Behaviour of concrete by partial replacement of recycled low density plastic granules

1Kavin Kumar S, 2Shankar K, 3Yokesh M
1Student, 2Student, 3Student
Kumaraguru College of Technology

***Abstract* - in this research low density poly ethylene (ldpe) granules are used for the replacement of coarse aggregate to produce concrete cubes, cylinders, prism, and reinforced concrete beams. ldpe mixed concrete cubes, cylinders, prism, and reinforced concrete beams were casted by hand mix and found the strength of concrete by compression test, split tension test, flexural strength test and young's modulus test experimentally evaluated. it is found that strength of plastic replaced concrete gained the strength of conventional concrete. this research study is aimed at concrete mix with partial replacement of coarse aggregate by ldpe plastic granules (0%, 15%, 25% and 35%) which will reduce the dead weight of structure and increase safety to the structure because of decrease in weight. hence the use of concrete not only beneficial for structural aspects it will also be helpful in disposal of plastic wastes.**

***keywords* - ldpe plastic granules, compressive strength, split tensile strength, flexural strength, young's modulus, %replacement.**

I. INTRODUCTION

The problem of disposing and managing solid waste materials in all countries has become one of the major environmental, economic, and social issues. A complete waste management system including source reduction, reuse, recycling, landfilling, and incineration needs to be implemented to control the increasing waste disposal problems. Typically, a plastic is not recycled into the same type of plastic products made from recycled plastics are often not recyclable. The use of biodegradable plastics is increasing. If some of these get mixed in the other plastics for recycling, the reclaimed plastic is not recyclable because the variance in properties and melt temperatures.

The purpose of this project is to evaluate the possibility of using granulated plastic waste materials to partially substitute for the coarse aggregate in concrete composites.

Among different waste fractions, plastic waste deserves special attention on account nonbiodegradable property which is creating a lot of problems in the environment. In India approximately 50 million tons of solid waste is produced annually. This is increasing at a rate of 2 to 4% every year. Plastics constitute 15% of total waste produced most of which is from discarded water bottles. The plastic waste cannot be disposed of by dumping or burning, as they produce uncontrolled fire or contaminate the soil and vegetation.

Considerable research and studies were carried out in some countries like USA and UK on this topic. However, there have been very limited studies in India on plastics in concrete. Hence an attempt on the utilization of waste Low Density Polyethylene (LDPE) granules as partial replacement of coarse aggregate is done and its mechanical behavior is investigated.

II. LITERATURE REVIEW

[1] "Experimental Investigation on the properties of Concrete with Plastic PET (Bottle) Fibres as Fine Aggregates: Dr. K. Ramadevi, Dr. R. Manju (2012)

Waste plastic bottles are major cause of solid waste disposal. Polyethylene Terephthalate (PET, PETE or polyester) is commonly used for carbonated beverage and water bottles. This environmental issue as waste plastic bottles is difficult to biodegrade and involves processes either to recycle or reuse.

[2] "Recycled plastics used as coarse aggregate for constructional concrete" SJB Institute of Technology, Bangalore

Landfill sites are becoming overcrowded and expensive for waste disposal, efforts are made to minimize the quantities of materials that are delivered to landfills. The threat due to leaching of non-biodegradable materials like waste plastics, scrap tyres. E-waste may contaminate the soil and ground water.

[3] "Studies on Concrete containing E plastic waste" Lakshmi.R, K.L.N.College of Information Technology, Sivagangai Nagan.S, Thiagarajar College of Engineering, Madurai (2010)

Utilization of waste materials and by-products is a partial solution to environmental and ecological problems. Use of these materials not only helps in getting them utilized in cement, concrete and other construction materials, it helps in reducing the cost of cement and concrete manufacturing, but also has numerous indirect benefits such as reduction in landfill cost, saving in energy, and protecting the environment from possible pollution effects.

[4] "Utilization of e-waste and plastic bottle waste in concrete" Ankit Arora, UG student, Dr. Urmil V. Dave, Senior Professor, Institute of Technology, Nirma University,Ahmedabad (2013)

E-waste and plastic waste are the major problem in today scenario as these are non- biodegradable. Attempts were made in past to use them in concrete by grinding them. But it failed to give good strength because grinded particle has flattened shape. Grinded plastic and e waste mixed with concrete is a good way to dispose them with cheap concrete production.

III. MATERIALS USED

1. **Cement**
   Cement is one the major component in the manufacturing process of concrete. It has the property to stick to any other raw material added in the preparation process of concrete, especially when meets water and hence produces a good paste. Here, OPC 53 grade cement is used whose properties are shown below.
2. **Fine Aggregate**
   Fine aggregate is first graded to decide the zone to which it belongs to. Generally, there are four categories of fine aggregate Zone-I, Zone-II, Zone-III & Zone-IV. In this work, sand of zone-II is chosen whose properties were given below. Generally, fine aggregate is passed through 4.75 mm sieve.
3. **Coarse aggregate**
   Coarse aggregate is another fundamental raw material which gives strength, hardness and increases the volume of the concrete. Here, coarse aggregate of size 20 mm and angular crushed shape is chosen.
4. **Plastic**
   Plastic is a material consisting of any of a wide range of synthetic or semi-synthetic organics that are malleable and can be moulded into solid objects of diverse shapes. Plastics are typically organic polymers of high molecular mass, but they often contain other substances. They are usually synthetic, most derived from petrochemicals, but many are partially natural. Plasticity is the general property of all materials that can irreversibly deform without breaking, but this occurs to such a degree with this class of mouldable polymers that their name is an emphasis on this ability.

LDPE GRANULES

5. **Water**
   Normal tap water is utilized in the present work in the preparation of concrete specimens.

IV. RESULTS & DISCUSSION

<u>TEST ON CONCRETE:</u>

<u>Slump Test:</u>

Workability is a term associated with freshly prepared concrete. This can be defined as the ease with which concrete can mixed, placed, compacted, and finished. Slump test is the most used method of measuring 'workability' of concrete in a laboratory or at site of work. It is used conveniently as a control test and gives an indication of uniformity of concrete from batch to batch. Vertical settlement of a standard cone of freshly prepared concrete is called 'slump'

Slump Test

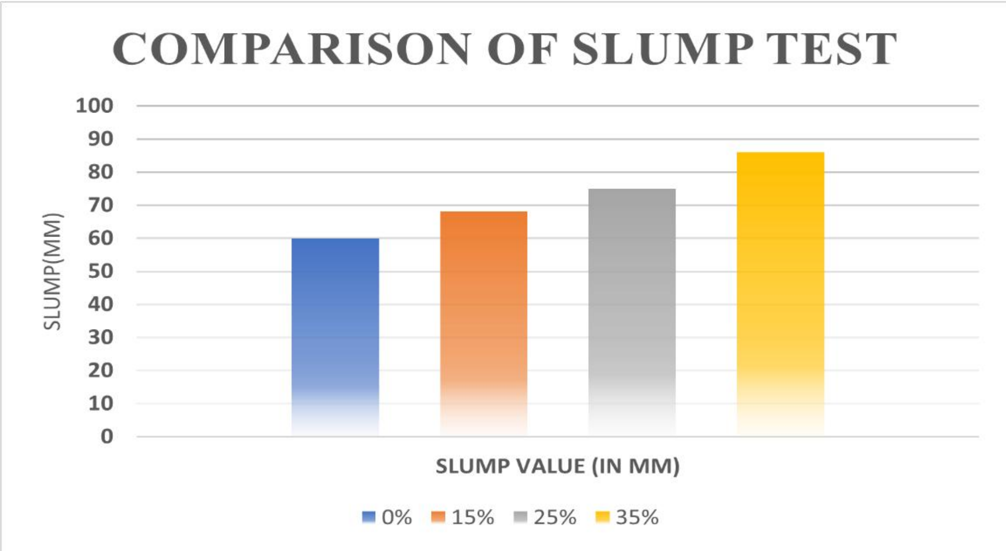

Fig 1: Slump values of concrete mixes replaced with various percentages of plastic granules

Compressive Strength Test:

Compressive Strength Test

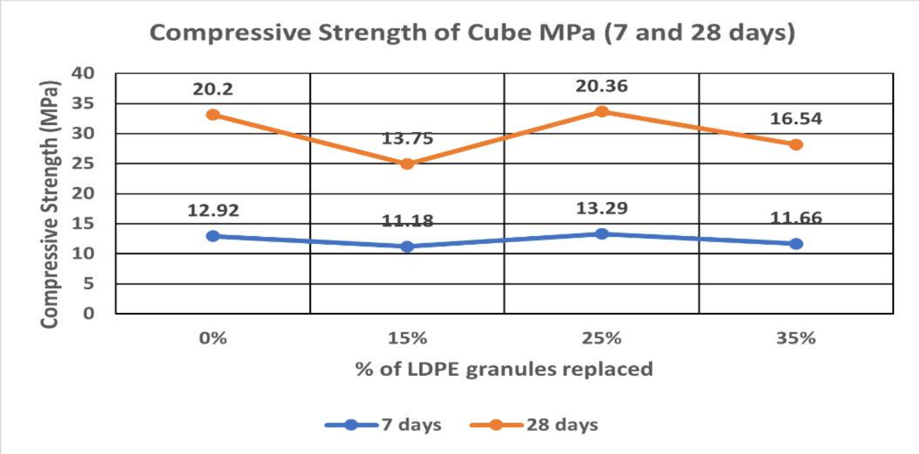

Fig 2: Compressive strength results comparison for 0% vs 15% vs 25% vs 35% plastic granules

Split Tensile Strength test:

Split Tension Test

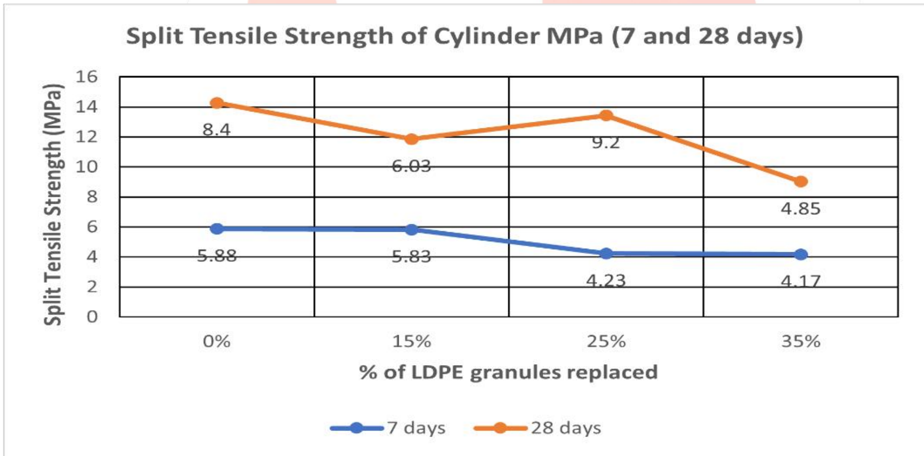

Fig 3: Split Tensile strength results comparison for 0% vs 15% vs 25% vs 35% plastic granules

Flexural Strength Test:

Flexural Strength Test

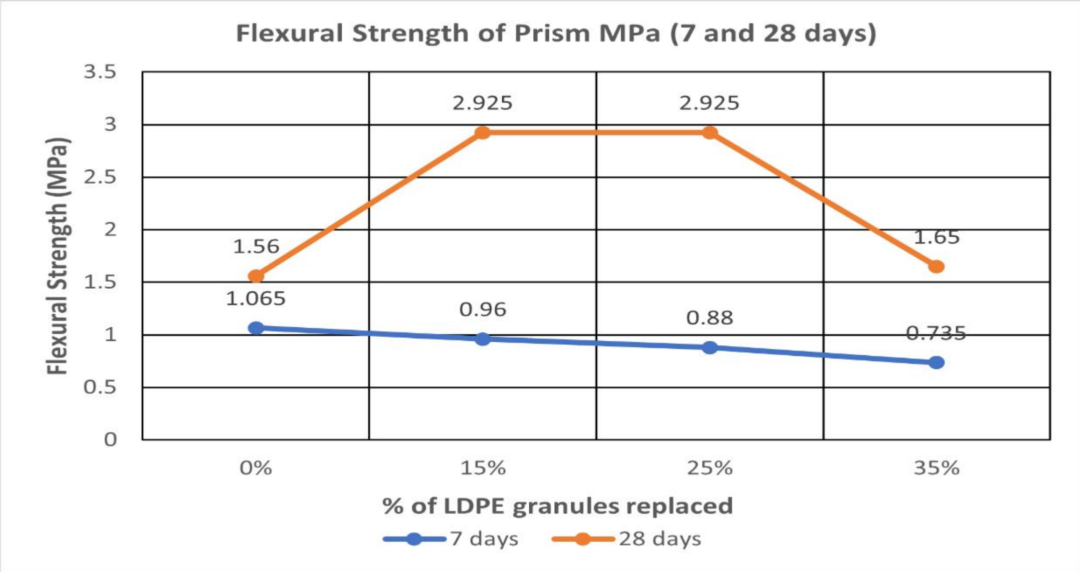

Fig 4: Flexural strength results comparison for 0% vs 15% vs 25% vs 35% plastic granules

Young's Modulus Test:

Young's Modulus Test

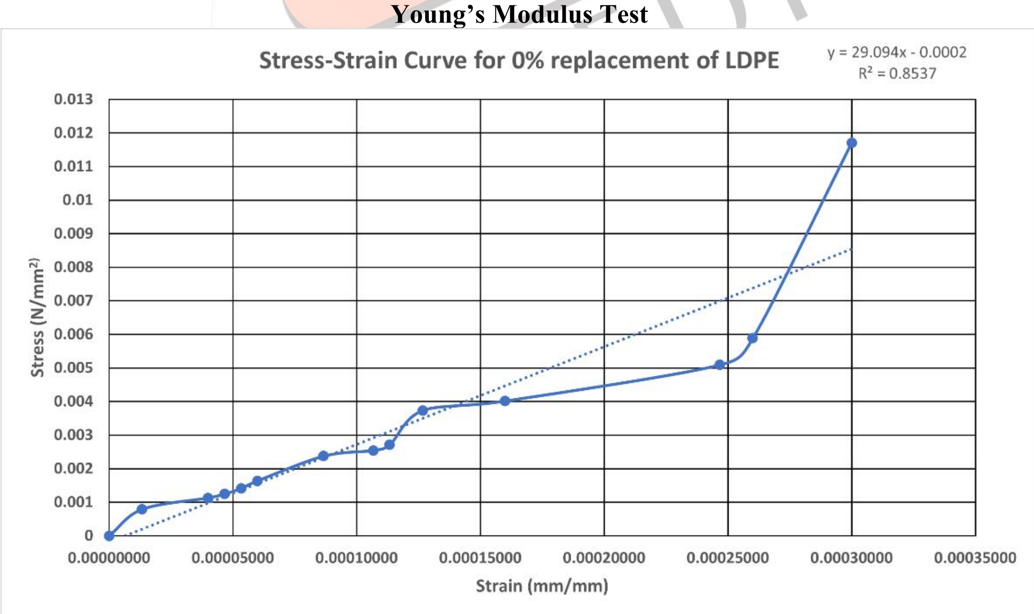

Fig 5: Young's Modulus Test results for 0% plastic granules

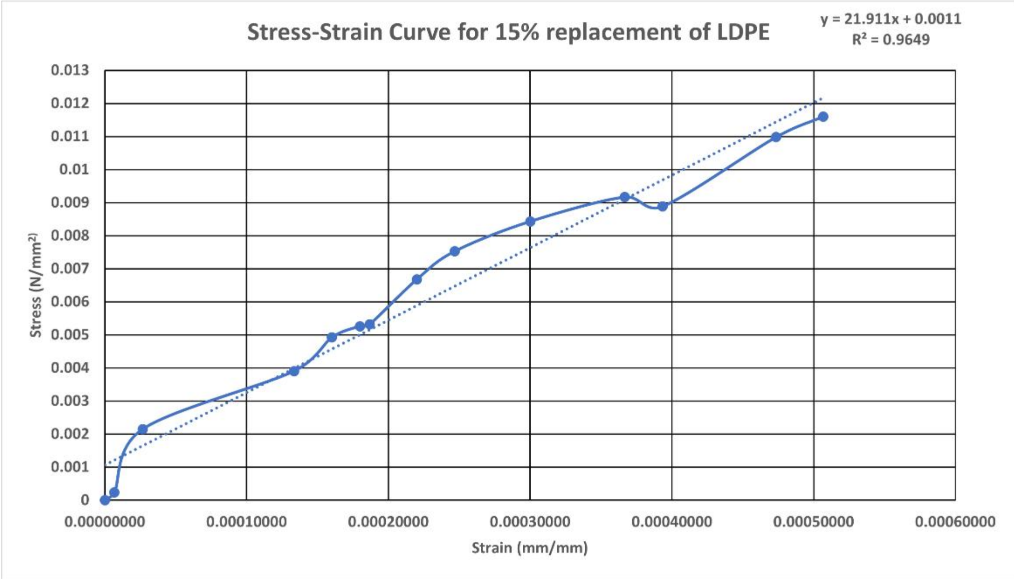

Fig 6: Young's Modulus Test results for 15% plastic granules

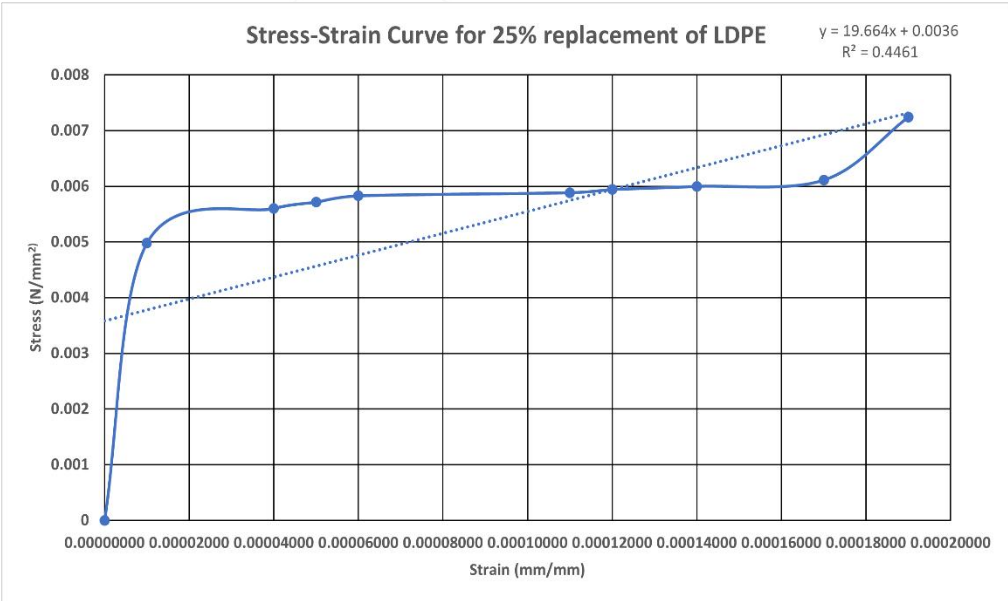

Fig 7: Young's Modulus Test results for 25% plastic granules

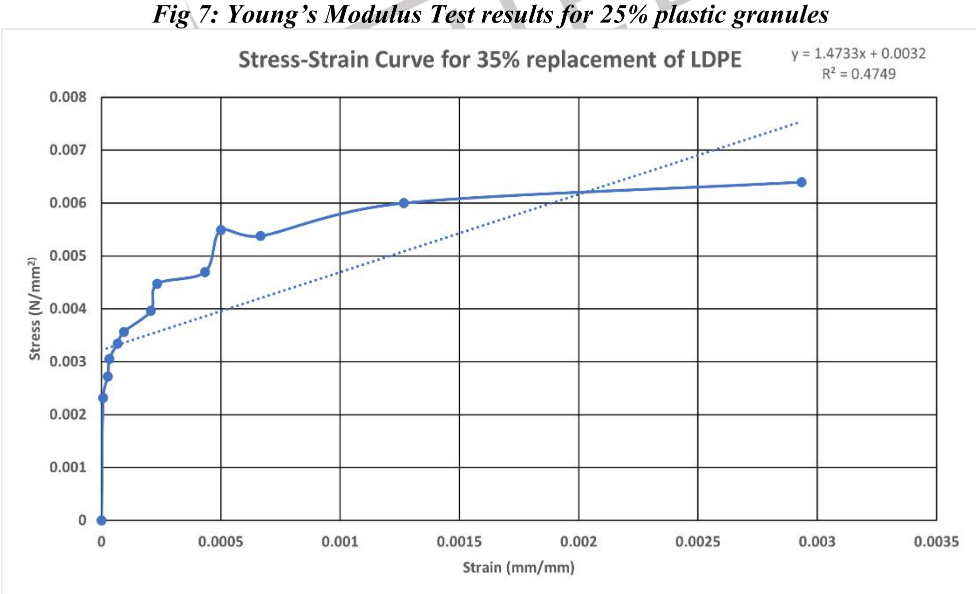

Fig 8: Young's Modulus Test results for 35% plastic granules

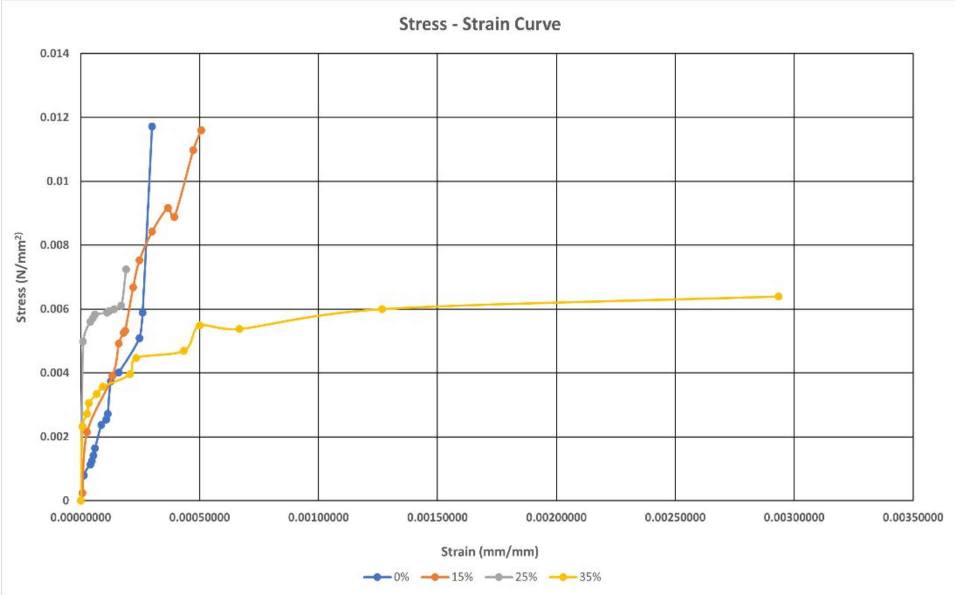

Fig 9: Young's Modulus Test results for 0% vs 15% vs 25% vs 35% plastic granules

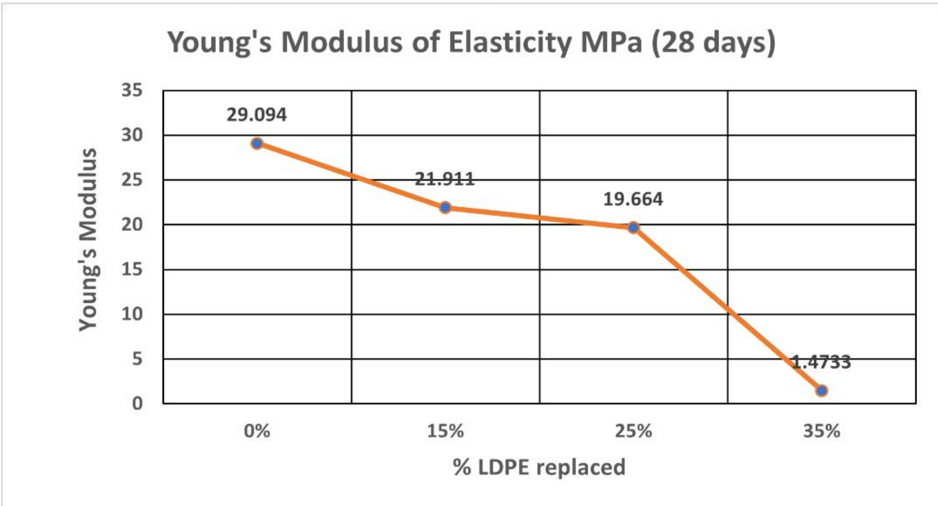

Fig 9: Young's Modulus Test results comparison for 0% vs 15% vs 25% vs 35% plastic granules

Flexural Strength Test on Reinforced Cement Concrete Beam:

Flexural Strength Test on Beam

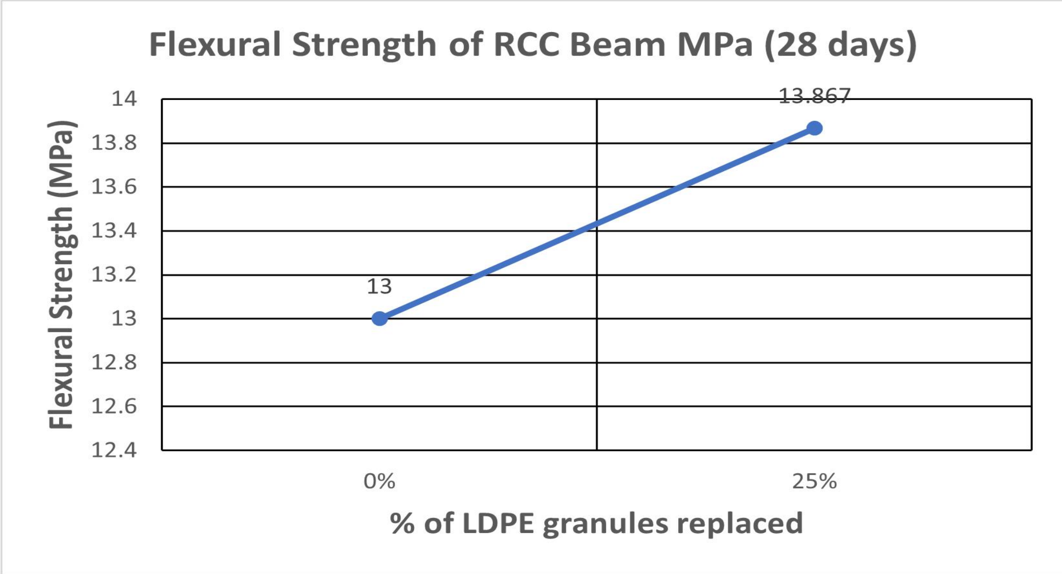

Fig 10: Flexural strength results comparison for 0% vs 25% plastic granules

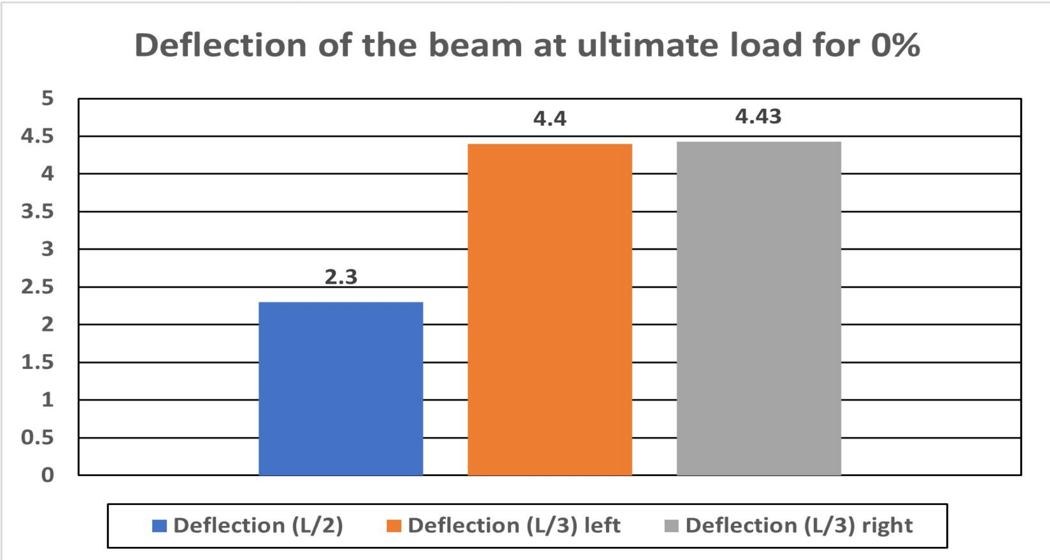

Fig 11: Deflection of beam for 0% replacement of plastic granules

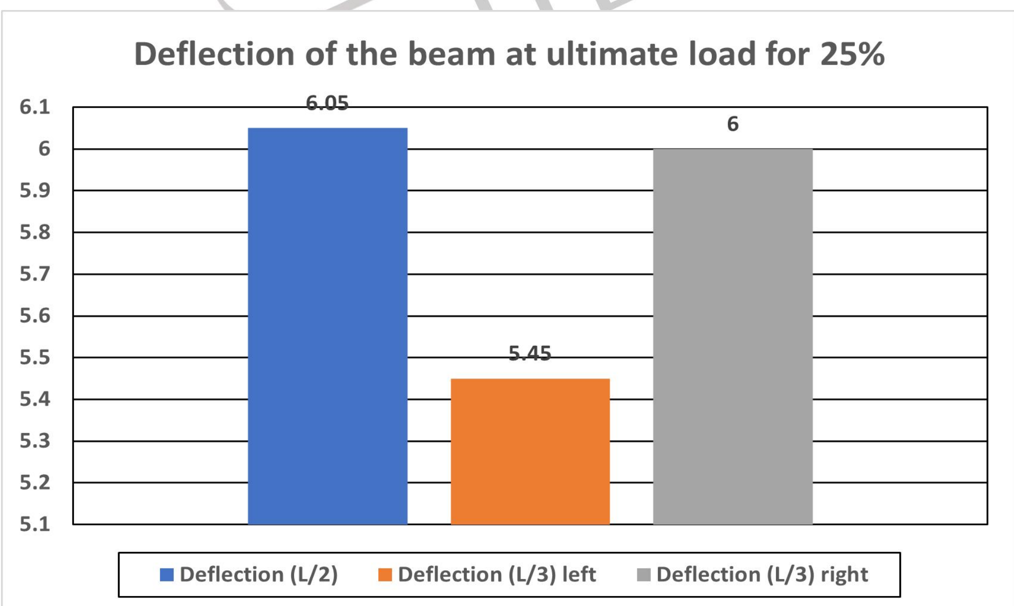

Fig 12: Deflection of beam for 25% replacement of plastic granules

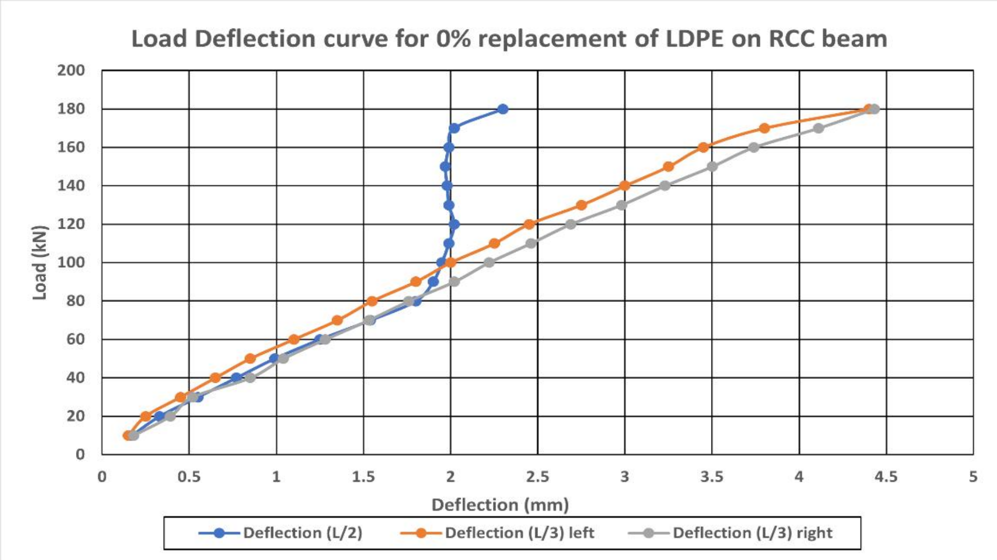

Fig 13: Load – Deflection curve of beam for 0% replacement of plastic granules

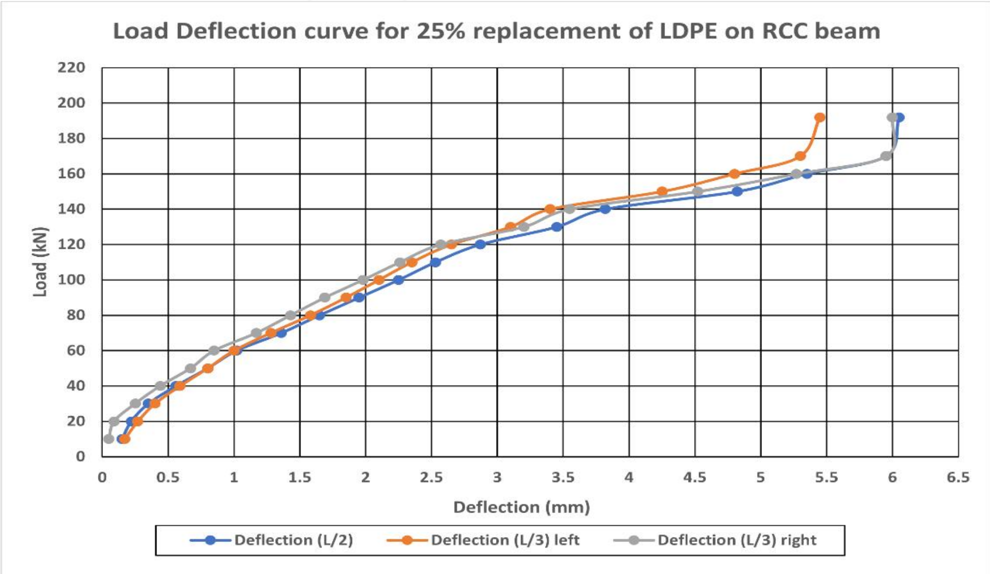

Fig 14: Load – Deflection curve of beam for 25% replacement of plastic granules

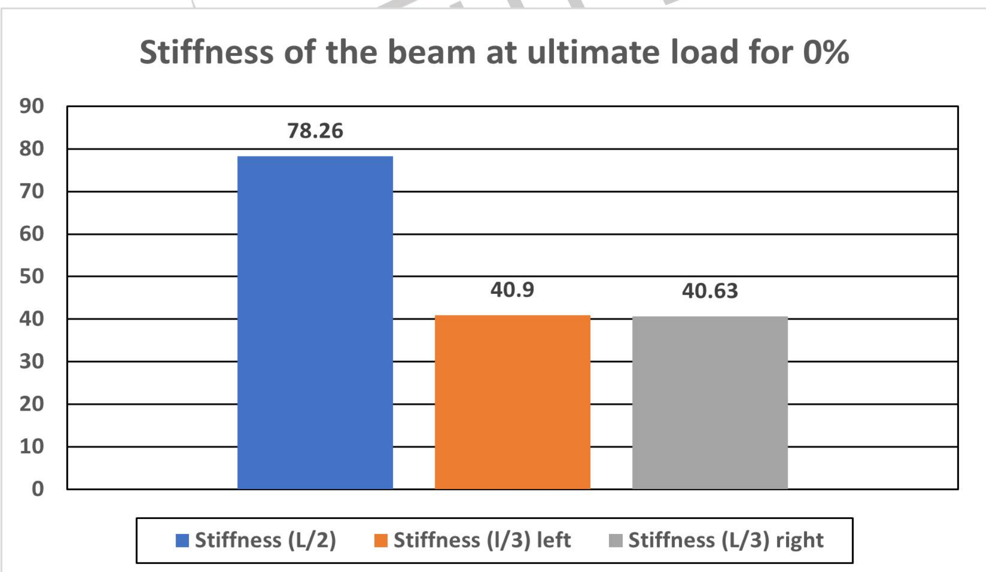

Fig 15: Stiffness bar chart of beam for 0% replacement of plastic granules

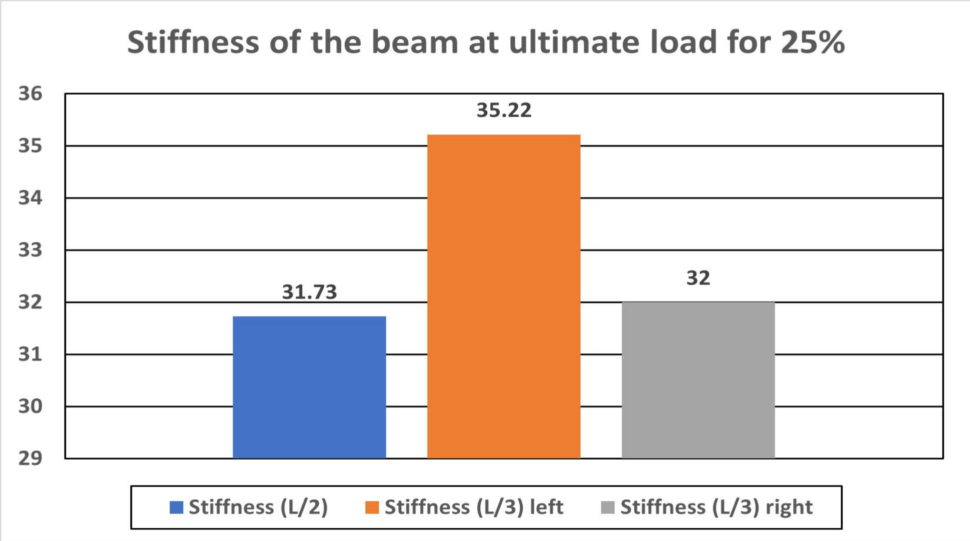

Fig 16: Stiffness bar chart of beam for 25% replacement of plastic granules

CONCLUSION

The experimental results have shown the use of waste plastic material in making concrete/mortar can provide an alternative solution to minimize the environmental impact due to unscientific disposal of waste plastic. The following conclusions were drawn:

- The properties of concrete containing various percentage of plastic waste (0%, 15%, 25%, and 35%) were tested for its physical properties and mechanical properties like **compressive strength, split tensile strength, flexural strength, and young's modulus test.**
- The waste plastic used for experiments is of LDPE (Low Density Poly Ethylene), 5-7mm size and **specific gravity of waste plastic is found to be 0.92.**
- The compressive strength of plastic replaced concrete specimen is compared with plain concrete and it is found that the compressive strength is achieved for a mix of waste plastic up to 25% (as a replacement for coarse aggregate) in concrete. The results are found for **0.78% higher than control mix.**
  Hence it is recommended for light weight concrete structures.
- The crack surface of the test concrete did not display any notable differences depending on the colour of the plastic waste.
- This research also has potential application to produce lightweight concrete, for minimizing the amount of polymer wastes in landfills, and the creation of decorative, attractive landscaping products.
- The flexural strength for RCC beam with 25% plastic waste is compared with plain concrete and it is found that the flexural strength is achieved.
- The maximum deflection at midspan for controlled beam is found to be 2.3 mm and for the plastic waste replaced beam is found to be 6.05 mm. **Which is 89.82% higher than the control mix.**
- The maximum stiffness at midspan for controlled beam is found to be 78.26 kN/mm and for the plastic waste replaced beam is found to be 31.73 kN/mm. **Which is 59.65% lower than the control mix.**
- The ultimate load at midspan for controlled beam is found to be 180 kN and for the plastic waste replaced beam is found to be 192 kN. **Which is 6.45% higher than the control mix.**
- The maximum energy absorption at midspan for controlled beam is found to be 14343.53 kN-mm and for the plastic waste replaced beam is found to be 4445.31 kN-mm. **Which is 69.01% lower than the control mix.**
- Hence the RCC beam with 25% plastic waste replaced for coarse aggregate is found to be similar that of control mix.

Disadvantages:

- Strength achieved for the plastic replaced concrete for 15% and 35% is slightly less than the conventional concrete but can be improved using admixtures.
- Cost of plastic is high in the place where we need to buy from the dealers and hence the cost of construction also increases.
- There is no proper bonding of plastic materials in the matrix unless admixtures are used

Scope of future work

The present research can be extended to

- The test can be carried out for different grades of concrete.
- The use of admixtures in the test can be performed to get improved strength.
- Experimental study has to be conducted for other varieties of plastics like HDPE, PP, PET etc.

- The durability of such a concrete has to be tested for beams and columns with varying proportions of waste plastic at different ages.

REFERENCES

[1] Praveen Mathew, Shibi Varghese, Thomas Paul - Recycled Plastics as Coarse Aggregate for Structural Concrete, IJIRSET, March 2013

[2] Lakshmi, Nagan.S, Studies on Concrete containing E plastic waste,

[3] INTERNATIONAL JOURNAL OF ENVIRONMENTAL SCIENCES, 2010

[4] IS 10262 (2009): Guidelines for concrete mix design.

[5] IS 456 (2000): Plain and Reinforced concrete code of practice

[6] IS 383 (1970): Specifications for coarse and fine aggregates from natural sources for concrete

[7] MS Shetty, Concrete Technology, Theory and Practice, Revised Edition, 2010

[8] V. Kasselouri - Rigopoulou, S. Gavela, S. Kolias "Use Of Polymeric Wastes in The Concrete Production" Polymers in concrete: a vision for the 21st century, Cement & Concrete Composites

[9] Comprehensive literature review on use of waste product in concrete B.V.Bahoria, Research Scholar, Civil Engg. Dept., YCCE, Nagpur, India Dr. D.K. Parbat, Professor, Civil Engg. Dept, GovernmenPolytechnic, Sakoli, Bhandara, India Dr.P.B.Naganaik, Professor, Civil Engg. Dept, GHRCE, Nagpur, India Dr.U.P.Waghe, Professor, Civil Engg. Dept, Y.C.C.E , Nagpur, India

[10] Mechanical Study on Concrete with Waste Plastic J.N.S. Suryanarayana Raju, M. Senthil Pandian, Department of civil Engineering, VIT University, Chennai, India International Journal of Research in Civil Engineering, Architecture & Design Volume 1, Issue 1, July-September, 2013

[11] International Journal of Emerging Technology and Advanced Engineering Website: www.ijetae.com (ISSN 2250-2459, Volume 2, Issue 6, June 2012)

[12] Experimental Investigation on the Properties of Concrete With Plastic PET (Bottle) Fibers as Fine Aggregates

[13] Dr. K.Ramadevi, Dr. R. Manju, Department of Civil Engineering, Kumaraguru College of Technology, Coimbatore, Tamilnadu, India