Construction of Water Absorbing Roads Using Super Absorbent Polymer

Rutwij Jatkar[1], Siddhi Alkunte[2], Danish Mir[3], Adesh Shinde[4], Ashish Kondekar[5]
[1, 2, 3, 4] Dept of Civil Engineering
[5]Faculty Member, Dept of Civil Engineering
[1, 2, 3, 4, 5] SITS, Narhe, Pune, Maharashtra, India – 411041

Abstract- *Transportation is necessary in order to provide the safe, efficient, rapid, comfortable, convenient, economical, and environmentally compatible movement of people, goods, etc. Areas which are connected by proper means of transport can be developed fast.*

Water absorbing roads: As the name suggest this type of roads can soak the water on surface maintaining the road quality, clean environment & providing enormous advantages. It will also help a lot to increase the ground water recharge by increased amount of percolation.

The aim to provide such road is to reduce the high amount of run-off, excess rain water coming from surrounding areas, storm water; and to allow these fluids to flow through the structure by using feasible, recyclable and a sustainable material that will soak up excess of water.

I. INTRODUCTION

1.1 BACKGROUND

Transportation is necessary in order to provide the safe, efficient, rapid, comfortable, convenient, economical, and environmentally compatible movement of people, goods, etc. Areas which are connected by proper means of transport can be developed fast. Remote areas and rural areas become accessible and communicable if connected by proper means of transport. The roads play an important role in the defense of our country as well as in cultural progress.

Water absorbing roads can soak the water on road surface maintaining the road quality, clean environment & providing enormous advantages. In these roads there is an attenuation layer that pushes the fluid into the drainage systems for irrigation, drinking water, swimming pools, etc. It will also help a lot to increase the ground water recharge by increased amount of percolation. If Materials which can be recycled & are easily available or other industrials/construction waste products etc. can be used in the construction of such roads then it will also help to solve the waste disposal problem along with various water & road problems.

The aim to provide such road is to reduce the high amount of run-off, excess rain water coming from surrounding areas, storm water; and to allow these fluids to flow through the structure by using feasible, recyclable and a sustainable material that will soak up excess of water.

India being one of the largest countries (7th) with a large road network needs a low maintenance & more adoptable roads. Requirement of roads compared to area of India is much more than existing roads. Therefore roads with not only the property of transportation are more favorable but also have to solve the water issues adapted in India.

1.2 MOTIVATION

The reasons that inspired us to take up this project are:

1. Increase in water scarcity & flood problems all over India.
2. The need for sustainable roads as roadways being one of the most important ways of transportation.
3. Reducing the high amount of storm water, run-off, excess rain water coming from surrounding areas and allowing these fluids to flow through the structure.

1.3 PROBLEM STATEMENTS

Problem Statements are as follows:

1. Ground water recharges or floods problem.
2. Road quality & maintenance problems.

1.4 OBJECTIVES

Objectives of the project are as follows:

1. To study different materials which can be used in road construction process & Study of different construction process.
2. To study & do the required tests on the material.
3. To compare the results with currently used materials & procedure.

II. METHODOLOGY

2.1 MATERIAL

The materials used and their properties are as follows:

1. Cement: Ordinary Portland Cement (OPC) 53 with specific gravity of 5.13g/cm^3.
2. Fine Aggregate: Fine Aggregate of zone II with specific gravity of 2.64g/cm^3 & size of 4.75mm.
3. Coarse Aggregate: Coarse Aggregate of zone II with specific gravity of 2.77g/cm^3 & size of 20.0mm.
4. Water Absorbent Polymer: Potassium Polyacrylate which can absorb almost 500-1000 times water to its weight. It is structured as white odorless solid. This material is highly resistant to heat. It has a good mechanical stability. Since it has high water absorbing capacity, it is also called as water lock agent. It is an environment friendly material.

2.2 MIX PROPORTION

Mix design carried out for M25 grade of concrete by IS 10262:2009 & IS 456:2000, having mix proportion of 1:1.64:2.26 (Cement: Fine Aggregate: Coarse Aggregate) with water cement ratio of 0.45 (Water:Cement).

The dosage of Potassium Polyacrylate varies from 0.30% to 0.90% at an increment of 0.30% by total volume of cement.

2.3 TESTS TO PERFORM

1. Compressive strength test to check the compression strength of the material used which can be done by casting cubes.
2. Split tensile test to check the tensile strength by casting of cylinder.
3. Water absorption test to test the total water holding capacity of the material.

2.3.1 PREPARATION OF SPECIMEN

Cube (15cm*15cm*15cm) for conducting compression test, cylinder (15cm*30cm) for conducting split tension test were prepared.

After which they were kept in curing tank before performing the tests.

Quantity of cubes & cylinder casted are:

Sr. No.	% SAP Variation	7 Days	28 Days
1.	0.0%	3 cubes	3 cubes
		1 cylinder	1 cylinder
2.	0.3%	3 cubes	3 cubes
		1 cylinder	1 cylinder
3.	0.6%	3 cubes	3 cubes
		1 cylinder	1 cylinder
4.	0.9%	3 cubes	3 cubes
		1 cylinder	1 cylinder

Figure 2.1 – Cylinder Specimens

Figure 2.2 – Cube Specimens

Figure 2.3 – Curing Tank

III. TEST RESULTS

3.1 COMPRESSIVE STRENGTH TEST

In this test the specimen (Cubes) is placed in Universal Testing Machine (UTM) & then the load is applied on it. Compressive Strength can be calculated by using following formula:

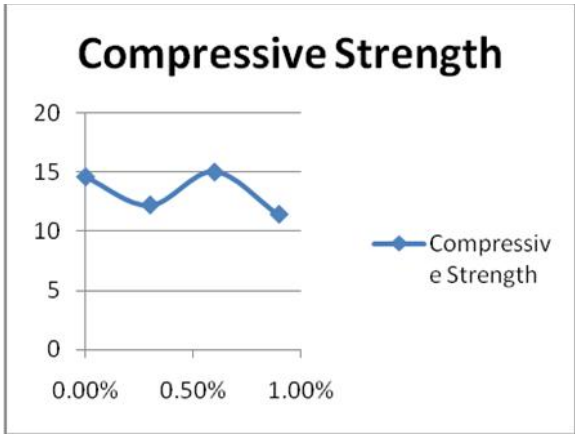
Compressive Strength =
Failure Load /Cross Section Area
Where, Cross Section Area =
= Length*Breadth
= 150*150
= 22.5*10^3 mm^2

(Note: Due to COVID-19 Pandemic & Lockdown we couldn't perform the test after 28 days therefore only the results of test conducted after 7 days are mentioned.)

The following observations were noted after 7 days of curing:

Table 3.1 – Compressive Strength Results

Sr No.	% Variation	Sample	Compressive Strength (MPa)	Average
1	0.0 %	A1	14.60	14.60
2		A2	14.40	
3		A3	14.70	
4	0.3 %	B1	12.20	12.20
5		B2	12.30	
6		B3	12.15	
7	0.6 %	C1	14.90	15.00
8		C2	15.05	
9		C3	15.10	
10	0.9 %	D1	11.40	11.40
11		D2	11.20	
12		D3	11.50	



It is clear from the above table & graph; after 7 days of curing compressive strength obtained with 0.6% variation is more than that of conventional concrete cube however the 0.3% variation and 0.9% variation are very less compared to 0.0% variation i.e. conventional concrete.

Figure 3.1 – Compressive Strength Test

Figure 3.2 – Cube Specimen at time of Compressive Strength Test

3.2 Spilt Tensile Test

In this test the specimen (Cylinder) is placed in Universal Testing Machine (UTM) & then the load is applied on it. Spilt Tensile Strength can be calculated by using following formula:

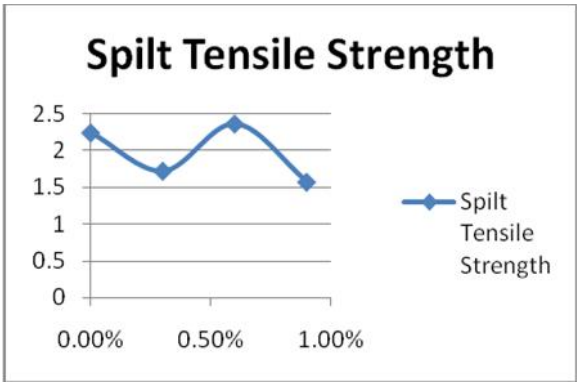
Spilt Tensile Strength =
Failure Load/Cross Section Area
Where, Cross Section Area =
= 3.14*Diameter*Length
= 3.14*150*300

= 141.3*10^3 mm^2
(Note: Due to COVID-19 Pandemic & Lockdown we couldn't perform the test after 28 days therefore only the results of test conducted after 7 days are mentioned.)

The following observations were noted after 7 days of curing:

Table 3.2 – Spilt Tensile Test Results

Sr. No.	% Variation	Sample	Spilt Tensile Strength (Mpa)	Average
1	0.0 %	A1	2.26	2.24
2		A2	2.22	
3		A3	2.25	
4	0.3 %	B1	1.74	1.72
5		B2	1.70	
6		B3	1.73	
7	0.6 %	C1	2.34	2.36
8		C2	2.36	
9		C3	2.39	
10	0.9 %	D1	1.60	1.57
11		D2	1.55	
12		D3	1.57	



It is clear from the above table & graph; after 7 days of curing spilt tensile strength obtained with 0.6% variation is more than that of conventional concrete cube however the 0.3% variation and 0.9% variation are very less compared to 0.0% variation i.e. conventional concrete.

Figure 3.3 – Spilt Tensile Test

Figure 3.4 – Cylinder Specimen at time of Spilt Tensile Test

3.3 Water Absorption Test

In Water absorption test it was observed that the moulds didn't absorb sufficient amount of water neither sign of water passing to lower level was observed. We could see very little amount of water was absorbed & the remaining water was as it is on the surface of moulds.

IV. RESULT & CONCLUSIONS

4.1 RESULT

The influence of Super Absorbent Polymer on the properties of concrete such as the Compressive Strength, Spilt

Tensile Strength is studied. An increase in the compressive strength is observed with the increase in the percentage of super absorbent polymer until it reaches 0.60% variation and then we can observe a gradual decrease in the compressive strength. Similar result is observed in spilt tensile strength test however very less capacity of water was absorbed while water absorbing test.

4.2 CONCLUSION

Based on the above experimental observation we can establish the following Conclusions:

1. Potassium Polyacrylate increases the compressive strength, spilt tensile strength for 0.60% variation as compared to conventional concrete.
2. Water was absorbed in very less amount which tells us that Potassium Polyacrylate in road construction will not give good results in case of water absorption.
3. Therefore we can conclude that Potassium Polyacrylate can be used to get better strength but we cannot use it as a water absorbing material for road construction.

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