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Experimental Investigation on the Effect of Waste Plastic on the Compressive Strength of Concrete in Marine Environment

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KEYWORDS

plastic, compressive strength, concrete, marine

ABSTRACT:

The amount of plastic garbage available today is huge, with around 50% to 60% of it being used for temporary purposes. Plastics end up in the trash when they've served their purpose. Durable and non-biodegradable, plastic trash is a major problem. trash plastics end up in landfills or mixed with other types of municipal solid trash due to careless disposal. In light of these facts, we need to find a new use for these plastic scraps. Therefore, we are constantly open to new ideas that find a way to recycle these waste plastics for building purposes. The tensile strength and strain capacity of regular, unreinforced concrete are poor, and it is fragile. A composite material known as Fibre Reinforced Concrete (FRC) is concrete that has been reinforced with short, irregularly shaped fibres of a specified geometry. It has long been known that adding small, consistently distributed, and closely spaced fibres to concrete can serve as a crack arrester and significantly enhance its qualities. This is the case with fibre-reinforced concrete. The main objective of this study is to lessen the hazardous condition by safely reusing waste plastic via an experimental programme that raises compressive strength when waste plastic is added in certain proportions. Additionally, the study aims to compare the performance of several concrete grades (M25, M30, and M35) with different percentages of waste plastic (0.5, 1.0, 1.5, and 0.5 percent by weight) after curing in potable water and then being exposed to the marine environment for 7, 14, and 28 days.

I. Introduction:

Today plastic is one of the major toxic pollutants because of its nature of non-biodegradable composed of plastic pollutes and toxic chemicals. During its production and disposal plastic causes severe damage to the environment. Ethylene oxide and benzene are the major chemicals which are used in the making of plastic and these chemicals cause severe effects on human life ranging from birth defects to cancer. Each year around 100 million tons of plastic is produced. Disposal of this plastic through landfilling, burning or recycling is a myth because plastic never undergoes plastic decomposition. There is now no solution to use this waste in any way. Persson (2003) tested self-compacting concrete for its sulphate resistance at 28 and 90 days. Based on the results of the experiment, the concrete mixes including limestone as filler had a greater loss of concrete mass when cured in a sodium sulphate solution. Research on concrete's resilience against sulphate attacks is a more recent development.

Schneider and Chen (2005) reported on the effects of varying chemical solution concentrations, concrete quality class, applied stress load level on concrete strengths, and corrosion mechanism of steel reinforcement along with other topics.

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According to Ferraris et al. (2006), there are other phenomena that need to be considered when analysing performance, including sulphate absorption and diffusion and the impact of ambient variables. The implanted reinforcing steel is more likely to corrode if the structure is exposed to air while in use.

II. Preparation of concrete cubes:

Moulds made of metal, ideally cast iron or steel, must be sturdy enough to avoid deformation. Their construction ensures the safe removal of the moulded specimen and guarantees that, once constructed, the dimensions and interior faces must be precise within specified tolerances. Figures 1,2 and 3 show the moulds, casting of cubes and curing tank.

Figure 1. Moulds (150mmx 150mm x 150mm)

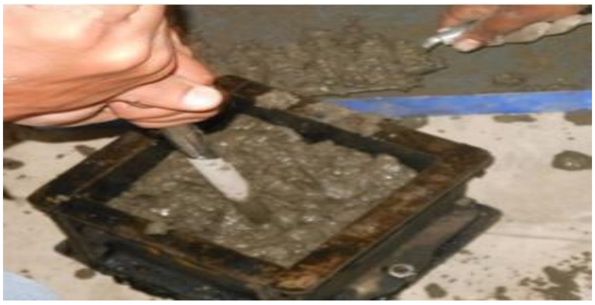

Figure 2. Casting of cubes

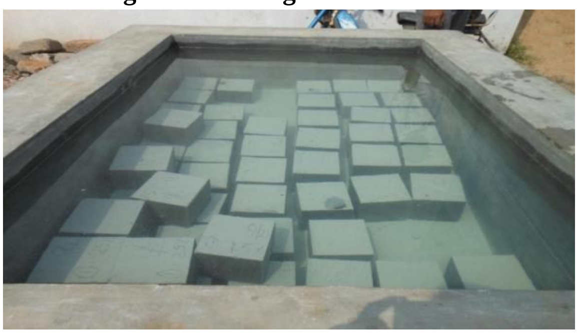

Figure 3. Curing Tank

After 7 and 28 days, the specimens are removed from the curing tank and allowed to dry. Then the dried cubes are tested to know the strength parameters of the design mix at the respective day strengths i.e., 7th day and 28th day strengths.

III. Variation of compressive strength for different mixes:

The compressive strength test is the most widely used method for assessing hardened concrete since it is easy to conduct. The compressive strength of concrete is one of its greatest features. The compressive test specimens are placed in a 150 x 150 x 150 mm mould. The cubes are taken out of the mould and kept in a curing tank until the day of testing after a 24-hour casting period. The load is applied to the cubes at a steady rate of 140 kg/sq.cm/minute in order to test the 300T UTM. With its cast faces pointing away from the viewer, the specimen is positioned in the UTM. The load at which the specimen fails is known as its ultimate load. At the ages of seven and twenty-eight days, this test was conducted. The average load of three specimens is used to calculate strength for each mix.

Cube compressive strength = load/area

where

Load = Load at failure of cube in N

Area = Application area = 150mm *150mm= 22500 mm^2

The compressive strength of concrete after 7,14, and 28 days of curing with varying amounts of recycled plastic. Presented in the table below are the compressive strength results for M25, M30, and M35 grade materials in both normal and marine water.

Table 1: Variation of compressive strength for M25 grade concrete

% of Fiber	7 Days Normal curing			14 Days Normal curing			28 Days Normal curing		
	0 Days Marine water curing	14 Days Marine water curing	28 Days Marine water curing	0 Days Marine water curing	14 Days Marine water curing	28 Days Marine water curing	0 Days Marine water curing	14 Days Marine water curing	28 Days Marine water curing
0	24.6	21.7	19.5	27.3	25.1	23.4	30.3	28.5	27.4
0.5	25.2	22.3	21.2	28.2	26.2	25.3	31.1	29.3	28.9
1	26.1	24.1	22.5	29.1	28.6	27.4	32.5	31.8	31.7
1.5	25.5	23.4	21.1	28.4	26.5	25.8	31.4	29.6	29.2

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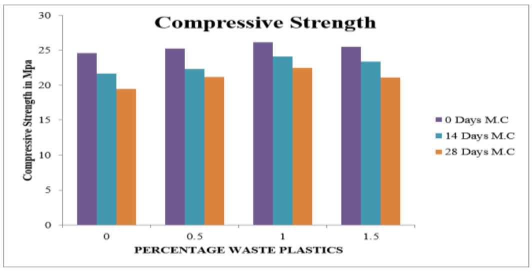

Figure 4. Compressive strength of M25 at different curing periods under marine environment after 7 days of potable water curing with %addition of waste plastics

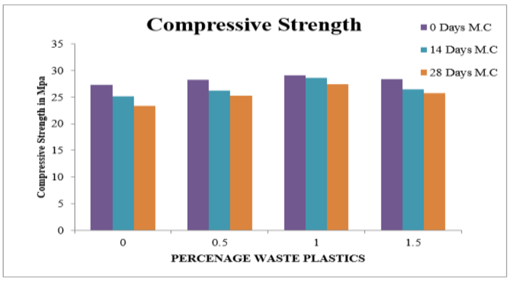

Figure 5. Compressive strength of M25 at different curing periods under marine environment after 14 days ofpotable water curing with %addition of waste plastics

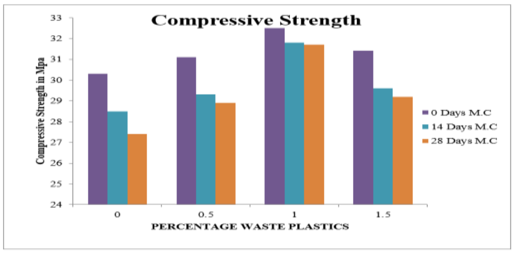

Figure 6. Compressive strength of M25 at different curing periods under marine environment after 14 days ofpotable water curing with %addition of waste plastics

The compressive strength of M25 concrete in both normal water and marine circumstances is shown in Table 1, Figures 4, 5 and 6. Compressive strength increases with increasing amounts of waste plastic up to 1.0 percent regardless of curing conditions, and decreases with increasing amounts below 1.5 percent. After seven days in potable water and twenty-eight days in marine treatment, one percent of waste plastic weakens. After 14 days in portable water and 28 days in marine, the compressive strength of 1.0 percent waste plastic drops. One percent of waste plastics has a reduction in compressive strength after 28 days in potable water and 28 days in marine water.

Table 2: Variation of Compressive Strength for M30 grade of concrete

% of Fiber	7 Days N.C			14 Days N.C			28 days N.C		
	0 Days M.C	14 Days M.C	28 Days M.C	0 Days M.C	14 Days M.C	28 Days M.C	0 Days M.C	14 Days M.C	28 Days M.C
0	28.4	27.1	25.2	32.9	31.8	30.9	36	35.1	34.1
0.5	29.1	28.3	25.3	33.3	32.5	31.5	36.9	36.3	35.8
1	30.8	29.5	26.7	34	33.8	32	38.1	37.7	36.5
1.5	29.5	28.9	25.9	33.9	32.9	31.6	37	36.6	35.9

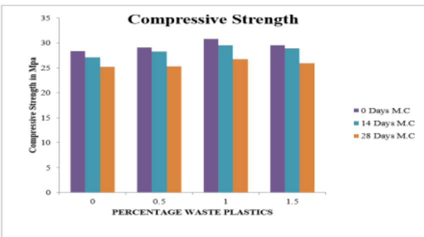

Figure 6. Compressive strength of M30 at different curing periods under marine environment after 7 days of potable water curing with %addition of waste plastics

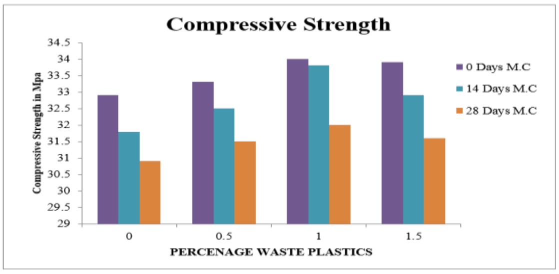

Figure 7. Compressive strength of M30 at different curing periods under marine environment after 14 days of potable water curing with %addition of waste plastics

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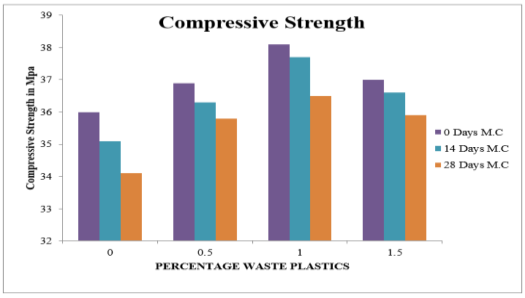

Figure 8. Compressive strength of M30 at different curing periods under marine environment after 28 days of potable water curing with %addition of waste plastics

The compressive strength of M30 concrete in both regular water and marine circumstances is shown in Table 2 and Figures 6, 7, and 8. Waste plastics exhibit a gain in compressive strength of up to 1.0 percent regardless of curing conditions, whereas a decrease of 1.5 percent is observed. Compressive strength decreases by about 5.61 percent for 1 percent waste plastics after 7 days in potable water and 28 days in marine curing. The compressive strength decreases by about 3.55% for 1.0% of waste plastics after 14 days of curing in portable water and 28 days of curing in marine. Compressive strength decreases by about 7% for 1% waste plastics after 28 days of curing in potable water and 28 days in marine environment.

Table 3: Variation of Compressive strength for M35 grade of concrete

% of Fiber	7 Days N.C			14 Days N.C			28 days N.C		
	0 Days M.C	14 Days M.C	28 Days M.C	0 Days M.C	14 Days M.C	28 Days M.C	0 Days M.C	14 Days M.C	28 Days M.C
0	34.1	31.1	27.9	40	36.1	34	44	41	38.6
0.5	35.2	32.1	30.1	41.1	38.9	37.1	44.9	45.1	44.1
1	36.9	33.4	32	42.3	41.1	39	46.5	47.5	46.3
1.5	35.6	32.6	30.5	41.6	39.2	38.1	45.6	45.9	44.9

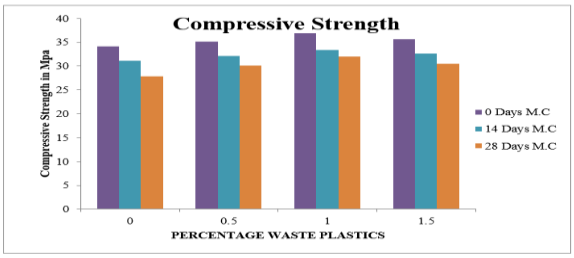

Figure 9. Compressive strength of M35 at different curing periods under marine environment after 7 days of potable water curing with %addition of waste plastics

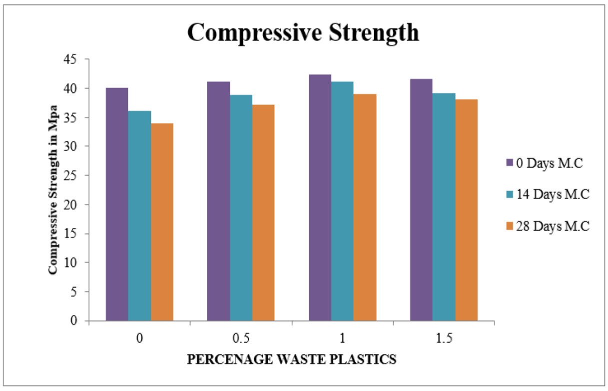

Figure 10. Compressive strength of M35 at different curing periods under marine environment after 14 days of potable water curing with %addition of waste plastics

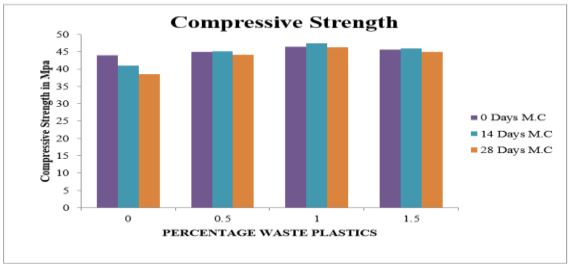

Figure 11. Compressive strength of M35 at different curing periods under marine environment after 28 days of potable water curing with %addition of waste plastics

Figures 9, 10, and 11, as well as Table 3, show the compressive strength of M35 concrete in both freshwater and saltwater environments. Waste plastics exhibit a gain in compressive strength of up to 1.0 percent regardless of curing conditions, whereas a decrease of 1.5 percent is obtained.

Curing in potable water for 7 days and in marine water for 28 days reduces the compressive strength of 1.0 percent waste plastic by about 14.69%. In seven days, one percent of waste plastic weakens in drinkable water, and in twenty-eight days in marine treatment. After 28 days in a marine environment and 14 days in portable water, the compressive strength of 1.0 percent waste plastic declines. After 28 days of curing in sea water and 28 days in potable water, the compressive strength of one percent of waste plastics is decreased.

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V. Conclusion:

This research examined the use of waste plastic fibres in concrete as a waste material by evaluating the impact of the fibres on concrete specimens that were cured in both freshwater and saltwater environments. In conclusion, it has been demonstrated that the strength qualities of concrete may be improved by using waste plastic fibres. This has a dual benefit of enhancing the strength characteristics of concrete while also addressing the issue of trash disposal. The results of the laboratory tests conducted for this inquiry led to the following findings.

- The workability of the made concrete was diminished as the proportion of waste plastics increased when 0%, 0.5%, 1%, and 1.5% of the total were added.
- Waste plastic fibre inclusions in concrete were shown to significantly enhance the strength qualities. The results of this study clearly show that adding fibres to concrete increases the mix's compressive strength.
- At 1% fibre level, all types of strengths were optimal, and as the addition of 1.5% fibre content increased, the strength decreased.
- Seven days in potable water and twenty-eight days in marine treatment are enough for one percent of waste plastic to deteriorate. Twenty-eight days in marine and fourteen days in portable water are required for the compressive strength of 1.0 percent waste plastic to diminish. Following 28 days of curing in potable water and 28 days in sea water, the compressive strength of 1% of waste plastics is decreased.
- The strength enhancement is more noticeable while curing in regular water, but as the curing duration increases in marine circumstances, concrete loses some of its strength.
- The purpose of this research is to offer a method for increasing the strength and ductility of concrete by using reinforcing fibres obtained from waste plastics.
- In conclusion, it has been demonstrated that the strength qualities of concrete may be improved by using waste plastic fibres. This has a dual benefit of enhancing the strength characteristics of concrete while also addressing the issue of trash disposal.

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