# Eco-Friendly Light Weight Concrete Using PET Plastic Aggregates

**Anandu R[1], Anila Babu[2], Arja V Nair[3], Nayana Prasad[4], Subhalekshmi[5]**

*[1-4]Student,Civil Engineering Department, Musaliar College of Engineering &Technology, Pathanamthitta, India*
*[5]Assistant Professor, Civil Engineering Department, Musaliar College of Engineering & Technology, Pathanamthitta, India*

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**Abstract -** *Construction sector is on its highest in 21st century. For a developing nation like India, construction sector is very important. And for construction the inevitable part is concrete. With the current situations we can't occupy more land for construction, so we should choose multi-storey buildings. For such cases need for economic and strong lightweight concrete is high. Another issue in our nation is the waste management problem, especially management of plastic wastes. Incorporating plastic waste as fine aggregate replacement is studied along with the replacement of cement by an industrial byproduct silica fume*

***Key Words*: Light weight concrete, PET, Silica Fume**

## 1. INTRODUCTION

In this study we are using a major plastic waste, i.e Polyethylene Terephthalate (PET) as replacement material for fine aggregate. Also for all replacement mixes cement is replaced by silica fume, which is an industrial waste for better strength. M25 mix is designed and prepared. Compressive strength test, split tensile strength test and flexural strength tests of various mixes were done.

### 1.1 Materials

- Cement – OPC 53 grade cement
- Fine Aggregate
- Coarse Aggregate
- PET Granules (recycled)- uniformly graded retaining on 2.36mm IS sieve
- Silica Fume
- Water

### 1.2 Material Testing and Design

Preliminary tests such as sieve analysis, specific gravity test, water absorption tests etc were done and according to the results obtained from the results M25 mix is designed as per **IS 10262: 2009**. Designed mix proportion is 1:1.62:2.78 with water cement ratio of 0.45. 7 mixes were prepared. Control concrete (CC) with no aggregate replacement, M1 mix with 5% replacement of fine aggregate by PET and 10% replacement of cement by Silica fume, M2 mix with 10% replacement of fine aggregate by PET and 10% replacement of cement by silica fume, M3 mix with 15% replacement of fine aggregate with PET and 10% replacement of cement by silica fume, M4 mix with 20% replacement of fine aggregate by PET and 10% replacement of cement by silica fume, M5 mix with 25% replacement of fine aggregate with PET and 10% replacement of cement by silica fume and last mix S1 with 10% replacement of cement by silica fume only.

**Fig -1:** PET aggregate

## 2. PREPERATION OF SAMPLE AND TESTS

Concrete mixes were manually mixes and various workability tests done. Cubes of size 15cm×15cm×15cm cylinders of size 15cm dia×30cm and beams of size 10cm×10cm×50cm were casted cured and tested.

Various tests conducted was workability tests (slump cone and compaction factor test) compressive strength test, split tensile strength test and flexural strength test

**Table-1:** Workability of mixes

| **Workability of mixes** | | |
|---|---|---|
| Mix | Slump (mm) | Compaction factor |
| CC | 63 | 0.92 |
| M1 | 57 | 0.92 |
| M2 | 55 | 0.9 |
| M3 | 55 | 0.89 |
| M4 | 50 | 0.89 |
| M5 | 45 | 0.85 |
| S1 | 62 | 0.92 |

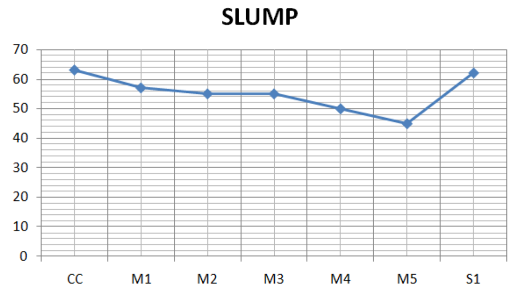


**Chart -1**: Slump of mixes

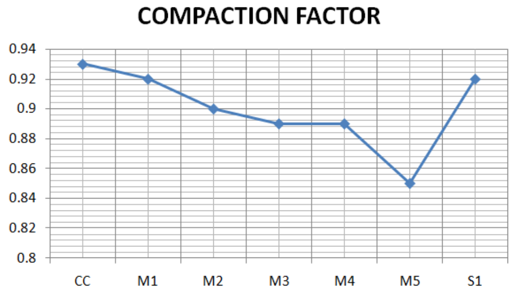


**Chart -2**: Compaction factor of mixes

The workability of the mixes was decreasing with the increase in the percentage of replacement of fine aggregates.

But all the mixes come under moderately workable except M5 mix, which has a slump of 45mm which is less than 50mm.

**Table -2:** Compressive strength tests of Mixes

| **Compressive strength of mixes (N/mm²)** | | | |
|---|---|---|---|
| Mix | 7days | 14 days | 28 days |
| CC | 18.22 | 20.44 | 32.44 |
| M1 | 8.22 | 22.22 | 36.33 |
| M2 | 19.11 | 26.67 | 37.33 |
| M3 | 20.44 | 26.67 | 44.44 |
| M4 | 19.55 | 26.22 | 40 |
| M5 | 18.66 | - | - |
| S1 | 26.22 | - | - |

**Table -3:** Split Tensile strength tests of Mixes

| **Split tensile strength of mixes (N/mm²)** | | | |
|---|---|---|---|
| Mix | 7 days | 14 days | 28 days |
| CC | 1.85 | 2.26 | 2.94 |
| M1 | 1.90 | 2.33 | 2.98 |
| M2 | 1.98 | 2.40 | 3.00 |
| M3 | 2.00 | 2.55 | 3.21 |
| M4 | 1.90 | 2.48 | 3.11 |
| M5 | 1.84 | - | - |
| S1 | 2.12 | - | - |

**Table -4:** Flexural strength tests of Mixes

| **Flexural strength of mixes (N/mm²)** | | | |
|---|---|---|---|
| Mix | 7 days | 14 days | 28 days |
| CC | 3.20 | 4.00 | 4.25 |
| M1 | 3.25 | 4.00 | 4.375 |
| M2 | 3.375 | 4.125 | 4.75 |
| M3 | 3.50 | 4.375 | 4.375 |
| M4 | 3.125 | 4.00 | 4.625 |
| M5 | 3.00 | - | - |
| S1 | 3.625 | - | - |

(The 14th and 28th day results of M5 and S1 mixes were not available due to the lockdown initiated to fight against second wave of Covid-19, instead we have 56th days results)

**Table -5:** 56th day strength values of M5 and S1 mixes

| **56th day strength values of M5 and S1 mixes (N/mm²)** | | | |
|---|---|---|---|
| Mix | Compressive strength | Split tensile strength | Flexural strength |
| M5 | 33.33 | 3.05 | 4.625 |
| S1 | 46.22 | 3.536 | 6.375 |

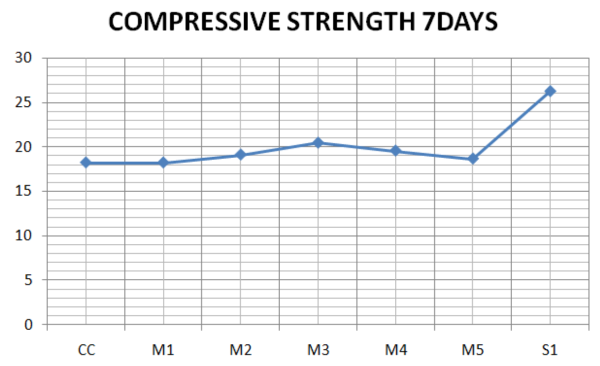


**Chart -3**: 7 day compressive strength of mixes

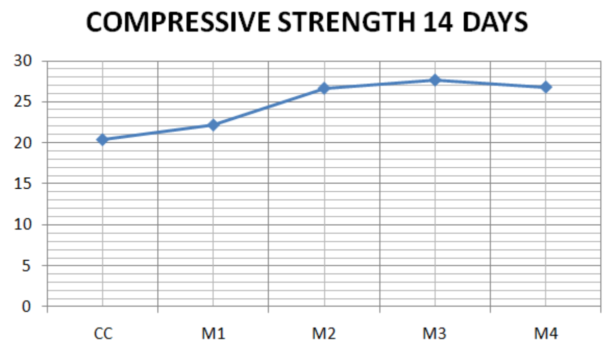


**Chart -4**: 14 day compressive strength of mixes

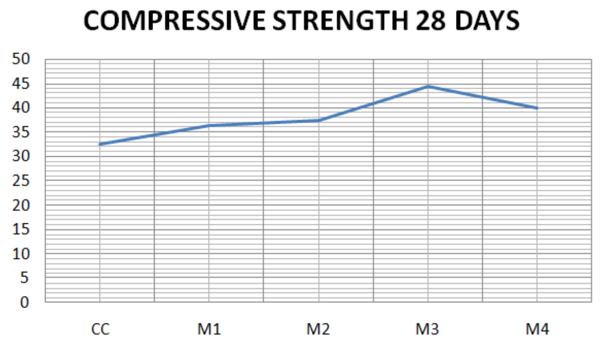


**Chart -5**: 28 day compressive strength of mixes

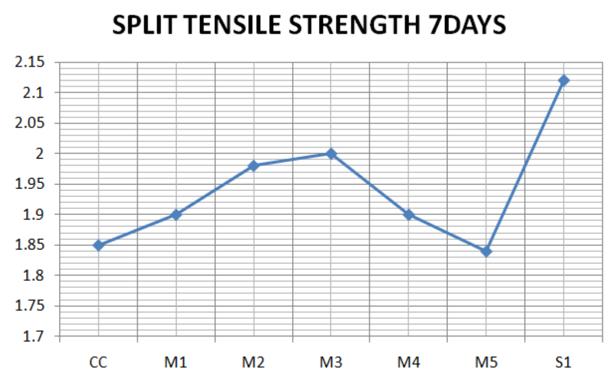


**Chart -6**: 7 day split tensile strength of mixes

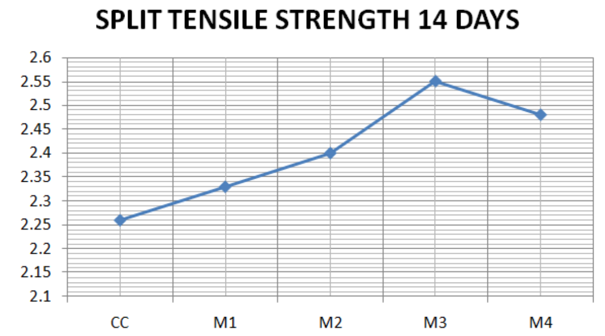


**Chart -7**: 14 day split tensile strength of mixes

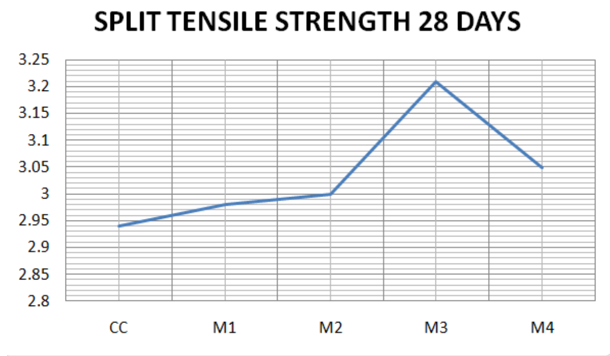


**Chart -8**: 28 day split tensile strength of mixes

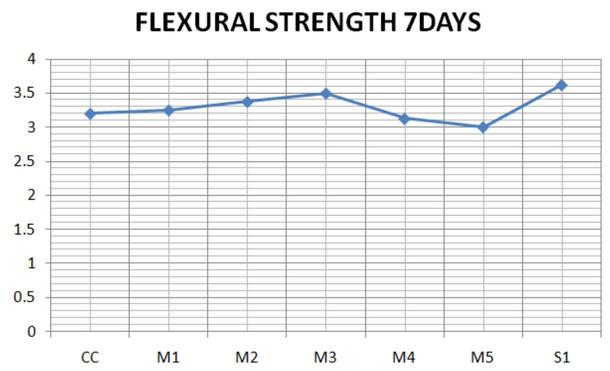


**Chart -9**: 7 day flexural strength of mixes

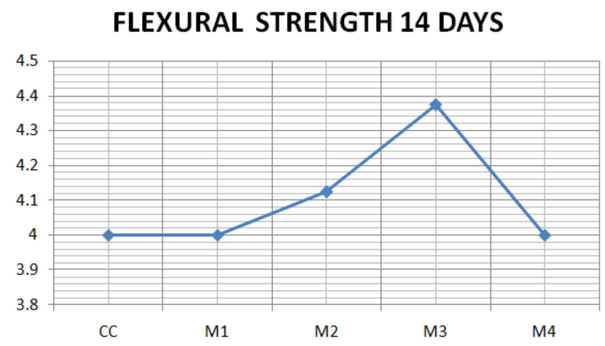


Chart -10: 14 day flexural strength of mixes

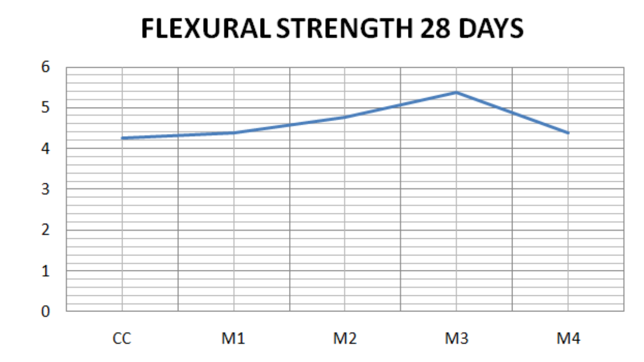


Chart -11: 28 day flexural strength of mixes

The strength of mixes obtained was greater than the control concrete. Among all replacement mixes M3 mix with 15% aggregate replacement and 10% cement replacement has the dominant result. The strength increase in mixes was due to the action of silica fume in mixes, while the decrease in workability is due to the non-binding of PET granules in mix.

## 3. CONCLUSIONS

The influence of replacement of fine aggregate by PET granules has been studied. Based on the experimental work conducted, the following conclusions are drawn. Materials used in the experimental study are cement, coarse aggregate, fine aggregate, plastic aggregates or PET granules and silica fume. The effect of replacing cement by silica fume is also studied and a percentage replacement of 10% by weight is selected for the study. The test on materials are completed and the mix is designed according to **IS 10262: 2009.** All mixes are prepared and left for curing. 7, 14 and 28 days strength (compression, flexure and tensile) of all mixes were done and compared to standard results. From the obtained results of various laboratory tests there is a gradual increase in strength of all replacement mixes. That is strength of replacement mixes are more than strength of control mix. Also M3 (mix with 15% replacement of fine aggregate by PET and 10% replacement of cement by Silica fume) has the highest strength compared to the rest of the mixes

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