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REVIEW OF RESEARCH

A STUDY ON FOUNDRY WASTE SAND MANAGEMENT

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ABSTRACT :

In the beginning of 21st century global people have started to face the problem of solid waste which is generated through various human activities. The major sources of this solid waste are domestic, agricultural and Industrial activities. These solid waste are mainly organic and inorganic in nature. Out of these waste some are easily degradable and some are non degradable as well as some are highly toxic to human life and environmental ecosystems. In this present attempt foundry industries are objected to study the nature of solid waste generated by them and to know the end use of these solid waste. Foundry industries are mainly using metallic (pig Iron, Scrap) and non metallic (Coke, Limestone, Green sand) as a raw material for casting. After casting or from this cast manufacturing process, foundry industries are generating high amount of waste sand and slag. Due to lack of knowledge about further use of foundry waste sand, it is dumped on ground, roadsides as well as used for land filling which further becomes the cause of pollution of air, water, ground water and land. This foundry waste sand shows high pH (7.8), water holding capacity (WHC) 41.55%, fluoride 2.28 mg/l and Iron 0.92mg/l.

KEYWORDS : *Foundry waste sand, Environment, Leachate, Fluoride, pH, WHC.*

INTRODUCTION

Kolhapur is a district place situated at the southern part of Maharashtra State on the border of northern Karnataka State. Kolhapur receives rich natural beauty and pleasant healthy environment. It is a place of Goddess Shri. Mahalaxmi and known as Dakshin Kashi. The region of Kolhapur receives as much as 1500-1600 mm annual rainfall, having 6-7 perennial rivers with highly fertile land. Because of this richness of natural wealth, Kolhapur region becomes most important last station for fast growth of various types of industrial zones in southern Maharashtra. In this diversified Industrial sectors, Kolhapur Foundry Industrial Sector is very much famous at National and International level for quality casting. As on today there are more than 350 foundries in and around the Kolhapur city.

According to Samraj (2016), President, The Institute of Indian Foundrymen, currently there are more than 4500 casting in India which employing 5 lakh people directly. The foundry industries are the mother of all Engineering and Manufacturing Industries which employing 5 Lakh people directly and 15 Lakh indirectly and earns a revenue of USD 18 billion annually with exports of USD 2 billion and contributes USD 1 billion to the exchequer and stands 2nd rank in world for casting production.

In this foundry industries mainly pig Iron, scrap and other unusable waste metallic material is used as a raw material, (photo plate No.1).

Photo Plate No.1 shows pig iron, scrap, coke and limestone used as a raw material in foundry industry.

For casting the job it requires the molds and for mold formation requires specific green sand which is rich in high quality silica (85-95%). Further this sand is charged with addition of 5-10 % bentonite (clay binder), 5 % Sea coal (Carbonaceous mold additive to improve casting finish) and 5% water and then it is homogenized with the help of mixture to make it ready for molds.

Photo plate 2 shows the 1-Natural green sand, 2-Processed sand, 3-Foundry waste sand, 4-Water washed foundry waste sand and 5-Natural river sand .

Photo Plate No.2 Shows the 1-Natural green sand, 2-Processed green sand, 3-Foundry waste sand, 4-Water washed FWS and 5-Natural river sand.

MANUFACTURING PROCESS OF CASTING:

The raw material like pig Iron, scrap and other metallic material as pig Iron (40%),metallic scrap (40%), Coke (12%) and limestone (8%) is loaded into furnace where it is heated at 14500C temperature (Photo Plate 3). At this temperature ferrous metallic material is molten and impurities are separated in the form of slag where pure molten metallic liquid is poured into pre formed sand molds. After cooling solidified metal cast is separated from the sand mold. For this process a vast quantity of processed sand is used by the foundry industry for casting. Two-three times this sand repeatedly used and then after it become useless for casting. Then this foundry waste

sand and slag is unscientifically used for land filling or dumped on road sides which further becomes cause of air, water and ground water pollution. The leachate of foundry waste sand and slag is not directly harm to human and animal life but sometimes it harm to earth's environment and ecosystem. According to EPA (US), 2007, near about 6-10 million tons of foundry waste sand is generated per year and out of it less than 10-15 % waste sand is recycled and remaining huge amount of waste sand is damped on ground.

Photo Plate No.3 Shows molten ferrous material collection and pouring into sand molds.

Considering the natural stock of green sand and day by day increased demand of green sand, the time has come to think about reuse and recycle waste sand and find some beneficial uses of this foundry waste sand. As on today about the reuse of foundry waste sand (FWS) there is lack of awareness and knowledge among the foundry owners and even limited literature as well as poor technology is available for how to make it reusable and where to use it in proper manner to adopt sustainable best foundry waste sand management practices.

MATERIAL AND METHODS:

To understand the problem of foundry waste sand management number of foundry industries were visited which are situated in Kolhapur region and made the discussion with production managers. Through the interaction lot of information's were collected regarding the use of raw material, furnace, silica sand and process on it to make suitable and ready for mold. To know the physico-chemical characteristics of green sand, processed ready sand and waste sand, samples were collected and brought to laboratory (Photo plate No.2). From these sands leachate was prepared with using distilled water as 1:5 mixture i.e. (20gm. of sand+100 ml. of distilled water) and kept it for overnight after stirring in well manner (Trivedy and Goel,1984). Next day upper supernatant was filtered through whatman filter paper No.1 and filtrate was collected and saved for physico-chemical analysis. From the saved leachate various parameters were analyzed with the help of methods which was prescribed by APHA (1998).

For the reuse and recycle point of view of foundry waste sand in concrete, the commonly used proportion which is used for concrete as 1:2:4 i.e.1 part cement (ppc Grade), 2 parts of foundry sand (Green sand, processed ready sand, foundry waste sand, water washed waste sand and commonly used natural river sand) were used for making concrete block. For this 25 gm. of (ppc grade) cement, 50 gm. of sand and 100 gm. of stone grit ½'' (inch size) was used. All this were mixed together and added 20 ml. of water and homogenized this mixtures. For making proper size of concrete block 1½'' diameter size PVC pipe was used with 3 inch in length. Then the all mixed mixture were introduced in a PVC mold which was already labeled. Then it was kept overnight

for curing and next day the concrete blocks were removed from PVC molds and labeled them. Then this separated concrete blocks were kept in water bath for 28 days for curing and then it was air dried (photo plate No.4) and its strength was measured with the help of compression testing machine (Ratnakar Enterprises Make, photo plate No.5).

Photo Plate No.4 Shows concrete blocks processed from various foundry sands.

RESULTS AND DISCUSSION:

Table 1.shows the physico-chemical characteristics of green sand, processed ready sand, foundry waste sand and commonly used natural river sand. The original foundry sand shows greenish yellow in color, processed ready green sand shows dark black color, foundry waste sand shows faint black color where natural river sand shows gray stony color. Processed and foundry waste sand shows black color due to presence of sea coal which is used for converting green sand in usable sand for mold to get superior finishing of casting. For odour point of view all sands were smelled and all sands don't have any odour. The texture of sand shows that the green sand shows 73.84%, processed ready sand contain 4.3%, Foundry waste sand contain 61.43% and natural river sand shows 89.70% of coarse sand respectively. The amount of silt and clay found 50.24% in processed ready sand,11.15% was found in foundry waste sand and raw green sand shows 10.12% silt and clay. Foundry waste sand shows decline in silt and clay and it may be due to burning of silt and clay due to pouring of hot liquid ferrous metal into mold.

Table.1 Physico-chemical characteristics of various foundry sands.

Sr. No	Parameter	Sample-I Green Sand	Sample- 2 Processed Ready sand	Sample-3 Foundry waste sand	River Sand
1	Colour	Gray- Green	Dark Black	Faint Black	Grey
2	Odor	Odorless	Odorless	Odorless	Odorless
3	Soil Texture				
	Corse Sand (%) 0.2 – 2.0 mm	73.84	4.3	61.43	89.70
	Fine Sand (%) 0.02 – 0.2 mm	16.04	37.46	27.42	4.52
	Silt + Clay (%) 0.002 – 0.02mm	10.12	50.24	11.15	5.78
4	Moisture Content (%)	0.06	2.69	0.57	NA
5	Water Holding Capacity(%)	23.02	84.12	41.55	NA
6	pH	7.70	7.93	7.80	NA
7	Total Hardness(mg/l)	120.00	80.00	80.00	NA
8	Calcium (mg/l)	32.06	32.08	24.05	NA
9	Magnesium (mg/l)	9.75	00	4.87	NA
10	Chlorides (mg/l)	4.26	14.20	14.20	NA
11	Alkalinity (mg/l)	40.00	50.00	30.00	NA
12	Iron (mg/l)	0.153	0.307	0.920	NA
13	Chromium (mg/l)	00	00	00	NA
14	Fluoride (mg/l)	2.32	2.40	2.28	NA

NA – Not Analysed

Moisture content also found very poor i.e. 0.06% in green sand, 2.697% in processed ready sand where

foundry waste sand shows 0.57% of moisture. Moisture percent found high in processed ready sand may be due to addition of water (5%) at the time of making ready sand for molds. Water holding capacity was found 23.02%, 84.12%, 41.55% in green sand, processed sand and foundry waste sand respectively. High water holding capacity found in processed ready sand may be due to presence of sea coal (organic matter) and it is found declined in foundry waste sand might be due to oxidation of coal ash (OM) which burns at high temperature when molten metal was poured in molds. This burn sand may reduces the water absorbing capacity up to 42.57% than the processed ready green sand.

Sand leachate was used for determination of chemical characteristics and this leachate of green sand shows 7.70 pH, processed sand leachate shows 7.93 pH and foundry waste sand leachate shows 7.80 pH. Total hardness of Green sand found 120.0 mg/l where processed ready sand and foundry waste sand observe 80.0 mg/l of hardness. Hardness is mainly depends on the presence of carbonates and bicarbonates. These carbonates may be oxidized due to high temperature of molten metallic liquid which introduced into molds and molds were processed from silica sand and sea coal.

From the Table 1, it is evident that the level of chloride remains same in processed sand and foundry waste sand (14.20 mg/l) which was very poor in green sand i.e. 4.26 mg/l. The amount of chloride found increased in remaining processed sand and foundry waste sand may be due to presence of sea coal. Alkalinity of green sand was found 40.0 mg/l and it was found high in processed sand (50.0mg/l) and it is found declined in foundry waste sand and it is 30.0 mg/l. It may be due to burning of salts at the time of contact between hot metallic liquid and sand molds.

In case of iron content in used sand shows continuous improvement in iron content i.e. natural green sand shows 0.153 mg/l, processed sand shows 0.307 mg/l and 0.920 mg/l of iron content found in foundry waste sand. It may be due to absorption of ferrous content by sand molds at the time of casting. The amount of fluoride in natural green sand was found 2.32 mg/l and it was found increased up to 2.40 mg/l in processed sand and again it was found declined in foundry waste sand and it was 2.28 mg/l. This is very important from the point of view of water pollution and if proper scientific management practices not considered today for its disposal, then it may be become the cause of water pollution as well as it may produce various adverse side effects among the animal and human body.

Considering the need and sustainable reuse of foundry waste sand which is generated by foundry industries, the green sand, processed sand, waste sand, water washed foundry waste sand and natural river sand was used for making concrete block. After curing of concrete blocks for 28 days in water bath its strength was measured (photo plate 5). Table 2 shows the strengths of various sand used concrete blocks. From the table 2 it is evident that the green sand concrete block shows 16.11 N/mm^2 strength and natural river sand used concrete block shows 19.12N/mm^2 strength where foundry waste sand concrete block shows 10.64 N/ mm^2 strength.

Table 2. Strength of concrete blocks processed from various foundry and River sand.

Sr. No	Name of foundry sand used in concrete blocks	Size of concrete block in mm	Compressive Strength N/mm^2
1	Raw Green sand	Diameter :52 Height :37	16.11
2	Processed Ready Sand	Diameter :52 Height :37	15.35
3	Foundry waste sand	Diameter :52 Height :37	10.64
4	Water washed foundry waste sand	Diameter :52 Height :37	10.78
5	River Sand	Diameter :52 Height :37	19.12

This is very important finding of this study which definitely useful to solve the environment related problems like air, water and land pollution due to unscientific disposal of foundry waste sand. This foundry waste sand is highly useful in manufacturing of concrete bricks, paving blocks, wall plaster and concrete road construction. As well as this foundry waste sand is highly useful in concrete partition wall if it is used in proportion of 50% river sand and 50% foundry waste sand.

From the point of view to reuse and eco-friendly use of foundry waste sand, Government organizations, private builders and other developers have to consider the scope, need and availability of foundry waste sand, they have to use this foundry waste sand in concrete construction which will be helps to solve the environmental problems as well as save the natural stock of river sand which is day by day becoming costly and scare. It also helps to preserve and protect river water and river ecosystem also.

Photo Plate No. 5 Shows the measurement of concrete block strength of various foundry sand used.

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