Partial Replacement of Fine Aggregate by Using Titanium Dioxide Waste in Concrete

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***Abstract*- The rapid increase in construction activities leads to scarcity of conventional construction materials such as cement, fine aggregate and coarse aggregate. Researchers are being conducted for finding cheaper materials. In India, there are many industries producing large amount of effluent treatment plant waste sludge which leads in problems of disposal. The final destination of effluent treatment plant sludge affects the environment. So alternative option is necessary for disposing effluent treatment sludge. In this study is subjected to the effective reuse of effluent treatment plant sludge of titanium dioxide wastes or sludge generated from Kerala Minerals and Metals Ltd (KMML). The aim of this study is to determine the strength parameters of concrete with the partial replacement of fine aggregate by waste sludge from KMML. Reuse of ETP sludge in concrete is an effective option for the problem of ultimate disposal up to greater extent. In this study the fine aggregate is replaced by the ETP sludge of Titanium dioxide with 2%, 4%,6% & 8% in M25 concrete mix. The various tests such as compression, tensile and flexural strength are conducted.**

Index Terms- Titanium Dioxide (TiO2), Effluent Treatment Plant (EFT), Titanium Tetra Chloride(TiCl4)Volatile Organic Compounds(VOC).

I. INTRODUCTION

The construction materials such as concrete, bricks, hollow blocks, solid blocks, pavement blocks and tiles are produced from various natural resources. Now a days construction activities increases all over the world. This sudden increase of these activities causes the shortage of conventional construction materials. It will be mostly affected in case of fine aggregate. River sand is the mostly used fine aggregate in the concrete for the construction purposes. The fine aggregate is used in the concrete for producing better workability and uniformity in concrete.

The demand of concrete is increases day by day. It will cause the utilization of river sand in large volume. It will cause the exploitation of natural resources and affects the water table etc. and also cost of river sand increased in last few years due to the administrative restrictions. In India there are many industries which produce large amount of effluent treatment plant sludge in every year which leads to increasing problems in disposal and environmental degradation due to continuous exploration and depletion of natural resources. Since the land is limited, another method should be used for the disposal of industrial waste sludge. The pollution control board and also various researchers are trying to reduce the environmental degradation of the industrial wastes by various researches including in the field of concrete .This study focuses on the replacement of fine aggregate by ETP sludge of TiO2 in M35 mix. The fine aggregate is replaced by 2%, 4%, 6% and 8% with waste sludge. The various tests such as compression, tensile and flexural strength are conducted.

Titanium dioxide (TiO2) is also termed as Titania, which is a material manufactured from selected sand. India’s first and only manufacturer of Rutile Grade Titanium dioxide by chloride process is KMML. The chlorides of impurity metals are removed from Titanium Tetra Chloride (TiCl4) by various processes to complete the manufacture of TiCl4. It is further purified by distillation to obtain pure Titanium Tetra Chloride in the liquid form .Titanium Tetra Chloride is vaporized, pre heated and oxidized with oxygen in the Oxidation Plant to manufacture raw Titanium Dioxide at a high temperature .The raw Titanium Dioxide is then classified and surface treated with various chemicals, filtered and washed to remove the salts, sent to the dryer.

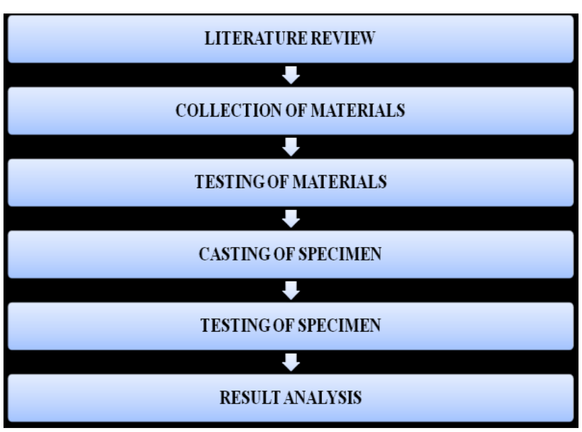
The Titanium Dioxide pigment in powder form which is as an ingredients in the manufacture of

paints. The effluents generated due to the production of TiO2 contain the various chemicals and it is leads to the problems of disposal and degrading the environment .The chemical composition of ETP sludge was tested at the research lab
at KMML which is approved by pollution control board of Kerala.

Fig 1 ETP Sludge of TiO2

The Environmental Protection Agency tracks emissions of the most hazardous air pollutants that negatively impact human health and the environment; these pollutants include carbon monoxide, sulphur dioxide, particulate matter, volatile organic compounds (VOC), nitrogen oxides (NOx), and lead. All these air pollutants are increasing worldwide, particularly in crowded cities. As a result, certain health problems are also increasing, such as cardiovascular disease and respiratory issues. Pollution can also affect the nervous system in a variety of ways (i.e., learning, memory, and behaviour; IQ loss) and contribute to cancer and premature death.

II. METHODOLOGY



III. TEST ON MATERIALS

Table 1: Tests on Materials Results

Sl no.	Parameters	Cement	Fine Aggregate	Titanium dioxide Waste	Coarse Aggregate
1	Specific Gravity	2.45	2.5	2.3	2.79
2	Consistency (in %)	32%	-	-	-
3	Initial setting time (in minutes)	45 minutes	-	-	-
4	Bulking (in %)	-	6%	8%	-
5	Sieve Analysis				
	• Uniformity Coefficient	-	8	1.67	1.3
	• Fineness Modulus	-	4.75	3.152	1.456

IV. MIX DESIGN

Concrete mix design is the method of finding right proportions of cement, sand and aggregates for concrete to gain target strength in structures.

Concrete mix = cement : sand : aggregates

Table 2 : Mix Proportion ratio(1: 1.01: 2.001)

Specimens	Cement (kg/m^3)	Fine Aggregate (kg/m^3)	Titanium dioxide sludge (kg/m^3)	Coarse Aggregate (kg/m^3)	Water Content (kg/m^3)	Water Cement Ratio
Conventional concrete	425.7	432	-	852.5	191.6	0.45
T2 concrete	425.7	423.36	8.64	852.5	191.6	0.45
T4 concrete	425.7	414.72	17.28	852.5	191.6	0.45
T6 concrete	425.7	406.08	25.92	852.5	191.6	0.45
T8 concrete	425.7	397.44	34.56	852.5	191.6	0.45

V. CASTING OF SPECIMEN

PREPARATION OF SPECIMENS

Mixing was done in a laboratory by hand mixing. While preparation of concrete, first aggregates and sludge were mixed properly and then cement is mixed. After mixing properly, then water was added. Before placing the concrete into the moulds, the inner side of moulds were greased properly. During placing of concrete moulds proper compaction was given using table vibrator.

Fig : 2 Casting Of Specimen

CURING OF CONCRETE SPECIMENS

Normal water curing was given to all concrete specimens. For that after casting the specimens are molded and placed in the curing tank for 28 days. And curing was done with the water available in the college. Here pond curing has adopted.

Fig 3 : Curing of Specimen

VI. RESULTS AND DISCUSSION

The compressive strength, tensile strength and flexural strength result of 7 days, 14 days and 28 days of replaced concrete are given below,

Table 3 :Compressive strength Tests Results

Compressive strength (N/mm^2)			
Specimens (cube)	7 days	14 days	28 days
Conventional concrete	18.72	25.92	28.8
T_2	16.89	21.1	23.2
T_4	17.4	22.8	25.2
T_6	18.26	23.38	28.2
T_8	22.3	20.11	19.8

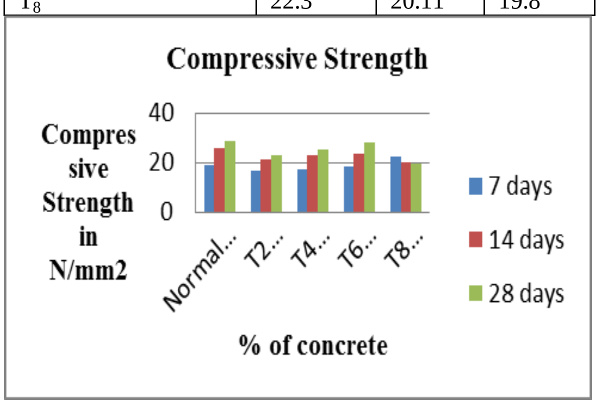


Fig 4:Comparison of Compressive Strength Between Replaced Concrete

From the above chart we can conclude that:

- The 8% replaced concrete has more strength than 6% replaced concrete at initial days.
- The 8% replaced concrete losses its strength day by day.
- The 6% replaced concrete gains strength day by day.
- The replacement increases the compressive strength decreases.
- The replaced concrete possess similar properties as that of conventional concrete.
- Thus 6% replaced concrete is an economic and eco –friendly concrete.

Table 4: Tensile strength Test results

Tensile strength (N/mm^2)	
Specimen (cylinder)	28 days
Normal concrete	2.12
T6 concrete	2.89

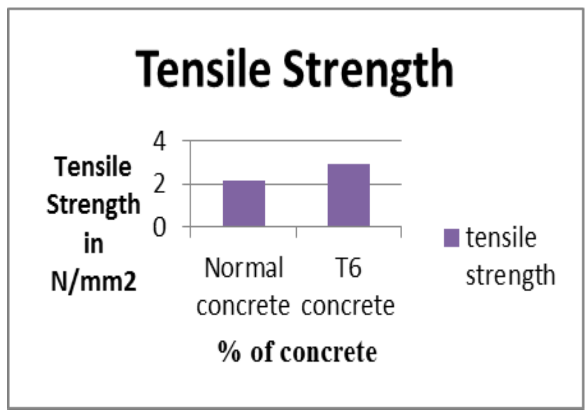


Fig:5 Comparison of Split Tensile Strength Between Replaced Concrete and Normal Concrete

From the above chart we conclude that,

- 6% replaced concrete possess more tensile strength than conventional concrete.
- Less reinforcement is required in replaced concrete.
- Economic concrete.

Table 5 Flexural strength results

Modulus of rupture (kg/cm2)	
Specimen (prism)	28 days
Normal concrete	3.48
T6 concerte	3.45

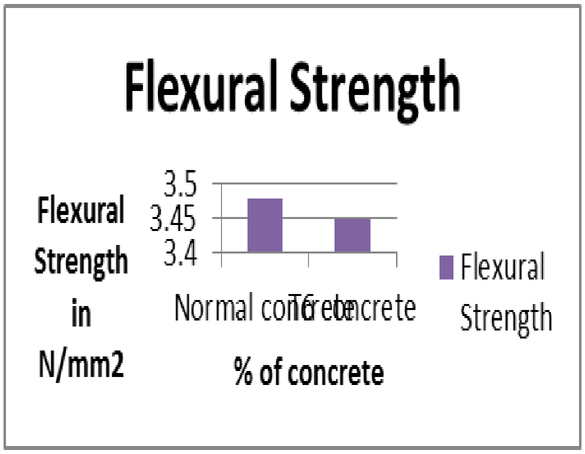


Fig 6: Comparison of Flexural Strength Test between Replaced Concrete and Normal Concrete

From the above chart we conclude that,

- Replaced concrete possess similar flexural strength as that of conventional concrete.
- Economic concrete

VII. CONCLUSION

Experimental investigations are performed to study the replacement of fine aggregate by ETP sludge of TiO2 in concrete. Mainly here 2%, 4%, 6% and 8% replacement of fine aggregate with titanium dioxide waste is done. The mechanical properties such as workability, compressive strength, tensile strength and flexural strength are determined.

And our conclusions are as follows:

1. The workability of the 6% replaced concrete fine aggregates with titanium dioxide waste (that is with 6% of Tio2 waste) is similar to that of normal concrete.
2. The compressive strength of the 6% replaced concrete has similar properties as that of conventional concrete.
3. The tensile strength of the 6% replaced concrete is greater than normal concrete.
4. The flexural strength of the 6% replaced concrete is similar to that of conventional concrete.
5. The overall performance of the 6% replaced concrete is similar to that of normal concrete.
6. The 6% replaced concrete is an economic and eco-friendly concrete

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