Effect of Wood Flours on Moulding Sand Properties

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ABSTRACT

Casting process involves number of variables which have to be controlled to get sound product (defect free). The sand moulds are used in most casting techniques because of their simplicity and ease of handling. Sand selection and deciding about its composition is considered as critical task in casting process. The right amount of silica sand (base sand) combined with clay (binder), water (moisture) along with additives impart required qualities in the mould are treated as basic ingredients of the moulding sand. This paper presents the results of the work carried out using different wood flours as an additive with the moulding sand mixture. The effect of four wood flours viz. Jack fruit, Mango, Acasia and teak on different properties of mould like Permeability number, Green and Compression strength were analysed. It was observed that the wood flours have significant effect on above said properties.

Keywords: Casting, Additives, Permeability, Green Compression strength, Green shear strength, Wood flour

1. Introduction

Casting is one manufacturing process which is continuously in use from ancient times and was considered as an art form. Tremendous improvement has taken place in casting techniques and is now a well established process and any complex geometry can be easily produced. Casting plays important roles in production of modern equipment for power, communication, transportation, agro-allied, construction, space, agriculture, chemical and petrochemical and other industries. Products of nearly any shape and size can be produce at economical costs with better dimensional accuracy and less scrap.

Sand is the basic element in the casting process on which influences the quality of the casting. Hence it is a basic need of foundry to have knowledge of sand properties at various compositions so that the right selection can be made. The sand used in mould & core making is mixed with suitable ingredients like binder, clay, moisture or water and additives to improve the properties like permeability, green strength, hot strength, shear strength, cohesiveness, plasticity etc. The properties of moulding sand are not only determined by the chemical composition of sand, but also by the amount of clay, moisture content and by the shape and size of silica grains in the sand [1].

In the analysis of the Ilorin sand for moulding and its suitability for casting process [2], the green compressive strength was found to be 36-60 kN/m^2. The permeability of moulding sand was 47-68.3 and standard shatter index values was 31-84 which were adequate for production of sand castings of ferrous and non-ferrous metals.

Sunday Aribo [3] investigated the effect of rice husk and corn cob ashes as aggregates for foundry moulding sand. Equal proportions of both the ingredients at 5 to 12.5% by weight were added to the

moulding sand along with clay and water at 4% by weight. Results revealed that green compression strength, green shear strength, moisture content and permeability decreased with increase in the additives while dry compression strength and dry shear strength increased with increase of additives.

A. P. Ihom et al. [4] used multiple linear regressions and developed a model to study the effect of clay and moisture on moulding sand permeability. Results revealed that 30% and -31% of the variation in permeability is observed respectively with variation in clay content and moisture content. It was also observed that as clay content decreases permeability increases and as moisture content increases green permeability decreases.

Tataram K. Chavan and H. M. Nanjundaswamy [5] investigated the effect of Tamarind powder, fly ash and coconut shell powder as additives on some of the green sand properties. Usage of Tamarind powder showed higher compression strength and higher shear strength than fly ash and coconut shell powder up to 1%. The optimum value obtained for moisture and clay is 7% and 8% respectively. The permeability number decreases with increase in the additives above 1%. Effect of Tamarind powder, fly ash and coconut shell powder as additives on compression strength, permeability and collapsibility of Olivine sand was studied by have been studied [6] and was found that coconut shell powder gives better compressive strength among all additives. The permeability number decreases with increase in the additives and the effect of fly ash on collapsibility was less as compared with other additives.

Saliu Ojo Seidu and Bolarinwa Johnson Kutelu [7] studied the effect of sawdust, coal dust and iron filling additives at different proportions on base or silica sand. Specimens prepared were tested for different properties like bulk density, porosity, permeability, green compression strength and green shear strength. Results showed that addition of sawdust resulted in better compaction than coal dust, iron filling additives. Also it is observed that as saw dust percentage increases moisture absorbing strength also increases. Further addition of coal dust to the moulding sand was found to improve sand porosity and permeability. In current work an attempt is made to study the suitability of wood flours, which are waste products of local saw mill industries, as a ingredients in casting process and to establish its effects on different process parameters.

2. Experimental methods

2.1 **Materials**

The commonly used ingredients in preparing moulding sand were base (silica) sand, moisture, clay and additives. The base sand size is maintained constant throughout the experimental runs whose average fineness number was 21. A standard sieve shaker is used to check the sand fineness number. Clay size and volume was kept constant during testing along with water quantity. The four wood flours selected for testing was collected from Shri Basavaraj Saw Mill, Shiralakoppa. All wood flours were distilled using 300 sieve no. The base sand and additives were mixed at different proportions to prepare specimens and were tested for permeability number, green compression strength and green shear strength.

2.2 **Sample preparation and Testing Method**

The moulding sand (78-80%), clay (15%), water (5%) are mixed with the four wood flours as per the proportions listed in Table 1.

Table 1 Composition of the specimens in different runs

Samples	Composition
1	80 % BS+ 15% Cl + 5 % W
2	79.5 % BS+ 15% Cl + 5 % W + 0.5% Jack fruit
3	79.5 % BS+ 15% Cl + 5 % W + 0.5% Nilgiri
4	79.5 % BS+ 15% Cl + 5 % W + 0.5% Mango
5	79.5 % BS+ 15% Cl + 5 % W + 0.5%Acasia
6	79 % BS+ 15% Cl + 5 % W +1% Jack fruit
7	79 % BS+ 15% Cl + 5 % W + 1% Nilgiri
8	79 % BS+ 15% Cl + 5 % W + 1% Mango
9	79 % BS+ 15% Cl + 5 % W + 1%Acasia
10	78 % BS+ 15% Cl + 5 % W +2% Jack fruit
11	78 % BS+ 15% Cl + 5 % W +2% Nilgiri
12	78 % BS+ 15% Cl + 5 % W + 2% Mango
13	78 % BS+ 15% Cl + 5 % W + 2%Acasia

Note: BS-base sand, Cl-Clay, W-water

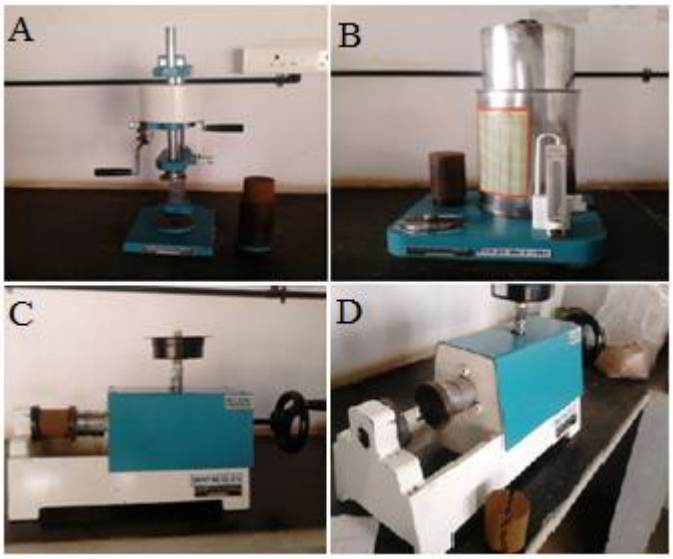

Fig. 1 A) Sample preparation B) Permeability Tester C) Shear strength test setup D) Sand specimen after Shear test

3. Results and discussions

The results of the experiments are listed in Table 2. The specimen prepared according to the required composition are tested for three parameters i.e. Permeability Number, Green compression strength, Green shear strength.

Table 2: Properties of moulding sand at different compositions

Samples	Composition	Permeability No.	Green compression strength, gm/cm^2 (kN/m^2)	Green shear strength, gm/cm^2(kN/m^2)
1	80 % BS+ 15% Cl + 5 % W	163	340 (33.35)	120 (11.77)
2	79.5 % BS+ 15% Cl + 5 % W + 0.5% Jack fruit	115	350 (34.33)	140 (13.73)
3	79.5 % BS+ 15% Cl + 5 % W + 0.5% Nilgiri	134	450 (44.14)	140 (13.73)
4	79.5 % BS+ 15% Cl + 5 % W + 0.5% Mango	151	400 (39.24)	120 (11.77)
5	79.5 % BS+ 15% Cl + 5 % W + 0.5%Acasia	134	340 (33.35)	120 (11.77)

6	79 % BS+ 15% Cl + 5 % W +1% Jack fruit	134	410 (40.22)	130 (12.75)
7	79 % BS+ 15% Cl + 5 % W + 1% Nilgiri	151	420 (41.20)	140 (13.73)
8	79 % BS+ 15% Cl + 5 % W + 1% Mango	142	350 (34.33)	140 (13.73)
9	79 % BS+ 15% Cl + 5 % W + 1%Acasia	163	400 (39.24)	150 (14.71)
10	78 % BS+ 15% Cl + 5 % W +2% Jack fruit	138	370 (36.29)	140 (13.73)
11	78 % BS+ 15% Cl + 5 % W +2% Nilgiri	156	420 (41.20)	140 (13.73)
12	78 % BS+ 15% Cl + 5 % W + 2% Mango	173	370 (36.29)	145 (14.22)
13	78 % BS+ 15% Cl + 5 % W + 2%Acasia	173	350 (34.33)	140 (13.73)

Note: BS-base sand, Cl-Clay, W-water

The permeability has increased with addition of wood flours from 0.5% to 2% for all the varieties except the mango wood flour at 1% addition. Permerability of the mouling sand with jack fruit, nilgiri wood flour upto 2% found to be less than that that of base sand. But the permeability of moulding sand with 2% mango, acasia wood flour is found slightly greater than that of the base sand while the premeability was less when the wood flour content is maintained at 0.5%. The effect of different wood flours proportions on permeability of the moulding sand is shown in Fig. 2.

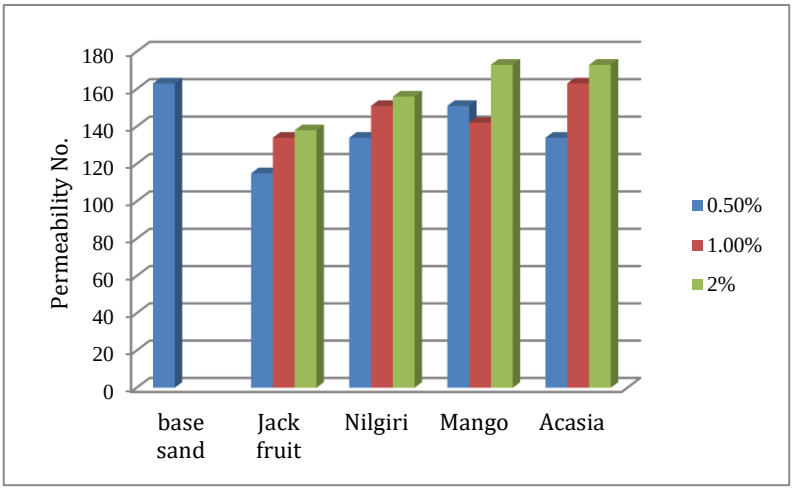

Fig. 2 Effect of Wood flour prportion on Permeability Number

Effect of different percentage of wood flour on Green Compression Strength (GCS) of moulding sand is shown in Fig. 3. The moulding sand achieved higher strength than that of the base sand with the addition of the wood flours at all porportions. Nilgiri wood flour has achieved the maximum GCS of 420gm/cm^2 at 0.5% content in the sand mix. The effects of jack fruit, acasia wood flour content on the moulding sand is found to be similar.

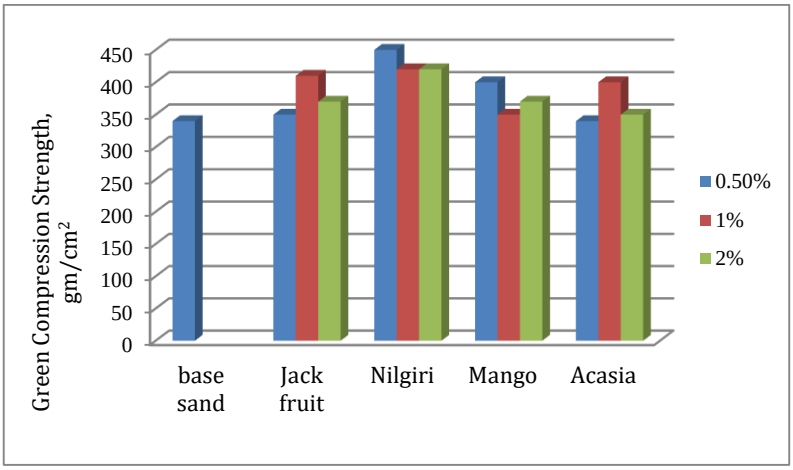

Fig.3 Effect of different % of Wood Additives on Green Compression Strength, gm/cm^2

Effect of different percentage of wood flour on Green Shear Strength (GSS) of moulding sand is shown in Fig. 4. The moulding sand achieved higher strength than that of the base sand with the addition of the wood flours at all porportions. Acasia wood flour has achieved the maximum strength a max GCS of 150gm/cm^2 at 1% of wood flour contentin the snd mix. It is also noticed that increasing the nilgiri wood flour had no effect on the GSS above 0.5%.

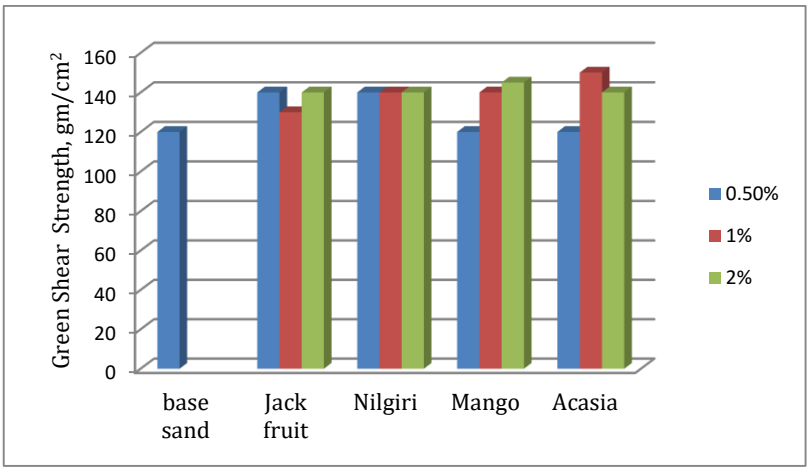

Fig. 4 Effect of different % of Wood Additives on Green Shear strength, gm/cm^2

5. Conclusions

Following conclusions can be drawn from the present work;

1. Permeability number can be either increased to 173 by using mango or acasia wood flour or decreased to 115 by using jackfruit at 0.5%, making it to suitable for usage as moulding sand additive for casting all types of steel.
2. 0.5% Nilgiri wood flour can be used to get better green compressive strength of 450 gm/cm^2 which is 24 % higher than base sand green compressive strength
3. All the wood flours are found to improve the green shear strength of the moulding sand. 2% of mango wood flour addition increased green shear strength to 145 gm/cm^2.
4. Casting process can be made eco-friendly by using current stated wood flours as additives in-stead of chemical additives for controlling moulding sand properties. The wood flours
5. The wood flours are generally a by product from the wood industries and hence can be easily obtained at economical costs.

Acknowledgement

The authors would like to thank Shri Basavaraj Saw Mill, Shiralakoppa, for providing different type of dry saw flours. Authors would like to thank the management and principal of SMVITM, Bantakal (Udupi) and PES Institute of Technology and Management, Shivamogga, Karnataka, India, their extending support to conduct experiments.

References

1. Jain, R. K. (1981). *Production Technology (A Text-Book for Engineering Students)*, Khanna Publishers, NAI SARAK, Delhi.
2. Shuaib-Babata, Yusuf Lanre, PE, Olumodeji,J,O.(2014). Analysis of Ilorin Sand Moulding Properties for Foundry Applications, *International Journal of Engineering Research & Technology (IJERT)*,Vol. 3, No. 1, 1520-1526
3. Sunday Aribo (2011), Effect of Varying Corn Cob and Rice Husk Ashes on Properties of Moulding Sand**,** *Journal of Minerals & Materials Characterization & Engineering***,** Vol. 10, No.15, 1449-1455
4. Ihom A, P., Ogbodo J, N., Allen A, M., Nwonye E, I., Ilochionwu C,. (2014). Analysis and prediction of green permeability values in sand moulds using multiple linear regression model, *African Journal of Engineering Research*, Vol. 2(1), 8-13
5. Tataram K. Chavan, Nanjundaswamy H, M,. (2013). Comparison of Fly ash with Coconut shell Powder and Tamarind powder on Green sand Mold Properties, *International Journal of Latest Trends in Engineering and Technology (IJLTET)*, Vol. 2, No. 4, 412-416
6. Tataram K. Chavan, Nanjundaswamy H, M,. (2013). Effect of Variation of Different Additives on Green sand Mold Properties for Olivine sand, *International Journal of Research in Engineering & Advanced Technology*, Vol. 1, No. 4, 1-4
7. Saliu Ojo Seidu, Bolarinwa Johnson Kutelu (2014), Effects of Additives on Some Selected Properties of Base Sand, *Journal of Minerals and Materials Characterization and Engineering*, No. 2, 507-512