COMMENTARY ON THE TEST METHOD FOR FLEXURAL TENSILE PROPERTIES OF CONTINUOUS FIBER REINFORCING MATERIALS (JSCE-E 532-1995)

INTRODUCTION

When CFRM manufactured as straight rod is tensioned after being bent, the bending stress, added lateral pressure etc. may cause reduction of strength. When uni- directionally strengthened CFRM is bent for use as tendon in prestressed concrete, it is important to be aware of the relationship between the bending conditions and the strength characteristics. However, no standard tests of this type have been established even for steel or plastic materials. The present test method was developed for CFRM bent up as external cables, or arranged in a curved layout as internal cables. The following standards were referred to in relation to the development of this test method:

-Architectural Institute of Japan: "Annotated Design Guidelines for Cable Structures"
-New Prestressed Concrete Bridge Structures Survey & Research Committee, Expressway Survey Commission: "Report on Research into New Prestressed Concrete Bridge Structures (Findings of Study of Utility and Applicability of External Cables)", March 1993

1. SCOPE

The present test is a materials performance test designed to determine the effects of bending on CFRM manufactured as straight rod etc., as compared to the tensile capacity when the material is straight. Stirrups, spiral bars and other CFRM bent from the time of manufacture fall outside the scope of this test.

2. DEFINITIONS

The bent section is also often known as a deviator. Likewise, the deflector is also known as a saddle, or a sheave if disk-shaped.

3. TEST PIECES

(Comment on 3.1) Since the loading test on sections of the CFRM other than the bent sections is identical to the tensile test, it was decided to require simply that "Test pieces shall be prepared and handled in accordance with the "Test Method for Tensile Properties of Continuous Fiber Reinforcing Materials". If sheaths, protective tubes etc. form an integrated part of the CFRM, the integrated unit shall be regarded as a single CFRM, and ideally tests shall be carried out in conditions approximating service conditions. In such cases, though, the material, thickness and geometry of the sheath or protective tubing must be clearly stated in the report.

(Comment on 3.2) In the "Test Method for Tensile Properties of Continuous Fiber Reinforcing Materials", the test section length deemed unaffected by the anchoring section is specified as "... not 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.". For the purposes of flexural tensile test, this is the minimum distance required between the anchoring section and the bent section, therefore the specification is altered to read "The length of the test section shall not be less than 100mm from the anchorage to the bent section, 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.". If the bent section is located in the center of the test section, then, the test section shall be more than twice as long as in tensile test. The length of test sections for multi-cables consisting of multiple strands of CFRM, the test length required is around 3 m, following the "Test Method for Performance of Anchorages and Couplers in Prestressed Concrete using Continuous Fiber Reinforcing Materials".

4. TESTING MACHINE AND DEVICES

(Comment on 4.5) The surface of the bent section in direct contact with the test piece must be robust and smooth, with no grooves. If the geometry and material of the deflector to be used in actual service has been decided, however, or if the present test is to be conducted for the purpose of determining the service geometry and material, the proposed deflector should be used in test. The geometry and material of the deflector must also be clearly noted in the report together with the test results. No specifications are given for the bending diameter ratio, as this should be decided according to the intended use. As a guide, the bending diameter ratios of deflectors currently in service are normally in the order of 100~150.

5. TEST TEMPERATURE

For CFRM incorporating sheathing or other protective treatment, or for deflectors with treated surfaces, the temperature effects of the protective material must be considered in the test.

6. TEST METHOD

A typical test procedure is illustrated in **Fig. C 1**.[1)~3)].

(Comment on 6.1) The dominant parameters in this test are the bending diameter, the bending angle and the nature of the contact between the CFRM and the deflector. The test conditions must therefore be determined with these parameters clearly spelled out. In addition to tests involving 1-point bending, i.e. using a single deflector, tests using multiple deflectors to bend the test piece at two, three or more points could also be considered but the standard test presented here is a 1-point bending test where the effects of a single bending diameter and bending angle are easier to determine. Three-point tests etc. may also be conducted if the results can be made consistent with those for the 1-point test.

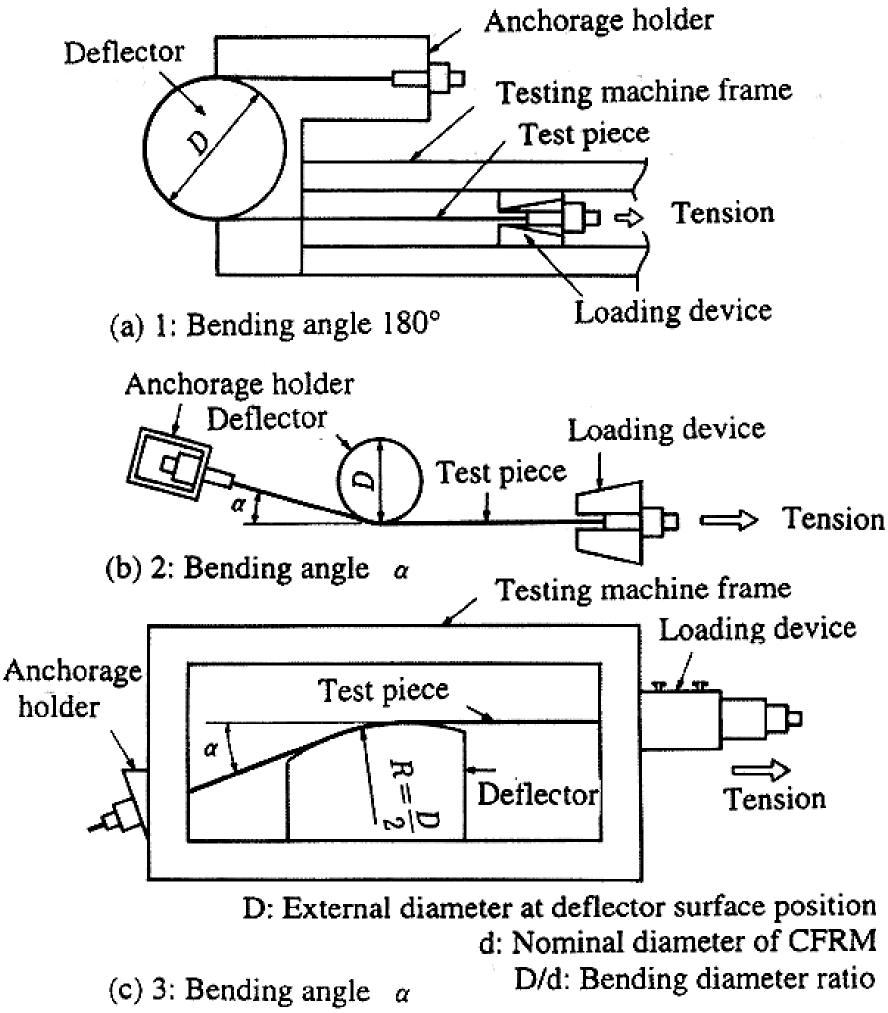

Fig. C 1 Typical bending tensile test set-ups (for reference) [1)~3)]

REFERENCES

1) Kobayashi, Kato and Enomoto: Research on sheaths for FRP Tendons, Summary of AIJ annual meeting, C Structures II, pp. 45~46, Oct. 1990
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3) Tokumitsu, Hino, Maruyama and Mutsuyoshi: Anchoring Systems and Tensile Properties in Flexure of Multi-type CFRM used as External Cables, Concrete Engineering Annual Papers, Vol. 15, No.2, pp. 813~816, Jun. 1993

Doc. 1: Architectural Institute of Japan: "Annotated Design Guidelines for Cable Structures", Chap. 7 "Detailing" 7.3 "Curved Sections of Cables", pp. 100~105, Jun. 1994
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