TEST METHOD FOR ALKALI RESISTANCE OF CONTINUOUS FIBER REINFORCING MATERIALS (JSCE-E 538-1995)

1. SCOPE

This specifications specifies mainly the test method for evaluating alkali resistance of CFRM used in place of steel reinforcement or prestressing tendon in concrete by immersion in an aqueous alkaline solution.

2. TEST PIECES

2.1 Preparation of test pieces

Test pieces shall as a rule not be subjected to any processing. For mesh-type CFRM, linear test pieces may be prepared by cutting away extraneous parts in such a way as not to affect the performance of the part to be tested.

2.2 Handling of test pieces

During sampling and preparation of test pieces, all deformation, heating, outdoor exposure to ultraviolet light etc. causing changes to the material properties of the test section of the test piece must be avoided.

2.3 Length of test pieces

The length of the test section shall not be less than 100mm, and not less than 40 times the nominal diameter of the CFRM. For CFRM in strand form, as an additional condition, the length shall not be less than 2 times the strand pitch.

2.4 Number of test pieces

The number of test pieces for pre- and post-immersion tensile testing shall not be less than five. If the test piece is found clearly to have failed at the anchoring section, or to have slipped out of the anchoring section, an additional test shall be performed on a separate test piece taken from the same lot.

3. IMMERSION IN ALKALINE SOLUTION

3.1 Preparation of alkaline solution

The alkaline solution used for immersion shall have the same composition as the pore solution found in the concrete.

3.2 Prevention of infiltration of solution into test piece

In order to prevent infiltration of the solution via the ends of the test pieces during immersion, both ends of the test pieces shall be covered with epoxy resin.

3.3 Immersion temperature

The specifications temperature for immersion shall be 60°C.

3.4 Mounting of test piece

The test piece shall be mounted on the immersion apparatus. If necessary a tensioning load shall be applied to the test piece. The alkaline solution must be prevented from absorbing CO_2 from the air and from the evaporation of water during immersion.

3.5 Period of immersion

The specifications immersion period shall be one month.

3.6 Post-immersion treatment

The test piece shall be washed in water after immersion.

4. EXTERNAL APPEARANCE AND MASS CHANGE

4.1 Inspection of alkaline solution

The pH value of the alkaline solution shall be measured before and after the alkali resistance test.

4.2 External appearance

The external appearance of the test piece shall be examined before and after the alkali resistance test, for comparison of color, surface condition, and change of shape. If necessary the test piece may be sectioned and polished, and the condition of the cross-section examined using a microscope, etc.

4.3 Measurement of mass change

After immersion, the hardened epoxy resin shall be removed from the ends of the test piece, which shall then be dried and the mass measured until the mass is constant. The rate of mass loss shall be calculated according to Eq. (1).

$$\text{Rate of mass loss (\%)} = \{(W_0/L_0 - W_1/L_1)/(W_0/L_0)\}\times 100 \quad (1)$$

where

W_0 = mass before immersion (g)
L_0 = length before immersion (mm)
W_1 = mass after immersion (g)
L_1 = length after immersion (mm)

5. TENSILE TEST

5.1 Testing machine and devices

Testing machine and devices shall be in accordance with the "Test Method for Tensile Properties of Continuous Fiber Reinforcing Materials".

5.2 Test temperature and test method

Test temperature and test method shall be in accordance with the "Test Method for Tensile Properties of Continuous Fiber Reinforcing Materials".

6. CALCULATION AND EXPRESSION OF TEST RESULTS

6.1 Handling of data

The material properties of CFRM shall be assessed on the basis only of test pieces undergoing failure in the test section. In cases where tensile failure or slippage has clearly taken place at the anchoring section, the data shall be disregarded and additional tests shall be performed until the number of test pieces failing in the test section is not less than five.

6.2 Tensile capacity retention rate

The tensile capacity retention rate shall be calculated according to Eq. (2), and rounded off to 2 significant places.

$$\mathrm{Re}t = (F_{u1} / F_{u0}) \times 100 \qquad (2)$$

where

Ret = tensile capacity retention rate (%)
F_{u1} = tensile capacity before immersion (N)
F_{u0} = tensile capacity after immersion (N)

7. TEST REPORT

The test report shall include the following items:

7.1 Common items

(1) Name of CFRM
(2) Type of fiber and fiber binding material, volume ratio of fiber
(3) Numbers or identification marks of test pieces
(4) Designation, nominal diameter, maximum cross sectional area
(5) Date of start and end of immersion

7.2 Items related to alkaline solution immersion

(1) Composition of alkaline solution, pH, temperature, immersion period and time
(2) Tensioning load and ratio of tensioning load to nominal tensile capacity (if tensioning is not carried out, this fact should be noted)
(3) Record of observation of external appearance, and rate of mass loss

7.3 Items related to tensile testing

(1) Test temperature and loading rate
(2) Tensile capacities for immersed and non-immersed test pieces, with averages and specifications deviations of tensile capacities and tensile strength
(3) Tensile rigidity, Young's modulus and the averages of these for all immersed and non-immersed test pieces

(4) Ultimate strain for all immersed and non-immersed test pieces, and average ultimate strain
(5) Tensile capacity retention rate
(6) Stress-strain curve for all immersed and non-immersed test pieces