LOADS TRANSMITED TO THE METALLIC TOWERS OF THE EXTRACTING INSTALLATIONS IN THE CASE OF THE APPLICATION OF THE SAFETY BRAKE

PhD, Eng., Assoc. Lecturer, Răzvan Bogdan Itu, Department of Industrial Mechanical Engineering and Transport, University of Petroșani, raz.van4u@yahoo.com
PhD Student, Eng, Alexandru Ioan Pop, Department of Industrial Mechanical Engineering and Transport, University of Petroşani, ionutpop6@yahoo.com

Abstract: In the paper there are presented certain aspects concerning the determination of loads transmitted through the bearings of the extracting pulleys of the structure of the metallic towers of the extracting installations In the case of the application of the safety brake The exemplification of the determination of the loads transmitted to the metallic tower in the case of the application of the emergency brake has been done by taking into study the extracting installation ,, Auxiliary well No.12", from Lupeni Mining Plant. The extracting installation is unbalanced. The wrapping organ of the installation machine is a double wheel with the wrapping of the extracting cable in one layer. The extracting vessels are untipping cages with two levels, with two trolleys per level. The drive of the installation's machine is asynchronous, the machine' s reducer having two drives.

Keywords: analytical calcul, force

Introduction

The normal development of the schedule of the movement of the extracting vessels or the stopping of the machine in a certain position of the vessels (maneuver braking) and the automated stopping of the machine (safety brake), independent of the will of the operator in one of the cases considered perturbations or distress, is insured by a braking device supplied with every extracting machine. Cases considered perturbations or distress are: lack of tension, a decrease in fluid pressure required for acting the brake, over-height of the extracting vessels, passing the max. speed limit overweight etc.

In the paper there are presented certain aspects concerning the determination of loads transmitted through the bearings of the extracting pulleys of the structure of the metallic towers of the extracting installations in the case when the emergency brake is applied due to an overcome of the max speed allowed.

In order to study the loads from the extracting cables transmitted to the structure of the metallic towers of the extracting installations through the extracting pulleys in the case when the emergency brake is applied it has been taken into study the tower of the extracting installation Auxiliary well No.12 Lupeni Mining Plant. The general and exploitation data of the installation taken into study are presented as follow.

The extracting installation taken into study

The extracting installation which works on auxiliary well no.12, from E.M. Lupeni, which is destined for the underground supply with materials and tools as well as for transporting personal. The personal and materials transport is done to and among levels 300, 400, 480, 650 and 690. The extracting installation that supplies the well (Fig.1) is unbalanced (without a balance cable) and has an extracting machine type 2T-3,5 1,8 (Fig.2) equipped with two asynchronous motors type AKH2-16-39-12YXP4, of 500 kW power and a nominal rpm of 490 rot/min(fig.3).

Figure 1. Extracting installation

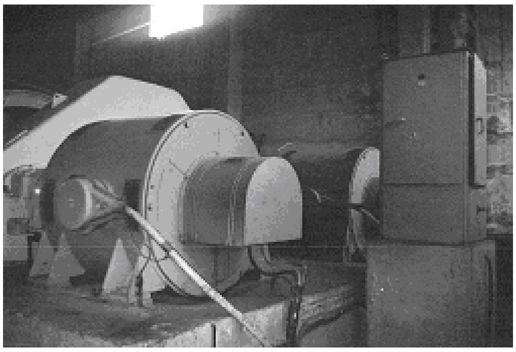


Figure 2. Extracting machine

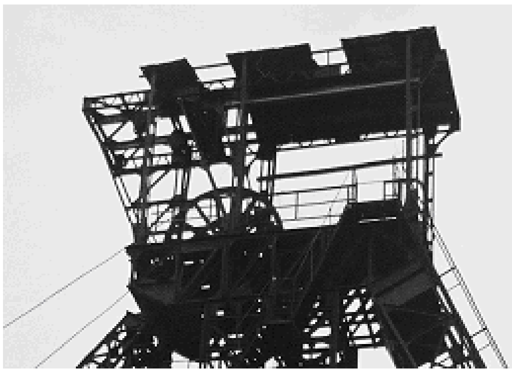


Figure 3. Extracting pulleys

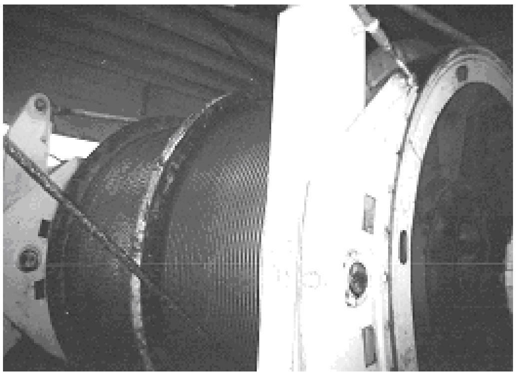
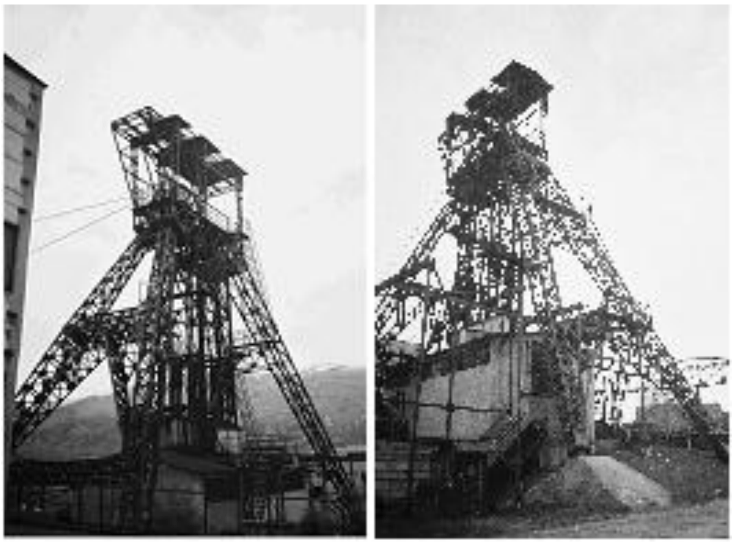


Figure 4. Wrapping organ

The reducer of the machine is of type 2U 1600 having the transmittance ratio of 11, 5 The extracting cables with diameters of Φ 44 mm and a mass (on a linear meter) of 7,05 kg/m on the left branch (from the extracting machine to the well) and Φ 44 mm and a mass 7,03 kg/m on the right branch are wrapped around the two extracting pulleys of Φ 4000 mm with a mass (the pulley, the axel of the pulley and the bearing of the axel) of 1850 kg (Fig.3), laying on the tower at a height of 22,95 m (pulley axel).

The cables are wrapped in a single layer (row) on each of the two wheels (wrapping organ (Fig.4)) of the machine, from which one is fixed and one is mobile and which are hooked at one end by the exterior end (side margin) of them. The other end of the cables going through the extracting pulleys is hooked to the extracting vessel through the cable tie device (D.L.C.). The extracting vessels are untipping cages with two levels, with two trolleys each level having a mass (own mass plus D.L.C.) of 4924 kg.

The mass of a trolley is of 650 kg, and the effective load is 1800 kg/trolley. Another main compo-nent of the extracting installation is the metallic tower (Fig.5) with a height until the pulley axel of 22,95 m. The structure of the tower is composed of the extracting pulley platform sustained by the leading component and the two abutments set up as a frustum pyramid The extracting machine lies on the ground (at a height of 3.695 m to the 0 level of the well (well collar), sideways from the tower (well tower), at a distance (of the wheel axel), towards the vertical portion of the extracting cables which enter the well of 32m. The length of the cable chord (the distance between the tangent points of the cable to the deviating pulley from the tower and the wheel of the extracting machine, in the central position of the chord (perpendicular on the wheel axel)), is for the left branch L_{cs}=35,450m, and L_{cd}=35,646m for the right branch. The incline angles of the cables chords are $\beta_s = 38^0\ 43^{'}\ 55''$ for the left branch and $\beta_d = 33^0\ 05^{'}\ 43''$, for the right branch, and the deviating angles (which are formed in the limit positions of the cable chord towards the interior side(interior angle) or exterior (exterior angle) of the wheel, over the central position of the chord) are: $\alpha_{e\ st} = 1^0 38^{'} 53^{''}$ şi $\alpha_{i\ st} = 0^0 42^{'} 11^{''}$ For the left branch and $\alpha_{e\ dr} = 1^0 40^{'} 33^{''}$ şi $\alpha_{i\ dr} = 0^0 39^{'} 43^{''}$ for the right branch.



a) b)

Fig.5. Metallic tower

a)North –West view; b) South-West view

Determination of loads

For the determination of the loads(efforts) which act upon the installation taken into consideration it has been taken into study the case when one of the vessels loaded with materials is descending on one of the branches.

On the calculation of loads it has been considered the fact that their variation is determined not only by the kinematics of the installation (kinematical parameters) but also by certain geometrical elements which define the position of the extracting machine towards the well geometrical elements regarding only the installations where the extracting machine lies on the ground.([1],[3],[4]).

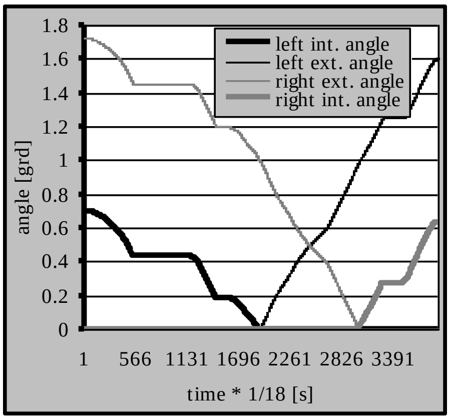


Figure 6. Deviating angles case 1

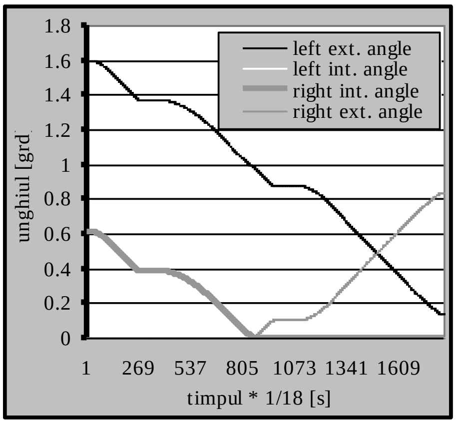


Figure 7. Deviating angles case 2

In Fig 6 and Fig 7 is presented the variation diagram for the deviation interior and exterior angles on the two extracting branches and for the two wheels of the wrapping organ of the extracting cable in the two considered cases.

For this purpose it has been taken into analysis the case when the full vessel(filled to max load) is descending on the left branch (case 1, the right case is climbing and the left one is descending) and the case the vessel is descending on the right branch (case 2, left vessel is climbing and the right one is descending).

The diagrams for the space, speed, and acceleration for the two cases taken into analysis are presented into Fig 8 case 1 and in Fig 9 case 2.

The variations of acceleration and space have been used for the calculation of the loads applied to the tower.

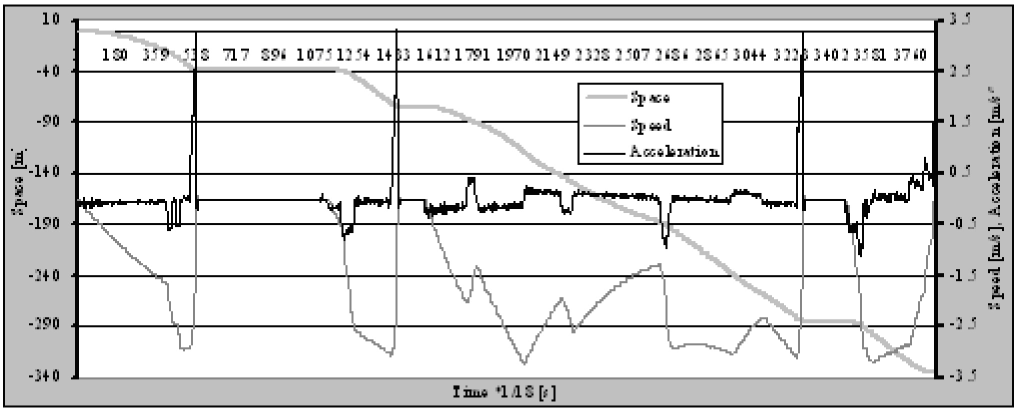


Figure 8. Speed acceleration and space for case 1

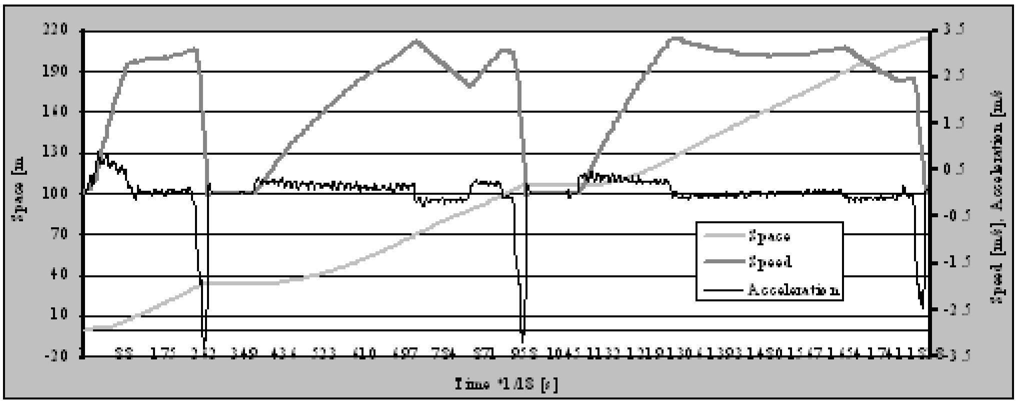


Figure 9. Speed acceleration and space for case 2

The determination of the loads acting upon the tower through the deviating pulleys has been done using the d'Alembert principle (the kinetics-static method [2]) taking into consideration the static forces (the weight of the extracting cable, the cage the trolley the pulley and the load), the friction forces (multiple friction and aero-dynamic resistances which for installations with cages is approximated with a coefficient of k'=0,2 from the useful load [1]) and the dynamic forces (which intervene only in the acceleration and deceleration periods, Fig. 8 and Fig. 9)).

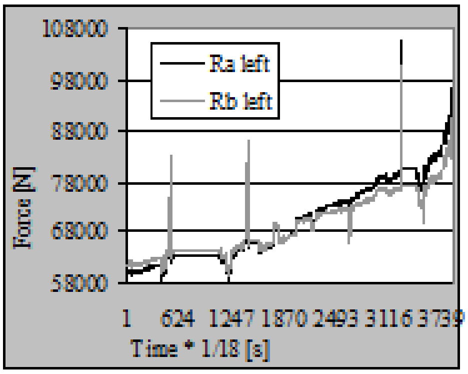


Figure 10. Reactions from the bearing of the left pulley when the left cage descends and the right one climbs,

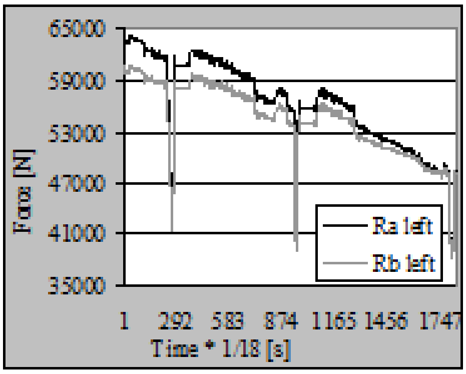


Figure 11. Reactions from the bearing of the left pulley when the left cage climbs and the right one descends.

The variation of the resultant forces from the bearings of the extracting pulleys for the two considered cases in the case of the application of the safety brake on the surpassing the max admitted speed is presented in fig 10 and fig 12, for case 1, for the left and right pulley and fig 11 and fig 13, for case 2, also for the left and right pulley.

The variation of the total resultants (reactions) the forces from the extracting pulleys for the two cases taken into consideration in the case of the appliance of the safety brake on the surpassing of the max speed is presented in fig 14 case 1 and fig 15, case 2, for both pulleys.

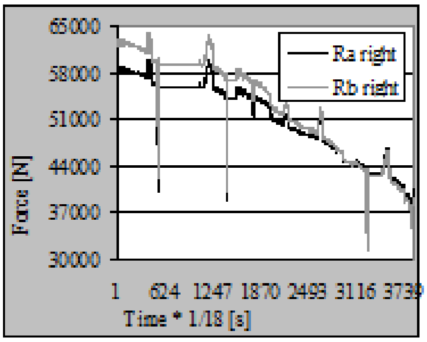


Figure 12. Reactions from the bearing of the right pulley when the left cage descends and the right one climbs,

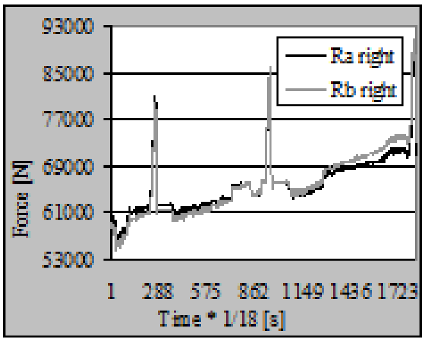


Figure 13. Reactions from the bearing of the right pulley when the left cage climbs and the right one descends.

In fig 16 and fig 17, there are presented the variations of the total loads on the tower for the two cases.

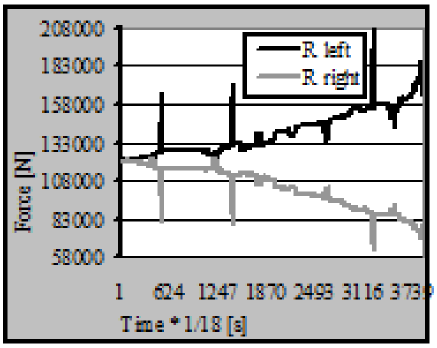


Figure 14. Reactions from the bearing of the left and right pulley when the left cage descends and the right one climbs, Case 1

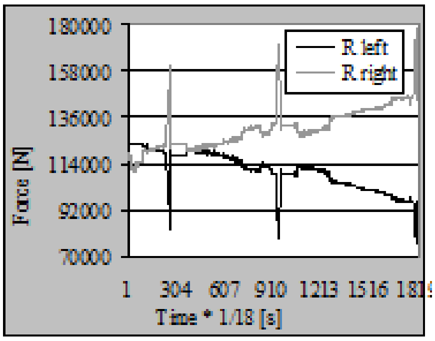


Figure15. Reactions from the bearing of the left and right pulley when the left cage climbs and the right one descends, Case 2

Conclusions

The calculation the structure of the mining extracting towers is done taking into consideration all the unfavorable combinations practically possible of the different loads called groups of loads. Following the classification and grouping of the loads transmitted to the extracting mining towers in the paper there are presented certain aspects concerning the establishing of the exceptional short term loads due to the extracting cycle in the case of the appliance of the safety brake which are transmitted to the structure of the metallic tower of an extracting unbalanced installation with extracting vessels untipping cages and an extracting machine with two wheels and the wrapping of the extracting cable on one layer and acting asynchronous. The loads transmitted to the tower through the bearings of the extracting pulleys from the tower due to the efforts from the extracting cables have been considered for an extracting cycle when the empty cages are climbing and descending on one of the two extracting branches. The variation of loads is due both for the cinematic parameters as well as for the geometric parameters of the extracting installation. As noticed from the variation of the total loads which act upon the tower during an extracting cycle in the case of the appliance of the safety brake the maximum values are in case 1 towards the end of the cycle and in case 2 at the beginning of the cycle (Fig 16 and Fig 17, and not at it’s end like in case 1. The maximum values of the loads determined are further used to determine the values of mechanical stress and strain from the elements of the structure of the metallic tower of the installation in order to verify its resistance.

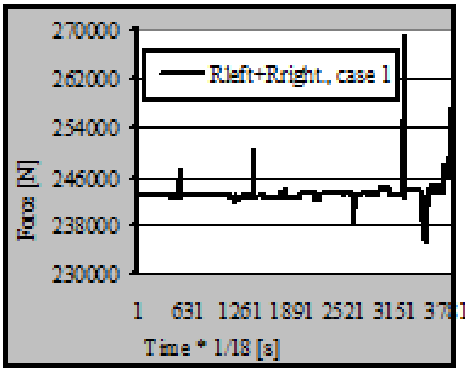


Figure 16. Total loads when the left cage descends and the right one climbs
Case 1

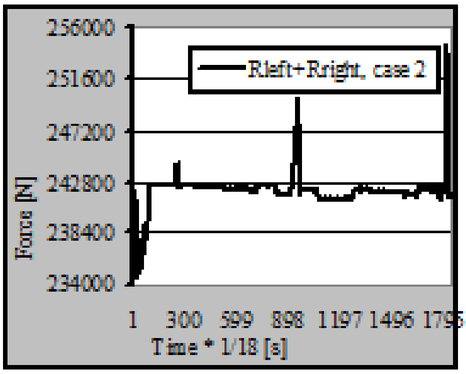


Figure 17. Total loads when the left cage climbs and the right one descends
Case 2

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