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Empirical Study on Fatigue Performance of Welded Square Pipe Joints in Steel Structure

YipingHe[1,*]
[1]Sichuan College of Architectural Technology, Deyang, Sichuan, China, 618000

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Abstract

The fatigue performance of welded square pipe joints exists in steel as an independent phase, which destroys the basic continuity of steel and increases the non-uniformity of steel structure.Therefore, the fatigue properties of welded square pipe joints in steel have a strong influence on the properties of steel.With the development of modern engineering technology, the requirements of steel strength, toughness and machining performance are increasingly strict, so the requirements for steel materials are also becoming higher and higher. By analyzing the source and distribution of the fatigue performance of welded square pipe joints in steel and the influence on the quality of steel, this paper analyzes the non-metallic sundries in steel for readers' reference.

Keywords: *Nonmetal, Inclusions, Metallographic Analysis, Microscopic Identification;*

1. Introduction

The development of modern engineering technology is very rapid, and the steel strength, toughness and processing performance requirements are gradually increased, just the quality requirements are also gradually increased. As an independent phase, non-metallic impurities exist in the steel. The existence of non-metallic impurities results in the destruction of the continuity of the steel and the increase of the non-uniformity of the overall steel structure, thus having a very severe impact on the performance of the steel. The fatigue property, shape, size and other factors of welded square pipe joints are different, and the influence on the steel performance is also different.So in order to further enhance the quality of the metal material and non-metallic impurities content less clean steel production, the need to control non-metallic inclusion content, and this is a very difficult task in the process of metallurgy, for metallographic analysis of the workers should also start from identification and separation of non-metallic impurities, improving the quality of metal materials[1].

The fatigue properties of welded square pipe joints should be observed and judged in color, shape, size and distribution by metallographic microscope, and the color and transparency of inclusions should be observed under dark field.Then the optical properties of various inclusions were observed under the orthogonality of polarized light and the different types of inclusions were analyzed. At the same time, according to the distribution of inclusions and the corresponding number, the relevant grades can be evaluated, and the influence of the fatigue performance of these welded square pipe joints on the performance of steel can be judged[2, 3].At present, there are many methods to identify and treat the fatigue performance of welded square pipe joints in steel, including chemical treatment, lithofacies, metallography, electron probe and electron scanning.Based on metallographic method, the fatigue properties of welded square pipe joints in steel are tested and analyzed in depth.

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2. Source classification of fatigue performance of welded square pipe joints in steel

2.1. Endogenous inclusion

The so-called endogenous inclusion refers to the inclusion formed by various physical and chemical reactions in the smelting process of metal. Generally speaking, the distribution of such inclusion is relatively uniform and has the characteristics of small particles.

2.2. Foreign inclusion

The so-called foreign inclusion refers to the contact and exchange of materials between the metal and the outside world during the smelting process, and further related effects occur. For example, the corresponding sand on the surface of the charge and the lining of the furnace can interact with the gold liquid, and can form a certain amount of slag, trapped in the metal interior. It is also possible that some flux is added to the outside world during this process, and such inclusions are characterized by irregular shape and larger overall size[4].

3. Metallographic analysis of fatigue performance of welded square pipe joints in steel

3.1. Influence of sample preparation on inclusion identification

The sample preparation process is closely related to the overall steel quality, and if the ordinary metallographic sample preparation method is used, it is likely to cause a large number of inclusions to flake off, resulting in a serious "trailing" situation.If we want to observe the different shape, size and distribution of inclusions accurately, we need to conduct more thorough metallographic detection. The surface of a considerable part of samples is relatively rough, and the effects of anisotropic energy inclusions in different directions can be weakened, resulting in corresponding errors in judgment. Therefore, to identify the different types of inclusions, it is necessary to prepare the corresponding non-metallic samples carefully, so as to ensure the surface smoothness and at the same time make the phase boundary contour of the inclusions relatively clear, so that there is no "trailing" situation. Further preparation of metallographic samples is needed to determine the inclusion characteristics more accurately[5, 6].

3.2. Characteristics and identification of fatigue properties of welded square pipe joints in steel under microscope

3.2.1. Field observation under clear vision.

The shape and distribution of inclusions can be clearly observed in the clear field, including the distribution of debris, deformation, quantity of debris, and organizational characteristics, so as to further identify the different species of inclusions.

3.2.2. Appearance of inclusion

Different inclusions have different geometric shapes and have certain rules according to the elements in them. For example, the appearance of spherical SiO2 is similar to glass, and the outer light of FeO is oval.

3.2.3. Distribution of inclusion

Generally speaking, the silicate is distributed in the shape of a single solitary particle, but at the same time, some oxides are clustered in groups and show a series distribution, such as Al2O3, FeO, MnO, etc., and inclusions are distributed along the crystal boundary.

3.2.4. Transparency and color of inclusions

In terms of physical characteristics, the transparency of inclusions can also be classified. The inclusion with higher transparency has higher reflective property in dark field, for example, silicate has more obvious reflective property in most dark field. And it's transparent in the dark. Some of the corresponding sulfides and iron oxides do not have specific reflexive ability. Different impurities in the open field and the dark field are also different, showing a variety of colors.

3.2.5. Quantitative analysis of inclusions

The fatigue properties of welded square pipe joints in steel can be analyzed and measured effectively by metallographic method.The metallographic method refers to the determination of inclusions in steel by means of metallographic microscope based on length

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index method. Comparison should be made because the overall inclusion content of the sample under test is different, and should be compared with the standard rated picture to analyze the amount, distribution and shape of the inclusion[5, 6].According to China's current yB25-77 general standard, the inclusion can be divided into brittle inclusion and plastic inclusion according to its plasticity and corresponding classification. The determination results include: the inclusion level of different experimental samples is not enough;The highest arithmetic mean of inclusions in test samples;The highest level of inclusion synthesis of different samples.At the same time, the diameter of the field of view should be adjusted in the process of evaluation. The length and number of different inclusions in 15 field of view were measured by micrometer eyepiece, and the total content of different inclusions was calculated by multiplying by exponent.

3.3. Influence of fatigue performance of welded square pipe joints on steel quality

Although the content of non-metallic inclusions in most steels is not large, it plays an important role in the quality of steel products. And the presence of sulfide is likely to lead to hot brittleness of steel. In the cold state of steel, the presence of partial inclusions will affect the strength and ductility of steel, and the hard inclusions will significantly reduce the cross-section shrinkage of steel. The non-metallic inclusions also have a certain influence on the tensile strength of steel, leading to plastic fracture when good steel is broken. When there is segregation or distribution of inclusions in steel, the fracture usually starts from these places, leading to a sharp decrease in the overall strength of steel. As for the larger inclusions, the presence of such inclusions also causes different influences on the overall steel samples, resulting in folding, folding and faults, etc., all of which are caused by improper operation and a large number of inclusions remain in the steel.

4. Determine the mechanism scheme of interarm welding steel structure

More and more researchers have carried out in-depth and effective research on the combined power combination control of parallel welded steel structure mechanism. References are used to measure the working pressure of welded steel structure, and the signal is used to determine the position of the electric governor.After some specific regulation, make the output power of the motor and the actual hydraulic system can match the required power, the control methods according to the actual load demand control motor, so that the hydraulic pump matching the actual motor power of the motor, but at the same time the corresponding feedback signals are not effective feedback, the team or the motor is equipped with hydraulic pump valve actuator fuel supply control, hydraulic pump power control, load sensing valve differential pressure control and proportional valve output.

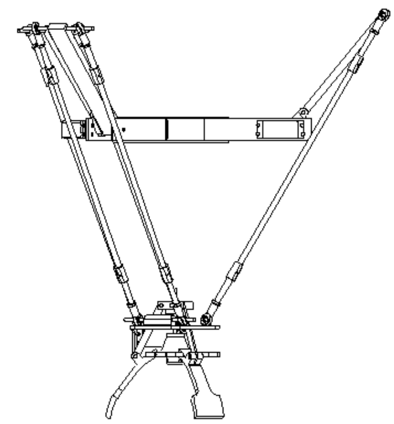

Figure. 1 Schematic diagram of the interlocking arm.

As shown below, the main function of the formula is to obtain the result of the freedom of space mechanism:

$$F = 6(n - g - 1) + \sum_{i=1}^{g} f_i \quad (1)$$

The working device of this design, in which the moving arm is connected with the bucket rod, which is connected with the bucket through the rocker mechanism.Among them, the moving arm moves with the bucket, the bucket moves with the bucket,

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are driven by the electric push rod which is connected in two.The moving arm and the whole working device will swing up and down along with the telescopic electric push lever of the moving arm. The electric push lever of the bucket is used to rotate around the upper hinge point of the arm, so that the bucket can be hinged to the front end of the arm.The bucket's electric push rod and connecting rod are used to rotate the bucket around the front hinge point of the arm.

Here take $n = 8,\quad g = 9,\quad \sum_{i=1}^{15} f_i = 15$

$$F = (n - g - 1) + \sum_{i=1}^{g} f_i = 6(8 - 9 - 1) + 15 = 3$$

When the manipulator's electric push rod works and the other two components (bucket and bucket) remain stationary at the maximum Angle, the collection stroke will be maximized in the maximum collection radius. The final excavation height and excavation depth (not the maximum excavation depth), i.e. the beginning and end point of the arc, are the maximum inclination Angle of the load and the downward slope (load and Angle horizontal line), which are determined by the motion of the movable arm electric push rod. Although the collection length is large, it is not often collected in this way.

4.1. Transmission mechanism scheme determination

In order to realize the transport of welded steel structure to a certain position, the transmission mechanism is driven by motor.At the moment, the electric solution is basically to operate the device using an electric putter, which USES electricity to change the transmission structure by adding power to your traditional hydraulic system, and an electric motor will replace a welded steel motor.By operating and controlling the speed of the motor to control the working state, so as to carry out working conditions; But the hydraulic pressure is to use the hydraulic can make the working device to carry on the collection working condition, needs to weld the steel structure engine.

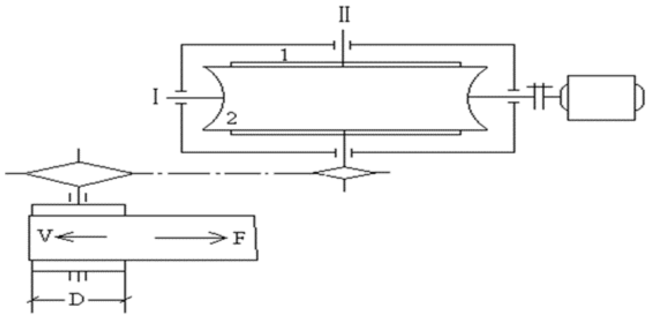

Figure. 2 Transmission mechanism diagram.

4.2. Performance requirements of the control system

4.2.1.General control systems have the following control requirements:

Smart picking robotic arms are now almost everywhere on the market.Electric is in the ascendant, almost can not see electric in the market, and you can see that it is also a small electric, now if you create electric, improve, wait until the technology is mature, you can get a better prospect, from the industry leading technology and development planning to get the first chance, so as to achieve some commercial purposes.

4.2.2. Transition process performance

The application technology of welded steel structure is the most mature, the performance is the best and the recognition is the highest.Excellent working ability; Electric technology is just beginning, the technology is still very immature, very few manufacturers can carry out this research, the production performance is not guaranteed, there is little recognition, and the working ability has not been mentioned, belongs to the future product, but not now.

4.2.3. Steady-state error

The power source of welded steel structure is welded steel structure, which not only consumes high, but also damages the environment.The investment in welded steel structures during the work period is very large.Because of the shortage of petroleum resources, welded steel structures will be less used in the future.Electric is environmentally friendly and pollution-free, and belongs to the mainstream product direction in the future, the future

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development is much better than welding steel structure.

4.3. Selection of sensors

According to the relevant requirements of this design, it is necessary to select a reasonable location of the sensor and detection device, combined with the use of visual sensors and other components.The existence of slip sensor is to determine whether the welded steel structure is trapped and firmly in the state, and the position detection device can further detect the position of action of the welded steel structure, the existence of the sensor, etc.

4.4. Position detection device

In this design, as a whole, the welding steel structure acquisition and use methods of single bucket electric welding steel structure include the following two methods: The first is the front shovel, cutting force forward, the other is the visual backhoe cutting force back.The shovel of welded steel structure is mostly used in loading and unloading conditions, and the visual backhoe is generally used for welding steel structure acquisition operations, such as welding steel structure to collect soil under trees, etc. The working device of visual backhoe and welded steel structure are generally smaller than the shovel. The design in this paper is a small welded steel structure.Now on the market large welded steel structure, more than 100 tons are applied in the mine, using the shovel;Small welded steel structure are common in our daily life, tonnage compared to the giant welded steel structure is light, can be designed using reverse shovel as a core, welded steel structure work devices need to be further updated, on the ground force is small, but the force in horizontal direction is very big, can undertake loading and unloading conditions, the bucket volume can also be made are relatively large.

4.5. Vision sensor

The most important role of welding steel structure vision is to ensure that it can be similar to human eyes as far as possible and can effectively and directly identify different objects. Color sensing is adopted for welding steel structure in this project, and corresponding welding steel structure varieties can be distinguished according to the different colors of different welded steel structures.

5. Fatigue performances of welded square pipe joints of steel structure

The working device initially positioned the visual backhoe design. The main basis for choosing the visual backhoe is the daily life and various literature mentioned, the design of visual backhoe device to determine whether special or general purpose. Based mainly on the empirical formula of visual backhoe, the requirements of visual backhoe should be ensured, at the same time, the standards of other parts should be considered to meet the requirements. In the overall design of the special equipment, the corresponding structural treatment scheme can be determined according to different conditions, and whether the equipment meets its performance requirements under special conditions or other conditions.

5.1. Design the layout of the moving arm and the electric push rod of the moving arm

Generally speaking, there are two types of visual backhoe arm: integral and combined. These two types have their own features. The former is relatively simple in overall construction and relatively cheap in price. When the stiffness is the same, the mass of the former is lighter, and the whole moving arm will be more suitable for long-term use under the same working condition.Combined movable arm is easy to replace connected parts, suitable for a variety of working conditions, need to transfer to other will be more convenient, because easy to disassemble.The design adopts an integral moving arm, and the arrangement of the electric push rod of the moving arm is a lower type.

5.2. Design the layout of bucket rod and bucket rod cylinder

There are two kinds of bucket lever: integral type and combined type. This design is also designed to be an integral bucket lever because there is no design to adjust the length of the bucket lever. The electric

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push lever of the bucket lever is placed above the bucket lever.

6. Calculation of main parameters

6.1. Motor selection

According to the above calculation results, the synchronous speeds that can meet the requirements are respectively,, and. 750r/min 1000r/min 1500r/min 3000r/min In order to meet the various requirements, the topic selected synchronous speed motor. n = 3000r/min

6.2. Calculation of rotation speed of each shaft

$T_0 = 9.55\times106 P_0/n_0 = 9.55\times106\times4.38/2920 = 14.325\text{N.m}$;

$$T_I = 9.55\times106 P_{II}/n_I = 9.55\times106\times4.3362/2920 = 14.1818\text{N}\cdot\text{m};$$

$$T_{II} = 9.55\times106 P_{III}/n_{II} = 9.55\times106\times3.09/63.69 = 463.33\text{N}\cdot\text{m};$$

$$T_{III} = 9.55\times106 P_{III}/n_{II} = 9.55\times106\times3.03/63.69 = 454.33\text{N}\cdot\text{m}$$

GB/T10085-1988

6.3. Selection of materials

This design USES the worm material of steel, and at the same time, the worm needs material hardness of higher material to meet the requirements. 45# The power of the generator is specially reserved, and its load rate is generally between 75 and 90 percent.When calculating the external load or performance error required for vehicle operation, the lower limit is usually set at 75%, and the upper limit is usually set at 90% when the external weight is reduced or the error factor is less influential.Usually the load rate does not exceed 90%.Therefore, the total power P required by the motor of pure electric refrigerator car is:

P = Pm/((0.75 ~ 0.90) and (2)

In the calculation of the formula, 80% of the valu e of the is reasonable.The value of MA is 4500kg. The value of g is 9.8;Value of is 0.015;V Max re presents the maximum speed of 90km/h;The value of CD is 0.7;The AD was 4.61.

Pm = 1 / eta (*f* (m_a g) / 3600 argument _max + (CD AD) / 76140 argument _max ^ 3) + P_0 / eta _0 = 92.06 kW

P = P_m/0.85 = 108.31KW available

6.4. Design according to the contact fatigue strength of tooth surface

In the design process, the primary task is to determine the tooth surface contact fatigue strength, and then continues to adjust the tooth root bending fatigue strength.Consult the design manual:

$$a \geq \sqrt[3]{KT_2\left(\frac{Z_E Z_P}{[\sigma_H]}\right)^2} \quad (3)$$

(1) The specific power Pd (kW/kg) refers to that different motor powers of the total mass of the automobile are different.

Through comparison, it can be found that the general range of specific power of special purpose vehicles is:

When the value of MA is less than 5×103, the value of Pd is 0.015~ 0.021kW /kg

When the value of MA is greater than or equal to 5×103, the value of Pd is 0.0075~ 0.011kW /kg

When the value of MA is greater than 19×103, the value of Pd is 0.00478~ 0.007kW /kg

(2) Determine the load coefficient K

$$K = K_A K_\beta K_v = 1.0\times1\times1.05 \approx 1.05$$

(3) Determine the elasticity influence coefficient Z_E

(4) Determine the contact coefficient Z_P

(5) Determine the allowable contact stress $[\sigma_H]$

$$N = 60 jn_2 L_h = 60\times1\times63.69\times365\times24\times10 \approx 33475460$$

The life coefficient is calculated as

$$K_{HN} = \sqrt[8]{\frac{10^7}{334754640}} = 0.6448$$

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the $[\sigma_H] = K_{HN} \bullet [\sigma_H]' = 0.6448 \times 268 = 173MPa$

(6) Calculate center distance

$$a \geq \sqrt[3]{1.05 \times 468667 \times \left(\frac{160 \times 2.9}{173}\right)^2} = 152.405mm$$

A stands for bucket capacity.A. Quantity B. average C. average D. averageBucket width, R stands for revolving bucket.Machinery. Radius. 2 □ here.Make □ = □ Max is shovel.Dou. Four. Chief.Parameters.R, B and 2 □.Between and Q, there is a.Next several. He guan. DepartmentBucket capacity Q: The main design parameter has been given q=0.5 cubic meter

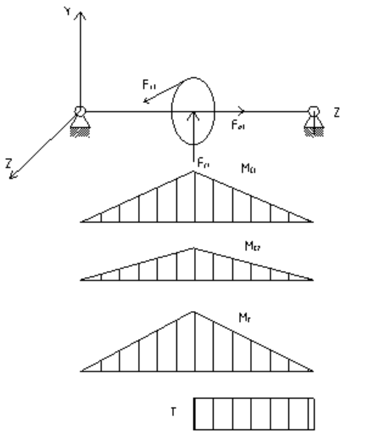

Figure. 3 Horizontal bending moment diagram.

In above 3, the movable arm and arm length than should provide enough for the backhoe mechanical force, the design process, also can't more than needed, in order to avoid wasteful, general now bucket rod and the proportion of the movable arm in middle scheme selection, usually there are three kinds of schemes, one is a long arm rod, is a kind of long rod, short arm another middle rate.The length ratio of these three is different, and the force provided will also be different. This time, the design adopts the intermediate ratio scheme.

After calculation, K1=1.8.Choose 10 = Angle KQV =95°~115°, which is equal to 100° in this design.

There are two types of backhoe arm: integral type and combined type. These two types have their own features. The former has a simple overall structure and relatively cheap price.At the same time, when the stiffness is the same, the mass of the former is lighter, and the integral moving arm will be more suitable for long-term use under the same working condition.There are two kinds of bucket lever: integral type and combined type. This design is also designed to be an integral bucket lever because the length of the bucket lever is not regulated by design. The electric push lever of the bucket lever is placed above the bucket lever, and the mechanism should not appear dead point in the whole stroke.

According to the above requirements, the Angle GFN=60° is preliminarily selected.

7. Conclusion

To sum up, although the welding of the steel tube node fatigue performance content is less, but the effects on the performance of the steel is larger, so the need for this type of steel to conduct a comprehensive testing and research, and based on the different characteristics in the inclusions in the microscope, with the method of metallographic microstructure can be more comprehensive appraisal level of fatigue performance of welded square tube node, according to the different standards for the quality of the steel, find out the corresponding law at the same time, also as far as possible to reduce the harmful non-metallic impurities, improve the overall quality of steel.

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