

Municipal Transport - Infrastructure

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Abstract One of the most important problems that we face in Poland, is a low degree of safety connected with municipal transport infrastructure. It stands out from numerous factors and conditions. That is why numerous actions aimed at improving transport safety are being undertaken. One of them is improved safety of vehicles that are directly connected with municipal transport safety.

Keywords transport infrastructure, crossing, roads, municipal transport

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1. Introduction

With the increase in the number of vehicles on the roads increases the likelihood of adverse events [8]. Road accidents are the cause of numerous deaths and disabilities in Poland. The price paid by our society for a rapid development of transportation is high. The situation concerning road traffic safety is serious, especially in large towns and cities. The development of automotive industry has led to the increase in traffic, traffic jams, and problems with parking, road accidents and pollution. It is now necessary to broaden a traditional scope of road engineering, which originally involved no more than the issues relating to roads construction and design, by the organization and safety issues. Methods that are used to counteract the threats are a part of the domain called safety [11]. There are many factors having influence on the status, opportunities and directions of creating transport systems in regions [6]. The most significant of them are: condition of transport infrastructure, both in quantitative and qualitative aspect, legal and organizational conditions, principles and methods of financing, domestic and international economic relations of the region, the nature of the region (industrial, touristic, agricultural), finally, the structure and nature of the transport needs of users of the systems, as well as continuity and regularity of the researches in this area [6].

2. Municipal Transport Infrastructure

Municipal transport comprises various means of transport from different branches of this domain. The basic ones are:

- means of rail transport, i.e.: subway, urban rail and tramway;
- means of road transport, i.e. bus, trolleybus, car.

Municipal transport infrastructure comprises various branches of transport, whose specificity roots from the adjustment to the transport needs that are typical for urban areas. They are the following:

- roads and streets with all fittings aimed at the organization of road and pedestrian traffic;
- railway, subway and tramway subgrades;
- energy network supplying subway, railway, tramways and trolleybuses;
- substations;
- stops, interchanges and stations;
- bus, tramway and trolleybus depots;
- parkings.

2.1. Crossings

A crossing is a road cross-cut, junction or fork with full or partial possibility of choosing the direction. Crossings should meet the requirements concerning:

- safety;
- traffic efficiency;
- adjustment to the pedestrian traffic;
- economic solutions.

The following recommendations should be taken into consideration:

- the number of inlets to crossings should not exceed four;
- crossing angles should be about 90 degrees, but must not be less than 60 degrees.
- intersections crossing angles should be ca. 90 degrees.

Traffic safety on the crossings requires to provide the drivers who are not on a major road with visibility of the

crosswise road sections adhering to the crossing (Figure 1). Roadblocks higher than 0.75 m cannot be placed in a visual field. A minimal required length of W_r visibility of a bus section is $W_r=150$ m, assuming that a driver starting from the inlet without right of way is 2 m from the roadway edge, e.g. provided the road is 14 m wide and design speed on the road with right of way is 60 km/h. It is recommended to provide the biggest visual field possible that makes it possible to observe the road with right of way from the distance not shorter than 2 m from the road edge [1].

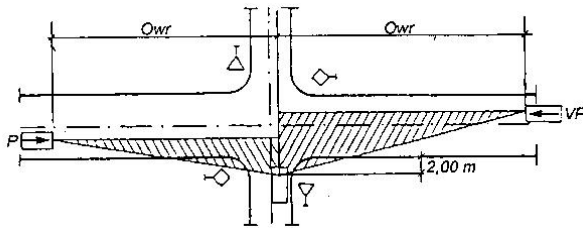


Figure 1. Visual field on the crossing while starting from a road without right of way [1]

The elements of urban system are parking places (along the curbs) and separated parkings. Figure 2 represents the schemes of typical parking places along the curbs [10].

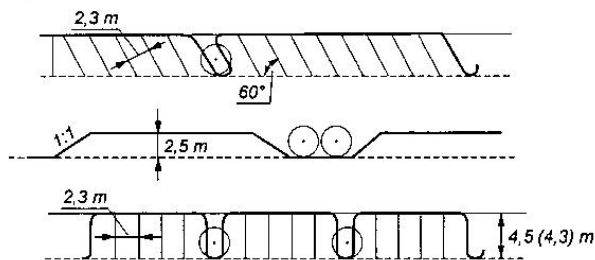


Figure 2. Typical curb parkings [1]

Parking needs are usually determined on the base of the number of drivers who want to use parking places in a particular area at the same time. As far as housing estates are concerned, there is one parking place per one flat and 20÷24 places per one thousand square metres of usable area of service facilities. Due to the proximity of destination and a short time of parking, curb parking is highly beneficial for its users, provided that the area is used well. However, it is a threat to traffic safety and flow.

Separate parking places are designed when the curb parkings capacity is too low. They can consist of one or many levels, and their functionality depends on the size of stands, manoeuvre roads and their system. An interesting solution of urban infrastructure system is the P & R (Park & Ride), whose objective is to reduce road congestion. The interest in P & R is increasing both in the country [5, 7, 9] and abroad [3, 4].

Due to the environment protection, it is unadvised to design parkings with more than 100 stands on the housing estate areas. Parking areas should be planted and artificially screened when necessary.

Bus stops are designed and used as far as bus transport is concerned (Figure 3). They should be located at least 20 m behind the crossing. Bus stops located before the crossing (at least 70 to 100 m) are more convenient for pedestrians, but they impede the traffic of cars that turn left on the crossing and within the whole area of before the crossing. Bus stops should not be placed opposite to each other. A shift between them has to be preserved so that the stopping buses do not impede the traffic.

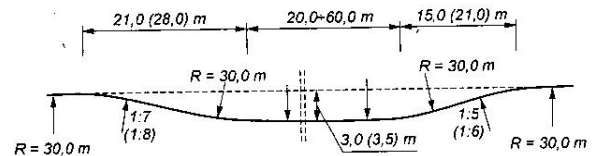


Figure 3. An example of a geometric lay-out of a bus buy (values for the GP class roads [speeded up roads] are given in brackets) [10]

In order to privilege municipal transport services, separate bus lanes or separate directions on unidirectional roads may be designed. As far as turnouts are concerned, they should be designed as the endings of L [local] and D [access] roads.

2.2. Roads

Qualification of roads is based on their communication functions and technical conditions connected with them. Roads also have composition, sociological and aesthetic functions, and mark out the areas of different use.

Considering functional reasons in the city communication system, there are the following:

- highways outside the urban area, aimed at communicating different metropolitan areas, connected in a collision-free way with the urban roads system;
- main arterial roads with considerable traffic;
- interdistrict arterial roads connecting particular towns;
- collective residential roads connecting residential estates;
- residential roads that are access roads to particular buildings, connected with collective roads.

According to indications relating to street design, the following division of streets creating a basic road system of a town/city has been introduced:

- urban express road (E);
- speeded up main road (GP);
- main road (G);
- collective road (Z);
- local road (L) [2];
- access road (D).

Roads of classes: E, GP, G and Z create, so called, basic system, and of L and D - service system.

Cars are ca. 2 m wide. Trucks' width does not exceed 2.6 m (with certain exceptions). Taking the above into consideration, lanes on the roads of basic system are 3.5 m

wide, on the service system - 3 m wide. 2.5 metres-wide lanes are admissible only in exceptional cases.

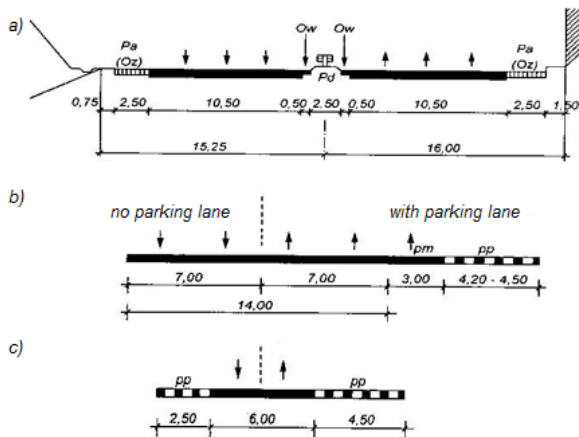


Figure 4. The examples of cross-sections of roads: a) E (urban express road); b) G (main road); c) L (local road) [1]

Urban express roads (E) are aimed at connecting remote urban agglomerations (Figure 4a). They can be the extensions of non-urban express roads and connect urban road with highways and non-urban express roads. They are only available for cars. There are two types of roadways used- with 3 or 2 lanes, so 11.5 m or 7 m wide. Connection with other roads is only possible on grade separate interchanges placed every 1.5 km to 3 km along the road. E roads do not serve the adjacent area. It is prohibited to stop and park. Design speed: 70 to 80 km/h.

Main speeded up roads (GP) are to connect remote cities. They can be the extensions of the 3rd class non-urban roads and connect urban roads with highways or express roads. There are two types of roadways used- with 3 or 2 lanes. Connections with other roads on crossings (horizontal) and on interchanges are placed every 0.6 km to 1.2 km. Basically, GP roads do not serve the adjacent area, so it is prohibited to stop and park. However, in case of modernization, it is allowed to create parking lanes and entrances. Design speed: 70 km/h.

Main roads (G) connect the areas within a city or a town. They can be the extensions of the 4th class non-urban roads and connect urban roads with non-urban roads and the 3rd class express roads. There are two types of roadways used, with 4 or 6 lanes in total, 21 m or 14 m wide in total (Figure 4b). Connections with other roads on crossings are placed every 0.4 km to 0.6 km. Main roads may serve the adjacent area, but it is recommended to park only on parking lanes and to limit the number of entrances. Design speed: 60 km/h.

Collective roads (Z) serve the housing estates or industrial districts. They can be the extensions of 5th and 6th class non-urban roads. Bidirectional roadways are usually designed for 4 lanes of the maximum width of 13 m. They may be connected with other Z or G roads (as well as L and D roads) on crossings places 0.15 km and 0.3 km along the road. Parking is allowed on parking lanes, a limited number of entrances is recommended. Design speed: 50 or 60 km/h.

Local roads (L) serve the housing estates. They are not designed to connect non-urban roads. Connections on

crossings are allowed only with Z, G and D class roads. Parkings and entrances are not limited. Design speed: not determined. Roadway width for 2 lanes: 6 to 7 m (Figure 4c).

Access roads (D) serve the groups of buildings and objects. Connections on crossings are allowed only with L, Z and D class roads. Roadway width: 5 to 6 m. One-lane, 4.5 m wide roads with passing places every 100 m are also allowed, provided the whole section is visible.

The road system should be designed in a way that the lower-class roads are connected with only one or two classes upper roads. In particular, it is not allowed to connect L and D class roads directly with urban express roads (E) and speeded up roads (GP). Connections with main roads (G) should be limited, e.g. only turning right may be allowed [1]. Figure 5 presented the scheme of road system classification.

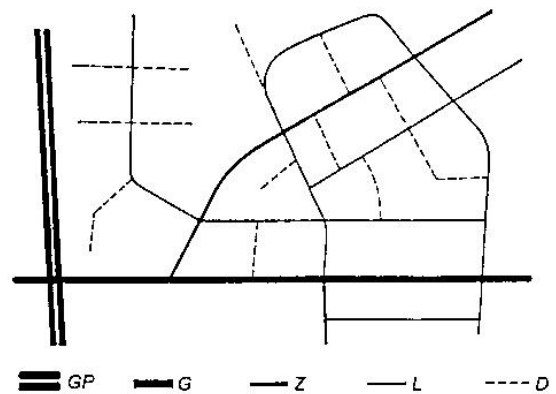


Figure 5. The scheme of road system classification [1]

A road is a parcel of land separated with lines, intended for car and pedestrian traffic, parking and for engineering territorial development. In a road's cross section, the following elements may appear:

- roadways;
- parking lanes;
- lanes dividing the two directions of traffic;
- emergency lanes, refuge islands;
- pavements;
- tramway subgrades;
- cycle tracks;
- green belts;
- cut and fill slopes;

Roadway is a part of road dedicated to vehicle traffic. In case of rail-vehicle traffic, a part of road dedicated to such traffic is called subgrade. Depending on its use, a road may not have a roadway, and then it works as an independent footway, tramway subgrade or cycle track.

A cross section (the number of lanes and their width) is designed considering the road's technical class (for E, GP, G and Z classes) and traffic volume.

Cycle tracks must be placed at similar distance (not shorter) from the road axis as pavements. It is allowed to design a cycle track on a unidirectional roadway.

Parking lanes may be placed on roads of G, Z, L and D classes, and everywhere else where it is necessary. However,

vehicles parked on such lanes must not disturb the visual field. In case of G class roads, it is recommended to increase the roadway width with the use of a manoeuvre lane; parking lanes should allow for angle parking.

Dividing lanes allow for dividing the two directions of traffic. Lamp posts, road signs etc. are placed on them in order to secure traffic.

Emergency lanes allow for emergency stopping and parking. When designing a road's cross section, one must take into consideration the requirements related to the roadway, pedestrian and cycle traffic outlines (Figure 6) [10].

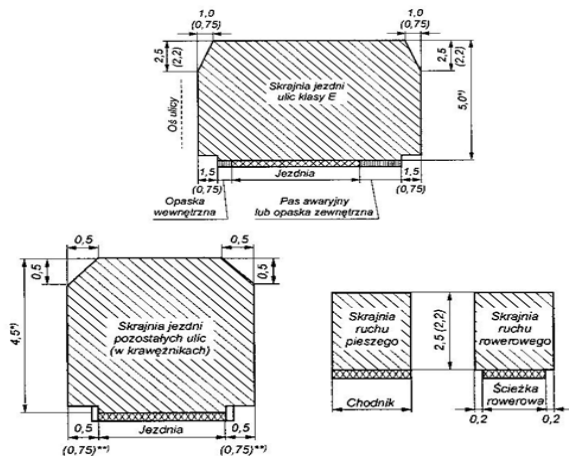


Figure 6. Roadway, pedestrian and cycle traffic outlines [10].

Figure 7 presents the infrastructure of conflict and typical crash types and the way to minimize the crashes.

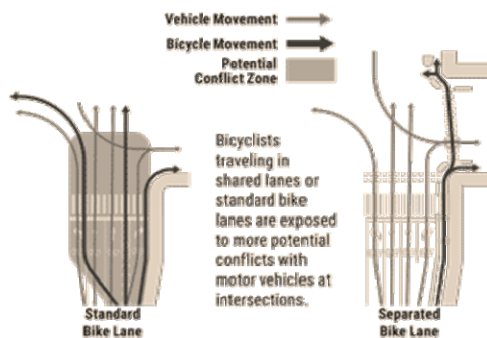


Figure 7. The infrastructure of conflict and typical crash types [12]

Ensuring the traffic safety needs the minimize bicyclist exposure to motor vehicles, decrease the speed differential at conflict points, and provide adequate sight distance for all roadway users. Fulfilling the criteria of safety should take place at the design stage.

3. Conclusions

A majority of Polish cities and towns struggle with serious communication problems. They are caused by, on the one hand, a rapid development of automotive industry and, on the other hand, unsustainable road engineering policy and underinvestment of road infrastructure. The number of cars in Poland has increased by almost 100%, and of trucks- by almost 90%. As a result, in the majority of cities, road system and their elements turned out to be insufficient. It caused, in turn, a high traffic volume. The consequence of this phenomenon is lower life quality of citizens and higher costs of transport in the cities and towns. The lack of appropriate hierarchy of sequences as far as their functions, tasks and, above all, speed and availability are concerned, is one of the biggest disadvantages of road networks in Poland. It makes it difficult to manage the network and provide a desirable safety level and sufficient road capacity [2], (Figure 7).

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