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# A Study of Utilization Aspect of Stone Waste in Indian Context

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**ABSTRACT**

*In the population of industrial era, disposal of waste of materials presents many problems. Major problems are occupied the sites for storage, adversely effect on environment. The Construction industries face these problems not only at the end of cycle life of the products but also at the beginning of it. So it is necessary to find the re-use of this waste and also to get other alternative source of aggregates. The main goal of this paper is to show the possibility of using the stone waste in construction industry. The paper tries to represents the management of waste coming from stone. In this paper we are try to study related to stone waste, its effect on environment , find out feasible solutions which are ultimately useful for construction industries.*

**KEYWORDS: stone waste, granite power waste, cementatious material, characteristics, utilization.**

## INTRODUCTION

There is an era of industrial explosion. So, it may lead to increasing demand of natural resources. The cost of natural resources is also increased. They have forced to focus on recovery, reuse of natural resources and find other alternatives. Stone waste/Granite has been commonly used as a building material. Today industry's disposal of the stone waste/Granite powder material is one of the environmental problems around the world. Stone waste/Granite blocks are cut into smaller blocks in order to give them the desired shape and size. During the process of cutting, in that original stone waste/Granite mass is lost by 30% in the form of dust. Every year 250-400 tons of stone waste/Granite waste is generated at site. The stone waste/Granite cutting plants are dumping the powder in any nearby pit or vacant spaces, near their unit although notified areas have been marked for dumping. This leads to serious environmental and dust pollution and occupation of vast area of land especially after the powder dries up .so it is necessary to dispose the stone waste/Granite waste quickly & use in construction industry.

## PRODUCTION OF STONE IN INDIA

**TABLE: 1**
**Country V/S Stone Production: Scenario of World**

| No | Country | Stone Production (Million tonnes) |
|---|---|---|
| 1 | China | 20.8 |
| 2 | Italy | 11.9 |
| 3 | India | 9.6 |
| 4 | Spain | 7.9 |
| 5 | Iran | 6.3 |
| 6 | Turkey | 3.7 |
| 7 | Portugal | 3.4 |
| 8 | U.S.A | 3.2 |
| 9 | South Africa | 2.0 |

**Source:** http://www.worldstonefairs.com

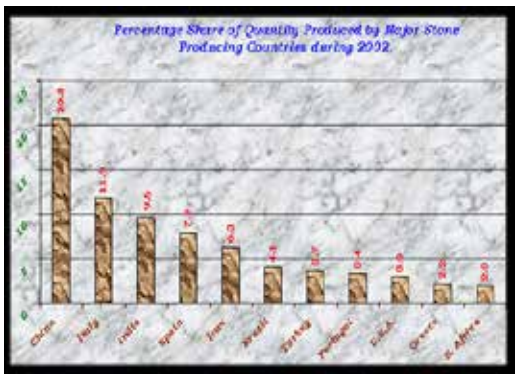


**Figure 1 Stone production in World**
**Source:** http://www.worldstonefairs.com

## THE SOURCE OF STONE WASTE

The principle waste coming in the stone industry is stone itself, specifically in the forms of overburden, screening residual, stone fragments. Stone wastes are generated as a waste during the process of cutting and polishing. It is estimated that 175 million tons of quarrying waste are produced each year, and although a portion of this waste may be utilized on-site, such as for excavation pit refill or berm construction, The disposals of these waste materials acquire large land areas and remain scattered all around, spoiling the aesthetic of the entire region. It is very difficult to find a use for all scrap stone and fines produced.

## CHEMICAL COMPOSITION

**TABLE: 2**
**Chemical Compositions of Various Stones (Marble, Granite, Kota Stone)**

| Chemical Composition | Marble | Granite | Kota stone |
|---|---|---|---|
| Lime (CaO) | 28-32% | 1-4% | 37-39 |
| Silica (SiO2) | 3-30% (varies with variety) | 72-75% | 24-26 |
| MgO | 20 to 25% | 0.5-1% | 4-6 |
| FeO + Fe2O3 | 1-3% | - | - |
| Loss On Ignition (LOI) | 20-45% | 5-10% | 32-35 |

The magnitude of the problem can be seen in the following table:

**TABLE: 3**
**The Magnitude of the Problem**

| | | |
|---|---|---|
| Finished stone produced | Saleable product | 30% |
| stone waste generated<br>• Mining waste (including small blocks of lower revenue boulders, cutting slurry).<br>• Processing waste (including broken tiles, dressing waste, cutting slurry).<br>• Polishing and transportation Waste | 50%<br>15%<br>0.5% | |
| Total Waste | | 70% |
| Total excavated stone | | 100% |

## WASTES FROM STONE QUARRYING ACTIVITIES

In order to extract the stone from the deposit an appropriate method of quarrying must be applied. The main objective of the exploitation method under the current strict framework of laws and directives concerning the environmental impacts should be the minimization of waste generation. The product of quarrying operations is the commercial size block with dimensions about 1.5x1.4x2.8 m. During extraction huge quantities of waste material are produced due to breakage of the products for various reasons such as physical–mechanical characteristics of the material, the degree of discontinuities in the deposit etc. The types of wastes generated from extraction activities of natural stones can be classified in four main categories based on their characteristics that condition the possibility of recovery.

a. Defective or "third choice" blocks with regular dimensions but either with poor technical-aesthetical properties or not the correct size for further processing.
b. Large shapeless blocks (=0.2 m3) which present excessive irregularity in geometry and cannot be sawed into slabs.
c. Small shapeless blocks (=0.2 m3 or dimension < 0.5 m) that are extracted from fractured parts of the deposit or derive from block squaring.
d. Small to fine size rocks (splints, chips), dust and slurry coming from drilling and cutting operations.

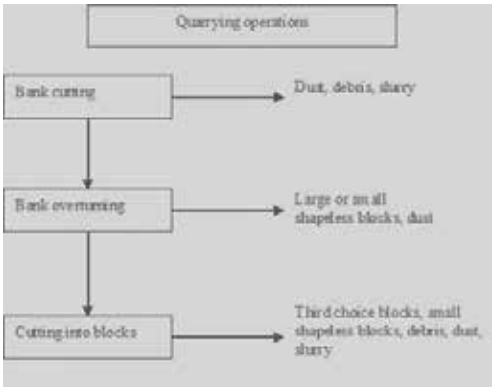


**Figure 2 Typical scheme of waste production from quarrying operations**

## WASTES FROM STONE PROCESSING ACTIVITIES

Processing of natural stone aims to produce finished (e.g. tiles) or semi-finished (e.g. slabs) products in order to cover the market needs as described in the relative paragraph. During the production of the marketable elements considerable amounts of wastes are generated (Figure 12). During the production of the above elements considerable amounts of wastes are generated. As reported in OSNET vol. 9, 2004 the quantity of waste for both calcite and silicate materials exceeds 30% of the raw material and can reach 40% (Stone 2004). The processing waste can be classified in three main categories depending on the size of the piece, according to OSNET vol. 9, 2004:

A. Large to medium size waste called scrap. This kind of waste can have a size of several centimeters and comes from broken or defective slabs whose surface might be polished.
b. Medium to small size waste consisting of splints, flakes, chips which are created during trimming of blocks or slabs.
c. Small size waste consisting of fine particles and has the form of dust or slurry. Slurry is created from all stone cutting operations when the cooling water mixes with the fine stone particles. It is collected and recycled in appropriate installments in order to recycle the water into the production process. Using press filters the water recovery can reach up to 90% still leaving a material called sludge with a high humidity content (22-28%).

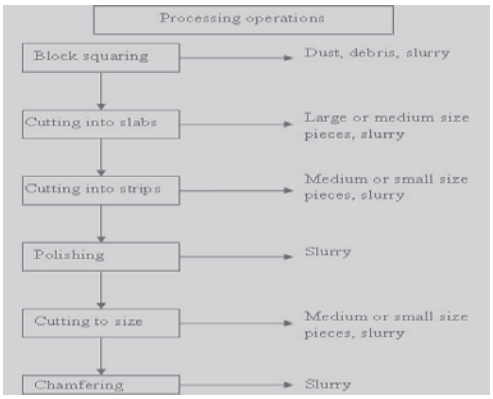


**Figure 3 Typical scheme of waste production from processing operations**

## PROBLEMS ARISE FROM STONE WASTE

There are numbers of problems arises from stone waste .following are the major problems occur due to stone waste.

1. When hazardous waste is dumped on the land, it reduces porosity, water absorption and water percolation leading to poor land quality.
2. In monsoon, the stone slurry is carried away to rivers, roads, drains and water bodies which affect the quality of water. So, it ultimately damage aquatic life, and reduce storage capacities.
3. When the stone slurry becomes dry, the fine particles are quickly dispersed and it leads to air pollution.
4. The sites which can be used as dumping ground are limited and give repulsive dirty look.
5. As the dumping layer of stone waste increases, finer particles block the flow regime of aquifers, thus it directly affects on the sub surface sources of water.
6. Due to opencast nature of the mining, de vegetation of the area is imminent. Also dried slurry deposited over plants and vegetation hampers their growth.
7. Running mines, abandoned mines, dumping sites, slurry waste sites, deposition of dried slurry over almost every structure in surrounding areas are a very bad sight. Hills having been excavated and dumps over them are very unaesthetic.
8. Already grown trees and bushes have died out and new ones do not grow. Animals have also been deprived of their food and shelter.
9. There are a number of accidents due to unscientific dumping of mine waste on road and quarry sites.

## MOST FEASIBLE USES OF STONE WASTE

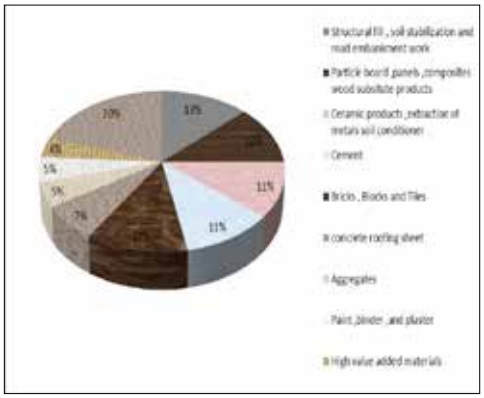

**Figure 4 Most Feasible Uses of Stone Waste**
**Source:** Google images

## STONE WASTE – UTILISATION POTENTIAL IN INDIA

**TABLE: 4**
**Utilization of Stone Waste in different areas of construction**

| Sr.No | Utilization Area | Utilization % |
|---|---|---|
| 1 | Structural fill ,Soil stabilization, and road embankment work | 10-15 |
| 2 | Cement | 10-12 |
| 3 | Aggregates | 2-5 |
| 4 | Bricks , Blocks, Tiles | 11-13 |
| 5 | Paint ,Binder ,Plaster | 2-5 |
| 6 | Concrete roofing sheets | 5-10 |
| 7 | Ceramic Products | 10-12 |
| 8 | Particle Board, Panels | 10-12 |

It is necessary to explore possible alternatives to arrive at technically sound and financially viable technologies to utilize stone slurry / powder / wastes.

## UTILIZATION OF STONE WASTE AND STONE SLURRY

**The areas where the utilization of stone waste and stone slurry needs to be explored as a substitute for conventional raw materials are as follows.**

### 1. As a filler material for roads and embankments

As stone dust is an inert material it can be mixed with certain types of soils for the preparation / rising of embankments etc. which will result in the saving of valuable soil. Central Road search Institute (CRRI), New Delhi has carried out preliminary research on the utilization of stone waste 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, In silty soil, there is 12 percent increase

in UCS with 10% stone waste dust - There is a 20% increase in UCS with 30% stone waste dust - There is no improvement in clayey soil. In concrete mixes there is a 15% increase in comp0ressive strength when sand is mixed with 35% stone waste dust. There is an improvement in the density of the concrete as well. Preliminary tests show that stone waste dust can be easily mixed with silty and sandy soils and compaction of the mix would result in better strength of base layers over which water bound Macadam can be laid. The preliminary results have been very encouraging and hence pilot level studies on this aspect need to be conducted.

**2. for manufacture of bricks**

Stone waste is 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. The stone waste slurry-lime bricks were made in laboratory using, slurry, sand and hydrated lime, cured in a steam at normal pressure. It attained strength of 50 – 60 kg / cm2. (Since this process requires steam curing it may not be economically feasible). Stone waste slurry-cement bricks were made using slurry, sand and Portland cement in different proportions and moulded by vibro-compaction technique; cured in stream at normal pressure. It attained a compressive strength in the range of 80 to 120 kg / cm2. Wet curing yields bricks with a compressive strength of 100 kg /cm2.The bricks thus produced have a perfect geometry, facilitating thin joints, resulting into high masonry strength to unit strength ratio and low mortar consumption. A pilot plant level study of this possibility needs to be conducted.

**3. 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 stone waste shows that it satisfies the chemical composition requirements of cement grade lime stone to a great extent. As a part replacement of limestone, either stone waste and or a combination of along with limestone and or lime can be used.

**4. Manufacture of Ceramic Tiles**

A possibility of utilizing stone waste 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.

**5. Manufacture of Thermoset Resin Composites**

The Macromolecular Research Centre at Jabalpur has conducted a short term programmed with a view to explore the possibility of converting stone waste slurry into Resin Composites. The preliminary results have demonstrated the technical feasibility of such an option. However, pilot plant level studies need to be conducted.

**6. Manufacture of lime**

Limestone is the main raw material for the production of Lime. Limestone can be replaced by stone waste.

**7. Manufacture of Activated Calcium Carbonate**

Limestone or combination of stone waste and stone waste dust (from slurry) can be used on the production of activated or precipitated calcium carbonate.

**8. Hollow Blocks and Wall Tiles**

Stone waste slurry waste and other clay products can be used in the production of Hollow prefabricated blocks for buildings if used in the right proportion.

**Other Possible Uses of Stone waste Slurry / Stone waste**

Broadly speaking, stone waste slurry and stone waste, due to the high percentage of limestone in it can be used as a substitute for lime stone in most of its industrial and other applications. It can have predominantly one or more materials like calcite, dolomite or serpentine.

There is a possibility of the use of stone waste slurry in many more industries; mainly as a substitute for limestone in the following:

1. In production of synthetic agglomerated stone waste
2. in manufacture of glass
3. in chemical manufacture
   a) Lime manufacture
   b) Plastics manufacture
   c) As diluents and carriers of pesticides
   d) In many other chemical processes as a substitute of limestone

4. Chemical and Industrial uses
   a) In iron and steel metallurgy as a substitute for limestone (as flux in the Refining of metals, etc.)
   b) In non-ferrous metallurgy in the manufacture of magnesium and magnesia, Uranium, alumina, nickel, tungsten, floatation of gold & silver.

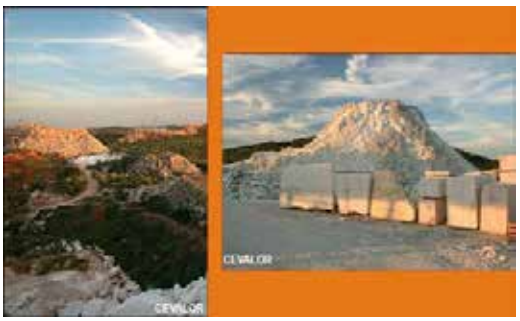

**Figure 5 Disposal of inert wastes produced in quarries and processing plants**

**CASE STADY**

The used brick in 1 m3 are 500 nos. The quantity of fly ash used is 500 x 0.00198375 = 0.991875 x 0.60 = 0.5951 m3, which is considering depth excavation saves 0.5951 m2 of agricultural land.

**Fly ash bricks Sample- 2 (O)**

- Fly Ash - 60%
- Quarry Dust - 10%
- Umeta Sand - 15%
- Sludge Lime - 10%
- Gypsum - 5%

**TABLE: 5**
**fly Ash Bricks Testing Results**

| Description | Results |
|---|---|
| Sample | 0 |
| Wt. Before Absorption of Water in Kg. | 2.797 |
| % Water Absorption | 12.920 |
| Average Crushing Stress N/mm2 | 7.830 |
| Average Density Kg / m3 | 1695.15 |
| Cost/No | 1.74 |

**TABLE: 6**
**Fly Ash Replacements by Stone Waste in Fly Ash Brick**

| Fly ash Mix proportion in Brick | Fly ash replacement by stone waste in Brick | Stone waste/ $m^3$ in Bricks | Save in 1m depth fertile land in $m^2$ |
|---|---|---|---|
| 60% | 10% | 0.0993 | 0.0993 |
| 50% | 20% | 0.1987 | 0.1987 |
| 40% | 30% | 0.2981 | 0.2981 |
| 30% | 40% | 0.3975 | 0.3975 |
| 20% | 50% | 0.4968 | 0.4968 |
| 10% | 60% | 0.5962 | 0.5962 |

In $1m^3$, No. of Bricks =500 nos
Volume of 1 Brick in $m^3$ = 0.00198375 $m^3$

**CONCLUSIONS**

We can say that if fly ash is replaced by stone waste (sludge) in fly ash brick by using 10%, 20%,30% , 40%, 50%, 60% stone waste (sludge) in 1m depth save 0.0993$m^2$, 0.1987$m^2$ 0.2981 $m^2$,0.3975$m^2$ , 0.4968 $m^2$ , 0.5962$m^2$ agricultural land. Use of stone waste (sludge) help in environmental prevention and prevention of fertile land utilized in brick production. Uses of stone waste (sludge) in brick can save the stone industry disposal costs and produce a 'greener' bricks for construction. An innovative supplementary cementitious Construction Material is formed through this study.

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