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Production of Artificial Stone from Dimension Stone Waste

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ABSTRACT: Million tons of waste are produced annually in mining and processing of dimension stone in Iran. In most cases, the waste is released in nature that would cause environmental hazards. In this work, artificial stone slabs were manufactured by combination of coarse waste and sludge powder of stone cutting factories. The results show that the manufactured stone slabs have physical and mechanical specifications according to Iranian national standards for building stone. With increasing the amount of resin in the composition, the flexural and tensile strength were increased and the compressive strength and water absorption coefficient were decreased. The slabs produced from granite waste compare to the slabs produced from marble waste had better physical and mechanical specifications. At the optimum condition, with the aim of using more waste, with a composition of 90% marble waste and 10% resin, artificial stone slabs were produced which have compressive strength about 143 MPa, flexural strength of 21 MPa, tensile strength of 25 MPa, water absorption coefficient 1% and density equal to 2.32 g/cm^3.

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1- Introduction

Iran is the fourth largest producer of dimension stone in the world, which owns nearly 9 percent of global production [1]. Due to the many problems such as, lack of technology and modern machinery in the quarry and processing of dimension stone, million tons of waste is produced annually in Iran [2-4]. In most cases, the waste is released in nature. The fine particles of waste stone sludge can be easily dispersed by wind and settle down by rain and snow. Without treatment or recycling, the waste stone would cause environmental pollution [5].

Recycling and re-using the waste stone fragments and sludge in different applications such as manufacturing concrete [6-8], brick [9, 10], ceramic [11, 12], artificial aggregates [13-18], and asphalt [19, 20] as well as stabilizing agriculture soils [21] and water treatment [22, 23] have been studied by many researchers.

In our previous work, production of artificial stone slabs using waste stone sludge was studied. The results showed that by combining 50% of stone sludge, 12% of ground quartz, 25% of waste glass, and 13% of resin, artificial stone slabs with a water absorption less than 0.64%, a density less than 2.68 g/cm^3, a flexure strength more than 45 MPa, a compressive strength more than 90 MPa, and a tensile strength more than 35 MPa can be obtained. The disadvantage of the results is high consumption of resin because the sludge powder is very fine. Resin consumption by more than 10%, increase the cost of production and may not be economically viable.

The aim of the present work is to increase the amount of waste and reduce the amount of resin by using coarse and fine waste in the composition of artificial stone and also improve the physical and mechanical specification of manufactured slabs according to Iranian national standards for building stone.

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2- Methodology

The coarse stone waste and powder sludge were obtained from granite and marble cutting factories in the industrial zone of Khorram-Abad No. 2. The coarse waste was crushed by jaw and con crushers and screened to two fractions of -6.7+1 mm and -1+0.15 mm. The particle size distributions of stone sludge powders were determined by a laser diffraction particle size analyzer. The results showed that the sludge powders were very fine and D50 (50% passing size) was about 15 µm.

Chemical and minerals compositions of the granite and marble stone waste were determined by the XRF and XRD analyses. Different portion of medium and fine waste, sludge powder and resin was mixed for manufacturing artificial stone slabs. Figure 1 summarizes the manufacturing process of the artificial stone slabs. The compression, tension and flexural strength, water absorption and density of slabs were determined.

3- Results and Discussion

Figures 2 and 3 demonstrate the strength of the manufactured artificial slabs. The compressive strength was decreased and the tensile and the flexural strength were increased with the increase in amount of resin. Increasing the amount of resin (or reducing the amount of waste), respectively had greatest impact on the strength of flexural, tensile and compressive.

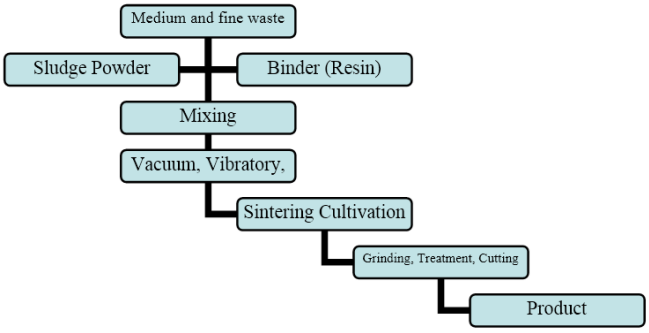
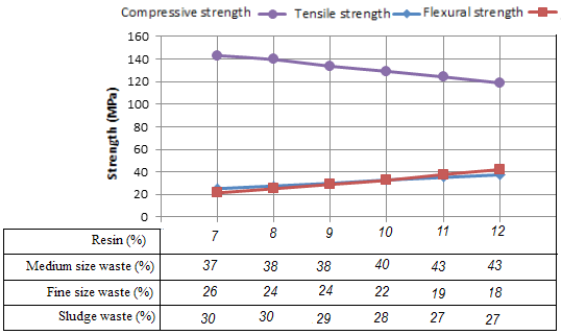
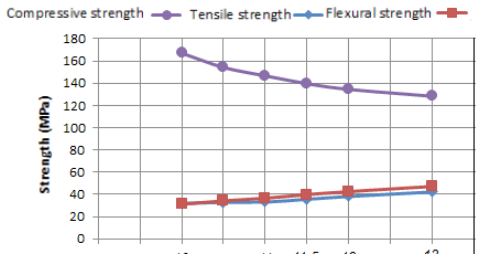


Figure 1. Manufacturing procedure of artificial stone slabs



Resin (%)	7	8	9	10	11	12
Medium size waste (%)	37	38	38	40	43	43
Fine size waste (%)	26	24	24	22	19	18
Sludge waste (%)	30	30	29	28	27	27

Figure 2. Strength of slabs made from marble waste



Resin (%)	10	10.5	11	11.5	12	13
Medium size waste (%)	34	34	35	37	38	39
Fine size waste (%)	24	23.5	23	20.5	20	18
Sludge waste (%)	32	32	31	31	30	30

Figure 3. Strength of slabs made from granite waste

The results also showed that water absorption coefficient and density were decreased with increasing the amount of resin (or decreasing waste stone).

4- Conclusions

The manufactured stone slabs have physical and mechanical specifications according to Iranian national standards for building stone. At the optimum condition, with the aim of using more waste, with a composition of 90% marble waste and 10% resin, artificial stone slabs were produced which have compressive strength of 143 MPa, flexural strength of 21MPa, tensile strength equal to 25 MPa, water absorption coefficient of 1% and density of 2.32 g/cm^3.

References

[1] M. Gussoni, "Annual Report and Prospects for the International Stone Trade (Stone sector 2016) by Internazionale Marmi e Macchine (IMM), Italy," 2016.

[2] K. Barani, "Stone industry in Lorestan province, problems and solutions (in persian)," in The International Congress of Investment Opportunities, Province of Lorestan, 2015.

[3] P. Yaghobi, "Economic analysis of stone industry, with an emphasis on building and decorative stones (in persian)," barresybazargani, vol. 71, no. April, pp. 69–81, 1394.

[4] K. Barani and H. Esmaili, "Production of artificial stone slabs using waste granite and marble stone sludge samples," J. Min. Environ., vol. 7, no. 1, pp. 135–141, 2016.

[5] K. Barani, "Identification and feasibility study of producing of by product from waste stone (in persian)," 2016.

[6] H. Esmaili, "Reuse and Application of Powder Sludge of Stone for manufactureing artificial stone (MS thesis in persian)," Lorestan University, 1393.

[7] H. M. A. Mahzuz, A. A. M. Ahmed, and M. A. Yusuf, "Use of stone powder in concrete and mortar as an alternative of sand," African J. Environ. Sci. Technol., vol. 5, no. 5, pp. 381–388, 2011.

[8] H. Binici, T. Shah, O. Aksogan, and H. Kaplan, "Durability of concrete made with granite and marble as recycle aggregates," J. Mater. Process. Technol., vol. 208, no. 1, pp. 299–308, 2008.

[9] H. Hebhoub, H. Aoun, M. Belachia, H. Houari, and E. Ghorbel, "Use of waste marble aggregates in concrete," Constr. Build. Mater., vol. 25, no. 3, pp. 1167–1171, 2011.

[10] M. Rajgor and J. Pitroda, "Stone Sludge: Economical Solution for Manufacturing of Bricks," Int. J. Innov. Technol. Explor. Eng., vol. 2, pp. 16–20, 2013.

[11] N. Bilgin, H. A. Yeprem, S. Arslan, A. Bilgin, E. Günay, and M. Marşoglu, "Use of waste marble powder in brick industry," Constr. Build. Mater., vol. 29, pp. 449–457, 2012.

[12] F. Saboya, G. C. Xavier, and J. Alexandre, "The use of the powder marble by-product to enhance the properties of brick ceramic," Constr. Build. Mater., vol. 21, no. 10, pp. 1950–1960, 2007.

[13] W. Acchar, F. A. Vieira, and D. Hotza, "Effect of marble and granite sludge in clay materials," Mater. Sci. Eng. A, vol. 419, no. 1, pp. 306–309, 2006.

[14] C. R. Cheeseman and G. S. Virdi, "Properties and microstructure of lightweight aggregate produced from sintered sewage sludge ash," Resour. Conserv. Recycl., vol. 45, no. 1, pp. 18–30, 2005.

[15] P. J. Wainwright and D. J. F. Cresswell, "Synthetic aggregates from combustion ashes using an innovative rotary kiln," Waste Manag., vol. 21, no. 3, pp. 241–246, 2001.

[16] M.-Y. Lee, C.-H. Ko, F.-C. Chang, S.-L. Lo, J.-D. Lin, M.-Y. Shan, and J.-C. Lee, "Artificial stone slab production using waste glass, stone fragments and vacuum vibratory compaction," Cem. Concr. Compos.,

vol. 30, no. 7, pp. 583–587, 2008.

[17] F.-C. Chang, M.-Y. Lee, S.-L. Lo, and J.-D. Lin, "Artificial aggregate made from waste stone sludge and waste silt," J. Environ. Manage., vol. 91, no. 11, pp. 2289–2294, 2010.

[18] K. Barani and H. Esmaili, "Production of artificial stone slabs using waste granite and marble stone sludge samples," J. Min. Environ., vol. 7, no. 1, pp. 135–141, 2016.

[19] M. Karaşahin and S. Terzi, "Evaluation of marble waste dust in the mixture of asphaltic concrete," Constr. Build. Mater., vol. 21, no. 3, pp. 616–620, 2007.

[20] P. C. Hou, "Reuse of waste glass powder for substitution of fine aggregate in the recycling asphalt concrete," Natl. Yunlin Univ. Sci. Technol. Dep. Constr. master's Cl., 2003.

[21] I. Zorluer and M. Usta, "Stabilization of soils by waste natural stone dust," in fourth national natural stone symposium, 2003.

[22] S.-C. Pan, C.-C. Lin, and D.-H. Tseng, "Reusing sewage sludge ash as adsorbent for copper removal from wastewater," Resour. Conserv. Recycl., vol. 39, no. 1, pp. 79–90, 2003.

[23] X. Chen, S. Jeyaseelan, and N. Graham, "Physical and chemical properties study of the activated carbon made from sewage sludge," Waste Manag., vol. 22, no. 7, pp. 755–760, 2002.

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