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RESEARCH ARTICLE

INVESTIGATION OF MECHANICAL PROPERTIES OF PAVER BLOCK MADE WITH EVA POLYMERS AND FLY ASH

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Abstract

The aim of the project is to replace cement with fly ash and course aggregate with Ethyl Vinyl Acetate (EVA) in paver block. In this thesis paver block design is by using cement concrete mixture of mix design M30 which is composed of 10mm coarse aggregate cement and fine aggregate (M-sand).In this thesis the cement is partially replaced with fly ash and partial replacement of EVA with coarse aggregate in paver block at various level of 5, 10, 15, and 20 percentage of its weight. The paver block curing process is done for 7days and 28days. After curing it is checked for its compression strength, water absorption test and densitytest.

Introduction:-

Block paving also known as Brick paving is a commonly used decorative method of creating a pavement or hardstanding. The main benefit of bricks over other materials is that individual bricks can later be lifted up and replaced. This allows for remedial work to be carried out under the surface of the paving without leaving a lasting mark once the paving bricks have been replaced. Typical areas of use would be for driveways, pavement, patios, town centres, and precincts more commonly in road surfacing. Bricks are typically made of concrete or clay, through other composite materials are also used. Each has its own means of construction. The biggest difference is the way they set hard ready for use. A clay brick has to be fired in a kiln to bake the brick hard. A concrete brick has to be allowed to set. The concrete paving bricks area porous form of brick formed by mixing small stone hard-core, dyes, cement and sand and other materials in various amounts. Many block paving manufacturing methods are now allowing the use of recycled materials in the construction of the paving bricks such as crushed glass and crushed old building rubble.There are many different laying patterns that can be achieved using block paving. The most common of these is the herringbone pattern. This pattern is the strongest of the block paving bonds as it offers the most interlock, therefore making it a good choice for driveways and road surfacing. A herringbone pattern can be created by setting the blocks at either 45 degrees or 90 degrees to the perpendicular. Other popular types of pattern include stretcher bond and basket weave; with the latter being better suited to paved areas that will only receive light foot traffic, due to its weaker bond.

Material Property:-

Ethylene-Vinyl Acetate:

Ethylene-Vinyl Acetate (EVA) also known as Poly Ethylene – Vinye Acetate, is the copolymer of ethylene and vinyl acetate. The weight percent vinyl acetate usually varies from 10 to 40%, with the remainder being ethylene. This amount of vinyl acetate greatly effects the character of the material. Higher quality EVA will have a higher percentage of vinyl acetate while EVA with very little vinyl acetate can be hard, brittle, and feel like cardboard.

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Ethylene-vinyl acetate is simply a soft plastic, it's the foaming process or "blowing" of EVA that makes it perfect for a shoe midsole. This amount of vinyl acetate greatly effects the character of the material. Higher quality EVA will have a higher percentage of vinyl acetate while EVA with very little vinyl acetate can be hard, brittle, and feel like cardboard. Ethylene-vinyl acetate is simply a soft plastic, it's the foaming process or "blowing" of EVA that makes it perfect for a shoe midsole.EVA is a waste from footwear industry was used in lightweight paver block. EVA waste showed high potential for use as masonry concrete and partitions. The acoustic performance of paving block with ethylene vinyl acetate (EVA) residues to reduce impact noise. Using EVA waste as lightweight aggregate shows good alternative approach for recycling plastic waste.

Fig 1:- Ethylene-Vinyl Acetate (Eva).

Table I:- Typical Characteristics

Property	Test method	Typical value	Unit
Vinyl Acetate content	RIL Test method	18	%
Density(23^{o}C)	ASTM D792	0.936	g/cm^{3}
Melt Flow Index	ASTM D1238	2	g/10min
Tensile strength at break	ASTM D638	20	MPa
Elongation at Break	ASTM D638	750	%
Vicat softening temperature	ASTM D1525(1Kg load)	64	^{0}C

Table II:- Physical properties of ethylene-vinyl acetate (eva).

Tensile strength	0.05-0.2 N/mm^{2}
Notched impact strength	No break Kj/m^{2}
Thermal coefficient of expansion	160-200 X 10^{-6}
Max cont use temperature	55-65^{o}C
Density	0.926-0.950 g/cm^{3}

Mix proportion:

The materials used for making Paver Block Made with Eva Polymers and Fly Ash are Ethylene-Vinyl Acetate (EVA)&Fly Ashas source material, Cement, Water(W),Aggregates includes fine aggregate(FA) and coarse aggregate(CA). IS mark 43 grade cement (Brand-ACC cement) was used for all concrete mixes. The cement used was fresh and without any lumps. Testing of cement was done as per IS: 8112-1989. The sand used for the experimental programme was locally procured and conformed to grading zone III as per IS: 383-1970.The sand was first sieved through 2.36 mm sieve to remove any particles greater than 2.36 mm and then was washed to remove the dust. Locally available coarse aggregates having the maximum size of 12.5 mm and 20mm were used in the present work. Testing of coarse aggregates was done as per IS:383-1970. The 12.5mm aggregates used were first sieved through 16mm sieve and 20mm aggregates were firstly sieved through 25mm sieve. They were then washed to remove dust and dirt and were dried to surface dry condition. Potable tap water was used for the concrete preparation and for the curing of specimens.SikaNoleek used to increase the workability and as water reducing agent. SikaNoleek is an integral water proofing admixture in powder form of concrete and mortar.

Table IV:- Mix proportion for m20 grade concrete.

Cement Kg/m^3	Fine aggregate Kg/m^3	Coarse aggregate Kg/m^3	Water Cement ratio Litres
375	921.5	1007.3	150

Table V:- Mix Proportion Ratio.

Cement	Fine aggregate	Coarse aggregate	Water Cement ratio Litres
1	2.68	2.45	0.45

FA: 10%, 15% & 20% replacement level of Fly ash by weight of sand and CA: 5%, 10% & 15% of EVA by weight of coarse aggregate

Mixing:-

After batching, the aggregates and binder are discharged separately or simultaneously, together with pigment if required, into the mixer and thoroughly mixed before any additional water is added. Mixes having high fines contents may require longer mixing. Based on measurement of the variable moisture content of the aggregates or visual assessment by experienced personnel, water is added to the mixture to bring it to OMC. Uniformity is important because differences in water content from batch to batch will result in differences in quality. It must be noted that certain pigments, because of their particle shape, can have a significant effect on OMC. After mixing, the mixture (and topping mix if required) is stored in hoppers ready for dispensing into the moulds.

Filling of moulds:-

Most production machines operate on one of two basic principles. In the first and more widely used system, an amount of mixture is progressively compacted under vibration until a predetermined height has been reached. In the second system, a gauged quantity of mixture is compacted for a set period. In both cases, variations in density will result if the gauged quantities are not consistent or the mixture is not uniformly distributed within the mould. These variations are over and above those due to variations in moisture content. Filling is usually facilitated by a period of previbration after which the moulds are “topped up” with a second filling of mixture. Where topping layers are used the “topping up” is done using a special topping mix. For very cohesive mixes some difficulty may be experienced when filling the moulds.3. Prototype model

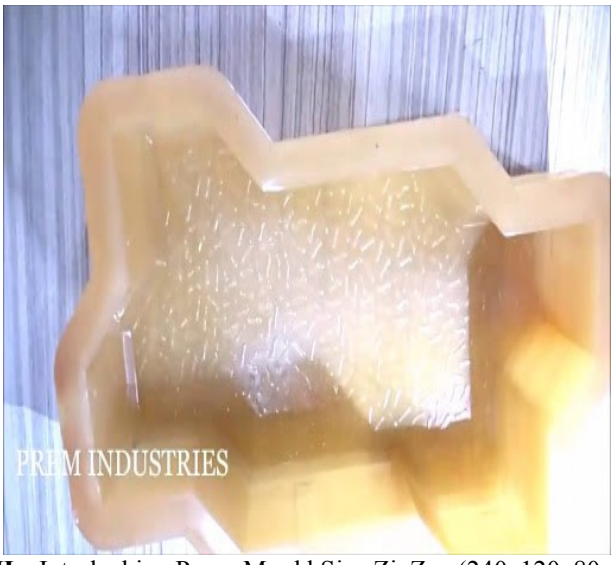

Fig II:- Interlocking Paver Mould Size ZigZag (240x120x80mm).

Compaction:-

The optimum period of vibration must be determined experimentally in the plant but is usually 3 to 12 seconds. Good compaction is more difficult to achieve in thicker blocks and those that have acute angles. For this reason concrete pavers with a thickness greater than 80 mm are seldom manufactured. Frequency and amplitude of vibration should be optimised for the specific materials being used and the number of blocks being moulded per cycle.

Curing:

As with all concrete products, the quality of concrete pavers is improved by water curing. However, it is not practicable to apply significant amounts of water onto newly moulded pavers or subsequently to subject them to water sprays or immersion in water. The phenomenon of efflorescence further complicates curing in practice. After moulding and on drying, soluble calcium hydroxide may migrate to the surface of the block, particularly if it is porous. Here the calcium hydroxide combines with carbon dioxide from the atmosphere to form less soluble calcium carbonate which is white in colour. Known as lime bloom, it is particularly noticeable on coloured pavers. Other than for aesthetic reasons, lime bloom is not a problem and will disappear with time by normal weathering and the action of rainwater which is mildly acidic. It can also be removed by chemical treatment. Unfortunately, the severity of lime bloom increases with effectiveness of wet curing.

Fig III.:- Curing of paving block.

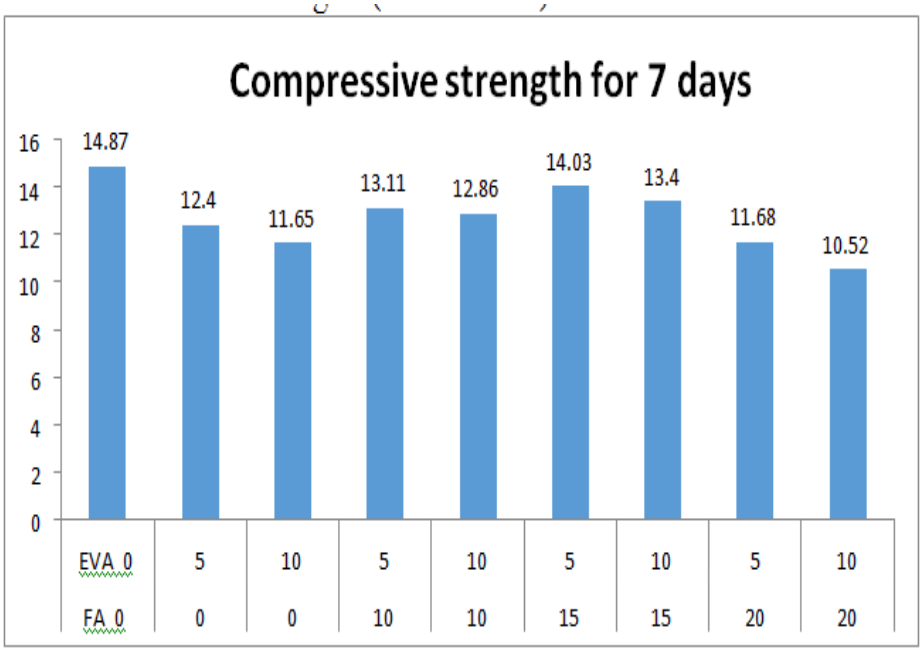

Fig IV:-Compressive strength for 7 days

Table V:- Compressive strength after 7 days.

Replacement of fly ash %	Replacement of EVA %	**LOAD ON CUBE, KN**	STRESS N/mm^2	AVERAGE
0	0	**436.7**	15.16	14.87
		420.4	14.6	
0	5	**368**	12.7	12.4
		350.8	12.1	
0	10	**358.7**	12.45	11.65
		312.1	10.84	
10	5	**398.1**	13.82	13.11
		356.4	12.4	
10	10	**415.7**	14.43	12.86
		325.7	11.31	
15	5	**425.7**	14.78	14.03
		382.4	13.28	
15	10	**395.4**	13.7	13.4

Table vi:-Compressive strength for 7 day

Experimental Investigation:

Compressive Strength:

Compression tests of specimens are made as soon as practicable after removal from curing pit. Test-specimen during the period of their removal from the curing pit and till testing, are kept moist by a wet blanket covering and tested in a moist condition. Place the specimen centrally on the location marks of the compression testing machine and load is applied continuously, uniformly and without shock. Compressive strength of the paving block specimens are tested

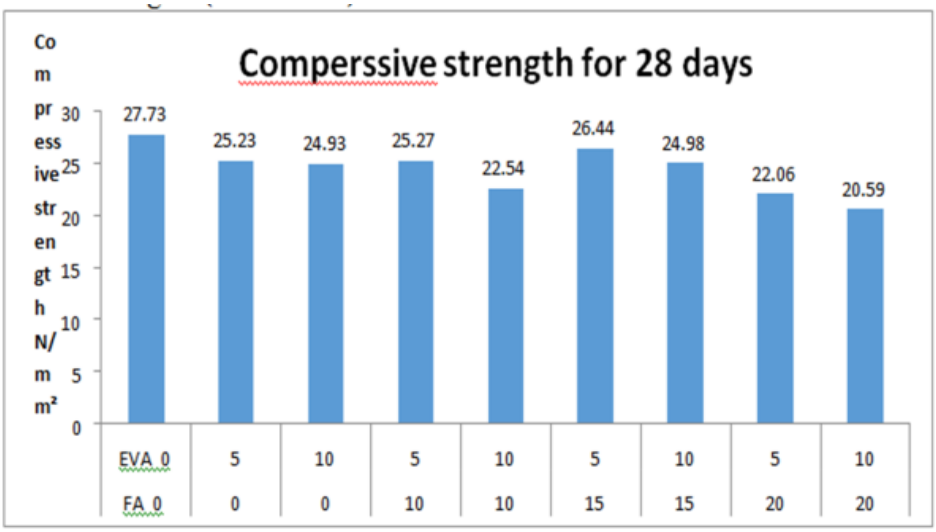

Fig V:- Compressive strength for 28 days.

Table VII:- Compressive strength for 28 day.

Replacement of fly ash %	Replacement of EVA %	LOAD ON CUBE, KN	Stress N/mm^2	Average
0	0	873.5	30.32	27.73
		723.6	25.12	
0	5	755.8	26.24	25.23
		697.3	24.21	
0	10	753.4	26.16	24.93
		682.4	23.69	
10	5	732.1	25.42	25.27
		723.8	25.13	
10	10	659.8	22.9	22.54
		639.1	22.2	
15	5	762.3	26.47	26.44
		759.8	26.4	
15	10	727.8	25.3	24.98
		710.11	24.66	
20	5	695.5	24.15	22.06
		576.1	20	
20	10	633.6	22	20.59
		552.3	19.2	

Water Absorption Test:-

The paver block passing through IS 10mm sieve is taken about 200g.They are dried in an oven at a temperature of 110^o + or – 5^{o}C for 24 hrs. The paver block is cooled to room temperature. Its weight is taken as W1 g. The dried paver block is immersed in clean water at a temperature 27^o + or – 2^{o}C for 24 hrs. The paver block is removed from water and wiped out of traces of water with a cloth.

Within three minutes from the removal of water, the weight of paver block W2 is found out.

Percentage of Water absorption,

% of water absorption= $\frac{B-A}{A}$

Where,

A = weight of oven dried sample in air.

B = weight of surface dry sample in air after immersion in water.

Table VIII:- Water absorption test for 7 days.

% of fly ash	% of EVA	Weight of oven dried specimen (W_1)g	Weight of saturated specimen (W_2) g	Weight of water absorbed $W_3 = (W_2 - W_1)$ g	% of water absorption = (W_3/W_1) *100	Average
0	0	5610	5670	60	1.06	
		5483	5546	63	1.14	1.10
0	5	5315	5378	63	1.17	
		5276	5341	65	1.22	1.19
0	10	5292	5362	70	1.31	
		5146	5219	73	1.40	1.35
10	5	5270	5348	78	1.46	1.49
		5128	5207	79	1.52	
10	10	5192	5277	85	1.61	
		5217	5304	87	1.64	1.63
15	5	5121	5213	92	1.76	
		5015	5108	93	1.82	1.79
15	10	4984	5078	94	1.85	
		5028	5124	96	1.87	1.86
20	5	5043	5141	98	1.91	
		5083	5183	100	1.93	1.92
20	10	5126	5227	101	1.93	
		5054	5155	101	1.96	1.945

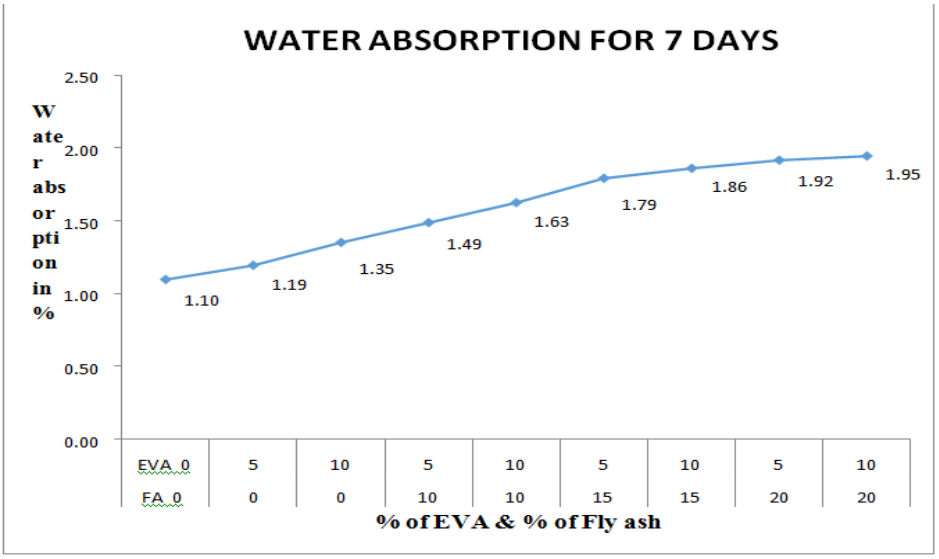

Fig VI.:- Water absorption test for 7 days

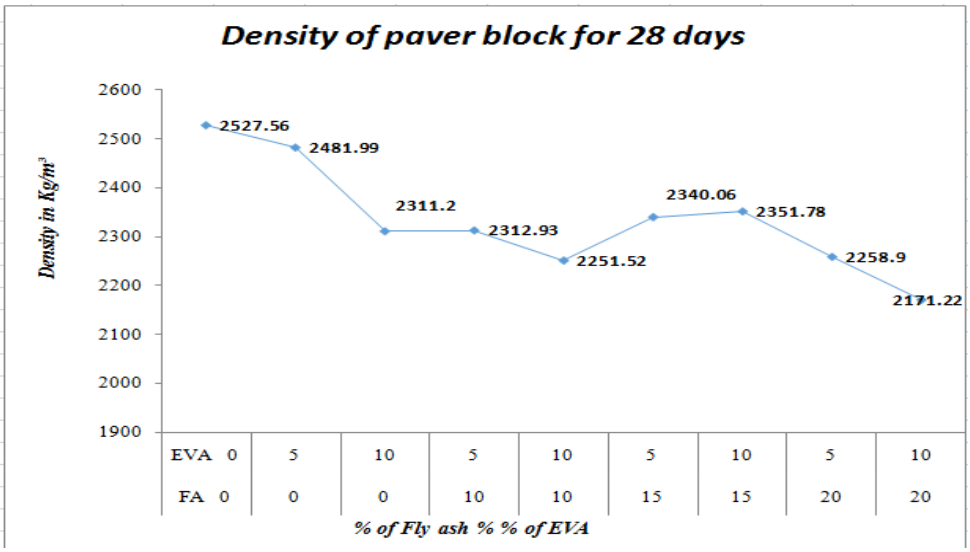

Fig VII:-Density of paver block for 7 days

Table IX:-. Water absorption test for 28 days.

% of fly ash	% of EVA	Weight of oven dried specimen (W_1)g	Weight of saturated specimen (W_2) g	Weight of water absorbed $W_3 = (W_2 - W_1)$ g	% of water absorption $= (W_3/W_1) * 100$	Average
0	0	5862	5892	30	0.5117	0.52
		5785	5815	30	0.5186	
0	5	5715	5745	30	0.5249	0.53
		5722	5753	31	0.5418	
0	10	5370	5401	31	0.5773	0.57
		5280	5310	30	0.5682	
10	5	5425	5456	31	0.5714	0.57
		5233	5263	30	0.5733	
10	10	5140	5170	30	0.5837	0.60
		5235	5267	32	0.6113	
15	5	5320	5355	35	0.6579	0.66
		5463	5499	36	0.659	
15	10	5373	5411	38	0.7072	0.71
		5464	5503	39	0.7138	
20	5	5263	5300	37	0.703	0.72
		5146	5184	38	0.7384	
20	10	5023	5061	38	0.7565	0.77
		4982	5021	39	0.7828	

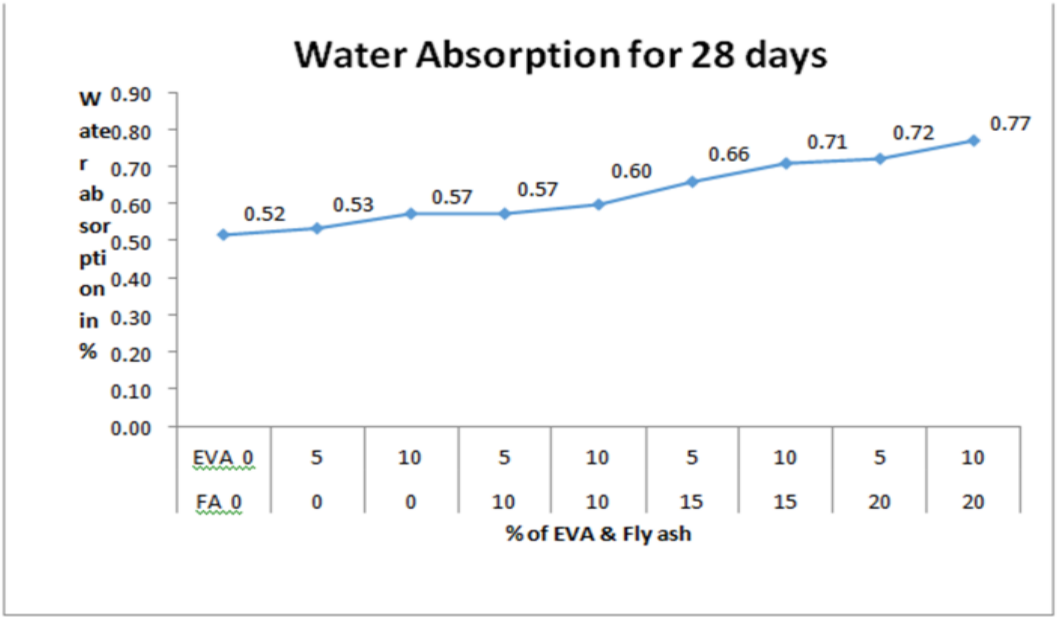

Fig VIII.:- Water absorption test for 28 days.

Result & Discussion:-

1. In this volume the effective use of EVA waste material is done by replacing the coarse aggregate about 5% and same as fly ah by 15% of cement gives nearer strength and reduces the weight while comparing normal concrete mix.
2. Thus, while comparing the Density of normal concrete and concrete with EVA & fly ash is about 9.5% of reduction over normal concrete and for compressive strength is about 4.8% of reduction in strength over normal concrete.
3. It can be used for construction for obtaining the lighter weight by adopting the higher design mix proportion to attain the required strength (i.e.) for attaining M20 strength the mix proportion should be done for M25 (or) M30.

References:-

1. NattakanDulsang et.al, Characterization of an environment friendly lightweight concrete containing ethyl vinyl acetate waste, Materials & Design, vol.96, pp- 350-356, 2016.
2. B.F. Tutikian, et.al, Lightweight concrete with EVA recycled aggregate for impact noise attenuation, Materials & construction, vol. 63, pp- 309-316, 2013.
3. Paulo Roberto Lopes Lima, et.al, recycled lightweight concrete made from footwear industry waste and CDW, waste Management, vol.30, pp-1107-1113, and 2010.
4. S. Saoula, et.al, Improvement of the performances of modified bituminous concrete with EVA and EVA-waste, Physics Procedia, vol.2, pp- 1319-1326, 2009.
5. Valeria Gregorova, et.al, Investigation of influence of Recycled plastics from cable, ethylene vinyl acetate and polystyrene waste on lightweight concrete properties, Procedia Engineering, vol.195, pp- 127-133, 2017.