EXPERIMENTAL STUDY OF AN ECO-FRIENDLY PAVER BLOCK

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ABSTRACT - The aim of this project is to replace cement with plastic waste in paver block and to reduce the cost of paver block when compared to that of conventional concrete paver blocks. The degradation rate of plastic waste is also a very slow process. Hence the project is helpful in reducing plastic waste in a useful way. In this project we have used plastic waste in different proportions with fly ash, coarse aggregate. The paver blocks were prepared and tested and the results werediscussed for 9 casts

We are using LDPE plastic waste and completely replacement of cement. Adding fly ash replacement for cement. We did this to make it necessary for unwanted waste. Using round dumblepaver blockmould. The materials used in this work are fine aggregate, coarse aggregate, fly ash, plastic LDPE (Low Density Poleyethelene).

Key words :plastic waste LDPE.

INTRODUCTION

Paver block paving is versatile, aesthetically attractive, functional, and cost effective and requires little or no maintenance if correctly manufactured and laid. Most concrete block paving constructed in India also has performed satisfactorily but two main areas of concern are occasional failure due to excessive surface wear, and variability in the strength of block. Natural resources are depleting worldwide at the same time the generated wastes from the industry and residential area are increasing substantially. The sustainable development for construction involves the use of Non- conventional and innovative materials, and recycling of waste materials in order to compensate the lack of natural resources and to find alternative ways conserving the environment.

Plastic waste used in this work was brought from the surrounding areas. Currently about 56 lakh tonnes of plastic waste dumped in India in a year. The dumped waste pollutes the surrounding environment. As the result it affects both human beings and animals in direct and indirect ways. Hence it necessary to dispose the plastic waste properly as per the regulations provided by our government. The replacement of plastic waste for cement provides potential environmental as well as economic benefits.

With the view to investigate the behavior of quarry rock dust, recycled plastic, production of plastic paver block from the solid waste a critical review of literature was taken up. An attempt was made by Nivetha C et.al to reuse the solid waste quarry dust fly-ash and PET with an aim not to lose the strength far from original Paver blocks. From the observations of test results, PET can be reused with 50% of quarry dust and 25 % of fly-ash in Plastic Paver block. The physical and mechanical properties of materials used in Plastic Paver block were investigated. For the test 6 cubes cube were cast for measuring Compressive strength. SatishParihar et.al used recycled plastic aggregate in various proportions in concrete mix and check there stability.Amount of waste plastic being accumulated in 21st centuries has created big challenges for their disposal, thus obliging the authorities to invest in felicitating the use of waste plastic coarse aggregate in a concrete is fundamental to the booming construction industry. Three replacement levels of 10 %, 20 %, 30 by weight of aggregates were used for the preparation of the concrete. Poonam Sharma et. al. discussed about cement concrete paver blocks for rural roads. The study of Joel Santhosh and RavikantTalluri indicated that fly ash and waste glass powder can effectively be used as cement replacement without substantial change in strength.

Materials used

Cement

Fine Aggregate, Coarse Aggregate, Fly Ash

Plastic (LDPE)

Equipment

Paver blockmould, Metal bucket.

OBJECTIVE AND SCOPE OF THE STUDY

- To reduce the weight of the conventional concrete.
- To increases the compressive strength of the concrete.

- To reduce the amount of dumping of wastes in landfill and under seas.
- To make use of waste materials.

Mixing Of Materials

Mixing of materials for Conventional paver block Cement

1) Fine Aggregate & Coarse Aggregate
2) Water
3) Fly Ash

Mixing of Materials for ecofriendly paver block Plastic (LDPE)

1) Plastic (LDPE)
2) Fly ash
3) Fine aggregate
4) Coarse aggregate

EXPERIMENTAL PROCEDURE

Properties of materials
plastic waste(LDPE):

Plastic waste used in making paver block was collected from the surrounding locality LDPE is indicated by resin number 4. It includes plastic bags. The plastic bag used is of about 50 microns. The basic properties are provided below.

Fig 1 Waste plastic material LDPE

Table 1: PROPERTIES OF LDPE

Sl.No.	Particulars	Value
1	Melting point	150˚
2	Thermal co efficient of Expansion	$100\text{-}200X10^{-6}$
3	Density	0.910-0.940
4	Tensile strength	0.20-0.40(N/mm^2)

Fine Aggregate:

Fine aggregates comprise of natural sand and stone which are graded into Zone 1 to Zone 4 depending on its ability to move through the 600-micron. The zones become gradually finer from Zone-1 to Zone-4. As per zones, 90% to 100% of the fine aggregate moves through 4.75 mm IS sieve and 0 to 15% moves through 150 microns IS sieve. With adherence to the IS specifications, the fine aggregates are categorized into coarse sand, medium sand, and fine sand.

Coarse Aggregate:

Locally available coarse aggregates were used in this work. Aggregates passing through 12mm sieve and retained on 10mm sieve were sieved and tested as per Indian standard specification IS:383-1970.

Cement:

Cement can be defined as the bonding material having cohesive & adhesive properties which makes it capable to unite the different construction materials and form the compacted assembly. Ordinary/Normal Portland cement is one of the most widely used type of Portland Cement. It is used for general construction purposes where special properties are not required. It is normally used for the reinforced concrete buildings, bridges, pavements, and where soil conditions are normal. It is also used for most of concrete masonry units and for all uses where the concrete is not subject to special sulfate hazard or where the heat generated by the hydration of cement is not objectionable. It has great resistance to cracking and shrinkage but has less resistance to chemical attacks.

Fly Ash:

Fly ash is a by-product of the combustion of pulverized coal in thermal power plants. It is removed by the dust collection system as a fine particulate residue from the combustion gases before they are discharged into the atmosphere. Fly ash particles are typically spherical, ranging in diameter from less than 1 micron to 150 micron, the majority being less than 45 micron. The range of particle sizes in any given fly ash is largely determined by the type of dust collection equipment used. The fly ash from boilers at some older plants, where mechanical collectors alone are employed, is coarser than from plants using electrostatic precipitators. Fly ash can effectively be used as cement replacement without substantial change in strength.

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MIX DESIGN FOR CONVENTIONAL BLOCK

Mix design for M40

Grade = M40

Type of cement = OPC 43 grade

Fine aggregate zone – II

Specific gravity cement = 3.15

Fine aggregate = 2.61

Corse aggregate = 2.66

Max cement = 400 kg/m^3

Max w/c ratio = 0.45

Mix calculation

1.) Target mean strength = 40+5 x 1.65 = 48025 Mpa

2.) Strength of w/c ratio

Assume w/c ratio = 0.6

3.) Calculation of cement content

Assume cement content 400kg/m^3

4.) Calculation of water

400 x 0.4 = 160 kg

5.) Calculation of coarse aggregate and fine aggregate as per IS : 10262

Fine aggregate V = $[\ w + \frac{c}{sc} + \frac{1}{p} x \frac{fa}{s_{fu}}] \ x\ [\frac{1}{1000}]\ ]$

Coarse aggregate V = $[\ w + \frac{c}{sc} + \frac{1}{1-p}\ x\ \frac{ca}{s_{ca}}]\ x\ [\frac{1}{1000}]\ ]$

$0.98 = [\ 160 + \frac{400}{3.15} + (\frac{1}{0.365})\ (\frac{fa}{2.61})\ ]\ x\ [\frac{1}{1000}]\ ]$

Fa = 660.2 kg ≈ 660 kg

$0.98 = [\ 160 + \frac{400}{3.15} + (\frac{1}{0.635})\ (\frac{ca}{2.66})\ ]\ x\ [\frac{1}{1000}]\ ]$

Ca = 1170 kg

cement	Fine aggregate	Coarse aggregate	Water content
400	660	1170	0.4
1	1.65	2.93	0.4

CHAPTER 2

PRELIMINARY TEST RESUTS

Tests on Fine Aggregate :

Determination of particle size distribution by sieve analysis:

Test for grain size analysis or sieve analysis of aggregates are done to determine its particle size distribution, fineness modulus, effective size and uniformity coefficient. Fineness modulus of sand (fine aggregate) is an index number which represents the mean size of the particles in sand. It is calculated by performing sieve analysis with standard sieves. The cumulative percentage retained on each sieve is added and subtracted by 100 gives the value of fineness modulus.

Calculation :

Table 2.SIEVE ANALYSIS OF FINE AGGREGATE

dry weight of sample = 1000gm

Fineness modulus of sand = 260/100 = 2.6

Specific Gravity :

Specific gravity refers to the relative (as compared to water) density of a unit volume of aggregate. Specific gravity of the aggregate generally is indication of its quality. A low specific gravity may indicate high porosity and therefore poor durability and low strength. The range of specific gravity for aggregates is generally between 2.4 and 2.9

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SI. NO.	IS SIEVE SIZE	Weight retained (gm)	Percentage weight retained (%)	Cumulative percentage of weight retained (%)	Percentage of fineness(%)
1	4.75	25	2.5	2.5	97.5
2	2.36	60	6.0	8.5	91.5
3	1.18	465	46.5	55	45
4	600 µ	275	27.5	82.5	17.5
5	300 µ	95	9.5	92	8
6	150µ	70	7	99	1
7	75µ	5	0.5	99.5	0.5
8	Pan	5	0.5	100	0

Observation and Calculation:

$$\text{Specific Gravity of sand} = \frac{\text{Dry weight of sand}}{\text{weight of equal volume ofwater}}$$

$$G = \frac{(m_2 - m_1)}{(m_4 - m_1) - (m_3 - m_2)}$$

Mass of empty pycnometer , m_1= 615 gm

Mass of Pycnometer + soil sample, m_2 = 1000 gm

Mass of Pycnometer + soil sample + water, m_3 = 1755 gm

Mass of Pycnometer + water, m_4 = 1570 gm

$$G = \frac{(1000 - 615)}{(1000 - 615) - (1755 - 1510)} = 2.68$$

Specific Gravity of soil = 2.68

Test on Coarse Aggregate :

Sieve analysis (particle size distribution) of 10mm down coarseaggregate:

Totalweighttaken: 1000 grams

Table 3.SIEVE ANALYSIS OF COARSE AGGREGATE

Sample No.	Sieve No.	Weight Retained in kg	Cumulative Weight Retained in kg	% Cumulative Weight Retained	% Passing
1	12.5 mm	0.555	18.5	18.5	81.5
2	10 mm	0.8905	29.68	*48.18*	51.82
3	4.75mm	0.957	31.88	80.1	19.94
4	pan	0.597	19.90	100	

MixRatio

Block type 2- Three paver blocks were casted using mix ratio provided below

Plastic waste = 1 kg
Fly ash = 1 kg
Fine aggregate = 1.5 kg
Coarse Aggregate = 1.7 kg

Block type 3 - Three paver blocks were casted using mix ratio provided below

Plastic waste = 0.75 kg
Fly ash = 0.25 kg
Fine aggregate = 1.5 kg
Coarse Aggregate = 1.7 kg

Preparation of TestSpecimens :

Plastic wastes are heated in a metal bucket at a temp of above 150˚. As a result of heating the plastic waste melt. The materials fly ash, aggregate and other materials as described in previous chapter are added to it in right proportion at molten state of plastic and well mixed. The metal mould is cleaned through at using waste cloth. Now this mixture is transferred to the mould. It will be in hot condition and compact it well to reduce internal pores present in it. Then the blocks are allowed to dry for 24 hours so that they harden. After drying the paver block is removed from the moulds and ready for the use.

Fig 2 Experimental Setup for moulding process 1

Fig 3 Experimental Setup for melting process

Fig 4 Experimental Setup for moulding process 2

TestOn Specimen

Compressive strength for paver blocks

Plastic paver blocks of size 215 x 115 x 60mm were casted. The maximum load at failure reading was taken and the average compressive strength is calculated using the following equation.

Compressive strength (N/mm^2) = (Ultimate load in N / Area of cross section (mm^2))

Fig 5 Experimental Setup for Compressive test

Oven test

As the paver block is made of plastic we need to know its melting point hence over test is performed. The paver block is kept in oven for 2hours in oven and after 2 hours its condition is verified.

RESULT ANDDISCUSSION

Compressive Strength

BLOCK TYPE I

Table 4. COMPRESSIVE STRENGTH RESULT FOR BLOCK TYPE I

Conventional specimen	Cement	F A	C A	Compressive stress (N/mm²)
PPB-1	1	1.65	2.93	8.45
PPB-2	1	1.65	2.93	9.67
PPB-3	1	1.65	2.93	9.89
			Avg	9.33

BLOCK TYPE II

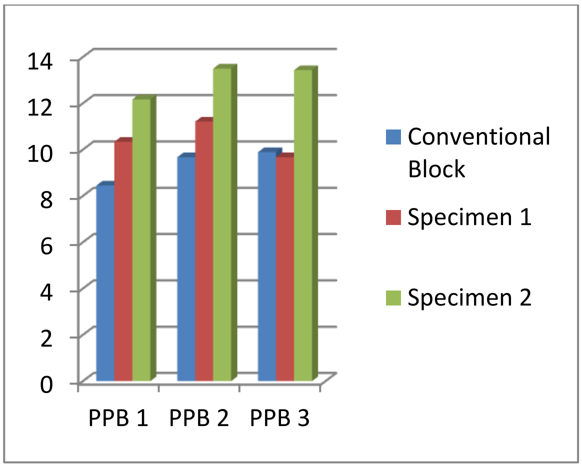
Table 5. COMPRESSIVE STRENGTH RESULT FOR BLOCK TYPE II

Specimen I	Plastic waste	Fly ash	C A	F A	Compressive stress (N/mm²)
PPB-1	1	1	1.7	1.5	10.34
PPB-2	1	1	1.7	1.5	11.21
PPB-3	1	1	1.7	1.5	9.67
				Avg	10.40

BLOCK TYPE III

Table 6. COMPRESSIVE STRENGTH RESULT FOR BLOCK TYPE III

Specimen II	Plastic waste	Fly ash	C A	F A	Compressive stress (N/mm²)
PPB-1	0.75	0.25	1.7	1.5	12.17
PPB-2	0.75	0.25	1.7	1.5	13.50
PPB-3	0.75	0.25	1.7	1.5	13.43
				Avg	13.03



Test result chart

Oven Test Result

Since the paver block is made of plastic it is required to know its heat resistance. Hence plastic paver block is placed in oven for 2 hours

Table 7. OVEN TEST RESULT

Specimens	Temperature (ºC)	Remarks
SPECIMEN I	50	no change
	100	no change
	150	Melts
SPECIMEN II	50	no change
	100	no change
	150	Melts

CONCLUSION

The following conclusions were drawn from the experimental investigation

- The utilization of waste plastic in production of paver block has productive way of disposal ofplastic waste.
- The cost of paver block is reduced whencompared to that of concrete paverblock.
- Paver block made using plastic waste, fly ash, fine aggregate and Coarse aggregate have shown better result.
- It also shows good heat resistance.
- Though the compressive strength is high when compared to the concrete paver block it can beused in gardens, pedestrian path and cycle way etc.
- It can be used inNontraffic and light traffic road
- It can be used as eco-friendly material for humans.
- The plastics dumped under the sea is reduced by replacing it as a eco-friendly material to improve our environment.
- By this method the unwanted waste plastic materials are converted into useful materials.

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