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Investigation of the Suitability of Sand from River Adofi in Delta State for Casting

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ABSTRACT

This Research, Investigation of the suitability of sand from river Adofi in Delta state for casting purposes with the effect of binding clay, bentonite and water. It is expected that the sand could be put to use in making mouldings for casting of ferrous and non ferrous material components for possible replacement of the imported products. The sample is be subjected to various physical and mechanical tests. These include permeability, green compression strength, and dry compression strength tests. Green shear strength, dry shear strength, field mould strength, shattered index and refractoriness tests will also be carried out on the sample. The sample investigated consisted of washed and unwashed sands prepared from control sample moulding sand. The results to be obtained will show the existence of peak values for the green compressive strength of the washed and unwashed sand, and peak values for the permeability and shatter index of the washed sand, with set amounts of binding clay, bentonite, as well as water in both cases. In addition, the working range for each type of property was seen to vary with the amount of water present in the sand. Samples containing 23–32% clay were found to possess adequate permeability, good strength and refractoriness suitable for casting of both ferrous and non-ferrous alloys. The results demonstrated the possible utility of the sand for making of sand casting moulds. This work is recommended for the foundry purposes.

Keywords: Moulding sand; Additives; Green compressive strength; Permeability; Shatter index

1. INTRODUCTION

Foundry technology is one of the important and versatile processes of manufacturing. Its prime purpose is to form solid or hollow objects, parts, etc of desired shapes, sizes, configurations, etc; by pouring a totally molten material into a prepared mould, to solidify and take up the shape of the mould cavity. Casting is a manufacturing process for making complex shapes that is difficult or costly to make through other methods. Liquid metal is poured into a mold of the desired shape, and then allowed to solidify. The solid part is also called a casting and it is ejected from the mold once solidified. Casting is most often used for making complex shapes that would be difficult or uneconomical to make by other methods. Casting is a metal shaping process by pouring the molten metal into a mould and allowing it to solidify. The resulting product can virtually have any configuration (pattern) the designer wants. Casting consists of various parts like cope, drag, pattern, sprue, runner, ingates, riser, etc. The process consists of design, solidification, shake out, finishing and heat treatment. Although casting is one of the cheapest methods it is associated with many defects like shrinkage cavity (hot spot), cold shuts, misrun, etc.

The basic simplicity of this, the most direct of all metallurgical processes, has provided the foundation for the growth of a vast industry with a wide diversity of products. To obtain a true perspective of the casting process, however, its characteristics must be seen in relation to the whole range of processes available for the production of metal structures. Foundry is facilities engaged in the manufacture of numerous types of castings using various casting processes. Foundry is a technology of casting metals into shapes by melting them into a liquid, pouring the metal in a mold, and removing the mold material or casting after the metal has solidified as it cools. A foundry is a firm where metal is melted and poured into moulds to produce metal castings. It is a factory that produces metal castings. Metals are cast into shapes by melting them into a liquid, pouring the metal in a mold, and removing the mold material or casting after the metal has solidified as it cools. The most common metals processed are aluminum and cast iron. However, other metals, such as bronze, brass, steel, magnesium, and zinc, are also used to produce castings in foundries. In this process, parts of desired shapes and sizes can be formed.

Foundry serves a variety of industries that cut across oil and gas, construction, mines and mineral processing, glass manufacturing, flour milling, marine and shipping, etc. A foundry is a metal factory where castings are produced. Metals are cast into shapes by melting them into a liquid, pouring the metal into a mould, and removing the mould material or casting after the metal has solidified as it cools. Sand casting is relatively cheap and sufficiently refractory even for steel foundry use. In addition to the sand, a suitable bonding agent (usually clay) is mixed or occurs with the sand. Foundry dates back to the ancient time and has certain advantages over the other processes of shape-producing desired components or parts such as forging, rolling, extrusion, powder metallurgy, machining.

i. Ease and economy in adaptability to the requirements of mass production.
ii. Certain metals and alloys such as highly creep resistant metal-based alloys for gas turbines can't be worked mechanically and can be cast only.
iii. Heavy pieces of complicated shapes of several tonnes can be cast while it would be difficult to make these in any other way.
iv. Casting is often the cheapest and most direct way of producing a shape with certain desired mechanical properties. Desired mechanical properties can be attained by operations such as; suitable control of alloy composition, grain structure and heat treatment.

v. Castings are often cheaper than forgings and weldments; depending on the quantity, type of material used and fixture for weldments. Where this is the case they are logical choices for engineering structures or parts.

vi. vi Castings have specific important engineering properties, these may be metallurgical, physical and economic. Intricate shapes having internal openings and complex sectional variations can be produced quickly and economically by casting since liquid metals can flow into any form, whereas tooling and machine cost in mechanical working would be too high to produce them.

vii. Casting is best suited for composite components requiring different properties in different sections. These are made by incorporating prefabricated inserts in a casting, some examples are; steel screw threads in zinc die castings, aluminum conductors into slots in iron armatures for electric motors, wear resistant skins into shock resistant components,

There are various types of moulding processes and two types of moulds, namely permanent and expendable; are used for casting. Sand casting employs the use of expendable moulds. It is the most widely used and adaptable casting process. The process is well suited to a whole variety of miscellaneous castings in sizes as low as individual teeth in a zipper to several tonnes such as the huge stern frames of ocean liners. The sand is composed primarily of silica (SiO_2). Green sand moulding is the most popular and widely used process in the foundry industry. The process is well suited to a whole variety of miscellaneous casting in sizes of less than 0.5- 4.64 kg. Dry sand moulds are used for heavier casting. Sand casting is best suited to ferrous and non ferrous metals at their high melting temperatures but also predominates for aluminum, brass, bronze, and magnesium. (Doyle, 1969; Jain 2005; Lindberg, 1977)

There is therefore a need to contribute towards proper public-available information on the sand, for optimal foundry technology with it and benefit of all. The shape, size, screen distribution and surface characteristics of a sand grains are the fundamental properties that determine whether it is suitable for production of castings. Its desirable foundry properties are green strength, permeability, dry strength, hardness, hot strength, flowability, plasticity, adhesiveness, cohesiveness, binding property, thermal stability with respect to cracks; buckling; flaking; and thermal shocks, adequate refractoriness, good mouldability, good collapsibility, chemical resistivity, reusability, ability to produce castings with good surface finish, and ease of preparation and moulding with it. Of the properties, the first four are of more test importance, and hence the commonly tested ones (Anonymous, 1963; Avalon and Baumeister, 1998). This is because most sands, from test experience turn to have more variation and deficiency in the four properties.

Moreover, the other properties depend to a great extent on the four (Jain 2005). Sand moulds and cores may suffer physical damage during preparation and handling or during pouring, if the green strength is too low; leading to sand inclusions or mis-shapen castings. If the mould permeability is too low, air entrapment may occur and there is risk of porosity in the casting. However, where the permeability is too high, sand may burn on the casting especially if the sand has low refractoriness. Dry strength of a casting sand is necessary to resist bad pressure at high temperatures, erosion failure, undesirable mould expansion, and for storage and handling when the mould is dry. As the hardness of sand increases, it also helps eliminate loose-sand inclusions and mould erosion. If the sand hardness it too high, its compactibility and flowability will be impaired, and hence ease of moulding with it will be reduced. On the other hand, hot strength of sand is necessary to avoid mould failure when hot metal is poured into it; the sand should have good collapsibility to enable moulds to be broken open to release castings from them. If refractoriness of sand is low, it will melt when hot metal is poured into it, and this will result into mould failure and bad castings from it (Doyle, 1969; Avalon and Baumeister, 1998; Middleton, 1988).

It is pertinent to know that each of the foundry properties depends on a combination of moisture content of the sand, amount and type of binder, size distribution of the sand grains, grain fineness, and shapes of sand grains, amount of fine materials present and mulling time. The practical mixture of green sand mould consists of; sand 65% to 93%, clay 3 to 30%, water 2 to 8%, and additives (Doyle, 1969; Anonymous, 1963; Dietert, 1966). The clay with water acting as the bond or binder is the principal source of strength of a sand. In some locations, clay and sand occur in the right proportion for moulding and these mixtures are referred to as "natural moulding sand", In other cases, a clay for bonding must be added to the sand in order to develop the requisite cohesiveness and plasticity. There are several types of clays which are essentially aggregates of minute, activated, crystalline, flake-shaped particles. The clays may be bentonites, kaolinites or fire clays.

2. MATERIALS AND METHODS

All the materials required for this research work were sourced locally. The silica sand was sourced from River Adofi in Ossissa, Ndokwa East Local Government Area of Delta State, The binding clay was sourced from from Umuekete clay deposit, in Ossissa Ndokwa East LGA Delta State. Each of the test specimens from the various mixture were subjected to the relevant sand mould test such as Green Compression Strength, Green Shear Strength, Dry Compression Strength, Dry Shear Strength and permeability test and sieve analysis.

All the tests were carried out with the sand testing equipment at the Federal Institute of Industrial Research (FIIRO) Oshodi, Lagos State, Engineering Materials Research Development Institute (EMDI) Akure Ondo State and University of Lagos Metallurgy and Materials Engineering Department Laboratory Nigeria. The test sample were prepared in accordance with the standard specification for the preparation of moulding sand test samples using Ridsolate standard sand rammer conforming to imperial (2″diameter x 2″Height) or DIN (SCM diameter by 5cm height). Test sample specimens were prepared for laboratory experiment from various moulding sand mixtures as shown in Table 1.

2.1 Sample Preparation

The required quantity of the sand, clay and water for each of the samples 1-5 were measured in accordance with the varying proportion and put into the laboratory mixer and then mixed for about five minutes. When thoroughly mixed, the mixture was discharged from the mixer through the discharge opening at the bottom of the mixer. These was done for the three rivers sand, the quantity that gives the required size of 5cm diameter x 5cm height was weighed on the weigh-balance and then poured into the specimen tube. This weight differs for different mixtures of sand component.

The tube with the sand sample inside it was positioned in the specimen rammer and then rammed with three drop of the standard weight of 6.6kg. After ramming, the specimen was ejected from the tube with the aid of specimen extractor. This procedure was repeated for the preparation of the standard test specimens for the various compositions of the moulding mixtures.

Table 1. Chemical Composition /Analysis of Silica Samples of Adofi River Sand

Constituent	Adofi River sand (%) A
SiO_2	97.46
Al_2O_3	1.67
Fe_2O_3	1.38
CaO	0.68
Na_2O	0.27
K_2O	0.01
TiO_2	0.69
Loss on ignition	2.39
Total	100.00

2.1 Determination of Grain Size Distribution

The stocks of sieve were arranged according to the sieve aperture with the largest aperture on top of the stock and then smallest aperture at the bottom (on top of pan). Some quantity of sand were dried in the air and 100g of the sand sample was taken on to the top of sieve stock and stocks were placed on a sieve shaker and then switched on, the time was set to allow for vibration for a period of fifteen (15) minutes and after vibrating for a period of 15minutes, the vibration stopped automatically. The sieves were removed one after the other beginning with one on top. The quantity of sand remaining on each sieve was weighed. The weight was recorded accordingly on each sieve in the column corresponding to the sieve mesh number, i.e. British Standard Sieve number (BSS). Each separate sieve weight was multiplied by the preceding sieve mesh number. The sum total of the product was divided by the total sample aligned and this produced the fineness number of the sand. Table 2 shows the results obtained

TABLE 2: Grain Size Analysis.
SAMPLE ADOFI RIVER SAND

Sieve Aperture (mm)	BSS No.	Wt Retained	% wt Retained	Cumulative % wt Retained	Product
1.4	10	0.15	0.15	0.15	-
1.00	16	3.26	3.26	3.41	32.6
0.71	22	6.61	6.61	10.02	105.76
0.50	30	9.21	9.21	19.23	202.62
0.355	44	23.98	23.98	43.21	719.40
0.250	60	38.76	38.76	81.97	1705.44
0.180	100	12.73	12.73	94.70	763.0
0.125	150	3.36	3.36	98.06	336
0.090	200	0.86	0.86	98.92	129
0.063	300	0.41	0.41	99.33	82
-0.063	350	0.14	0.14	99.47	42
					4118.62

2.3 Determination of Green Compression Strength

The Green Compression Strength was carried out using the universal sand strength testing machine. In the sand mixture, 150g was weighted and poured in the specimen tube or core box which is placed beneath the ramming head on the ramming machine. Three ramming blow is applied and removed. The rammed sample is place in the compression heads in the lower position of the strength tester machine. Load is applied simultaneously until the sample collapse. Using the magnetic rider on the scale readings were taken in $KN/m^{2.}$ 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. This experiment was repeated for clay content varied thus; 10%, 15%, 20%, 25%, and 30%.for the Adofi rivers sand and It was discovered that the Green Compression Strength (GCS) reduced with increase percentage of clay content in the sample as shown in **Table 3.**

Table 3: Adofi River Sand
Sand Clay Content = 0%

Sand %	Clay %	Water %	Permeability	Green Compressive Strength KN/M^2	Green Shear Strength KN/M^2	Dry Compressive Strength KN/M^2	Dry Shear Strength KN/M^2	Moisture %	Compactability
84	10	6	100.88	7.467	5.33	105.0	45.0	8	34
79	15	6	108.68	8.55	3.25	215.0	52.5	6.0	36.9
74	20	6	111.31	9.25	2.75	140.0	42.5	6.0	41.1
69	25	6	105.63	10.75	2.50	190.0	65.0	6.0	46.18
64	30	6	101.42	13.75	2.00	164.5	60.0	6.0	51.57

2.4 Determination of Green Shear Strength

The Green Shear Strength (GSS) which is the measure of the shear strength of the prepared sample, when shear load is applied in its green state. The machine used for the GCS was also used for the determination of green shear strength (GSS), except that the compression head was replaced with shear head in the machine. Samples were prepared in the way as in the green compressive strength. But this the rammed sample is placed in the shear heads in the lower position of the ramming machine where simultaneous head was applied until it shears. The reading was taken using the magnetic rider. The shear strength was recorded at the point of failures of the sample loaded. The GSS decreased as shown in Table 3a.

Table 4: Grain Size Seive Analysis of Sample Adofi River Sand

Screen size μm	BSS No.	Weight Retained	% Weight Retained	Cumulative % wt Retained
425	10	0.10	0.10	0.10
300	16	0.13	0.13	0.23
250	22	0.21	0.21	0.44
212	30	8.31	8.31	8.75
180	44	23.40	23.40	32.15
150	60	67.20	67.20	99.35
106	100	0.21	0.21	99.56
75	150	0.20	0.20	99.76
-75	200	0.16	0.16	99.92

2.5 Results of Grain Size Distribution (A.F.S Fineness Number of the Samples)

Table 5: Grain Size Analysis Of Sample Adofi River Sand

Screen size μm	BS Sieve no	% Sand retained on sieve	Multiplied by previous sieve no	Product
425	10	0.10	10	10
300	16	0.13	2.08	12.08
250	22	0.21	4.62	16.70
212	30	8.31	249.3	266
180	44	23.40	1029.6	1295.6
150	60	67.20	4032	5327.6
106	100	0.21	21.0	5348.6
75	150	0.20	32	5380.6
-75	200	0.16	40	5420.6
	TOTAL	99.96		5420.6

Source: study 2015

AFS Grain fineness number = 5420.6/99.96 = 54.23 ≈ **54** AFS

2.6 Results of Determination of Green Compression Strength of the Sand Samples

Table 6: Adofi River Sand Distribution of Various Properties

Sand %	Clay %	Water %	Permeability	Green Compressive Strength KN/M²	Green Shear Strength KN/M²	Dry Compressive Strength KN/M²	Dry Shear Strength KN/M²	Moisture %	Compactability
84	10	6	100.88	7.467	5.33	105.0	45.0	8	34
79	15	6	108.68	8.55	3.25	215.0	52.5	6.0	36.9
74	20	6	111.31	9.25	2.75	140.0	42.5	6.0	41.1
69	25	6	105.63	10.75	2.50	190.0	65.0	6.0	46.18
64	30	6	101.42	13.75	2.00	164.5	60.0	6.0	51.57

Sand Clay Content = 0%

3. DETERMINATION OF PERMEABILITY

Permeability is defined by the **A.F.S.** as that physical property of moulded sand which allows gas to pass through it. It is determined by measuring the rate of flow of air through the **A.F.S.** Standard rammed specimen under standard pressure. 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. 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.

The general formula for calculating permeability is:

$$P = \frac{V * h}{\rho * a * t} \quad (1)$$

Where ρ = permeability number
V = Vol of passing through the specimen
h = Height of the specimen in cm
p = Pressure of the air in cm of water
a =Area of cross-sectional of specimen in cm^2
t = Time in minutes

A standard method requires that 200ml of air should be forced through a specimen 2inches(5.08cm) high and 2inches diameter (20.268cm^2 area) by substituting these values for V, h, and a and measuring the time in seconds,the formula becomes,

$$P = \frac{30072}{\text{Air pressure in cm of water} * \text{time in seconds}} \quad (2)$$

$$= \frac{30072}{t\ (secs)} \quad (3)$$

The rammed specimen still inside the core tube was locked on the permeability meter and 2000ml of air was forced through the specimen and the time taken was recorded in seconds.

The time was slotted into the formula and the permeability values were recorded.

The result was recorded as shown in Table 6.

3.1 Determination of Dry Shear Strength

The prepared standard sample of 5cm diameter x 5cm height was dried in an oven at a temperature of 110^{o}C for 30 minutes and then removed from the oven to cool in an air to ambient temperature.
The same universal testing machine was used for dry compression strength. In this case, the shear head was replaced for the compression head. The shear strength was recorded at the point of failures of the standard test sample. The failed sample due shear load is shown in Table 3.

3.2 Determination of Dry Compression Strength

The prepared standard sample of 5cm diameter x 5cm height was dried in an oven at a temperature of 110^{o}C for a period of 30minutes and then removed and allowed to cool in the air to ambient temperature. After cooling, the sample was fixed into the universal sand-testing machine with the compression head in place. The compressive load was applied and the samples failed at the ultimate compressive strength of the sample. The point at which the failure occurs was recorded at GCS and it is shown in Table 3a

Table 7. Satisfactory Sand Permeability Properties and various tested Permeability of the samples

Metals	Clay Content (%)	Moisture Content (%)	Permeability	A Permeability
Heavy Steel	10 -12	4-5	130-300	100.88
Light Steel	7-12	6-8	125-200	108.68
Heavy Grey Steel	10-19	6-8	70-120	
Aluminium	8-17	4.5 - 5.5	10-30	111.31
Brass and Bronze	10-22	5 - 7.5	15 -40	
Light Grey Iron	8-17	4 - 6	20-50	105.63
Malleable Iron	8-18	5 - 7	20-60	101.42
Medium Grey Iron	11-25	6 -8	40-80	

Source: Dietert (1966), Mikhailov (1989), Ademoh & Abdullahi (2009).

A= Adofi River sample

The permeability of various sand sample which ranges from 100 – 111.31, for Adofi River sand at various proportion of clay and moisture content. Hence it shows that Adofi River sand are suitable for casting of heavy grey steel, and light steel and light steel.

3.3 Green and Dry Compressive strengths

The results analysis in table 3a, 3.4.1 compared with the literature values in table 3.2 shows that the dry compressive strength values for all the specimens are within the acceptable standard range for most ferrous and non-ferrous metals, and therefore meet the need for their casting applications. The casting from these moulding sands are likely to be of fine surface finish with little or no defect if properly handled and other necessary factors are considered. The sand samples A, B, and C from Ologodo, and Ubuh river in dry condition can withstand the pressure intensity up to 350KN/m^2, 298KN/m^2, 206KN/m^2, 290KN/m^2, 197KN/m^2, and 171 KN/m^2 respectively during the period of solidification in the mould. It is an indication that the moulding sands may be suitable for large variety of castings.

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Table 8: Satisfactory Green Compressive Strength Sand Properties and various tested Green Compressive Strength of the samples

Metals	Clay Content (%)	Moisture Content (%)	Green Compressive Strength KN/M²	A Green Compressive Strength KN/M²
Heavy Steel	10 -12	4-5	70 - 85	55
Light Steel	7-12	6-8	70 - 85	68
Heavy Grey Steel	10- 19	6-8	70 - 105	
Aluminium	8-17	4.5 - 5.5	50 -85	72
Brass and Bronze	8-22	5 - 7.5	50 - 70	
Light Grey Iron	8-17	4 – 6	50- 85	85
Malleable Iron	8-18	5 – 7	70 - 85	
Medium Grey Iron	8-25	6 -8	70 - 85	103

Source: Dietert (1966), Mikhailov (1989), Ademoh & Abdullahi (2009).

A= Adofi River sample

From the analysis in the table above, the three samples A, have excellent Green compressive strength. Sample A are suitable for casting of Aluminum, Brass and Bronze, light grey iron, malleable iron and medium grey iron.

Table 9: Satisfactory Dry Compression Strength Sand Properties and various tested Dry Compression Strength of the samples

Metals	Clay Content (%)	Moisture Content (%)	Dry Compression Strength(KN/m^2)	**A** Dry Compression Strength(KN/m^2)
Heavy Steel	10 -12	4-5	1000 -2000	105.0
Light Steel	7-12	6-8	400 – 1000	215.0
Heavy Grey Steel	10-19	6-8	50 – 800	
Aluminium	8-10	4.5 - 5.5	200 - 550	140.5
Brass and Bronze	10-15	5 - 7.5	200 - 800	
Light Grey Iron	8-13	4 - 6	200 - 550	190.0
Malleable Iron	8-14	5 - 7	210 - 550	
Medium Grey Iron	11-15	6 -8	350 - 800	164.5

Source: Dietert (1966), Mikhailov (1989), Ademoh & Abdullahi (2009).

A= Adofi River sample

Sample A, have their applications in heavy grey steel.

5. RESULTS AND DISCUSSION

The Green Compression Strength (GCS) of the moulding sand mixture decreased from 11.11psi (76.59KN/m^2) to 4.2 psi (28.98KN/m^2) of 6% water addition respectively. This shows that Umuekete clay has good bonding characteristic even in little addition water. Metals can be cast with 1% water addition to the moulding sand mixture, mould wall erosion could occurred during pouring of hot liquid metal as a result of friable nature of the mould. The Green Shear Strength (GSS) of the moulding sand mixture was observed to be decreasing from 1.2psi (8.28KN/m^2) to 0.2 psi (1.38KN/m^2) of 1% and 10% water addition respectively. The Dry Compression Strength for 1% water content is 62psi (427.8KN/m^2) and this value increases with further increase in moisture content of the mixture reaching the maximum value of 467.5 psi (3225.75KN/m^2). It was discovered that the strength of the dry sample is greater than that of calibrated strength on the universal testing machine. The dry shear strength of sample of moulding mixture was observed to increase with moisture content reaching a maximum at 10% water addition as shown in Table 3.

River Adofi sand is sub-angular in shape and whitish in colour. It is very fine silica sand; the free content of clay of the sand makes it suitable for use as core sand in addition to its suitability for use as a moulding sand. Umuekete clay is very fine clay and has a high plastic in nature when mixed with water. This characteristic of the clay makes it suitable for foundry application as a binder. The grain fineness number of River Adofi sand is 41.412 AFS fineness number. This grade of fineness number is suitable for all types of alloys steel as this belongs to the group of fineness number that has a wide range of application. The other grades of the sand are very much available within the shore of the river. The selection of the appropriate grade of grain size for a specific application largely depends on experience and the nature of the alloy production in a particular foundry industry.

River Adofi sand and Umuekete clay when mixed together with varying percentage of water produce a plastic mass with varying degree of strength. In the green state of the mixtures; the strength decrease with increasing moisture content, reaching its ultimate strength at 1% water addition which is friable. The level of strength reach between 2% to 6% water additions conforms to the standard specification for metal casting moulding sands. Although the strength level of 8% and 10% water addition are relatively lower enough these levels of moisture content are considerably much higher for some alloys such as ferrous alloys, under green application.

When mould is applied under dry condition, high moisture content could be an advantage and when the strength is the major factor under consideration. These important properties, such as permeability, green compression strength, and dry compression strength attain their highest value with moisture of 2% and 4% water addition. This makes 2% and 4% water addition more suitable for optimum moulding properties requirement. Water and clay are the major property variables that influence the strength of the moulding (Jain 1986; Uhvotu 2006).

6. CONCLUSION AND RECOMMENDATIONS

An investigation into the properties of Adofi river sand for application in foundries has reveal that the samples have angular grain shapes which gives them greater interlocking strength as well as better venting properties. They have good green compression strength and adequate permeability to produce good quality casting. The permeability for Adofi river sand are moderate and therefore these can be used for light castings.

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