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DIAGNOSTICS OF REMAINIG LIFE OF MACHINE PARTS

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Summary: *Paper considers the task of forecasting of individual remaining resource of metal wares of bridge cranes when their life time corresponding to norm is elapsed. Decision of the task is based on application of Integral Strain Gauges. The feature of used for this goal gauges is varying sensitivity to accumulated fatigue damages. Authors have developed effective methods of determination of equivalent number of loading cycles and equivalent stresses of researched places with the help of gauges.*

1. Introduction

Determination of metal constructions remaining life is very important task for prevention of damage of crane with elapsed projected service life. In present time this task is usually solved by calculations. However often main initial data about real loading of metal construction are absent. Therefore these calculations are not effective. Known methods are taken no account real stress-strain conditions of construction and fatigue capacity depending on service conditions.

2. Main part

The paper considers design-experimental method of diagnostic of remaining life of metal crane constructions. Method is based on using of features of Integral Strain Gauges (ISG) reactions as result of cyclic loading of samples and construction (Syzrantsev and others, 1997; 1998; 1999). ISG reaction (appearance and increasing of "dark spots" on surfaces with size to 0.1 mm) characterizes process of accumulation of fatigue damages in base metal.

Realizing of method is as follows. ISGs with variable sensitivity along length for cyclic deformation amplitude were used for experiments. Status of "dark spots" on gauges surfaces depending of operating stress levels was fixed using microscope and digital camera and base line of their finish was estimated. Gauges were placed on crane construction near geometry thickeners of stresses and welds. Gauges were oriented by base line in thickeners direction. About 10..12 gauges were placed on every of 6 estimated cranes. Information of gauges was

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read after half of year and one year of crane operation. Status of "dark spots" and borders of their displacement from base line was fixed on the same regions of ISGs.

Samples produced of construction material were used for decoding of ISG data. Samples with ISG were tested till damage at different stress levels. Research results have been allowed to develop models providing the solving of task of establishing of equivalent stresses and equivalent numbers of loading cycles by ISG data. Mathematically this task leads to solving of system of two transcendental equations. First equation uses value of offset of "dark spots" appearance border on surface of ISG gluing on construction. Second equation describes new status of "dark spots" on gauge in comparison with base. As result of realization of method we have obtained equivalent stress values and corresponding numbers of loading cycles in places of gauges gluing over exploitation period of construction with ISG. Remaining life of metal construction (cycles or operating hours) is calculated on base of fatigue diagram and operating time of crane before ISG placing. Remaining life of welds of constructions is calculated by stress concentration factors.

Base stages of method are described below. Material of estimated constructions was mild steel. Gauges were made on base of aluminum foil. Points of fatigue diagram we have obtained as result of testing of samples till damage at different stress levels. The fatigue diagram with trust intervals corresponded to probability of damage 0,99 is shown on figure 1.

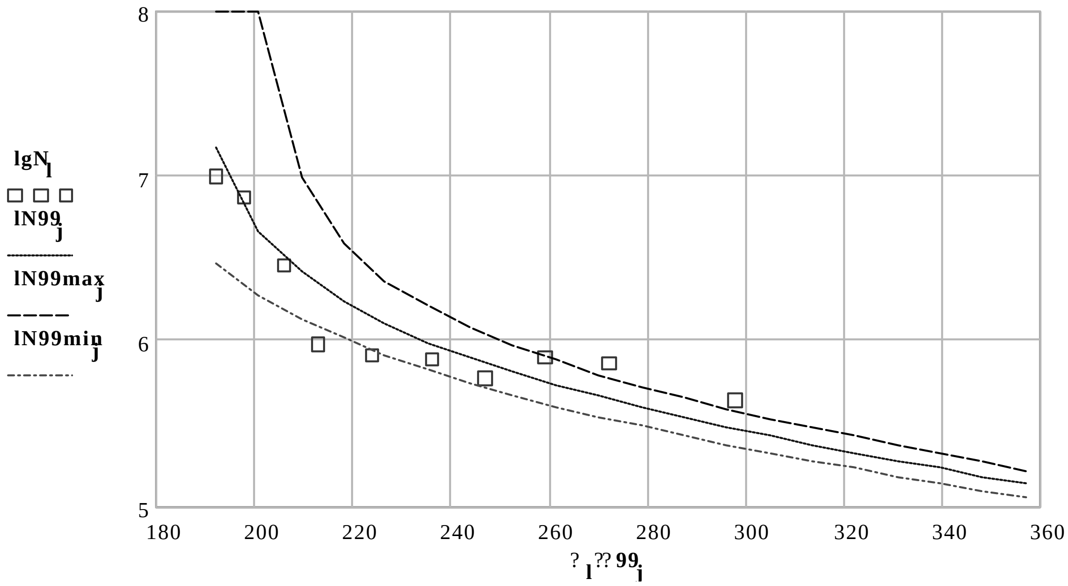

Figure 1.Fatigue diagram for mild steel

Processing of experimental data allowed to establish calibrating dependence at different levels of stresses till appearance of first "dark spots". Calibrating dependence is shown on figure 2.

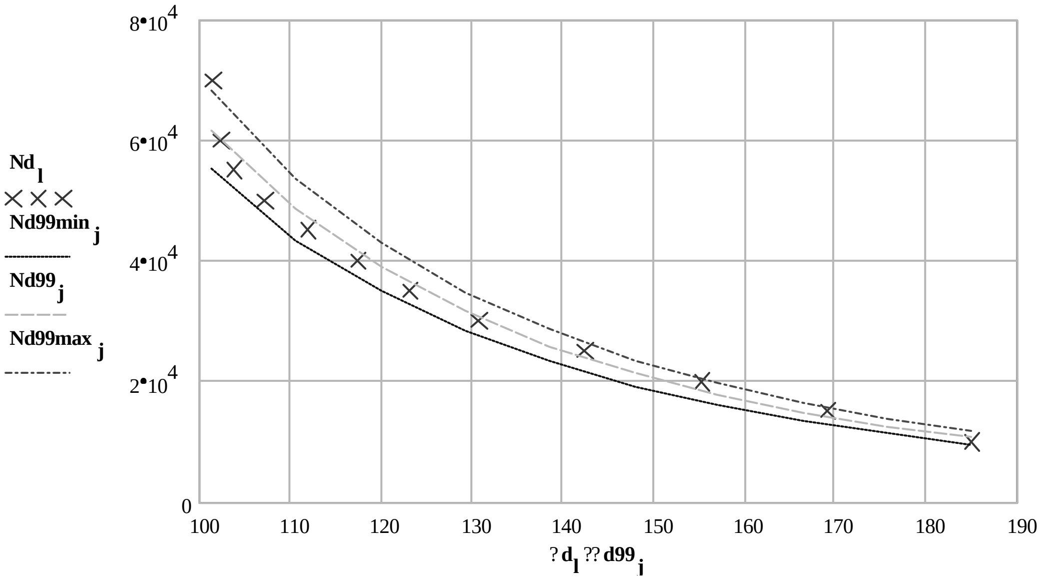

Figure 2. Calibrating dependence for ISG established in accordance with moment of appearance of first "dark spots"

The next stage was establishment of calibrating dependence for samples according to difference of relative square of "dark spots". By experimental data equation connecting amplitude of stress, numbers of deformation cycles and relative square of "dark spots" was obtained. Experimental points and curves calculated by this equation are shown on figure 3.

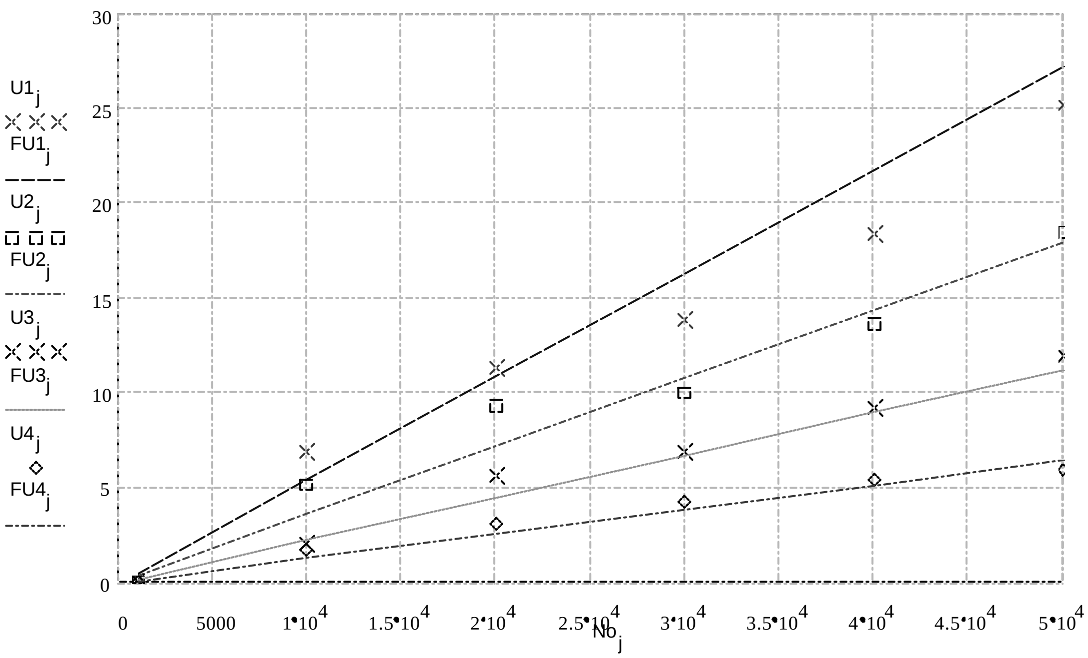

Figure 3. Experimental points and calculated curves

Using of ISGs with variable sensitivity along length for cyclic deformation amplitude, calibration dependence (figure 2) and fatigue diagram (figure 3) allowed to determine equivalent stress and equivalent numbers of loading cycles for each of researched cranes.

3. Conclusions

Two cranes with largest damage have been defined as result of analysis of six bridge crane constructions. Remaining life for these cranes according to base metal is 50 and 100 years. However remaining life according to welds is not enough for exploitation with using lifting capacity. Lifting capacity of cranes has been reduced at 25% and life time of cranes has been limited by two years.

4. References

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