ANALYSIS OF FLAT CABLE CONNECTING DEVICES FOR WINDING INSTALLATION VESSELS

RĂZVAN-BOGDAN ITU[1], VILHELM ITU[2]

Abstract: Winding installations have the role of transporting, between underground and surface, useful minerals, materials, equipment, and people, with extraction vessels. Cable connecting devices connect winding installation cables to extraction vessels. Depending on their design, connecting cables can be: with loop and core, self-tightening with wedged core on one or both sides; with hinged jaw; with cone-shaped friction wedges; with wedges and bridles. The paper presents an analysis of flat metal cable connecting devices.

Keywords: Cable connection device

1. INTRODUCTION

Flat cable connection devices for equilibrium provide connection between extraction vessel and flat cable to compensate for hoisted materials.

Table 1 shows the constructive-functional characteristics of flat cable devices for equilibrium.

Table 1. **Characteristics of flat cable connection devices for equilibrium**

No.	Characteristic	UM	Value of characteristic		
			DLCLE-118	DLCLE-129	DLCLE-135
1	Maximum static load	tones/kN	2/20	3,5/35	5,5/55
2	Flat cable section	mm	106×15,5 118×17	124×18 129×19	135×20
3	Specific cable mass	kg/m	5,447/6,726	7,558/8,128	8,865
4	Cable fixing	-	With loop and eccentric core		
5	Bolt diameter	mm	60	70	70
6	Cover plate width for	mm	40	48	40

---

[1] *Assistant, Ph. D. Eng., University of Petroşani*
[2] *Lecturer, Ph.D. Eng., University of Petroşani, drituv@yahoo.com*

No.	Characteristic	UM	Value of characteristic		
			DLCLE-118	DLCLE-129	DLCLE-135
	attaching to the skip				
7	Number of fixing clamps of flat cable	pc	6	6	6
8	Space btw. clamps	mm	120	120	120
9	Size - Length (height)	mm	1327	1577	1706
	- Width	mm	380	460	500
	- Thickness	mm	238	250	258
10	Weight	kg	190	248	290

2. DEVICE CONSTRUCTION AND FUNCTIONING

Main constructional-functional parts of flat cable connection

The main constructive-functional parts of flat cable connecting devices for equilibrium DLCLE-118, DLCLE-129 and DLCLE-135 are shown in Fig. 1 and 2.
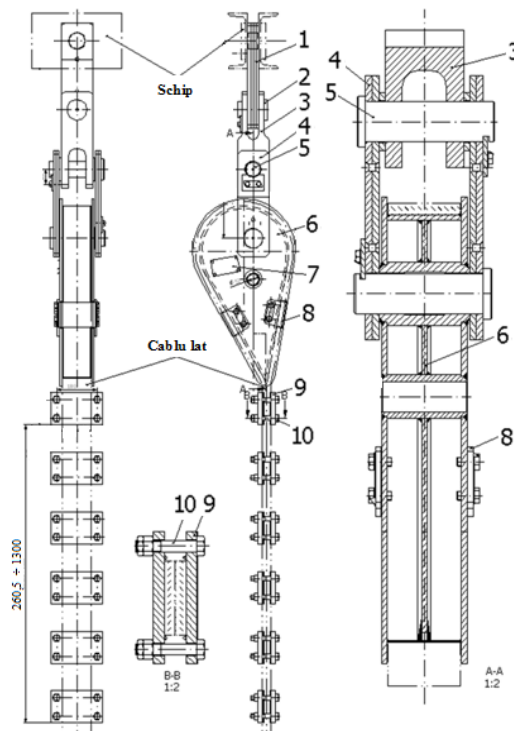

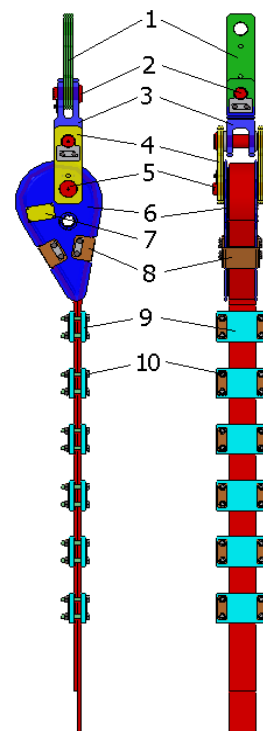**Fig. 1.** Flat cable connecting device DLCLE 118, 129, 135

Fig. 2. Flat cable connecting device for equilibrium DLCLE 118

The three typo-dimensions of flat cable connecting devices have the same constructive shape, the difference lying in the dimensions of the component elements,

which are subject to different trials depending on the characteristics of the compensation cable.

According to Fig. 1, such a device is made up of a series of elements of resistance making the connection between the bottom of the extraction vessel and the eccentric core, its functional width being determined by the width of the flat cable and a series of clamps for fixing the end of the cable wound around the core.

The whole of the device is fixed to the extraction vessel by means of cover plate 1, which is a structure of resistance made up of four steel plates riveted between them and processed by cutting to nominal size. The connection to the eccentric core 6 is done by means of a fork 3 and two cover plates 4, made up od two steel plated riveted between them, and the connection between the three elements being made by bolts 2 and 5, made of allied steel and thermally treated.

The eccentric core is a welded metal structure, Fig. 3, with a central plate giving the shape and position of the two sleeves, and the winding plate and the exterior plates make up the canal around which the end of the flat cable is wound for compensation. The core, besides the bolt 5 sleeve also has a hole used to support the device in view of mounting the cable. The label 7 is fixed tot the core, to identify the device and the two flanges 8, having the role of fixing the flat cable to the canal of the metal core.

The loose end of the cable is passed along 1500 mm over the cable entering the core, the two branches being seized in six double clamps 9, each having four tightening screws 10, with nuts and counter-nuts.

The material of the important parts, the plates of the cover plate seizing the extraction vessel, all the connection bolts, the connection fork, the plates of the intermediary cover plate, the lower and the upper plate of the eccentric core respectively, should be monitored for defects, non-destructively, before the material flow, and should meet the prescriptions specified in the technical documentation.
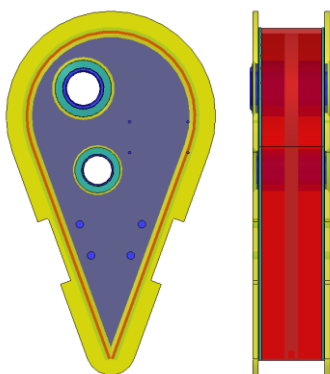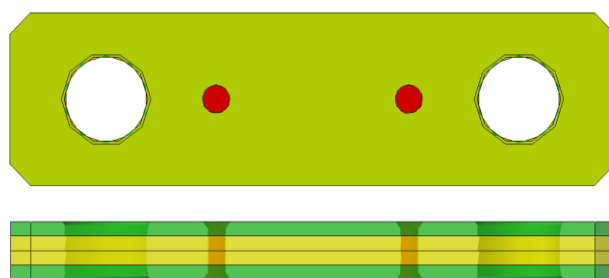

Fig. 3. Eccentric core   **Fig. 4.** Cover plate for attaching the skip

In the execution of the skip that seizes the cover plate, Fig. 4, of the intermediary cover plate and the lower and upper plates of the eccentric core, the

following conditions should be met:

      - heat straightening of the sheets of which the before mentioned subassemblies are made, is not allowed;

      - the piece will be cut out from the sheet along the outline by chipping or thermal cutting, in which case a processing addition of minimum 10 mm is left, which will be removed by chipping;

      - the piece will be cut out so that the direction of lamination of the sheet would coincide with the strain direction of the piece, along it.

      In the execution of the subassemblies made up of plates, the exterior and interior plates are gripped in a package and the boring for riveting is done, after which they are riveted together, and the other boring operations will be done. After assembling the plate packages by riveting, the end of the rivet is processed, so that the outside of the of the plate surface would not be extended in the exterior

      In order to execute the connecting bolts and forks, the forging of the material is not allowed, only its mechanical processing.

      Before its installation at the place of use, all the component pieces of the device are verified. The component elements showing defects or damages, which might adversely influence the functioning of the device will not be allowed.

      The extraction vessel to which the equilibrium device is attached is found on pegs of a safety bridge.

      At the upper part, the device is mounted by means of bolts to the extraction vessel, and at the lower part the flat cable is mounted by winding around the eccentric core and fixing by clamps.

      The daily verification of the devices is done by careful visual examination and tapping, watching whether the component parts show fissures or deformations.

3. SIZE VERIFICATION OF DEVICES.

      Starting from the mathematical equilibrium model of the cable and metal core, shown in Fig. 5, and the non-slip condition of the end of the cable blocked between clamps and cable, the relations of determination of clamps tightening force is given below:

$$N_1 = \frac{G \cdot e^{-\mu\theta}}{\mu_1 \cdot \left(1 + e^{-\mu\theta}\right)} \quad [N] \tag{1}$$

where: G is the maximum weight of the equilibrium cable, $G = 20000$ N; μ – friction coefficient between the cable and the metal core, $\mu = 0,1$; θ – winding angle of the cable on the metal core, $\theta = 220°$; μ_1 – friction coefficient between cables, $\mu_1 = 0,1$.

      For a dynamic coefficient of the winding installation of 1,6 ... 2 and a safety coefficient higher than 10, a number of twenty-one M20 screw result executed in OLC 35q, with a flow limit of 370 MPa. Due to the use of clamps with four tightening screws, six clamps for safe fixing of the end of the cable are required.

The cover plates and fork have been tried for tear and shear in the bolt area and for contact pressure between their boring surfaces and bolts.
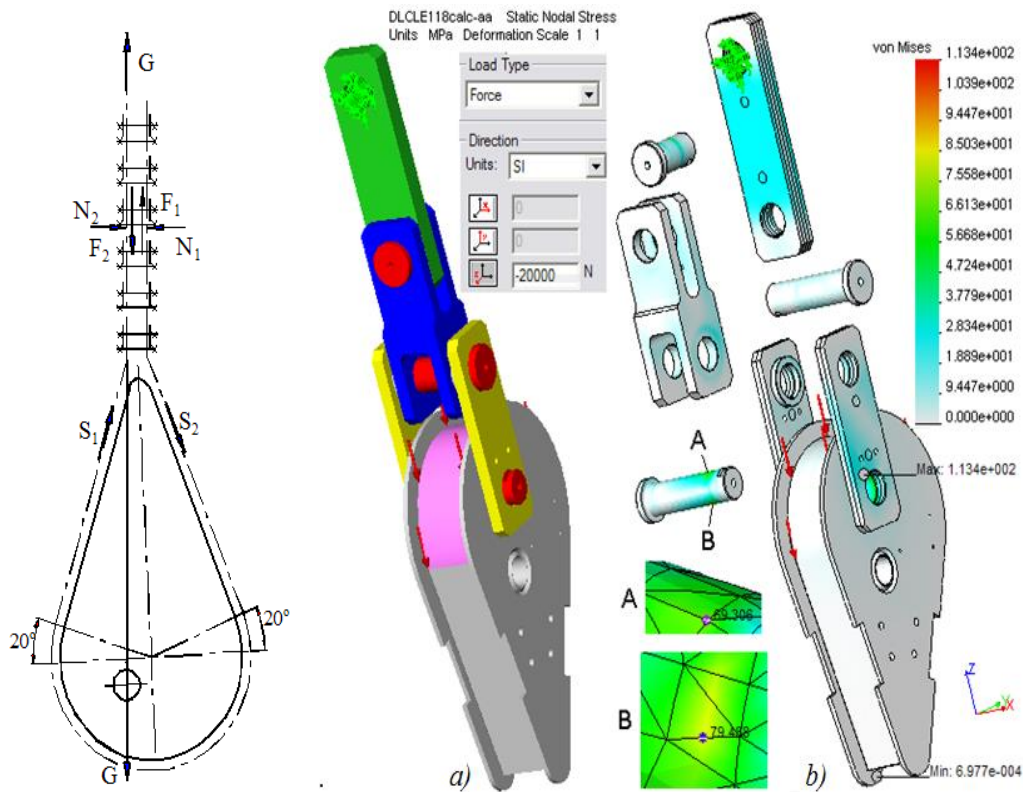
Fig. 5. Mathematical model of fixing forces of cable

Fig. 6. Numerical analysis with finite elements of device DLCLE 118

Bolts have been tried for strains at bending and shear, for a safety coefficient higher than 10, the use of one 42MoCr11, 31MoCr11, 31MnCrSi11 or 25MnCrSi11.alloyed steels of improvement resulting.

Fig.6 shows the numerical analysis with finite elements of the device DLCLE 118, in Fig. 6,a showing the way of loading, fixing with of the boring of the bolt of attachment to the skip, and application to the surface of the metal heart of a force equal to the maximum weight of the cable, 20000 N. Fig. 6,b shows that the maximum strain of the bolts occurs in the area of separation between the cover plate an the sleeve of the metal heart due to the shear strain, this is highlighted by the detail A and B, where tensions equivalent to 69,306 MPa and 79.468 MPa come up, confirming the necessity of using alloyed steels of improvement.

4. CONCLUSIONS

In drawing up the documentation of execution for connecting devices of flat cables for equilibrium in contract No. 193/ASL/2006, concluded with CNH Petrosani, the following technical economic aspects had been in view:

- simplification of constructive solutions from technological point of view (eccentric core and clamps in welded construction compared to their cast construction);
- equalization, as far as possible, of constructive solutions for flat cable connecting device, which equips multi-cable winding installations in the Jiu Valley. This was particularly difficult, since it was necessary to maintain the inter changeability with the present constructions;
- use of constructive solutions that had been verified in practice for similar devices;
- maintaining the present safety coefficient, and in some cases, its increase;
- decrease of costs by reducing maneuver.

REFERENCES

[1]. **Dumitrescu I., Cozma B., Urdea Gh. B.,** *Study of Coal Transportation Flow from the face to the Ground in Lonea Mine*, 15 th GeoConference on Science and Technologies in Geology, Exploration and Mining SGEM 2015, Conference Proceedings, vol. III, pp. 603 – 610, ISBN 978-619-7105-09-4, ISSN 1314-2704.

[2]. **Dumitrescu I., Cozma B.,** *The constructive analysis of the borer heads for the rotative boring,* Proceedings of the 13th International Conference, Modern Tehnologies, Quality and Innovation, ModTech 2009, Iaşi, 21-23 mai 2009, pag. 243-247, ISSN 2066-3919.

[3]. * * * *"Execuţia desenelor pentru piesele de schimb vase de extracţie (DLC, tije, arcuri, DEC şi DLCLE)".* Contract nr. 193/ASL, 18.12.2006, C.N.H. Petroşani.