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Evaluation of some physical and mechanical properties of blends of Jos (Laranto) Sands for foundry applications.

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Abstract: *This research targets local sands in Jos Plateau state for foundry applications. Two sands (A and B) from Laranto community in Jos Plateau State Nigeria, were blended together to obtain a homogenous mixture. The sand blends were in proportions 50:50, 80:20 and 60:40 of A and B respectively. A sieve analysis was done for sand A before the blend. Properties such as Green compression strength, dry compression strength, and permeability of the sand blends were determined. It was discovered that the green compression strength was best at 60:40 sand blend with a value of 75.85KN/m^2 and was least at 80:20 blend with a value of 9.65KN/m^2. The best permeability numbers were observed at the 80:20 blends of sand, but with resultant poor green compression strength. Generally, the best properties were obtained from the 60:40 sand blends as compared with the other sand blends.*

Keywords: *Properties, Sand, Blends, Foundry and Laranto*

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I. Introduction

Foundry sand (Base sand) consist primarily of clean, uniformly sized high proportion of silica, and have bonding quality which depend on the presence of some kind of clay material which can be baked to form bonded mould for ferrous (iron and steel) and non-ferrous (copper, aluminium, brass, etc.) metal casting. Foundries are work establishments where ferrous and non-ferrous metals are melted by application of heat and then cooled in a mould to yield a solid mass. This solidified metal takes the shape of the pattern cavity made in the mould. The pattern itself is a replica of the object which the foundry man wants to produce [1]. Most silica contains impurities which cause scabbing of the casting surfaces when used [2].

The art of foundry has been practiced in Northern Nigeria for over 100 years [3], but the country is yet to enjoy the benefits of these foundries because of lack of significant growth due partly to the traditional knowledge gap that exist with owners [4].

Considerable economies in the cost of raw material for foundry moulds and cores for casting can be achieved by fully exploiting those sources of sand nearer to the foundry than better known and more publicised types of sand [5]. Though, good quality sand is essential for foundry work regardless of initial cost.

Silica sand (SiO2) is the commonly used sand in foundry but not all sands are suitable for casting. This is because there are certain properties that are required before they can be used, these properties include: green compression strength (GCS), dry compression strength (DCS), permeability (P), shatter index (SI), mouldability (M) refractoriness, moisture content (MC), etc. Refractoriness is the ability of the moulding sand to easily withstand the high temperature of molten metal and as such will not fuse during the pouring operation [6].

Nigerian foundry industries could still be said to be in its infancy after fourty four (44) years of independence [7]. They also stated in their study that almost all foundries in Nigeria embark on sand casting technique with 60 percent of the needed raw materials imported.

It is necessary to sometimes have a blend of sands to achieve a good mix of these sands for casting purposes in foundry applications. Hence, the need for this study.

II. Materials and Methodology

2.1 Materials/Equipment

The materials used include; Sand from Jos (Jos A and Jos B) were collected from a location called Laranto in Jos Plateau State, Nigeria, Shovels, hoes, and head pans .The equipment used include; ; Crucible furnace made by Scanda-Ovnenas Alleroid, model no- KHEI-170, Electronic weighing balance, Sand mixer, Universal testing machine with serial number M-8415, Digital thermometer with probe.

The two sands are naturally bonded reddish silica sand of 20% clay content. This was used to substitute the binder required.

The property of Jos A sand was assessed before preparing a blend of the two sands, since the sands were from the same location but two hundred (200) meters apart from each other.

2.2 Methodology

2.1.2 Determination of Green Compression Strength

The Green Compression Strength was carried out using the universal sand strength testing machine. A prepared standard sample was positioned in the compression head which was already fixed into the machine. The sample was loaded gradually, while the magnetic rider moved along the measuring scale. As soon as the sample reached its maximum strength, the sample experienced failure and the magnetic rider remain in position of the ultimate strength, while the load was gradually released.

2.1.3 Determination of Permeability

Gas permeability of a moulding sand is the ability of the sand mould to allow the passage of gaseous product from the mould cavity to the atmosphere. Permeability number of a moulding sand depends on degree of fineness of the sand, as well as its moisture content [8]. Inadequate sand permeability usually results to explosions and other detrimental casting defects. The permeability test was carried out on the standard sample specimen of 5cm diameter x 5cm height. The specimen, while still in the tube, was mounted on permeability meter. The permeability meter is an electrical perimeter and it employed the orifice method for rapid determination of sand permeability. Air at a constant pressure is applied to the standard sample specimen, immediately after producing the sample and the drop in pressure was measured on the pressure gauge, which is calibrated directly in permeability numbers.

Table 1: Sieve Analysis of Jos A sand

S/N0	Aperture (mm)	BSS N0	% Wt Retained	Product
1	1.40	14	0.33	2.31
2	1.00	18	1.68	23.52
3	0.71	25	2.22	39.96
4	0.50	35	3.67	91.75
5	0.355	45	36.61	281.35
6	0.250	60	57.07	2568.15
7	0.180	80	4.02	241.2
8	0.125	120	1.56	124.8
9	0.090	170	0.35	42.0
10	0.063	230	0.06	10.2
11	-0.063	-230	0.14	32.2
			107.71	3457.44

Table 2: Some physical properties of Jos sand (Laranto)

S/N0	Sand Sample	
1	Colour	Reddish brown
2	Grain Shape	Mostly Sub-angular, round
3	AFS grain fineness number	32.10

III. Results and Discussion

Table 3: Blends of sands (Jos A = 50%; Jos B = 50%)

	I	II	iii	iV
Jos A (gm)	217.5	220	221.75	227.5
Jos B (gm)	217.5	220	221.75	227.5
Water (ml)	65	60	56.5	45
GCS (KN/m^2)	41.15	55.16	69.64	48.27
Permeability	85	50	15	25

Table 4: Blends of sands (Jos A = 80%; Jos B = 20%)

	I	Ii	Iii	iv
Jos A (gm)	360	364	368	372
Jos B (gm)	90	91	92	93
Water (ml)	50	45	40	35
GCS (KN/m^2)	9.65	10.34	11.03	11.03
Perrmeability	140	200	215	225

Table 5: Blends of sands (Jos A = 60%; Jos B = 40%)

	I	II	III	IV
Jos A (gm)	279	270	264	261
Jos B (gm)	186	180	176	174
Water (ml)	35	50	60	65
GCS (KN/m^2)	10.34	24.13	62.05	75.85
Permeability	65	77	85	90

3.1 Discussion

Jos Laranto sand contains about 20-30% Clay. The Green compression strength of blend 60/40 for sand A and B respectively proved to be better at 11.1Psi ($76.54KN/m^2$) with a moisture content of 65ml. But generally, blends 50/50 for the sands showed the best green compression strength over a range of moisture contents, with ranges between $41.37KN/m^2$ to $68.95KN/m^2$.

The lowest value of the green compression strength is $9.65KN/m^2$ with moisture content 50ml. This is an indication of poor bonding property for this sand blend.

The permeability numbers of sand blend 80/20 for sand A and sand B respectively, proved to be higher than those of sand blends 50/50 and for blends 60/40, with ranges between 140 and 225, and this level of permeability makes the sand blend 80/20 unsuitable for moulding purposes. The green compression strengths of sand blends at 80/20 ratios of A and B proved to be the lowest with ranges between 1.4Psi ($9.65KN/m^2$) to 1.6Psi ($10.96KN/m^2$).

The grain fineness number (GFN) of Jos A (Laranto) sand is 32.10 AFS fineness number. This grade of fineness number is suitable for non-ferrous castings.

IV. Conclusion

In conclusion, the properties of the sand blends from Laranto Jos, Plateau State in ratios 50:50 and 60:40, of sands A and B respectively, have properties which could be useful for foundry use, considering the Green compression strength, Permeability and grain fineness number, whereas, the sand blend with ratio 80:20 for A and B respectively showed poorer properties and may not be useful for foundry applications.

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