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A Review on Precast Cement Concrete Paver Blocks Using Fly Ash

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Abstract: Paver block is used in various applications like in street road and other construction places. Portland cement generates large amounts of carbon dioxide (CO2) which is responsible for global warming hence it is a greenhouse gas. Solid unreinforced pre-cast cement concrete paver blocks is a versatile, aesthetically attractive, functional, cost effective and requires little or no maintenance if correctly manufactured and lay. Paver blocks can be used for different traffic categories. There are various types of Industrial Waste available in local markets, and certain of it can be used in the construction industry for utilization of waste material and eco-friendly condition. Various paper and research works based on fine aggregate (sand) replaced by various percentages of other industrial waste material and cement replaced by various percentage of other slurry base material and found that increased in strength, durability, and reduction in cost and utilization of waste material. Various waste materials are use like fly ash, rise husk ash, paper sluge, various fibres use for improving strength of paver block.

Keywords: Paver Block, Industrial Waste, Strength, Mix Proportion, Construction Industry.

1. INTRODUCTION

Pavers are the modern day solution for less cost outdoor application. Paver block is used in various places like in street road and other construction places. Interlocking concrete Pavement has been largely used in a number of countries for quite something as a specialized problem solving technique for providing pavement in areas where conventional types of construction are less durable due to many operational and environment constraints. Concrete block pavements have become an attractive engineering and economical alternative to both flexible and rigid pavements. The 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, container yards and roads. Interlocking paver blocks are installed over a compacted stone sub base and levelling bed of sand. Concrete paver blocks are made with concrete basically consisting of cement, fine aggregates, coarse aggregates (10 mm and below), water, chemical agents etc.

We all know for pavement of paver block required high compressive strength and to increase the compressive strength of paver blocks various efforts have been taken. Interlocking concrete paving blocks has various advantages over bitumen and concrete pavements in their structural, aesthetics, construction and maintenance, operational and economical characteristics. Like other pavement surfaces, the design of concrete paving blocks is based upon environmental, traffic, sub grade support and pavement materials conditions and their interactive effect.

2. LITERATURE REVIEW AND PREVIOUS WORK

Rajendra .D and H. Gokulram (2017) studied the properties of materials and mix proportions, preparation of concrete with waste Cuddapah stones, hardened state characteristics, and influence of various parameters on hardened state concrete and utilization of various materials in the structural members. Waste Cuddapah stones (WCS) were partially replaced as coarse aggregates in 20%, 40% and 60% respectively and fly ash (FA) was partially replaced with cement by 20% respectively are casted and tested for 7 and 28 days. Fresh and hardened concrete properties are evaluated by workability test, compressive strength and split tensile test with a fixed water cement ratio 0.4. The test results were compared with the conventional concrete properties and show that there is an increase in strength of the concrete.

Atul Thakur et al (2017) studied partial replacement (by weight) of cement with RHA in paver blocks for determining the change in the compressive strength, water absorption and abrasive resistance of paver blocks. Partial replacement of cement in different percentage as like 0%, 15%, 20%, 25%, 30%, 35% and 45% has been done. The compressive strength has been determined at the end of 7, 28 and 56 days, water absorption test and abrasion resistance has been determined at 28 days.

Darshan Pokharkar et al. (2017) 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. Paver block is used in various applications like in street road and other construction places. Portland cement generates large amounts of carbon dioxide (CO2) which is responsible for global warming hence it is a greenhouse gas. Solid unreinforced pre-cast cement concrete paver blocks is a versatile, aesthetically attractive, functional, cost effective and requires little or no maintenance if correctly manufactured and paver blocks can be used for different traffic categories.

Atul Thakur et al (2017) studied partial replacement (by weight) of cement with RHA in paver blocks for determining the change in the compressive strength, water absorption and abrasive resistance of paver blocks. Partial replacement of cement in different percentage as like 0%, 15%, 20%, 25%, 30%, 35% and 45% has been done. The compressive strength has been determined at the end of 7, 28 and 56 days, water absorption test and abrasion resistance has been determined at 28 days.

B. Kaviya (2016) studied for manufacturing paving blocks with crusher dust is studied. Paving blocks replaced with crusher dust by various percentages and its properties have also been studied. The results show that replacing sand with crusher dust has a minimal reduction in weight and also it leads to economy. Since the availability of sand is reducing now-a-days using of crusher dust will reduce polluting the environment since it is being dumped in many places.

Koli Nishikant et al (2016) looked at the feasibility of waste glass inclusion as partial FA replacement systems. Properties of concrete incorporating waste glass as partial substitution for FA amounts of 15%, 30% and 45% were investigated. The waste glass material used was obtained waste collectors. The results obtained show clearly that glass enhances the compressive strength properties of the final concrete product. The study indicated that waste glass can effectively be used as fine aggregate replacement (up to 45%) without substantial change in strength.

Deshpande B. C and P Darade M. M (2015) examines the effect of fly ash, as partial replacement to cement and dust as partial replacement to fine aggregate on the various properties of pavement block. Investigation is done on M30 mix using fly ash as partial replacement by weight of cement. Experimentation is carried out to find the compressive strength, flexural strength and abrasion resistance of the concrete paving blocks.

Joel Santhosh and Ravikant Talluri (2015) investigated concrete paving blocks may be produced with locally available cement, aggregates, fly ash and waste glass powder as the mineral admixture. Different mix proportions are prepared using cement replaced by equal quantity of fly ash and waste glass powder. The study indicated that fly ash and waste glass powder can effectively be used as cement replacement without substantial change in strength.

Patel et al. (2014) noticed that foundry sand is technically sound, environmentally safe for sustainable development. Partial replacement of Cement with foundry sand in paver block so determined the change in the compressive strength and cost of paver block maximum replacement 50% so results are water absorption is 2% & compressive strength 23.48 N/mm2 cost of paver block is 20.13% lower than standard mix proportion.

Sharma et al. (2014) found that in India brick kiln industries are the third largest industry where the coal is used for baking the clay brick and residue of brick kiln called brick kiln dust. Paver Block is widely used in now a day in various area so partial replacement of cement with brick kiln dust 0% to 30% with maximum super plasticizer 2% so result shows that 15% of cement replaced with brick kiln dust give good and effective result.

Raja et al. (2014) analyzed that manufacture sand is the best alternative of Fine aggregate for the concrete paver block. To use of the Manufacture sand, we can achieve compressive strength is 43.80N/mm^2 in M30 grade paver size 200mmX200mmX50mm. Manufacture sand is good alternative of river sand and cost is also economical.

Santos et al. (2013) presents this work was to study the use of coal waste to produce concrete paving blocks. Analyzed say that coal is used to replace conventional sand as a fine aggregate for concrete paving blocks. The demand of conventional sand can be minimized and a part of coal tailings can be used and reducing the volume in coal waste deposits.

Patel et al. (2013) found that foundry sand in various engineering applications can solve the problem of disposing of foundry sand and other purposes. Foundry Sand can be used as a partial replacement of cement in supplementary addition, to achieve different properties of concrete. The application of a used foundry sand as a replacement with cement is feasible for strength in interlocking paver blocks. Used foundry sand can be used to prepared low cost temporary structure.

Kashiyani et al. (2013) found that the compressive strength and water absorption have good property obtained with the inclusion of PPF in paver block. The addition of a 0.4% fiber mixed on The concrete paver block for compressive strength up to 40% and reduce the water absorption and it makes paver block dense than standard blocks.

Kalingarani et al. (2012) concluded that Interlocking concrete paver block (ICPB) is widely used in exterior flooring so aim of the study is making ICPB with the use of maximum industrial waste like fly ash and copper slag.

Vaz Aaron et al. (2012) found that cement concrete is second most consumed commodity in the world someone generated a large amount of carbon dioxide it is responsible for global warming effect. Geopolymer concrete used as an option for OPC in precast concrete products. Geopolymer concrete is a ecofriendly option for waste stabilization. GPC paver blocks have high compressive strength compared to OPC. They also have high early strength gain curing time 24hours at 60°C and OPC is curing 28 days in water so geopolymer concrete used Benefit in the manufacture paver block.

M Ravi et al. (2012) analyzed that experimental study on strength characteristics and water absorption of iron ore tailings based concrete paver blocks compared with that of conventional concrete paver blocks. Iron ore tailing is obtained from the mining industry waste handling and disposing them is a problem so used of iron ore in concrete for their improvement in strength. The use of iron ore tailing from 5% to 15% has shown increases in the compressive strength of the concrete compared to normal concrete and 15% to 25% has resulted in lower compression strength compared to that of conventional blocks.

Kalingarani .K et al (2010) produce interlocking concrete paver blocks from industrial wastes .The main reason for the use of the industrial wastes is to reduce the landfill problem and also to control the depletion of the natural resources. For this purpose various industrial wastes such as copper slag, fly ash, phosphogypsum, and sludge were selected and their physical and chemical properties were studied. Various mixes with different proportions of these industrial wastes were casted and tested as per the standards given in the Indian standards for precast concrete blocks for paving (is.15658:2006). These test results are then compared with the results of the conventional paver blocks.

M. C Nataraja and Lelin Das (2010) investigated various properties such as compressive strength, split tensile strength, bending strength and water absorption of paver blocks consisting of crushed granite, unconventional materials such as kadapa and broken paver for various percentage replacements of coarse aggregate are studied as per IS 15658:2006.

Tapkire et al. (2010) Investigated Recycled plastic used in the concrete paver block amount of plastic waste more and the problem for their disposal, so waste utilized in the construction industry, plastic waste like plastic bottles, pallets, carry bags; polypropylene (PP) and polyethylene Terepthalate (PET) were as alternative replacements of a part of the conventional aggregates of concrete. 20% Recycled plastic are used in place of aggregates in concrete, which does not affect the properties of concrete.

Nanda et al. (2010) said that Stone crusher dust is added certain percentage with fine aggregate it added up to 50% by weight so negligible effect on reduction of physical and mechanical properties of paver block and they reduce costs up to 56%.

Radhikesh P et al. (2010) studied for producing paving blocks using crusher dust is presented. Some of the physical and mechanical properties of paving blocks with fine aggregate (sand) replaced by various percentages of crusher dust are investigated. The test results shows that the replacement fine aggregate by crusher dust up to 50% by weight has a negligible effect on the reduction of any physical and mechanical properties while there is a saving of 56% of money. The percentage of saving was less but highly beneficial for mass production of paving blocks. The shaving would be more if the sand availability is at a greater distance. This also reduces the burden of dumping crusher dust on earth which reduces environmental pollution.

3. SHAPES AND CLASSIFICATIONS

There are four generic shapes of paver blocks corresponding to the four types of blocks as below and figure 1.3 shows the different shapes of paving blocks:

a. Type A: Paver blocks with plain vertical faces, which do not key into each other when paved in any pattern,
b. Type B: Paver blocks with alternating plain and curved/corrugated vertical faces, which key into each other along the curve/corrugated faces, when paved in any pattern,
c. Type C: Paver blocks having all faces curved or corrugated, which key into each other along all the vertical faces when paved in any pattern and
d. Type D: 'L' and 'X' shaped paver blocks which have all faces curved or corrugated and which key into each other along all the vertical faces when paved in any pattern.

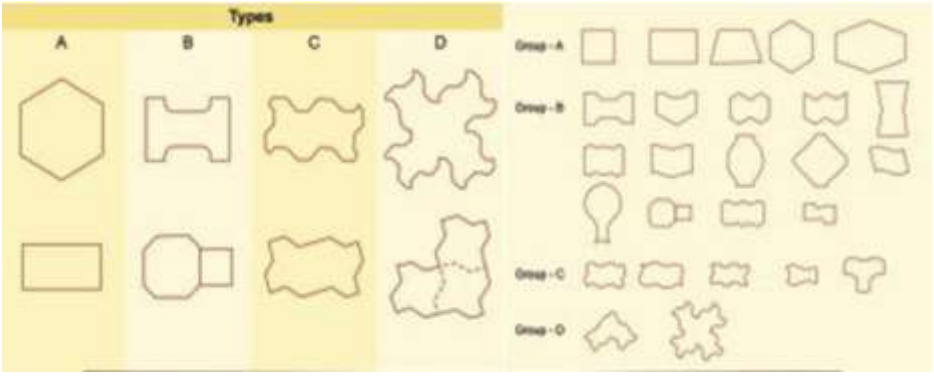

Fig. 1: Different Shapes of Paving Blocks

4. ADVANTAGES OF PAVING BLOCK

- Capability of being moulded in different sizes, shapes, and colours
- Good stability and durability, if properly manufactured and installed.
- Easy to produce and easy laying
- Good indoor climate (balanced humidity; cool)
- Various attractive patterns can be formed
- Equipment to produce tiles can be easily made by local workshop

5. APPLICATION OF PAVER BLOCK

A. Non-Traffic Areas
Building Premises, Footpaths, Malls, Pedestrian Plaza, Landscapes, Monuments Premises, Premises, Public Gardens/Parks, Shopping Complexes, Bus Terminus Parking ranges and Railway Platform, and so forth

B. Light Traffic
Car Parks, Office Driveway, Housing Colony Roads, Office/Commercial Complexes, Rural Roads, Residential Colony Roads, Farm Houses, and so forth.

C. Medium Traffic
Boulevard, City Streets, Small Market Roads, Intersections/Rotaries on Low Volume Roads, Utility Cuts on Arteries, Service Stations, and so forth.

D. Heavy and Very Heavy Traffic
Container/Bus Terminals, Ports/Dock Yards, Mining Areas, Roads in Industrial Complexes, Heavy-Duty Roads on Expansive Soils, Bulk Cargo Handling Areas, Factory Floors and Pavements, Airport Pavement, and so forth.

6. CONCLUSION

A survey of journal articles published between 2010 and 2017 yields studies that vary in scope and level of analysis, yet with consistently good results.

Concrete has become a vital part of our lives. With each passing day, the use of concrete is increasing at a very high rate. One of the main constituents of concrete is Portland cement. With the increase in use of concrete, the manufacturing and consumption of cement has increased drastically. Although cement has exceptional binding properties and is very suitable for use in concrete, the manufacturing of cement results in emission of large amounts of CO_2. Due to this, researchers have started finding alternatives to cement that are economical as well as environment friendly.

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. Several researchers have studied the use of waste materials in concrete such as coal, fly ash, plastic waste, Industrial waste fiber, rubber pads, marbles etc., for making the concrete products. The advantages of using such type of concrete products are these products having low cost as well as they conserve natural resources.

The major findings of literature survey are as follows:

1. There are various types of waste material like stone crusher dust, Recycled plastic or plastic waste, Fly ash, Copper slug, marble waste, coal waste, foundry sand, brick kiln are used to replaced material aggregate or cement in the manufacture of paver block for reduction of cost.
2. There are various types of mix design with different material like Geopolymer concrete is used instead of OPC, iron ore tailing from the mining industry, rubber pad is used for improving the compressive strength of Paver Block.
3. There are various types of fiber used in The Paver Block like nylon Fiber, polypropylene fiber, coconut fiber, polyester fiber for improving compressive strength, abrasion resistance and flexural strength of Paver block.
4. Different size, Different shape and Different strength Paver block used in different area.
5. Compressive strength of Paver block depends on a water cement ration of mix proportions.
6. There are various waste material used in the manufacture of Paver block like ceramic waste, rice husk ash, fly ash, glass powder for improving the strength of Paver block.

These alternatives are generally termed as Supplementary cementitious materials (SCMs). The use of these materials not only helps in reducing the consumption of cement but also serves as an efficient method for their safe disposal. This work reviews the effect of using the various alternatives that can be used in concrete as partial replacement of cement in manufacturing of paver blocks. The literature review of various researchers reveals that a single alternative cannot provide all the benefits that cement does. Rather, a suitable combination of these products can be incorporated in concrete to provide properties similar to or better than that of Portland cement concrete.

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