Crane Metal Structure Crack Monitoring Method

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Abstract. It is well-known that metal cracking is a very bad thing. Its existence exacerbates the degree of damage of the instrument. We are not willing to see it. However, all large-scale heavy equipment has a certain degree of danger. For operators, there has been a lack of effective guidance methods for the monitoring of metal structure damage for a long time. The cranes involved in this article are even more bulky. If problems arise, they will not only endanger the life of the workers, but also cause some economic losses. Due to a variety of man-made uncontrollable and complicated factors, there are no concrete simple and feasible methods for engineering cracking of some metal cracks. Therefore, it is a very important topic to study the monitoring method of cracks in metal structures of cranes. In this paper, finite element analysis is used to monitor the cracks of metal structures to a certain extent. It is believed that the proposed method is applicable to the project implementation of crack monitoring.

Key words: Crack, Crane, Monitor, Metal structure.

1. Introduction
Mechanical load-bearing structures generally play a decisive role in large-scale equipment. Its production should generally meet a certain degree of use. It is also an engineering structure, and our requirements for it are relatively high. Compared to some traditional load-bearing structures, machinery has the following advantages: Its safety is relatively high, its strength is not easy to break, but at the same time it does not bring a burden on the weight, that is to say it the quality is lighter. With the development of society, its production has also become more and more modern and has been widely used. However, for different use environments, different media to be solved, different attribute metals, and different degrees of difficulty in maintenance, the mechanical properties thereof have a great difference. In the process of assembly and use, due to artificial or unintentional long-term overload use, different weather conditions cause different weather conditions where corrosion may occur in the metal structure, which will produce metal cracks. In addition, microscopic pores and grain boundaries may be more or less cracked even if it is invisible to the naked eye. We know that cracks that are macroscopically visible to the naked eye are a serious threat to cranes. If you do not tinker with them in time, there will be no small disaster. However, the microscopic situation cannot be neglected. It will also change to a qualitative change in the long run. For example, the sudden breakage of the main boom of the large coal unloaded at the Shanghai Coal Handling Company caused
catastrophic damage. The sudden failure of the boom system of the Taiwan Ton Meter Multi-purpose Crane of the Hong Kong Moulin Company was a failure, which we did not want to see [1]. Therefore, it is necessary to monitor the size of the metal structure cracks and the extent of damage, or to further repair.

2. Determination of crack-sensitive area
If the metal structure of the crane is of uniform texture, then its crack generation largely depends on the first principal tensile stress of the internal material properties of the metal structure, and for a metal structure, it is the largest main pull. Higher stress occurs in the area of the weld. There is also a situation where if a small, tiny crack is left behind in the weld by accident, the crack will involuntarily happen and we will not consider the control activity, that is, it will slow down again and again. Slow cracks cause a critical initial spread. From the point of view of the relationship between the area of crack generation and the magnitude of force analyzed above, we can build a working model of different bad loads based on the relevant finite element analysis theory and use the powerful interactive function of ANSYS to achieve Analysis of the stress distribution gives a distribution cloud. In the general diagram of the cloud diagram, the crack-sensitive areas are marked one by one, so that they can be checked on the computer when the inspection is convenient. This is easy to do and the project implementation is relatively simple. In this way, there is no need to do a wide range of inspections. We only need to check the marked areas that have been marked in the previous step.

2.1. The basic Concept and Classification of Cracks
In our daily processing, for the sake of simplicity, we always refer to the defects of some metal structures as “cracks”, and the actual cracks are various. For example, in smelting [2], heat treatment, and welding, defects such as slag, air bubbles, etc. may be generated. In order to consider the simplicity of the problem in general, we set the radius of curvature of the place where the defect is very sharp to zero, and the material will inevitably appear crack, which is the defect [3]. Without a little precaution, these defects will also appear in the metal structure of the crane and will have unpredictable and serious consequences. What's more serious is that these microscopic cracks will grow in a specific direction, and slowly it will evolve into macroscopic cracks under the macroscopic phenomenon, which will affect the safety of production. This is very bad. If the cracks are roughly classified according to their geometric characteristics, the cracks can be roughly divided into deep-buried cracks, surface cracks, and penetration cracks, which are better handled [4].

3. Determination of crack length
We know that parts of a metal structure have a certain ability to withstand and that over-bearing parts will cause bending on the body and affect its use. This is what we least want to see [5]. We define a length parameter $a_c$, when the metal structure of the crane carries a certain mass and reaches this length, it is assumed that the bearing capacity of this metal structure is achieved, which is a very useful parameter. When this length is reached, the metal may quickly expand its structure and be destroyed accordingly.

We performed some analysis on the metal structure of H268 steel [6], and the length of the limit can be calculated using a formula:

$$ a_c = \frac{K^2}{Y^2 \sigma_t} \times 1000 = \frac{9296000}{\sigma_t} $$

(1)

Among them, we describe the shape of the metal structure with a parameter, which is $Y$, and we assume that $Y=1.12$, the unit $\sigma_t$ we define is MP, and the unit of the calculated limit length is assumed to be mm.
If we want to know the value of the critical limit length of the crack, we can know from the above formula that what we need to do is to find out the size on the tension map and then calculate the value of the limit length [7].

We define the fracture toughness as:

$$K_I \approx 90 \text{MPa}\sqrt{m}$$

In this case, the limit length of the metal structure is:

$$a = \frac{K_I}{\sqrt{Y/\sigma_0}} \times 1000 = \frac{90^2}{2050400} \times 1000 = \frac{2050400}{\sigma_0^2}$$

4. Crack diagnoses and monitoring

As we mentioned earlier, if there is obvious crack in the metal structure of the crane, it will inevitably cause some bad consequences. It even means that it will threaten the safety of everyone's lives and cause physiology and mental problems to the staff on the spot. Indelible wounds, which we do not want to see, must be avoided [8]. As of now, there are many studies on the prediction of the life of cracks in metal structures, but they are all limited [9]. Some studies focused on the metal of certain special materials. Some research focused on some simple parts with stress. Some studies concentrated on stressors that were prone to fatigue, and their research methods were relatively simple [10]. However, there is no safe, convenient and practical method for the diagnosis and control of cracks. In the following, we will seek a method that meets the needs of the site and meets the needs of the site. This is to some extent quite necessary. We strive to ensure that the method of crack diagnosis and control can be found as far as possible, while also ensuring the safety, ease of implementation, effectiveness, and simplicity of the proposed method [16]. Spectral analysis methods, modal analysis methods, acoustic emission methods, etc. are currently available diagnostic methods which can be roughly used. However, since these methods are not very good for crack sensitivity or positioning accuracy performance, it is clear that these methods in the field, there will be no effective application. If we do so, we must think of other methods to do a certain replacement [11]. For the sake of safety and simplicity of the experiment, we simplified the cracks in the metal structure by forming cracks. For sensitive areas, we can use the finite element analysis method to display the distribution map [12], that is to say, the places with high tensile stress are most likely to produce cracks. In this way, the diagnosis of cracks can be performed. The method is very simple. On the stress map, we can find the stress in this part of the crack in the corresponding part [15], and combine the parameters to get a series of what we want [13]. Although this method is somewhat crude and inaccurate, it can solve some problems after all. I believe it will be welcomed by everyone. The detailed process is shown in the figure 1 below.

![Figure 1. The detailed process](image)
5. Conclusion
This paper considers the crack problem of metal structures from the perspective of using the public. Taking the elasticity mechanics, mathematics, computer science, and simulation science as the starting point, it focuses on the metal structure fault-cracking of cranes, a thorny issue [14]. Taking into account the scientific nature, convenience, and feasibility, we will develop a series of software for this issue to facilitate public use. This article has initially solved the monitoring problem of metal cracks in the load-bearing structure of large cranes. Experiments have shown that this method is very good, and it can be said that we have achieved the expected best results to some extent, and we have reason to believe that the implementation of the project. It is very helpful.

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