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Permeable Concrete with Waste Plastic and Concrete Waste

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A B S T R A C T

This paper discusses about the composite made by combining Waste plastic (WP) and concrete demolition waste aggregates(CDW) or natural aggregates. Waste plastic was melted to create binder. The waste plastic used is Poly propylene. Construction demolition waste of concrete(CDW) or natural aggregates(NA) was used as coarse aggregate. The composite was created by mixing the constituents in various ratios. Then the composite was cast into Permeable tile blocks. The tile blocks were tested for Compressive strength, flexural strength, water absorption and unit weight. The results show the CDW fails before Plastic in flexure and some treatment is to be done for CDW to improve its properties for use in pavements.

Keywords: *Waste plastic, Poly Propylene, Concrete Demolition waste, Permeable concrete,*

Introduction

The present age is age of plastics. We can find plastic in every component, equipment, food packaging, etc. Majority of the plastics are of single use and find very few reuse. Only around 10% of plastics are recycled worldwide. Waste plastics are a menace to environment, we can find it everywhere in land, water and in air. Micro and nano plastics are now in food chain. Micro plastics are now found in breast milk [1] and cow milk and fish. Micro plastics are also found in human blood [2] with scientists found 80% of samples having micro plastics. Prof John Boland, [3] says humans are consuming millions of micro or nano plastics every day. Hence we are now in a situation where there is no option of discarding plastics, but we must recycle as much as possible.

Hence there is ample scope in recycling plastics and finding new ways is usage of plastics.

About 548 million tons [4] Construction demolition waste are proposed be generated by 2025 worldwide. India [5] about 150 metric tons of construction and demolition wastes are generated every year. Bricks and concrete waste from demolition can be used in variety of ways. Bricks can be used as Surkhi. Waste Bricks can be used in conjunction with new bricks. Concrete wastes [6] can be used as base layer for pavements, roads and also aggregates for fresh concrete.

2. Literature review

Steve et al, [7] substituted waste plastic as replacement for natural aggregates and found that 5% replacement of natural aggregates with Poly Ethylene Terephthalate (PET) gave improved results at 7 days as compared to control mix.

Mahindra et al, [8] used High density Poly ethylene (HDPE) as binder for making pervious concrete with natural aggregates. They found that optimum percentage of binder plastic is 23.8%. This gave a compressive strength 4.98N/mm2 with optimum porosity 14.5%.

Brian, [9] in his review, concludes that maximum percentage of 10% of waste plastics can be used in asphalt concrete due to poor interfacial adhesion between the plastic and the asphalt binder.

Agyeman, et al [10] explains that blocks made from the waste plastic can be used in non-traffic areas such as walkways, footpaths, pedestrian plazas, landscapes, monument premises as the blocks have low water absorption. Non traffic areas are recommended as plastic may be eroded by abrasive characteristics of tyres of vehicles.

Plastics [11] are a major component of municipal solid waste (MSW) and are recycled for their potential use in pavement. Paving blocks with plastic waste have wide use in road construction and buildings.

Paver block [12] made from plastic waste, quarry dust, coarse aggregate show better results. The utilization of waste plastic in production of paver block has is the best way of recycling of plastic waste. The cost of paver block is also reduced.

recycled waste concrete [13] made with partial replacement of cement by recycled waste powder 10% is shows less strength than control concrete. Same waste when replaced as coarse aggregate by 10% of natural aggregate shows same strength as control concrete.

Construction Demolition Waste (CDW) [14] in concrete is possible without heavily affecting the properties. The CDW will save about 12.075 m3 of fine aggregate and 21.625 m3 of coarse aggregate for 100 m^3 of concreting work. Hence it is suitable alternative for the conventional aggregates.

The compressive strength [15] at 28 days of recycled concrete by 30% replacement of coarse aggregate shows results comparable to the conventional concrete.

Recycled aggregates [16] are treated with epoxy resin to reduce the water absorption. The recycled aggregates that are obtained from site-tested concrete specimen make good quality concrete. Recycled aggregate concrete shows almost same results as normal concrete in split tensile strength and compressive strength. The slump value of recycled aggregate concrete was low.

Use Recycled Aggregate [17] at a replacement level of 30% in concrete is good. The addition of precoated and pozzolanic materials as a treatment to recycled aggregates improves workability, strength, and durability.

Namburi et al[18] replaced fine aggregate with 10% plastic waste and demolition waste as partial replacement of coarse aggregate in range 0%, 10%, 20%, 30%, 40%, and 50% of the total amount of coarse aggregate. The results showed 10% plastic waste and 10% recycled aggregate resulted in excellent quality for new concrete.

2. Manufacturing Procedure

Concrete demolition wastes (CDW) are obtained from cubes from private concerns for consultancy work. The cubes were broken and sieved through 10mm sieve. The aggregates passing through the 10mm sieve are then sieved in 4.75mm sieve. The aggregates passing through the 10mm sieve and retained in 4.75mm sieve are used for coarse aggregates. Natural aggregates in concrete demolition wastes are removed from the samples. Only mortar aggregates were considered.

The waste plastic is Poly propylene (PP) waste obtained from local waste plastic processor/vendor. The PP is in the form of nodules or aggregates. The PP acts as a binder in the composite.

The aggregates obtained from sieved CDW are preheated in oven using induction stove upto 200ºC. Then waste plastic is added to the preheated aggregates and mixed thoroughly. The heating and mixing is continued until we get a uniform composite. The ratio of CDW to PP is kept at 80:20(Mix1), 85:15(Mix 2) and 90:10(Mix 3).

In another set of casting Natural Aggregate (NA) of size range 4.75-10mm are preheated and mixed with PP in NA: PP ratios 80:20, 85:15 and 90:10.

The composites thus obtained are cast into permeable blocks or tiles in moulds of size 12.5x10.5x2.5cms.

2. Tests and Results

The blocks are tested for density water absorption and compressive strength as per Indian Standards. The results are enumerated as follows.

Table 1 – Comparison of results

	CDW				**NA**			
Mix	**Flex. strength in Mpa**	**Comp. Strength In Mpa**	**Water Absorption In %**	**Density In gms/cc**	**Flex. Strength in Mpa**	**Comp. Strength in Mpa**	**Water absorption in %**	**Density In gms/cc**
1	0.314	8.5	3.96	1.75	0.537	10.6	3.43	2.05
2	0.303	3.41	3.73	1.86	0.512	6.54	3.14	2.1
3	0.329	2.13	1.94	1.79	0.504	4.86	1.78	2.27

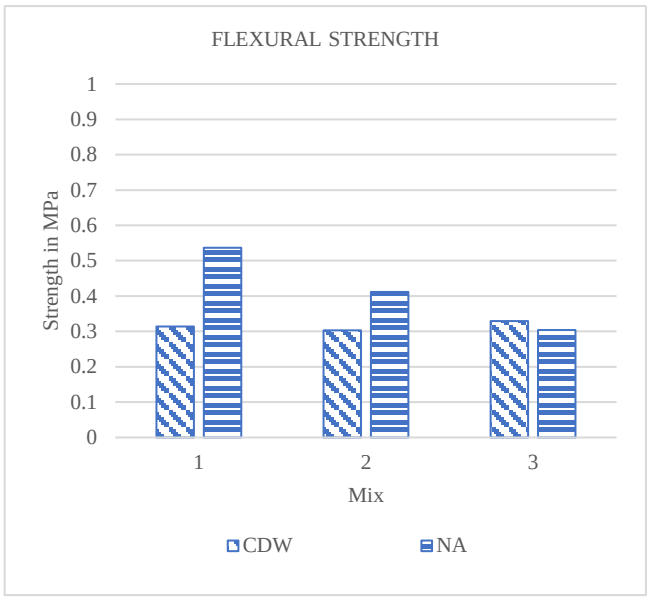

Figure 1 – Flexural strength

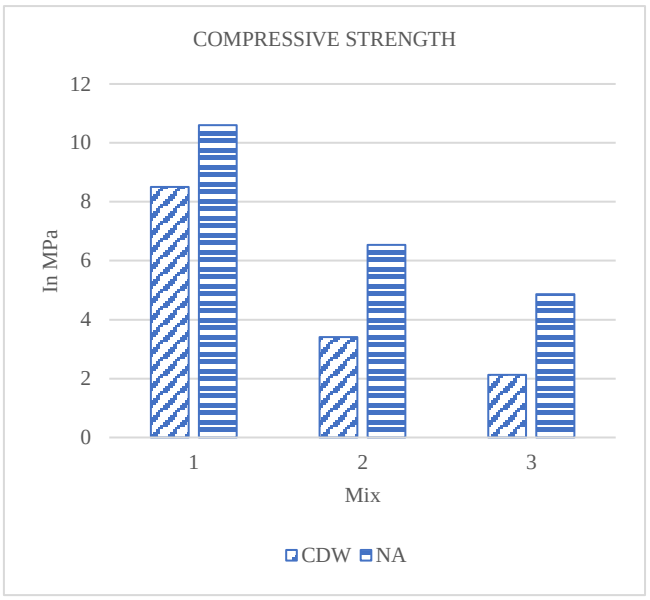

Figure 2 – Compressive Strength

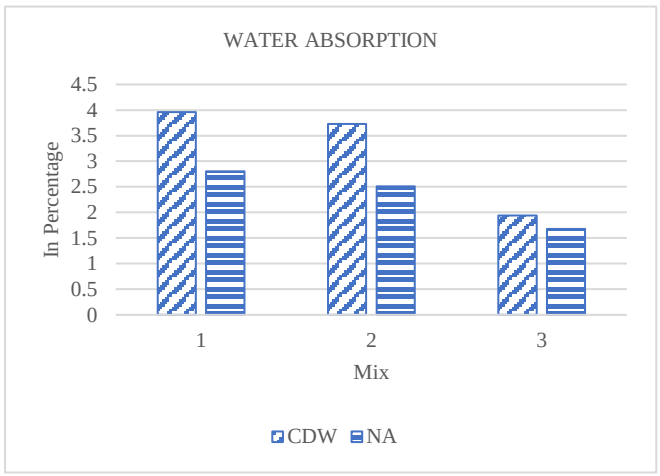

Figure 3 – Water Absorption

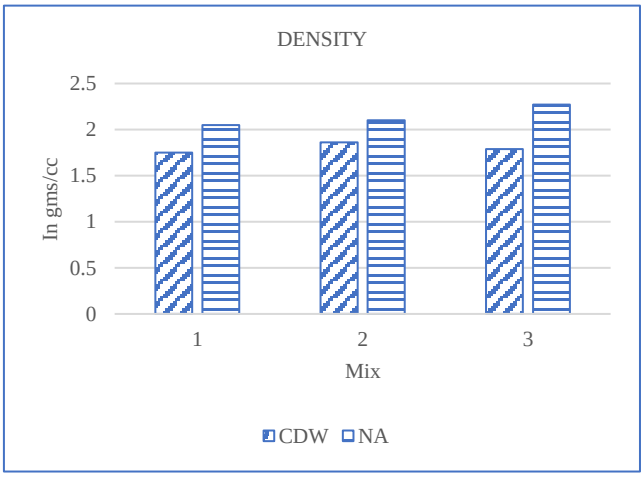

Figure 4 – Density

Figure 5 – Flexure failure Blocks Image

2.1. Discussion of Results

1. The flexural strength of CDW permeable concrete blocks/tiles show almost same strength, irrespective of mix

2. The flexural strength of NA permeable concrete blocks/tiles reduction in strength with reduction in PP content

3. The compressive strength of CDW permeable concrete blocks/tiles decrease with decrease in PP content

4. The compressive strength of NA permeable concrete blocks/tiles decrease with decrease in PP content, But shows 2-3 MPa increase as compared to CDW blocks.

5. Water absorption is less than 4% for all CDW and NA mix permeable concrete blocks/tiles

6. The density around 1.8 gms/cc for CDW and 2.1gms/cc for NA permeable concrete blocks/tile. The increase is due to Natural aggregates density.

3. Conclusion

The experimental studies show decrease of 0.2 MPa in flexural strength in CDW blocks as compared to NA blocks. The compressive strength of CDW is also 2-3 MPa less than NA. These Figure 5 shows broken blocks in flexural strength test, In the NA tiles the failure is predominantly on the bonding surface between aggregate and waste plastic. In the CDW tiles the failure is predominantly on the aggregates. Hence there must be some pretreatment of CDW before using it as an aggregate in normal or permeable concrete. As from literature review, we can conclude that the blocks can be only used in areas of less traffic. Since the permeable concrete blocks/tiles of CDW use only waste materials, it is environment friendly as we are having another option for recycling of 2 wastes viz. waste plastic and CDW.

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