A STUDY ON STRENGTH AND DURABILITY PROPERTIES OF RECYCLED AGGREGATES BASED ON GEO-POLYMER PAVER BLOCKS

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***Abstract*- One of the major problems in India is the lack of facility for pedestrians and non- motorized vehicles. The majority of road network built, lacks pedestrian safety and convenience to promote walking. Around 50% of work-related trips are performed using non-motorized form of transport. Paver block is one of the most popular options for construction of facilities for pedestrians and non-motorized vehicles as these blocks are aesthetically pleasing, comfortable to walk on, extremely durable, and easy to maintain. Most commonly used paver blocks are Concrete Paver Blocks. Conventional concrete paver blocks consist of cement, coarse aggregate, and fine aggregate. The ecological impact of raw material production for concrete is substantial, which makes it very important to study alternatives for sustainable construction. Moreover, manufacture of ordinary Portland cement generates large amounts of greenhouse gases. Numerous research efforts have been made continuously to establish geopolymer as the most suitable alternative binder material in view of economical and environment consideration. In this project, use of reclaimed asphalt pavement (RAP) aggregates as a substitute to coarse aggregates in geopolymer concrete paver blocks is being studied. RAP is removed or reprocessed pavement material containing asphalt and aggregates. RAP is generated when asphalt pavements are removed for reconstruction or resurfacing. Every year, a lot of reclaimed asphalt pavement (RAP) is produced due to repair and reconstruction of roads. Although RAP has been reused in several applications, a large portion of it remains unutilized. This un-utilized RAP, if processed properly, can be a good source for fine and coarse aggregates. In this present study, an attempt is made to manufacture fly ash and GGBS based geopolymer concrete paver blocks containing varying percentages of RAP aggregates and study the strength and durability properties of the paver blocks thus made.**

I. INTRODUCTION

Due to the vast geographical spread of the country and varied conditions of topography, road transportation has become the important mode of transport in India. India consists of 62,15,797 kilometers road network, and is the second largest road network in the world. The Indian government is giving top priority to improve road transportation facilities countrywide through allocation of enormous capital investments. One of the major problems in India is the lack of facility for pedestrians and non- motorized vehicles. The majority of road network built, lacks pedestrian safety and convenience to promote walking. Around 50% of work-related trips are performed using non-motorized form of transport. Paver block is one of the most popular options for construction of facilities for pedestrians and non-motorized vehicles as these blocks are aesthetically pleasing, comfortable to walk on, extremely durable, and easy to maintain. Most commonly used paver blocks are Concrete Paver Blocks. Conventional concrete paver blocks consist of cement, coarse aggregate, and fine aggregate. The ecological impact of manufacture of the raw materials for concrete (such as cement, coarse and fine aggregates) is significant.

Reclaimed asphalt pavement (RAP) is the term given to removed or reprocessed pavement materials containing asphalt and aggregates. These materials are generated when asphalt pavements are removed for reconstruction. When properly crushed and screened, RAP consists of high quality, well-graded aggregates coated by asphalt cement. Asphalt pavement is generally removed either by milling or full-depth removal. RAP is processed using a series of operations including crushing, screening, conveying, and stacking. RAP can be used to a larger extent as a base course; however, a limitation is of using RAP as fill material is the unknown risk of leaching of pollutants from the aggregate to the environment.

II. LITERATURE REVIEW

POONAM SHARMA (2016) As per the study of this journal, these concrete paver blocks can be used at habitation areas on rural roads. It will give a good aesthetic view as compare to cast in situ concrete roads. As regard of maintenance point is concern the damaged blocks can be easily replaced whereas in case of concrete roads the replacement of damaged concrete is difficult. The further analysis & monitoring can be categories under scope for future work. Thus, using these concrete paver blocks reduces construction cost and maintenance cost as these are pre-cast blocks the research activities are done easily.

RAMAN (2017) In this study we observed that in the design mix for our requirements and defects occurring in the lifespan of the blocks, in their early life of paver blocks, those pavements stiffen progressively with an increase in load repetitions. These identified defects needed to be removed from the blocks. So, this study is then carried out to determine the possible causes of those defects in the paver blocks. A second mix-design is then carried out keeping in mind those identified defects. After the design of the blocks studies are again carried out to determine the elimination of the defects. If that mix-design doesn't solve our problems, then, a third iteration could be carried to possibly eliminate all still occurring defects. Eliminating the defects in concrete paver blocks are mainly studied in this research.

CHARINNAMARAK (2018) From the literature that we have studied, After investigating the qualities of concrete paving blocks manufactured using a mixture of calcium carbide residue, fly ash, and recycled concrete aggregate, It is possible to use a calcium carbide residue-fly ash mixture as the binder and recycled concrete aggregate as the aggregate to manufacture concrete paving blocks without Portland cement. These blocks are environmentally friendly and convert waste materials into value- added materials, The compressive strengths of the resukting concrete paving blocks were increased as the curing age increased. In addition, finely grinding the binder resulted in a substantial increase of the compressive strengths of the resulting concrete paving blocks.

ASHWINI R (2020) This study examines the feasibility of using various waste materials in concrete paver blocks to reduce consumption of natural resources, increased global warming and hazardous waste material generation. Excessive waste is generated from the construction, thermal power plant and industrial sector causing landfill issues. The following materials are studied in this paper: Waste foundry sand, fly ash, GGBS as a replacement to cement and aggregates in concrete paver blocks. Various test results are mentioned like compressive strength, water absorption, splitting tensile strength, flexural strength and abrasion resistance test along with the optimum replacement percentage values of various waste materials which can be used to get better results.

III. EXPERIMENTAL STUDY

The Following Materials used to produce RAP aggregate based geopolymer concrete paver blocks are:

• Fly ash • GGBS • NaOH, Na2SiO3 • Natural fine aggregates • Natural coarse aggregates • Fine RAP aggregates • Coarse RAP aggregates

The properties of materials are determined as per the IS codal Provisions.

IV RESULTS

Table 1 Properties of cement, GGBS, FLY-Ash

Property	**Cement**	**GGBS**	**Fly Ash**
Fineness	4%	8%	8.3%
Specific gravity	3.12	2.98	3.13
Density	1440kg/m^3	1800kg/m^3	1750kg/m^3
Normal consistency	30%	30%	31%

Table 2 Properties of natural fine aggregates and Quarry dust

Property	Natural fine aggregate	Quarry Dust
Specific gravity	2.62	2.56
Water absorption	1,25%	1.35%
Fineness modulus	2.73	2.83
Bulk density	1.46(g/cc)	1.76(g/cc)
Sieve analysis	Zone II	Zone II

Table 3 Properties of natural coarse aggregates and RAP Aggregates

Property	Natural coarse aggregate	RAP aggregate
Specific gravity	2.78	2.60
Bulk density	1.49 (g/cc)	1.37 (g/cc)
Water absorption	1.2%	1.04%
Fitness modulus	7.06	7.1
Aggregate impact value	18.2%	14.5%

Table 4 Slump of fresh concrete mixes

Mix designation	Slump
Control Mix	75
R0-QD0	75
R10-QD10	70
R20-QD20	65
R30-QD30	55

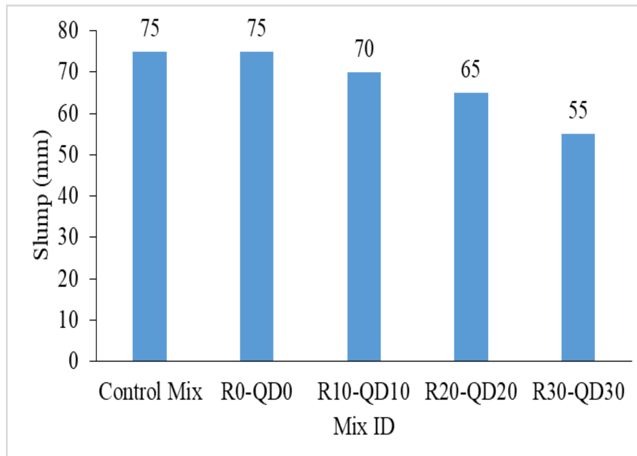

Fig 1 Slump of fresh concrete

After preparation of fresh concrete of cement and Geo-polymer mix, the slump test was performed according to IS 1199. Table 4 and Fig.1 shows the slump of fresh mix. As seen, the addition of RAP and Quarry dust has decreased the slump values for some of the mixes with varying molar ratios. The maximum slump was observed for Control Mix, R0- QD0mix and a decreasing trend was noticed with the addition of RAP and quarry dust in the mix. A reduction in slump can be attributed to the presence of high porous in the concrete.

Table 5 Compressive Strength of different concrete mixes for paver blocks

Mix designation	Compressive Strength (MPa)
Control Mix	75.33
R0-QD0	82.62
R10-QD10	72.46
R20-QD20	63.94
R30-QD30	55.32

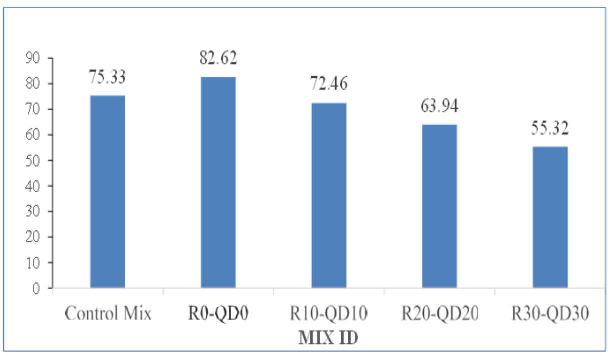

Fig 2 compressive strength of paver blocks results graph of mixes

Table 6. Compressive Strength of different concrete mixes for cubes

Mix designation	Compressive Strength (MPa)
Control Mix	74.33
R0-QD0	84.68
R10-QD10	65.94
R20-QD20	49.62
R30-QD30	45.34

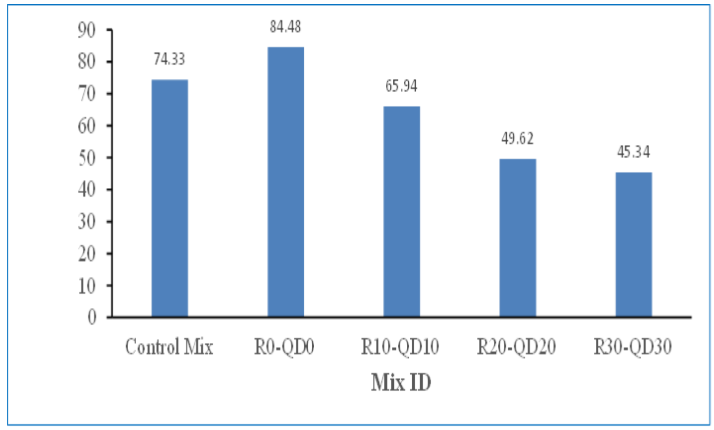

Fig3. Compressive strength of cubes results graph of mixes

Above values shows then compressive strength of control mix, R0-QD0, R10-QD10, R20- QD20 and R30-QD30 specimens at the ages of 28 days, As seen, the addition of RAP and Quarry dust has slightly increased the compressive strength for R0-QD0 and from there it was decreased slightly for the remaining mixes.

Table 7 Split Tensile Strength of different concrete mixes of paver blocks

Mix designation	Split Tensile Strength (MPa)
Control Mix	5.28
R0-QD0	5.42
R10-QD10	5.16
R20-QD20	4.86
R30-QD30	4.53

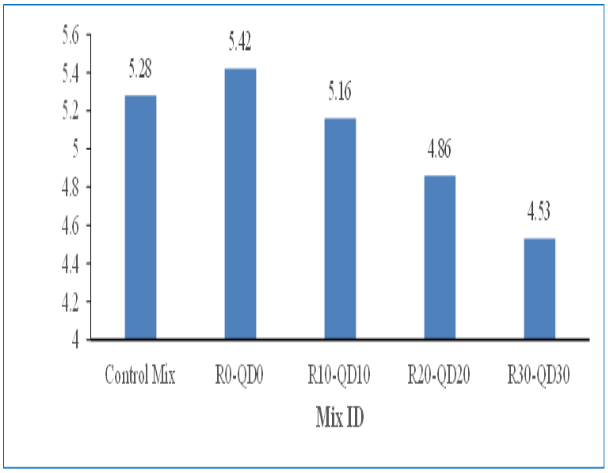

Fig 4. Split tensile strength for paver blocks results graph of mixes

V. CONCLUSIONS

Based on the experimental investigations done, the following conclusions can be drawn:

1) The specific gravity of RAP aggregates and quarry dust is slightly low compared to that of natural coarse and fine aggregates.

2) RAP aggregates have lower water absorption than natural aggregates, whereas the water absorption of quarry dust was observed to be slightly higher than natural fine aggregates.

3) Replacement of coarse and fine aggregates with RAP and quarry dust, respectively, lead to a proportionate decrease in the workability of concrete. Even though the workability of such concretes was less than that of the control mix, the slump was sufficient for most of the concreting work.

4) Increase in the percentage replacement of coarse and fine aggregates with RAP and quarry dust, respectively, leads to a decrease in the compressive strength, flexural strength, and split tensile strength of the mixes. The initiation of failure in this case may be due to the weak bond between the asphalt binder coating around the RAP based aggregates and the concrete matrix.

5) With increase in the percentage of replacement of natural aggregates with Rap aggregates and quarry dust there is slight increase in the water absorption and porosity of the concrete, which means that the mixes with RAP aggregates and quarry dust are slightly less durable compared to mixes with 100% natural aggregates.

6) These results suggest that if appropriately designed, up to 30% of RAP and 30% of quarry dust can be used in manufacturing of geopolymer paver blocks without much effect on the performance of the paver blocks.

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