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Analysis of the Mechanical Properties of Tin fibers on Concrete

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Abstract: *This work on analysis of the mechanical Properties of Tin fibers on concrete is based on experimental investigationcarried out on various percentages of Tin fiber and Concrete mixture. The use of concrete is influenced by its high resistance to compressive load and low resistance to tensile force, however, the composite of concrete and tin fiber possesses a higher resistance to tensile force when compared to the non-composite concrete. The tin fibers when combined with concrete, links any crack created by tensile stress within the concrete and thwarts any widening that may tend to occur.These tin fibers derived from waste mineral cans have economic and environmental benefits; they improve the mechanical properties of concrete without increasing the cost of production while reducing the quantity of unused waste mineral cans in the environment. The analysis investigates the effect of introducing tin fibers into concrete on the three main mechanical properties of concrete which are Flexural Strength, Indirect Tensile Strength and Compressive Strength. These tin fibers where used at ratios of 1%, 2%, 3% and 4% by weight of Cement. The result obtained indicates a positive effect on Tensile and Flexural Strengths with a negative effect on Compressive Strength. The effects on Tensile and Flexural Resistances indicates a linear increase with addition of tin fibers.*

Keywords: *Tin fiber, Mechanical properties, Flexural strength, Tensile strength, Compressive strength, Concrete.*

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I. Introduction

The ever increasing agricultural and industrial wastes in our society has become a major source of concern to environmentalist and researchers generally. One seamless way of reducing these wastes is to find a use for them, thus the use of Tin Fibers in Concrete.

The effect of fibers on the properties of concrete had been a research point for many scientist who sort to investigate its mechanical properties. These fibers are used as additives either alone or along other cementing materials. In either of the cases, the fibers has been known to improve significantly the mechanical properties of concrete [1]. In all the researches, the researchers agreed that Tin Fibers in Concrete increases the flexural and tensile resistances significantly [3,7], but have varying opinions on the compressive strength. Some researchers claim that tin fibers increases the compressive strength [2,5], while others are of the opinion that tin fibers reduces the compressive strength of concrete [4,7].

II. Experimental Setup

The experimental setup involved the testing of a total number of 50 specimens of tin fiber concretes; where three mechanical property tests were carried out on them. The test are namely flexure test, tension test and compression test. The specimens were of specific shapes according to testing requirements. Prisms with dimensions of $60 \times 10 \times 10\ cm$were used to measure the flexural strength; cylindrical specimens of $20 \times 35\ cm$ dimensions were used in measuring the tensile strength while cubic shaped specimens of $20 \times 20 \times 20\ cm$ dimension were used in measuring the compressive strength. Concretes with additives of tin fibers of different ratios to cement weight were casted to investigate the effect of these tin fiber additives on the mechanical properties of concrete. The tin fibers were added to the concrete as a percentage of the cement weight, these fibers were used at ratios 1%, 2%, 3% and 4% of the cement weight. A control specimen was used which had no fiber additive. Figures 1 and 2 below shows the flexure and tension tests respectively.

Figure 1: Flexure test

Figure 2: Split tension test

III. Materials

The materials used in this investigation were first tested to ensure they satisfied the Nigerian Society of Engineer's specifications.

Unicem cement of grade 32.5 produced by United Cement Company was used in all the mixes. The testing of the cement was done according to the specifications of the Nigerian Society of Engineers.

The coarse aggregate adopted in this investigation is crushed dolomite which has a specific gravity of 2.60 as measured. The coarse aggregates were washed and dried naturally over a 24 hour period to avoid fine material effects in the coarse. These coarse aggregates used were gotten from Akamkpa in Cross River State of Nigeria, there nominal maximum size is 14mm.

Natural siliceous sand with 2.50 fineness modulus was used in the specimen mixture.

The tin fibers used in this work were gotten from mineral can wastes. They were shredded into strips of definite length of 50mm and width of 5mm which resulted in an aspect ratio of 10. These shredded fibers were washed and dried naturally before using them as additives in the concrete mixture specimens. The water used in this work for mixing and curing the specimen for the 28-day mortar prime strength was gotten from the Calabar Municipal water supplied by the Cross River State Water Board LTD. Figure 3 and 4 below shows the washed tin fibers and the concrete mix with fiber additives respectively.

Figure 3. Tin fibers

Figure 4. Tin fibers in concrete

IV. Results And Discussion

Flexural strength

The flexural strength test results of the mixes with different ratios of fibers showed a significant increase in the flexural strength of the specimens as compared with the control specimen. The mix with 1% tin fiber additive had an increase of 5% in its flexural strength, while the mix with 2% tin fiber additive had an increase of 8% in its flexural strength. The highest increase in flexural strength was obtained when the tin fiber additive was 4% and that corresponds to an increase of 15.2% in flexural strength. Table 1 below shows various flexural strength of the different specimen mix. Similarly, figure 5 shows the effect of using fiber additives of various ratios on the flexural strength of concrete.

Tensile strength

Split tension test was used to measure the tensile strength of the mixes with different ratios of fiber additives. Results obtained showed that the addition of tin fiber additives increased the tensile strength and the percentage of increase appreciates as the ratio of the tin fiber additive increases. Table 2 below shows the indirect tensile strength of different mix of specimens, while figure 6 shows the effect of tin fiber additive of various ratios on the indirect tensile strength of the specimens.

Table 1: Flexural Strength

Configuration	Specimen Number	Flexural Strength (Mpa)	Average Flexural Strength (Mpa)
Control	1	8.84	8.93
	2	8.6	
	3	9.34	

F-1%	1	8.92	9.17
	2	9.43	
	3	9.17	
F-2%	1	9.21	9.32
	2	9.12	
	3	9.63	
F-3%	1	9.33	9.72
	2	9.51	
	3	10.32	
F-4%	1	9.53	10.06
	2	10.62	
	3	10.03	

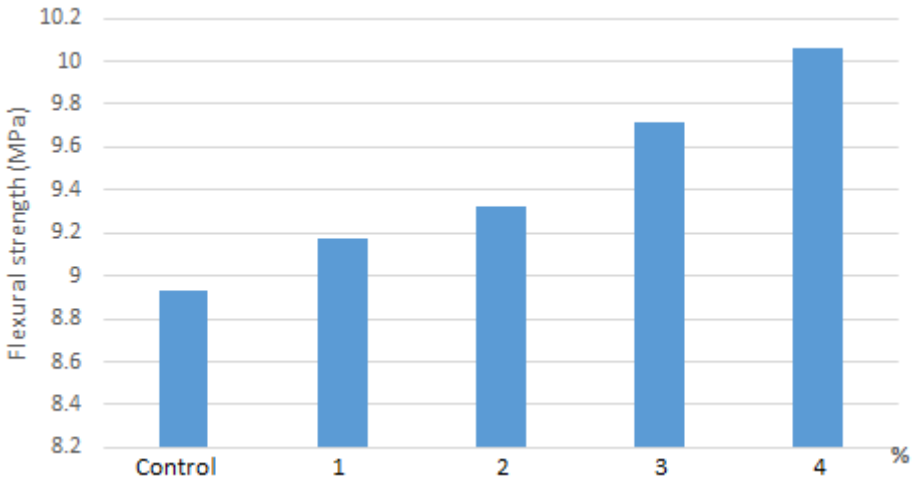

Figure 5: Flexural Strength

Table 2: Tensile Strength

Configuration	Specimen Number	Tensile Strength (Mpa)	Average Tensile Strength (Mpa)
Control	1	3.77	3.72
	2	3.6	
	3	3.8	
F-1%	1	3.74	3.82
	2	3.94	
	3	3.78	
F-2%	1	3.86	3.85
	2	3.79	
	3	3.91	
F-3%	1	4.22	4.15
	2	4.11	
	3	4.12	
F-4%	1	4.28	4.29
	2	4.23	
	3	4.35	

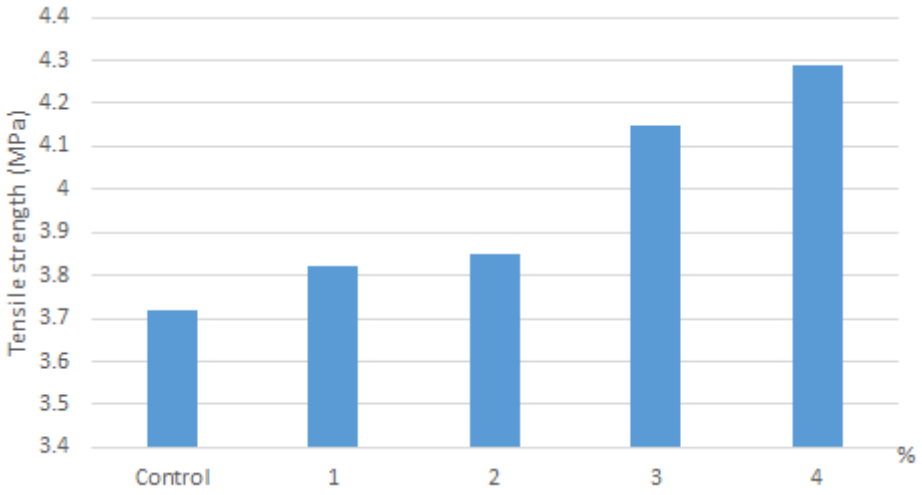

Figure 6: Tensile Strength

Compressive strength

After the 28-days mortar period, all the specimens with tin fiber additives showed a significant reduction in their compressive strength. The reductions in compressive strength varied with the various ratios of fiber additives, the higher the fiber additive, the more the decrease in compressive strength. This phenomenon is believed to be caused by the smoothness of the tin fibers employed. Ahmed [8] in his work suggested that twisting the fibers will reduce the rate at which the compressive strength is reduced because the twisted fibers will have a better bonding with the concrete. Table 3 below shows the compressive strength of the various specimens while figure 7 shows the effect of fiber additives on the compressive strength of concretes.

Table 3: Compressive Strength at 28-days

Configuration	Specimen Number	Compressive Strength at 28-days (Mpa)	Average Compressive Strength at 28-days (Mpa)
Control	1	34.30	34.90
	2	34.50	
	3	35.90	
F-1%	1	29.57	29.69
	2	30.24	
	3	29.26	
F-2%	1	21.97	27.32
	2	29.93	
	3	30.06	
F-3%	1	27.02	24.62
	2	23.57	
	3	23.28	
F-4%	1	27.13	24.51
	2	21.88	
	3	24.51	

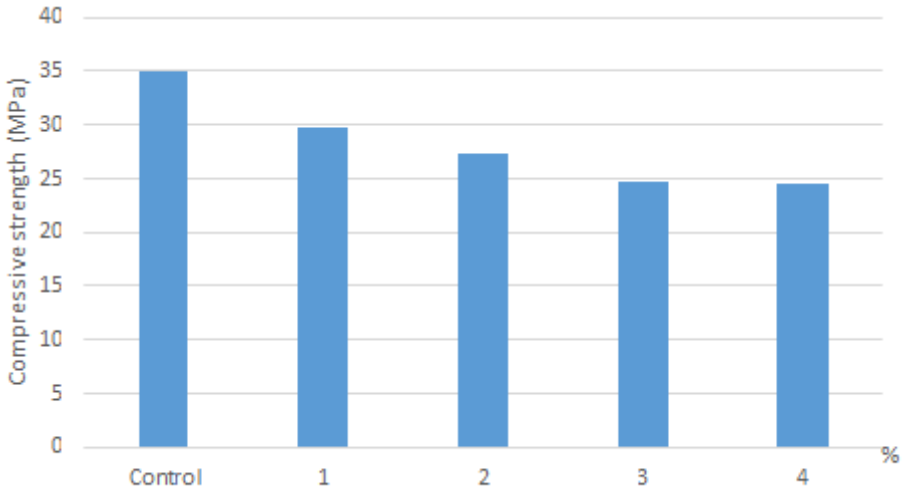

Figure 7: Compressive Strength at 28-days

V. Conclusions

Tin fibers gotten from shredding mineral can waste into strips with an aspect ratio of 10 were employed as additives to concretes at varying percentages which ranges from 1% to 4%. Results obtained indicates an increase in the flexural and indirect tensile strengths. On the other hand, there was a significant reduction in the compressive strength of all the samples. These reduction in compressive strength increased directly as the ratio of tin fiber additive increased.

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