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DESIGNING AN EFFECTIVE INTERSECTION USING CAD ENVIRONMENT

Abstract: *Ensuring the safety and streamline in road traffic are very important aims, with regard to the nowadays people mobility level. Road infrastructure is an essential element that can meet these requirements. Thus, it is proposed to develop an effective model of intersection by using CAD software tools. This type of intersection can be successfully used on almost any category of roads, increasing road traffic safety, reducing passing times through the intersection and in the same time, reducing conflict points and increase the intersection capacity.*

Key words: *road traffic, CAD designing, effective intersection, road safety, transport capacity.*

1. INTRODUCTION

The intersection of roads from a network is an issue of high importance both in terms of increasing the vehicles crossing capacity around intersection but mostly increasing safety in movement of road traffic participants [3, 4].

In the context of social development at global and national level, the population mobility requirement is in constant increase. Road transport pathways shows most advantages in terms of transport dynamicity, efficiency, speed and comfort. Also this is the most widely used mode of transport [1].

A key component of the transport system is the road way. It must provide safe for traffic participants and an increased transport capacity, regardless of the weather or traffic conditions. The road way as a contribution factor has pretty significant share of traffic accidents, about 15%. The essentials road elements, which increase the risk of vehicles traffic insecurity are [2,6]:

- road clothing presents the lowest coefficients of adhesion on curves or gradients;
- the existence of craters in a carriageway;
- the icy road surfaces are not treated with unfrozen materials;
- the lack of advance warning panels at the crossing level with the railway;
- the lack of road signs warning (road surface in work, irregularities);
- the lack of indicators of overall tonnage limitation or speed;
- high gradients, very steep ramps and slopes rushed;
- the existence of too many ad panels on the side of the road or even the monotony of the road;
- particularly dangerous curves;
- unguided intersections and traffic light signalling system incomplete;
- design of intersections with inefficient geometry in accordance with the requirements of the continuing growth in traffic.

Therefore, it can be seen that predominate the issues related to the geometry of the road surface and its surface conditions, and from this category, the crossing of intersections plays an especially important role in providing security in road traffic and to increase the capacity of transportation [5, 7].

Considering the fact that worldwide annual it registers over a million deaths and 50 million people are severely injured as a result of accidents on the road, which are attracting annual costs by hundreds millions of dollars, as well as the fact that at the national level from the total number of vehicles involved in traffic accidents, more than 70% are represented by cars, taking measures to streamline the structure and geometry of the roads network, represents a major challenge.

2. CONSIDERATIONS IN DESIGNING ROADS AND INTERSECTIONS

2.1 Relevant aspects with regard to the roads

The main elements of roads geometry are:

- alinements and curves connecting radius, in horizontal plane, declivity;
- connection radius of vertical curves, design step, in the longitudinal profile;
- width of road elements, overstretching of carriageway in curves, transversal slopes, in transversal profile.

In accordance with the technical regulations in force, on designing and building of roads, besides the essential conditions of safety and comfort, it takes into account also the rational use of land, protecting the environment but mostly framing their into technical classes in accordance with the road traffic characteristics [3, 5].

Reported on these criteria, the roads are divided into five technical classes, presented in figure 1. These classes include: highways, framed in technical class I; expressways, framed in technical class II and III; European national roads, framed into I, II and III technical classes; national secondary roads, framed in IV and V technical classes; district roads, framed in II, III and IV technical classes and communal roads, framed in IV and V technical classes.

Framing within the technical classes as well as road limit speed determined, are components that underlie the design of geometric elements of the route of a road [5, 7].

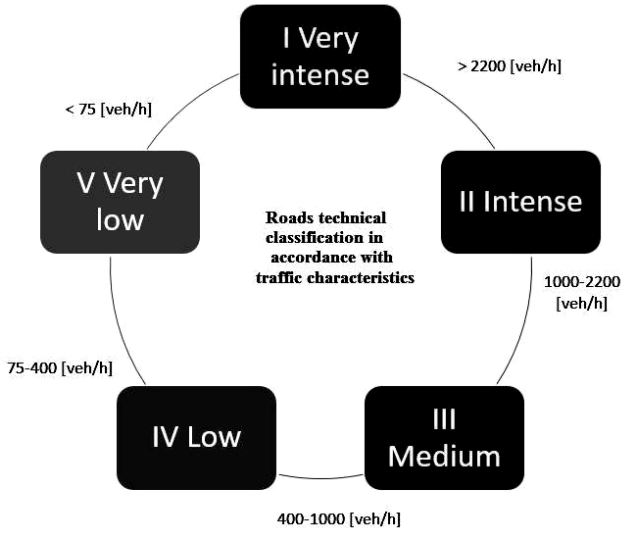

Fig. 1 Technical classification of roads

Studies carried out for the purpose of designing roads are made under construction or reconstruction project of a city (or an aria of a city), and also in the urban mobility study.

In the context of systematization stage of a town, the street plan position depends on many elements of which it's note the intersection with other streets or ways of communication. Crossroads can be made at the level or uneven, depending on the class of road designed. For example, intersecting highways or express roads, are made uneven [6].

2.2 Relevant aspects with regard to the intersections

Connection made between two or several road ways through some network nodes, are called intersections. If the movement of vehicles through an intersection takes place so that their trajectories are not intersecting, then passing through the intersection is made at the same time. Otherwise, passing through an intersection must be conducted through the traffic lights or signs.

At the moment of choosing a type of intersection at designing stage, it has to take account of [2, 4]:

- minimizing the number of conflict points;
- increasing the radius value of the intersection access arcs, if the roads axis angles are low;
- prioritize the flow of vehicles that allow the growth of traffic volume with the minimum risk of accidents;
- indication of traffic signals.

Determination of the passing capacity through an intersection is based on setting the main road artery with priority and then the secondary road arteries.

In this way, it is made a numbering of the turning movements which are categorized into the ranks according with the multitude of priority which it has to provide.

Thus, in figure 2 it is shown such a situation, where the priorities ranks have been divided into four, and the number of passes through the intersection in every direction has been spread from one to twelve.

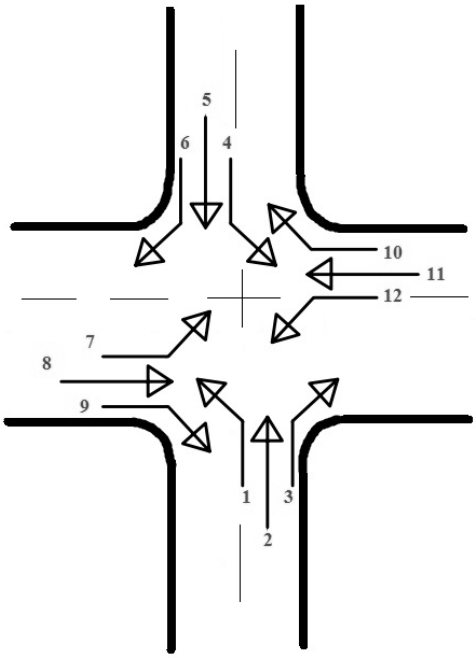

Fig. 2 Passing through the intersection capacity

So, in accordance with the ranks established, the passing through intersection order is [6,7]:

- rank I: 8, 9, 10, 11;
- rank II: 7, 12, 3, 6;
- rank III: 2, 5;
- rank IV: 1, 4.

Vehicles points of conflict in an intersection are very important elements in the design stage, so this aspect involve ensuring minimum visibility distances of two vehicles that run on two directions, in order to avoid the occurrence of a traffic accident. In figure 4 is presented a sketch of what does this means.

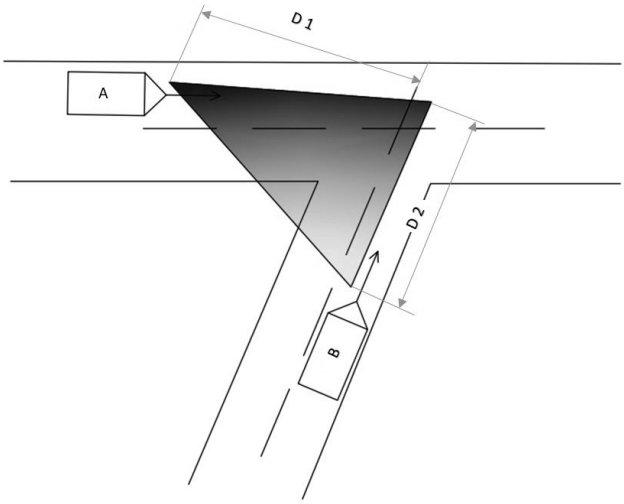

Fig. 3 Avoid intersection point of conflict

The field of vision is composed by the distances D1 and D2, which are minimum required distances for avoid any crash possibility between vehicle A and vehicle B, regardless of the speeds with which these are passing.

3. CASE STUDY WITH REGARD ON THE DESIGN OF AN EFFICIENT INTERSECTIONS

The simplest and most common type of intersection is the T-shaped. Because every band has only two lanes of traffic ways, for this type of intersection is specific the fact that it generates 3 points of conflict.

From geometric point of view, this type of intersection must be designed with angles more close to 90° between their axis, and with inclinations towards the horizontal plane up to 2,5 % (for a designed speed of 50 km/h).

CAD modelling of a road intersection presents the benefits of compliance with precision on the geometric elements required by the legal technical regulations, it also allow geometry optimization of an intersection type analysed, depending on intersecting roads specific and last but not least the use of model result in traffic simulations [1, 2].

Based on precision and complexity given by SolidWork's tools in this way, it has been made the 3D model for a T-shape intersection and then, starting from presented specific standardized geometrical elements of T-shape intersection (polylines of longitudinal profile axis used for vertical alignment, joint radius, slope angle, visibility minimum distance, etc.) and imposed traffic conditions too, it has been made a new 3D model for an efficient intersection.

In figure 4 is presented an intermediary image with regard to the CAD elements used for respect the geometrical conditions.

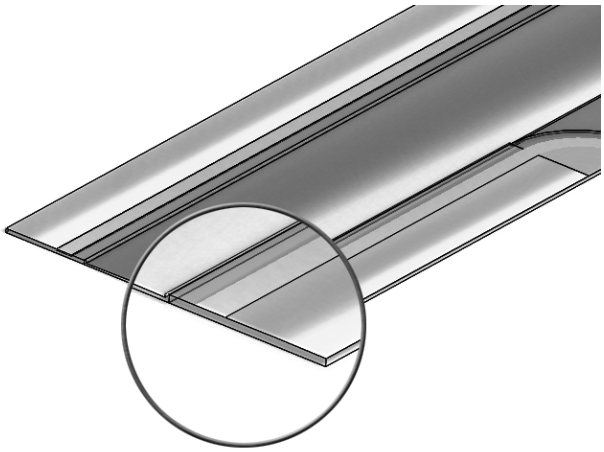

Fig. 4 Road detail on the T-shape intersection

In figure 5 it is shown the model of T-shape intersection designed.

Due to the existence of several constraints in the development of passing through T-shaped intersection, as the need to stop and start on the place, a lot of time for passing through the intersection, existing points of conflict, reducing its capacity and so on, it has been developed an efficient model of intersection with regard to the T-shape conditions, called "Turbo gyration" intersection. This type of intersection becomes basically a succession of T-shape intersections using median separators, and it presents the major advantage of reducing the time waiting of vehicles in safety conditions and also allows access for motor vehicles of high tonnage and high long, without any problem.

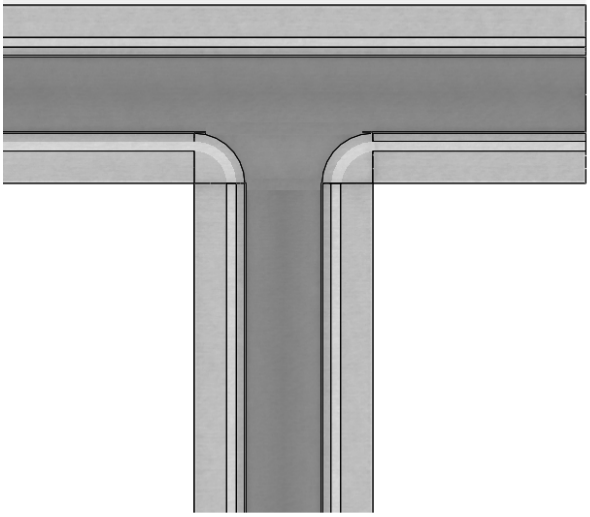

Fig. 5 T-shape intersection

The turbo gyration intersections are classified by number of arms in two: with 4 and 3 arms. The four arms allow for traffic predominantly making movement forward or right (classic or spiral turbo gyration) or all movements (rotor turbo gyration). The 3 arms allow for traffic predominantly making movement forward (extended knee turbo gyration) and all movements (star turbo gyration).

In order to improve the efficiency of road traffic in an T-shape intersection, it has developed a 3D model of an intersections with 3 arms, type.

In figure 6 is presented an assembly view of the new designed intersection and in figure 7 is presented a detail view with regard to the principal direction of traffic flow, from the geometrical parameters point of view, specific to the intersection designed.

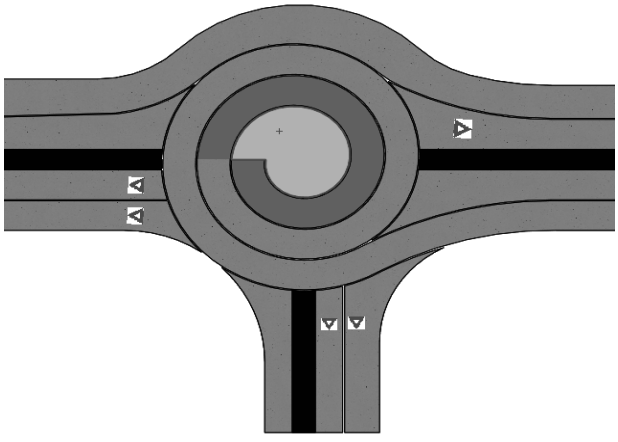

Fig. 6 Turbo gyration intersection

The geometrical elements chosen for the star turbo gyration designed, are composed by [6]:

- the inner radius of the interior lane is 10.5 [m];
- the outside radius of the interior lane is 15.85 [m];
- the outside radius of the inner lane is 16.15 [m];

- the outside radius of the outside lane is 21.15 [m];
- the connecting curve radius is 10 [m];
- the lane width for heavy duty vehicles is 5 [m].

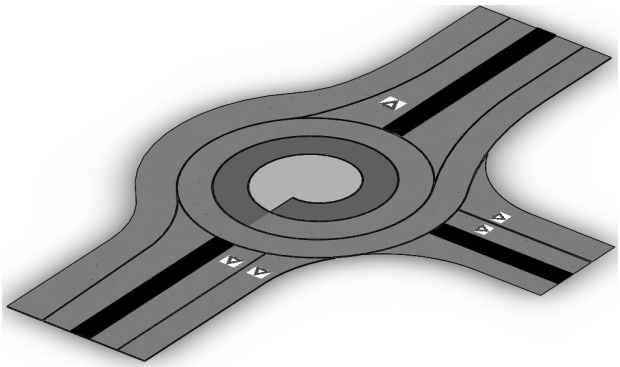

Fig. 6 Turbo gyration intersection- axonometric view

4. CONCLUSION

In the context of social development and increased mobility, centred on using the road vehicles as a means of transport impose permanent measures which should be taken to optimize road traffic.

Road infrastructure plays a key role in achieving this aim. Therefore, designing an effective intersection which allows increasing traffic flow capacity it's an opportunity.

T-shape intersections are found almost on all classes of roads, but these shows some shortcomings as well as long times waiting for pass, major conflict points or inadequate geometry.

So it has been designed a new type of intersection which replaces the T-shape one, called extended knee turbo gyration. This brings advantages such as lower waiting time and increased passing capacity through the intersection as well as increasing road safety and environmental pollution. At the same time, it is very useful for road access of tonnage and long vehicles.

This type of intersection can be used also on roads of category I (very high circulated), because it allows the passage up to 3800 standard vehicles.

The CAD software used, has proved to be very useful for the realization of the intersections models designed in compliance with the conditions of the road geometry and vertex of intersection.

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