International Journal of Engineering and Management Sciences (IJEMS) Vol. 8. (2023). No. 1
DOI: 10.21791/IJEMS.2023.1.8.

Analysis of Structural Strengths Applied the Cableway Group

D. LATES[1], C. ALFIANU[2]

[1]SC IRUM SA, Romania, daniel.lates@irum.ro
[2]Institute SC IRUM SA, Romania, calin.alfianu@irum.ro

Abstract. This paper will present the analysis of structural strengths for the cableway group. Three loading scenarios were analyzed. Each of these scenarios will be presented on the cableway group and explained with the intervening forces.

Keywords: cableway, structural strengths, forestry.

Introduction - Description of forest cableway

Forestry cableways are cable transport equipment used in forestry operations for wood collection operations (see Fig.1). They are used to collect wood in hard-to-reach, steep and remote areas. These installations are composed of power units placed on sleds that serve to move them by self-traction to the place of operation.

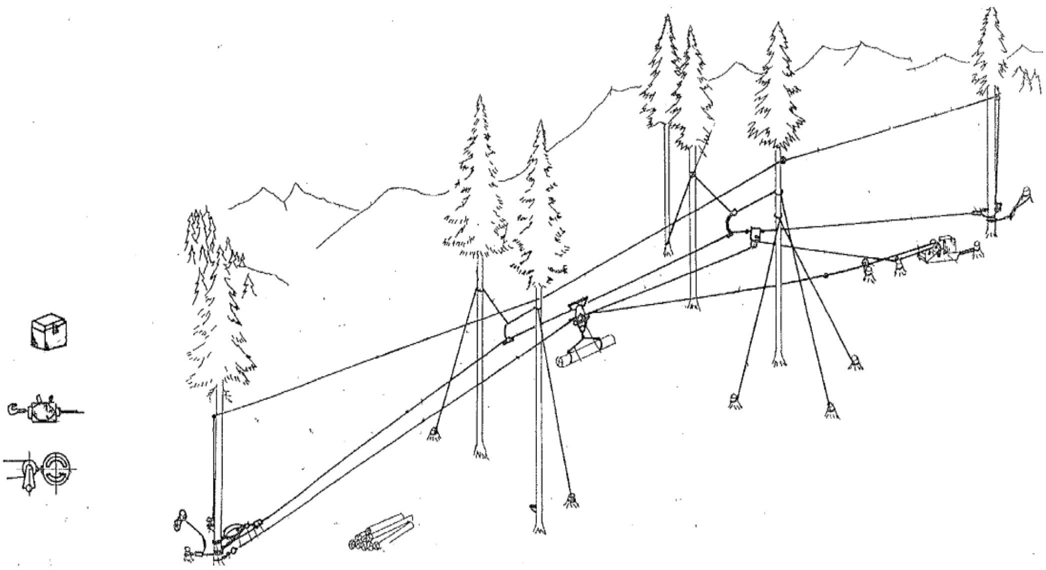

Figure 1. The basic drawing of the sleigh-type cableway

There are a multitude of solutions introduced depending of the configuration of forestry roads, regulation regarding the forest harvesting, economical power of the agent, tradition, etc.

The scope of this project refers to a "sled" type skyline group which is mostly used in case of moving the logs on the low side of the carrying line, in the temporary storage area.

1. Purpose

The scope of the virtual validation is to ensure sufficient confidence in order to proceed with physical testing of the skyline structure. The study is not about the behaviour of the ground, but only the mechanical resistance of the metal frame.

The severe working conditions during the log harvesting, the distance covered by carrying cable and the harsh terrain the skyline group needs to pass through in order to be secured in position requires attention to the strength of skyline unit.

The validation of the metal structure is using FEA (Finite Elements Analysis) method. We are not focusing on the thematic of discretisation (meshing), but to the loading scenarios in order to detect the worst case where the metal structure is strongly stressed. The scenarios are used to establish the loading and contacts management.

The stress is evaluated in the vicinity of the welds (which are also modelled on the 3D model) and they will be interpreted considering the fatigue (the principal consideration on welded structure).

2. Loading scenarios

2.1. Lifting into working position

The scenario tries to determine the constraints and loads for the static analysis in case the funicular group is self-propelled uphill to be taken to the work location. The soil is modeled to create the mathematical model:

In might be one of the most severe regimes, the weight of the skyline group is much higher than the maximum load that skyline is capable of carrying. Self-caring uphill might stress the skyline components more that the logs transport.

Constraints:

- sliding contact on the sole of the sled with the ground;
- cable end blocked;
- solidification contacts between welded components;
- sliding contacts without friction in bearings (radial or axial);
- gear sliding contacts.

Loads:

on the ground plane, in the direction opposite to the direction of the cable Friction force:

$$F_f = \mu \cdot \text{Gn} = 0.35 \cdot 24{,}000 \text{ N} = 8{,}400 \text{ N} \quad (1)$$

DOI: 10.21791/IJEMS.2023.1.8.

Distributed over the entire surface of the two skis; in the ground plane, in the direction opposite to the direction of the cable Tangential gravitational force Gt=23,000 N, (see Fig.2).

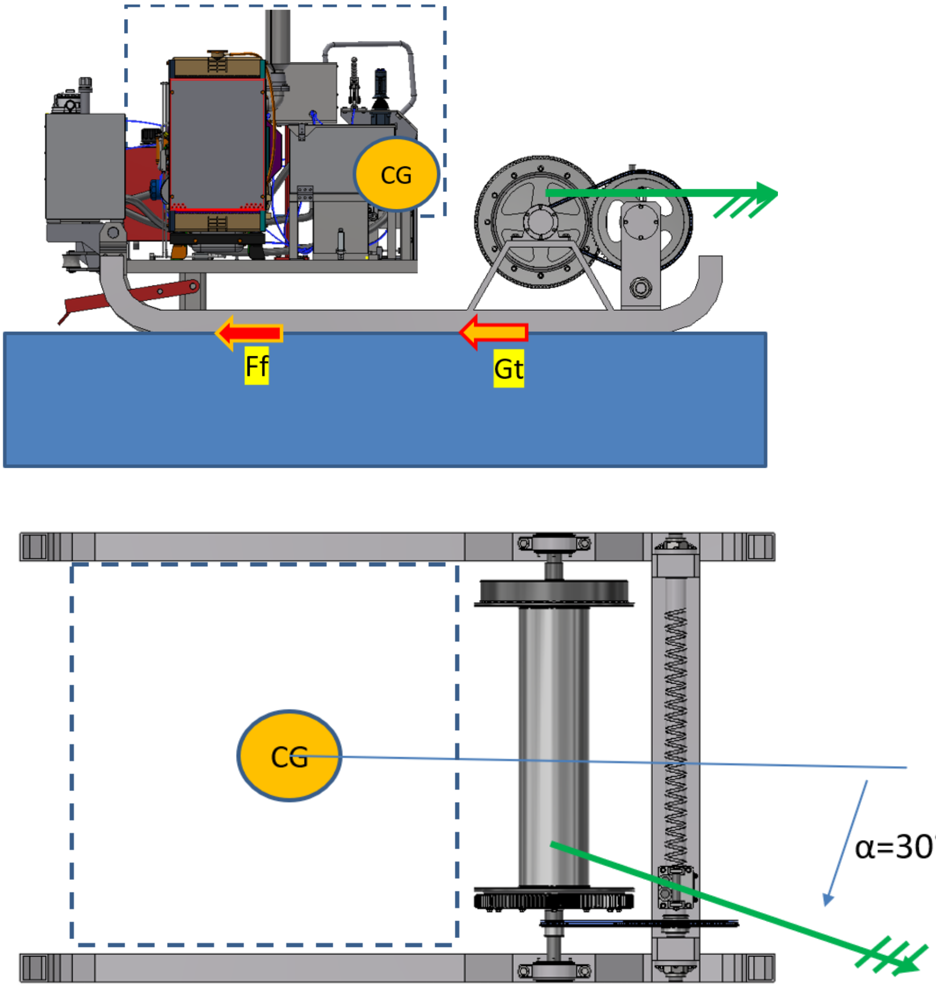

Figure 2. The scenario of lifting into working position

2.2. Brake support in the absence of the traction cable

The scenario tries to determine the constraints and loads for the static analysis if the cableway group rests on its brakes (hoe) when the cable is disconnected. It is important that the funicular is stable (does not roll back). This is a safety dfevice, in the case of cable breaking or the anchor failure.

The soil is modeled to create the mathematical model:

Constraints:

- sliding contact on the sole of the sled with the ground;
- solidification contacts between welded components;
- sliding contacts without friction in bearings (radial and axial);
- gear wheel sliding contacts; embedding the brake (hoe) in the ground.

Loads:

- in the center of gravity, the tangential component of the weight of the funicular Gt=23,000 N;
- in the ground plane, in the direction opposite to the direction of the cable tangential gravitational force Gt=23,000 N, (see Fig.3). A conservative result will occure in case of deglecting the friction forces between the skis and ground.

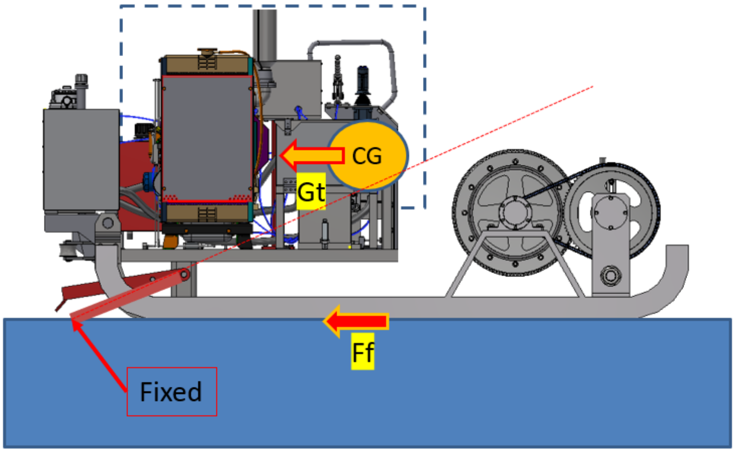

Figure 3. Braking scenario without traction cable

2.3. Lifting the maximum load

The scenario tries to determine the constraints and loads for the static analysis in the situation where the cableway group is fixed in the place of exploitation and pulls the maximum load including the weight of the traction cable considering an overload factor 2. The tension in the cable is inclined 30° to the longitudinal plane of the funicular group and 20° upwards. This will create a non-symetric distribution of load. The soil is modeled to create the mathematical model:

Constraints:

- sliding contact on the sole of the sled with the ground;
- ground group connection embedment contacts;
- solidification contacts between welded components;
- sliding contacts without friction in bearings (radial or axial);
- gear sliding contacts.

Loads:

Vertically downwards in the center of gravity, the normal component of the gravitational force Gn= 66,000 N; in the ground plane opposite the projection of the load, the friction force 8,400 N, (see Fig.4).

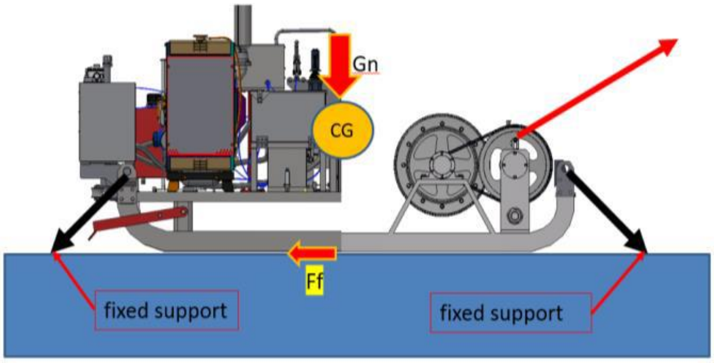

Figure 4. Maximum load lifting scenario

CONCLUSIONS:

These presented scenarios can help in the disassembly of cableway -type equipment that uses the sled-type motor group. The forces involved in the operation of such a funicular are very important for it to work in optimal, safe conditions and to have a much higher reliability of the product.

ACKNOWLEDGMENTS:

This work was supported by the project: Forestry funicular with hybrid drive and energy recovery, MySMIS: 120499. Priority axis 1: Research, technological development and innovation (CDI) in support of economic competitiveness and business development Action: 1.2.1 Stimulating the demand of enterprises for innovation No. financing contract: 353/390029/27.09.2021.

References

[1] Lates, D., Inte, R., A., Chirca, M., Dranca, M., Oprea, C. (2022), Initial evaluation of the performances of a sled-type forest cableway, International Conference INTER-ENG 2022, Interdisciplinarity in Engineering, Targu Mures.

[2] Lates, D., Moica, S., Veres, C., Pozdirca, P., Harpa, E. (2019), Design of Smart Forestry Cableway, Elsevier, Procedia Manufacturing 32,79-86.

[3] Barbu, M. C., (2013), Forest And Wood Industry In Romania, ISSN 2069-7430 ISSN-L 1841-4737, Pro Ligno, 9(4).

[4] Dragan, I.C., Bora, L., Cerchez, G., Comanescu, A., Stan, I. (1971) Funiculare Forestiere (cableway forestry), Ceres, Bucuresti.

[5] Naftali S. (1958), Funiculare (cableway). Editura Tehnica, Bucuresti.

[6] Leadshine Technology Co.: Motor Torque Calculation. Wire Drive Loads, available at: https://www.datasheetarchive.com/whats_new/80ffbfe4c355015327e99f6b8cff5d43.html