

## Reusing of stone waste in various industrial activities

Elham Khalilzadeh Shirazi

Department of Environmental Engineering, Graduate School of the Environmental and Energy,  
Science and Research Campus, Islamic Azad University, Tehran, Iran  
khalilzadeh.elham@yahoo.com; Cell phone: 098-912-2363353 ; Fax: 098-21-22752870

**Abstract**— In recent years, large amounts of stone waste have been generated in natural and artificial stone industry with significant environmental impacts. To solve the problems, stone waste in different forms could be used in different industrial activities in particular construction industry and other activities such as paper, ceramics industry (faience), paints, plastics and polymers, glass, rubber, siderurgy, sugar, pharmaceuticals, textiles or in articles such as soaps or candles. Further it could be applied as agriculture soil corrective, acid water treatment and dumpsites sealing. This paper reveals an overview of current solutions of reducing environmental and economical disadvantages of this kind of by-product.

**Keywords**- stone waste; Reuse, industry, environmental impact.

### I. INTRODUCTION

Natural and artificial stone industry generates large volume of stone waste. It is classified to various forms such as powder or fines, aggregates, larger stone pieces and cobbles, damaged blocks or slabs and stone slurry. Stone slurry is a semi-liquid substance consisting of particles originated from the sawing and polishing processes and water used to cool and lubricate the sawing and polishing machines. (1) These generated wastes cause environmental, health and economical drawbacks.

### II. ENVIRONMENTAL PROBLEMS

On the one hand, when stone slurry is disposed in landfills, its water content is drastically reduced and the stone dust resulting from this, presents several environmental impacts. In other words, in dry season the stone powder dangles in the air, flies and deposits on vegetation and crop. All these significantly affect the environment and local systems. In some cases, stone dust disposed in the riverbank and around the production facilities cause reduction in porosity and permeability of the topsoil and results in water logging. Moreover, fine particles result in poor fertility of the soil due to increase in alkalinity. (29) In addition, destroying vegetation cover, regional topographic changes, soil erosion and disordering landscape are other negative environmental impacts. On the other hand, waste from quarry and fabrication operations can be unsafe and environmentally detrimental. Runoff from the scrap mounds can cause erosion problems, and fines introduced into natural waterways can suffocate local ecosystems. Other types of manufacturing wastes, like antifreeze and lubricants, have

the potential to create environmental problems if they are leaked onto the ground or into a waterway.

### III. HEALTH PROBLEMS

Scrap stone can create an undesirable visual impact as well as dangerous working conditions if it is not well organized or if piles are allowed to be stacked carelessly. Airborne dust from uncovered stockpiles or poorly functioning filtration equipment can cause respiratory, ocular, or dermal irritation for employees and be a visual or even respiratory burden on local communities. Silicosis, a lung disease causing breathing difficulties and sometimes mortality, could potentially afflict employees if the stone contains silica. (5,14)

### IV. ECONOMICAL PROBLEMS

From another perspective, due to the huge amounts of stone waste generated in generation sources and plants, vast sums of money spend on its transportation to landfills. Besides, the accumulation of waste in landfills is also a pressing problem for many businesses, from economic perspective. Further, if waste must be disposed of off-site, landfill fees can create additional costs for quarry and fabrication operators. (17)

Therefore it is extremely important to incorporate this kind of waste in other industrial activities.

### V. STONE WASTE APPLICATIONS

So far, a lot of researches have been done all around the world in utilization of natural and artificial stone wastes in different types of industries, in particular, construction materials. The continued depletion of natural resources in construction industry throws new light on the potential use of some industrial wastes like stone waste in its different materials. Examples with reference to reusing stone waste in mentioned industry are: Cement industry, Tiles, Mortars, concrete and self-compact concrete (SCC), Other cement-based products, Pavement, Embankment, Agglomerate marble, producing glues and paints. Stone that is unsuitable as a structural or finish material can be used to construct gabion retaining walls. Stone (rip-rap) gabion walls are more cost effective than reinforced concrete and can easily be constructed by non-specialist local labor. Flat stone fragments can be strategically laid to create a mosaic walkway, while bulkier cobbles can line a flower bed or pathway.

Other industries consist of Paper industry, Ceramics industry (faience), Agriculture soil corrective, for example

granite powder can be utilized as amendments and fertilizers for acid soils. Natural stone in powder form can be used in fertilizer or as a sidewalk bed. Its inherent mineral constituents, such as calcium and magnesium, are needed nutrients for soil and plant life. Acid water treatment, Dumpsites sealing. For other applications, an independent research undertaken in Spain focused on the fact that it was possible to insert marble and limestone slurry in the market as calcium carbonate to be used in sectors such as cement, paints, plastics and polymers, paper, ceramics and glass. Furthermore, it is possible to speculate that ground marble (or marble slurry) can be used in the manufacturing of industrial applications such as varnishes, rubber, latex applications, vinyl compounds, PVC and foams or even in the food industry (composed food for animals, flours, pastry, cereals, gums, etc.). According to the latter studies, other

authors refer to the possibility to apply this waste in plastics, rubber ,paints, siderurgy, sugar, pharmaceuticals, textiles or in articles such as soaps or candles. In conclusion, the options are not exhausted once it is realized that the possibility to use this waste as a line marker in sports stadiums can be a business opportunity.

Some special applications of stone waste with other residuals including the following can be cited.

In some cases, artificial aggregate can made from waste stone sludge and waste silt. Furthermore, reuse of waste material from decorative quartz solid surfacing in the manufacture of hot bituminous mixes was studied in Spain.(2\_33)

The summary of different applications of various stone waste forms are mentioned in Table 1.

TABLE I. DIFFERENT APPLICATIONS OF VARIOUS STONE WASTE FORMS

Stone waste forms	Different applications for stone waste reusing					
Fines	Asphalt and concrete production	Brick manufacturing	Construction fill	Media for biofiltration systems or soil remediation	Mineral content for soil	Synthetic aggregate production
Aggregate	Construction fill	Constructure mixture ingredient	Landscaping & decorative uses	Media for biofiltration systems	Residential driveway development	Roadbed construction material
Larger stone pieces and cobbles	Fill for gabion retaining walls	Jetty rock	Landscaping & decorative uses	Rip rap	-	-
Damaged blocks or slabs	Aggregate	Cut stone tiles	Stone pavers	Veneer	-	-

## VI. CONCLUSION

Nowadays, large quantities of artificial and natural wastes in different forms are generated all around the globe. Regarding to waste management methods, these kinds of wastes need to be treated through sound solutions like reusing , reduction and recycling instead of being accumulated at open-air dumpsites or landfill , or disposed at waterways and around the production facilities, causes environmental and health problems. On the other hand, high charges for its transportation reveals the necessity of different studies on feasibility reuses. This paper presented several solutions for the incorporation of this industrial by-product in construction materials such as Cement , Tiles, Mortars ,concrete and self-compact concrete(SCC), Other cement-based products, Pavement, Embankment, Agglomerate marble, producing glues and paints. Other industries consist of Paper industry, Ceramics industry (faience), Agriculture soil corrective and dumpsite sealing, among others. Although there would be a plethora of solutions, hoping some of these mentioned options will effective.

## REFERENCES

- [1] N. Almeida, F. Branco, J. Brito and J.R., Santos, "High-performance concrete with recycled stone slurry", *Cement concrete Res.*, vol. 37, pp. 210-220, 2007.
- [2] N. Almeida, F. Branco, J. Brito and J.R., Santos, "Recycling of stone slurry in industrial activities: Application to concrete mixtures", *Building and Environment* 42(2007) 810-819
- [3] H. L. A., Soares, "Caracterizac-a-o e Aplicabilidade na Indu´ stria dos Cimentos de Lamas de Rochas Ornamentais Transformadas na Regia˜o de Pe˜ro Pinheiro". Aveiro: Geoscience MSc.; 1997
- [4] S. Singh, V. Vijayalakshmi Marble, "slurry—a new building material", In: TIFAC News and Views (<http://www.tifac.org.in/news/marble.htm>); 2004.
- [5] J. Munoz-Montano, Project Reference BRST985531. "Recycling of waste originated in the process of cutting natural stone". In: BRITE/EURAM3; 2003
- [6] S. Pereira and B. N. Rewastone, "ROC MAQUINA Dimension Stone", *Industry*, vol. 42, pp.28–31, 2001.
- [7] A. Pe˜rez, "Natural stone: exploitation and cutting waste AITEMIN Research Project—exploitation of cutting waste originated from thenatural stone preparation process" In: [http://www.aitemin.es/docs/piedra\\_natural\\_aprov\\_res/doc\\_e.html](http://www.aitemin.es/docs/piedra_natural_aprov_res/doc_e.html), 2003
- [8] I. F., Ponte and A. Stellin, "Aproveitamento de Finos de Teares do Espı˜rito Santo na Indu´ stria Cera˜ mica". Rio de Janeiro:VI SHMMT, XVIII ENTMMME;2001
- [9] N. Almeida, "Reutilizac-a˜o de Lamas de Tratamento de Rochas Ornamentais em Beto˜ es". Lisbon:MSc. in Construction; 2004.
- [10] A. Soeiro, M. R. Veiga and F. A. Branco, "Incorporac-a˜o de Lamas de Serrac-a˜o de Ma˜rmores e Calca˜ rios em Argamassas de Cimento e Areia" *Construlink*, vol.2, 2004.

- [11] STONEMART, “Stone to space—CPRI’s marble waste building products evoke response in stonemart 2000”. In: <http://powersearch.cpri.res.in/news75/N12.htm>; 2000.
- [12] J. L. Calmon, F. A. Tristão, F. S. S. Lorde llo, S. A. C. Silva, F. V. Mattos, “Aproveitamento do Resíduo de Corte de Granito para a Produção de Tijolos de Solo-Cimento” Floriano’ polis: VII ENTAC; 1998.
- [13] W. A., Moura, J. P. Gonc-alves and R. S. L. Leite, “Utilização do Resíduo de Corte de Mármore e Granito em Argamassas de Revestimento e Confecção de Lajotas para Piso” Feira de Santana , vol.26, pp.49–61, 2002.
- [14] S. Pareek, “Gainful utilization of marble waste: an effort towards protection of ecology and environment” In: Workshop on Marketing & Technical Issues Related to Stone Industry, <http://www.edos-india.com/papers>; 2003
- [15] W. Moura and J. P. Gonc-alves Utilização do Resíduo do Beneficiamento de Rochas Ornamentais (Mármore e Granitos) na Construção Civil.Foz do Iguacu:IX ENTAC, 2002.
- [16] R. Martins, “Aplicação es Industriais de Natas Resultantes da Indústria Transformadora de Rochas Ornamentais Carbonatadas”. Aveiro:MSc. in Minerals and Industrial Stones;1996.
- [17] S. Miletic, M. Ilic, M. Milosevic and A. Mihajlov, “Building materials based on waste stone sludge”. San Sebastia’ n: WASCON; 2003.
- [18] R. L. S. Nunes, H. S. Ferreira, G. A. Neves, H. C., “Ferreira Reciclagem de Resíduos de Granito para Uso na Indústria de Revestimentos Cera’ micos, SP”. In: 46th congress of ceramics; 2002.
- [19] R. R. Menezes, H. S. Ferreira, G. A. Neves, H. C. Ferreira, “Uso de Rejeitos de Granitos como Mate’ rias-Primas Cera’ micas”. Cera’ mica, vol. 48(206), 2002.
- [20] M. F. Franco and C. A. Cupeto, “Utilização de Subprodutos Resultantes da Serragem dos Mármore (‘Nata’) para Cobertura de Resíduos Sólidos Urbanos” Estremoz: Assimagra; 1996
- [21] M. T. Barral Silva , B. Silva Hermo and E. García-Rodeja, “Vázquez Freire N , Reutilization of granite powder as an amendment and fertilizer for acid soils”, Chemosphere, Vol. 61, Issue 7, pp. 993-1002, November 2005.
- [22] I. Bekir Topcu, T. Bilir and T. Uygunglu, “Effect of waste marble dust content as filler on properties of self-compacting concrete” Constr. Build.Mater., vol. 23, pp. 1947-1953, 2009.
- [23] BILDCRETE. Bildcrete—Marble Dust Field Marker. In: [www.bildcrete.com/lime](http://www.bildcrete.com/lime); 2004
- [24] B. Binici, T. Shah, O. Aksogan and H. Kaplan, “Durability of concrete made with granite and marble as recycle aggregates”, J. Mater. Process. Tech., Vol. 208, Issues 1-3, 21, pp. 299-308, November 2008.
- [25] F. Chang, M. Lee, S. Lo and J. Lin, “Artificial aggregate made from waste stone sludge and waste silt”, J. Environ. manag.,vol. 91,issue 11, pp. 2289-2294, 2010.
- [26] J. Gonc-alves, “Utilização de Resíduo de Corte de Granito (RCG) como Adição para Produção de Concretos”. Porto Alegre;MSc. In Civil Engineering;2000
- [27] M. Hunger and H. J. H., Brouwers, “Natural Stone Waste Powders Applied to SCC Mix Design”, Restoration of Buildings and Monuments Bauinstandsetzen und Baudenmalpflege, Vol. 14, No. 2, 131–140 (2008).
- [28] IMERYS, “Performance Minerals Company”. In: [http://www-perfmins.com/usa/pvc\\_usa.html](http://www-perfmins.com/usa/pvc_usa.html), <http://www.fitzchem.com/cgi-bin/>; 2004
- [29] M. A. Montero, M. M. Jordan, M.B. Almendro-Candel, T. Sanfeliu and M.S. Hernandez-Crespo, “The use of a calcium carbonate residue from the stone industry in manufacturing of ceramic tile bodies”, Appl. Clay Sci., vol. 43, pp.186-189, 2009.
- [30] M. C. Rubio, F. Moreno, A. Belmonte , A. Menéndez, “Reuse of waste material from decorative quartz solid surfacing in the manufacture of hot bituminous mixes”, Constr. Build. Mater.,Vol. 24, Issue 4, pp. 610-618, April 2010.
- [31] M. Shahul Hameed and A. A. S., “Sekar Properties Of Green Concrete Containing Quarry Rock Dust And Marble Sludge Powder As Fine Aggregate ARPN”, J. Eng. Appl. Sci., 2009.
- [32] P. Torres, H. R. Fernandes, S. Olhero and J. M. F. Ferreira, “Incorporation of wastes from granite rock cutting and polishing industries to produce roof tiles”, J. Eur. Ceram. Soc., Vol. 29, Issue 1, pp. 23-30, January 2009.
- [33] V. Vijayalakshmi, S. Singh, D. Bhatnagar, “Marble slurry—a new resource material for entrepreneurs”. Jodhpur: National Seminar on Small Scale Mining; 2001.