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"Experimental Study on Use of Plastic Waste as a Partial Replacement of Coarse & Fine Aggregate in Concrete"

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Abstract: In this paper, a substantial growth in the consumption of plastic is observed all over the world in recent year, which has led to huge quantities of plastic related waste. Recycling of plastic waste to produce new materials which can be used for concrete appears as one of the best solution for disposing of waste due to its economic and ecological advantages. The properties of cement composites containing various type of plastic waste as aggregate filler. As 100% replacement of natural aggregate with plastic aggregate is not feasible partial replacement at various percentage. In this project uses M25, M30, M35, and M40 grade of concrete and mostly used in construction sites. Waste plastic will incrementally adding in by replacing for aggregates that will provide an advantage in reducing the dead weight of structure. This mix in the form of cubes and cylinders were subjected to compression and split tension to ascertain the strength parameter. The Plastic waste tests like workability, compressive strength, splitting tensile strength, flexural strength, water absorption, density and durability.
Keyword: Aggregates, Concrete, waste Plastic aggregates.

I. INTRODUCTION

Concrete is the most widely used man made construction material in the world, and its second only to water as the most utilized substance in the planet. Seeking aggregates for concrete and to dispose of the waste from various commodities is the present concern. Today sustainability has got top priority in construction industry. In the present study the waste plastics were used to prepare the coarse aggregates and fine aggregates as sand thereby providing a sustainable option to deal with the waste plastic. Since the 20th century, plastics have been used increasingly in a large range of products because of their favourable properties, including low density, high strength-to-weight ratio, high durability, ease of design and manufacture, and low cost. Currently, polymer products are widely used in almost every field, particularly in packaging, building and construction, automotive, electrical and electronics, agriculture, and other industries. The global plastic production in 2015-16 is reported to have increased to 288 million tons. Central Pollution Control Board has estimated the generation of 15,342 tonnes of plastic waste in the country, out of which, 9,205 tonnes were reported to be recycled and leaving 6,137 tonnes uncollected and littered, More than 15,000 tonnes of plastic waste are generated in India every day, of which 6,000 tonnes remain uncollected and littered[(1)]. Most types of plastics are not biodegradable and are chemically unreactive in the natural environment; hence, such polymer products persist for decades, even for centuries. Some common types of Polypropylene (PP) can release toxic compounds into the air, water, and soil slowly under certain circumstances. Hence, plastic wastes are considered to be a serious environmental problem universally.

The Polypropylene (PP) manufacturing is 9.4 billion. Recycling process of this material is 4.95 million and totally waste material is 9255 tonnes not to be used and totally waste plastic.

The waste plastic is used in various application. However, efforts have also been made to explore its use in concrete and asphalt concrete. The development for new construction materials using waste plastic is importance to both the construction and the plastic industries.

A. Why Replace of Waste plastic?

1) Polymer have a number of vital properties, which exploited alone or make a significant and expanding contribution to construction needs.
2) Durable and corrosion resistant.
3) Good insulation for cold, heat.
4) It is economical and has a longer life.
5) Maintenance free.

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6) Ease of processing.
7) Light weight.
8) Resistance to chemical, water and impact.
9) Comparatively lesser production cost.

II. PROPOSED METHODOLOGY

The waste Plastic Aggregate in concrete is acceptable there are for the making of concrete used coarse aggregate having size 10mm and fine aggregate (sand) used for making a concrete and plastic aggregate used in concrete. Test carried out on aggregate specific gravity, sieve analysis, water absorption, all these test conduct on waste plastic aggregate sample. Conventional aggregate and compressive strength, tensile strength, flexural strength of concrete at coarse aggregate 10% ,15%, 20% replacement of waste plastic aggregate and 10%,20% addition of waste plastic fine aggregates in concrete.

III. MATERIALS

A. *Cement*

Ordinary Portland cement of 53-grade was used as it satisfied the requirements of IS: 269- 1969 and results have been tabulated in table 1.

Table no:-1 Properties of Cement

Initial setting time	25min.
Final setting time	240min.
Fineness (90umsieve)	1.7%
Standard consistency	31.5%

B. *Water*

Portable tab water is used for preparation of specimens and curing of specimens.

C. *Fine Aggregate*

As per IS 383-1970, table 4 sand used for experimental program was locally produced and was conforming zone II. The specific gravity of fine aggregate was found to be 2.77.

D. *Coarse Aggregate*

Locally available coarse aggregate passing from 20mm sieve and conforming IS 383-1970 were used in present work. The specific gravity of coarse aggregate was found to be 2.86.

E. *Plastic Aggregates*

Plastic aggregates are made from locally available plastic collect.

Table no:2 Types of Aggregates

Test	Types of aggregates			
	Coarse aggregates	Fine aggregates(sand)	Plastic coarse aggregates	Plastic fine aggregates(sand)
Specific Gravity	2.86	2.77	1.04	0.89
Water Absorption (%)	0.85%	1%	NIL	NIL
Density (kg/m^3)	1865	1080	840	640
Moisture content	NIL	1%	NIL	1%

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F. Mix Design

The mix was designed as per IS 10262:2009 for M25, M30, M35, M40 grade concrete. Concrete mixes are prepared by partial replacement of natural Aggregates by waste plastic coarse aggregates with different percentages (10%, 15%, 20%) respectively and adding fine as sand percentage of plastic fine aggregates (10% and 20%) for every mix. The materials of each mix are given in table:-

Table no:-3 Mix Design

Mix Design	Water (Lit/m^3)	Cement (kg/m^3)	Sand (kg/m^3)	Coarse (kg/m^3)	Admixtures (kg/m^3)
M25	157.6	358	790	1183	7.16
M30	157.6	394	778.4	1167.7	5.91
M35	157.6	405	775.2	1162.8	6.075
M40	157.6	415	771.9	1157.7	6.225

Table no: -4 Mix Types

Mix No.	Cement	Sand	C.A.	P.F.A.	P.C.A.
Mix 01	100%	100%	100%	-	-
Mix 02	100%	90%	85%	10%	15%
Mix 03	100%	90%	90%	10%	10%
Mix 04	100%	80%	90%	20%	10%
Mix 05	100%	80%	85%	20%	15%
Mix 06	100%	90%	80%	10%	20%
Mix 07	100%	80%	80%	20%	20%

IV. RESULTS AND DISCUSSION

A. Slump Test

Slump test is done before casting of each mix, Slump of concrete is increase respectively increase of PCA and PFA in concrete. Reason of slump increase was less water absorption of plastic aggregates and plastic fine aggregates. The slump test results are shown in figure.1.

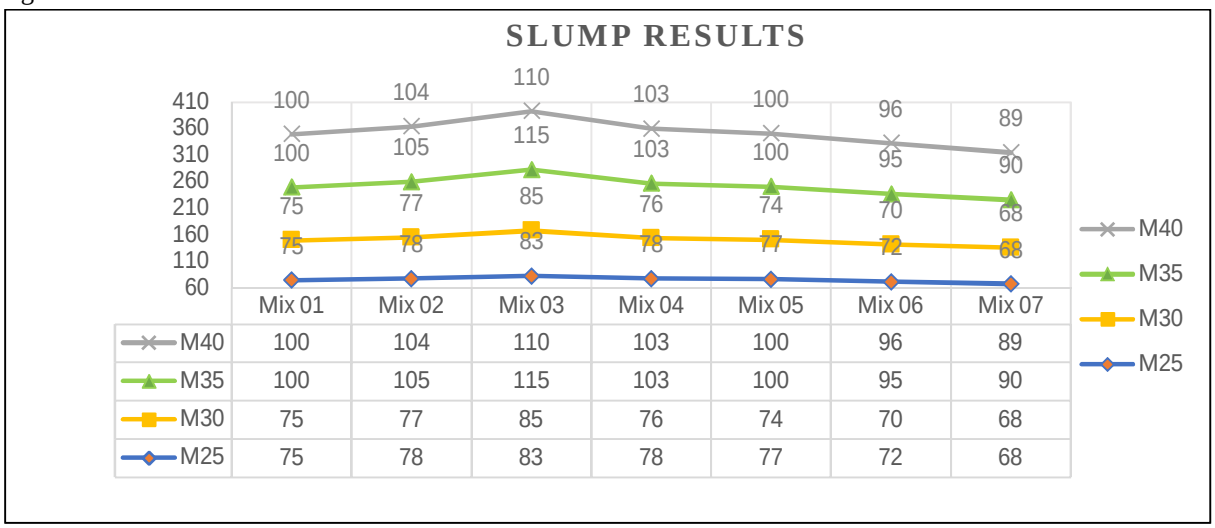

Figure 1 Slump test Results

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B. Compressive Strength

The compressive strength results of different mixes are given by fig 2.In the present investigation compressive strength of concrete produced by replacing natural aggregates by waste plastic aggregates.

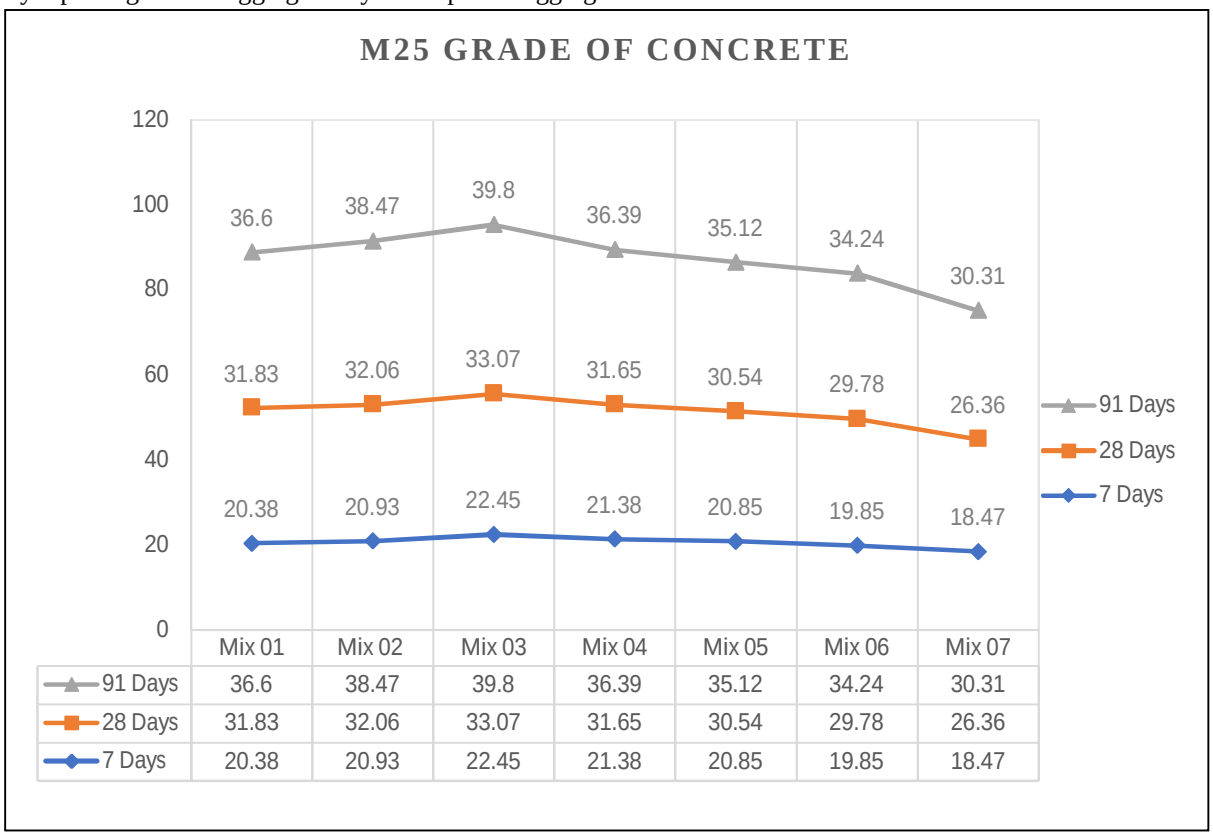

Figure 2 M25 Grade Compressive Strength Test Results

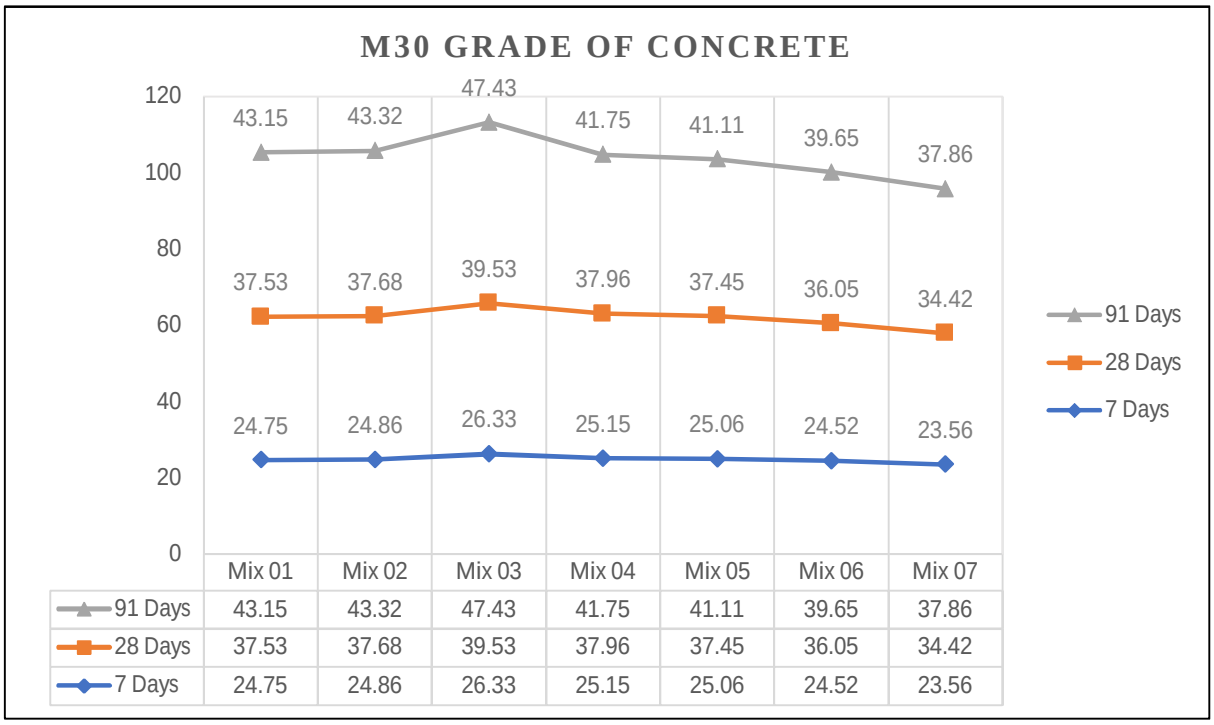

Figure 3 M30 Grade Compressive Strength Test Results

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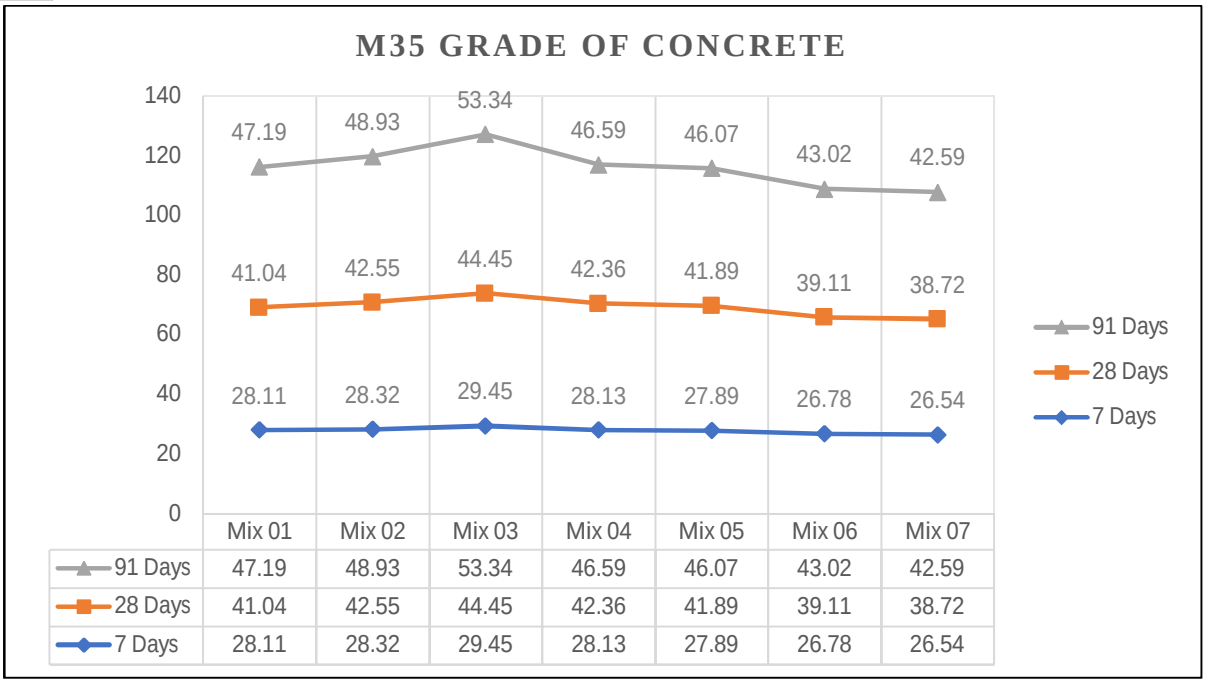
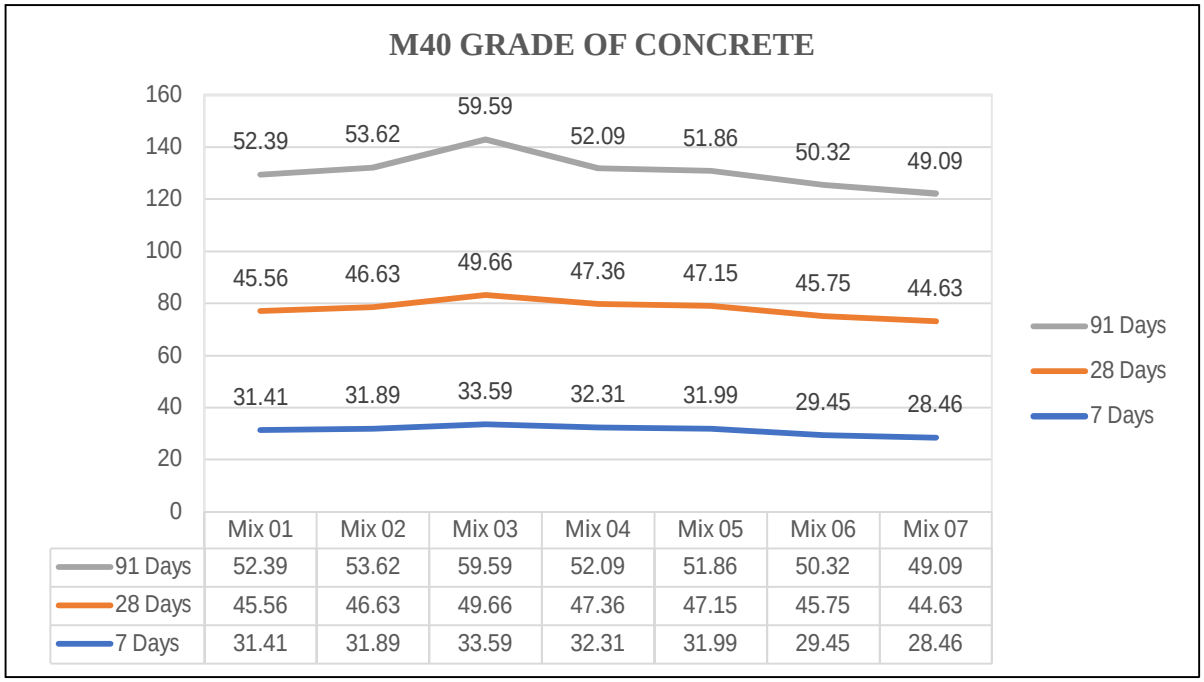


	Mix 01	Mix 02	Mix 03	Mix 04	Mix 05	Mix 06	Mix 07
91 Days	47.19	48.93	53.34	46.59	46.07	43.02	42.59
28 Days	41.04	42.55	44.45	42.36	41.89	39.11	38.72
7 Days	28.11	28.32	29.45	28.13	27.89	26.78	26.54

Figure 4 M35 Grade Compressive Strength Test Results



	Mix 01	Mix 02	Mix 03	Mix 04	Mix 05	Mix 06	Mix 07
91 Days	52.39	53.62	59.59	52.09	51.86	50.32	49.09
28 Days	45.56	46.63	49.66	47.36	47.15	45.75	44.63
7 Days	31.41	31.89	33.59	32.31	31.99	29.45	28.46

Figure 5 M40 Grade Compressive Strength Test Results

C. Split Tensile Strength

The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. Tensile strength is an important property of concrete because concrete structures are highly vulnerable to tensile cracking due to various kinds of effects and applied loading itself. However, tensile strength of concrete is very low in compared to its compressive strength. The Size of cylinders 300mm length and 150mm diameter are placed in the machine such that load is applied on the opposite of the cylinder are casted.

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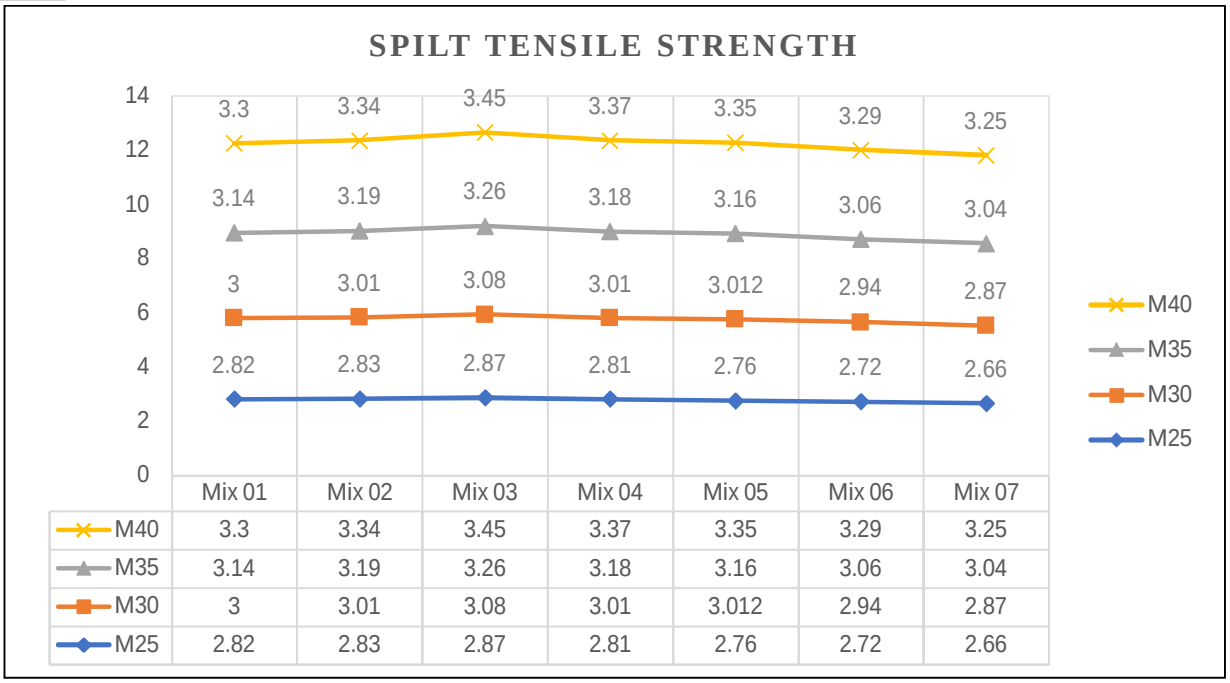
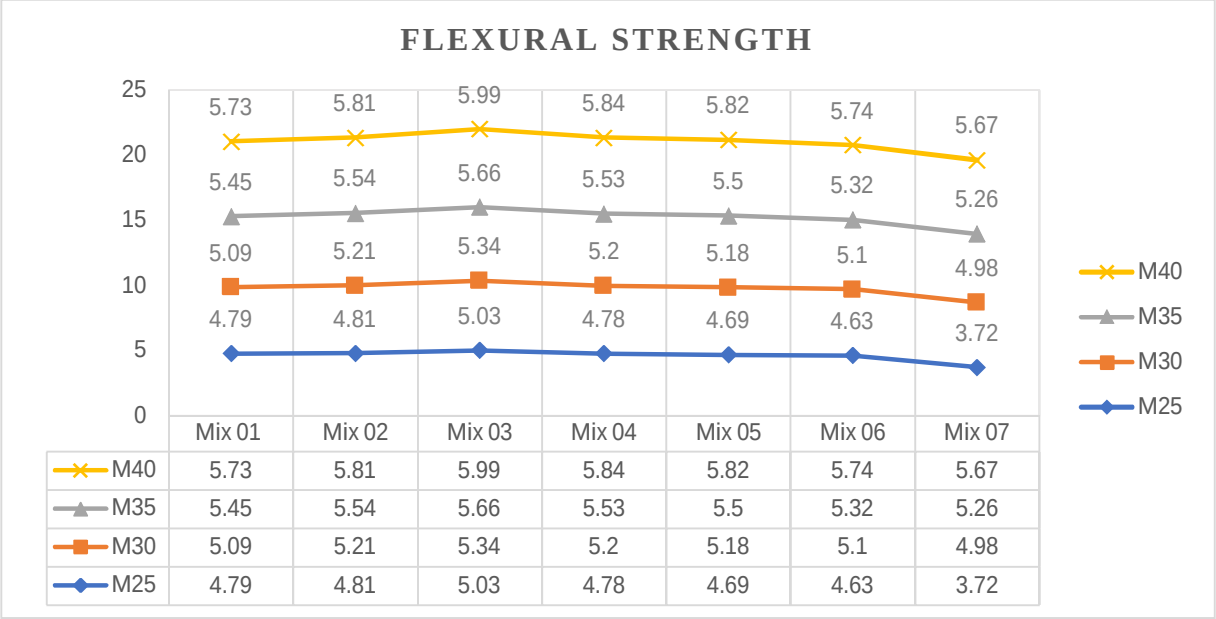


	Mix 01	Mix 02	Mix 03	Mix 04	Mix 05	Mix 06	Mix 07
M40	3.3	3.34	3.45	3.37	3.35	3.29	3.25
M35	3.14	3.19	3.26	3.18	3.16	3.06	3.04
M30	3	3.01	3.08	3.01	3.012	2.94	2.87
M25	2.82	2.83	2.87	2.81	2.76	2.72	2.66

Figure 6 Split Tensile Strength Test Results

D. Flexural Strength Test

Flexural strength, also known as modulus of rupture, or bend strength, or transverse rupture strength is a material property, defined as the stress in a material just before it yields in a flexure test. It is measured in terms of stress, here given the symbol.



	Mix 01	Mix 02	Mix 03	Mix 04	Mix 05	Mix 06	Mix 07
M40	5.73	5.81	5.99	5.84	5.82	5.74	5.67
M35	5.45	5.54	5.66	5.53	5.5	5.32	5.26
M30	5.09	5.21	5.34	5.2	5.18	5.1	4.98
M25	4.79	4.81	5.03	4.78	4.69	4.63	3.72

Figure 7 Flexural Strength Test Results

V. CONCLUSION

A. It is identified that waste plastic can be disposed by using them as construction materials in concrete.

B. The workability property of concrete was affected in waste plastic aggregates to the movement of aggregates. The dry density was also reduced and made concrete light weight.

C. Increase the Compressive Strength 10% of waste plastic aggregates Compare to normal concrete.

D. Increase the Split Tensile Strength 10% Compare to normal concrete due to waste plastic aggregates.

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E. Increase the Flexural Strength 10% Compare to normal concrete due to waste plastic aggregates.

F. However Strength noticeably decreased when the plastic content was more than 20% as plastic waste aggregates in concrete.

G. From this experimental investigation, the composites would appear to be low cost materials which would help to resolve some solid waste problems and preventing environment pollution.

H. Optimum replacement of waste plastic aggregates and optimum strength getting in mix 3 or 10% replacement of waste plastic aggregates.

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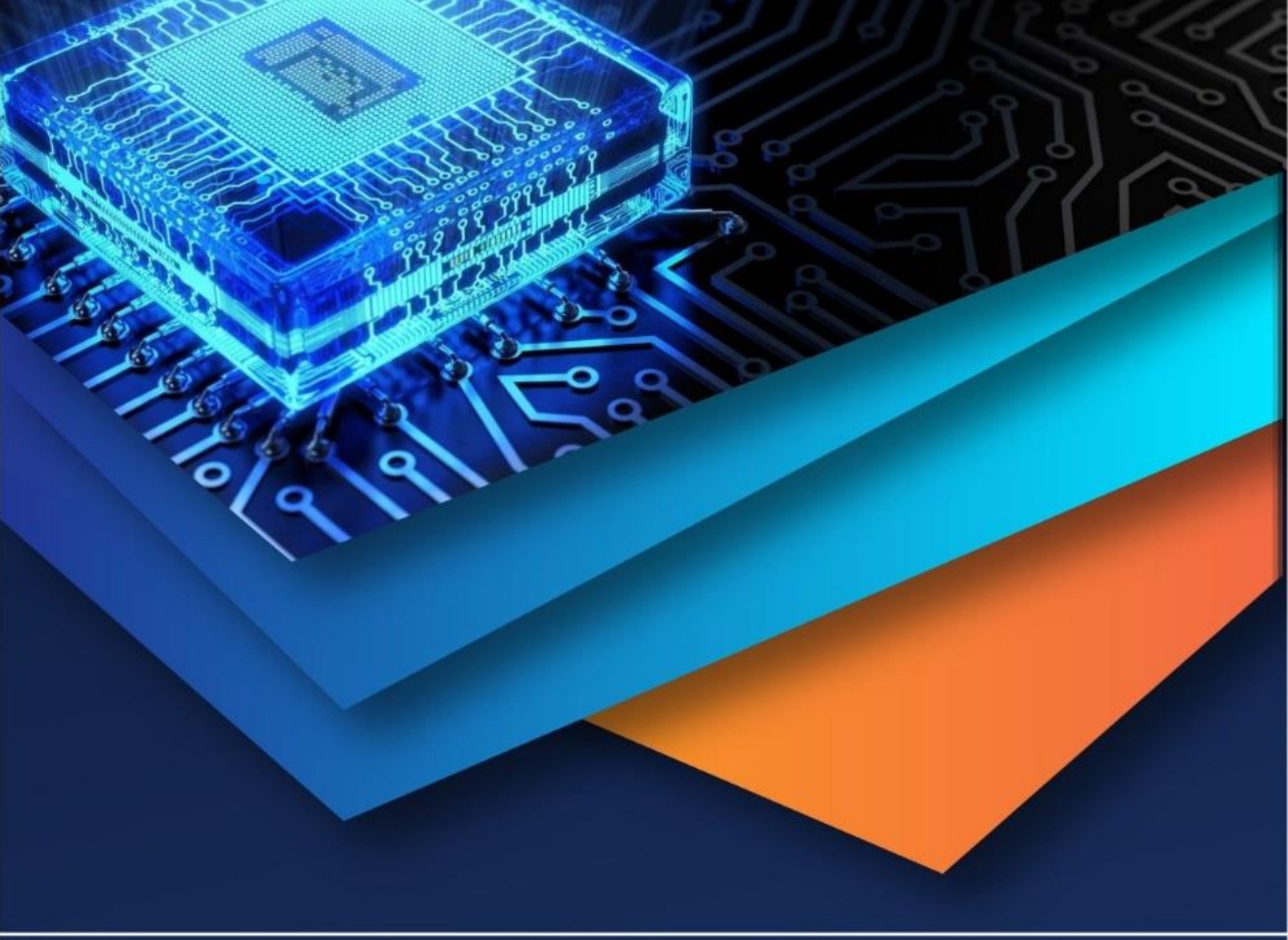

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