



A REVIEW ON INFLUENCE OF RECYCLED AGGREGATES IN PERVIOUS CONCRETE

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Abstract: Pervious concrete is a very special type of concrete with high porosity made using large aggregates with little to no fine aggregates. It allows water from precipitation and other sources to pass directly through thereby reducing the runoff from the site and allowing ground water recharge. The study proposes the replacement of natural coarse aggregates in the mixture, with recycled coarse aggregates. The utilization of recycled coarse aggregates from construction and demolition wastes serves as a sustainable solution, which reduces the overall cost and environmental pollution. In this paper, a review on mechanical properties and permeability indices of pervious concrete made with recycled coarse aggregates is studied.

Index Terms – Pervious concrete, Coarse aggregate, Permeability

I. INTRODUCTION

1.1 General Background

Pervious concrete, also called permeable or porous concrete is a special type of concrete with a high porosity of 15% -35%, made using large aggregates (9mm-19.5mm) consists of cement, single sized coarse aggregate with little to no fine aggregates. It increases ground water storage in urban areas and protect pristine water resources by allowing the water from precipitation and others sources to pass through the material. It offers multiple environmental benefits including controlling storm water runoff, restoring ground water supplies, improving water quality as well as reducing water pollutions. The light colour of concrete pavements absorbs less heat from solar radiation than darker pavements, and the relatively open pore structure of pervious concrete stores less heat, helping to lower heat island effects in urban areas.

Primary design objective of pervious concrete is to increase its permeability without much compromising its compressive strength. Since compressive strength of pervious concrete depends upon type and size of coarse aggregate, water cement ratio and cement to aggregate ratio, it requires a careful consideration. High flow rate of water together with light weight makes pervious concrete an ideal material to be used in pavements. High permeable pavement has a great advantage in reduction of storm water runoff as compared to other conventional non-pervious pavements. This property has lead pervious concrete to be increasingly used in urban settings to improve the storm water quality and reducing rainfall runoff. Pervious concrete has also been used as a load bearing walls in houses. Application of pervious concrete is limited to sidewalks, parking lots and low traffic volume areas.

In many countries, waste materials are dumped illegally or sent to landfills and a large amount of demolition waste is produced every year. The disposal of demolition is a huge environmental and social problem. Recycling of these wastes can minimize the problem of waste landfills. Recycled concrete aggregates are fragments and pieces of concrete buildings which are demolished and rebuild. The recycling and re-use of non-degradable construction wastes as recycled concrete aggregate is trending due to its potential to reduce landfill volume and pollutions. The use of recycled aggregate helps in reducing the consumption of natural aggregates.

1.2 Advantages

- The ability to drain surface water runoff faster and decrease the cost of drainage facilities, detention basins and water supplies.
- Increase ground water storage and protect pristine water resources.
- Decrease the effect of heat island.
- Reduce the pollutants of storm water and purify the ground water.
- Increase skid resistance and surface friction.
- Achieve lower noise level than normal concrete.
- More efficient use of land development.
- Replenishes water tables and aquifers.
- Minimises flash flooding and standing water.

1.3 Disadvantages

- Cost of maintenance and cleaning is high.
- It does not handle heavy traffic vehicles and loadings.
- Resistance to freeze-thaw cycles and de-icing chemicals attack are more sensitive than normal concrete.
- Runoff from adjacent areas needs to be prevented.

II. MATERIALS

2.1 Ordinary Portland Cement

Cement is a substance used for construction that sets, hardens and adheres to the other materials to bind them together. It is in the form of a finely ground powders, when it is mixed with water, it goes to harden state form like solid mass substance. Ordinary Portland cement is a compound of lime, silica, alumina and iron oxide.

2.2 Coarse aggregate

Aggregates are the main components of concrete which greatly varies the strength, density and other properties of concrete. Coarse aggregates are construction component made of rock quarried from ground deposits. They are generally categorized as rocks larger than 4.75 mm and less than 50 mm. Aggregates plays important in strength factor of the structures it is an essentially needed material in construction of all major works.

2.3 Recycled coarse aggregate

The secondary aggregates are termed normally as recycled coarse aggregate. Recycled concrete aggregates are fragments and pieces of concrete buildings which are demolished or rebuild. Recycled coarse aggregate contains original aggregate attached with mortar. The attached mortar is light and porous in nature. It has lower strength, stiffness and high water absorption due to the presence of weak attached mortar to the aggregate.

III. LITERATURE REVIEW

P.C.Bala murugan et.al (2019), conducted a study on performance of pervious concrete made with normal and recycled aggregate. A concrete mix ratio of 1:3 and a water cement ratio of 0.35 are adopted. Construction and pre-used specimen wastes are used in this investigation. Slump test and compaction factor test is carried out for different water-cement ratios of 0.35, 0.4 and 0.5. The compressive strength and split tensile strength of pervious concrete with recycled aggregate is found to be less than pervious concrete made with normal aggregates. This strength reduction can be due to poor aggregate-cement paste bonding in recycled coarse aggregate mixes. The presence of adhered mortar on recycled coarse aggregate will absorb the mixing water and it reduces the amount of cement paste. This eventually results in poor bonding between cement paste and coarse aggregate and compressive strength was reduced.

Ali A. Aliabdo et.al (2018), conducted a study to determine the properties of pervious concrete permeability indices (water permeability, density, voids ratio) and strength indices (compressive, flexural, splitting tensile strengths in addition to pervious concrete degradation) with different levels of recycled concrete aggregate. The considered percentages of recycled aggregate replacement were 50% and 100% by weight of natural coarse aggregate. The effect of aggregate size was studied by considering aggregate sizes of 9.5 mm and 19 mm. From the test results it is found that the use of recycled aggregate slightly affected the permeability indices and negatively affected the strength indices. Increase in recycled aggregate content increases the permeability and decreases the strength. Percentage increase in permeability for 9.5mm aggregate size is 13.3% and 18.8% for 50% and 100% recycled aggregate replacement levels, respectively. The reduction in 28 days compressive strength using 9.5 mm aggregate size is 5% and 31% for 50% and 100% replacement levels, respectively. This negative effect could be due to higher voids ratio and bad bonding between RCA and cement paste. Use of RCA slightly decreases the fresh and hardened density of PC due to lower density and higher void ratio of RCA.

Soon Poh Yap et.al (2018), conducted a study on the mechanical properties and permeability of pervious concrete made with blended normal granite aggregates and RCA. RCA replacement levels of 20%, 40%, 60%, 80% and 100% were used. Experimental results showed that the RCA mixes produced lower mechanical properties. In the mix RCA 20 with 20% RCA replacement showed very close compressive strength to that NA mix, but for RCA replacement >20%, the compressive strengths of RCA mixes reduced with increasing RCA content. This strength reduction can be due to poor aggregate-cement paste bonding in RCA mixes. The presence of adhered mortar on RCA will absorb mixing water and it reduces the amount of cement paste. This eventually results in poor bonding between cement paste and coarse aggregate and compressive strength was reduced.

Ji Wenzhan et.al (2018), conducted a study which focuses on tests the on recycled aggregate obtained by crushing high-strength waste concrete (TOU) and low-strength waste concrete (PU), and analyzes the effect of porosity, amount of cement, mineral admixture and recycled aggregate on the strength of permeable concrete. The porosity is inversely proportional to the strength, and the amount of cement used is proportional to the strength. The mineral admixture can effectively improve the workability of the mixture. The quality of recycled aggregates had a significant effect on strength. Compared with the concrete using PU aggregates, the strength of 7 days and 28 days concrete using TOU aggregates increased by 69.0% and 73.3%, respectively. The strength of the recycled aggregate pervious concrete prepared in this test reached 35.8 MPa, which meets the requirements for general pavement use.

Rasih Sriravindrarah et.al (2012), conducted an experimental investigation on pervious concrete with reduced cement content and recycled concrete aggregate for sustainable permeable pavement construction. 70% of cement was replaced by High fineness ground granulated blast furnace slag by weight. The properties of the pervious concrete were evaluated by determining the compressive strength at 7 and 28 days, void content and water permeability under falling head. The compressive strength of pervious concrete increased with a reduction in the maximum aggregate size from 20 to 13 mm. The results also showed that the Permeability

of pervious concrete is influenced by the porosity and the use of recycled concrete aggregate had no significant effect on the permeability of pervious concrete. The empirical inter-relationships developed among porosity, compressive strength and water permeability could be used in the mix design of pervious concrete with either natural or recycled concrete aggregates to meet the specification requirements of compressive strength and water permeability.

Jian-Xin et.al (2019), conducted a study on pervious concrete designed using waste glass cullet (WGC) and recycled concrete aggregate (RCA). The mechanical properties and water permeability behaviour of the pervious concrete were determined. The experimental results showed that the use of silica fume in the cement paste was effective to compensate for the low compressive strength of the pervious concrete due to the use of narrowed graded aggregates without the incorporation of fine particles (less than 2.36 mm). Although the incorporation of recycled aggregates (WGC and RCA) into the pervious concrete led to reductions in compressive strength, the water permeability of the pervious concrete was improved as the use of WGC improve the water permeability due to the negligible water absorption nature and smooth surface of glass cullet. Compared to the PCs prepared with single small-sized aggregates, the PCs with single coarse-sized aggregates exhibited much higher permeable coefficient but had lower compressive strength. However, introduction of 10% silica fume as cementitious materials could significantly improve the compressive strength although decrease the permeability of the PCs correspondingly. The use of WGC or RCA to replace the natural single-sized aggregates resulted in reductions of compressive strength due to the decrease in the density and weak bonding between the paste and the aggregates.

Weidong Zhang et.al (2019), conducted a study on the physical and mechanical properties of pervious concrete with a water-cement ratios of 0.25 and 0.3 and different replacement ratios of recycled aggregate such as 10, 20, 30 and 40%. Void content, abrasion resistance, compressive strength, split tensile strength and water permeability of pervious concrete were determined. Results indicate that increase in water-cement ratio and replacement ratio increased the void content and permeability coefficient of pervious concrete but showed a decrease in abrasion resistance, compressive strength and split tensile strength. The effective void content of pervious concrete at water-cement ratio of 0.25 was lower than that of pervious concrete at water-cement ratio of 0.3. This may be due to lower water-cement ratio, less amount of cement and less grout on the surface of the coarse aggregate which improves the effective void content of Pervious concrete. The effective void content values increased with the increasing of replacement ratio of recycled coarse aggregate or water-cement ratio.

Rabiah Rizvi et.al (2010), conducted a study on the use of recycled concrete aggregates in pervious concrete pavement. Natural coarse aggregates in pervious concrete are replaced by 15%, 30%, 50% and 100% of recycled concrete aggregates. For each of five mixes, 18 cylinders were casted. Fresh concrete tests including slump, entrained air, temperature and weight were done to establish the effect of addition of the RCA into the mix and cylinders were tested for compressive strength, void content and permeability. Results showed that pervious concrete containing 15% recycled concrete aggregates had a very similar strength, permeability and void content to those of the control mix. Mixes containing 30% or more aggregate had less strength and more permeability and void content. Less strength can be due to the presence of adhered mortar on recycled coarse aggregate which will absorb mixing water and reduces the amount of cement paste.

IV. CONCLUSIONS

Pervious concrete is one of the most promising sustainable material. It is designed to have enhanced amount of interconnected voids which allows water to percolate through the material. Using recycled aggregate. It was found that replacing natural aggregates with recycled aggregates resulted in an increment in permeability coefficient. Use of recycled aggregate decreases the strength parameters, which can be due to the presence of adhered mortar on recycled coarse aggregate which will absorb mixing water and reduces the amount of cement paste. This results in poor bonding between cement paste and coarse aggregates. Addition of supplementary cementitious materials shows an increase in strength parameters of pervious concrete.

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