

# Royal Enterprises America

## Royal Fibers<sup>□</sup>

For Use in Cast-in-Place, Wet-Cast, and Dry-Cast Concrete

### Guide Specification

*Not for use as a construction document. Edit carefully to meet your specific project requirements. You must determine suitability of this guide specification in whole or part for a particular project.*

### Part 1 General

#### 1.1 Section Includes

- A. Royal Fibers<sup>□</sup> fiber reinforcement for cast-in-place, wet-cast, and dry-cast concrete.

#### 1.2 Related Sections

- A. Section 03300 Cast-in-Place Concrete.

#### 1.3 References

- A. American Society for Testing and Materials (ASTM)
  - 1. ASTM C 1116 Standard Specification for Fiber Reinforced Concrete and Shotcrete.
  - 2. ASTM C 1018 Standard Test Method for Flexural Toughness and First Crack Strength of Fiber-Reinforced Concrete (Using Beam with Third Point Loading).
  - 3. ASTM C 1399 test method for obtaining Average Residual Strength of fiber reinforced concrete.
- B. American Concrete Institute (ACI)
  - 1. ACI 544.1R State of the Art Report on Fiber Reinforced Concrete.
  - 2. ACI 544.2R Measurement of Properties of Fiber Reinforced Concrete.
- C. Japan Society of Civil Engineers (JSCE): JSCE-SF4 Standard for Flexural Strength and Flexural Toughness, "Method for Steel Fiber Reinforced Concrete," Concrete Library of JSCE No. 3 June 1984, pp 58-66.

#### 1.4 Submittals

- A. Submit copies of manufacturer's literature for fibers including product data, brochures, guide specifications written batching and mixing instructions and appropriate Material Safety Data Sheets (MSDS).
- B. Submit copies of a certificate prepared by concrete supplier, under provisions of Section [01400], stating that the specified fibers were added to each batch of concrete delivered to the project site. Each certificate should be accompanied by one copy of each batch delivery ticket indicating product name, manufacturer and quantity of fiber reinforcement added to each concrete load.

## 1.5 Quality Assurance

- A. Manufacturer: Provide technical assistance from design through construction for use of fiber reinforcement.

*A field mock-up may not be needed for every project. Delete the paragraph B if a mock-up is not necessary.*

- B. Mock-up: Provide mock-up(s) of concrete using fiber reinforcement specified in this Section. Mock-up(s) shall be representative of Work of Related Sections and techniques specified in this Section. Mock-up(s) is (are) to be approved by [architect/engineer] [owners representative]. Use mock-up(s) for reference during project.

## 1.6 Delivery, Storage and Handling

- A. Deliver fiber reinforcement in sealed, undamaged containers with labels intact and legible, indicating material name and lot number.
- B. Deliver fiber reinforcement to location where it will be added to each truckload.
- C. Store materials covered and off the ground. Do not allow boxes to become wet.

## Part 2 Products

### 2.1 Manufacturer

- A. Royal Enterprises America  
30622 Forest Blvd.  
PO Box 430  
Stacey, MN 55079  
800/817-3240

### 2.2 Materials

*Paragraph A below specifies fiber type by material properties. Different dosage and length fibers should be used for different applications and is usually specified in Part 3 Execution of this Guide Specification.*

- A. Fiber Reinforcement: drawn metallic wire fibers with the following typical physical properties:

1. Specific Gravity (Bulk Relative Density): 7.8
2. Tensile Strength: 1 034 MPa (150,000 psi)
3. Modulus of Elasticity: 206 700 MPa (30,000,000 psi)

*Edit toughness index in paragraph B below if 2.03 paragraph A is not specified. Contact manufacturer for assistance.*

- B. Fiber reinforcement provided in this section shall produce concrete conforming to the requirements for each type and class of concrete required, as indicated on drawings, and in Section [03300] and requirements of:

1. ASTM C 1116: Type I
2. ASTM C 1399: Average Residual Strength

### 2.3 Mixes

*Coordinate fiber loading with batching operations, mixture proportions, and design as specified in Section 03300 Cast-In-Place Concrete. Other fiber dosages than those specified are possible to meet specific project requirements. Any fiber dosage may reduce slump compared to non-*

*fiber reinforced concrete. Contact manufacturer for technical assistance to determine fiber dosage and mixture proportions. Fiber balls do not usually occur when using Royal Fibers. If balling has occurred it is due to mixture proportions, equipment, and/or procedure. To avoid the formation of fiber balls, do not overcharge a low-shear mixing drum with a slug of fibers. Consider addition of fibers to the mixing drum by distributing fibers on the aggregates on the aggregate feed belts.*

A. Add fibers by distribution on the aggregates during addition to the mixing drum or on the aggregate feed belt.

B. Add fibers after concrete has been loaded into the truck.

*The paragraph C below specifies Royal recommended fiber reinforcement dosage for relatively normal concrete mix proportions to obtain concrete structural material property improvements at 39.2 kilograms per cubic meter (66 pounds per cubic yard).*

C. Add fiber reinforcement at 39.2 kilograms per cubic meter (66 pounds per cubic yard), approximately 0.5 percent by volume.

D. Add fiber reinforcement with drum turning.

E. Once fiber reinforcement has been added, turn truck drum at ACI established mixing speed for adequate recommended mixing time usually not less than 5 minutes at ACI established mixing speed.

F. To ensure adequate mixing due to variable fin wear and drum turning speed, truckload must not exceed 80 percent of rated capacity when using fiber reinforcement.

G. Back concrete up to discharge end of drum then take concrete back down into drum and mix for adequate recommended mixing time usually not less than 5 minutes at ACI established mixing speed.

*Retain Paragraph G only for fiber reinforcement loading when the fibers are not added onto or into the concrete and may be hung up or trapped in a dead spot of the mixing environment.*

H. If truck drum contains less than 50 percent capacity, back concrete up to top of discharge end of drum and put fiber reinforcement directly on top of concrete before mixing.

*The following only describes requirements specific to using Royal fibers. Other requirements for mix proportions and design, placement and finishing should be specified in Section 03300 Cast-In-Place Concrete.*

## Part 3 Execution

### 3.1 Placement

A. Place concrete in accordance with provision of Section 03300 Cast-In-Place Concrete and with additional instructions as follows.

B. Avoid using rakes or other tools that will align fibers or disrupt uniform fiber dispersion when moving concrete.

C. Using flat tined pitch forks (potato fork) may be useful for moving low slump concrete.

*Fiber balls do not usually occur when using Royal fibers. If balling has occurred, it is due to mix proportion, equipment and/or procedures.*

D. Remove fiber balls from mixture if they occur.

### 3.2 Finishing

- A. Using a roller bug (rolling, jitter bug) screed to bury fiber reinforcement near surface may make final finishing easier.
- B. Hand Finishing: use steel/magnesium tools.
- C. Broom Finishing: use a stiff bristle broom. Hold broom so that bristles lie flat on surface. Avoid positioning bristles perpendicular to surface. Pull broom in one direction. Do not push broom.
- D. During hand finishing, remove protruding fibers (if desired for aesthetics) by grabbing and removing the fibers.
- E. At the fiber concrete and form interface, cut “bridging” fibers away with a margin trowel before using a radius tool for edging.

### 3.3 Schedules

*A schedule may be needed to coordinate fiber dosage specified in this section with drawings indicating areas for each fiber dosage type especially if more than one fiber dosage is specified in this Section.*

- A. Provide Fiber Reinforced Concrete with minimum dosage and minimum Average Residual Strength (ARS) according to the following schedule:
  - a. Slab on ground interior, dosage 66 pcy, ARS = 400 psi.
  - b. Slab on ground exterior, dosage 33 pcy, ARS = 100 psi.

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#### Wet-cast concrete Laboratory

40 mm long (1.6 inch) Royal fiber @ 0.50% dosage (39.2 kcm, 66 pcy) 2.85 MPa (415 psi)  
 41 mm long (1.6 inch) competitive fiber @ 0.50% dosage (39.2 kcm, 66 pcy) 3.15 MPa (455 psi)

#### Wet-cast concrete Transit Truck

40 mm long (1.6 inch) Royal fiber @ 0.57% dosage (44.3 kcm, 75 pcy) 1.97 MPa (285 psi)  
 50 mm long (2.0 inch) competitive fiber @ 0.57% dosage (44.3 kcm, 75 pcy) 1.91 MPa (275 psi)

#### Dry-cast concrete

40 mm long (1.6 inch) Royal fiber @ 0.25% dosage (19.6 kcm, 25 pcy) 0.91 MPa (135 psi)  
 40 mm long (1.6 inch) Royal fiber @ 0.50% dosage (39.2 kcm, 66 pcy) 1.43 MPa (210 psi)  
 40 mm long (1.6 inch) Royal fiber @ 0.75% dosage (58.8 kcm, 99 pcy) 3.01 MPa (440 psi)

#### Shotcrete placement

19 mm long (0.75 inch) Royal fiber @ 0.19% dosage (19.6 kcm, 25 pcy) 0.52 MPa (75 psi)  
 19 mm long (0.75 inch) Royal fiber @ 0.38% dosage (29.5 kcm, 50 pcy) 0.77 MPa (112 psi)  
 19 mm long (0.75 inch) Royal fiber @ 0.57% dosage (44.3 kcm, 75 pcy) 1.13 MPa (164 psi)