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DURABILITY OF CONCRETE BY ADDING BASALT FIBRE

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Abstract – *Basalt fiber is a high performance non-metallic fiber made from basalt rock melted at high temperature. Basalt fibers do not contain any other additives in a single producing process which gives additional advantage in cost. Basalt fibers have no toxic reaction with air or water and are non-combustible and explosion proof. In this study, trial test for concrete with basalt fiber [0%.1%,2%] are conducted to show the difference in durability parameters. Rapid Chloride penetration [RCPT], Water permeability Test [WPT], Sorptivity test were conducted for the concrete mix. The test results show that concrete with basalt fiber have better durability parameters then the normal concrete.*

Key Words: Basalt fiber, concrete, durability.

1. INTRODUCTION

Today there is very significant growth developed in the manufacture of many composite materials. For this purpose, industry is trying to find the new material which can benefit them both in commercial and economic way. Sustainability, energy conservation, corrosion risk, environment is the important when new product is manufactures.

Durability is the ability to last a long time without significant deterioration. Concrete resists weathering action, chemical attack, and abrasion while maintaining its desired engineering properties. Different concretes require different degrees of durability depending on the exposure environment and the properties desired. Adding basalt fiber to the concrete might increase the durability in all aspects.

2. MATERIALS FOR PRODUCTION OF CONCRETE WITH BASALT FIBER

2.1 Basalt fiber

Basalt fiber is a material made from extremely fine fibers of basalt, which is composed of the minerals plagioclase, pyroxene and olivine. It is similar to fiberglass, having better physicomechanical properties than fiberglass, but being significantly cheaper than carbon fiber. It is used as a fireproof textile in the aerospace and automotive industries and can be used as a composite to produce products such as camera tripod. The manufacture of basalt fiber requires the melting of the quarried basalt rock at about 1400 Celsius. The molten rock is then extruded through small nozzles at produce continuous filaments of basalt fiber. There are three main manufacturing techniques, which are centrifugal-blowing, centrifugal-multirole and die-blowing. The typically have a filament diameter of between 9 and 13 µm.

2.2. Coarse aggregate

Aggregates of size 20mm and 12.5 mm were used. Tests were conducted to determine various properties of coarse aggregate. The coarse aggregate used is of specific gravity 2.80 and bulk density 1652 Kg/m^3

2.3. Fine aggregates

Crushed stone [M. sand]- Zone II with FM of 2.99 is used. The M. sand used is of specific gravity 2.67.

2.4.Cement

Cement is a binder, substance used in construction that sets, harden and adheres to other materials, binding them together. Cement is seldom used solely, but is used to bind sand and gravel together. Cement is used with fine aggregates to produce mortar for masonry.

3. DETAILS FOR EXPERIMENTAL WORK

3.1. Preparation of test specimen

The test specimen was casted in cast-iron steel moulds. The ingredients required for moulding were weighed in digital balance and placed in pan mixer machine for mixing in dry condition. The investigation was carried out with standard mix M25 [1:1:2] with water cement ratio 0.52. This is done to know the inclusion of basalt fiber in optimum proportion in construction activities using cement concrete.
For this purpose, 3 concrete sample were mixed with proportion as follows:

Sample 1 – M25 grade with 0% of basalt fiber by cement weight
Sample 2 – M25 grade with 1% of basalt fiber by cement weight
Sample 3 – M25 grade with 2% of basalt fiber by cement weight

3.2 Water permeability test

Three sample of concrete each with cube size 150x150x150mm is roughened and the remaining portion is sealed with cement paste.

The specimens are cured for 28 days and then water pressure is applied on the middle roughened portion so that water can penetrate inside the concrete and at the pressure of 5kg\cm^2.

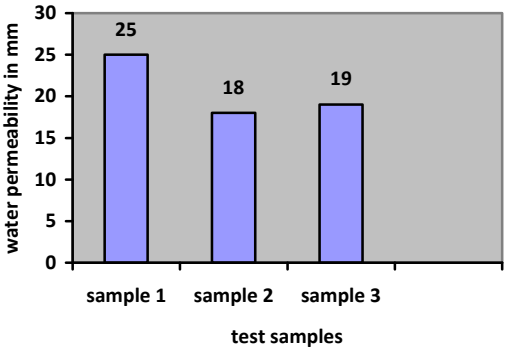
After this, the specimen are split to know the penetration of water. The specimen are split in compression machine by applying concentrated load at two diagonally opposite points slightly away from central axis. The average of three maximum values of penetration is calculated. The depth of penetration of water should not be more than 25mm otherwise the specimen are considered to be failed in permeability test.

Permeability of concrete can be minimized by adopting low water-content ratio, ensuring proper compaction and curing of concrete.

TABLE-1: Water Permeability Test Values

TRIAL MIX NO	DEPTH PENETRATION IN mm	AVERAGE DEPTH PENETRATION IN mm
0%	30	25
	22	
	23	
1%	20	18
	20	
	15	
2%	17	19
	22	
	18	

CHART-1: Water front Vs samples of 0%, 1% and 2% of basalt fiber added concrete



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3.3 Rapid Chloride Permeability Test

This test is conducted according to ASTM C1202 standards. The concrete slice with 100mm dia and 50mm thickness is drilled from the concrete specimen for the test. Between two test cells, stainless steel mesh is placed and it is tightened.

After that, place the concrete sample between the cell and tighten the four corners of the cell with nuts. 0.3% of NaOH solution and 3% of NaCl solution are added in the cell respectively.

The cables are connected between the cells and multimeter, after that 60 volts of current were passed from DC current meter.

The volt ammeter reading is noted for 6 hours at the interval of 30 minutes each.

Average current flowing through one cell is calculated by,

I = 900*2*I cumulative coulombs.

$I_{CUMULATIVE} = I_0+I_{30}+I_{60}+I_{90}+I_{120}+I_{150}+I_{180}+I_{210}+I_{240}+I_{270}+I_{300}+I_{330}+I_{360}$

where

In=current readings in “n” minute in mA

n=0,30,60…….360minutes

Table-2: Rapid Chloride Penetration Test Values

TRIAL MIX	CHLORIDE PERMEABILITY [coulombs]
0%	3612
1%	2472
2%	3738

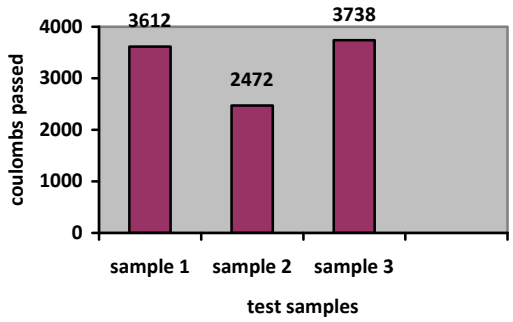

CHART-2: Coulombs passed across samples of 0%, 1% and 2% of basalt fiber added concrete

3.4 Sorptivity Test

Sorptivity test is used to determine the rate of absorption in the capillary suction. The specimen size of 100mm diameter and 50mm thickness were drilled from the specimen. The drilled specimen were kept in the oven at temperature of 100°C ± 10°C for 7 days, after that the specimen were drowned with water level not more than 5mm above. Flow from perennial surface is prevented by sealing it with suitable epoxy coating. The quantity of water absorbed in 30 minutes are measured by weighing the specimen on balance weighing. Surface water on the specimen was wiped with dampened tissue and its weighing operation was completed within 30 seconds.

$$I=S.t^{1/2}$$

where s= sorptivity in mm
t= elapsed time in minute
I=Δw/Ad
Δw= change in weight=W2-W1
W1=oven dry weight of cylinder in gm
W2=weight of cylinder after 30 minutes capillary suction of water in gm
A=surface area of specimen through which water penetrated
d= density of water

Table-3: Sorptivity test values

TRIAL MIX	ABSORPTION [mm]	AVERAGE[mm]
0%	1.75	1.63
	1.61	
	1.54	
1%	1.75	1.68
	1.62	
	1.67	
2%	2.31	1.89
	1.79	
	1.57	

TRIAL MIX	ABSORPTION [%]	AVERAGE [%]
0%	4.18	4.01
	4.10	
	3.74	
1%	3.89	3.95
	3.98	
	3.98	
2%	4.93	4.21
	3.86	
	3.83	

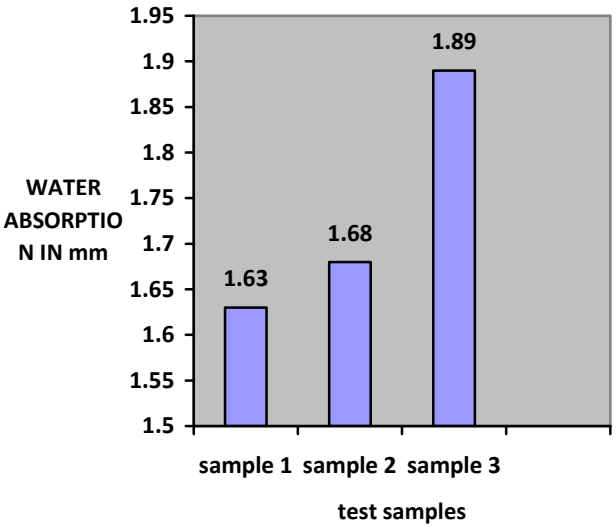

CHART-3: Average water absorption by test specimen.

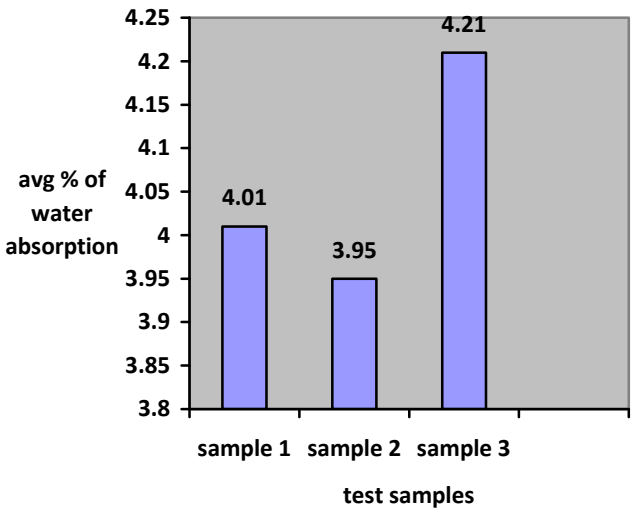

CHART 4-% of water absorption by test specimens

4. CONCLUSIONS

Based in experimental investigation carried out in this work, the following conclusion can be drawn:

1. In water permeability test the minimum value is attained at 1% of trial mix, the penetration depth is about 18mm which is very low when compared with 0% trial mix as fiber arrests the formation of micro cracks the permeability of concrete is reduced.
2. In rapid chloride penetration test, the optimum value is attained at 1% of trial mix. After that the chloride contact tends to increase.
3. In sorptivity test, the water absorption is less in 1% of trial mix, so the optimum value is attained at 1% of trial mix.
4. From the above test results we found that durability parameter holds good when 1% of basalt fiber is replaced with cement weight.

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