ENGINEERING PROPERTIES OF CONCRETE WITH USING WASTE SHREDDED PLASTIC.

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Abstract. This study investigates the potential of shredded plastic as a partial replacement for traditional aggregates in concrete mixtures to optimize durability properties. Shredded plastic was incorporated into the concrete mixtures at various replacement levels to evaluate the effect on the mechanical and durability properties of the resulting concrete specimens. Results show that the inclusion of shredded plastic in the concrete mixtures improves the workability of fresh concrete, reduces water absorption, and enhances the mechanical properties of hardened concrete. Moreover, the incorporation of shredded plastic in concrete mixtures leads to a significant reduction in the production cost of concrete while simultaneously addressing the issue of plastic waste disposal. These findings suggest that utilizing shredded plastic in concrete mixtures could be a viable and sustainable solution for enhancing the durability properties of concrete.

Further analysis of the experimental results reveals that the optimal replacement level of shredded plastic in the concrete mixtures ranges from 10% to 20% by volume, depending on the specific durability property being evaluated. The improved durability properties of the resulting concrete specimens are attributed to the reduced porosity and enhanced microstructure resulting from the incorporation of shredded plastic. These findings have significant implications for the construction industry, where concrete is the most widely used building material. The use of shredded plastic in concrete mixtures can help reduce the environmental impact of plastic waste while simultaneously improving the durability of concrete structures. Overall, this research highlights the potential of shredded plastic as a sustainable and cost-effective alternative to traditional aggregates in concrete mixtures for optimizing the durability properties of concrete.

INTRODUCTION

The construction industry is one of the largest consumers of natural resources and produces a significant amount of waste. One of the major challenges faced by this industry is the disposal of plastic waste, which has become a significant environmental concern. In recent years, there has been increasing interest in utilizing shredded plastic waste as a partial replacement for traditional aggregates in concrete mixtures. This approach has the potential to address the issue of plastic waste disposal while simultaneously enhancing the durability properties of concrete.

The use of plastic in concrete has been studied extensively in the past few decades. Several researchers have investigated the effect of plastic fibers and particles on the mechanical and durability properties of concrete. However, most of these studies have focused on the use of plastic fibers, which have limitations in terms of their availability and compatibility with concrete mixtures. On the other hand, shredded plastic particles have several advantages, such as low cost, easy availability, and compatibility with concrete mixtures. Despite these advantages, there is a lack of comprehensive research on the effect of shredded plastic particles on the durability properties of concrete.

In this context, the present study aims to investigate the potential of shredded plastic particles as a partial replacement for traditional aggregates in concrete mixtures for optimizing durability properties. The study focuses on evaluating the effect of shredded plastic particles on the mechanical and durability properties of concrete, including compressive strength, water absorption, and chloride permeability. The findings of this study are expected to provide insights into the use of shredded plastic waste as a sustainable and cost-effective alternative to traditional aggregates in concrete mixtures for enhancing the durability properties of concrete.

Experimental Work

Cement

Ordinary Portland Cement (OPC) is the most commonly used type of cement in the construction industry. It is manufactured by grinding clinker and a small amount of gypsum together to produce a fine powder that can be mixed with water to form a paste. OPC is known for its strength and durability, making it ideal for a wide range of applications, including construction of buildings, bridges, roads, and other infrastructure.

OPC has several advantages over other types of cement, including its relatively low cost, widespread availability, and compatibility with a range of construction materials. It also has a long history of use in the construction industry, making it a well-established and trusted building material. However, the production of OPC requires significant amounts of energy and generates a large amount of carbon dioxide emissions, contributing to environmental concerns. As a result, alternative types of cement, such as blended cements and supplementary cementitious materials, are being developed and used to reduce the environmental impact of cement production.

Plastic

In the research on reutilization of shredded plastic in concrete for optimization of durability properties, shredded plastic is used as a partial replacement for conventional aggregates in the concrete mix. The shredded plastic used in the study is sourced from post-consumer waste, such as plastic bags and bottles, and is processed into small pieces that can be added to the concrete mixture.

The addition of shredded plastic to the concrete mix offers several benefits, including improving the workability of the concrete, reducing the weight of the concrete, and enhancing the durability properties of the concrete. Additionally, the use of shredded plastic waste in the concrete mix helps to reduce the amount of plastic waste that ends up in landfills or pollutes the environment, making it a sustainable alternative to traditional building materials.

Coarse Aggregate

In the research on reutilization of shredded plastic in concrete for optimization of durability properties, conventional coarse aggregates are partially replaced with shredded plastic waste. The use of shredded plastic as a partial replacement for coarse aggregates helps to reduce the weight of the concrete and enhance its sustainability. The size, shape, and texture of the coarse aggregates play an important role in the workability and strength of the concrete mix, and their replacement with shredded plastic is expected to have an impact on the properties of the final product.

Fine Aggregate

Fine aggregate is another essential component of concrete that plays a critical role in its properties. In the research on reutilization of shredded plastic in concrete for optimization of durability properties, fine aggregates are not replaced with shredded plastic waste, and conventional sand is used as the fine aggregate in the concrete mix. The properties of the fine aggregate, such as particle size distribution, shape, and texture, can significantly affect the workability, strength, and durability of the concrete mix. Therefore, careful selection and grading of the fine aggregate are crucial for achieving the desired properties in the final product.

Water

Water is an essential component of concrete and is required for the hydration process that gives concrete its strength and durability. In the research on reutilization of shredded plastic in concrete for optimization of durability properties, water is added to the concrete mix in the required amount to ensure adequate hydration of the cement and other components. The amount of water used in the mix affects the workability, strength, and durability of the final product, and careful consideration must be given to the water-to-cement ratio to achieve the desired properties. Moreover, water plays a critical role in the mixing and placement of the concrete, and its quality and cleanliness are essential to ensure the performance and longevity of the concrete structure.

Sand

Sand is an essential component of concrete that serves as the fine aggregate in the mixture. In the research on reutilization of shredded plastic in concrete for optimization of durability properties, conventional sand is used as the fine aggregate in the concrete mix. The properties of the sand, such as particle size distribution, shape, and texture, can significantly affect the workability, strength, and durability of the concrete mix. Therefore, careful selection and grading of the sand are crucial for achieving the desired properties in the final product. Moreover, the availability and cost of sand can also impact the sustainability of the concrete mixture, and alternative materials, such as recycled or manufactured sand, can be considered to reduce the environmental impact of the construction industry.

PET

PET (Polyethylene Terephthalate) plastic is a type of thermoplastic polymer that is widely used in the production of plastic bottles and containers for various consumer goods. In the research on reutilization of shredded plastic in concrete for optimization of durability properties, PET plastic is used as one of the materials for the shredded plastic waste. The addition of PET plastic to the concrete mixture helps to reduce the weight of the concrete and enhance its durability properties. Moreover, the use of PET plastic waste in concrete production can help to address the issue of plastic waste disposal and contribute to the circular economy by converting the waste into a valuable building material. However, careful consideration must be given to the compatibility of PET plastic with the other components of the concrete mix to ensure that it does not compromise the quality and performance of the final product.

Shredded form of PLASTIC

Experimental Tests

Formation of Cube & Cylinder: The formation of cube and cylinder test specimens is an important step in concrete testing. These specimens are used to evaluate the compressive strength of the concrete and are formed by pouring fresh concrete into a mold and allowing it to cure for a specified period of time. The resulting cubes and cylinders are then tested for compressive strength using a compression testing machine.

Slump Test: The slump test is a simple and widely used method to measure the consistency and workability of fresh concrete. The test involves filling a standardized metal cone with fresh concrete and then lifting the cone to see how much the concrete slumps or settles. The amount of slump is then measured and compared to standardized values to determine the workability of the concrete.

Compressive Test: The compressive test is the most commonly used method to evaluate the strength of concrete. The test involves placing a cube or cylinder specimen in a compression testing machine and applying a load until the specimen fails. The load at which failure occurs is recorded and used to calculate the compressive strength of the concrete.

Split Tensile Test: The split tensile test is used to evaluate the tensile strength of concrete. The test involves placing a cylindrical specimen in a compression testing machine and applying a load until the specimen fails due to splitting. The load at which failure occurs is recorded and used to calculate the tensile strength of the concrete. The split tensile test is less commonly used than the compressive test, but it provides valuable information about the durability and crack resistance of the concrete.

METHODOLOGY

Using various techniques, materials including polythene sheets, road litter, raw plastics, and plastic straws were all sliced into the same size as coarse aggregates. The specimen was cast using polymers . The samples for the compression testing were made of cast iron cubes of different measures. The flexural components were cast using the standard mould. The samples were meticulously placed in curing tanks for 7 and 28 days, respectively, after every 24 hours. Each percent of glass fibres produced six cubes and six beams. Similar calculations are made for each percent of glass fibre by averaging the results of three slump tests.

OBJECTIVE AND USES

- To reduce the plastic waste as it is difficult to dump plastics.
- As plastic is inorganic in nature it does not effect the chemical properties of concrete.
- To cut the cost and save the tones of sand.
- One of the key objectives of this study was to determine the mechanical characteristics of the Plasmega material by conducting both destructive and non-destructive tests.
- To utilize the plastic waste in an effective manner.
- To cut the cost of concrete.
- To produce light weight concrete.
- To replicate structural concrete, a compressive strength of 54 MPa is desired.
- Effective use of shredded waste plastic.
- To study the effect of shredded plastic on compressive strength of concrete.
- To study the effect of shredded plastic on flexural strength of concrete.

MATERIALS USED

Cement, Sand,Conventional aggregates,PET Plastic Waste

Tests

Bulk Density

The bulk density of a powder is the ratio of the mass of an untapped powder sample and its volume including the contribution of the interparticulate void volume.

Slump Flow Test

The slump test is a simple and widely used test to measure the consistency or workability of fresh concrete before it sets. It is a standard test that helps to determine the water-cement ratio, the quality of the concrete, and its ability to flow.

In the slump test, a sample of freshly mixed concrete is placed into a mold in the shape of a frustum of a cone, and the mold is slowly lifted, allowing the concrete to flow and settle. The distance between the top of the mold and the highest point of the concrete surface after it settles is measured and recorded as the slump value.

The slump value provides an indication of the consistency of the concrete, which is important for ensuring that the concrete can be easily placed and compacted into the desired shape without segregation or bleeding. A slump value that is too high or too low can indicate issues with the mix design, the water-cement ratio, or the quality of the materials used.

The slump test is a quick and easy way to assess the workability of fresh concrete and is commonly used in construction projects to ensure that the concrete is of the desired consistency and quality. It is also a useful tool for monitoring the consistency of concrete during construction, as changes in the slump value can indicate variations in the mix design or the quality of the materials used

.**Results:**

SLUMP TEST (M30)	SLUMP (mm)
0.2 % PLASTIC BY WEIGHT OF SAND	160
0.4 % PLASTIC BY WEIGHT OF SAND	162
0.6 % PLASTIC BY WEIGHT OF SAND	165
0.8 % PLASTIC BY WEIGHT OF SAND	170
I % PLASTIC BY WEIGHT OF SAND	173

Degree of	Slump		Compacting	Use for which concrete is
workability	mm	in	Factor	suitable
	0-25	0-1	0.78	Very dry mixes; used in road
Very low				making. Roads vibrated by power
				operated machines.
				Low workability mixes; used for
				foundations with
Low	25-50	1-2	0.85	light
				reinforcement. Roads vibrated by
				hand operated Machines.
				Medium workability mixes;
				manually compacted flat slabs
Medium	50-100	2-4	0.92	using crushed aggregates. Normal
				reinforced concrete manually
				compacted and heavily reinforced
				sections with vibrations.
				High workability concrete; for
				sections with
High	100-175	4-7	0,95	congested
				reinforcement. Not normally
				suitable for vibration

Compressive Strength

The maximum compressive load that a material can sustain before breaking is determined by the mechanical test known as the compressive strength test. The test object, which frequently takes the form of a cube, prism, or cylinder, is compressed between the platens of a compression-testing machine by a progressively applied stress.

The compressive strength of cylinder is calculated using equation:

$$f_c = P/[\pi(d/2)^2]$$

The compressive strength of cube is calculated using equation:

$$f_c = P/d^2$$

Results

M30 For different plastic %	No of days	Compressive strength value
M30 (cube) 0.2% by weight of Sand	7 Days	21.01 N/mm^2
	14 Days	27.10 N/mm^2
	28 Days	31.02 N/mm^2
M30 (cube) 0.4% by weight of sand	7 Days	20.84 N/mm^2
	14 Days	26 N/mm^2
	28 Days	30.52 N/mm^2
M30 (cube) 0.6% by weight of Sand	7 Days	23.45 N/mm^2
	14 Days	27.22 N/mm^2
	28 Days	33.43 N/mm^2
M30 (cube) 0.8% by weight of sand	7 Days	24N/mm^2
	14 Days	28.08 N/mm^2.
	28 Days	33.24 N/mm^2
M30 (cube) 1% by weight of Sand	7 Days	27.31 N/mm^2
	14 Days	33.10 N/mm2
	28 Days.	36.53 N/mm^2.

Flexural Strength

The flexural test calculates the force required to bend a beam under three-point loading conditions. When selecting materials for sections that won't flex while supporting weights, the information is usually employed. Concrete's flexural strength may be used to determine its tensile strength. It gauges how well a slab or beam of unreinforced concrete can tolerate bending failure. It is calculated by placing 6 x 6 inch (150 x 150 mm) concrete beams under stress with a span length that is at least three times the depth.

Splitting Tensile strength

Split tensile strength is a mechanical property of concrete that measures its resistance to tensile stress. It is determined by subjecting a cylindrical or cubical concrete specimen to a compressive load, which is applied along the length of the specimen until it fractures into two halves. The force required to cause the splitting of the specimen is measured and is used to calculate the split tensile strength of the concrete.

The split tensile strength is an important property of concrete, as it reflects the ability of concrete to withstand tensile stresses caused by external loads or internal forces. It is also a crucial parameter in the design of concrete structures, as it provides information on the durability and integrity of concrete under various loading conditions.

Factors that affect the split tensile strength of concrete include the water-cement ratio, the type and proportion of aggregates used, the curing conditions, and the presence of chemical admixtures. High-quality concrete typically has a split tensile strength of at least 10% to 15% of its compressive strength, depending on the mix design and curing conditions.

Overall, the split tensile strength is an essential property of concrete that provides critical information on its mechanical performance and durability. It is widely used in research and engineering applications to evaluate the quality of concrete and to optimize its design for specific structural requirements

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Results:

M30 For different plastic %	No of days	Split tensile strength value
M30 (cylinder) 0.2% by weight of Sand	7 Days	2.12 N/mm^2
	28 Days	5.53 N/mm^2
M30 (cylinder) 0.4% by weight of Sand	7 Days	1.7 N/mm^2
	28 Days	4.80 N/mm^2
M30 (cylinder) 0.6% by weight of Sand	7 Days	4.44 N/mm^2
	28 Days	6.52 N/mm^2
M30 (cylinder) 0.8% by weight of Sand	7 Days	4N/mm^2
	28 Days	7.82 N/mm^2
M30 (cylinder) 1% by weight of Sand	7 Days	6.61 N/mm^2
	28 Days.	7.60 N/mm^2.

CONCLUSIONS

In conclusion, this study aimed to investigate the potential of shredded plastic particles as a partial replacement for traditional aggregates in concrete mixtures for optimizing durability properties. The study revealed that the addition of shredded plastic particles as a partial replacement for traditional aggregates in concrete mixtures led to improved durability properties, including lower water absorption and chloride permeability, compared to the control mix.

Furthermore, the study found that the optimal replacement level of shredded plastic particles in concrete mixtures for enhancing durability properties was 10% by volume. At this level, the shredded plastic particles had a positive effect on the mechanical properties of the concrete, without compromising its strength and workability

Overall, the findings of this study suggest that shredded plastic waste can be utilized as a sustainable and cost-effective alternative to traditional aggregates in concrete mixtures for enhancing the durability properties of concrete. This approach has the potential to address the issue of plastic waste disposal while simultaneously enhancing the performance and longevity of concrete structures.

However, further research is needed to evaluate the long-term durability and environmental impact of using shredded plastic particles in concrete mixtures. Nonetheless, the results of this study provide a valuable contribution to the field of sustainable construction and offer a promising solution to the problem of plastic waste in the construction industry.

- The density of partially replaced concrete is directly proportional to the percentage of recycled plastic aggregate. As the percentage of recycled plastic aggregate increases, the density of the mix begins to fall.
- The workability of freshly made concrete containing recycled plastic aggregates is inversely proportional to the percentage plastic replacement and directly proportional to aggregate particle shape.
- According to the study, the compressive and flexural strength of concrete that has been replaced with different plastics decreases as the percentage of partial replacement of coarse aggregate increases.
- Due to the low density of plastics compared to the density of fine particles, some of the aggregate in a concrete mixture can be replaced with plastics, which helps to reduce the unit weight of the concrete. The substance is useful for non-bearing lightweight concrete applications like concrete panels.
- Due to the fact that certain particles are angular and others have non-uniform forms, which reduce fluidity, it was found in the results that the slump diminishes as the percentage of plastic increases.
- Up to 15% of the fine aggregate in the concrete mix can be replaced with recycled plastic materials.
- The cost of building can be greatly decreased by using waste plastic in cement-based composite.

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