Research on increasing the lastingness of a rolling bridge

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Abstract: - The paper's purpose is to analysis the stresses and strains state in the strength structure of a rolling bridge, presenting a fast and evaluated computer aided solving method for complex static indeterminate structures. The analysis of the stresses and strains state of the strength structure of a rolling bridge for increasing its solidity in exploitation is made using the calculation software with finite elements COSMOS/M. The research performed allows the evaluation of the stresses state, pointing out the critical areas and measures which are imposed in order to increase the solidity and bearing capacity of the strength structure for the rolling bridge. The results we have obtained allowed us to make up a study about the dimension optimization of the strength structure in order to design the rolling bridge. Thus, the material use could be reduced without exceeding the limits of the most appropriate resistance.

Key-Words: stress, rolling bridge, analysis, model, strength, finite elements, shell type.

1 Introduction

Metallurgy industry develops certain technological processes whose features need the use of all equipments of the assemblies – these equipments belong to the hardware cattegory, [1]. The most appropriate equipments we use in this domain are the rolling bridges, because they provide some advantages, such as: they could adjust according to the features of the technology process, they could lift up and transport a large range of weights, they do not need too much space, and are used for a large range of activities. The sub-installation is the most important element of the strength structure when assembling the rolling bridges, because it should provide the lastigness, stiffness during transportation and assembling, easy maintenance during use, and its elements should adjust to the dvnamic use of the equipment [1], [17]. Their design features very widely according to their major operational specifications, such as: type of motion of the rolling bridge structure, weight and type of the load, location of the rolling bridge, geometric features and environmental conditions. Since the rolling bridge design procedures are highly standardized with these components, most effort and time are spent on interpreting and implementing the available design standards, [1], [2]. The research of the strength structures stress for the elevating and conveying plants, represents a very important stage for the design of some installations according to the reliability imposed by the norms and standards in the field [9], [12], [15]. DIN - Taschenbuch and F.E.M Rules (Federation Europeene de la Manutention) offer design methods and empirical approaches and equations that are based on previous design experience and widely accepted design procedures. DIN- Taschenbuch are collection of standards related to rolling bridge design. This norms generally state standards values of design parameters. F.E.M rules are mainly an accepted collection of rules to guide rolling bridge designers. It includes criteria for deciding on the external loads to select crane components, [2], [3]. There are many published studies on structural and component stresses, safety under loading and dynamic behavior of cranes, [2], [3], [4],[9],[13],[16],[17]. Solid modeling of rolling bridge structures and finite element analysis to find the displacements and stress values has been investigated by Demirsoy, [7]. Solid modeling technique applied for rolling bridge structures and an analysis of these structures using the finite element method provided in [11]. Solid modeling of a rolling bridge, the loadings at different points on the bridge and their application of the finite element method have been studied in [2], [3], [6], [13], [16].

This paper approaches the issue of the static stresses-strains state analysis for the strength structure of an overhead rolling bridge using the finite elements method. The rolling bridge is installed inside a hall of the iron (and steel) works where we perform the steel continuous casting. The analysis of stresses and strains is performed using the finite elements calculation software COSMOS/M, [19], [20].

2 Application of finite element method to a rolling bridge

Among numerical techniques, the finite element method is widly used due to the availability of many user-friendly commercial softwares. This method can be applied to obtain solutions to a variety of problems in engineering. Steady, transient, linear or nonlinear problems in stress analysis, heat transfer, fluid flow and electromechanism problems. The finite element method can analyse any geometry, and solves both stresses and displacements, [2],[3]. This method approximates the solutions of the entire domain under study as an assemblage of discrete finite elements interconnected at nodal points on the element boundaries. The approximate solution is formulated over each element matrix and thereafter assembled to obtain the stiffness matrix and displacement and force vectors of the entire domain, [2],[3],[5], [17]. Modern methods we have used are based on calculation software implemented through automatic data processing devices and allow us to study the stress very accurately, especially because balance and continuous equations are performed very fast and accurate. The results are accurate, mainly if the structure modeling and connection environment are as much accurate as possible. [8],[14], [19].

In this study finite element modeling is carried out by means of the COSMOS commercial package. This program have a modular form in accordance the stages of the method: pre-processing, solutions (processing) and post-processing. This program has shell type elements with three or four nodes per element and six degrees per node in the finite elements library which secure a very good calculation accuracy. This type of finite elements allows us to perform a liniar or non-liniar analysis of the strength structure of the rolling bridge. In case we shape up and we use such type of finite elements, the elements are compatible if only we should use a complete cubic polynomina, [2], [3], [5], [8], [10], [14], [17]. A shell element may be defined, which allows in the plane or curved surface of the element and posseses both length. It width and may only be used in 3 D simulation, [2],[3],[14],[17].

3 The study and the research program

In order to carry out our study about increasing the lastingness of the strength structure of a rolling bridge during the production process, we should consider the way it works when we use big weights after a time the equipment had been used for the production process. Therefore, it is extremely important to know the values of both stresses and strain state of the strength structure. Thus, we should shape up the strength structure with the help of a special software based on finite elements, [17]. The study and research software helps us get the data we need to shape up, to carry out the shaping up and the result analysis.

According to these requirements, the study has been made for:

- analysing the structure and the connection amongst the elements of the strength structure;

- specifying the loading and combinations during their use;

- shaping up using finite elements, in order to carry out the space calculation;

- carrying out the space calculation and connection amongst the elements of the strength structure, with the help of COSMOS software (finite elements-based);

- analysing the calculations and results.

4 Structure analysis of a rolling bridge

The rolling bridge we are analysing is able to lift up to 100 KN, and the items are lift up to 17,3 m. It is made up by the following main sub-installations: strength structure -1, trolley - 2, the translation mechanism - 3, the electric installation and additional elements -4, fig.1.



Fig.1 The strength structure of a rolling bridge

In the case of the particular rolling bridge we are analysing, the strength structure is made of lockerbeams - both the two longitudinal beams and the two end beams. They made up a close-plan rectangular area. The longitudinal beams are very long and stressed, thus we make them according to a variable cross-section within the core of the beam, so that they could lift up the highest loads and work highly accurately. The height of the longitudinal beams is reduced at both ends, so they work like the "equal-resistance beams", fig.2.



Fig.2 Design scheme of the longitudinal beam

The cross-sections of the longitudinal beams are made of two side cores who are 6 mm thick, and two tracks – one high and one low – who are 8 mm thick. They made up a resistance element who has a high degree of stiffness when being twisted and bent, and who provides a perfect combination amongst all elements, fig.3.

If we refer to this type of beams, the cutting force reaches its peak within the area of the bearings, and it is taken over by the core of the locker; along the beams. When determining the sizes the most decisive element is the moment of deflection – it reaches the highest value for the less appropriate loading moment, [9], [12], [17], [18]. Thus, the core of locker is less important for taking over the bending loads than the bed plate of the beam. Thus, the relation between the thickness and the height is big. In case of loads, the longitudinal beams are stressed by two types of tensions – compression and stretching.



Fig.3 The cross section of the longitudinal beams

The connection between the cores and the tracks is provided by the welding lines, because these beams are stressed repeatedly and that may cause fatigue. A non-continuous welding could cause some tension and decrease the resistance to fatigue. In order to avoid the "fog" phenomenon, in case of such beams we have used longitudinal and crosswise stiffness ribs – they are situated 70 mm away from the side cores and the two tracks. These ribs are most effective within the area where the tangential tensions occur, and they take over the loads from the wheels of the beam and segregate them on their surface.

As far as the end beams are concerned, they are identical, fig.4.



Fig.4 Design scheme of the end beams

The end beams have a constant section along their lengths and they are made of some sheets welded to the locker, fig.5.



Fig. 5 Cross section along the end beams within the central and end area

Both ends of such beams are provided with some plates in order to connect the bearings of the rolling wheels, as well as some protection plates against bridge derailment which might occur during an overrated use of the rolling wheels. We connect the longitudinal beams to the end beams to provide stiffness and durability to the rolling bridge. The relation amongst the elements of the strength structure enable the transmission of the loads caused by utilisation towards each structure element. There are two types of connections: connections who are transmitted by forces alone, and correspond to some simple bearings who allow the spinning of the elements within the values due to the elastic deformation; and connections who transmit the forces and moments who correspond to a continuous bearing.

Therefore we have welded the beams and we have introduced some stiffness small plates within the angular inner areas.

5 Loading schemes

The strength structure of the rolling bridge provides a certain static closed area. During the shaping up process, the presence of different elements, the loads, and weight of the elements of the structure have been made up by concentrated weights; we have been able to change it with the help of some compressed forces, whose positions on the strength structure are described in fig.6.



Fig.6 The pattern of the loading strength structure of a rolling bridge

The values of the forces are the following: $F_1=4375N, F_2=9700N, F_3=9500N, F_4=5600 N,$ $F_5=2800 N, F_6=4215 N, F_7= 3375 N, F_8=31 489 N,$ $F_9=31 489 N, F_{10}=62 807 N.$

The position of the forces along the strength structure has been performed with the help of the following dimensions/sizes: $a_1=1005$ mm, $a_2=3315$ mm, $b_1 = 850$ mm, $b_2 = 400$ mm, $b_3 = 3970$ mm, $l = b_1 + b_2 + b_3, c_2 = 850$ mm, $c_3 = 130$ mm, $c_4 = 825$ mm, $c_5 = 180$ mm, $c_6 = 2c_1 = 1120$ mm.

6 Numerical example of an overhead crane bridge

The overhead rolling bridge with the lifting capacity of 100 KN, lifting height of 17,3 m and with a gauge of 11 m was selected as a study object. The configuration of the overhead rolling bridge is shown in fig.1. The driving unit is installed on the strength structure. The design values used in the rolling bridge analysis from the F.E.M and DIN standards are presented in table 1.

Handling Capacity	100 KN
Lifting height	17,3 m
Gauge	11 m
Distance between axes	4,25 m
Trolley velocity	10 m/min
Travelling crane velocity	63 m/min
Total duration of use	U4
Load spectrum class	Q3
Appliance group	A5
Loading type	Н
Dynamic coefficient	$\psi = 1,15$
Amplifying coefficient	$\gamma_{\rm c} = 1, 11$

Table 1. Rolling bridge property values

7 Solid and finite element modeling of the strength structure

The analysis with finite elements for such a complex structure as of an overhead rolling bridge with the lifting capacity of 100 KN, lifting height of 17,3 m with a gauge of 11 m and the distance between axes of 4,25 m, is a very difficult problem. The difficulties are given by the geometrical configuration of the strength structure and its dimensions. In these conditions, in order to perform a complete analysis with finite elements which is able to point out all the aspects regarding the stressstrain state distribution from the structure, there is required the use of a carefully elaborated calculation model able to eliminate the approximations which appear in the elaboration of the geometric model and to allow the use of some finite elements suitable as type, number and implicitly as size.

In the paper [16], there is presented the analysis with finite elements of the stresses and strains state from such a strength structure, but where the problem solving is done using finite elements of beam type with rigid nodes (BEAM 3D). Such an approach allows a general study of the strength structure mode of behavior, but without making evident the aspects concerning the phenomena of stress concentration or a detailed studying of the stress-strain distribution. Taking into account the constructive requirements and the solutions chosen for the design of the overhead rolling bridge, there was required the use of the shell type finite elements according to the theory with moments.

The modern programmers of analysis with finite elements use advanced finite elements of shell type, capable to provide the interelements compatibility for all the loading cases, [8], [10]. Shell-type finite elements are finite elements who evolve from the thin plate-type. One of their dimensions is smaller than the other two. As far as the loads are concerned, they are introduced through the end surfaces of through the middle surface, and they allow the identical distribution along the centre line of any cross-section of the finite element, free of the longitudinal and cross distribution of the external loads. The centre line of any cross-section changes its shape due to the deformation. Thus, the cross shrinkage cannot be neglected, except for the normal direction along the centre surface.

In order to design the shape of the strength structure we have used two reference systems: a global reference system that we report the entire problem to, and a local reference system which is associated to a sub-domain of the problem we are analyzing.

In order to get the geometric model in view

wireframe of the strength structure we use the designs of the components and the entire design of the strength structure. When modeling, the difference amongst the aggregate, the loading and the weight of the elements is calculated in condensed mass. The topology of the strength structure of the rolling bridge is defined so that it is generated with the help of the GEOSTAR modulus of the software, which allowed us to get the geometric model in view wireframe.



Fig. 7 Wireframe view for the right-end beam

Fig.7 represents the geometric model we have obtained for the right-end beam in view wireframe, meanwhile fig.8 represents a detailed for geometric model we have obtained for the connection between the right-end beam and the longitudinal beam II.



Fig. 8 Detail of the wireframe view of the connection between right-end beam and longitudinal beam II

In the elaboration of the calculation model for the stress-strain state study we have used the packs of programmers COSMOS/M which has shell type elements which secure a very good calculation accuracy, with deviations under 4 % related to the exact methods of calculation, [8], [10], [19], [20]. When choosing the calculation model presented in fig.9, there have been in view the availabilities provided by the pack of programmers COSMOS/M, which don't limit the analysis dimension by the number of elements or the number of nodes used, [20].



Fig.9 Solid model of the strength structure

This has allowed the elaboration of a calculation model where the approximations introduced by geometrical modeling are negligible.

Because the geometrical model has been elaborated in accordance with the workshop drawings, and the height number of elements of shell type used at meshing has allowed a calculation model very closed to the real geometry of the strength structure of the analyzed rolling bridge.

The boundary conditions regarding the supporting and loading way have been introduced as follows, [5], [14]:

a. In the insert of blockings for certain degrees of freedom from the structure nodes, we had in view the presence of those four wheels of the rolling bridge. For the nodes placed at the drive wheels level there have been introduced blockings for the linear displacements u,v and w according to the three directions of the global system of axes XYZ of the structure, and for the driven wheels there have been introduced only the linear blocking u and w according to the directions y and z.

b. The forces have been distributed in the nodes in front of their application area according to the loading diagram of the rolling bridge. The existence of some eccentric loadings by means of some rigid arms, has led to their replacement with an equivalent system of loads directly applied on the structure, in order to avoid the supplementary use of some finite elements of beam type with high stiffening.

The vertical equivalent forces $F_{v \ echiv}$ and the horizontal ones $F_{h \ echiv}$ are applied to those six nodes placed at the upper surface level of the cross section of the structure in the front of their application area. These equivalent forces represent the components obtained by the reduction of the force F_{total}

eccentrically applied in the centroid "C" of the cross section, distributed in the eccentrically placed nodes, fig.10.



Fig.10 The equivalent loading diagram for the eccentrically applied loads

The horizontal equivalent force is therefore calculated with the relation (1).

$$F_{hechiv} = \frac{F_{total} \cdot e}{\frac{h}{2}} \tag{1}$$

The loadings have been considered in the elastic field, and therefore the elastic constants have been introduced, corresponding to the material OL 37.

The thicknesses g_i , where i = 1,2,...n, where "n" represents the number of thicknesses of the component walls of the rolling bridge strength structure, have been introduced as real constants attached to the finite elements in the stage of the structure meshing here have been used a number of 42896 finite elements with a number of 20627 nodes and 12326 degrees of freedom.

The two endbeams have been divided into 6714 finite elements each and the two longitudinal beams have been divided into 14734 elements each. The big number of shell-type finite elements allowed us to come up with a calculation method which is almost similar to the real shape of the strength structure we have analyzed, [10], [17].

8 Results

The analysis of the strength structure of the rolling bridge using finite elements have been calculated all the stresses and strains tensor from the structure nodes and from the centroids of the finite elements. In the post processing stage, for a quick and efficient interpretation of the results, there have been represented under the form of spectrum the stress fields at the whole structure level. The software allowed us to:

- write the variation of the equivalent stresses of the whole strength structure and for certain critical areas; - the variation of the elements of the tangential stresses τ_{xy} , τ_{yz} , τ_{xz} within the areas where it reaches the highest values;

- the variation of the main normal tensions $f\sigma_{1,}$ $\sigma_{2,}\sigma_{3}$ within the areas where it reaches their highest values;

- the distribution field of all components of the mutation elements u, v, w along a horizontal line, according to the axis X, Y and Z, as well as along the resulting mutation u_{rez} ;

- the view of the distorted position of a strength structure compared to the non-distorted position;

- the distribution of the equivalent stresses fields, of the main normal stresses, and of all elements of the tangential tension tensors for the whole strength structure. Analyzing these data, it results a series of conclusions regarding the behavior of the strength structure of the rolling bridge.

We have selected some values we have considered important from amongst the analysis of the folders which contained the results. We have selected those values of the stresses and strains which could cause some critical areas where stresses points are gathered (within the strength structure of the rolling bridge). We should consider that the beams of the strength structure of the rolling bridge are made of OL 37 then, the analysis of stresses and strains is more effective if we use the theory of the specific form modifying energy (stated by von Misses) as a determining factor for reaching the limit stages, [18]. According to this hypothesis, in the case of the space tension, the equivalent stress are determined according to the relation (2), [18]:

$$\sigma_{ech} = \sqrt{\sigma_1^2 + \sigma_2^2 + \sigma_3^2 - (\sigma_1 \sigma_2 + \sigma_2 \sigma_3 + \sigma_3 \sigma_1)} \le \sigma_a$$
(2)

The main conclusions which results from this analysis are presented in next paragraph.

In fig. 11 are presented the variation spectrum of von Misses equivalent stresses for the entire strength structure of the rolling bridge.



Fig. 11 Variation spectrum of von Misses equivalent stresses for the entire strength structure of the rolling bridge

Bigger values of the equivalent stresses (within the admissible limits) occur in the central areas of the two longitudinal beams, in fig. 12, as well as in the connection areas between them and the end beams, fig.13.



Fig. 12 Diagram variation of Von Misses equivalent stresses at the middle of the longitudinal beam I

The maximum equivalent stress calculated according to the theory of the specific form modifying energy is $\sigma_{von Misses max} = 168$, 98 MPa and is recorded in the node 15104 placed, on the lateral external surface of the longitudinal beam I near the connection with the right end beam. This size exceeds the allowable stress for the case I of loading according to Bach, for the steel OL 37, $\sigma_{von Misses max} > \sigma_a$ ($\sigma_a = 150$ MPa), fig.13.



Fig.13 Diagram variation of Von Misses equivalent stresses at the level of the outside edge of the longitudinal beam I and right-end beam

In order to point out the variation modulus of the equivalent stresses within the critical areas, in fig. 12 and 13, we have represented the variation graphics of the equivalent stresses for 6 respectively 20 successive nodes situated in the area we study. We calculate the abscissa according to some parametric coordinates then, value "1" represents the total measured length between the first and the last node we have draw in our design. This peak of tension is possible due to the tension-concentration at the point where the I-type longitudinal beam and right-end beam are connected.



Fig.14 Diagram variation of Von Misses equivalent stresses at one end of the strength structure, in the area where the longitudinal beam I connects to the left-end beam

Another extreme value of the equivalent stress is recorded in the 4856 node which is situated at one end of the strength structure, in the area where the longitudinal beam I connects to the left-end beam, fig. 14. Referring to the coordinate axis system, the coordinates of this node are: x = 0 mm, y = 350 mm, z = 11350 mm.

Fig.14 describes the distribution field of this stresses and the variation graphic of the equivalent stress for six running nodes – this direction encloses the node no. 4856.

The calculation software allows us to see the elements of the tension tensor at the level of the whole resistance structure of the equipment we analyse: τ_{xy} , τ_{yz} and τ_{xz} , as well as in the case of the critical areas, when all the elements reach their highest values. In fig. 15, we describe the variation spectrum of the tangential tension τ_{xy} for the entire strength structure of the rolling bridge.



Fig.15 Variation spectrum of the tangential tension - τ_{xy} - for the whole resistance structure of the rolling bridge

If we analyze the tangential tension τ_{xy} , we see that the variation domain is within 46,992 MPa – 31,1640 MPa. The variation domain for τ_{yz} is within 30,067 MPa –30,732 MPa, and for τ_{xz} is within 76,853 Mpa – 57,853 MPa.

Tangential stresses have extreme values, as follows: $\tau_{zx} = -76,853$ MPa, at the upper side of the right-end beam, where it connects to the longitudinal beam I (2517 node); $\tau_{xy} = -46,996$ MPa (1732 node) and $\tau_{zy} = 30,732$ MPa (1809 node), as they are close and situated on the right-end beam, close to the origin point of the global axis system, fig.16.



Fig. 16 Areas of extreme values for the components of the tangential stresses

The same area records the 1702 node real value for a normal tension of $\sigma_y = -182,226$ MPa, and the connection area between the longitudinal beam I and extreme values for $\sigma_x = 132,164$ MPa (3123 node) and $\sigma_z = 155,315$ MPa (15104 node), fig. 17. According to this it results that the connection between the right end beam and the longitudinal beam I is a critical area for which have to be taken measures of improving the constructive solutions in order to decrese the peaks of stress which appear.

As far as the main normal stresses are concerned σ_1 , σ_2 , σ_3 , they reach the highest values within the connection area between the two longitudinal beams and the right end beam, as follows:



Fig. 17 Areas of extreme values for the components of the normal stresses

- the main normal stresse σ_1 = 182,89 N/mm², reaches the highest value within the area which is close to the area where von Misses equivalent stresses reaches the highest value, fig.17.

- the main normal stress σ_2 = 81,92 N/mm², reaches the highest value within the area which is close to the highest point of the σ_1 tension of the node 3123, fig.17.

- the main normal stress $\sigma_3 = -192,554$ N/mm², reaches the highest value within the area which is close to the node 1702, the specific point where the component of the normal tension σ_y has reached the highest value, fig.17.

In order to study any strains of the strength structure caused by the working loading, the paper work refers to the study of any resulting displacement on a horizontal plan, according to all three axis of the global reference system.

Fig. no. 18 describes the resulting shifting element which is drawn up according to "x" axis; in Fig. no. 19, the shifting element is drawn up according the "y" axis; in fig. 20, the shifting element is drawn up according to the "z" axis.



Fig.18 The distribution of the ,,u" deformation, representing the horizontal shifting for the resistance structure, according to ,,x" axis

In fig. 18, we see that the domain of the deformation of ",u"-variation, representing the horizontal shifting, according to ",x" axis, for the entire resistance structure have within 0,38182 mm and 20,183 mm.



Fig.19 The distribution of the "v" deformation, representing the horizontal shifting for the resistance structure, according to "y" axis

In fig. 19, we see that the domain of the deformation of "v"-variation, representing the horizontal shifting, according to "y" axis, for the entire resistance structure have within 7,6429 mm and 0,15098 mm.

Fig. 20 we see that the domain of the deformation of ,,w"-variation, representing the horizontal shifting, according to "z" axis, for the entire resistance structure have within -1,1586 mm and 1,0848 mm.



Fig.20 The distribution of the "w" deformation, representing the horizontal shifting for the resistance structure, according to "z" axis

If we compare all figures – fig. no.18,19 and 20, we see that the "u" shifting reaches higher values than "v" and "w".

After analysing any displacement we have seen that the highest values are recorded at the middle of the opening of the longitudinal beam I, fig. 21.

We find the highest displacement in case of 15992 node, which reaches u_{rez} = 20,87 mm. The components of the liniar displacement according to all three directions of the global axis system are:

u =15,18 mm, v = 3,75 mm and w = 0,075 mm.

The highest result is possible according to the relation (3).

$$u_{rez} = \sqrt{u^2 + v^2 + w^2}$$
(3)

These results are possible because the longitudinal beam I is twisted and bent, and the shape of the cross section has been designed to take over the bending caused by the vertical loads.



Fig. 21 The rolling bridge in strain state under the action of the nominal loads

The node that are situated near the area where we have the highest value of the mutation, we have the following values:

- node no. 15989, $u_{rez} = 20,86 \text{ mm}$
- node no. 15994 $u_{rez} = 20,85 \text{ mm}$
- node no. 15988, $u_{rez} = 20,85 \text{ mm}$

After we have analysed all the elements referring to the deformation, we concluded that the longitudinal beam I represents the critical area for the strength structure.

9 Conclusions

All finite elements we have evaluated are used for shaping up the equipment, and they have ensured us a lot of possibilities for approximating the contour of the strength structure, and we have distributed the tensions within the strength structure of the rolling bridge more appropriatedly.

We can see an increase of the discretion high quality within those areas where we have tension focus points or focused forces, which has resulted in greater accuracy that obtained from variant of solid modeling with type finite element beam, treated in paper, [16].

By analysing the stresses fields, we are able to see that the main critical area of the rolling bridge is represented by the connection between the longitudinal beam I and the right-end beam. Thus, we have to pay all the attention while designing it as well as during the production, in case we want to redesign the structure. Also, the area of the right-end beam near the global axis system needs special attention in order to improve the product and to eliminate any possible tension peak.

The research performed allows the evaluation of the stress state, pointing out the critical areas and measures which are imposed in order to increase the solidity and bearing capacity of the strength structure for the rolling bridge. The study of the stresses within the strength structure of the rolling bridge allows us to make a study of size improvement in order to reduce the material consumption, by reducing the caliber of the caisson without decreasing the required material resistance.

A much more complete analysis of this issue is possible if using it within a dynamic environment.

References:

- Alămorean M., Coman L., Niculescu S.,-Machines and high transports. Organ specific mechanism and high power cars, Technical Publishing House, Bucharest, 1996
- [2] Alkin C., Imrak C.E., Kocabas H., Solid modelling and finite element avalysis of an overhead crane bridge, *Acta Polytechnica*, Vol. 45 No. 3, 2005, pp. 61-67
- [3] Alkin C., Solid modelling of overhead crane bridges and analysis with finite element method, M. Sc. Thesis, Istambul Technical University, Istambul, Turkey, 2004
- [4] Baker K.N., Meager D.R., Taylor R.W, Fatigue damage to large electric overhed travelling crane, *First national Structural Engineering Conference*, Vol.87, Nr.10, 1987, pp.372-376
- [5] Banerje P.K., *The boundary element methods in engineering*, McGrawHill, 1994
- [6] Celiktas M., Calculation of rotation angles at the wheels produced by deflection using finite element method and the determination of motion resistance in bridge cranes, *Journal of mechanical design*, Vol. 120, 1998
- [7] Demirsoy M., *Examination of the motion resistance of bridge cranes*, PhD. Thesis, Dokuz Eylul University, Izmir, Turkey, 1994
- [8] Dumitru I., Faur N., *Calculation elements and application in the material strength*, Politechnica Publishing House, 1999
- [9] Errichello J., Crane design: Theory and calculations of reliability, *ASME Journal of Mechanical design*, Vol.105, 1983, pp. 283-284

- [10] Faur N., The evolution and calculation accuracy fot the thin shell type finite element with moments, *Scientific journal of University Politechnica of Timisoara*, Vol. 45(59), 2000, pp. 15-25
- [11] Ketill P., Willberger N.E, Application of 3D solid modelling and simulation programs to a bridge structure. PhD. Thesis, Chalmares University of Technology, Sweden
- [12] Kogan J., Crane design: Theory and calculation of reliability, John Wiley &Sons, 1976
- [13] Mahanty D.K., Iyer S., Manohar V., Design evaluation of the 375 T electric overhead travelling crane, Tata consultancy service, India
- [14] Mastorakis K., Martin O., Finite element modelling of filleted Structure, *Finite element method, published by WSEAS Press*, pp.38-43, 2008
- [15] Mladenova C.D., Mladenov I.M. An experiment in increasing the lifting capacity of the pouring side crane, *Journal of theoretical* and applied mechanics, Vol.38, No.3, 2008, pp. 201-2002
- [16] Neguţ;N.,Hluşcu,M. Pinca B. C.- Analysis of tension and deformation state of the resistance structure of a rolling bridge to optimize dimensional, 12th National Symphosium of Mechanical robots, Timişoara, 1994
- [17]Pinca B. C., *Optimization of a strength structure* of a metallurgical aggregate, PhD. Thesis, Politechnica University, Timişoara, Romania, 2002
- [18] Timoshenko S., Gere J., Theory of elastic stability, Technical Publishing House, Bucharest, 1967
- [19] Zienkiewicz O.C, Taylor R. L., La method des elements finis, AFNOR, Paris, 1991
- [20] COSMOS User's guide, Structural research analysis corporation, Santa Monica, 1999