International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

# Experimental Investigation on Mechanical Properties of SCC Developed with Manufactured Sand and Plastic Waste

***Shashi Kumar V N[1], N Ranjith Kumar[2], S Guru Bramham[3], C Jyoyhi[4], B Swetha[5], K Nandini[6]***

1Assistant Professor, Department of Civil Engineering, Yogananda Institute of Technology and Science, Tirupati, India.
2UG Studen , Department of Civil Engineering, Yogananda Institute of Technology and Science, Tirupati, India.
3UG Student, Department of Civil Engineering, Yogananda Institute of Technology and Science, Tirupati, India.
4UG Student , Department of Civil Engineering, Yogananda Institute of Technology and Science, Tirupati, India.
5UG Student , Department of Civil Engineering, Yogananda Institute of Technology and Science, Tirupati, India.
6UG Student , Department of Civil Engineering, Yogananda Institute of Technology and Science, Tirupati, India.

ABSTRACT

The plenitude of waste plastic is a significant issue for the maintainability of the earth as plastic contaminates waterways, land and seas. Be that as it may, the adaptable conduct of plastic (it is light weight, adaptable, solid, dampness safe and modest) can make it a swap for or option in contrast to many existing composite materials like cement. In the course of recent decades, numerous investigates have utilized waste plastic as a swap for totals in concrete. This paper presents a far reaching survey of the designing properties of self-compacting concrete (SCC) supplanting cementitious material by weight with the upgraded rates of fly debris. Expansion of superplasticizers fluidizes the solid and consolidating strengthening cementitious materials or admixtures opposes isolation during stable blend stream relies upon moderate plastic speed. In this investigation, the consolidated impacts of waste Polyethylene Terephthalate (PET) particles and pozzolanic materials on the physical and mechanical properties of self-compacting concrete (SCC) are assessed. Made sand contrasts from common ocean and stream dug sand in its physical and mineralogical properties. These can be both helpful and negative to the new and solidified properties of cement. The supplanting proportions of fine totals with a similar load of waste PET totals are 0, 10, 20, 30, 40 weight percent (wt %). In addition, the supplanting proportion of concrete with a similar load of fly debris is 30 weight percent (wt %) separately. The usefulness of SCC containing waste PET particles was resolved utilizing droop stream, V-channel and L-box tests. Mechanical (compressive, pliable, flexural tests).

**Keywords:** Self-compacting concrete, Workability, Compressive strength, Split tensile strength, Flexural strength, Eco-friendly, Plastic waste (Polyethylene Terephthalate).

## 1. INTRODUCTION

In the course of the most recent decades, immense amounts of a non-degradable waste, particularly as waste plastics, for example, polyethylene terephthalate (PET) have demonstrated that they have genuine difficulties to nature; in addition they are considered as one of the perilous wellsprings of contamination. The reuse of plastic waste (PET) bottle scrap assumes a significant job in reasonable strong waste administration. Plastic waste administration assists with sparing common assets that can't be renewed, diminishes contamination of nature. Additionally, the present reusing state and authoritative powers present incredible weights on plastic reused and reusing. The utilization of plastic as total in the solid as extraordinary potential for future great solid turn of events.

The solidified self-compacting concrete (SCC) is thick, homogeneous and has indistinguishable designing properties and solidness from customary vibrated concrete. SCC comprises fundamentally of indistinguishable constituents from typically vibrated concrete. Be that as it may, there is a reasonable contrast in solid arrangement. Self-compacting concrete requires the higher extents of ultra-fine materials and the consolidation concoction admixtures, especially a viable high water reducer.
Concrete is a composite development material made fundamentally out of concrete, totals and water. The total is commonly coarse rock or squashed shakes, for example, lime stone or stone alongside a fine total, for example, M-sand. The concrete normally utilized as Portland concrete. The Various compound admixtures are likewise added to accomplish different properties and furthermore quality. Water is then

blended in with this dry composite which empowers it to be formed and afterward cemented and solidified. Concrete as generally high compressive quality, yet low in elasticity. Therefore, normally fortified with materials those are solid in strain. Concrete is broadly utilized for making compositional structures, establishments, block divider, asphalts, spans, streets, runways, stopping structures, dams, pools, pipes and so forth, structures made by cement can have a long life. As concrete has a high warm mass and extremely low porousness, it can make for vitality productive lodging. Plastic is a typical item that can be found in an alternate structures bottles, containers, wind shields, bulbs, cathode beam tube and so on, these items have restricted life time and should be reused so as to maintain a strategic distance from ecological issues identified with their storing or land filling. During the most recent decades it has been perceived that plastic waste is of enormous volume and is expanding step by step in the shops, development zones and processing plants.

## 2. EXPERIMENTAL STUDY

### *2.1 Materials Used:*

Ordinary Portland cement 43 Grade is used in concrete according to the BIS specifications 12269-1987. Coarse aggregates are 10mm and 12 mm passing in the ratio of 60:40. Specific gravity of coarse aggregate is 2.74. M-sand with maximum size of 4.75 mm is used. Specific gravity of the sand is 2.65. Polyethylene terephthalate (PET) is replaced with fine aggregate partially. Class F Fly ash has used with specific gravity of 2.2. Tap water is used. Conplast Super plasticizer 430 and Fosroc Viscosity Modifying Agent are used.

2.2 MIX PROPORTIONS

The cementitious content of Self-compacting concrete with the fly ash is 442 kg/m3. The coarse aggregate of size 12 mm is 28.08% by weight and of size 10mm is 18.72% by weight. The fine aggregates content is 54.13% by the volume. The water to binder (cement + fly ash) ratio is 0.43 for all mix. The 30% fly ash used in concrete with 0% PET is considered as the reference to SCC. In addition, the replacement ratio of fine aggregate with PET granules is varying from 10%, 20%, 30% and 40%. SCC mix designed with PET and fly ash increased the workability compared to the SCC mix with only Fly ash.

### *2.3 Test Procedure*

To decide the filling and passing capacities of new SCC. Droop stream, V-channel and L-box tests were performed. The solid were casted into the molds of 3D square (150x150x150 mm) and round and hollow molds (length = 300mm, dia = 150mm) with no vibration. All the examples were relieved for 7 and 28 days in a water tank at 22±2 $^{0}$C until testing. Compressive, split ductile and flexural tests were performed at 7 years old and 28 days as indicated by IS 516:2004 and IS 5816:1999 separately.

## 3. RESULTS AND DISCUSSION

### *3.1 Properties of fresh self-compacting concrete*

As indicated by European Federation of National Associations Representing for Concrete (EFNARC) 2005, SCC streams alone under its dead weight up to leveling, warmth out and joins itself in this way with no section of additional compaction, essentialness and without a nameable disengagement. In light of the high substance of powder, SCC may demonstrate more plastic shrinkage or drag than the customary concrete mixes. These perspectives should subsequently be considered laying out and deciding SCC. It ought to fulfill the prerequisites for the functionality as referenced in underneath table.

**Table 1.** Workability tests for various percentage of plastics

| % of plastic used in SCC | Slump flow (mm) | V-funnel (sec) | L-box (h2/h1) |
|---|---|---|---|
| 0 | 557 | 8.9 | 0.86 |
| 10 | 563 | 8.6 | 0.87 |
| 20 | 593 | 8.5 | 0.89 |
| 30 | 619 | 8.0 | 0.9 |
| 40 | 627 | 9.4 | 0.8 |

### *3.1.1 Slump flow test*

Droop stream distance across with PET substitution up to 40% in SCC is estimated as appeared in figure. The slump diameter with only 30% fly ash is 627 mm which is satisfying SF1 class EFNARC requirements. Since Fly ash absorbs water and slump flow reduces. The water substance and water folio proportion ought to be rectified before the sand is supplanted. Increment in PET substitution, expands free water content in SCC and the ease increments. Since PET has low water assimilation, droop stream breadth increments with the augmentation in PET substitution level. Fly ash helps in absorbing excess water due to replacement of plastic and thus SCC flows without any bleeding. Retention period of slump is measured at 10min and the slump loss reduces with the replacement of plastic increases. SCC mixtures with PET plastic granules satisfy SF2 class which is applicable for structural elements.

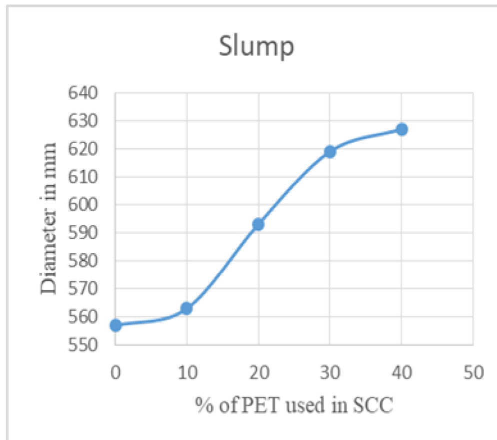


**Figure 1:** Slump flow test

**Figure 2 :** Slump diameter with varying % of PET

### *3.1.2 V-funnel test*

The stream time for all blends ought to be estimated in V-channel as for shifting PET substitution. The droop stream time lessens with an expansion in PET substitution for M-sand in SCC. The lowest slump flow times are noted in the mixtures with increase in PET replacement level compared to SCC with no PET and it indicates segregation resistance. V-funnel flow times with PET particles shows that the acquired qualities are in the limits of VS2/VF2 consistency fulfilling oneself compacting solid measures of EFNARC 2005. SCC with no PET particles and SCC with plastic material (PET) can be categorized as class VF2.

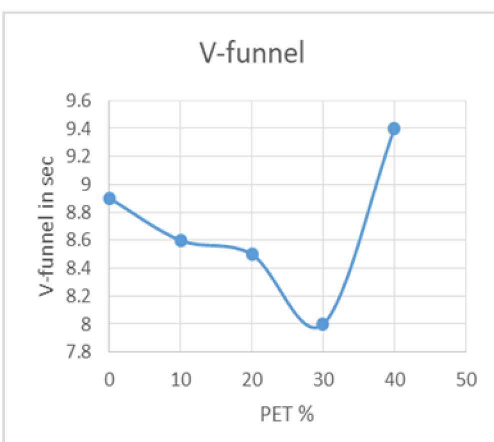


**Figure 3** V-funnel flow test

**Figure 4** Flow time with different % of PET

***3.1.3 L-box test***

The (H2/H1) heights ratio value of L-box, maximum it should be 1 for mentioning perfect SCC fluidity. All blends in SCC with PET arrived at the EFNARC confinements as appeared in table. Size of PET granules doesn't influence in SCC reduced the L-Box height ratio after 40% replacement as shown in figure.

**Figure 5** L-box test

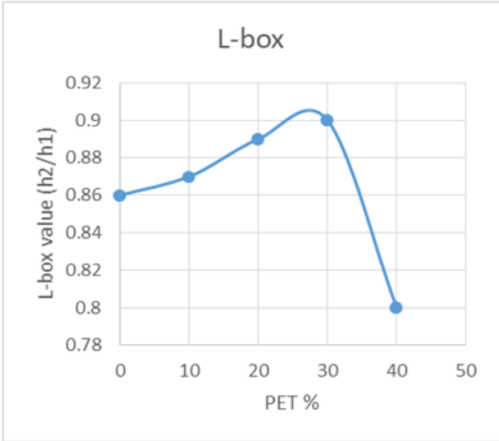


**Figure 6** L-box test (h2/h1) with % of PET

***3.2 Properties of Hardened SCC***

***3.2.1 Compressive strength:***

The incorporating waste plastic (PET) for fine total substitution in SCC blend diminishes the quality. The quality got speaks to of M40grade concrete up to 30% PET substitution for M-sand in SCC. The reduction in the compressive strength of SCC containing PET up to 40% replacement is linear that doesn't reach SCC replaced with Fly ash. In this work, Interfacial transition zone weakens with the increased porosity due to the presence of PET. Since, PET is a hydrophobic material, it inhibits the hydration of concrete by confining the water development in SCC and thus compressive strength reduces. PET granuels have progressively explicit surface region because of smooth surface in concrete framework that for the most part ascribed to the poor bond quality between the plastic PET and the concrete lattice. The consequences of compressive quality at 7 and 28 days are appeared in fig.

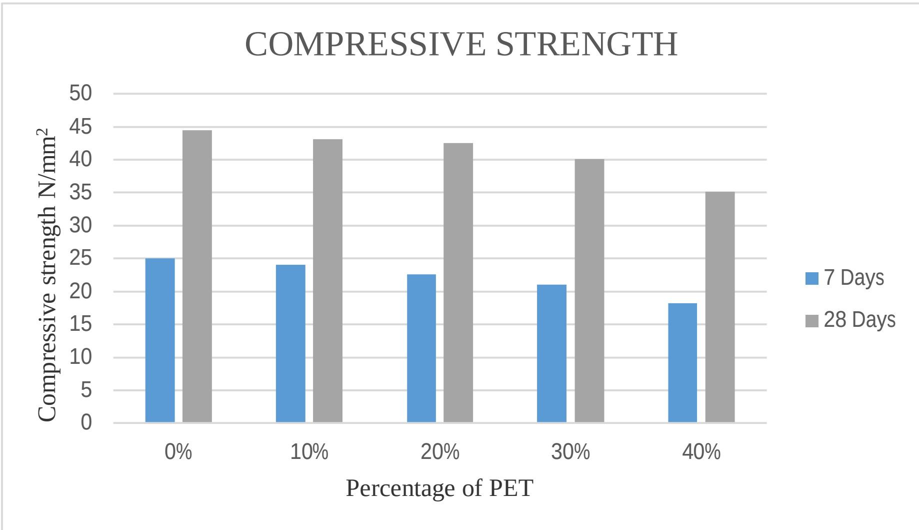


**Figure 7** Compressive strength variations at different % PET replacement for M-sand

### *3.2.2 Split tensile strength test:*

The plastic (PET) aggregates in SCC are less brittle and flexible. Rather than the brittle failure observed, specimens with PET particles yield a little before sufficient load is reached. In this study, Split tensile strength decreased from 0 to 40% during 7 days and 28 days period of curing. Due to the characteristics of PET such as round shape, smoothness and solidity nature, particles separate from matrix due to poor bonding in ITZ when concrete failure point reached. But the specimen gives the desirable strength according to the design criteria when, even concrete elements need not to focus on tensile strength.

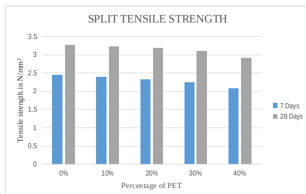


**Figure 8** Tensile strength variations at different % PET replacement for M-sand

### *3.2.3 Flexural strength test:*

The strength obtained represents of M40 grade concrete up to 20% PET replacement for M-sand in self-compacting concrete. The decrease in the flexural quality of SCC containing up to 40% replacement is linear that doesn't reach SCC replaced with Fly ash. The flexural test quantifies the power required to twist a pillar under these point stacking conditions.

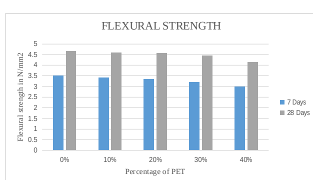


**Figure 9** Flexural strength variations at different % PET replacement for M-sand

The pillar is frequently used to choose materials for flaw that will bolster loads without flexing. Flexural modulus is utilized as a sign of the materials firmness when flexed. This test strategy follows the ASTM D-790 technique where the solidified solid example lies on two 40cm separated supporting ranges and the heap is applied to the middle by the stacking nose creating three focuses pending at a predefined rate in disappointment.

## 4. CONCLUSIONS

The consolidated impacts of waste plastic PET particles and pozzolanic material fly debris on the compressive, split malleable, flexural quality of self-compacting concrete are tentatively assessed for M40 grade concrete. Coming up next are the resolutions drawn from examination:

1. As plastic (PET) consists of powder content, as the concrete as a low absorption property of water.
2. PET granules show negative effects on the concrete chemistry even Fly ash contributed significant effort to improve the hardened properties of SCC.
3. Compression strength of concrete is higher in 20% plastic material substitution level higher contrast with that of typical concrete just as all the level of the plastic cement accomplishes more than the quality of ordinary cement for 7 & 28 days.
4. The parting elasticity of SCC with PET is lower than that of SCC without PET. Be that as it may, the crack of SCC with plastic granules PET isn't as weak as the SCC with nil plastic PET.
5. To oppose isolation, exceptional consideration is required for examples with PET replacement during SCC development. The outcomes indicated that with a proper decision of molecule size and grading of PET plastic granules, it can be feasible to generate structural grade concrete mixes with 30% sand replacement.

## REFERENCES


1. Al-Manaseer AA, Dalal TR. Concrete containing plastic aggregates. ConcrInt 1997; 19:47–52.
2. Batayneh, Malek, Marie, Iqbal, Asi, Ibrahim, 2007. Use of selected waste materials in concrete mixes. Waste Manage. 27, 1870–1876.
3. Byung-Wan, Jo, Seung-Kook, Park, Jong-Chil, Park, 2008. Mechanical properties of polymer concrete made with recycled PET and recycled concrete aggregates. Constr. Build. Mater. 22, 2281–2291.
4. Ch. Bala Rama Krishna And P. Jagadeesh Influence Of Admixtures On Plastic Wastes In An Eco-Friendly Concrete A Review International Journal Of Civil Engineering And Technology, 8(6), 2017, Pp. 388–397.
5. CH. Bala Rama Krishna and P. Jagadeesh, Compressive strength evaluation of eco- friendly concrete replacing sand partially with High impact polystyrene, International Journal of Civil Engineering and Technology, 9(1), 2018, pp. 865–870.
6. Choi, Y.W., Moon, D.J., Chung, J.S., Cho, S.K., 2005. Effects of waste PET bottles aggregate on the properties of concrete. Cement Concr. Res. 35, 776–781.
7. EFNARC, 2005. Specification and guidelines for self-compacting concrete. English ed. Norfolk, UK: European Federation for Specialist Construction Chemicals and Concrete Systems.
8. Foti, Dora, 2011. Preliminary analysis of concrete reinforced with waste bottles PET fibers. Constr. Build. Mater. 25, 1906-1915.
9. Kim, S.B., Yi, N.H., Kim, N.Y., Kim, J.J., Song, Y., 2010. Material and structural performance evaluation of recycled PET fiber reinforced concrete. Cement Concr. Compos. 32 (3): 232–40.
10. Marzouk, O.Y., Dheilly, R.M., Queneudec, M., 2007. Valorization of post-consumer waste plastic in cementations concrete composites. Waste Manage. 27,310–318.
11. Ochi, T., Okubo, S., Fukui, K., 2007. Development of recycled PET fiber and its application as concrete-reinforcing fiber. Cem. Concr. Comp. 29, 448–455.
12. Rebeiz, K.S., Fowler, D.W., 1996. Flexural strength of reinforced polymer concrete made with recycled plastic waste. ACI Struct. J. 93(5): 524–53.
13. Rebeiz, K.S., Fowler, D.W., Paul, D.R., 1991. Making polymer concrete with recycled PET. Plast. Eng. 47 (2): 33–34.
14. Reis, J.M.L., Carneiro, E.P., 2012. Evaluation of PET waste aggregates in polymer mortars.Constr. Build. Mater. 27:107–11.
15. Reddy, A.N.,Meena, T. An experimental investigation on mechanical behaviour of eco- friendly concrete, IOP Conference Series: Materials Science and Engineering, Volume 263, 2017, Issue 3.
16. Semiha, A., Cengiz, D.A., Kubilay, A., An investigation on the use of shredded waste PET bottles as aggregate in lightweight concrete. Waste Manage 30 285-290.
17. S.M. Hama, N.N. Hilal, 2017. Fresh properties of self-compacting concrete with plastic waste as partial replacement of sand. International Journal of Sustainable Built Environment. 6, 299–308.
18. KaliyavaradhanSenthil Kumar, KaliyamoorthyBaskar, Recycling of E-plastic waste as a construction material in developing countries, J Mater Cycles Waste Manag, (2015), 17:718–724.