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PARTIAL REPLACEMENT OF FINE AGGREGATE AND CEMENT IN PAVER BLOCKS USING WASTE MATERIALS

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Abstract : *A parametric experimental study for producing paving blocks using fine and coarse waste glass is presented. Some of the physical and mechanical properties of paving blocks having various levels of fine glass (FG) and coarse glass (CG) replacements with fine aggregate (FA) are investigated. The test results show that the replacement of FG by FA at level of 20% by weight has a significant effect on the compressive strength, flexural strength, splitting tensile strength and abrasion resistance of the paving blocks as compared with the control sample because of pozolanic nature of FG. The compressive strength, flexural strength, splitting tensile strength and abrasion resistance of the paving block samples in the FG replacement level of 20% are 69%, 90%, 47% and15 % higher as compared with the control sample respectively. It is reported in the earlier works the replacement of FG by FA at level of20% by weight suppress the alkali-silica reaction (ASR) in the concrete. The test results show that the FG at level of 20% has potential to be used in the production of paving blocks. The beneficial effect on these properties of CG replacement with FA is little as compared with FG.*

Keywords - waste glass, fine glass, paving blocks, flexural strength, alkali-silica reaction.

I. introduction

Concrete block pavements (CBP) are formed from individual solid blocks that fit closely next to one another to form a pavement surface. A typical CBP is placed on a thin bed of sand overlaying a sub base. CBP can be placed with a variety of shapes and patterns. There are joint spaces between blocks. These spaces are filled with sand having suitable grading. The blocks are restrained from two sides by edge restraints.CPBS are manufactured from semi-dry mixes. During manufacturing process vibration and pressure is applied to the mix. By this process dense and strong CPB can be achieved to form strong and durable paving surfaces. Moreover interlocking behavior of CBP gives the ability of spreading loads to larger areas.CBP has several advantages over asphalt and concrete pavements in their structural, aesthetics, construction and maintenance, operational and economical characteristics.

Concrete paver blocks were first introduced in Holland in the fifties as replacement of paver bricks which had become scarce due to the post-war building construction boom. These blocks were rectangular in shape and had more or less the same size as the bricks. During the past five decades, the block shape has steadily evolved from non-interlocking to partially interlocking to fully interlocking to multiply interlocking shapes. Consequently, the pavements in which non-interlocking blocks are used are designated as `Concrete Block Pavement (CBP)' or non-interlocking CBP, and those in which partially, fully or multiply interlocking blocks are used are designated as `Interlocking Concrete Block Pavement (ICBP)'. CBP/ICBP consists of a surface layer of small-element, solid un-reinforced pre-cast concrete paver blocks laid on a thin, compacted bedding material which is constructed over a properly profiled base course and is bounded by edge restraints/ kerb stones, The block joints are filled using suitable fine material.

II. literature survey

Literature reviewing on following papers of paver blocks were studied and referred. Given below are the papers etc that have been reviewed for the comparative study between normal paver blocks and the paver blocks by partial replacement of fly ash and glass powder.

II.1 1 P. Turgut, E. S. Yahlizade:-"study of paver blocks using waste glass 2013" A parametric experimental study for producing paving blocks using fine and coarse waste glass is presented. Some of the physical and mechanical properties of paving blocks having various levels of fine glass (FG) and coarse glass (CG) replacements with fine aggregate (FA) are investigated. The test results show that the replacement of FG by FA at level of 20% by weight has a significant effect on the compressive strength, flexural strength, splitting tensile strength and abrasion resistance of the paving blocks as compared with the control sample because of pozzolonic nature of FG. The compressive strength, flexural strength, splitting tensile strength and abrasion resistance of the paving block samples in the FG replacement level of 20% are 69%, 90%, 47% and 15 % higher as compared with the control sample respectively. It is reported in the earlier works the replacement of FG by FA at level of 20% by weight suppress the alkali-silica reaction (ASR) in the concrete. The test results show that the FG at level of 20% has a potential to be used in the production of paving blocks. The beneficial effect on these properties of CG replacement with FA is little as compared with FG.

II.2 Suresh Chandra Patanaikab , Dr. Akshaya Kumar Sabat:-"Utilization of fly ash in construction 2014" Fly ash is a rich cementations industrial waste which has the great potential to substitute Portland cement, a major producer of CO2 and there by decreasing green house gas emissions. The production of fly ash in India is likely to be more than 175 million tons by the year 2012.Though due to lot of efforts by State and Central Government the utilization of fly ash has gone beyond 50%, still a lot has to be done for full utilization of this precious wealth from the waste. The eastern state of Orissa in India has a large coal deposit thus facilitating thermal power plants and producing more and more fly ash day by day. But the effective utilization is restricted only to manufacture of Fly-ash Bricks, producing fly ash based Pozzolanic cement and use in pavements. The utilization in high volume mass concrete is very negligible due to absence of any major infrastructure projects or even a single RMC (Ready Mixed Concrete) plant in the state. In this context a study was made for utilization of fly ash generated by captive power plant of NALCO (National Aluminum Company), Angul, Orissa along with varying dosages of super plasticizer. The various Mix Design as per Bureau of Indian Standards (BIS) methods were made by replacement of cement from 10% to 40% by fly ash. The super plasticizer helped for compensating the loss in early age strength by reducing the water cement ratio and increasing the workability of the mix.

II.3 Asst.Prof.Vaishakhi A Talati:-"Utilization of waste materials in paver blocks" 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.

II.4 Karasawa, Suda, Naito and Fujiwara:-"Fly ash as substitute for fine aggregate 2013" The amount of coal combustion by-products in Japan has been increasing recently due to the increased number of coal -fired power plants. The demand for more effective applications for recycling coal ash than the conventional use as a substitute for clay in cement has become intense. This study investigated the applicability of fly ash as a substitute for fine aggregate in concrete paving blocks, which is regarded as inferior in quality to concrete of the Japanese Industrial Standard specifications, by testing the fresh properties and strength characteristics. The results show that if fly ash accounts for 25% of the mixture of fly ash and cement by weight, the plastic deformation during demolding and curing and the flexural strength satisfy the target values of 1 mm and 6 MPa. The authors conclude that fly ash can be used as a substitute for fine aggregate in the production of concrete blocks for pavement.

III. materials and methodology

The objective of this research is to form the background knowledge about CBP to exterminate the performance problems and to evaluate the abrasion and mechanical properties of Concrete Blocks (CBs) produced by adding fly ash and glass powder in varying proportions. The aim of this project is to minimize the use of ordinary Portland cement (OPC) by the replacement of fly ash (FA) and glass powder (GP) in varying proportions and to reduce the effect of solid waste generated due to its daily increasing disposal problems. Fly ash generated by coal combustion composing of fine particles that are driven out of boiler with fuel gases and the ash that fall in the bottom of the boiler is called bottom ash. The disposal of million tone of fly ash is a very serious problem leading to the environment pollution. Globalization has led to the development of various part of world and the land available for civilization is less, which indirectly affect the eco-system and in addition to these, at the fly ash disposal also take in account a large consideration of land use. a coal fire power plant produce 71.1 million ton of fly ash, if nearly 42 million tons of unused fly ash has been recycled , it would reduce the need for approximately 27500 acre ft of land fill space and will often reduce the pollution. Along with fly ash, a small quantity of glass powder (a another solid waste) approximately 15% into concrete is to be added as an aggregate which leads to increasing of the compressive strength of concrete by 13%.Hence an attempt is made to reuse the solid waste created, keeping in the mind significance of the nature along with civilization, globalisation of the world.

As now a day's disposal of solid waste is becoming a major problem and therefore some percentage of the waste in the form of fly ash and glass powder is used to reduce the pollution caused by these elements. As a civil engineer thinking of the environment and its adverse effects due to modernisation and thinking of the future generations we got the inspiration of using such solid waste in construction field. That's why formation of interlocking paving block along with fly ash and glass powder as an aggregate is an attempt made by us and various tests such as compressive strength, abrasion resistance test, water absorption test etc. are conducted and compared with ordinary paver blocks units in further chapters.

Hence it`s a sincere attempt made to study the effect of fly ash with glass powder in our project and to make it as successful as it can be.

1. Effects of Ordinary Portland Cement (OPC):

Portland cement is caustic, so it can cause chemical burns, the powder can cause irritation or with severe exposure lung cancer, and can contain some hazardous components such as crystalline silica and hexavalent chromium. Environmental concerns are the high energy consumption required to mine, manufacture, and transport the cement and the related air pollution including the release of greenhouse gases (e.g., carbon dioxide), dioxin, NOx, SO2, and particulate. Portland cement manufacture can cause environmental impacts at all stages of the process.

2. Aggregate :

Aggregate is a granular material, such as sand, gravel, crushed stone, crushed hydraulic-cement concrete, or iron blast-furnace slag, used with a hydraulic cementing medium to produce either concrete or mortar

3. Coarse Aggregate :

Those particles that are predominantly retained on the 4.75 mm (No. 4) sieve, are called coarse aggregate.

4. Fine Aggregate :

Those particles passing the 9.5 mm (3/8 in.) sieve, almost entirely passing the 4.75 mm (No. 4) sieve, and predominantly retained on the 75 µm (No. 200) sieve are called fine aggregate.

5. Water :

Water is an important ingredient of concrete as it actively participates in the chemical reactions with cement. The workability of any concrete mix mainly depends upon the quantity of wateradded. The principle purpose of using water is to produce hydration of water which causes setting. Since it helps to form the strength giving cement gel, the quantity and quality of water is required to be looked into very carefully. But in practices very often great control or the properties of cement and aggregates is exercised, but the control on the quality of water is often neglected. Since the quality of water affects the strength, it is necessary for us to check the quality of water. The water should be free from acids, salts, alkalis, salts, oils and other injurious materials. The water used for making concrete should have pH value between 6 to 8. Sea water should not be used for reinforced cement concrete if unavoidable it should be used for plain cement concrete

6. Glass powder :

In this project we are going to replace the cement partially using glass powder which is rich in silica. Therefore, we have planned to prepare some numbers of cubes, cylinders and prisms using conventional concrete and going to test them for its strength and other properties then we are going to prepare concrete specimens using glass powder at various proportions like 0, 25, 50, 75 and 100%. The casted specimens are tested for its strength. From the test results, we are going to compare the behavior of glass powder concrete with conventional concrete. In this work we are going to use waste glasses, so the cost will be comparatively economical.

Concrete is the most widely used building material in construction industry. Its a homogeneous mixture of cement, fine aggregate, coarse aggregate and water. The strength of concrete is mainly depends upon the cement content. Cement is a finely pulverized material which by itself is not a binder but develops the binding property as a result of hydration. The binding nature of cement is due to the presence of silica. Glass is an amorphous (non-crystalline) that in essence, a super-cooled liquid and not a solid.

Glass can be made with excellent homogeneity in a variety of forms and sizes from small fibers to meter-sizes pieces. Primarily glass is made up of sand, soda ash, limestone and other additives (Iron, Chromium, Alumina, ,Lead and Cobalt).Glass has been used as aggregates in road construction, building and masonry materials.

6.1 Applications & properties of glass :

Glass is a uniform amorphous solid material, usually produced when the viscous molten material cools very rapidly to below its glass transition temperature, without sufficient time for a regular crystal lattice to form. The most familiar form of glass is the silica-based material used for windows, containers and decorative objects.Glass is a biologically inactive material that can be formed with very smooth and impervious surfaces.

6.2 Advantages of using glass powder in concrete :

a. The reuse of very finely ground waste glass in concrete has economical and technical advantages. If the glass could be ground to a very fine size, it could satisfy the active pozzolanic behavior.Glass waste is recognized to be increasing year by year in a large volume from shops, construction areas and factories.
b. These waste storage disposals are becoming a serious environmental problem.
c. Thus usage of waste glass in construction sector is also advantageous as the construction cost gets lowered.

7. Fly Ash :

Fly ash, also known as "pulverized fuel ash" in the United Kingdom, is one of the residues generated by coal combustion, and is composed of the fine particles that are driven out of the boiler with the flue gases. Ash that falls in the bottom of the boiler is called bottom ash. Fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys of coal-fired power plants, and together with bottom ash removed from the bottom of the boiler is known as coal ash. Depending upon the source and makeup of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of silicon dioxide (SiO_2) (both amorphous and crystalline),aluminium oxide (Al_2O_3) and calcium oxide (CaO), the main mineral compounds in coal-bearing rock strata.Constituents depend upon the specific coal bed makeup, but may include one or more of the following elements or substances found in trace concentrations (up to hundreds ppm): arsenic, beryllium, boron, cadmium, chromium, hexavalent chromium, cobalt, lead, manganese, mercury, molybdenum, selenium, strontium, thallium, and vanadium, along with very small concentrations of dioxins and PAH compounds.

7.1 Classes of fly ash :

Two classes of fly ash are defined by ASTM C618: Class F fly ash and Class C fly ash. The chief difference between these classes is the amount of calcium, silica, alumina, and iron content in the ash. The chemical properties of the fly ash are largely influenced by the chemical content of the coal burned

7.2 Class F fly ash :

The burning of harder, older anthracite and bituminous coal typically produces Class F fly ash. This fly ash is pozzolanic in nature, and contains less than 20% lime (CaO). Possessing pozzolanic properties, the glassy silica and alumina of Class F fly ash requires a cementing agent, such as Portland cement, quicklime, or hydrated lime—mixed with water to react and produce cementations compounds. Alternatively, adding a chemical activator such as sodium silicate (water glass) to a Class F ash can form a geopolymer.

7.3 Class C fly ash :

Fly ash produced from the burning of younger lignite or sub-bituminous coal, in addition to having pozzolanic properties, also has some self-cementing properties. In the presence of water, Class C fly ash hardens and gets stronger over time. Class C fly ash generally contains more than 20% lime (CaO). Unlike Class F, self-cementing Class C fly ash does not require an activator. Alkali and sulfate (SO4) contents are generally higher in Class C fly ashes.In our product we have used class F fly ash.

8. Mix Design :

Mix design is a step by step procedure to work out the various proportions of the ingredients of the concrete and determining their relative proportion with object of producing concrete possessing certain desirable properties like workability in fresh state, minimum desirable strength and durability in hardened strength . Using the property of material the mix design has been adopted from to design for M40 grade of concrete.

The following basic data are required to be specified for design of a concrete mix proportioning of a particular grade of concrete:

1. Grade designation.
2. Type of cement
3. Maximum nominal size of aggregate.
4. Minimum cement content.
5. Maximum water cement ratio.
6. Workability
7. Exposure condition.
8. Maximum temperature of concrete at the time of placing.
9. Method of transporting and placing.
10. Early age strength requirements if required.
11. Type of aggregate
12. Maximum cement content.
13. Whether an admixture shall or shall not be used and the type of admixture and the condition of use.

IV. TEST AND RESULTS

In the previous chapters we have discussed about the materials and methodology with practical approach that is to be done in our project and various tests as per the procedure of Indian standards are performed. Hence in this chapter we are mentioning about the results of the tests performed and discussed in the previous chapters.
The results of the tests are mentioned in the tables and graphs are plotted as per results below as follows:

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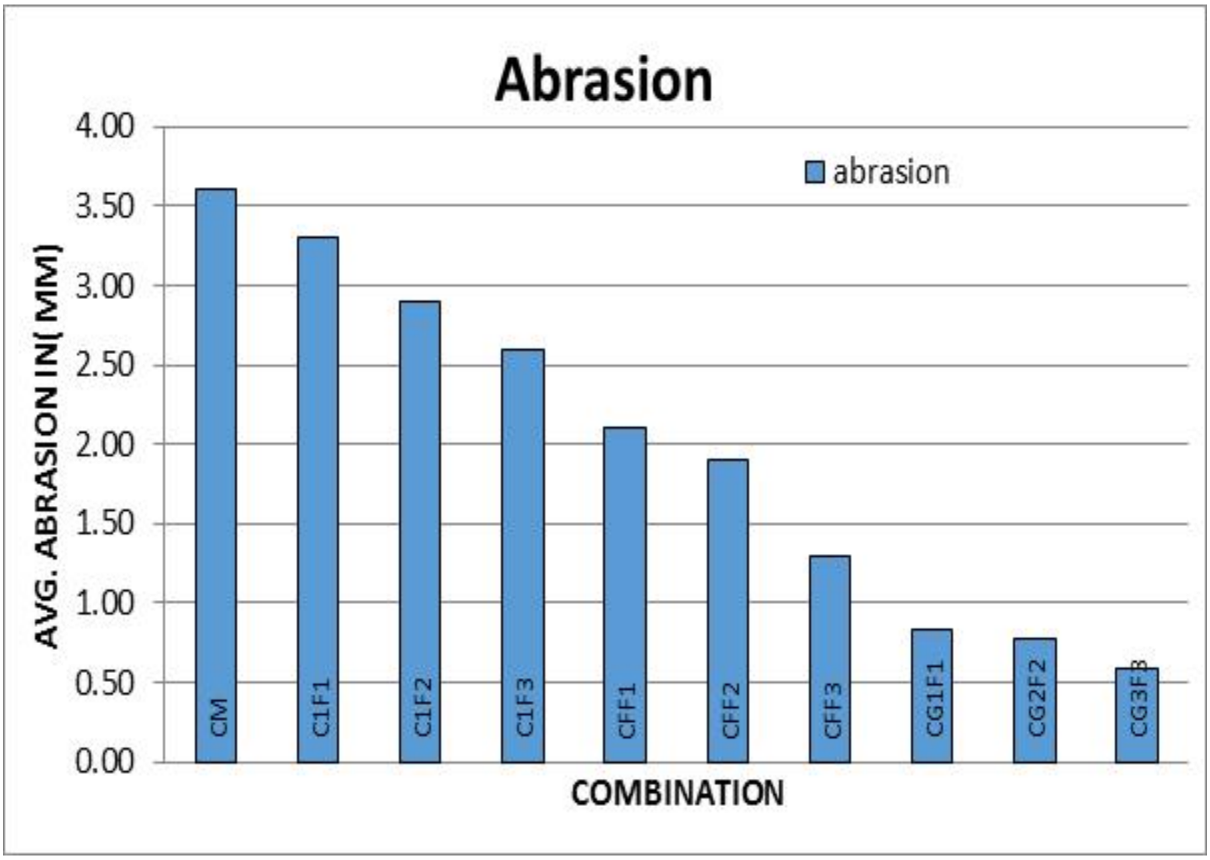
Abrasion in mm			
intial	Final	abrasion	Avg
60	59.969	3.10	3.60
60	59.961	3.90	
60	59.962	3.80	
60	59.970	3.00	3.30
60	59.965	3.50	
60	59.966	3.40	
60	59.968	2.50	2.90
60	59.968	3.20	
60	59.970	3.00	
60	59.978	2.23	2.60
60	59.971	2.88	
60	59.973	2.69	
60	59.981	1.88	2.10
60	59.974	2.56	
60	59.981	1.86	
60	59.983	1.70	1.90
60	59.980	2.00	
60	59.980	2.00	
60	59.988	1.20	1.30
60	59.987	1.30	
60	59.986	1.40	
60	59.992	0.80	0.84
60	59.991	0.89	
60	59.992	0.83	
60	59.993	0.70	0.78
60	59.992	0.78	
60	59.991	0.87	
60	59.995	0.51	0.59
60	59.994	0.60	
60	59.993	0.66	



V. Conclusion

In the last chapter we discussed about the result part and now in this chapter we will be discussing about the conclusion that we can bring about from the results of the tests performed.

code	Workability
CM	135
C1F1	125
C1F2	115
C1F3	110
CFF1	100
CFF2	100
CFF3	125
CG1F1	115
CG2F2	110
CG3F3	100

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