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RECYCLED PAVEMENT BLOCKS

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ABSTRACT

Concrete paving blocks are ideal materials on the footpaths and roads for easy laying, better look and finish. In this paper, a parametric experimental study for producing paving blocks using waste steel aggregates (the form of rounded bearings of size 6.35 mm) is presented. Waste steel bearings are added in concrete of paver blocks in various percentages. Rubber pads are also used below the paver blocks. Impact strength of paver blocks with various percentages of waste steel aggregates and using rubber pads is investigated. Test results show that combination of using rubber pads and adding various percentages of waste steel aggregates in paver blocks gives upto 50% more impact strength than ordinary paver blocks.

Index Terms- Waste Steel Aggregates, Compressive Strength, Flexural Strength, Concrete Interlocking Paving Blocks, Impact Test.

INTRODUCTION

Concrete plays the key role and a large quantity of concrete is being utilized in every construction practices [6]. Keiji Tomaro recycled municipal solid waste into concrete paver blocks [2]. In various countries, the concrete paver blocks become an attractive engineering and economical alternative to the both flexible and rigid pavement [1].Interlocking concrete pavements are special dry mix precast piece of concrete commonly used in exterior landscaping pavement applications. Concrete paving blocks are ideal materials on the footpaths for easy laying better look and finish [8]. Concrete block pavements have become an attractive engineering and economical alternative to both flexible and rigid pavements. The strength, durability and aesthetically pleasing surfaces have made paving blocks attractive for many commercial, municipal and industrial applications such as parking areas, pedestrian walks, traffic intersections, container yards and roads [3].Interlocking paver blocks are installed over a compacted stone sub base and leveling bed of sand. Concrete paver blocks are made with concrete basically consisting of cement, fine aggregates, coarse aggregates (10 mm and below), water, chemical pigments, etc.

Overall performance of concrete paver blocks used are mainly governed by properties of materials, water cement ratio, mixing process and curing process.

Properties of coarse aggregate play very important role in performance of paver blocks. These properties are texture, shape, size, grading, water- absorption, specific gravity, etc. Natural coarse aggregates can be replaced by artificially manufactured rounded aggregates so as to reduce cement content and thus overall cost of paver block. Design parameters of materials for estimating concrete strength, the accuracy of calculating concrete strength is based on input design parameters of materials involved such as water-binder ratio, admixture, age, moisture content [11].

RESEARCH METHODOLOGY

In cycle marts and motorbike repairing garages, steel bearings are used in wheels of cycles and motorbikes. The purpose of ball bearings is to reduce rotational friction and support radial and axial loads. It achieves this by transmit the loads through the balls. Once ball bearings lose their lubrication, it becomes useless material. Such steel bearings are wasted in large quantity in cycle marts, garages and factories.

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These waste steel rounded bearings can be used in manufacturing concrete paver blocks as coarse aggregates in some amount. Steel has higher specific gravity and density as compared to coarse aggregates. As steel bearings used in paver blocks as coarse aggregates, the density of paver block increases with adding steel bearings. The strength of paver blocks can be increased as well and this is very significant. Hence adding steel bearings in paver blocks is beneficial as it helps to increase the compressive strength, abrasion resistant capacity, impact value of paver blocks.

EXPERIMENTAL STUDY

Paving block specimens (figure 1) of sizes 0.250 m x 0.110 m x 0.080 m, made of concrete with cement, fine aggregate (sand/coarser dust) and coarse aggregate in the ratio (1:1.84:2.76) by weight with water cement ratio was 0.32 (by weight) are cast with following addition of waste rounded steel aggregates.

1. Concrete paving block with addition of 0% waste steel aggregates of cement content
2. Concrete paving block with addition of 10% waste steel aggregates of cement content
3. Concrete paving block with addition of 20% waste steel aggregate of cement content
4. Concrete paving block with addition of 30% waste steel aggregate of cement content
5. Concrete paving block with addition of 40% waste steel aggregate of cement content

Figure No. 1: Zigzag type paver blocks

Impact Test

It consists of aggregate impact testing machine. The weight of hammer in aggregate impact testing machine is 14 kg. During testing, a steel ball of 2.1 cm was used at center of paver blocks from top surface. Blows are applied on each paver blocks till failure occurs.

Figure No.2: Impacts testing on paver block using rounded steel ball

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Figure No.3: Rubber pad

MATERIALS AND ITS TEST RESULTS

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In manufacturing of paver blocks, OPC 53 had been used [7]. In place of OPC 53, OPC 33, OPC 43 can also be used.
Standard Consistency - 33%
Initial Setting time - 2Hrs 20 Minutes
Final Setting Time - 5Hrs 10 Minutes
Specific gravity – 2.85
Strength of cement - 38.32 N/mm (for 28 Days)

Coarse aggregates

Aggregates are the important constituents in concrete. They give body to the concrete, reduce shrinkage and affect economy [9]. The aggregates used for production of paver blocks are sound and free from honeycombed particles. The nominal size of coarse aggregates is 6mm in this work.
Sand: Fineness Modulus: 2.01, Specific Gravity = 2.62

Fine Aggregates

The conventional sources of fine aggregates for paving blocks are river sand or, alternatively, artificial sand by crushing rocks [4]. Fine aggregates are used as per requirement of IS 383,both river and quarry dust are used [12].

Water

Water quantity is important for the mixture to complete the chemical reaction and provide proper workability [9]. The water used for mixing concrete is potable water of pH lies at 7.5 and water is free from organic matter and the solid contents are within the permissible limits as per IS 456-2000 [12].

WASTE ROUNDED STEEL AGGREGATES

Shape

Rounded, Size: 6. 3 5 mm (1 /4” inch) diameter, Surface: Corroded, weight of single steel bearing: 1 gram, Density of material: 7.85 g/cubic cm

Rubber Pad

Rubber pad of size 10 mm was used at bottom side of of paver blocks

Test results for paving blocks

3 sets of samples from each category are prepared for calculating the average vales of impact strength of paving blocks for 7 days. Results in impact testing are tabulated below.

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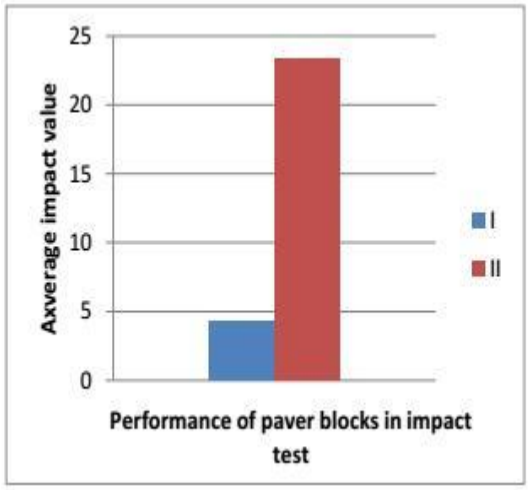
Table No.1:
Concrete block with 0% waste rounded steel aggregates

Type of impact testing	No. of paver blocks	Weight of paver block (in Kg)	Impact value	Average impact value
I	1	4.500	3	4.33
	2	4.500	5	
	3	4.500	5	
II	1	4.500	13	23.33
	2	4.550	34	
	3	4.500	23	

From above results in impact tests, graphical representations are as following. In graphs there are two types of paver blocks.

I- Paver blocks without rubber pads
II- Paver blocks with rubber pads



Graph No.1: Concrete block with 0% waste rounded steel aggregates

I. Paver blocks without rubber pads
II. Paver blocks with rubber pads

Table No.2: Concrete block with 10% waste rounded steel aggregates

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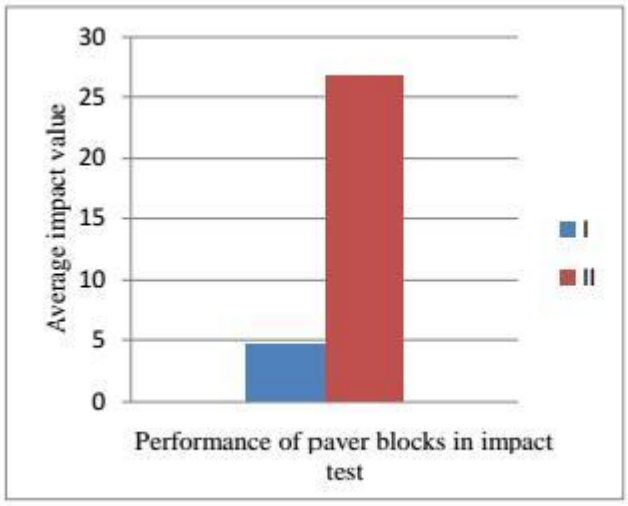
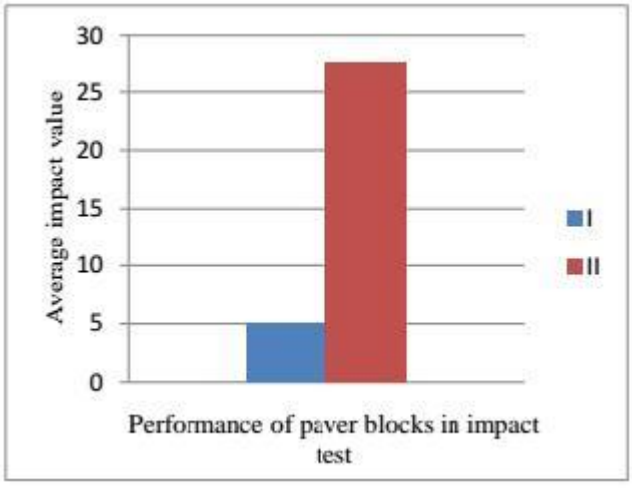
Type of impact testing	No. of paver blocks	Weight of paver block (in Kg)	Impact value	Average impact value
I	1	4.500	4	4.67
	2	4.600	5	
	3	4.500	5	
II	1	4.500	30	26..67
	2	4.500	24	
	3	4.600	26	



Graph No.2: Concrete block with 10% waste rounded steelaggregate

I – Paver blocks without rubber pads
II –Paver blocks with rubber pads

Table No.3:
Concrete block with 20% waste rounded steel aggregates



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Type of impact testing	No. of paver blocks	Weight of paver block (in Kg)	Impact value	Average impact value
I	1	4.600	4	5
	2	4.600	6	
	3	4.550	5	
II	1	4.700	20	27.67
	2	4.600	35	
	3	4.600	28	

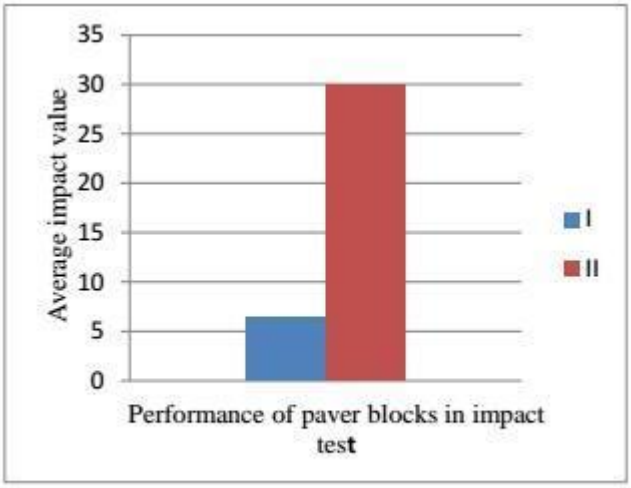
Graph No.3: Concrete block with 20% waste rounded steel aggregates

I – Paver blocks without rubber pads

II – Paver blocks with rubber pads

Table No.4:
Concrete block with 30% waste rounded steel aggregates

Type of impact testing	No. of paver blocks	Weight of paver block (in Kg)	Impact value	Average impact value
I	1	4.600	7	6.33
	2	4.650	6	
	3	4.600	6	
II	1	4.700	42	30
	2	4.600	21	
	3	4.650	27	



Graph No. 4: Concrete block with 30% waste rounded steel aggregates

I – Paver blocks without rubber pads

II – Paver blocks with rubber pads

Table No. 5

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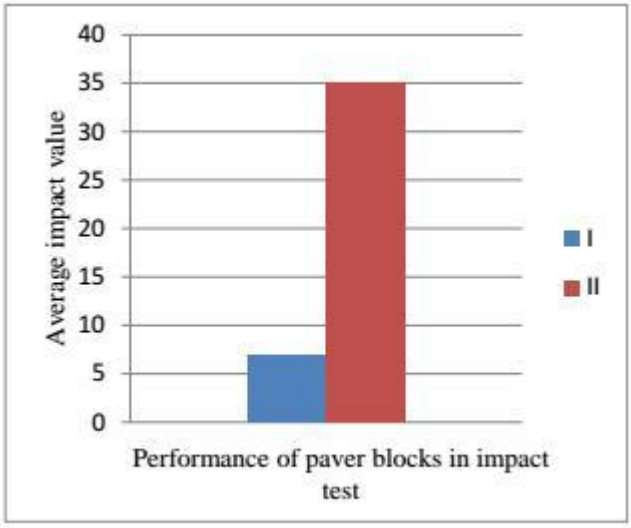
Concrete block with 40% waste rounded steel aggregates

Type of impact testing	No. of paver blocks	Weight of paver block (in Kg)	Impact value	Average impact value
I	1	4.650	3	5
	2	4.600	11	
	3	4.650	7	
II	1	4.700	61	35
	2	4.600	24	
	3	4.700	20	



Graph No. 5: Concrete block 40% waste rounded steel aggregates

I – Paver blocks without rubber pads
II – Paver blocks with rubber pads

Specifications for Precast Concrete Paver Blocks

In this work, all paver blocks cast as per IS-15658:2006. For technical specifications for manufacturing concrete paver blocks, manual for precast concrete paver blocks of Hindustan Petroleum Corporation Limited Retail Upgradation Department, North Central Zone was referred [5].

RESULTS AND DISCUSSIONS

To observe the effect in impact strength in paver blocks, waste rounded steel aggregates at 10, 20, 30 and 40% of cement content in paver blocks were used. Paver blocks are cast with and without rubber pad. Paver blocks cast with 0%, 10%, 20%, 30% and 40% waste rounded steel aggregates of cement content are compared with and without rubber pad in impact test. Following test results were observed in impact test.

a) As the percentage of steel aggregates increases, density of paver blocks also increases. (Paver blocks cast with 30% and 40% waste rounded steel aggregates of cement content in paver blocks give higher impact value than paver blocks cast with 0%, 10%, 20% waste rounded steel aggregates of cement in paver blocks.)
b) As the density of paver blocks increases, impact strength of paver blocks also increases.(Densities of paver blocks cast with 0%, 10%, 20%, 30% and 40% waste rounded steel aggregates of cement content are 2.241 g/cm3, 2.254 g/cm3, 2.260 g/cm3, 2.303 g/cm3 and 2.312 g/cm3. (Paver blocks cast with 30%

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and 40% waste rounded steel aggregates give higherimpact strength than paver block cast with 0%, 10% and 20% waste rounded steel aggregates of cement content.)

c) Impact strength of paver blocks using rubber pad is much greater than that of paver blocks without rubber pads.

CONCLUSIONS

The following conclusions can be drawn from the experimental investigation carried out.

a) Impact test on paver blocks using rubber pad gives 5 to 7 times more impact value than paver blocks without using rubber pad.

b) Impact value of paver blocks increases as percentage of waste steel aggregates increases. Paver blocks cast with 30% and 40% waste rounded steel aggregates give higher impact strength than paver block cast with 0%, 10% and 20% waste rounded steel aggregates of cement content.

c) Impact strength of paver blocks increases as density of paver blocks increases. Densities of paver blocks cast with 0%, 10%, 20%, 30% and 40% waste rounded steel aggregates of cement content are 2.241 g/cm3, 2.254 g/cm3, 2.260 g/cm3, 2.303 g/cm3 and 2.312 g/cm3. (Paver blocks cast with 30% and 40% waste rounded steel aggregates give higher impact strength than paver block cast with 0%, 10% and 20% waste rounded steel aggregates of cement content.

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