JSCE-SF2 METHOD OF MAKING SPECIMENS FOR STRENGTH AND TOUGHNESS TESTS OF STEEL FIBER REINFORCED CONCRETE

1. SCOPE

This standard specifies methods of making molded specimens for compressive strength tests, flexural strength tests, shear strength tests, compressive toughness tests and flexural toughness tests of steel fiber reinforced concrete[1),2)].

Note 1) The method of making specimens for strength and toughness tests for shotcreted steel fiber reinforced concrete will be specified separately.

Note 2) The method of making specimens for strength and toughness tests using cores shall be in accordance with JIS A 1107 (Method of Obtaining and Testing Drilled Cores and Sewed Beams of Concrete).

2. SAMPLING OF CONCRETE

2.1 In case of making steel fiber reinforced concrete in the laboratory, the specifications of the Japan Society of Civil Engineers standard, JSCE-SF 1 (Method of Making Steel Fiber Reinforced Concrete in the Laboratory), shall be followed.

2.2 In case of sampling concrete from a mixer, hopper, conveying apparatus or location of placement, the method shall be in accordance with JIS A 1115 (Method of Sampling Fresh Concrete).

3. NUMBER OF SPECIMENS

3.1 In case of making specimens from a sample mixed in accordance with section 2.1, the number of specimens required for tests of identical conditions[3)] shall be not less than three[4)]. It is desirable for these three or more specimens to be made from not less than two batches of concrete.

Note 3) The age of tests shall be included in these conditions.

Note 4) The number of specimens for flexural strength tests and flexural toughness tests shall be not less than four.

3.2 The number of specimens in case of making specimens according to section 2.2 shall be decided depending on the objective of the test.

4. SPECIMENS FOR COMPRESSIVE STRENGTH TESTS AND COMPRESSIVE TOUGHNESS TESTS

4.1 Dimensions of Specimens

The specimen shall be cylinders with a height equal to twice the diameter.

The diameter of the specimen shall be 15 cm when fiber length exceeds 40 mm. When fiber length does not exceed 40 mm, the diameter of the specimen shall be 10 cm.

4.2 Apparatus for Making Specimens

4.2.1 The mold shall be a metallic cylinder consisting of side walls (with one or two joints vertically) and a base plate, and it shall have some suitable means to be able to assemble firmly.

4.2.2 The mold shall be watertight and shall hold its dimensions when casting a specimen.

4.2.3 Errors in dimensions of the mold shall not exceed 1/200 for diameter and 1/100 for height. The planeness[5)] of the surface of the mold base plate shall be within 0.02 mm. When assembled, the axis of the side walls (cylinder) and the base plate of the mold shall be at a right angle.

Note 5) Planeness as used here is expressed as the distance between the two planes passing through the highest and lowest points on the flat surface portion.

4.2.4 Molds shall be assembled with joints lightly coated with modelling clay, stiff grease, etc. The inner surface of the mold shall be coated with mineral oil prior to casting of concrete.

4.2.5 In case of consolidation of concrete using a mallet, the mallet shall be of a weight[6)] and dimensions sufficient for consolidating concrete.

Note 6) In general, mallets used for consolidation are of weights of approximately 1 kg.

4.2.6 In case of consolidation by a rod vibrator, the vibrator shall conform to JIS A 8610 (Internal Vibrators for Concrete).

4.2.7 In case of consolidation by a table vibrator, the vibrator shall be capable of consolidating the concrete adequately.

4.2.8 The plate used for capping shall be a polished glass plate or a polished steel plate with thickness not less than 6 mm, and the size shall be larger than the diameter of the mold by 25 mm or more.
The planeness of the capping plate shall be within 0.02 mm.

4.3 Casting of Concrete

4.3.1 Consolidation Using Mallet
When the diameter of the specimen is 15 cm, concrete shall be placed in the molds in approximately two equal layers, and when the diameter is 10 cm, in one layer. The side of the mold shall be tapped approximately 30 times per layer with a mallet, consolidating in a manner that irregularities on the surface will be flattened out[7)].

Note 7) This method is suitable for concrete with slump value of 5 cm or higher. When segregation is expected to occur, the number of tapping with the mallet shall be reduced so as to eliminate segregation of concrete.

4.3.2 Consolidation Using Rod Vibrator
When the diameter of the speciman is 15 cm, concrete shall be placed in approximately two equal layers, and when the diameter is 10 cm, in one layer. The rod vibrator shall be held against the side of the mold to consolidate until irregularities at the surface of the concrete have been flattened out[8]. The rod vibrator shall not be inserted in the concrete for consolidation by internal vibration.

Note 8) The consolidation shall not be performed holding the rod vibrator against only in one place on the side of the mold.

4.3.3 Consolidation Using Table Vibrator
Concrete shall be placed in the mold in one layer, the mold secured tightly to the table, and consolidation shall be performed by applying vibration. The duration of vibration shall be determined in accordance with the quality of concrete and the capacity of the vibrator in order that the concrete will be thoroughly consolidated. Care shall be taken not to allow steel fibers to settle by too long duration of vibration[9].

Note 9) In case of consolidating concrete with slump of 7±1 cm using a table vibrator of 3000 rpm, the duration of vibration shall be about 5 to 10 sec.

4.3.4 When consolidation has been completed, the top surface of concrete shall be slightly below the top of the mold.

4.4 Finishing of Top Surface of Specimen

4.4.1 The top surface of the specimen shall be finished to a plane perpendicular to the axis of the specimen by the method given below. The planeness[5] of the finished surface shall be within 0.05 mm.
When necessary, the capping shall be made as thin as possible.

4.4.2 When capping is to be performed before stripping of the mold, the top surface shall be washed with water and to remove laitance at a suitable time after casting of the concrete[10]. Cement paste shall be placed on the washed surface after water has been wiped off and the paste shall be uniformly pressed down to the top end of the mold with a capping plate.
The cement paste (water-cement ratio 0.27-0.30) shall be mixed approximately 2 hours prior to use, and shall be used upon remixing without adding water. However, in case the top surface is to be ground to an exactly plane surface after hardening, freshly mixed cement paste may be used.
In order that the capping plate will not be bonded to the cement paste, measures shall be taken such as to insert a thin sheet of paper under the capping plate.

Note 10) The time shall be after 2 to 6 hours for concrete with stiff consistency and after 6 to 24 hours for concrete with wet consistency.

4.4.3 When capping is to be performed after stripping of the mold, a mixture of sulfur and mineral powder[11], or hard gypsum, or a mixture of hard gypsum and portland cement shall be used. In such case a suitable device shall be used in order that the axis of the specimen and the surface of the cap will be perpendicular to each other. The specimen shall be covered with a wet cloth to prevent drying until the capping paste has hardened.

Remarks 1: A mixture of sulfur and mineral powder shall be used for sulfur capping. This mixture shall be heated to 130-145°C[12], spread out on a polished steel plate, and the specimen to be pressed down evenly on the mixture. When capping has been performed using sulfur, capping shall be performed at least 2 hours before compressive strength test.

Note 11) The mineral powder used shall be a material such as refractory clay powder, fly ash, or rock powder, which together with sulfur will not change chemically upon heating. A ratio in a range of 3:1 to 6:1 by weight will be suitable for the mixture of sulfur and mineral powder.

Note 12) Raising the temperature higher than this will cause the mixture to become rubbery, and strength will be reduced.

Remarks 2) When the compressive strength of concrete is expected to be less than 300 kgf/cm^2 [29.4 N/mm^2), capping may be done using hard gypsum paste or a mixture of hard gypsum and portland cement paste. In such case it must be ascertained beforehand that the compressive strength of the paste will be 300 kgf/cm^2 [29.4 N/mm^2] or higher. The compressive strength of the paste shall be tested using broken pieces of 4 x 4 x 16 cm beams made of the same mix proportioned paste as the one used for capping. To perform capping, the required quantity of water shall be added to the hard gypsum or the mixture of hard gypsum and portland cement, and mixed until uniform mixture is obtained. The paste shall be spread on a capping plate, and the specimen to be pressed evenly down on the plate.

4.4.4 When capping is not performed, the bearing surfaces of the specimen shall be finished by grinding.

5. SPECIMENS FOR FLEXURAL STRENGTH, FLEXURAL TOUGHNESS AND SHEAR STRENGTH TESTS

5.1 Dimensions of Specimens

The cross section of the specimen shall be a square and when steel fiber length exceeds 40 mm, the width and height shall be 15 cm. When steel fiber length is 40 mm or below the width and height shall be 10 cm.
The length of the specimen, for flexural strength and flexural toughness tests, shall at least 8 cm larger than 3 times the height of the specimen. For shear strength tests, the length shall be not less than 2 times and not more than 4 times the height of the specimen[13].

Note 13) Although it would be permissible to obtain shear strength using a flexural strength test specimen, the testing shall not be done with a portion of a specimen broken in flexure.

5.2 Apparatus for Making Specimens

5.2.1 The mold shall be comprised of a metal base plate and side plates capable of being assembled firmly by means of metal securing fixtures.

5.2.2 The mold shall be watertight and shall hold its dimensions when casting a specimen.

5.2.3 Errors in dimensions of the mold shall not exceed 1/100 of cross-sectional dimensions.
The planeness[5] of a side surface shall be within 0.05 mm, and the two side plates when assembled shall be parallel, and shall not tilt or twist.

5.2.4 The mold shall be assembled with joints lighly coated with modelling clay or stiff grease. The internal sides of the mold shall be coated with a mineral oil prior to casting concrete.

5.2.5 In case of consolidation using a mallet, it shall be as specified in section 4.2.5.

5.2.6 In case of consolidation using a rod vibrator, it shall be as specified in section 4.2.6.

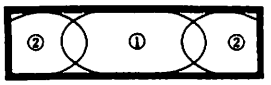
5.2.7 In case of consolidation using a table vibrator, it shall be as specified in section 4.2.7.

5.3 Casting of Concrete

5.3.1 Concrete shall be cast with the longitudinal axis of the specimen set horizontally.

5.3.2 Placing of sample in a mold shall be done using a rather large mixing shovel in order that the portion corresponding to the section of maximum bending moment during loading will not constitute a weak point[14].

Note 14) Placing of sample in the mold shall be done according to the procedure shown in Fig. 1. It is desirable for the sample at the portion (①) corresponding to the section of maximum bending moment to be cast with a larger quantity than other portions (②).



(Note) Numerals indicate order of casting.

Fig. 1 Procedure for casting sample in mold.

5.3.3 Consolidation Using Mallet
Concrete shall be placed in the molds in two approximately equal layers. Each layer shall be consolidated until irregularities on the surface have been flattened out by striking the mold approximately 30 times with the mallet. However, in case of making a specimen of 10 x 10 x 40 cm, placing shall be done in one layer.
Spading shall be performed along the side and end surfaces of the mold with each layer and the sides of the mold shall be lightly tapped with the mallet.

5.3.4 Consolidation Using Rod Vibrator
Concrete shall be placed in the molds in two approximately equal layers. Each layer shall be consolidated until irregularities on the surface have been flattened out by holding the rod vibrator against the sides of the mold. However, in case of making a specimen of 10 x 10 x 40 cm, placing shall be done in one layer.
The rod vibrator shall not be inserted in the concrete for consolidation by internal vibration.
With each layer, spading shall be performed in accordance with section 5.3.3, and the sides of the mold shall be lightly tapped with a mallet.

5.3.5 Consolidation Using Table Vibrator
Concrete shall be placed in one layer. The quantity of concrete shall be such that it will be slightly higher than the top surface of the mold when consolidation has been completed. The mold shall be secured tightly to the table and consolidation shall be performed by external vibration. The duration of vibration shall be set in accordance with section 4.3.3.

5.3.6 After placing, the surplus concrete at the top shall be removed[15] and finishing to be done by a trowel.
Loading is generally done in a direction perpendicular to the direction of casting, but when the directions of loading and casting coincide, the concrete surface to be loaded shall be capped with cement paste just after bleeding ends.

Note 15) In case of removing surplus sample, the shaded portions in Fig. 2 shall be removed in order that the portion corresponding to the section of maximum bending moment during loading will not constitute a weak point.

Fig. 2 Removal of surplus sample.

6. REMOLDING AND CURING

6.1 After the concrete has been placed and is hardened, the mold shall be stripped. Removal of specimen from molds shall be later than 24 hours and within 48 hours after placing the concrete. Up to the time of remolding, the top surface of the specimen shall be covered with a glass plate, a steel plate, or wet cloth to prevent evaporation of moisture.

6.2 The standard temperature during casting and curing of the specimen shall be $20\pm3°C$[16]. The specimen after removal from the mold shall be cured in a moist condition until the strength test is performed.
In order to maintain a moist condition, the specimen shall be stored in a water tank, damp sand or saturated humid atmospheres[17].
Specimens shall note be cured in such a way that they are getting washed continuously by fresh water.

Note 16) In case of any other temperature, the temperature during casting and curing shall be recorded.

Note 17) In case of curing by covering with damp sand or wet cloth, care must be exercised as the temperature inside will at all times be lower than the ambient air temperature due to evaporation of moisture.

7. TRANSPORTATION OF SPECIMENS

The time for hauling of specimens made in the field to the laboratory in case of curing in accordance with section 6.2 shall be as early as practicable within limits that the specimens will not be damaged.

8. REPORT

The report shall include necessary items from the following:

1) Objective of test,
2) Number of specimens,
3) Kinds and properties of materials used,
4) Mix proportions of concrete,
5) Date and time of making specimens, age, date and time of strength test,
6) Method of making sample or method of obtaining sample,
7) Configuration and dimensions of specimens and method of placing,
8) Air temperature and humidity at time of making specimens,
9) Curing method and curing temperature,
10) Others.