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A Decision-Making Method for Selecting TMT Rod Based on Bipolar Valued Fuzzy Sets

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ABSTRACT

This paper discusses the theory of fuzzy and bipolar valued fuzzy sets and apply this theory to solve a decision-making problem for selecting TMT rods for better building construction. The opinion of the experts in the optimal selection of the TMT rods is analyzed in this study using extensive index of a Bipolar valued fuzzy number.

Keywords: Bipolar valued fuzzy number, Decision set, Bipolar valued fuzzy decision set, Extensive index.

1.Introduction:

Good planning makes it simpler to execute any types of work, especially bigger projects like concrete constructor. The material for construction could not compromised because it determines the longevity of building.The main construction materials are such as TMT bar,Cement,sand, Bricks etc.Out of all these, TMT bar is one of the most important components in construction that bond with reinforced cement concrete.It is always recommended to buy the TMT bars from reputed brands. The intricacies of building process may not be understood only by reference information available; we might need some expert and experienced guidance. Here are some people like Architect,Civil engineer,Material engineer,Construction supervisor,experienced home builder etc.who can help us to choose the perfect TMT bars for our decision making problem. To make this problem very efficient, we use fuzzy and bipolar fuzzy concepts.

In 1965, Zadeh [10] introduced the notion of a fuzzy subset of a set. Since then it has become a vigorous area of research in different domains. There have been a number of generalizations of this fundamental concept such as intuitionistic fuzzy sets, interval-valued fuzzy sets, vague sets, soft sets. In 1994,W.R. Zhang [11] introduced bipolar fuzzy set and relations and Lee [4] introduced the operation in bipolar-valued fuzzy sets. Bipolar-valued fuzzy sets are an extension of fuzzy sets whose membership degree range is enlarged from the interval [0, 1] to [−1, 1]. In a bipolar-valued fuzzy set, the membership degree 0 means that elements are irrelevant to the corresponding property, the membership degree (0, 1] indicates that elements somewhat satisfy the property, and the membership degree [−1, 0) indicates that elements somewhat satisfy the implicit counter-property. Bipolar-valued fuzzy sets and intuitionistic fuzzy sets look similar each other.

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In this paper, bipolar valued fuzzy number and bipolar valued Fuzzy decision sets are used to decision making problems for TMT rod selection with help of some experts and researchers.

2.Preliminaries:

Definition. 2.1. A fuzzy set in anon empty set η is a mapping,Υ:$\eta\rightarrow$ [0,1] for each p in η.

Definition 2.2.A bipolar valued fuzzy set $(B_iFS)\eta$ in P is defined as an object of the form η = {<p, η^+(p), η^-(p) >/ p∈P}, where η^+: P$\rightarrow$ [0, 1] and η^-: P$\rightarrow$ [–1, 0]. The positive membership degree η^+(p) denotes the satisfaction degree of an element p to the property corresponding to a bipolar valued fuzzy set η and the negative membership degree η^-(p) denotes the satisfaction degree of an element p to some implicit counter-property corresponding to a bipolar valued fuzzy set η.

Example. Considerη = { < p, 0.7, –0.4>, < q, 0.5, –0.8>, < r, 0.4, –0.5> } is a B_iFS of P = { p, q, r }.

Definition. 2.3. Let η be the fuzzy decision set and is denoted by M_p^D and is defined by M_p^D ={ $\beta_{M_p^D}(p)/p: \epsilon P$} which is a fuzzy set over P and its membership function $\beta_{M_p^D}$ is defined by $\beta_{M_p^D}$: P$\rightarrow$ [0,1], where $\beta_{M_p^D}(p)$ = $\frac{1}{|K|}\sum_{i=1}^{n}\beta_p(P)$,where K is the number of characteristics influences the particular population.

Definition. 2.4. The extensive index of a B_iFN, E_p= $\{\beta_p^+, \beta_p^-\}$ is defined as

EI(E_p) = $\beta_p^+(1+(\beta_p^+)^2)+\beta_p^-(1+(\beta_p^-)^2)$ .This EI is used to identify an ideal solution from the various objects from given population.

Definition. 2.5. A bipolar valued fuzzy decision set (B_iFSD) in P is defined by $B_iM_p^D$={$(\beta_{M_p^D}^+(p), \beta_{M_p^D}^-(p))/ p\epsilon P$}, where $\beta_{M_p^D}^+$: P$\rightarrow$ [0,1] and $\beta_{M_p^D}^-$: P$\rightarrow$ [0,1] are the positive and negative membership degrees respectively, such that $\beta_{M_p^D}^+$ =$\frac{1}{|K|}\sum_{i=1}^{n}\beta_p{}^+(P)$ and $\beta_{M_p^D}^-$ =$\frac{1}{|K|}\sum_{i=1}^{n}\beta_p{}^-(P)$.

3. **Actual Data analysis for selecting TMT Rod:**

The real data analysis is taken for the study of this decision making problem. The builder must keep in mind that the selection of appropriate material must be at bar with the design and careful consideration of contextual preconditions. Builder wants to select the best TMT bars in a particular location for the construction. The bipolar valued fuzzy methodology has been applied for the optimal selection of TMT bars.

The optimal selection is taken from the 5 popular types of TMT bars, T_1 , T_2 , T_3, T_4 and T_5.A builder has to measure the strength of a bar by considering the five unique characteristics of its Gradation, Brand and Certification, Manufacturing Technique, Rust resistance and Bending Ability and are named as C_1 , C_2 , C_3 , C_4 and C_5 . To make more precise,Ten experts in the field of construction are consulted about the characteristics of various types of TMT bars.

The committee of experts will give their opinion in the form of linguistic terms and later can be converted into the membership value with the help of the table.

Linguistic Term	Positive membership	Negative membership
Completely satisfy	1	-0.2
Strongly satisfy	0.8	-0.4
Satisfy	0.5	-0.6
Strongly dissatisfy	0.3	-0.7
Completely dissatisfy	0	-0.9

For instance, an expert may give the comment that the positive membership value of first TMT bar T_1 is strongly satisfy the characteristics Gradation, completely satisfythe characteristics Brand and Certification, Satisfy the characteristic Manufacturing technique, strongly dissatisfy the characteristic rust resistance and satisfy the

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characteristic Bending ability and negative membership values have been assigned based on relative grade values from the experts.

On the basis of expert's opinion, we construct a bipolar fuzzy set T_1 as follows,

T_1 ={(p_1,0.8,-0.4),(p_2,1,-0.2),(p_3,0.5,-0.5),(p_4,0.3,-0.7), (p_5,0.5,-0.2)}

In the similar way, we can construct the following bipolar fuzzy sets

T_2 ={ (p_1,0.5,-0.6),(p_2,0.8,-0.8),(p_3,1,-0.2),(p_4,0.5,-0.4), (p_5,0.8,-0.6) }

T_3 ={ (p_1,0.3,-0.7),(p_2,0.5,-0.4),(p_3,0.8,-0.6),(p_4,1,-0.2), (p_5,0.3,-0.7) }

T_4 ={ (p_1,1,-0.7),(p_2,0.5,-0.6),(p_3,0.3,-0.4),(p_4,0,-0.8), (p_5,0.8,-0.2) }

T_5 ={ (p_1,0.8,-0.4),(p_2,0.3,-0.6),(p_3,0.7,-0.2),(p_4,0.5,-0.7), (p_5,0.8,-0.4) }

The above bipolar valued fuzzy sets can be written in the tabular form as follows:

P	**P_1**	**P_2**	**P_3**	**P_4**	**P_5**
T_1	(0.8, -0.4)	(1, -0.2)	(0.5, -0.5)	(0.3, -0.7)	(0.5, -0.2)
T_2	(0.5,-0.6)	(0.8,-0.8)	(1,-0.2)	(0.5,-0.4)	(0.8,-0.6)
T_3	(0.3,-0.7)	(0.5,-0.4)	(0.8,-0.6)	(1,-0.2)	(0.3,-0.7)
T_4	(1,-0.7)	(0.5,-0.6)	(0.3,-0.4)	(0,-0.8)	(0.8,-0.2)
T_5	(0.8, -0.4)	(0.3, -0.6)	(0.7, -0.2)	(0.5, -0.7)	(0.8, -0.4)

The B_iFSD set $B_iM_p^D$ has been attained by using the definition 2.5.

$B_iM_p^D$ = { (0.62, -0.4)/T_1 , (0.72,-0.52)/ T_2 , (0.58, -0.52)/ T_3, (0.52, -0.54)/ T_4, (0.62,-0.46)/ T_5 }

The Extensive index for all T_i's using the definition 2.4 is as follows

EI(T_1)= 0.3943

EI(T_2)= 0.4326

EI(T_3)= 0.1145

EI(T_4)= -0.0369

EI(T_5)= 0.3010

From the above values, the result of analysis revealed that the type II (T_2) is the best option which include all the essential characteristics of TMT rods.

Conclusion:

In constructing field, Concrete is complete material which gives exhaustive strength for the building. our decision may get influenced by numerous information sources, preconditions, considerations and other factors involved in the concrete construction. For best selection of TMT rods, the builders are using different technologies like bipolar valued fuzzy set with the application of experiments by considering positive and negative values of the responses from the experts views.This application magnifies the results and helps in decision making in the selection of TMT rods.

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