Utilization of Industrial Sludge and Quarry Dust in Manufacturing of Bricks

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***Abstract*— Sewage sludge refers to the residual, semi solid material that is produced as a by-product during sewage treatment of industrial or municipal Waste water. Sludge obtained from activated sludge process was used. This Sludge was processed and was then dumped so the odour was impressively reduced. Dumping sludge along with the fly ash used as an ingredient in making of burnt clay bricks and will test the strength of these sludge burnt clay bricks. This paper presents the results of the utilization of dried sludge and quarry dust as brick making materials. The different slabs of percentages of dried sludge that can be mixed with quarry dust and fly ash for brick making are 20%,30% and 40% for sample 1,2 and 3 respectively. The standard compressive strength of the bricks is 10.5N/mm^2 and 7 N/mm^2 for first and second class brick respectively. The study evaluated the suitability of the use of sludge as partial substitute for clay in brick manufacturing. In this study, three different proportions of dry sludge, quarry dust and fly ash are experimented and evaluated its feasibility as building material with minimum required strength. This study also emphasized on casting of light weight brick by adopting the best possible proportions without compromising with the minimum required compressive strength.**

***Keywords*— Industrial sludge, Dry sludge, bricks, clay, municipal solid waste.**

I. INTRODUCTION

Sludge resulting from municipal solid waste and wastewater treatment plants creates problems of disposal. Land filling and spreading of the dewatered sludge on land is general practice used for disposal of sludge. However, for highly urbanized cities, sludge disposal by land filling might not be appropriate due to land limitation. Incineration might be an alternative solution. However, a substantial amount of ash will be produced after the burning process and must be disposed of by other means. Successful pilot and full-scale trials have been undertaken in brick manufacture, cement manufacture, land application. The mineralogical composition of the "water treatment sludge" is particularly close to that of clay and shale. This fact encourages the use of water treatment sludge in brick manufacturing.

II. OBJECTIVES OF STUDY

a) For conservation natural soil and to reduce excavation
b) To check the feasibility of dry sludge for making bricks.
c) To reduce the cost of bricks and comparatively of the construction.
d) Utilization of dry sludge for manufacturing of bricks.
e) To reduce self weight of wall by making light weight bricks made by using dry sludge as a major constituents.
f) To find out proper disposal methods and sewage in the form of dry sludge.
g) To examine the effect of dry sludge in brick properties.

III. MATERIALS

1. DRY SLUDGE

Now days, disposal of sewage has become a necessity for societies. The construction of treatment plants has caused problems with huge content of dry sludge. It has been found that each person produce 35 to 85 grams of solid sludge per day. In recent years, waste production has increased dramatically in developing nations such as India.

There are two methods to solve the problem such as disposal of solid waste (dry sludge) including land filling and using dry sludge as fertilizers. But by both these methods some harmful material remains in sludge which causes harm to environment including land, air and water as a whole.

Fig No. 1: Dry Sludge

In the sense grit sludge may be generated in a grit channel or chamber. Grit particles are removed because they may damage pumps and other equipment. Hence we try dry sludge as a soil.

Table (1): Chemical Composition of dry Sludge

Ingredients	Ratio by Weight (%)
SiO_2	43.12
Fe2O3	5.26
AL2O3	15.97
CaO	5.56
MgO	0.85
SO3	1.49
Na2O	0.52
K2O	0.26
Cl^-	0.012
LOI	26.79

From above Table No. 1, it is obvious that is the major chemical compositions of the sludge were silicon, aluminum, and iron oxides, which are extremely similar to the major chemical compositions of the brick clay, but with higher alumina content. The dried sludge is pulverized using a pestle and mortar. The powder is then sieved through a series of sieves. The sieving process is done to separate the impurities and large particles of sand that may be included within the sludge. The last stage of sludge preparation process involves the removal of the organic content, which indicated by a relatively high value of loss on ignition (L.O.I) given in Table No.1

2. QUARRY DUST

It is the byproduct occurred while crushing of coarse aggregate such as stones, rocks etc. this dust obtained as a waste from the quarrying activity can be utilized for various purposes.

Testing of quarry dust

Specific gravity of quarry dust and sand is almost similar and ranges from 2.62 to 2.70 for zone II. Whereas density is 1520 to 1680 Kg/m^3.

3. FLY ASH

Fly ash is a coal combustion product obtained in the coal fired boilers along with the flue gases. Chemical properties of fly ash belong to the content of coal burned such as anthracite, bituminous and lignite. Fly ash can be replace to the cement in many construction and experiment activities due to its suitability.

Testing of Fly ash

Specific gravity of fly ash ranges from 2.1 to 3.0vand surface area by Blaine's air permeability apparatus can be 170 to $1000M^2/Kg$.

EXPERIMENTAL SETUP

Three different series of mixing ratios were tried. The mould used for the testing the cubes is of size (100X100X100)mm for compression test. Three cubes are casted for each sample and underwent compression test after 7 and 14 days and average values were taken for final compressive strength.

Different proportion of sludge, quarry dust and fly ash are taken for different sample. Proportion of material changes taken by percentage and weigh batching is preferred for accuracy. Several mixing and preparation techniques were attempted. The best sample preparation technique was found to be similar to that adopted in actual manufacturing process. Mixing of the raw materials includes two main steps, dry mixing and the blending with water. To ensure homogenous mixture hand mixing is preferred.

Table No.2: Different proportion of the samples

Sr. No.	Sample 1(20%)	Sample 2(30%)	Sample 3(30%)
Quarry dust	60	50	40
Sludge	20	30	40
Fly Ash	20	20	20

RESULTS AND DISCUSSION

COMPRESSIVE STRENGTH

All the cubes of each sample to be tested under compressive testing machine (CTM) placed one by one on the horizontal platform with the flat rough surface facing upward between plates of the machine. Apply load axially at a uniform rate of 14N/mm^2 per minute till the cube fails with the crack. Note the maximum load at which cube failed. Compressive strength of cube of each sample taken after its 7 and 14 day.

Compressive strength is determined by the ratio of Load at which cube failed to the cross section area of cube.

Sample 1

Table No.3: Compressive strength of cubes after 7 and 14 day

Cube No.	Compressive Strength (7day)	Cube No.	Compressive Strength (14day)
1	**2.36**	**1**	**4.10**
2	**2.42**	**2**	**4.10**
3	**2.39**	**3.**	**4.13**

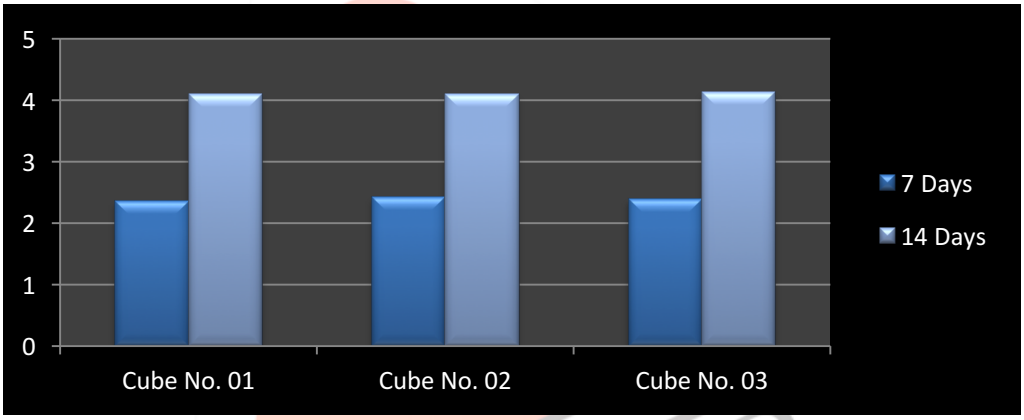

Chart 1: Compressive strength of cubes of sample 1

Sample 2

Table No.4: Compressive strength of cubes after 7 and 14 day

Cube No.	Compressive Strength (7day)	Cube No.	Compressive Strength (14day)
1	**2**	**1**	**6.71**
2	**4.60**	**2**	**6.68**
3	**4.61**	**3.**	**6.50**

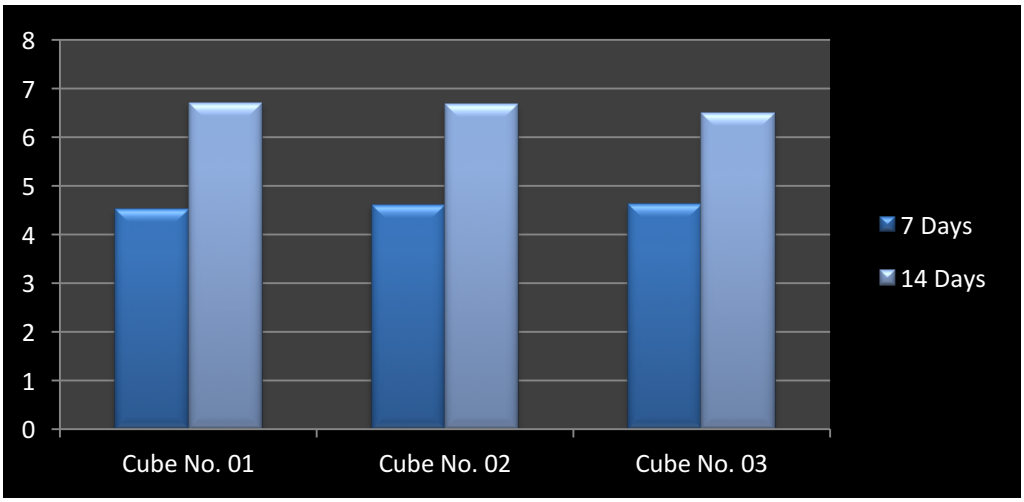

Chart 2: Compressive strength of cubes of sample 2

Sample 3

Table No.5: Compressive strength of cubes after 7 and 14 day

Cube No.	Compressive Strength (7day)	Cube No.	Compressive Strength (14day)
1	2.95	1	4.89
2	3.10	2	4.83
3	3.10	3.	4.93

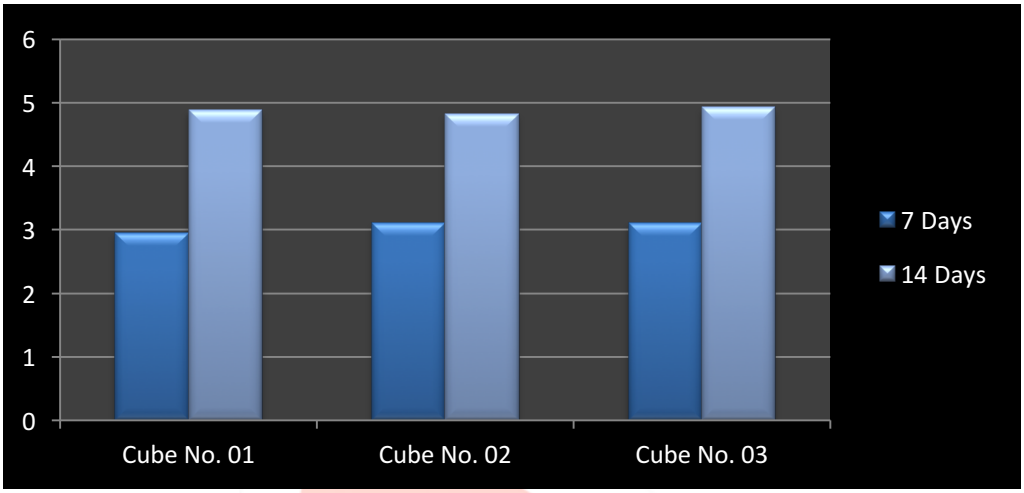

Chart 3: Compressive strength of cubes of sample 3

Above results also demonstrates that compressive strength of bricks containing 30% of dry sludge is more as compare to other fractions taken for the experiment. Sample 2 which is composition of 50% of quarry dust, 30% dry sludge and 20% fly ash gives the maximum compressive strength as compare to other percentage variation of materials. The min. compressive strength second class brick should be 7.0N/mm^2. It is also being observed that one can increase the percentage of sludge up to certain limit (in above case from chart No.2, compressive strength started decreasing on 40% use of sludge in sample 2) after that it may affect the strength and overall quality of product.

Water Absorption

Here in case of water absorption test both conventional and bricks of different percentage of sludge and quarry dust are considered and immersed in water for 24 hour and after testing all the results has been compared as follows.

Table No 6: Weight of bricks contained sludge of different percentage after water absorption

Brick sample	Conventional Brick	Sample 1 (20%)	Sample 2 (30%)	Sample 3 (40%)
1.	2790	2440	2077	2265
2.	2765	2414	1880	2260
3.	2773	2400	1910	2247

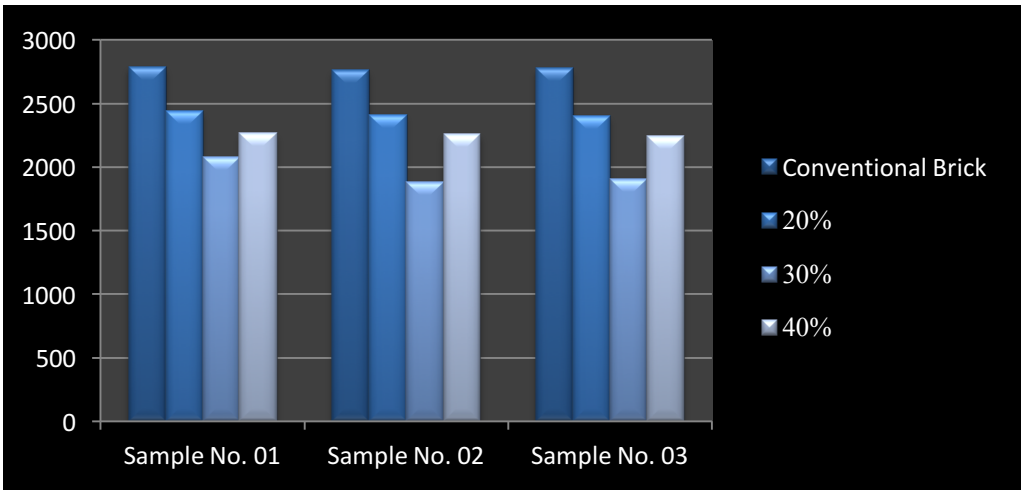

Chart 4: Weight of different samples of cube on water absorption

From the Chart No.4 it is cleared that the bricks made with 30% of sludge sample are lighter in weight than other two percentages taken for the manufacturing of brick.

Conclusion

The conclusion based on the various test results are as follows.

From the study it is concluded that dry sludge can be one of the essential ingredient for manufacturing of light weight bricks.

Among the Various sample considered for the experiment mixture of 50% of quarry dust, 30% dry sludge and 20% fly ash gave the feasible results. It is observed that on initial addition of 20% of sludge the compressive strength is not serviceable where as on addition of 30% sludge compressive strength of cube increases significantly which meets min. required compressive strength of second class brick. On further increment of sludge to 40% for the sample 3 shows the decrease in strength as compare to 30% sludge in the sample. This study also satisfies the entire objective which is considered for the study as follows:

1) Maximum value of compressive strength obtained on adding 30% sludge which is 6.71N/mm^2 so this brick can be used for structural construction purpose.

2) On 30% use of dry sludge and 20% fly ash it is observed that weight of brick reduces and obtained light weight product which ultimately reduces the self weight of structure.

3) As the dry sludge and quarry dust are waste materials so it can reduce the cost of brick and consequently the total cost of construction.

4) This study gives the best possible solution to avoid dumping of waste and to reduce land pollution it is used on large scale.

5) By this study we can conclude that second class bricks can be replace by the bricks manufactured by using waste materials such as dry sludge and quarry dust and it is feasible construction of non structural members with safety and serviceability.

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