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APPLICATION OF TEMPORARY ROUNDABOUTS IN ENHANCING OF ROAD BASIC CAPACITY

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Abstract

The accelerated urbanization process and the development of the City of Osijek as the regional center of Slavonia and Baranja have resulted in frequent traffic congestion on the city's southern bypass. This is particularly evident during peak hours of commuting to and from work, as well as on weekends. The southern bypass, specifically the existing D2 expressway, located in what was once the outskirts of Osijek, can no longer ensure the continuity of traffic flow intended for a motor vehicle road with a design speed of 110 km/h. Consequently, speed limits of 70 km/h have been imposed on certain sections. The Osijek southern bypass is a dual-carriageway road, consisting of northern and southern lanes with two traffic lanes each. The bypass has lost its primary intended purpose as a transit corridor and has become an "urban" expressway woven into the city's traffic fabric, primarily used to connect the eastern and western parts of the city. Given the intensive construction and reconstruction of the tram tracks and main streets in Osijek, the majority of urban traffic spills over onto the southern bypass. The most prominent problem is identified at the „FRIGIS" interchange, which absorbs all increased urban and transit traffic heading north. The increase in traffic flow has led to congestion, reduced interchange capacity, and the formation of vehicle queues on the expressway route. A proposed solution to this problem lies in the installation of temporary prefabricated roundabouts within the interchange itself through two interconnected phases. This paper presents positive examples of the application of temporary prefabricated roundabouts aimed at increasing traffic safety and the throughput capacity of traffic flows at the intersection of state roads D2 and D7 – the „Frigis" interchange within the Osijek southern bypass.

Keywords: temporary roundabouts, road basic capacity, Osijek bypass, state road D2, "FRIGIS" interchange

1 Introduction

State road D2 is a section of the Podravina major road, which connects Croatia in a west-east direction. All traffic traveling in this direction in the vicinity of the City of Osijek is directed to the Osijek south bypass. The Osijek south bypass begins after the 'JOSIPOVAC' interchange (connection to the A5 motorway - Corridor Vc) and ends at the existing 'TENJSKA' interchange (figure 1). The bypass was designed and constructed as an expressway with dual carriageways, each featuring two traffic lanes, with a total length of 12.2 km and a design speed of 110 km/h. There are a total of six grade-separated interchanges and seven structures located along the route itself.

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Figure 1 Osijek south bypass [1]

The accelerated urbanization process and the development of the City of Osijek as the regional center of Slavonia and Baranja have resulted in frequent traffic congestion on the city's south bypass, particularly during peak hours for commuting and on weekends. Due to its location in what was once the outskirts of Osijek, the south bypass, specifically the existing D2 expressway, and its associated interchanges can no longer ensure the continuity of traffic flow intended for a road reserved for motor vehicles with a design speed of 110 km/h. Consequently, speed limits of 70 km/h have been implemented on certain sections of the expressway. The bypass has lost its intended primary purpose as a transit corridor and has become an 'urban' expressway integrated into the city's traffic fabric, primarily used to connect the eastern and western parts of the city. Given the intensive construction and reconstruction of the tram network and main streets in Osijek, all city traffic is spilling over onto the south bypass. The most prominent issue has been identified at the "FRIGIS" interchange, which handles all increased urban and transit traffic heading north (toward the Retfala district and Baranja). This increase in traffic flow has led to documented congestion, reduced interchange capacity, and the formation of vehicle queues along the south bypass route.

2 Existing traffic flow and proposed solution

2.1. 'FRIGIS' Interchange

From a traffic perspective, the "FRIGIS" interchange (figure 2) represents the most complex intersection on the entire route of the south bypass, as it serves as the junction for long-distance transit and local (urban) traffic flows. The interchange is designed as a modified grade-separated intersection of the partial cloverleaf type. Through its geometric characteristics, it facilitates the intersection of state roads D7 and D2, as well as the intersection of urban thoroughfares – the 'S' connecting road and Svilajska Street. In addition to urban traffic, the subject interchange services traffic directions from Đakovo, Vinkovci, Vukovar, and Beli Manastir, connecting them to Corridor Vc (A5 motorway) as the primary route, and to the City of Osijek, Beli Manastir, and the border crossing with the Republic of Hungary as the secondary route.

The design documentation for the permanent solution of the "FRIGIS" interchange is currently in the preparation phase. It is difficult to estimate the completion of the design documentation, administrative procedures, and the actual construction process of the new interchange, as it will certainly extend several years into the future. The current problem of traffic flow congestion is evident, making it necessary to intervene immediately to relieve pressure and increase the capacity of the existing interchange. This can be achieved through rational and economically acceptable spatial interventions, specifically by implementing prefabricated roundabouts.

The main transit corridor toward Baranja (figure 3) proceeds via the existing southern slip road, a T-junction, a temporary prefabricated roundabout, and the intersection of the D7 and D2 state roads. The proximity of the 'Portanova' shopping center (with 1, 600 parking spaces), the nearby Retfala district, and newly built retail chains in the Svilajska Street zone result in slowed traffic and occasional congestion of the traffic flow.

Figure 2 Traffic directions at the "FRIGIS" Interchange [2]

Figure 3 Existing transit traffic flow (marked in red)–direction of vehicles traveling toward Baranja (Beli Manastir, Republic of Hungary border crossing) [2]

During peak loads during commuting hours (from 7:00 to 8:00 and from 14:00 to 16:00) and on weekends (Friday – Saturday), difficulties in traffic movement and traffic congestion occur, with occasional standoffs at the intersection of the south bypass slip road and Svilajska Street, as well as at the northern approach of the existing temporary roundabout from the direction of Svilajska Street (figure 4).

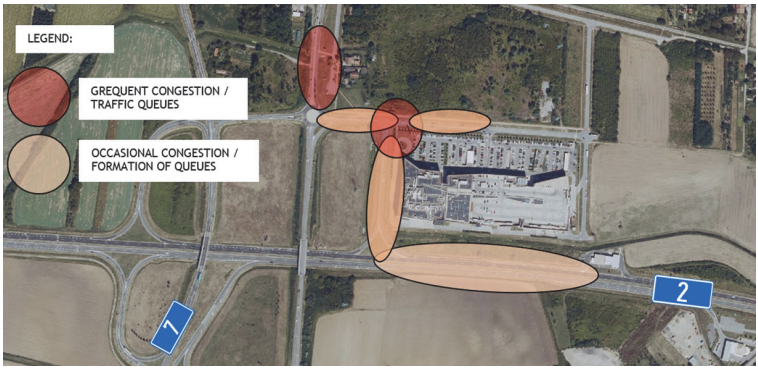

Figure 4 Existing traffic flow with locations of frequent and temporary traffic congestion [3]

Based on the situations shown in figures 3 and 4, it is evident that the existing traffic solution cannot accommodate the current traffic load, which results in reduced flow, occasional slowdowns, and the formation of vehicle queues on the D2 state road, specifically along the south bypass route.

2.2 Proposed solution aimed at increasing traffic flow capacity

Mitigating the issues and finding a partial solution to increase traffic flow capacity within the interchange itself is based on the idea of physical separation of traffic flows. The separation of transit traffic from local urban traffic is proposed through two interdependent phases (figure 5).

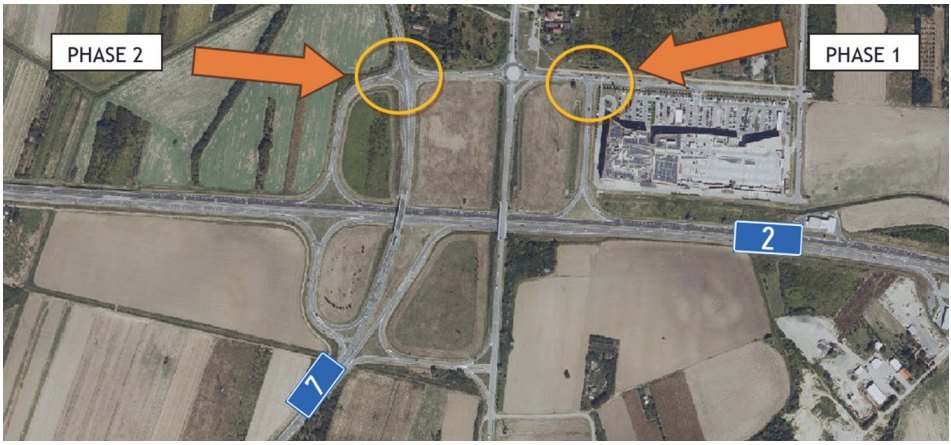

Figure 5 Micro-location – phase 1 and phase 2 [2]

2.2.1 Phase 1

Phase 1 proposes the modification of the existing intersection of the D2 state road and Svilajska Street (currently a T-junction) by altering the existing traffic signaling and equipment within the intersection zone. The primary focus is on channeling the already congested traffic flow, with the goal of implementing measures to mitigate the impact of 'traffic surges' during peak periods. Increased urban traffic, the presence of heavy transit vehicles, and vehicles destined for the 'Portanova' shopping center all contribute to the traffic congestion during commuting hours and weekends.

The proposed solution involves the installation of a temporary “mini” prefabricated roundabout designed to increase the existing capacity of the intersection. The layout of the roundabout was determined based on vehicle tracking simulations for the designated design vehicle (a tractor-trailer). The simulations confirmed that a tractor-trailer can navigate all approaches in all directions, with the exception of a U-turn (full circle), which was not tested as it is prohibited by appropriate traffic signage.

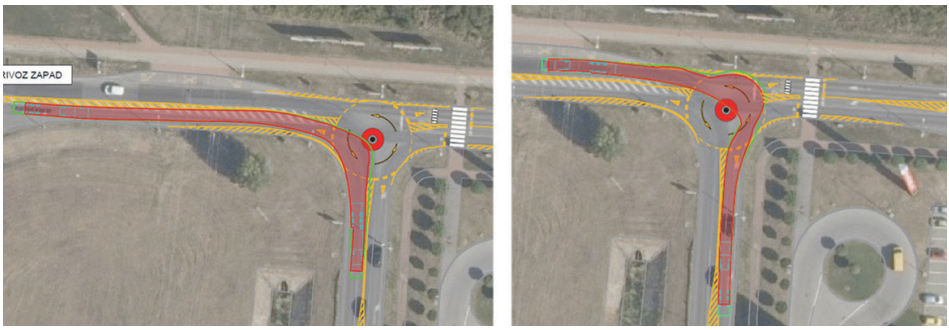

Figure 6 Vehicle tracking analysis for the „mini“ roundabout, tracking 1 i 2 [3]

The vehicle tracking analysis was conducted using the Autodesk Vehicle Tracking software package, which is part of the Autodesk AEC Collection and is directly integrated into Civil 3D. The construction of the temporary prefabricated roundabout is designed as a ‘spatial barrier’ using plastic New Jersey barriers (K24) and appropriate traffic signaling to provide drivers with timely information on traffic flow navigation. Physical barriers (plastic New Jersey barriers) are placed at the approaches of the newly designed roundabout to physically separate opposing traffic flows and the carriageway from areas where traffic is prohibited.

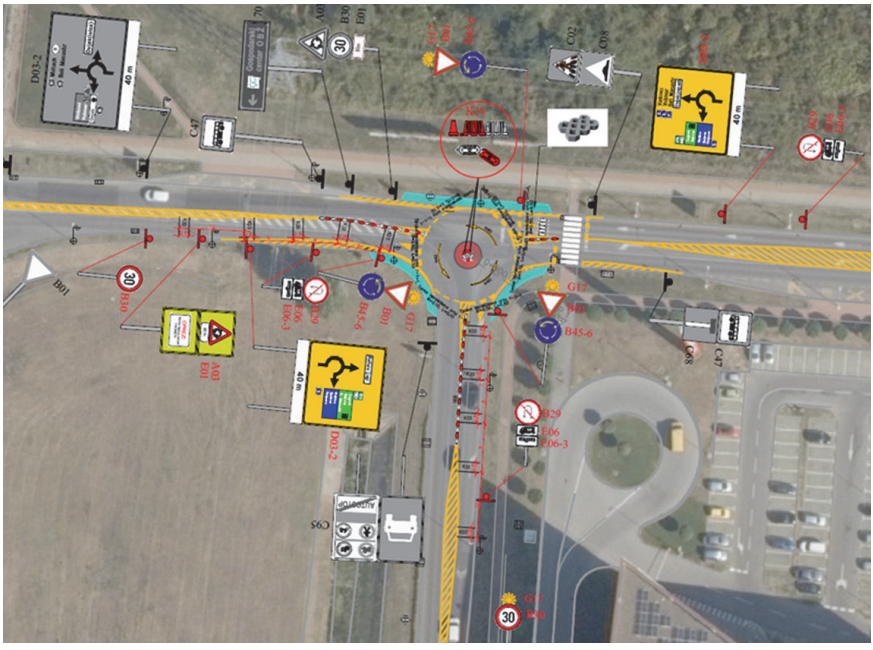

Figure 7 Construction of the phase 1 „mini“ roundabout showing spatial barriers for the physical separation of traffic directions [3]

2.2.2 Phase 2

Phase 2 envisages works on the reconstruction of the D7–D2 intersection by installing a temporary prefabricated roundabout and modifying the existing traffic signaling. The layout of the temporary roundabout was determined based on vehicle tracking analysis for the selected design vehicle (a tractor-trailer). The analysis confirmed that a tractor-trailer can navigate all approaches in all directions (figure 8).

Figure 8 Vehicle tracking analysis for the temporary roundabout, phase 2 tracking 1, 2 and 3 [2]

The temporary roundabout structure is designed as a temporary traffic circle. The central island (rotunda) is formed by the circular placement of separation barriers (plastic New Jersey barriers) to physically separate traffic surfaces and define the shape of the central circle. The outer part, a 1.5-meter wide mountable apron, is painted red for enhanced visibility. Splitter islands are formed by placing separation barriers to physically divide opposing traffic flows and separate the carriageway from non-traffic areas.

Figure 9 Separating traffic flows through the application of temporary roundabouts at “FRIGIS” interchange [2]

At all approaches where the existing pavement width is excessive, traffic lanes are defined using H50 yellow directional lines, which signify a change in the usable pavement surface. Along with the horizontal road markings, flexible PVC bollards are installed at regular intervals. These bollards are made of soft orange plastic with RA2 class retroreflective markings. The dimensions of the bollards are: 80 mm in diameter, 210 mm base, 760 mm in height, and a weight of 2.5 kg per unit, secured directly to the asphalt using three anchor bolts.

3 Conclusion

This paper presents a positive example of the application of temporary prefabricated roundabouts aimed at increasing traffic safety and flow capacity at the intersection of state roads D2 and D7 – the "FRIGIS" interchange within the Osijek south bypass. The increase in capacity is primarily achieved by separating existing traffic flows, specifically by isolating long-distance transit traffic from local urban traffic. This separation was implemented using temporary prefabricated roundabouts to channel and provide unambiguous traffic guidance within the interchange itself (figure 9). The application of temporary prefabricated roundabouts can significantly influence the increase of traffic flow efficiency at specific critical sections and key points of existing interchanges. Furthermore, prefabricated roundabouts can substantially contribute to reducing traffic congestion and increasing road safety; however, they are, and above all should remain, temporary in nature until a permanent solution is adopted. In addition to their previously described role in increasing capacity, the significant function of temporary prefabricated roundabouts in traffic regulation during construction works, aimed at more efficient and safer traffic flow, must not be overlooked.

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