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INFLUENCE OF ADDITION OF MATERIAL WASTE INMANUFACTURING OF PAVER BLOCKS

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Abstract: *Owing to the present scenario use of paver blocks is increasing day by day. On the other hand due to increase in industrialization generation of material waste is also increasing rapidly. Disposal of such material waste is a major problem as it may contain harmful chemicals which may affect Environment Therefore use of material waste in manufacture of paver blocks proves to be a good alternative.This Project is carried out for using the Material Waste in manufacturing of Paver Blocks. The use of paver blocks is increasing day by day. Due to increase in industrialization the generation of material waste is also increasing. Thus the one of best alternative can be using the waste in other works. The Aim of study is use of material waste in manufacturing of paver blocks & making the Paver Blocks Economic without compromising with Strength Parameters. It consists Replacing Fine Aggregate (sand) with Material Waste like Silica Flumes, Foundry Dust, Abrasive Waste(Emery) and Fly Ash in different proportion.*

Keywords: *concrete block, Fly ash, Foundry sand, Abrasive waste, Silica fume*

I. INTRODUCTION

Over the past two decades, paving composed of segmental blocks has become a feature of our towns and cities. Existing pavements subjected to heavy bus traffic and industrial loads have been monitored and their service life shown to be satisfactory. During this period, extensive research has been carried out on the engineering characteristics and structural performance of segmental block paving. The South African Bureau of Standards has published specifications relating to the quality of concrete paving blocks and required standards of construction. The Committee of Urban Transport Authorities has published a catalogue of designs forsegmental block pavements. But the aesthetic use of segmented paving and the contribution it can make to improve our urban landscape.

1.1.1 History

Although pavers made out of concrete may be a new product. The first record of stone paving dates back to 4000 BC in Assyria and by 2000 BC, flagstones were being used to pave village streets. Cobblestones were the traditional method of stone paving, being uncut and often water-worn stones or large pebbles about 150mm in size. Later hand-cut stone blocks were introduced. Road-making using brick was common in Mesopotamia in 2000 BC and clay brick paving was in use in India in 300 BC. It was the Romans who introduced hexagonal-shaped flagstones as a surface course, so the concept of shaped, rather than rectangular blocks, is certainly not new. Perhaps the most famous of all Roman roads is the Appian Way, built by Roman engineers in 312 BC. The 377 kilometre road was surfaced with tight-fitting paving stones that still carries traffic between Rome and Italy’s south-eastern port of Brandish. Concrete paving blocks were first manufactured in the Netherlands in 1924. It was probably World War II that led to the growth of concrete blocks as a paving material. Large areas of the Netherlands were destroyed during the War and, because clay bricks were in short supply (and what was available was being used to rebuild housing), concrete blocks were introduced as an alternative. Subsequently, concrete block paving (cbp) became recognised as a paving material in its own right
The research carried out by Shackel in the late ’70s and early ’80s remains the most comprehensive yet conducted into the performance of concrete blockpaving. A hierarchy of block shapes was developed, the existing design curves were examined, the role of the bedding and jointing sands was investigated in earnest, and various base and sub-base materials were tested. Most of the research by Shackle was carried out at the CSIR in South Africa. This has resulted in South Africa being recognised as a world leader in concreteblock paving.

1.1.2 Application of concrete block paving

Concrete pavers are a versatile paving material, which due to the availability of many shapes, sizes and colours, has endless streetscape design possibilities. The use of concrete block paving can be divided into the following categories:

Roads: Main roads Residential roads Urban renewal Intersections Toll plazas Pedestrian crossings Taxi ranks Steep slopes Pavements (sidewalks)	**Commercial Projects** Car parks Shopping centres and malls Parks and recreation centres Golf courses and country clubs Zoos Office parks Service stations Bus termini Indoor areas Places of worship
Domestic paving Pool surrounds Driveways Patios Townhouses and cluster homes **Specialised Applications** Cladding vertical surfaces Storm water channels Embankment protection under freeways	**Industrial Areas** Factories and warehouses Container depots Military applications Mines Wastewater reduction works Quarries Airports and harbours

1.1.3Comparison of concrete block paving with other types of pavement

In certain specific areas,choiceof block paving is depend on its cost effectiveness, aesthetic qualities, ease of construction, maintenance and in-service advantages. In general it can be said that concrete block paving excels in terms of cost and performance in the following circumstance.

- Where heavy or concentrated wheel load are to be carried and especially where a high frequency of turning or slewing moments is expected.
- Where volume of traffic is high.
- Where sub grade condition are poor.
- Where ready access to underground service is required.
- Where the appearance and aesthetic qualities of the pavement are major design consideration.

1.1.4Paver Block Characteristics

- The inter locking concrete paver tiles should conform to IS-15658: 2006.They shall be tested as per the code and have to qualify limits specified byus down below.
- The surface should be of anti skid and anti glare type.
- The paver should have uniform chamfers to facilitate easy drainage of surface run off.
- The concrete mix design should be followed of each batch of materials separately and weigh batching plant is to be used to achieve uniformity instrength and quality.
- The pavers shall be manufactured in single layer or more to ensure smooth surface on top and to remove all voids.
- The pavers shall be havingcemented Grey colour without any pigment or colouredwith pigment or with chemically treated top surface as specified.
- All paver blocks shall be sound and free of cracks or other visual defects,which will interfere with the proper paving of the unit or impair thestrength or performance of the pavement constructed with the paver blocks.
- The compressive strength requirement of concrete paver block shall beminimum 47.2 MPa (N/sqmm) for 28 days (Testing as per IS-15658)after applying the correction factor as per IS-15658:2006.

II. MANUFACTURE OF PAVER BLOCKS

Cement concrete is a mixture of Portland cement, aggregates (sand and stone chips) and water. The process of manufacture of cement concrete paving blocks involves the following steps:
a) Proportioning
b) Mixing
c) Compacting
d) Curing

e) Drying

- A concrete mix of 1:2:4 (cement: sand: stone chips) by volume may be used for cement concrete paving blocks with water to cement ratio of 0.62. The concrete mix should not be richer than 1:6 by volume of cement to combined aggregates before mixing. Fineness modules of combined aggregates should be in the range of 3.6 to 4.0.
- All the raw materials are placed in a concrete mixer and the mixer is rotated for 15 minutes. The prepared mix is discharged from the mixer and consumed in the next 30 minutes.Vibrating table may be used for compacting the concrete mix in the moulds of desired sizes and shapes.
- After compacting the blocks are remoulded and kept for 24 hours in a shelter away from direct sun and winds. The blocks thus hardened are cured with water to permit complete CEMENT CONCRETE TILES AND PAVING BLOCKS miniaturisation for 14 to 21 days. Water in the curing tanks is changed every 3 to4 days. After curing, the blocks are dried in natural atmosphere and sent for use.
- The concrete paving blocks gain good strength during the first 3 days of curing and maximum gains in strengths are secured in the first 10 to 15 days of curing. After curing, blocks are allowed to dry in shade so that the initial shrinkage of the blocks is completed before they are used in the work. A drying period of 7 to 15 days would normally complete the drying shrinkage after which they can be used. The concrete tiles are similarly produced with the help of semi-dry pressing of the mixture and allowed to set for 24-36 hours. It is cured in the tanks for 15 days. If need be water can also be sprinkled to gain maximum physical strength in 15-21Days.

Sand is replace by following waste materials in different proportion i.e. 10%, 20%, 30% & 40%.

1. **Fly ash:** The most widely used supplementary cementations material in concrete is a by-product of the combustion of pulverized coal in electric power generating plants.
2. **Foundry sand: -** Foundries produce ferrous and non-ferrous castings, and in the process generate large quantities of waste sand that can no longer be used in the casting process. Non-reusable sand accounts for 55 to 90 percent of the total waste stream of a facility. Nationally, only two percent of foundry sand is considered hazardous. The remaining 98 percent is a non-hazardous industrial by-product that can be reused in a variety of products or disposed of in non-hazardous landfills. The foundry industry uses approximately 100 million tons of sand per year. Roughly 90 percent is reused for making moulds within the foundries, but 9 to 13 million tons of this sand is no longer useable in the casting process. Of this sand, approximately one million tons are recycled for other uses every year; the remaining 8 to 12 million tons are land filled. Many foundries have invested in sand reclamation systems that can recover up to 95 percent of sand used in the casting process. These systems represent an important environmental and economic opportunity for foundries, helping to control production costs and to reduce the amount of waste for disposal. Even with this increase in sand reclamation, there is a limit to the number of times sand can be effectively reused in the casting process, eventually resulting in a large amount of used sand that could be beneficially reused elsewhere.
3. **Abrasive waste: -** They are non metallic synthetic emery aggregates which are polyhedral in shape and can be graded in factory for optimum performance.
4. **Silica fume**: It is also known as micro silica, is an amorphous (non-crystalline) polymorph of silicon dioxide, silica. It is an ultrafine powder collected as a by-product of the silicon and ferrosilicon alloy production in electric arc furnace and consists of spherical particles with an average particle diameter of 150 nm. Silica fume reduces bleeding significantly because the free water is consumed in wetting of the large surface area of the silica fume and hence the free water left in the mix for bleeding also decreases. Silica fume also blocks the pores in the fresh concrete so water within the concrete is not allowed to come to the surface.It contains aluminium oxide (55-60%) & ferric oxide (25-30%) to give hardness.The construction elements treated with this material will exhibit increased resistance to abrasion , impact, dusting, absorption & deteriorationEmery is a form of corundum which is rich in Aluminium Oxide(55-60%) and Ferric Oxide (25-30 %).It can be applied to Fresh Concrete Slab as a monolithic topping or to harden concrete slab as a separate bonded topping.

Physical properties of silica fumes:

Property	**Result**
Partical size	<1µm
Bulk density	130-430kg/m³
Specific gravity	2.2
Specific surface	15000-30000m²/kg

Chemical properties of fly ash:

Properties	Result	
	Class F	Class C
$Fe_2O_3+Al_2O_3+SiO_2$	70	50
SO_3	5	5
Moisture content	3	3
Loss on ignition	6	6

Physical properties of foundry sand:

Property	Results
Specific gravity	2.39-2.55
Bulk density(kg/m³)	2590
Absorption(%)	0.45
Moisture content(%)	0.1-10.1

Chemical properties of foundry sand:

Constituents	Value
SiO_2	83.03
Al_2O_3	0.021
Fe_2O_3	0.950
CaO	1.03
MgO	1.77
SO_3	0.057
Loss on ignition(%)	2.19

Physical Properties of Abrasive waste:-

Hardness	8 – 9 on Mohr's Scale of 10
Form	Bluish Black dry grains
Mineral phase	Corundum along with Hematite
Particle Shape	Polyhedral
Crystalline	Poly Crystalline to Amorphous
Specific Gravity	3.85
Bulk Density	3.9

Chemical Properties of Abrasive waste:-

CHEMICAL CONSTITUENTS	AMOUNT (%)
Al_2O_3	57
Fe_2O_3	25
SiO_2	5-6
MgO	2-3
CaO	1-2
TiO_2	1-2
Loss on Ignition	4

III. METHODOLOGY

3.1 Manufacture of Paver blocks

Cement concrete is a mixture of Portland cement, aggregates (sand and stone chips) and water. Aggregates passing through 4.7 mm IS sieve are known as fine aggregates and the aggregates retained on this sieve are coarse aggregates. The process of manufacture of cement concrete paving blocks involves the following steps:
a) Proportioning
b) Mixing

c) Compacting
d) Curing
e) Drying

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4 days. After curing, the blocks are dried in natural atmosphere and sent for use.
The concrete paving blocks gain good strength during the first 3 days of curing and maximum gains in strengths are secured in the first 10 to 15 days of curing. After curing, blocks are allowed to dry in shade so that the initial shrinkage of the blocks is completed before they are used in the work. A drying period of 7 to 15 days would normally complete the drying shrinkage after which they can be used. The concrete tiles are similarly produced with the help of semi-dry pressing of the mixture and allowed to set for 24-36 hours. It is cured in the tanks for 15 days. If need be water can also be sprinkled to gain maximum physical strength in 15-21Days.

Compression test results for various proportion of waster material:-

Sample	Area(cm2)	Comp. strength(Kg/cm2)
Conventional	430.75	528.60
F 10	430.75	526.82
F 20	430.75	526.97
F 30	430.75	527.12
F 40	430.75	528.10
FS 10	430.75	530.18
FS 20	430.75	532.10
FS 30	430.75	535.11
FS 40	430.75	535.23
S 10	430.75	515.64
S 20	430.75	516.23
S 30	430.75	516.34
S 40	430.75	516.9
A 10	430.75	545.15
A 20	430.75	546.85
A 30	430.75	546.37
A 40	430.75	546.98

Where, FS- foundry sand: S-silica fume: F- fly ash; A-abrasive waste

Rate of Waste Materials:-

Fly Ash = 400 rs/m³

Foundry Sand = 250 rs/m³

Silica Fumes = 900 rs /m³

Abrasive waste (emery) = 1300rs /m³

Waste Material Block => / **Materials**	40% fly ash	40% foundry Sand	40% silica fumes	40% Abrasive waste	Conventional Block
Cement(rs)	2160	2160	2160	2160	2160
60% sand(rs)	120	120	120	120	210
Aggregate(rs)	500	500	500	500	500
40% Waste Material(rs)	66.24	41.40	165.60	215.85	-
Cost per 1m³ concrete(rs)	2846.24	2821.40	2945	2995.85	2870
Cost of Block	**7.36**	**7.29**	**7.60**	**7.75**	**7.49**

IV. CONCLUSION

From the test result it is observed that for various proportions i.e. 10%, 20%, 30% & 40% of Fly ash compressive strength of paving block is little less than the compressive strength of conventional brick. Same as fly ash, use of foundry sand gives little more compressive strength than conventional block.Only little economy can be achieved & waste may utilized save the land from dumping of non degradable material. If we talk about other two waste material silica fume & Abrasive waste, silica fume give less compressive strength & Abrasive waste gives more compressive strength than the conventional block. These both options give considerable change in strength parameter. Based upon the economy &requirement one may switch to either option among 4 discussed above.

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