures 2 and 3 (*see* Note) show typical results on the correlation of compressive strength of concrete specimens normally cured and accelerated-cured by the Boiling Water Method and the Warm Water Method respectively. It is found that a correlation exists between the results obtained on concrete specimens, cured by accelerated method and cured by normal method, for mixes employing different materials and mix proportions. It is also found that the strength of concrete after accelerated curing (by either method) is of the order of 50 percent of that obtained on normally cured, 28 days old specimens. When results of concrete with specific ingredients and mix proportions are considered, the dispersion of results is considerably

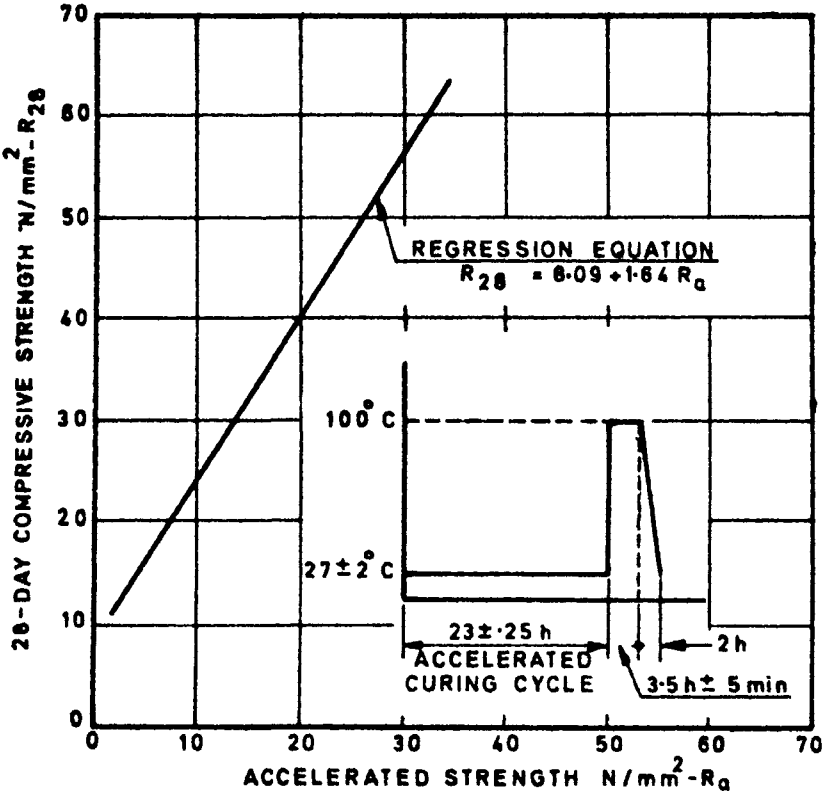


FIG. 2 TYPICAL RELATION BETWEEN ACCELERATED AND 28-DAY COMPRESSIVE STRENGTH OF CONCRETE (BOILING WATER METHOD)

reduced, and the coefficient of variation of results from accelerated curing methods may, in that case, be expected to be of the same order as obtained in normally cured, 28 days conventional tests. Although the tests have shown that the correlation between results from accelerated curing method and normally cured 28 days conventional tests is not materially affected by the chemical composition, fineness and strength of cements, the mix proportions or use of some indigenous admixtures, it is preferable to establish the actual correlation under site conditions for the specific materials and mix proportions to be adopted, for use in each case.

NOTE — The typical correlation curves given in Fig. 2 and 3 are based on a series of tests conducted at the Cement Research Institute of India, New Delhi.

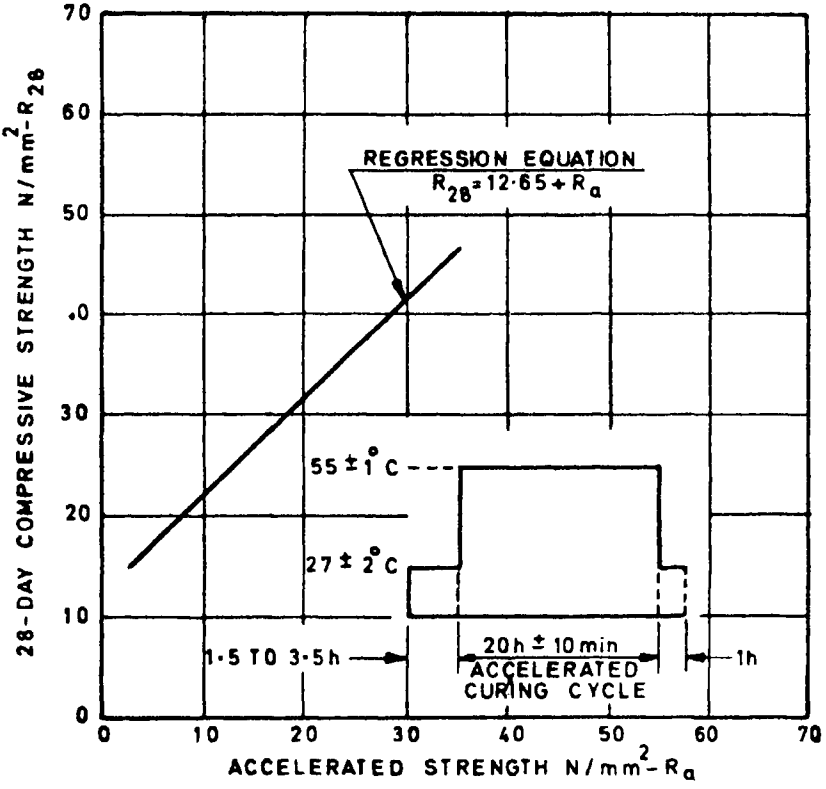


FIG. 3 TYPICAL RELATION BETWEEN ACCELERATED AND 28-DAY COMPRESSIVE STRENGTH OF CONCRETE (WARM WATER METHOD)