

# WHAT ARE THE DIFFERENCES BETWEEN MICRO AND MACRO-SYNTHETIC FIBERS

ASTM C1116 defines Type III Synthetic Fiber Reinforced Concrete or Shotcrete as concrete that contains micro and/or macro synthetic fibers for which documentary evidence can be produced confirming their long-term resistance to deterioration when in contact with the moisture and alkalis present in cement paste or the substances present in air-entraining and chemical admixtures. ASTM D7508 also provides specific definitions, such as denier and length, to further define the differences between these types of fibers. It is also stated within C1116 that polypropylene based fibers, micro-synthetics and macro-synthetics, are known to be durable within concrete.

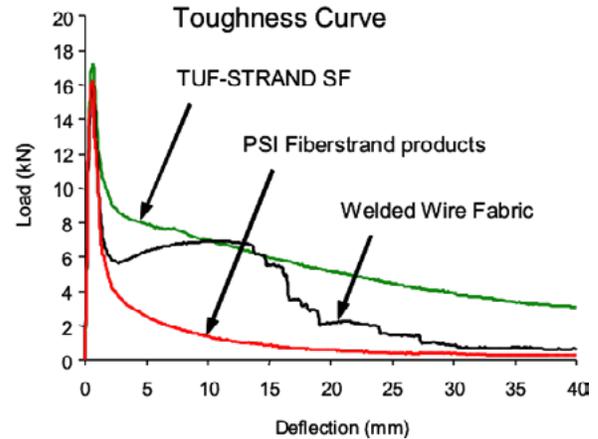


Although micro-synthetic fibers provide superior resistance to the formation of plastic shrinkage cracks versus welded wire reinforcement, they are unable to provide any resistance to further crack width openings caused by drying shrinkage, structural load or other forms of stress. However, these products should be regularly specified in any type of concrete to improve cracking resistance, spall protection, freeze-thaw durability and improve the homogeneity of concrete during placement. Monofilament and fibrillated micro-synthetic fibers are available in  $\frac{1}{2}$ " -  $\frac{3}{4}$ " (12 – 19 mm) lengths with typical dosage rates varying from 0.5 - 1.5 lbs/yd<sup>3</sup> (0.3 – 0.9 kg/m<sup>3</sup>) depending on the product and application.

Macro-synthetic fibers can also provide resistance to plastic shrinkage but will provide concrete with enhanced durability, toughness and the ability to provide limited structural capacity when properly designed. These fiber products are dosed at amounts that are engineered to be equivalent to conventional steel reinforcing, such as welded wire reinforcement and steel rebar, and will be distributed three dimensionally throughout the concrete section. These calculations can be based on simple tensile strength conversion, flexural bending moments or yield line theory analysis. Macro-synthetic fibers can be likened to the use of steel fibers, but with different physical characteristics. These fibers will usually be easier to place and finish in comparison to steel fibers due to lighter weight, a non-corrosive nature and the ability to be pumped with ease. Macrosynthetic fibers are typically  $\frac{1}{2}$ " - 2" (38 – 50 mm) in length with dosage rates varying from 3.0 - 15 lbs/yd<sup>3</sup> (1.8 – 9.0 kg/m<sup>3</sup>) depending on the product and application.

ASTM Standardized test methods, such as C1399, C1609, C1550 and C1579 measure the physical and mechanical performance of Fiber Reinforced Concrete (FRC) and the ability of fibers to resist concrete cracks from opening further. Performance based specifications on the use of FRC will typically require testing data based on these standards. The Euclid Chemical Company maintains a database of testing results in various concrete mixtures to assist design professionals in properly specifying the correct dosage rate of fibers for slabs on ground, precast elements, wall construction, composite steel decks and shotcrete.

Computer spreadsheets and mobile based calculators have been developed providing easy conversions of single layer conventional reinforcing to appropriate dosage rates of macro-synthetic fibers. An advanced analysis can also be performed for the complete design of a slab on ground system using fiber reinforced concrete.



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