JSCE-SF4 METHOD OF TESTS FOR FLEXURAL STRENGTH AND FLEXURAL TOUGHNESS OF STEEL FIBER REINFORCED CONCRETE

1. SCOPE

This standard specifies the methods of tests for flexural strength and flexural toughness of steel fiber reinforced concrete by third-point loading.

2. TESTING MACHINE AND APPARATUS

2.1 Testing Machine

The testing machine shall be as specified in JIS B7733 (Compression Testing Machines), possible for a flexure test apparatus to be attached, and as a standard shall be a hydraulic type, maximum capacity of not more than 100 ton

2.2 Flexure Test Apparatus

The apparatus for applying third-point load[1] shall not be of a construction to restrain deformation of the specimen by the slightest amount up to the specified deflection.

Note 1) Fig. 1 shows an example of the principle of the test apparatus. For flexure supports a set of upper and lower rollers (about ø30mm) capable of rotating in the longitudinal direction shall be used. Since steel fiber reinforced concrete will show large deformation, it will be most desirable for flexure supports to be combinations of steel rods and bilge contacts.

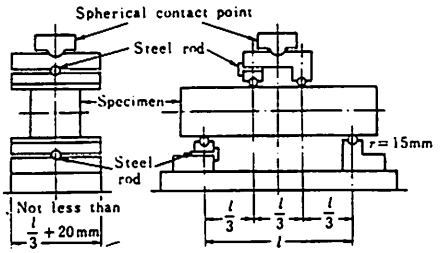


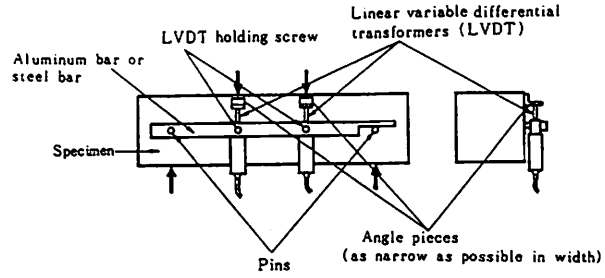
Fig. 1 Example of flexure test apparatus.

2.3 Deflection Measurement Apparatus

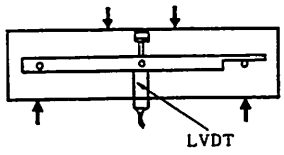
The deflection measurement apparatus[2] used for measuring the load-deflection curve of a specimen shall be comprised of electrical linear variable differential transformers (LVDT) and jigs to hold them, and shall be capable of measuring deflection with specified accuracy[3].

Note 2) Fig. 2 shows an example of a deflection measurement apparatus. The pins and angle pieces supporting the aluminum bar or steel bar of the deflection measurement apparatus may be bonded to the specimen with adhesive.

Note 3) In case of exactly determining bending toughness, deflections must be measured at locations of loading points (Fig. 2a). However, it will be permissible normally for deflection measured at the middle of the span (Fig. 2b) to be used.



(a) Measurement of deflection at loading points



(b) Measurement of deflection at middle point

Fig. 2 Example of deflection measurement apparatus.

3. SPECIMENS

3.1 Specimens shall be made in accordance with the Japan Society of Civil Engineers standard, JSCE-SF2 (Method of Making Specimens for Strength and Toughness Tests of Steel Fiber Reinforced Concrete), or JSCE-SF3 (Method of Making Specimens for Strength and Toughness Tests of Shotcreted Steel Fiber Reinforced Concrete).

3.2 Specimens shall be tested in their conditions immediately after completion of the prescribed curing.

4. METHOD OF TESTING

4.1 The testing machine shall be used in a range from 1/5 to full capacity. When it is possible to change capacity with the same testing machine, the range shall be considered for each capacity separately.

4.2 The sides of the specimen when fiber reinforced concrete was cast in the mold shall be taken as the top and bottom surfaces. The specimen shall be placed at the middle of the width of the supports and the upper loading apparatus shall be made to contact the third points of the span. In this case, gaps shall not be permitted to be visible between the contact surface of the loading apparatus and the specimen.

4.3 The test span shall be 3 times the specimen height.

4.4 Load shall be applied to the specimen continuously without impact. The rate of loading up to maximum load shall follow JIS A1106 (Method of Test fo Flexural Strength of Concrete). In case of measuring deflection beyond the maximum load, the loading shall be performed in a manner to maintain the deflection rate approximately constant. In this case, the deflection rate shall be in a range of 1/1,500 to 1/3,000 of the span minute.

4.5 The maximum load indicated by the testing machine until failure of the specimen shall be read to three significant digits.

4.6 The width of the failed cross-section shall be measured to the nearest 0.2mm at three locations and the average value shall be obtained to four significant digits.

4.7 The height of the failed cross-section shall be measured to the nearest 0.2mm at two locations and the average value shall be obtained to four significant digits.

4.8 The values of flexural strength, residual flexural strength, flexural toughness and equivalent flexural strengh shall be indicated by the average of not less than four specimens.

4.9 In case the specimen fails outside of the middle third of the span in the tension surface, the results of the test shall be discarded.

5. CALCULATION

5.1 Flexural Strength

Flexural strength shall be calculated by the equation below and be determine to three significant digits.

$$\sigma_b = \frac{P\ell}{bh^2}$$

where, σ_b : flexural strength (kgf/cm^2) [N/mm^2]

P : maximum load obtained in accordance with section 4.5 (kgf) [N]

ℓ : span (cm) [mm]

b : width of failed cross-section obtained in accordance with section 4.6 (cm) [mm]

h : height of failed cross-section obtained in accordance with section 4.7 (cm) [mm]

5.2 Flexural Toughess

(1) Flexural toughness shall be expressed by flexural toughness factor.

(2) As shown in Fig. 3, flexural toughness shall be determined to three significant digits from the area below the load-deflection curve until measured deflection becomes 1/150 of the span (ℓ)4).

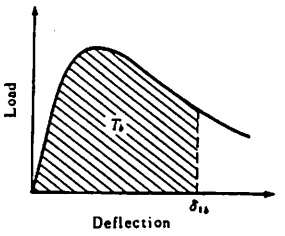


Fig. 3 Flexural toughness.

(3) Flexural toughness factor shall be calculated by the equation below and shall be determined to three significant digits.

$$\overline{\sigma_b} = \frac{Tb}{\delta_{tb}} \cdot \frac{\ell}{bh^2}$$

where, $\overline{\sigma_b}$: flexural toughness factor (kgf/cm^2) [N/mm^2]

T_b : flexural toughness (kgf.cm) [J]

δ_{tb}: deflection of 1/150 of span (ℓ)5) (cm) [mm]

2 mm when span is 30 cm/3 mm when span is 45 cm

Note 4) When the specimen fails before reaching the specified deformation, the area immediately before failure shall be obtained.

Note 5) In case if the specimen fails before reaching the specified deflection, δ_{tb} shall be 1/150 of the span.

6. REPORT

The report shall include necessary items from the following:

1) Mix proportions of concrete,
2) Age,
3) Number of specimens,
4) Height and width of specimen,
5) Maximum load,
6) Location of deflection measurement,
7) Flexural strength,
8) Flexural toughness,
9) Curing method and curing temperature,
10) State of failure of specimen,
11) Others.