

RESEARCH ARTICLE

OPEN ACCESS

APPLICATION OF TOPSIS METHOD FRAME THE RANKING OF EXPERIMENT BASED ON EPOXY CONCRETE

Amit C Gohil¹, Hardik G. Chothani^{2*}

¹Research scholar, Gujarat Technological University, Ahmedabad, Gujarat-India.

¹Assistant Professor, Mechanical Engineering Department, Government Engineering College Bhavnagar, Gujarat, India.

²Associate Professor, Mechanical Engineering Department, Government Engineering College Bhavnagar, Gujarat, India.

¹<https://orcid.org/0000-0001-8671-6189> , ²<https://orcid.org/0000-0003-2773-4365> 

E-mail* chothanihardik@gmail.com.

ARTICLE INFO

Article History

Received: February 07, 2026

Reviewed: March 07, 2026

Accepted: March 10, 2026

Published: June 30, 2026

Keywords:

Epoxy concrete, TOPSIS,
Compressive strength,
Flexural strength
Multi-response optimization

ABSTRACT

Its new era of manufacturing where machine tool assembled using new alternate material epoxy concrete to develop mechanical properties in newly developed machine tool structure. An issue related to optimization involving numerous features presents a considerable challenge in determining the optimal solution, due to the varied characteristics inherent among the attributes. A total of 25 distinct experimental trials were conducted, analyzing five specific attributes: resin quantity, aggregate size, sand percentage, shaking duration, and curing duration. This research presents a methodical framework for parameter selection. The TOPSIS method has been employed to convert various responses into a single preference number, referred to as the Multi-Performance Characteristic Index. The ideal machining parameters are determined utilizing the Technique for Order Preference by Similarity to Ideal Solution method. The analysis conducted using the TOPSIS method indicates that experimental run 21 represents the optimal solution, characterized by the ideal machining conditions of amount of resin 20%; size of aggregate 0.75 mm, 25% percentage of sand, shaking time 20 minute and curing time 18 hours



Copyright ©2026 by authors and Galileo Institute of Technology and Education of the Amazon (ITEGAM). This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

I. INTRODUCTION

Epoxy granite composites are increasingly significant in the machine tool industry, supplanting traditional cast iron materials because of their reduced weight and superior mechanical characteristics. [1] In real life, a product or process typically comprises several conflicting responses, and the Taguchi method does not effectively address this multi-response optimization challenge. It is essential to determine an equivalent aggregated index through the systematic accumulation of various responses, which can be ultimately enhanced through the application of Taguchi method. [2] Arunramnath R, 'Multi-attribute decision-making methods are utilized in various research studies to assist individuals in identifying best alternative from a constrained selection of options. [3] Khashayar Jafari, 'Discusses the advantages of PC in relation to cement concrete include its superior compressive, flexural, and tensile strengths, rapid curing process, reduced permeability, and enhanced corrosion resistance [4] Shanmugam Chinnuraj, 'The characteristics of strength of the developed material are inferior to those exhibited by traditional materials.

Machined tool structures are designed to attain stiffness levels that are equal to or exceed those of cast iron structures. This is accomplished through the application of form design principles and the integration of reinforcements utilizing materials with a high elastic modulus, including structural steel, carbon, and glass fibers. [5] An essential consideration for the formulation of permeable concrete mixes is achieve the optimal equilibrium for compressive strength and porosity. Enhanced porosity improves permeability; however, it simultaneously reduces compressive strength. [6], [7]. Pengfei Cao, 'The findings indicate that gradation of aggregate is the primary factor influencing porosity, damping ratio, and compressive strength, while the particle size range significantly affects flexural strength. The best parameter combination, which includes an aggregate scattering modulus of 0.45, an integrated content of 83%, and a particle size range of 0.117–9.5 mm, led to the PC demonstrating superior overall performance.

This performance is characterized by the smallest porosity and markedly enhanced static as well as dynamic mechanical attributes.[8] M. Amudha, 'TOPSIS facilitates the automation of the selection process, addressing ambiguity and uncertainty effectively. This can also serve the purpose of relocation. The optimal solution is physics, which is directly connected to the properties of pure elements. A homogeneous mixture consists of substances that exhibit uniform properties throughout.[9] Wirachchaya Chanpuypetch, 'This study provides actionable insights for the countryside and those interested in economic decisions tree initiatives facilitate the customization of decision-making criteria and options specific to distinct contexts. [10] Daryl Anne B, 'The Energy Plan 2023–2050 outlines a pioneering application of machine learning-driven multi-criteria decision analysis of marine renewable resources within a developing archipelagic framework. The findings provide actionable insights for decision-makers and engineers concerning eco-friendly innovations alternatives for initial implementation in the Philippines' renewable microgrid transition.[11] Qingyang Han, 'This paper presents a multi-indicator assessment model based on TOPSIS, utilizing the entropy weighting process to evaluate potential sites for the conversion of coastal coal-fired power plants in China to nuclear technology.[12] Ibrahim Sabry a, 'This study presents a hybrid multi-objective optimization framework that integrates enhance the optimization of friction stir welding parameters for AA6063-T6 aluminium alloy. [13] In standard complex decision-making approaches, the weights assigned to properties

Evaluate the relative significance in the procedure for making choices. The assessment of the criteria varies. In weighing methods, there exist two categories: subjective methods and objective methods.[14] Jitendra Kumar, 'used the TOPSIS methodology to improve the quality of the surface finish by optimizing the cutting settings for face milling in titanium alloy.[15] Conducted an analysis of the manufacturing characteristics of alloys composed of different material like AL CU, and steel utilizing the TOPSIS method. Practically used methodology facilitates the selection of a specific alloy that is conducive to machining for manufacturers. [16] G. Sakthivel, 'Paper presents a novel perspective on MCDM techniques for assessing the optimal fuel combine for decision-makers, including product manufacturers and R&D engineers worked to meet fuel efficiency and pollution standards to help the environment resolution.[17] Garima Joshi, 'The results demonstrate that the combined TOPSIS-Taguchi approach effectively identifies the best variable set for attaining enhanced performance in general. The parameter values selected for the acquired ISL complex background dataset are then applied to generate multiple-level HOG results.[18]

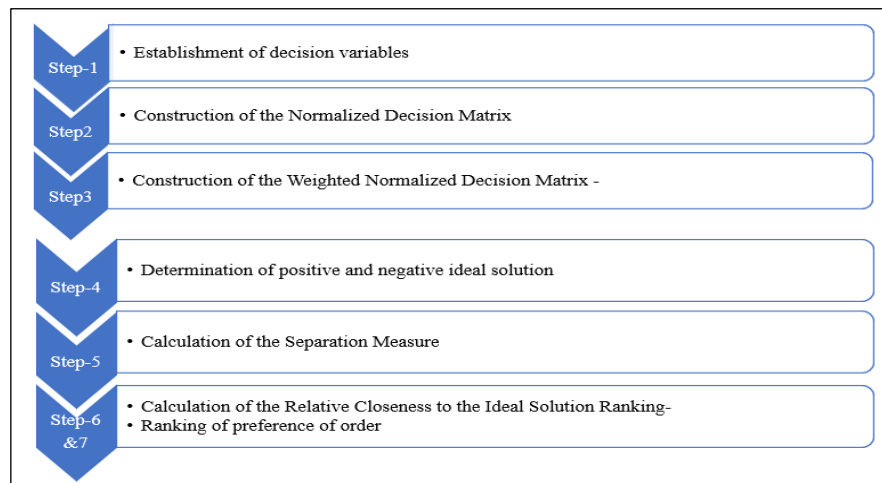


Figure 1. Detailing the sequential process of the TOPSIS.

Source: [19].

Table 1: Scale for assessing relative importance intensity [20].

Magnitude of Relative Significance	Definition	Explanation
I	Equal event importance	Two events provide equal contributions to objective 1.
III	Medium importance of one over other	Experience and judgment indicate a preference for one activity over another.
V	Essential or strong importance	Analysis and evaluation distinctly indicate a preference for one activity over the other.
VII	Demonstrated importance	An event is highly preferred, and its superiority is evidenced through practical application.
IX	Extreme importance	The evidence supporting one event over another is of the utmost reliability and confirmation.
II, IV, VI, VIII	Values that exist between the two neighboring assessments	When a resolution is required.
Reciprocals of the aforementioned nonzero values	Reciprocal for inverse comparison	

Source: Authors, (2026).

II MATERIAL AND METHODS.

Composite developed by using epoxy resin, sand and concrete by casting route method. Composite prepared for the required compressive strength of the dimension ($50 \times 50 \times 50$ mm) and flexural strength of the dimension ($250 \times 25 \times 25$ mm) fabricated in open mould. Concrete crushed and sieve as per the required size. Specimen prepared and test for mechanical properties. This property enhances for the lathe bed structure. Figure 2.a) and b), shows the dimension of specimen. In this research composite prepared considered on the basis five factor and five level which mention in Table 2. Table 3 shows l25 to run the experiment and shows output response.

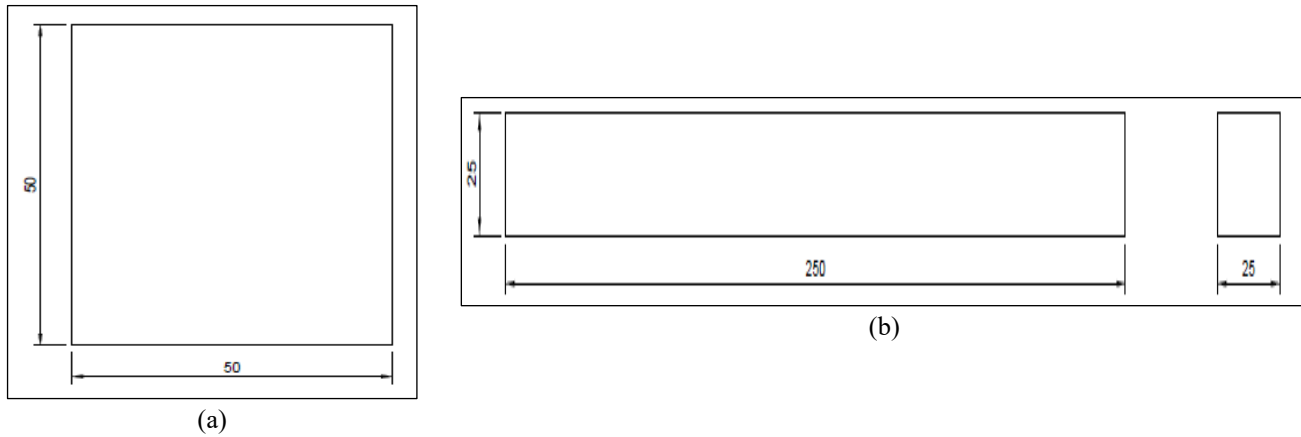


Figure 2. a) mould for compressive strength b) mould for flexural strength.

Source: Authors, (2026).

Table 2: Selected Process parameter and level for experimental run.

Parameters	Level 1	Level 2	Level 3	Level 4	Level 5
Epoxy resin percentage	12 %	14 %	16%	18%	20%
Size of aggregate	0.75mm	1mm	2mm	4mm	5mm
Percentage of sand	5%	10%	15%	20%	25%
Shaking time	5min	10min	15min	20min	25min
Curing time	6hr	12hr	18hr	24hr	30hr

Source: Authors, (2026).

Table 3: L25 run for the experiment.

Experiment run	Amount of resin	Size of Aggregate	Percentage of sand	Shaking time	Curing Time	Compressive strength	Flexural strength
1	12%	0.75mm	5%	5mn	6h	53.96	46.80
2	12%	1mm	10%	10mn	12h	35.21	32.45
3	12%	2mm	15%	15mn	18h	22.72	29.80
4	12%	4mm	20%	20mn	24h	32.40	28.48
5	12%	5mm	25%	25mn	30h	51.96	57.41
6	14%	0.75mm	10%	15mn	24h	52.19	48.35
7	14%	1mm	15%	20mn	30h	45.56	29.58
8	14%	2mm	20%	25mn	6h	44.09	48.79
9	14%	4mm	25%	5mn	12h	39.00	44.82
10	14%	5mm	5%	10mn	18h	28.94	37.54
11	16%	0.75mm	15%	25mn	12h	46.05	57.40
12	16%	1mm	20%	5mn	18h	37.97	50.34
13	16%	2mm	25%	10mn	24h	51.58	39.96
14	16%	4mm	5%	15mn	30h	20.47	35.77
15	16%	5mm	10%	20mn	6h	40.87	46.80
16	18%	0.75mm	20%	10mn	30h	50.33	52.99
17	18%	1mm	25%	15mn	6h	39.80	39.30

18	18%	2mm	5%	20mn	12h	33.14	43.27
19	18%	4mm	10%	25mn	18h	46.05	64.03
20	18%	5mm	15%	5mn	24h	55.46	60.05
21	20%	0.75mm	25%	20mn	18h	65.88	72.86
22	20%	1mm	5%	25mn	24h	44.59	54.56
23	20%	2mm	10%	5mn	30h	54.98	52.99
24	20%	4mm	15%	10mn	6h	38.00	39.74
25	20%	5mm	20%	15mn	12h	48.56	27.82

Source: Authors, (2026).

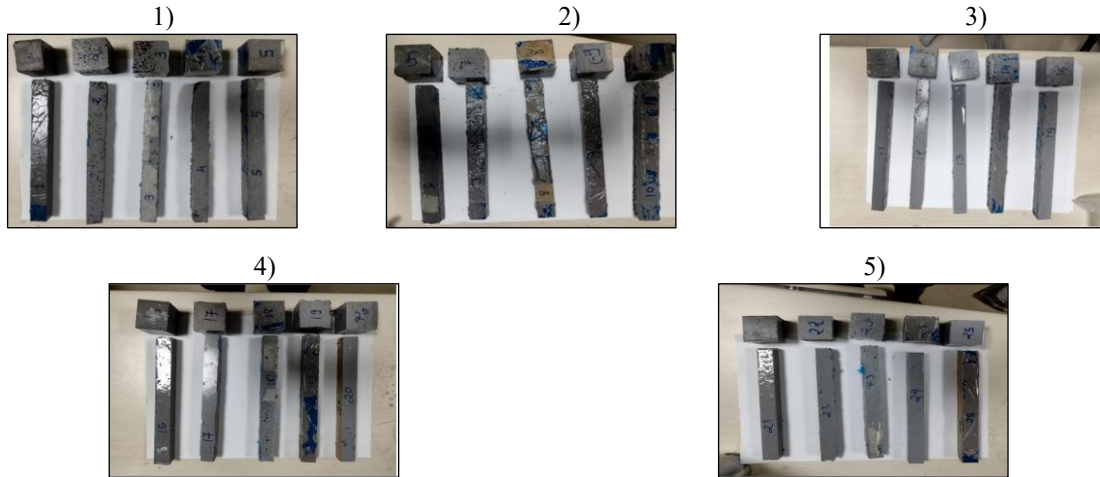


Figure 3. Sample of specimen prepared for testing.
Source: Authors, (2026).

II.1 MULTI-OBJECTIVE OPTIMIZATION METHODS.

MADM are employed numerous research articles to aid decision makers in pinpointing the best alternatives from a constrained selection of options. Taguchi's approach to the design of experiments and optimization is centered solely on addressing and enhancing single response issues. In situations where various responses are evaluated for an industrial application or research study, Taguchi's method fails to provide a reliable solution. Taguchi's method is not suitable for solving optimization problems that involve different results responses exhibiting contradictory attributes. Taguchi's method achieves optimal solutions through the application of Analysis of Variance and the Signal to Noise ratio. The ANOVA results demonstrate the degree of significance or impact that process parameters (input variables) have on every result response. The effect percentage of every variable that is input can be determined using the results obtained from ANOVA.[1] This work presents two responses: compressive strength and flexural strength. For both responses, a higher value indicates a more favorable outcome.

Step 1: The decision matrix serves as the initial phase in the TOPSIS methodology, each experiment (25) to be consider as alternative and two strengths as attribute. Where CS1 to CS25 are compressive strength from 1 to 25. same as FS1 to FS25 are flexural strength for 1 to 25 experiments.

$$Dm = \begin{bmatrix} CS_1 & FS_1 \\ CS_2 & FS_2 \\ \vdots & \vdots \\ CS_{25} & FS_{25} \end{bmatrix} \quad (1)$$

Step 2: The normalization matrix can be expressed using the given equation.

$$r_{ij} = \frac{a_{ij}}{\sqrt{\sum_{i=1}^{25} a_{ij}^2}} \quad (2)$$

Where, i = alternative with respect to the attribute j = attribute to the alternative.

a_{ij} = Place the value of compressive strength and flexural strength.

Table 4: Normalization decision matrix.

Experiment run	Compressive strength	CS^2	r_{ij}	Flexural strength	FS^2	r_{ij}
1	53.96	2911.68	0.24	46.80	2190.24	0.20
2	35.21	1239.46	0.16	32.45	1053.00	0.14
3	22.72	516.20	0.10	29.80	888.04	0.13
4	32.40	1050.02	0.15	28.48	811.11	0.12
5	51.96	2699.84	0.23	57.41	3295.68	0.25
6	52.19	2723.59	0.23	48.35	2337.72	0.21
7	45.56	2076.08	0.21	29.58	874.98	0.13
8	44.09	1943.93	0.20	48.79	2380.46	0.21
9	39.00	1520.69	0.18	44.82	2008.83	0.19
10	28.94	837.64	0.13	37.54	1408.95	0.16
11	46.05	2120.42	0.21	57.40	3294.76	0.25
12	37.97	1441.42	0.17	50.34	2534.12	0.22
13	51.58	2660.91	0.23	39.96	1596.80	0.17
14	20.47	419.18	0.09	35.77	1279.42	0.15
15	40.87	1670.52	0.18	46.80	2190.24	0.20
16	50.33	2533.11	0.23	52.99	2807.94	0.23
17	39.80	1584.36	0.18	39.30	1544.49	0.17
18	33.14	1097.99	0.15	43.27	1872.29	0.18
19	46.05	2120.60	0.21	64.03	4100.10	0.27
20	55.46	3076.26	0.25	72.86	5308.58	0.31
21	65.88	4340.17	0.30	60.05	3606.00	0.26
22	44.59	1988.09	0.20	48.50	2352.25	0.21
23	54.98	3022.58	0.25	52.99	2808.15	0.23
24	38.00	1444.00	0.17	39.74	1579.59	0.17
25	48.56	2357.88	0.22	27.82	773.95	0.12
	$\sum_{i=1}^{25} x_{ij}^2$	49396.62		$\sum_{i=1}^{25} x_{ij}^2$	54897.70	
	$\sqrt{\sum_{i=1}^{25} x_{ij}^2}$	222.25		$\sqrt{\sum_{i=1}^{25} x_{ij}^2}$	234.02	

Source: Authors, (2026).

Step:3

Weight of each response or attribute considered as w_j where $j = 1, 2$ here no priority so equal weight practice assumed. $w_1 = w_2 = 0.5$ [20].

w_1 =weight for compressive strength

w_2 =weight for flexural strength

The weighted normalize equation return as $v_{ij} = w_j \times r_{ij}$ (3)

Table 5. Weighted normalize equation.

Experiment run	Compressive strength	r_{ij}	$v_{ij} = w_j \times r_{ij}$	Flexural strength	r_{ij}	$v_{ij} = w_j \times r_{ij}$
1	53.96	0.24	0.1214	46.80	0.20	0.09999
2	35.21	0.16	0.0792	32.45	0.14	0.06933
3	22.72	0.10	0.0511	29.80	0.13	0.06367
4	32.40	0.15	0.0729	28.48	0.12	0.06085
5	51.96	0.23	0.1169	57.41	0.25	0.12266

6	52.19	0.23	0.1174	48.35	0.21	0.10330
7	45.56	0.21	0.1025	29.58	0.13	0.06320
8	44.09	0.20	0.0992	48.79	0.21	0.10424
9	39.00	0.18	0.0877	44.82	0.19	0.09576
10	28.94	0.13	0.0651	37.54	0.16	0.08020
11	46.05	0.21	0.1036	57.40	0.25	0.12264
12	37.97	0.17	0.0854	50.34	0.22	0.10755
13	51.58	0.23	0.1160	39.96	0.17	0.08538
14	20.47	0.09	0.0461	35.77	0.15	0.07642
15	40.87	0.18	0.0919	46.80	0.20	0.09999
16	50.33	0.23	0.1132	52.99	0.23	0.11322
17	39.80	0.18	0.0895	39.30	0.17	0.08397
18	33.14	0.15	0.0745	43.27	0.18	0.09245
19	46.05	0.21	0.1036	64.03	0.27	0.13681
20	55.46	0.25	0.1248	72.86	0.31	0.15567
21	65.88	0.30	0.1482	60.05	0.26	0.12830
22	44.59	0.20	0.1003	48.50	0.21	0.10362
23	54.98	0.25	0.1237	52.99	0.23	0.11322
24	38.00	0.17	0.0855	39.74	0.17	0.08492
25	48.56	0.22	0.1092	27.82	0.12	0.05944

Source: Authors, (2026).

Step:4 Positive Ideal best Solution and Negative Ideal worst Solution.

Positive Ideal best Solution :

$$V^+ = (\max v_{i1}, \max v_{i2}), V^+ = (0.1482, 0.15567),$$

Negative Ideal worst Solution:

$$V^- = (\min v_{i1}, \min v_{i2}), V^- = (0.0511, 0.05944),$$

Step:5 Determine the separation metric for each row.

$$S_i^+ = \sqrt{\sum (v_{ij} - V_j^+)^2} \quad (4)$$

Table 6. Separation metrics for Positive Ideal Solution (Best):

Experiment run	Vij FOR CS	Vij FOR FS	$\sum (v_{ij} - V_j^+)$ For CS Eq (1)	$\sum (v_{ij} - V_j^+)^2$ Eq (2)	$\sum (v_{ij} - V_j^+)$ For FS Eq (3)	$\sum (v_{ij} - V_j^+)^2$ Eq (4)	EQ (2) + EQ (4)	$S_i^+ = \sqrt{\sum (v_{ij} - V_j^+)^2}$
1	0.1214	0.0999 9	-0.029	0.0008	-0.06	0.0036	0.0044	0.06647815
2	0.0792	0.0693 3	-0.071	0.0050	-0.09	0.0082	0.0132	0.11503467
3	0.0511	0.0636 7	-0.099	0.0098	-0.10	0.0093	0.0191	0.13805116
4	0.0729	0.0608 5	-0.077	0.0059	-0.10	0.0098	0.0158	0.12559996
5	0.1169	0.1226 6	-0.033	0.0011	-0.04	0.0014	0.0025	0.04990537
6	0.1174	0.1033 0	-0.033	0.0011	-0.06	0.0032	0.0043	0.0653974
7	0.1025	0.0632 0	-0.047	0.0023	-0.10	0.0094	0.0116	0.10782413
8	0.0992	0.1042 4	-0.051	0.0026	-0.06	0.0031	0.0057	0.07543576

9	0.0877	0.0957 6	-0.062	0.0039	-0.06	0.0041	0.0080	0.0894667
10	0.0651	0.0802 0	-0.085	0.0072	-0.08	0.0064	0.0136	0.11650964
11	0.1036	0.1226 4	-0.046	0.0022	-0.04	0.0014	0.0035	0.05957637
12	0.0854	0.1075 5	-0.065	0.0042	-0.05	0.0028	0.0069	0.0831991
13	0.1160	0.0853 8	-0.034	0.0012	-0.07	0.0056	0.0067	0.08198324
14	0.0461	0.0764 2	-0.104	0.0108	-0.08	0.0070	0.0178	0.13337383
15	0.0919	0.0999 9	-0.058	0.0034	-0.06	0.0036	0.0070	0.08349171
16	0.1132	0.1132 2	-0.037	0.0014	-0.05	0.0022	0.0035	0.05950542
17	0.0895	0.0839 7	-0.060	0.0037	-0.08	0.0058	0.0094	0.09713678
18	0.0745	0.0924 5	-0.075	0.0057	-0.07	0.0046	0.0103	0.10127385
19	0.1036	0.1368 1	-0.046	0.0022	-0.02	0.0005	0.0027	0.05187407
20	0.1248	0.1556 7	-0.025	0.0006	0.00	0.0000	0.0007	0.02559161
21	0.1482	0.1283 0	-0.002	0.0000	-0.03	0.0010	0.0010	0.03174949
22	0.1003	0.1036 2	-0.050	0.0025	-0.06	0.0032	0.0056	0.07514942
23	0.1237	0.1132 2	-0.026	0.0007	-0.05	0.0022	0.0029	0.0536731
24	0.0855	0.0849 2	-0.065	0.0042	-0.08	0.0056	0.0098	0.09899173
25	0.1092	0.0594 4	-0.041	0.0017	-0.10	0.0101	0.0118	0.10850691
V^+	0.1482	0.1556 7						
V^-	0.0511	0.0594 4						

Source: Authors, (2026).

$$S_i^- = \sqrt{\sum (v_{ij} - V_j^-)^2} \quad (5)$$

Table 7. Separation measure for Negative Ideal Solution (Best):

Experiment run	Vij FOR CS	Vij FOR FS	$\sum (v_{ij} - V_j^-)^2$ For cs Eq (1)	$\sum (v_{ij} - V_j^-)^2$ Eq (2)	$\sum (v_{ij} - V_j^-)^2$ For FS eq (3)	$\sum (v_{ij} - V_j^-)^2$ Eq (4)	EQ (2) +EQ (4)	$S_i^- = \sqrt{\sum (v_{ij} - V_j^-)^2}$
1	0.1214	0.09999	0.0714	0.0051	0.0400	0.0016	0.0067	0.0818
2	0.0792	0.06933	0.0292	0.0009	0.0093	0.0001	0.0009	0.0307
3	0.0511	0.06367	0.0011	0.0000	0.0037	0.0000	0.0000	0.0038
4	0.0729	0.06085	0.0229	0.0005	0.0008	0.0000	0.0005	0.0229
5	0.1169	0.12266	0.0669	0.0045	0.0627	0.0039	0.0084	0.0917
6	0.1174	0.10330	0.0674	0.0045	0.0433	0.0019	0.0064	0.0801
7	0.1025	0.06320	0.0525	0.0028	0.0032	0.0000	0.0028	0.0526
8	0.0992	0.10424	0.0492	0.0024	0.0442	0.0020	0.0044	0.0662
9	0.0877	0.09576	0.0377	0.0014	0.0358	0.0013	0.0027	0.0520
10	0.0651	0.08020	0.0151	0.0002	0.0202	0.0004	0.0006	0.0252

11	0.1036	0.12264	0.0536	0.0029	0.0626	0.0039	0.0068	0.0824
12	0.0854	0.10755	0.0354	0.0013	0.0476	0.0023	0.0035	0.0593
13	0.1160	0.08538	0.0660	0.0044	0.0254	0.0006	0.0050	0.0708
14	0.0461	0.07642	-0.0039	0.0000	0.0164	0.0003	0.0003	0.0169
15	0.0919	0.09999	0.0419	0.0018	0.0400	0.0016	0.0034	0.0580
16	0.1132	0.11322	0.0632	0.0040	0.0532	0.0028	0.0068	0.0826
17	0.0895	0.08397	0.0395	0.0016	0.0240	0.0006	0.0021	0.0462
18	0.0745	0.09245	0.0245	0.0006	0.0324	0.0011	0.0017	0.0407
19	0.1036	0.13681	0.0536	0.0029	0.0768	0.0059	0.0088	0.0937
20	0.1248	0.15567	0.0748	0.0056	0.0957	0.0092	0.0147	0.1214
21	0.1482	0.12830	0.0982	0.0096	0.0683	0.0047	0.0143	0.1196
22	0.1003	0.10362	0.0503	0.0025	0.0436	0.0019	0.0044	0.0666
23	0.1237	0.11322	0.0737	0.0054	0.0532	0.0028	0.0083	0.0909
24	0.0855	0.08492	0.0355	0.0013	0.0249	0.0006	0.0019	0.0434
25	0.1092	0.05944	0.0592	0.0035	-0.0006	0.0000	0.0035	0.0592
V^+	0.1482	0.15567						
V^-	0.0511	0.05944						

Source:Authors, (2026).

Step 6: Closeness coefficient or the calculation of the relative proximity of the distinct alternative to the positive ideal solution is presented as follows:

$$C_i = \frac{S_i^-}{S_i^+ + S_i^-}$$

Table 8. Closeness coefficient or Relative nearness.

Experiment run	S_i^-	S_i^+	$S_i^+ + S_i^-$	$C_i = \frac{S_i^-}{S_i^+ + S_i^-}$ preference value	Preference value higher is better	Rank Order
1	0.0818	0.066478	0.148278	0.551666	0.825897	21
2	0.0307	0.115035	0.145735	0.210657	0.790224	20
3	0.0038	0.138051	0.141851	0.026789	0.647574	5
4	0.0229	0.1256	0.1485	0.154209	0.643659	19
5	0.0917	0.049905	0.141605	0.647574	0.628748	23
6	0.0801	0.065397	0.145497	0.550525	0.581259	16
7	0.0526	0.107824	0.160424	0.327881	0.580378	11
8	0.0662	0.075436	0.141636	0.467396	0.551666	1
9	0.052	0.089467	0.141467	0.367578	0.550525	6
10	0.0252	0.11651	0.14171	0.177828	0.469843	22
11	0.0824	0.059576	0.141976	0.580378	0.467396	8
12	0.0593	0.083199	0.142499	0.416143	0.463402	13
13	0.0708	0.081983	0.152783	0.463402	0.416143	12
14	0.0169	0.133374	0.150274	0.112461	0.409918	15
15	0.058	0.083492	0.141492	0.409918	0.367578	9
16	0.0826	0.059505	0.142105	0.581259	0.352997	25
17	0.0462	0.097137	0.143337	0.322318	0.327881	7
18	0.0407	0.101274	0.141974	0.286673	0.322318	17
19	0.0937	0.051874	0.145574	0.643659	0.304793	24
20	0.1214	0.025592	0.146992	0.790224	0.286673	18
21	0.1196	0.031749	0.151349	0.825897	0.210657	2
22	0.0666	0.075149	0.141749	0.469843	0.177828	10

23	0.0909	0.053673	0.144573	0.628748	0.154209	4
24	0.0434	0.098992	0.142392	0.304793	0.112461	14
25	0.0592	0.108507	0.167707	0.352997	0.026789	3

Source: Authors, (2026).

Step 7: Final ranking

The final ranking indicates that the most preferable solution, where a higher value is deemed better, is identified in experiment 21, which exhibits the highest closeness coefficient compared to the other experiments listed in the table above. $21 > 20 > 5 > 19 > 23 > 16 > 11 > 1 > 6 > 22 > 8 > 13 > 12 > 15 > 9 > 25 > 7 > 17 > 24 > 18 > 2 > 10 > 4 > 14 > 3$.

III RESULT AND DISCUSSION.

III.1.1 Result of Topsis

TOPSIS study reveals that experimental trial 21 is the optimal combination with highest preference order. Preference order of different alternatives ranked in descending order is presented $21 > 20 > 5 > 19 > 23 > 16 > 11 > 1 > 6 > 22 > 8 > 13 > 12 > 15 > 9 > 25 > 7 > 17 > 24 > 18 > 2 > 10 > 4 > 14 > 3$. Hence, to achieve the desired solution, the experimental run is the most optimal setting for the compressive strength and flexural strength followed by experimental runs 21. Optimal condition of with 20% resin, 0.75mm aggregate size, 25% sand, 5 minutes of shaking, and 18 hours of curing period.

III.1.2 Effect Of Various Parameter Om Compressive Strength.

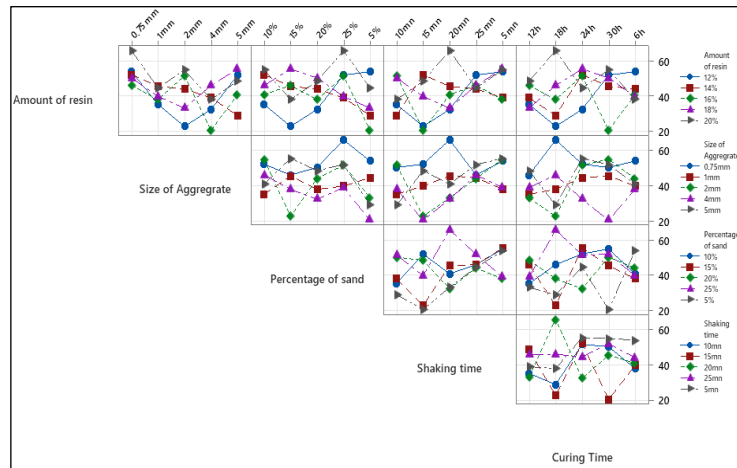


Figure 4. Interaction plots for compressive strength.

Source: Authors, (2026).

From the Minitab software by doing ANOVA analysis, it gives interaction plot for the effect amount of resin, size of aggregate, percentage of sand, shaking time and curing time on compressive strength. Interaction plot shows the effect of parameter amount of resin, size of aggregate, percentage of sand, shaking time and curing time on compressive strength. From the observation show that not parallel and connecting lines in the majority of graphs suggest significant interaction effects, indicating that compressive strength is affected by the combined impact of processing and material parameters, rather than by isolated factors alone. The figure 4 shows the highly significance of parameter on the compressive strength. Compressive strength increases as the percentage of resin increase from 16 to 20% and size of aggregate from 0.75 mm to 2 mm. The plot indicate that percentage of sand have good impact on compressive strength. As the sand percentage increase the from 15 to 25% it increases the strength. This plot shows as the shaking duration increases from 15 minute to 25 minute it gives good result of strength. And in create void free compactness in prepared specimen. For curing time from 24 hours and 30 hours it produces the good compressive strength.

III.1.3 Effect of various parameter om flexural strength.

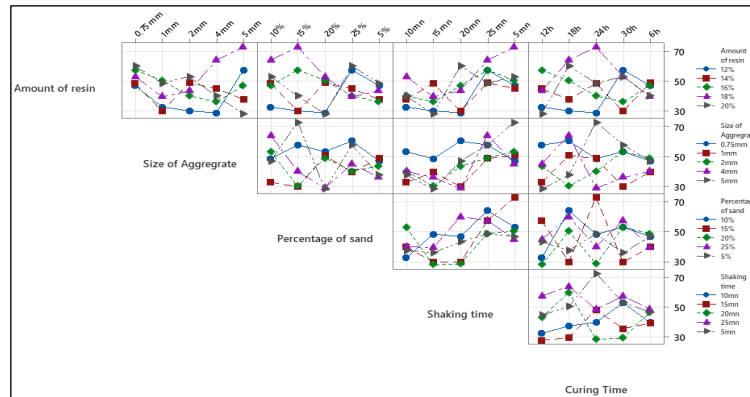


Figure 5. Combine interaction plots for flexural strength.

Source: Authors, (2026).

It observed from above figure 5 it shows the impact of parameter on the three-point bending or flexural strength. It shows that highly influence of parameter respectively amount of resin, size of aggregate, percentage of sand, shaking time and curing time on flexural strength. From the figure as the percentage of resin increases from 16 to 20% it increases the flexural strength because it gives good bonding characteristics between the material. The size aggregate vary from 0.75 mm to 5 mm for the smaller size from 0.75 to 2 mm it produces the impact on flexural strength and the prepared specimen highly dense. Percentage of sand from 15 to 25 % it places inside the porous gap of mixture pouring inside the mould and make a specimen with highly flexural strength. Same way shaking time from 15 to 25-minute increases it will proper vibrate because of more shaking time it developed good flexural strength. Curing time at 18 to 24 hours it produces good strength in specimen.

IV. CONCLUSIONS

This work, presents main focus on the obtaining of suitable parameter for the compressive and flexural strength of epoxy concrete specimen prepared by using TOPSIS method. With the help of TOPSIS method define the ranking of run experiment and best experiment among the L25. And make a comparison of the result of TOPSIS and Taguchi method. Best suitable solutions obtained by Taguchi method which provide five different combinations of process parameters for Compressive strength. Optimal condition of with 20% resin, 0.75mm aggregate size, 25% sand, 5 minutes of shaking, and 18 hours of curing period. Optimal solutions found by Taguchi method provide five different combinations of process parameters for Flexural strength. Optimal condition with 18% resin, 0.75mm aggregate size, 25% sand, 5 minutes of shaking, and 18 hours of curing period. By studying TOPSIS methodology, the suitable development bed structure from the mechanical properties of material condition selected by its closeness to ideal solution achieve in experiment number 21 which have parameter amount of resin 20%, size of aggregate 0.75mm, percentage of sand 25%, shaking time 20 minute and curing time for 18 hours.

V. AUTHOR'S CONTRIBUTION

Conceptualization: Amit C Gohil, Hardik G. Chothani.

Methodology: Amit C Gohil, Hardik G. Chothani.

Investigation: Amit C Gohil, Hardik G. Chothani.

Discussion of results: Amit C Gohil, Hardik G. Chothani.

Writing – Original Draft: Amit C Gohil.

Writing – Review and Editing: Amit C Gohil, Hardik G. Chothani.

Resources: Hardik G. Chothani.

Supervision: Hardik G. Chothani.

Approval of the final text: Amit C Gohil, Hardik G. Chothani.

VI. REFERENCES

- [1] R. Arunramnath, P. R. Thyla, N. Mahendrakumar, M. Ramesh, and A. Siddeshwaran, Multi-attribute optimization of end milling epoxy granite composites using TOPSIS. *Mater. Manuf. Process.*, vol. 34, no. 5, pp. 530–543, 2019, doi: 10.1080/10426914.2019.1566960.
- [2] A. Singh, S. Datta, and S. S. Mahapatra, Application of TOPSIS in the Taguchi Method for Optimal Machining Parameter Selection. *J. Manuf. Sci. Prod.*, vol. 11, no. 1–3, pp. 49–60, 2012, doi: 10.1515/jmsp.2011.002.
- [3] R. Arun Ramnath, P. R. Thyla, and A. K. R. Harishsharran, Machining parameter selection in milling epoxy granite composites based on AHP. *Mater. Today Proc.*, vol. 42, no. xxxx, pp. 319–324, 2020, doi: 10.1016/j.matpr.2020.09.340.
- [4] K. Jafari, M. Tabatabaeian, A. Joshaghani, and T. Ozbakkaloglu, Optimizing the mixture design of polymer concrete: An experimental investigation. *Constr. Build. Mater.*, vol. 167, pp. 185–196, 2018, doi: 10.1016/j.conbuildmat.2018.01.191.
- [5] S. Chinnuraj and T. P. Ramaswamy, Optimization of Process Parameters of Epoxy Granite for Strength and Damping Characteristics Using TOPSIS Method. *J. Test. Eval.*, 2019, doi: 10.1520/JTE20190002.
- [6] C. Sánchez-Mendieta, J. J. Galán-Díaz, and I. Martínez-Lage, Relationships between density, porosity, compressive strength and permeability in porous concretes: Optimization of properties through control of the water-cement ratio and aggregate type. *J. Build. Eng.*, vol. 97, no. September, pp. 1–11, 2024, doi: 10.1016/j.jobbe.2024.110858.

- [7] B. A.-H. 3 Hussein J. Almansori1, Adnan Al-Sibahy*2, Mechanical strength and hydraulic properties of modified porous concrete mixtures Mechanical strength and hydraulic properties of modified porous concrete mixtures. J. Phys. Conf. Ser. Pap., vol. 2, no. 2nd International Conference for Civil Engineering Science (ICCES 2021), pp. 1–10, 2021, doi: 10.1088/1742-6596/1895/1/012027.
- [8] P. Cao, G. Liang, X. Chai, Q. Liu, and M. Lv, Effects of aggregate gradation, content, and size range on the mechanical and damping properties of polymer concrete for precision machine tool beds. Constr. Build. Mater., vol. 491, no. December 2024, p. 142834, 2025, doi: 10.1016/j.conbuildmat.2025.142834.
- [9] M. Amudha, M. Ramachandran, V. Saravanan, P. Anusuya, and R. Gayathri, A Study on TOPSIS MCDM Techniques and Its Application. Data Anal. Artif. Intell., vol. 1, no. 1, pp. 9–14, 2021, doi: 10.46632/daai/1/1/2.
- [10] W. Chanpuypetch, J. Niemsakul, and W. Atthirawong, An integrated AHP-TOPSIS approach for bamboo product evaluation and selection in rural communities. Decis. Anal. J., vol. 12, no. November 2023, p. 100503, 2024, doi: 10.1016/j.dajour.2024.100503.
- [11] D. A. B. Varela and W. Ongsakul, Energy for Sustainable Development A machine learning-driven MCDA-TOPSIS framework for wave energy converter selection in the Philippines. Energy Sustain. Dev., vol. 89, no. October, p. 101860, 2025, doi: 10.1016/j.esd.2025.101860.
- [12] Q. Han *et al.*, Annals of Nuclear Energy Research on TOPSIS multi-indicator evaluation model based on entropy weight method for C2N site selection. Ann. Nucl. Energy, vol. 221, no. March, p. 111566, 2025, doi: 10.1016/j.anucene.2025.111566.
- [13] I. Sabry, A. I. Mourad, and M. Elwakil, Multi-response optimization of friction stir welding parameters for AA6063-T6 using hybrid RSM – ANN – GRA – TOPSIS. Mater. Today Commun., vol. 51, no. December 2025, p. 114524, 2026, doi: 10.1016/j.mtcomm.2025.114524.
- [14] C. Wu, C. Lin, and C. Lee, “Optimal marketing strategy: A decision-making with ANP and TOPSIS Cheng-Shiung Strategy. Intern. J. Prod. Econ., vol. 127, no. 1, pp. 190–196, 2010, doi: 10.1016/j.ijpe.2010.05.013.
- [15] J. Kumar and G. S. Singh, Optimization of Machining Parameters of Titanium Alloy Steel using : TOPSIS Method. vol. 2, no. 2, pp. 1019–1022, 2016.
- [16] S. Dey and S. Chakraborty, A study on the machinability of some metal alloys using grey TOPSIS method. vol. 5, pp. 31–44, 2016, doi: 10.5267/j.dsl.2015.9.002.
- [17] G. Sakthivel, MECHANICAL ENGINEERING A hybrid multi-criteria decision modeling approach for the best biodiesel blend selection based on ANP-TOPSIS analysis. Ain Shams Eng. J., vol. 6, no. 1, pp. 239–256, 2015, doi: 10.1016/j.asej.2014.08.003.
- [18] J. V. C. I. R, G. Joshi, S. Singh, and R. Vig, Taguchi-TOPSIS based HOG parameter selection for complex background sign language recognition. J. Vis. Commun. Image Represent., vol. 71, p. 102834, 2020, doi: 10.1016/j.jvcir.2020.102834.
- [19] A. Shukla, P. Agarwal, R. S. Rana, and R. Purohit, Applications of TOPSIS Algorithm on various Manufacturing Processes: A Review. Mater. Today Proc., vol. 4, no. 4, pp. 5320–5329, 2017, doi: 10.1016/j.matpr.2017.05.042.
- [20] C. Chen, “Process (AHP) Approach,” 2006, doi: 10.1177/0047287506291593.