

EFFECT OF SILICA FUME ASH AND GRF ON THE STRENGTH AND DURABILITY PROPERTIES OF CONCRETE

Er. K. Pradeep¹, Dr. R. Viji²

¹PG Student, Department of Civil Engineering, University College of Engineering (BIT- Campus), Tiruchirappalli, Tamilnadu, India,

²Assistant Professor, Department of Civil Engineering, University College of Engineering (BIT Campus), Tiruchirappalli, Tamilnadu, India

Abstract - This paper deals with the durability of concrete and how the durability changes when the silica fume and glass reinforced fiber are added. Durability is defined as the ability of concrete to resist chemical attack and weathering action. The primary factor that affect the durability of the concrete is water cement ratio, temperature, age and curing of concrete. Along with conventional materials glass reinforced fiber and silica fume ash were added in proportion. The results were obtained using rapid chloride permeability test and water absorption test. In every ratio three set of samples were made and the average is taken. In first ratio Cement-80%, Silica Fume Ash-10%, Glass Reinforced Fiber-10% is taken and analysed. In second ratio Cement-90%, Silica Fume Ash-5%, Glass Reinforced Fiber-5% is taken and finally Cement-70%, Silica Fume Ash-20%, Glass reinforced Fiber-10% is taken and the comparative study is made. Water absorption test is also conducted and compressive strength is found.

Key Words: Compressive Strength; Durability; Silica fume; Rapid chloride permeability; water absorption

1. INTRODUCTION

Silica fume ash which is also known as micro silica is an amorphous polymorph of Silicon di oxide. It is non crystalline in nature. It is a by-product in the form of ultra-fine of the ferrosilicon alloy production and silicon production. The main field of application is as pozzolanic material for top performance concrete. Silica fume ash is an ultra-fine material with spherical particles less than 1µm in diameter and average being 0.15µm. The specific gravity range from 2.2 to 2.3. Silica fume ash is added to Portland Cement Concrete to improve its properties, in particular its bond strength, abrasion resistance and compressive strength.

Glass fibre-reinforced concrete consists of high-strength, alkali-resistant fibre embedded in a very concrete matrix. In this kind, every fibres and matrix retain their physical and chemical identities, whereas giving a synergistic combination of properties that can't be achieved with either of the elements acting alone. In general, fibres square measure the principal load-carrying members, while the surrounding matrix keeps them in the desired locations and orientation, acting as a

load transfer medium between the fibers and protective them from environmental injury.

The fibers provide reinforcement for the matrix and completely different useful functions in fiber-reinforced composite materials. Glass fibres is incorporated into a matrix either in continuous or discontinuous (chopped) lengths. Durability was poor with the initial quite glass fibers since the hydrogen ion concentration of cement reacts with its oxide. In the Nineteen Seventies alkali-resistant glass fibers were commercialised. Alkali resistance is achieved by adding zirconium dioxide to the glass. The higher the zirconium dioxide content the higher the resistance to alkali attack. The best fibers have zirconia contents of 19% or higher. The design of glass-fiber-reinforced concrete panels uses a information of its basic properties beneath tensile, compressive, bending and shear forces, let alone estimates of behavior beneath secondary loading effects like creep, thermal response and moisture movement. Glass-reinforced fiber concrete architectural panels have the general appearance of pre-cast concrete panels, but differ in several significant ways. For example, the GRF panels, on average, weigh substantially less than pre-cast concrete panels due to their reduced thickness. Their low weight decreases hundreds superimposed on the building's structural elements creating construction of the building frame additional economical. This paper presents the results of an investigation on the strength and durability properties of concrete containing silica fume. The strength properties studied include both the compressive and splitting tensile strength, whereas the durability properties studied include RCPT and water absorption.

2. EXPERIMENTAL PROGRAMME

2.1 Materials:

Ordinary Portland cement, Silica Fume Ash and Glass Reinforced Fiber are the important materials required for conducting this experiment. Besides this coarse aggregates and fine aggregates are used as per the usual procedure. The usual range of coarse aggregate used for concrete are 9mm to 35mm in diameter whereas the fine aggregates are the materials which retains under 4.75mm size sieve.

Table 1: Chemical composition of cement, silica fume ash and GRF

Oxides (%)	OPC	Silica Fume	GRF
Na ₂ O Equivalent	0.49	0.005	0.7
SiO ₂	20.1	97	62
Chloride	0.08	0.09	0.5
CaO	63	-	22
Al ₂ O ₃	4.2	-	12
MgO	1.5	-	5
SO ₃	3	0.1	3
Fe ₂ O ₃	2	-	2.3
LOI	2.9	1.6	1.5

Table 2: Mix proportions

MIX ID	OPC (%)	SF (%)	GRF (%)	W/c ratio	Slump(mm)
C80S10G10	80	10	10	0.30	66
C90S5G5	90	5	5	0.30	68
C70S20G10	70	20	10	0.30	70

2.2 TEST METHODS

The important tests required to conduct this experiment are:-

- Compressive Strength Test
- Tensile Strength Test
- Rapid Chloride Penetration Test
- Water absorption Test

3. RESULTS AND DISCUSSION

3.1 Compressive Strength of Concrete

Compressive strength is defined as the ability of the concrete to withstand the load applied. Achieving a highly compressive concrete is a challenge now a days. One of the major important engineering property of concrete is Compressive Strength. The compressive strength is usually expressed in terms of characteristic strength. IS 516 is the standard used for doing compressive strength of concrete. Three different types of mix are taken as explained in the mix proportion table.

Table 3: Compressive Strength Results

Grade of concrete	Mix ID	Compressive Strength(N/mm ²)		
		7 days	14days	28days
M20	C80S10G10	14.5	23	27.5
	C90S5G5	16.2	19.8	26.6
	C70S20G10	20.1	28.9	33.5

3.2 Tensile Strength of Concrete

Tensile strength is an important property of concrete. But tensile strength is very low when compared to compressive strength. Here Split tensile strength is conducted for our paper. IS5816 is the standard followed for conducting split tensile strength of concrete. Concrete usually have less tensile strength as per his property, that concrete is strong in tension and weak in compression. As explained in Mix design table three different proportion of sample are taken and the test is conducted.

Table 4: Split Tensile Strength of Concrete:

Grade of concrete	Mix ID	Split Tensile Strength(N/mm ²)		
		7 days	14days	28days
M20	C80S10G10	2	2.8	3.6
	C90S5G5	2.2	2.9	3.9
	C70S20G10	3.5	4.1	4.9

3.3 Rapid Chloride Penetration Test

Chloride attack is an important property that deal with the durability of concrete. The important test that we have to conduct for checking the durability of concrete is Rapid Chloride Permeability Test. The same three mix are taken, but this time the mix is taken three times and the test is done and the average value is obtained, so it makes the test more precise. American Society for Testing and Materials (ASTM) C1202 is followed for conducting rapid chloride permeability test. The result of RCPT test is obtained in columns

Table 5: Rapid Chloride Permeability Test of Concrete:

Grade of concrete	Mix ID	RCP(Columbs)			
		Sample I	Sample II	Sample III	Average
M20	C80 S10 G10	3450	3344	3412	3402
	C90 S5 G5	3100	3034	2999	3044
	C70 S20 G10	2800	2811	2777	2796

Reinforced with Silica Fume Ash". IJETAE and ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 5 and Issue 5

- 4) ASTM 1585-13 Standard Test Method for Measurement of Rate of Absorption of Water by Hydraulic-Cement Concrete
- 5) Siddiue, R., Utilisation of silica fume in concrete: Review of hardened properties, Resource, Conservation and Recycling 2011;55:923-932
- 6) Poon, C.S., Kou, S.C., Lam, L., Compressive strength, chloride diffusivity and pore structure of high performance met kaolin and silica fume concrete. Constr. Build. Mater. 20(10), 858-865(2006)

3.4 Water Absorption Test

Water absorption test is an important test conducted for checking the durability of the concrete. As the silica fume ash is increased the water absorption is reduced. The water absorption test is done for 28 days and the strength is checked. The water absorption is high for Mix ID C90S5G5 and medium for C80S10G10 and high for C70S20G10. IS1124 is the Indian Standard followed for Water Absorption Test.

4. CONCLUSIONS:

Based on this research, the following conclusion can be made:

- (i) Silica fume ash is a by-product which is effectively used.
- (ii) Based on the compressive strength test results it is understood that C70S20G10 is good and effective.
- (iii) Split Tensile strength express the same mix is good to adopt as per the compressive strength.
- (iv) As per the water absorption test and rapid chloride permeability test the durability is effectively increased when we introduce silica and glass reinforced fibre.

5. REFERENCES:

- 1) AS 1210.10-2000 Methods of testing concrete- Determination of indirect splitting tensile strength of concrete cylinder tests
- 2) AS 1012.19-1999 Methods of testing concrete- Determination of compressive strength of concrete specimens
- 3) Rafik K. Abd-ELwahab, Ahmed S. Elamary (2015), "Ductile Failure of Concrete Beam