Development and Evaluation of Self-Consolidated High Strength Lightweigh Steel Fiber Concrete in UAE

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Summary

In this paper, development of self-consolidated high strength lightweight steel fiber concrete (SCHSLWSFC) with local materials in the United Arab Emirates is discussed. The experimenta investigation consisted of two phases. Phase I dealt with the development to achieve workability density, and strength targets with different steel fiber percentages. Evaluation of the mechanica properties was conducted in Phase II. Results from both phases showed that volumetric steel fiber percentages up to 0.65% could be used to achieve a SCHSLWSFC mix which has a 28-da compressive strength of 53 MPa (7600 psi) and density of 1950 kg/m3 (121 lb/ft^3). Results of th experimental investigation will be presented and discussed.

Keywords: Steel Fibers, Lightweight, Self-Consolidated, Concrete, Construction Materials

1. Introduction

Workability, durability, and strength are some of the challenges that face the utilization of lightweight aggregate in structural applications. Concrete with lightweight coarse aggregate provides many advantages, which include dead weight reduction, thermal insulation, and improved fire resistance. In addition, some design requirements lead to heavily reinforced and congested cross-sections, which demand higher flowable concrete. Self-consolidated concrete provides an ideal solution for strength and durability requirements in addition to higher flowability.

ACI 213R-03[1] and ACI 211.2-98/2004 [2] define structural high strength lightweight concret as the lightweight concrete that have a 28-day compressive strength of 40 MPa (6000 psi) or higher. In addition, concrete density should be in the range of 1120 and 1920 kg/m3 (70 and 12 lb/ft3). Several research efforts were directed to improve properties of lightweight aggregate concrete to meet the structural and design requirements. Adding steel fiber to lightweight concrete will improve compressive strength, tensile strength, cracking and post-cracking behavior.

To have a better understanding of the mixture to be developed a thorough research was conducted for each individual property that was included in the mix: Lightweight Concrete, Self Consolidated Concrete and Fiber Reinforced concrete. Through this procedure the advantages

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and limitations of each concrete type was clear and taken into consideration during the development phase. A brief discussion is included in the following subsections:

2. Experimental Procedure

The main objective of the experimental investigation is to develop a SCHSLWSFC mix to achieve 40 MPa compressive strength or higher and density less or equal to 1950 kg/m^3 ACI [1 Five volumetric ratios; 0.25%, 0.5%, 0.75%, 1.0% and 1.25%; of the steel fibers where used i the evaluation. Workability, steel fiber volume and fresh unit weight were determined during fresh stage evaluation. For hardened stage; compressive strength, flexural strength and dry un weight were used as evaluation criteria.

3. Discussion

The five selected increments of steel fiber percentages,0.25%, 0.5%, 0.75%, 1.00% and 1.25% were evaluated and test results were analyzed to determine the steel fiber percentage that coul be used to achieve a compressive strength of 40 MPa and a unit weight less than 1950 kg/m Analysis of the results "Strength vs. Unit Weight" and "Strength vs. Fiber Percentage" showe that about 0.65% steel fiber could be used to achieve the target criteria.

Two mixes with 0.65% steel fiber were prepared and the fresh and hardened stage properties were evaluated. Table 4 provides a summary of the results.

Table 4: 0.65% Results Summary

Mix	28 Day Compressive Strength (MPa)	28 Day Flexural Strength (MPa)	28 Day Hardened Unit Weight (kg/m^3)	SCC	Actual Steel Fiber Volume
1	49.36	10.44	1955.2	Yes	0.63%
2	53.2	9.32	1961.5	Yes	0.55%

4. Concluding Remarks

Development of a self-consolidated high strength lightweight fiber reinforced concrete (SCHSLWSFC) mix was discussed. All mixes achieved the minimum strength requirement within the first week of curing. In addition, all mixes with up to 1% of steel fiber per volume achieved the target criteria, 40 MPa compressive strength and 1950 kg/m^3 dry unit weigh Analysis of the results showed that a 0.65% steel fiber could be used to meet both target strengt and dry unit weight. Additional mix was prepared with the suggested steel fiber percentage 0.65%) and the target criteria were achieved. In general, addition of steel fiber improved th mechanical properties of the concrete. It is important to note that all materials used in the development of the SCHSLWSFC mix could be found easily in the United Arab Emirates.