SULPHATE RESISTANCE OF TERNARY BLENDED FIIBER REINFORCED CONCRETE

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ABSTRACT

Concrete is most used construction material because of ease of construction and its properties like compressive strength and durability. It is difficult to point out another material of construction which is versatile as concrete. It is well known that plain concrete is not good to sulphate resistance

Most of the soils contain some sulphate in the form of calcium, sodium, potassium and magnesium. Higher concentration of sulphate in ground water is generally due to the presence of magnesium and alkali sulphates. Sea water contains the sodium, magnesium and calcium sulphate in the dissolved form. Sulphate is the common occurrence in sea water environments.

Several admixtures have been developed to improve the strength and workability properties of concrete, of all admixtures used in concrete micro silica occupies a special position for a quite reasons as follows. The improvement in durability resistance to chloride, sulphate, freezing and thawing, alkali aggregate reaction, frost attack, increase in compressive strength, reduces the permeability and bleeding. Micro silica effectively improve the structure of interface eliminate the weakness of the interfacial zone. In the past, attempt has been made to improve sulphate resistance of concrete.

This paper reports the results from laboratory studies on the durability of concrete that contains terinary blends of Portland cement, micro silica and flyash. Concretes made with these proportions generally show excellent fresh and hardened properties since the combination of micro silica and flyash is somewhat synergistic. For instance, flyash appears to compensate for some of the workability problems often associated with the use of higher levels of micro silica, whereas the micro silica appears to compensate for the relatively low early strength of fly ash concrete. Furthermore, these data indicate that the diffusivity of the concrete that contains ternary blends continues to decrease with age.

INTRODUCTION

According to the U.S Geographic Service in 2006, approximately 7.5 cubic kilometers of concrete is produced every year, and thus, it is the most used human made construction material in the world. It is interesting to note that the word ‗concrete‘ comes from the Latin word ‗concretes‘ which means compact or condensed. This material is generally highly durable and can be made to possess superior mechanical properties, such as high compressive and flexural strengths. It is typically made out of Portland cement, supplementary cementations material, Water, aggregates, and depending on its application and the requirements of a specific project, different types of chemical and mineral additives may be used in its production.

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Most of the soils contain some sulphate in the form of calcium,sodium,potassium and magnesium. Higher concentration of sulphate in ground water is generally due to the presence of magnesium and alkali sulphates. Sea water contains the sodium, magnesium and calcium sulphate in the dissolved form

When it comes to resistance to different types of chemicals, the durability of concrete is quite influenced by its manufacturing process (curing methods, finishing, etc.) and the materials that are used. Moreover, if sufficient research and studies have not been previously performed, the produced concrete may not meet the durability parameters for specific environmental conditions and subsequently, the result of its application may be disastrous.

Although most concrete structures have considerable long life expectancies, there are also a significant number of infrastructures in the world, such as wastewater systems,underground structures, coastal works which are constantly under corrosion from different types of chemicals, such as sulphates like magnesium sulphate. Unfortunately, this continuous invasion and ingression of sulphate ions into concrete can ultimately lead to serious damages to structures, which will consequently result in costly repairs or in some cases, complete replacement of the Whole structure.

Concrete exposed to sulfate solutions can be attacked and may suffer deterioration to an extent dependent on the concrete constituents, the quality of the concrete in place and the type and concentration of the sulfate. Knowledge of the sulfate-resisting characteristics of concrete is necessary so that the appropriate steps can be taken to minimize the deterioration of concrete exposed to sulfate solutions.

Other protection systems, such as coatings and liners, can be used to protect the concrete surface from diffusion of sulphate ions into concrete and subsequently, serious damage. The problem with the coatings is that they are costly and must be applied with great skill and accuracy. Thus, avoiding any uncovered areas that may be susceptible to the ingression of sulphate ions, which would cause further degradation is crucial. It has been proven that liners are effective in corrosion protection and frequently used in the past, but they have some limitations depending on the diameter and design of the sanitary utilities. The problem with liners is that the installation must be done very carefully with great accuracy;

Otherwise, they can be completely useless. As depicted in Figure 1.1, liners may also delaminate and grow thin over time, which result in huge expenses in repairs and restorations (Ramsburg 2004).

Figure 1. Delaminated liners of a sewer manhole (Ramsburg 2004).

LITERATURE REVIEW:

1) International journal of civil and structural engineering. Volume 2, No 1, 2011 © Copyright 2010 All rights reserved Integrated Publishing services Research article ISSN 0976 – 4399- Effect of replacement of Cement by Micro silica – in Sulphate resistance of concrete (WPFRC) Concrete – An experimental investigation-by Prahallada M. C1, Prakash K.B2.

   Conclusion: The maximum replacement of microsilica is of 10% for M30 grade Concrete.

2) IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 6, Issue 4 (May. – Jun. 2013), PP 57-63 www.iosrjournals.org www.iosrjournals.org 57 | Page Experimental -Investigations of Mechanical properties on Micro silica (Silica Fume) and Fly Ash as Partial Cement Replacement of sulphate resistance Concrete –by-Magudeaswaran P1, Eswaramoorthi P2.
   Conclusion : Due to use of the micro silica in a OPC concrete the life of that Concrete is increase 4-5 times than the OPC concrete

3) Dikeon JT, "Fly Ash Increases Resistance of Concrete to Sulphate Attack", United States Department of the Interior, Bureau of Reclamation, *Research Report No 23*, US Government Printing Office, 1975.
   Conclusion: *Reduced expansion of concretes containing 30% fly ash and improved sulphate resistance afforded by fly ash use.*

4) Dunstan ER, "A Spec Odyssey – Sulphate Resistant Concrete for the 80's", United States Department of the Interior, *Water and Power Resources Service*, March, 1980.
   Conclusion: Flyash reduces the susceptibility of concrete to attack by Magnesium sulphate by removal of Ca(OH)2.

5) Franklin eric kujur, Vikas Srivastava, V.C. Agarwal, Denis and Ahsan Ali (2014) –Stone dust as partial replacement of fine aggregate in concrete‖, Journal of academia and industrial research, volume 3, issue 3, pp 148-151.
   CONCLUSION :Optimum replacement level of natural river sand with stone dust is 60%. However , strength of concrete made using stone dust is higher at every replacement level than the referral concrete.

6) Suribabu, U.Rangaraju, M. Ravindra Krishna (2015) "Behaviour of Concrete on Replacement of Sand with Quaries Stone Dust as Fine Aggregate", IJIRSET, Vol. 4, Issue 1, pp 18503-18510.
   CONCLUSION: Concrete acquires maximum increase in compressive strength at 60% sand replacement. The percentage of increase in strength with respect to control concrete is 24.04 & 6.10 in M30 and M35 respectively ACI Committee 544, State-of-The-Art Report on Fiber Reinforced Concrete, ACI 544 1.R-96
   Conclusion: The compressive strength, split tensile strength, flexural strength and modulus of elasticity increase with

the addition of fiber content as compared with conventional concrete.

7) Peng Zhang and Qingfu Li (2013) ‗Fracture Properties of Polypropylene Fiber Reinforced Concrete Containing Fly Ash and Silica Fume', Research Journal of Applied Sciences, Engineering and Technology 5(2): 665-670, 2013.

CONCLUSION: The durability of concrete improves and addition of polypropylene fibers greatly improves the fracture parameters of concrete .

Material used & Experimental investigations:

Cement:53 grade OPC cement is used in this project. The various tests results are represented in the table 1

Fly ash: It constitutes 30% weight of cement. Normally fly ash is produced from coal and ignite fired plant. Both the fuels leave around 30 to 45% of their weight as waste material in the form of ash. In the present investigations fly ash from National Thermal Power Corporation RAMAGUNDAM is used.Due to spherical shape of flyash particles,it can increase workability of cement while reducing water demand. Puzzoloana character of flyash helpsto produce high rate of hydration and resistance to sulphate attack.

Two kinds of Fly ash are produced from the combustion of coal:

- Class C -High, more than 10% ,calcium content produced from sub-bituminous coal
- Class F –Low ,less than 10% ,calcium content produced from bituminous coal

Fly ash shall confirm to Grade 1 or Grade 2 of IS 3812-1981.

FLYASH

MICRO SILICA:

It constitutes 10% of weight of cement. Silica fume is the by-product of silicon metal and ferrosilicon alloys. This product, which is also known as micro silica, is famous for its great fineness and high silica content. Silica fume has a very high surface area and from a pozzolanic point of view, is very active. It has been many years since this product was used for the first time in concrete and it has successfully enhanced the properties of concrete, such as strength, abrasion and microstructure. It should be noted that in terms of resistance to sulphate ions penetrations, silica fume will significantly improve the concrete performance. However, when it comes to concrete resistance to sulphates, there are different opinions about the effectiveness of this type of SCM. For example, Durning et al. (1991) reported that silica fume would improve the resistance of concrete against a 5% magnesium sulphate solution by refining the pore structure and reducing the amount of Ca(OH)2. They also found that the C-S-H formed in the concrete which contains silica fume is more stable in low pH conditions.

MICRO SILICA

Comparision of chemical and physical characteristics

Components of cement, flyash, silica fume

Property	Portland Cement	Siliceous (ASTM C618 Class F) Fly Ash	Calcareous (ASTM C618 Class C) Fly Ash	Slag Cement	Silica Fume
SiO_2 content (%)	21.9	52	35	35	85–97
Al_2O_3 content (%)	6.9	23	18	12	—
Fe_2O_3 content (%)	3	11	6	1	—
CaO content (%)	63	5	21	40	< 1
MgO content (%)	2.5	—	—	—	—
SO_3 content (%)	1.7	—	—	—	—
Specific surface[b] (m^2/kg)	370	420	420	400	15,000–30,000

Specific gravity	3.15	2.38	2.65	2.94	2.22

STONE DUST:

It constitutes 60% of fine aggregate. . Stone crusher dust, which is available abundantly from crusher units at a low cost in many areas, provides a viable alternative for river sand in concrete. The investigations indicate that stone crusher dust has a good potential as fine aggregate in concrete construction. Use of Stone crusher dust does not only reduces the cost of construction but also helps reduce the impact on the environment by consuming the material generally considered as waste product with few applications. The investigations indicated that stone crusher dust has potential as fine aggregate in concrete structures with a reduction in the cost of concrete by about 20 percent compared to conventional concrete. Crusher dust not only reduces the cost of construction but also the impact on environment by consuming the material generally considered as a waste product with few applications. Every year 200-400 tons of stone dust is g enerated by stone cutting plants and is dumped as waste . It produces good improvement in the strength properties, abrasion and durability of concrete.

Recron Polypropylene Fiber

Compressive Strength Results of Various Concrete Mixes:

Compressive Strengths of M30 Grade concrete before immersing in Sulphate solution:

TABLE

M30 (0.43:1:13:2.63)	Compressive strength (N/mm2)		
	3 Days	7 Days	28 Days
Normal	15.12	26.46	37.8
Replacement of cement and sand	16.32	27.74	40.8
Replacement of cement and sand and addition of fiber	17.77	31.1	44.44

Compressive Strengths of M35 Grade concrete Before immersing in Sulphate solution :

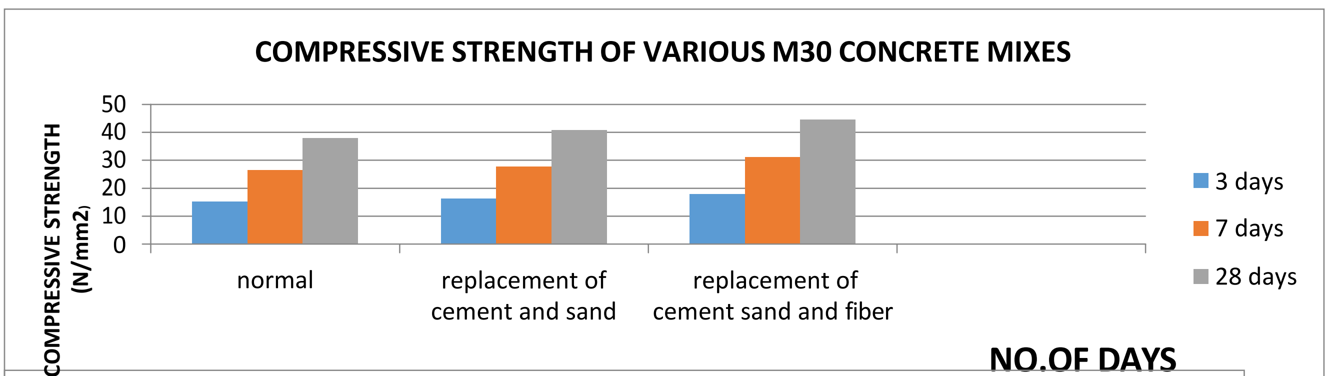
Weights of Rectangular Prisms before & After Immersion in Magnesium Sulphate:

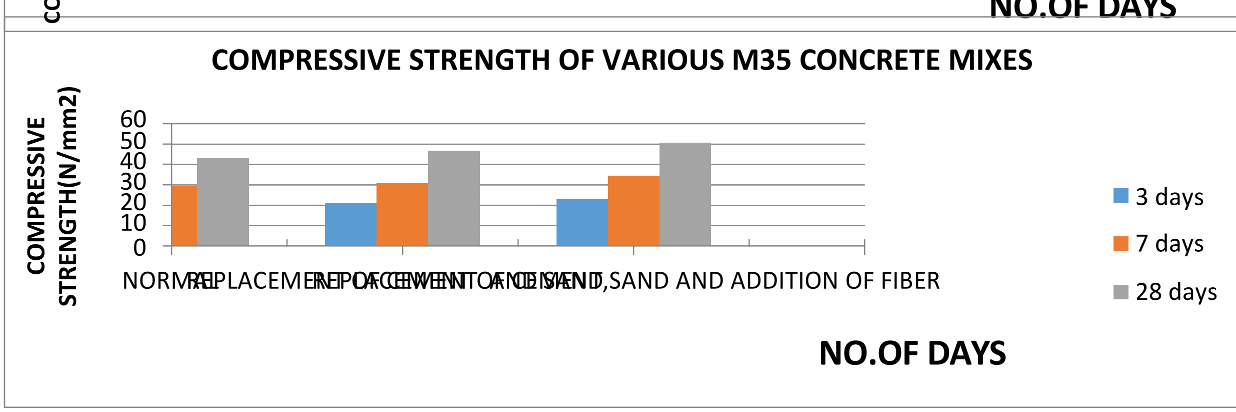
TABLE

Grade of concrete	Type of concrete	Weight(kg) 0 days	15 days	30 days	45 days
M30	NORMAL	12.08	12.08	12.07	12.04
	Replacement of cement and sand	12.02	12.025	12.025	12.00
	Replacement of cement and sand addition of fiber	12.00	12.00	11.99	11.98

Graphical Representation of Strength Results (Before Immersion In Magnesium Sulphate Solution):

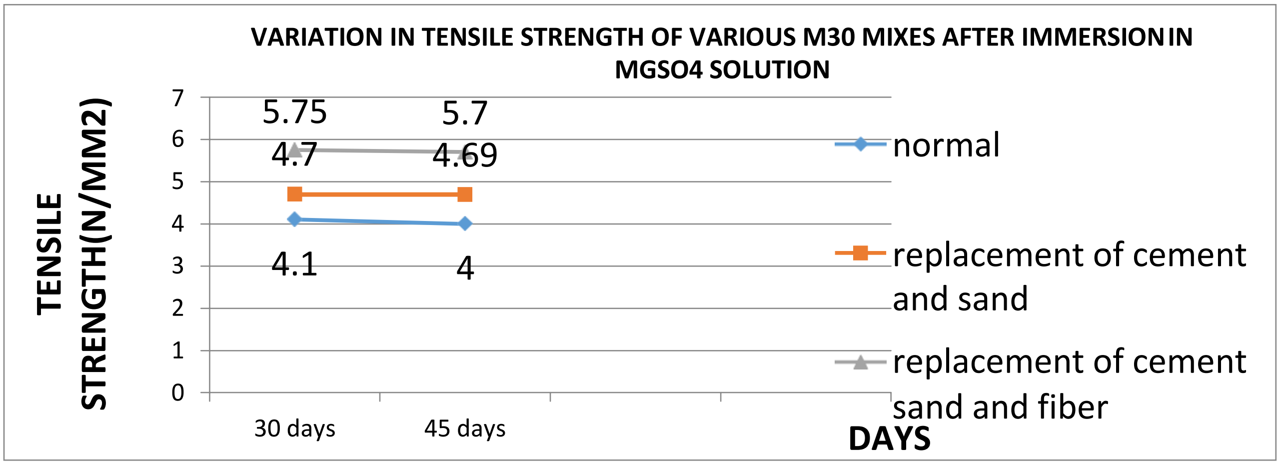
Compressive Strength:



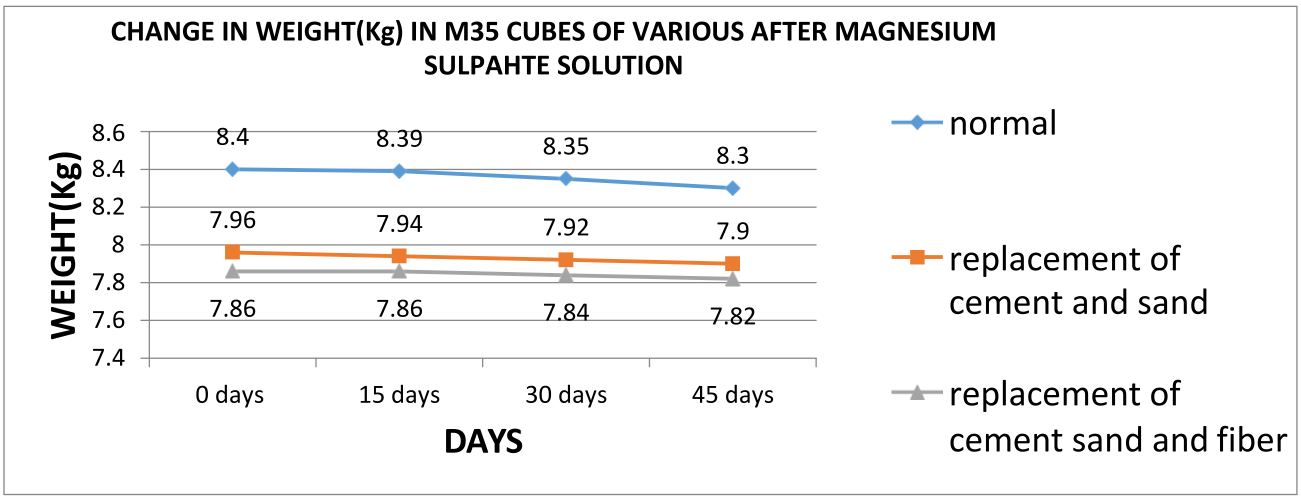


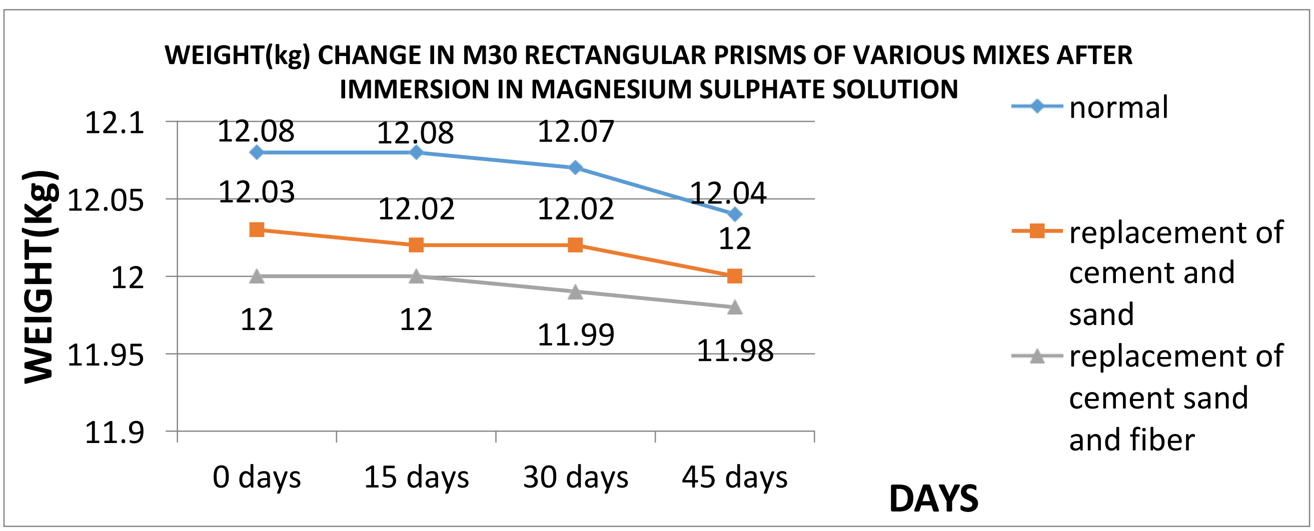
Graphical Representation of Strength Results (After Immersion In Magnesium Sulphate Solution):

Tensile Strength:



COMPARISION OF STRENGTHS BEFORE AND AFTER IMMERSION:





CONCLUSION:

Fly ash 30% and micro silica(10%) replacement of cement and 60% replacement of fine aggregate (sand) with stone dust and addition of recron polypropylene fiber in the concrete showed result in resistance of sulphate attack on the concrete in interms of Durability and strength properties of concrete.

STRENGTH PROPERIES: COMPRESSIVE STRENGTH:

BEFORE IMMERSION: For both the grades of concrete (M30&M35) strength increases from Normal, Replacement Of Cement And Sand, Replacement of Cement And Sand and Addition of Fiber.

AFTER IMMERSION: For both the grades of concrete (M30&M35) Strength variation decelerates from normal ,replacement of cement and sand, replacement of cement, sand, addition of fiber.

Tensile strength:

BEFORE IMMERSION:

For both the grades of concrete (M30) Strength Increases From Normal, Replacement of Cement And Sand, Replacement of Cement and Sand and Addition Of Fiber.

AFTER IMMERSION:

For both the grades of concrete (M30) Strength variation decelerates from normal, replacement of cement and sand, replacement of cement, sand, addition of fiber.

DURABILITY: Measured in terms of weight, percentage in the variation of weight loss decreased from Normal, Replacement of cement and sand, Replacement of cement, sand and addition of Fiber.

The variation in change in the dimension decreases from Normal, Replacement of cement and sand, Replacement of cement, sand and addition of fiber.

In addition to the above benefits it is eco-friendly and economical.

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