ABOUT THE ANGULAR ACCELERATIONS EFFECTS ON VEHICLES MOVEMENT IN CURVES

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Abstract

This work tries to clear up the angular acceleration effects on vehicles movement in curves, especially on transition curves. Angular acceleration causes discomfort and the plan geometry of the road curves does not take into account the effects of this type of acceleration. The nature of these effects explained and, finally, the influence of angular acceleration in crossing a transition curve is quantified thus making a comparison with the actual knowledge.

Key words: clothoid, angular acceleration, transition curve

INTRODUCTION

Most of the time, the minimum length of the clothoids is determined by criteria of limiting normal acceleration variation. The limitation of angular acceleration is not generally a limiting factor. However, Professor R. Bereziuc (1) develops this aspect, even speaking about a limiting criterion which is given by the angular acceleration. So this acceleration would be limited to 0.02 ... 0.05 rad / s^2 (Bereziuc, 1981), (Zarojanu, Știucă, 2016). We believe that it would be interesting to know the extent to which current transition curves used in the design and construction of roads satisfy the comfort provided by the breaching acceleration angle prescribed.

MATERIAL AND METHOD

According to the criterion of limiting acceleration normal variation, theminimum length of the clothoids is:

L = V3 / 47.j.R where:
V [km / h] is the speed of movement;
R [m] is the radius of the circular curve;
j[m/s^3] is the change of normal acceleration with respect to time j=0,5…0,7 m/s^3;
In this case the running time of the clothoid becomes $t=V^2/47.j.R$;
The angular acceleration$a_\omega=\omega/t$ where:
ω [rad / s] is the angular velocity;

The maximum angular velocity will be the entrance on the circular curve as ω = V / ρ, where

P is the curvature radius ranging from ∞ in alignment to the R value on the circular curve and therefore again the angular acceleration will be maximum at the entrance on the circular curve, so it is that angular acceleration that needs to be limited.
Thus for $j=0,5\ m/s^3$we have:

$$V = 50km / h\ ie\ a_{\omega}=\omega/2t = \frac{\frac{v/3,6}{R}:}{\frac{2v^2}{47.j.R}} = 0,065\ rad/s^2 \quad [1]$$

The 2^{nd} factor in the denominator's expression of the angular acceleration is due to the fact that ***t*** represents the time of the clothoidbrowsing and therefore we cannot consider the entire value of the angular velocity, but only its average, in order to be closer to the truth.
$V = 100km / h\ a_{\omega} = \dots\ \dots\ \dots = 0,033\ rad/s^2$

Thus higher than that agreedupon (Bereziuc, 1981), so lack of comfort.
If $j=0,7\ m/s^3$the situation is more serious, as expected, as the variation of normal acceleration is faster.
So, for V = 50 km / h is obtained, according to [1], $a_{\omega} = 0,09\ rad/s^2$, and for V = 100 km / h there will be the angular acceleration of $0,045\ rad/s^2$.

RESULTS AND DISCUSSION

1. The limitation criterion in terms of comfort of the angular acceleration is more restrictive than the normal acceleration variation. The values of the angular acceleration, even if bigger, still have the same size limitations as indicated by prof. Bereziuc R. (1);
2. The angular acceleration does not depend on the radius. This is because in this present paper an approximation was made using the arithmetic mean for the angular velocity. It is true that the error is not too big but, on the clothoid, the angular velocity variation is more complex;
3. The angular acceleration decreases upon the circulation speed, which was expected, and it increases at the same time with the increasing acceleration of the normal variation, which is also expected (more severe driving conditions).

CONCLUSIONS

1. The limit of comfort conditions of the same angular acceleration is more restrictive than normal acceleration variation. As the minimum length of the clothoidsis determined from the condition of the limiting acceleration

of the normal variation j=0,5…0,7 [m/s^3], this should be limited to j = j=0.3..0,5 [m/s^3]

2. The values of the angular acceleration have the same order of magnitude as the one indicated by Prof. Bereziuc R. (1);

3. The angular acceleration does not depend on the radius.

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