A Numerical Method for Macro-fiber Distribution and Orientation In Hardened Concrete Components

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Abstract

Fiber reinforced concrete as a construction material has been widely used. Fibers, as the reinforced component, the physical properties and the distribution influence the engineering properties of the composite. To illustrate the engineering properties, fiber distribution and orientation are necessary. Steel fibers can be easily captured by X-ray, but it is difficult them to express being numerical because they don't show as perfect circular shape on the grinding face. To get the more exact information for this, the numerical method for the orientation and distribution of fibers have to be more elaborately. This paper presents a possible method which makes the calculate for orientation possible.

Keywords : Fiber reinforced concrete, fiber orientation and distribution, numerical method

1. The properties of this research

The properties of this research are to numerical the orientation and distribution of the macro-fibers on any section surface of a hardened concrete. Since the orientation can influence the enhancements. Thus influence the final engineering properties. The traditional method can only observe the fiber situation. While only observation is not enough for deeper analyses. In this paper, a possible method which can calculate the results is raised, and those calculative result will contribute the deeper analysis.

2. Calculation method

On the section surface of the concrete samples, the morphology configuration of steel fiber can be measured and those characteristics can be used to illustrate the fiber distribution and orientation. Moreover, the absolute value of sine θ can be provided as the parameter of the orientation of the steel fiber (see figure 1 and 2). Each of steel fiber inside the composite has their sine θ value. According to their orientation properties, the value will as close as 1 if the fiber vertical to the section, and as close as 0 if the fiber parallel to the section as shown in the equation (1)

3. Test result and discussion

The calculation method for an average value of the sine θ , here, present by d/l_1 have been analyzed. The value between 1 to 0.8 took the central part for all the four mixtures. That is to say, the 80 present of steel fiber showed nearly vertical to the fraction surface and also vertical to the load direction. On the other hand, some fibers will show nearly parallel to the friction surface, the rate of those kinds of fiber only took 0.3% to 0.8% which is very low in the composite. The average value of the angle was about 60 degree. The test results and analysis have been shown in Table 1.

$$|\sin\theta| = \begin{cases} 1(l_1 = d) \\ \frac{d}{l_1}\{l_1 | d \langle l_1 \langle L\} \\ 0(l_1 = L) \end{cases} \qquad (1)$$

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θ : the angle between steel fiber and assumed fraction surface.
l1: the longer diameter of the steel fiber section.
d: the diameter of the steel fiber.
L: the length of steel fiber.

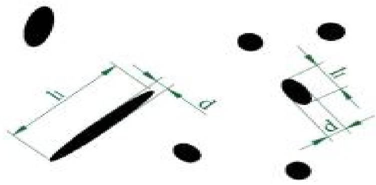

Figure 1. Section analysis of steel fiber

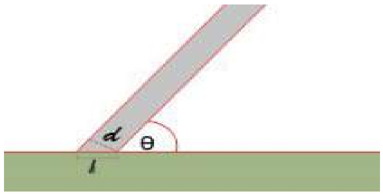

Figure 2. Angle value between steel fiber and assumed fracture surface

Table 1. d/l1 value analysis

Mixture	d/l1	Aggragate	Average d/l1	%	Average Θ
S25	1-0.8	0.8<d/l1≤1.0	0.862	77.7	59.5
	0.8-0.6	0.6<d/l1≤0.8		13.6	
	0.6-0.4	0.4<d/l1≤0.6		5.2	
	0.4-0.2	0.2<d/l1≤0.4		3.0	
	0.2-0	0≤d/l1≤0.2		0.3	
S50	1-0.8	0.8<d/l1≤1.0	0.887	80.4	62.5
	0.8-0.6	0.6<d/l1≤0.8		11.6	
	0.6-0.4	0.4<d/l1≤0.6		5.7	
	0.4-0.2	0.2<d/l1≤0.4		2.0	
	0.2-0	0≤d/l1≤0.2		0.3	
S75	1-0.8	0.8<d/l1≤1.0	0.874	78.8	60.9
	0.8-0.6	0.6<d/l1≤0.8		13.2	
	0.6-0.4	0.4<d/l1≤0.6		5.1	
	0.4-0.2	0.2<d/l1≤0.4		2.4	
	0.2-0	0≤d/l1≤0.2		0.5	
S100	1-0.8	0.8<d/l1≤1.0	0.879	80.3	61.5
	0.8-0.6	0.6<d/l1≤0.8		12.0	
	0.6-0.4	0.4<d/l1≤0.6		4.6	
	0.4-0.2	0.2<d/l1≤0.4		2.2	
	0.2-0	0≤d/l1≤0.2		0.8	

4. Conclusion

The orientation can be calculated. Based on the calculative results, the average θ is amount 59.5-62.5 degree.

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Reference

1. F.Soltanzadeh, J.A.O. Barros, R.F.C. Santos, High performance fiber reinforced concrete for shear reinforcement: experimental and numerical research, Constr. Build. Mater. 77, pp.94~109, 2015
2. S.P. Shah, L.Ferrara.S.H. Kwon, Recent Research on Self-Consolidating Steel Fiber-Reinforced Concrete, ACI Special Publication, pp.272, 2010