International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 12| Dec -2016 www.irjet.net p-ISSN: 2395-0072

Study and analysis in making of bricks using construction debris

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Abstract - The amount of construction & demolition (C&D) waste generated in the country has increased considerably in recent years due to rapid pace of development. There is no uniform and systematic process followed in determining the total quantity of C&D waste generated or in collection, transportation and disposal of C&D waste anywhere in India. A study was thus carried out to determine the potential reuse of construction debris as a brick making material. The study investigates the potential for reusing construction debris as a replacement for sand. The brick characteristics, both strength and aesthetic tests such as water absorption test, compressive strength test and efflorescence are to be conducted on bricks made using construction debris and normal bricks which are to be compared. This project will thus be very useful in an eco- friendly environment.

Keywords: debris, bricks, water absorption, compressive strength, efflorescence

1. Introduction

The management of C&D waste is of major concern due to the shortage of dumping sites and increase in transportation and disposal costs. C&D waste strewn across our cities chokes surface drains, disrupts traffic and is an eyesore on the urban landscape. Recycling of C&D waste has important implication on natural resources and environment. Partial replacement of building materials by use of C&D waste would lead to reduction of sand mining from river beds or cutting of rocks. Industrialized countries have system in place for recycling of construction and demolition debris and even in-situ recycling of black top roads. Appropriate management of C&D waste would thus be greatly beneficial for our country as a whole such as

- To comply with policy, legislation and regulation on waste management such as disposal.
- To provide an economical alternative to the C&D industry for land-based disposal, as recycling is more sustainable and the cost of land-filling is increasing
- To eliminate illegal dumping and associated negative impacts on the landscape, especially in rural areas.
- To control waste disposal thereby reducing the transportation costs
- To conserve natural resources and reduce our dependency on materials
- To reduce the volumes of waste being diverted to landfill
- To reduce the environmental harm caused by waste burial and mining of materials
- To use less energy in material/aggregate production

The C&D plant can efficiently recover bricks, soil, sand and concrete which can be reused. Thus the process not only helps in reducing waste, but also indirectly leads to decreasing pollution. Therefore this process is being looked at by scientists and engineers throughout the world.

An effort towards use of waste materials in structural elements like bricks without any combustion and autoclave pressure is not taken up very effectively and implemented in real time projects so far by the industry because

1. Unaware of recycling techniques
2. Unaware about the possible materials that can be used as substitutes
3. No specifications are available

Therefore there is a need to develop a sustainable technology for replacement of natural resources by waste materials is the manufacture of bricks. This project thus makes use of construction debris from demolished buildings for the manufacture of clay brick and its compressive strength, water absorption and presence of efflorescence is compared.

2. Experimental methods

A plastic mould was used to produce rectangular bricks (230mm x 110mm x 100mm) as shown in figure 1. Bricks were made from clay and powdered debris by 0%, 10%, 20%, 40% debris by weight as shown in figure 2 and 3. The clay and debris were mixed together by hand. Water was added according to the optimum moisture content before the mixture was kneaded into the moulds in thin layers by applying a hammering motion using a steel rod in order to compact it. The wet bricks were left to air-dry in the moulds for over three days in the sun at temperatures varying from 35^0 C to 40^0C as shown in figure 4. Slow drying was necessary to prevent the bricks from cracking or internal steam formation. Finally, the completely sun dried bricks were placed into a kiln. It is important to burn bricks to remove the water accumulated by crystallization and to activate chemical reactions in the ingredients of clay. At a temperature of 650^0C, organic matter in the clay is oxidized and water crystal vaporizes. When the temperature is increased to 1100^0C, the particles of alumina and silica bind together by fusion. At temp above 1100^0C, more glossy mass is formed. This stage is known as vitrification. The process imparts hardness, strength and durability. The kiln was then shut down and bricks were left to cool down naturally. The slow burning of bricks was done to prevent the bricks from cracking. Compressive strength was determined for the 0%, 10%, 20%, 40% debris containing bricks using a UTM testing machine. A loading was applied to the bricks until they failed and maximum loading rate was recorded. The compressive strength was taken as the average result from a set of 3 tests for each respective brick type.

2.1 Debris preparation

Debris is collected from the demolished sites. The concrete debris is crushed and then the debris was sieved using 1.18mm, 600 microns, 300 microns & PAN. The debris was then weighed and packed in ratios of 10% (400 gms), 20% (800 gms), and 40% (1600 gms) taking the total weight of a brick as 4.0kgs.

Figure- 1: Plastic mould

Figure- 2: Concrete waste being crushed

Figure- 3: Clay preparation

Figure- 4: Bricks kept for drying under natural sun light after moulding

3. Results and Discussion

The bricks produced using construction debris is observed for its various physical characteristics such as colour, shape, size, texture and hardness. The performance is also tested by finding their compressive strength developed, water absorption, and the effect of efflorescence for mix proportion of bricks. The results obtained are discussed in detail in the following sections.

3.1 WATER ABSORPTION TEST

The test was carried out by immersing the bricks in cold water for 24 hours after that its change in weight is calculated for water absorption test as shown in figure 5.Water absorption percentage after 24 hrs immersion in cold water is given by the formula,

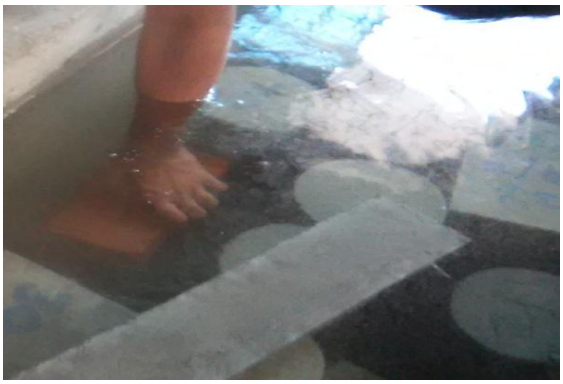
$$W = \{(M2- M1)/ (M1)\} \times 100 \quad \text{(eq.1)}$$

The water absorption of bricks produced using debris for various mix proportions used in this study are determined as given in the table 1.

Table- 1: Water absorption for various percentage of debris

Weight of bricks	Percentage of debris (%)			
	0	10	20	40
Initial weight in kg	3.018	3.104	3.112	NOA
Final weight after 24 hours in kg	3.237	3.417	3.432	NOA
Water absorption (%)	7.25	10.08	10.28	NOA

From the test results we can observe that there is minimal increase in water absorption with respect to increase in percentage of bricks produced using debris. The water absorption value for different mix proportions is represented in the figure 6.



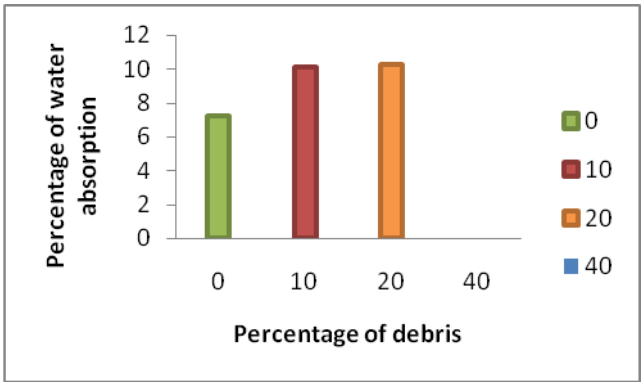


Figure- 5: Bricks immersed in water **Figure- 6:** Water absorption for various percentage of debris

3.2 Compressive strength test

The compressive strength of bricks produced using debris with various mix proportions are tested by using Universal Testing Machine as shown in figure 7. Average compressive strength of the given bricks is given in Table 2.

Compressive strength = {maximum load at failure (N)}/ {average area of bed face mm^2)} (eq. 2)

Table- 2: Compressive strength of bricks

Percentage of debris (%)	0	10	20	40
Compressive strength of bricks produced in kg/cm^2	48.52	34.35	47.2	NOA

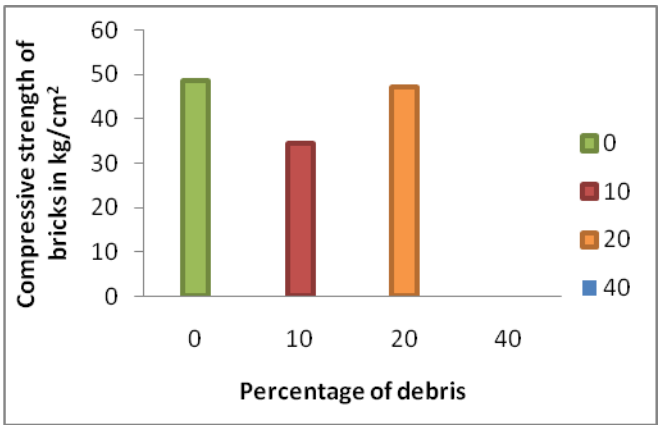


Figure- 7: Compressive strength in UTM **Figure- 8:** Compressive strength vs percentage of debris

3.3 Efflorescence test

The test was conducted by soaking the bricks in water for 24 hours and deposition of patches on the bricks were studied as shown in figure 9. The liability to efflorescence shall be reported as 'nil', 'slight', 'moderate', 'heavy' or 'serious' in accordance with the following definitions and the results were shown in Table 3.

- Nil - When there is no perceptible deposit of efflorescence.
- Slight - When not more than 10 percent of the exposed area of the brick is covered with a thin deposit of salts.
- Moderate - When there is a heavier deposit than under 'slight' and covering up to 50 percent of the exposed area of the brick surface but unaccompanied by powdering or flaking of the surface.
- Heavy - When there is a heavy deposit of salts covering 50 percent or more of the exposed area of the brick surface but unaccompanied by powdering or flaking of the surface
- Serious - Place the end of the bricks in the dish, the depth of immersion in water being 25 mm. Place the When there is a heavy deposit of salts accompanied BP powdering and or flaking of the exposed surfaces

Table- 3: Effect of efflorescence

Percentage of debris (%)	Effect of efflorescence
0	Nil
10	Slight
20	Slight
40	NOA

Figure- 9: Mild Efflorescence

4. Conclusion

This project study is done to find out if construction debris can be utilized or substituted instead of sand in the manufacturing of burnt clay bricks. From the tests conducted the results obtained are as follows:

- Mixture with 40% of debris cannot be used to manufacture a brick as the brick bursts down into pieces during the heating process in a kiln.
- The color, shape, size and texture of the bricks were found to be satisfactory.
- The brick gives a perfect sound when banged with each other
- The hardness & crushing strength of the bricks are found to be satisfactory.
- The water absorption property of all the bricks manufactured with construction debris is similar to the water absorption value of normal burnt clay bricks. It is in accordance with IS code standards.
- The compressive strength of the bricks manufactured with construction debris is found to be equally strong as compared to the normal burnt clay bricks.
- The amount of efflorescence is found to be mild in all the bricks as compared to the normal burnt clay brick where no efflorescence is found.

In production of these bricks no skilled labors are required and these bricks can be molded into different shapes and sizes. With further research and analysis it can be said that the bricks produced with construction debris can be used for construction of buildings and other purposes. With this denouement it can be concluded that the construction debris can be used as a replacement of sand in the brick industry thereby reducing the overall cost of a brick, as sand is the costliest material in the production of a brick.

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