International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075, Volume-8 Issue-5S March, 2019

An Experimental Study on Mechanical Properties of Concrete using Sludge Ash

Sukanya.M, Madhuvannthan. S, Thaarani. T, Nathiya. P, Nirmal. S

Abstract: ***The aim of this project is to give a simple method of using the sludge ash in partial replacement with cement. The disposal of sewage sludge affects the environment as it may contain harmful pathogens, heavy metals and excess phosphorous and nitrogen. The sludge produced from waste water treatment plant is incinerated. The sludge ash retained is partly replaced with cement in concrete at different proportions (5%, 10%, and 13%) and the behaviour of the concrete is studied. The casted specimens are tested for 7 days and 28 days of curing strength as per Bureau of Indian Standards (BIS) specification codes. Mechanical properties such as compressive strength, tensile strength and flexural strength of the sludge concrete are determined. The strength obtained from the above process is compared with the nominal concrete and the difference in the strength, flexure and tension is studied.***

Keywords: ***Sludge ash, casting, curing, compression test***.

I. INTRODUCTION

The sludge from the waste water treatment plant is one of the leading factor having insufficient land space for the disposal. Water treatment plants are the most essential to each of the corporations. It cannot be avoided and it is mandatory for the treatment process. It involves treating large quantity of waste water from the manual disposal and produces both dry and wet sludge. However, some of the sludge are disposed of on an engineered landfill, and some are openly dumped, which will lead to surface water and ground water contamination.

The sludge (dry state) is collected from the waste water treatment plant in Coimbatore. The dry sludge contains particles of various sizes which are random and not uniform. The process of breaking large sized particle sludge involves crushing equipments such as drop weight hammer, jaw crusher, roll crusher and ball mill. The grounding of the particles into smaller size helps in the process of burning easy and quick. The dry sludge particles are separated manually and the bigger sized particles are crushed with the drop weight hammer with continuous blows of 15. The resulting crushed particles are then grounded by jaw crusher and roll crusher and finally fed into the ball mill which gives finer particles. The finer particles are then to be burned in an open space or the particles are filled into a mould and burnt along with the bricks in saengalsoolai. The particles results into ashes which are then sieved through 90 micron sieve plate and the passing particles are partially replaced to the cement content in the concrete.

II. LITERATURE REVIEW

The experiments with various kinds of sludge waste emerging from various sectors have been performed by many researchers and scholars. Some of the informations are obtained from the below given articles.

S. Arulkesavan studied the possible utilization of textile water in concrete by analyzing their durability properties. The different stages of effluent such as raw effluent, anaerobic process outlet, and tertiary treated outlet were tested which showed up good results.

D. Vouk made cement mortars using sewage sludge ash (SSA).The supplementary cementitious material (SSA) increases the water demand and reduces the workability, compressive strength and density of concrete mixes. The utilization of SSA in cementitious materials must be carefully controlled as SSA varies significantly.

Doh ShuIng made a partial replacement in concrete using sewage sludge ash. The results between Sludge, Sludge ash and cement were compared after some tests were carried out. The 5% SSA replacement to cement in concrete has a increase in compressive strength of concrete up to 10% and lower water absorption when compared to normal samples.

Ghada Mourtada Rabie found that when different percentages of dry or wet sludge were used in cement weights, the significant strength loss was found to be null. The wet sludge and dry sludge having approximate strength of 13.76% and 7.73% respectively shows that the former has more adverse effect than later on compressive strength and reduced strength development.

Thevaneyan Krishta David replaced the cement and fine aggregate using Sewage Sludge Ash. The density and compressive strength of concrete were determined. Some Pozzolanic properties of Ordinary Portland cement matches with the Sewage Sludge Ash. The SSA will be grounded with ball mill and used as cement replacement. The replacement study shows that when SSA is replaced to cement in 10% in concrete, the compressive strength remains same for both.

Revised Manuscript Received on March 08, 2019.

Sukanya.M, Assistant Professor, Department of Civil Engineering, Karpagam College of Engineering, Coimbatore, Tamil Nadu, India

Madhuvannthan. S, UG student, Department of Civil Engineering, Karpagam College of Engineering, Coimbatore, Tamil Nadu, India

Thaarani. T, UG student, Department of Civil Engineering, Karpagam College of Engineering, Coimbatore, Tamil Nadu, India

Nathiya. P, UG student, Department of Civil Engineering, Karpagam College of Engineering, Coimbatore, Tamil Nadu, India

Nirmal. S, UG student, Department of Civil Engineering, Karpagam College of Engineering, Coimbatore, Tamil Nadu, India

III. MATERIAL PROPERTIES

A. Cement

Grade 53 of Ordinary Portland Cement (OPC), locally available has been used and the following gives the properties of cement.

The properties of cement are Specific gravity, Fineness test, Initial setting time, Standard consistency and Final setting time. Their corresponding values were found to be 3.15, 32 %, 4%, 32 mins and 9 hrs 20 mins respectively.

B. Sludge ash

The following shows the chemical properties of the ETP sludge. However the sludge is burnt for the replacement.

The sulphate and chloride contents were found to be 1045 mg/l and 5012 mg/l respectively in the sludge. The Specific gravity of the sludge was found to be 2.45 where total hardness and water content being 750 mg/l and 22 % respectively and the pH was 13. Some volatile solids were too less in percentage.

Fig. 1 Sludge Ash

C. Coarse aggregate

Stone aggregates of size 20 mm available at local are used as coarse aggregate in the concrete.

The fineness modulus of the coarse aggregate was found to be 5.5.The water absorption was 1.5 % and specific gravity was 2.8.

D. Fine aggregate

Locally available M-sand that passes through the sieve size of 4.75 mm is taken as fine aggregate. The following are the properties of M-sand.

The properties of FA tested in this project were fineness modulus, specific gravity and water absorption and the corresponding value obtained from the tests were found to be 2.34, 2.77 and 2.3% respectively.

E. Water

Ordinary portable water is used for the process of mixing and also for curing of concrete. W/C (Water-Cement ratio) of 0.45 is adopted in preparing the concrete. The water has a pH value of 6.7.

IV. MIX PROPORTION

The mix design for M20 grade satisfies the specifications given in the concrete mix IS 10262: 2009.

Table. 1 Mix Proportion - M20

S. No	Materials	Quantity (kg/m^3)
1	Cement	438
2	Fine aggregate	657.02
3	Coarse aggregate	1179.17
4	Water	197
5	Water-Cement ratio	0.45

Hence, the mix ratio of concrete obtained is 1: 1.5: 2.69.

V. EXPERIMENTAL INVESTIGATION

A. Compressive strength testing

The compressive strength of the specimen of standard size 150 mm x 150 mm x 150 mm cubes are tested for 7, 28 days of curing. The strength of the concrete is obtained from 3 trial mixes of cubes. The coarse aggregate and fine aggregate are first mixed and then cement is added with sludge ash in the proportions of 5%, 10% and 13% respectively. The water is added to the mixture and mixed well. The concrete is then poured into the cubes in three layers and tampered with tamping rod of size 12 mm and compacted well. The cubes are demoulded and are subjected for curing. The cubes are taken out after curing period and is tested for compressive strength. Load is applied until the failure point has been reached.

Compressive strength of the specimen is calculated by,

$$f_{ck} = P/A$$

Where,

f_{ck} = Compressive strength (N/mm2)
P = Ultimate load (N)
A = Loaded Area (mm2)

Fig. 2 Compressive strength of concrete

B. Split tensile strength testing

The split tensile strength of the specimen of standard size 150 mm x 300 mm cylinders are tested. Three trial mixes are casted with the highest compressive strength obtained from the above value.

The casted cylinders are then demoulded and curing is done for 28 days. The testing of the specimen is carried out after the wetness on the specimen are wiped away. Lower plate and upper plate are fixed in the compressive testing machine with the cylinder. Load is applied to the specimen until the failure is reached. The split tensile strength of the specimen are noted by,

$$T = 0.637 \times k \times (P/S)$$

Where,

T = Tensile splitting strength (N/mm2)
K = 1.3-30 x (0.18-t/1000)2
P = failure load (N)
S = area of failure (mm)
S = l x t
l = length of failure (mm)
t = thickness of failure plane (mm)

C. Flexural strength testing

The flexural strength test is carried out on specimen of standard size 500 mm x 100 mm x 100 mm prism. The testing is done on three trial mixes with highest compressive strength value and the specimen is casted. Curing is done for 28 days. The prism is placed in the universal testing machine and the load is applied until the failure of the specimen is attained.

The flexural strength of the specimen is calculated by using,

$$f_b = pl / bd^2$$

Where,

p = maximum load (Kg)
l = supported length (cm)
b = width of the specimen (cm)
d = failure point depth (cm)

Fig. 3 Flexural strength of concrete

VI. RESULTS AND DISCUSSIONS

Table. 2 Average compressive strength

Mix	% of sludge	Average compressive strength (MPa)	
		7 days	28 days
M1	0	21.3	29.4
M2	5	20.9	28.2
M3	10	18.5	27.6
M4	13	16.4	23.4

Table. 3 Average Tensile strength

Mix	% of sludge	Average Tensile strength for 28 days (MPa)	
		7 days	28 days
M1	0	12.1	14
M2	5	11.8	13.2
M3	10	9.7	10.2
M4	13	7.6	9.5

Table. 4 Average flexural strength

Mix	% of sludge	Average Flexural strength for 28 days (MPa)	
		7 days	28 days
M1	0	3.1	3.5
M2	5	2.95	3.12
M3	10	2.7	2.88
M4	13	2.63	2.79

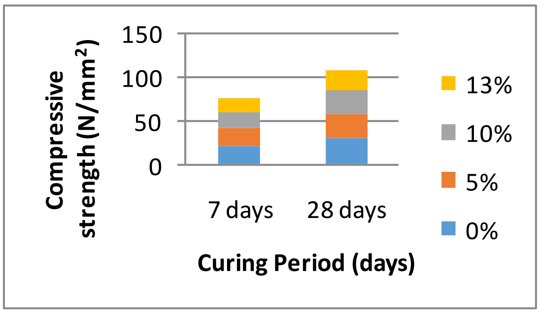

Fig. 4 Comparison chart for compressive strength of concrete cubes

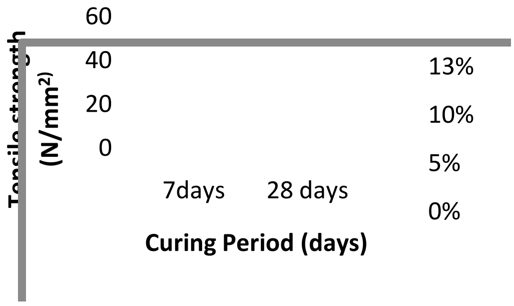

Fig. 5 Comparison chart for tensile strength of concrete cylinders

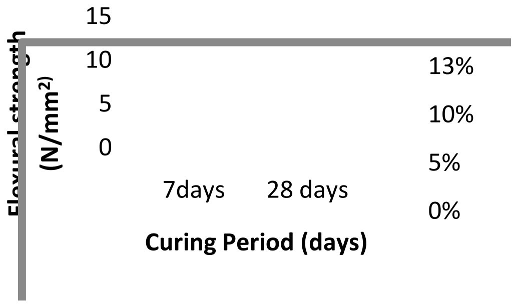

Fig. 6 Comparison chart for flexural strength of concrete prism

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

VII. CONCLUSIONS

This project gives the comparison study with conventional concrete and sludge ash replaced concrete. The strengths (Compressive, Tensile and Flexural) are studied and their results show the highest strength in the graphical representation.

The percentage variation between the compressive strength of conventional concrete and sludge ash concrete for 7 days are 1.88%, 13.15%, 23.01% and 28 days are 4.09%, 6.12%, 20.41% for 5%, 10% and 13% replacement respectively.

The percentage variation between the tensile strength of conventional concrete and sludge ash concrete for 7 days are 2.48%, 19.9%, 37.2% and 28 days are 5.8%, 27.16%, 37.15% for 5%, 10% and 13% replacement respectively.

The percentage variation between the flexural strength of conventional concrete and sludge ash concrete for 7 days are 4.84%, 12.91%, 15.17% and 28 days are 10.86%, 17.72%, 20.29% for 5%, 10% and 13% replacement respectively.

From the above studied results, it is clear in view that the percentage variation between the strength of conventional concrete and sludge ash concrete is less for 5% replacement and the variation increases with increase in percentage replacement with sludge ash.

REFERENCES

1. D. Vouk, D. Nakic, N. Stirmer and C. R. Cheeseman (2016). Use of sewage sludge ash in cementitious materials.
2. R. Baskar, K.M. Meera Sheriffa Begum, S.Sundaram (2006). Characterization and reuse of textile effluent treatment plant water sludge in clay bricks.
3. S.Arulkesavan, V.Jayabal, S.Purusothaman, J.Uma Maheshwaran & P.Vignesh (2017). Experimental study on effect of concrete made with textile effluent treatment effluent water.
4. Maha Alqam , Ahmad Jamrah and Haya Daghlas (2011). Utilization of cement incorporated with water treatment sludge.
5. RaghunathanT, GopalsamyP, Elangovan.R (2010). Study on strength of concrete with ETP sludge from dyeing industry.
6. Doh Shu Ing, Siew Choo Chin, Tan Kim Guan and Adilen Suil (2016). The use of sewage sludge ash as partial replacement of cement in concrete.
7. Rafiu O. Yusuf and Zainura Zainon Noor, Moh'd Fadhil Moh'd Din, Ahmad H. Abba (2012). Use of sewage sludge ash in the production of cement and concrete.
8. Srinivasan. K, Vazhviniyan. R, MohanKumar. L2, Palpandi. K (2016). Replacement of fine aggregate using sludge in concrete.
9. Thevaneyan Krishta David and Sivasan Karan Nair (2009). Compressive strength of concrete with sewage sludge ash.
10. Ghada Mourtada Rabie, Egypt (2016). Using of wastewater dry and wet sludge in concrete mix.
11. Sreedevi Lekshmi, Sheeba Sasidharan (2015). Experimental study on the use of textile sludge in concrete.
12. Sandhesh N U, Varun K, Prashanth V P (2014). A study on engineering properties of textile ETP sludge based cement concrete.
13. J.Balasubramanian, P.C.Sabumon, John U. Lazar, R.Illangovan (2005). Reuse of textile effluent treatment plant sludge in building materials.
14. Mr.G.J.Kulkarni, Prrof.A.K.Dwivedi & Prof.S.S.Jahgerdar (2012). Textile mill sludge a fine aggregate in concrete.
15. IS – 10262: 2009, Bureau of Indian Standards, New Delhi. Indian Standard Code for concrete mix proportioning guidelines (First Revision), July 2009.
16. IS - 456:2000, Bureau of Indian Standards, New Delhi. Indian Standard Code for plain and Reinforcement Concrete (Fourth Revision), July 2000.
17. "Concrete Technology Book" M.S.Shetty.