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Construction of Sustainable Rigid Pavements by Usage of Vitrified Polish Waste Admixed Fibre Reinforced Concrete

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Abstract*— Rigid pavements are considered to be superior to other types of pavements because of their load carrying capabilities and long life, they also require less maintenance and rehabilitation when compared to bituminous pavements. But rigid pavements do not form a major part of India's transportation system because of their high initial construction cost, with cement being its primary ingredient. But the condition is slowly changing, by knowing the advantages of rigid pavements they are also now constructed vastly along many road transit networks of the country and white toppings are provided on damaged bituminous pavements, Various mineral and chemical admixtures are used in construction of concrete pavements to improvise the engineering properties of concrete and to reduce their initial cost of construction. Currently a wide research is going on in using industrially generated waste materials as a partial replacement of cement in Pavement Quality Concrete (PQC). In previous studies, industrially generated wastes such as fly ash, silica fume, etc., are used successfully as partial cement replacement in PQC. Here in this study, an attempt is made to replace the cement partially with industrial generated waste material, Vitrified Polish Waste (VPW) in varying proportions of 5% and optimum addition is found out. There by improving pavement sustainability and reduction of waste disposal problems for vitrified tiles industry, also considering other major issues in concrete pavements like micro shrinkage, cracking and low flexural strength the usage of polyester fibre Recron -3S is also done to cope up with above problems. The optimum replacement of VPW is again mixed with varying proportions of polyester fibre Recron-3S from 0.1% there by improving the pavement's flexural strength and other properties at optimum fibre dosage. Then the results are compared with ordinary M40 grade of concrete.
Keywords*— Vitrified Polish Waste (VPW), Recron-3S, Rigid Pavement, Waste disposal, Pavement Quality Concrete (PQC)

I. INTRODUCTION

Good and well established connectivity among various important places in a country always plays a major role in its development. For a country like India which primarily focussed on the infrastructural growth and improved mobilisation of people, road ways come as its first priority. Modernization of road networks is also a primarily focussed zone in country's development plan. Constructing pavements having high quality, more design life, reduced cost of construction with an environmentally friendly approach is the latest challenge in construction industry that is globally faced. As petroleum and crude oil resources are diminishing day by day bituminous and asphalt pavements will be a myth in near future hence studies are going on in the area of rigid pavement construction to improve quality of rigid pavements, reducing its construction cost etc... As a part of which usage of various industrially generated wastes in rigid pavements came into spotlight, usage of some of these industrially generated wastes as mineral admixtures satisfies above requirements. Vitrified tiles industry is the largest growing industry in the country with increased constructional needs of country it is estimated that the waste produced from each plant per day is nearly 10-15 tonnes **(S. N. Misra, B.B. Manchhoya et.al.,[1]2013**) and its production is increasing 20% every year **(K.Purnanandam et.al.,[2]2013**) which is a serious environmental issue, studies showed that these waste possess good pozzolanic properties, and hence here an attempt is made to use this VPW in pavement construction along with polyester fibre Recron 3-S to enhance the properties of pavement, thereby leading to good quality pavement construction and reducing disposal problems.

II. LITERATURE REVIEW

Gina Matias,Maulina Faria, Isabel Torres,[3] (2014) studied about the lime mortars partially replaced with ceramic waste and influence on their mechanical behaviour, they found that in terms of mineralogical identification, silica and alumina compounds were detected (though the amount of these materials in the amorphous state was not determined). The presence of limestone was also detected in wastes derived from roof tiles, bricks and pottery. **Luiz Renato, Steiner Adriano et.al, [4]** (2015) studied about the

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properties of sludge coming from polishing of ceramic tiles. They conducted, x-ray diffraction, x-ray fluorescence (composition), laser diffraction (particle size) to know about the physical and chemical properties of this sludge and recommended its usage as supplementary Cementous material (SCM), **Abhinav. S. Pawar, K. R. Dhabekar [5]** (2014) studied the behaviour of rigid pavement (concrete) which occurs when cementing waste material (GGBS) and steel fibres are added and to compare with normal concrete of M40 grade. GGBS replacement ratios (10%, 20%, 30%, 40% and 50%).The comparison between normal concrete, GGBS concrete and with steel fibre concrete was made. Optimum results were found at addition of 30% GGBS and 1% steel fibres to the mix, **Venkata Sairam Kumar, N. B. Panduranga Rao et.al [6]** (2013) have investigated on partial replacement of cement with quarry dust for studying mechanical properties of concrete. In this experimental work, the percentages of quarry dust used as a partial replacement of cement in concrete was 0, 10%,15%, 20%, 25%, 30%, 35%, and 40% for M20, M30, M40 grade concrete. They have concluded from the experimental studies that 25% of partial replacement of cement with quarry dust improved hardened concrete properties. **Srinivasan, K. Sathiya [7]** (2010) studied the effect of partial replacement of cement with industrially generated bagasse ash in M 20 grade of concrete and found improved properties of flexural and compressive strength, and suggested an advantageous replacement of up to 10%. **K. Dhillon. Ramandeep, Sharma. Shruti et.al, [8] (2014)** studied the effect of steel and polypropylene fibres on fly ash concrete Cement has been replaced with 15, 20 and 25 per cent fly ash by mass. Two types of fibres, steel as well as polypropylene fibres have been used in percentages of 0.5% and 1.0% by volume and observed an increase in strength because of fibre addition. **Shaik. Allimran Tippu, Vr. Prasanth Kumar, [9] (2015)** studied the properties of concrete admixed by replacing cement with silica fume in varying proportions of 5% and usage of coconut shells as coarse aggregate and concluded in his investigation that usage of silica fume at 30% with coconut shell aggregate gave optimum results.. A through study on Indian standard codes for laboratory sampling, and testing of concrete and materials used is also done before proceeding into testing phase which includes the following codes (**IS: 10262-2009 [10], IS: 456-2000 [11], IS: 2386-1963 [12], IS: 4031-1988 [13], IRC: 44-2008 [14], IS: 516-1959 [15]**), the design of rigid pavement is performed according to standards specified by **IRC: 58-2002 [16].**

III. OBJECTIVE OF THE STUDY

The objective of the study is

A. To study the characteristic properties of vitrified polish waste (VPW) as an effective cementitious replacement material, finding optimal addition of VPW replacement

B. Evaluating compressive and flexural characteristics of concrete replaced with optimal amount of vitrified polish waste and recron-3s polyester fibre, thereby finding optimal fibre addition.

C. Testing durability characteristics of optimum mixes, evaluating change in strength characteristics

IV. METHODOLOGY

The experimental study is conducted according to the following methodology, the required materials for the study are collected and necessary preliminary investigations are performed. Assessing the attained results mix design calculations for M 40 grade are performed and samples are casted for varying proportions from 5% of VPW replacement. The casted samples are tested for compressive and flexural strengths for 7 and 28 days and optimum additions of VPW found, Recron-3s fibre in incremental proportions of 0.1% is added to this optimum and optimum fibre addition that supplements optimum VPW is found out. The methodology is represented in Fig. 1 as a flow chart.

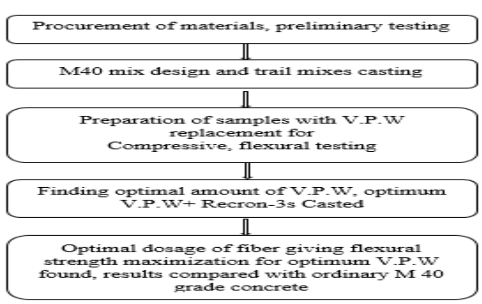

Fig 1: Flow chart showing methodology

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V. MATERIAL INVESTIGATION

A. Cement

Ordinary Portland cement of 43 grade confining to **IS: 8112-2013 [17]** is used in the experimental investigation. Table. 1 shows the chemical composition of cement used and Table. 2 shows the properties of cement tested according to IS: 4031-1988.

TABLE 1: Chemical Composition of Cement

Oxide composition	Percentage %
SiO_2	21.80
Al_2O_3	6.50
Fe_2O_3	3.71
CaO	60.50
MgO	3.35
SO_3	0.50
K_2O	0.20
Na_2O	0.15
L.O.I	1.5

TABLE 2: Properties of Cement

Test	Result
Specific Gravity	3.12
%Fineness of Cement	98%
Normal Consistency	31%
Initial Setting Time	50 min
Final Setting Time	185 min
Soundness	2mm

B. Fine Aggregate

The fine aggregate used in this experimental investigation is river sand bought from Nagavali river region confining to **IS: 383-1987 [18]** specifications ,the sample is sieved to remove deleterious, oversized particles and tested for its properties according to IS: 2386-1963 and the results are displayed below in Table. 3. The sieve analysis of fine aggregate is conducted to know the gradation of the aggregate, its zoning according to IS: 383-1987 and fineness modulus. For this investigation 1000 g of fine aggregate is taken and sieved. The fine aggregate used can be placed under zone-III according to IS: 383-1987 as the %passing through 0.6μ sieve satisfying zone-III requirements and the fineness modulus calculated is attained as 2.43 and the graphical representation for grain size analysis is shown in below Fig. 2

Test	Result
Specific Gravity	2.67
Sieve Analysis	Zone-III
Fineness Modulus	2.43
Bulking of Sand	35.67@ 6% w.c
Water Absorption	1%

TABLE 3: Properties of Fine Aggregate

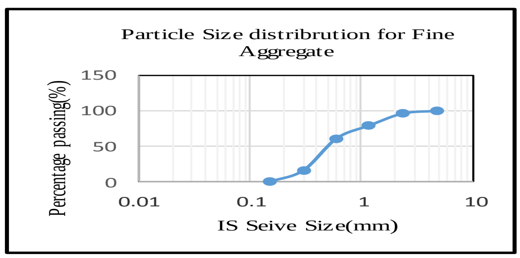

Fig 2: Gradation of Fine Aggregate

C. Coarse Aggregate

In this investigation crushed stone aggregate of sizes 20mm and 10mm are used which are in accordance with IS: 383-1987 . Specific gravity for both fractions attained same, flakiness and elongation index attained for sample is < 15% and tested for properties according to IS: 2386-1963 and the results are displayed below in Table. 4

TABLE 4: Properties of Coarse Aggregate

Test	Result
Specific Gravity	2.69
Crushing Value	18.5%
Impact Value	22.8%
Abrasion Value	21.5%
Water Absorption	0.5%

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D. Vitrified Polish Waste (VPW)

VPW is a waste material generated from tiles industry, for this investigation VPW is collected from R.A.K Ceramics, Samalkot, East Godavari district, Andhra Pradesh, India and used, in this investigation the specific gravity of VPW was found out to be 2.46 and attained a fineness of 98% when passed through 90 micron sieve. The composition of VPW is shown in below Table. 5 and the material look as shown in Fig. 3.

TABLE 5: Composition of V.P.W

Oxide composition	Percentage %
SiO_2	49.52
Al_2O_3	14.70
CaO	1.40
Fe_2O_3	0.40
MgO	2.45
Na_2O	2.71
K_2O	2.69
P_2O_5	0.05

Fig 3: VPW used in Study

E. Recron-3S Polyester Fibre

The Recron polyester fibre used in the study is attained from Reliance Industries Limited (R.I.L), this is an eco-friendly fibre which disperses and separates in the concrete mix and improves flexural strength, reduces shrinkage cracking and also helps in increase of durability. The properties of Recron polyester fibre are shown below in Table. 6 and Recron fibre shown in Fig. 4

TABLE 6: Physical Properties of Recron-3S

Property	Value
Cut length	12 mm
Shape	Special Triangular
Colour	Brilliant white
Material	Polyester
Tensile Strength	4000-6000 kg/cm^2
Aspect ratio	340
Young's modulus	17.5x10^3 Mpa

*Courtesy Reliance Industries

Fig 4: Recron-3S Fibre

F. Mixing Water

Water is the major ingredient of concrete, the water used for casting and curing of concrete should be free from acids, bases and other unwanted impurities. Since water is an important participant in chemical reaction with cement and formation of C-S-H gel the quality of water used should be monitored carefully. Ordinary potable drinking water confining to IS: 456-2000 is used in this test procedure.

G. Chemical Admixture

Because of the fineness of cement particles they form lumps when water is added to concrete, this process traps considerable

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amount of water in mixing stage and reduces workability. To counter this problem and to attain good workability with low water/cement ratio a chemical admixture Master Rehobuild 823 PQ manufactured by B.A.S.F industries is used as plasticizer. This product is in accordance with **IS: 9103-1999 [19]** and is chloride free. This is a brown coloured solution and disperses immediately in mixing water. Based on trial and error method optimum dosage attained is 0.7% by weight of cementitious material used which gave a reduction of 15% water content. The other physical properties of plasticizer used are shown in Table. 7

.

TABLE 7: Properties of Plasticizer

Property	Value
Density	1.19
pH	>6
Specific gravity	1.190
Chloride content	Nil
Slump retention	3-4 hours
Air entrainment	Approx. 1%

*Courtesy BASF Industries

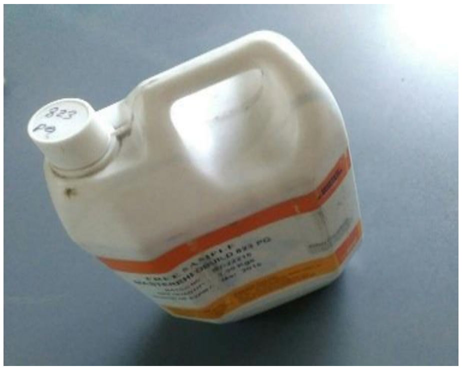

Fig 5: Master Rehobuild 823 PQ

VI. MIX PROPORTIONING

Mix design for M40 grade of concrete used in this investigation is made following the codal specifications of IRC: 44-2008 in accordance with IS: 10262-2008. The mix design is based on the properties of materials used. Trail mixes are casted with varying proportions of materials and W/C ratios to select the mix with better workability, strength and economy. The mix was designed for a slump of 25-50±5 mm which is desirable for road construction. The obtained mix proportion is (1:1.529:2.987) with 0.38% W/C ratio. The coarse aggregate used consists of 60% 20mm aggregates and 40% 10mm aggregates. Necessary batch corrections were done during casting. The details of the design mix used is given below in Table. 8. Samples are prepared by replacing cement with VPW to this mix in incremental proportions of 5%, 10%...until the optimum dosage is found and later fibre addition is done to this optimum replacement.

TABLE 8: Mix Proportion Details

Ingredient	Weight
Cement	418.421 Kg/m^3
Fine Aggregate	640.14 Kg/m^3
Coarse aggregate	1250 Kg/m^3
Water	159 lit
Plasticizer	2.94 lit

VII. EXPERIMENTAL INVESTIGATION FOR FINDING OPTIMUM VPW

A. Preparation of Samples and Casting

The preparation of samples for testing is done by mixer, with coarse aggregate first and followed by sand, cement and VPW, the plasticizer is added to mix by diluting with mixing water. The total mixing time is 3 minutes and the mixing of VPW with cement was done until uniformity in colour was achieved. Recron fibres are added in later stage after finding optimum VPW and blended thoroughly. This mix was then transferred to cube moulds (150x150x150mm) and prism moulds (500x100x100 mm) for casting which are oiled previously. The mix is placed in 3 layers in the mould and compacted with tampering rod, then table vibration is done to expel air and the top surface is finished with a trowel. The water absorption capacity and moisture content were taken into consideration and necessary batch corrections were performed during casting. The samples were casted and left for 24 hours before demoulding, and then they were placed in a curing tank and cured for 7 days and 28 days

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B. Testing Methods

Experimental investigation on fresh concrete mix was done by using a slump cone test following codal specifications of IS: 516-1959. Similarly tests on hardened concrete like compressive strength test and flexural strength test for 7 and 28 days were also done following IS: 516-1959

C. Mix Designations for VPW Replacements

The below is the tabular form Table. 9 showing mix designations and quantity of materials used and the constituents of mixes are detailed in Table. 10 as follows

TABLE 9: Mix Designations for VPW Replacement

Mix Name	Constituents
CC	Design mix
VPW 1	CC+5% VPW
VPW 2	CC+10% VPW
VPW 3	CC+15% VPW
VPW 4	CC+20% VPW
VPW 5	CC+25% VPW
VPW 5	CC+30% VPW

TABLE 10: Constituents of VPW Replacement

S. no	Mix Name	Quantity of Materials Used						
		Cement (kg)	VPW (kg)	F.A (kg)	C.A (kg)	Wate r(lts)	Ch. A (lts)	Fibre (kg)
1	C.C	418.42	0	640.14	1250	159	2.94	0
2	VPW 1	397.43	20.921	640.14	1250	159	2.94	0
3	VPW 2	376.57	41.842	640.14	1250	159	2.94	0
4	VPW 3	355.65	62.763	640.14	1250	159	2.94	0
5	VPW 4	334.73	83.684	640.14	1250	159	2.94	0
6	VPW 5	313.89	104.53	640.14	1250	159	2.94	0
7	VPW 5	292.3	125.52	640.14	1250	159	2.94	0

D. Test on Fresh Concrete (Slump Cone Test)

Test on fresh concrete is conducted to know and analyse the workability of the mix. Slump cone test is conducted to analyse the workability of the mix in this investigation. The following shown is the result of slump cone test conducted for varying VPW proportions for control mix which showed a reduction in slump with increase in VPW addition. Table. 11 and Fig. 6 will give a complete detailing.

TABLE 11: Slump Values for VPW Replacement

Mix Name	Slump (mm)
C.C	55
VPW 1	52
VPW 2	48
VPW 3	45
VPW 4	41
VPW 5	38
VPW 6	35

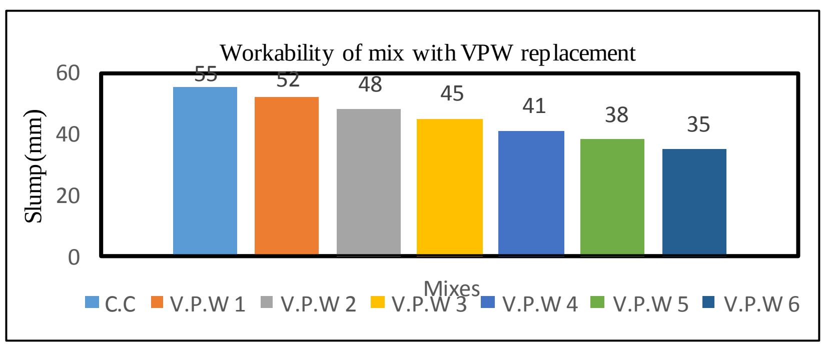

Fig 6: Graphical Representation of Slump Values

E. Tests on Hardened Concrete

Tests on hardened concrete also known as tests for measure of strength and durability of concrete they give us an insight to various aspects of concrete behaviour under loading, here in this investigation since the design for pavement is based on flexural strength of concrete according to IRC: 44-2008, tests such as compressive strength test and flexural loading test are performed on concrete, these tests are important because they are also an indirect measure of various properties like resistance to shrinkage, young's modulus, durability etc. From these results the optimum VPW dosage which gives maximization of compressive and flexural strengths for mix is selected, details of which are explained below.

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F. Compressive Strength Test

The crushing strength of hardened concrete is determined through compressive strength test. For this test cubes of dimensions (150x150x150 mm) are prepared with incremental replacements of VPW and tested for compressive strength for 7 and 28 days, the cubes were air dried before testing. Three cubes were tested for each mix and average value of 3 cubes attained is taken as compressive strength for that mix, the test was performed according to IS: 516-1959. The specimens are subjected to a rate of loading of 5.25 kN/s in a Compressive Testing Machine (C.T.M) of capacity 2000 KN.

$$Compressivve\ Strength = \frac{Failure\ load\ applied\ (P)}{Area\ of\ specimen\ (A)}$$

The details of compressive strength of samples with VPW replacements is shown in below Table. 12, from the table it is clear that the compressive strength showed a significant increase when VPW is added to concrete mix up to 15% addition and later it showed fluctuation and gradually started decreasing. The maximum compressive strength is attained at 15% addition where it showed an increment of 9.14% and 11.54% for 7 and 28 days when compared to design mix. The results are detailed in graphical forms shown in Fig. 7 below.

TABLE 12: Compressive Strength Values for VPW Replacement

S.no	Mix Name	Compressive Strength (Mpa)	
		7 Days	28 Days
1	C.C	33.8	48.60
2	VPW 1 (5%)	34.60	49.82
3	VPW 2 (10%)	35.72	52.65
4	VPW 3 (15%)	36.90	54.21
5	VPW 4 (20%)	34.29	51.42
6	VPW 5 (25%)	31.64	47.32
7	VPW 6 (30%)	29.50	43.24

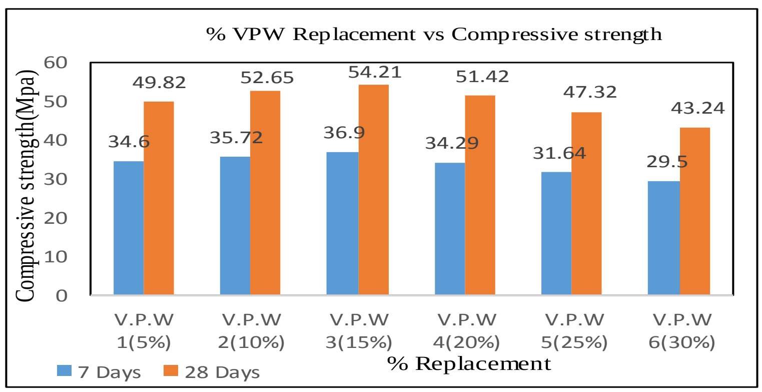

Fig 7: % VPW Replacement Vs Compressive Strength

G. Flexural Strength Test

Flexural strength also known as modulus of rupture is calculated as per the following procedure, prisms of dimensions (500x100x100 mm) were casted and cured for 7 and 28 days respectively then they are dried and tested in a Universal Testing Machine (U.T.M) of 2000 kN capacity following the test procedure mentioned in IS: 516-1959. The load is applied as a third point loading which will ensure the loads are applied without any eccentricity. The axis of specimen aligned with axis of the machine, then the load is applied through two steel roller bars attached to third point of loading device and placed on two lines 13.3 cm apart on the prism, Load is applied without shock and increased gradually @ 180 kg/min or 1.8 kN/min, the failure load is noted and the flexural strength is calculated by below formulae and reported in N/mm^2, the average flexural strength of three prisms is taken as flexural strength of that mix, the results are shown on below Table. 13

$$Flexural\ Strength = \frac{Pl}{bd^2}\ if\ a > 13.3\ cm\ or$$
$$= \frac{3Pa}{bd^2}\ if\ a\ between\ 11\ to\ 13.3\ cm$$

Where

P = Peak or maximum load applied in N
l = Length in mm of span for which specimen was supported
a = Distance between line of fracture and nearest support
b = Breadth of specimen in mm
d = Height of specimen in mm

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TABLE 13: Flexural Strength Values for VPW Replacement

S.no	Mix Name	Flexural Strength (Mpa)	
		7 Days	28 Days
1	C.C	4.34	5.20
2	VPW 1 (5%)	4.80	5.96
3	VPW 2 (10%)	4.94	6.74
4	VPW 3 (15%)	5.34	7.12
5	VPW 4 (20%)	4.89	6.84
6	VPW 5 (25%)	4.40	5.25
7	VPW 6 (30%)	3.92	4.62

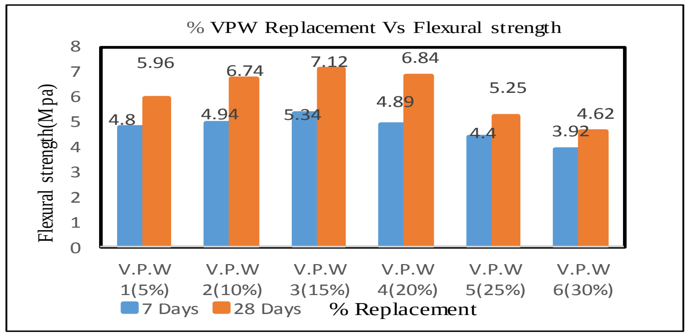

Fig 8: % VPW Replacement Vs Flexural Strength

From the table above the flexural strength also showed an increment because of addition of VPW the flexural strength increased to tis maximum at 15% replacement by 23.4% for 7 days and 36.92% for 28 days when compared to design M40 mix. The results are shown in graphical form in above Fig. 8

H. Relation between Compressive Strength

The compression and flexural strength values of concrete replaced with varying proportions of VPW for 28 days is regressed linearly to check the R^2, goodness and consistency of data, a trend line is drawn and to assess the relation and equation is developed for plotted points as shown in below Fig. 9. From the below graph R^2 value attained is 0.955 which is close to 1 hence we can say that the data is having a good fitness level.

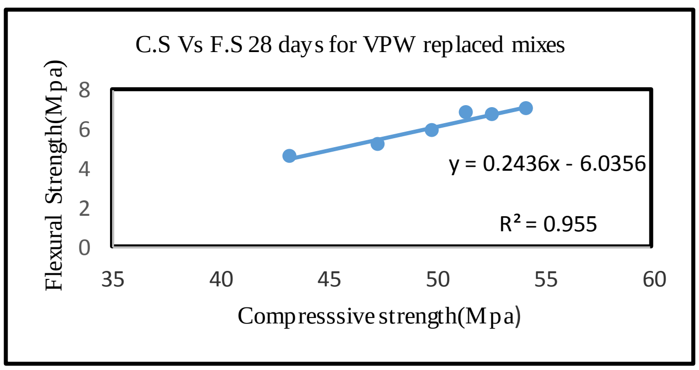

Fig 9: C.S Vs F.S at 28 Days for VPW Replaced Mixes

I. Water Absorption Test

Water absorption is also an important test to know the durability of concrete in long run, the water absorption test for the concrete cubes casted for the various mixes replaced with VPW is conducted as per the following procedure. The test is carried to know the 28 days water absorption, first the cubes are casted and cured for 28 days, then the cubes are taken out from water then wiped off with cloth and oven dried at 110^0C for 24 hours until constant weight attained, then its weight is noted as dry weight W_1, then the cubes are immersed in water for 3 hours and its saturated weight is noted as W_2, now from this water absorption is calculated by following formulae. The details of water absorption test are as shown in bellow Table. 14. From the tabular form it can be observed that the water absorption is increasing with increase in VPW content.

$$Water\ Absorption\ \% = \frac{Wet\ weight(W_2) - Dry\ weight(W_1)}{Dry\ Weight(W_1)} x100$$

TABLE 14: W.A Details for VPW Replacement @28 days

S.no	Mix Name	W.A % 28 days
1	C.C	0.60%
2	VPW 1 (5%)	1.54%
3	VPW 2 (10%)	1.76%
4	VPW 3 (15%)	1.84%
5	VPW 4 (20%)	1.97%
6	VPW 5 (25%)	2.23%
7	VPW 6 (30%)	2.34%

Hence from the above testing it is can be concluded that the optimum addition of VPW content is 15% to the design mix which causes a considerable increase in compressive and flexural strength of design mix now to enhance its flexural properties even more the optimum VPW is added to Recron-3s polyester fibre and further investigation is carried as follows

VIII. RECRON-3S FIBRE ADDITION FOR OPTIMUM VPW

A. Mix Designations for Optimum VPW with Recron-3S Concrete

The method of preparing samples and codes followed are same as mentioned above. The below is the tabular form showing mix designations for optimum VPW replacement for Recron polyester fibre. The mix designations are shown in Table. 15 and mix constituents in Table. 16

TABLE 15: Optimum VPW + Recron -3S Mix

Mix Name	Constituents
C.C	Design mix
VPW R1	CC+15% VPW+0.1%R.P.F
VPW R2	CC+15% VPW+0.2%R.P.F
VPW R3	CC+15% VPW+0.3%R.P.F
VPW R4	CC+15% VPW+0.4%R.P.F
VPW R5	CC+15% VPW+0.5%R.P.F

*R.P.F=Recron Polyester Fibre

TABLE 16: Constituents of Optimum VPW + Recron- 3S

S. no	Mix Name	Quantity of Materials Used						
		Cement (kg)	VPW (kg)	F.A (kg)	C.A (kg)	Water (lts)	Ch. A (kg)	Fibre (kg)
1	VPW R1	355.65	62.76	640.14	1250	159	2.94	0.418
2	VPW R2	355.65	62.76	640.14	1250	159	2.94	0.836
3	VPW R3	355.65	62.76	640.14	1250	159	2.94	1.255
4	VPW R4	355.65	62.76	640.14	1250	159	2.94	1.673
5	VPW R5	35.65	62.76	640.14	1250	159	2.94	2.092

B. Slump Cone Test

The slump cone test results for assessing the workability of optimum VPW replacement with varying Recron fibre dosage is as shown in below Tabular form Table. 17 and Fig. 10. It is observed that the slump further decreases on addition of fibres to the mix of optimum VPW.

TABLE 17: Optimum VPW+ Recron -3S Mixes Slump Values

Mix Name	Slump (mm)
VPW R1	42
VPW R2	40
VPW R3	37
VPW R4	35
VPW R5	33

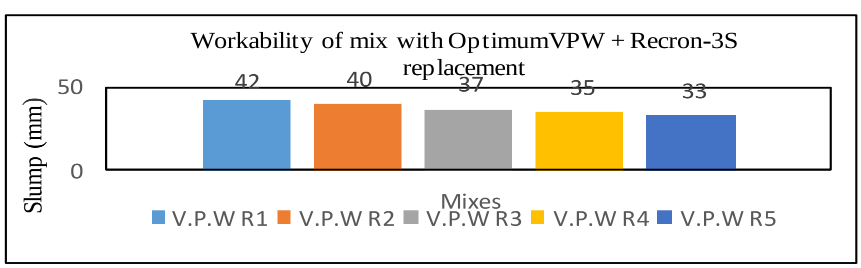

Fig 10: Graphical Representation of Slump Values

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C. Compressive Strength Test

For the above found optimum dosage of VPW i.e. 15%, Recron polyester fibres are added in incremental additions of 0.1% and compressive strength and flexural strengths are evaluated by following test procedures mentioned in IRC: 516-1959. The results of compressive strength are detailed in Table. 18 and Fig.11 below.

S. no	Mix Name	Compressive Strength (Mpa)	
		7 Days	28 Days
1	C.C	33.8	48.60
2	VPW R1 (0.1%)	39.41	55.82
3	VPW R2 (0.2%)	39.72	58.67
4	VPW R3 (0.3%)	40.14	60.12
5	VPW R4 (0.4%)	36.12	53.24
6	VPW R5 (0.5%)	32.26	46.46

TABLE 18: C.S Values for Optimum VPW+R.P.F Mixes

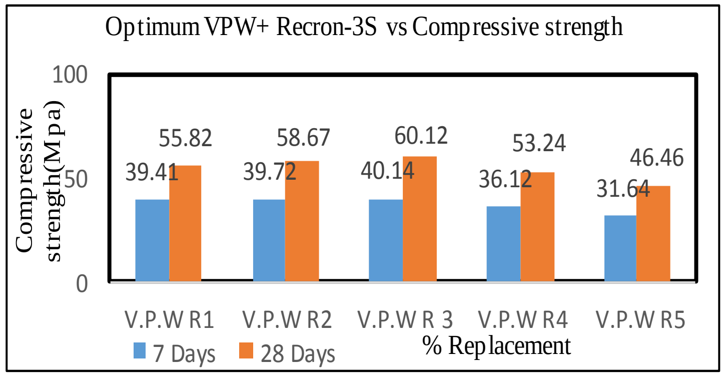

Fig 11: % Optimum VPW+R.P.F Replacements Vs C.S

from the above tabular form it is understandable that compressive strength increased considerably when compared to design mix, the addition of fibres to optimum amount of VPW showed an increase in compressive strength trend up to 0.3% addition and started fluctuating, the optimum addition is found at 0.3 % where it showed an increase of 18.75% and 23.70 % when compared to design mix.

D. Flexural Strength Test

The flexural strength details for the addition of Recron-3s fibre for optimum dosage of VPW is as displayed in Table. 19, the test is conducted according to similar procedure mentioned in IS: 516-1959 and the results are analysed. From the above table it is analysed that flexural strength increase is predominant due to addition of fibre from initial stage itself, maximization of flexural strength occurred at 3% addition of fibre to optimum VPW, the flexural strength increased by 41.7% and 57.8% for 7 days and 28 days when compared to flexural strength of design mix. The flexural strength details are illustrated in graphical form in below Fig. 12.

TABLE 19: F.S Values for Optimum VPW +R.P.F Mixes

S. no	Mix Name	Flexural Strength (Mpa)	
		7 Days	28 Days
1	C.C	4.34	5.20
2	VPW R1 (0.1%)	5.60	7.68
3	VPW R2 (0.2%)	5.85	7.92
4	VPW R3 (0.3%)	6.14	8.26
5	VPW R4 (0.4%)	5.90	7.35
6	VPW R5 (0.5%)	5.40	6.70

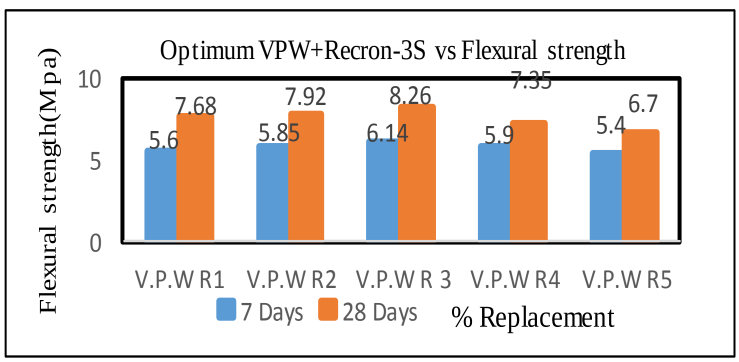

Fig 12: %Optimum VPW+R.P.F Replacements Vs F.S

E. Relation between compressive and Flexural strengths

The compressive and flexural strength values attained at 28 days for replacement of optimum VPW with varying Recron fibre dosages is regressed linearly and tested for R^2 values to attain the linear reliability, the graph is plotted and analysed as shown in below Fig. 13. From the graph R^2 value attained is 0.98 which is also very close to 1 hence the linear reliability of attained data is very good and the values are having a good fit.

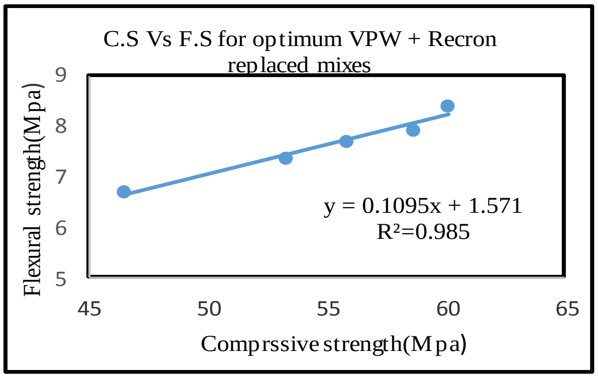

Fig 13: C.S Vs F.S for Optimum VPW+R.P.F Mixes @28 Days

F. Water Absorption Test

Water absorption test is carried out for optimum replacement of VPW mixed with varying fibre dosages and the test is carried as similar to procedure mentioned above and the results observed are presented in below Table.20 It can be observed from above table that the water absorption has an increasing trend but it is comparatively low when compared to design mix replaced with varying VPW content this reduction is caused by the addition of fibres, hence water absorption is decreased and durability increased by addition of fibres.

TABLE 20: W.A Details of Optimum VPW+R.P.F Mixes @28 Days

S.no	Mix Name	W.A % 28 days
1	VPW R1 (0.1%)	0.74
2	VPW R2 (0.2%)	0.82
3	VPW R3 (0.3%)	0.88
4	VPW R4 (0.4%)	0.94
5	VPW R5 (0.5%)	1.20

From the above experimental procedures it is evident that the 0.3% addition of fibre to optimum VPW addition gives flexural and compressive strength maximization, now these results are analysed as follows in brief.

IX. COMPARISION OF STRENGTHS OF OPTIMAL REPLACEMENTS

The compressive and flexural strengths attained for optimal mixes along with design mix is detailed in the Table. 21 below.

TABLE 21: C.S and F.S Values of Optimal Mixes and C.C

S.no	Mix name	Constituents	C.S(Mpa) 28 days	F.S(Mpa) 28days
1	C.C	C.C	48.60	5.20
2	VPW 3	C.C+VPW 15%	54.21	7.12
3	VPW R3	C.C+VPW 15%+0.3%R.F	60.12	8.26

From the table it is evident that there is an increase in compressive and flexural strengths because of addition of VPW and Recron polyester fibres to design mix. Compressive strength increased by 11.54 % and flexural strength by 36.92 % by optimum VPW addition when compared to design mix, similarly compressive strength increased by 10.9% and flexural strength by 16 % when Recron fibres are added to optimum VPW mix when compared to optimum VPW mix without fibres, the reduction in water absorption is also induced by fibre addition, hence these mixes show considerable increase in mechanical properties and durability when compared to design mix. The graphical representation of compressive and flexural strengths for optimal mixes are shown in below Fig. 14 and Fig. 15.

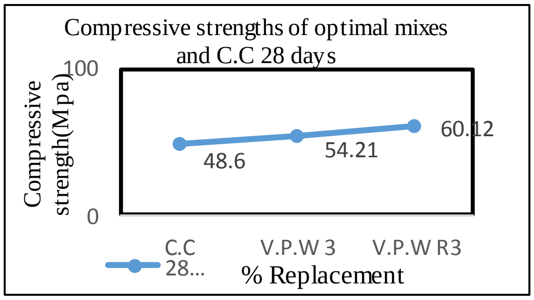

Fig 14: C.S Detailing of Optimal Mixes and C.C @28 Days

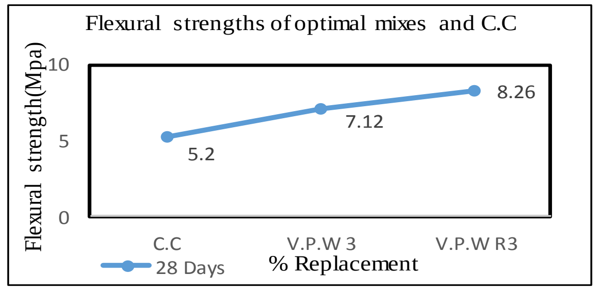

Fig 15: F.S Detailing of Optimal Mixes and C.C @28 Days

X. CONCLUSIONS

A. The following are the major conclusions drawn from this experimental investigation

B. The optimum addition of VPW to M 40 grade design mix is fund at 15% where compressive and flexural strength maximization occurred.

C. At 15% addition of VPW to M40 grade go concrete compressive strength increased by 9.14% and 11.54% for 7 and 28 days when compared to conventional mix

D. Similarly at 15% VPW addition the flexural strength of mix increased by 23.4% and 36.92 % for 7 and 28 days when compared to conventional mix.

E. Although up to 20% VPW can be added without any considerable loss in strength of Mix

F. The optimum dosage of fibre to optimum VPW is 3% i.e. (15% VPW+ 3% R.P.F) mix gave optimal values.

G. For 3% addition of R.P.F with optimum VPW compressive strength increased by 18.75% and 23.70 % when compared to conventional M40 mix.

H. The compressive and flexural strengths of optimum VPW mix with 3% R.P.F increased by 10.9% and 16% for 28 days when compared to VPW optimum mix without fibres.

I. Similarly flexural strength increased by 41.7% and 57.8% for 3% addition of R.P.F with optimum V.P.W

J. The compressive and flexural of all mixes strengths showed good regression relation and R^2 value attained is close to 1 in both the cases

K. The workability of the mix decreased gradually because of VPW addition and when further fibre is added to mix the workability decreased even more

L. The water absorption increased considerably with increase in VPW addition, when fibers are added to optimum VPW this increased further

M. Problem of environmental disposal of industrial wastes tackled through this experimental investigation leading to sustainable and eco- friendly pavement construction.

XI. FUTURE SCOPE

Further investigations can be carried on several industrial wastes suitability in concrete making individually or compositely. VPW usage with combination of other industrial wastes in concrete making can be analysed. They also can be tested with fibres singly or with a combination to achieve desired properties for the concrete mix. Studies should be encouraged towards innovative materials usage in concrete making which is beneficial in both constructional and environmental aspects.

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REFERENCES

[1] S. N. Misra, B. B. Manchhoya et.al, "Thermo physical characteristics of vitrified tile polishing waste for use in traditional ceramics. An innovative of CGCRI, Naroda Centre", International Journal of Modern Physics, Vol .22, pp. 118-133, 2013.

[2] K. Purnanandam, R. Dayakar Babu, P. Balaji Chakravarthy, V. Surya Prasad, "Strength characteristics of Vitrified Polish Waste modified with cement," Proceedings of Indian Geotechnical Conference Roorkee, pp. 1-6

Volume 4 Issue VIII, August 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)
[3] Gina Matias,Maulina Faria, Isabel Torres, "Lime mortars with ceramic wastes: Characterization of components and their influence on the mechanical behavior", The Journal Of Construction And Building Materials,Vol.73,pp.523-534,Dec 2014.
[4] Luiz Renato, Steiner Adriano et.al," Effectiveness of ceramic tile polishing residues as supplementary cementitious materials for cement mortars", The Journal Of Sustainable Materials And Technologies,vol.4,pp-30-35,April 2014.
[5] Abhinav.S.Pawar,K.R.Dabhekar,"Study of Concrete based Pavement by using Fibres and Cementing Waste Materials" International Journal of Research in Engineering and Technology,Vol-3,issue-5,May-2014.
[6] VenkataSairam Kumar, Dr.B.Panduranga Rao, Krishna Sai M.L.N," Experimental study on partial replacement of cement with quarry dust, International Journal of Advanced Engineering Research and Studies E-ISSN: 2249–8974. IS: 2720 (Part - 16)-1979, "Laboratory determination of CBR". June 2013.
[7] R. Srinivasan, K. Sathiya, "Experimental Study of Bagasse ash in Concrete", international Journal for Service Learning in Engineering, Vol. 5, No. 2, pp. 60-66, Fall 2010, ISSN 1555-9033.
[8] Dhillon. Ramandeep, Sharma. Shruti et.al, "Effect steel and polypropylene fibres on fly ash concrete", International Journal of Research in Advent Technology, Vol. 2, No. 3, March 2014, E-ISSN: 2321-9637
[9] Shaik. Allimran Tippu, Vr. Prasanth Kumar, "A study on effect of silica fume on mechanical properties of light weight coconut shell concrete", International Journal of Research in Engineering and Technology, Vol-4, Issue-4, April 2015, E-ISSN: 2319-1163
[10] IS: 10262-2009, "Recommended guidelines for concrete mix design, Bureau of Indian standards", New Delhi, India.
[11] IS 456 -2000, "Code of Practice for Plain and Reinforced Concrete", Bureau of Indian Standards, New Delhi.
[12] IS: 2386-1963, "Methods of testing aggregate for concrete".
[13] IS: 4031-1988, "Code for physical tests on O.P.C".
[14] IRC: 44-2008, "Recommended guidelines for mix design of Cement Concrete Pavements"
[15] IS: 516-1959, "Indian standard methods of tests for strength of concrete, Bureau of Indian Standards", New Delhi, India
[16] IRC: 58-2002, "Guide lines for the design of plain jointed Rigid Pavements for the Highways".
[17] IS: 8112-2013, "Indian standard specifications for OPC 43 grade cement".
[18] IS: 383-1987, "Indian standard specifications for coarse and fine aggregate from natural sources for concrete".
[19] IS: 9103-1999, " Indian standard specifications for concrete admixtures"