Low-cost construction materials using marble slurry, waste plastic and sand

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Abstract:

Marble slurry and waste plastic bottles pose a serious environmental threat in Rajasthan. Marble slurry is either dumped by the roadside or dumped at slurry dumping yard. In both cases, the slurry is open to spread through wind, surface flow of water and also penetrate the ground and damage the soil of nearby areas, degrade the quality of ground and surface water.

Plastic is a non-bio-degradable substance which takes thousands of years to decompose, that creates land as well as water pollution to the environment. In this project, we propose to make low-cost building materials, namely bricks, paver blocks, roof tiles etc. using marble slurry, waste plastic and sand composite. Initially, the waste plastic was heated in oven up to 300°C. The sand and marble slurry were added to molten plastic and this mixture was poured into a mould and compressed by applying 110 KN load and allowed to cool down. A preliminary block of size 72 mm x 45 mm x 45 mm made in the lab has the compressive strength of 6 MPa. The results show that products made using this composite has desired mechanical properties and has a potential to be commercialized. Commercialization of such technology will provide a sustainable and environmentally friendly product that also solves the problem of disposing of the waste products (marble slurry and waste plastic) and preserve the natural resource, i.e., an earth-based clay material used in making bricks, paver block, roof tiles etc.

Keywords: *Marble slurry waste, Plastic waste*

Introduction:

Marble slurry

Marble ranks the largest produced natural stone in the world and it accounts for 50% of the World's natural stone production. Around 90% of the world's production of marble comes from India and approx. 85% of India's production is received from Rajasthan and almost all mining and processing activities are concentrated around Udaipur, where the proposed study is planned to undertake. Rajasthan has around 4000 marble mines and about 1100 marble gang saws (processing plants). The industry involves Mines, Processing plants, Cutters for the production of tiles for walls and floors, articles, waste reproduction and other ancillary works.

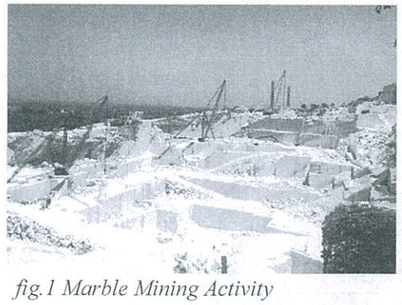

fig.1 Marble Mining Activity

fig.2 Marble slurry dumping yard

fig.3 Marble slurry dumped by the roadside

fig.4 Marble slurry dumped illegally in residential areas

In a recent judgment passed by the Rajasthan High Court, Chief Justice Arun Mishra said: "There are 250 marble processing units in the Sukher industrial area and they are dumping about 70 tons of slurry daily as a result of which about 700x500 meters of the valley has been ruined.

Waste Plastic

About 20,000 bottles being bought every second. More than 480 billion plastic drinking bottles were sold in 2016 across the world, up from about 300 billion a decade ago. If placed end to end, they would extend more than halfway to the sun. By 2021 this will increase to 583.3 billion, according to the most up-to-date estimates from Euro monitor International's global packaging trends report. Fewer than half of the bottles bought in 2016 were collected for recycling and just 7% of those collected were turned into new bottles. Instead, most plastic bottles produced end upon landfill or in the ocean.

Composition of waste material used-

Marble Slurry:

The average chemical composition (in percent) of marble of Rajnagar – Kelwa belt near Udaipur is given below.

Sample	1 (in %)	2 (in %)	3 (in %)
Sio_2	7.58	11.44	0.32
Fe_2O_3	0.73	0.72	0.64
CaO	30.34	29.40	32.65
MgO	16.99	12.28	21.29
L.O.I	43.94	44.76	45.06
So_3	-	0.34	-

Table 1. Composition of marble slurry

Waste plastics: are commonly used substances which play an important role in almost every aspect of our lives. The widespread generation of plastics waste needs proper end-of-life management. The highest amount of plastics is found in containers and packaging's (i.e. bottles, packaging, cups etc.), but they also are found in durables (e.g. tires, building materials, furniture, etc.) and disposable goods (e.g. medical devices). The diversity of plastics applications is related with their specific properties, low density, easy processing, good mechanical properties, good chemical resistance, excellent thermal and electrical insulating properties and low cost (in comparison to other materials). Post-production and postconsumer plastics are utilized in a wide range of applications.

Waste plastic	Available as
Poly-ethylene terephthalate(PET)	Drinking water bottles etc.

Table 2. Type of plastic waste

Plastic properties.

S. No.	Properties	Value
1	Density at 20℃	1.38 g/cc
2	Elastic modulus	2.8 - 3 GPa
3	Tensile strength	55 – 75 MPa
4	Elongation at break (%)	50 – 150 %
5	Thermal conductivity	0.15 – 0.24 W $m^{-1}K^{-1}$
6	Ignition temperature	350°C

Table 3. Composition of plastic waste

Note - Results were taken from Chennai central institute of plastic engineering and technologies

Processing Technology & Testing:

A most common method in which marble slurry is used in various products is with cement to make bricks and other related product. But such products exhibit high efflorescence leading to inferior quality. This happens because of the presence of water and hydration process.

In our product, we have altogether eliminated the use of water and cement. Instead, we use molten plastic as a binding material and marble slurry and sand act as filler material. Use of marble slurry increases the density and reduces the porosity of the final product and thus enhances the mechanical properties of the final product.

To make the bricks with marble slurry, waste plastic and sand, the waste plastic was heated in oven up to 300°C. The sand and marble slurry were added to molten plastic and this mixture was poured into a mould and compressed by applying 110 KN load and allowed to cool down.

For preliminary study a block of size 72 mm x 45 mm x 45 mm was cast where the waste plastic, marble slurry, and sand were used in 1:0.5:1 ratio by weight. The sand was well graded and the particle size of the slurry was less than 600 micron. The block was tested for compressive strength in Universal Testing Machine. The compressive strength of the specimen was 6 MPa. This is very close to the compressive strength of second class bricks.

Future Work:

The preliminary result of the specimen was very promising and indicate that the technology has potential to be commercialized. However detailed study and analysis need to be conducted before commercial production of such bricks, paver blocks and roof tiles begin. Following are some areas that require further study

1. Optimum Mix Proportion:

In order to find the optimum proportion of waste plastic, marble slurry and sand that given highest compression strength a detailed study needs to be conducted to test the specimen made with the different proportion of waste plastic, marble slurry and sand.

2. Fire Resistance:

As plastic is inflammable substance, a detailed study needs to conduct to assess the fire resistance of bricks, paver blocks and roof tiles. Various additive available in market needs to be studied and cost-effective solution needs to be found.

Conclusion:

References:

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