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MINIMIZING EFFECT OF WHITE MARBLE POWDER TO SOIL ENVIRONMENT: A CASE STUDY OF LANG LANH DEPOSIT, LUC YEN DISTRICT, YEN BAI PROVINCE

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Abstract

The quality of both natural and man-made environment is essential to social-economic development in Luc Yen district. The relationship between environment and mining quarries were studied using factors such as the amount of discharged marble powder, soil, and marble powder content in soil. By applying anti-compressive level measure, the results show that marble powder does not harden soil. However, it increases anti-compressive of concrete containing marble powder. The discharged marble and marble powder that recovered were used as an additive in concrete and to make Feng Shui souvenir. Only one type of marble powder can adapt among three samples and only two out of six formulas show remarkable results. During grinding and polishing, marble is not suitable for making a souvenir. It needs to have more research to find the solution to recover marble powder for making construction material to replace sand in the river.

Keywords: Luc Yen district; Marble powder; Mining industry; Construction product

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1. Introduction

In recent years, the Vietnam mining industry has grown significantly. More and more mining fields are getting to work. Mining is increasingly attracting the attention of the whole society. Economic values combining with competitiveness and sustainability and environment quality of mining industry have received a lot of attention and are widely discussed. Multidimensional approaches to assessing the quality of mining will contribute to forming the right solutions to enhance the environmental quality of mining in Vietnam.

For years, Vietnam has been considered as a potential country with over 5,000 mineral deposits and more than 60 different minerals. White marble minerals bring back some of the high economic benefits, and are valued by both domestic and foreign investors.

White marble is distributed in 11 northern provinces, mostly concentrated in Nghe An and Yen Bai provinces. Over 70 mines have been explored and exploited so far. Approximately 200 million cubic meters of white marble are eligible/suited for making stone flooring and 1.2 billion tons of high quality calcium carbonate powder.

1.1. Research objectives, questions and hypotheses

a) Research questions

This research focused on four main questions:

- Whether or not white marble powder created during mining processing affects the soil environment in the mining area compared with soil without white marble powder?
- How much white marble powder does each particular mining method discharge into the soil environment?
- How does each mining method affect pH level and compressive resistance level?
- What are the handling or recalling methods to minimize negative impacts while providing economic benefit?

b) Research objectives

This research aims to

- Assess the quantity of white marble powder from different mining methods on the discharge of powder into soil environment.
- Measure the effect of white marble powder on soil compressive resistance level.
- Propose handling or recall methods to minimize the most effect and bring some economic values.

c) Significance of the study

- Create a concrete knowledge base for later research. Other researchers can use the data and results in this research as scientific evidence and for primary reference.
- Set a premise as a guidance for sustainable development of the Luc Yen district and marble companies
- Contribute to the understanding of researcher, businessman, environmentalist, authorities about awareness and their behavior while they exploit marble, protect environment and give policies.
- Can be used as sample and standard to apply to any marble mining field in Luc Yen district.
- Point out the amount of marble powder and the way to recall it, and gives a new direction for further development.

d) Scope of the Study

- Mining has been developed significantly in recent years in many fields, such as: coal, metal, minerals,… Many companies and groups are set up in Luc Yen district, which is making changes to this small area. New plants and factories are being built; new socio-economic directions are being given to this area due to the marble exploiting industry.
- Specific scope: The study was conducted directly at a marble mining field in Lieu Do commune, Luc Yen district, and Yen Bai province.

2. Physical geographic and socio-economic characteristics

2.1. Physical geography

- The selected study area covers an area of 0,35 km^2 located in Lieu Do commune, Luc Yen district, Yen Bai province. It is a part of the 1: 50,000 VN-type terrain map with the number F-48-42-C defined by the points 1, 2, 3 and 4 with the following square coordinates:

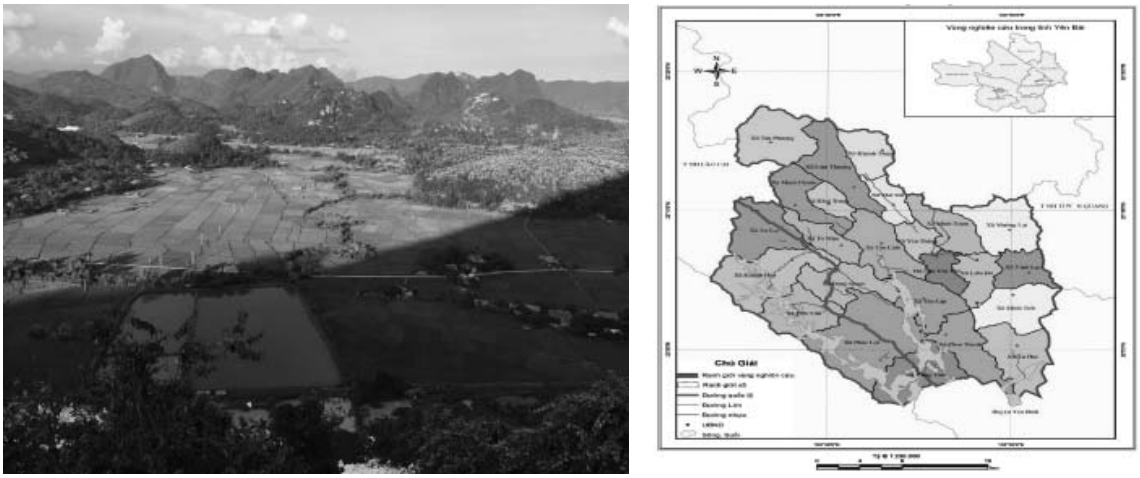
Table 1. The coordinates of the study area

Point	UTM Cord		VN2000 Cord	
	X(m)	Y(m)	**X(m)**	**Y(m)**
1	2441.873	479.698	2442.302	479.082
2	2442.634	479.461	2443.063	478.845
3	2442.728	479.689	2443.157	479.073
4	2441.964	480.286	2442.393	479.670

Source: Lang Lanh marble mining exploitation License

- Topographic, rivers and streams features

The karst topographic in the study site has an altitude of 453,7 m including peaks within the limestone range that extends northwest-southeast. The mountain range has low slopes to the southwest and northeast, the aqua longitudinal divide in the northwest - southeast. In general, the limestone terrain has jagged, steep slopes, many of which form a vertical wall. In the northeast of the mining area, it borders on the mountainous plain. At the foot of the mountain, there is a thin Quaternary cover, mainly of the deluvi - eluvi - proluvi origin. The vegetation is quite well-developed, mostly thorny and vines. In the study area there are no flowing rivers and streams, only temporary flows are present. There is water on heavy rainy days and exhausted immediately after the rain. In the north-east of the study area (outside the area) there is Lanh stream flowing eastwards which is often exhausted in the dry season. In the rainy season, there is frequent water which sometimes rises for 2 - 3 hours (Fig.1a and 1b).



(a) ***(b)***

Figure 1: Location (a) and topographic map (b) of study area

- Climatic characteristics/features

The study area is located from the low to medium mountainous terrains under the influence of tropical monsoon climate. There are two distinct seasons: rainy season and dry season.

- The rainy season: From April to October, the rainfall varies from 130 to 150 mm with the largest concentration in July and August reaching over 300 mm. The temperature is 30^0C - 38^0C, the highest temperature is 39^0C - 40^0C. In the rainy season, there are often cyclones, hailing and flooding, which makes it difficult to conduct research on geology and mining. The average wind speed is 1m/s and the strongest is 24m/s. Usually from January to July, the wind speed is over 1m/s.

- The dry season: From November to March of the next year, the weather is cold, usually with the northeast monsoon and drizzle. The temperature is around 10 - 18^0C. The average temperature is 15^0C and the lowest one is 20 - 40^0C. During the period from December to March, it is usually cold and humid. The dry season usually has northeast winds with frost and cold weather.

2.2. Socio-economics

- Residence

The inhabitants of this area are mainly Kinh, Tay and Dao ethnic minorities. Most of them live in Yen The town and concentrate in the northern part of the limestone range in the lowland delta, where the terrain is low and comfortable. Their literacy and living standards is rather low and limited. Their main occupations are agricultural practices and small traders, and few people work in forestry.

- Economy

In the mining and surrounding areas, local industrial facilities have not yet been well equipped. Few private enterprises are opened for mining white marble and limestone. About 5 km northwest of the mine is Yen The town with car terminals, hospitals, schools at all levels and markets ... This is considered as a trading, cultural and political center of Luc Yen district. There are approximately 3 - 4 km of high-voltage power lines and low-voltage power stations serving the daily life, agricultural production and some local industries.

- Traffic

The research area which is about 5 km far from Luc Yen district has good traffic conditions.

+ Road: It is about 240 km from Hanoi to the mining area; about 5 km From Yen The town along the road and rocky road to the mine; about 2 km from the study area to the mine.

+ Railway: It is 155 km from Ha Noi to Yen Bai by train, about 90 km from Yen Bai station to the mining area by road.

In general, the infrastructure is favorable for mineral research, exploitation and processing.

2.3. Literature review

All of the mines are located in the old metamorphic limestone karst terrain. So, the area object has been studied by many domestic and international geologists, especially from 1965 until now.

- In 1965, Dovjicov AE and his colleagues carried out the geological mapping of the Northern Vietnam at the rate of 1:500,000, in which the limestone formations were metamorphosed in Lieu Do area classified in terms of Proterozoic age, located in the Chay River composition zone.

- In 1985 - 1987, Tran Xuyen and authors of Geological Delegation 207 set up the geological map of mineral Bac Quang sheet 1:200,000, classified the disturbed limestone formations in the studied area into the formation An Phu Neoproterozoic - early Cambrian.

- In 1986 - 1987, Nguyen Van Ngoc and his research team conducted the search of gems in An Phu area, Luc Yen 1: 10,000 scale. Then, many enterprises and private gem mining companies were founded in Luc Yen (outside the study area).

- In 2000, Nguyen Van The and authors of Geological Group 203 undertook the geological mapping and mineral prospecting of Luc Yen Chau 1: 50,000 map group, the white marble formations from metamorphic limestone were classified into An Phu formation. ($NP - \varepsilon_1 ap$).

- In 2001, Thanh Phat Investment and Trading JSC researched white marble in Nam Ngu, Dong Phu (located near the study area). The research results showed that the reserve primary level was 26,894,000 tons and the secondary level was 55,403,000 tons.

In general, previous studies (before 1995) focused mainly on gem minerals. White marble has only been mentioned in the field of producing conventional building materials, whereas other fields have not been studied. At present, Luc Yen stone marble is being studied by researchers and investors because of its economic value and benefit, especially in the field of producing stone blocks for export. Studies on paving stone, fine calcium carbonate and super smooth and fine arts raw material are also being carried out.

2.4. Geo-morphological features of Lang Lanh Marble Mine.

- Stratigraphy

In the study area, the white marble body is similar to An Phu formation and is arranged to the second layer with the direction continuously running in the northwestern and southeastern areas. In the northeastern part of the study area, the petrographic components are calcite mineral appearing less than white and gray marble. The stone has a mono- structure dipped into northeast with a sloping angle of 40 to 60 degrees.

The mineral composition of the marble is mainly composed of calcite from 93% to nearly 100%. The other minerals have a negligible content and marble structure with thick layers of block style, granular texture and irregular dimension.

- Tectonic

In the research area, the previous documents as well as the current geological survey documents have not detected faults. The main finding are the expression of split crack and the broken rock.

- Minerals

In the marble quarry, there is only purely metamorphic white marble, and gray-white marble, which is a valuable research object for paving and for the production of calcium carbonate powder.

For the detection of heavy minerals (mineral ores, rubi sapphire), previous researchers have taken samples in loose formations or along white marble in the study area. The results indicate that the following minerals are found in the sample: 96 - 98% of the samples are found in quartz minerals, ore minerals are <1mm in size, the results show that limonite spinel, zircon have few amount.

The sample analysis show that only a few heavy metals (limonite, zircon, and spinel) are found in the study area with low content of no economic significance. Thus, except white marble in the study area, the other minerals are not valuable.

2.5. Geological characteristics of marble body

Marble is a metamorphic rock made from original carbonate rock, mainly from calcium carbonate ($CaCO_3$) with a stratigraphic or block and layer structure. The main ingredient is calcite.

Marble is the result of regional metamorphic or thermal contacted metamorphic exposure from carbonate sedimentary rocks such as marble, dolomite, or metamorphic rocks. Metamorphism causes the original calcite minerals to be completely recrystallized creating the mosaic calcite texture, and independent aragonite or dolomite crystals.

White marble body

In the study area, the white marble body occupies the main mass. The marble is located in the same 40 - 60^0 and has a thick layer to the block texture, particle size from fine, medium to large. The main amount of calcite is about 99%

to 100%, other minerals account for a negligible proportion. The basic chemical content is as follows: CaO from 53.35% to 55.44%, average 55.13%; MgO from 0.10% to 0.73%, average 0.19%; Total Fe is from 0.01% to 0.08%, average 0.02%; SiO2 from 0.01% to 0.50%, average 0.24%; Al2O3 from 0.01% to 0.15%, average 0.03%; Whiteness from 85.5% to 93.7%, average 91.0%, not only meets the requirements for the manufacture of paving, blocks, but also meets the standards for producing calcium carbonate powder served for different industries.

Gray marble body

Located upper layer of white marble body and distributed in the north-east of the study area covering about 6 hectares with grayish - green marble body, it has little graphite scales and phlogopite. They form the strip in the northwest - southeast with the length of about 450 m, width from 80 m to 220 m. In karst cavity there is little development. The marble is composed of thick layers to block, medium to large particles size. The mineral composition is mainly composed of calcite from 93% to 98%, and graphite and phlogopite minerals account for 2 - 7%. The basic chemical content is as follows: CaO from 44.85% to 55.44%, average 50.25%; MgO from 0.10% to 7.46%, average 3.29%; total Fe from 0.01% to 1.12%, average 0.15%; SiO2 from 0.40% to 11.94%, average 2.19%; Al2O3 from 0.03% to 3.26%, average 0.50%; whiteness from 65.5% to 92.8%, average 77.7%. They have a high stone monolith ensuring quality requirements of the production of marble paving stones.

Based on references of previous research documents combined with geological research papers, especially materials obtained from research and pilot exploration of Thai Duong Service and Training JSC shows that white marble in Lang Lanh Marble quarry has a pure whiteness, uniformity and high mechanical strength. The technical characteristics of Lang Lanh Marble quarry do not only meet the requirements for the manufacture of facing and stone blocks, but also meet the standards for producing calcium carbonate powder for domestic use and export.

3. Conceptual framework

This research is divided into two main directions. Firstly, we examine if white marble powder hardens soil, and second, we examine if white marble powder can be reused by making concrete and or Feng Shui souvenirs.

The amount of white marble powder in drilling process is observed and measured according to every drill hole. Different drilling method will discharge different amount of white marble powder. In this research, 2 kinds of countersink drill bits in drilling are observed and measured during the internship period: 34 mm diameter air - compressed piercing rotary manual operating and 76 mm piercing air - compressed semi - automatic operation.

Real field work showed that diameter of drill holes varied comparing with countersink drill bits bit diameter, it can be explained because during drilling process, the countersink drill bits bit shaked and the drill shaft is not straight. In marble cutting and shaping, 11 mm diamond wires are used to cut primitive marble block into multi size cube and rectangular marble block.

Figure 2: Drill countersink drill bits in marble exploiting

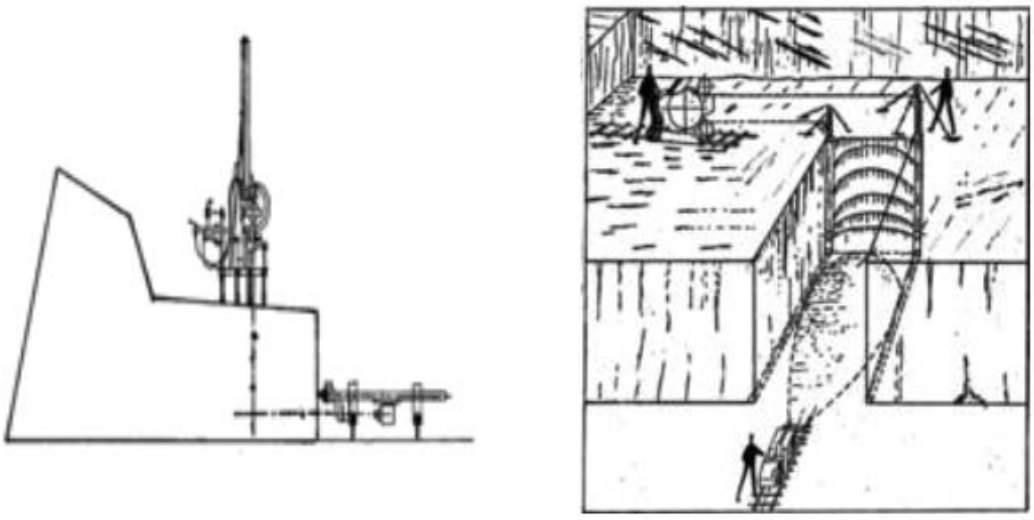


Figure 3: Drilling and diamond - wired cutting marble from primitive marble block

Source: Nguyen Xuan An

Figure 4: Cutting marble block and discharging powder to surrounding environment

Figure 5: Soil samples collected and captured, stored in plastic box with polyethylene membranes

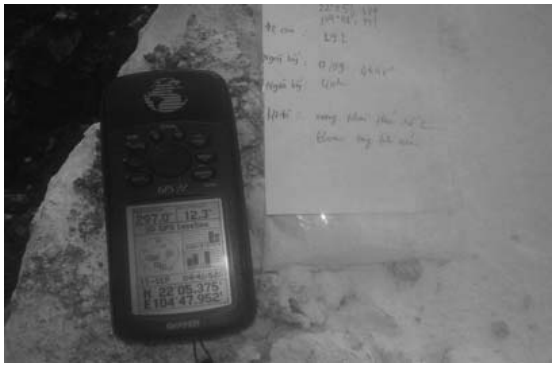


Figure : Sampling point and GPS device: GPS 72 - Garmin

Figure 7: Concrete samples using white marble powder

A 34 mm dill hole will be deployed vertically to serve 2 main things: using AD1 explosive to break marble, and to make path to connect with 76 mm horizontal drill hole. These two holes are connected, then the diamond wires running through marble block are cut into smaller block (Fig. 4).

There are 4 soil samples chosen including soil without white marble powder, one sample with white marble powder discharged using diamond wire, one soil sample mixed with white marble powder discharged in manual air compressed drill, and soil with white marble powder discharged by semi - automatic air compressed drill. Their coordination is all marked by Garmin GPS 72 with main features of sampling places (Fig. 5).

Also, 3 white marble powder samples are collected according to 3 different exploiting methods: white marble powder discharged using diamond wire in cutting process, white marble powder discharged in manual air compressed drill and white marble powder discharged by semi-automatic air compressed drill.

3.3.2. Experiment

Lastly, five concrete samples are created to examine the compressive resistance level between concrete using white marble powder as additive in different rate replacing for sand and standard concrete samples Marx 200 according to Vietnam's Ministry of Construction.

3.3. Analysis and Experiment

3.3.1. Analysis

All soil samples collected according to TCVN 2683: 2012 with the size 25 x 25 x 25 cm. Only the soil sample without white marble powder is not put into plastic box right after being separated from the ground, it was covered and wrapped with a poly-ethylene paper to keep moisture and soil particle structure. The others are put in to a plastic box 25 x 15 x 5 cm. All of the soil samples will be analyzed in Truong Phat Joint Stock Company at 173 - Nguyen Hoang Ton, Hanoi according to the following categories:

Particle range, linkage level, pH, compress resistance level.

=> Comparing compressive resistance level between samples.

Table 2. Mixing formulas in recalling white marble powder into concrete experiment Marx 200

No	Name	Mixing formulas	Mixing ratios
1	E1	Cement, WMPDSAACD, Gravel	1,18 kg cement + 2 WMPDSAACD + 3.03 x10^{-3} m^3 gravel + 0.62l water
2	E2	Cement, WMPDMCAD, Gravel	1.18 kg cement + 2 WMPDMACD + 3.03 x10^{-3} m^3 gravel + 0.62l water

3	E3	Cement, WMPDUDW, Gravel	1.18 kg cement + 2 WMPDUDW + 3.03 x10^-3 m^3 gravel + 0.62l water
4	E4	Cement + Sand + Gravel + fresh water	1.18 kg cement + 1.63 x10^-3 m^3 sand + 3.03 x10^-3 m^3 gravel + 0.62l water
5	E5	Cement + WMPDMCAD + Additives + Gravel + salt water	1.18 kg cement + 1 WMPDMCAD + 1 Additives + 3.03 x10^-3 m^3 gravel + 0.62l salt water

This research created 3 concrete samples with different white marble powder levels using salt water (cement + white marble powder + sand + additives+ sea water) and created 6 concrete samples with different level white marble powder using fresh water (cement + white marble powder + sand + additives+ fresh water) and 1 concrete sample without marble powder as standard. Build Feng Shui souvenir from waste marble

All concrete samples are analyzed and compared in terms of their compressive resistance level. There are 3 times making concrete with total 10 samples when the size of concrete is 15 x 15 x 15 cm. After being molded for 4 hours, the concrete needs watering for maintenance. A wet towel and a hand sprayer are used for this step and 28 days after the maintenance, concrete samples are ready for being analyzed.

4.2. White marble powder amount discharged in particular methods.

4.2.1. White marble powder discharged in cutting using diamond wire.

After observation combining with fieldwork data collection and technique measurement, the white marble powder volume in cutting and drilling is described as follows:

When cutting marbles with a 11 m diamond wire, the normal cutting speed is $1m^2$ surface per 25 to 40 minutes and this result is dependent on how new the wire is. It is less than $1m^2$ surface if the cutting particle is old or eroded. And the data of average white marble powder in cutting marble cannot be measured because it may need more than 6 or 7 times to cut. And the amount of the white marble powder discharged in this method can only be measured according to the surface area.

Theoretically, the amount of white marble powder is:

(Parameter of cutting particle) x (Ideal area of cutting surface)

1,1 cm x100 x 100 = 11 000 cm^3 (1,1 x 10^{-3} m^3)

However, the amount of white marble powder in reality is more than this, approximately about 0.012 m^3 to 0.014 m^3 according to 12 mm to 14 mm cut vein.

4.2.2. White marble powder discharged from manual and semi - automatic air-compressed drill.

By using 34 mm and 76 mm diameter piercing air- compressed countersink drill bits, white marble powder discharged in drilling equals the volume of countersink drill bit into marble block which is calculated in following formula:

(Countersink drill bit radius)^2 x (π) x (Length of drill hole))/ $1m^3$

And the white marble powder amount in one meter long in theory according to these exploitation methods is:

34 mm drill bit:

$(1.7)^2$ x 3.14 x 100 / (100 x 100 x 100) = 9.0476 x 10^{x4} cm^3

76 mm drill bit:

$(3.8)^2$ x 3.14 x 100 / (100 x 100 x 100) = 4.5341 x 10^{-3} cm^3

However real field observation proves that drill hole diameters are slightly

larger than 34 mm and 76 mm because of steep terrain, unstable and rough ground. It leads to volume of white marble powder will be more than that results above. Some observed drill holes are 36 mm and 78 to 80 mm. Furthermore, drill shaft is not straight. It is slightly bended because in operation, it has to resist to pressure from compressed air and marble weight.

All calculated configurations are served for reference purposes only because in reality, white marble powder volume depends on many variables such as unity level of marble, smooth level of marble and marble texture. In other words, it is impossible to predict the amount of white marble powder precisely.

Table 3. Comparing table of designed and theoretical parameter

Items	Designed parameter	Real parameter	Theoretical wmp volume	Real wmp volume
Cutting particle	11mm diameter	12 - 15 mm	(0.011 m^3/vein) x meter	(0.012 - 0.015 m^3/vein) x meter
Manual air-compressed drill bit	34 mm diameter	36 - 38 mm	(9.0476 x 10^{x4} cm^3/hole) x meter	(1.0173 x 10^{-3} cm^3) x meter
Semi-automatic air-compressed	76 mm diameter	77 - 80 mm	(4.5341 x 10^{-3} cm^3/hole) x meter	x $10^{-3}cm^3$) x meter

4.3. Compression results of concrete samples

Five concrete samples are examined at Truong Phat Consultancy Investment and Construction Joint Stock Company - Material Experiment and Construction Quality Examination Center (Tab. 4)

Table 4. Results of Construction Quality Examination on Compression and Compressive strength

No	Sample	Parameter (cm)			Compression force kN	Compressive strength kG/cm^2
		L	W	H		
1	E1	15.1	15.1	15.1	141	63.1
2	E2	14.8	15.3	15.1	230.2	103.7
3	E3	15.5	14.5	15.1	166.1	75.4
4	E4	15.5	14.7	15.5	196.2	90.7
5	E5	15.2	15.2	15.7	233.3	103

This experiment uses E4 as a standard followed by Marx 200 according to Vietnam's Ministry of Construction. From the result, it can be seen that E2 and E5 are significantly higher than M4. This means they can take a better compressive force and E1, E3 are not strong enough compared with E4. From the table above, E4 gains 169.2 kN of pressure force meanwhile E3 and E2 using white marble powder as an additive to provide a potential result for further study and application into other fields, (103.7 and 103 kN).

Discussion: The fineness of white marble powder influences the compression resistance level of concrete containing them. It can be explained by white marble powder discharged from manual air- compressed drill used in E2 and E5 sample all mixed and connected to sand, cement mixture creating a better force resistant material. Too rough or too fine white marble powder will

decrease see earlier correction level. Because marble is very easy to break, the bond among marble crystals is weak and unstable. Being too big marbles means taking more force on the surface and it's easier to break down them from the inside. Too fine marble powder also degrades the resistant compress level. Too small and fine powder fills into space among sand. It will create a weak bond linkage when marble powder is combined with cement. This linkage cannot take a vertical direction compress force.

4.4. Compression results and particle parameter of soil samples

Table 5. Results of physical and mechanical properties of soil

Sample ID		M 1	M 2	M 6	M1	M2	M 3	M 4
		WMP			Soil	Soil + WMP		
Parameters								
1. Particle composition %	>10 mm	0	0	0	0	0	0	0
	10 - 5 mm	0	0	12.7	0	1	0	0.3
	5 - 2 mm	0	1.4	15.2	0.2	1.7	0.5	0.5
	2 - 1 mm	0	4.1	9.4	0.1	0.8	0.3	1
	1 - 0.5 mm	0.3	21.8	23.8	0.5	1.6	5.6	5.5
	0.5 - 0.25 mm	0.6	28.9	20.7	1.9	1.7	15.3	10.2
	0.25 - 0.1 mm	5.6	18.6	11.1	1.5	2.1	13.2	12.2
	0.1 - 0.05 mm	26.7	10.3	4.3	1.1	5.5	7	11.9
	0.05 - 0.01 mm	50.1	10.6	1.8	13.3	40.1	15.8	18.6
	0.01 - 0.005 mm	7.7	1.2	0.5	9	10	5.5	7.2
	<0.005mm	9	3.1	0.5	72.4	35.5	36.8	32.6
2. Density g/cm^3		2.73	2.73	2.73	28.4	2.76	2.77	2.76
3. Experimental moisture %					33.61	29.23	19.54	24.95
4. Volume and mass when humid: g/cm^3					1.91	1.92	1.76	1.87
5. Volume and mass when dry: g/cm^3					1.87	1.9	1.66	1.79
6. Humid compress resistant level: kG/cm^2					1.89	0.73	0.97	0.62
7. Dry compress resistant level: kG/cm^2					12.6	4.71	2.93	2.69

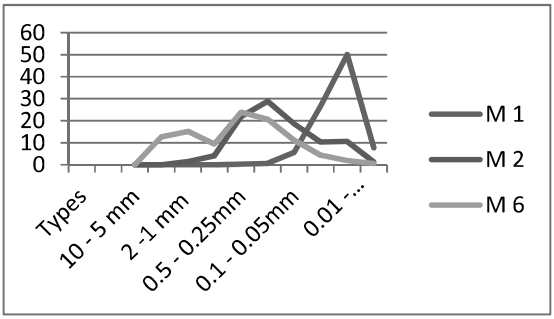


Figure 8: Particle composition range of 3 white marble powder samples

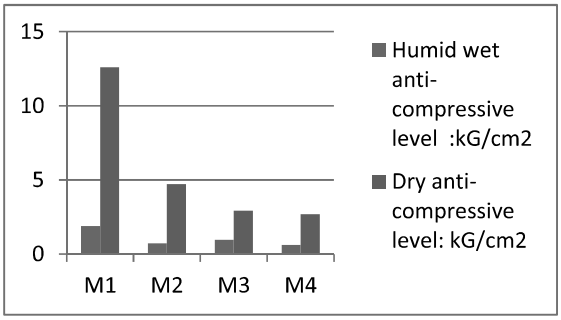


Figure 9: Level of soil and white marble powder mixture

From these results, M1 is regarded as the finest powder with particle range varies from 0.005 mm to 1 mm; and M6 varies up to 5 mm; M1 particle range focuses mainly at 0.01 to 0.1 mm. The rest of the particles concentrate around 0.1 to 0.5 mm.

Particle sizes of white marble powder discharged in three exploitation methods will influence the compression resistance level of the materials containing them inside (Fig. 8, 9).

Soil and white marble mixture in 4 samples illustrates that the dry see earlier level is greater than the wet resistant level. In M1- soil only, it is dramatically higher about 12 kG/cm^2 with dry samples and nearly 2kG/cm^2 with wet samples. When soil is mixed with marble powder, it becomes more porous. In other words, marble powder softens soil creating more space inside the soil. This can be explained by the texture of the marble body. They have a deviant structure and weak bond and it is very easy to break. In a certain size, marble crystal creates spaces in side the material when force engages or attacks. They break and decrease the force resistance.

4.5. Making Fengshui souvenir from wasted marble

Small size marble in Lang Lanh Quarry is not suitable for making fengshui souvenirs. Marble body is not uniform as it has small cracks. During grinding processes, marble is crushed and fragmented. When being polished, the surface is not durable enough to fight against weathering process.

Though these results cannot completely reflect all features and characteristics of marble powder, it opens a new episode for researchers to make use of marbles. These two recalling methods such as applying into concrete, construction materials and making fengshui souvenir may not bring successful results, but it provides meaningful scientific basis for further studies.

4.6. Comparison with other cement additive

Silicalite cement additive is made from a fine silica powder . It can be used as an extender for lightweight cements and a compressive - strength enhancer for low-temperature and lightweight cements. This product also imparts thixotropy to some cement slurries. Silicalite additive can be used in wells with bottom hole circulating temperatures between 50°F and 500°F (10°C and 260°C).

Silicalite additive is available as a powder or a compacted material. Compacted Silicalite additive does not have the same performance properties as the liquid or powder forms. Therefore, designs including compacted Silicalite additive should be subjected to laboratory testing before being used in the field.

White powder cement additive absolutely shows outstanding characteristics such as: it is easy to be found, produced and can be utilized in local resources and requires simpler technical features, etc,…Besides, white marble can be among the top priorities that bring a lot of economic benefit.

5. Conclusions and Recommendations

5.1. Conclusions

This research has met its initial goal: measuring the amount of discharged marble powder in 3 different exploiting methods; cutting using diamond wire, manual and semi-automatic drill using compressed air. We found that the level of white marble powder affects soil

compression resistance level: white marble powder decreases soil. We proposed handling or reuse methods to minimize the worst effect and bring back some economic values by using it as an additive in concrete, replacing for industrial construction sand and reusing wasted marble to make fengshui souvenirs.

In a certain size and fineness, white marble powder can improve compression resistance: white marble powder discharged from semi - automatic air compressed drill with the marble powder size ranging from 0.02 - 5mm and white marble powder discharged from manual air compressed drill with the marble powder size ranging from 0.005 to 10mm.

White marble powder decreases soil anti-compression level. At all dry and wet samples, white marble powder significantly decreases soil anti-compression level: about 12 kG/cm^2 at dry and nearly 2kG/cm^2 at wet standard sample compared with the maximum about 5 kG/cm^2 and 1 kG/cm^2 in other samples.

5.2. Recommendations

Based on research goals and the given results above. However, We provide some recommendations to expand this research area.

- Research result applications

In the short term, with high anti-compressive concrete samples, we should continue to invest more in research and development to get a complete product; keep a balance between economic value and market demand. Because white marble powder can soften soil, it should be mixed with fertilizer and applied in hardened soil to improve soil quality.

- Further research direction

In the long term, further investment is needed to determine which marble amount can provide the best compression resistance. Modern devices and advanced techniques will be used for further research. More support, information and examining samples should be given to students.

This research can be used as base for secondary researches: white marble amount affecting soil quality and white marble amount affecting concrete see earlier level with an aim to replace industrial construction sand.

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