Paver Blocksby using fly ash and GGBS (Geopolymer Concrete)

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Abstract:- **The living planet earth has encountered global warming due to various issues. One of the main reasons is construction industries since the foremost component of concrete is cement, which has its own environmental problems. The cement industry is one of the prime producers of carbon-di-oxide. It is estimated that about 7% of greenhouse i.e. Carbon-di-oxide gas is being emitted into atmosphere on account of production of OPC alone at global level. On other hand disposal of solid waste is a major problem. Coal power plants produce solid waste called fly ash whose disposal is difficult. Therefore urgent changes are required relating to emissions, production and application of sustainable and eco-friendly materials. This led to concept of geo polymer concrete by which cement can be entirely avoided in the concrete. This paper aims to develop geo-polymer paver blocks. The paver blocks developed are tested for their compressive, *split tensile, flexural and abrasive strength as per Indian Standards 15658:2006***

Need for the study:

- To find Alternate material for cement to Control and reduce the global warming from the emission of carbon dioxide during cement production.
- To Preserve natural resources by replacing river sand by M-sand
- To minimize the dumping of waste material into ground .
- To reduce the environmental problems by replacing industrial by-products into useful construction materials.

INTRODUCTION

Paver block has been used in construction for about thousands of years. Paver block is nothing but an unreinforced solid block appropriate for outdoor applications. The first concrete pavers were shaped just like a brick, 4" × 8" (10cm × 20cm) and they were called Holland Stones. These units turned out to be cheap to produce and were exceptionally strong. In addition to being economical, interlocking concrete pavers are also broadly obtainable in water-permeable designs, which have additional ecological benefits. These paver blocks allowed water to drain through their interlocks and prevent soil erosion or increase wter level in the neighboring land area. Production of ordinary Portland cement had resulted in emission of greenhouse gas i.e. Carbon-di-oxide. As of 2010 the world production of OPC was 3300 million tons annually. This accounts for 5% of man-made emission of carbon-di-oxide at global level. On other hand clearance of solid waste is a major problem. Coal power plants produce solid waste called fly ash whose disposal is difficult. As the intricacy of environmental issues and solid waste management increases day by day it has become essential to develop sustainable and eco-friendly materials. This led us to develop geo polymer paver blocks for medium traffic with thickness of 80 mm. paver blocks were produced and tested for their properties. Geo polymers involves the activation of fly ash by alkaline solution which does not require water for curing.

MATERIALS USED:

The material used in the experimental work namely,

Cement

a substance made of burned lime, clay, sand and water to make mortar or sand, water and gravel to make concrete.

FLYASH

Fly ash is extracted from pulverized or crushed coal by suitable process such as by cyclone separation or electrostatic precipitation. Fly ash collected at later stages of electrostatic precipitator is finer than the fly ash collected at initial stages of electrostatic precipitator.

GGBS

Ground-granulated blast-furnace slag (GGBS or GGBFS) is obtained by quenching molten iron slag (a by-product of iron and steel-making) from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder.

FINE AGGREGATE

Aggregate is the granular material used to produce concrete or mortar and when the particles of the granular material are so fine that they pass through a 4.75mm sieve, it is called fine aggregate.

M- SAND

Manufactured sand (M-Sand) is a substitute of river sand for concrete construction. Manufactured sandis produced from hard granite stone by crushing. The crushed sand is of cubical shape with grounded edges,

washed and graded to as a construction material. The size of manufactured sand (M-Sand) is less than 4.75mm

COARSE AGGREGATE[10 mm]

Coarse aggregates are any particles greater than 0.19 inch, but generally range between 3/8 and 1.5 inches in diameter. Gravels constitute the majority of coarse aggregate used in concrete with crushed stone making up most of the remainder.

POTABLE WATER

Potable water used for mixing and curing is clean and free from injurious amount of oils, acids, alkalis, salts, sugar, organic material or other substances that may be deleterious to concrete. Portable water is used for mixing concrete. The pH value of water lies between 6 and 8 that indicate the water is free from organic matters.

CHEMICAL COMPOSITION OF FLY ASH

S.No.	**. Oxides**	**Requirements as per IS 3812-2003 (% by Mass)**	**Test result (% by Mass)**
1.	SiO2+Al2O3+Fe2O3	Total > 70.0	88.86
2.	CaO	<50	0.5
3.	SiO2	> 35.0	53.66
4.	MgO	< 50	2.89
5.	SO3	< 50	0.35
6.	Na2O	--	0.36
7.	Loss of ignition including moisture	< 7.0	1.02

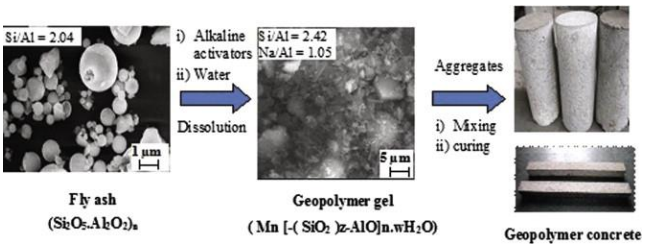
CHEMICAL COMPOSITION OF GGBS

S.No.	**Characteristics**	**Requirements as per BS:6699(%by Mass)**	**Test result(%by Mass)**
1.	Loss on ignition	< 3.0	0.29
2.	Insoluble Residue	< 1.5	0.4
3.	Magnesia Content	< 14.0	7.86
4.	Sulphide Sulphur	< 2.0	0.5
5.	Sulphite Content	< 2.5	0.4
6.	Glass content	> 67.0	93
7.	Moisture	< 1.0	0.1
8.	Chloride content	< 0.1	0.008
9.	Manganese	< 2.0	0.11
10.	Chemical Moduli CaO+MgO +SiO2 CaO+MgO/ SiO2 CaO/SiO2	 > 66.66 > 1.0 < 1.4	 77.46 1.37 1.13

Alkaline activator solution

Alkaline activation is a chemical process in which a powdery aluminosilicate such as a fly ash is mixed with an alkaline activator to produce a paste capable of setting and hardening within a reasonably short period of time.

Material	**7days Compressive Strength N/mm²**	**14 Days Compressivestrength N/mm²**
G40	27.3	35.5
M40	27	34



HYDRATION:

It is the series of irreversible exothermic chemical reaction between cement and water.

POLYMERIZATION:

A chemical process that cobines several monomers to form a polymer or polymeric compound.

ACTIVATOR SOLUTION

Molarity - 8

Ratio - **1(Sodium Hydroxide) : 2.5(Sodium Silicate)**

Mixing for 5 liter of water:

Sodium hydroxide - 640 ml

Sodium silicate - 970 ml

FINENESS TEST :
the fineness of cement is 4%
the fineness of flyash is 6.4%
the fineness of GGBS is 6%

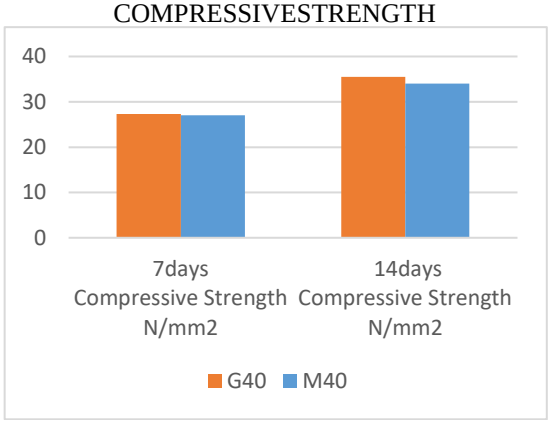
FLOW TABLE TEST :

Spread Diameter=24.3+22.3+26.3=72.9/3 =24.3 cm

Workability of our concrete mix is **24.3cm**

COMPRESSIVE STRENGTH TEST:

COMPRESSIVESTRENGTH



ABRASION TEST:

The abrasion wear test was conducted as per the procedure given in IS 15658: 2006 and the loss involume and thickness of the specimens were calculated. The average loss in thickness is 3.17mm which is less than the limiting maximum value of 3.5 mm prescribed for general purpose paver blocks. Hence the paver blocks can be used for general purpose applications.

Specimen No.	Size in mm	Initial weight W1in kg	Weight after abrasion W2 in kg	Density in kg/m3	Loss in Volume in m3 = Weight loss /Density	Loss in Thickness in mm
1.	71 x 71 x 60	0.861	0.815	2846	1.616×10^{-5}	3.2
2.	71 x 71 x 60	0.857	0.812	2831	1.589×10^{-5}	3.15
3.	71 x 71 x 60	0.872	0.825	2855	1.646×10^{-5}	3.27
4.	71 x 71 x 60	0.862	0.818	2847	1.545×10^{-5}	3.06
Average					1.599×10^{-5}	3.17

LIGHT LOADING

HEAVY LOADING

CONCLUSION

• The maximum compressive strength of 35.5 Mpa , is achieved at 30:70 replacement of FLYASH and GGBS respectively as compare to 34 Mpa of strength of conventional concrete for 14 days curing in potable water. Thus maximum strength is achieved in 70 % of GGBS replacement than other replacement levels.
• Using FLYASH and GGBS instead of cement not only provides the economy in the construction but it also facilitates environmental friendly disposal of the waste slag which is generated in huge quantities from the steel industries.

• Ambient curing of geopolymer concrete will give better results. So thereby, saving potable water.
• Hopefully one day in the future GEOPOLYMER CONRETE PAVER BLOCK will replace CONVENTIONAL CONCRETE as the most abundant man-made material in construction field.

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