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THE DETERMINATION OF THE GEOMETRIC ELEMENTS FOR ZALĂU BYPASS

Ştefan-Silvian CIOBANU

Scientific Coordinators: Prof. PhD. Eng. Ioana SIMINEA
Lecturer PhD. Eng. Tatiana OLINIC

University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăşti Blvd, District 1, 011464, Bucharest, Romania, Phone: +4021.318.25.64

Corresponding author email: ciobanustefans@gmail.com

Abstract

The paper is aimed to present the determination of road geometrical properties for the bypass of Zalău. The work is based on information provided by the Agency for Environmental Protection Zalău. The main characteristics determined in the paper are the length of alignments and the ray of circular and progressive curves. The importances of this work are the current conditions, mentioned in the paper such as high vibration and air pollution.

Key words*: road plane, bypass Zalău, progressive curves, chlotoid curves.*

INTRODUCTION

The paper aimed to present the construction of a bypass in Sălaj County, near Zalău. This alternative route will connect the national road DN1F and the county road C DJ191. (Figure 1)

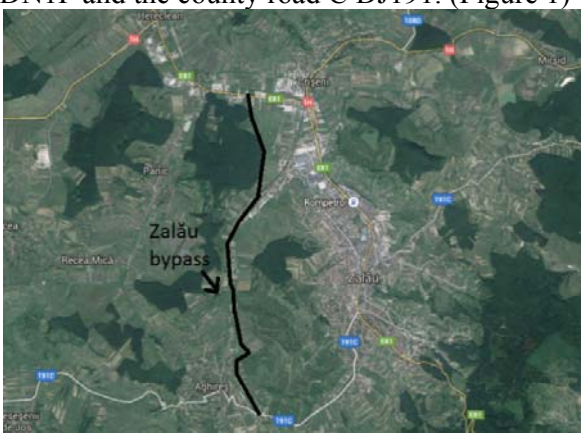

Figure 1. Representation of Zalău bypass

The importance of this work is the current situation. The national road DN 1F passes through central area of the city Zalau on a length of about 7 km, with very high declivity (12%) and a winding path that measures about 4 km.

During the route, from the data provided by the Agency for Environmental Protection Zalau and those taken from the General Urban Plan of the City of Zalau, results a range of the noise pollution and well air level above permissible limits. Also, appeared a lot of cracks on the surface of the buildings situated near the road, these cracks are caused by vibrations caused by the heavy vehicles.

Taking into account the current situation, the decision to design and construct an alternative route was taken in order to achieve a separation of transit traffic from local transit of Zalău.

This road will be fit in technical class III and will connect the national road DN 1F and DJ 191 county road C, measuring 9.63 km.

MATERIALS AND METHODS

The road plan is made up of a succession of curves and alignments (Figure 2) whose geometry have been adopted taking into account the design speed of 40 km/h (corresponding to a technical class III of the road).

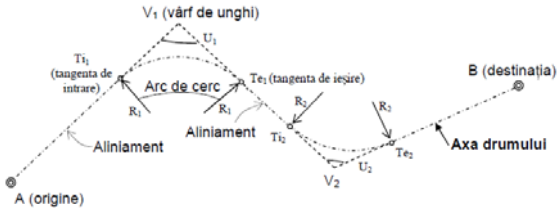

Figure 2. Representation of a road plan

The alignments have lengths between 50 m and 30 m and are connected with circular curves

and progressive curves, respectively clothoids curves rays measuring between 150 m and 1300 m.

The arc geometry is determined by the angle U between the two alignments and the radius connection R (Figure 3). The U angle between alignments result from the study route, directly measuring the land with topographic methods, or in the map studies case, by indirect trigonometrical methods

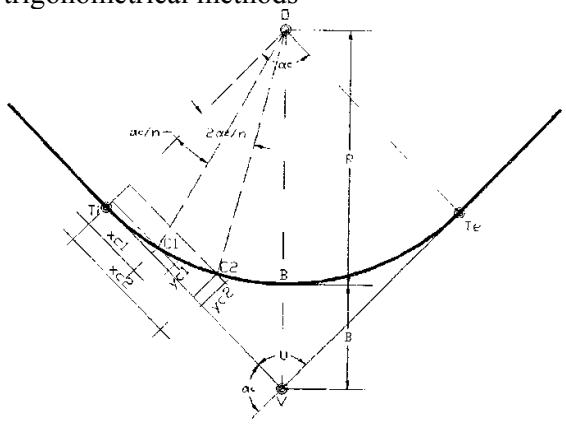

Figure 3. The main elements of connecting with arc

Basis for determining the characteristic rays is:

$$R \cong \frac{V^2}{13 * (k * p \pm g * p)} = \frac{V^2}{13 * p(k \pm g)}$$

Based on her curves ray performed following classification:

- minimum -ray $R_{min} = \frac{V^2}{13 * p_s(k+g)}$;
- current ray $R_c = \frac{V^2}{13 * p_a(k+g)}$;
- recommendable ray $R_r = \frac{V^2}{13 * p_a(k-g)}$;

V - speed design;
K - coefficient of comfort;
p - curve slope, depending on the geometry form;
g - gravitational acceleration.

Upon registration of the vehicle in a curve will emerge centrifugal force. (Figure 4) This tends to remove the vehicle from the route and at the same time will cause a shock felt in the steering wheel by the driver. The amount of centrifugal force is given by the following equation:

$$F_c = \frac{m * V^2}{R} = \frac{P * V^2}{g * R}$$

m- vehicle mass (kg)
P - vehicle weight (kg)
g - gravitational acceleration (m / s2)
v - speed of the movement of the vehicle (m / s)
R - curve radius arc (m)

To ensure a shift line, from the alignment on main circular curve it is necessary to introduce a transition curve (progressive curve) which have the property that the radius of curvature has a variable value from (ie 0) in the alignment point tangential to the R value (ie 1 / R) at the point of contact with the arc Introduction of progressive curves must satisfy two criteria:

- Geometric criteria refer to the following conditions:
  - gradual curve to be tangent to alignment points Oi, Oe, where the radius of curvature is ∞
  - the radius of curvature gradually decreases the arc length gradual curve to the point Si, is tangent to the arc, where ρ = R
  - in common with the turn point arc, Si, Se, progressive curve admits common tangent arc and radii are equal.
- Mechanical criteria refer to the condition that varies proportionally during normal acceleration, t: $a_n = \frac{V^2}{R} = j * t$ or centrifugal force varies progressively.

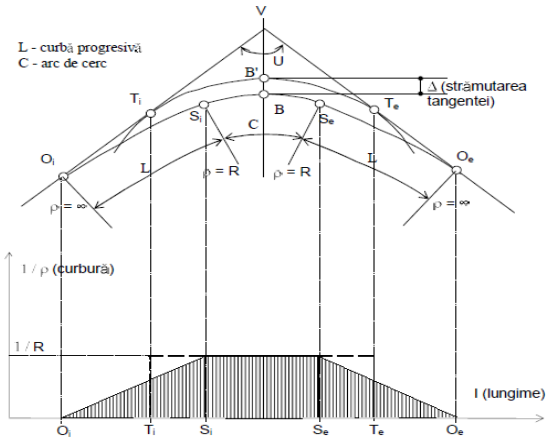

Figure 4. Represention of the variation of the centrifugal force in connection with gradual curves

Among all the progressive curves, the best option it is the clothoids curve, this curve is called the mechanical excellence trajectory because it represents a vehicle traveling at a constant speed, steering input is done evenly. In this case, the product of the radius and arc length curvature properly to any point on the curve is constant. From the viewpoint graphic is represented by two symmetrical branches with two asymptotic points I and II (Figure 5).

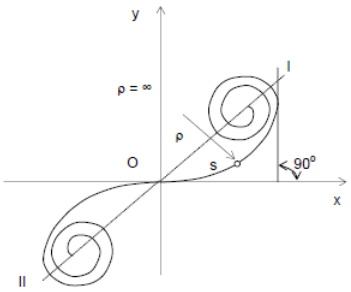

Figure 5. Graphical representation of clothoid

Is characterized by that the product of the radius of curvature (R) that decreases gradually along the clothoid and arc length appropriate (L), considered from the origin, is constant:

$A^2 = R * L$,

A – the clothoid module means length.

The minimum length of clothoid arc that connects the alignments is established by the criteria of the limiting normal acceleration, according to:

$L_{min} = \frac{V^3}{47R*J}$;

V - design speed in km / h;

R - radius in common point of clothoid arc and the radius arc

J - normal acceleration coefficient of variation, meaning a coefficient of comfort in m / s3.

J = 0.5-0.7 -for ordinary roads

J = 0.3-0.5 -for highways

Clothoid basic elements are:

α - clothoids independent variable representing the angle formed by the tangent at a point of clothoids with the positive direction of the axis abscise.

x1 - the horizontal axis of the current point;

Y1 - ordered the same point;

r1 - polar radius;

φ - polar angle;

ρ - radius of curvature;

x01 = x1 – abscissa center of curvature corresponding to the same point;

Y1 - ordered the same center of curvature;

δ1 - moving the bend arc;

s1 - clothoid arc length between the origin and point arc clothoids O1;

n1 - abscissa of the normal foot on the tangent point arc clothoids;

x "- the difference between abscissa point and corresponding center of curvature;

b1 - the normal length;

γ - the angle between the polar radius and the radius corresponding to the point.

Clothoids real elements are obtained by multiplying the basic elements determined clothoids real clothoids module A.

Aρ1=R;

RESULTS AND DISCUSSIONS

According to the methodology described in the previous chapter, it has been calculated the characteristics of the rays depending on speed (Table 1) and all the clothoids curves (Table 2).

Table 1. The ray values determined according to speed

	V	V	V
	40 km/h	32.5 km/h	25 km/h
minimum ray (m)	70	50	30
current ray (m)	165	110	65
recomandable ray (m)	495	330	195

CONCLUSIONS

Through this work it was shown the importance of the construction of the bypass in Sălaj County, near Zalău. This bypass will considerably reduce the traffic and also will reduce the air pollution in the downtown area.

Progressive curves are very important in connecting alignments, especially the excellent mechanical curves, named clothoid curves; using these curves the shocks created by the centrifugal force will be reduced.

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Table 2. The clothoids curves characteristic values

Curve 1				Curve 2				Curve 3			
v (km/h)	40.000			v (km/h)	40.000			v (km/h)	40.000		
R (m)	75.000			R (m)	75.000			R (m)	100.000		
U	152.600			U	31.130			U	122.560		
L/R	0.488			L/R	0.488			L/R	0.336		
t	0.495			t	0.495			t	0.410		
α	15.60	clothoids real elements		α	15.60	clothoids real elements		α	10.70	clothoids real elements	
γ	89.60			γ	89.60			γ	92.86		
φ	5.20			φ	5.20			φ	3.57		
r_1	0.70	r_0	36.66	r_1	0.70	r_0	36.66	r_1	0.58	r_0	33.58
x_1	0.70	x_0	36.53	x_1	0.70	x_0	36.53	x_1	0.58	x_0	33.53
x"	0.35	x"	18.19	x"	0.35	x"	18.19	x"	0.29	x"	16.73
y_1	0.06	y_0	2.99	y_1	0.06	y_0	2.99	y_1	0.32	y_0	1.88
δ_1	0.01	δ_0	0.75	δ_1	0.01	δ_0	0.75	δ_1	0.01	δ_0	0.47
ρ	1.43	ρ	75.00	ρ	1.43	ρ	75.00	ρ	1.72	ρ	100.00
s	0.70	s	36.75	s	0.70	s	36.75	s	0.57	s	33.62
n	0.71	n	37.28	n	0.71	n	37.28	n	0.59	n	33.85
b	0.06	b	3.08	b	0.06	b	3.08	b	0.03	b	1.91
y	1.44	y	75.75	y	1.44	y	75.75	y	1.73	y	100.47
A= R/ρ	52.50	C	19.09	A= R/ρ	52.50	C	162.20	A= R/ρ	57.98	C	88.02

Curve 4				Curve 5			
v (km/h)	32.500			v (km/h)	25.000		
R (m)	55.000			R (m)	35.000		
U	118.370			U	10.800		
L/R	0.611			L/R	0.960		
t	0.555			t	0.695		
α	19.61	clothoids real elements		α	30.75	clothoids real elements	
γ	86.92			γ	79.48		
φ	6.35			φ	10.23		
r_1	0.78	r_0	33.74	r_1	0.97	r_0	33.46
x_1	0.78	x_0	33.57	x_1	0.96	x_0	33.03
x"	0.39	x"	16.68	x"	0.47	x"	16.26
y_1	0.08	y_0	3.45	y_1	0.16	y_0	5.35
δ_1	0.02	δ_0	0.87	δ_1	0.04	δ_0	1.35
ρ	1.27	ρ	55.00	ρ	1.02	ρ	35.00
s	0.78	s	33.89	s	0.98	s	33.81
n	0.80	n	34.66	n	1.04	n	35.84
b	0.08	b	3.63	b	0.18	b	6.04
y	1.29	y	55.87	y	1.06	y	36.35
A= R/ρ	43.17	C	36.64	A=R/ρ	34.40	C	82.08