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Experimental Investigation on The Partial Replacement of Sand with Plastic in Concrete

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ABSTRACT

An Experimental study have been devoted to investigating the" PARTIAL REPLACEMENT OF SAND WITH PLASTIC IN CONCRETE". One of the main environmental problems today is the disposal of the waste plastics. On the other side, the Indian Construction Industry is facing problems due to insufficient and unavailability of sand. To find a solution for this problem, one of them can be used to solve the other problem. So, an attempt has been made to use Shredded Waste Plastic. The use of plastics in various places as packing materials such as bottles, polythene sheets, containers, packing strips etc., are increasing day by day. To circumvent this pollution crisis, from many products being produced from reusable waste plastics. So, we need to search for new construction materials as waste plastics in concrete and studies have been conducted to focus particularly on the behavior of compression members with various proportions of plastic wastes. The shredded waste plastic wastes were mixed with cement concrete in various proportions and test specimens were cast (Cubes, Cylinders and Beams) to study the behavior of plastic mixed concrete in axial compression, Split Tensile Strength and Flexural Strength. Five replacement levels 5%,10%,15%,20%, and 25% by volume of aggregates were used for the preparation of the concrete.

Keywords : Workability, Elasticity, Shredded Plastic, Specimen, Cubes, Cylinder, Beam, Compressive Strength, Split Tensile, Flexural Strength, Water cement ratio etc.,

I. INTRODUCTION

Concrete is the world's most versatile, durable and reliable construction material. It is one of the most widely used construction material, which is associated with Portland Cement. It is one of the leading components for making concrete. 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 recycled plastics were used to prepare the fine aggregates thereby providing a sustainable option to deal with the plastic waste. There are many recycling plants across the world, but as plastics are recycled, they lose their strength with the number of recycling. So, these plastics will end up as earth fill. In this circumstance instead of recycling it repeatedly, if it is utilized to prepare aggregates for concrete, it will be a boon to the construction industry

Disposal of waste has become a major problem to the agencies in the town and cities. The waste plastic available in the domestic waste mainly consists of Low-Density Polyethylene (LDPE). Plastic bags dumped in the dustbins find their way into the drainage system and clog them. Often, these are burnt along the roadside, which produces fumes causing air pollution. Industrial wastes from Polypropylene (PP) and Polyethylene Terephthalate (PET) were studied as alternative replacements of a part of the conventional aggregates of concrete. Five replacement levels. 5%,10%,15%,20%, and 25% by volume of aggregates were used for the preparation of the concretes.

The productive use of waste material represents a means of alleviating some of the problems of solid waste management (Davis and Cornwell, 1998). The reuse of wastes is important from different points of view. It helps to save and sustain natural resources that are not replenished, it decreases the pollution of the environment and it also helps to save and recycle energy production processes. Wastes and industrial by-products should be considered as potentially valuable resources merely awaiting appropriate treatment and application.

Plastic wastes are among these wastes; their disposal has harmful effects on the environment due to their long biodegradation period, and therefore one of the logical methods for reduction of their negative effects is the application of these materials in other industries Concrete plays an important role in the beneficial use of these materials in construction.

Although some of these materials can be beneficially incorporated in concrete, both as part of the cement binder phase or as aggregates, it is important to realize that not all waste materials are suitable for such use.

Concrete is a crucial building material utilized all over the world. Aggregates are the vital constituents of the concrete. The mining of aggregates in rivers has led to deterioration of river basins, also increase in pollution and changes in pH level. The process of extraction of sediments causes the river to cut its channel through the bottom of the valley floor in both upstream and downstream of the removal site. The sand mining in rivers had gone up to such an extent that in many countries, there is a legal prohibition on sand mining. Even In places where there is no debar, nowadays satisfactory sand is not promptly available which is required to transport sand over a long distance.

The search for an alternate source is of high priority. Artificially manufactured sands are used as a substitute to the natural sands but are uneconomical. If an appropriate industrial or agricultural by-product, which is a waste material, is used to replace sand partially it will diminish the problems and complications due to the inadequacy of sand. On the other hand, it will also be an environment friendly technique of disposal of huge quantities of materials that would otherwise contaminate land, air and water. If this waste can be used as a partial sand replacement material in concrete, it will be an extremely valuable resource. Lightweight concrete has been universally used in several structural applications and its utilization increments every year on a global basis. The explanation for this is that using lightweight concrete has countless benefits.

Plastic is a common material which finds its application in day-to-day life. Lack of proper disposal methods for plastic waste is one of the main hazards faced by the world today. It affects the ecological system very badly as plastic is not a biodegradable material. In present day research on concrete technology by using waste materials is growing at a faster rate. The new innovations are undertaken worldwide, many organizations had started a large number of research projects on replacement of sand by waste plastic material in concrete. So, on account of these facts, the replacement of sand by waste plastic material in concrete and similar construction materials has to be promoted in the upcoming days. Plastic is of manmade material and is a stable polymer which is light weight, resistant to any type of external attacks like fire etc. There are two types of plastics they are thermoset and thermo plastic polymers. Thermoset plastic this plastic becomes rigid once subjected to heat and cannot be melted on heating as the molecular chains are strongly bonded with meshed cross link. Epoxy resin, phenol, silicone and melamine are some of the examples for thermo setters. Now a day's this type of plastic is decomposed by conceal. The pollution caused by heating of plastic is increased and in order to reduce this issue waste plastic is used in concrete and in the construction of walls in buildings.

Thermo plastic is a material which is soft in nature on heating and hardens on cooling to lower temperatures. This process can be done several times and it is reusable material. Polyamide, polyethylene terephthalate and polyethylene are some of the examples of thermo plastic. Thermoplastics are mostly rubbery due to alternating rigid crystalline and elastic amorphous regions. Plastic waste is one of the dangerous waste pollutions on earth. For the reduction of this, so much research is going in the field of recycling process. Among them plastic replacement in concrete is one of the effective methods. Mostly plastic materials are amorphous solids, in those some of them are crystalline materials. Long chain mixtures of polymers are usually called as plastics. Plastics in their fresh forms have a distinct order.

II. METHODOLOGY

OPC-53 Grade, Natural River Sand, 20 mm Coarse Aggregate, Water, Metakaolin and Shredded waste plastic are the materials used. Materials are tested and the results for Specific Gravity, Fineness Modulus Specific Gravity of Cement, Standard Consistency, Impact test, Water Absorption are found and based on these properties and results mix calculations and proportions are arrived. Based on the mix proportions casting of Cubes, Cylinders and Beams are carried out.

The explanations of flow chart are presented in the following sections:

III. MATERIALS

CEMENT:

Concrete is made by ordinary Portland cement, water and aggregates. The ordinary Portland cement is hydraulic cement that hardens in water to form a water-resistant compound. A hydraulic binder, i.e. A finely ground inorganic material which, when mix with water, form a paste which sets and harden by means of hydraulic reaction sand processes and which, after hardening retains its strength and stability even under water. Cement is a mixture of limestone, clay, silica and gypsum. It is a fine powder which when mixed with water sets to a hard mass as a result of hydration of the constituent compounds. It is commonly used construction material.

FINE AGGREGATE:

The fineness modulus is an indicator of the fineness of an aggregate and is most used for evaluating fine aggregate. The higher the number, the coarse the

aggregate. The fineness modules are computed by adding the cumulative percentage retained on the set of sieves ranging 4.75 mm, 2.36 mm, 2 mm, 710μ, 425μ, 212μ, 150μ and pan. The fineness modulus of a fine aggregate is useful in estimating the properties of fine aggregate in concrete mixture. Natural river sand with fraction passing through 4.75 mm sieve was used and tested as per IS: 2386-1963 (part-1).

COARSE AGGREGATE:

Aggregate is a collective term for the mineral materials such as gravel and crushed stone that are used with a binding medium such as bitumen, cement, lime, etc. to form compound materials such as asphalt concrete and plain cement concrete. Aggregate is also used for base and sub base coarse for both flexible and rigid pavement. By volume aggregate generally account for 92 to 96 % of HMA and about 70 to 80 % of plain cement concrete. Aggregate can either be natural or manufactured. Natural aggregate is generally extracted from large rock formation through an open excavation. Extracted rock is typically reduced to usable sizes by mechanical crusher. Manufactured aggregate is often the by-product of other manufacturing industries.

SHREDDED WASTE PLASTIC:

Plastic is a material consisting of any of a wide range of synthetic or semi-synthetic organics that are malleable and can be molded 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 commonly derived from petrochemicals, but many are partially natural. Plasticity is the general property of all materials that are able to irreversibly deform without breaking, but this occurs to such a degree with this class of moldable polymers that their name is an emphasis on this ability. Although some of these materials can be beneficially incorporated in concrete, both as part of the cement binder phase or as aggregates.

METAKAOLIN:

The raw material in the manufacture of Metakaolin is kaolin clay. Kaolin is a fine, white, clay mineral that has been traditionally used in the manufacture of porcelain. Kaolin's are classifications of clay minerals, which like all clays, are phyllosilicates, i.e., a layer silicate mineral. In case of Metakaolin, the change that is taking place is dehydroxylization, brought on by the application of heat over a defined period of time. Dehydroxylation is a reaction of decomposition of kaolinite crystals to a partially disordered structure.

IV. EXPERIMENTAL INVESTIGATION

All the theoretical analysis, such as Introduction, Literature Review, Aim, Scope of present Investigation, Experimental Methodology, Study on Materials, Properties of Materials, Mix Design and Proportioning are carried out. From the theoretical procedures, it is justified again that the mix proportion is found to be all right, as in the theoretical explanations given in the various Literature Studies. However, the theoretical explanations are verified by Practical Lab Experiment.

MIX CALCULATIONS:

Materials	Cement (kg)	Fine aggregate (kg)	Coarse Aggregate (kg)	Water (Lit)
Weight	403.20	693	1302	201.60
Ratio	1	1.718	3.229	0.50

PROPORTIONING:

The Proportioning is the process of finding the replacement value of the plastic with the fine aggregate in terms of percentages. In this scenario we have decided to use 5 proportions i.e., 5%,10%,15%,20% and 25 %, but when we go for 100% the plastic does not bind with the cement. So, the last one has been neglected and the remaining percentages have been taken in to account. For each Proportion **2 Cubes, 1 Cylinder and a Beam** is casted according to the **IS 516:1959**

Specimen Casted	Days	Number of Specimen Casted					
		0 %	5%	10 %	15 %	20 %	25%
Cube	7	2	2	2	2	2	2
	14	2	2	2	2	2	2
	28	2	2	2	2	2	2
Cylinder	28	1	1	1	1	1	1
Beam	28	1	1	1	1	1	1

SLUMP CONE TEST

The slump is used to determine the workability of fresh concrete. Slump test is followed as per **IS 1199:1959**

Plastic %	Mix Proportions (kg/m³)					W/c Ratio	Slump (mm)
	Water	Cement	Coarse Aggregate	Fine Aggregate	Plastic		
0	201.6	403.20	1302	693.000	0.000	0.5	85
5	201.6	403.20	1302	658.370	34.629	0.5	81.50
10	201.6	403.20	1302	623.733	69.266	0.5	78
15	201.6	403.20	1302	589.333	103.666	0.5	76
20	201.6	403.20	1302	554.370	138.629	0.5	72
25	201.6	403.20	1302	519.703	173.296	0.5	69

COMPACTION FACTOR

Sl.No.	% OF PLASTIC	W/C RATIO	COMPACTION FACTOR
1	0	0.50	0.87
2	5	0.50	0.85
3	10	0.50	0.84
4	15	0.50	0.82
5	20	0.50	0.80
6	25	0.50	0.78

V. RESULTS AND DISCUSSION

COMPRESSIVE STRENGTH OF CUBE:

Compression test was carried out on cube specimens. The size of the specimen is 150mm x 150mm x 150mm. The individual variation of specimens was not more than ± 15 percent of the average. The specimens stored in water were tested immediately on the removal from the tank. The specimens were wiped off and the dimensions of the specimen and their weight were recorded before testing.

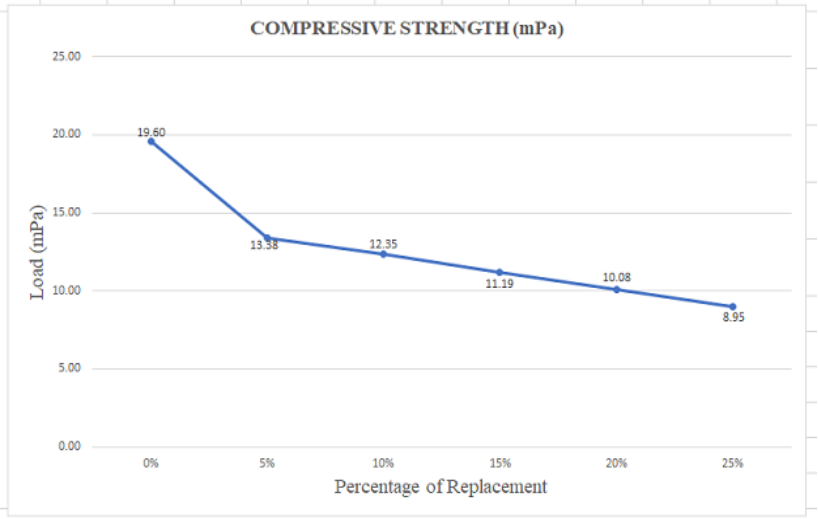

Fig.1 – Compressive Strength of Cube for 7 Days

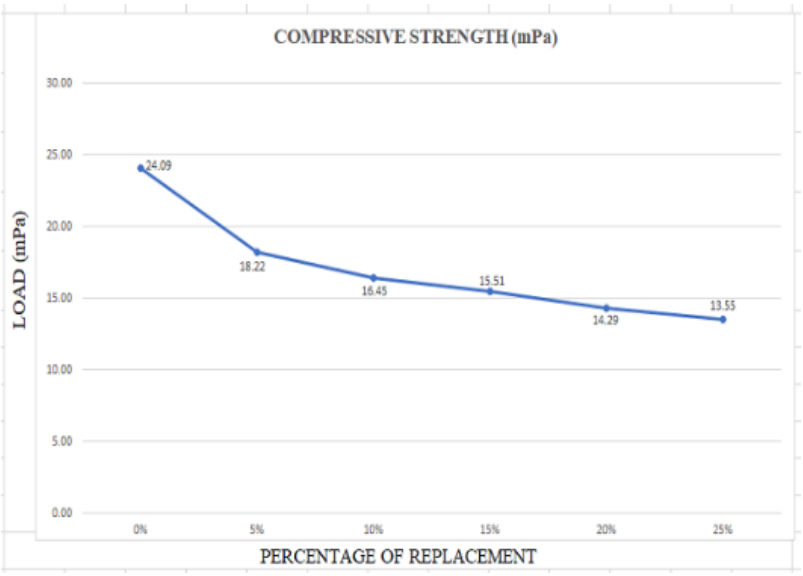

Fig.2 – Compressive Strength of Cube for 14 Days

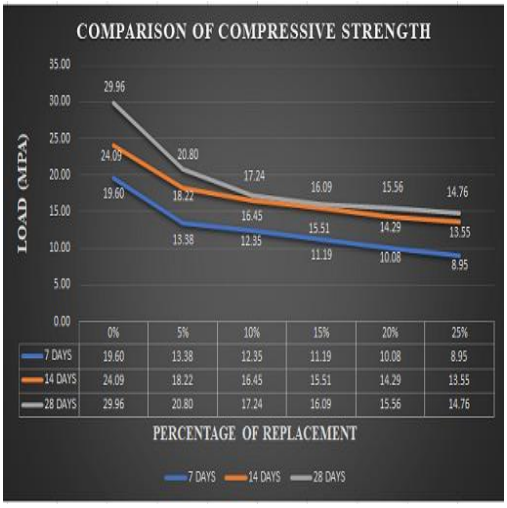

Fig.3 – Compressive Strength of Cube for 28 Days

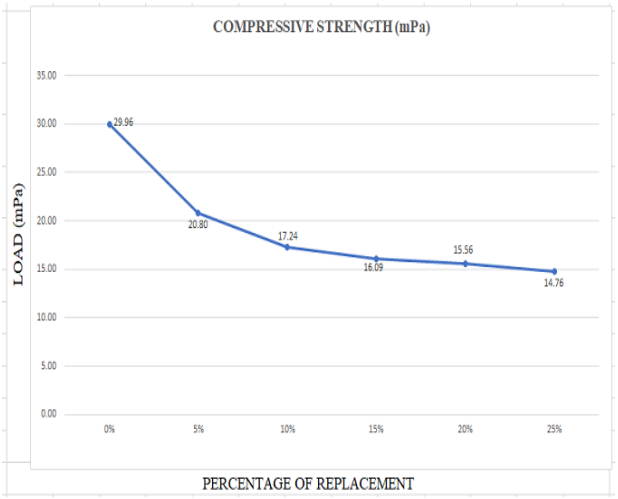

Fig.4 – Comparison of Compressive Strength

Fig.5 – Casting and Testing of Compressive Strength of Cube

SPLIT TENSILE TEST OF CYLINDER:

The indirect method of applying tension in the form of splitting was conducted to evaluate the effect of Crushed Rock Dust (CRD) and Marble Sludge Powder (MSP) on tensile properties of concrete. The split tensile strength is more reliable technique to evaluate tensile strength of concrete compared to other method. The split tensile strength of 150 mm diameter and 300 mm long concrete cylindrical specimens was determined to assess the effects of CRD and MSP on the tensile properties of the concrete.

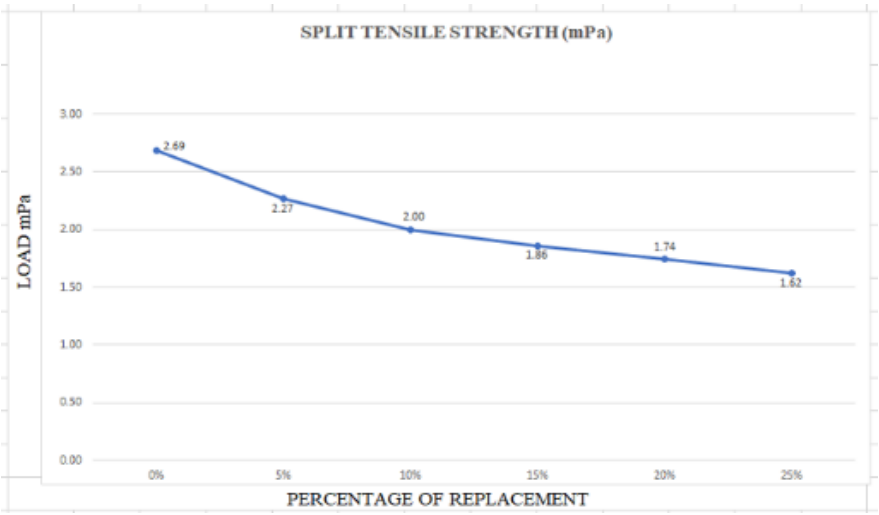

Fig.6 – Split Tensile Strength of Cylinder

Fig.7 – Casting and Testing of Split Tensile Strength of Cylinder

FLEXURAL STRENGTH OF BEAM:

Flexural strength is one measure of the tensile strength of Concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending. For the flexural strength test, beams of dimensions 750×150×150 mm were cast and tested on the Flexural Testing Machine.

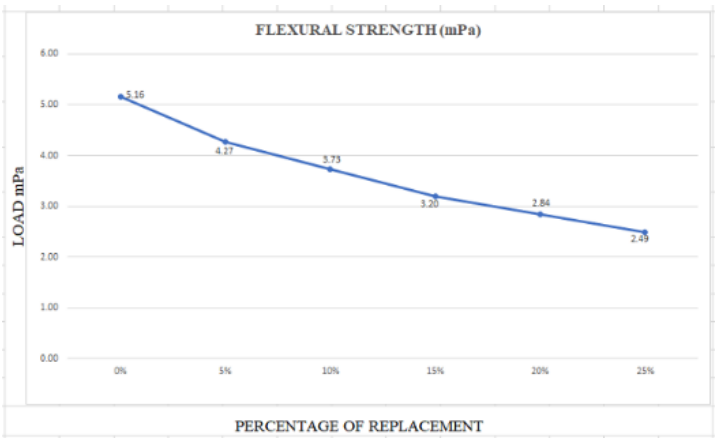

Fig.8 – Flexural Strength of Beam

Fig.9 – Casting and Testing of Flexural Strength of Be

Formulas:

* The Compressive Strength of the specimen was calculated by using the formula, F = P/A (N/mm2)
* The Split Tensile Strength of Cylinder = 2P / πDL (N/mm2)
* Flexural strength is calculated by F= PL / (bd2) (N/mm2)

VI. CONCLUSION

* The Strength of the concrete with plastic as fine aggregate is determined based on the properties of shredded
waste plastics and various percentage replacements at 5%, 10%, 15%, 20% and 25% with the
shredded waste plastic.
*From previous study on various Literature reviews, it is found that addition of plastic as partial fine

aggregate replacement reduces the concrete workability.

*To improve the workability and to get better compressive strength of the specimen an admixture has metakaolin at a level of 5% is decided and added to the mix. Even though if we use too much of shredded waste plastic it produces the loose concrete which is weak in bonding strength which causes the replacement criteria to be restricted under 20%.

*The density of concrete is decreased when plastic content increased.

* From this experimental case study, it is found that up to 10% of replacement of fine aggregate may be used for RCC Structural element. From 15% to 25% it may be used for non-structural works like pavement works, Plain Cement Concrete works (PCC), Screed for Flooring.

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VII. REFERENCES

[1]. Syed Baboo Rai, S. Tabin Rushad, Bhavesh Kr, and S.K.Duggal Of study of waste plastic mix concrete with plasticizer, National Institute of Technology Patna, Patna 800005, India, International Scholarly Research Network ISRN Civil Engineering ,Volume 2012,article,ID 469272,5 pages.

[2]. K. Annas, of Performane of concrete using Light Waste PET Fibre , University Tun Hussein Onn Malaysia, Advanced Materials Research Voi.. 795(2013) pp 352-355.

[3]. Khileshsarwe , of Study of strength property of concrete using waste plastics and steel fiber, Jabalpur Engineering college, Jabalpur , India. International Journal of Engineering and Science (IJES) Volume 3, Issue 5, PP 09-11,2014, ISSN:2319-1813.

[4]. M.Elzafraney, P.Soroushian and M.Deru of Development of Energy –Efficient Concrete Buildings Using Recycled Plastic aggregates, Journal of Architectural Engineering ASCE/DECEMBER 2005.

[5]. Madan mohanreddy.K , Ajitha .B. and bhavani .R , of Melt densified Post Consumer Recycled Plastic Bags Used As Light Weight Aggregate In Concrete, Srikalahasteeswara Institute of Technology , Srikalahasti , AP , India – 517640 ,

Volume 2 , Issue , July – August 2012, pp 1097-1101.

[6]. Md.Mostafizur Rahman , Md. Akhtarul Islam , mainuddin Ahmed and Md. AbdusSalam , of Recycled Polymer materials as aggregates for concrete and blocks , Shahajalal University of Science and technology (SUST) , Sylhet-3114, Bangladesh , Journal of chemical Engineering , IEB Volume ,Che.27, No.1, June , 2012.

[7]. Praveen Mathew, shibhi Varghese , Thomas Paul , EldhoVlightarghese of Recycled Plastic as Coarse aggregate for Structural Concrete , M.A. College of Engg., Kothamangalam , kerala , india , International journal of Innovative Research in science , Engineering and Technology , Volume 2 , Issue 3 March 2013.

[8]. FLYNN, L A. Feasibility study: Using Recycled Polymer Fiber as secondary Reinforcement in Concrete structures. ASC Proceeding of the 34th Annual Conference, Central Connecticut State University, New Butain, Connecticut, 15-18 April 1998. 249- 256.

[9]. REBEIZ, K S, CRAFT, A P. Plastic waste management in construction: technological and institutional issues. Resources, Conservation and Recycling. Vol. 15, 1995. pp 245-257.

[10]. Renji Xavier C and Nidhin B Parappattu, [STUDY ON THE EFFECT OF REPLACEMENT OF FINE AGGREGATE WITH PLASTIC GRANULES ALONG WITH STEEL AND POLYPROPYLENE FIBERS], International Journal of Innovative Research in Advanced Engineering (IJIRAE), September 2016.

[11]. Suryakanta Panigrahi and Nagarampalli Manoj Kumar, [Behaviour of Concrete by Partial Replacement of Coarse Aggregate with Recycled Plastic Granules], International Journal of Engineering Research & Technology (IJERT) 04, April-2021.

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