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The Effect of Glass Fibers[GF] on Plain Concrete Strength

K. I . M. Ibrahim
Construction Engineering
Dept. , College of Engineering at Qunfudha ,
Umm-Al-Qura University- KSA on Sabbatical leave from higher Institute of Engineering and Technology of Kafr-EL-Shiekh – Egypt

***Abstract*: Concrete is a construction material which most usually used in the world. Fiber reinforced concrete[FRC] is a special concrete in which small and irregular fibers are dispersed homogeneously. The fibers used in FRC may be of dissimilar materials like carbon, steel, polypropylene, glass, asbestos, aramid. The adding of these fibers into concrete can noticeably increase the flexural strength compressive strength, tensile strength, and impact strength of concrete. FRC has found a lot of applications in the field of civil engineering. This work investigates The Influence of glass fiber [GF]content on Concrete Strength . Concrete mixes having a fixed water/cement ratio equals 0.5 and a constant cement content equals 350kg/m3are prepared. GF with 18mm length and four volume fractions of 0%, 0.03%,0.06% and 0.09% are used. The results illustrate that The adding of GF gave a optimistic influence on the strength of plain concrete.**

Keywords: Glass Fibers ,Compressive Strength, FRC, Flexural Strength And Tensile Strength

INTRODUCTION

Concrete is characterized by brittle fracture, the almost total loss of loading capability once failure is initiated. This characteristic which limits concrete using can be overcome by adding a little amount of short arbitrarily distributed fibers (glass ,steel , natural and synthetic) and can be practiced between others that remedy weaknesses of concrete, as low development resistance, little durability, large shrinkage cracking, , etc [1]. The durability and concrete strength can be altered by making appropriate changes in its ingredients like aggregates, cemetitious material, and water and by adding some particular ingredients [2]. The existence of micro cracks at the mortar-aggregate boundary is responsible for the intrinsic weakness of plain concrete. The plain concrete weakness can be finished by fibers inclusion in the mixes [3]. Different types of fibers, as those used in traditional composite materials have been distributed into the concrete mixture to enhance its toughness, or capability to resist crack development. The fibers aid to transport loads at the inner micro cracks. Such a concrete is named fiber reinforced concrete (FRC). Thus FRC is considered a composite material basically consisting of usual concrete or mortar reinforced by fine fibers [4]. The fibers interlock and catch up around particles of aggregates and significantly reduce the workability, while the mix becomes extra cohesive and less prone to segregation. The fibers are dispersed and spread randomly in the concrete during mixing and thus enhance concrete properties in all directions. Fibers help to enhance the fatigue strength, ductility performance, impact strength ,pre-crack tensile strength, abrasion resistance, and remove shrinkage and temperature cracks [5].therefore, this work explores the using possibility of glass fibers ,try to do parametric study on tensile strength, compressive strength, and bending strength for various percentages of glass fiber. currently, a number of laboratory experiments on GFRC mechanical properties have been done. Chandramouli et al (6) had conducted experimental study to learn the using effect of the alkali resistance glass fibers on flexural strength, compressive strength and tensile strength on M20, M30, and M40 concrete grades . The glass fiber reinforced polymer concrete mechanical properties were evaluated. The author noticed that the rupture modulus of polymer concrete containing about 20 %polyester resin and approximately 80% fine aggregate is approximately 20 MPa. The about 1.5 % chopped glass fibers (by weight) addition to the material growths the rupture modulus by approximately 20 %and the fracture toughness by about 55% . Muthuswamy (7) described the experimental study on hybrid fiber reinforced high performance concrete[HFRHPC] using three fibers types namely, polyester, steel and glass of fibers .Silica fume was used as a mineral admixture to partially replace the cement in concrete and a super plasticizer was added to get the preferred workability. A comparison with plain concrete and steel fiber reinforced concrete[SFRC] showed significant enhancement in the strengths of SFRC because of adding fibers and silica fume.

II. MATERIALS

A local materials were used in all concrete mixes and experienced in relation to Egyptian Standard Specifications (ESS) and American Standard of Testing Materials (ASTM) . Gravel was used as a coarse aggregate with 25mm maximum size and its particle shape was roughly round . In this research, the used fine aggregate was natural sand and it composed primarily of siliceous material . Portland Cement was used and tested to assure its agreement with ESS 373-1991.supper-plasticizer was used to remain the water cement ratio equals to 0.50 with slump [6-12cm]. the used glass fibers(GF) were 18mm length.

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III. CONCRETE MIXES PROPORTION

Table (1) : Concrete Mixes Proportion

Mix no.	Fiber type	Fiber content %	Cement kg/m^3	Gravel kg/m^3	Sand kg/m^3	Water kg/m^3	Super-plasticizer kg/m^3
1	glass	0	350	1261	631	175	2.1
2	glass	0.03	350	1261	631	175	2.45
3	glass	0.06	350	1261	631	175	2.8
4	glass	0.09	350	1261	631	175	3.15

4 mixes were prepared as following , the first mix not including glass fiber[GF]s as a reference mix ,the other 3 mixes were with dissimilar contents of GF[0.03%,0.06%,0.09%] to study fiber content effect on the flexural compressive , tensile concrete strengths . These mixes are the same except for the volume of percentage of fibers. For all mixes, water/ cement ratio was 0.50 ,the cement content was 350 kg/m3and. Super-plasticizer was also used to keep the slump equals to 6-11 cm.

VI. DESCRIPTION OF TESTED SPECIMENS

24 cubes of 15x15x15cm sides ,24 cylinders of 15 cm diameterx30cm height and 24 beams of 10x10x50cm dimensions were prepared for compressive strength , tensile strength and flexural strength .Concrete mixes were poured and were compacted for ensuring from concrete complete compaction inside the forms

V. TEST RESULTS

Table(2): Compressive strength results

GF content %	Compressive strength kg/cm^2	
	7 days	28 days
0	224[control]	284[control]
0.03	250[+12%]	305[+7%]
0.06	254[+13%]	332[+17%]
0.09	259[+15%]	347[+22%]

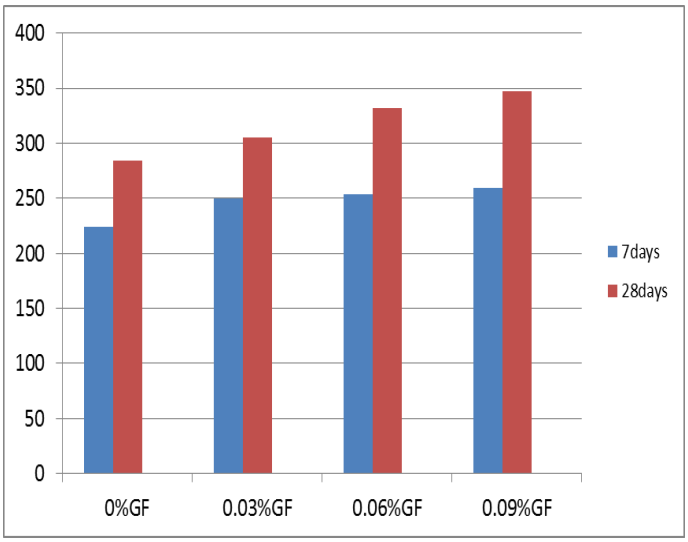

Fig.(1) : The GFRC compressive strength (kg/cm2)

Table (3): Split tensile strength results

GF content %	Split strength kg/cm^2	
	7 days	28 days
0	16[control]	19[control]
0.03	20[+25%]	25[+32%]
0.06	25[+56%]	32[+68%]
0.09	28[+75%]	38[+100%]

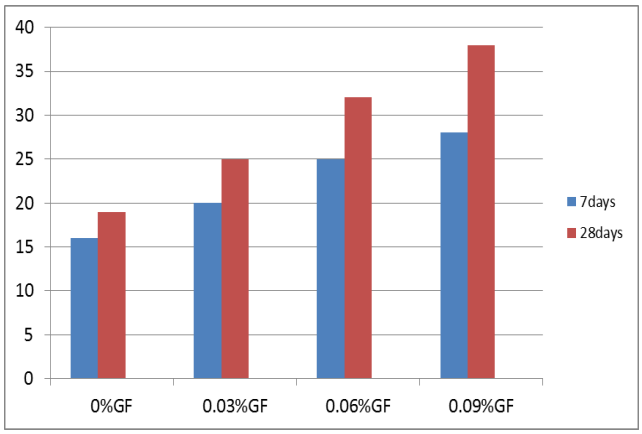

Fig.(2) : The GFRC tensile strength (kg/cm2)

Table (4): Flexural strength results

GF content %	Flexural strength kg/cm^2	
	days7	days 28
0	[control]34	[control]43
0.03	[+18%]40	[+12%]48
0.06	[+35%]46	[+42%]61
0.09	[+56%]53	[+60%]69

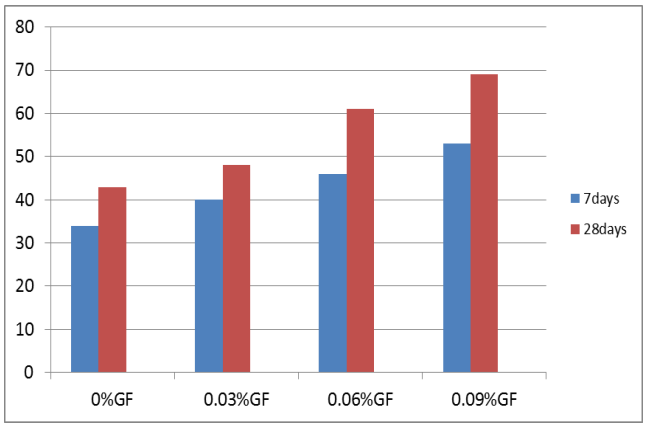

Fig.(3) : The GFRC flexural strength (kg/cm2)

From Tables[2,3,4] and figures [1,2,3], it is apparent that the control concrete compressive strength at 28 days is 27 % upper than that at 7 days strength and that of GFRC were 22%,31% and34% for GF content equals to[0.03%,0.06% and 0.09%] respectively. The 28 days GFRC compressive strength increases with approximately 7%,17% and22% for GF content equals to[0.03%,0.06% and 0.09%] respectively with comparison to plain concrete. Therefore reinforcing with GF contributes greatly in improvement the plain concrete compressive strength. Also, the plain concrete[without GF] tensile strength was 24 % upper than that at 28 days strength as compared to 7 days strength. The tensile strength of GFRC at 28 days was approximately 32%,68%

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and 100% upper than that of plain concrete for 0.03%,0.06% and 0.09% of fiber content respectively. The flexural strength of GFRC at 28 days was approximately 28 % bigger than that strength at 7 days. The increase in GFRC flexural strength at 28 days ranges from 12 % to 60%. These results establish the supremacy of GFRC.

VI. CONCLUSIONS

1. With 0.03 % GF addition , the compressive, tensile and flexural strengths increase was approximately 7% , 32% and 12% respectively over plain concrete.
2. With 0.06 % GF addition , the compressive, tensile and flexural strengths increase was approximately 17% , 68% and 42% respectively over plain concrete.
3. With 0.09 % GF addition , the compressive, tensile and flexural strengths increase was approximately 22% , 100% and 60% respectively over plain concrete.
4. Therefore reinforcing with GF greatly contributes in improvement the plain concrete strength .

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