STRUCTURAL AND FUNCTIONAL SOLUTIONS FOR THE IMPROVEMENT OF THE SLIDING STEEL MINE TIMBERING

Simaschevici Alexandru, *drd.ing.Universitatea din Petroșani,*
Simaschevici Horia, *Prof.dr.ing.,Universitatea din Petroșani,*

ABSTRACT

This study analyses the mathematical model of the phenomena which occur in a flexible joint and brings into discussion new structural solutions in order to improve the operation of the gripping system of the heavy sections.

THE DIMENSIONING OF THE BRIDLES IN A FLEXIBLE JOINT ACCORDING TO THE STRESSES ACTED UPON THE SECTIONS AND THE CLAMPIONG FORCE OF THE BRIDLES

The bending moments M, normal forces N and peripheral forces T occur in all the sections of the arch of a sliding steel mine timbering including the median section of the bridle under the action of the external force.

Moreover, the bridles are tightened up with steel clamps and screw nuts (figure 1).

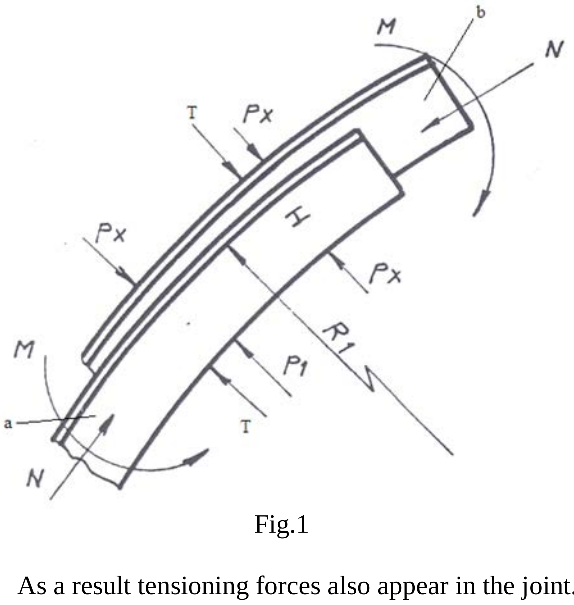

Fig.1

As a result tensioning forces also appear in the joint.

Being under mine pressure the 2 heavy sections a and b will distance themselves one from another depending not only on the stresses from the sections but also on the clamping forces in the bridles Px figure 1.

In order to determine the adequate clamping forces of the bridles on the basis of the principle of independence of forces and the overlapping of their effects, we shall consider the joint surface to be alternately stressed to a single effort, adding all their effects in the end.

We will take into consideration the joint which, under the action of the M bending moment the b section will press the a section leaning on the superior bridle (figure 2)

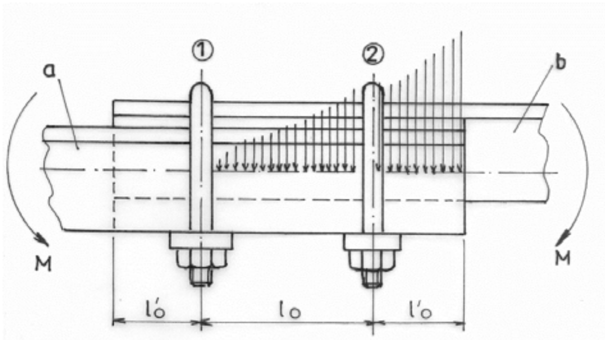

Fig.2.

The problem to be solved is to determine the value of the resultant and its working point.

The bending moments and their values of pressure on the sections don't modify when the sign of the bending moments changes.

Only the role of the bridles changes when this pressure acts upon them: the inferior bridle is working if the stress moment is negative and if the moment is positive the superior bridle is working if the stress moment is negative and if the moment is positive the superior bridle is working.

The clamping force will be unequally distributed over the contact surface and this unequal distribution will depend on the stress of the bridle

If bridle 2 is freely assembled without and the sections will tighten perfectly we can consider that the clamping force is distributed on the law of the triangles, its stress base will be equal to $l_0 + l_0'$(figure 2).

If a free space appears between the sections or when the bridles are stressed the distribution law of the force will modify because it will add up or substract from the forces from the bridles.

The resultant working point of this pressure given by the bending moment in the case of triangular load will remain at a distance of 2/3 $(l_0 + l_0')$ and $(l_0 + l_0')$ from the extremities.

If the distribution law of the force is more complex the researches will show only the centre of gravity. The resultant would be more or less determined and would little differ from the chosen one.

The size of the resultant will be:

$$R_M = \frac{3 \cdot M}{2(l_0 + l_0')} \quad (1)$$

This pressure way be bigger than the stress force of the second bridle situation in which the bridle stops functioning.

Depending on the sign, the traverse force will increase or decrease the pressure force. The cross force is considered to be positive when it pushes up the left side of the beam while the right side of the beam is pushed down.

It can be said that the cross force presses the sections one from another and the negative traverse force on the contrary, tend to separate the sections. In conclusion, the force created through the stresses of the bridles always amplifies the pressure force.

Until the sliding starts all the forces that operate in the flexible joint (the external forces M, N, T, P_x and the frictional force F) are in balance. The forces that act upon the sections will be:

$$p = \sum P_x + T + \frac{3M}{2(l_0 + l_0')} \quad (2)$$

Where $\sum P_x$ - represents the overall force of the bridles.

These forces make the frictional forces appear on the contact surface of the sections (figure 3).

The equation of equilibrium for these forces and of the frictional forces is:

$$p = \sum P_x + T + \frac{3M}{2(l_0 + l_0')} - 2F \sin\alpha_0 - 2 \cdot F_1 \cdot \cos\alpha_0 = 0 \quad (3)$$

but: $F_1 = F \cdot \mu$ (4)

then: $2N_0 = \frac{\sum P_x + Q + \frac{3M}{2(l_0 + l_0')}}{\sin\alpha_0 - \mu \cdot \cos\alpha_0}$ (5)

Where α_0 is the angle of inclination for the lateral edges from the section;

This is the normal force that appears on the contact surfaces of the sections resulting after the action of M, N, T, and P_x forces and μ is the coefficient of friction.

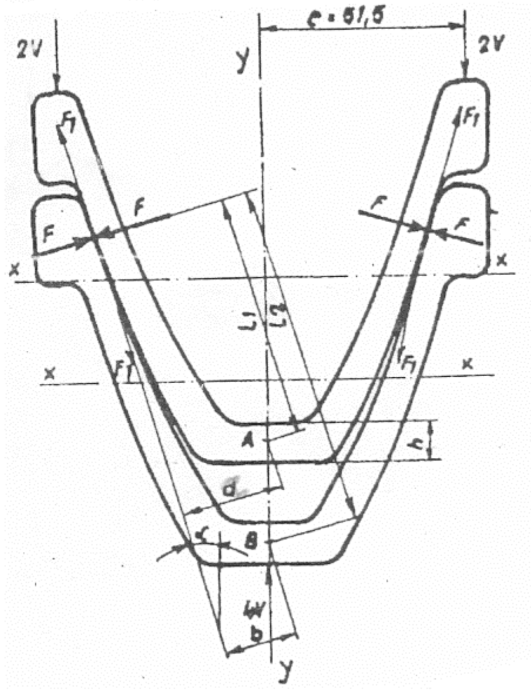

Fig.3.

The normal force N will separate the sections and the frictional force will oppose to this displacement.

$$F_{f1} = \mu \cdot 2 \cdot F_1 \quad (6)$$

meaning that:

$$F_{f1} = \mu \cdot \frac{\sum P_x + T + \frac{3M}{2(l_0 + l_0')}}{\sin\alpha_0 - \mu \cdot \cos\alpha_0} \quad (7)$$

A frictional force F_{f2} also appears at the sliding of the sections from the bridles which under the action of the positive traverse force will be equal to:

$$T_{f2} = \mu \cdot \left[\sum P_x + \frac{3M}{2(l_0 + l_0')}\right] \quad (8)$$

Thus $F_f = F_{f1} + F_{f2}$.In the equilibrium state, before the sliding, there is the following dependency F_f>N, in the case of equality the sliding occurs.

As shown above, the sliding must occur in leaps because of the inequality of the coefficient of friction in the equilibrium and sliding state.

In the case of resting position F_{frep}> N as N increases, the equality F_{frep}=N may appears and this is the moment when the sliding begins. But the equality disappears because F_{frep}>F_{fmis}as soon as the sliding begins and the inequality F_{fmis}<N. For such an inequality the sliding is made through leaps and stops when the forces of friction>N. The normal force decreases due to the sliding of the arc. The sliding from the bridles can be expressed through the following relation:

$$N = \mu \cdot \left[\frac{\sum P_x + T + \frac{3M}{2(l_0 + l_0')}}{\sin\alpha_0 - \mu \cdot \cos\alpha_0} + \sum P_x + \frac{3M}{2(l_0 + l_0')} \right] \quad (9)$$

If we note:

$$A = 1 + \frac{1}{\sin\alpha_0 - \mu \cdot \cos\alpha_0} \quad (10)$$

and

$$B = 1 + \sin\alpha_0 - \mu \cdot \cos\alpha_0 \quad (11)$$

After calculations we get the pressure force from the bridles:

$$\sum P_x = \frac{N}{\mu \cdot A} - \frac{3M}{2(l_0 + l_0')} - \frac{Q}{B} \quad (12)$$

Conclusions and proposals for improving the holding systems of the heavy sections

From the previous studies it results that the bridles should be designed according to the geological mine conditions where the timbering will be used, estimating the values of the moments of flexure M generated by the asymmetrical mine pressure.

Because of the moment of flexure is the operating bridles tend to slide one towards the other and the mine timbering will malfunction.

The first condition that we should take into consideration for the fabrication of the holding systems of the sections is that the bridles maintain the same distance between them from the installation irrespective of the values of the stress or this distance way raise during the sliding through guidance.

The clamp of the bridles can be fabricated from round steel with threads at the ends or from strip fixed with 2 screws.

Like the screws, the clamps stressed to stretch should be made from steel of superior quality because they are the most stressed components of the bridles.

The deformation within acceptable elastical limits of the screws as well as the joining (with elastic formulae) of the contact surfaces between the bridles and the sections will prevent the sections and the timbering from getting stuck the transformation of the timbering into a rigid support submitted to buckling phenomenon.

The strengthening of the sections with stand –ins should be considered where the geological mine conditions would be harsher than the estimated ones.

Figure 4 presents a bridle that assembles SG 18, SG 23 sections or equivalent sections brought from the import where the bottom clip 2 covers the bottom section decreasing the maximum mechanical stress from the section and reducing the distortion of the section.

The clamp (1) will be made from round steel ϕ30 with M 30 threads and with one M 30 nut. The clip 2 will be assembled on the gripping section trough blockage or heat treatment so that it will not slide during the operation and maintain its initial position.

The clamp 1 will be the part that will slide on the superior section during the sliding of the timbering, the friction coefficient of a cylindrical surface on a level surface is smaller than the friction coefficient between 2 level surfaces.

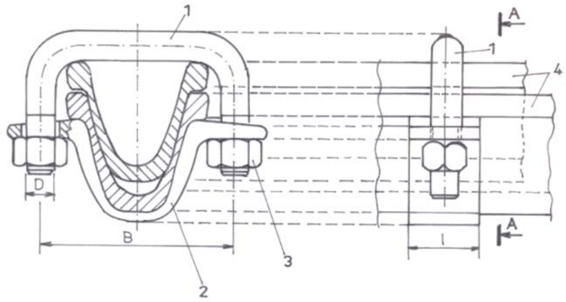

Fig.4

In figure 5 the represented bridle has the clamp 1 made from strip and joint with 2 screws of ϕ30 mm in diameter. The 2 bridles drawn with adapter shoulders, the left one guided towards the abutment and the right one towards the light of the mine working separate from each other and the stresses from the bridles diminish. In this way the clip 2 is free and the shoulders have the role of controlling the bridles.

Figure 5 presents an attachment made up of 2 bridles connected by a spacer made up from spring steel and placed towards the light of the mine working. This will slide at the same time with the bottom section maintaining its position towards its end.

This attachment can be used for gripping the SG-18, SG-23. Sections, figure 6a or the SG-29 section, figure 6b.

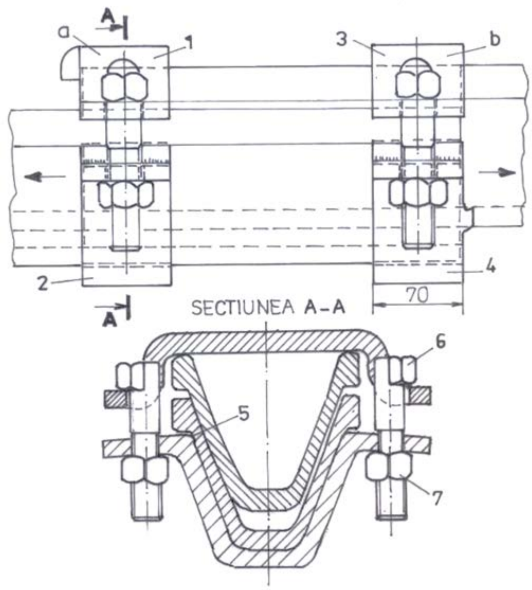

Fig.5.

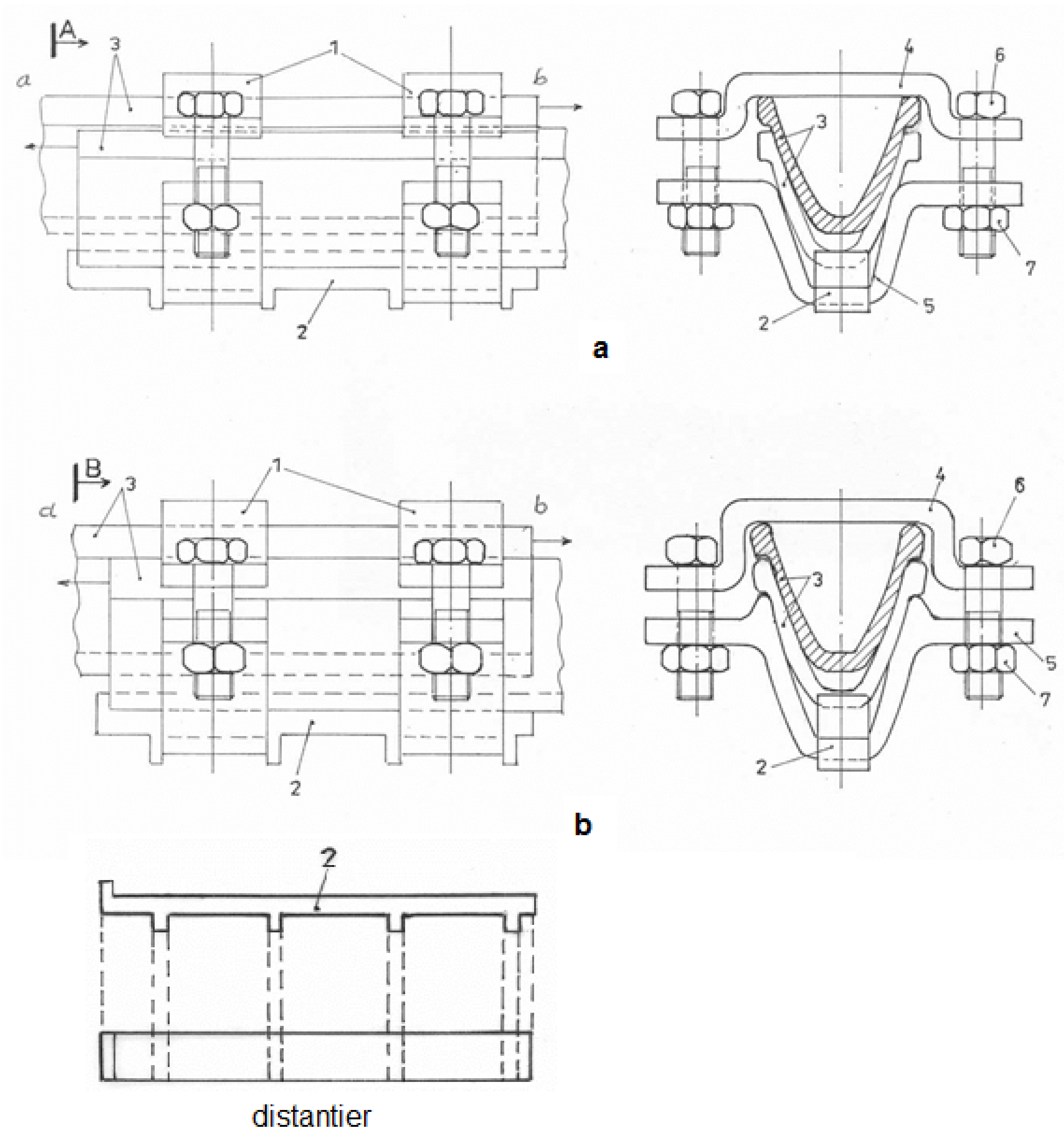

Fig. 6

BIBLIOGRAFIE

(1) Leţu N., Redermacher L - *Metode de dimensionare a susţinerilor metalice pentru lucrările miniere orizontale.* Ed. INID Bucureşti, 1995

(2) Leţu N.,Butulescu, V., Pleşea V.,Semen, C-tin. *Eficientizarea lucrărilor orizontale la minele din Valea Jiului,* Editura POLIDAVA-DEVA, 2001

(3) Pleșea V. *Proiectarea și construcția susținerii lucrărilor miniere subterane din sectorul carbonifer,* Editura UNIVERSITAS Petroșani, 2004.

(5) x x x- *Prospecte comerciale ale firmelor producătoare de susțineri metalice glisante*