UTILIZATION OF GLASS POWDER AND FLY ASH IN CONCRETE PAVER BLOCKS

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Abstract :Concrete paver blocks are playing a vital role in the construction field. In earlier times these blocks were made by natural stone and clay. The main advantage of paver blocks it should be flexible and it should avoid cracks and maintain good strength properties. Paver blocks are the modern day solution for low cost outdoor applications. Their strength, durability and pleasing surfaces have made paver blocks attractive for many commercial, municipal and industrial places such as parking areas, pedestrian walks, traffic intersections, yards and roads. This project strictly follows IS 15658:2006 code for paver blocks. Aggregates of size 4.75 mm is going to be used. Cement has been replaced in various percentages of Fly ash Class-C and M-Sand with various percentages of Glass powder of size 90µ. These products are left largely unused and are hazardous to human health. By casting trihex paver block of size 260×250×60 mm with M30 grade of concrete mix were used. Test result shows that fly ash and glass powder can be effectively used and more durable in paver blocks.

Key words: Fly ash, Glass powder, Paver block, Compressive Strength, Durability, Cost analysis

1. INTRODUCTION

Earlier times materials like brick, clay or concrete were used for paving. These conventional materials used for paving are replaced by the interlocking pavers. Interlocking concrete paver blocks are also called as segmental pavers. Romans used segmental pavers to build roads. Paving blocks have made a trigger in the construction industry and used for various purposes based on their strength characterization. Mass production of paving blocks have reduced their price in an effective manner and made it easily available in every places. With the invention of the paving block machines, it has become comfortable for their laying works. Paver blocks have various Features being durable, easy to walk, excellent interlocking characteristics and it give more aesthetical appearance when laid. As per IS:15658:2006 the standard thickness of paver blocks are 50 mm ,60 mm and 80 mm are cast commonly in India. Paver blocks require higher compressive strength since used in outdoor applications.

Literature Review on Paver Blocks

Osman gencel (2011) Properties of concrete paving blocks with waste marble; marble industry produces large amount of waste marble which causes environmental problems. Mechanical strength decreases with increased marble content while freeze-thaw durability and abrasive wear resistance increases. Waste marble is well usable instead of conventional aggregates in the concrete paving block production.

Eshmaielganjian (2014) Using waste materials and by products to produce concrete paver blocks; compressed paving blocks could be successfully prepared using cement and waste materials. Ground granulated blast furnace slag(GGBS) was more effective in reducing the cement content than run-of-station ash (ROSA),cement by-pass dust (BPD), basic oxygen slag (BOS), plasterboard gypsum (PG), incinerator bottom ash aggregate (IBAA), recycled concrete aggregate (RCA). The concrete paver block prepared with OPC, GGBS and BPD can reduce cement content by up to 30%.

Chameeraudawattha (2017) Mud concrete paver block for pedestrian pavements; the mud concrete paving block is a combination of cement and soil mixed together with the addition of water. A series of test cubes were cast and tested with different ratios of soil & cement by controlling the water content. In addition, different vibration patterns were applied to identify the best method to achieve the required compressive strength of blocks for pedestrian pavements. Soil cement blocks have the wet compressive strength of 1.32 N/mm^2, and 1.97 N/mm^2 for 3.5% and 7% cement respectively. According to the results obtained in the laboratory tests series for mix design, it can be concluded that the new block can be produced using soil with 5% of fine particles, 55% of 65% sand particles, 18% of 22% cement by weight together with a moisture content of 14%–15%.

Hanan A. El noughy (2012) Properties of paving units incorporating slag cement; The aim of this study is to investigate the effect and possibility of using Portland slag cement in the production of interlocking paving units. Compressive strength requirement was almost met when slag cement was used in the upper layer at age 180 days. The compressive strength is increased and it was found to be around 55N/mm^2.

D.Wattanasiriwech (2009) Paving blocks from ceramic tile production waste; This paper presents the use of waste mud from ceramic tile production as the main component in paving blocks. Compressive strength values of the blocks were compared with the standard value as prescribed by the Thailand Industrial Standard. The blocks containing 15 wt% cement required a long curing period of up to 28 days for their compressive strength to reach the standard requirement while the compressive strength of the blocks containing 25–30 wt% cement exceeded the standard requirement after curing for only 7 days.

Dr. M.B. Varma (2011) Reuse of waste steel rounded bearings from cycle shops and motorcycle repairing garages for manufacturing paver blocks; Also steel has high specific gravity and density as compare to coarse aggregate which increases the density of paver blocks if used as substitute of coarse aggregate. Hence using of steel in paver blocks increases compressive strength, abrasion resistance capacity, impact value. In this study he utilized different mix proportion replacing cement by waste steel at 0%-40% by weight.

Sithanandhanvanitha (2015) Utilization of waste plastic as replacement of coarse aggregate in paver blocks;Rapid industrialization & urbanization in the country leads lot of development which in terms also leads to increased productivity of wastes & other products. So the tests were carried to use the waste materials plastic as partial replacement of coarse aggregate in M20 concrete.Waste plastics were incrementally added in 0%, 2%, 4%, 6%, 8% & 10% to replace same amount of coarse aggregate. Paver blocks were casted to check the strength of it for 7, 14 and 28 days. The result shows the compressive strength of paver block using plastic were equal to PCC. The optimum modifier content of waste plastics is found to be 4% for paver blocks.

2. MATERIALS AND METHODS

In this investigation, cement, fine aggregate, coarse aggregate, Class-C fly ash and glass powder (90μ) has been used. Ordinary Portland cement of grade 53 was used in this investigation confirming to the standards of ACI544:IR96. The maximum size of the coarse aggregate was 10 mm and specific gravity was 2.61. Locally available M-Sand was used to cast all the paver blocks which passes through 4.75 mm sieve. Potable water was used throughout the casting process.

Table 1 and Table 2 shows the characteristics of fly ash and glass powder.

SL.NO	PROPERTIES	TEST RESULT
1	Loss of Ignition (LOI)	2.53%
2	Sand & Silica	67.89%
3	Calcium Oxide(Cao)	1.41%
4	Magnesium Oxide(Mgo)	0.94%
5	Iron Oxide (Fe_2O_3)	1.68%
6	Aluminum Oxide(Al_2O_3)	18.23%

TABLE 2

SL.NO	PROPERTIES	TEST RESULT
1	Sand & Silica (acid insoluble)	81.14%
2	Calcium Oxide (Cao)	5.21%
3	Magnesium Oxide (Mgo)	1.30%
4	Iron Oxide (Fe_2O_3)	Nil
5	Aluminum Oxide (Al_2O_3)	2.24%

From the characteristics of fly ash and glass powder, it was observed that silica predominates in both the samples, which directs that these materials can be used as supplementary cementitious materials in paver block production.

3. Mix Proportion

Mix design has been derived based on IS 10262:2009 for M30 grade of concrete.

The mix ratio adopted is 1:1.474:2.287. Characteristic compressive strength attained at the field after 28 days was around 40Mpa. Maximum size of the coarse aggregates was 10 mm. The specimens were designated as CPB, PB_1, PB_2 and PB_3.

TABLE 3-Mix Proportions

SPECIMEN ID	CEMENT %	M-SAND %	FLY ASH %	GLASS POWDER %
CPB	100	100	0	0
PB_1	80	80	20	20
PB_2	70	70	30	30
PB_3	60	60	40	40

Table 3 shows the mix proportions for the paver blocks for the study.

FIG 1 Casting work

FIG 2 Water absorption test

FIG 3 Compressive strength test

FIG 4 Flexural strength test

Figure 1, 2, 3 and 4 shows the casting, curing and testing of paver blocks as per the mix proportions planned.

4. COMPRESSIVE STRENGTH TEST

Compressive strength tests were performed with the cast paver block specimens after 28 days of curing. The paver moulds were filled with the mix concrete. After 24 hours the casted specimens were de-moulded. The blocks were shifted to the curing tanks and kept for curing for about 28 days.

The specimens were tested for its compressive strength after curing. A compression testing machine of 2000kn capacity was used. Load was applied as per the bureau of Indian standards.

Compressive strength = Load / Area (Mpa).

5. FLEXURAL STRENGTH TEST

The flexural strength of the paver blocks was determined based on IS 15658:2006. The specimens were tested in an universal testing machine of 1000kn capacity. Three specimens of each samples were tested and the average of the three was calculated as follows:

Flexural strength = PL / bd^2

P = Maximum load

L = Length

B = Breadth

D = Depth

6. WATER ABSORPTION TEST

Water absorption test is used to determine the amount of water absorbed under specified conditions. The paver blocks is completely immersed in water for 24 hours then removed from the water tank and immediately weighted. The weight of the each specimens are noted down; this is the saturation stage.

After saturation, the paver blocks are dried in a ventilated oven and weight of each specimens were noted down after complete drying process. The dry weight of each specimens are taken and the corresponding water absorption percentage has been arrived.

7. COST ANALYSIS

Cost analysis is the technique through which all of the costs associated with the development of that specimen can be determined. Higher performance life has been achieved through this replacement and lower capital cost compared to the conventional concrete paver blocks. Due to replacement of specific industry waste materials.

8. RESULTS AND DISCUSSIONS

Paver blocks with designated proportions were cast and tested for its compressive strength, flexural strength and water absorption. Table 4 shows all outcomes and the above said parameters.

The test results as paver blocks reveals that

TABLE 4

Specimen ID	**Average Compressive strength at 28 days (Mpa)**	**Average Flexural strength at 28 days(Mpa)**	**Average percentage of Water absorption < 6%**	**Cost Analysis per paver block**
CPB	38.621	1.985	1.116	Rs.15.23
PB_1	40.301	1.890	0.974	Rs.13.73
PB_2	42.570	2.220	0.841	Rs.13.21
PB_3	40.770	2.065	0.716	Rs.12.65

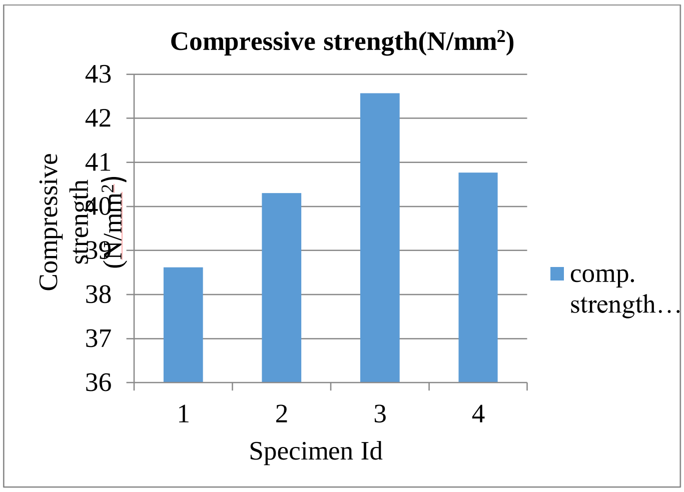

Fig 5. Compressive strength graphical representation

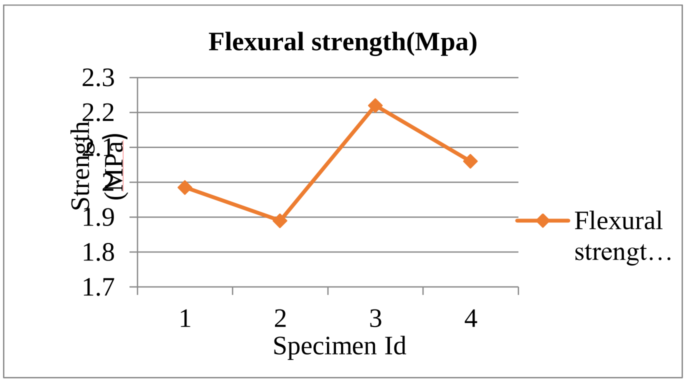

Fig 6. Flexural strength graphical representation

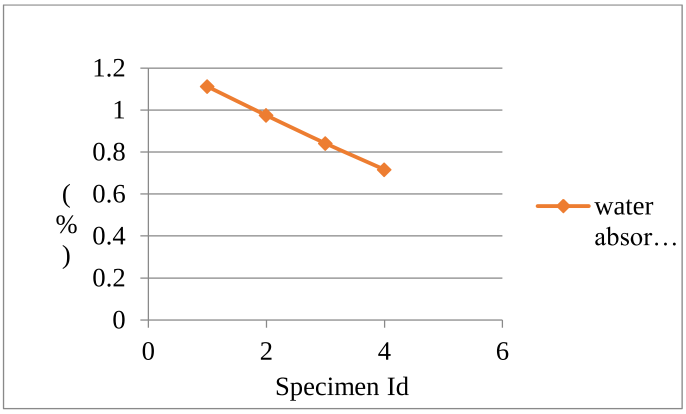

Fig 7. Water absorption test graphical representation

9. CONCLUSIONS

Investigations were made to determine the characteristic strength of the concrete pavers by replacing the cement with fly ash and M-sand with glass powder to attain a good surface and texture. The main purpose of my investigation is to reduce the pore spaces of the paver blocks by addition of glass powder in it and to produce a cost effective paver block. To utilize the waste products in an effective manner this research has been made. Based on the raw materials collected the mix proportions were designated with appropriate ratios. The compressive strength is increased as the percentage of replacement is made. It resists the chemical attack due to the presence of calcium oxide in the fly ash.

- The proper finish is obtained as the percentage of replacement is increased with fine glass powders in place of the manufacturing sand.
- Using of these waste materials is found to be more economical and the cost is also being reduced.
- With the replacement of fly ash and glass powder the water absorption rate decreases slightly.
- It was found that the replacement of 30 % of fly ash and glass powder against cement and manufacturing sand shows a good result in compressive strength and flexural strength.

REFERENCES

[1] Aaron., Souza D., “Geo polymer paver blocks”, Proc of Int. Conf. On Advances in Civil Engineering July 2012.

[2] Dhanaraj mohan patil., Dr.Keshav K sangle., “Experimental investigation of waste glass powder as partial replacement of cement in concrete”, International journal of advanced technology in civil engineering, Volume-2, Issue 1,2013, pp112-117.

[3] Dr. Vijayakumar G., Vishaliny H., Dr. Govindarajalu D.,”Studies on glass powder as partial replacement of cement in concrete production”, International journal of emerging technology and advanced engineering, Volume-3, Issue 2, 2o13, pp153-157.

[4] Bajad M N., Modhera C D., Desai A K.,”Higher strength concrete using glass powder”, Journal of structural engineering, Volume-39, Number 3, 2012,pp 380-383.

[5] Jegan J., Sriram B.,”Replacement of cement by granite powder in paver blocks”,IRJET Volume-5, 2018, p-ISSN:2395-0072.

[6] Hanan A El noughy.,”Properties of paving units incorporating slag cement”, HBRC volume 9, Issue 1, 2013.

[7] Eshmaiel ganjian.,”Using waste materials and by products to produce concrete paver blocks”,

[8] *Pozzolans in Concrete*, ACI SP 153, 1995.Balogh, A., "High-Reactivity Metakaolin," *Concrete Construction*, p. 604, July 1995.

[9] Ambroise, J., Murat, M., and Pera, J., "Hydration Reaction and Hardening of Calcined Clays and Related Minerals. IV. Experimental Conditions for Strength Improvement on Metakaolin Mini cylinders," *Cement and Concrete Research*, Vol. 15, pp. 83-88, 1985.

[10] Chatterji, S., Mario Collepardi, and GiacomoMoriconi, "Pozzolanic Property of Natural and Synthetic Pozzolans: A Comparative Study," *Fly Ash, Silica Fume, Slag & Other Mineral By-Products in Concrete*, vol I, ACI SP-79, 1983.