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# A Study On Composite Material Selection Using The MOORA Method

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***Abstract:*** The process of choosing the best composite material for a given application is based on the application's needs and desired characteristics. To guarantee optimum performance and functionality, factors including hardness, weight, toughness, cost, and adaptability with the target environment must be taken into care. Choosing the best "composite material" for a given application requires thorough consideration and evaluation of available options. Mechanical features, ambient circumstances, cost, manufacturing viability, and desired performance attributes are all taken into account during this procedure. Engineers can identify a composite material that satisfies particular specifications and achieves the ideal mix of attributes and performance by examining these aspects. Arguably, the most demanding phases in the planning and creation of any structural part is selecting the right kind of materials. The factors of the composites such as "Interlinear shear strength, tensile strength, flexural strength, impact strength, and Micro-hardness", are taken into consideration all over the process of choosing them. A decision-making methodology called "MOORA" evaluates and prioritizes options considering a number of factors. It creates an overall performance index, turns the criteria into ratios, and establishes the weights for each criterion. "MOORA", which is utilized extensively in business, engineering, and research on the environment, offers a methodical way to choose the optimal option by taking into consideration of relative relevance as well as performance levels. Alternate Parameters are "PSF1, PSF2, PSF3, PSF4, VSF1, VSF2, VSF3, and VSF4". Evaluation Parameters used are Micro-Hardness, Tensile strength, Flexural Strength, Interlaminar shear strength, and Impact strength. For the composite material selection, "VSF3" is in the 1st rank, "PSF3" in the 2nd rank, "VSF4" in the 3rd Rank, "VSF2" in the 4rth rank, "PSF2" in the 5fth rank, "PSF4" in the 6th rank, "VSF1" in the 7th rank, and "PSF1" in the 8th rank. the 3rd Rank, "VSF2" in the 4rth rank, "PSF2" in the 5fth rank, "PSF4" in the 6th rank, "VSF1" in the 7th rank, and "PSF1" in the 8th rank.

***Index Terms*** **– MOORA (Multi-Objective Optimization by Ratio Analysis), Composite material, "VSF3", "Impact strength", "tensile strength".**

## I. Introduction

The process was developed with AHP and weighted with objective wear resistance keeping wear and structural applications in mind. This strategy can be used in other decision-making situations with different possibilities and criteria [1]. The selection of a suitable composite material to construct a specific structure according to the working conditions and practical requirements associated with the combination leaf springs is necessary for the seamless installation of more than one leaf spring. Springs are well known for holding and gathering energy to store it before releasing it [2]. Due to the substantial amount of energy used in creating metal components, which has an environmental impact, it is characteristic in the layout of automobile components to replace metals with fiber from nature as the basis material. As a consequence, in this study, natural fibers were chosen for the combination bio composite that was used in designing a vehicle anti-roll bar took a vehicle anti-roll bar in order to discover the appropriate natural fiber which could satisfy both customer and the environment's requirements [3].

Additionally, because composite materials can be mixed with multiple kinds of fibers and matrix structures, choosing acceptable combination materials and designs for structures might be difficult for untrained structural builders [4]. It requires extensive experimental labor. To achieve the required surface quality, ascertain the ideal shear conditions for glass-fiber-reinforced polymer composites (GFRP) materials. In this investigation, a number of instruments. The following variables were used to collect data: depth, feed rate, & flute cutting, and chopping rate. The connection between the functions of the end grinding cutting parameters and the resultant surface roughness has been examined [5]. In the presented work, a Fuzzy AHP and M TOPSIS-based technique were utilized to select composite components for mechanical and along with structural applications based on various material specific characteristics. In helping the selection of alternate composites based on the requirements, numerous mechanical characteristics such as flexural & impact resilience, the degree of hardness density, tension strength, and wear resistance have been selected [6]. The AHP-TOPSIS technique serves as an effective tool to fix MCDM problems, and it has been used responsibly in a variety of applications. However, the mechanical and wear specifications for polymer composite materials selected using that approach are seldom documented. So, Ian's attempts are over. Using the AHP-TOPSIS technique, select the best choice from the collection of composite elements undergoing consideration [7]. The objective of this study was to find the optimum geometry bumper beam concept to meet the safety standards of the given Product Specifications (PDS). Different bumper beam designs with similar front curves, thickness and overall size were studied to determine the mechanical properties of the developed hybrid composite material. Good concept selection was found to be essential to sustainability, while materials were a sustainable factor. Also, structural optimization has revealed the potential of bio-based composite materials for use in vehicle structural components [8]. The adoption of structural components with walls that are thin. Many studies have been conducted on the crashworthiness of combined material structures in an extensive variety of applications in the automotive sectors, particularly the employment of such elements as energy-absorbing devices. Many parameters affecting the absorption of energy efficiency of thin-walled shells having simple cross-sectional forms were investigated in laboratories utilizing various testing methods, including axial loading, bending, and combination loading [9]. The choice of cryostat materials is frequently determined by the thermal conductivity and thermal expansion factors, both of which are significantly influenced by fiber advantages. More than half of the loadings were in-plane, allowing for the use in conventional composite material research studies. For such objectives, conventional fabrication treatments are viable [10]. For optimal auto-consolidation at cost-effective rates, compound materials creation and selection are essential. The material being processed must have a wide processing window and have good mechanical properties under good mechanical properties under the appropriate functioning conditions in the environment [11]. There isn't a standard method for choosing AE signals as of now. Therefore, it is impossible to compare the results or transfer them to other composite systems. A novel waveform-based technique for choosing AE Events that result in damage is suggested in the present paper. Precise localization and rating based on the signal's strength are steps in the process [12]. One of the most often used commercial PMMCs, aluminum composite matrix composites (AMCs) strengthened with particles comprise an important amount very hard ceramic particles within the ductile Al-matrix. AMCs with particles of ceramic are almost isotropic and relatively simple to produce when compared to fiber-reinforced composites. Al-SiC composites have gained the most traction in the last ten years thanks to their customized qualities, strong forming characteristics, low cost-effectiveness, and high-quantity manufacturing processes. They also hold the most promise for future growth [13].Among the promising methods of producing extremely hot self-lubricating composites is to use a combination of inorganic solid lubricants. This study was intended to examine the idea of a synergetic lubricating action involving graphite and $MoS_2$. By using powder metallurgy to develop a nickel-based self-lubricating composite, molybdenum disulfide along with graphite have been included as lubricants to the composite to further improve its tribological capabilities [14]. A recommended multi-objective hierarchical genetic algorithm (MOHGA) for composite structure multi-objective optimization is based on global and local dominance thoughts and has age structure. As an outcome, individuals who belong to the same subspecies share the same material preferences and hybrid composite structure topology. Two distinct levels have been employed to distribute the materials in hybrid composite structures: the laminate level and the structural topology level [15].

## II. MATERIALS AND METHODS

While In every one of these situations, the MOORA method's findings almost affirm the conclusions reached by earlier researchers, demonstrating the method's applicability, potential, and flexibility to tackle a range of challenging problems with decision-making in the contemporary industrial surroundings [16].The management or decision-makers can efficiently and promptly make accurate decisions regarding the design of the product, substance, manufacturing system, facility setting, capacity layout, material, and supplier by employing the MOORA method [17].A multi-objective optimum strategy like the MOORA approach, first put forward by Brauer (2004), can be successfully used to resolve a variety of challenging issues related to making decisions. The MOORA approach limits itself to simple ratio analysis, which requires very little labor from people and very little mathematical imagination [18]. The financial ratios (discrete information) are gathered using the MOORA approach, and the multiple goals credit lending problem is subsequently resolved using GP by taking into account every pertinent information (continuous data), goals, and limitations. Merely discrete-type ratios of finance are employed in the suggested credit assessment model in this article, and the MOORA method—one among several MADM methodologies—is employed as the rating methodology [19]. The equipment was employed to assess as well as select the most effective material for the main component of the AHM while taking into account a number of decision-making criteria. The applicability of the presented technique was illustrated using a case examination of the shaft. The blueprint for the AHM components is then implemented, machine-fabricated, and tested in order to assess the effectiveness of the performance [20]. This study examined the temperature at the chip-tool proximity, the primary cutting force, and the rate of tool wear during varying machining circumstances during turning procedures [21]. The AHP technique, TOPSIS, and Accessing MOORA are used to calculate the values for every criterion while sorting objects. Target-based characteristics like toughness and density. Mechanical qualities such as tensile strength, hardness, wearing percentage, and coefficients of friction. The criteria-selection method takes generated composites under effect [22]. The wire cut machining with electrical discharge process applies the “multi-objective optimization” on the foundation of proportion estimation (“MOORA”) approach to identify the most advantageous value for the parameters used for output [23]. The metallurgical grade Vickers-Hardness Test was employed to evaluate the weldment's hardness. The focus of this investigation is to examine how oxide fluxes affect welding parameters and weld shape. Parameter optimization utilizing the AHP-MOORA and ASRS methodologies [24]. When using the Fuzzy “MOORA method”, a mixed weight calculation strategy is used. The aim of this study is to identify the best hotel (hotel number one was identified in this article), evaluate the standard of hotel amenities in Turkey, and demonstrate the applicability to apply the fuzzy MOORA conduct to the service sector [25].

**Evaluation Parameters**

1.Micro- Hardness: A material's exterior resistance to being dented or punctured by an insignificant indenter is referred to as its micro hardness. It may be examined using a microscope while offering important details regarding the material's durability, power, and ability to endure localized distortion.

2.Tensile Strength: The maximum stress that a material can endure before breaking under tension has been referred to as tensile strength. A material's capacity to cope with tensile or stretching pressures without breaking is assessed by that characteristic.

3.Flexural strength: The capacity of a material to withstand stretching or flex without breaking is recognized as its flexural strength. It denotes the highest stress a material can bear before cracking whenever bending forces are put on it.

4. ILSS interlaminar shear strength: The acronym "ILSS" (Interlaminar Shear Strength) describes a material's capacity to withstand forces of shearing across its separate layers or laminates. It demonstrates the greatest strain that materials can withstand before commencing to separate or slide away from each other while shear forces have been introduced.

5. Impact strength: Impact strength is an expression used to describe what a substance can do to absorb energy following an immediate impact or shock. It determines how susceptible a substance is to breaking or failure when exposed to high-velocity objects.

**Alternate Parameters**

They are: “PSF1, PSF2, PSF3, PSF4, VSF1, VSF2, VSF3 and VSF4”.

Where PSF is a polyester fabric mat is made by weaving or knitting polyester fibers together, resulting in a durable and flexible textile. It exhibits excellent strength, resistance to elongation and versatility, making it well suited for applications ranging from apparel and upholstery to industrial purposes and VSF is a fabric mat made of viscose fibers derived from cellulose, recognized for its silky texture and beautiful drapery properties. Widely used in apparel and home textiles, these mats offer a lightweight feel, excellent color absorption and retention properties.

## III. RESULT AND DISCUSSION

**TABLE 1.** Composite Material Selection

| Composites | Micro-hardness | Tensile strength | Flexural strength | ILSS interlaminar shear strength | Impact strength |
|---|---|---|---|---|---|
| PSF1 | 23.9 | 30.27 | 41.85 | 49.34 | 1.351 |
| PSF2 | 28.7 | 38.46 | 47.13 | 53.92 | 1.505 |
| PSF3 | 33.3 | 42.23 | 53.42 | 59.43 | 1.796 |
| PSF4 | 35.2 | 38.65 | 50.26 | 51.04 | 1.933 |
| VSF1 | 24.27 | 36.19 | 51.71 | 55.59 | 1.556 |
| VSF2 | 29.58 | 40.06 | 54.36 | 57.13 | 1.924 |
| VSF3 | 35.12 | 44.53 | 58.67 | 60.87 | 2.036 |
| VSF4 | 37.43 | 39.87 | 57.09 | 56.19 | 2.192 |

Table 1 shows the various composites and its evaluation parameters.

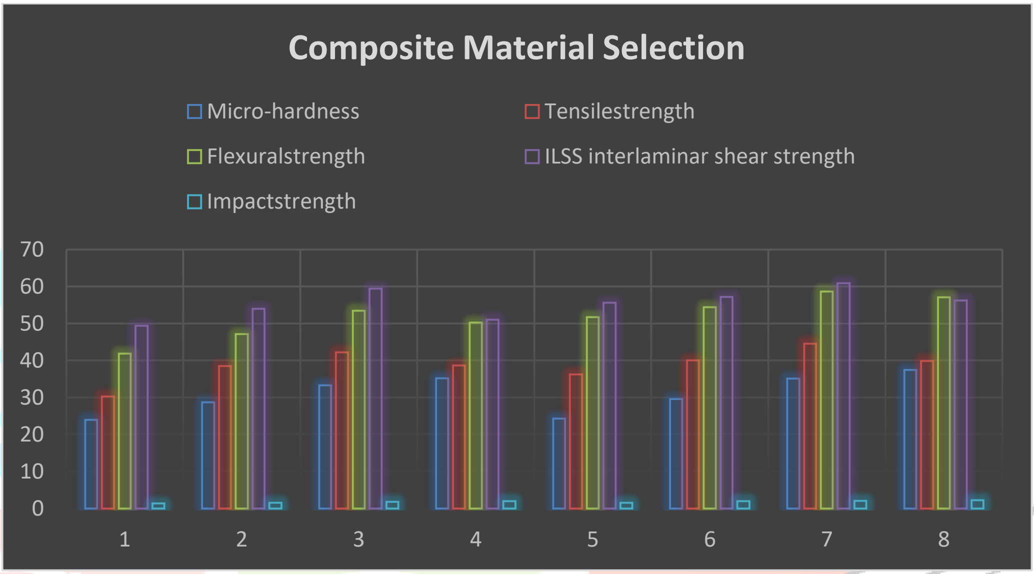


**FIGURE 1.** Composite Material Selection.

Figure 1 illustrates the Composite Material Selection for the various composites and the evaluation parameters such as "impact strength" , "flexural strength" and other parameters are highlighted in the figure.

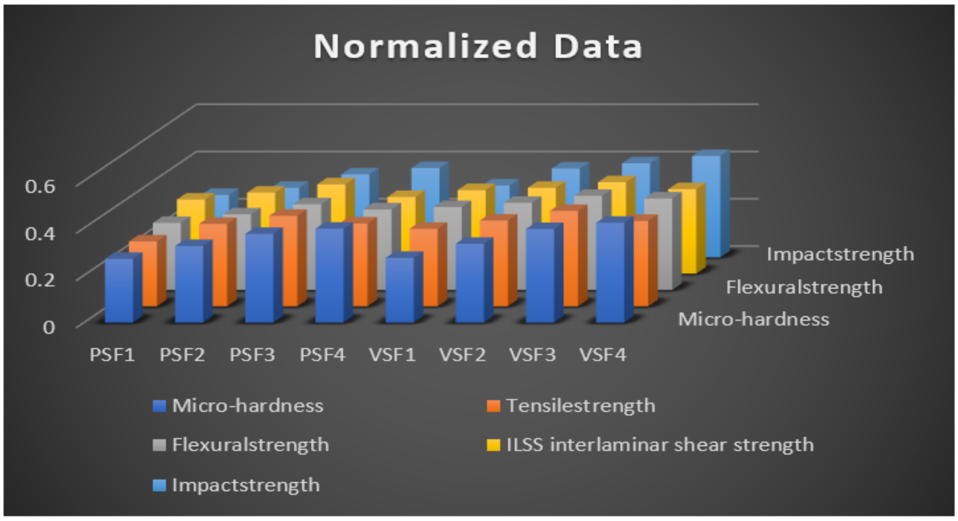


**FIGURE 2.** Normalized Data

Figure 2 illustrates the Normalized Data for the selection of composite materials.

**TABLE 3.** Weight Matrix

| Composites | Micro-hardness | Tensile strength | Flexural strength | ILSS interlaminar shear strength | Impact strength |
|---|---|---|---|---|---|
| PSF1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| PSF2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| PSF3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| PSF4 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| VSF1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| VSF2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| VSF3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| VSF4 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |

Table 2 shows the Weight Matrix for the various composite types and the considered Evaluation parameters as listed above in the table.

**TABLE 4.** Weight Normalized Decision Matrix

| Composites | Micro-hardness | Tensile strength | Flexural strength | ILSS interlaminar shear strength | Impact strength |
|---|---|---|---|---|---|
| PSF1 | 0.05398 | 0.054901 | 0.056842 | 0.062794 | 0.052863 |
| PSF2 | 0.064821 | 0.069755 | 0.064013 | 0.068623 | 0.058889 |
| PSF3 | 0.075211 | 0.076593 | 0.072556 | 0.075636 | 0.070276 |
| PSF4 | 0.079502 | 0.0701 | 0.068264 | 0.064958 | 0.075636 |
| VSF1 | 0.054816 | 0.065638 | 0.070234 | 0.070749 | 0.060885 |
| VSF2 | 0.066809 | 0.072657 | 0.073833 | 0.072709 | 0.075284 |
| VSF3 | 0.079322 | 0.080765 | 0.079687 | 0.077469 | 0.079667 |
| VSF4 | 0.084539 | 0.072313 | 0.077541 | 0.071512 | 0.085771 |

Table 4 shows the Weighted Normalized Decision Matrix for the 8 types of composites and 5 of the evaluation parameters.

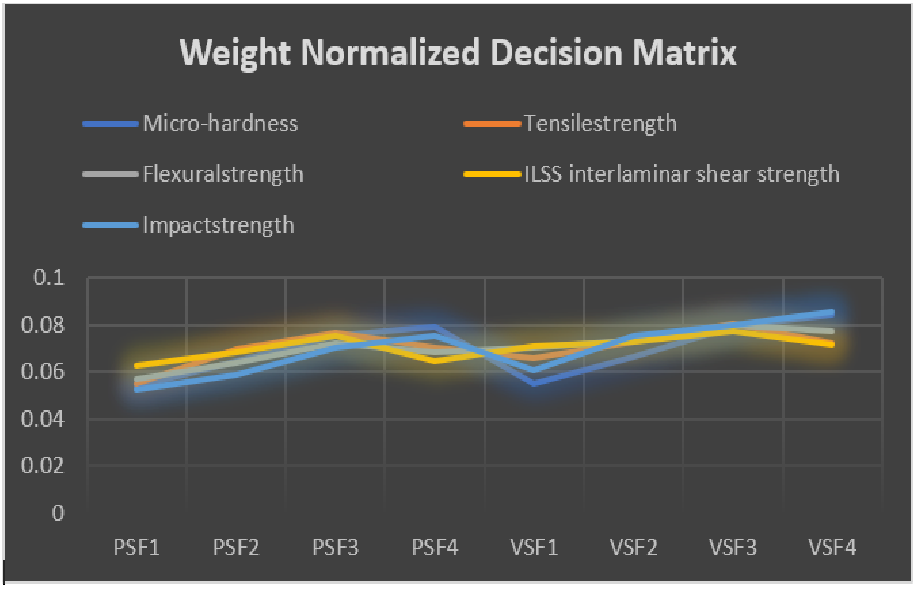


**FIGURE 3.** Weight Normalized Decision Matrix for the eight types of composites and five types of the Evaluation Parameters.

**TABLE 5.** Assessment Value

| Composites | Assessment value |
|---|---|
| PSF1 | 0.175654 |
| PSF2 | 0.208324 |
| PSF3 | 0.229721 |
| PSF4 | 0.207189 |
| VSF1 | 0.200552 |
| VSF2 | 0.210724 |
| VSF3 | 0.237575 |
| VSF4 | 0.220135 |

Table 5 shows the Assessment Value for the Selection of Composite materials.

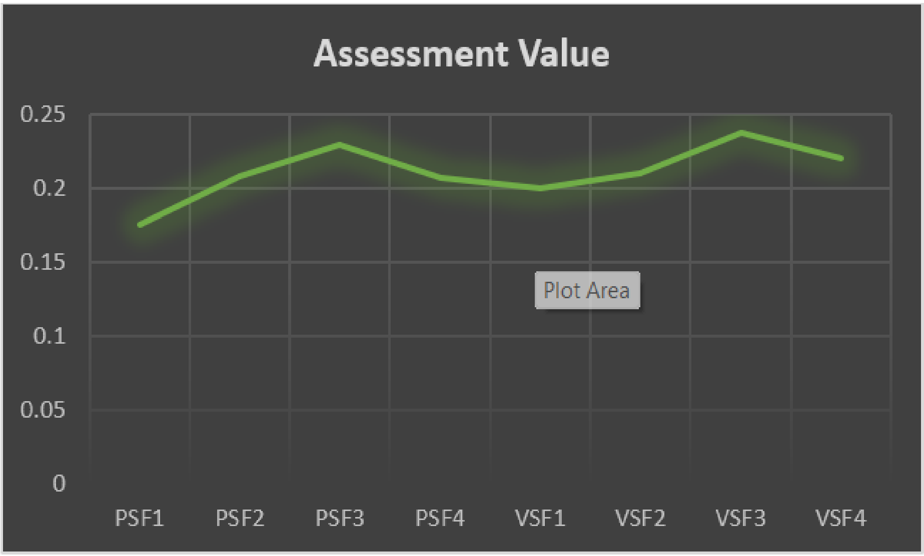


**FIGURE 4.** Assessment Value for the Composite Material Selection.

**TABLE 6.** Rank

| Composites | Rank |
|---|---|
| PSF1 | 8 |
| PSF2 | 5 |
| PSF3 | 2 |
| PSF4 | 6 |
| VSF1 | 7 |
| VSF2 | 4 |
| VSF3 | 1 |
| VSF4 | 3 |

Table 6 shows the Rank of the Eight types of Composites listed above and “VSF3 is in the first rank”.

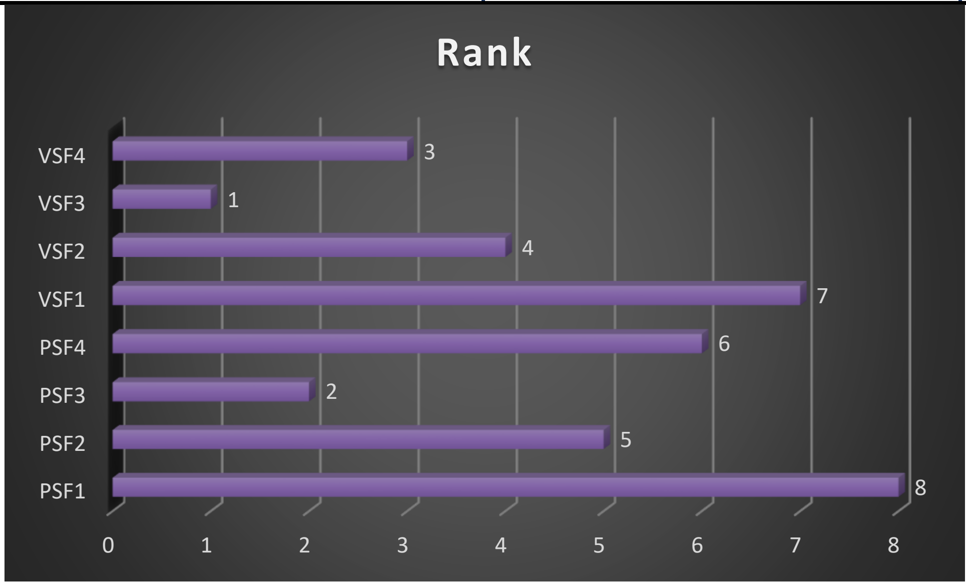


**FIGURE 5.** Rank for the Composite Material Selection.

Figure 5 illustrates the Rank of the composites for the five evaluation parameters. "VSF3 is the best composite so far when subjected to five different tests".method.

## IV. CONCLUSION

The process of choosing the best composite material for a given application is based on the application's needs and desired characteristics. Choosing the best "composite material" for a given application requires thorough consideration and evaluation of available options. The process was developed with AHP and weighted with objective wear resistance keeping wear and structural applications in mind. This strategy can be used in other decision-making situations with different possibilities and criteria. In every one of these situations, the MOORA method's findings almost affirm the conclusions reached by earlier researchers, demonstrating the method's applicability, potential, and flexibility to tackle a range of challenging problems with decision-making in the contemporary industrial surroundings.

## REFERENCES

1. Patnaik, Prabina Kumar, Priyadarshi Tapas Ranjan Swain, Srimant Kumar Mishra, Abhilash Purohit, and Sandhyarani Biswas. "Composite material selection for structural applications based on AHP-MOORA approach." *Materials Today: Proceedings* 33 (2020): 5659-5663.
2. Ke, Jun, Zhen-yu Wu, Xiao-ying Chen, and Zhi-ping Ying. "A review on material selection, design method and performance investigation of composite leaf springs." *Composite Structures* 226 (2019): 111277.
3. Mastura, M. T., S. M. Sapuan, M. R. Mansor, and A. A. Nuraini. "Environmentally conscious hybrid bio-composite material selection for automotive anti-roll bar." *The International Journal of Advanced Manufacturing Technology* 89 (2017): 2203-2219.
4. Chen, J. L., S. H. Sun, and W. C. Hwang. "An intelligent data base system for composite material selection in structural design." *Engineering fracture mechanics* 50, no. 5-6 (1995): 935-946.
5. Erkan, Ömer, Mustafa Demetgül, Birhan Işik, and İbrahim Nur Tansel. "Selection of optimal machining conditions for the composite materials by using Taguchi and GONNs." *Measurement* 48 (2014): 306-313.
6. Calado, Elcin Aleixo, Marco Leite, and Arlindo Silva. "Selecting composite materials considering cost and environmental impact in the early phases of aircraft structure design." *Journal of Cleaner Production* 186 (2018): 113-122.
7. Patnaik, Prabina Kumar, Priyadarshi Tapas Ranjan Swain, and Abhilash Purohit. "Selection of composite materials for structural applications through MCDM approach." *Materials Today: Proceedings* 18 (2019): 3454-3461.

8. Davoodi, M. M., S. M. Sapuan, D. Ahmad, A. Aidy, A. Khalina, and Mehdi Jonoobi. "Concept selection of car bumper beam with developed hybrid bio-composite material." *Materials & Design* 32, no. 10 (2011): 4857-4865.
9. Mamalis, A. G., M. Robinson, D. E. Manolakos, G. A. Demosthenous, M. B. Ioannidis, and J. Carruthers. "Crashworthy capability of composite material structures." *Composite structures* 37, no. 2 (1997): 109-134.
10. Schutz, J. B. "Properties of composite materials for cryogenic applications." *Cryogenics* 38, no. 1 (1998): 3-12.
11. Sharp, Richard, Scott Holmes, and Cindy Woodall. "Material Selection/fabrication issues for thermoplastic fiber placement." *Journal of Thermoplastic Composite Materials* 8, no. 1 (1995): 2-14.
12. Maillet, Emmanuel, and Gregory N. Morscher. "Waveform-based selection of acoustic emission events generated by damage in composite materials." *Mechanical Systems and Signal Processing* 52 (2015): 217-227.
13. Khorshidi, R., and A. Hassani. "Comparative analysis between TOPSIS and PSI methods of materials selection to achieve a desirable combination of strength and workability in Al/SiC composite." *Materials & Design (1980-2015)* 52 (2013): 999-1010.
14. Li, Jian Liang, and Dang Sheng Xiong. "Tribological properties of nickel-based self-lubricating composite at elevated temperature and counterface material selection." *Wear* 265, no. 3-4 (2008): 533-539.
15. Conceição António, Carlos A. "Local and global Pareto dominance applied to optimal design and material selection of composite structures." *Structural and Multidisciplinary Optimization* 48 (2013): 73-94.
16. Chakraborty, Shankar. "Applications of the MOORA method for decision making in manufacturing environment." *The International Journal of Advanced Manufacturing Technology* 54 (2011): 1155-1166.
17. Attri, Rajesh, and Sandeep Grover. "Decision making over the production system life cycle: MOORA method." *International Journal of System Assurance Engineering and Management* 5 (2014): 320-328.
18. Khan, Akhtar, and Kali Pada Maity. "Parametric optimization of some non-conventional machining processes using MOORA method." In *International journal of engineering research in Africa*, vol. 20, pp. 19-40. Trans Tech Publications Ltd, 2016.
19. Ic, Yusuf Tansel. "A multi-objective credit evaluation model using MOORA method and goal programming." *Arabian Journal for Science and Engineering* 45, no. 3 (2020): 2035-2048.
20. Emovon, Ikuobase, Oghenenyerovwho Stephen Okpako, and Edith Edjokpa. "Application of fuzzy MOORA method in the design and fabrication of an automated hammering machine." *World Journal of Engineering* 18, no. 1 (2021): 37-49.
21. Gadakh, V. S., Vilas Baburao Shinde, and N. S. Khemnar. "Optimization of welding process parameters using MOORA method." *The International Journal of Advanced Manufacturing Technology* 69 (2013): 2031-2039.
22. Raju, Siva S., Gunji B. Murali, and Prabina K. Patnaik. "Ranking of Al-CSA composite by MCDM approach using AHP–TOPSIS and MOORA methods." *Journal of Reinforced Plastics and Composites* 39, no. 19-20 (2020): 721-732.
23. Patel, Jaksan D., and Kalpesh D. Maniya. "Application of AHP/MOORA method to select wire cut electrical discharge machining process parameter to cut EN31 alloys steel with brasswire." *Materials Today: Proceedings* 2, no. 4-5 (2015): 2496-2503.
24. Chaudhari, Pavan G., Priyank B. Patel, and Jaksan D. Patel. "Evaluation of MIG welding process parameter using Activated Flux on SS316L by AHP-MOORA method." *materials today: proceedings* 5, no. 2 (2018): 5208-5220.
25. Gürbüz, Feyza, and Gizem Erdinç. "Selecting the best hotel using the Fuzzy-Moora method with a new combined weight approach." In *2018 2nd International Symposium on Multidisciplinary Studies and Innovative Technologies (ISMSIT)*, pp. 1-8. IEEE, 2018.