

STUDY OVER THE STATE OF STRESS AND DISPLACEMENTS FROM THE STRUCTURE OF THE TOWERS OF THE HOIST DEVICES DUE TO OPERATING LOADS

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ABSTRACT

The demand of safety in the hoisting process continuously imposes the optimal functioning of these devices, as important element in the transport flow of the mineral substance and the waste rock as of personal, equipment, and different materials between the underground and surface.

In the paper there is presented an analysis of the behavior of the towers of the hoisting devices with regard to stress and displacements of the tower structure during the operation in case of drums as wrapping element for the cables.

1. INTRODUCTION

The calculation the structure of the mining hoist's towers is done taking into consideration all the unfavorable combinations of the practically possible different loads called groups of loads and are established taking into account in their form the compatibility of their acting simultaneously.

The loads are classified into: permanent, short term - temporary, long term - temporary, and exceptional. The groups of loads with loads that can be introduced into groups of loads are the fundamental group of loads which contains permanent loads, long term loads, one or more short term loads and the special loads grouped from the fundamental group and one of the exceptional loads.

In order to establish the state of strain and displacements from the structure of the tower due to the short term functioning loads transmitted through the extracting cables during an extracting cycle, it has been taken into study the tower of the extracting installation „Auxiliary well Valea Arsului“ Vulcan Mining Plant, which has the general and working data presented as follows.

2. THE HOIST CONSIDERED FOR ANALYSIS

The hoist which works on auxiliary well Valea Arsului, from Vulcan Mining Plant, which is destined [3] for the underground supply with materials and tools as well as for transporting personal among levels 580, 650, and 700 the surface level being 783 m from the sea level.

The extracting installation that supplies the well (fig.1) is unbalanced and has an extracting machine type 2T-3,5×1,7 (fig.2) equipped with one asynchronous



Fig.1. Hoisting device
„Auxiliary shaft“



Fig.2. HOISTING machine
type BAMERT 3x0,9



Fig.3. Hoist tower
„Auxiliary shaft“

motor type AKH -14 - 46 -10, of 600 kW , 585 rpm. The reducer of the machine is of type TD-170 having the transmittance ratio of 11,5. The extracting cables with diameters of $\varnothing 42$ mm and a mass (on a linear meter) of 6,9 kg/m on the left branch (from the extracting machine to the well) and $\varnothing 40$ mm and a mass 6,17 kg/m on the right branch are wrapped around the two extracting pulleys of $\varnothing 3500$ mm with a mass (the pulley, the axis of the pulley and the bearing of the axis) of 3050 kg (fig.3), laying on the tower at a height of 23,7 m (pulley axel).

The cables are wrapped in a single layer (row) on each of the two wheels of the machine, from which one is fixed and one is mobile and which are hooked at one end by the exterior end (side) 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 cages with one level, with two trolleys per level weight a mass (own mass plus D.L.C.) of 4661 kg. The mass of a trolley is of 650 kg, and the effective load is 1800 kg/trolley.



Fig.4. Pulley platform



Fig.5. Leading component



Fig.6. Abutment

The height of the tower (fig.3) till the pulley axis of 23,7 m. The structure of the tower is composed of the extracting pulley platform (fig.4) sustained by the leading component (fig 5) and the abutment (fig 6) The extracting machine lies on the ground (at a height of 0.7 m to the 0 level of the well (well collar), sideways from the tower (well tower), at a distance (of the wheel axis), towards the vertical portion of the extracting cables which enter the well of 42m.

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 axis)), is for the left branch $L_{cs} = 46,226$ m, and $L_{cd} = 46,358$ m for the right branch.

The incline angles of the cables chords are $\beta_s = 34^{\circ} 04' 29''$ for the left branch and $\beta_d = 29^{\circ} 44' 41''$, 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: $\alpha_{e\ st}=19'29''$ and $\alpha_{i\ st}=45'21''$ For the left branch and $\alpha_{edr} = 31'53''$ and $\alpha_{idr} = 32'46''$ for the right branch.

3. LOADS TRANSMITTED TO THE TOWER

Considering the elevator leaving the horizontal 580m until it reaches the surface ramp (783 horizon) it has been considered for analysis, the case of personal transport entering the underground when the left elevator full of personal is descending on the right wing (case 1); the right elevator is descending on the right wing (case.2). The kinematics elements for the cases taken into analysis are presented in fig 7 and 8.

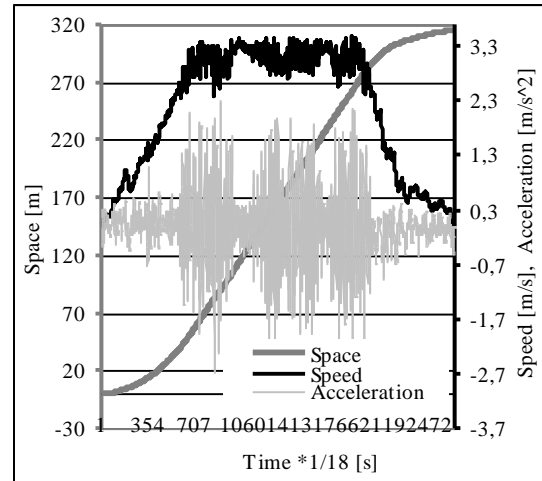
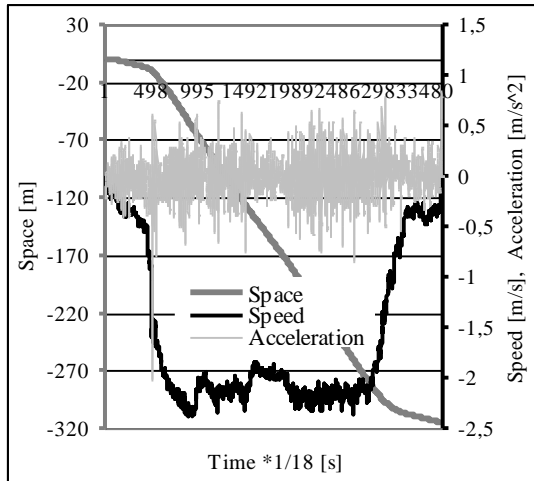


Fig.7. Kinematic elements on the elevator left climbing personal entrance, case 1

Fig.8. Kinematic elements on the elevator left descending personal entrance, case 2

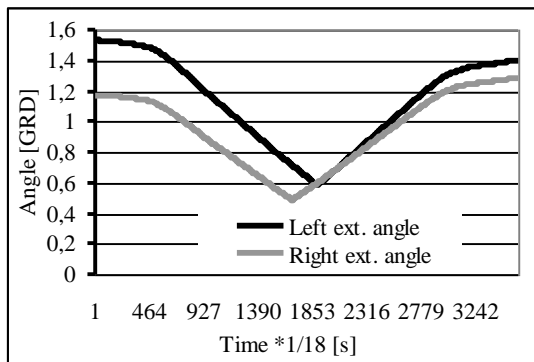


Fig.9. Deviating angles for case 1 from fig 7

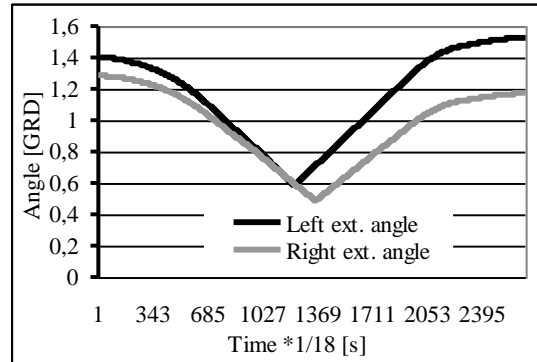


Fig.10. Deviating angles for case 2 from fig 8

The calculation of loads has been done taking into consideration the static, friction and dynamic forces [1], [2].

In the calculation of loads it has been used the d'Alembert [1] principle decomposing the efforts from the cable chords, in their touch points on the pulleys

into components on three perpendicular directions which correspond to the axis system chosen in the discretisation of the structure of the tower of the installation. The components of the efforts from the cable chords variate both because of the incline angles of the chords but also because of the deviation angles of them (fig.9 and fig.10).

Considering the left bearing and the right bearing, of each deviating pulley, there is presented the variation of the components of the forces on each pulley (fig.11 and fig.12) and the loads on the entire tower (fig.15 and fig.16), for each case taken into study.

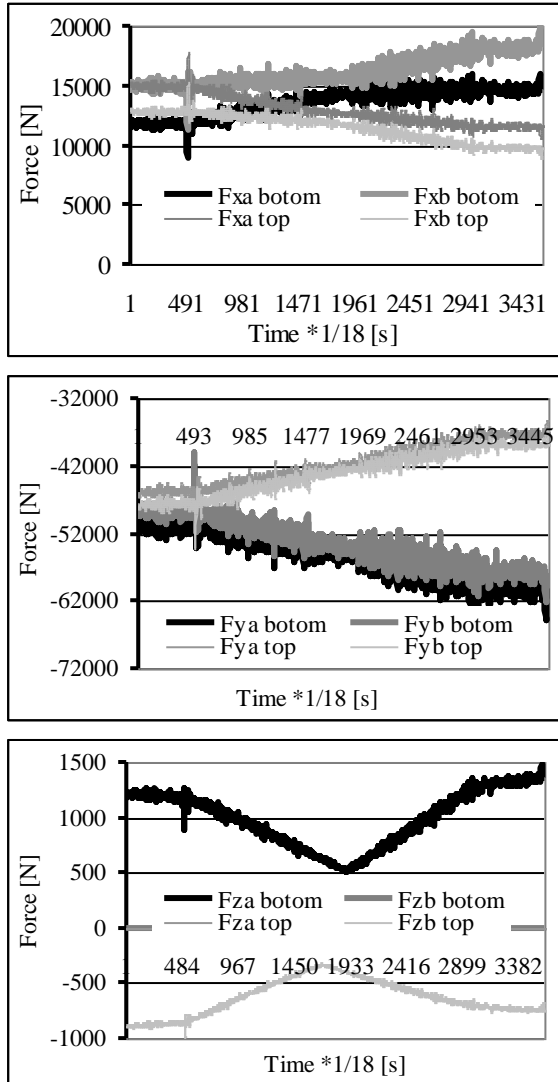


Fig.11. Forces in the pulley bearings left and right in case 1

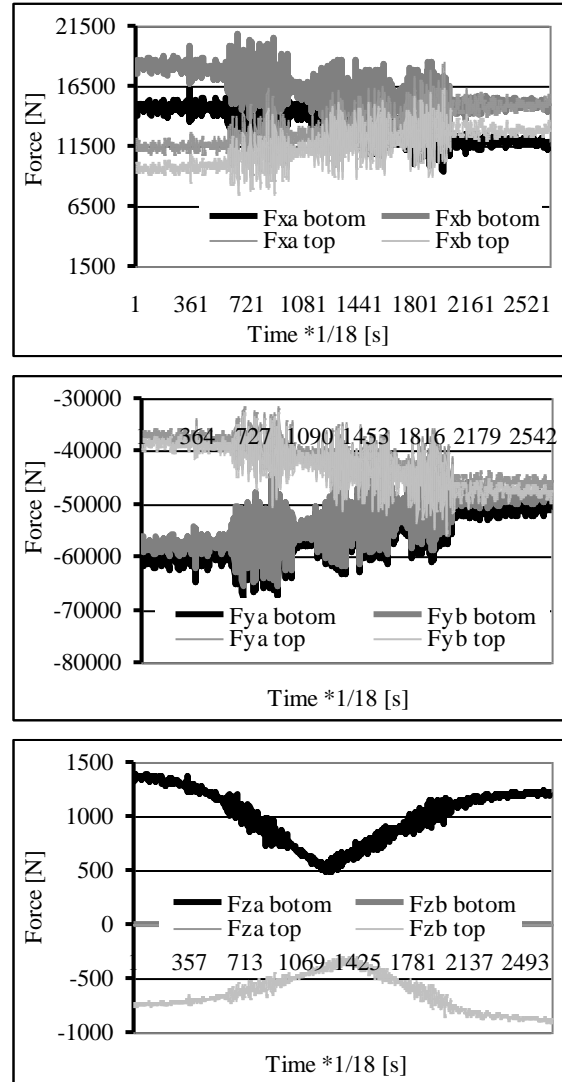


Fig.12. Forces in the pulley bearings left and right for case 2

4. STRESS AND DISPLACEMENTS

Due to the complexity of the tower the most appropriate method of study is [1] that of the finite element.

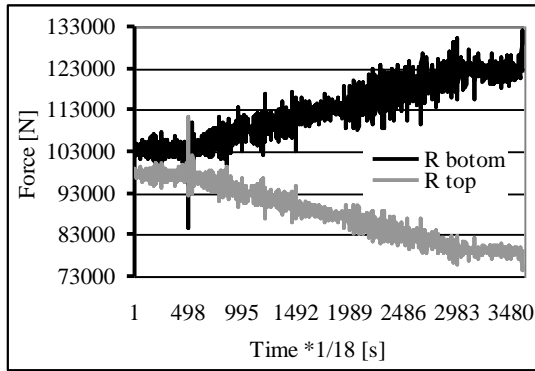


Fig.13. Forces on the pulleys elevator left climbing, right descending, case 1

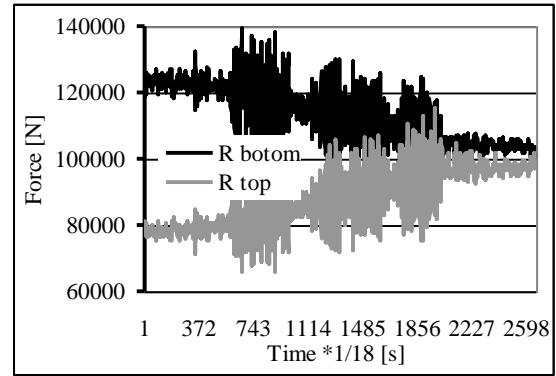


Fig.14. Forces on the pulleys elevator left descending, right climbing, case 2

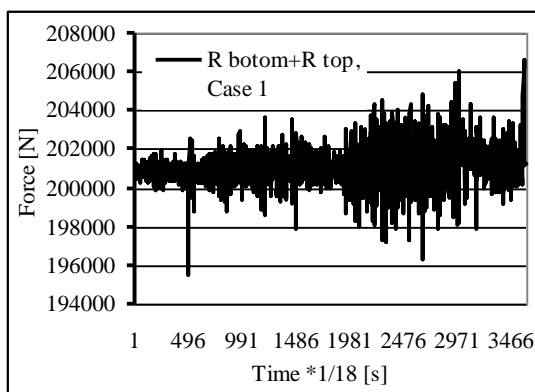


Fig.15. Total loads when the elevator left climbing , right descending case 1

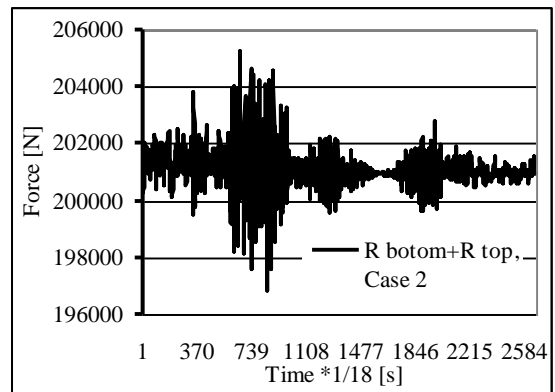


Fig. 16. Total loads when the elevator left descending, right climbing, case 2

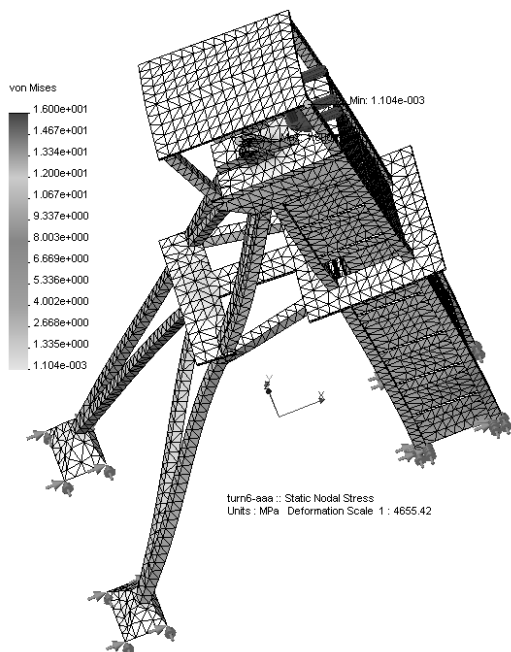


Fig.17. Stress, case 1

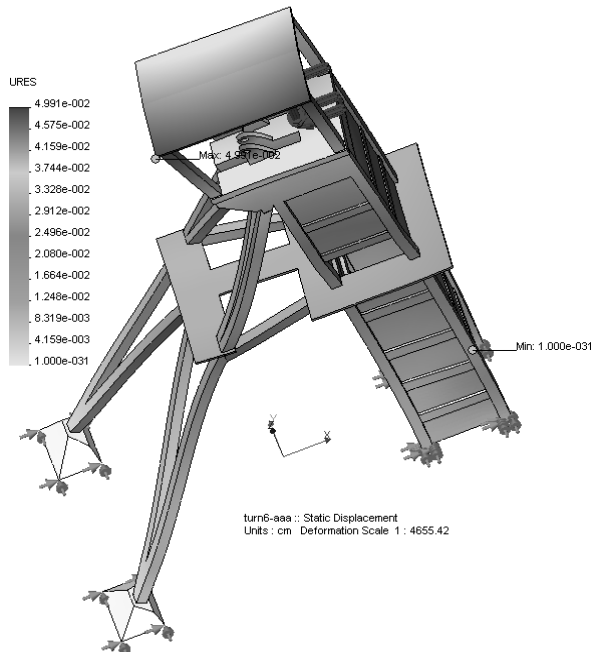


Fig.18. Displacements, case 1

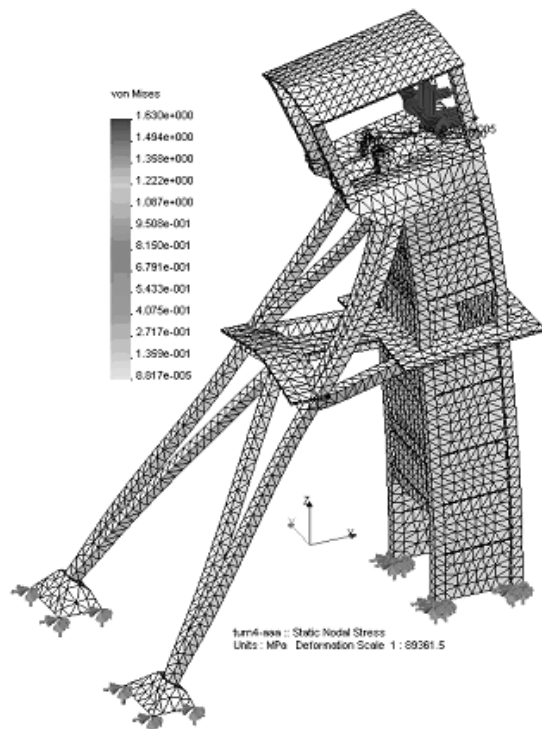


Fig.19. Stress, case 2

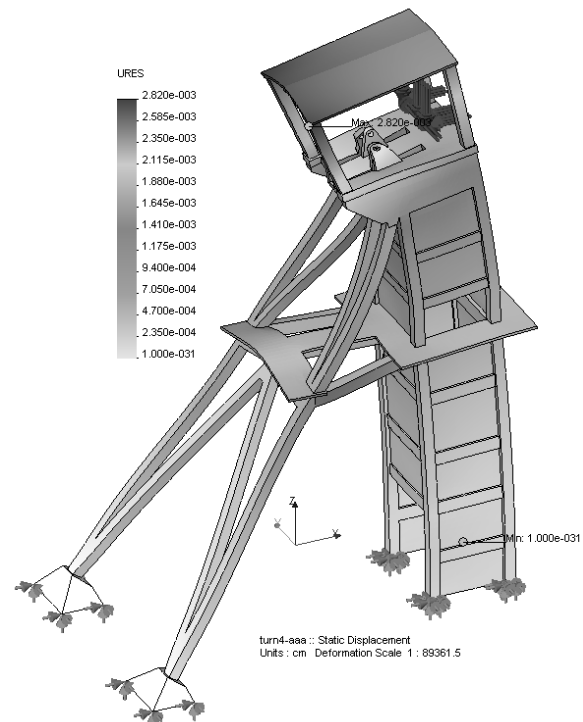


Fig.20. Displacements, case 2

In order to analyze the state of stress and displacements with the method of the finite element and the tower structure has been modulated the geometrical and mechanical characteristics have been established and introduced into the calculation software. In the cases taken into study the mass of the tower has been calculated with the help of the software. In fig 17 and 18 there are presented the strains and displacements for case 1, and in fig 19 and 20 for case 2.

5. CONCLUSIONS

The max values of strain and displacements have been determined from the tower structure, in order to establish the measuring points and to verify through experimental measurements the values obtained through numerical calculation. Following these results there have been obtained information necessary in order to improve the maintenance of the extracting installations and to improve the existing system of repair and supply for this type of installations.

REFERENCE

- [1] ITU, V., RIDZI, M.C.: **Strains and displacements in the elements of the metallic towers of the extracting installations due to the tower's own weight.** - Mines Magazine , vol 170, no. 8/2005, p. 25-31;
- [2] MAGYARI, A.: **Mining mechanical installations.** - Editura Tehnică, Bucharest, 1990;
- [3] **Technical documentation** - Vulcan Mining Plant