

## **Reuse of iron ore mineral waste in civil engineering constructions: A case study**

One of the major concerns for mining industry is the accumulation and disposal of mine wastes. Mine wastes includes the overburden waste, which is the top layer of soil of any mining area above the ore body and tailings, the product obtained after extraction of valuable metal from ore. The study was conducted in Goa, one of the states in western part of India where iron mining alone contributed 98% of the overall mineral mined and which valued approximately 80 million US dollars from 2001-2002. For the case study different companies situated in Goa were chosen for collecting samples of mine waste and examining its suitability for construction uses.

The amount of waste in mining is indirectly represented as Stripping Ratio (volume of overburden material required to be handled in order to extract some tonnage of ore). The stripping ratio for open cast mining is high and in India iron ore is predominantly mined through open cast mining. The mine wastes contains host lateritic rocks with minerals associated with ore body. The mine wastes mostly encountered in overburden are natural materials without modification other than crushing and tailings where natural materials are processed to varying degrees during ore processing and possibly containing inorganic and organic additives. Presently the rate of mining is 16-21 million tons of ore with stripping ratio of 1:3 that is almost 40-50 million cubic meters of waste per year. Having exhausted the available area for waste dumps within leasehold areas, mining companies had to procure private land for creating waste dump facilities. The need of land will increase year by year unless methods of utilization are established.

Along with the disposal problem the high concentration of heavy materials jeopardize the environment. Studies by Juwarkar et al. (2003) on the mines of Goa suggested that the mine waste were devoid of plant growth supportive nutrients thus when mixed with agricultural soil can affect the productivity. Also the average rainfall in Goa varies between 3000-4000mm. The accumulated mine waste when subjected to this heavy rainfall leaches deep into the ground contaminating the sub-surface as well as surface sources of water. This consequently increases water pollution and decreases fish population.

For ascertaining the different physio-mechanical properties of mine waste different companies were chosen for collecting the waste samples. Dignem mines of Timlo Pvt. Ltd (TPL), Advalpal mines of infrastructure logistics Pvt. Ltd (ILPL), Bicholim mines of Dempo mining corporation Pvt. Ltd (DMC) and Salitho mines of Salgaonkar mining industries Pvt. Ltd (SMI). The tests were carried out in accordance with ASTM standards for concrete testing.

Sieve analysis for coarse and fine aggregates was carried out by taking random samples from different companies. It was found from the semi-log graph that volume of approximately 50% of the total is within the usable range as aggregates for making concrete whereas 20% is in the range of sand-silt-clay material which can be used for making bricks. Tests for ascertaining physical properties like elongation index, flakiness index, aggregate crushing value, aggregate impact value, specific gravity and water absorption was carried out and it was found that the physical properties of mine aggregates belonging to different mines were within 5% range of standard specification and were in conformity with the concurrent IS for aggregates.

To study the mechanical properties of concrete made from both mine waste aggregate and normal aggregate, concrete cube of 15cm\*15cm\*15cm with ratio 1:2:4 (cement: sand: aggregate) was used. For each series triplicate specimen were cast using 15cm\*15cm\*15cm mould. Mixing and casting procedure was done in accordance with ASTM standard for concrete testing. Uniaxial Compressive Strength (UCS) was determined after 7, 14, 28 days curing. From concrete cubes made of lateritic rocks it was found that after 14 and 28 days the UCS obtained was 17.13MPa and 21.93MPa respectively. According to IS 456 code of practice water cured after 14 and 28 days should be 15.49MPa and 20.59MPa respectively. Since UCS obtained from mine waste is greater than the recommendation they can be suitably used as concrete.

The huge amount of mine waste can also be used in land reclamation. Many foreign countries have successfully utilized waste to fill empty quarries so that the land can be reused. To ensure safety, cubes were constructed with lateritic rocks and after curing for 28 days underwent Toxicity Leaching Procedure Test (TLPT) which confirmed that hydraulic binder arrests metal mobility and can be used without affecting the environment.

From the given study we can conclude that the mine wastes can be seen as a resource and can be suitably used for construction as the values are concurrent with the IS Codes. The lateritic aggregates can be used in different fields such as road construction, manufacturing of building materials and land reclamation. Utilization of these resources will help mining industries in Goa to deal with the problems of disposal as well as prevent the harmful effects the mine wastes in the environment.