Improving the Strength Behaviors of Concrete by Adding Different Industrial waste

M. Ponni Maria

Abstract: ***Industrial wastes mostly dumped into the soil or water sources which will pollute the environment. As a mitigation measure now a days the industrial wastes are used as a construction materials. In this project, industrial waste material such as Glass bottle, Illuminate sludge were used in varying percentage as fine grained substitution and Metakaolin is used as a binding material substitution. M30 concrete mix is used to test the compressive and split tensile strength of the concrete specimens. Cement is replaced with metakaolin in 4, 8, 12, 16 and 20%. Fine aggregate is replaced by illuminate sludge in 25, 50, 75 and 100% and beer glass bottle waste in 10, 20, 30, 40, and 50%.The Glass material does not pollute the environment but storage of waste glass material results wastage of land. Thereby glass powder can be used as a substitution in construction. Then the Illuminate sludge and Metakaolin are the waste from the Titanium Product. The materials to be used for the experiment are collected and the physical properties tests were done as per codal specifications. The experiment is conducted to determine the strength of concrete specimen by adding different industrial waste in various proportions. For every industrial wastes each ratio, three specimens were prepared to find out the compressive and split tensile strength of concrete at 7, 14 and 28 days and finally it was allowed to curing for obtaining the optimum strength of concrete. The substitution of Glass bottle powder waste up to 30%, Illuminate sludge 20% and Metakaolin 8% will give the optimum compressive strength. bottle powder waste up to 30% Illuminate sludge 20% and Metakaolin 8% will give the optimum compressive strength.***

Keywords: Glass bottle, Illuminate sludge, Industrial Waste, Metakaolin.

I. INTRODUCTION

GENERAL

From the manufacturing industries there are so many types and amounts of wastes are generated. This industrial waste will pollute the air, soil and water sources, and finally ending up in the sea. The disposal of industrial waste is one of the major elements in the industrial waste management system. The soil and ground water is highly polluted by industrial effluents and sewage.

Many of our water sources are highly polluted by industrial waste and also affect those people who consume this water. Also disposal of industrial waste into sea makes it unfit for survival of marine life. In this project beverage glass bottle powder and Illuminate sludge were used as a partial substitute for fine aggregate and Metakaolin is used as a substitute for cement.

This project deals with the replacement of waste material for different constituents in concrete with different percentage for attaining an increase in strength of concrete than control mix and also to control the environmental pollution. For this compressive, split tensile strength as well as durability have to be checked after relevant material test.

Partial replacement of waste glass powder accordingly 5%, 10%, 15% to 50% by weight of M40 grade concrete as per [1]Abdullah Anwar,(2016). The maximum values of compressive, split tensile and flexural strength were found at 10% replace and this will improve the compressive strength was 16.56% , split tensile strength 7.16% and flexural strength was 6.57%. According to [2]Ahmad Shayan, (2002), glass powder is used for the replacement of cement as well as for the fine aggregate. Glass particles ranging from 12mm to 4.75mm, 4.75mm to 0.15mm, less than 10µ are used as coarse aggregate, fine aggregate and cement. The study says that 30% of glass powder could be incorporated as cement and 50% of fine and coarse aggregate could also be replaced in concrete with acceptable range of strength.

10% replacement of Metakaolin as per [14]P. Dinakar, Pradosh K. Sahoo And G. Sriram, (2013) which gives the optimum level in terms of compressive strength and split tensile strength to produce high strength and high performance concrete. According to [15]M.Narmatha and Dr.T.Felix kala (2017) the substitution proportion of Metakaolin is to be used was 5%,10%, 15% to 20% by the weight of cement. The increase in Metakaolin content improve the compressive strength and split tensile strength up to15% cement replacement. Replacement of fine and coarse aggregate with cupola slag with 15% on M20 and M25 grade concrete as per [16]R.Balakrishnan and S. Anne Ligoria (2015) the result showed higher compressive strength.

II. METHODOLOGY

Materials is required were collected and tested as per IS recommendation. Specific gravity, Impact, Water absorption, Fineness modulus tests were conducted in fine and Coarse aggregate as per IS2386-1963 and the values obtained are within permissible limit. Tests on cement such as Consistency, Specific gravity, fineness, initial and final setting time were conducted by following IS: 4031- 1988 Procedure. Mix design for M30 grade concrete was done as per IS10262-2009. Workability of concrete was determined by conducting compaction factor and slump cone test. 150mm X 150mm concrete cubes were prepared for conducting compressive strength test. Metakaolin is added to concrete by partially replacing cement in 4%, 8% and 12%, Glass bottle powder is 10%, 20%, 30% and 40% and Illuminate sludge is 10%, 20%, and 30%. Compressive strength of concrete was tested on concrete cubes after 7, 14

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and 28 days. Finally variations in strength of conventional concrete and industrial waste materials added concrete were compared.

III. DESCRIPTION OF MATERIALS

A. Cement

Ordinary Portland cement of 53 grades is used for this experiment. Cement is typically the bonding agent or glue of the concrete which keeps all the different elements of concrete together. In addition to that cement also helps in giving strength to mix.

Table- I: Properties of Cement

S.NO	Parameter	Tests results
1	Consistency	29
2	Fineness of cement	4.33 %
3	Specific gravity	3.15
4	Initial setting time	30 minutes
5	Final setting time	600 minutes

B. Coarse Aggregate

The natural coarse aggregate obtained from the locally available quarries is of maximum size of 20mm and satisfying the grading requirements of BIS (IS 383-1970).

Table- II: Properties of Course Aggregate

S.NO	Parameter	Tests results
1	Impact	28
2	Fineness modulus	2.67 %
3	Specific gravity	3.15
4	Water Absorption	0.5%

C. Fine Aggregate

For the normal mix river sand is used as fine grained throughout this project. Fine aggregates should be clean, hard and free from organic material for the good quality concrete mix.

Table- III: Properties of Fine Aggregate

S.NO	Parameter	Tests results
1	Impact	28
2	Fineness modulus	2.78 %
3	Specific gravity	2.8
4	Water Absorption	1%

D. Water

Water is required for the hydration processes of the cement. Drinking water is used as mixing water for concrete. The pH value of water is found to be 6.8 that indicate the water is free from the organic matters.

E. Metakaolin

Metakaolin is a Pozzolanic material, so it can be used as a partial substitution of binder material in the concrete mixes. The particle size of less than 75µ is used in this experiment.

Table-VI: Properties of Metakaolin

S.NO	Parameter	Values
1	Specific gravity	2.15
2	Normal Consistency (4% replace)	29
3	Specific gravity	2.15
4	Particle Shape	Spherical
5	Initial setting time (4% replace)	65 minutes

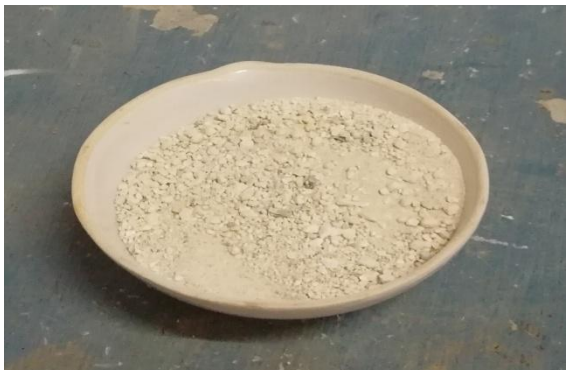

Fig-1*:* Metakaolin

F. Illuminate sludge

Illuminate sludge is a by- product during the extraction of titanium dioxide. It was being dried under sun then the dried particles were crushed into fine particles and sieved using IS sieve size of 75µ.

Table- V: Properties of Illuminate sludge

S.NO	Parameter	Tests results
1	Specific gravity	4.03
2	Normal Consistency (10% replace)	30
3	Fineness modulus	2.96
4	Initial setting time (10% replace)	130 minutes
5	Water Absorption	25%
6	Percentage of Bulking (5% water added)	11%

Fig-2: Illuminate sludge powder

G. Glass Bottle

Waste glass bottle from beverage industry are been collected from road side. Cleaned and after drying crushed into particle size similar to sand of Zone II grading.

The fine particles sieved through using an IS sieve size of 4.75mm and 150µ is taken for the experiment.

Table- IV: Properties of Glass Bottle

S.NO	Parameter	Tests results
1	Specific gravity	3.63
2	Fineness modulus	3.36

Fig-3: Glass Bottle powder

IV. MIX PROPORTION

The M30 (1: 1.8: 3.38) concrete mix with a water/cement ratio of 0.42 was designed as per the guidelines given in the Indian standards IS 10262 – 1982 and IS 456-2000.

V. SPECIMEN MIXING, CASTING AND CURING

The proper supervision has been done for correct mixing. The compressive strength is tested on 150x150x150 mm cubes specimen and tensile strength test is conducted on 150mm diameter and 300mm long cylinder specimen were prepared. One day is allocated for setting in the mold in a leveled surface. After demoulding the specimens after the samples are transferred to the curing tank for 28 days.

VI. TESTING

The testing of compressive and split tensile strength has been done at 7 days, 14 days and 28 days respectively. The unconfined compressive strength test was carried out on 150x150x150mm cube in the compressive strength testing machine of 200 tones capacity. A loading rate of 2.5 kN/s was applied which approximately equals to the 140 kg/cm 2 /minute as given in IS: 516-1959.

VII. RESULT

Table- VII: Compressive strength test result of Glass Bottle

Compressive strength of Glass Bottle (N/ mm^2)			
Replacement %	7 days	14 days	28 days
Conventional	22.27	27.51	29.27
10%	21.85	26.99	28.72
20%	24.76	30.57	32.54
30%	27.28	33.69	35.86
40%	23.46	28.98	30.84

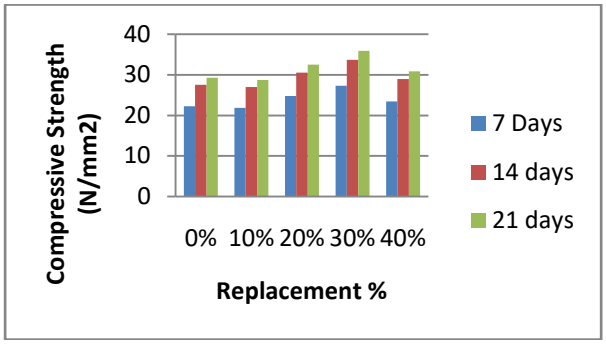

Fig-4: Compressive strength of Glass Bottle (N/ mm^2)

Table- VIII: Compressive strength test result of Illuminate sludge

Compressive strength of Illuminate sludge (N/ mm^2)			
Replacement %	7 days	14 days	28 days
Conventional	22.27	27.51	29.27
10%	24.42	30.16	32.10
20%	22.69	28.02	29.82
30%	19.76	24.40	25.97

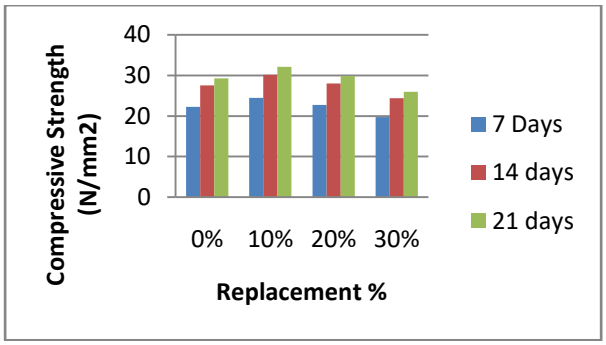

Fig-5: Compressive strength of Illuminate sludge (N/ mm^2)

Table- IX: Compressive strength test result of Glass Bottle

Compressive strength of Metakaolin (N/ mm^2)			
Replacement %	7 days	14 days	28 days
Conventional	22.27	27.51	29.27
4%	29.69	36.66	39.02
8%	39.78	49.13	52.28
12%	23.18	28.63	30.47

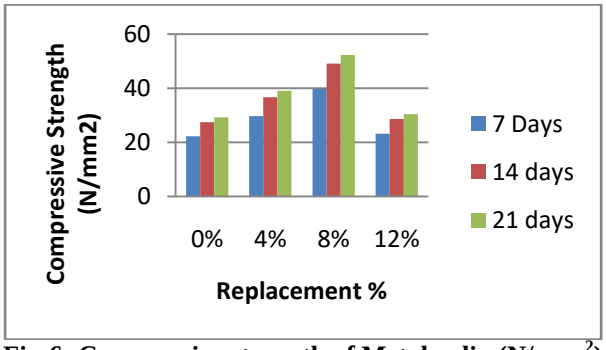

Fig-6: Compressive strength of Metakaolin (N/ mm^2)

Table- VII: Split tensile strength test result of Glass Bottle

Split tensile strength of Glass Bottle (N/ mm^2)			
Replacement %	7 days	14 days	28 days
Conventional	1.38	1.70	1.81
10%	2.18	2.69	2.86
20%	2.55	3.15	3.35
30%	2.12	2.62	2.75
40%	1.86	1.92	2.20

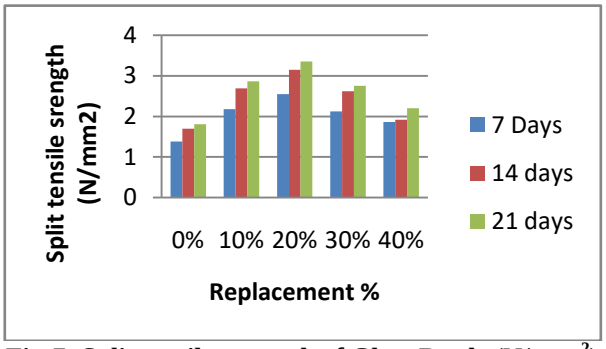

Fig-7: Split tensile strength of Glass Bottle (N/ mm^2)

Table- VII: Split tensile strength test result of Illuminate sludge

Split tensile strength of Illuminate sludge (N/ mm^2)			
Replacement %	7 days	14 days	28 days
Conventional	1.38	1.70	1.81
10%	2.29	2.83	3.01
20%	2.26	2.79	2.97
30%	2.12	2.62	2.79

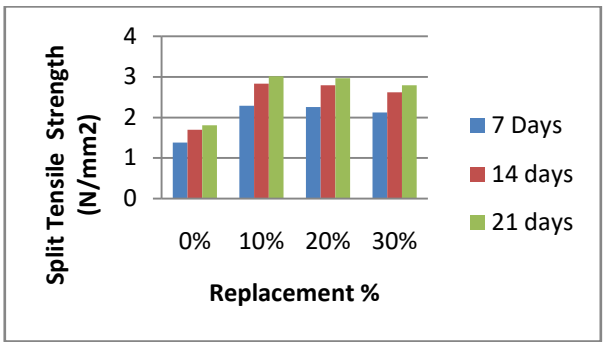

Fig-8: Split tensile strength of Illuminate sludge (N/ mm^2)

Table- VII: Split tensile strength test result

Split tensile strength of Metakaolin (N/ mm^2)			
Replacement %	7 days	14 days	28 days
Conventional	1.38	1.70	1.81
4%	2.83	3.49	3.72
8%	3.68	4.54	4.84
12%	2.83	3.49	3.72

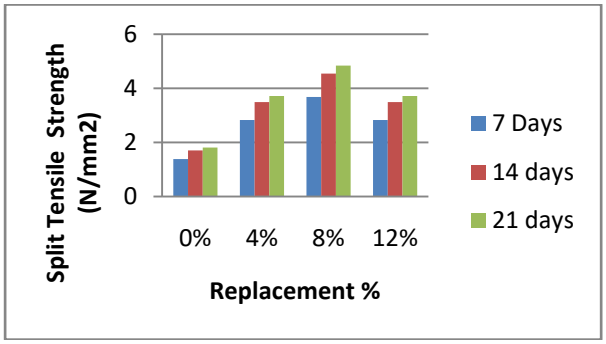

Fig-9: Split tensile strength of Metakaolin (N/ mm^2)

VIII. CONCLUSION

In this project, it is concluded that the optimum compressive strength was obtained while adding glass bottle and Illuminate sludge in 30% and 10% respectively by replacing fine grained and 8% in Metakaolin as a binding material substitution. The optimum split tensile strength was obtained while adding glass bottle and Illuminate sludge in 20% and 10% respectively by replacing fine grained and 8% in Metakaolin as a binding material substitution. As the result use of industrial waste can produce high strength concrete as well as it is economical and environmental friendly.

REFERENCES

1. Abdullah Anwar, "The influence of waste Glass Powder as a Pozzolanic Material in Concrete", International Journal of Civil Engineering and Technology (IJCIET), Vol.7 Issue 6, Nov- Dec2016 pp. 131 - 148.
2. Ahmad Shayan, (2002), "Value added utilisation of waste glass in concrete", IABSE Symposium Melbourne, pp 1-11.
3. Sanjay N Patil, Anil K Gupta, Subhash S Deshpande (2013), "Metakaolin- Pozzolanic Material For Cement in High Strength Concrete", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), pp: 46-49
4. Dr. Srinivasu K, Krishna Sai M L N, Venkata Sairam Kumar.N (2014), "A Review on Use of Metakaolin in Cement Mortar and Concrete", International Journal of Innovative Research in Science, Engineering and Technology,Vol.3.
5. Ch. Devi, M.S. Saandeepya and R. Vimala, " Improving The Quality of Traditional Concrete by Utilizing Flyash and Waste Glass Powder with Added Substance Nylon Fiber", International Journal of Civil Engineering and Technology, 8(7), 2017, pp. 274– 282. [12]
6. Rahul Roy and Pratyush Kumar. "Study and Experiment Analysis of the Feasibility of Partial Replacement of Industrial Waste Glass Powder as Cement in Self Compacting Concrete. " International Journal of Civil Engineering and Technology, 8(6), 2017, pp. 1-9
7. Glass Beverage Bottles And Our Environment" (online)
8. Prof. Jayrshkumar Pitroda, Dr. L.B.Zala, Dr. F.S. Umrigar "Innovative use of paper industry waste (Hypo Sludge) in design mix concrete."International Journal of Advanced Engineering and Technology, Vol.3, 2013, pp. 31– 35
9. IS 10262 -2009 "Indian Standard Concrete Mix Proportioning - Guidelines", Bureau of Indian Standards, New Delhi.
10. IS 456 -2000 "Code of Practice for Plain and Reinforced Concrete", Bureau of Indian Standards, New Delhi.
11. IS 5816: 1999 "Indian standard on method of tests for splitting tensile strength of concrete cylinders", Bureau of Indian standards, New Delhi.
12. IS:516-1959 "Indian Standard methods Of tests for strength of Concrete", Bureau of Indian standards, New Delhi.
13. Shrikant S. Jahagirdar, S. Shrihari And B. Manu "Reuse of textile mill sludge in Cement based solid blocks" International J. of Engg. Research & Industrial Applications (IJERIA). Vol.5, No. III (August 2012), pp. 213-224

14. P. Dinakar,Pradosh K. Sahoo And G. Sriram "Effect of metakaolin content on the properties of higH strength concrete" International Journal Of Concrete Structures And Materials(IJCSM) September 2013, Volume 7, Issue 3, pp 215–223
15. M.Narmatha and Dr.T.Felix kala (2017) "Analyse the Mechanical properties of Metakaolin using as a replacement of cement in concrete".International Journal of Civil Engineering 4(1):25-30 · January 2017
16. R.Balakrishnan and S. Anne Ligoria (2015) in their paper "Utilization of Cupola slag in concrete as fine and coarse aggregate" International Journal of Civil Engineering and Technology (IJCIET) Volume 6, Issue 8, Aug 2015, pp. 06-14.
17. Vishwash .K, Prof. B.R.Patel, Prof. D.J. Varia (2016) in their paper presents "Suitability of concrete using cupola slag as replacement of coarse aggregate" International Journal of Scientific & Engineering Research, Volume 7, Issue 2, February-2016

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