

**KANSAS DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION TO THE
STANDARD SPECIFICATIONS, EDITION 2015**

Delete SECTION 1722 and replace with the following:

SECTION 1722

FIBROUS REINFORCEMENT FOR CONCRETE

1722.1 DESCRIPTION

This specification covers both micro and macro fibers for use as reinforcement in concrete. Micro fibers are used to control plastic shrinkage cracks in concrete, while macro fibers control cracking in hardened concrete and are often used as a substitute for traditional crack control steel reinforcing bars or mesh. In addition, macro fibers add toughness, and impact and fatigue resistance to hardened concrete.

1722.2 REQUIREMENTS

a. Micro fibers.

(1) Provide fibrillated, interconnected, synthetic fibers that conform to the requirements of ASTM D 7508, contain no reprocessed olefin materials and are specifically manufactured as concrete reinforcement.

(2) Provide fibers that are graded with a maximum length of 2 inches and a minimum tensile strength of 32 ksi.

b. Macro fibers.

(1) Provide synthetic fibers as defined in ASTM C 1116, Type III synthetic fiber-reinforced concrete, except fibers shall have the physical requirements described below.

(2) Provide monofilament, non-fibrillated fibers made from virgin polyolefins (polypropylene or polyethylene).

(3) Provide fibers having a minimum length of 1.5 inches, a maximum length of 2.25 inches, and an aspect ratio (length divided by equivalent diameter) between 70 and 100, inclusive.

(4) Provide fibers with a minimum tensile strength of 70 ksi and a minimum modulus of elasticity of 800 ksi.

(5) Provide fibers, which when tested using the procedure described in **subsection 1722.4b.**, result in a minimum equivalent flexural strength ($f_{e,3}$) of:

$$\text{Minimum required } f_{e,3} = 140 + .015 (x - 4000) \text{ psi}$$

In the above equation, (x) is the average concrete compressive strength as defined in **subsection 1722.4b.(2)(c)**.

(6) Provide fibers, which when tested using the procedure described in **subsection 1722.4b.**, result in a minimum strength ratio ($R_{e,3}$) of 25%.

1722.3 TEST METHODS – MICRO FIBERS

None specified.

1722.4 TEST METHODS – MACRO FIBERS

a. Determine the tensile strength and the modulus of elasticity of macro fibers using ASTM D 2256, “Standard Test Method for Tensile Properties of Yarns by the Single-Strand Method”, Configuration A, Condition 1. Calculate the modulus using the initial modulus defined in section 16 and Appendix X1 of D 2256.

b. Determine equivalent flexural strength ($f_{e,3}$) and strength ratio ($R_{e,3}$) using ASTM C 1609, “Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam With 3rd-Point Loading)”, with the modifications described below.

(1) Definitions.

(a) Equivalent Flexural Strength ($f_{e,3}$) = area under the flexural stress-deflection curve divided by ($L/150$). A horizontal line of value $f_{e,3}$ will have an area below the line between 0 and ($L/150$) equal to the area below the flexural stress-deflection curve between 0 and ($L/150$).

(b) Strength Ratio ($R_{e,3}$) = $f_{e,3}$ / peak strength x 100%. The peak strength is obtained from the flexural stress-deflection curve.

(c) $L/150$ = a deflection corresponding to the span length of the test specimen/ $150 = 0.12$ inches (3.0 mm).

(2) Modifications to C 1609.

(a) Utilize 6 x 6 x 20 inch (150 x 150 x 500 mm) beam specimens tested using an 18 inch (450 mm) span.

(b) Test at least three beam specimens using the concrete mixture described in **subsection 1722.4b.(f)** below.

(c) Test beam specimens when the concrete compressive strength of the batched concrete used in beam testing is between 3,000 and 5,000 psi. Make cylinders prior to the addition of fibers. Test three 6 x 12 inch cylinders to verify concrete compressive strength of beam specimens at time of testing. No single cylinder break shall deviate from the other breaks by more than 10%. Provided the average of the three breaks is within the test limits described above, beam testing can proceed.

(d) Fill the beam mold in one single placement and not in multiple layers or segments. A single placement maintains the continuity of the fiber reinforcement throughout the test beam. Do not consolidate the mix by rodding.

(e) Use supporting rollers during beam tests that conform to ASTM C 1812.

(f) In addition to the strength requirements, use test concrete satisfying the following:

- 0.42 minimum water cement ratio by weight
- no supplementary cementitious materials
- air-entraining admixtures only
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- maximum aggregate size: $\frac{3}{4}$ inch
- fine aggregate: naturally occurring (uncrushed) sand - no manufactured sand
- percent air by volume: $6.5 \pm 1.5\%$
- minimum fiber dosage: 4.0 lbs per cubic yard of concrete

c. Testing shall be performed by a laboratory regularly inspected by the Cement and Concrete Reference Laboratory (CCRL) of the National Institute of Standards and Technology, or other approved reference laboratory.

1722.5 PREQUALIFICATION

a. Manufacturers wishing to provide fibrous reinforcement for concrete for KDOT projects must be prequalified.

b. Submit a small sample to the Bureau of Construction and Materials for prequalification. Include the following information:

(1) Name, address and telephone number of the manufacturer and the preferred contact person.

(2) Name of product and manufacturer’s recommended dosage rate or rates.

(3) Technical data sheets.

(4) Material Safety Data Sheets.

In addition, submit either of the following:

(5) For micro fibers - Test reports substantiating the requirements of **subsection 1722.2a**.

(6) For macro fibers - Test reports substantiating the requirements of **subsection 1722.2b**. For the ASTM C 1609 requirements, include both the mix design of the test concrete, the compressive strength data of the test

concrete at the time of beam testing, and the fiber dosage used during testing to satisfy the $f_{e,3}$ and $R_{e,3}$ requirements of **subsection 1722.2b**.

c. The submittal will be reviewed and the manufacturer will be notified of the results. The Bureau of Construction and Materials will maintain a list of prequalified fibrous reinforcement. For each prequalified macro fiber, a minimum fiber dosage, reported from **subsection 1722.5b.(6)**, will be shown for each product.

1722.6 BASIS OF ACCEPTANCE

Prequalification as required by **subsection 1722.5**.

Receipt and approval of a Type C certification as specified in **DIVISION 2600**.

In addition, when macro fibers are being used as a substitute for 6 X 6 – W4 X W4 welded wire reinforcement in valley gutters and entrance pavement, or as a substitute for 6 x 6 – W1.4 X W1.4 welded wire reinforcement in concrete ditch lining, provide a copy of the approved mix design with the prequalified fiber manufacturer, product name, and dosage clearly identified. Use a fiber dosage that is not less than the product's value shown on the prequalified list.

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