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CONSIDERATIONS REGARDING THE CONSTRUCTIVE PARAMETERS OF THE FOREST SKYLINE SUPPORTS

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Abstract: *In the present paper are presented the main constructive parameters for the forestry skylines supports. It also analyses the carriage stability at his passing on the supports in function of the curvature radius and the carriage movement velocity. In the present paper is highlighted the influence of the main cable deflection on the carriage stability and the paper proposes a calculation relation for the curvature radius determination in function of the carriage movement velocity and the slope of the main line (cable). There is also analyzed the way in which the constructive parameters of the tree shoe for the native skylines correspond to the stability necessities.*

Key words: *support, skyline, tree shoe.*

1. Introduction

The forest skylines represent logging means which provide soil and seed protection, reason for which their promotion in the forest exploitation is necessary and benefic. The above mentioned request must be realized especially in the mountain zones, with great slopes, exposed to erosion, where the logging alternative is represented by the manual or animal logging, both involving long distances. The distribution of the forestry territories from our country for which the skylines constitute the only mechanized mean for the ecological logging, justifies the efforts and the research continuation in order to improve and promote the skyline logging means in the logging practice. In this order of ideas, in the present work are analyzed the constructive parameters for the forest skylines supports. The supports (Figure 1) are metallic elements which are incorporated in the spar construction and they present the principal role in the main cable sustaining at the designed height.

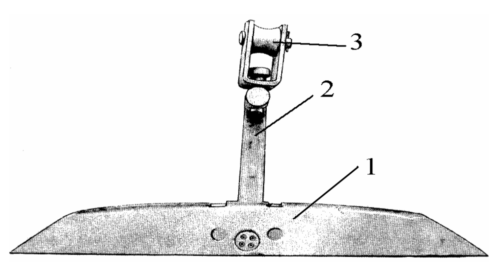

Fig. 1. *A support for the main cable in case of the FP 2 skyline:*
1 - *blade*; 2 - *arm*; 3 - *catching system*

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The component elements for the supports are: the blade, the arm and the catching system. The blade presents a constructive channel where the main cable is sustained. The principal parameters for the blade are the length and the curvature. The blade can be fixed on the arm or it can be articulated. The catching system differs in function of the spar construction, and, in the most frequent case the support is suspended on transversal cables, on the rolls. The carriages of the skylines can lift off the cable when the velocity of the carriage on the support is high. The supports represent breakpoints in the vertical plan of the skyline, which, in order to be passed in adequate security conditions, must provide a corresponding recordation of the line.

Unlike the fixed blade supports, where the carriage trajectory corresponds mostly to the blade curvature, in the case of the supports with articulated blade, the trajectory of the carriage is modified by the rotation of the blade. The stability of the carriage at their passing on the supports depends by the following factors:

- the instantaneous curvature radius of the trajectory;
- passing velocity;
- wind action;
- the accidental breaking of the line in the transversal plane.

2. The Curvature Radius from the Stability Condition

The relations recommended by the specialty literature for the curvature radius calculation [2], [3] do not take in consideration an important parameter which influences the curvature radius - the maximum working declination. In order to realize an argumentation for this fact, in the following ideas will be determined a calculus relation for the curvature radius from the carriage stability condition.

At the curved trajectories passing, on the carriage is recorded the centrifugal force normally oriented on trajectory, and which presents the tendency to lift the carriage from the line. The centrifugal force is calculated with the relation:

$$F_c = \frac{m\nu^2}{R},$$

where:

- m - the carriage weight;
- ν - the passing velocity;
- R - the instantaneous curvature radius of the trajectory.

From the above mentioned factors, the greatest influence is presented by the trajectory radius. The carriage velocity, the breaking and the wind action can be attenuated as influence by taking in consideration of some restrictive exploitation rules.

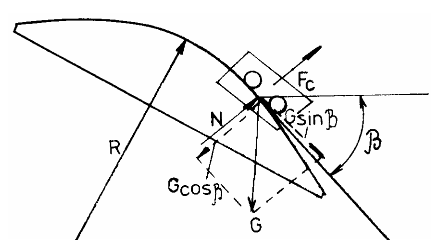

Fig. 2. *The scheme of the curvature radius calculation*

In Figure 2 is presented the wheel of the carriage along with the main forces which act on the wheel at the support passing. The tendency of the support lifting, caused by the centrifugal force is counteracted by the normal component of the carriage weight (G cosβ).

The tangential component (G sinβ) moves the carriage forward by defeating the forwarding resistance. Because the rolling resistance of the wheels on the cable is negligible, the reaction of the support (N) is, practically, normal to the trajectory. From the forces equilibrium on the normal trajectory condition results:

$$G \cdot \cos\beta - F_c - N = 0,$$
$$mg \cos\beta - \frac{m\nu^2}{R} - N = 0. \qquad (1)$$

The *N* reaction represents a linking force with a single way. It does not block the carriage lifting, and, as a consequence, it cannot take negative values. Consequently, from the relation (1) results:

$$g \cos\beta - \frac{\nu^2}{R} > 0,$$

from where:

$$R > \frac{\nu^2}{g \cos\beta}. \qquad (2)$$

From the relation (2) results that the curvature radius of the supports with fixed blade on the trajectory radius for the supports with articulated blade depend on the passing velocity and the slope of the trajectory tangent. When the carriage does not leave the way, the tangent to the trajectory is also a tangent to the support curvature. As above mentioned, the stability of the carriages at the support passing is influenced by some more factors. By taking in consideration of these factors, along with some exploitation security measures will be considered a security coefficient (k_s), which in the case of the forest skylines can be valued at 1.5. In this case, the relation (2) will be:

$$R = \frac{\nu^2 k_s}{g \cos\beta}. \qquad (3)$$

In the calculus relations for the curvature radius in the case of the materials skylines and fixed skylines, the β slope influence is not taken in consideration, despite the fact that in the reality this slope should be considered, as it result from the Figure 3, where is presented the radius variation in function of the slope for different values of the passing velocity.

The error determined by the slope inconsideration can be calculated as follows:

$$E\% = \frac{\frac{\nu^2 k_s}{g\cos\beta} - \frac{\nu^2 k_s}{g}}{\frac{\nu^2 k_s}{g}} \cdot 100 = \frac{1-\cos\beta}{\cos\beta} \cdot 100. \qquad (4)$$

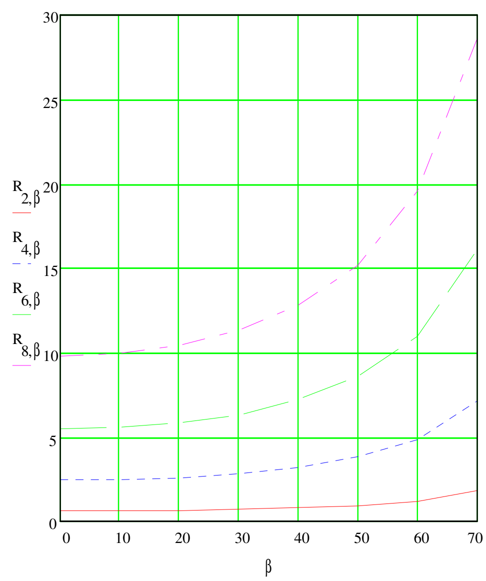

Fig. 3. *The curvature radius in function of the slope*

As it results from the relation (4), the error generated by the fact that the slope is not taken in consideration, does not depend by the velocity. In Figure 4 is presented the error variation (*E%*) in function of the slope β.

If the above exposed figure is analyzed, results that for the angles greater than 60º the calculus error is above 100%, and, as a result, the slope becomes significant. In the specialty literature [1], [4] are recommended the following relations for the curvature radius calculation:

$R = \frac{v^2}{5}$ - for the forest skylines;

$R = \frac{v^2}{2}$ - for the permanent skylines.

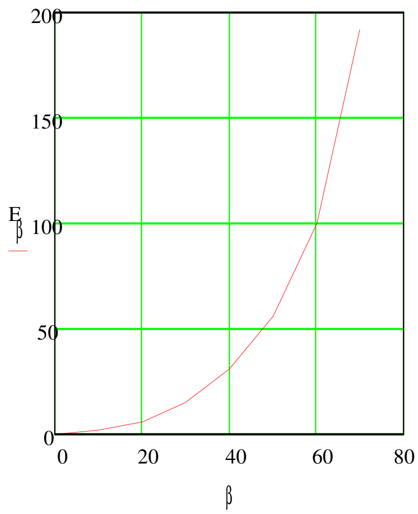

Fig. 4. *The variation of the calculus error in function of the slope*

In order to highlight the results obtained with the above described relations in comparison with the proposed relation there can be presented the graph from the Figure 5.

From the analysis of the Figure 5 results that the relation (6) covers only situations in which the angles are smaller than 60-70º. Also, the relation (5), utilized in the tree shoe radius dimensioning for the forest skylines, covers only slopes of the trajectory tangent with values smaller than 30-35º.

For greater values, the relation (5) becomes inadequate. There can be remarked that to the carriage exit from the tree shoe to the downhill part, the trajectory slope becomes greater than the slope of the corresponding chord and it can take values up to 50-70º.

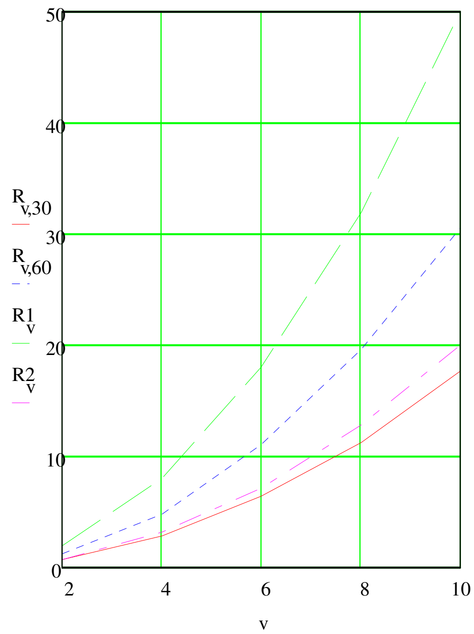

Fig. 5. *The curvature radius in rapport with the velocity determined with different calculus relations*

The length of the blade results in function of the breaking angle and the curvature. Usually, the tree shoes of the forest skylines present a circle arc curved blade.

3. The Length of the Tree Shoe Blade

The length of the blade results in function of the breaking angle and the curvature.

Usually, the tree shoes of the forest skylines present a circle arc curved blade. The contact length between the tree shoe blade and the cable in function of the radius and the breaking angle α is determined by the relation:

$$L = 2R \sin \frac{\alpha}{2}. \quad (5)$$

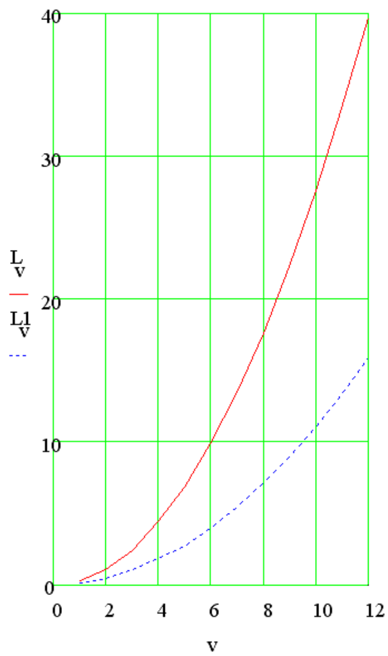

Fig. 6. *The blade channel variation in function of the velocity for a breaking angle of 16°*

If the *R* is replaced, results the following relations for the blade channel length:

$$L = v^2 \sin\frac{\alpha}{2}, \tag{6}$$

$$L1 = 0.4v^2 \sin\frac{\alpha}{2}. \tag{7}$$

In Figure 6 is presented the blade channel length variation in function of the velocity and by taking in consideration of the (6) and (7) relations.

As it can be observed in Figure 6, both relations return some values which are too big for the tree shoe length, the relation (6) being acceptable only for permanent skylines.

4. The Constructive Parameters of Some Forest Skyline Tree Shoes

The main constructive parameters of the tree shoes which influence the exploitation of the skylines are:

- The curvature radius;
- The length of the blade;
- The allowed braking angle.

In Table 1 are presented the values of the above mentioned parameters for the most utilized skylines (native concepts).

In order to observe if the shoes parameters correspond to the exploitation conditions, there have been analyzed 15 skylines from the Brasov Forest District, and have been determined the breaking angles in rapport with the spans height, the cable effort and the terrain slope. There have been observed that in the case of the skylines with great spans, high slopes and montage efforts under 80…90 kN, there appear cable breakings which are greater than the capable angle of the support.

Along with the parameters, the configuration of the tree shoe extremity has a major importance in the functionality of the tree shoe.

The configuration of the tree shoe extremity for the FP 2 and FPU 500 skylines is considered unsatisfactory. If the FP 2 skyline is considered, it has a radius of 4 meters and a capable angle of 17º.

Constructive parameters of tree shoe for some native forest skylines Table 1

Type	**Curvature radius, [mm]**	**Maximum braking angle, [^{0}]**	**Blade length, [mm]**
FP-2	4000	17	1190
FPU-500	2000	25	860
Modified support, FP-2 +FPU-500	3000	18	930

By taking in consideration of the trajectory radius in rapport with the utilization domain of the skyline, can be concluded that for normal working conditions regarding the montage effort and the tree shoe adjacent spans semi sum, the trajectory radius is smaller than the tree shoe radius. Thus, at montage efforts above 110 kN and spans under 100 meters, the trajectory curvature radius presents values between 1100 mm and 1300 mm. In the same time, the capable breaking angle of 17º, appears as being insufficient and adequate only for spans up to 150 meters and montage efforts greater than 90 kN.

5. Conclusions

The main conclusion of the presented paper is that, along with the carriage velocity, the slope of the support is an important factor which influences the stability of the carriage at the passing on the supports. In the case of the supports with articulated blade, the trajectory radius is smaller than the tree shoe radius. Consequently, the passing velocity of the carriages has to be lower than the passing velocity of the fixed-blade supports with the same blade profile. The lifting probability is greater on the charged carriers moving from uphill when they are passing the arm of the support from downhill part.

For more severe slope situations are imposed velocity restrictions in order to provide stability and security in the forest skylines exploitation. The tree shoe radius from the stability condition depends on the carriage movement velocity and the maximum working slope for the tree shoe.

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