

The Development Of Artificial Marble From Dolomite (Batu Reput) In Perlis

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ABSTRACT

Perlis is one of the major producers of "Batu Reput" in Malaysia and majority of the deposits contain of high-purity calcium and magnesium carbonate. The composition of Batu Reput is similar with the ordinary dolomite. Currently, the 'Batu Reput' is used as filler in the road construction, however with this new invention, it can be value added and maximized its application in the daily life, for example as construction materials, decorative products, souvenir and etc. This paper presents the fabrication of Artificial Marble from 'Batu Reput' and in this case, it was used as filler in the matrix of epoxy which is acted as a binder.

Keywords: Artificial marble, dolomite, epoxy.

1. INTRODUCTION

Dolomite is a sedimentary carbonate rock, which is consists of entirely or mostly of the mineral dolomite that is $(\text{CaMg}(\text{CO}_3)_2)$ [1]. Dolomite is the name given according to the French mineralogist Deodat de Dolomieu. It is a common sedimentary rock-forming mineral that can be obtained in the massive beds of several hundreds feet of thickness. They are deposited in all over the world and are quite common in sedimentary rock sequences. These rocks are called appropriately enough dolomite or dolomitic limestone. Most, if not all, dolomite is a replacement of pre-existing limestone and this replacement process is known as dolomitisation [2]. The process is often incomplete and rocks termed 'dolomite' are usually a mix of dolomite, dolomitic limestone and limestone. Therefore, dolomite deposits are always associated with limestones [3]. This fact, together with the presence of variable amounts of impurities, such as silica, iron oxides and alumina, has an important bearing on the suitability of dolomite for specific applications. Dolomite has a number of applications; majority of its application is in construction industry, where it may substitute for limestone. However, for some applications, dolomite is specifically valued for its magnesia (MgO) content, and chemical composition is all-important.

Dolomite usage is increasingly important in different branches of industry such as the food and pharmaceutical industries, production of fertilizers, glass, building materials, and even the kinescopes (picture tubes) for color television [6]. Unfortunately, dolomite is now used mainly as a building material or as a filler for glass, plastics and colors, in spite of its ability to adsorb certain poisonous substances [7].

Perlis has been blessed with huge dolomite reserves which known to the local as "Batu Reput". The reserves quantity of dolomite is huge, but it has a very limited application for example as road construction filler [4] [5]. Due to its limited application, the value of dolomite

seems to be cheaper than limestone, granite, or sand (in the market). In view of this circumstances, an extensive researchers have been conducted which mainly focused on the understanding of the properties of dolomite through characterization, physical and mechanical testing, etc. The output of this research will be used as a reference to the local government in the setting up of the policy about the application of dolomite. In view of diversification, KUKUM has went extra-mile in inventing an artificial marble made from dolomite which applied the high filler loading composite concept to manufacture the artificial marble. KUKUM's artificial marble based on polymer resin (thermoset) and dolomite, which combined in creating an artificial material that, performed and surpassed the natural marble and tiles that available in the market, physically, thermally and mechanically. Besides, from its excellence physical strength, this KUKUM artificial marble provides lower cost in product processing and manufacturing. KUKUM artificial marble allows the creation of many shape and form. It is a non-porous, stainless and can be colorful.

2. OBJECTIVE

The objective of this research is to diversify the application of "batu reput" in Perlis, Malaysia; as a useful materials and develop processing technique from a sustainability perspective including economic, value-added, environmental and social aspect.

3. RAW MATERIALS

Liquid epoxy resin type 311 was used as a binder. It has special characteristic to have low viscosity during processing without the application of diluents. Diamine was used as a hardener. The physical strength, toughness, brilliance adhesion, chemical resistance and low shrinkage have established liquid epoxy resins as a major raw materials for high quality solvent-free coatings, linings, industrial flooring, grouting and concrete reinforcements. They may also be used for tooling, encapsulation, adhesives, filament winding and laminates.

The dolomite that was used in this research is pearly, translucent mineral, colorless or white in color. The elements found in this mineral are Ca, C, Mg, and O, which were characterized by XRF. First, the dolomite was ground and sieved into a few mesh sizes in the range of 4mm, 2.36 mm, 1.18 mm, 600 μ m, 300 μ m, 150 μ m & 75 μ m.

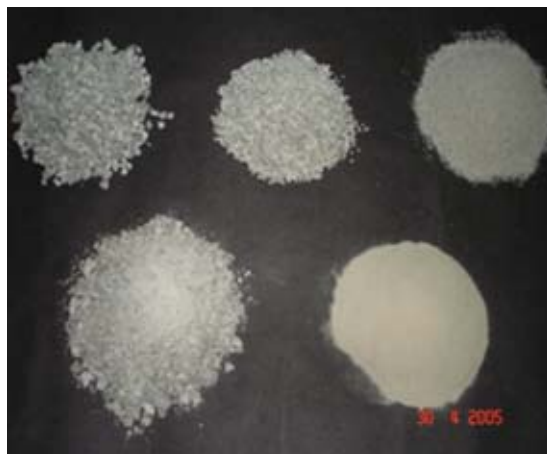


Figure 1: Different mesh sizes of dolomite 'Batu Reput'.

4. THE MANUFACTURE OF ARTIFICIAL MARBLE

The artificial marbles were obtained from the mixture of 30 wt. % dolomite in the epoxy resin. After manually mixing the mixture with the stirrer in container, then the mixtures were poured into the silicone rubber mould which having a feature or shape of the final product shape. The product will take five to six hours of optimum curing time (in room temperature) to the shape of the product. In order to obtain the different pattern, the colouring agent can be used either to the resin or to the dolomite. Whereas, the use of different mesh size of the dolomite may also contribute to the different appearance of the final products. The fabrication process in which involved in manufacturing of KUKUM artificial marble is shown in Figure 2.

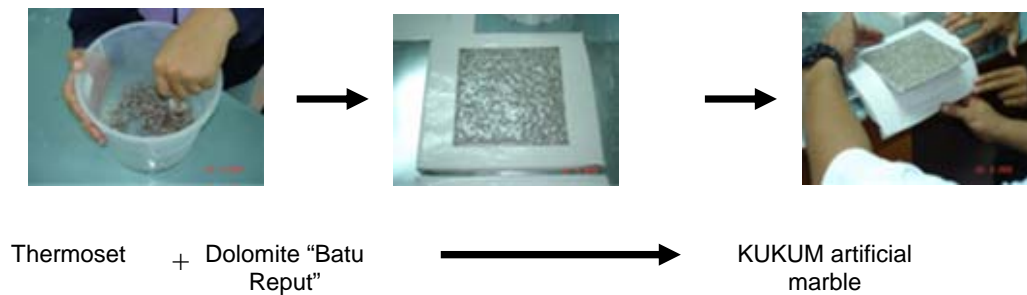


Figure 2: The fabrication process involved in manufacturing of KUKUM artificial marble.

5. MEASUREMENTS

The basic mechanical test such as three points bending, modulus of rupture (MOR) and Charpy impact test were carried out to both KUKUM artificial marble and commercial tile product for the comparison. Bending strength was measured by using Universal Testing Machine (Instron) under the mode of three points loading jig according to the ASTM D790.

The Charpy impact test was measured using the TQ instrument impact tester. The hardness of the raw materials and the product was determined by using Rockwell hardness tester. The density results also been used to compare the KUKUM artificial marble and commercial tile product.

6. RESULTS AND PRODUCTS

Dolomite is a kind of primary sediment mineral and has a widespread geologic distribution. Its chemical formula is written as $\text{CaMg}(\text{CO}_3)_2$, with the chemical composition in oxide by weight percent CaO 42.56 wt.%, MgO 22.73 wt.%, Fe_2O_3 0.51 wt.% and SiO_2 0.8 wt.%.

Table 1 exhibits the properties of raw materials which were used in this fabrication process. The hardness of dolomite is 89.95 HRB while epoxy is 4.17 HRB. Epoxy has low hardness value because of the soft behaviour of polymer materials whereas dolomite has higher hardness due the rock characteristic in the dolomite. No results for bending test for dolomite due to the difficulties in machining dolomite into the bar shape because of too brittle and irregular in shape of the aggregate. However, the bending strength of the epoxy is 101.99 MPa. Charpy test has shown that epoxy can absorb 9.08 Joule of energy before fracture, on the other hand; dolomite has not obtained any result due the brittleness and difficulties in machining process.

Table 1: The properties of dolomite “batu reput” and epoxy.

Properties/Materials	Dolomite ‘Batu Reput’	Epoxy
Hardness (HRB)	89.95	4.17
Bending (MPa)	Not Available	101.99
Charpy Impact (J)	Not Available	9.08

Table 2 shows the comparison on the properties between the KUKUM artificial marble and the tiles which are commercially available in the markets. In general, KUKUM artificial marble shows comparable properties with industrial tiles such as density, bending strength and impact strength. No density and MOR results can be presented from the industrial/homogeneous tiles because of its brittleness characteristic. The most important criteria in KUKUM artificial marble is the density result. It is lighter than the other tiles. Other advantages of the KUKUM artificial marble product are:

- Flexible style and design
- Solid structure with heat, fire and moisture resistance
- Good strength and long-lasting
- Easy to assemble.
- Easy machining to the desired shape

Table 2: Properties of KUKUM artificial marble and commercial tiles.

Properties	Commercial Ceramic Tile	Industrial/ Homogenous Tile	KUKUM artificial marble
Density (g/cm ³)	0.1729	-	0.1203
MOR (kg)	11.2	-	26.5
Bending Strength (MPa)	26.16	40.12	39.72
Charpy Impact Test (J)	7.33	8.03	8.33
Hardness	-	-	36.55 HRF

Artificial marble can sustain applied heat up to 400°C and also able to absorb load compared to industrial marble for long duration. In addition, it is environmental friendly because it contains of high filler loading (70 percent Dolomite and 30 percent epoxy). Artificial marble is lighter than the industrial marble and the process to produce is cheaper and easier. Artificial marble is hard and be able to resist fracture, it has ability to sustain load and absorb energy for long service time. This artificial marble has been awarded silver medal in ITEX 2005 (International Innovation Technology Exhibition, Kuala Lumpur) and IPTA EXPO 2005 (Public Institution Higher Learning Education Research and Development Exhibition, Kuala Lumpur). In addition to artificial marble, research is also carried out to focus on the fabrication of several souvenirs such as a chest set, paper weight, small vase and many others as shown in Figure 3.



(a)



(b)

Figures 3 (a-b): Final product of KUKUM artificial marble.

7. CONCLUSION

There is a potential for producing artificial marble from dolomite “batu reput” in Malaysia. It can be utilised for producing a moderate strength of tiles and artificial marble. The artificial marble can be manufactured without using any thermal process compared to the conventional tiles. In addition to artificial marble, dolomite “batu reput” also can be manufactured to produce several souvenirs such as a chess set, paper weight, small vase and many others.

8. REFERENCES

- [1] Nermin Gence (2006), *Wetting behaviour of magnesite and dolomite surface*, Applied Surface Science 252 3744–3750
- [2] British Geological Survey (2004), *Dolomite*, Natural Environment Research Council, UK.
- [3] Xu Lingling, Deng Min (2004). *Dolomite Used as Raw Material to Produce MgO-based Expansive agent*. Cement and Concrete Research. 89, 121-124
- [4] S. Yoshikazu, E. D. M. Peter, T. Ohji. (2001). *Synthesis and Deformation Behaviour of Nano-diphasic Materials from Natural Dolomite*. Material Science and Engineering. A304-306. 780-784.
- [5] S.M. Nazry, K. Nizar, J.B. Shamsul, C.M. Ruzaidi & H. Kamarudin(2004), *Characterization of Perlis “Batu Reput” and the potential application.*, Materials & Mineral Proceeding, USM
- [6] Karaca.S, Gurses.A, Ejder. M & Acikyildis.D (2006), *Adsorptive removal of phosphate from aqueous solutions using raw and calcinated dolomite*’ Journal of Hazardous Materials B128 (2006) 273–279
- [7] Xu Lingling & Deng Min (2005) *Dolomite used as raw material to produce MgO-based expansive agent*’Cement and Concrete Research 35 (2005) 1480–1485