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Brick Manufacturing Using Foundry Sand as Partial Replacement for Fly-ash

V. Parthiban[1], K. Gowtham[2*], M. Pramoth Keerthan[3], K. Santhosh Kumar[4]
[1] *Assistant Professor, Department of Civil Engineering, Sri Ramakrishna Engineering College, Coimbatore, India*
[2,3,4] *Student, Department of Civil Engineering, Sri Ramakrishna Engineering College, Coimbatore, India*

***Abstract*: The foundry is an industrial sector where various iron, scrap steel, and ferroalloys are melted down in arc furnaces or cupolas, shaped in sand, ceramic, or metal moulds, and the cast, steel, nodular, and tempered foundry products needed in industry are produced as raw or processed materials. Especially in establishments such as factories and workshops that produce parts of the automotive, construction, and machine and in steel industry, foundry sand is used to mould foundry products (iron-steel industry and aluminium- and copper-based alloys).Foundry sand is used to prepare metal foundry moulds. For 1 ton of production, 4-5 tons of sand is required. This ratio may be changed based on the type of the metal that needs to be casted, part size, and moulding technique. Sands that contain more than 90% of silica and 7–15% clay (bentonite or kaolinite clay) and have a sintering temperature of over 1500°C are defined as foundry sands. Foundry sand disposal is a herculean task for the industrial sector in today's scenario. In order to overcome this problem to some extent, it is required to convert it into some useful products. Hence, this project gains its importance for the effective utilization of foundry sand into foundry sand bricks**

***Keywords*: Bricks, Flyash, Foundry sand, Compression**

1. Introduction

Foundry sand is clean, uniformly sized, high quality silica sand, used in foundry casting processes. The sand is bonded to form molds or patterns used for ferrous (iron and steel) and non-ferrous (copper, aluminum, brass) metal castings. Foundry processes can be divided into two types as ferrous foundries and non-ferrous foundries. Foundry processes involve making the mould and the core, melting and pouring the metal into the mould, and finally removing the mould and core and finishing the product. The most common type of sand, found in non-tropical coasts and continental areas, is called silica, and usually takes the form of quartz. "solid waste" means any garbage or refuse, sludge from a wastewater treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, resulting from industrial, commercial, mining, and agricultural operations, and from community activities. Causes of solid waste pollution are pollutants from households, industrial units, manufacturing units, commercial establishments, landfills, hospitals and medical clinics. Trash collected from households often takes the form of plastic bags and organic waste. Contamination of ground water can result in poor drinking water quality, loss of water supply, degraded surface water systems, high cleanup costs, high costs for alternative water supplies, and/or potential health problems. The consequences of contaminated ground water or degraded surface water are often serious. Groundwater contamination occurs when man-made products such as gasoline, oil, road salts and chemicals get into the groundwater and cause it to become unsafe and unfit for human use. Materials from the land's surface can move through the soil and end up in the groundwater.

2. Methodology

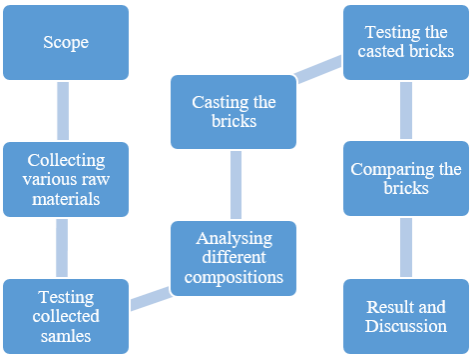

Fig. 1. Methodology

3. Experimental Setup

A. *Objectives*

The main objective of the project is,

- To collect the soil samples containing waste foundry sand.
- To examine the physical, chemical, mineral properties of the waste foundry sand samples collected from the dumped land.
- To interpret and conclude the results with Indian Standards.
- To manufacture the bricks using different compositions.
- To predict the quality of the bricks by undertaking the

*Corresponding author: gowtham.1709010@srec.ac.in

certain tests.

- To suggest the best quality brick among derived compositions.

B. Collecting various raw materials

The raw materials are collected from different locations to undertake the experiment. Some of the materials are listed below,

Table1
Raw material

Raw material name
Cement
Flyash
M-sand
Foundry sand

C. Testing the collected sample

Various experiments were carried out in the laboratory for the investigation of the field samples. The chemicals and materials used corresponding to the experiments are listed below.

Table 2
Reagents and chemicals used for foundry sand

S.no	Experiment name	Testing method
1.	Estimation of Acidity and alkalinity	Volumetric titration
2.	Determination of p^H	P^H metry

Table 3
3Materials used and tests undergone

S.no.	Material name	Test undergone
1.	Cement	Specific gravity, fineness.
2.	Fly ash	Specific gravity, fineness, bulk density.
3.	M-sand	Specific gravity, fineness.
4.	Foundry sand	Specific gravity, fineness, bulk density, soundness.

D. Analyzing different composition

The different types of compositions are derived to make the high strength and good quality brick. These are the derived compositions.

Table 3
Different mix proportions

Mix proportion (%)				
S.no.	**Foundry sand**	**Flyash**	**Cement**	**M-sand**
1.	40	30	10	20
2	40	30	12	18
3.	40	30	15	15
4.	40	30	18	12
5.	40	35	10	15
6.	40	40	10	10
7.	40	35	15	10
8.	40	25	20	15
9.	40	25	15	20
10.	40	35	13	12

- The above mentioned values are the mix proportions for casting the bricks.
- By following these proportions the raw materials are used for manufacturing the bricks.
- Before using the raw materials, it should be tested for maintaining the quality of the bricks.
- Once the materials are tested it can be used for casting the bricks.
- The materials above mentioned are in percentage format. We should convert it into kg for calculating the quantity required.

4. Laboratory Investigation

1) Specific gravity test

- The specific gravity is the ratio between the density of an object, and a reference substance.
- The specific gravity can tell us, based on its value, if the object will sink or float in our reference substance.
- To determine the specific gravity of cement, kerosene is used which does not react with chemical.

Table 4
Specific gravity

Description	**Fly-ash**	**Foundry sand**
Wt. of empty bottle (W1g)	0.655	0.655
Wt. of empty bottle + Material (W2g)	1.314	1.320
Wt. of empty bottle +Material+ water(W3g)	1.805	1.812
Wt. of empty bottle + full water(W4g)	1.420	1.420

Formulae:

Specific Gravity=W2 –W1/((W4 –W1) - (W3 – W2))

Calculation:

Fly-ash= 1.314-0.655 /((1.420)-(0.655)) - ((1.805)-(1.314) = 2.405

Foundry sand=1.320-0.655 /((1.420)-(0.655)) - ((1.812)-(1.320)) = 2.39

2) Fineness test

The fineness of cement is a measure of the size of particles of cement and is expressed in terms of specific surface area of cement. Fineness can be calculated from particle size analysis (sieve analysis) or by using air permeability method or by using sedimentation method. Sieve analysis measures the cement particle size whereas air permeability method & sedimentation method measures specific surface area. Since cement particles are very fine (smaller than 90 micron), hence sieve analysis is not suitable for cement. Due to this disadvantage, fineness of cement is always measured by air permeability method & expressed in terms of specific surface area.

Table 5
Fineness of fly-ash

S.No.	**Weight of the sample taken (g)**	**Weight of the residue(g)**	**Fineness (%)**
1.	100 g	6 g	6.1 g
2.	100 g	6.3 g	
3.	100 g	6 g	

Table 6
Fineness of foundry sand

S. No.	**Weight of the sample taken (g)**	**Weight of the residue(g)**	**Fineness (%)**
1.	100 g	8 g	8.2 g
2.	100 g	8 g	
3.	100 g	8.6 g	

3) Bulk density test

- The bulk density or unit weight of an aggregate is defined as mass of the aggregate per unit volume .It is expressed in kg/liter.
- The shape of particles greatly affects the closeness of

the packing.

- If the moist sand is measured by volume and no allowance is made for bulking, the mix will be richer than that specified because for given mass moist sand occupies a considerably larger volume than the same mass of the dry sand.

Table 7
Size of cylinder required for bulk density test

Size of largest particles	Nominal capacity [liter]	Inside diameter [cm]	Inside height [cm]	Metal thickness [mm]
4.75 mm and under	3	15	17	3.15
Over 4.75 to 40mm	15	25	30	4.0
Over 40mm	30	35	41	5.0

Table 8
Bulk Density

Property	Test results	Specifications
Bulk density	Fly-ash	640 kg/m^3
	Foundry sand	1025 kg/m^3

4) Soundness test

Soundness of cement is the ability of a hardened paste to retain its volume after setting. A cement is said to be unsound (i.e., having lack of soundness) if it is subjected to delayed destructive expansion. Unsoundness of cement is due to presence of excessive amount of hard-burned free lime or magnesia. The test is designed to accelerate the expansion in cement paste by application of heat. Soundness test is performed t ascertain the soundness or unsoundness of cement, which affect's durability of the structure in which cement is used.

Calculation:

Fly-ash:

Initial distance between the indicator points (mm) = 20mm

Final distance between the indicator points (mm) = 25mm

Expansion in mm = Final length – Initial length = 5mm

B. Brick casting

Hence the required test for materials are carried and analyzed.We have proportioned some mix ratios or proportions for casting the bricks using Foundry sand. By following these proportions the raw materials are used for manufacturing the bricks. The materials above mentioned are in percentage format. We should convert it into kg for calculating the quantity required by following these proportions the raw materials are used for manufacturing the bricks. The materials above mentioned are in percentage format. We should convert it into kg for calculating the quantity required.

The above mentioned values are the required quantity for casting bricks

- The ten numbers of bricks were casted for each proportion.
- Among these ten proportions we took 3 proportions which have irrelevant values to each other.
- By this we have saved the material wastage and made the brick cost effectively.
- Only the proportions are different, the procedure for manufacturing each type of bricks is same.
- These are the three consolidated proportions to be casted. The ten numbers of bricks were casted for each proportion.
- At this stage the raw materials are added in the mixture or blender for mixing.
- The materials are mixed thoroughly for producing good quality of bricks.
- All the raw materials were added at this stage.

Table 9
Quantity required for brick casting

S.no.	Foundry sand	Fly ash	Cement	M-sand
1.	26.3	7.5	3.6	10.11
.2	26.3	8.8	5.4	5.0
3.	26.3	6.3	7.2	7.5
Total for 30 bricks (kg)	78.9	22.6	16.2	22.61

Fig. 2. Transferring raw materials

- Well mixed raw materials are transferred to the machine through conveyer belts.
- At this stage we can check the quality of mix.

Fig. 3. Casting raw materials into bricks

- At this stage the raw materials are casted and the bricks were manufactured.
- The machine used for manufacturing bick is Hydraulic press machine.
- It can produce 10 bricks at single stroke.

Fig. 4. Switching the casted bricks

At this stage the casted bricks are taken away from the

machine conveyer belt.

- The bricks were now kept for drying process.

Fig. 5. Drying or setting

- At this stage the bricks are kept for drying or setting.
- This process takes about 24hrs from the casting.
- After this process, these bricks are soaked with water for curing.
- The curing process takes about 7 days.
- After this process, the bricks are tested.

C. Testing the casted bricks

- The bricks casted using foundry sand is now tested for checking the quality of the brick.
- These bricks are tested using physical method.
- The chemical tests are already carried out while it is in the form of raw material. Once the brick is tested and acquires desired strength then it will be used for construction of walls, pavers, etc.

1) Compression test

- To determine batch quality
- To determine consistency in manufacture
- To reduce material costs and achieve lean manufacturing goals
- To ensure compliance with international and industry standards
- Certain materials subjected to a compressive force show initially a linear relationship between stress and strain.

Fig. 6. Compression test on foundry sand brick

2) Efflorence test

- Efflorescence is a whitish crystalline deposit on surface of the bricks.
- Usually magnesium sulphate, calcium sulphate and carbonate of sodium and potassium are found in efflorescence.
- The movement of groundwater into the foundations of buildings and by capillary action into brickwork is very often the cause of efflorescence.
- A shallow flat bottom dish containing sufficient distilled water to completely saturate the specimens is used for the test.

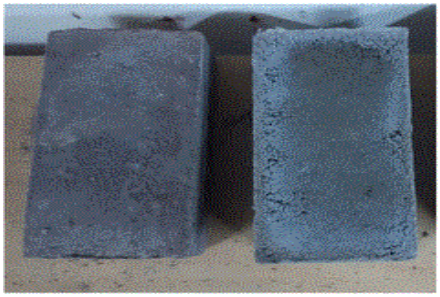

Fig. 7. Efflorescence test on foundry sand brick

Table 10
Compression test on Foundry Sand brick

Samples	**Size Of The Specimen (cm)**	**Weight (Kg)**	**Crushig Load (KN)**	**Compressive Strength (N / mm2)**
Sample1	22 x 10.5 x8	3.57	30.7	1.33
Sample2	22 x 10.4x8	3.57	106.5	4.65
Sample3	22.05x10.5x8	3.80	125.7	5.32

3) Result

Efflorescence (crystalline deposit) occurrence observed on the sample bricks.

4) Water absorption test

- A brick with water absorption of less than 7% provides better resistance to damage by freezing.
- The degree of compactness of bricks can be obtained by water absorption test, as water is absorbed by pores in bricks.
- The water absorption by bricks increase with increase in pores.
- The bricks, which have water absorption less than 3 percent can be called as vitrified.

Fig. 8. Water absorption test on foundry sand brick

Water absorption test on bricks are conducted to determine durability property of bricks such as degree of burning, quality and behavior of bricks in weathering. The water absorption value is 14% for foundry sand brick.

5. Results and Discussion

Table 11
Comparisons and Discussions

S.no	Tests carried Out	Comparison and discussion	
1.	Compression test	Fly-ash brick	The average compression test value is 3.76 n/mm^2
		Foundry sand brick	The average compression test value is 3.65 n/mm2
2.	Efflorence test	Fly-ash brick	Efflorescence (crystalline deposit) occurrence observed on the sample bricks.
		Foundry sand brick	Efflorescence (crystalline deposit) occurrence observed on the sample bricks.
3.	Water absorption test	Fly-ash brick	The water absorption value is 12% for fly-ash brick.
		Foundry sand brick	The water absorption value is 14% for foundry sand brick.

6. Conclusion

Based on the comparisons and discussions of the test results, the following conclusions are drawn: Among those mix proportions and samples the Eight set of Foundry sand bricks attained the required strength. From the tests carried out we concluded that the brick manufactured using foundry sand is comparatively same as fly-ash brick. The manufacturing cost is low when compared to fly-ash bricks. Foundry sand bricks can be used for land boundary fencing, paver blocks and partition blocks. Many literatures have been collected and studied to adopt the procedure to achieve the objective of the investigation. Based on the reviews, experimental investigation have been carried out to study laboratory investigations such as specific gravity test, fineness test, bulk density test, compression test, impact test, efflorence test, soundness test, hardness test, water absorption tests were carried out.

Table 12
Mix proportion of sample brick

S.no.	Foundry sand	Flyash	Cement	M-sand
8	40	25	20	15

References

[1] Nitin Kumar Department of Civil Engineering, MIT Moradabad, Uttar Pradesh, India. Published on the topic:"A Review Study on Utilization of Waste Foundry Sand" in 2017 at IRJET.

[2] R. Alonso-Santurde, A. Coz, J.R. Viguri, A. Andrés, Department of Chemical Engineering and Inorganic Chemistry, University of Cantabria, Av. Los Castros s/n, 39005 Santander, Spain. Published on the topic: "Recycling offoundry by-products in the ceramic industry" In 2012 at ELSEVIER.

[3] Nabil Hossiney*, Pranab Das, Mothi Krishna Mohan, Jaison George , Department of Civil Engineering, Christ University, Kengeri Campus, Mysore Road, Bangalore, 560074, Karnataka, India. Published on the topic:"In-plant production of bricks containing waste foundry sand" in 2018 at ELSEVIER.

[4] Ana Andres and Natalia Quijorna. Published on the topic :"Recycling of waste foundry sand in fly ash bricks." in 2018 at ELSEVIER.

[5] V.Parthiban, Department of Civil Engineering, Sri Ramakrishna Engineering College, Coimbatore, Tamil Nadu, India. Published on the topic:" Experimental Investigation on Mechanical Properties of Concrete with Fly Ash Aggregate" at IJSRD.

[6] N.L. Ukwattage,Deep Earth Energy Laboratory, Monash University, Clayton Campus, Building 60, Victoria 3800, Australia. Published on the topic:"A laboratory-scale study of the aqueous mineral carbonation of coal fly ash for CO2 sequestration"at ELSEVIER.