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STRENGTH CHARACTERISTICS ANALYSIS OF CONCRETE REINFORCED WITH LATHE MACHINE SCRAP AND ETP SLUDGE

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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 TiO2 pigment and lathe scrap. In this study, Natural sand was partially replaced with ETP sludge in the range of 0%, 6 % 12%, 18 % and 24% by weight and Lathe waste 2 % by weight. The designed mix proportion for normal concrete is 1:1.38:1.83 with water cement ratio of 0.42.

Keywords: Lathe Machine Scrap, Compressive Strength, Split Tensile Strength, Concrete, workability, Fiber reinforcement

1.1 INTRODUCTION

Concrete is the most important construction material, which is manufactured at site. Concrete required for extensive construction activity can always be made available since all the ingredients of concrete are materials of geological origin. Various research and efforts have been made to obtain a durable, strong and economical concrete mix. The investigation reported in this project was carried out to study the feasibility of using industrial waste fibres in fibre reinforced concrete. Waste fibre from lathe industry were collected and used in this investigation. A total of 63 number of concrete cube specimens were casted with and without fibres and were tested under compression as per relevant Indian standard specifications. Test result indicated that addition of waste fibres from lathe increases the compressive strength and many other properties of concrete but up to certain limit of percentage. The Concrete mix design can be defined as the art of obtaining a concrete of the required properties, at the lowest cost, by suitable choice and proportions of available materials. Needless to say, a property designed concrete mix for the specified strength requirement should have the minimum cement content to make mix economical. It should, however, be stressed that the precise relationship falls between the properties of concrete and the specific characteristics such as water cement ratio, aggregate cement ratio and grading, apart from such elusive quantities as aggregate-particle shape and texture. Hence, concrete mix design cannot be mechanically done and is likely to remain an art, rather than a science, for some time to come. The purpose of concrete mix design is to ensure the most optimum properties of the constituent materials to meet the requirements of the structure being built. Mix design should ensure that the concrete:

- Complies with the specifications of structural strength laid down, which is usually stated in terms of the compressive strength of standard test specimens.
- Complies with the durability requirements to resist the environment in which the structure will serve its functional life.
- Be capable of being mixed, transported, and compacted as efficiently as possible without undue labour.
- And last, but not least, be as economical as possible.

The design of concrete is science that can be described here only in its broad outlines. The starting point of any mix design is to establish the desired workability characteristics of wet concrete, the desire physical properties of the cured concrete and the acceptable cost of the concrete.

1.2 LATHE INDUSTRIAL WASTE

Lathe industrial waste fibers are the most common type of fibers added in concrete and is manufactured from cold drawn wire. The high modulus and high tensile strength of these fibers provides good toughness to the plain concrete. In addition to this, surface roughness of these fibers can improve the frictional resistance (bond) with the cement matrix. The high stiffness of steel fibers can improve flexural performance. Crack bridging efficiency of lathe industrial waste fibre depends primarily on their length, interfacial fiber–matrix bond properties and the elastic modulus. Experimental studies in the past provided adequate experimental observation that the increase in pullout resistance depends upon the type of Lathe industrial waste fibers with different shapes (hooked and corrugated) and lengths were used. Although Lathe industrial waste fibers cause an improvement in the load carrying ability of concrete, their Contribution to early age shrinkage crack resistance is well advocated**.** The improvement of crack resistance due to

shrinkage is better controlled with the used of hooked Lathe industrial waste fibers and waste flex sheet polypropylene fibers and also improved flexural and drying shrinkage properties.

1.3 ETP SLUDGE OF Tio_2

Titanium dioxide (TiO2) is also called Titania, which is a substance manufactured from selected sand. KMML is India's first and only manufacturer of Rutile Grade Titanium dioxide by chloride process. 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 produce 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.

Figure 1: Lathe machine

Figure 2: ETP sludge

2.0 LITERATURE REVIEW

Prof. Kumaran M et al studied the effect of Lathe Waste in Concrete as Reinforcement. An Experimental investigation is carried out on the strength of lathe waste concrete and deformational behavior of lathe waste concrete beams. The waste steel scrap available from the lathe is used. Optimum combination of lathe waste is studied. For this cube and cylinder compressive strength, flexural test and split tensile strength tests were carried out. The deformational behavior was investigated with this optimum content. A total of 24 reinforced lathe waste concrete beams had been tested to investigate the influence of lathe waste and combined effect of lathe waste and stirrups on the deflection, cracking, ultimate load and failure pattern. Beams without stirrups and with stirrups are studied. The experiments have demonstrated the advantages of combining lathe waste with steel stirrups. Load- deflection behavior of simply supported beams is increased. Reinforced lathe waste concrete beams show less deformation than similar reinforced normal conventional concrete beams. The combination of lathe waste and stirrups increases the ultimate load of concrete beams. Test results indicated that the inclusion of lathe waste significantly improves the strength and deformational characteristics of concrete.

Jais Joy et al studied the performance of Steel Scrap in Concrete. It is inevitable to think about sustainable development by reducing the wastes generated or reusing it. Hence an attempt has been made in the present investigations to study the performance of addition of waste materials like binding wire, steel nails, steel lathe waste fiber (turn fiber) from workshop at a dosage of 0.5%, 1% and 1.5% of total weight of concrete. Experimental investigation was done using M25 mix and tests were carried out as per recommended procedures by relevant codes. Total of 162 specimens of scrap concrete and PCC were made. This paper aims to have a comparative study between turn fiber, binding wire and steel nail in M25 concrete. The test parameters include compressive strength, split tensile strength and flexural strength of conventional concrete and steel scrap in concrete.

Saranya C. V et al experimentally investigated the standard Concrete by Using Lathe Industry Waste & Waste Flux Sheet. This study is focused on the influence of fibre addition in a high strength concrete mix by adding both the fiber extracted from waste flux sheet and lathe industrial waste. Now-a-days flux sheets are most widely used for various advertisement works which is non-biodegradable material. Hence the main focus in this paper to reuse the waste flux sheet and reduce soil pollution. HSC production and the application technologies are most updated. The performance of concrete is to be enhanced with the addition of lathe industrial waste fibre dosage as well as the inclusion of waste flux sheet fibre. The addition of both lathe industrial waste fibre and waste flux sheet fibre will be result in improved flexural strength and split tensile strength. This study is the part of the research program on evaluating the performance of high strength concrete using lathe waste and Waste flux sheet. The compressive strength for all mix proportions of fiber combinations showed a favorable improvement in the strength properties due to crack arresting mechanism of fibers at different scales of cracking.

Raghunathan T et al studied on the Strength of Concrete with ETP Sludge from Dyeing Industry. In this paper, it is envisaged to create a new composite material which can be derived from the already existing non degradable and hazardous waste materials. The new composite material is a combination of Ordinary Portland cement and Dyeing Industry Effluent Treatment plant Sludge (DIETPS). It replaces the non availability of natural building materials such as sand and related aggregates. It is the method of extracting wealth from the waste. Various compositions of mixtures are made in Phase I of the research. The test results of different mixtures are analyzed. The economical composite, 1:1.7 having sufficient strength as per IS codes for Bricks was selected. The composite mixture having high quality with low cost is selected for future use as a nonconventional building material named as Synthetic Sludge Aggregate (SSA). This SSA is used to manufacture synthetic fine aggregates. The fine aggregates are then used as replacement of sand in various percentages is M20, M30 and M40 concrete and compressive strength and split tensile strength characteristics are studied as per BIS standards.

Shrikant S Jahagirdar et al studied the utilization of Textile Mill Sludge in Burnt Clay Bricks. The Investigation of the effect of Textile mill sludge addition in burnt clay bricks is done under this study. Chemical composition of sludge and soil samples was analysed by ICP-AES, SEM and XRF facilities. Sludge percentage is varied from zero to thirty-five percent by weight. Firing temperature and firing period are varied to understand the variations in characteristics of burnt bricks. Parameters such as compressive strength, density, water absorption, efflorescence and ringing sound are studied as per BIS (Bureau of Indian Standards) procedures. Density of bricks, compressive strength and ringing sound reduces as sludge content in bricks increases whereas water absorption and efflorescence increases. Higher firing temperature and firing period i.e. 8000C and 24 hours give good results in terms of compressive strength with same percentage of sludge as compared to other temperature and firing period combinations. Textile mill sludge up to 15% can be added so as to get compressive strength greater than 3.5 N/mm2.

Designation	Mix	Water	Cement	Weight of Lath waste (2 %)	Weight of ETP sludge	Fine Agg. (Sand) (kg/m^3)	Coarse Agg (kg/m^3)
C-0	Control	197	519	-	-	718	950
C-1	6%	197	519	14.36	43.08	660.56	950
C-2	12 %	197	519	14.36	86.16	617.48	950
C-3	18 %	197	519	14.36	129.24	574.4	950
C-4	24 %	197	519	14.36	172.32	531.32	950

Table 1: Mix Designation

3.0 EXPERIMENTAL METHODOLOGY

The control mix containing cement, natural sand and coarse aggregates was designed as per Indian Standard Recommended Guidelines IS: 10262-2009. Natural sand was partially replaced with ETP sludge in the range of 0%, 6 % 12%, 18 % and 24% by weight and Lathe waste 2 % by weight. The designed mix proportion for normal concrete is 1:1.38:1.83 with water cement ratio of 0.42. In this study five mix proportions were made. First is control mix and the other four mixes contained ETP Sludge which was partially replaced with fine aggregates. Nine cubes were casted for each percentage of ETP Sludge replaced with fine aggregate. The mix designation and quantities of various materials for each designed concrete mix have been tabulated in Table 1.

4.0 RESUT & DISCUSSION

4.1 COMPRESSIVE STRENGTH TEST

The experimental test results for various fiber concrete mixtures are given in shown in Figure 3. It is noted from the trend lines that plain cement concrete showed a brittle failure when loaded in compression and absorbed very less fracture energy before failure, resulting in sudden failure. Whereas, all the fiber concrete specimens showed a gradual failure accompanied by complete crushing of concrete. This shows that the fracture energy is released safely due to straining of fibers at failure and gradual dissipation of internal failure energy. Fibers are known to inhibit micro-crack formation by strengthening the matrix and thereby control the brittle failure. Compared to reference concrete, all fiber concrete mixes demonstrated higher compressive strength due to higher reinforcing efficiency. Compressive strength of the specimen shall be calculated by dividing the maximum compressive load taken by the specimen by its cross-sectional area.

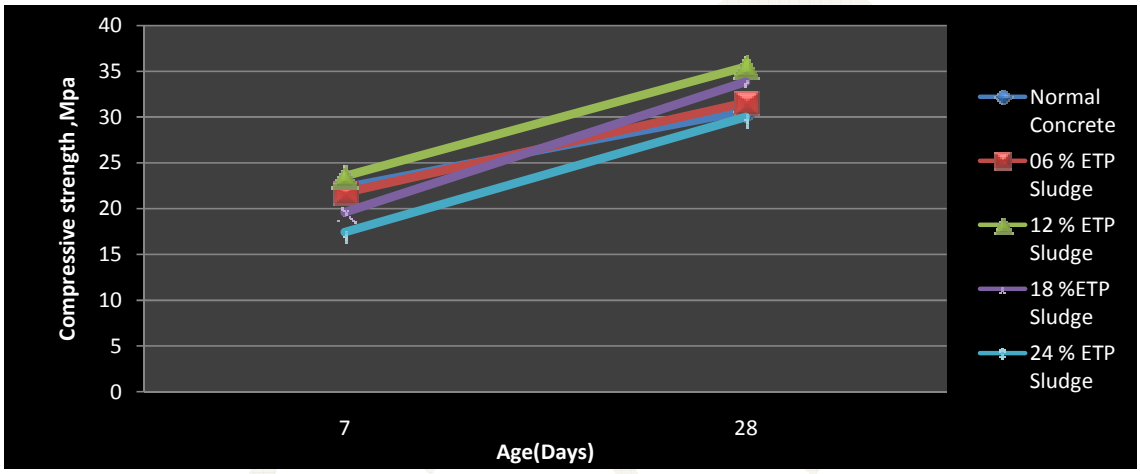

Figure 3: Compressive strength test results of various mixes

4.2 SPLIT TENSILE STRENGTH TEST

The experimental trends of the results with and without steel and ETP Sludge are represented in Figures 4. The split tensile behavior of fiber concrete specimens exhibited higher tensile strength compared to conventional plain concrete without fibers. The influence of F/c ratio on the split tensile value was noted to be another important parameter influencing the concrete properties. The increase in the fine to coarse aggregate ratio showed a decrease in the strength properties due to increase in the void structure between the aggregates.

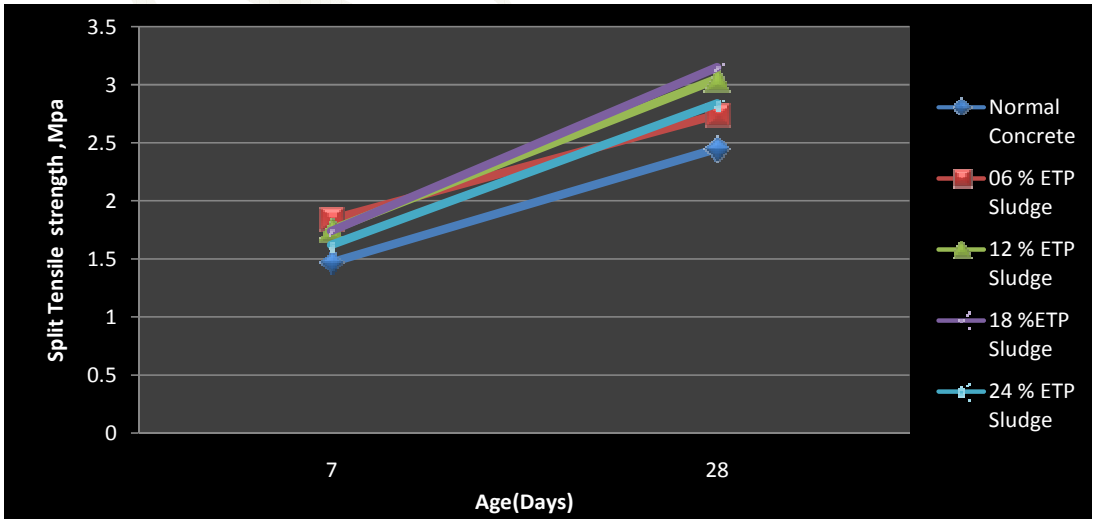

Figure 4: Split tensile strength test results of various mixes

CONCLUSION

Experimental investigations are carried out to study the replacement of fine aggregate by ETP sludge of TiO2 in concrete. The mechanical properties such as compressive strength, flexural strength, split tensile strength, were examined. The major conclusions drawn from this research are presented below:

1. The workability of the mix containing ETP sludge of TiO2 shows an inverse relation with the increase of replacement.
2. The environmental degradation due to the effect of ETP sludge can be reduced up to certain limits by the partial replacement.
3. The maximum compressive strength of concrete is achieved at 12 % replacement of fine aggregates with ETP Sludge.
4. The maximum split tensile strength of concrete is achieved at 18 % replacement of fine aggregates with ETP Sludge.
5. A slight decrease is noted in compressive strength after 12 % replacement.
6. Up to 12 % replacement of sand with ETP Sludge in concrete, the slump values were increased. On 18 and 24% replacement of sand with ETP Sludge in concrete, there was significant decrease in slump values.
7. The environmental degradation due to the effect of ETP sludge can be reduced up to certain limits by the partial replacement.
8. The increased cost of construction due to the scarcity of fine aggregate can be reduced with the ETP sludge up to some extent.
9. Based on these studies, up to 15% replacement of ETP sludge is possible in the concrete for achieving the target mean strength as per Indian slandered code of mix design. However 5% of ETP sludge replacement is recommended based on these studies for getting similar properties of normal concrete.
10. ETP sludge based concrete performs and fulfills the basic properties of conventional concrete for the optimized water to binder ratio (0.42) and strength gaining mechanism is not uniform as like conventional concrete at initial period of time but it is as good as conventional concrete after 28 days.
11. The waste steel scrap material which is available from the lathe can be used as steel fibres for innovative construction industry.

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