ISSN XXXX XXXX © 2017 IJESC

Research Article Volume 7 Issue No.10

TOPSIS Ranking of Epoxy Hybrid Composites

Bala Nagesh.Dukkipati[1], Suresh.J.S[2], Jitendra Gummadi[3]
Assistant Professor[1, 3], Professor& HOD[2]
Department of Mechanical Engineering
Dhanekula Institute of Engineering and Technology, Andhra Pradesh, India[1]
Amrita Sai Institute of Science and Technology, Andhra Pradesh, India[2]
NRI Institute of Technology, Andhra Pradesh, India[3]

Abstract:
In This Research Article Epoxy based composites reinforced with Glass Fiber with weighted proportion modified Fillers like Titanium oxide and silicon carbide are fabricated by manual hand layup process and mechanical properties like Tensile Strength, Flexural Strength, Hardness and impact strength are determined. Selection of a composite with respect to above mechanical characterization parameters is a difficult task; some selection procedure techniques are required to overcome from this confusion state. TOPSIS is one of the selection procedure technique adopted for this problem. This technique provides a base for decision-making processes where there are limited numbers of choices but each has large number of attributes. In this paper some composites are considered with different compositions and various mechanical properties. Selection of the best composite is done using TOPSIS technique

Keywords: Epoxy, TOPSIS, Mechanical Properties

1. INTRODUCTION

The TOPSIS (technique for order performance by similarity to ideal solution) was first developed by Hwang & Yoon (1981). It is one of the best grading methods of multi criteria decision making (MCDM) that is taken place in compromising subgroup of compensating models of decision making [1]. TOPSIS is a multiple criteria method to identify solutions from a finite set of alternatives based upon simultaneous minimization of distance from an ideal point and maximization of distance from a nadir point [2]. TOPSIS has also been used to compare company performances [3] and financial ratio performance within a specific industry [4]. A great deal of work has already been done on the use of TOPSIS for selection of the best alternatives in many fields. However, the use of TOPSIS for selection of the material is hardly been reported.

2. LITERATURE REVIEW

TOPSIS is a multiple criteria method to identify solutions from a finite set of alternatives based upon simultaneous minimization of distance from an ideal point and maximization of distance from a nadir point. TOPSIS has been applied to a number of applications many researchers. Singh et al. [5] studied the selection of material for bicycle chain in Indian scenario using MADM Approach. They concluded that both MADM and TOPSIS methods User friendly for the ranking of the parameters. Huang et al. [6] studied the multi-criteria decision making and uncertainty analysis for materials selection in environmentally conscious design. It was reported that TOPSIS method demonstrates a reasonable performance in obtaining a solution; and entropy method presents designers' or decision makers' preference on cost or environmental impact and effectively demonstrates the uncertainties of their weights. Khorshid et al. [7] studied the selection of an optimal refinement condition to achieve maximum tensile properties of Al-15%Mg2Si composite based on TOPSIS method and observed that the TOPSIS method is considered to be a suitable approach in solving material selection problem when precise performance ratings are available. Ghaseminejad et al. [8] used data envelopment analysis and TOPSIS method for solving flexible bay structure layout, and found that this method is useful for creating, initial layout, generating initial layout alternatives and evaluating them. Chakladar and Chakraborty [9] studied the combined TOPSIS-AHP-method-based approach for non-traditional machining processes selection and also include the design and development of a TOPSISAHP- method-based expert system that can automate the decision-making process with the help of a graphical user interface and visual aids. Shahroudi and Rouydel [10] studied a multi-criteria decision making approach (ANP TOPSIS) to evaluate suppliers in Iran's auto industry. Lin et al. [11] studied on customer-driven product design process using AHP and TOPSIS approaches and results shows that the proposed approach is capable of helping designers to systematically consider relevant design information and effectively determine the key design objectives and optimal conceptual alternatives. Isiklar and Buyukozkan [12] studied a multi-criteria decision making (MCDM) approach to assess the mobile phone options in respect to the users preferences order by using TOPSIS method.

3. METHODOLOGY

The objective of this work is to develop TOPSIS method for composite selection. In order to comply with collecting quantitative and qualitative data for TOPSIS composite selection model that could be applied by a seven steps approach was performed to ensure successful implementation.

4. TOPSIS METHOD

The TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is implemented to measure the proximity to the ideal solution. The basic concept of this method is that the chosen alternative should have the shortest distance from the positive ideal solution and the farthest distance from negative ideal solution. Positive ideal solution is composition of the best performance values demonstrated (in the decision matrix) by any alternative for each attribute. The negative-ideal solution is the composite of the worst performance values. The steps involved for calculating the TOPSIS values are as follows [13]: **Step 1**: This step involves the development of matrix format. The row of this matrix is allocated to one alternative and each column to one attribute. This matrix is called as a decision matrix (D). The matrix can be expressed as:

$$\begin{matrix} A1 \\ A2 \\ \vdots \\ Ai \\ \vdots \\ Am \end{matrix} \begin{bmatrix} X11 & X12 & \cdot & X1j & X1n \\ X21 & X22 & \cdot & X2j & X2n \\ \vdots & \vdots & & \vdots & \vdots \\ Xi1 & Xi2 & \cdot & Xij & Xin \\ \vdots & \vdots & & \vdots & \vdots \\ Xm1 & Xm2 & \cdot & Xmj & Xmn \end{bmatrix}$$

Step2: Calculate the normalized decision matrix. The normalized value r_{ij} is calculated as follows:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad i = 1,2...m,\ j = 1,2...n$$

Step 3: Calculate the weighted normalized decision matrix. The weighted normalized value (v_{ij}) is calculated as follows:

$$v_{ij} = r_{ij} X w_{ij}, \quad i = 1,2,..m \text{ and } j = 1,2,...n.$$

Where w_j is the weight of the j[th] criterion or attribute and $\sum_{j=1}^{n} w_j = 1$

Step 4: Determine the ideal (best) and negative ideal (worst) solutions in this step. The ideal and negative ideal solution can be expressed as:

$$A^* = \{(\max_i v_{ij} \mid j \in C_b), (\min_i v_{ij} \mid j \in C_c)\} = \{v_j^* \mid j = 1,2,...,m\}$$

$$A^- = \{(\min_i v_{ij} \mid j \in C_b) (\max_i v_{ij} \mid j \in C_c)\} = \{v_j^- \mid j = 1,2,...,m\}$$

Step 5: Calculate the separation measures using the m-dimensional Euclidean distance. The separation measures of each alternative from the positive ideal solution and the negative ideal solution, respectively, are as follows:

$$S_i^* = \sqrt{\sum_{j=1}^{m} (V_{ij} - V_j^*)^2}, \quad j = 1,2,...m$$

$$S_i^- = \sqrt{\sum_{j=1}^{m} (V_{ij} - V_j^-)^2}, \quad j = 1,2,...m$$

Step 6: Calculate the relative closeness to the ideal solution. The relative closeness of the alternative (A_i) with respect to (A*) is defined as follows:

$$RC_i^* = \frac{S_i^-}{S_i^* + S_i^-}, \quad i = 1,2,...m$$

Step7: Rank the preference order.

5. RESULTS AND DISCUSSIONS

Table.1.

	NORMALIZED MATRIX			
	T.S	F.S	IS	H
C1	0.418258	0.379553	0.282138	0.409831
C2	0.515719	0.411163	0.423207	0.440568
C3	0.477778	0.385568	0.493742	0.450814
C4	0.442713	0.556001	0.564276	0.46106
C5	0.367189	0.478628	0.423207	0.471306

Table.2

	DECISSION MATRIX			
	Tensile strength	Flexural strength	Impact Strength	Hardness
C1	232.6	321.8	8	80
C2	286.8	348.6	12	86
C3	265.7	326.9	14	88
C4	246.2	471.4	16	90
C5	204.2	405.8	12	92

Table.3

	WEIGHT NORMALIZED MATRIX			
	T.S	F.S	IS	H
C1	0.104564	0.094888	0.070535	0.102458
C2	0.12893	0.102791	0.105802	0.110142
C3	0.119444	0.096392	0.123435	0.112703
C4	0.110678	0.139	0.141069	0.115265
C5	0.091797	0.119657	0.105802	0.117826

Table.4

	BEST & WORST SOLOTIONS			
	T.S	F.S	IS	H
POSITIVE IDEAL SOLUTION	0.08823	0.100852	0.075485	0.061662
NEGATIVE IDEAL SOLUTION	0.036025	0.028701	0.044033	0.057028

Table.5

SEPERATION MEASURES OF ATTRIBUTES	
S*	S-
0.044070419	0.10883283
0.114570003	0.224753455
0.144997056	0.226929026
0.157975533	0.254474486
0.159479085	0.218681591

Table.6

RELATIVE CLOSENESS	COMPOSITE RANKING
C1*	R
0.288224216	5
0.337642448	4
0.389854497	2
0.383017398	3
0.42172308	1

From the table-6 the ranks of epoxy resin glass fiber reinforced hybrid composites are determined. It was observed that the composites (C5), (C3) and (C4) of epoxy based hybrid composites obtained first three ranks. The composites C1 obtained last rank as well as the composite C2 obtained fourth rank.

6. REFERENCES

[1]. Chen, C.T., (2000). Extensions of the TOPSIS for group decision-making under fuzzy environment, Fuzzy sets and systems, Vol. 114 (1), pp. 1-9.

[2]. Olson, D.L., (2004). Comparison of weights in TOPSIS models, Mathematical and Computer Modeling, vol.40 (7), pp.721-727.

[3]. Deng, H., Yeh C.H. & Willis R.J., (2000). Inter-company comparison using modified TOPSIS with objective weights, Computers & Operations Research, vol.27 (10), pp. 963-973.

[4]. Feng C.M. & Wang R.T., (2001). Considering the financial ratios on the performance evaluation of highway bus industry, Transport Reviews, vol.21 (4), pp. 449-467.

[5]. Singh, H., & Kumar, R. (2012). Selection of Material for Bicycle Chain in Indian Scenario using MADM Approach, Proceedings of the World Congress on Engineering, Vol. 3.

[6]. Huang, H., Zhang, L., Liu, Z., & Sutherland, J. W. (2011). Multi-criteria decision making and uncertainty analysis for materials selection in environmentally conscious design, The International Journal of Advanced Manufacturing Technology, 52(5-8), pp.421-432.

[7]. Khorshidi R., Hassani A., Honarbakhsh R.A., & Emamy M., (2013). Selection of an optimal refinement condition to achieve maximum tensile properties of Al-15% Al– 15%Mg2Si composite based on TOPSIS method, Materials & Design, 42, pp. 442-450.

[8]. Ghaseminejad A., Navidi H., & Bashiri M. (2011). Using Data Envelopment Analysis and TOPSIS method for solving flexible bay structure layout, International Journal of Management Science and Engineering Management, 1(6), pp.49-57.

[9]. Chakladar N. D. & Chakraborty S. (2008). A combined TOPSIS-AHP-method-based approach for non-traditional machining processes selection, Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture, 222(12), pp.1613-1623.

[10]. Shahroudi K., & Rouydel H., (2012). Using a multi-criteria decision making approach (ANP-TOPSIS) to evaluate suppliers in Iran's auto industry, International Journal of Applied, 2(2), pp. 37-48.

[11]. Lin M. C., Wang C. C., Chen M. S., & Chang C. A. (2008). Using AHP and TOPSIS approaches in customer-driven product design process, Computers in Industry, 59(1), pp.17-31.

[12]. Isiklar G., & Buyukozkan G., (2007). Using a multi-criteria decision making approach to evaluate mobile phone alternatives, Computer Standards & Interfaces, 29(2), pp.265-274.

[13]. Mohammadi A., Mohammadi A., Aryaeefar H., (2011). Introducing a new method to expand TOPSIS decision making model to fuzzy TOPSIS, The Journal of Mathematics and Computer Science, Vol .2, pp.150-159.