ISSN XXXX XXXX © 2017 IJESC

Research Article Volume 7 Issue No.6

Study of Use of Waste Polyurethane Foam as a Partial Replacement for Fine Aggregate in Concrete

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Abstract:
Due to industrialization construction industry has grown up tremendously with this there is increase in demand of construction materials. For sustainable development there is need of utilizing alternative materials in construction and utilization of waste material is very important aspect of sustainability Due to wide application of Polyurethane foam, a large number of polyurethane wastes are produced. Polyurethane foam has properties like sound insulation, high thermal conductivity, and lightweight. Due these properties we can use it into concrete as a partial replacement for fine aggregate which also gives one environmental friendly disposal method for polyurethane foam. This paper highlights the study of properties such as compressive strength and tensile strength of Polyurethane Foam based concrete which is compared with conventional concrete.

Keywords: Compressive Strength, Spilt Tensile Strength, Polyurethane Foam

I. INTRODUCTION

Over the last few years, India's infrastructure system has grown up tremendously in order to accommodate the growth of mass construction including huge amount of man, material, and machine requirement. Infrastructure requires huge amount of material (i.e. Cement, Sand and Coarse Aggregate.) which is contributing in making of concrete. Good sand is extracted from river bed for construction purpose which is serious issue as it causes flood or diversion of water flow. To avoid such problems government has banned sand extraction. So it is need of time to find some alternate material for sand. Polyurethane foam is also one of the larger polymer product groups within the plastic family. Polyurethane wastes from end of life vehicles, scrapped refrigerator, district heating tubes and many other sources are receiving increased attention over its rising amounts and its treatment and disposal. However, this material is having properties such as sound insulation, high thermal conductivity, and lightweight so we can use these materials in construction industry which will add new material for construction and add new method of its disposal which is environmental friendly. This study aims at the use of Polyurethane Foam in concrete and analyzing its properties such as compressive strength, tensile strength along with its comparative study of strength against conventional concrete. In this study 5-30% Fine aggregate is replaced by polyurethane foam.

II. LITERATURE REVIEW

A. ***Ancuta Elena Tiuc, HoratiuVermensan, Timea Gabor, OvidiuVasile,***"Improved Sound Absorption properties of polyurethane foam mixed with textile waste", Sustainable Solutions for Energy & Environment, EENVIRO- YRC 2015, 18-20 November 2015, Energy Procedia (2016) 559- 565
In this paper author deals with experimental study on acoustical properties improvement by use of Polyurethane foam and textile waste. Author states that this is beneficial material as well as green buildings. Author concludes that, 60% polyurethane foam and 40% textile waste is best proportion for better sound absorption

B. ***P. mounanga, W. Gbongbon, P. Poullain, P. Turcry,***"Propotioning and characterization of lightweight concrete mixtures made with polyurethane foam waste", Cement & Concrete Composites 30 (2008) 806-814
This paper presents the results of an experimental study concerning the incorporation of polyurethane foam waste into cementitious mixture to produce lightweight concrete. Author has used correlation to prepare lightweight concrete containing volume in fraction, between 13% to 34% of PUR foam aggregates. Thermal conductivity observed by author is 0.60 to 1.33W/ m K

C. ***Amor Ben Fraj, Mohamed Kismi, Pierre Mounanga***, "Valorization of coarse rigid polyurethane foam waste in light weight aggregate concrete", Construction & Building Material 24 (2010) 1069- 1077
Author concludes that PUR Foam waste is feasible to use in concrete for making lightweight concrete & concrete has been shown good workability also. This study examines the mechanical properties and durability of lightweight concrete incorporation PUR foam waste as coarse aggregates. Author states that compressive strength achieved by use of PUR Foam waste is between 8 to 16 Mpa.

III. METHODOLOGY

Different basic tests are taken on concrete ingredient that is cement (Ordinary Portland cement 43 grade), fine aggregate and coarse aggregate. Mix proportion of concrete is modified for using polyurethane foam with partial replacement of fine

aggregate with 0%, 5%, 10%, 15%, 20% and 25% of polyurethane foam. Different elements are casted with this percentage replacement and tested under standard conditions.

A. Test on Ingredients:

Table.1. Physical Properties of Materials

Test	Fine Aggregate	Coarse Aggregate
Specific Gravity	2.56	2.7
Water Absorption (%)	0.52	1.00
Moisture Content	1.5	Nill
Fineness Modulus	3.48	6.9

B. Properties of Polyurethane Foam:

Table.2. Physical Properties of Polyurethane Foam

Test	Polystyrene
Specific Gravity	45
Water Absorption (%)	12.8
Fineness Modulus	3.44

C. Casting of Specimen:

Specimens are casted as per design mix and tested after appropriate curing, and tests taken are compressive strength or cubes (150mm X 150mm X 150mm) and spilt tensile strength of cylinders (150mm X 300mm). From the studies, optimum results are found out and compared with conventional concrete.

IV. MIX PROPORTION

Concrete mix design procedure as per IS 10262:2009, a concrete mix proportions with characteristic compressive strength or 20Mpa was designed without any admixtures with water cement ratio 0.50. The mix adopted for study is given in table below:

Table.3. Mix Proportion Concrete

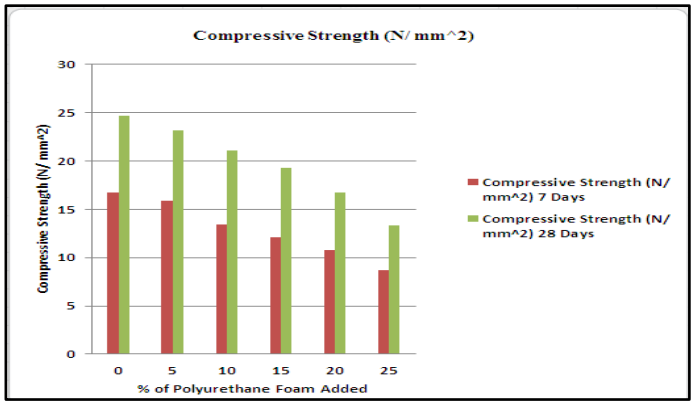
Material	Water	Cement	Fine Aggregate	Coarse Aggregate
Kg/ m^3	186	372	687.48	1143
Ratio	0.5	1	1.85	3.071

VI. TEST RESULTS AND DISCUSSION

On the concrete specimen the compressive strength and spilt tensile strength test were conducted, results obtained are discussed below:

A. Compressive Strength

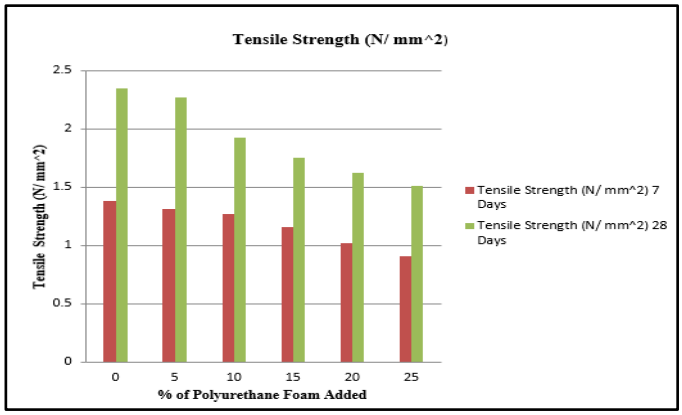
Specimens are casted in concrete cube of size (150mm X 150mm X 150mm) and cured the tested under compressive strength under compression testing machine (CTM). Graph No.1 shows compressive strength of concrete using polyurethane foam at 7th and 28th day for 0.50 W/C



Graph .1. Compressive Strength of Polyurethane foam based Concrete

B. Spilt Tensile Strength

Specimens are casted in concrete cylinder of size (150mm X 300mm) and cured the tested. Graph No.2 shows Spilt Tensile strength of concrete using polyurethane foam at 7th and 28th day for 0.50 W/C



Graph.2. Tensile Strength of Polyurethane Foam based Concrete

V. CONCLUSION

The partial replacement of fine aggregate with polyurethane foam reduces the compressive strength and tensile strength of concrete. This polyurethane foam based concrete is best suitable for non-structural a element which does not require high compressive and tensile strength also after this study, it has proven better way for disposal of polyurethane foam also use of polyurethane foam as partial replacement for sand saves the amount of sand required.

VI. REFERENCES

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