Design of Reinforced Concrete Beams Strengthened with Fibers

Jacob Bailey  
*Indiana University - Purdue University Fort Wayne*

Jerry Brown Jr.  
*Indiana University - Purdue University Fort Wayne*

Jeremy Hoffman  
*Indiana University - Purdue University Fort Wayne*

Follow this and additional works at: [http://opus.ipfw.edu/stu_symp2013](http://opus.ipfw.edu/stu_symp2013)  
Part of the Civil and Environmental Engineering Commons

Recommended Citation  
[http://opus.ipfw.edu/stu_symp2013/6](http://opus.ipfw.edu/stu_symp2013/6)

This is brought to you for free and open access by the IPFW Student Research and Creative Endeavor Symposium at Opus: Research & Creativity at IPFW. It has been accepted for inclusion in 2013 IPFW Student Research and Creative Endeavor Symposium by an authorized administrator of Opus: Research & Creativity at IPFW. For more information, please contact admin@lib.ipfw.edu.
Behavior of Reinforced Concrete Beams Strengthened with Fibers

Jacob Bailey, Jerry Brown Jr., and Jeremy Hoffman, Department of Civil Engineering
College of Engineering, Technology, and Computer Science, Indiana University-Purdue University Fort Wayne

ABSTRACT

Concrete is a brittle material with limited tensile capacity. Therefore, reinforcement is required in structural concrete members in regions with tensile stresses. Structural fibers may significantly increase the tensile strength of concrete. However, the contribution of the fibers to the tensile strength of concrete is not appreciated by design codes. Consequently, the main objective of this study is to design a methodology to explore the feasibility of using fibers to reduce concentrated shear reinforcement in gravity weight and lightweight concrete beams. This will involve investigating the influence of the fibers on the cracks and widths as a failure mode. A simplified formula for predicting the contribution of synthetic fibers to the shear strength of concrete will be developed.

The formulas available in literature were developed for steel fibers not for synthetic fibers; their applicability will be evaluated. Nine normal weight and nine lightweight reinforcement concrete beams of a size of 6x9x21 in. will be designed, fabricated, and tested. The synthetic fiber content and stirrups spacing are varied among the different beams in each group.

VARIABLES

- Type of Concrete: Normal Weight, Structural Lightweight
- Spacing of Stirrups: No Stirrups, 4” Spacing, 6” Spacing
- Amount of Fibers: No Fibers, 5 lb/yard³, 7 lb/yard³

J³ Method

The J³ Method is a multi-step procedure that is more complicated than the procedure for the Fiber Factor Method. The J³ Method procedure is also able to evolve when necessary, for example when different fiber types, different beam sizes, and fiber tensile strengths are available. The J³ Method takes all of those changes into effect along with the orientation factor and the J³ Factor (Effectiveness Factor). Steps 1 through Step 8 of the J³ Method are for determining the total shear strength of the fibers located within the shear failure area. The last steps (Steps 9 through Step 11) are for determining the effective shear strength contribution of the fibers in the shear failure area. These steps vary and cannot be predicted in a precise manner. The orientation factor can only be estimated, and a conservative estimate is best to be chosen. The J³ (Effectiveness) Factor is an estimation also, and it is based on fiber type. For example the K Factor for the strux fibers is estimated at around 0.3, while the J³ Factor for Steel Fibers would be around 1. They vary due to the different properties of the fibers, with the main factor being rigidity.