The Effects of LLDPE on Fracture Characteristic of High Performance Concrete

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Introduction

Compared with most materials, concrete is considered as a brittle material. The brittleness of concrete increases with strength, and for super-high-strength concrete, failure can be sudden, explosive and disastrous. Therefore, it is necessary to carry out research on the brittleness of concrete in order to establish parameters for assessing the brittleness, find ways to improve the brittleness, and to design and manufacture concrete materials with high strength and low brittleness. Strength, stiffness, toughness and fracture energy are all the fracture properties for such purpose.

Figure 1. Test set-up of the three-point bending test

Materials

The cement used for the concrete was Procem ordinary Portland cement. It is classified as Class 52.5 N CEM 1 according to BS EN 197-1. Oven-dry granite aggregates were used with diameter D_{max} = 10 mm. Siliceous natural sand was used. The silica fume used for strengthening the concrete was Elkem microsilica grade 940-D Densifiled and 10% of the total cementitious material was replaced by. Structuro 11180 superplasticizer, a new generation polycarboxylate (PC+) polymer superplasticizer (high range water reducer), was used for the mix. Linear low density polyethylene LLDPE is in powder form was used.

Results

The HPC could largely improve the compressive strength by up to 15.7%, while the addition of 5% LLDPE did not show any enhancement. The tensile strength was considerably increased for all dosages of LLDPE, with the maximum increases of 83.2% for 1.5% LLDPE. The fracture energy was also enhanced by adding all dosages of LLDPE, with a maximum increase of 24.3%. The modulus of rupture, fracture toughness and dynamic Young's modulus were not improved for lower dosages but slightly decreased for higher dosages of polymers.

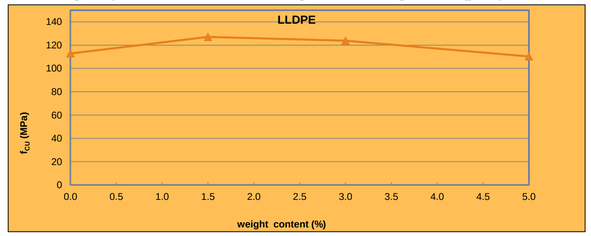

Figure 2: Compressive strength of the HPC with different contents of polymers at 28 days

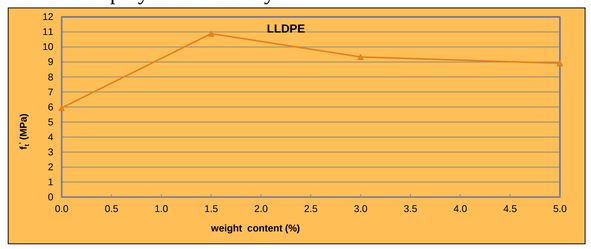

Figure 3: Splitting tensile strength of the HPC with different contents of polymers at 28 days

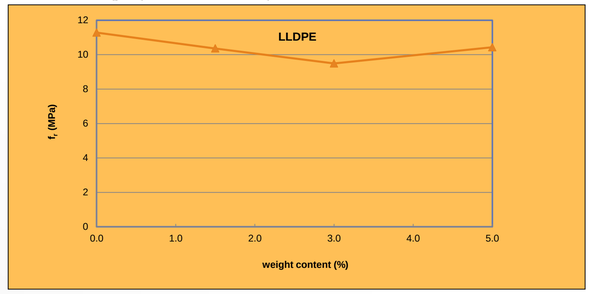

Figure 4: Modulus of rapture of the HPC with different contents of polymers at 28 days

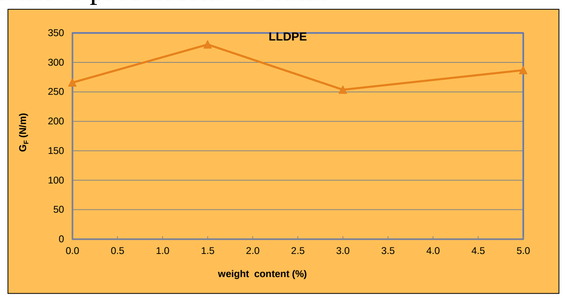

Figure 5: Fracture energy of the HPC with different contents of polymers

Figure 6. : Splitting tension test

Figure 7. Ultrasonic testing

Table 1: Concrete mix design (volume of mix per 1 m^3)

Mix	1	2	3	4
SBR latex in mix design	0.0%	1.5%	3.0%	5.0%
Target compressive strength at 28 days (MPa)	110	110	110	110
Max aggregate size (mm)	10	10	10	10
Cement (kg)	502	502	502	502
Aggregate (kg)	1005	1005	1005	1005
Sand (kg)	830	809	786	756
Water (litre)	134	113	99.5	60
Silica fume (kg)	55	55	55	55
Superplasticizer (litre)	20	20	20	20
LLDPE(kg)	0	8.4	16.8	28
Water–cementitious materials (w/cm) ratio	0.25	0.25	0.25	0.25

Figure 8. linear low density polyethylene (LLDPE) powder add to high performance concrete with different percentages

Conclusions

The present study was designed to investigate the effects of LLDPE latex on the fracture properties of high performance concrete, including fracture energy and modulus of rapture. Other properties such as compressive and tensile strength, flexure strength, modulus of elasticity and density were also measured. The main finding in this study is that the adding 1.5%, 3%, 5% LLDPE to the high-performance concrete enhanced the fracture energy, and improves compressive strength with 1.5% and 3%, tensile strength was improved with all percentage of amounts of LLDPE. fracture toughness and dynamic Young's modulus were not improved for lower dosages but slightly decreased for higher dosages of polymers.

Literature cited

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Acknowledgments

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