Dolomitic Limestone Powder: Cement Substitute in the Production of Structural Concrete Paving Blocks

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Date received: October 18, 2021
Revision accepted: September 18, 2023

Abstract

Manufacturers are replacing or combining cement with mineral additives such as slags, natural pozzolans, sand, diatomaceous earth and limestone to reduce carbon dioxide emissions and energy usage. Due to its high magnesium content, dolomitic limestone has long been utilized in concrete production to reduce costs and environmental risks associated with making cement. This study aimed to produce a reliable and appropriate concrete mixture for concrete paving blocks using dolomitic limestone powder that passed the no. 24 sieve as cement replacement at replacement levels of 0 (control mix), 8, 12, 16, 20, 24, 28 and 32%, satisfying the minimum compressive strength requirement for structural concrete of 20.7 MPa (3,000 psi). The ASTM E877-13 was used to sample the dolomitic limestone, and the 1:1.5:3 concrete class combination was utilized to proportion the quantities of cement, sand and aggregates (3/8"). After 28 days, the specimens were cured and the compressive strength, through the varying water-cement ratios in the concrete mixture, was determined. Results showed that dolomitic limestone powder can substitute cement by 16% by weight, using a concrete mix of 523-g cement, 936-g sand, 1,868-g gravel, 100-g dolomitic limestone powder, and 166-g water with a water-cement ratio of 0.318, exceeding the minimum necessary compressive strength of concrete of 20.7 MPa by 24.9% or 5.16 MPa. Therefore, it is advised to utilize this proven concrete mixture as a basis for a potential business venture in the production of concrete paving blocks for structural concrete applications such as walkways, sidewalks, parking lots and commercial areas, as well as in places where loads are very high, like airports, courtyards, docks and freight yards.

Keywords: compressive strength, dolomitic limestone, paver block, structural concrete

1. Introduction

The paving block is a solid unreinforced pre-cast paving unit that comes in a variety of shapes and colors (Patel and Pitroda, 2014). Commonly used in the construction of driveways, patios, walkways, public plazas and other open spaces, paving blocks can be produced from different materials; the most common and preferred of which is made of concrete easily satisfying the strength, durability and workability requirements (Goel and Sharma, 2022). Conventionally produced concrete is composed of cement, sand, aggregates and water. Regardless of whether concrete is cast-in-place or precast, wet-mixed or dry-mixed, the mix proportion of the component materials affects not only the mechanical properties but also the production cost. However, among the component materials of concrete, cement has the greatest impact on the attainment of the desired mechanical properties and the minimization of production costs (Goel and Sharma, 2022).

Today, the extensive use of concrete in the construction industry worldwide puts a high demand on cement resulting in possible scarcity of its supply in the future. Hence, this has prompted manufacturers and researchers alike to look for suitable additives or replacements in the production of cement clinkers and cement substitutes in the production of concrete (Sawyer, 2016). Although primarily aimed at reducing energy consumption and global greenhouse emission, recent developments in cement manufacturing include blending cement raw materials with other minerals such as slag, fly ash, limestone and diatomaceous earth (Sawyer, 2016; Saidi and Hasan, 2020). Moreover, in the pre-cast concrete industry, the use of cement substitutes is becoming a popular means of reducing production costs. One of these promising cement substitutes is the naturally occurring dolomitic limestone.

Dolomitic limestone has pozzolanic and cementitious characteristics which makes it suitable as a binder. Previous studies have demonstrated that the replacement of cement with dolomitic limestone in a controlled amount resulted in the production of pre-cast concrete products passing minimum standards (Sawyer, 2016; Moon *et al*., 2017). Aside from the mix proportion of the component materials, the activities involved in the manufacture of pre-cast concrete products, such as the paving block, likewise affect the products' quality and cost. In the mixing of the raw materials, molding, placing and compacting of the concrete mix, demolding, and curing of paving blocks, there is a need to establish a reliable mixture proportion for the attainment of the concrete paving block's desired quality and uniformity of properties (Pani *et al*., 2018).

Powers' model is a quantitative model applied in different contexts of practical significance for concrete mixture proportioning (Bentz *et al*., 2009). It idealizes hydration as a reaction between cement particles and water to produce a single hydration product such as the concrete paving blocks. In this study, Powers' model was used to determine the reliable and appropriate concrete mixture at various water-cement (w/c) ratios with varying dolomitic limestone powder cement replacement levels.

2. Methodology

2.1 Preparation of Component Materials

2.1.1 Ordinary Portland Cement

In this study, the Type 1 Ordinary Portland Cement (OPC) was used with the chemical compositions (American Society for Testing and Materials [ASTM] C150/C150M-22, 2022) shown in Table 1.

Table 1. Chemical Properties of the Type I OPC

Cement component	Chemical composition (%)
CaO	63.82
SiO_2	20.09
Al_2O_3	3.87
SO_3	3.50
Fe_2O_3	1.69
MgO	2.22
Na_2O	0.30
K_2O	0.39
TiO_2	0.16
MnO	0.05

2.1.2 Dolomitic Limestone Powder

Dolomitic limestone powders were prepared by random sampling. The particle size distribution of the sample was determined through sieve analysis using sieve no. 24, after coning and quartering a batch of sample of limestone (ASTM E877, 2013). Coning and quartering is a method used to reduce the sample size of a powder without creating a systematic bias. The technique involves pouring the sample so that it takes on a conical shape, and then flattening it out into a cake. Then, it is divided into quarters, i.e., the two quarters which sit opposite one another are discarded, while the other two are combined and constitute the reduced sample for particle size testing; the average results were calculated. The reduced sample was then prepared after crushing into less than 10 mm, and subsequently reduced by splitting through the riffle divider into about 6 kg each. It was then dried at an oven temperature of 110 +/- 5 °C to a constant weight. After 5 h of oven drying, the sample was weighed for moisture content determination. It was then subjected to chemical analysis by pulverizing the dolomitic limestone powder to a size passing the no. 24 sieve (ASTM E877-13, 2013) at the laboratory of Philippine Mining Service Corporation, Cebu City. The physical and chemical compositions of the dolomitic limestone powder are shown in Tables 2 and 3. The minus 5 mm refers to the dolomitic limestone powder passing the 5-mm diameter mesh and the plus 5 mm for the retained sample.

Table 2. Physical properties of dolomitic limestone powder

Dolomitic limestone powder	Chemical composition (%)
Minus 5.0 mm	98.02
Plus 5.0 mm	1.98
Moisture content	< 6

Table 3. Chemical properties of dolomitic limestone powder

Cement component	Chemical composition (%)
CaO	34.26
MgO	18.48
SiO_2	0.15
Al_2O_3	0.08
Fe_2O_3	0.04

2.1.3 Sand, Aggregates and Water

Fine sand and 3/8” aggregate (choker) were tested for grading test, water absorption test (C136/C136M-19, 2019) and Los Angeles abrasion test (ASTM C131/C131M-20, 2020). Component materials were then each weighed following Powers’ model (Brouwers, 2004).

2.2 Equipment Used

The equipment used in the preparation of the concrete paving block specimens consisted of 1) the paving block maker, 2) the drop-weight and 3) the paver mold. The equipment was fabricated using steel plates and angle bars, a welding machine and a lathe machine. Figure 1 shows the paving block maker, the paver mold and the lathe machine of the concrete paving block equipment.

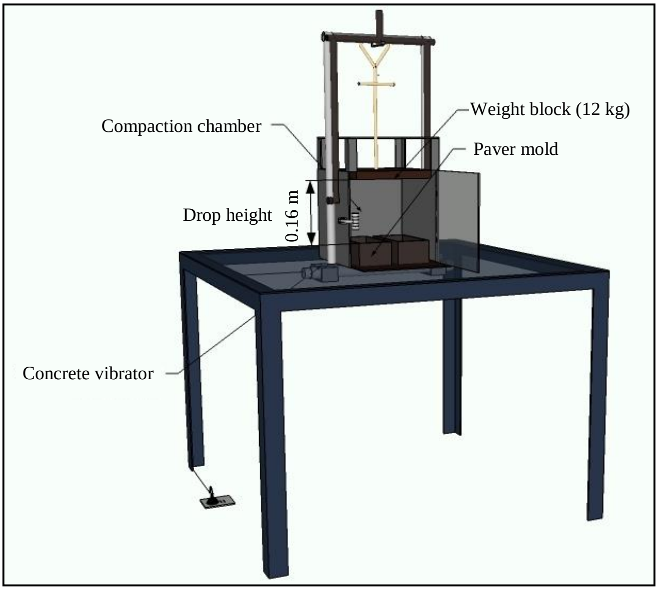

Figure 1. Paver block equipment

2.3 Design Concrete Mixes based on Powers' Model

The Powers' model (Bentz *et al.*, 2009) idealizes hydration as a reaction between cement particles and water to produce a single hydration product known as "cement gel." The quantitative model utilized the following assumed values (Jensen and Hansen, 2001), all in mass units of water per unit mass of cement reacted: (1) a non-evaporable water content of 0.23, (2) a chemical shrinkage of 0.064 and (3) a cement gel water content of 0.19. Based on these values, they provided the following estimates for volumetric phase fractions as a function of the degree of hydration (α) and starting water-to-cement ratio (w/c). For concrete mixture proportioning with w/c ratio less than 0.42, Equations 1 (chemical shrinkage), 2 (capillary water), 3 (gel water), 4 (solid gels), 5 (cement), 6 (volume balance) and 7 (volume balance with limestone filler) are used when a greater proportion of concrete is being produced.

$$V_{cs} = 0.2\ (1 - p) \propto \quad (1)$$

$$V_{cw} = p - 1.32\ (1 - p)\propto \quad (2)$$

$$V_{gw} = 0.60\ (1 - p)\propto \quad (3)$$

$$V_{gs} = 1.52\ (1 - p)\propto \quad (4)$$

$$V_{c} = (1 - p)\ (1 - \propto) \quad (5)$$

$$V_c + V_{gs} + V_{gw} + V_{cw} + V_{cs} = 1 \quad (6)$$

$$V_c + V_{gs} + V_{gw} + V_{cw} + V_{cs} = 1 - V_{LF} \quad (7)$$

where:

$$p = \frac{w/c}{\left(\frac{w}{c} + \frac{\rho_w}{\rho_c}\right)}$$

ρ_w and ρ_c are densities of water and cement and V_{LF} is the fractional volume of limestone filler.

Using assumed values (Jensen and Hansen, 2001), calculated volumes of unhydrated cement, solid products of hydration, gel pores, capillary pores, sand and gravel were determined as shown in Table 4.

Table 4. Calculated volumes (%) using assumed values

Description	Percentage (%)
Volume of unhydrated cement	3.70
Volume of hydrated cement	12.33
Volume of water from the w/c ratio	13.64
Volume of solid products of hydration	13.29
Volume of gel pores	5.17
Volume of capillary pores	3.81
Volume of sand	22.47
Volume of aggregates/gravel	44.06
Volume of entrapped air	7.50

In recent years, a greater proportion of concrete has been produced with a w/c ratio of less than 0.42. The Powers' model implies that in these concrete mixes, a portion of the cement only functions as an inert filler as there is insufficient space and/or insufficient water for complete hydration to occur. It is in these concrete mixes that the replacement of a portion of cement with less expensive and more environmentally friendly filler, such as limestone powder, is attractive (Bentz *et al*., 2009). Figure 2 shows the compressive strength/gel-space ratio expression obtained from a curve fitting of experimental data (Bentz *et al*., 2009).

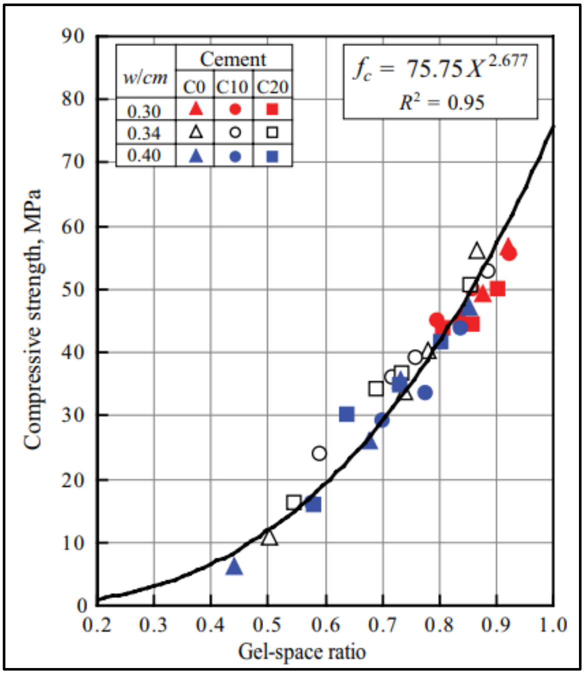

Figure 2. Experimental compressive strength of concrete as a function of gel-space ratio

The water-(cement+limestone) ratio for concrete mixtures containing dolomitic limestone powder as a cement substitute, represented as w/cm, is calculated using the regression equation derived from the two k-values of 0.85 and 0.20 at 12 and 24% cement replacements (Boubitsas, 2004; Lundgren, 2004) as shown in Figure 3.

The w/c ratio with dolomitic limestone as cement substitute is

$$^{w}/_{cm} = \frac{w}{(c + kR)}$$

where *w* is the amount of water, *c* is the amount of cement, and *k* is taken from the regression equation in Figure 3.

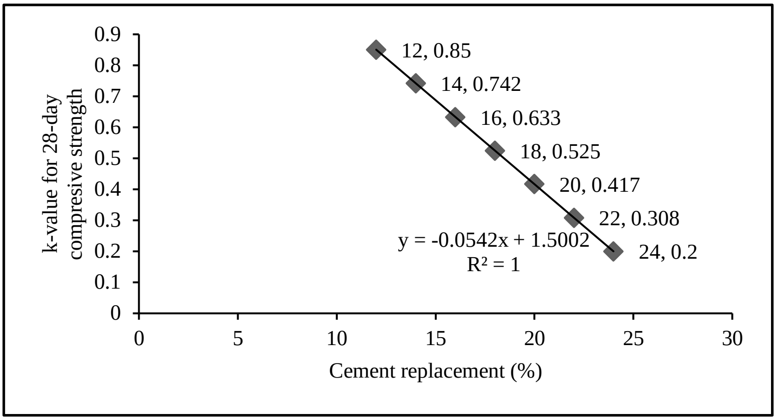

Figure 3. k-value for % of dolomitic limestone as cement replacement

2.3.1 Proportioning of Materials

Component materials of concrete paving blocks were determined using the volumetric method incorporating the assumed values (Jensen and Hansen, 2001) in determining the cement gel of the Powers' model (Bentz *et al*., 2009). Quantities of component materials were calculated as shown in Table 5.

Table 5. Mix proportions of component materials of concrete paving blocks

Cement replacement (%)	No. of samples	w/c ratio	Water (g)	Dol. limestone (g)	Cement (g)	Sand (g)	Choker (g)
0	5	0.350	218	0	621	936	1,868
8	5	0.323	185	50	573	936	1,868
12	5	0.318	174	75	548	936	1,868
16	5	0.318	166	100	523	936	1,868
20	5	0.324	161	125	498	936	1,868
24	5	0.335	158	150	473	936	1,868
28	5	0.352	158	175	449	936	1,868
32	5	0.379	160	200	424	936	1,868

2.4 Casting of Concrete Paving Blocks

Concrete paving blocks were then cast and produced after pre-determined amounts of cement, sand, gravel and water. The steps involved in the production of concrete paving blocks were the following:

The predetermined amounts of cement, dolomitic limestone powder (passing sieve no. 24), sand, 3/8" aggregate, and the mixing water were weighed. The cement and dolomitic limestone powder were mixed thoroughly until the mixture appears homogeneous. The sand and 3/8” aggregates were also mixed separately until the mixture appears homogeneous. The component materials in previous steps were then mixed until uniformity of the mixture was apparent. The predetermined amount of potable water was then poured into the mixture of the component materials; mixing of the water with the component materials was done for at least five minutes using hand trowels. The mixture was then tested for workability by conducting a slump test. For dry-mix concrete, a zero slump is required, the concrete mix was then poured into two molds. An amount of the mix enough to fill more than half of each of the mold was first poured and then slightly compacted using the 1” x 1” tamping rod. An additional amount of the mix was poured, enough to overfill the two molds with 5-10-mm mix thickness; the two molds were then vibrated through contact with a concrete vibrator that was operated at 60 Hz for 26 s using Equation 8 or 9 (Bhattacharjee, 2011).

$$t = \frac{25}{\varnothing}\left[\frac{100}{s+5} + A\right] F\sqrt{V} \qquad \text{for } V < 25\ L \tag{8}$$

$$t = \frac{25}{\varnothing}\left[\frac{100}{s+5} + A\right] F\,(0.1V+2.5) \quad \text{for } V < 25\ L \tag{9}$$

where t = time required (in seconds) for vibrating the concrete; s = slump (in cm); $\varnothing$ = diameter of the needle vibrator (in mm); A = shape of aggregates (A = 1.0 [round]) and (A = 5.0 [crushed]); and F = the steel (F = 1.0 [without steel] and (F = 1.5 [with steel]).

Then, the two molds with the mix were then placed in the chamber of the paver block maker for compaction using the 12-kg drop-weight dropped from a height of 16 cm. For better compaction, the drop-weight was made to fall thrice on the mix in the two molds; two molds were removed from the chamber and the excess materials above their brim were scraped off. The compacted paver blocks were then removed from their molds after 24 h and stored in a room under a normal condition where they were cured for 28 days through sprinkling with water (ASTM C192/C192M-19, 2019).

2.5 Slump Test (Workability) of Concrete Paving Blocks

The slump test refers to the workability of the concrete (ASTM C143/C143M-12, 2012). The test determines how fluid the concrete would be: it gives information on workability and the volume of water in the concrete mixture, i.e., if it is too wet or too dry. The higher the slump, the more fluid is the concrete (British Standard Institution, 2019). In this research, a dry-mix concrete mixture with a zero slump (Figure 4) was adopted, which is applicable to concrete paving blocks.

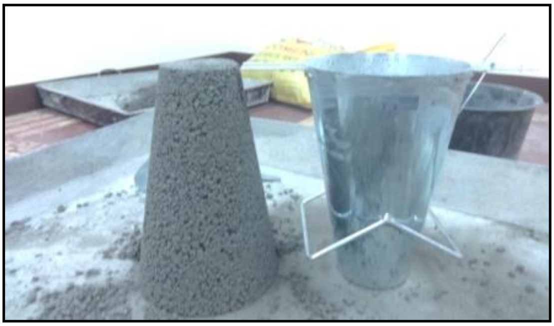

Figure 4. Slump or workability test of a dry-mix concrete

2.6 Compressive Strength Test of Concrete Paving Blocks

A day prior to compressive strength testing (C140/C140M-21, 2022), concrete paving block specimens were allowed to dry at normal room temperature without direct exposure to sunlight. The sprinkling of water (C192/C192M-19, 2019) as part of the curing process was stopped. Before the start of the compressive strength test, each concrete paving block specimen was weighed. The flexural test was not included in this study because paver blocks primarily bear the axial load in footpaths, tool plazas, parking areas, taxiways, etc. This study primarily focused on the determination of the compressive strength test using Powers' model utilizing the dolomitic limestone powder as a cement substitute in the production of concrete paver blocks at varying percentages (Goel and Sharma, 2022).

2.7 Data Analysis

The results of compressive strengths were analyzed statistically using the analysis of variance (ANOVA) to identify the significance of the variation in compressive strengths of all concrete paving blocks. The ANOVA was utilized to determine whether there were any substantial variations in compressive strengths across groups of specimens (Baguhin and Cabahug, 2019; Neri *et al.*, 2023). If the estimated F-value is smaller than the critical F-value, the null hypothesis is accepted when employing this test; otherwise, the null hypothesis is rejected. The P-value, however, was also employed to confirm the significant difference between groups of specimens to reject the null hypothesis. The next step was to perform a least square difference (LSD) post hoc t-Test to identify the sample or samples that significantly differ from the other sets of specimens. According to the null hypothesis, sample mean values do not differ significantly.

3. Results and Discussion

3.1 Compressive Strength Results

Table 6 shows the average 28-day compressive strength of concrete paving block specimens. Compressive strength is computed as the recorded maximum load on a specimen divided by the loaded area which was 100 x 200 mm. The tabulated average values were the arithmetic means of five results.

When 16% of dolomitic limestone powder was used as a cement replacement, the minimum compressive strength requirement (20.7 MPa) for structural concrete (Association of Structural Engineers of the Philippines, 2015), was clearly succeeded by 24.9% or 5.16 MPa and the control mix (22.81 MPa) by 13.4% or 3.05 MPa (Table 6).

Table 6. Average 28-day compressive strengths of concrete paving blocks

Cement replacement (%)	No. of samples	W/C ratio	Compressive strength (MPa)
0	5	0.350	22.81
8	5	0.322	12.62
12	5	0.317	18.23
16	5	0.318	25.86
20	5	0.323	13.92
24	5	0.334	14.90
28	5	0.352	14.39
32	5	0.378	15.77

This result can be explained by the normal wide particle size distribution of limestone, which allows the limestone particles to fill the spaces between the clinker particles reducing the requirement for water and densifying the structure of the hardened cement paste (Hawkins *et al*., 2003). Hawkins *et al.* (2003) found that reducing the water content and densifying the concrete improved durability, which was validated in this study when the water content at 16% cement replacement was reduced to 166 g from 218 g (0%), 185 g (8%), and 174 g (12%). As evidenced by their compressive strengths of 12.62

MPa (8%) and 18.23 MPa (12%) to 25.86 MPa (16%), the reduction of the water content densified the concrete, which increased the compressive strength due to the improved packing of the particles and filling of voids between the cement grains (Hawkins *et al*., 2003). Additionally, the cementitious qualities of the dolomitic limestone powder were comparable to those of cement made with calcium oxide, silicon dioxide, aluminum oxide, and iron oxide, thereby making increasing its durability.

However, after the 16% cement substitution, compressive strengths decreased because dolomitic limestone acts as a diluent when substituted in large amounts, lowering compressive strength (Hawkins *et al*., 2003). When the dilution effect predominates, the total amount of cement available for hydration reaction decreases, and the consequent greater distance between responding cement particles slows down the pace of reaction of the overall mixture. As a result, the solution becomes less concentrated, which reduces the development of hydration products (Jayapalan, 2013). Additionally, this study reduced the w/c ratio at increasing percentages of cement replacements to offset the diluting effect (Hawkins *et al*., 2003). Moreover, it is anticipated that the compressive strength of the paver block would reduce, and this reduction is caused by the dolomitic limestone powder, which is a weaker or softer material than the unhydrated powdered cement clinker (Hooton *et al*., 2007; Bentz *et al.,* 2009).

3.2 Differences of the Compressive Strengths

The results of the ANOVA within and between groups of specimens is shown in Table 7. The F-value was greater than the $F_{critical}$ value, i.e., there was a significant difference within groups of samples. The P-value was less than 0.05 validating that there was really a significant difference within samples. Further, Table 8 shows the LSD post hoc t-Test results within group sample means. For all sample comparisons, two group samples of 8 and 16, and 16 and 20%, had the highest absolute average differences of 13.24 and 11.94%, respectively, showing that each of the sample means was significantly different from the other.

Table 7. Results of the ANOVA among specimens

Source of variation	SS	df	MS	F	P-value	$F_{critical}$
Between groups	463.179	7	66.1685	10.7824	0.00005102	2.6572
Within groups	98.1872	16	6.137			
Total	561.367	23				

Table 8. The results of the LSD post hoc t-Test

Description	0% vs. 8%		0% vs. 12%		0% vs. 16%		0% vs. 20%		0% vs. 24%		0% vs. 28%		0% vs. 32%	
Count	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Sum	68.43	37.86	68.43	54.69	68.43	77.58	68.43	41.76	68.43	44.70	68.43	43.17	68.43	47.31
Average (%)	22.81	12.62	22.81	18.23	22.81	25.86	22.81	13.92	22.81	14.90	22.81	14.39	22.81	15.77
Variance	0.0036	2.1904	0.0036	3.5721	0.0036	0.9948	0.0036	4.3327	0.0036	4.00	0.0036	9.00	0.0036	25.00
Absolute of average differences (%)	10.19		4.58		3.05		8.89		7.91		8.42		7.04	
Least square difference (LSD) (%)	4.288		4.288		4.288		4.288		4.288		4.288		4.288	
Remarks	4.288 < 10.19		4.288 < 4.58		4.288 > 3.05		4.288 < 8.89		4.288 < 7.91		4.288 < 8.42		4.288 < 7.04	
Decision	Has a significant difference		Has a significant difference		Has no significant difference		Has a significant difference		Has a significant difference		Has a significant difference		Has a significant difference	

Table 8 continued.

Description	8% vs. 12%		8% vs. 16%		8% vs. 20%		8% vs. 24%		8% vs. 28%		8% vs. 32%	
Count	3	3	3	3	3	3	3	3	3	3	3	3
Sum	37.86	54.69	37.86	77.58	37.86	41.76	37.86	44.70	37.86	43.17	37.86	47.31
Average (%)	12.62	18.23	12.62	25.86	12.62	13.92	12.62	14.90	12.62	14.39	12.62	15.77
Variance	2.1904	3.5721	2.1904	0.9948	2.1904	4.3327	2.1904	4.00	2.1904	9.00	2.1904	25.00
Absolute of average differences (%)	5.61		13.24		1.30		2.28		1.77		3.15	
Least square difference (LSD) (%)	4.288		4.288		4.288		4.288		4.288		4.288	
Remarks	4.288 < 5.61		4.288 < 13.24		4.288 > 1.30		4.288 > 2.28		4.288 > 1.77		4.288 > 3.15	
Decision	Has a significant difference		Has a significant difference		Has no significant difference		Has no significant difference		Has no significant difference		Has no significant difference	

Description	12% vs. 16%		12% vs. 20%		12% vs. 24%		12% vs. 28%		12% vs. 32%	
Count	3	3	3	3	3	3	3	3	3	3
Sum	54.69	77.58	54.69	41.76	54.69	44.70	54.69	43.17	54.69	47.31
Average (%)	18.23	25.86	18.23	13.92	18.23	14.90	18.23	14.39	18.23	15.77
Variance	3.5721	0.9948	3.5721	4.3327	3.5721	4.00	3.5721	9.00	3.5721	25.00
Absolute of average differences (%)	7.63		4.31		3.33		3.84		2.46	
Least square difference (LSD), %	4.288		4.288		4.288		4.288		4.288	
Remarks	4.288 < 7.63		4.288 < 4.31		4.288 > 3.33		4.288 > 3.84		4.288 > 2.46	
Decision	Has a significant difference.		Has a significant difference.		Has no significant difference.		Has no significant difference.		Has no significant difference.	

Table 8 continued.

Description	16% vs. 20%		16% vs. 24%		16% vs. 28%		16% vs. 32%	
Count	3	3	3	3	3	3	3	3
Sum	77.58	41.76	77.58	44.70	77.58	43.17	77.58	47.31
Average (%)	25.86	13.92	25.86	14.90	25.86	14.39	25.86	15.77
Variance	0.9948	4.3327	0.9948	4.00	0.9948	9.00	0.9948	25.00
Absolute of average differences (%)	11.94		10.96		11.47		10.09	
Least square difference (LSD) (%)	4.288		4.288		4.288		4.288	
Remarks	4.288 < 11.94		4.288 < 10.96		4.288 < 11.47		4.288 < 10.09	
Decision	Has a significant difference		Has a significant difference		Has a significant difference		Has a significant difference	

Description	20% vs. 24%		20% vs. 28%		20% vs. 32%		24% vs. 28%		24% vs. 32%		28% vs. 32%	
Count	3	3	3	3	3	3	3	3	3	3	3	3
Sum	41.76	44.70	41.76	43.17	41.76	47.31	44.70	43.17	44.70	47.31	43.17	47.31
Average (%)	13.92	14.90	13.92	14.39	13.92	15.77	14.90	14.39	14.90	15.77	14.39	15.77
Variance	4.3327	4.00	4.3327	9.00	4.3327	25.00	4.00	9.00	4.00	25.00	9.00	25.00
Absolute of average differences (%)	0.98		0.47		1.85		0.51		0.87		1.38	
Least square difference (LSD) (%)	4.288		4.288		4.288		4.288		4.288		4.288	
Remarks	4.288 > 0.98		4.288 > 0.47		4.288 > 1.85		4.288 > 0.51		4.288 > 0.87		4.288 > 1.38	
Decision	Has no significant difference		Has no significant difference		Has no significant difference		Has no significant difference		Has no significant difference		Has no significant difference	

4. Conclusion and Recommendation

Based on the results, it was concluded that the concrete mixture, containing 523 g of cement, 936 g of sand, 1,868 g of choker, 100 g of dolomitic limestone powder, and 166 g of water with a w/c ratio of 0.318, was the most reliable and appropriate concrete mixture for structural concrete paving blocks using 16% of the dolomitic limestone powder as cement substitute by weight. It is recommended to utilize this tested concrete mixture as a basis for a potential business venture to produce structural concrete paving blocks. There is a need to conduct a comparative study using a constant w/c ratio in the production of concrete paving blocks; a separate study using much finer dolomitic limestone using a constant w/c ratio; and another study automating the paver block equipment using a constant w/c ratio. These future works should utilize this mineral for sustainability while minimizing the environmental impacts for a long-term ecological balance.

5. References

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