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UTILISATION OF WASTE MATERIALS IN BRICK MANUFACTURING

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Abstract - *Brick is one of the most important building unit due to its strength properties. Attempts were made to manage wastes into the production of bricks. In this paper we experimentally describe the recycling of the waste products like granite wastes, saw dust and fly ash by incorporating into bricks. This would be a practical solution for problems like cost expenditure on waste management and its effect on nature. The granite and fly ash are extremely close to brick clay in chemical composition, so it could be a potential substitute for clay bricks. The granite waste is generated in granite process industries and it is disposed-off on the roads of urban areas. So the use of these powdered form of wastes in producing construction elements is considered to be the most economic and environmentally sound option. The present work involves the manufacture of bricks with the above said materials and tests on mechanical properties. From the test results it is inferred that the addition of fly ash and granite gives better results than saw dust.*

Key Words: Handmade bricks, FlyAsh, Granite waste, sawdust, Waste Management.

1. INTRODUCTION

Brick is one of the most common masonry units due to its strength properties. Many attempts have been made to incorporate wastes into the production of bricks, for example, rubber, limestone dust, saw dust, processed tea waste, fly ash, polystyrene, granite powder, marble powder, sludge, etc. Most manufactured bricks with different types of waste have shown positive effects in the properties of fired clay bricks. The history of brick manufacturing goes back 8000 years when the fabrication of the earliest sun dried clay bricks was discovered. Recycling of waste is for achieving sustainable development. On the other hand, recycling waste without properly based scientific research and development can result in environmental problems greater than the waste itself. The successful research and development of a new building material or component using waste as raw material, is a very complex and multidisciplinary task having technical, environmental, financial, marketing, legal and social aspects (John and Zordon 2001) Now-a-days the cost of construction materials is increasing incrementally. In India, the cost of cement during 1995 was Rs.1.25/kg and in 2008 the price increased three times. In case of bricks the price was 0.66 per brick in 1995. Also due to high transportation costs of these raw materials, demand, environmental restrictions, it is essential to find functional substitutes for conventional building materials in the construction industry (Pappu et al., 2007).

2. MANUFACTURING OF BRICK

The specimen brick is manufactured and testing of brick which is made by utilising the wastes like Fly ash, Saw dust and Granite dust.

2.1 Chemical composition of raw materials

Fly ash from thermal power plant (45.5% of wastes in dump site annually in India) Saw dust from wood industries (12% of saw dust produced annually in India)Granite dust from granite quarry (30% of granite dust produced annually in India).The chemical composition of flyash, granite and saw dust is shown in table-1 and table-2.

Table-1 Chemical composition of fly ash and granite wastes

Composition	Fly ash	Granite
SiO_2	27-59%	70 - 77%
Fe_2O_3	1-30%	11 - 13%
Al_2O_3	5.-34%	3 - 5%
CaO	0.3-28%	1 - 2%
MgO	0.4-9%	2 - 3%
Na_2O	0.2-7%	0 - 0.9%
Others	0.2-28%	0 - 10 %

Fig -1: Waste Materials fly ash, granite waste, saw dust

Table -2 Chemical composition of saw dust

Composition	Bast fiber (%)	Woody core (%)
Cellulose	55	48
Hemicellulose	16	12
Pectin	18	6
Lignin	4	28
Wax + Fat	1	1
Ash	4	2
Protein	2	3

2.1 Specimen Details

As per Indian Standard: 2117-1963, "code of practice for manufacture of hand-made common burnt clay building bricks", Manufacturing of specimen includes the preparation of soil, moulding, drying of bricks, burning and cooling.

Table -3 Specimen details of handmade burnt bricks

% of waste added	No. of Bricks			Total no. of bricks
	Using fly ash	Using saw dust	Using granite dust	
0	-	-	-	14
3	14	14	14	42
6	14	14	14	42
9	14	14	14	42
12	14	14	14	42
15	14	14	14	42
			Total = 224	

The specification details of the bricks is given in Table -3.The soil is left in heaps and exposed to weather for at one month. The purpose of weathering is to disintegrate big boulders of clay under the action of atmospheric agencies to make it a uniform mass and also to eliminate the impurities which get oxidized. After weathering, the required quantity of water should be added with the soil to obtain the right consistency for moulding. Addition of waste materials can be made to modify the composition of soil. The quantity of water to be added, ranges from 1/4 to 1/3 of the weight of soil. It is done by hand moulding process by using plastic mould which has a dimension of 21cm x 9cm x 9cm. During moulding bricks are sorted with 1mm gap between each and every brick. Bricks are dried by natural drying for 4 days. Bricks are arranged and kiln has been created for firing. Firing is done by rice husk. Bricks are burnt above 800°C.

Fig -2: Preparation of specimen

3. TESTING OF HANDMADE BRICK

The specimen is tested for Compression test, Water absorption test, Efflorescence test, Hardness test, Soundness Test, Falling test.

Table -4 Test results of fly ash handmade bricks

Fly ash	0%	3%	6%	9%	12 %	15 %
Water absorption	15.3%	11.8 %	12.4%	13.3%	14.5 %	13.1 %
Crushing strength N/mm²	5.64	8.25	7.99	6.73	6.48	6.1
Hardness	✓	✓	✓	✓	✓	✓
Soundness	✓	✓	✓	✓	✓	✓
Falling test	✓	✓	✓	✓	✓	✓
Efflorescence	nil	nil	nil	nil	nil	nil

Table- 4 represents the test results of fly ash added bricks which range from 0 to 15%.Water absorption for fly ash added bricks are below 20%. So these are classified as first class bricks. In the above table minimum water absorption of fly ash added bricks is 11.8% and maximum absorption is 14.5%. The maximum crushing strength is attained when 3% of fly ash is added. And the crushing strength is reduced gradually for every 3% addition of waste due to the CaO

content.Successfully passed hardness, soundness and falling tests. There is no efflorescence.

Table -5 Test results of granite handmade bricks

Granite waste	0%	3%	6%	9%	12%	15%
Water absorption	15.3%	11.05%	11.1%	11.3%	11.6%	11.4%
Crushing strength N/mm²	5.64	7.34	7.7	7.91	8.06	7.74
Hardness	✓	✓	✓	✓	✓	✓
Soundness	✓	✓	✓	✓	✓	✓
Falling test	✓	✓	✓	✓	✓	✓
Effloroscence	nil	nil	nil	nil	nil	nil

Table - 5 represents the test results of granite dust added bricks which range from 0 to 15%. Water absorption for granite waste added bricks are below 20%. So these are classified as first class bricks. In the above table minimum water absorption of fly ash added bricks is 11.05% and maximum absorption is 11.6%.The maximum crushing strength is attained when 12% of fly ash is added. And the crushing strength is increased gradually for every 3% addition of waste due to increase in density. Successfully passed hardness, soundness and falling tests. There is no efflorescence.

Table -6 Test results of saw dust handmade bricks

Saw dust	0%	3%	6%	9%	12%	15%
Water absorption	15.3%	15%	20.5%	28%	35%	42.5%
Crushing strength N/mm²	5.64	3.19	1.93	0.69	0.53	0.31
Hardness	✓	✓	✓	✗	✗	✗
Soundness	✓	✓	✓	✓	✓	✓
Falling test	✓	✗	✗	✗	✗	✗
Efflorescence	nil	nil	nil	nil	nil	nil

Table-6 represents the test results of sawdust added bricks which range from 0 to 15%. Water absorption for saw dust added bricks are below 20% up to 6% only. So these are classified as first class bricks. And other bricks which is having water absorption more than 20% is classified as second class bricks. In the above table minimum water absorption of saw dust added bricks is 15% and maximum absorption is 42.5%. The maximum crushing strength is attained when 3% of fly ash is added which is equal to 3.19 N/mm2. And the crushing strength is reduced gradually for every 3% addition of waste due to reduction in density of bricks as shown in chart 1.

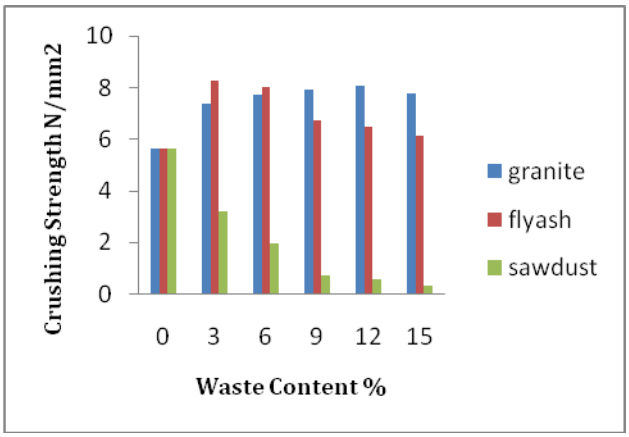

Chart -1: Crushing strength Vs waste content

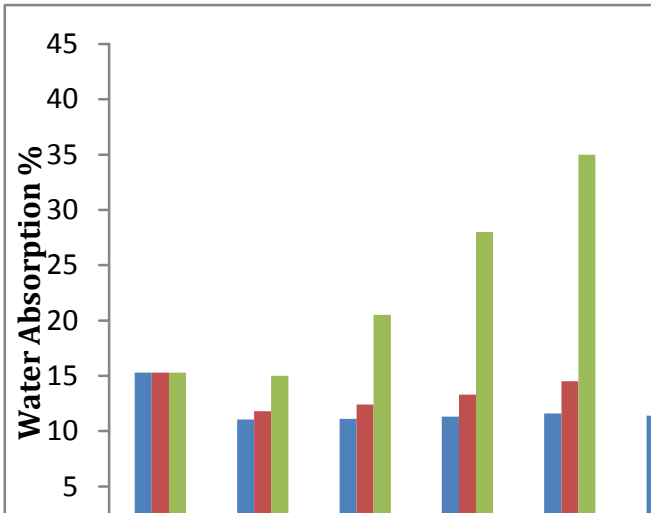

Chart -2: Water absorbtion Vs waste content

3. CONCLUSIONS

The specimen brick using fly ash has Water absorption for all percentage of wastes are less than 20%. So as per IS : 1077-1957 these are classified as 1st class bricks. Optimum crushing strength has reached when 12% of waste is added which is equal to 8.06 N/mm2. So as per IS : 1077-1966 it is classified as class A bricks. As per IS : 1077-1971 Granite waste added bricks can be used for good structures such as outer walls and facing work when no plastering work is done. These are also used in floors and reinforced bricks

slabs. Such bricks should be laid in rich mortar. Successfully passed the hardness, soundness, and falling test. There is no efflorescence. The weight of granite waste added brick has increased by 14%. So water absorption is less for granite waste added bricks

The specimen brick using fly ash has Water absorption for all percentage of wastes is less than 20%. So as per IS : 1077-1957 these are classified as 1st class bricks. Optimum crushing strength has reached when 3% of waste was added which is equal to 8.25 N/mm2.As per IS : 1077-1971 flyash waste added bricks can be used for good structures such as outer walls and facing work when no plastering work is done. These are also used in floors and reinforced bricks slabs. Such bricks should be laid in rich mortar. Successfully passed the hardness, soundness, and falling test. There is no efflorescence. The weight of fly ash added brick has increased by 5%. So water absorption is less for granite waste added bricks.

The specimen brick using saw dust has Water absorption of 15% for 3% addition of sawdust (class1 brick). And for 6% it increases to 20.5% (class 2 brick).Optimum crushing strength has been reached when 3% of waste is added which is equal to 3.19 N/mm2which is less than the compressive strength of normal brick(5.64 N/mm2).Saw dust added bricks (up to 6%) can be used for inferior construction works or at places where there is a less rainfall or presence of dampness. Successfully passed the soundness and hardness upto 6%.There is no efflorescence. The weight of saw dust added brick has decreased by 41%. So water absorption is more for saw dust added bricks.

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