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FABRICATION OF BRICK MANUFACTURING WITH INCORPORATING OF PAPER SLUDGE AND TO IMPLEMENT GREEN TECHNOLOLOGY FOR SUSTAINABLE DEVELOPMENT

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Abstract-- The large amount of sludge is generated in paper manufacturing plants make necessary the initiation of reuse to reduce the sludge generated as a waste, such as its use in brick manufacturing. If sludge is disposed, it effects to environment in various ways. In this paper, the materials used for brick manufacturing are clay (mix of red and black clay), paper sludge, rice husk and fly ash. The physical and chemical properties of these materials are studied. The experiments have been conducted on hand moulded bricks in various mix proportions. In this, all bricks have been dried in natural conditions and lab tests are conducted as per IS Standards. The compressive strength satisfies the need of IS Code wherein, sludge added in brick manufacturing with 20% additionally and partial and fully replacement of rice husk with 10 and 20% of sludge. The water absorption of bricks also satisfies as per codes.

Key Words **---- Brick, Paper Sludge, Compressive Strength, Water Absorption, Waste and Recycling, Green Technology.**

I. INTRODUCTION

The environmental pollution causing irreparable damage to society is one of the major problems that the world is facing today. There is an immediate need for the communities and industries to come up with measures such as environmental rules and clean waste disposal technologies. Waste handling is also one of the major problems in industrial plants as well as in pulp and paper industries. One of the waste management is reusing and recycling industrial waste for applications such as building materials and construction process. Recycling industrial waste by blending them into building materials is a solution to the pollution prevention.

Paper industry releasing lot of sludge in waste water treatment, sludge is a waste material and it is used in paper pads and egg trays. It is used in brick manufacturing we can reduce large amount of sludge and sustainable development occurs for future generations. Paper sludge mainly consists of cellulose fibre and inorganic materials. The moisture content of paper sludge may vary from 60-75%. However this value can be reduced to 35% by dewatering process. Paper sludge also contains heavy metals from inking activities such as writing and painting.

Two types of sludge are generated in paper mill such as sewage sludge and deinking sludge. The disposal of sludge can be done as, land disposal as an agriculture fertilizer; disposal in a landfill site; combined incineration at heat and power plants at paper mill. If sludge is burnt in incinerators, serious air pollution problems are occurred.

II. OBJECTIVES OF STUDY

- To study about the various (partially and fully) mix proportions in manufacturing process of Bricks.
- To find good workable mix proportion for brick.
- The study of sludge properties and parameters.
- To analyse the various strength parameters of the fabricated paper sludge (Green) Bricks.

III. MATERIALS USED

The main raw material used in brick manufacturing is Agricultural clay. It is one of the most abundant natural mineral materials on earth. For brick manufacturing, clay must possess some specific characteristics and properties. Such clays must have plasticity, which permits them to be shaped or moulded when mixed with water. Fly ash is used as one of the mixing material in the brick and rice husk also used as batching material for brick manufacturing. Here sludge is used as extra material. Small amounts of Manganese, Barium and contrasting additives are blended by the whole of clay to produce antithetical shades.

A. Properties of clay

Silica (sand) – 50% to 60% by weight.

Alumina (**clay**) – 20% to 30% by weight.

Lime – 2 to 5% by weight.

Iron oxide – ≤ 7% by weight.

Magnesia – less than 1% by weight.

B. Properties of sludge

TABLE 1
CHEMICAL PROPERTIES OF SLUDGE

S.NO	Parameters	UOM	ETP Sludge
1.	pH	-	8.1
2.	Ec	µS/Cm	183
3.	Exchangeable Ca	mg/kg	5689
4.	Exchangeable Mg	mg/kg	746
5.	Exchangeable Na	mg/kg	150
6.	Available Nitrogen	mg/kg	240
7.	Available Potassium	mg/kg	189
8.	Available Phosphorous	mg/kg	69
9.	Organic matter	%	18.06

TABLE 2
TOXICITY CHARACTERSTICS:

1.	Flammable		No
2.	Explosive		No
3.	Corrosive		No
4.	Toxic		No
5.	Carcinogenicity		No

TABLE 3
PROXIMATE ANALYSIS

1	Moisture	%	2.91
2	Ash	%	75.69
3	Volatile matter	%	21.30
4	Fixed Carbon	%	0.10

IV. EXPERIMENTAL PROCEDURE

There are four different operations are involved in the process of manufacturing of bricks. They are

- Preparation of clay
- Moulding
- Drying and
- Burning

Fig.1 Mixing of Sludge

Fig.2 After Mixing

Fig.3 Prepared Bricks

Fig.4 Drying of Bricks

Fig.5 Burning of Bricks

1. Un-soiling: It is the by the number of melting of eclipse layer pollute which consists of vegetation or contrasting impurities.

2. Digging: It is the by the number of palaeontology of clay. It is done manually by tools or by machines one as excavators

3. Cleaning: It is the ceasing to exist of impurities a well known as stones and excess materials, it is done by member of the working class picking or sieves

4. Weathering: It is done to earn the adequate meet of crying in clay. In this manner clay is sweet in the construct of layers (600 to 1200mm) and unarmed to after world for by seat of one pants drying for at antipodal 30days.

5. Blending: It is the style of mixing other part and parcel material one as conglomerate, shale, lime free of error etc to clay. This provides desired characteristics to clay.

6. Tempering: It is to mingle the clay into a of the same opinion mass mutually uniform consistency

7. **Moulding:** It is the process of giving desired shape to the tempered clay. It is done manually or by machines. Mould is made up of wood or steel. Clay is introduces in the mould firmly. Then mould is lifted with jerk and inverted on a ground or table. For getting the depression of frog, moulds are provided with frog arrangement.

8. Drying: It is to disband all excessive moisture contained at the predate of moulding without adverse the bricks and to the way one sees it brick intimately enough so it can act with regard to operations in burning. Drying can be done by two methods:

9.Natural Drying: Moulded bricks are arranged in rows called hacks by all of space surrounded by bricks for sending out of air. Natural drying is not suitable in monsoon season.

10. Artificial Drying: In this manner bricks are dried artificially in irate chambers or furnaces. This means is likely for large gat to one feet production.

11. Burning:

Burning removes raw material from the clay from one end to the other and provides tensile strength and fury to bricks. Burning makes the brick preferably durable. The latitude required for ardent is virtually 900 to 1200 period of time centigrade

A. Brick manufacturing process by adding sludge additionally

1. The clay is extracted from agricultural land.
2. For that clay fly ash and rice husk is added
3. To that clay 10% paper sludge is added.
4. The material is mixed with sludge and moulded.
5. The brick is dried for 8 to 10 days.
6. It is burnt at a temperature of 800 to 1200 C.
7. The brick is prepared from partial replacement of clay with 10% sludge.
8. Similarly the brick with 20%, 30% and 40% sludge is prepared.

B. Sludge is added in Brick manufacturing, full replacement of rice husk (clay 80%, fly ash 10%, sludge 10%, 20%, 30% and 40%)

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C. Sludge is added in Brick manufacturing with partial replacement of rice husk and fly ash.(clay 70%, fly ash 10%, rice husk 10% and sludge 10%,20%. 30% and 40%)

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V. RESULTS AND DISCUSSION

A. Compressive strength results

TABLE 4
SLUDGE IS DIRECTLY ADDED (ADDITIONALLY) IN BRICK MANUFACTURING

S.NO	Percentage of sludge	Average Compressive strength (kg/sq.cm)
Sample-1	10	26.8
Sample-2	20	35.2
Sample-3	30	7.4
Sample-4	40	6

TABLE 5
SLUDGE IS ADDED IN BRICK MANUFACTURING, FULL REPLACEMENT OF RICE HUSK (CLAY 80%, FLY ASH 10%, SLUDGE 10%, 20%, 30% AND 40%)

S.NO	Percentage of sludge	Average Compressive strength (in kg/sq.cm)
Sample-1	10	48.6
Sample-2	20	41
Sample-3	30	27.6
Sample-4	40	24.4

TABLE 6

SLUDGE IS ADDED IN BRICK MANUFACTURING WITH PARTIAL REPLACEMENT OF RICE HUSK AND FLY ASH.(CLAY 70%, FLY ASH 10%, RICE HUSK 10% AND SLUDGE 10%,20%. 30% AND 40%).

S.NO	Percentage of sludge	Average Compressive strength (in kg/sq.cm)
Sample-1	10	64.6
Sample-2	20	40
Sample-3	30	35
Sample-4	40	25

B. Water absorption test results

TABLE 7
SLUDGE IS DIRECTLY ADDED (ADDITIONALLY) IN BRICK MANUFACTURING

S.NO	Percentage of sludge	Average Water absorption value (in percentage)
Sample-1	10	24
Sample-2	20	20
Sample-3	30	30
Sample-4	40	40

TABLE 8
SLUDGE IS ADDED IN BRICK MANUFACTURING, FULL REPLACEMENT OF RICE HUSK (CLAY 80%, FLY ASH 10%, SLUDGE 10%, 20%, 30% AND 40%)

S.NO	Percentage of sludge	Water absorption value (in percentage)
Sample-1	10	17.6
Sample-2	20	18
Sample-3	30	16.6
Sample-4	40	23

TABLE 9
SLUDGE IS ADDED IN BRICK MANUFACTURING WITH PARTIAL REPLACEMENT OF RICE HUSK AND FLY ASH.(CLAY 70%, FLY ASH 10%, RICE HUSK 10% AND SLUDGE 10%,20%. 30% AND 40%).

S.NO	Percentage of sludge	Average Water absorption value (in percentage)
Sample-1	10	17.4
Sample-2	20	20
Sample-3	30	31
Sample-4	40	41

C. Efflorescence test

The prepared bricks have no efflorescence

D. Size, shape and colour test

The prepared bricks are good size, shape and color. Results are within limits

E. Soundness test

The bricks are not broken and a clear ringing sound is produced

F. Hardness test

The prepared bricks are sufficiently hard.

G. Discussions

Graphs are drawn between compressive strength and percentage of sludge added. On X-axis percentage of sludge and on Y-axis compressive strength values are noted.

1. Graph of percentage of sludge and compressive strength

Case 1: sludge added directly in brick work

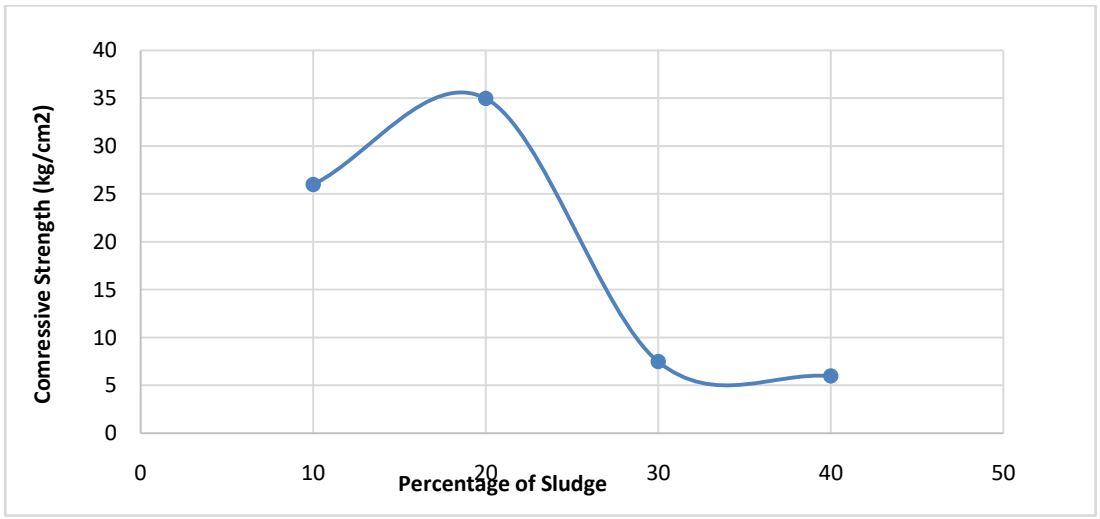

Fig.6 Variation of Compressive Strength When Sludge added Additionally

At 10% of sludge the compressive strength is 25kg/sq.cm but at 20% the value is suitable. If sludge added directly in brick work at 20% of sludge the compressive strength is 35 kg/sq.cm. These types of Bricks can be used as third class bricks and these are used at temporary constructions. Due to less weight the compressive strength is not obtained for 30 and 40 percentage of sludge mixing.

Case 2: sludge added instead of rice husk in brick manufacturing

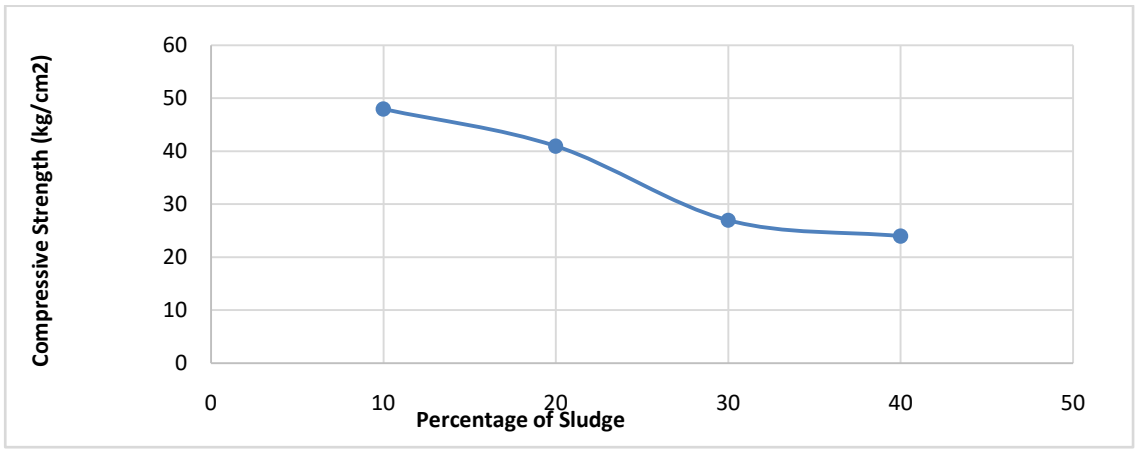

Fig.7 Variation of Compressive Strength Sludge added fully replacement of Rice Husk

If sludge added instead of rice husk then compressive strength of bricks at 10 and 20% gives suitable values. Percentage of sludge increases then weight and compressive strength of bricks decreases. These types of bricks can be used as second class bricks, for these bricks plastering is necessary. 30% and 40% sludge added bricks have less weight and less compressive strength. So these are not suitable for any purpose.

Case 3: clay, rice husk, sludge and 10% of fly ash added in brick manufacturing

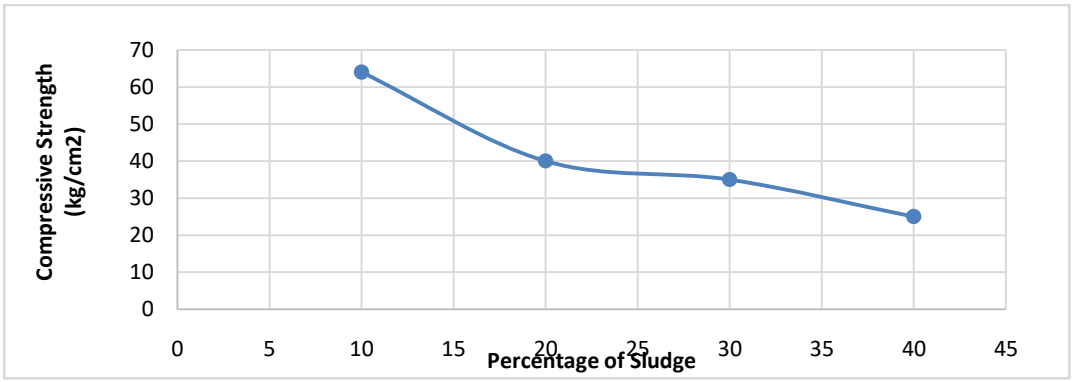

Fig.8 Variation of Compressive Strength When Sludge added Partial replacement of Rice Husk

In this case also at 10 and 20% of sludge the compressive strength of brick is good and these types of bricks can be used as second class bricks. From this we observed that, if percentage of sludge increases then both weight and compressive strength decreases. These types of bricks can be used as second class bricks, if these are used in construction plastering is necessary.

2. Graphs of percentage of sludge and water absorption:

Case 1: sludge is directly added in brick manufacturing

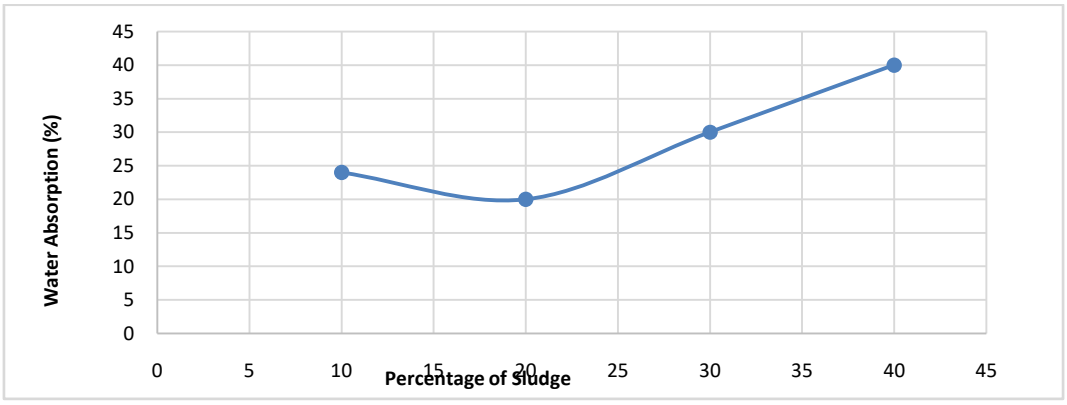

Fig.9 Present Water Absorption of Bricks When Sludge added Additionally

The water absorption at 20% sludge is 20%. This value is within limit and at 30 and 40% of sludge the water absorption value is high, the limit is exceeding for these types of bricks.

Case 2: sludge added instead of rice husk in brick manufacturing

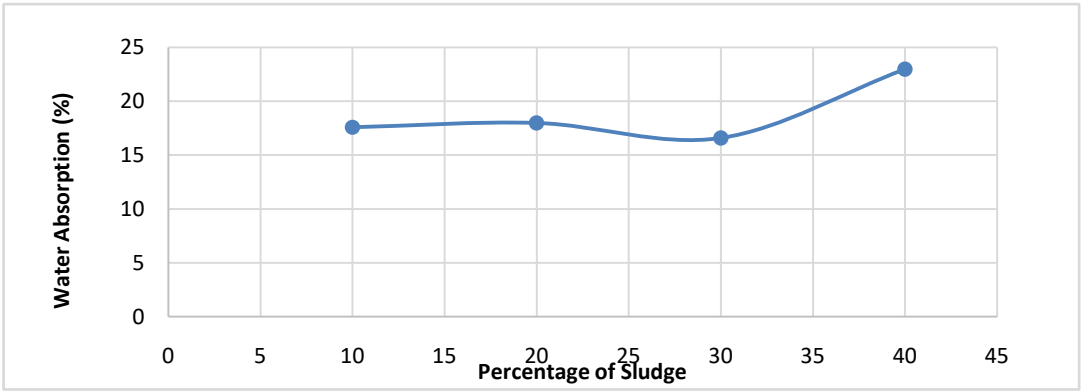

Fig.10 Present Water Absorption of Bricks Sludge added fully Replacement of Rice Husk

The water absorption values at 10, 20and 30% of sludge are 17% and 18%. These values are within limit. At 40% the value is exceeded so it is not considered.

Case 3: clay, rice husk, sludge and 10% of fly ash added in brick manufacturing

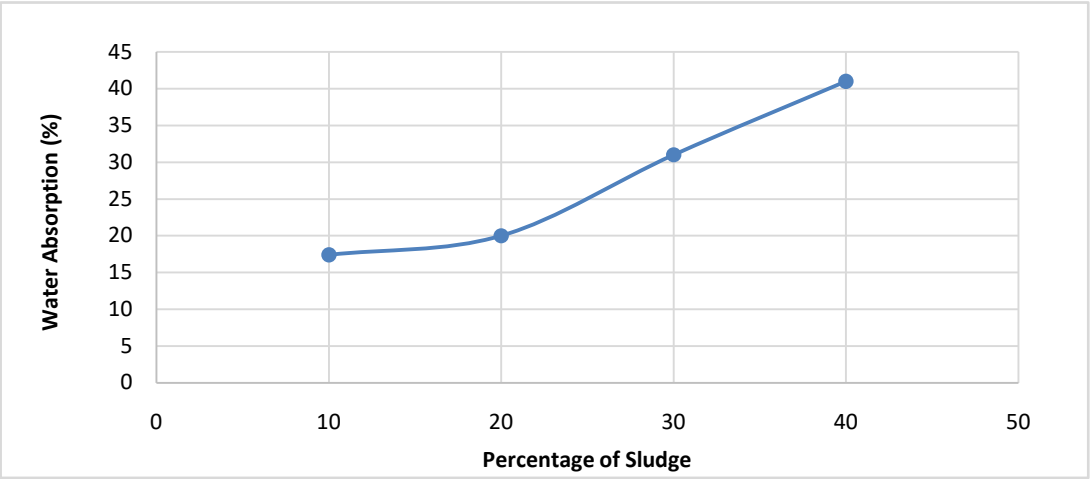

Fig.11 Present Water absorption of Bricks Sludge added Partial repalcement of Rice Husk

In these types of bricks at 10 and 20% of sludge the water absorption values are within limit in construction work these are not affected in any way. If percentage of sludge increases the water absorption also increases so those are not considered for construction work.

VI. CONCLUSIONS

- In this project the sludge generated from waste water treatment in paper industry can be used in clay brick manufacturing. Laboratory tests have been conducted on hand moulded bricks composed of various weighed proportions.
- Since sludge is a waste material and can be utilise free of cost for brick making, so brick manufacturing it is economical, beneficial to society and eco friendly.
- The compressive strength of bricks suitable at certain limit (=10% and 20%) with addition of sludge and partial replacement of sludge.
- In this project, the compressive strength of bricks in some trials found to be less than 35kg/sq.cm and some fulfil the criteria of minimum compressive strength of bricks as per (Indian Standard: 1725,1997).
- Paper sludge brick has about 30% weight reduction when compared with normal brick.
- The sludge added directly (in additionally) in brick work, then at 20% of sludge the compressive strength is 35 kg/sq.cm and water absorption is 20%. These values are suitable for third class bricks.
- The sludge added instead of rice husk (partial replacement) then at 10 and 20% of sludge the compressive strength values are 48.6 kg/sq.cm and 40 kg/sq.cm and water absorption values are 17.6% and 18%. These types of bricks can be used in construction
- The sludge added with partial replacement of fly ash and rice husk at 10 and 20% the compressive strength values are 64.6 kg/sq.cm and 40 kg/sq.cm and water absorption values are 17.4% and 20%. These types of bricks can be used in construction
- It is energy efficient, It is waste to wealth and sustainable development occurs
- By using like this sludge can be reused and it contains organic matter so carbon dioxide and other gases released from this sludge can be reduces.
- If waste used like this or in various works, waste can be reduced then Green technologies takes place and cleaner development mechanism will occur.
- Then sustainable development takes place and pollution can be reduces, then it is useful for further generations

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