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Effect of Iron Oxide on Mechanical Properties of Green Sand Mould

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***Abstract*— The present day requirement of industries is to produce a good quality of castings with minimum cost. The quality of the cast products that are produced utilizing quartz sand based moulds largely depends on the mould properties, namely compression, shear strengths and permeability which depend on input parameters. This study presents the statistical evaluation of selected properties of moulding sands chromite and zircon sands with addition of various binders and various additives. It is expected that the sand could be put to use in making mouldings for casting steel components for possible replacement of the imported products. The results obtained showed the existence of peak values for the green compressive strength and the permeability of the unwashed sand, with set amounts of binding clay, bentonite,coal-dust and iron-oxide additives. In addition, the working range for each type of property was seen to vary with the amount of water present in the sand. The results demonstrated the possible utility of the sand for making of sand casting moulds.**

Keywords*—Green sand mould, Compression Strength, shear Strength, Permeability

I INTRODUCTION

Casting is a manufacturing process where a solid is melted, heated to proper temperature (sometimes treated to modify its chemical composition), and is then poured into a cavity or mold, which contains it in the proper shape during solidification. Thus, in a single step, simple or complex shapes can be made from any metal that can be melted. The resulting product can have virtually any configuration the designer desires. Since metal casting involves working with metal in its molten form, the process can be dangerous if undertaken by the reckless or ill informed. The melting points of several metals are well above 1,000º C [1]. It is vital that anyone wanting to work with metal casting take all the proper precautions. Casting has marked advantages in the production of complex shapes, parts having hollow sections or internal cavities, parts that contain irregular curved surfaces (except those made from thin sheet metal), very large parts and parts made from metals that are difficult to machine. Because of these obvious advantages casting is one of the most important of the manufacturing processes.

Today, it is nearly impossible to design anything that cannot be cast by one or more of the available casting processes. Metal casting requires specialized equipment, knowledge, and some creativity. While metal casting is used on an Industrial level as the process cuts cost and proves to be highly efficient. However, as in all manufacturing techniques, the best results and economy are achieved if the designer understands the various options and tailors the design to use the most appropriate process in the most efficient manner[2]. The various processes differ primarily in the mold material (whether sand, metal, or other material) and the pouring method (gravity, vacuum, low pressure, or high pressure). All of the processes share the requirement that the materials solidify in a manner that would maximize the properties, while simultaneously preventing potential defects, such as shrinkage voids, gas porosity, and trapped inclusions[3].

In this work, the properties of moulding sand. compression strength and shear strength are calculated and analyzed for various sands.

II CASTING PROCESS

Sand casting, also known as sand molded casting, is a metal casting process characterized by using sand as the mold material. The term "sand casting" can also refer to an object produced via the sand casting process. Sand castings are produced in specialized factories called foundries. Over 70% of all metal castings are produced via a sand casting process.

Basic process of sand casting

In general there are six steps in this process.

I.Place a pattern in sand to create a mold.

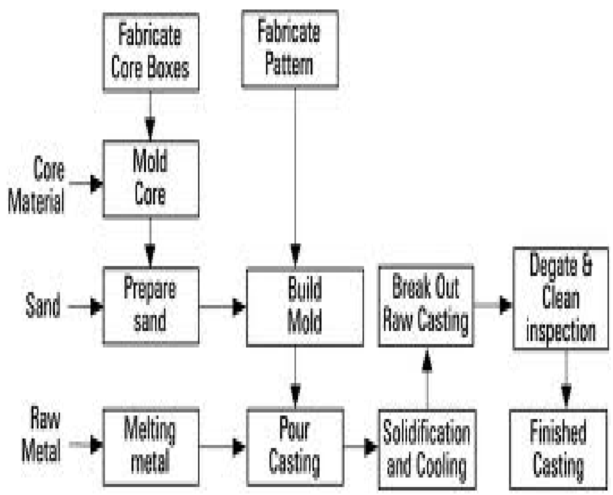
ii.Incorporate the pattern and sand in a gating system

iii.Remove the pattern.

iv.Fill the mold cavity with molten metal.

v.Allow the metal to cool.

vi.Break away the sand mold and remove the casting



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III SAND TESTING

A. Sand Testing Equipment

The molding sand after it is prepared should be properly tested to see that require properties are achieved. Tests are conducted on a sample of the standard sand. The molding sand should be prepared exactly as it is done in the shop on the standard equipment and then carefully enclosed in a container to safeguard its moisture content. Sand tests indicate the molding sand performance and help the foundry men in controlling the properties of molding sands. Sand testing controls the molding sand properties through the control of its composition.

Sand rammer

Sand rammer consists of calibration sliding weight actuated by cam, a cup to accommodate specimen tube below ram head, a specimen stripper to strip compacted. specimen out of specimen tube, a specimen tube to prepare the standard specimen of 50mm diameter by 50mm height for an AFS standard specimen. The cam is actuated by a user by rotating the handle, causing a cam to lift the weight and let it fall freely on the frame attached to the ram head. This produces a standard compacting action to the pre-measured amount of sand. After the specimen has been prepared inside the specimen tube, the specimen can be used for various standard sand tests such as the permeability test, the quartz sand compression test, the shear test , or other standard foundry test.

No. Of strokes: It is the number of ramming strokes which we give to the sand mould to gain strength.In our process we have a range of 3-5 ramming strokes.

Compression strength test

The compressive strength of sand is the maximum compressive stress that a mixture is capable of sustaining when prepared, rammed and broken under standard conditions. The rammed cylindrical specimen(5 cm diameter & 5 cm length) is formed by placing a weighed amount of sand in a tube and ramming the sand. The instrument used for breaking the specimen must continuously register the increasing load until this specimen fractures. The green strength of sands is generally in the range of 30 to 160 KPa.

Shear strength test

The procedure to extract the shear strength of sand is as same as compression strength. This is accomplished by changing the load surface on the testing machine from compression pads to shear pads. The specimen then rupture's in shear along its longitudinal axis, when sufficiently loaded. Shear strength may vary from 10 to 50 KPa.

Permeability test

The quantity of air that will pass through a standard specimen of the sand at a particular pressure condition is called the permeability of the sand.

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Steps involved are:

i. The air (2000cc volume) held in the bell jar is forced to pass through the sand specimen.

ii. At this time air entering the specimen equal to the air escaped through the specimen

iii. Take the pressure reading in the manometer.

iv. Note the time required for 2000cc of air to pass the sand

v. Calculate the permeability number

vi. Permeability number (N) = ((V x H) / (A x P x T))

Where,

V-Volume of air (cc)

H-Height of the specimen (mm)

A-Area of the specimen (mm^2)

P-Air pressure (gm / cm^2)

T-Time taken by the air to pass through the sand (seconds)

IV EXPERIMENTATION

New silica sand was obtained and this was mixed with betonite, coal dust and water. The silica sand was obtained in bags of 25 kg. For every sample of 700 gms, 574 gms of silica sand, 49 gms of bentonite, 35 gms of coal dust, 42 ml of water were added and mixed. Along with the composition of silica sand,other different compositions of silica sand are prepared by addition of varying percentages of iron oxide to the slica sand.A sample which has no Fe content and also a sample with no coal dust is also prepared

Materials	Weight composition wt%)
Silica Sand	82
Bentonite	7
Coal dust	5
Water	6

V RESULTS AND DISCUSSION

a. Effect of additives on Compression strength

a.Sand in % b.Bentonite in % c.Coal Dust in % d.Water in % e.Iron Oxide in %

From above table it is clearly observed that the compression strength

a	b	c	d	e	Compression strength (gm/cm^2)			
81	7	5	6	1	205	220	200	208.
80	7	5	6	2	180	170	200	183.3
79	7	5	6	3	210	205	210	208
82	6	5	6	1	220	180	200	200
82	5	5	6	2	200	210	210	206
82	4	5	6	3	205	190	180	191
82	7	4	6	1	200	200	200	200
82	7	3	6	2	180	190	200	190
82	7	2	6	3	200	200	190	196
82	7	5	5	1	180	190	170	180
82	7	5	4	2	190	195	180	188
82	7	5	3	3	220	195	200	205
82	7	-----	6	5	190	195	175	186
82	7	5	6	-----	184	210	200	198

has been reduced to certain value when compares to standard value i.e from 342 to 330 g/cm^2

b. Effect of additives on Shear Strength strength

a	b	c	d	e	Compression strength (gm/cm^2)			
81	7	5	6	1	340	320	330	330
80	7	5	6	2	300	310	305	305
79	7	5	6	3	280	260	300	280
82	6	5	6	1	285	300	290	291
82	5	5	6	2	250	220	240	236
82	4	5	6	3	290	280	300	290
82	7	4	6	1	320	320	340	326
82	7	3	6	2	280	245	290	271
82	7	2	6	3	240	240	240	240
82	7	5	5	1	300	280	300	293
82	7	5	4	2	280	300	290	290
82	7	5	3	3	320	340	300	320
82	7	----	6	5	230	250	280	253
82	7	5	6	-----	340	345	341	342

From above table it is clerly observed that the shear strength has been increased to certain value when compared to standard value i.e 198 to 208.33g/cm^2

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c. Effect of additives on Permeability

a	b	c	d	e	Permeability number			
81	7	5	6	1	16.7	17.3	16.7	16.9
80	7	5	6	2	11.8	12.2	14.3	12.76
79	7	5	6	3	9	12.2	12.6	11.2
82	6	5	6	1	12.6	13.8	13.4	13.26
82	5	5	6	2	19	17.3	18.4	18.23
82	4	5	6	3	17.3	17.3	17.3	17.3
82	7	4	6	1	12.6	12.6	14.7	13.3
82	7	3	6	2	14.7	17.3	19	17
82	7	2	6	3	20	17.8	17.3	18.36
82	7	5	5	1	13.8	12.2	13	13
82	7	5	4	2	9	10.7	6.5	8.733
82	7	5	3	3	9	10.7	7.7	9.133
82	7	-----	6	5	30	24.2	24.2	26.13
82	7	5	6	-----	7.7	10.7	8.2	8.866

From above table it is clear that the permeability number has been increased to certain value when compared to standard value i.e 8.86 to 16.9

VI CONCLUSION

From the above results it has been observed that shear strength and permeability of the molding sand has reached the maximum value by adding iron-oxide to the molding sand.

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