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Analysis of Pervious Concrete with POFA Blended Cement and Waste Bottle Fibers as a Sustainable Construction Material

D.S.V.P.Pavan Kumar[1], Dr.D.Venkateswarulu[2]

1P.G Scholar, Department of Civil Engineering, Godavari Institute of Engineering & Technology (A),Rajahmundry, Andhra Pradesh, India

2Professor & Head of the Department, Department of Civil Engineering, Godavari Institute of Engineering & Technology (A), Rajahmundry, Andhra Pradesh, India

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KEYWORDS

Concete,Wbf,Pervious Concrete

ABSTRACT:

Concrete containing coarse aggregate, cement paste and no fine aggregate called pervious concrete. A porous surface with high number of interconnected voids is useful to drain water. In which water is allowed to pass through the surface and allows storm and rain water to eventually absorb back in to the surrounding soils. In this generation of “Green buildings” pervious concrete may be a natural choice for application in natural aspect. On the other hand disposal of industrial

waste is one of the major problems in industries. Palm oil fuel ash is a local agriculture waste from palm oil industry and on the other a huge amount of waste bottles are producing every year all over the world and causing severe damage to the environment. There is heap of analysis work goes with in the field of permeable concrete. The study focuses on the two fold advantage of waste disposal and cost of construction by utilizing these waste materials. The aim of the present study was to access the performance of pervious concrete with POFA blended cement and Waste bottle fibers (WBF) as a sustainable construction material and comparing the results of Slump, compressive strength, for different cement aggregate Mix proportions of pervious concrete.

INTRODUCTION

1.1 CONCRETE

The components that made up concrete include crushed stone aggregate also known as aggregate embedded in cement mortor and sand. In his hardened state concrete IS aggregation of stones or similar hard material embedded in cement-sand mortar. In normal concrete, aggregate forms the skelton matrices it’s about 60-75% by volume and 25-40% paste and 1 to 2% voids. Now a days concrete is most widely used material for the construction purpose. It is strong in compression but weak in tension due to its composite nature. Heat of hydration is the main principle which is involved to increase the strength. The four ingredients of concrete for normal concrete is cement, natural sand, aggregate and water. But in case of modern concrete it is not only this 4 ingridients but also it has definitely 2 more ingredients. The additional ingredients other than four components are chemical admixtures that may be accelerators, water reducers, retarders etc and one more component is mineral admixtures that may be flyash, silica fume, rice husk ash and other pozzolanic materials. These are added to the concrete system during production, in order to improve the performance of concrete either in hardened state or in fresh state.

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OBJECTIVES OF THE PRESENT INVESTIGATION

Pervious concrete which has been prominently used as applications in non-pavements and for pavement applications it is in limited use. The main purpose of this thesis is to know the suitability of pervious concrete for the purpose of construction of road pavements.

The main objectives of this present study is as follows

- To analyse the properties of no fines concrete with waste bottle fibers.
- To conduct the required laboratory experiments to assess the strength.
- To analyze the results obtained and conclude the effectiveness of pervious concrete as a pavement material.

LITERATURE REVIEW

R. Brown, A.Shukla et al, 2002 reported that The fibers are more beneficial in enhancing ductility, pre-crack tensile strength, removing temperature fluctuations from concrete, and preventing shrinkage cracks. Various Polypropylene fibers are mixed into the concrete during the batching process.

MALHOTRA (1976) has done a research on no fines concrete. Research mainly concentrates on the characteristics and applications of pervious concrete. From the research he concluded that an attempt has made for different laboratory experiments and different tests on cubes and cylinders to know the relation between strength characteristics of the materials.

PAUL KLIEGER (2003) has done a study on the effects of entrained air on the durability and strength of normal concrete. Though he never used the amount of voids shown in no fines concrete.

AMMAR A. MUTTAR (2013) carried out an investigation on the mechanical and durability characteristics of pervious concrete without or with fibre. The experimental results shows that the fibre addition in pervious concrete will shows a prominent improvement in the mechanical and durability characteristics.

METHODOLOGY

MATERIALS

3.1.1 Portland cement

Portland cement, which is created by burning a mixture of argillaceous (clay) and calcareous (calcium) organic material at high temperatures and then grinding the resulting clinker to a fine powder, may be a seldom used building material in the construction sector. Joseph Aspadin, an English mason, produced it for the first time in 1924. It was his portland cement patent.

3.1.2 Aggregates

The first idea was to use aggregates as an easy-to-use concrete filler to reduce the amount of Portland cement required. It is currently widely believed, though, that the type of mixture employed in concrete will have a positive impact on the properties of the concrete's pliable and hardened states. Since they make up one-eightieth of the concrete mixture, their qualities are essential to the qualities of concrete. Four broad categories will be used to classify aggregates: heavyweight, conventional weight, light weight, and ultra-low weight aggregates

Classification of aggregates

The alternative employed in the manufacture of fine quality concrete, is to get the combination in a minimum of 2 size teams, i.e.:
1) Fine aggregate in which the size aggregate is not of larger that 5milli meters in size.
2) Coarse aggregate, the size of material is at least 5milli meters in size.
On the opposite had, few are some characteristics shows by the aggregate but it is absent in the raw rock: particle size and shape, absorption and surface texture. All these characteristics have a substantial effect on the standard of the concrete, may be in contemporary or within the hardened state.

EXPERIMENTAL STUDY

The laboratory experimental analysis work is carried out using a variety of laboratory tests, as well as specifics regarding the laboratory experiments and

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JCHR (2024) 14(1), 2538-2544 | ISSN:2251-6727

outcomes from a range of tests on the component materials are listed below.

1. Portland cement
2. Coarse aggregate
3. Water
4. Palm oil fuel ash
5. Waste bottle Fibres

Fig 4.10 Pervious concrete block after curing period

RESULTS AND DISCUSSIONS

5.1 GENERAL

The findings of an experimental study on waste bottle fiber reinforced concrete blended with palm oil fuel ash, wherein concrete mixes labeled as CA1, CA2, and CA3 have employed palm oil fuel ash in place of some of their cement. After cubes and cylinders are cured in regular water for seven, fourteen, and twenty-eight days, the workability, compressive strength, and split tensile strength are examined when cement is replaced with varying percentages of palm oil fuel ash, ranging from 0% to 20% with increments of 5%. The same workability, compressive strength, and split tensile strength tests are performed using additional discrete waste bottle fiber reinforcement, and the test results are reported in this chapter.

5.4 EVALUATING THE OPTIMUM CONTENT OF POFA AT W/C RATIO OF 0.45

For evaluating the optimum content of palm oil fuel ash different laboratory experimentations includes strength tests like compressive and split tensile tests were performed. Cube of standard specimens sizes of 150mm*150mm were cast to know the compressive strength as per specifications Indian standards BIS: 516-1959. Cubes were casted with different proportions of cement, palm oil fuel ash ass replacement to the cement and aggregates and mixes are designated as CA1, CA2, and CA3 and the mixes are 1:4, 1:6 and 1:8 by keeping the water cement ratio of 0.45. For the same mixes split tensile strength test also conducted by preparing the concrete cylinders of size 150*300mm.

5.5 COMPRESSIVE STRENTH TEST

Cube moulds of size 150mm*150mm were casted for compressive strength as per specifications of Indian standard BIS: 516-1959. These casted specimens were tested for every seven fourteen and every 28 days, at a rate of 3 cubes at each mix on day. The strength at that age is reported as the average value of the three specimens.

Table 5.2: Influence of POFA on the Compressive strength for different percentages of POFA for different mixes

POFA (%)	C : A = 1 : 4 (CA1)			C : A = 1 : 6 (CA2)			C : A = 1 : 8 (CA3)		
	7 Days	14 Days	28 Days	7 Days	14 Days	28 Days	7 Days	14 Days	28 Days
0	12.6	19.5	23.7	9.2	14.8	18.7	6.5	10.3	13.6
5	13.8	20.1	25.3	11.1	17.3	20.6	9.8	12.1	14.8
10	16.4	21.6	27.1	13.7	18.6	21.9	12.0	13.3	16.1
15	18.5	22.7	28.4	15.5	20.4	23.4	14.1	15.7	17.3
20	17.3	20.4	25.6	14.6	18.2	20.0	12.4	13.5	15.7

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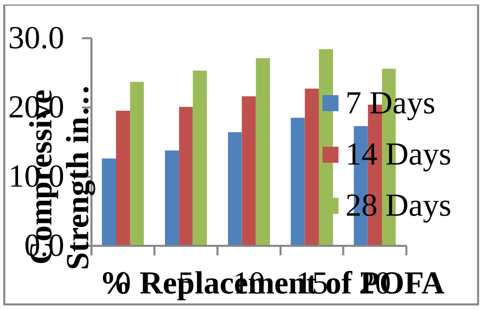

Fig: 5.5 shows the Compressive Strength with replacement of POFA for Mix CA1

5.6 SPLIT TENSILE STRENGTH

The test methodology involves applying compressive line loads along the opposing generators of a concrete cylinder whose axis is positioned horizontally between the plates. An elastic analysis yields a fairly homogeneous tensile stress over roughly two thirds of the loaded diameter as a result of the applied line loading. This tensile stress's magnitude, which is acting perpendicular to the line of applied compression, is determined by

Table 5.3: Variation of split tensile strength for different percentages of POFA for different mixes

POFA (%)	C : A = 1 : 4 (CA1)			C : A = 1 : 6 (CA2)			C : A = 1 : 8 (CA3)		
	7 Days	14 Days	28 Days	7 Days	14 Days	28 Days	7 Days	14 Days	28 Days
0	0.76	1.16	1.42	0.74	0.86	1.07	0.36	0.58	0.76
5	0.83	1.22	1.5	0.62	1	1.19	0.54	0.66	0.83
10	0.97	1.3	1.63	0.78	1.08	1.25	0.69	0.74	0.95
15	1.14	1.37	1.71	0.89	1.17	1.36	0.8	0.91	1.04
20	1.02	1.24	1.53	0.83	1.04	1.13	0.71	0.75	0.89

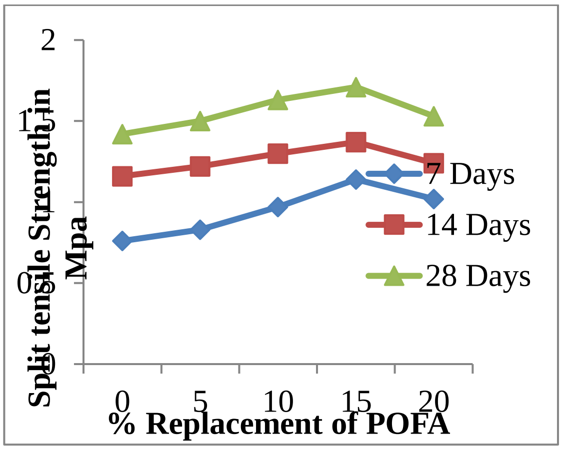

Fig: 5.9 shows the split tensile Strength for percentage replacement of POFA for Mix CA1

From the detailed test results of compressive strength and split tensile strength it is observed that the results for the 15% replacement of Cement with POFA can be considered as optimum for all the mix proportions considered and for the mix CA1 i.e. for the ratio of 1:4 the results were more pronounced.

EVALUATING THE OPTIMUM CONTENT OF WASTE BOTTLE FIBRES (WBF) WITH AN OPTIMUM 15% POFA AS REPLACEMENT IN CEMENT AT W/C RATIO OF 0.45

After finding the optimum content of palm oil fuel ash further waste bottle fibers were added. Different laboratory experimentations includes strength test was conducted. Cube moulds of size 150mm*150mm are casted for compressive strength as per the specifications of Indian standard BIS: 516-1959. Cubes were casted with different proportions of cement, palm oil fuel ash ass replacement to the cement and aggregates and mixes are designated as CA1, CA2, and CA3 and the mixes are 1:4, 1:6 and 1:8 by keeping the water cement ratio of 0.45. For the same mixes split tensile strength test also conducted by preparing the concrete cylinders of size 150*300mm. Immediately after casting and proper finishing, the cubes specimens were covered with membranes to control the loss of moisture from them. These casted Specimens were demoulded after twenty four hours and then kept for water curing at room temperature till the testing. Cubes are tested for Compressive strength carried out at 7, fourteen and 28 days. Split tensile strength tests for cylinders were conducted after seven, 14 and twenty eight days of normal water curing..

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Variation of slump for different percentages of WBF for Different Mixes

WBF (%)	SLUMP(mm) CA1	SLUMP(mm) CA2	SLUMP(mm) CA3
0	35	41	48
0.5	31	38	42
1	28	36	38
1.5	26	33	35
2	25	31	32

Fig: 5.12 shows the slump values for addition of percentages of WBF for Mix CA1

Table 5.5: Variation of Compressive strength for different percentages of WBF for Different Mixes

WBF (%)	C : A = 1 : 4 (CA1)			C : A = 1 : 6 (CA2)			C : A = 1 : 8 (CA3)		
	7 Days	14 Days	28 Days	7 Days	14 Days	28 Days	7 Days	14 Days	28 Days
0	18.5	22.7	28.4	15.5	20.4	23.4	14.1	15.7	17.3
0.5	18.9	24.2	31.2	14.3	22.3	28.1	11.4	14.9	17.7
1	21.1	26.4	32.7	16.8	24.5	29.8	13.5	15.6	18.2
1.5	22.8	28.1	34.6	18.1	26.7	31.5	15.2	17.3	19.6
2	21.3	25.5	31.4	16.6	23.1	27.7	13.9	14.5	17

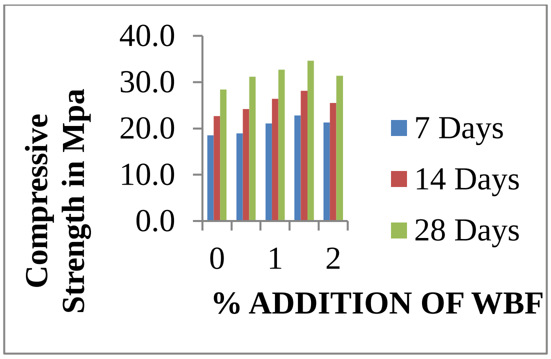


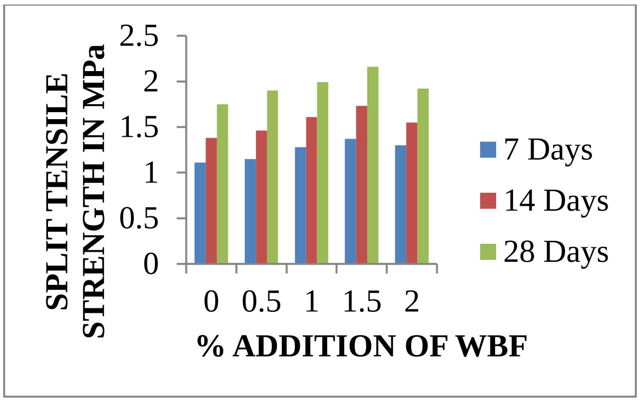
Fig: 5.15 shows the Compressive Strength for percentage addition of WBF for Mix CA1

From the graphs, it can be finding that there is a gradual increase in Compressive strength with percentage addition of waste bottle fibers. From the above results the 1.5% addition of waste bottle fibre with 15% Cement replacement with POFA can be considered as optimum for all the mix proportions considered.

From the graphs, It can be say that there is a gradual increase in Properties of concrete with percentage replacement of POFA and percentage addition of Waste Bottle Fibre. From the results it is concluded that 1.5% addition of Waste Bottle Fibre shows prominent results with compressive strength.

Table 5.6: Variation of Split tensile strength for various percentages of WBF for Different Mixes

WBF (%)	C : A = 1 : 4 (CA1)			C : A = 1 : 6 (CA2)			C : A = 1 : 8 (CA3)		
	7 Days	14 Days	28 Days	7 Days	14 Days	28 Days	7 Days	14 Days	28 Days
0	1.11	1.38	1.75	0.91	1.2	1.38	0.8	0.89	0.97
0.5	1.15	1.46	1.9	0.86	1.32	1.65	0.65	0.84	1.01
1	1.28	1.61	1.99	0.99	1.46	1.74	0.76	0.88	1.04
1.5	1.37	1.73	2.16	1.05	1.58	1.86	0.83	0.96	1.12
2	1.3	1.55	1.92	0.97	1.35	1.62	0.78	0.82	0.95



CONCLUSIONS

The analysis shows that, replacement of cement with POFA gives good results. The following findings and conclusions are drawn based on the laboratory experimental study conducted during investigation.

- From the laboratory experimental study, it is found that the cement with percentage replacement by POFA gives prominent results in increase in the strength of concrete.
- With the slump cone test results it is noted that, with the increment of percentage of POFA in concrete leads to improvement in workability of the concrete.
- During testing, normal concrete specimen's shows a typical cracking pattern, but with after addition of Waste Bottle Fibre specimens show reduction in cracks. From this we can observe ductility behaviour of concrete due to fibres addition. The average compressive strength for different aggregate cement ratios decreases with an increase in aggregate cement ratios.
- As the aggregate cement ratio increases, rate of permeability increases. The mixtures with lower cement aggregate ratio 1: 4 and 1:6 are found to be useful for a pavement which requires more compressive and tensile strength with low permeability.
- The specimens with high cement aggregate ratio 1: 8 and 1:10 are found to be useful for a pavement that requires less compressive strength and high permeability.
- Among all the mixes CA1 i.e. cement aggregate ratio 1: 4 shows an increment in the compressive strength results Up to 15% replacement of POFA about 19.83% and further addition of WBF to the optimum percentage of POFA shows an increment in the compressive strength results Up to 1.5% and is about 21.83%.
- Among all the mixes CA1 i.e. cement aggregate ratio 1: 4 shows an increment in the tensile strength results Up to 15% replacement of POFA about 20.4% and further addition of WBF to the optimum percentage of POFA shows an increment in the tensile strength results Up to 1.5% and is about 23.42%.
- From the analysis It is Cleary found and evident that the Replacement of POFA to the cement shows prominent results in improvement of Mechanical Properties to some extent and on further concrete blended with Waste Bottle Fibres the compressive strength was more pronounced.
- Finally from the results it can be summarized that the waste materials like POFA and Waste Bottle Fibre inclusions had shown promising effect on the Mechanical Properties of concrete, thereby giving a two-fold advantage in solving a problem of waste disposal and ground water recharge.

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