

Materials Science, Mechanical Structures and Engineering

Edited by
Salmah Husseinayah



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Materials Science, Mechanical Structures and Engineering

Selected, peer reviewed papers from the
2014 2nd International Conference on
Mechanical Structures and Smart Materials
(2nd ICMSSM 2014),
August 16-17, 2014, Kuala Lumpur, Malaysia

Edited by

Salmah Husseinsyah



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Preface

Dear Distinguished Authors and Guests,

The Organizing Committee warmly welcomes you to the 2014 2nd International Conference on Mechanical Structures and Smart Materials (2nd ICMSSM 2014), held in Kuala Lumpur, Malaysia, August 16-17, 2014.

The topics of ICMSSM 2014 cover different areas of Mechanical Structures and Mechanical Engineering, Material Science and Engineering, Materials Manufacturing and Processing .The peer-reviewed, selected papers and additional lectures with breakthrough contributions enlighten the technical program. Apparently, the conference program is extremely rich, professional, and featured with high-impact. The aims of the conference therefore provide an excellent platform for participants to exchange and share new ideas and practical experiences, to establish business or research relations and to search global partners for future collaboration.

We earnestly hope that the conference proceeding can contribute and provide you for significant and improved knowledge in the contemporary scientific and material fields.

On behalf of the organizing committee, I would like to thank Anne, Tanja, Dorte and all the editors from Trans Tech Publications for their great support to ICMSSM 2014. Without their excellent editorial work, the proceedings of ICMSSM 2014 cannot be published so timely and successfully.

Finally we wish all the authors and attendees a unique, rewarding and enjoyable memory at the 2nd ICMSSM2014 in Kuala Lumpur, Malaysia. We look forward to your participation in the 3rd ICMSSM in 2015.

With our warmest regards,

Jenny Ji

Conference Organizing Chair

August 26, 2014

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CHAPTER 1:
Materials Science

The Fuzzy Comprehensive Evaluation of 18Cr2NiWA's Cutting Processing Performance

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Keywords: 18Cr2NiWA; cutting performance; fuzzy comprehensive evaluation

Abstract. The evaluation of material cutting performance is a complicated and comprehensive process. Only by using the fuzzy comprehensive evaluation way can we get a satisfactory result. This essay, on the basis of fuzzy theory, illustrates the steps of fuzzy comprehensive evaluation, introduces the factors influencing 18Cr2NiWA's cutting processing performance, gives a fuzzy evaluation of the factors, and thereby successfully solves the problems regarding these multi-factors' decision and evaluation.

0 Introduction

We should consider all aspects of factors because the things have variety of attributes or are affected by many factors. Fuzzy comprehensive evaluation means to make decision and overall evaluation of factors affected objects or phenomena, it is a mathematical tool for fuzzy synthetic decision.^[1]

1 The basic steps of fuzzy comprehensive evaluation

First, we should make a independent evaluation according to each factor, and then click the all factors comprehensive evaluation, which mainly comprises the following steps:

(1) Analysis of the influence of elements

The factor set refers to the various important factors affecting evaluation objects as a collection of elements, the commonly used U said, $U = (u_1, u_2, \dots, u_n)$.

(2) Determine the weight number

In order to reflect the importance of each factor, the factors of u_i should be given a corresponding weight a_i , the form by the weight set $A = (a_1, a_2, \dots, a_n)$ is be called the weight number,

and each weight should satisfy the normalization, $\sum_{i=1}^n a_i = 1, a_i \geq 0$.

(3) Evaluation results

The judge may make the evaluation objects of all kinds of the total evaluation results of the set, usually expressed in V, $V = (v_1, v_2, \dots, v_m)$

(4) Single factor fuzzy evaluation matrix

We can separate from a factor to determine membership about the evaluation set elements and the alternative element set, first, we judge factor u_i included in the i according to the evaluation object, the j element of u_j evaluation factors on the u_i concentration of membership degree is r_{ij} ($0 < r_{ij} < 1$), the single factor evaluation is in $R_i, R_i = (r_{i1}, r_{i2}, \dots, r_{im})$, Then the single factor evaluation matrix is

$$R = \begin{pmatrix} r_{11} & r_{12} & \dots & r_{1m} \\ r_{21} & r_{22} & \dots & r_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ r_{n1} & r_{n2} & \dots & r_{nm} \end{pmatrix}$$

The single factor evaluation matrix can actually be regarded the fuzzy relation matrix between set of U and the alternative set of V, it is expressed as:

$$R_i = \frac{r_{i1}}{(u_i, v_1)} + \frac{r_{i2}}{(u_i, v_2)} + \dots + \frac{r_{in}}{(u_i, v_n)}$$

(5) Fuzzy comprehensive evaluation matrix

We must consider all of the influencing factors to obtain correct and comprehensive evaluation result, single factor fuzzy evaluation reflects only one of the factors that affect the evaluation object, so his will be through the fuzzy comprehensive evaluation in order to achieve the desired effect.^[2]

$$B = A \circ R = (a_1, a_2, \dots) \begin{pmatrix} r_{11} & r_{12} & \dots & r_{1m} \\ r_{21} & r_{22} & \dots & r_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ r_{n1} & r_{n2} & \dots & r_{nm} \end{pmatrix} = (b_1, b_2, \dots, b_m)$$

2 The solution that meet the processing properties of materials and conform to fuzzy evaluation on 18Cr2Ni4WA

The cutting performance of the artifact material mainly depends on the material mechanics, physical properties (such as hardness, strength, ductility, toughness and thermal conductivity), the chemical composition and microstructure is the main factors affecting the mechanical, physical properties, so the machining properties of materials is not a single basic attribute, it is the comprehensive reflection of some basic properties of the material, rather than a comprehensive performance, we should use an index system and evaluation guidance not a single index.^[3]

The traditional methods for evaluating materials cutting performance mainly use the relative processing, such as:

- ① Tool life or cutting speed of the life;
- ② Cutting forces or cutting temperature;
- ③ Surface quality;
- ④ The difficulty level of chip breaking.

In fact, those are some fuzzy concept no absolute boundaries, such as a material easy cutting, easier cutting or hard cutting, there are many fuzzy in the evaluation of Material cutting performance. Moreover, we only use fuzzy comprehensive evaluation to evaluate the processing performance of material in order to get the convincing results, because the evaluation of processing performance of materials is a complex and comprehensive process.^[4]

18Cr2Ni4WA can be used in the case of tempering treatment but no carbonization, it belongs to the common low carbon alloy steel, high strength and good hardenability. The mechanical factors affecting the cutting performance: hardness, tensile strength, elongation, impact toughness, thermal conductivity, the physical and mechanical properties of the material are shown in table 1.