Comparison of Strength of Mix Design of Concrete Paver Block using Waste Steel Rounded Bearings as Aggregate and Rubber Pad

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Abstract— Concrete paver blocks are perfect materials on the footpaths and streets for simple laying, better look and finish. In this paper, a parametric experimental study for producing paver bricks utilizing waste steel aggregate (the type of rounded bearing balls of size 6.30 mm) is exhibited. Waste steel bearing balls are included in concrete of paver bricks in different rates. Elastic rubber Pads are additionally utilized underneath the paver bricks. Compressive strength and Impact strength of paver bricks with different rates of waste steel aggregate and utilizing elastic Rubber Pads is researched. Test results demonstrate that mix of utilizing elastic Rubber Pads and including different rates of waste steel aggregate in paver bricks gives upto 50% more strength than common paver bricks.

Key words: Waste Rounded Steel Bearing Aggregates (WRSBA), Compressive Strength, Flexural Strength, Concrete Interlocking Paving Blocks, Compressive Strength Test, Impact Test

I. INTRODUCTION

Concrete assumes the key part and a substantial amount of cement is being used in each construction practices. Researchers reused municipal solid waste into concrete paver bricks. In different nations, the concrete paver bricks turn into an attractive engineering and economical alternative to the both flexible and rigid pavement. Interlocking concrete pavements are unique dry blend precast piece of concrete ordinarily utilized as a part of outside landscaping pavement applications. Concrete paver bricks are perfect materials on the pathways for simple laying, better look and finish. Concrete block pavements have turned into an appealing designing and economical option for both flexible and rigid pavement .The strength, durability and aesthetically pleasing surfaces have made paver bricks appealing for numerous commercial, municipal and industrial applications for example, parking areas, pedestrian, traffic intersections container yards and streets. Interlocking paver bricks are introduced over a compacted stone sub base and leveling bed of sand. Concrete paver blocks are made with concrete fundamentally comprising of cement, fine aggregate, coarse aggregate (10 mm and beneath), water, compound colors, and so forth.

General execution of concrete paver bricks utilized are mostly represented by properties of materials, water cement proportion, blending process and curing process. Properties of coarse aggregate play critical part in execution of paver bricks. These properties are composition, shape, size, grading, water-retention, specific gravity, and so on. Common coarse aggregate can be supplanted by fabricated rounded aggregate in order to decrease cement substance and thus overall cost of paver blocks. Design parameters of materials for calculating concrete strength, depends on input design parameters of materials included, for example, water-cement proportion, admixture, age, moisture content

II. METHODOLOGY

In cycle shops and motorbike repairing garages, steel bearing balls are utilized as a part of wheels of cycles and motorbikes. The reason for metal balls is to reduce rotational friction and support radial and pivotal loads. It accomplishes this by transmit the loads through the balls. When ball bearing balls lose their oil, it gets to be useless material. Such steel bearing balls are wasted in large amount in cycle stores, carports and production lines. These waste steel rounded bearing balls can be utilized as a part of manufacturing concrete paver bricks as coarse aggregate in some sum. Steel has higher specific gravity and density when contrasted with coarse aggregate. As Steel bearing balls utilized as a part of paver bricks as coarse aggregate, the density of paver piece increments with including steel bearing balls. The strength of paver bricks can be expanded too and this is exceptionally critical. Henceforth including steel bearing balls in paver bricks is valuable as it serves to increase the compressive strength, abrasion resistance capacity, impact value of paver bricks.

III. EXPERIMENTAL STUDY

Paver bricks samples of sizes 0.200 m x 0.160 m x 0.080 m, made of cement with concrete, fine aggregate (sand/coarser dust) and coarse aggregate in the proportion (1:2.77:2.48) by weight with water concrete proportion was 0.40 (by weight) are cast with following addition of waste rounded steel aggregate.

1) Concrete paver blocks with expansion of 0% waste steel aggregate of cement substance
2) Concrete paver blocks with expansion of 5% waste steel aggregate of cement substance
3) Concrete paver blocks with expansion of 10% waste steel aggregate of cement substance
4) Concrete paver blocks with expansion of 20% waste steel aggregate of cement substance
5) Concrete paver blocks with expansion of 30% waste steel aggregate of cement substance
6) Concrete paver blocks with expansion of 40% waste steel aggregate of cement substance

Fig. 1: Casted Paver Blocks

IV. COMPRESSIVE STRENGTH

Compressive Strength test is done by applying load on the Paver Block using a Universal Testing Machine (UTM). The block is placed horizontally with flat surface facing on the top and placed in between the plates of compression testing machine (Fig.2). The load at which the block fails or crushes is noted. Compressive Strength is given by Load / Area.

Fig. 2: Compressive strength testing machine

V. MATERIALS AND ITS TEST RESULTS

A. Cement

In producing of paver bricks, OPC 43 had been utilized. In place of OPC 43, OPC 33, OPC 53 can likewise be utilized.
Standard Consistency - 33%
Initial Setting time - 2Hrs 22 Minutes
Final Setting time - 5Hrs 15 Minutes.
Specific gravity – 2.85
Strength of cement - 38.32 N/mm 2 (for 28 Days)

B. Coarse Aggregate

Aggregate are the vital constituents in concrete. They offer bulk to the concrete, lessen shrinkage and influence economy. The aggregate utilized for creation of paver bricks are sound and free from honeycombed particles. The nominal size of coarse aggregate is 6mm in this work.

Sand: Fineness Modulus: 2.01, Specific Gravity = 2.62

C. Fine Aggregates

The customary source of fine aggregate for paver bricks is river sand or, on the other hand, artificial sand by smashing rocks. Fine aggregate are utilized according to prerequisite of IS 383, both river and quarry dust are utilized.

D. Water

Water amount is essential for the blend to complete the chemical reaction and give appropriate workability. The water utilized for blending concrete is potable water of pH lies at 7.5 and water is free from organic matter and the solid substance are inside of the admissible limits according to IS 456-2000 .

E. Waste Steel Aggregate

weight of single steel bearing: 1 gram,
Density of material: 7.85 g/cubic cm
Shape: Rounded, Size: 6.30 mm (1/4" inch) diameter,
surface: Corroded,

F. Rubber Pad

Elastic Rubber Pad of size 10 mm was utilized at base side of paver bricks in impact test.

Fig. 3: Rubber Pad

VI. TEST RESULTS FOR PAVER BLOCKS

3 sets of tests from every classification are readied for computing the normal values of strength quality of paver bricks for 28 days. Results in compression testing are classified beneath.

Sr. No.	Compressive Strength in N/mm^2					
	0% WRS BA	5% WRS BA	10% WRS BA	20% WRS BA	30% WRS BA	40% WRS BA
1	37	39	40.5	42.5	44	45.5
2	37	38.5	40	42	43.5	45.5
3	37.5	39	39.5	41.5	44.5	49
average	37.16	38.83	40	42	44	46.7

Table 1: Compressive strength of Paver Block at 28 days without rubber pad:

Sr. No.	Compressive Strength in N/mm^2					
	0% WRS BA	5% WRS BA	10% WRS BA	20% WRS BA	30% WRS BA	40% WRS BA
1	56	58.1	60.2	63	64.4	67.2
2	55.3	57.4	58.8	62.3	63.7	67.2
3	56.7	58.8	59.5	61.6	65.8	71.4
average	56	58.1	59.5	62.3	64.6	68.6

Table 2: Compressive strength of Paver Block at 28 days with rubber pad:

From above results in compression test with and without rubber pad, graphical representation are as following. In graphs y-axis indicates average compressive strength. In graphs there are two types of paver blocks:

- Paver blocks without rubber pad
- Paver blocks with rubber pad

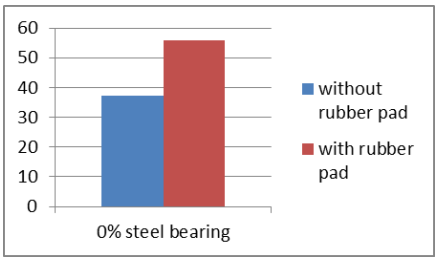

Fig. 4(a): Graph 1.Concrete paver block with 0% waste rounded steel aggregate

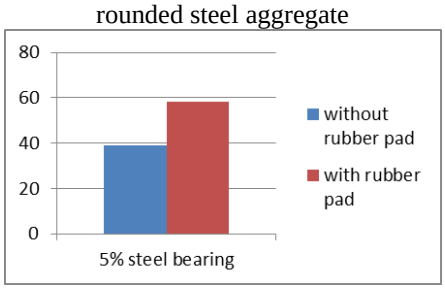

Fig. 4(b): Concrete paver block with 5% waste rounded steel aggregate

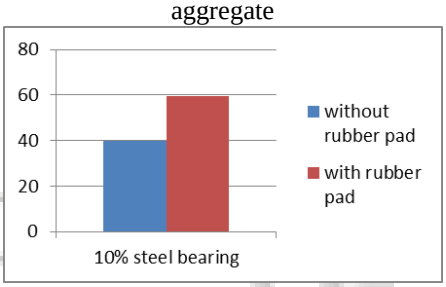

Fig. 4(c): Graph 3.Concrete paver block with 10% waste rounded steel aggregate

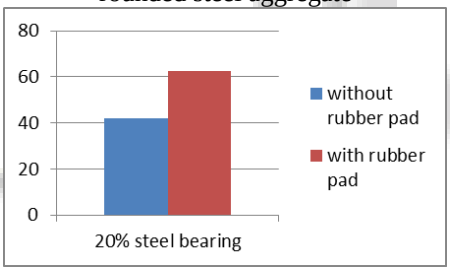

Fig. 4(d): Graph 4.Concrete paver block with 20% waste rounded steel aggregate

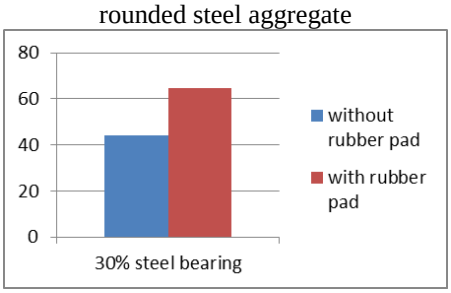

Fig. 4(e): Graph 5.Concrete paver block with 30% waste rounded steel aggregate

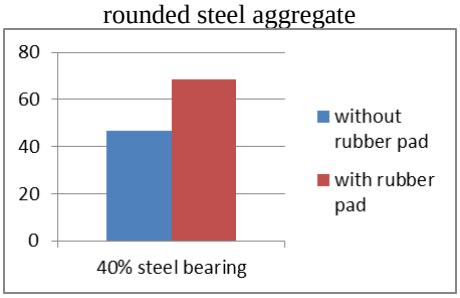

Fig. 4(f): Graph 6.Concrete paver block with 40% waste rounded steel aggregate

Compressive Strength comparison of Paver Block at 28 days with WRSBA and with and without rubber pad:

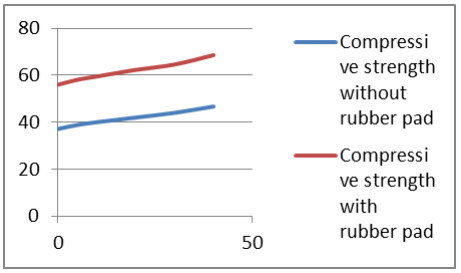

Fig. 4: Graph of Compressive Strength and percent of WRSBA at 28 days

The above figure is drawn between Compressive Strength and percent of WRSBA at 28 days. Then increase of WRSBA as % of cement, Compressive Strength of Paver Block increases but use of rubber pad below the paver block increase more compressive strength.

VII. Specification for Paver Blocks

In this work, all paver bricks cast according to IS-15658:2006. For technical specifications and manufacturing concrete paver bricks, manual for precast concrete paver bricks of Hindustan Petroleum Corporation Limited Retail Upgradation Office, North Central Zone was referred

VIII. Results and Discussions

To watch the effect in impact quality in paver bricks, waste rounded steel aggregate at 5,10, 20, 30 and 40% of cement substance in paver bricks were utilized. Paver bricks are cast without elastic Rubber Pad. Paver bricks cast with 0%, 5%,10%, 20%, 30% and 40% waste rounded steel aggregate of cement substance are compared with and without elastic Rubber Pad in compressive test. Following outcomes were seen in compressive test.

- As the percentage of steel aggregate increments, density of paver bricks also increments. (Paver bricks cast with 30% and 40% waste steel aggregate of cement content in paver bricks give higher compressive strength than paver bricks cast with 0%, 10%, 20% waste steel aggregate of cement in paver bricks.)
- As the density of paver bricks increases, Compressive strength of paver bricks additionally increases.(Densities of paver bricks cast with 0%, 10%, 20%, 30% and 40% waste steel aggregate of cement substance are 2.240 g/cm3, 2.255 g/cm3, 2.261 g/cm3, 2.305 g/cm3 and, 2.312 g/cm3. (Paver bricks cast with 30% and 40% waste steel aggregate give higher compressive strength than paver square cast with 0%, 10% and, 20% waste steel aggregate of cement content.)
- Compressive strength of paver bricks utilizing elastic cushion is much more than that of paver bricks without elastic rubber pad.

IX. Conclusions

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

1) In this Compressive Strength analysis of Paver Block with 0%, 5%, 10%, 20%, 30%, and 40% WRSBA are

tested and graph shown that WRSBA is partially replaced with OPC 43 grade give higher strength as compared to conventional mix i.e. 0%. Then WRSBA give economic value as compared to conventional mix i.e. 0%.

2) The Compressive Strength increase with the increase in WRSBA content replacement, the values are acceptable according to IS 15658:2006.
3) Compressive test on paver bricks utilizing elastic cushion gives more compressive strength value than paver bricks without utilizing elastic cushion.
4) Compressive estimation of paver bricks increments as rate of waste steel aggregate increments. Paver bricks cast with 30% and 40% waste steel aggregate give higher compressive quality than paver piece cast with 0%, 10% and 20% waste steel aggregate of concrete substance.
5) Compressive strength of paver bricks increments as density of paver bricks increments. Densities of paver bricks cast with 0%, 10%, 20%, 30% and 40% waste steel aggregate of bond substance are 2.2410 g/cm3, 2.255 g/cm3, 2.261 g/cm3, 2.305 g/cm3 and 2.312 g/cm3. (Paver bricks cast with 30% and 40% waste steel aggregate give higher compressive strength than paver block cast with 0%, 10% and 20% waste steel aggregate of cement content.

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REFERENCES

[1] Sudhir S. Kapgate and S.R.Satone, "Effect of Quarry Dust asPartial Replacement of Sand in Concrete",Indian StreamsResearch Journal,Volume 3,Issue 5,June 2013, pp.2230-7850.
[2] Jaykumar P.T. et al.,"Experimental Investigation on Paver Blocks using Steel Slag as Partial Replacement of Aggregate and Sludgeas Partial Replacement of Cement ", International Journal of Science and Research (IJSR), India Online ISSN: 2319-7064,Volume 2 Issue 5, May 2013,pp. 87-91.
[3] Radhikesh P. Nanda et al., "Stone crusher dust as a fine aggregate in Concrete for paving blocks", International Journal of Civil and Structural Engineering, Volume 1, No 3, 2010, pp. 613-620.
[4] Priyank Bhimani, "Performance of Concrete with China Clay (Kaolin) Waste", International Journal of Latest Trends in Engineering and Technology (IJLTET), Vol. 2 Issue 3 May 2013, pp. 49-54.
[5] M.C. Natraja and Lelin Das, "A simplified Mix Proportioning for Cement Based Composites with Crushed Tile waste Aggregates",Journal of science and Industrial research,Vol. 70,May 2011, pp. 385-390.
[6] Jen-Chei Liu et al., "Estimating the Strength of Concrete Using Surface Rebound Value and Design Parameters of Concrete Material", Tamkang Journal of Science and Engineering, Vol.12,2009, No. 1, pp. 1-7.
[7] Vijaya Kishore K., "Utilization of Sludge Concrete in Paver Blocks", International Journal of Emerging trends in Engineering and Development, Issue 2, Vol 4, May 2014, pp. 509-516.
[8] Tung-Chai Ling et al., "The Effect of Cement and Water Cement Ratio on Concrete Paving Block", Regional Postgraduate Conference on Engineering and Science, RPCES July 2006, Johore, pp. 26-27.
[9] Tomaru Keiji, "Recycling municipal solid waste into concrete paving blocks", 9th. International Conference on Concrete Block Paving. Buenos Aires, Argentina, 2009/10/18-21, Argentinean Concrete Block Association (AABH) Argentinean Portland Cement Institute (ICPA) Small Element Paving Technologists (SEPT).
[10] Osman Gencel et al., "Properties of concrete paving blocks made with waste marble", Journal of Cleaner Production 21,2012, pp. 62-70.
[11] Cassiano Rossi dos Santos et al., "Use of Coal Waste as Fine Aggregates in Concrete Paving Blocks", Geomaterials, 2013,3, pp.54-59.
[12] Specifications for Manufacturing, Supplying and Laying of 80mm Thick Precast Cement Concrete Interlocking Paver Blocks as per IS-15658:2006, "Hindustan Petroleum Corporation Limited Retail Upgradation Department, North Central Zone".

