Short Communication

Pak J Sci Ind Res 1999 42 (4)209-210

A Note on Physical and Chemical Tests on Some Dimension Stones

Zubair Chughtai[a] Viqar Husain*[b] and Mohammad Akif[a]

[a]PCSIR Laboratories, Jamrud Road, Peshawar, Pakistan

[b]PCSIR, PPI Building Kamal Ataturk Road, Karachi, Pakistan

(Received 13 July 1998; accepted 1st December 1998)

Recent years have seen the development of a new "Stone Age" with the considerable increase in the use, production and awareness of dimension stones (Rees 1991). Dimension stone is a natural building stone that is selected, trimmed or cut to specified or indicated shapes or sizes with or without one or more mechanically dressed surface (Harben and Pardy, 1991). Materials constituting dimension stones are varied and may include granite, limestone, onyx, marble, slate, sandstone, quartzite and serpentine. In Pakistan, like other parts of the world the demand of marble, onyx, granite and other dimension stones is fast growing.

In Pakistan and other developing countries, environmental pollution is increasing very fast. Possibilities of dangerous levels of air pollution and acid rains have also increased many folds due to frequent use of hydrochloric, sulphuric and nitric acids in modern industries. Present study was undertaken with the aim of finding acid effects on marble and granite samples collected from some important deposits of Pakistan and North West Frontier Province (NWFP). A granite sample from Italy was also studied for effects of acids as a standard reference for physical and chemical tests, which were compared with ASTM values.

Three samples of granite from Bunair, Malakand (NWFP) and Italy were taken from museum of PCSIR Laboratories Pheshawar and four samples of marble belonging to various deposits of NWFP were provided by Shakeel Marble Industry, Peshawar for this study. The physical tests carried out included compressive strength, specific gravity, water absorption and hardness (ASTM 1976, 1987;Harrison 1993). The samples were also subjected to acid tests to note their chemical reaction.

Three cubes 2" x 2" x 2" of each sample were tested on hydraulic machine to find out compressive strength of the sample according to ASTM methods. Similarly, specific gravity and water absorption tests were also carried out on these samples. The compressive strength and specific gravity of four marble samples are given in Table 1. The hardness of these samples ranges from 3.5 to 4. All these values are according to the specification of ASTM. Compressive strengths and hardness of green and red marble samples are greater than white and black marble due to different mineral composition. The high strength of coloured marble may be due to the presence of some ferruginous and other heavy minerals. It is evident that the compressive strength of granite samples is greater than marble samples. The specific gravity of granite is little less than marble. Water absorption of granite in some cases is close to marble whereas hardness of is little more than marble. Therefore, hard blades are required for cutting the granite. Thus, it may be concluded that granite samples are better than marble samples.

Test of hydrochloric, sulphuric and nitric acids on granite and marble samples were carried out. One percent of all three acids were prepared and effects of these acids were studied on three granite and four marble samples. This effect was noticed for a period of one to seven days. Very little effect of three acids was found on the granite as compared to the marble samples, all marble samples on the other hand were very much affected by the acids. Further, the effect of acids on marbles increased with the passage of time. The effect of nitric and hydrochloric acids is more on marbles as compared to sulphuric acid. Reactions of marble with acids are given below :

(1) $2HCl + CaCO_3 = CaCl_2 + CO_2 + H_2O$

(2) $H_2SO_4 + CaCO_3 = CaSO_4 + CO_2 + H_2O$

(3) $2HNO_3 + CaCO_3 = Ca(NO_3)_2 + CO_2 + H_2O$

These equations show that all types of marbles and acids react with each other and form salt, water and carbon dioxide. The reaction of 1% solution of HCl for 1 to 7 days on granite and marble samples shows that hydrochloric acid more on all marble samples than granite. The loss of weight in marble is more than granite samples.

Colour and luster of granite samples are not affected by acid treatment unlike marble. The reaction of 1% solution of sulphuric acid for 7 days shows that it reacts with four marble samples less effectively as compared to hydrochloric acid. It is due to the fact that H_2SO_4 reacts with marble to form $CaSO_4$ or gysum,

Table 1

Specific gravity and compressive strengths of marble

	White	Green	Red	Black	ASTM
Specific gravity	2.70	2.70	2.76	2.73	2.65-2.90
Compressive Strength (Kg cm^{-2})	7145	11264	16896	7920	800-1800

*Author for correspondence

water and carbon dioxide. In the presence of water, gypsum gets precipitated on the surface of marble and helps stopping further reaction on it. Thus, the reaction of sulphuric acid on marble becomes slow. The colour and polish of marble are also affected with sulphuric acid, but very little effect of nitric acid is noticed on granite samples in this regard.

Each sample of granite or marble (not less then 100 g) was taken, washed with water to remove the dust and other impurities and dried at 120°C for at least one to two h in oven then weight after cooling. The sample was then put in a cylinder carefully and the acid of required strength was added in the ratio 1:2. Cylinder was covered with plastic sheet or disk. Later it was partially opened to allow the gas to escape from the bottle and kept for 24 h. The bottle was stirred carefully two to three times during the period. After 24 h, sample was washed with water very carefully using soft brush, dried in oven again at 120° C for one to two hours and then weighed at room temperature. The difference in the weight is the loss of weight due to acid reaction.

The compressive strength and specific gravity of granite samples of Bunair, Malakand and Itlay samples (Table 2) are within limits according to the specification of ASTM. Similarly, water absorption and hardness are also within permissible limit. Hardness of three granite samples is between 5 to 6. Granite samples from Malakand compares favorably with the sample of Italy.

The effect of 1% of nitric acid for 7 days on all marble samples is more as compared to other two acid effects e.g. HCl and H_2SO_4. Similarly, the color and polish of marble is also more affected by nitric acid than other two acids. In the case of granite, there is very little effect of nitric acid which does not even remove its color and polish.

Table 2

Specific Gravity and compressive strengths of granite

	Bunair	Malakand	Italy	ASTM
Specific gravity	2.65	2.63	2.22	2.60-2.80
Compressive Strength (Kg cm^{-2})	19200	20800	21500	1600-2400

Similarly, effects of the three acids (HCl, H_2SO_4, HNO_3) of different concentrations (from 1% to 5%) have been studied on the marbles and the results are the same; marble samples are more affected than granite. When acid concentration increases, the reaction on marble increases. But the granite remained unaffected by increasing the concentration solution of the acids. It may be concluded from the study that in the areas/localities where there is a potential danger of air pollution due to industrial activities, the use of granite in the construction of buildings should be preferred over that of marble.

References

ASTM 170 1976 *Standard and test method for compressive strength of natural building stone*, American Society for Testing and Material.

ASTM C-97 1987 *Standard test method for specific gravity and water absorption* American Society for Testing and Material

Harben P, Pardy J 1991 Stone evaluation from cradle to grave stone. *Industrial Minerals* 47-61.

Harrison D J 1993 *Industrial minerals laboratory manual on lime stone.* British Geological Survey Technical Report WG/92/29 mineralogy and petrology series.

Rees K H 1991 Dimension stone review the new stone age. *Industrial Minerals* 43-52.