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Research Article

FAHP and TOPSIS Prediction of Diamond Segments Wear When Using Frame Saw to Cut Granites

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Fuzzy Analytic Hierarchy Process (FAHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) approaches were employed to predict the sawability of a diamond frame saw to cut granites. FAHP is used to determine the weights of the criteria of decision-makers and TOPSIS is used to rank sawability. The sawability was evaluated by diamond segment wear. The prediction of segment wear is important to determine the segments service life and sawing cost and may determine cutting parameter selection for a given stone. Sawing experiments were conducted to verify the analysis result of the applied method in this study. The experimental results are in good agreement with the theoretical analysis. The ranking method can be used to evaluate segment wear. Stone properties, such as uniaxial compressive strength, shore hardness, quartz content, and bending strength, must be determined for the best segment wear ranking.

1. Introduction

The prediction of stone sawability directly affects cutting parameter selection and sawing cost estimation for stone companies. A reasonable prediction of stone sawing can make the process more efficient. Scholars have studied the prediction of sawability by using diamond tools to cut stones. Stone sawability is related to rock properties and cutting parameters. Sawability criteria are mainly based on power consumption, slab production rate, specific cutting energy, classification, segment wear, and sawing efficiency. The main evaluation methods mainly include fuzzy analytic hierarchy process (FAHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) approaches, artificial neural networks, multiple regression statistical analysis, and multifactorial fuzzy approach. Brazilian tensile strength, uniaxial compressive strength, hardness, bending strength, quartz content, Young's modulus, impact strength, shear strength, density, porosity, abrasivity, and grain size are the input parameters of the prediction model. The sawability criteria, main evaluation methods, and input parameters are presented in Tables 1, 2, and 3, respectively.

The effects of carbonate rock properties, such as uniaxial compressive strength, Schmiazek F-abrasivity factor, Mohs hardness, and Young's modulus on power consumption and production rate have been reported [1, 2]. The artificial neural network method is better than the statistical regression method to product the slab production of carbonated stones by shear strength [3]. The influence of P-wave velocity, impact strength, point load strength, and Schmidt hammer value on slab production were evaluated [4]. A slab production prediction model was established using some rock properties, such as uniaxial compressive strength, Schmidt hammer valve, Los Angeles abrasion (LA abrasion), and Brazilian tensile strength [5]. The relationship between slab production and rock properties including uniaxial compressive strength, Brazilian tensile strength, Cerchar abrasivity index, porosity, and density was proposed [6]. A classification method of stone sawability was proposed, and the sawing rate was classified into five categories [7]. The influence of cutting

Table 1: The main sawability criteria.

Sawability criteria	References (researchers)
Power consumption	Mikaeil et al. (2011) [1]
Slab production	Mikaeil et al. (2013) [2]; Kahraman et al. (2006) [3]; Kahraman et al. (2004) [4]; Ataei et al. (2012) [5]; Tumac (2016) [6]; Mikaeil et al. (2011) [7]; Ersoy and Atıcı (2004) [8]; Fener et al. (2007) [9]; Sadegheslam et al. (2013)
Specific cutting energy	Yurdakul and Akdaş (2012) [10]
Classification	Tutmez et al. (2007) [11]; Delgado et al. (2005) [12]
Segment wear	Xu and Zhang (2004) [13]; Wei et al. (2003) [14]; Eyuboglu et al. (2003) [15]; Ersoy et al. (2005) [16]; Özçelik (2007) [17]; Buyuksagis (2007) [18]
Sawing efficiency	Buyuksagis and Goktan (2005) [19]

Table 2: The main evaluation methods.

Evaluation methods	References
FAHP and TOPSIS	[1, 2, 20]
Artificial neural networks	[3, 6, 13]
Multiple regression statistical analysis	[4, 5, 7–10, 15–19]
Multifactorial fuzzy approach	[11, 13]

Table 3: The input parameters of the prediction model.

Input parameters	References
Uniaxial compressive strength	[1, 2, 4, 6–11, 14–19]
Brazilian tensile strength	[4, 7–11, 15–19]
Hardness	[1, 2, 4, 6–12, 14–19]
Bending strength	[10, 16]
Quartz content	[3, 8, 12, 14, 16–19]
Young' modulus	[1, 2, 8, 15, 16]
Impact strength	[4, 8, 9, 11, 16]
Shear strength	[3, 8, 16]
Density	[6, 8, 10, 16, 18]
Porosity	[6]
Abrasivity	[1, 2, 4, 6–9, 11, 14, 16, 18, 19]
Grain size	[8, 16]

parameters and rock properties on specific sawing energy was reported [8]. Production can be predicted from LA abrasion loss, tensile strength, and compressive strength [9]. The specific cutting energy based on rock properties and cutting parameters was evaluated [10]. Sawing performance was classified into three categories, and the stone processing companies can select a suitable saw to cut stones only by the model developed [11]. Rock hardness has greatly influenced stone sawing rates compared with other stone properties [12]. The influences of cutting speed and depth of cut on segment wear were studied [13]. Segment wear and cutting force can be evaluated based on rock properties [14]. Shore scleroscope hardness, water absorption, and cone indenter hardness had a greater effect on segment wear than other rock properties [15]. The wear mechanism of diamond segments and a matrix was studied, and the cutting specific energy during the sawing process associated with segment wear was proposed [16]. The effects of mineralogical properties on segment wear and sawing speed were tested. Experimental results indicated that as the texture coefficient values increased, wear and sawing speed increased; however, as the grain size increased, segment wear decreased [17]. A predictive model of specific wear showed that plagioclase and bending strength were the most dominant rock parameters [18]. The optimum sawing performance for a particular stone based on depth of cut and travel speed was investigated [19].

Stone sawability when using a diamond frame saw to cut granite was predicted in this study. A prediction model was established by using segment wear as the evaluation criterion, and stone properties, including SiO_2 content, quartz content, orthoclase content, plagioclase content, shore hardness, density, uniaxial compressive strength, and bending strength as input parameters, and FAHP and TOPSIS techniques were employed to evaluate the sawability.

2. Theoretical Concepts

2.1. FAHP—Fuzzy Analytical Hierarchy Process

2.1.1. Triangular Fuzzy Number. The theory of fuzzy sets was first proposed by Zadeh in 1965 [21]. The method of fuzzy comparison judgment based on triangular fuzzy number was described by van Laarhoven and Pedrycz in 1983 [22].

Definition 1. M is defined as a fuzzy number on U ($U \in (-\infty, +\infty)$), if its membership function $\mu_M(x) : U \to [0, 1]$, $\mu_M(x)$ is illustrated in

$$\mu_M(x) = \begin{cases} \dfrac{1}{m-l}x - \dfrac{l}{m-l} & x \in [l, m] \\ \dfrac{1}{m-u}x - \dfrac{u}{m-u} & x \in [m, u] \\ 0 & x \in (-\infty, l] \cup [u, +\infty). \end{cases} \quad (1)$$

Set u and l as the upper and lower bounds of the fuzzy number M, respectively, m is the maximum value, and the triangular fuzzy number (l, m, u) is shown in Figure 1.

Table 4: Relative weight of evaluation index.

Relative weight	Illustration
M_1	Criterion i is equally important compared to criterion j
M_3	Criterion i is moderately more important than criterion j
M_5	Criterion i is more important than criterion j
M_7	Criterion i is strongly more important than criterion j
M_9	Criterion i is extremely more important than j
M_2, M_4, M_6, M_8	The scale value corresponding to the intermediate state
Reciprocal	If the ratio of i and j is a_{ij}, the importance of j and i is a_{ji}, $a_{ji} = 1/a_{ij}$

Operation rules of two fuzzy numbers [23]: if $M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u_2)$, the algorithms of M_1 and M_2 are as follows:

$$\begin{gathered} M_1 + M_2 = (l_1 + l_2, m_1 + m_2, u_1 + u_2), \\ M_1 \times M_2 = (l_1 l_2, m_1 m_2, u_1 u_2), \\ \lambda \times (l, m, u) = (\lambda l, \lambda m, \lambda u) \quad \lambda > 0,\ \lambda \in R, \\ \frac{1}{M} \approx \left(\frac{1}{u}, \frac{1}{m}, \frac{1}{l}\right). \end{gathered} \tag{2}$$

2.1.2. Fuzzy Analytic Hierarchy Process.

The method of fuzzy analytic hierarchy process has been used widely [24, 25], and it is divided into several steps: constructing the fuzzy judgment matrix, determining the initial weight, and gaining the final weight, as described next.

(1) Constructing the Fuzzy Judgment Matrix. Figure 2 shows the relative weight of the evaluation index. Based on a nine-point fundamental scale [26], the triangular fuzzy judgment set is provided in Table 4 [27]. According to this nine-point fundamental scale, experts compare each group (such as C_1 and C_2) to get a fuzzy number:

$$(l_1, m_1, u_1), (l_2, m_2, u_2), \ldots, (l_n, m_n, u_n). \tag{3}$$

Then the fuzzy numbers are integrated:

$$\left(\frac{l_1 + l_2 + \cdots + l_n}{3}, \frac{m_1 + m_2 + \cdots + m_n}{3}, \frac{u_1 + u_2 + \cdots + u_n}{3}\right). \tag{4}$$

(2) Determining the Initial Weight. Let $X = \{x_1, x_2, \ldots, x_n\}$ be an object set and $U = \{u_1, u_2, \ldots, u_n\}$ be the target set, as described [28]. The degree analysis values for each object are recorded as $M_{gi}^1, M_{gi}^2, \ldots, M_{gi}^m$, $i = 1, 2, \ldots, n$, where M_{gi}^j $(j = 1, 2, \ldots, m)$ are triangular fuzzy numbers.

The fuzzy synthetic value (initial weight) of the first i object is expressed as follows:

$$S_i = \sum_j^m M_{gi}^j \otimes \left[\sum_{i=1}^n \sum_{j=1}^m M_{gi}^j\right]^{-1}, \tag{5}$$

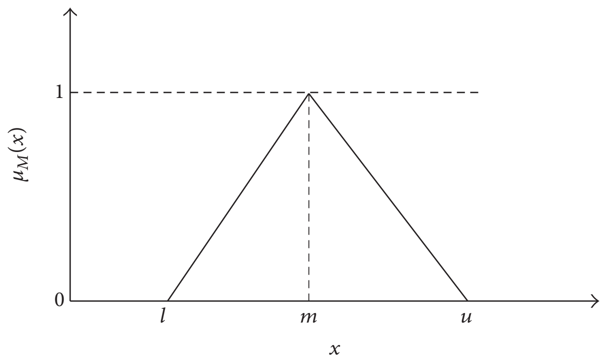

Figure 1: Triangular fuzzy number membership function.

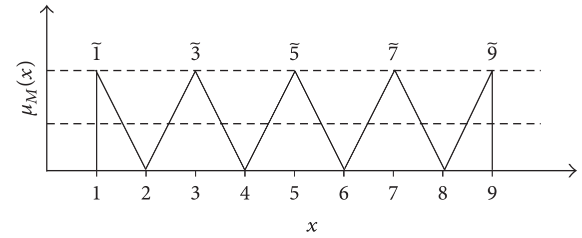

Figure 2: Fuzzy numbers of linguistic variable set.

where

$$\begin{gathered} \sum_{j=1}^m M_{gi}^j = \left(\sum_{j=1}^m l_j, \sum_{j=1}^m m_j, \sum_{j=1}^m u_j\right), \\ \sum_{i=1}^n \sum_{j=1}^m M_{gi}^j = \left(\sum_{i=1}^n l_i, \sum_{i=1}^n m_i, \sum_{i=1}^n u_i\right), \\ \left[\sum_{i=1}^n \sum_{j=1}^m M_{gi}^j\right]^{-1} = \left(\frac{1}{\sum_{i=1}^n u_i}, \frac{1}{\sum_{i=1}^n m_i}, \frac{1}{\sum_{i=1}^n l_i}\right). \end{gathered} \tag{6}$$

(3) Gaining the Final Weight

Definition 2. M_1 and M_2 are two triangular fuzzy numbers. If $M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u_2)$, the possibility degree of $M_1 \geq M_2$ is defined as triangular fuzzy function:

$$V(M_1 \geq M_2) = \sup_{x \geq y} \left[\min\left(u_{M1}(x), u_{M2}(y)\right)\right], \tag{7}$$

Table 5: Main physical and mechanical properties of stone workpiece.

Rock properties	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10
SiO_2 (%)	72.36	75.25	72.78	73.28	73.82	70.19	67.25	64.2	72.53	67.34
Quartz (%)	29.2	40.3	32.15	28.7	36	26.7	45.11	25.2	31.1	19.3
Orthoclase (%)	20.35	41.35	56	49	27.98	56.2	17.65	57.9	27.35	30.25
Plagioclase (%)	42.5	13.35	10.45	13.3	20.53	13.2	25.07	8	35.26	25
Shore hardness (HSD)	85	102	98.46	111	85.14	115	104	90.5	101	75
Density (g/cm^3)	2.56	2.68	2.7	2.6	2.61	2.65	2.58	2.64	2.62	2.65
Bending strength (MPa)	8.93	15.1	20.64	14.8	20.16	17.06	17.1	12.8	12.9	7.63
Compression strength (MPa)	92.3	165.9	226.3	162.5	199.48	168.29	209.9	153.8	219.3	85.69

where sup is the smallest upper bound

$$V(M_1 \geq M_2) = \mu(d) = \begin{cases} 1 & m_1 \geq m_2 \\ \dfrac{l_2 - u_1}{(m_1 - u_1) - (m_2 - l_2)} & m_1 \leq m_2,\ u_1 \geq l_2 \\ 0 & \text{otherwise.} \end{cases} \quad (8)$$

Definition 3. The possibility of a fuzzy number greater than the other k fuzzy numbers is defined as

$$\begin{aligned} V(M \geq M_1, M_2, \ldots, M_k) &= V[(M \geq M_1), (M \geq M_2), \ldots, (M \geq M_k)] \\ &= \min V(M \geq M_i), \quad i = 1, 2, \ldots, k \end{aligned} \quad (9)$$

if $d(A_j) = \min V(S_i \geq S_k)$, $k = 1, 2, \ldots, n$, $k \neq i$; the final weight vector is described as

$$w' = \left(d'(A_1), d'(A_2), \ldots, d'(A_n)\right)^T. \quad (10)$$

Standardized weight vector is obtained through standardized processing as follows:

$$w = \left(d'(A_1), d'(A_2), \ldots, d'(A_n)\right)^T. \quad (11)$$

2.2. TOPSIS (Technique for Order Preference by Similarity to an Ideal Solution). The TOPSIS evaluation method was first proposed by Hwang and Yoon [29] based on the degree of closeness between a limited evaluation object and an ideal goal. TOPSIS evaluation methods are as follows:

(1) Normalizing the evaluation object:

$$r_{ij} = \frac{w_{ij}}{\sqrt{\sum_{i=1}^{n} w_{ij}^2}}. \quad (12)$$

(2) Constructing a normalized weighting matrix:

$$v_{ij} = w_{ij} \times r_{ij}. \quad (13)$$

(3) Determining positive and negative ideal solutions:

$$\begin{aligned} A^+ &= \{v_1^+, v_2^+, v_3^+, \ldots, v_m^+\}^T, \\ &\qquad v_j^+ = \max_i \{v_{ij}\}, \ j = 1, 2, \ldots, m, \\ A^- &= \{v_1^-, v_2^-, v_3^-, \ldots, v_m^-\}^T, \\ &\qquad v_j^- = \min_i \{v_{ij}\}, \ j = 1, 2, \ldots, m. \end{aligned} \quad (14)$$

(4) Calculating the distance between the evaluated object and the positive and negative ideal:

Distance to ideal solution:

$$D_i^+ = \sqrt{\sum_{j=1}^{n} \left(v_j^+ - v_{ij}\right)^2}. \quad (15)$$

Distance to negative solution:

$$D_i^- = \sqrt{\sum_{j=1}^{n} \left(v_j^- - v_{ij}\right)^2}. \quad (16)$$

(5) Calculating the closeness of each evaluation index to the ideal solution:

$$C_i = \frac{D_i^-}{D_i^+ + D_i^-}, \quad 0 \leq C_i \leq 1. \quad (17)$$

(6) Determining the ranking of evaluation indexes according to C_i values.

3. Materials and Methods

Ten granite samples were selected from a stone sawing company and used as the workpiece for the experiments. Table 5 lists the main physical and mechanical properties of the stone workpiece. The rock properties were tested by a construction engineering quality test center in Shandong, China. A uniaxial compressive strength test was carried out using five 50-mm cubic specimens at a 0.6~0.4 Mpa/s constant loading rate according to GB/T 9966.1 Chinese

Figure 3: Sawing machine.

Standard. Next, the bending strength test was performed using five specimens with dimensions of 20 mm × 40 mm × 160 mm at a 0.2 Mpa/s loading rate according to GB/T 9966.2 Chinese Standard. The shore hardness test was conducted in accordance with GB/T 9966.5 Chinese Standard using five specimens with dimensions of 20 mm × 100 mm × 100 mm. The distance of the test point from the workpiece edge was greater than 10 mm. A density test was done in accordance with GB/T 9966.3 Chinese Standard using five 50-mm cubic specimens.

A diamond frame saw is typically used to cut large stone blocks (~2 m × 2 m × 2 m.). Figure 3 shows the sawing machines that can mount 60~120 blades. The stroke of a diamond frame saw is 600 mm. The flywheel speed is ~85 r/min, and the feed rate of the block table is 60 mm/h. The blade size is 4500 mm × 180 mm × 3.5 mm and the size of the diamond segments is 20 mm × 10 mm × 4.5 mm. The mesh of the diamond particles is 40/50, and the diamond concentration is 20.

4. FAHP–TOPSIS Evaluation of Sawability Using a Diamond Frame Saw to Cut Granite

4.1. Determining the Standardized Weight. SiO_2 (C_1), quartz (C_2), orthoclase (C_3), plagioclase (C_4), shore hardness (C_5), density (C_6), bending strength (C_7), and compression strength (C_8) were chosen as input parameters, and the diamond segment wear was predicted using a diamond frame saw to cut granite.

Twenty decision-makers evaluated the importance of these factors by completing a questionnaire. Seven of the respondents are stone industry professors, graduate students, or other scientific researchers. Seven respondents are granite plate production enterprise managers and workshop workers, and the rest are engineers or people who work in companies that manufacture stone processing equipment. To increase the reliability of the weight factors, each decision-maker scored the parameters according to Table 4. The pair-wise comparisons of the decision-makers' values are transformed in the fuzzy judgment matrix, as shown in Table 6.

The fuzzy comprehensive value was calculated according to (5), and the initial weights are shown in Table 7. According to (8) and (9), the final weight was determined and is presented in Table 8. The final weight was standardized, to obtain the normalized weight of the stone parameters.

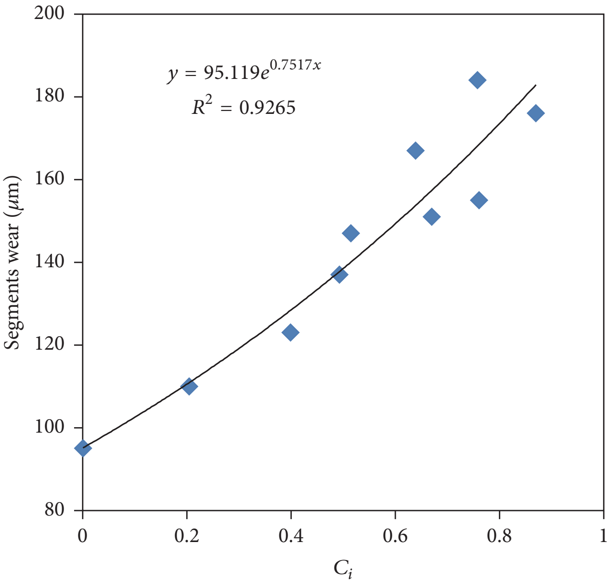

Figure 4: Graph of segment wear against C_i.

4.2. Ranking the Sawability. Because the values of C_1, C_3, C_4, and C_6 are zero, stone properties with nonzero values, including quartz (C_2), shore hardness (C_5), bending strength (C_7), and compression strength (C_8), were chosen to rank the sawability, as listed in Table 9.

First, normalization processing of the data was performed by application of (12), as listed in Table 10. Then, a normalized weighting matrix was constructed via (13), as listed in Table 11.

According to (14), the positive and negative ideal solutions are as follows:

$$\begin{aligned} A^{+} &= \{0.1386, 0.0274, 0.0849, 0.1703\}, \\ A^{+} &= \{0.0593, 0.0178, 0.0314, 0.0645\}. \end{aligned} \quad (18)$$

The evaluation results were determined by application of (15) and (16) and are shown in Table 12.

4.3. Experimental Results. Table 13 lists the experimental results of segment wear as measured by micrometer. A graph of segment wear against C_i was constructed, as shown in Figure 4. As segment wear increases, C_i increases. The determination coefficient ($R^2 = 0.9265$) illustrated that there

Table 6: Fuzzy judgment matrix.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
C_1	(1, 1, 1)	(0.2, 0.25, 0.33)	(1, 2, 3)	(2, 3, 4)	(0.33, 0.5, 1)	(3, 4, 5)	(0.25, 0.33, 0.5)	(0.17, 0.2, 0.25)
C_2	(3, 4, 5)	(1, 1, 1)	(4, 5, 6)	(5, 6, 7)	(2, 3, 4)	(6, 7, 8)	(1, 2, 3)	(0.33, 0.5, 1)
C_3	(0.33, 0.5, 1)	(0.17, 0.2, 0.25)	(1, 1, 1)	(1, 2, 3)	(0.25, 0.33, 1)	(2, 3, 4)	(0.2, 0.25, 0.33)	(0.14, 0.17, 0.2)
C_4	(0.25, 0.33, 0.5)	(0.14, 0.17, 0.2)	(0.33, 0.5, 1)	(1, 1, 1)	(0.2, 0.25, 0.33)	(1, 2, 3)	(0.17, 0.2, 0.25)	(0.13, 014, 0.17)
C_5	(1, 2, 3)	(0.25, 0.33, 17)	(2, 3, 4)	(3, 4, 5)	(1, 1, 1)	(4, 5, 6)	(0.33, 0.50, 1)	(0.2, 0.25, 0.33)
C_6	(0.2, 0.25, 0.33)	(0.13, 0.14, 0.17)	(0.25, 0.33, 0.5)	(0.33, 0.5, 1)	(0.17, 0.2, 025)	(1, 1, 1)	(0.14, 0.17, 0.2)	(0.11, 0.13, 0.14)
C_7	(2, 3, 4)	(0.33, 0.5, 1)	(3, 4, 5)	(4, 5, 6)	(1, 2, 3)	(5, 6, 7)	(1, 1, 1)	(0.25, 0.33, 0.5)
C_8	(4, 5, 6)	(1, 2, 3)	(5, 6, 7)	(6, 7, 8)	(3, 4, 5)	(7, 8, 9)	(2, 3, 4)	(1, 1, 1)

Table 7: Initial weight.

		l	m	n
C_1	SiO_2	0.0490	0.0878	0.1535
C_2	Quartz	0.1377	0.2219	0.3561
C_3	Orthoclase	0.0314	0.0580	0.1097
C_4	Plagioclase	0.0198	0.0358	0.0656
C_5	Shore hardness	0.0726	0.1252	0.2120
C_6	Density	0.0144	0.0212	0.0366
C_7	Bending strength	0.1022	0.1700	0.2798
C_8	Compression strength	0.1787	0.2802	0.4375

Table 8: Final weight and normalized weight.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
Final weight	0	0.7523	0	0	0.1764	0	0.4781	1
Normalized weight	0	0.3126	0	0	0.0733	0	0.1986	0.4155

Table 9: Stone parameter data.

Granite	Quartz (%) (C_2)	Shore hardness (HSD) (C_5)	Bending strength (MPa) (C_7)	Compression strength (MPa) (C_8)
G1	29.2	85	8.93	92.3
G2	40.3	102	15.1	165.9
G3	32.15	98.46	20.64	226.3
G4	28.7	111	14.8	162.5
G5	36	85.14	20.16	199.48
G6	26.7	115	17.06	168.29
G7	45.11	104	17.1	209.9
G8	25.2	90.5	12.8	153.8
G9	31.1	101	12.9	219.3
G10	19.3	75	7.63	85.69

Table 10: Normalized matrix.

Quartz (%) (C_2)	Shore hardness (HSD) (C_5)	Bending strength (MPa) (C_7)	Compression strength (MPa) (C_8)
0.2870	0.2758	0.1850	0.1672
0.3961	0.3310	0.3127	0.3004
0.3160	0.3195	0.4275	0.4098
0.2820	0.3602	0.3065	0.2943
0.3538	0.2763	0.4175	0.3612
0.2624	0.3732	0.3533	0.3048
0.4434	0.3375	0.3542	0.3801
0.2477	0.2937	0.2651	0.2785
0.3057	0.3278	0.2672	0.3971
0.1897	0.2434	0.1580	0.1552

was a high statistical correlation between segment wear and the C_i value. Thus, the prediction model of sawability is acceptable and reasonable using the FAHP and TOPSIS method. The regression equation of segment wear y and C_i value is as follows:

$$y = 95.119e^{0.7517x}. \tag{19}$$

5. Conclusions

A diamond frame saw is capable of mounting more than 60 blades, each 4500 mm in length. Twenty-six diamond segments are welded on each blade. Segment wear is directly related to the cutting performance and sawing cost, so an accurate prediction of the segment wear of a diamond frame saw would be beneficial to a stone sawing company.

Table 11: Weighting matrix.

Quartz (%) (C_2)	Shore hardness (HSD) (C_5)	Bending strength (MPa) (C_7)	Compression strength (MPa) (C_8)
0.0897	0.0202	0.0367	0.0695
0.1238	0.0243	0.0621	0.1248
0.0988	0.0234	0.0849	0.1703
0.0882	0.0264	0.0609	0.1223
0.1106	0.0203	0.0829	0.1501
0.0820	0.0274	0.0702	0.1266
0.1386	0.0247	0.0703	0.1579
0.0774	0.0215	0.0527	0.1157
0.0955	0.0240	0.0531	0.1650
0.0593	0.0178	0.0314	0.0645

Table 12: Evaluation results.

D^+	D^-	C_i	Ranking
0.1222	0.0314	0.2043	9
0.0530	0.0938	0.6387	5
0.0400	0.1251	0.7577	3
0.0737	0.0715	0.4927	7
0.0353	0.1124	0.7610	2
0.0729	0.0773	0.5145	6
0.0193	0.1288	0.8699	1
0.0883	0.0585	0.3985	8
0.0539	0.1092	0.6696	4
0.1430	0.0001	0.0007	10

Table 13: Experimental results of segment wear (μm).

Stones	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10
Wear (μm)	110	167	184	137	155	147	176	123	151	95

The predicted segment wear of granite was studied using FAHP and TOPSIS mathematical methods. FAHP is utilized to determine the weight of factors, and TOPSIS is used to rank the sawability. For validation of the employed ranking method, a sawing experiment was conducted and diamond segment wear was measured and was used as the evaluation criterion. A prediction mathematical model of C_i and segment wear was established, and the analysis showed that these two values showed a high statistical correlation. Overall, this ranking method is reasonable and acceptable for evaluating segment wear at a stone sawing company using a diamond frame saw to cut a large granite block (2 m × 2 m × 2 m). Segment wear of a diamond frame saw can be determined based on rock properties, such as quartz, shore hardness, bending strength, and compression strength.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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