

## STUDY OF MARBLE WASTE AND ITS UTILIZATION

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**Abstract** - As per the current marble mining processes adopted by Industries, large amount of direct and indirect waste is being generating continuously through marble cutting, polishing and grinding processes, which in turn, leading to environmental issues. Lot of research has been carried out on the generation of different types of waste through mining processes. The objective of this study is to understand the marble mining process, identify the bottlenecks of existing methods and processes of marble mining, enlisting various remedial measures through reusing of marble waste and reduction of detrimental effect on environment. This study proposes few products made of marble waste by existing industries; however, economic viability of such product production needs to be investigated further. Authors have covered both environmental and ecological impacts of marble waste and highlighted ten different ways of proper utilization of marble waste in various applications like manufacturing of cement, roads, concrete, bricks etc. to diminish the adverse environmental effects.

**Key Words:** mining, waste generation, environment and ecology

### 1. INTRODUCTION

Mining of minerals has been an old act of the mankind. Marble extraction has also been an old task of mining people. In the ancient era it used to be within the reach of emperors has been seen from the era of ancient temples and Tajmahal of Agra. Marble now a days has become the need of the common people. As the marble industry grew up in early eighties, the new industry was welcomed by all sectors of society with the hope that, there will be prosperity, employment, market uplifted and industrialization of the region. The expected results were also seen for few years but thinkers and society very soon realized the problems and drawbacks of the much liked industry. The problem was the ecological, environmental, and sociological and pollutant hazards of the waste generated in mining and processing by the snow falling numbers of the mining and processing units. Marble waste use as a material is a very important environmental management tool for achieving sustainable development.

The marble industry as a whole is different from other industries by the fact that, the marble is a Dimensional Stone "which means that the marble stone is sold by size not by weight (In other words in sqm or sqft, not by tones or kilograms). The selling price increases with size, all the operations as mining and processing are aimed to get slabs as big as possible.

### 2. MARBLE EXTRACTION PROCESS

Marbles are stones formed inside the earth through the cooling of the magma. Inside the earth, after the mantle, is located a deep layer of melted stone composed by reactions of radioactive elements, which ends up suffering a process of decomposition. The decaying material releases an intense heat wave that merges the stones around. The geological events, as the movement of plates or pressure, make the stones be pushed to the surface. When the rocks reach the surface occurs a cooling that originates igneous rocks, as marble. Marble being a dimensional stone is mined out and processed in a completely different manner than any conventional mining and processing activity.

The quarrying of marble is different from the mining of other minerals. In marble quarrying large size of blocks are excavated. In India stones are excavated mainly by open case mines but in Italy and some other countries deeper deposits are excavated by underground mines. Earlier extraction of marble was done manually by using jack hammer and jib crane. But now mechanization has started and one of the Indian mines has achieved the target of highest production in the world. Due to mechanization production as well as recovery of marble has increased. It has reduced the waste generated at the quarry site. Jib cranes are also replaced by modern derrick cranes. Moreover deployment mobile heavy earth moving machinery has changed the total scenario of the modern marble mining. Loading and transporting machines are also revolutionarily changed.

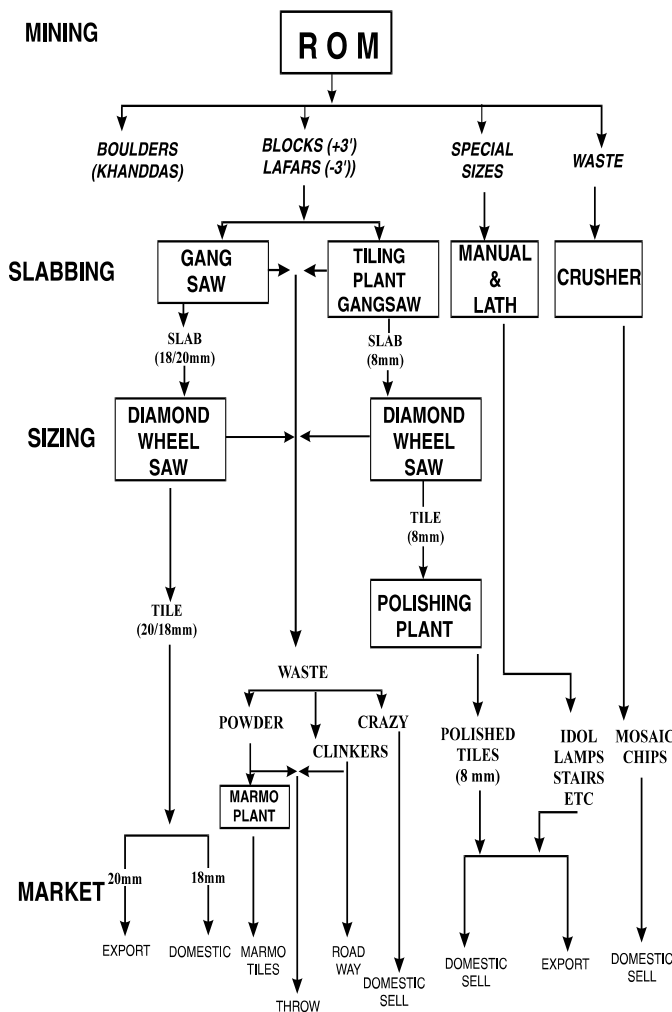


Fig. 1: Flow Chart of the Marble Production

As shown in the fig. 1.1, the marble industry can be divided into mining, processing & marketing. The mining involves production of blocks, whereas processing segment involves slabbing, sizing and polishing operations. The end products can be slabs / tiles (polished, unpolished) or special monuments, articles, crazy, chips and waste. The mines produce Blocks, Laffers, along with waste. Blocks and Laffers are divided into slabs, of required thickness at Gangsaw and then with the help of wheel cutter prepares relevant sizes. If required the tiles are polished in polishing plants. The finished products at gangsaws are slabs sawed from blocks.

Marble blocks are brought from mines to processing units. The blocks are dressed if required and fixed on equipment called Gangsaw. This equipment has gang of many saws numbering from 62 to 72 and hence it is called a gangsaw. Each saw is brazed with number of segments called diamonds segments. These segments act as teeth and cut block into required thickness. The saw when moves, it cuts stone. In this process heat is also generated along with generation of dust. The water required per plate is 10 to 12 litres per minute and

therefore, a gangsaw requires about 43000 litres water per hour. Processing technology is also advanced, the segment manufacturing modified, better rate of sawing has now been achieved.

### 3. MARBLE WASTE GENERATION

“The end material that is non-usable in any form, obtained after all the ‘primary’ and ‘secondary’ application is called as waste.”

According to above definition, the waste should be only non-usable after even secondary application but in case of marble quarry waste, even the reduction in primary usage causes heavy reduction in financial returns since the large size blocks / tiles fetching returns manifold as compared to smaller blocks / tiles or any secondary product. The marble waste generation varies widely from 30% by weight (in mechanized mines using wire saw cutting methods for extraction of marble blocks) to 65% by weight (at mines where mining is resorted to and the rocks are fractured). Waste produce during quarrying by mechanized processes can be estimated at 30% to 40% of the production

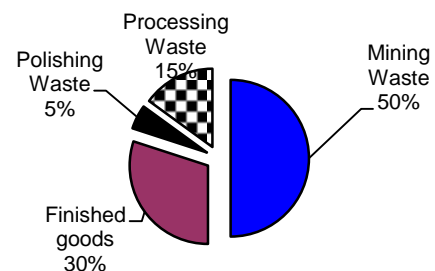


Fig. 2 Waste Generation during the Marble Production

#### 3.1 Types of Marble Waste

There are two types of marble waste:

##### (i) Quarry waste

This waste includes blocks of various sizes and shapes, undesirable trimming and shaping of mined out blocks before dispatch to processing units. There are two types of Quarry Waste as follows:

##### a) Direct waste

##### ➤ Causes of direct quarry waste

- **Removal of Topsoil:** Elimination of topsoil and staking the same for re-handling is an important process in the quarrying for sub-surface deposits. The medium and large size quarries generally dump the topsoil at a separate place little away from quarry. Whereas the small quarries do not

have dumping facility and dispose the soils at any suitable point in quarry itself.

- **Overburden removal:** Removal of overburden to expose the deposit is a critical operation and is a major source of quarry waste. Drilling and blasting is frequently needed to blast the rock portion. The good quality rocks could be utilized for creating blocks. Other weathered portions of rock rubbles etc. are stacked in relevant place.

- **Development of benches:** The development of benches is a primary requirement for extracting the blocks. The process includes making of proper approach roads, ramps, forming of required sizes of benches etc. A considerable amount of waste is generated from this process but only second to that of overburden.

- Other causes of direct quarry waste may include Primary block splitting, Secondary block splitting etc.

#### b) Indirect waste

##### ➤ Causes of indirect quarry waste

- **Initial cut:** For the initial cut of the deposit, a 'V'-cut is made by wire saw or deposit is solely opened by the chain saw. In both the cases the initial blocks are not of proper sizes (smaller), which do not fetch good selling prices.

- **Presence of natural crack patterns:** Once a direction of mining is judiciously decided by taking all relevant parameters, it could not be altered frequently. In the circumstance any sudden alternation in natural crack pattern could lead to smaller size blocks.

- **Geological and Geo-technical features:** Apart from the cracks, wastes are also generated from sudden change in geological and geo-technical defects. Such as variation in grain size and color, presence of specks, veins, segregation, adverse occurrence and orientation of joints, shear zones, folds etc.

- **Primitive technology:** This is the most common cause of generation of huge amount of indirect waste. Most of the mine operators are not of sound financial background, not deploying mechanization are producing large amount of waste due to cheap but primitive Overburden technology.

##### ➤ Forms of quarry waste

- (a) Rejected blocks
- (b) Very small blocks
- (c) Slurry (due to dust from cutting, carving and drilling operations)
- (d) Dressing chips

#### (ii) Processing waste

This waste produced in processing of marble is of direct type, i.e. produced, as a byproduct of the operation, thus only having any depleted secondary use. Various types of waste generated during processing of marble are:

- (a) Dressing waste
- (b) Cutting waste
- (c) Polishing waste
- (d) Transportation Waste
- (e) Handling waste

##### ➤ Cause of processing waste

The processing waste, as termed as direct waste above, is the result of slabbing, sizing and polishing operations. During these operations, a groove, of the width of cutting tool and length of block / slab is converted into the waste (slurry.) In the gang sawing, after each slab thickness (8/18 /20 mm) there is a groove of 5 mm thickness (sawing thickness) i.e. in one block 62 (in 62 blade gang saw) grooves are cut for entire length and breadth.

##### ➤ Forms of processing waste

- Slurry (due to dust from cutting, carving and polishing operations)
- Rejected pieces /chips resulting from final cutting of usable tiles or slabs of desirable dimension (commonly termed as crazy)
- Chips and small pieces, resulting from carving etc.

#### 4. PROBLEMS GENERATED DUE TO MARBLE WASTE

**(a) Conservation of Natural Resources:** The valuable national wealth is getting wasted mainly due to lack of management and technology. This waste, if used, can change perhaps the entire scenario of the industry.

**(b) Air pollution:** This is the most hazardous impact of the marble industry. Slurry is produced at almost every operation and it is a great problem. When it gets dry, it causes air pollution and related problems.

**(c) Water pollution:** Like any other industry, the marble industry needs water in its different operations for cutting, cooling and flushing. In these operations water gets contaminated by marble slurry.

**(d) Visual impacts:** Abandoned mines, dumping sites, slurry waste sites, deposition of dried slurry over almost every structure in surrounding areas gives a very bad, dirty look and aesthetic problem.

**(e) Accidents due to unscientific dumping:** Due to dumping of mine waste and marble slurry on road side causing dust in air (polluting air) and creating less visibility, due to less visibility number of accidents occurs.

**(f) Accidents due to slippery roads:** In rainy season marble slurry flows over roads. Due to marble slurry road becomes slippery and many accidents take place.

**(g) Loss to flora & fauna:** Already grown trees and bushes die out and new ones do not grow due to deposition of marble slurry and dried slurry deposited over plants and vegetation also. It is also increases the soil alkalinity and affects the plants. Marble slurry or powder affect the soil fertility and reduce them. Animals also suffer for their food and shelter

## 5. PRACTICAL UTILIZATION OF MARBLE WASTE

**(a) As a filler material for roads and embankments:** As marble dust is an inert material it can be mixed with certain types of soils for the preparation / raising of embankments etc. which will result in the saving of valuable soil. Central Road Research Institute (CRRI), New Delhi has carried out preliminary research on the utilization of marble dust in road sector. Unconfined Compressive Strength (UCS) have been performed to determine the strength of the mixes with soils and it has been observed that, there is a 20% increase in UCS with 30% marble dust

**(b) Manufacture of Portland cement:** Cement grade limestone is the main raw material along with clay and other corrective materials for the manufacture of Portland cement. Analysis of marble waste shows that it satisfies the chemical composition requirements of cement grade limestone to a great extent. As a part replacement of limestone, either marble waste and or a combination of along with limestone and or lime can be used.

**(c) For manufacturing of concrete:** In concrete mixes there is a 15% increase in compressive strength when sand is mixed with 35% marble dust. There is an improvement in the density of the concrete as well.

**(d) For manufacture of bricks:** Marble slurry is chemically dolomitic in nature and consists of very fine particles. It may be used as a fine aggregate in manufacturing bricks by using cement or lime as a binder. Central Brick Research Institute (CRRI), Roorkee has conducted research on this aspect. The results are very encouraging and the physical properties of the bricks produced by this process exceed those of normal bricks.

**(e) Manufacture of Ceramic Tiles:** A possibility of utilizing marble slurry as a raw material for production of Ceramic Wall tiles needs to be evaluated on a pilot plant level. A leading ceramic producer in the country has undertaken laboratory scale studies on this matter, which were reported to be highly successful.

**(f) Manufacture of Thermo set Resin Composites:** The Macromolecular Research Centre at Jabalpur has conducted a short term programme with a view to explore the possibility

of converting marble slurry into Resin Composites. The preliminary results have demonstrated the technical feasibility of such an option. However, a pilot plant level study needs to be conducted.

**(g) Used as substitute of limestone:** Limestone is the main raw material in many industrial applications. Limestone can be replaced by marble waste in these applications like in production Lime, synthetic agglomerated marble, glass, Plastics, diluents and carriers of pesticides, in iron and steel metallurgy as a substitute for limestone (as flux in the refining of metals, etc.), In non-ferrous metallurgy in the manufacture of magnesium and magnesia, uranium, alumina, nickel, tungsten, floatation of gold & silver, As a mineral filler for putty and chalking compounds based on linseed oil or plastic, as a neutralizing agent and filler for paints, rubber etc., as curing material helping in effective curing of water and in many chemical manufacturing/ processes.

**(h) Manufacture of Activated Calcium Carbonate:** Limestone or combination of marble waste and marble dust (from slurry) can be used on the production of activated or precipitated calcium carbonate.

**(i) Hollow Blocks and Wall Tiles:** Marble slurry waste and other clay products can be used in the production of Hollow prefabricated blocks for buildings if used in the right proportion.

**(j) Used to create home ware:** Waste material from the mining and cutting of marble has been used by Italian designer Francesca Gattello to create a range of simple home ware. The designer combined waste stone powder with clay to create an experimental ceramic material, that she then hand-turned on a wheel to create the collection

## 6. CONCLUSION

Necessary measures to reduce the damage to environment and ecology of the mining area and vicinity need to be taken to go a long way to better the quality and management of the environment in marble mining sector. Proper mines waste disposal methods should be adopted. Better technique of mining be adopted so as least waste is generated in mining operations. Proper land area be identified and allotted closer to the marble processing centers, for disposal of the pressed marble slurry cake. This land should be developed as a proper landfill site for which competent consultants should be engaged. It should be ensured that the marble slurry is disposed off only at the above earmarked site. Use of waste & byproducts as aggregates has greater potential because 75% of concrete is composed of aggregates, use in Brick results in saving of soil and use as substitute of limestone in various industries. The physical and chemical properties of marble dust are suitable for its proposed use. None of the mineral constituents in waste is in undesirable concentration. In this paper, only some basic study of using marble waste in various industries is investigated.

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