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THE EFFECT OF TECHNICAL PARAMETERS OF THE ROAD IN THE STABILITY OF VEHICLE MOTION WHILE GOING THROUGH A BEND ROAD

Mr.sc. Mevlan Bixhaku, Mr.sc. Visar Baxhuku,
Faculty of Mechanical Engineering
Mr.sc. Ramadan Duraku
Ministry of Transport and Communications
Prishtina, Kosova

ABSTRACT
This paper analyses the effect of the road curb radius and cross section pitch in the stability of the vehicle while going through a bend road.
The effect of these parameters is determined as the function of the friction coefficient by defining the borderline sliding and rolling-over speed.
The analyses have been carried analytically and graphically as well.
The results were discussed based on graphically presented diagrams build with PC Crash 8.0 and MathCad software.
Key words: Vehicle Motion, Road Curve Radius, Friction Coefficient, Stability

1. INTRODUCTION

During a movement of vehicle in a curved trajectory, apart from other forces known to have impact on the rectilinear movement, a significant impact on the velocity and the stability of vehicle moving in the curved trajectory is also due to the road technical parameters. Strength of these parameters depends on the curve radius; friction coefficient and road incline of curved trajectory (figure 1).

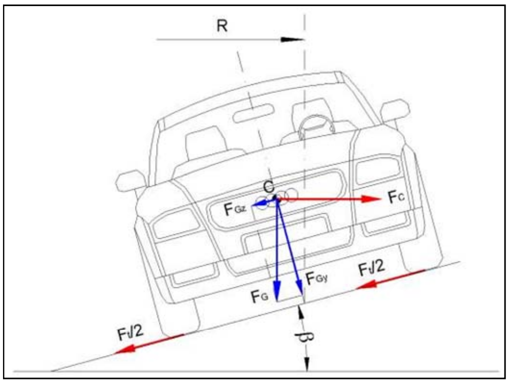


Figure 1. Forces acting in a vehicle while moving in inclined road trajectory.

In order to improve stability conditions, curved roads (inclined) are inclined from inside, while this road inclines from inside increases the stability of moving vehicle.
In case when forces acting at curved trajectory are quite big, while friction forces are not as big, which is a case with slippery roads, the first may dominate the later and as the result the vehicle will slide from its course.
Normally, two axles do not slide simultaneously and this depends very much for the spread of vehicle weight, way of haulage, pneumatically status and other factors.

2. IMPACT OF ROAD TECHNICAL PARAMETERS IN A CRITICAL SLIDING VELOCITY

Critical velocity of vehicle movement at horizontal curve with known radius (R) and road incline (β) is expressed by hereunder formula:

$$V_s = \sqrt{g \cdot R \frac{sin\beta + \mu_t\, cos\beta}{cos\beta - \mu_t\, sin\beta}} \quad \text{[m/s]} \qquad \text{.... (1)}$$

2.1. Impact of road curve radius (R)

Depending on the curve radius, hereunder is data gained by which it is clear what is impact of curve radius in the movement velocity and side acceleration.

In hereunder diagram (figure 2) is presented the impact of curve radius during movement of vehicle in a curved road with various initial velocities: 60 km/h, 80 km/h and 100 km/h. The radius of curve is measured practically (existing curve –real), with a value R=110 m. Friction coefficient has the value of μ=0.8. Simulation of movement of Mercedes A170 CDI is done using PC Crash 8.0 software. Movement of vehicle is initially done in a part that is rectilinear road (R=∞), then it continues movement through a curved road with a radius as given above. This is done with intention to analyze changes on initial velocity of movement and of side acceleration during movement of vehicle in a curved road.

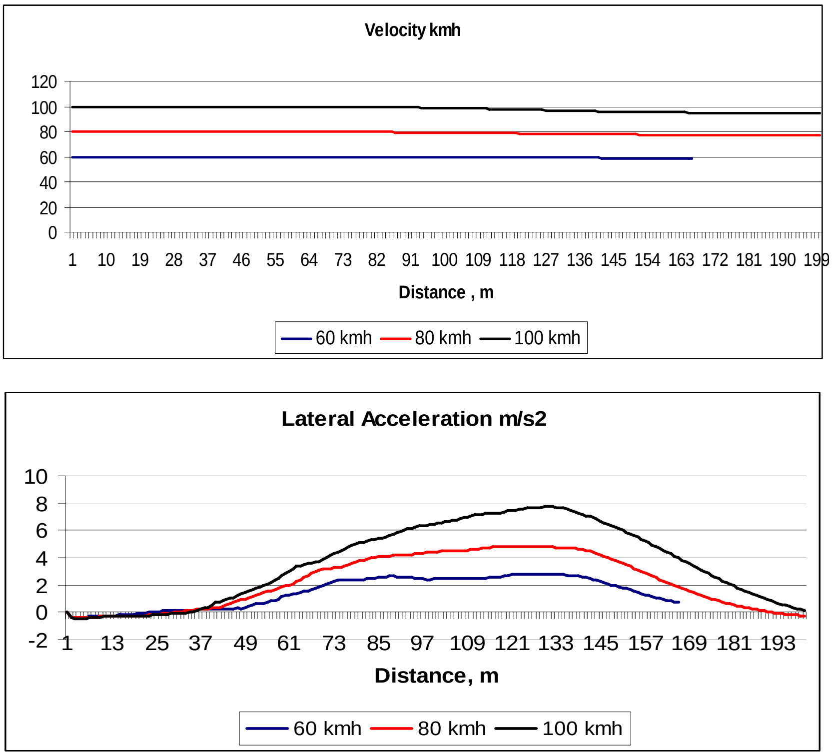


Figure 2. Impact of curved road radius (R) in movement of vehicle in a curved road

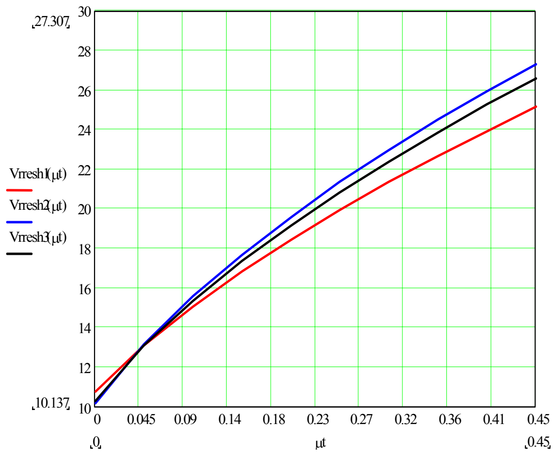
The movement is simulated in a distance of 200 m, in which changes of velocity and side acceleration are also presented.

2.2. The impact of lateral friction coefficient

Compared to the friction in other fields of machinery (handles, axle-bearing etc.) where is tried to reduce friction, we have here different approach – we try here to increase as much as it is possible the lateral friction coefficient between tire and road surface.

With increase of lateral friction coefficient the stability of driving is also increased, because at any time it could be assured additional reaction on the road surface, by which possible misbalances are balanced. The strength of lateral friction coefficient depends on a number of factors such is: kind, status and form of road, material and pneumatics construction, driving speed, road temperature and temperature of pneumatics, feature of flips etc.

Following is presented in a diagram format differences in a critical slide velocity depending on lateral friction coefficient.



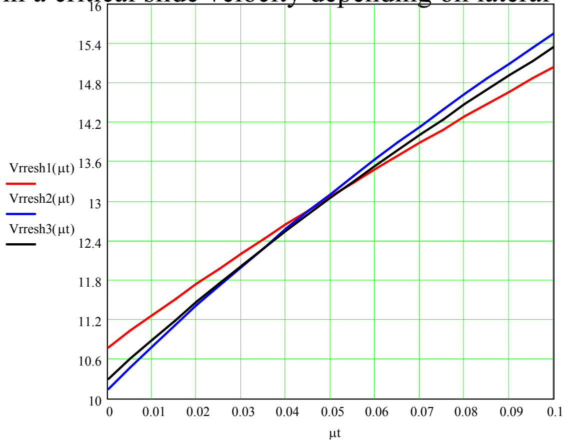


Figure 3. Impact of lateral friction coefficient in a critical velocity

In above diagrams is analyzed the impact of lateral friction coefficient in a slide critical velocity of a vehicle moving in a curved road for three various values of curved road radius and the angle of road inclination.
The values of curve radius and angle of road incline are measured, while lateral friction coefficient takes values at 0 - 0.45.

2.3. Impact of road inclination (β)
Values of road inclination depend on a radius of curve. This relation is applied in order to adjust the impact of road construction to a movement of vehicles.
With increase of radius of curve we may apply minimal value of road inclination and on the other side with reduce of minimal radius the maximum value of road inclination in a curved road is applied.

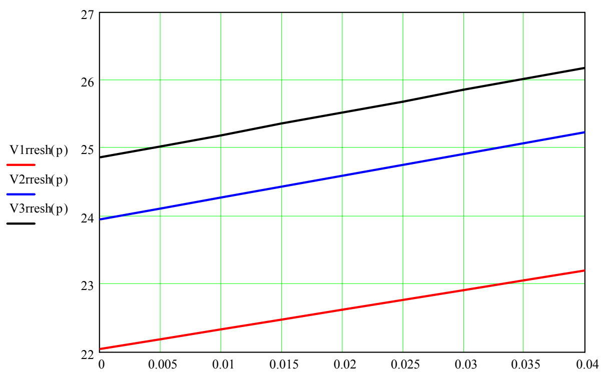


Figure 4. The impact of road inclination

Curves in a diagram are gained using three various values of curve radius applied, which give a change to a critical velocity in proportion to a curve radius: with increase of road curved radius and of road inclination also the critical slide velocity is increased.

3. CONCLUSIONS
While analyzing expressions and diagrams presented (Figures 1, 2, 3) we may conclude as regards critical velocity of vehicle in a curved road the following:

- *With reduction of curve radius, side acceleration is increased and movement velocity is reduced compared to the initial one;*

- *With increase of the value of side acceleration, the possibility of slide of vehicle moving at curved road is increased (Figure 2),*
- *With increase of curve radius (R), the impact of road inclination is reduced (β) (Figure 3),*
- *For small values of lateral friction coefficient (μ_t), the impact of road inclination (β) is dominant on increase of critical slide velocity.*

4. REFERENCES

[1] Baxhuku, V.: Critical slide and flips velocity of vehicles moving at curved road, Master work, Prishtina, Kosova 2007.
[2] Roper, L.: Physics of Automobile Rollovers, August 2003- USA.
[3] Softueri PC Crash & PC Rect, Schtefan DataTechnic – Linz Austria, 2001.
[4] Rotim, F.: Elementi sigurnosti cestovnog prometa, Zagreb, Croatia, 1997.
[5] Geca, A.: Safety and information on traffic, Prishtine, Kosova, 2001.