Make the following Section a part of the Standard Specifications:

"SECTION 719 – MACROFIBERS FOR CONCRETE REINFORCEMENT

719.01 Definitions.

(A) Microfibers are used in low volume, in general, are short, normally under an inch, and are thin fibers, having an equivalent diameter of approximately less than 0.012 inches. Microfibers increase homogeneity, reduces bleeding, plastic settlement, and plastic shrinkage cracks. Microfibers when the high number of individual fibers are evenly distributed throughout the concrete will reinforce the concrete in all directions to control the cracking of concrete in its plastic state. The fibers increase the tensile strain capacity of the plastic concrete by intersecting the micro-cracking when the concrete shrinks restricting the widening of plastic shrinkage cracks. In general, microfibers do not prevent cracking since the fibers do not engage until the crack starts but aids in keeping cracks from becoming large and in many cases noticeable to the unaided eye.

(B) Macrofibers are used in high volume, in general, are long, normally over 0.75-inches long, but not in all cases, and are thicker fibers than microfibers, having an equivalent diameter of approximately greater than 0.02 inch. Glass and carbon nanotubes and fibers other than polymeric may not fit these dimensional qualities. Macrofibers when the high number of individual fibers evenly distributed throughout the concrete transfer stresses across a crack after cracking has begun. Macrofiber performance relies on the frictional bond between the macrofiber and the hardened cement paste. Macrofibers tend also to reduce the segregation and bleeding of the plastic concrete; minimize crack widths, minimize curling, and hold the cracked pieces of harden concrete together but does not prevent cracks or significantly increase strength.

719.02 Macrofibers for Concrete Reinforcement. Macrofibers for Concrete Reinforcement must comply with the following requirements:

(A) Macrofibers or structural fibers are made from but are not limited to polyvinyl alcohol**,** (PVA) or polymeric, or glass, or other materials e.g., basalt fibers or carbon nanotubes, or a combination of types of fibers. All fibers, in general, must be designed for the structural reinforcement, i.e., it must be a structural macrofiber designed for use in concrete to give it additional structural properties, e.g., average residual strength, ductility, impact. Microfibers may be blended with the macrofibers to aid in the control of plastic cracking, but the blend must be substantially made up of macrofibers.

(B) The structural fibers must be 100% virgin material and must be non-corrosive, non-magnetic, and 100% alkali proof. Glass structural fibers must be resistant to damage due to mixing and alkali-resistant. The use of recycled material, i.e., macro fiber made from recycled material, must not be used without

acceptance of the Engineer and MTRB or when allowed by the Contract Documents.

(C) The structural fibers must have a tensile strength equal to or above 83 KSI. Polymeric structural fibers must be tested in accordance with ASTM D 7508 - Standard Specification for Polyolefin Chopped Strands for Use in Concrete. Structural fiber must meet or exceed the requirements of ASTM C-1116 - Standard Specification for Fiber-Reinforced Concrete. Structural fibers that are not addressed in ASTM C-1116 or ASTM D 7508 must comply with relevant industry testing standards that have been accepted by the Engineer. Submit testing standard to Engineer for review and acceptance.

(D) Structural fibers must be gray in color or if a color other than gray is used it may be accepted by the Engineer if the contractor can prove that the fiber is not more visible than a gray-colored fiber.

(E) Structural fibers must be uniformly mixed into the concrete and must not exhibit “balling” or “bird nesting” of the fibers. If this occurs, revise means and methods to eliminate the “balling” or “bird nesting” of the fibers. Do not place concrete until the revision is submitted to the Engineer and accepted.

(F) Use an amount of structural fibers that must meet or exceed a minimum average residual strength (ARS) specified when tested at the end of the specified testing period, if not specifically specified the test must be conducted at 28 days or the time the concrete is specified to be tested for strength, flexural or compressive, whichever is the specified time for strength testing.

(G) ASTM C1399 - Standard Test Method for Obtaining Average Residual-Strength of Fiber-Reinforced Concrete or ASTM C1609 - Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam with Third-Point Loading) must be used to determine the average residual strength. The rollers the sample is placed on during testing must freely rotate; the roller support system must be a low friction system, and the coefficient of friction in the roller supports must be approximately 0.10.

(H) Microfibers and macrofibers must be added to the mix using the manufacturer’s fiber feeders or a manufacturer’s accepted method to uniformly distribute the fibers into the mix. Use the fiber manufacturer's recommended procedures to achieve uniform distribution of the fibers throughout the batch of plastic concrete and prevent damage to the fibers**.**

719.03 Prohibited Use. No steel or metallic structural fibers or any other structural fiber must be used that could injure people’s bare skin, animals, or damage bicycles’ tires, etc. in areas where such traffic may occur, e.g., crosswalks, sidewalks, roadways open to bicycle traffic unless they are specified in the Contract Documents. The Engineer will solely decide if the steel structural fibers will be detrimental to bare

skin, animals, or damage bicycles' tires, etc. or if the location where it is to be used is acceptable. Steel structural fibers will be allowed for use in ultra-high-performance concrete applications or when accepted by the Engineer and MTRB.

719.04 Dosage Label. When structural fiber is shown in pounds, e.g., 7½ pounds per cubic yard of concrete, it is being used as a generic label and it must not be taken as to mean the actual dosage, it is a specified dosage in pounds that may provide the required average residual strength. When a type and brand are specifically specified that dosage will meet the required average residual strength requirement. The dosage of one manufacturer's structural fiber will in general, not have the same results as the same dosage weight of another manufacturer's structural fiber. No two structural fibers from different manufacturers are necessarily the same; it is imperative to note that structural fiber types and categories are not interchangeable by simply using direct substitution of a dosage rate. The concrete mix may impact the results of the average residual strength test. Therefore, the dosage of the structural fiber must be adjusted to meet the required minimum average residual strength. If only a dosage is given, call out the brand and type and concrete strength showing ARS test results of the macro fiber in the submittal.

(A) No additional compensation will be granted for the additional weight of the fiber or additional admixtures or any adjustments to the concrete mix needed to be added to meet the required average residual strength.

(B) If less structural fiber is used than stated by the dosage label no rebate will be requested.

(C) Submit to the Engineer for review and acceptance of a certified test results package from an accredited third-party independent material testing laboratory.

(D) The laboratory and technician used must: be an AASHTO resource (formally AMRL) or another USA nationally certifying entity certified for all the test methods used in proving the dosage of structural fibers to be used meets or exceeds the required ARS, and it must also be located in the United States of America.

(E) The ARS must be based on the average results from a lot.

(1) A lot must be the ARS test performed on a minimum of six test samples.

(2) ARS tests performed on a lot must be acceptable when five samples have an ARS equal to or greater than the specified ARS, only one test sample's result can be below the specified ARS, but it must be no lower than 50 psi and still have a lot be acceptable. The ARS for the lot must be calculated by averaging the residual strength results including any low results. If the test results exceed the required maximum residual

strength by more than 50 psi, the specified required maximum residual strength plus 50 psi must be used in place of the actual high test result in calculating the lot's ARS. Tests that exceed the required maximum residual strength by less than 50 psi must use the actual test results in the calculation of the lot's ARS. The lot's ARS must equal or exceed the required ARS to be acceptable for use.

(3) Retesting of a mix that was found unacceptable must be done only one time.

(4) Retest a new lot of samples with a revised mix if the previously tested lot is not found acceptable.

(5) Failure to meet these standards will be cause for rejection of all test results and must serve as applicable proof of noncompliance with contract document requirements.

(6) Concrete used for all ARS tests must closely match the mix to be used on the project. The fibers used must be identical to the ones to be used on the Project.

(7) Submit as part of the certified test results package:

(a) The mix design used for the ARS test with compressive strength and flexural strength if applicable.

(b) The project's actual mix design.

(c) The certified ARS and strength test results.

(d) The certified test ARS package results must not have been performed more than five years before the date of the submittal.

(e) Catalog cuts for fibers to be used and indicate the type, brand name length, and fiber's name, e.g., fibrillated polypropylene, Harry's Fiber, 2.0 inches, Harry's Best Fibrillated Macrofiber.

END OF SECTION 719"