STATE OF STRAIN AND DISPLACEMENTS FROM THE STRUCTURE OF THE EXTRACTING TOWER IN THE CASE OF APPLICATION OF THE SAFETY BRAKE

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ABSTRACT**:** *The development in safe conditions of the extracting process continuously imposes the need of optimal functioning of the extracting installations as important links in the transport flow of the mineral substance and of the sterile for the transportation between the underground and the surface of personal, machines and different mining tools. In the paper there is presented an analysis of the behavior of the towers of the extracting installation with regards to strains and displacements of the resistance structure during the functioning of the extracting installations with pulleys as a wrapping organ for the cables.*

KEYWORDS: loads, tower, strain, displacements, structure

1. INTRODUCTION

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 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 „New Skip Shaft'' from Lonea Mining Plant, which has the general and working data presented as follows.

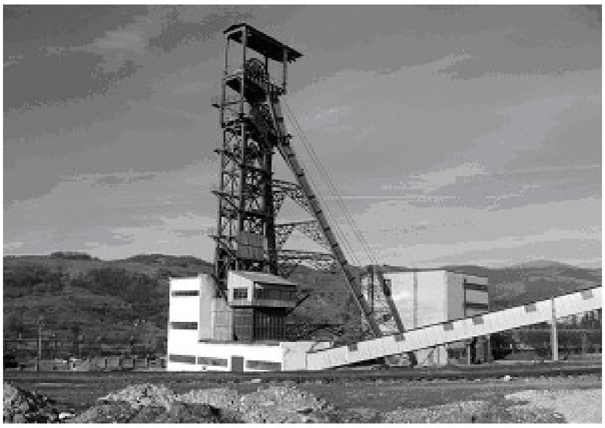

Fig.1. Extracting installation

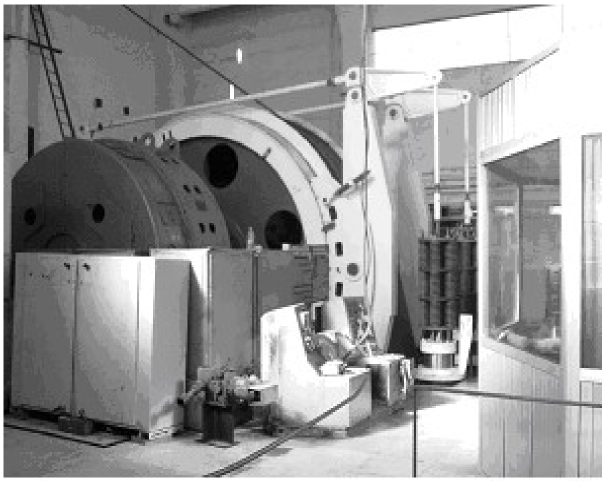

Fig.2. Extracting machine

2. THE INSTALLATION TAKEN INTO STUDY

The extracting installation that operates on the new skip well from Lonea Mining Plant, is destined [3] for the extraction from the underground of minerals. The extraction is done from the horizon +169,140 to the surface (the surface level is +704,5m; and the skip unloading level is +715,5m). The installation (Fig.1) is ballanced and has an extracting machine type MK 5x2 (Fig.2) equipped with two motors type P2S-1000-213-HUHLH/1998, of 1000 kW power and a nominal rpm of 54 rot/min (Fig.3).

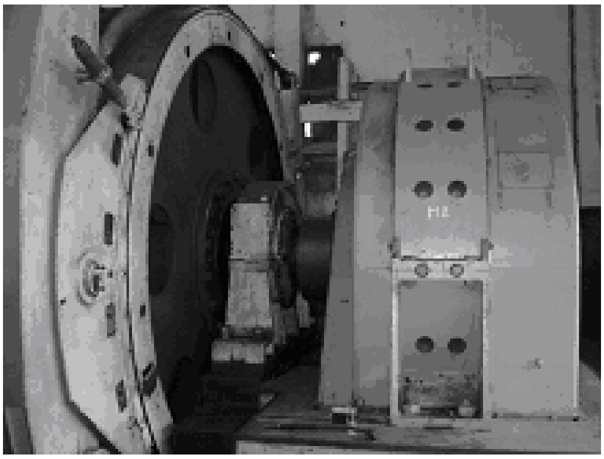

Fig.3. The motor

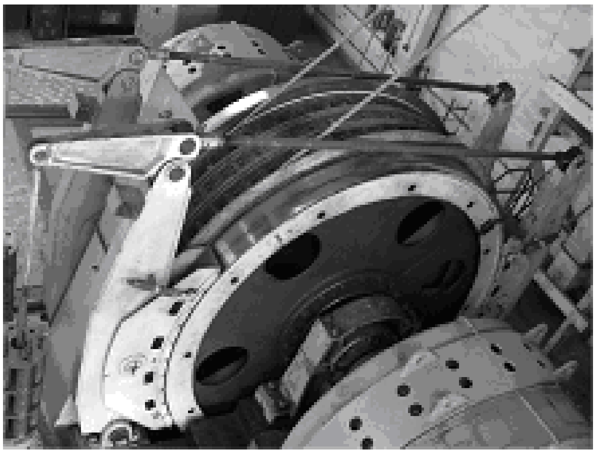

Fig.4. Wrapping organ

The cables are wrapped around a moving wheel of Φ 5000 mm (Fig.4). The extracting cables with diameters of Φ 46,5 mm and a mass (on a linear meter) of 8,049 kg/m are wrapped around the two extracting pulleys of Φ 5000 mm with a mass (the pulley, the axel of the pulley and the bearing of the axel) of 5430 kg (Fig.5), laying on the tower at a height of 47 m (pulley axel).

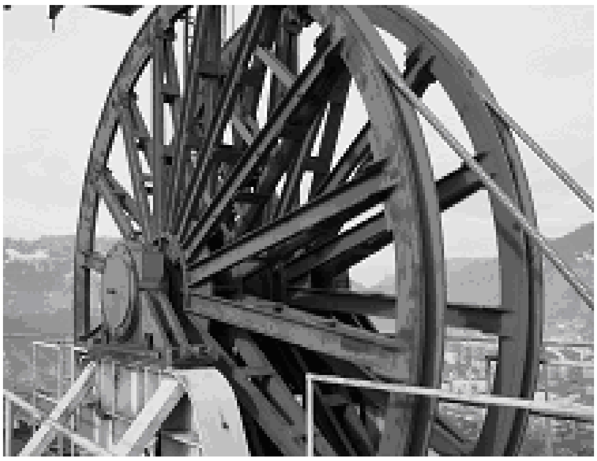

Fig.5. Extracting pulleys

The ballanced cables have a section of 135x20 mm and a mass (on a linear meter) of 9,062 kg. The extracting vessels are skips having a mass (own mass, plus D.L.C., plus D.E.C. and suplimentary mass) of 21600 kg. and the effective load is 7000-8000 kg/skip. Another main component of the extracting installation is the metallic tower (Fig.6) with a height until the pulley axel of 51 m. The structure of the tower is composed of the extracting pulley platform sustained by the leading component and the one abutment set up as a frustum pyramid The extracting machine lies on the ground (at a height of 6,45 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 44m.

Fig.6. Metallic tower

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 bottom branch L_{ci}= 52,91690824m, and L_{cs}= 59,30405431m for the top branch. The incline angles of the cables chords are β_i = 43^0 43` 31``,37317428 for the bottom branch and $\beta_s$ = $42^0$ 21` 58``,20794964, for the top branch [2].

3. LOADS TRANSMITTED TO THE TOWER

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 skips is descending (ascending) 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],[2]).

For this purpose it has been taken into analysis the case when the skip is descending on the top branch (case 1, the skip of the bottom branch is climbing and the top one is descending) and the case when the skip is descending on the bottom branch (case 2, the skip of the bottom branch is descending and the top one is climbing).

The diagrams for the space, speed, and acceleration for the two cases taken into analysis are presented into figure 7 case 1 and in figure 8 case 2. The variations of acceleration and space have been used for the calculation of the loads applied to the tower. 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. 7 and Fig. 8).

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 figure 9 case 1, loads when the top cage descends and the bottom one climbs and figure 10, loads when the top cage climbs and the bottom one descends case 2, for both pulleys.

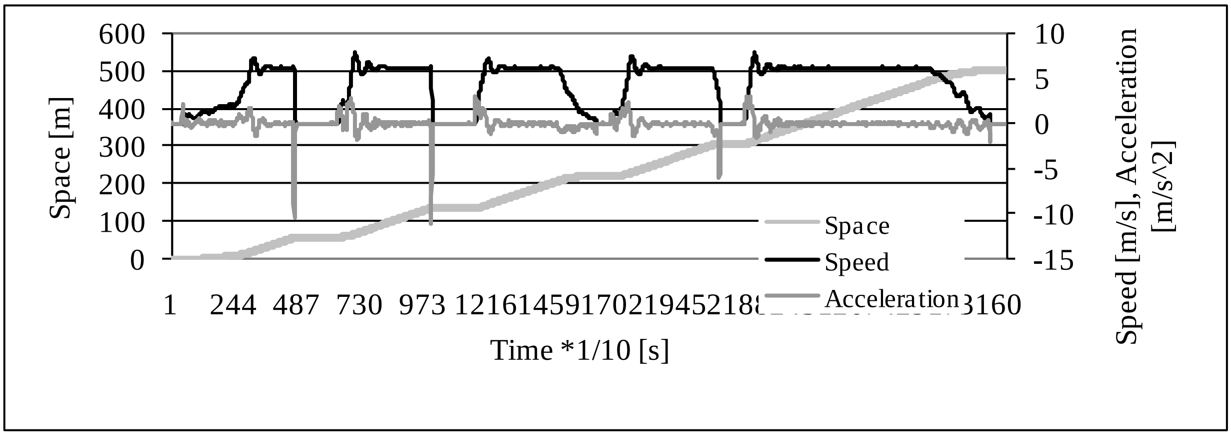

Fig.7. Speed, acceleration and space for case 1

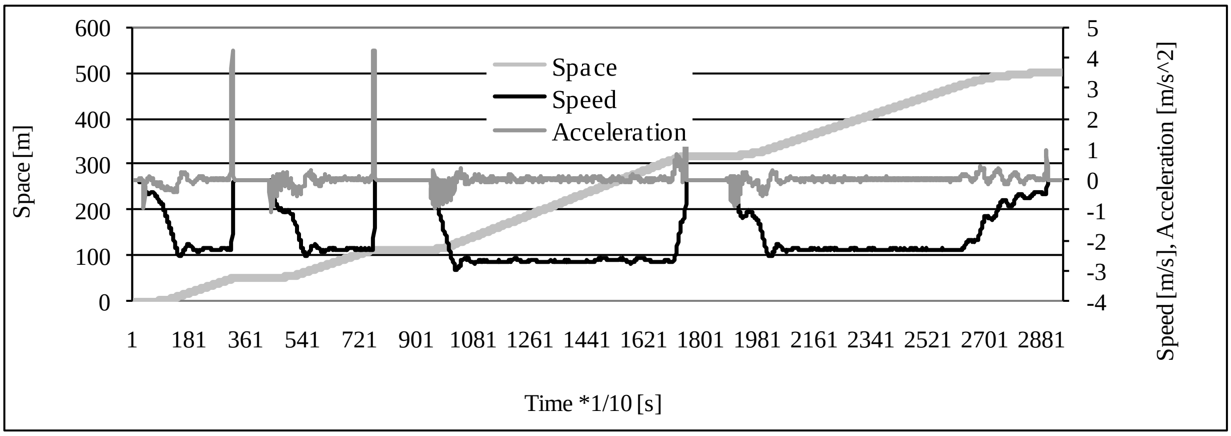

Fig.8. Speed, acceleration and space for case 2

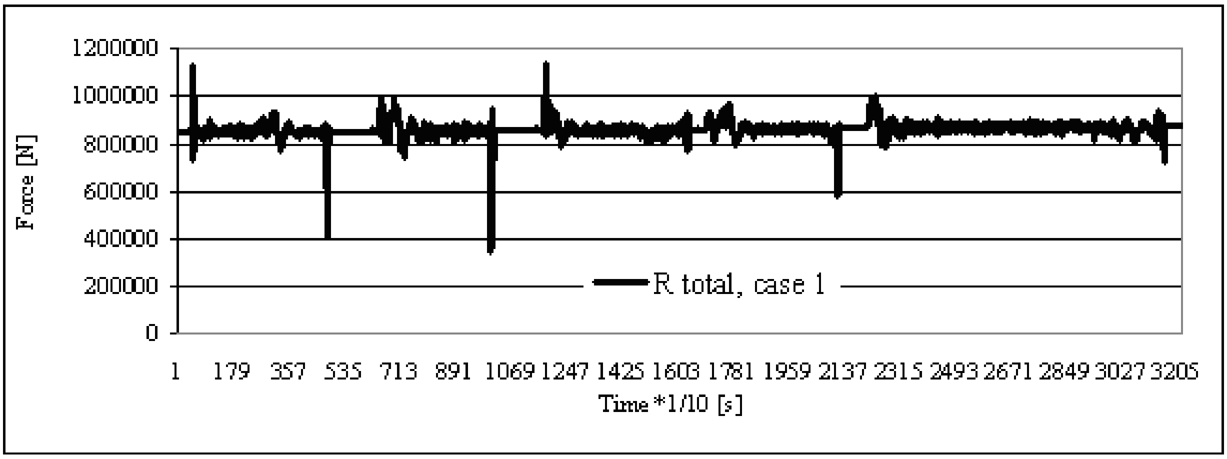

Fig. 9. Total loads when the top cage descends and the bottom one climbs case 1

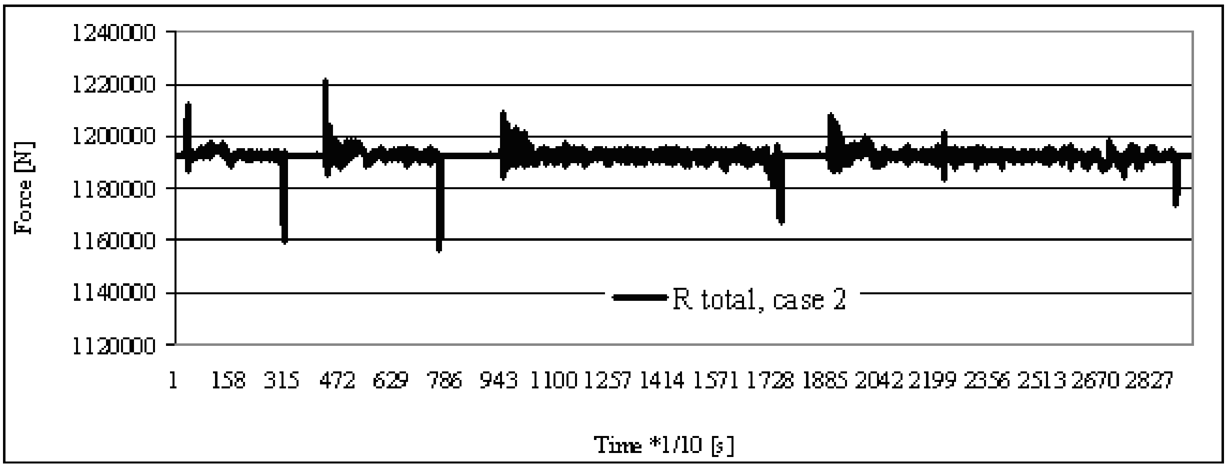

Fig. 10. Total loads when the top cage climbs and the bottom one descends case 2

4. STRAIN AND DISPLACEMENTS

Due to the complexity of the tower the most appropriate method of study is [1] that of the finite element. In order to annalyse the state of strain 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 11 and 12 there are presented the strains and displacements for case 1, and in fig 13 and 14 for case 2.

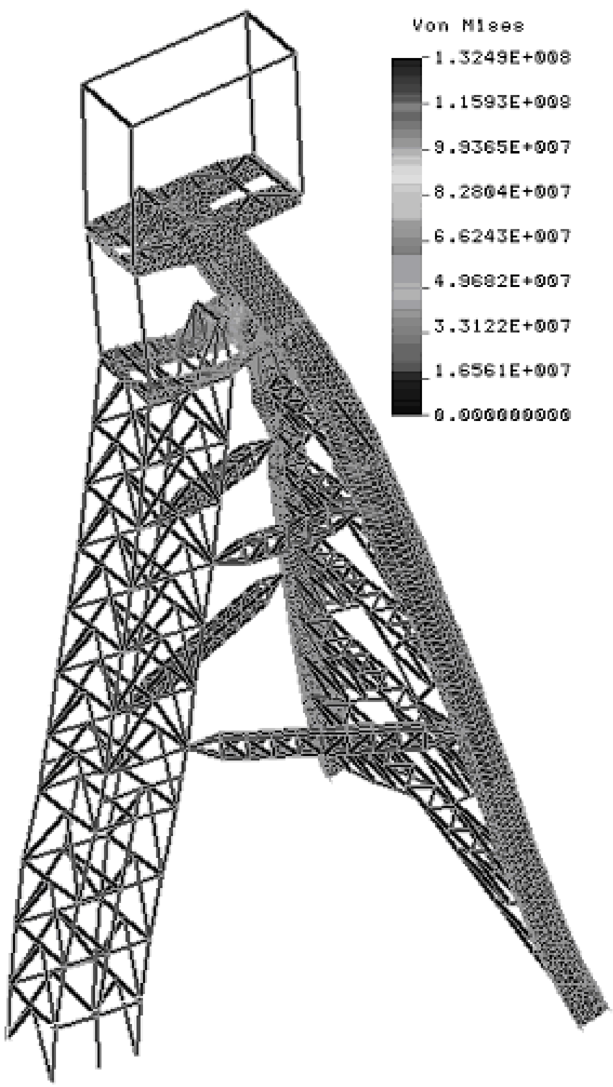

Fig.11. Strain, case 1

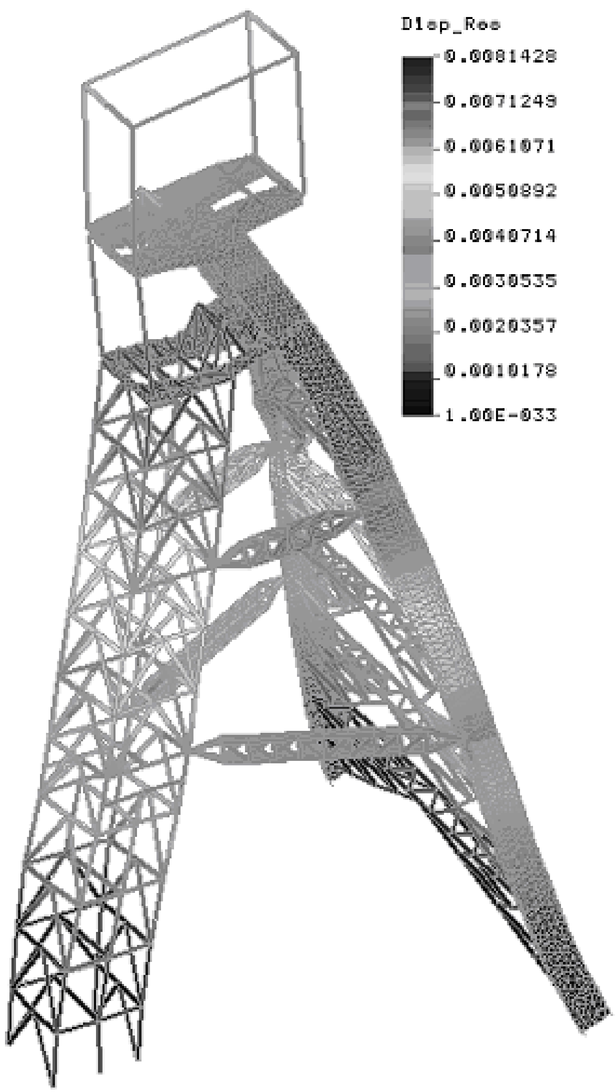

Fig.12. Displacements, case 1

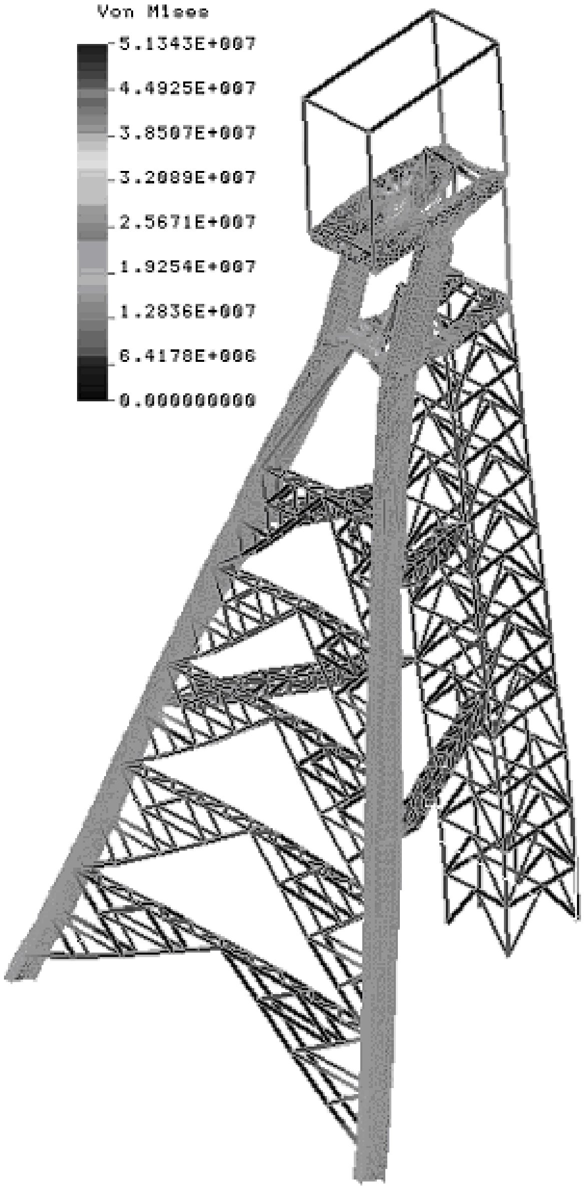

Fig.13. Strain, case 2

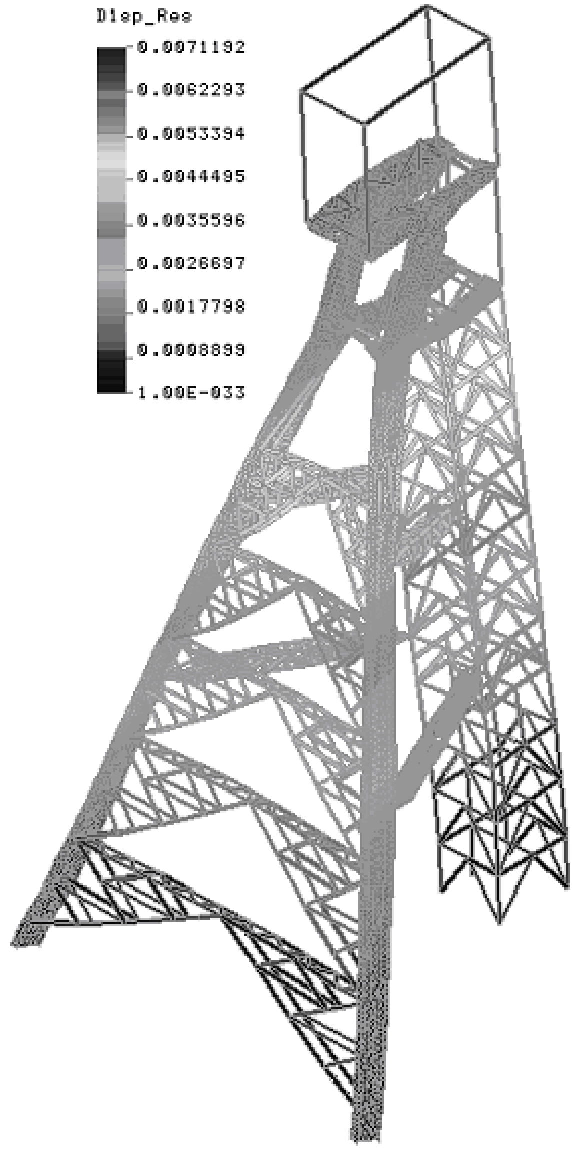

Fig.14. Displacements, case 2

5. 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 skip and the wrapping organ of the extracting machine is moving wheel.

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 in the case when the emergency brake is applied due to an overcome of the max speed allowed when the skip 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 of the cycle and in case 2 at the beginning of the cycle (Fig 9 and Fig 10).

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.

There have been determined and localized the max values of strain and displacements from the tower structure, in order to establish the measuring points, in order 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.

6. RERENCES

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