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Experimental study on the use of Recycled Plastic as Partial replacement of Coarse Aggregate

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***Abstract*—**Plastic is a synthetic material made using organic polymers. They are non-biodegradable, hence are accumulating on mother earth in greater quantity. The accumulation of plastics has hazarding effects on the environment, aquatic animals, human beings, etc. To reduce these effects it is very important to take a proper step and therefore there is an enormous requirement for recycling plastic. Plastics can be reused in many ways such as packaging, in automobiles, airbags, seat belts, construction, etc.

In this work, recycled-plastics are crushed into small pieces of size 20mm passing and 10mm retaining which are used as substitute of coarse aggregate in M20 concrete. The basic tests (specific gravity, water absorption, etc) on each materials of concrete is conducted. Partial replacement of coarse aggregate by 0%, 10%, 15% of recycled-plastic is done. The strength of the specimens are calculated. The behavior of concrete due to replacement of aggregate at different percentage level of plastic is done and optimum percentage of replacement is found.

Keywords—Concrete, Recycled plastic aggregate, Strength, Workability

I. INTRODUCTION

Plastics are widely used because of their low cost, simplicity, versatility and waterproofing and are used in a wide range of products and products from paper towels to space shuttles. Although there are many polymers, plastics are, in general, lightweight and very strong. Plastics can be molded, extracted, cast and blown into shapes and films or foams that look infinitely or embedded in textile fiber. many types of coverings, sealants and glues are actually plastics, many traditional materials metal, ceramic, and pipes used for plumbing or vinyl protection for many of their previous uses. wrapped in plastic. Some general facts about plastic are as follows. The cost of plastics as a packaging material in consumer products is cheap compared to other materials. Plastic packaging helps to significantly reduce packing of waste and food waste. Plastic construction products and add-on products save a lot of energy. Manufacturers of plastic work to keep plastic out of the sea.

Due to the widespread use of plastic in many industries, there is a proliferation of its products in an extreme environment that causes adverse effects on wildlife, aquatic animals, people, etc. Plastic impurities can be classified into micro-, maso-, or macro-, debris, based on size. The prevalence of plastic waste is associated with the fact that plastic is inexpensive and durable, lending high levels of plastic to human use. Plastic can adversely affect land, water and sea routes.

The presence of plastic debris makes it difficult for the movement of aquatic life. They can also affect the oxygen levels in the water bodies, which puts the lives of living things in these habitats at risk. Some marine organisms swallow small amounts of plastic debris and are poisoned by chemical elements. On the other hand, plastics can be eye-catching if they are spread everywhere. It also causes stagnant water which provides perfect breeding environment for insects such as mosquitoes. Burning of plastic objects also creates pollution. Some of the most common ways to cause plastic pollution are: When items come from retail stores, they are more likely to be packed in plastic bags. Most of these thermoplastics are mass-produced. When these plastics are used, they are discarded or discarded. Pet bottles are also a plastic waste that are usually used in Pharmacy industries for packaging of medicines. The damaged bottles are discarded which eventually pollutes the environment.People generally discard the plastic bags rather than reusing it because of it's easy availability everywhere. Fishing is an important source of income for countries with large coastlines but materials that are being used in fishery are mostly made up of plastics that are left behind and end up in sea bed.

Plastics in presence of water is very harmful as it releases toxins and can cause cancer. Children can also pick up discarded plastic items and this can lead to congestion and death. Deforestation also affects agriculture: Plastic sheets have been widely distributed. They make the environment look unclean and unattractive. When plastics are buried, chemicals released by them decreases the soil fertility and kills microorganisms that decomposes the soil. They can also make areas less sensitive to microorganisms. plastic pollution, therefore, affecting the ecological balance. Animals can't digest plastics, it causes serious health issues to them in turn affects the animal husbandry industry. Fishing is an important source of income for countries with large coastlines but materials that are being used in fishery are mostly made up of plastics that are left behind and end up in sea bed. Plastics are made up of petrochemicals. Burning them releases harmful gases into atmosphere which causes acid rain. Inhaling these gases can cause respiratory problems like asthma and lung problems. Plastics tend to stuck in conduits of sewerage system, disrupting it's flow and blocks the system. No one wants to travel elsewhere just to interact with polluted areas and possibly get diseases and ailments. The plastics around the beach make the beaches unsightly and unattractive to visitors.

As plastic contamination progresses to a higher level and as it cannot control the use of plastic, it is necessary to recycle so-called recycling of plastic. Recycling of plastic is the process of

recycling or disposing of plastic and recycling it into useful products. Recycling plastic is very important because recycling of plastics conserves natural energy and resources and saves landfill. Used plastic is used in a variety of fields, such as packing, building, gardening, textiles, street furniture, textiles / garbage bags, and other uses.

In this process, the plastics are crushed to pieces and filtered. The retained ones are used as a partial replacement of natural coarse aggregate in M20 concrete. Basic tests (Specific gravity, water absorption, etc.) for each concrete specimen is performed. A partial replacement of natural coarse aggregate by 0%, 10%, 15% plastic is made. A study of the behaviour of concrete specimen due to replacement of aggregate at different percentage levels of plastic is done and a suitable percentage of replacement is found

II. PRELIMINARY ANALYSIS

Cement: Different grades of cement are suitable for preparing concrete mix and choice of cement content depends on required strength and permeability of the mix. In this present study OPC of grade 43 is used conforming to the IS 12269-1987 requirements.

Sl No	Name of the Experiment	Results	As per IS 12269:1987
1	Specific gravity	3.12	3.1-3.16
2	Normal Consistency	26%	-
3	Initial Setting Time	37 minutes	Minimum 30 minutes
4	Fineness Test (Sieve Method)	3.38%	Not Exceeding 10%

Table 1: Preliminary Test of Cement

Fine aggregate: Fine aggregate plays an important role in concrete. Adding percentage of fine aggregate is responsible for permeability and strength. In this present study, locally obtained M sand is used as fine aggregate.

Sl No	Name of the Experiment	Results	As per IS 383-1970
1	Specific gravity	2.6	2.60-2.67
2	Water absorption	2.89%	3%(Maximum)
3	Sieve analysis	Grading zone II	Grading zone II
4	Fineness Modulus	2.9	2-3.5

Table 2: Preliminary Test of Fine aggregate

Coarse aggregate: Nominal crushed stone passing through 12mm and retained on 10mm was adopted in the present study.

Recycled-plastic aggregate: The recycled plastic is crushed into pieces in a machine at a factory in Nayandahalli, Bengaluru. The size of plastics is 12mm passing and 10mm retaining. The material used here is Raffia which is commonly used to produce packaging material such as cement bags. The polymers used for its manufacture are HDP(high-density polyethene) and polypropylene

SL NO	Name of the Experiment	Results (Coarse aggregates)	Results (Plastic aggregates)	As per IS 2386-1963
1	Specific gravity	2.6	0.98	2.5-3.2
2	Water absorption	0.55%	0.38%	0.1-2%
3	Impact Value	18.33%	0.00%	Max 30%
4	Flakiness Index	13.89%	-	Max 15%

Table 3: Preliminary Test of Coarse aggregates and recycled-plastic aggregates

III. CONCRETE MIX DESIGN

The process of selecting suitable proportion of raw materials and determining their corresponding value for the purpose of producing the required concrete, strength, durability, and economic viability as far as possible is called concrete mix design. If the plastic concrete does not work, it cannot be properly laid and bonded. Mix design is therefore very important.

The compressive strength of reinforced concrete is often regarded as an indication of structures, depending on many factors eg quality and quantity of cement, water and aggregate mixing; setting, placing, compaction. The difference in material costs comes from the fact that cement costs several times more than the aggregates, so the goal is to produce as lean mix as possible. From a technical point of view rich mix can lead to high shrinkage and cracking of structural concrete and high hydration temperature changes in concrete which can cause cracks.

The actual cost of concrete is related to the cost of the materials required to produce the mean strength called the characteristic strength specified by the engineer. This depends on the quality control measures, but there is no doubt that quality control adds to the cost of concrete. The extent of quality control is often an economic compromise and depends on the size and type of work. Personnel costs depend on the performance of the concrete mix, e.g., poor performance of concrete mix can lead to higher labor costs in obtaining the level of mixing and equipment available.

Casting of concrete specimens

IV. RESULTS AND DISCUSSIONS

Slump Test: The slump value sharply increased with increased plastic percentage and it lied in the range of 50-100mm i.e, it had medium workability.

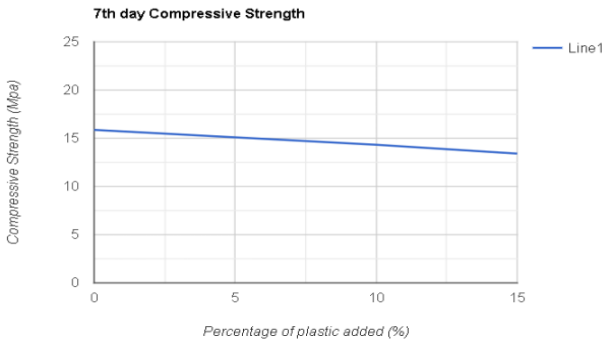
S.No	W/C Ratio	Percentage of plastic replaced(%)	Height of mould H1(mm)	Height of subsided concrete H2 (mm)	Slump H1-H2 (in mm)	Average Slump value (mm)
1	0.45	0	300	245	55	55
	0.45	0	300	248	52	
	0.45	0	300	242	58	
2	0.45	10	300	225	75	70
	0.45	10	300	245	55	
	0.45	10	300	220	80	
3	0.45	15	300	200	100	100
	0.45	15	300	184	116	
	0.45	15	300	216	84	

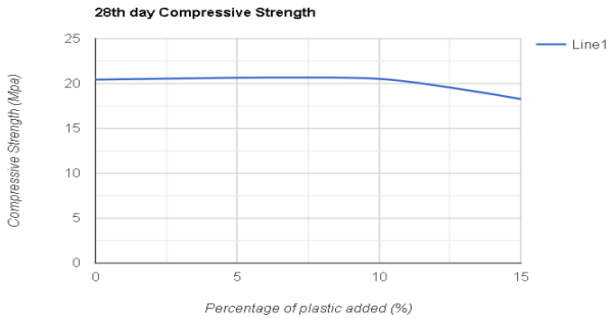
Table 4: Slump test results

Compressive strength test: Cube specimens of size 150mm were casted for 7th day and 28th day compressive strength test with 3 trials for each percentage level of plastic. It was observed that for 28th day strength, there was slight increase (0.5%) in strength for 10% replacement whereas there was a sharp decrease (11%) in strength for 15% replacement.

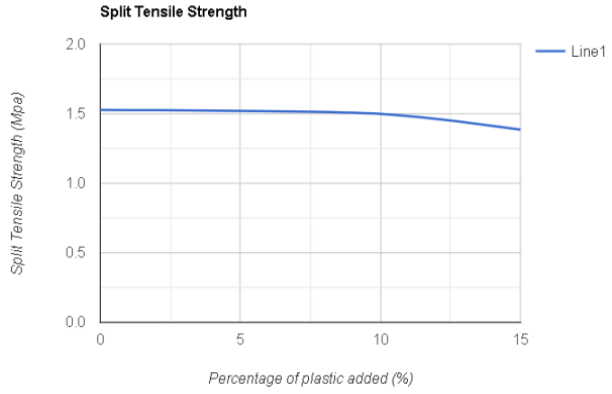
% Plastic Added	Peak Load (kN)		Compressive Strength (Mpa)	
	7th Day	28th Day	7th Day	28th Day
0%	354	468	15.73	20.8
	371	454	16.48	20.17
	346	458	15.37	20.35
10%	317	469	14.08	20.84
	336	462	14.93	20.53
	315	455	14	20.22
15%	295	410	13.11	18.22
	309	408	13.73	18.13
	301	416	13.37	18.48

Table 5:Compressive strength test results





Split tensile test: Cylindrical specimens of size 150mm diameter and 300mm height were used for the test. The tensile strength is obtained by taking average of the three specimens. Satisfactory results were obtained for 10% plastic replacement.



Percentage of plastic added (%)	Trials	Weight (KN)	Average Weight (KN)	Split tensile strength (N/mm2)
0	1	107	108	1.527
	2	105		
	3	112		
10	1	107	106	1.499
	2	103		
	3	108		
15	1	98	98	1.386
	2	95		
	3	101		

Table 6: Split tensile test results

V. CONCLUSION

The concrete containing various percentage of plastic showed that, the workability increases as plastic percentage increased i.e, Slump value increases with increase with percentage of plastic. The maximum Slump value achieved is 100mm with 15% of plastic replaced concrete. The waste plastic used for experiment is RAFFIA and it has a specific gravity of 0.98. The good property of this plastic is it's Impact Value which was obtained as 0. From this Impact Value it can be concluded that the plastic replaced concrete can be used in Pavements. The compressive strength of the replacement concrete is compared to the control concrete specimen. It is found that the compressive strength of 10% of concrete with replaced plastic

is close to that of controlled concrete specimen. The Split tensile strength of concrete with replaced plastic is compared with controlled concrete specimen and it is found that the Split tensile strength of 10% plastic replaced concrete is very near to the Split tensile strength of controlled concrete specimen. It is found that 10% of replacement gives satisfactory results of strength. The weight of concrete reduces with increase in percentage replacement. It can be recommended for Light Weight Concrete Structures.

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