Experimental Study on Behaviour of Concrete by CETP Sludge

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Abstract- **Leaving the waste material to the environment directly cause environmental problems. Rapid Industrialization and Urbanization is causing serious environmental problems to the environment. One of the major concerns amongst these is safe and sound disposal of solid wastes. The treatment of effluents from the production of industries results in sludge generation from the treatment plant which poses a huge challenge for its disposal. Therefore, an attempt is made to initialize them in an effective way. In this experimental investigation, an attempt has been made to investigate the behaviour of concrete and its mechanical properties with replacement of cement with CETP sludge. The outcomes show there is a possibility in accommodating the sludge in concrete by solidification. This report is meant for discussion of beneficial utilization of CETP sludge waste with conventional building material in Construction application. From this study, the use of the CETP sludge will be identified for structural and non-structural applications by conducting future experimental studies. To evaluate the effect of dry sludge on concrete performance, its physical and mechanical properties were studied. In this research an attempt is taken to bring into play the sludge waste in various proportions so that the final product property of concrete mixture is same as the control mix. Waste sludge material will be replace cement in various percentages such as 20%, 15%, 10%,5% ,and 0%. Reference concrete mix is to be also made for comparative reasons. Test will be conducted on fresh and harden concrete. Cube, cylinder and beam will be casted for grade M30 for the determination of workability, compressive strength, tensile strength and flexure strength.**

Index Terms- Cement, F.A-Fine Aggregate, C.A.-Coarse Aggregate, CETP Sludge, Polypropylene fiber compressive strength, flexure strength test, split tensile strength.

1. INTRODUCTION

Vapi GIDC Estate is "Declared Chemical Estate" housing over 1400 industries, two third of which are chemical related units. Almost 80% of the industries belong to Small Scale Sector. The rapid industrialization was the goal and the national and state economic policy was to encourage SSI sector for maximum employment at minimum capital. • Common effluent treatment plant Vapi having capacity 55 MLD containing waste water of chemical and biochemical industry. • Which generate 200 metric tonnes sewage per day? • This sludge is used to deposit in sand bag and used for land filling. • The big problem of deposition and handling of sludge during rain it causes environment pollution. The CETP Vapi wastewater plants produce an increasing volume of sludge. The quantities of sludge in all Vapi area are estimated to be 200 metric ton. The large quantities of sludge and the scarcity of land area are significantly increasing the sludge risk to public health. The growing problem of wastewater sewage sludge disposal in the CETP can be alleviated if new disposal options other than landfill can be found. 2 Procedures for Paper Submission

1.1Aim of Research

This work was directed toward establishing the use of wastewater sludge in concrete mixtures and non-structural elements. The successful use of sludge will help in reducing the environmental and health problems related to the bad handling of sewage sludge at wastewater treatment plants and the scarcity of land area needed for disposal.

1.2 Statement of the Problem

The CETP Vapi wastewater plants produce an increasing volume of sludge. The quantities of sludge in all Vapi area are estimated to be 200 metric ton. The large quantities of sludge and the scarcity of land

area are significantly increasing the sludge risk to public health. The growing problem of wastewater sewage sludge disposal in the CETP can be alleviated if new disposal options other than landfill can be found.

1.3 Objective of the Research

The overall objective of the work is to investigate the feasibility of incorporating dry wastewater sludge in concrete mixtures. The main aim was achieved through the following.

1. To study the influence of dry wastewater sludge on fresh and hardened concrete properties.
2. To determine the optimum dry sludge to cement ratio which can be used in concrete mix?

2. METHODOLOGY

The following tasks were done to achieve the research objective:

1. Collecting of the relevant information and documents related to wastewater treatment plants in CETP Vapi and their quality and quantity.
2. Undertake a comprehensive literature review on relevant subjects focused on the using of sewage sludge in construction field.
3. Site visit to the CETP Vapi treatment plant to obtain information and collect samples.
4. Develop a suitable experimental program to study the use of wastewater sludge in concrete mixtures.
5. Analysis the experimental tests result and draw conclusions.

3. LIST OF MATERIALS

- Cement
- Fine aggregate
- Course aggregate
- Water
- CETP sludge
- Polypropylene fiber (additive)

4. DESIGN MIX METHODOLOGY

- The concrete mix design was proposed by using IS10262:2009.The grade of concrete used was M30 with water to cement ratio 0.45. The mix design proportions for 1 m3 of concrete. When cement ratio get decreases then the percentage of the sludge girt increases. In which ratio is constant & also F.A (kg/m3), C.A (kg/m3), Water (kg/m3) is constant

4.1 Target Strength

- The majority of the construction works in study area are residential buildings with multiple floors and they are not more than three floors. The minimum grade of concrete recommended is M30 (IS: 456-2000) and a target strength of 38.25 MPa is fixed in this work. Also, this work is carried out to find the influence of brackish water in strength of concrete in the study area.
- The design mix proportions for the required target strength is as follows,
- Cement: Sand: Coarse Aggregate: w/c = (1: 1.87: 3.37:0.45)
- The concrete mix design was proposed by using IS10262:2009.The grade of concrete used was M30 with water to cement ratio 0.45. The mix design proportions for 1 m3 of concrete. When cement ratio get decreases then the percentage of the sludge
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Quantity Required for M30 Grade Concrete

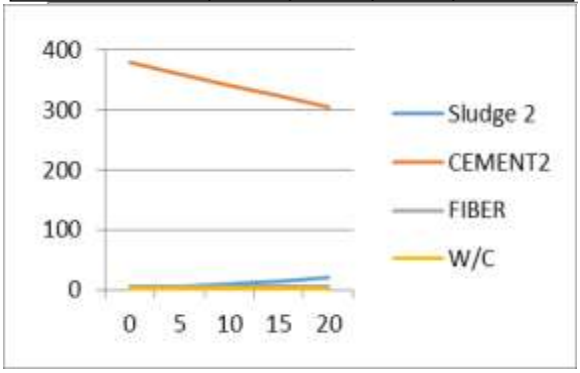
Sludge %	W/C ratio	Cement (kg/m^3)	F.A (kg/m^3)	C.A (kg/m^3)	Water (kg/m^3)	Sludge (kg/m^3)	Polyprpelyene fiber Additive 0.5%
0	0.45	380	710	1280	145	….	12.5
5	0.45	361	710	1280	145	19	12.5
10	0.45	342	710	1280	145	38	12.5
15	0.45	323	710	1280	145	57	12.5
20	0.45	304	710	1280	145	76	12.5

Cube Specimens Quantity

Trial Mix NO.	% OF sludge	COMPRESSIVE TEST CUBE			TOTAL Nos. CUBE
		7 DAY	14 DAY	28 DAY	
1	0%	3	3	3	9
2	5%	3	3	3	9
3	10%	3	3	3	9
4	15%	3	3	3	9
5	20%	3	3	3	9
TOTAL CUBE		15	15	15	45

Flexural Strength Test -beam Specimens Quantity

Trial Mix NO.	% OF sludge	FLEXURAL STRENGTH TEST - BEAM			TOTAL Nos. BEAM
		7 DAY	14 DAY	28 DAY	
1	0%	3	3	3	9
2	5%	3	3	3	9
3	10%	3	3	3	9
4	15%	3	3	3	9
5	20%	3	3	3	9
TOTAL BEAM		15	15	15	45



5. LITERATURE REVIEW

General Many research works are completed and also are in progress to reuse and recycle the CETP waste into useful products. In this article a preliminary effort has been initiated to study feasibility of incorporating CETP sludge in concrete in construction applications

5.1 Review of research papers

A.Yagie, S.Yagie, E.Vazqeze. (2004)1 had studied on the dry sewage sludge and determines its compatibility with cement. The dry sewage sludge was replaced to cement. The proportions of dry sewage sludge were taken as 0%, 2.5%, 5%, and 10% to the weight of the cement. The dry sludge concrete specimens were compared with the control specimen and also ones which were submerged in seawater and in fresh water. The strength of concrete with 2.5% and 5% of sludge addition were almost similar. The strength decrease by addition of 10% of dry sludge. As per his study the strength of concrete containing sludge was acceptable as compared to control concrete.

Kartini K, Dahila Lema.et.al (2015)2 had conducted study on domestic waste sludge powder (DWSP). The wet sludge was dried in natural sunlight and then it was dried in furnace for 72 hours to remove moisture, dried sludge was crushed into Los Angeles Abrasion test machine and sieved through 90µm.The dry sludge powder was used as a cement replacement and taken as 3%, 5%, 7%, 10% and 15% proportion to the weight of cement. Grade 30, 40 and 50 with w/c ratio=0.60. The compressive strength was checked for 7, 28&60 days. For grade 30, the strength of specimen at 28 day of specimen containing 3% and 15% sludge was below control concrete specimen. For grade 40, the strength of specimen containing 5% and 7% sludge was optimum and for grade 50, the strength of specimen containing 10% and 15% of sludge was low. As sludge may contain S03 which retard the setting of the concrete.

M.Alqedra, M.Arafa, M.Mattar (2011)3 had studied on influence of low and high organic wastewater sludge on concrete. The low organic is the sun dried sludge, contains 7 high sand contain and high organic sludge is the sludge taken from secondary pond, can be used as an additive in concrete mixes. Both sludge was taken as proportion 0%, 2.5% and 10%. The strength was checked at 28&90 days' age. The result shows that the strength of specimen containing sludge was higher at 90 days for the low organic sludge used as a sand replacement and that of compressive strength of high organic strength at 90-day age shows acceptable strength with2.5% and 5% sludge.

Haider Mohammed Owaida, et.al (2013)4 had carried out experimental work on use of alum sludge as partial cement replacement and compressive strength, splitting tensile strength and flexural strength of concrete block was checked. The Ordinary Portland Cement and admixture as added. The chemical characteristic of alum sludge was carried before using as cement replacement. The alum sludge powder was taken to weight of cement as 0%, 6%, 9%, 12% and 15% mix proportions with water cement ratio=0.33. The compressive strength and splitting tensile strength was checked at 3, 7 and 18 days and that of flexural strength at 28days.Results shows that higher strength was obtained at 6% addition of sludge because of presence of silica, alumina and ferric oxide in alum sludge and cement too.

Shayan Pirouz, Seyed Mostafa Khezri, (2015) 5 had conducted study on sludge from filtration plant. The dry sludge was taken as 0%, 10%, 20%, 30%, 40% and 50% mix proportions to the weight of cement with water to cement ratio=0.60. The concrete specimen was cured for 7, 28 and 90 days. The compressive strength of concrete specimen were tested and result shows that strength at 90 day age higher than 28 day age and that of 28 and 90 days strength was higher than 7 day age strength. Therefore increasing curing period strength will increase.

Balasubramanian et.al6 examined the potential reuse of textile effluent treatment plant (ETP) sludge in building materials. The tests were conducted as per Bureau of Indian Standards (BIS) specification codes to evaluate the suitability of the sludge for structural and non-structural application by partial replacement of up to 30% of cement.

Ghada Mourtada Rabie7 Sanitary and Environmental Department, Cairo University, Egypt.The aim of this thesis is to implement a new way of discarding the large amount of 8 sludge which produced from the wastewater treatment plants in Egypt, since the amount of sludge produced every year in Egypt are about "4 Million ton ", this amount of sludge is considered a big/dangerous problem which facing Egypt today. Thus, all over the world the researchers are trying to explore a new and suitable way to solve the sludge huge amount which produced from the WWTPs. One track of these solutions is to use sewage sludge in Construction field" concrete mixtures and in manufacturing interlock brick samples'', evaluated the reuse of sewage sludge from urban wastewater treatment plants in a mixture with cement and to develop new construction materials. According to results findings, no significant strength loss was observed when using the dry or wet sludge with different percentages from the cement weight, in which the strength loss was increased to 63.7% after 7-days and 61.6% after 28-day for dry and for wet 73.4% after 7-days and 68.5% after 28-days when 20% of wet and dry sludge pellets by cement weight was added to concrete mixture. The results showed that the wet sludge retarded the strength development and has more adverse effect on compressive strength than the other dry sludge for the same percentage as the average strength loss after 28-days for wet percentages approximate about 13.76% and for dry sludge approximate about 7.73%. Finally the study concluded that the dry and wet sludge can be used in as an additive to concrete mixtures till 15% form cement weight as one of the available disposal options for Egypt sludge. The study recommended that more researches are needed to evaluate the durability of sludge concrete and the behavior of reinforced sludge concrete..

D. Mandlik, Prof. S. A. Karale8 2018 This study utilized replacement of 5%, 10 %, 15 % and 20% by weight of OPC with water binder (w/c) ratio of 0.50 and 0.45 for Grade 20 and Grade 30 respectively. The performance of sludge concrete in terms of its compressive strength, split tensile strength test, flexure strength test were investigated. All values of compressive strength for sludge concrete were lower compared to the OPC control, and the strength decreased as the percentage of replacement with sludge increased for Grade 20 and Grade 30, at replacement of 10 %. Meanwhile, water absorption and water permeability for the sludge concrete increased as the replacement increased. Overall, with further research in producing quality, the potential of using this waste as a cement replacement material is very promising 9 Milind V. Mohod9 (2015)Compressive strength of concrete increases with increase in fiber dosage up to 0.5%, then it starts decreasing. So the optimum percentage fiber found from research is found out to be 0.5%.In splitting tensile strength test, it was found that tensile strength was significantly improved only for 0.5% of fiber dosage and as the percentage of fiber volume dosage increases a continues drop of strength was observed. In flexure strength the improvement in the behavior due to the addition of the PPF is the similar to that in tensile strength. Hence we may conclude that the optimum value of fibre content is 0.5% for both tensile strength and flexural strength

6. CONCLUSIONS

From the literature review, it can be concluded that this CETP sludge used as a cementations materials for the production of structural members and non-structural members. In this experimental investigation, an innovative approach has been formulated to make use of the CETP industry sludge. Besides from the previous literatures, it has been planned to replace the cement with sludge for

suitable proportions. The mix combination of the concept has been originated and implemented to verify the strength parameters and workability of concrete. Apart from the strength parameters, durability, leachate analysis and possibility in structural applications were initiated

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