OPTIMISATION OF COATING MATERIALS FOR LOW CARBON STEELS BY FUZZZY AHP TECHNIQUE

Resmi V. Prasad[1], Daniel C. Ribu[2], Dr.Rajesh R[3]
[1]Asst. Professor, Lourdes Matha College of Science and Technology, Kerala
[2]Asst. Professor, Lourdes Matha College of Science and Technology, Kerala
[3]Principal, Rohini College of Engineering and Technology, Tamil Nadu

Abstract
Multiple-criteria decision-making (MCDM) or multiple-criteria decision analysis (MCDA) is a sub-discipline of operations research that explicitly evaluates multiple conflicting criteria in decision making (both in daily life or in professional settings). The AHP organizes feelings, intuition, and logic in a structured approach to decision making. The AHP provides such a framework that enables us to make effective decisions on complex issues by simplifying and expediting our natural decision-making processes. The AHP provides a measure of the consistency of pairwise comparison judgments by computing a consistency ratio.
The ratio is designed in such a way that values of the ratio exceeding 0.10 are indicative of inconsistent judgments. Although the exact mathematical computation of the consistency ratio is beyond this discussion, a approximation of the ratio can be obtained.
Key words: AHP, pairwise comparison, consistency ratio, etc

1. Introduction

In this rapidly progressing generation, one has to make decisions instantly and precisely. Most of the problems are depending upon not only one condition but on several conditions as the situation demands. Therefore, MCDM (Multi Criteria Decision Making) Techniques are used for solving these types of modern day problems. Analytical Hierarchy Process (AHP) is the most preferred MCDM technique used due to the considerably simple technique and accuracy. The Analytic Hierarchy Process (AHP) is a theory of measurement. When applied in decision making it assists one to describe the general decision operation by decomposing a complex problem into a multi-level hierarchic structure of objectives, criteria, sub criteria and alternatives. The AHP provides a fundamental scale of relative magnitudes expressed in dominance units to represent judgments in the form of paired comparisons. A ratio scale of relative magnitudes expressed in priority units is then derived from each set of comparisons. An overall ratio scale of priorities is then synthesized to obtain a ranking of the alternatives. From its axioms to its procedures, the AHP has turned out to be historically and theoretically a different and independent theory of decision making from utility theory [1, 2, 3].

2. The AHP Approach

A typical AHP [3, 4, 5, 6 and 7] problem starts by defining the problem proceeded by identifying the goal to achieve, pair wise comparison of components with respect to criteria's and at last structure them as a hierarchy that resembles with family tree which is viewed as a logical and organized form in representing the problem.

Intensity of Importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
3	Weak Importance of one over another	Experience and judgement slightly

		favour one activity over another
5	Essential or strong importance	Experience and judgement strongly favour one activity over another
7	Demonstrated Importance	An activity is strongly favoured and its dominance demonstrated in practice
9	Absolute Importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between the two adjacent judgements	When compromise is needed
Reciprocals of above non zero	If activity i has one of the above non zero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i	

Table 1: Scale of Relative Importances (according to Saaty (1980))

One of the most crucial steps in many decision-making methods is the accurate estimation of the pertinent data. The AHP method, determines the relative importance, or weight, of the alternatives in terms of each criterion involved in a given decision-making problem. An approach based on pairwise comparisons which was proposed by Saaty (1980) Pairwise comparisons are used to determine the relative importance of each alternative in terms of each criterion. In this step, the decision-maker has to express his opinion about the value of one single pairwise comparison at a time.

The main problem with the pairwise comparisons is how to quantify the linguistic choices selected by the decision maker during their evaluation. All the methods which use the pairwise comparisons approach eventually express the qualitative answers of a decision maker into some numbers which, most of the time, are ratios of integers. Since pairwise comparisons are the keystone of these decision-making processes, correctly quantifying them is the most crucial step in multi-criteria decision-making methods which use qualitative data. Pairwise comparisons are quantified by using a scale. Such a scale is an one-to-one mapping between the set of discrete linguistic choices available to the decision maker and a discrete set of numbers which represent the importance, or weight, of the previous linguistic choices. The scale proposed by Saaty is depicted in table 1. The values of the pairwise comparisons in the AHP are determined according to the scale introduced by Saaty (1980). According to this scale, the available values for the pairwise comparisons are members of the set: {9, 8, 7, 6, 5, 4, 3, 2, 1, 1/2, 1/3, 1/4, 1/5, 1/6, 1/7, 1/8, 1/9} (see also table 1). For each criteria, the pairwise comparsion between various alternatives are done. After making pairwise compasrion, the pairwise comparison matrix for each criteria is formulated. The next step is to normalise the matrix and the weights of the various alternatives based on the criteria are calculated. Ranking of the alternatives are done as per the weights computed.

3. Problem Definition

In this paper, a coating material is selected from the list of four alternatives based on four criteria using the AHP method as described above.
From the extensive literature survey, the four coating materials (alternatives) selected were Alumina, Zirconia, Titanium Dioxide, Nickel alloy The main criteria considered were Young's Modulus, Cost, Availability and Appearance.

3.1 Making Comparison Matrix

The various alternatives were compared for each criteria and pair-wise comparison matrix was developed. The pair-wise comparison were done based on the scale developed by Saaty [1,2,3].

E	alumina	zirconia	TiO2	Sn3N4
alumina	0.561	0.732	0.471	0.375
zirconia	0.112	0.146	0.353	0.25
TiO2	0.140	0.049	0.118	0.25
Sn3N4	0.187	0.073	0.059	0.125

Cost	alumina	zirconia	TiO2	Sn3N4
alumina	0.063	0.025	0.045	0.088
zirconia	0.188	0.075	0.045	0.088
TiO2	0.313	0.375	0.227	0.206
Sn3N4	0.4375	0.525	0.68	0.62

Av.	alumina	zirconia	TiO2	Sn3N4
alumina	0.158	0.250	0.206	0.379
zirconia	0.032	0.050	0.088	0.015
TiO2	0.788	0.450	0.618	0.530
Sn3N4	0.023	0.250	0.088	0.076

Ap.	alumina	zirconia	TiO2	Sn3N4
alumina	0.60	0.66	0.54	0.44
zirconia	0.20	0.22	0.32	0.31
TiO2	0.12	0.07	0.11	0.19
Sn3N4	0.09	0.04	0.04	0.06

The criteria comparison matrix

Criteria comp	E	C	Ap.	Av.
E	0.597	0.525	0.300	0.741
Criteria comp	0.085	0.075	0.300	0.037
Ap.	0.199	0.025	0.100	0.074
Av.	0.119	0.375	0.300	0.148

3.2 Development of Priority Ranking

The overall priority for each decision alternative is obtained by summing the product of the criterion priority (i.e., weight) (with respect to the overall goal) times the priority (i.e., preference) of the decision alternative with respect to that criterion. Ranking these priority values will give the AHP ranking of the decision alternatives.

Ranking	E	C	Ap.	Av.	Weight.
alumina	0.535	0.055	0.438	0.248	0.398
zirconia	0.215	0.099	0.313	0.046	0.171
TiO2	0.139	0.280	0.188	0.597	0.269
Sn3N4	0.111	0.565	0.063	0.109	0.162

4. Results and Discussions

From the weights calculated, the ranking has been done and the ranking obtained as below:

Material	RANK
Alumina	1
Zirconia	3
Tio2	2
Sn3n4	4

5. Conclusion

The aim of this research is to construct a fuzzy AHP model to evaluate the best coating material for the Low carbon steels. The young's modulus of a material greatly influences the selection of the appropriate material.

In future, it is not an option but essential to implement this method for dealing a variety of multi criteria decision making problems due to its flexibility

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