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The State-of-the-Art in the Rehabilitation of a PIONEER Crane

The paper is focused on the analysis about the state of stress in the girder of a PIONEER crane with a prescribed vertical loading of 0,75 tones belonging to the thermal power-station Timisoara. The analysis has been performed with a FEA software (COSMOS/M) which is able to conduct to important results regarding the map of stress, especially in areas where high stress concentration are present. There have been automatically combined a wide range of finite elements: shell, brick, beam,truss-cable simulating the different zones of the girder. The combination of the most advanced standard components as well the implementation of the modular product concepts and the state-of-the-art regarding the design of cranes must be in a perfect agreement with the state of stress in the metallic structure. In the end, a comparison between the FEA results and the classical calculus with the strength of materials theory has been performed.

1. Introduction

On 1986 S.C. Colterm S.A. Timisoara made an acquisition which consists in two PIONEER cranes for the thermo-electric power station South Timisoara. Between 1980 and 1990, the PIONEER crane was out of order. The possible reason was the non-correct dimensioning and manufacturing of the cast iron rolling shaft around where the truss-cable was wrapped up. The cranes are used especially for manipulating concrete blocks, as hoisting and transporting machines for the railway line belonging to the power station. The investment ,which will improve the productivity and will produce benefits after 1 year, will consist in the following modernizations:

-the replacement of the electrical mechanism of the rolling shaft;
-the replacement of the equilibrium loading;
-the replacement of the fourth wheels of the axles and the adjustment of the length of the axle to a rolling distance of 1435 mm which is typical for the railway transport;
-the replacement of the truss-cable with beam;
-the increasing of the propping-on zone of the chassis of the crane by using four additional distance elements.

Figure 1. View of the PIONEER crane

2. The Finite Elements Analysis

The FEA regarding the state of stress in the girder has been performed with the COSMOS/M software.

The geometry of the girder is presented in figure 2:

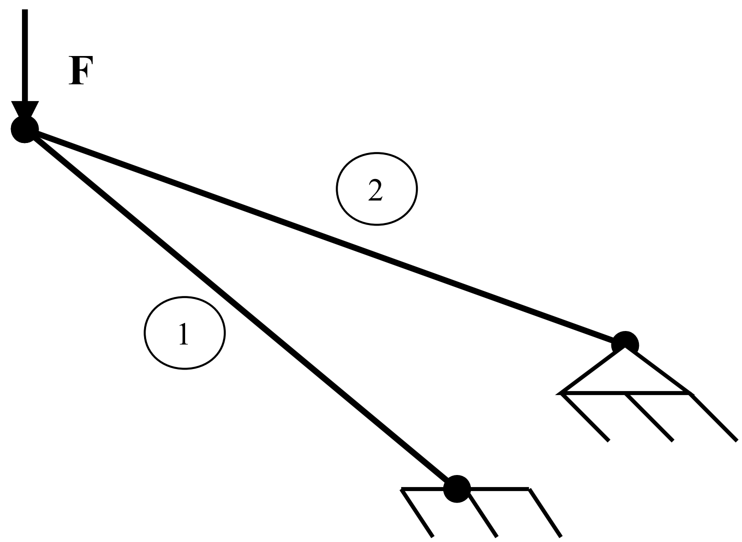

Figure 2. The girder of the PIONEER crane

In order to simulate the loading it is necessary to specify:

-the pointed forces in the nodes

-the uniformly distributed forces on the beam.

The basic software to perform the calculus was MathCAD.

Calculus for beam element 1:

$$K_1 := \begin{pmatrix} 3.794\times10^{4} & -3.788\times10^{4} & -1.066\times10^{5} & -3.794\times10^{4} & 3.788\times10^{4} & -1.066\times10^{5} & 0 & 0 & 0 \\ -3.788\times10^{4} & 3.794\times10^{4} & -1.066\times10^{5} & 3.788\times10^{4} & -3.794\times10^{4} & -1.066\times10^{5} & 0 & 0 & 0 \\ -1.066\times10^{5} & -1.066\times10^{5} & 5.025\times10^{8} & 1.066\times10^{5} & 1.066\times10^{5} & 2.512\times10^{8} & 0 & 0 & 0 \\ -3.794\times10^{4} & 3.788\times10^{4} & 1.066\times10^{5} & 3.794\times10^{4} & -3.788\times10^{4} & 1.066\times10^{5} & 0 & 0 & 0 \\ 3.788\times10^{4} & -3.794\times10^{4} & 1.066\times10^{5} & -3.788\times10^{4} & 3.794\times10^{4} & 1.066\times10^{5} & 0 & 0 & 0 \\ -1.066\times10^{5} & -1.066\times10^{5} & 2.512\times10^{8} & 1.066\times10^{5} & 1.066\times10^{5} & 5.025\times10^{8} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

Calculus for beam element 2:

$$K_2 := \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 5.893\times10^{3} & -2.914\times10^{3} & -54.294 & -5.893\times10^{3} & 2.914\times10^{3} & -54.294 \\ 0 & 0 & 0 & -2.914\times10^{3} & 1.441\times10^{3} & -109.814 & 2.914\times10^{3} & -1.441\times10^{3} & -109.814 \\ 0 & 0 & 0 & -54.294 & -109.814 & 4.698\times10^{5} & 54.294 & 109.814 & 2.349\times10^{5} \\ 0 & 0 & 0 & -5.893\times10^{3} & 2.914\times10^{3} & 54.294 & 5.893\times10^{3} & -2.914\times10^{3} & 54.294 \\ 0 & 0 & 0 & 2.914\times10^{3} & -1.441\times10^{3} & 109.814 & -2.914\times10^{3} & 1.441\times10^{3} & 109.814 \\ 0 & 0 & 0 & -54.294 & -109.814 & 2.349\times10^{5} & 54.294 & 109.814 & 4.698\times10^{5} \end{pmatrix}$$

$v_1 := 0$ $\quad F_{2y} := -3000$ $\quad v_3 := 0$

$\phi_1 := 0$ $\quad M_{2z} := 0$ $\quad M_{3z} := 0$

$$U_g := \begin{pmatrix} 0 \\ 0 \\ 0 \\ -2.0998641148815319114 \\ -2.2538848464274831090 \\ 9.2259463480513021051 \cdot 10^{-4} \\ 0 \\ 0 \\ -1.2308122871321639212 \cdot 10^{-3} \end{pmatrix} \qquad F_g := K_g \cdot U_g \qquad F_g = \begin{pmatrix} -5.807 \times 10 \\ 5.871 \times 10^{3} \\ -2.324 \times 10^{5} \\ -9.485 \times 10^{-12} \\ -3 \times 10^{3} \\ 4.83 \times 10^{-11} \\ 5.807 \times 10^{3} \\ -2.871 \times 10^{3} \\ -7.533 \times 10^{-14} \end{pmatrix}$$

The state of displacement in the girder is presented in figure 3 :

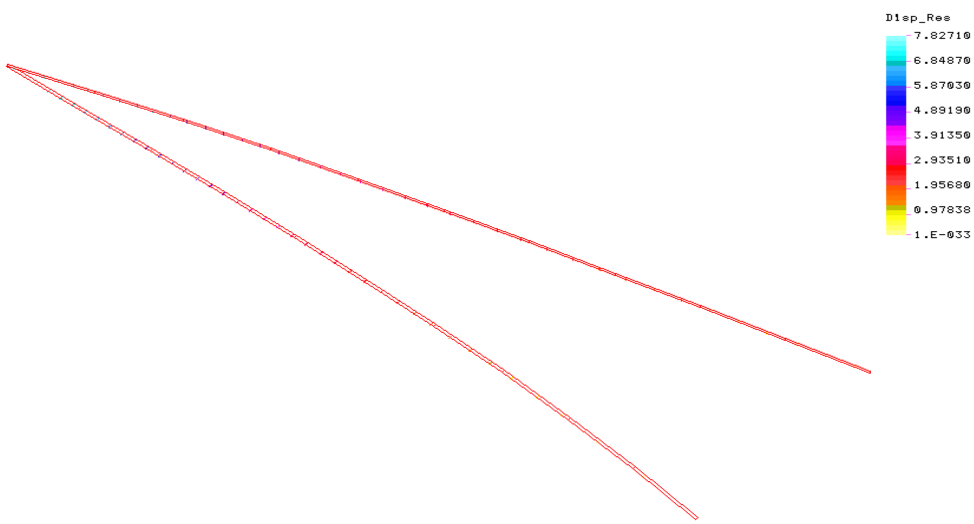

Figure 3. The state of displacement in the girder

3. Conclusions

On the basis of the FEA, the rehabilitation of the crane conduced to the increasing of the productivity with 15 %.

The replacement of the equilibrium loading conduced to the increasing of the nominal loading from 250 kg to 300 kg in safety activity conditions.

Important saving costs have been performed especially by eliminating the cost of fuel of the automotive hoisting machines.

A wide range of proposals have been performed in order to rehabilitate the similar railway cranes.

4. References

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