Brick Making From Over Burden Dump, a Mine Waste

[1]Navneet Nunar, [2]A.K.Gautam

[1]M.Tech Student, [2]Assistant Professor
Maharishi University of Information Technology, Lucknow

***Abstract*: Mineral waste utilization as a construction material for making building bricks and blocks has already started in developed and developing countries. In India, marble slurry, tailings and red mud are being suggested to use as a building material. Utilization of mine spoil for constructional bricks and blocks will generate additional employment during and after mine operation. Waste rock utilization in coal mining area reduce environmental impact, more availability of land resource and reduction in mining cost, which occurs on the maintenance of mine spoil as reclamation, plantation, slope stability etc. The plantation will be more effective and cheap in plain land than unstable sloppy dumps. Utilization of mine spoil for manufacture of constructional bricks will also conserve precious soil used in making clay bricks.**

Keywords: **Over Burden Dump, Mine, Waste, coal**

Introduction-

Coal is a very important resource for India where most of the industries such as thermal power plant, mineral industries are using coal for extracting energy. Around the world, India dominates the third position in the largest production of coal and has the fourth largest coal reserves approx. (197 Billion Tons). It has been estimated that 75% of India's total installed power is thermal of which the share of coal is about 90%. Nearly about 600 Million tons of coal is produced worldwide every year. Coal based thermal power plant has consumed about 640 million tons of coal in 2015-16 which is about three fourth of the total coal consumed in the country. Surface mines are producing about 328 Mt coal along with huge quantity of overburden waste rocks as mine spoil. There is 84 million m3 (Mm3) annual overburden removal with an accumulation of 916 mm^3 since 1990 only in one coal company of India (South Eastern Coal field Ltd., SECL). This volume of overburden is going to accredited every year due to dumping of overburden, increase of depth of coal seam and coal production. Mining causes the destruction of natural ecosystems through removal of soil and vegetation and burial beneath waste disposal sites. The restoration of mined land in practice can largely be considered as ecosystem reconstruction and restore the capability of the land to capture and retain fundamental resources. In ecological restoration planning. If only 60% of total overburden (535.08 Mm3) is utilized for making bricks, about 160524 million bricks may be constructed from 321 Mm3 overburden per year. As mines are well dispersed in Andhra Pradesh, Assam, Chhattisgarh, Jammu & Kashmir, Jharkhand, Madhya Pradesh, Maharashtra, Orissa, West Bengal and Uttar Pradesh, there will be proper distribution of bricks made with overburden for building and other purposes.Utilization of mine spoil for manufacture of constructional bricks will also conserve precious soil used in making clay bricks.

Overburden is composed of mostly friable sandstone, a little shale, and fired clay and rarely conglomerate at few places. Textural analysis of overburden (sandstone) may divide mine-spoil as:

- coarse grain sandstone (> 5 mm grain size);
- medium grain sandstone (1-5 mm grain size);
- Fine grain sandstone (< 1 mm grain size).

Literature review:-

Mines waste can be further classified as solid mining, processing and metallurgical wastes and mine waste water. Mining wastes either do or do not contain ore mineral, industrial minerals, metals, coal or mineral fuels, or the concentration of the mineral, metals, coal or mineral fuels is sub economic. It is based on the concentration of the ore element in each unit of the mined rock and on the cost of the mining that unit. As a result, every mine has different criterion for separating mine waste from ore. Mining waste includes overburden and waste rock excavated and mined form surface and underground operation. Waste rock is essentially wall rock material removed to access and mine ore. In coal mining, waste rocks are referred to as "spoils".
Mining waste is heterogeneous geological material and may consist of sedimentary, metamorphic or igneous rock, soil and loose sediments. As a consequence, the particle sizes ranges from the clay size particles to boulder size fragments. The physical and chemical characteristic of mining waste vary according to their mineralogy and geochemistry, type of mining equipment, particle size of the mined material, and moisture content.
Utilization of mine spoil for constructional bricks and blocks will provide huge amount of employment during and after mine operation. Waste rock utilization in coal mining area reduce environmental impact, more availability of land resource and reduction in mining cost, which occurs on the maintenance of mine spoil as reclamation, plantation, slope stability etc. The plantation will be more effective and cheap in plain land than unstable sloppy dumps12-16. Utilization of mine spoil for manufacture of constructional bricks will also conserve precious soil used in making clay bricks (jamal et al, 2008).

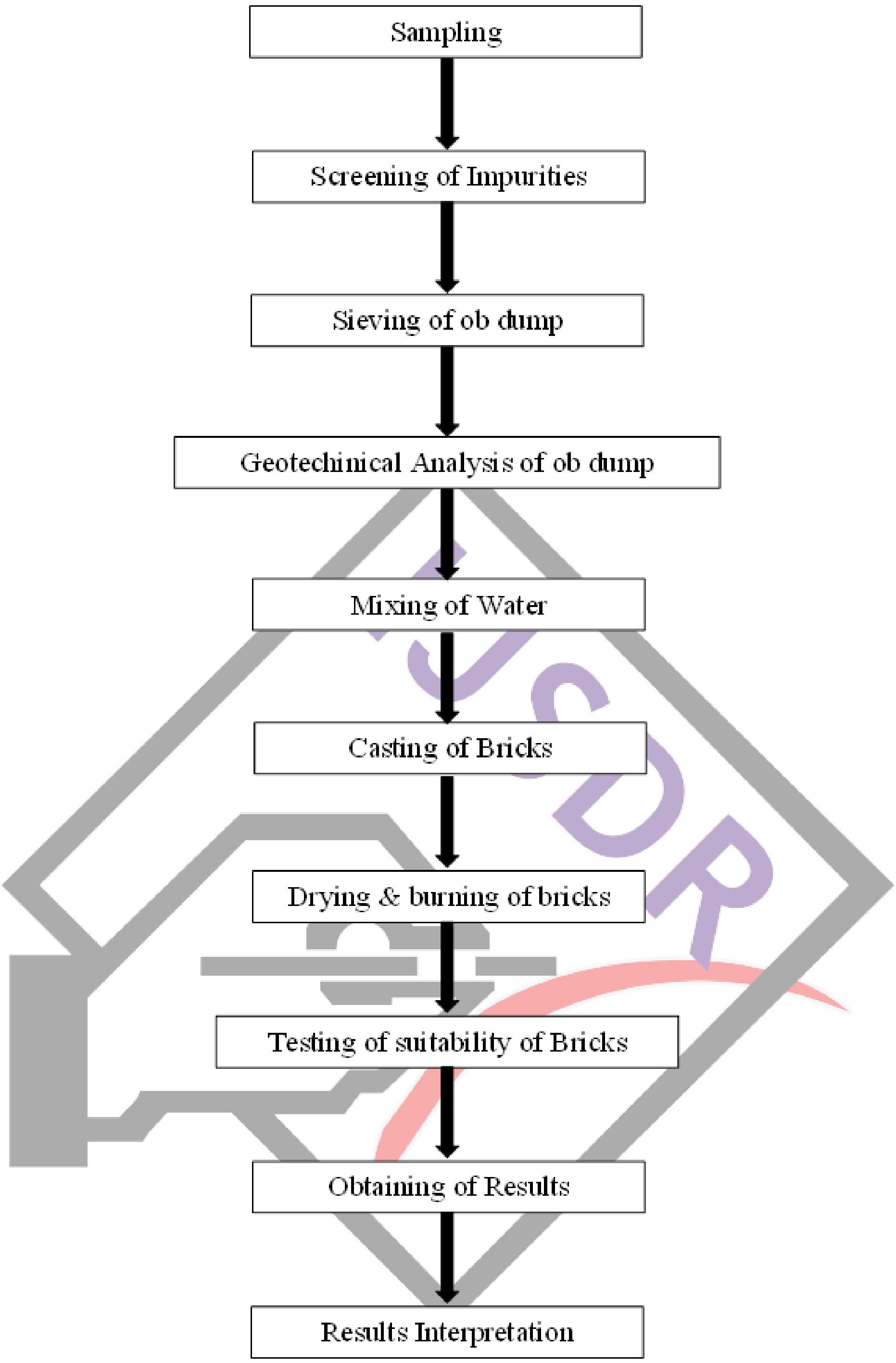
Primary data collection

The sampling for over burden dump is done at Bastacolla Area, Jharia coalfield, Dhanbad, Jharkhand. About 35 kg of over burden dump is collected from the sampling area for the present study. Bastacolla Area is situated in the eastern flank of Jharia coalfield. It adjoins most ancient Archeam Rocks, which form a bowl shape in eastern site of Jharia Coalfield. The total leased-hold area is 1210 hac. And is situated mostly on eastern side of Dhanbad-Patherdih railway line (dismantled) and between Dhanbad city and Lodna barrier.

At present Bastacolla Area is having four underground coal producing units namely Bastacolla, Bera, Dobari, Kuya and four opencast units namely Ghanoodih OCP. Golukdih/Kuya OCP, Bera OCP and Kujama OCP and has achieved the production to thetune of 20.50 lakh tonne during 2009-10, out of which Underground produced 5.73 lakh tonne, and opencast produced 14.77 lakh tonne. The Area registered a profit of 17.84 Crore. The project area, which forms a part of OCP VIII Block, is located in the eastern part of Jharia Coalfield and falls in Dhanbad District of Jharkhand. It is about 8 Km east of Dhanbad Railway station and in between N 99500 to N 105600 and E 91800 to E 96400

Figure 1 sample collection site

Research methodology



Generally lots of impurities are presents in over burden dump like lump of coal, rocks, particle of ore and fossil and chemicals impurities was also been found such as heavy metals etc. so while screening only those impurities was remove which can become barrier in making of bricks And those impurities are rocks and lumps of coal because they can create problem while casting of bricks these impurities are removed by handing picking by spreading the ob dump all over the floor and then the rock and coal lumps were pickup by hands.

Sieving of ob dump: - After the screening of impurities the all the ob dump is thoroughly sieve with 4.75 mm (IS: 2720:1983) sieve in order to maintain evenness in the grain fines.

Geotechinical Analysis of ob dump: - Geotechnical property of the ob dump was analysed in the Geotechnical Laboratory by performing following test

- Specific Gravity
- Bulk Density
- Moisture Content
- Compaction

- Permeability
- Grain Size analysis
- Plastic Limit
- Shrinkage Limit

Mixing of Water: - After the geotechnical analysis Water is mixed in a ratio of 10% by weight and then thoroughly mixed with hands.

Casting of Bricks: - After mixing of water bricks are casted with the help of mould of standard size**.**

Drying & burning of bricks: - After the casting of bricks they are left in sun light for drying and when they get dry they are shifted to muffle furnace in order to burn them at a temperature at about 1100^{o} C.

Testing of suitability of Bricks:-After the burning of bricks the testing for the suitability is to be done on then. The test performed on them are

- Compression Strength Test
- Water Absorption Test
- Efflorescence Test
- Impact Test
- Soundness Test
- Hardness Test
- Structure Test

Obtaining of Results: - After performing all the suitability test on bricks then results were obtain and on the basis of that results conclusion were made.

Analysis

Analysis of sample will be done in Geotechnical laboratory for Geotechnical parameter (IS: 2720:1983) by preparing the sample according to IS: 2720(part 1)-1983 and conducting the following test

a) **Specific gravity**:-

This test is done to determine the specific gravity of fine-grained Ob dump by density bottle method as per IS: 2720 (Part III/Sec 1) – 1980. Specific gravity is the ratio of the weight in air of a given volume of a material at a standard temperature to the weight in air of an equal volume of distilled water at the same stated temperature.

Calculation

$$\text{specific gravity} = \frac{w_2 - w_1}{(w_4 - w_1) - (w_3 - w_2)}$$

Where,

W1 = Weight of empty specific gravity bottle

W2 = Weight of bottle + bitumen

W3 = Weight of bottle +water

W4 = Weight of bottle + water +bitumen

b) **Bulk density**:-

Soil bulk density is the mass of dry soil per unit of bulk volume, including the air space. Soil bulk density can vary substantially among different soil types and is affected by management practices. Incorporation of large amounts of organic matter into the soil will lower the bulk density, while processes that compact the soil will increase bulk density.it is done as per IS:2720 (part 2)-1973.

Calculation:-

$$\text{Bulk density} = \frac{\text{mass (g)}}{\text{volume (cc)}}$$

- m = mass of sample in g
- V = volume of sample in cc

c) Moisture content

This method covers the laboratory determination of the moisture content of a soil as a percentage of its oven-dried weight. The method may be applied to fine, medium and coarse grained soils. The method is based on removing soil moisture by oven-drying a soil sample until the weight remains constant. The moisture content (%) is calculated from the sample weight before and after drying. It is analysed according to IS: 2720 (part 2)-1973

Calculations

Calculate the moisture content of the Ob dump as a percentage of the dry Ob dump weight.

$$\text{Moisture content} = \frac{w_2 - w_3}{w_3 - w_1} X\ 100$$

- W_1= Weight of can (g)
- W_2= Weight of moist Ob dump + can (g)
- W_3= Weight of dried Ob dump + can (g)

d) Compaction

Standard Proctor Compaction Testing can be performed in a lab. The testing first determines the maximum density achievable for the Ob dump and uses it as a reference for field testing. It also is effective for testing the effects of moisture on the soil's density. For soil with higher densities a Modified Proctor Compaction Test which uses higher values will be necessary. It was done as per IS: 2720(part 8)-1983

Calculation

Calculate the moisture content of each layer of the Ob dump as a percentage of the dry sample weight.

$$\text{Moisture content} = \frac{w_2 - w_3}{w_3 - w_1} X\ 100$$

- W_1= Weight of tin (g)
- W_2= Weight of moist Ob dump + tin (g)
- W_3= Weight of dried Ob dump + tin (g)

e) Permeability

In this test flow of water through a relatively short soil sample connected to a standpipe which provides the water head and also allows measuring the volume of water passing through the sample. The permeability of soil is also known as the falling head permeameter. The falling head permeameter is used to measure the permeability of relatively less pervious soils. Permeability is done by falling head method as per IS: 2720(part 17)-1986

Calculation

The coefficient of permeability is given by

$$k = \frac{2.3aL}{At} \log_{10}\left(\frac{h_1}{h_2}\right)$$

Where,

- h_1 = initial head,
- h_2 = final head,
- t = time interval,
- a = cross-sectional area of the liquid stand pipe,
- A =cross-sectional area of the specimen,
- L = length of specimen.

f) Plastic limit

The plastic limit of a soil is the water content of the soil below which it ceases to be plastic. It begins to crumble when rolled into threads of 3mm diameter. Plastic limit is done as per IS: 2720(part 5)-1958

Calculation

$$\text{Plastic limit} = \frac{w_2 - w_3}{w_3 - w_1} X\ 100$$

- W_1= Weight of tin (g)
- W_2= Weight of moist Ob dump + tin (g)
- W_3= Weight of dried Ob dump + tin (g)

g) Shrinkage limit

The shrinkage limit is the water content of the soil when the water is just sufficient to fill all the pores of the soil and the soil is just saturated. The volume of the soil does not decrease when the water content is reduced below the shrinkage limit. Shrinkage limit is done as per IS: 2720(part 5)-1958

Calculation

Shrinkage limit can be determined from the relation

$$\text{shrinkage limit} = \frac{(M_1 - M_s) - (V_1 - V_2)\rho_w}{M_s}$$

Where

M_1= initial wet mass,

V_1= initial volume

V_2= final volume

M_S = dry mass

h) Grain size analysis

This test is performed to determine the percentage of different grain sizes contained within a soil. The mechanical or sieve analysis is performed to determine the distribution of the coarser, larger-sized particles, and the hydrometer method is used to determine the distribution of the finer particles. The distribution of different grain sizes affects the engineering properties of soil. Grain size analysis provides the grain size distribution, and it is required in classifying the soil. Grain size analysis is done by sieve as per IS: 2720 (part 4)-1985.

Calculation

- The percentage of Ob dump retained on each sieve shall be calculated on the basis of total weight of Ob dump sample taken.
- Cumulative percentage of Ob dump retained on successive sieve is found.

Graph: - Graph is drawn between log sieve sizes vs. % finer. The graph is known as grading curve. Corresponding to 10%, 30% and 60% finer, obtain diameters from graph are designated as D_{10}, D_{30}, D_{60}.

Brick Analysis

1. Compression Strength Test

This test is performed to determine the compressive strength of bricks. It is additionally known as crushing strength test of bricks. Normally, 5 samples of bricks are selected and transported to the laboratory for testing. A brick sample is kept on the crushing machine and then the pressure is thoroughly applied axially until it breaks. The maximum pressure at which the brick starts to crack is noted. The test is repeated with all 5 brick samples one by one and the average result is considered as the compressive strength or crushing strength of bricks.

Compressive Strength of Bricks.

- Compressive Strength of first class brick is 105 kg/cm^2.
- Compressive Strength of 2nd class brick is 70 kg/cm^2.
- Compressive Strength of common building brick is 35 kg/cm^2.
- Compressive Strength of sun dried brick is 15 to 25 kg/cm^2.

2. Water Absorption Test

In this test, bricks are weighed first in dry condition (W1) and then they are fully submerged in water for 24 hours. After immersion of 24 hours, the bricks are collected and weighed again in wet condition (W2). The difference of weight between dry and wet condition is considered as the water absorbed by the bricks. Then the amount of water absorption is determined in percentage. The less water consumption by the bricks indicates their greater quality. A brick will be considered as good quality if it does not consume more than 20% water of its own weight.

- Absorption value is calculated by the simple relationship.

Absorption % = w2-w1/w1 x 100

Where W1 is dry weight, W2 is weight after immersion for 24 hours.

- The average of five values for the five samples shall be taken as the water absorption of the brick.
- It shall be within the specified limits for the classification of the bricks.

3. Efflorescence Test (ISS 1077-1970)

This test is carried out to obtain the presence of alkaline substances in bricks. First, bricks are fully submerged in fresh water for 24 hours. After 24 hours they are collected from water and left them to dry. After completely dried the bricks are closely observed to find the presence of alkali. If a white or grey layer is formed on the brick surface, it means alkali is present in the brick.

- Take five bricks at randomly.

- Place each brick on end in a separate shallow flat bottom dish containing distilled water.

Note that depth of immersion of bricks should not be less than 2.5 cm in each case.

- Keep the above dishes (containing water and bricks) in a warm (18°C to 30°C) room which has adequate Ventilation.(The water from the dishes will be lost due to absorption by bricks and subsequent evaporation).
- Add fresh quantity of distilled water when the bricks appear having dried.
- At the end of the second drying, each brick is observed for efflorescence; that is an appearance of any white patch of salt on the surface of the brick.

The efflorescence is reported only by qualitative words as follows:

Serious.

Salt deposition is all round and quite heavy and increases with repeated weting and drying. Powdering of salt is prominent.

Heavy. Salt deposits cover more than 50 percent of the surface area. The tendency to powder is absent.

Moderate. Salt deposits cover 10-50 percent surface area. The salt forms thin layers without showing any tendency to peel off in flakes or become powdery.

Slight. Salt covers the surface area of less than 10 percent and forms only a very thin sticky layer.

Nil. There is seen no deposit of any salt even after repeated wetting.

It is required that efflorescence should not exceed than the specified degree in various classes of bricks.

4. Impact Test

In this test few bricks are dropped from 1-meter height. If bricks are broken it indicates low impact value and not acceptable for construction work. Good quality bricks do not break at all.

5. Soundness Test

In this test, two randomly selected bricks are hardly punched with each other. If they produce a clear metallic sound and remain unbroken then they are good quality bricks. Soundness test of bricks shows the nature of bricks against sudden impact. In this test, 2 bricks are chosen randomly and struck with one another. Then sound produced should be clear bell ringing sound and brick should not break. Then it is said to be good brick.

6. Hardness Test

This test is done to know the hardness of bricks. In this test, scratches are made on the surface of the brick by a hard thing. If it does not leave any impression on the brick surface then it will be considered as good quality bricks. A good brick should resist scratches against sharp things. So, for this test a sharp tool or finger nail is used to make scratch on brick. If there is no scratch impression on brick then it is said to be hard brick.

7. Structure Test

In this test, a brick is fractured and firmly investigated. If any flaws, holes or cracks are seen inside the broken brick, then it is considered as poor quality brick. To know the structure of brick, pick one brick randomly from the group and break it. Observe the inner portion of brick clearly. It should be free from lumps and homogeneous.

Conclusion

- Compressive Strength Test of the bricks was tested in a lot of five brick and a average value of the compressive strength of the bricks was calculated which was 67.22 kg/cm^2 and the compressive strength value of the second class brick is 70 kg/cm^2 and the compressive strength value of the bricks commonly used in building construction is 35 kg/cm^2.
- The water absorption was tested on two bricks and then average of both the values were calculated and it is 22.48% which is little bit high it should not exceed 20%.
- Nil efflorescence was found on the brick while testing the brick which is a very good result.
- The result for impact test was very good as after dropping all five bricks from one meter distance no brick got break.
- While striking two bricks with each other for soundness test, a sharp metallic sound was heard which shows that that quality of the brick is very good.
- After trying to put some scratches with finger nail for hardness test, no mark was made on the brick which shows that the quality of the bricks is very good.
- No hole or crack is found while examining for structure test this also shows that the quality of brick is very good.
- The overall brick is very good compressive strength is good which is very close to class second brick and all other tests such as impact test, soundness test, hardness test & structure test the results are very good but for water absorption test the value is little bit high (which can be subject of further study) but it can ignore for some area overall the bricks made from over burden dump can be used for construction.

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