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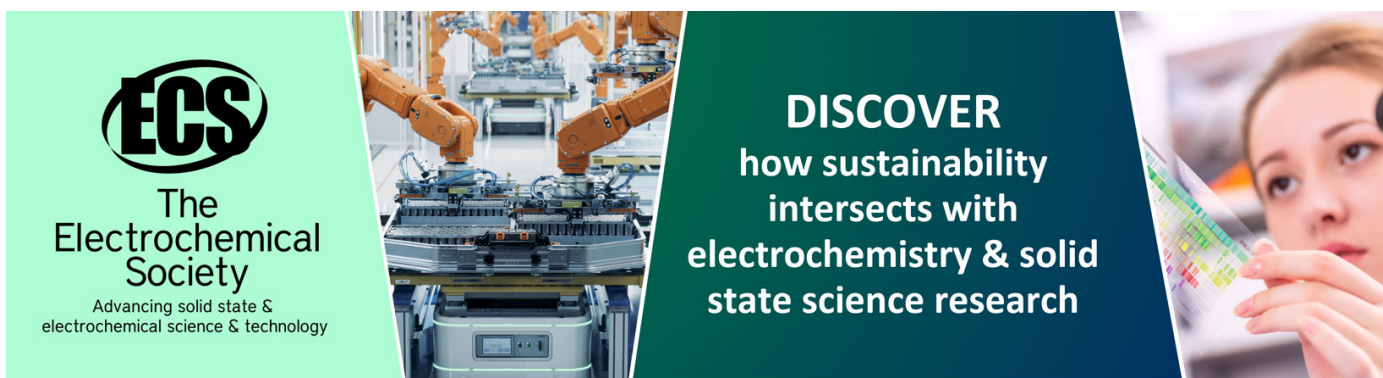
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A review of fatigue life prediction method for portal crane

Li-xin Ren^{1,a}, Jian-qiang Ma², Yao-ting Tong¹, Zheng-qiu Huang¹

¹Shanghai Institute of Special Equipment Inspection and Technical Research, Shanghai, 200062

²Shanghai Minhang District Special Equipment Inspection Institute, Shanghai 201199

^aemail: renlx@ssei.cn,

Abstract: The primary damage cause of crane is fatigue damage. The fatigue life prediction method determines service life and the design of the crane. So it is very important to study the prediction method of fatigue life. This paper summarize the existing prediction methods of fatigue life systematically. The research of fatigue life was involved in mechanics, metal material ,vibration mechanics, fracture mechanics, fatigue theory and so on, which made a difference between the predicted result and the actual life. The development of the fatigue life evaluation methods are promoted because of the application of new skills, but it still needs more learning.

1. Introduction

With the development of logistics industry in the world, portal crane is widely used in shipyards and ports because it is a large lifting equipment to improve the production capacity of loading and unloading operations. The trend of portal crane are high reliability, high-speed, low energy consumption and intelligence, long life, large-scale, automation and environmental protection^[1]. The safety accidents of portal crane occur from time to time because it is a special equipment [2]. At present, due to historical reasons, there are many portal cranes in China's ports with potential safety hazards. Fatigue is one of the primary failure forms of portal crane, and its failure process needs to accumulate, which may lead to serious consequences. A large number of welding structures are used in portal crane. There are defects and fatigue damage caused by stress concentration in the welding parts. It is necessary to study the fatigue life prediction method for portal crane. In this paper, based on probability statistics ,mechanic sand intelligent technology, three existing components of fatigue life assessment of portal crane are discussed.

1.1 PREDICTION METHOD BASED ON MECHANICS

In crane life prediction, the fatigue life prediction method based on mechanics plays an important role and is one of the most widely used methods in engineering, including prediction method based on stress / strain [3,4], fatigue damage accumulation [5], fracture mechanics [6], damage mechanics [7,8] and energy [9]. The advantages and disadvantages of various life prediction methods based on mechanics are listed in Table 1. Although the method based on the new theory can improve the prediction accuracy, there are some problems in engineering application, such as complex calculation and insufficient research. Therefore, different life prediction methods should be selected according to the actual situation. The mechanical method of prediction accuracy mainly depends on experiment and theory.



Table 1. Comparison of fatigue life prediction methods based on mechanics^[10]

Theory	Definition	Advantage	Disadvantage
Stress/ Strain	Predict fatigue life based on S-N or ϵ -N curves .	Less parameter of material Simple method Massive data accumulation	Strong experience Poor universality
Accumulation of fatigue damage	The theory of fatigue damage accumulation including linear and nonlinear accumulation	Consider the effect of variable load Ripe method	The influencing factors cannot be fully considered
Fracture mechanics	It is assumed that there is a defect in the material or component. When the SIF reaches the critical value, fracture occurs.	Consider fatigue crack propagation Explan reasonably the mechanism of fatigue crack propagation	Ignore crack stage It is difficult to calculate the SIF of complex structure
Damage mechanics	The internal damage (microcrack or micropore, etc.) of materials under external load can be identified as the continuous distribution of available performance degradation caused by material and structural damage variables.	For strain fatigue and fracture mechanics Considering the initiation stage of fatigue crack	sophisticated analysis process Insufficient
Energy	Damage caused by different load types can be called energy based damage parameters	Uniform different damage	Insufficient

2. Prediction method based on probability statistics

The application of crane life evaluation has been realized^[11,12]. The parameters such as the size of crack, material characteristics and load are regarded as certain quantities in the traditional fatigue life computation method,. But, the parameters are often uncertain in engineering application. The prediction of fatigue life should be dispersive and accord with certain distribution characteristics. The application of probability theory and statistical theory can solve the problems of discreteness and uncertainty. By combining the distribution of known parameters with the method of considering the probability of randomness, it is concluded that the remaining life contains certain reliability. The probability based life

prediction method can be combined with fracture mechanics or cumulative damage method. Due to the probability model, the reliability of traditional mechanical methods is improved, but the reliability of prediction results is limited by the sample size and probability model.

3. PREDICTION METHOD BASED ON INTELLIGENCE TECHNOLOGY

The traditional fatigue life prediction methods mainly focus on the theoretical research and experimental research, and achieve approximate quantitative or qualitative prediction through experiments and physical models. The engineering problems such as variation and randomness limit the prediction accuracy.

Although the method of probability statistics can solve the actual random problems to a certain extent, it is limited by data volume. Intelligent technologies such as big data can solve these problems. Its signal acquisition reflects the change of structural performance, and new technical algorithms such as fuzzy calculation, neural network, expert system, evolutionary algorithm and rough set theory are used to predict fatigue life, which can be used for more complex environmental conditions or structures[13,14]. However, due to lack of optimization, the prediction method by intelligent technology needs further research.

4. Conclusion

This paper summarizes the existing fatigue life prediction methods. The study of fatigue life involves mechanics, metal materials, fracture mechanics, vibration mechanics, fatigue theory and so on, which makes the prediction result quite different from the actual life. Some conclusions are as follows:

(1) Life prediction method based on mechanics uses the failure mechanism and failure mechanism of dynamic characteristics to predict the remaining life, which has been widely used in all kinds of industries.

(2) Life prediction method based on probability statistics can reflect the common rule and general characteristics of mechanical product life, but it needs a lot of data and experiments accumulation.

(3) Compared with the life prediction method based on probability statistics and mechanics, the life prediction method based on intelligent technology is the future development trend, which needs more research.

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