Decision Support System for HCS Material Selection

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ABSTRACT

Selection of correct and optimize way of the material is one of the immense important requirement for manufacturers. Increasing demand of manufacturing products and their variants makes this selection procedure more complicated and requires greater expertise involvement and hence takes more time. Eventually the selection is based on the previous records and performance of the available material with some suggestions from the expertise. This study tries to propose the way of selection of material for helical compression spring with reference to part requirement such as modulus of elasticity, tensile strength, modulus of torsion, Rockwell hardness and cost. The study reveals the part and process requirement for efficient and economical output through material selection. Such material selection decision support system enables conflict free decision making which routes to the minimization of rejection and rework time.

Keyword : *MCDM, Selection of Alternative, Ranking of Alternatives*

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1. INTRODUCTION

Decision Making is the complex action of selection amongst two or more alternatives. The typical MCDM problem deals with the evaluation of a set of alternatives in terms of a set of decision criteria. Although, there are certain chances of neglecting the better solutions on the basis of considerations of other important criteria's for selection. In business context, MCDM problems are more complicated and usually of large scale. Multiple-criteria evaluation problems consist of a finite number of alternatives, explicitly known in the beginning of the solution process. In Multiple criteria design problems the alternatives are not explicitly known. An alternative can be found by solving a mathematical model. The number of alternatives is either infinite or not countable or typically very large if countable. The MCDM problems divided into two major classes with respect to the way the weights of the alternatives are determined: Compensatory and Outranking Decision Making. The example of the former is Analytical hierarchy Process (AHP) and the latter is Elimination and Choice Expressing Reality (ELECTRE). The basic working principle of any MCDM method is same. Selection of Criteria, Selection of Alternatives, Selection of Aggregation Methods and ultimately Selection of Alternatives based on weights or outranking. While selecting the most suitable material from an ever increasing array of feasible alternatives, with each having its own characteristics, applications, advantages and limitations, the designers should have a clear understanding of the functional requirements for each individual component and a detailed knowledge of the considered criteria for a specific engineering design. Improper selection of material may often lead to huge cost involvement and ultimately drive towards premature component/product failure. Selection of proper materials for different components is one of the most challenging tasks in the design and development of products for diverse engineering applications. So the designers need to identify and select proper materials with specific functionalities in order to obtain the desired output with minimum cost involvement and specific applicability. Selecting the most appropriate material in the presence of multiple, generally conflicting criteria is a typical multi-criteria decision-making (MCDM) problem. Thus, a systematic and efficient approach to material selection is necessary in order to select the best alternative for a given application.

2. LITERATURE REVIEW

The role that materials play in the design and proper functioning of the products has already been well acknowledged. An incorrectly selected material for a given product may cause premature failure of the final product. The right choice of the available material is critical to the success and competitiveness of the manufacturing organization.Kaiser et al. [1] reported on procedure and preliminary research results of long-term fatigue tests up to a number of 109 cycles on shot peened helical compression springs with two basic dimensions, made of three different spring materials. Pollanen et al. [2] proposed optimum design of the spring which minimize of wire volume, space restriction, desired spring rate, avoidance of surging frequency and achieving reliably long fatigue life. Prawoto et al. [3] discussed about automotive suspension coil springs, their fundamental stress distribution, materials characteristic, manufacturing and common failures. Berger and Kaiser [4] reported that the results of very high cycle fatigue tests on helical compression springs which respond to external compressive forces with torsional stresses. Ronald E. Giachetti [5] stated that the material and manufacturing process selection problem is a multi-attribute decision making problem. These decisions are made during the preliminary design stages in an environment characterized by imprecise and uncertain requirements, parameters, and relationships. Material and process selection decisions must occur before design for manufacturing can begin. S. Krishna et al. [6] achieved a composition of alloy has to be precisely correlated at a state of best alloy combination to make good resilience spring ranging from 2mm- 3mm wire thickness which can be achieved by a proper selection of alloys with different aspects of mechanical properties in a real time power generation device for rapid movement of the rack and pinion power generator. Athreya Srinivas et al. [7] studied orthogonal array, signal-to-noise ratio, and the analysis of variance are employed to study the performance characteristics on facing operation.

3. METHODOLOGY

3.1 Analytical Hierarchical Process (AHP)

One of the most popular analytical techniques for complex decision making problems is analytic hierarchy process. Saaty developed AHP, which decomposes a decision making problem in to a system of hierarchies of objectives, attributes and alternatives. In this study AHP is used to calculate weight ages and confirm the consistency.

Table 3.4 : Pair Wise Comparison Matrix

	Tensile Strength	**Modulus of Elasticity**	**Modulus of Torsion**	**Rockwell hardness**	**Cost**
Tensile Strength	1	1	2	2	1 1/2
Modulus of Elasticity	1	1	3	3 1/2	4
Modulus of Torsion	1/2	1/3	1	2	1 ½
Rockwell Hardness	1/2	2/7	1/2	1	2 ½
Cost	0.66	0.25	0.66	0.4	1

The geometric mean method of AHP is used to find out the relative normalized weights of the attributes because of its simplicity and easiness to find out the maximum Eigen value and to reduce the inconsistency in judgments. The above matrix is treated as A1 matrix in case of consistency test

Table 2: Geometric Mean

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Criteria	GM_j
Tensile Strength	1.43
Modulus of Elasticity	2.11
Modulus of Torsion	0.87
Rockwell Hardness	0.70
Cost	0.53

After preparing the matrix normalize it & find the weight of the each criterion is calculated as follow.

Table 3: Relative Weight

Parameters	Weight
Tensile Strength	25
Modulus of Elasticity	38
Modulus of torsion	15
Rockwell Hardness	13
Cost	9

4. RESULT AND DISCUSSION

The relative weight of the various parameters which affect the selection of the spring material is found out and from the calculations it can be state that the percentage contribution of the modulus of elasticity for selection of the material affects greatly

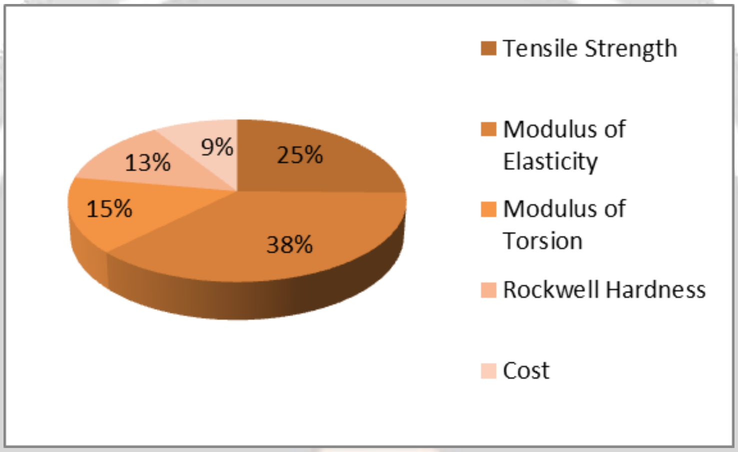

Figure 1: Relative Weight Distribution of Material Parameters

5. CONCLUDING REMARK

When the fatigue loading is applied on the spring it tends to buckled and deforms on its application. The solid height of the spring changes and failure occurs near base of the spring. The analytical approach to assign weight to the different parameters helps to focus on the desired parameters.

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