Study on the Properties of Top Mix Concrete Pavement

Dr.G.Lavanya[1] S.Kausalya Devi[2], M.Kayalvizhi[2], T.Nithya[2], R.Ramkumar[2]
[1] *Professor, Department of Civil Engineering, University College of Engineering, Ramanathapuram, Tamilnadu.*
[2] *Team members, Department of Civil Engineering, University College of Engineering, Ramanathapuram, Tamilnadu.*

Abstract

Top mix concrete is considered to be an advanced pavement material in terms of environmental benefits from it's basic features – high water permeability. Top mix concrete which is also known as no fines, porous, gap graded and permeable concrete has been found to be a reliable storm water management tool. Top mix concrete is effective in managing run-off from paved surfaces , prevent contamination in run-off, repelling salt water intrusion, control pollution in water seepage recharge. This paper presents the results of experimental work that is aimed at testing the properties of top mix concrete prepared with three different fly ash to cement ratio. The cement has been replaced with 30% , 40% and 50% fly ash The results show that changes in the replacement of fly ash with cement causes difference in the strength characteristics. The mix proportions had the same volume of cement paste so as to obtain the void content for all the samples.

Keyword - *Top mix concrete, fly ash, cement, void content, permeability*

I.INTRODUCTION

Top mix concrete pavement is also called porous concrete, permeable concrete, no fines concrete, porous concrete and thirsty concrete. Top mix concrete pavement is a special type of concrete with a high porosity used for concrete flat applications. Top mix concrete pavement is an open graded structure with interconnected voids through which rain and storm water is permitted to percolate into the aquifer. It consists of cement, coarse aggregate, fly ash and water. If the aggregate is angular, voids in the aggregate will increase. However, no systematic
study on the effect of angularity of aggregate on the voids content of concrete is reported. Top mix concrete pavement is traditionally used in parking areas, areas with light traffic, residential streets, pedestrian walkways, and green houses. Top mix concrete pavement is an environmental friendly building material and EPA (Environmental Protection agency) has identified it as a Best Management Practice (BMP) for storm water Management.

II. SCOPE

The present study was conducted to investigate top mix concrete made by fly ash, cement, coarse aggregates and water. In this study, several mix proportion were used and top mix concrete specimens were tested for density and void content, compressive strength and infiltration rate.

III. LITERATURE REVIEW

S Deepika et.al., had conducted an experimental investigation of pervious concrete using single size aggregate (coarse aggregate) without fine aggregates and as an admixture they used fly ash by partially replacing the cement. They had laid pervious concrete trial mixes with the different size of aggregates with and without fine aggregates and tests for compression strength and infiltration test. They conducted the mix proportions to select the optimum effective mix designed. They had done 9 mix proportions having variation of cement – 300, 350, 400 kg/meter cube, RCA percentage of replacement – 0, 50, and 100[3].

Ketan et.al., had conducted an experimental investigation of pervious concrete using titanium Dioxide. They have partial replaced cement by TiO_2. They had laid pervious concrete trial mixes with the different size of aggregates with and without fine aggregates and tests for compression strength, water permeability, porosity and density. Trial mixes for their investigation were selected with optimum compression strength along with sufficient permeability. The came to conclusion that addition of TiO_2 replacement to cement increased compression strength and split tensile strength and had no adverse effect on permeability of pervious concrete.

Hariet et.al., had explained the experimental investigation carried on minor scale, the pervious concrete. They had created a miniature scale model in pragmatic way so that real time problems which were possible in the future may be realized. So they had chosen an area to create that pervious concrete placement, test like infiltration test according to ASTMCI70. Tests were carried out on the pervious concrete miniature model were two quantities of water were used for conduction of the test say 1 gallon, 5gallon.They observed that infiltration rate

was 312.64 inch/hour suggested that good rate of percolation and use of practical purpose. Hence they understood that infiltration largely varies depending on the voids present in concretes and size of aggregate.

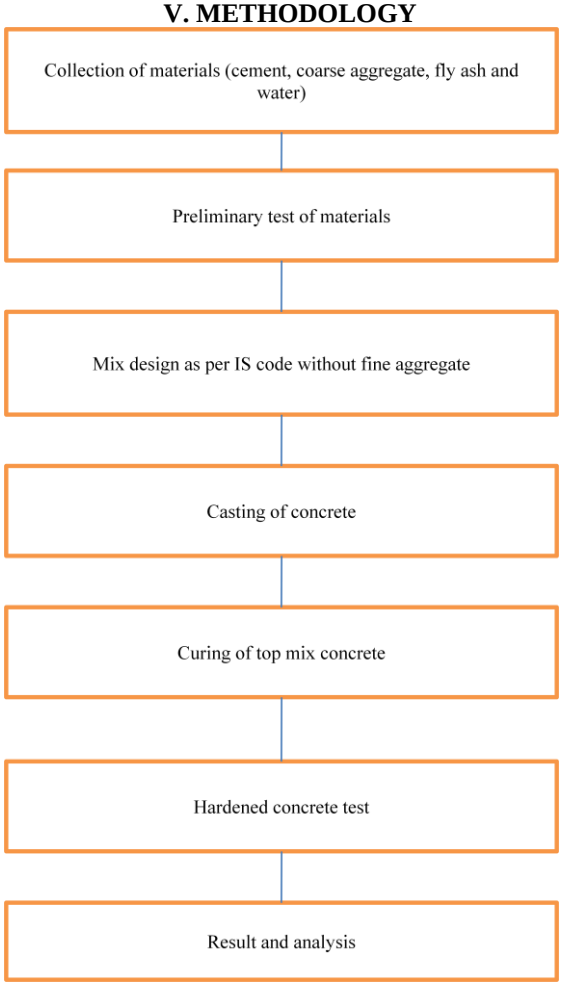
Nandhin et.al., had conducted a study on characterization of previous concrete for pavement, so that study the effect of various size of coarse aggregate, fine aggregate percentage and the use of fly ash on previous concrete and characterize the mix for use in pavement. They conducted 10 mixes were formulated and studied. Various tests like compressive, tensile and flexural strength were done. (Permeability, pores, abrasion).They found that with the addition of fly ash, the mix yielded lower strength than that of conventional pervious concrete mainly because of lower bond strength. Hence fine aggregate was added to the concrete mix for strength improvement.

IV. MATERIAL USED

- **COARSE AGRREGATES**: In top mix concrete generally singular size of coarse aggregates are used. For design of top mix concrete , 20 mm of coarse aggregates and its specific gravity of aggregate is 2.67 as per the IS code 10262:2009 for mix design is used and also if coarse aggregate size decreases compressive strength increases.
- **CEMENTITIOUS MATERIAL:** Ordinary Portland cement of OPC grade-53 as per the IS code 1489:1991 is used and its specific gravity is 3.15.
- **FLY ASH:** It is waste material from thermal power plant. Fly ash of class F as per IS 3812 Part-1- 2013 is used.. Class f Fly ash was used have a lower content of CaO and exhibit Pozzolonic properties. Specific gravity of fly ash is 2.6 as per Specific gravity Test IS: 3812 Part I. Size of fly ash is 89micrometer.
- **WATER:** Portable water is used locally available.

Fig 1 Compressive strength of

V. METHODOLOGY



VI. PARAMETERS

TMC 20 denotes 20% Fly Ash with 80% Cement
TMC 30 denotes 30% Fly Ash with 70% Cement
TMC 40 denotes 40% Fly Ash with 60% Cement
TMC 50 denotes 50% Fly Ash with 50% Cement

VII. RECOMMENDED CODE BOOKS

IS 456 : 2000 – Plain And Reinforced Concrete
IS 10262 : 2009 – Concrete Mix Proportioning
The above mentioned code books are used to design the mix proportion of top mix concrete pavement.

VIII.FORMATION OF CUBES

Volume of cubes= 150×150×150 (in mm)
No. of cubes= 6
Total volume of all cubes= 0.02025 cubic meter

IX. MIX DESIGN

Table-1

Determination of Percentage of Voids (P_v):

Percentage of voids $(P_v) = (V_{wt} - V_s) / V_{wt} \times 100$

No.	Concrete sample	Coarse aggregate (in kg for one mould)	Cement(in kg for one mould)	fly ash (in kg for one mould)	Voids ratio & Water cement ratio
1.	TMC 20	3.77	1.23	0.31	20% & 0.45
2.	TMC 30	3.77	1.08	0.46	20% & 0.45
3.	TMC 40	3.77	0.93	0.62	20% & 0.45
4.	TMC 50	3.77	0.77	0.77	20% & 0.45

X. COMPRESSIVE STRENGTH

Table-2 gives the detail of the number of specimens cast for different mixes. A total number of 24 cubes specimens were casted and tested. The concrete mixes of different proportion TMC20, TMC30,TMC40 and TMC50 Were tested to compression strength as per Indian standards figure shows the compressive strength while conducting test in compression testing machine.

Compressive strength = P/A

P = Applied load in kN

A = Area of the cube in mm^2

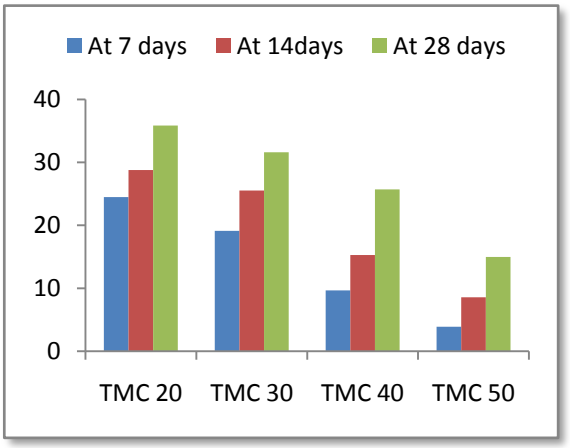
XI. INFILTRATION TEST

Table-2 gives the detail of the number of specimens cast for different mixes. A total number of 24 cubes specimens were casted and tested. The concrete mixes of different proportion TMC20, TMC30, TMC40 and TMC50 were tested to infiltration rate as per Indian standards figure shows the infiltration test.

S. No	Sample	Avg. value of compressive strength of concrete in N/mm^2			Infiltration Rate (in inch/hour)
		At 7 days	At 14 days	At 28 days	
1.	TMC 20	24.5	28.78	35.85	1269.99
2.	TMC 30	19.11	25.52	31.61	1265.00
3.	TMC 40	9.67	15.28	25.70	1224.79
4.	TMC 50	3.89	8.57	14.98	1198.65

COMPRESSIVE STRENGTH

Compressive strength of top mix concrete depend upon the porosity of concrete, age, binder material (type of cement),test specimen shape and size ,showed huge influence on the strength of top mix concrete. Compressive strength is inversely proportional to porosity hence, when compressive strength increases porosity decreases. When the replacing of cement by fly ash is increased 10% in top mix concrete, the characterstics strength of top mix concrete is gradually decreased.

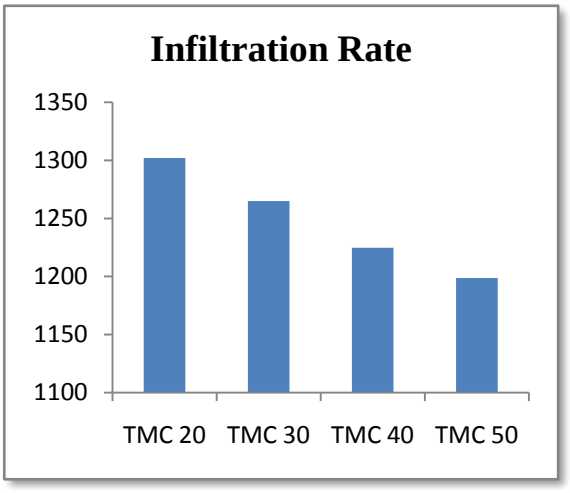


INFILTRATION RATE

When the replacing of cement by fly ash is increased 10% in top mix concrete, the infiltration rate of top mix concrete is gradually decreased.

is inversely proportional to porosity hence, when compressive strength increases porosity decreases.

To calculate the Infiltration Rate of In-Place top mix Concrete. An infiltration ring is temporarily sealed to the surface of a pervious pavement. After pre wetting the test location, a given mass of water is introduced into the ring and the time for the water to infiltrate the pavement is recorded. The infiltration rate is calculated using the equations provided in the standard.



XII. CONCLUSION

The top mix concrete needs proper mix design. The mix design for the replacement of the cement in the concrete by fly ash up to a few percentage. The proportion of cement, fly ash , water, coarse aggregate and water-cement ratio have been calculated with the help of Indian standard code (IS: 10262 : 2009). To cast the concrete cubes the mix design is very essential.

Top mix concrete is a cost- effective and environmentally, friendly solution to support sustainable construction. The optimum replacement of cement by fly ash is found to be 20% in the present study.

It is clearly seen from the experimental result that top mix concrete has very low compressive strength, so it cannot be used for structural applications but it should be significantly used for so many other applications such as, sidewalks, parking lots, sports surfaces, swimming pool decks and drive ways. The smaller the size of coarse aggregate should be able to produce a higher compressive strength.

ACKNOWLEDGE

We owe lot to our project guide **Dr.G.LAVANYA, Ph.D.**, Assistant Professor of Civil Engineering, for his directing us all the way towards the completion of our project and to thank our project coordinator **Dr.J.JEGAN, Ph.D.**, and **Dr.T.SEKAR, Ph.D.,** Professor and Dean of Civil Engineering, University College of Engineering, Ramanathapuram for his valuable comments & suggestion for successful completion of this project.

REFERENCES

[1] Design Of Pervious Concrete Mixtures , John t. Kevern ,vernon k.Schaefer and Kejin wang 2009 , www.researchgate.com

[2] Mix proportions of cementitious material in pervious concrete Pankaj R. Teware , Shrikant M. Harle , MAT Journals 2016.

[3] Water absorbing pavements by using porous concrete , Jannathul Thasni.P , Jouhar Shareef and Krishnapriya 2018, www.irjet.com

[4] Partial Replacement of Silica Fume and Fly Ash in Pervious Concrete, V.Prakash, K.Chandrasekar, P.Vinoth, www.irjet.net

[5] Design of eco friendly pervious concrete, M. HarshavarthanaBalaji, M.R.Amarnaath, R.A.Kavin, S. Jaya pradeep.

[6] Experimental study on implementation of Pervious Concrete in Pavements,Nishith M N, Gururaj Acharya, Shaik Kabeer Ahmed, IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 3 Issue 5, May 2016.