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Analysis of Unconventional Signalized At-Grade Intersections

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Abstract : **The article deals with two types of unconventional intersections – the *Median U-Turn* intersection and the *Superstreet* intersection. Available published sources of information have been analyzed for information about the characteristics, design and operations of unconventional intersections. A comparison of unconventional and typical intersections has been made to determine the types of intersections which are more preferable in the specific traffic situations in urban areas. In the process of study it has been identified which of the analyzed intersections provide the best level of service and movement efficiency for the current traffic flow distribution and intensity.**

Keywords: **unconventional intersection, traffic congestion, arterial street, level of service.**

INTRODUCTION

In the middle of the 20th century the average level of automobilization in the USA reached 300 vehicles per 1000 people (see Fig. 1). As a result, the traffic situation in the arterial street corridors of the largest cities changed considerably – the increase of traffic intensity led to the increased numbers of traffic congestions and road accidents. To amend the given situation, a development of unconventional signalized at-grade intersections was started in the states of Michigan and New Jersey.

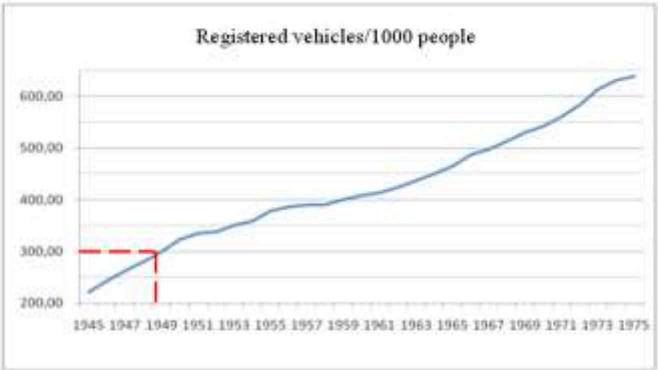

Fig.1. Total amount of registered vehicles in the USA (1945 – 1975) [1]

Currently the funding assigned to building and maintenance of transportation infrastructure in Latvia is very limited. At the same time, the increase of the automobilization level (see Fig. 2) and traffic intensity in the arterial streets of Riga cause greater numbers of traffic jams. In such conditions, unconventional signalized intersections are becoming very suitable for the traffic situation in Latvia.

The article deals with two of the most perspective and widely used types of unconventional intersections – the *Median U-Turn* (MUT) intersection (see Fig. 3) and the *Superstreet* intersection (see Fig. 4). A comparison of unconventional and typical intersections has been made to determine the types of intersections which are more preferable in the specific traffic situations in urban areas. The study compares the main characteristics of the traffic quality at unconventional intersections with those at the corresponding conventional four-leg intersections. In the process of the study it has been identified which of the analyzed intersections provide the best level of service (LOS) and movement efficiency for the current traffic flow distribution and intensity.

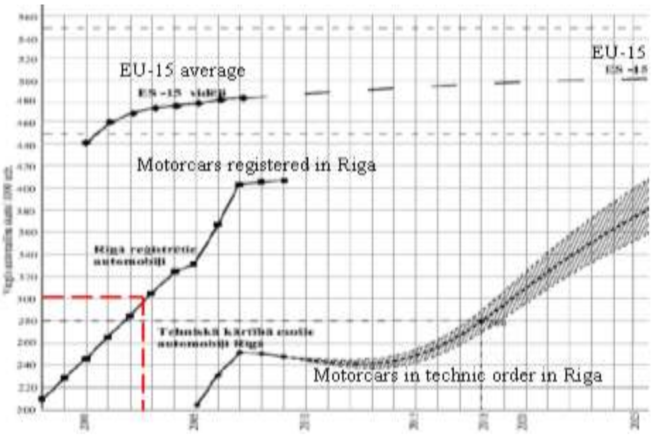

Fig.2.Forecast of automobilization dynamics in Riga [2]

Fig.3. Median U-Turn intersection in Troy (Michigan), USA [3]

Fig.4. Superstreet intersection in Michigan, USA [3]

THE NEED TO IMPROVE ARTERIAL STREET INTERSECTIONS

Deficiencies of traditional improvements of typical signalized intersections

Congestions are very common for a lot of arterial streets located in urban and suburban areas, and there are very few limited options to ensure a short-term solution of the problem.

Good coordination between adjacent land owners and the transportation system planners can ensure a long-term solution of the traffic problems in new and developing urban areas. However it does not provide a sufficiently fast relief for the already developed areas [4].

Congestions significantly decrease the capacity of arterial streets, which is limited by the effectiveness of intersections. The currently widely used traffic control and organization methods have limited efficiency [5].

Transportation engineers make attempts to improve the operations of conventional intersections by creating coordinated traffic signal systems and increasing the number of signal phases. Among other solutions, additional right and left turn traffic lanes are often created.

The research of the additional lane efficiency at signalized intersections [6] shows that conventional methods of improving intersections by adding new lanes have diminishing results. It has been identified that adding of one additional through movement lane extends the effective operational lifespan of an intersection by 15 years, adding of the second additional through movement lane extends it by 10 years, but adding the third through movement lane extends it only by 6 years.

At large at-grade intersections, all traffic participants suffer from the significant increase of their travel time. This increase occurs due to a larger number of longer signal phases, large volumes of left turn traffic, big amounts of pedestrian traffic flows and the growing difference in traffic intensity on different lanes.

Long signal cycles at one arterial intersection can create congestions at other arterial street intersections.

The traditional reconfiguration of an arterial signalized intersection is rather ineffective at intersections with large traffic flow volumes.

Creation of the grade separated pedestrian bridges, traffic interchanges and bypasses is very expensive and cases obstructions to traffic [4].

The application of traffic interchanges in urban areas has a lot of significant limitations. They require large right of way, and minimum distances are needed to be maintained between subsequent interchanges, which is often impossible in urban areas. Moreover, the building and maintenance of interchanges is considerably more expensive than that of intersections.

Traffic safety and quality can be improved by restricting certain maneuvers or the pedestrian traffic (see Fig. 5), although such restrictions often limit access to the adjacent areas. Such restrictions severely lower the quality of life in the territories located next to the intersection and, thus, they are negatively assessed by local residents and business owners [5].

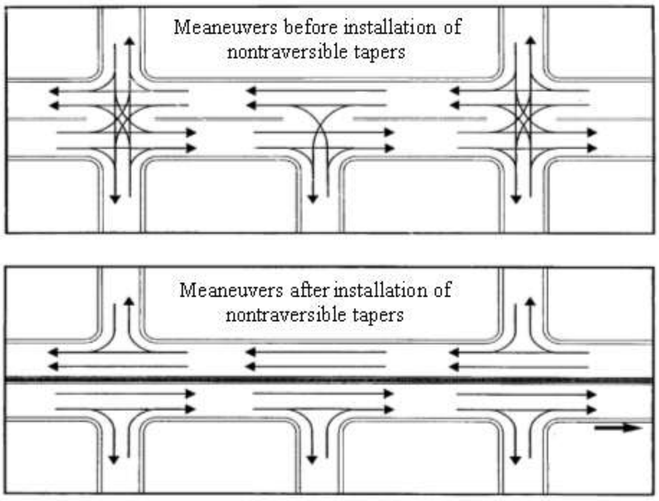

Fig.5. Reduction of conflict points at intersections by installation of nontraversable medians [7]

Intelligent transportation systems are used mainly on high speed highways and effective improvement of public transport system can be achieved predominantly only through expropriation of large land spaces and widening of the existing right of way [4].

These aspects create the need for exploring new unconventional intersection design solutions with the increased overall traffic capacity.

The use of unconventional signalized intersection designs in improving the arterial intersections

Unconventional arterial intersections have been developed and are being implemented to maximize the intersection traffic capacity.

All unconventional intersection designs have three fundamental principles:

1. Traffic problems are usually caused by left turn movements. The main emphasis at unconventional intersections is laid on altering these movements (see Fig. 6). Generally, left turns and U-turns can be performed indirectly by using directional crossovers, additional intersections, T-intersections and roadways.

2. The main function of arterial streets is providing optimal traffic conditions for through-moving traffic flows. At unconventional intersections, travel time for these traffic flows is reduced considerably.

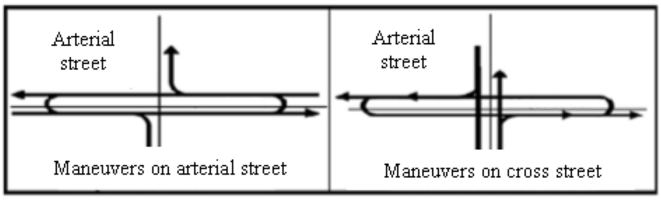

Fig.6. Left turns and U-turns at Median U-Turn intersections are performed on crossovers [4]

3. All unconventional intersections are theoretically safer than the typical intersections because they have reduced number of conflict points which are locally deconcentrated, compared to the corresponding conventional intersections. (see Fig. 7).

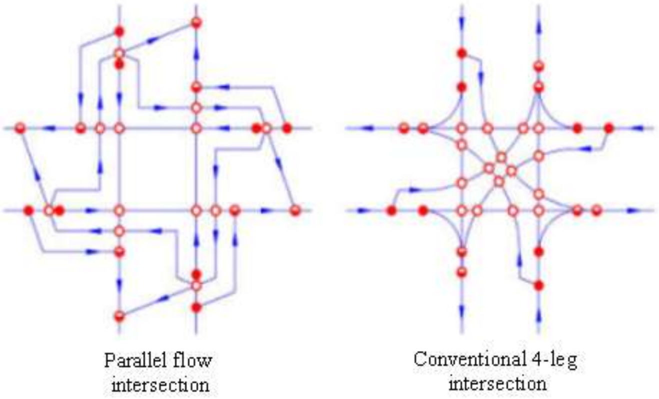

Fig.7. Conflict points at the Parallel flow intersection and the corresponding conventional four-leg intersection [10]

All basic geometric elements of a conventional intersection are widely used at unconventional intersections alongside with additional elements that are distinctive only for unconventional intersections:

1) jughandles (see. Fig. 8.);
2) quadrant roadway (see. Fig. 10.);
3) wider taper;
4) additional intersections;
5) additional roadways;
6) channeling tapers.

All unconventional intersections have reduced number of signal phases – usually these intersections have two-phase signal cycles. In some cases, when the total traffic intensity at the intersection exceeds 10 000 veh/h, a three-phase signal cycle is applied.

Several types of unconventional intersections, e.g. the *Jughandle* intersection (see Fig. 8), have been successfully used for many years. Other, more innovative intersection designs, e.g. *Continuous flow* intersection (see Fig. 9), are based upon older unconventional intersection designs that have already proven themselves in operation. Unconventional intersections are not universal solutions for solving traffic problems. For many arterial streets unconventional intersections will not provide the desired effect, but in most cases their use is very promising.

Fig.8. Jughandle intersection in Pequannock (New Jersey), USA [8]

Although unconventional intersections, due to their geometric and traffic organization features, can create larger driver confusion than conventional intersection designs, it is not a sufficient reason for rejecting otherwise superior intersection designs. It has been proven in operational practice that the use of clear and understandable traffic control methods can reduce driver confusion at these intersections. It has been also established that drivers get used to unconventional intersections better if such intersections are created in subsequent intersection places along the arterial street section.

Fig.9. Continuous Flow intersection in Fenton (Missouri), USA [9]

To compare the relative level of the intersection safety with that at conventional intersections, a conflict point method is being used [4].

Although the information about new unconventional intersection designs is not sufficient to perform a road accident analysis, a lot of research has been done about the older types of unconventional intersections, which show that, in comparison with the corresponding conventional intersections, there are fewer accidents at unconventional intersections [6].

Unconventional intersections can be divided into two large groups:

1) intersections that are more effective when used in subsequent intersection systems;
2) intersections that are more effective when used in separate arterial intersections.

Systems of the same design subsequent intersections are created in intersection locations where mayor arterial streets intersect with smaller cross streets. Such intersections can also be created without integrating them in a coordinated system, but in this case they will not reach their full work capacity. The main emphasis in subsequent intersection systems is laid on reducing the waiting time of arterial through-moving traffic flows.

Nowadays the most widely used intersections of this type are the *Median U-turn* intersections and the *Superstreet* intersections, which are being analyzed in the study.

Separately placed intersections are used in intersection places of two mayor arterial streets. Their main goal is to ensure the optimal traffic movement efficiency for through-moving traffic flows on both of the intersecting streets. When creating this type of intersection designs, the main emphasis was laid on the larger traffic capacity of a single individual intersection, rather than integrating it in a coordinated system [5].

At present, the two most perspective types of such intersections are considered to be: the *Continuous Flow* intersection and the *Quadrant Roadway* intersection (see Fig. 10).

Fig.10. Quadrant Roadway intersection Bloomfieldhill (Michigan), USA [11]

UNCONVENTIONAL SYSTEM INTERSECTIONS

Median U-turn intersection

Left turns at MUT intersections can be made indirectly by using the directional crossovers which are closest to the intersection downstream.

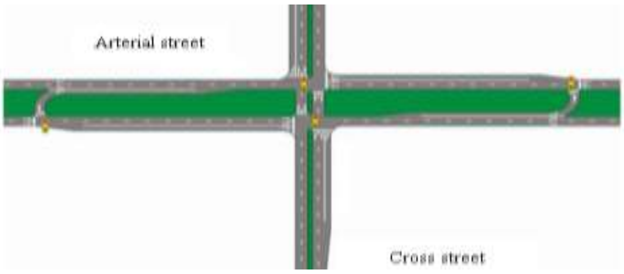

Fig.11. Conceptual design of the MUT intersection [3]

Michigan State Transportation Department developed the MUT intersection (see Fig. 11) design in 1960s. The design was developed to reduce the number and severity of congestions which were mainly caused by mutually crossing left-turning traffic flows. During the implementation of the newly designed bi-directional crossovers were converted to single direction crossovers.

MUT intersections considerably simplify traffic organization at intersections with large traffic intensity. Direct left turns are forbidden at the main intersection, thus allowing to create a simple two-phase signal cycle.

MUT intersections require wider taper, to ensure effective U-turn movements for longer vehicles. The US road design standard (AASHTO) provides geometric parameters of directional crossovers which depend on the number of traffic lanes and the size of vehicles.

When choosing the distance between the intersection and the closest crossover, the design must ensure sufficiently long left turn lane length that determines the traffic capacity of the lane (see Fig. 12.). The length depends on the traffic intensity of the left-turning traffic flow. It is also important not to create the inadequately long left turn lanes – the intersection travel time must be as short as possible.

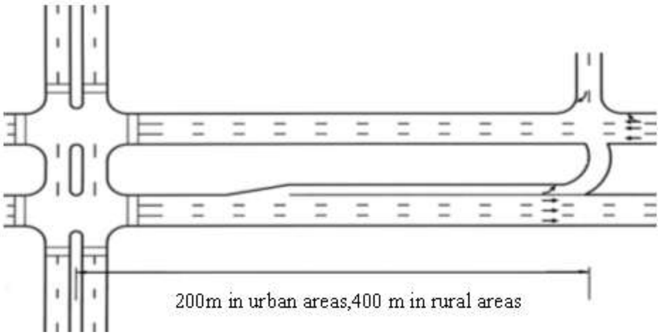

Fig.12. Recommended distance between a crossover and the main intersection [4]

When creating MUT intersections, it is important to place the road signs and tune the traffic light cycles correctly to prevent the additional traffic safety and organization risks.

Conventional intersections, compared to the corresponding MUT intersections, have twice as much conflict points, besides that, MUT has no crossing conflict points for the left-turning traffic (see Fig. 13, Table 1).

TABLE 1

COMPARISON OF CONFLICT POINTS AT MUT AND A TYPICAL FOUR-LEG INTERSECTION

Conflict point type	4-leg signalized intersection	MUT intersection
Merging/Diverging	16	12
Crossing (Left turn)	12	0
Crossing (Others)	4	4
Total	32	16

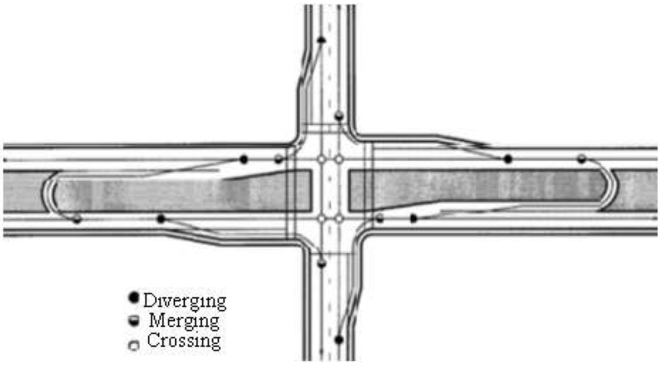

Fig.13. Conflict points at the Median U-Turn intersection [12]

The MUT intersection is the most analyzed of all the unconventional intersections. Many authors have performed extensive studies and have created traffic simulation models, while examining the MUT intersection. All of the studies show that the MUT intersection compared to the standard intersection ensures better capacity and lower travel time (especially in cases with small and medium left-turning traffic flows).

For years Michigan State Transport Department (MSTD) has been engaged in accident registration and analysis on arterial streets where bi-directional crossovers are reconstructed to single direction crossovers. It has been concluded, that the number of traffic accidents was considerably lower on the reconstructed streets.

In cases with large left-turning traffic flows, the travel time losses increase considerably.

The MSTD data suggest that arterial streets with 8 traffic lanes, which are equipped with MUT intersections, have the total traffic intensity of approximately 100 000 veh/24 h, and the intersection traffic intensity reaches 150 000 veh/24h.

Although traffic jams at MUT intersections can occur during the peak hours of traffic intensity, the overall intersection and system malfunctions are very rare.

Grade-separated interchanges are usually constructed at intersection places with large traffic intensities. However, the MUT intersections can also effectively prevent congestions while allowing access to land spaces adjacent to street corridors, thus they can be considered as a reasonable alternative.

There are no known cases when the MUT intersection had to be reconstructed because of the insufficient capacity or a low level of traffic safety. The most dangerous period for the MUT intersections is the first 2-3 months when drivers get used to this type of intersection. The MUT intersections are recommended for use on arterial streets with two roadways and a space for perspective widening.

The MUT intersections are common in the USA – in Michigan (especially near Detroit), Maryland, Florida and New Mexico.

Superstreet intersections

The Superstreet and MUT design layouts are very similar, but the Superstreet intersection has an additional “break” for the through-moving traffic flows on the cross street, which allow independent operations for opposite intersections on the arterial street (see Fig. 14). Vehicles on the arterial street can perform direct left turns, whereas through-moving and left-turning flows on the cross street can make the maneuvers indirectly – by using directional crossovers (see Fig. 15).

Fig.14. Conceptual design of the Superstreet intersection [3]

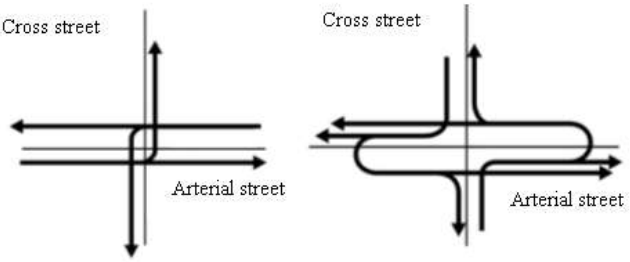

Fig.15. Transport flow movement routes for the arterial and cross streets [12]

The concept of the Superstreet intersection was introduced in 1987. Currently, there are very few completely constructed Superstreet intersections (see Fig. 17, 18) from which to gain conclusions about the operational activity of the current intersection type, although many elements used in the Superstreet intersections have been widely implemented in conventional intersections.

Fig.17. Superstreet intersection corridor in Brunswick County (North Carolina), USA [9]

In the Superstreet intersection design, a simple four-leg intersection is basically converted into two independent T-intersections. Due to the intersection’s ability to operate independently on opposite driving directions of the arterial street, an independent traffic signal cycle for opposite traffic flow directions (including, if necessary, different cycle lengths) can be applied. As a result, an efficient traffic flow distribution can be achieved for both traffic directions.

The correctly adjusted traffic signals of the Superstreet design also ensure relatively small travel time losses for the through-moving traffic flows on the cross street. The Superstreet design provides a safer (without crossing conflict points), but longer (two stages) intersection crossing path for pedestrians.

Fig.18. Superstreet intersection in Chapel Hill (North Carolina) [13]

In several studies the travel time was analyzed on arterial streets of the Superstreet intersections, compared to the corresponding conventional intersections and other unconventional intersections. The main advantages of the Superstreet intersection have been identified as:

1) reduced travel time for through movements on the arterial street;

2) reduced travel time for one pair of left-turning movements (usually on the arterial street);

3) coordinated through movements for both driving directions on the arterial street;

4) lesser level of threat for pedestrians;

5) smaller number of locally decontrated conflict points (see Fig. 16., Tab. 2.).

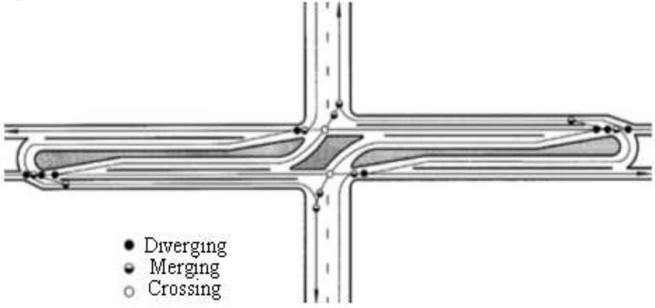

Fig.16. Conflict points at the Superstreet intersection [4]

TABLE 2

COMPARISON OF CONFLICT POINTS AT THE SUPERSTREET AND THE TYPICAL FOUR-LEG INTERSECTION

Conflict point type	4-leg signalized intersection	Superstreet intersection
Merging/Diverging	16	18
Crossing (Left turn)	12	2
Crossing (Others)	4	0
Total	32	20

Intersections with large amounts of through movements on cross streets are unsuitable for Superstreet design because of the “break” in the middle of the intersection, which might cause traffic congestion in the directional crossovers.

COMPARISON OF TRAFFIC CHARACTERISTICS IN UNCONVENTIONAL SIGNALIZED INTRSECTIONS AND STANDARD SIGNALIZED FOUR-LEG INTERSECTIONS

Methods of the study

The study provides the comparison of two types of unconventional intersections (the Median U-Turn intersection and the Superstreet intersection) with the corresponding conventional four-leg signalized intersections. Both of the analyzed intersections have the same number of traffic lanes.

During the study, the primary traffic quality characteristics and the levels of service have been determined for all of the analyzed intersections. Based on the obtained data, the conclusion has been made as to which of the analyzed intersections is more suitable for the current traffic flow distribution.

The traffic flow computer simulation (VISSIM) visualizations [3] created at the Maryland University have been used as input data for the study. The traffic flow in the given intersections is not affected by other intersections, and the analyzed intersections are not a part of a larger intersection system. Visualizations have been used to conduct the visual traffic counting and to measure the length of the traffic signal phases and cycles.

The visual traffic counting has been done according to method developed by Professor V. Siljanov [14]. Traffic intensities of all traffic flows and distribution of traffic flows at the intersections have been determined based on the traffic counting data. When determining the traffic flow intensities, the traffic flow was reduced to cars according to the method used in Germany for signalized intersections – Richtlinien für die Anlage der Lichtsignalanlagen [15].

The traffic flow intensities and the flow distributions determined for the unconventional intersections have also been used for the corresponding conventional intersections.

The traffic signal cycle and the phase lengths for the corresponding typical intersections have been determined according to recommendable values [15]. The three-phase traffic signal cycle with a protected left turn phase has been selected for the conventional intersections.

The operational efficiency of each of the analyzed intersections has been established by calculating the average vehicle delay time, the number of stops before the intersection and the congestion length.

The traffic quality characteristics have been calculated according to the method developed by Professor V. Brilon of Ruhr University [16]. LOS has been defined for all traffic flows in each intersection, based on the calculated traffic quality characteristics.

To determine the traffic quality characteristics for each intersection, it is necessary to calculate all of the needed traffic quality criteria.

The intersection capacity test has been done. Depending on the test results, an average length of congestion at the end of the green traffic phase (N_{GE}) has been calculated (see Formula 1).

Based on the congestion length, the main traffic criteria have been calculated – the average vehicle waiting time w (see Formula 2) and the average number of stops a vehicle has to make to cross the intersection (see Formula 3).

$$N_{GE} = 523{,}8 * q_i * (1{,}09 * x - 1 + \sqrt{(1 - 1{,}09 * x)^2 + \alpha * (1{,}09 * x - x_0)/(174{,}6 * q_i)}) \quad (1)$$

where
q_i – capacity of a signal group (veh/s);
x – average utilized capacity at the peak hour (veh/s);
α – criterion dependant on the number of lanes;
x_0 – capacity criterion (veh/h).

$$w_i = (C * (1 - \lambda)^2)/(1 * (1 - \lambda * x)) + N_{GE,i}/q_i \text{ (s)}, \quad (2)$$

where
C – total length of the traffic signal cycle(s);
λ – amount of green phase;
$N_{GE,i}$ – congestion length at the end of the green phase (veh).

$$h_i = 0{,}9 * (1 - \lambda)/(1 - \lambda * x) + N_{GE,i}/(q * C) \text{ (times)} \quad (3)$$

Based on the traffic quality criteria of each of the small intersection locations, the total intersection criteria have been calculated for each traffic flow by arithmetically summarizing the given criteria for each of the small intersections according to the operational conditions defined for the intersections. Based on the calculated criteria, LOS has been determined for each of the traffic flows.

The calculated results have been used to determine which of the analyzed intersections provides the best operational efficiency.

COMPARISON OF OPERATIONAL EFFICIENCY OF THE ANALYZED INTERSECTIONS

Comparison of efficiency of the MUT intersection and the corresponding conventional four-leg intersection

Analyzed intersections have two through-moving lanes, a right-turn lane and a left-turning lane on the arterial street and a through-moving lane, a right-turning lane and a left-turning lane on the cross street.

The examined intersections have large amounts of through-moving (2936 veh/h), right-turning (645 veh/h) and left-turning (394 veh/h) traffic flows on the arterial street and mediocre amounts of through-moving (287 veh/h), right-turning (251 veh/h) and left-turning (323 veh/h) traffic flows on the cross street.

During the study it has been determined that to ensure the sufficient LOS for the through-moving and right-turning lanes on the arterial street, when both intersections have the same traffic intensity and flow distribution, the traffic signal cycle length of the conventional intersection must be 36 % longer than the traffic signal cycle of the MUT intersection (see Fig. 19).

If an increased traffic signal cycle length is set for the conventional intersection, both conventional and MUT intersections ensure the same LOS for the through-moving and left-turning lanes on the arterial street (see Fig. 20).

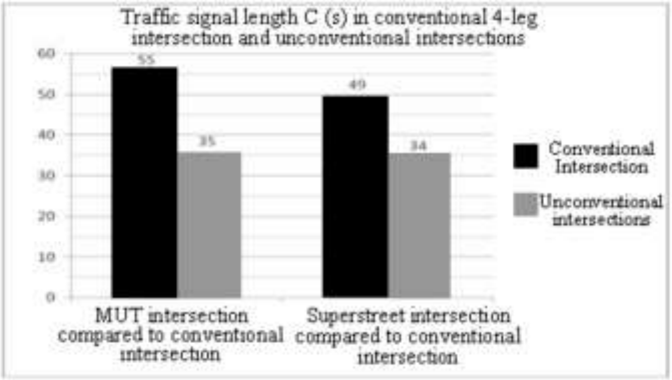

Fig.19. Comparison of the traffic signal cycle length for the typical four-leg and unconventional Intersections

The average waiting time (104 seconds) for the left-turning lanes on the arterial street in the conventional intersection corresponds to LOS F, which is completely unacceptable. Contrary to the conventional intersection, the MUT intersection for the left-turning lanes on the arterial street ensures an excellent vehicle average waiting time of 28 seconds, which corresponds to LOS B (see Fig. 20). In comparison it has been determined that the MUT intersection ensures 73 % less vehicle waiting time on the arterial than the conventional intersection.

Left-turning lanes on the arterial street of the MUT intersection ensure 90 % shorter congestion length at the end of the green traffic phase than the corresponding conventional intersection (see Fig. 21).

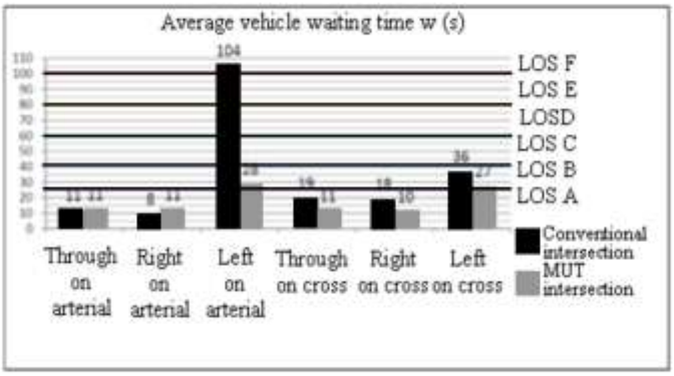

Fig.20. Average vehicle delay time at the MUT intersection and the corresponding typical four-leg intersection

The MUT intersection for all traffic flows on the cross street ensures the less average vehicle waiting time than the corresponding four-leg intersection.

The Average amount of vehicle stops and the average congestion length at the end of the green phase for the left-turning lanes on the cross street at the MUT intersection are slightly larger than for the corresponding four-leg intersection (see Fig. 21, 22), which can be explained by the need to drive through a larger amount of separate intersection places to make the required maneuver.

Although the amount of left-turning vehicles on the cross street is relatively large (37.5%), both intersection types on the cross street ensure good LOS.

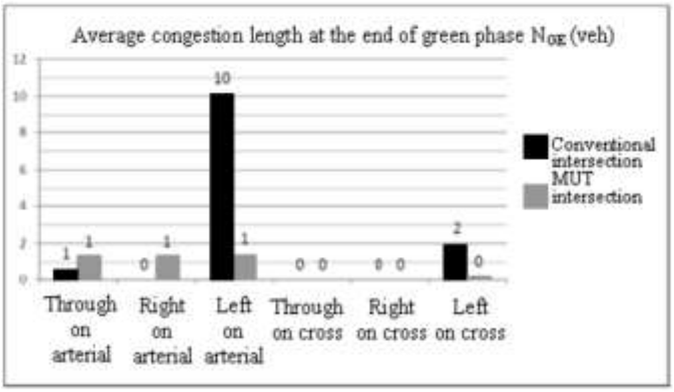

Fig.21. Average congestion length at the end of the green phase at the MUT intersection and the corresponding typical four-leg intersection

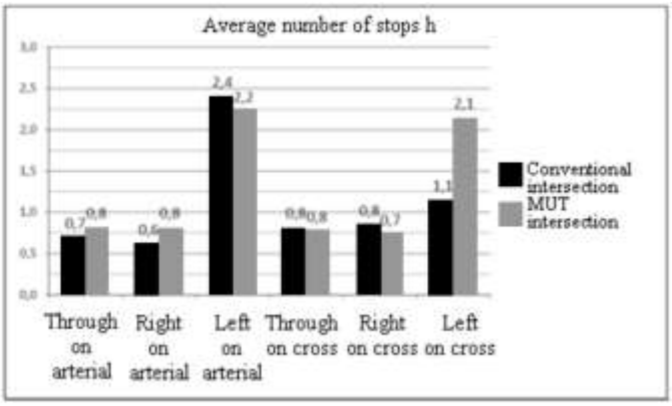

Fig.22. Average number of stops required for vehicle to cross the MUT intersection and the corresponding typical four-leg intersection

The operational efficiency of the conventional intersection on the arterial street, even in the conditions of a relatively small amount of left-turning vehicles (16 %), is unacceptable. As a result, the travel time increases significantly and congestions start appearing. The MUT intersection distributes the traffic flows as efficiently as on the cross street.

Completing the traffic quality characteristics analysis, a conclusion has been made that the MUT intersection ensures better operational efficiency than the corresponding conventional four-leg intersection, which is determined by the shorter traffic signal cycle length and the average vehicle waiting time.

Comparison of efficiency of the Superstreet intersection and the corresponding conventional four-leg intersection

The analyzed intersections have two through-moving lanes, a right-turning lane and two left-turning lanes on the arterial street, as well as a through-moving lane, a right-turning lane and a left-turning lane on the cross street.

Examined intersections have large amounts of through-moving (2232 veh/h), right-turning (372 veh/h) and left-turning (912 veh/h) traffic flows on the arterial street and mediocre amounts of through-moving (290 veh/h), right-turning (414 veh/h) and left-turning (537 veh/h) traffic flows on the cross street.

To provide the average waiting time which does not significantly exceed the lower limit of LOS F for the left-turning lanes on the cross street, while ensuring the acceptable LOS for all other traffic lanes, the traffic signal cycle of the conventional intersection must be by 31% longer than that of the Superstreet intersection (see Fig. 19).

If an increased length of the traffic signal cycle is set for the conventional intersection, both the conventional and the Superstreet intersections ensure the same LOS for all traffic lanes on the arterial street (see Fig. 23.).

The conventional four-leg intersection does not ensure the acceptable LOS for the left-turning lanes on the cross street (see Fig. 23). The Superstreet intersection ensures the average LOS (LOS C) for all traffic lanes on the cross street and the equally good intersection capacity.

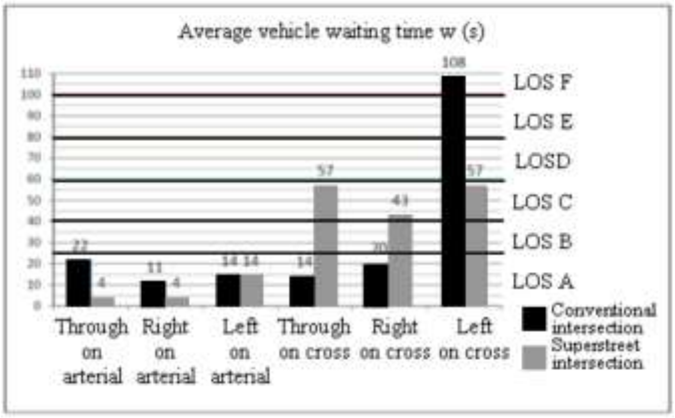

Fig.23. Average vehicle delay time at the Superstreet intersection and the corresponding typical four-leg intersection

The Superstreet intersection has the slightly higher average amount of vehicle stops but the lower average congestion length at the end of the green phase for the left-turning lanes on the cross street (see Fig. 24, 25), which can be explained by the need to drive through a larger amount of separate intersection places to make the required maneuver. However, in normal traffic conditions, there will be no traffic congestions at these intersections.

Both intersections ensure excellent LOS on the arterial street in the conditions where there is a medium amount (23.5%) of left-turning vehicles. The operational efficiency of the conventional intersection on the cross street in the conditions of large amounts (43.3 %) of left-turning vehicles is unacceptable. This situation creates a considerable misbalance in the intersection capacity for different lanes. The Superstreet intersection, on the other hand, ensures moderately good, economically effective and balanced traffic conditions.

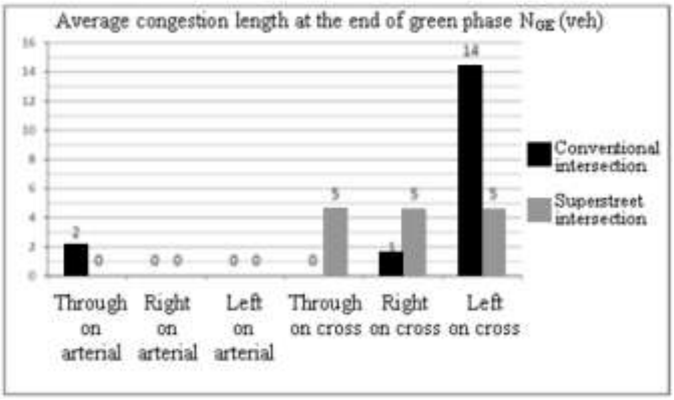

Fig.24. Average congestion length at the end of the green phase at the Superstreet intersection and the corresponding typical four-leg intersection

Completing the traffic quality characteristics analysis, a conclusion has been made that the Superstreet intersection ensures better operational efficiency and higher levels of service than the corresponding conventional four-leg intersection, which is determined by the shorter traffic signal cycle length and the average vehicle waiting time.

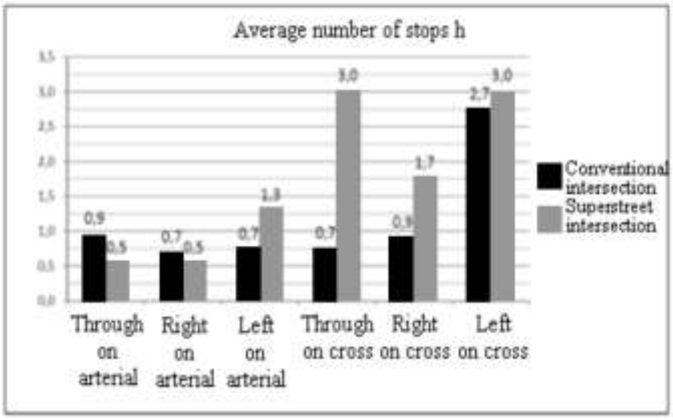

Fig.25. Average number of stops required for a vehicle to cross the Superstreet intersection and the corresponding typical four-leg intersection

CONCLUSIONS

In all analyzed traffic conditions unconventional intersections ensure better intersection efficiency than the corresponding conventional four-leg intersections.

Unconventional intersections provide acceptable LOS for all the test flows by locally redistributing and deconcentrating the traffic flows with the help of multiple coordinated intersection places.

Although in some situations they increase the amount of the vehicle stops required to make the maneuver for certain flows (see Fig. 22, 25), the average congestion length and the vehicle waiting time for these flows is maintained within the acceptable limits.

The MUT intersection increases the amount of the required vehicle stops for the left-turning vehicles on the cross street to ensure acceptable LOS for the left-turning vehicles on the arterial street.

The Superstreet intersection slightly deteriorates all traffic quality parameters for the through-moving vehicles on the cross street to ensure better LOS for the left-turning vehicles on the cross street.

Both of the unconventional intersections ensure the acceptable levels of service for all traffic flows in the condition of a similar total intersection traffic intensity (q_{sum} = 6700 – 7200 veh/h) (see Fig. 26.). In these traffic conditions, the corresponding conventional intersections can not ensure the acceptable levels of service for all traffic flows. A conclusion can be made that the analyzed unconventional intersections have a larger total intersection capacity than the corresponding conventional intersections.

The MUT and the Superstreet intersections are more suitable for the traffic conditions with a large traffic intensity on the arterial street and a relatively small traffic intensity on the cross street. The analyzed unconventional intersections in traffic situations with small or medium amounts ($q < 800$ veh/h) of left-turning vehicles on the arterial and cross streets, large amount ($q = 2200 – 2800$ veh/h) of through-moving vehicles on the arterial street and small amount of through-moving vehicles on the cross street ensure higher LOS than the conventional four-leg intersections.

Analyzed intersections ensure better LOS for the traffic flows on the arterial street than for the traffic flows on the cross street. This conclusion conforms to the theoretically described one of the basic operational principles of the unconventional system intersections – main function of unconventional arterial intersections is providing optimal traffic conditions for through-moving traffic flows on the main arterial streets.

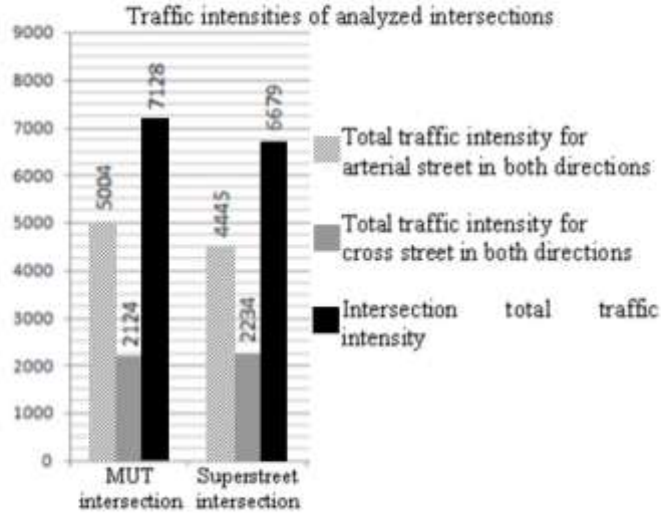

Fig.26. Traffic intensities of the analyzed intersections

The MUT intersection ensures an equally good intersection capacity for left-turning traffic flows on both arterial and cross street. The Superstreet intersection is better suited for larger amounts of left-turning vehicles on the arterial street. The average waiting time for the left-turning vehicles on the cross street at the Superstreet intersection is longer than at the MUT intersection.

Unconventional intersections are more efficient than conventional intersections. Each type of unconventional intersections is suited for the specific traffic conditions, and, depending on the particular traffic situation at the intersection, the right type must be chosen to guarantee the most appropriate traffic conditions at the intersection.

The MUT intersections are suitable for the conditions of approximately equal amounts of left-turning vehicles on the arterial and cross streets. The Superstreet intersections are suitable for the conditions of larger amounts of left-turning vehicles on the arterial street than on the cross street.

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Reinis Kivliņš. Netipisku regulējamu vienlīmeņa ceļu mezglu analīze

Mūsdienās Latvijā vērojams ceļu būvniecībai atvēlēto līdzekļu samazinājums. Vienlaikus paaugstinās automobilizācijas līmenis un satiksmes intensitāte, kas Rīgas maģistrālajās ielās izraisa biežus sastrēgumus. Šādos apstākļos pasaulē sastopamie netipiski regulējami ceļu mezgli kļūst aktuāli arī Latvijā. Rakstā apskatīti Sadalošās joslas – apgriešanās vietas un *Superstreet* tipa mezgli. Analizēta literatūras avotos pieejamā informācija par netipisko mezglu īpašībām un ekspluatācijas pieredzi pasaulē. Apskatīta netipisku mezglu izmantošanas lietderība dažādos satiksmes un apbūves apstākļos, salīdzinot tos ar standarta vienlīmeņa ceļu mezgliem. Pētījuma ietvaros veikts aprēķins, lai salīdzinātu satiksmes kvalitātes galvenos raksturlielumus netipiskos mezglos un atbilstošos standarta četrzaru mezglos. Satiksmes kvalitātes galvenie raksturlielumi tika noteikti pēc Rūras Universitātes profesora V. Brilona izstrādātās metodikas. Darba gaitā noteikts, kurš no apskatītajiem mezgliem nodrošina vislabāko satiksmes ērtības līmeni un darbības efektivitāti.
Pētījuma rezultātā tika izdarīts secinājums, ka SJAV un Superstreet mezgli ir piemērotāki izmantošanai potenciālo krustojumu vietās ar lieliem apjomiem pa galveno ielu braucošu transportlīdzekļu un salīdzinoši nelieliem apjomiem pa krustojošo ielu braucošiem transportlīdzekļiem. Netipiskie mezgli visu virzienu transporta plūsmām nodrošina labākus satiksmes ērtības līmeņus nekā atbilstošie standarta mezgli pie salīdzinoši nelieliem (q < 800 vtrl/h) pa kreisi griezošu un pa pakārtoto ceļu caurbraucošu transportlīdzekļu apjomiem un lieliem (q = 2200 – 2800 vtrl/h) pa galveno ceļu caurbraucošiem transportlīdzekļu apjomiem. Superstreet mezgli ir piemērotāki mezgliem, kur pa kreisi nobraucošās transporta plūsmas ir ievērojami lielākas par pa kreisi uzbraucošajām tranportlīdzekļu plūsmām.

Рейнис Кивлиньш. Анализ нетипичных регулируемых одноуровневых развязок автомобильных дорог

В наши дни, в связи с уменьшением средств, предназначенных для строительства дорог, и увеличением числа транспортных пробок на магистральных улицах городов, нетипичные регулируемые развязки автомобильных дорог становятся очень актуальными и в Латвии. В статье рассмотрены два нетипичных узла – узел разделительной полосы – поворотного маневра, и узел типа *Суперстрит*. Произведен анализ информации, доступной в литературных источниках, данные о свойствах и эксплуатационном опыте нетипичных регулируемых одноуровневых развязок автомобильных дорог и рассмотрена рациональность их применения при конкретной застройке и транспортной ситуации. Произведено исследование с целью сравнения главных параметров дорожного движения в нетипичных регулируемых развязках и в соответствующих типичных регулируемых развязках. Главные параметры дорожного движения анализованных нетипичных регулируемых развязок вычислены, используя методику, разработанную професором В. Брилоном из Рурского университета. В исследовании определено, которая из рассмотренных развязок при данном распределении транспортных потоков и интенсивности дорожного движения обеспечивает лучший уровень удобства дорожного движения и рабочей эффективности.
В ходе исследования сделан вывод, что узел разделительной полосы – поворотного маневра и узел типа *Суперстрит* лучше всего подходит к использованию на перекрестках с большими объемами транспортных потоков на главной дороге и сравнительно малыми объемами транспортных потоков на второстепенной дороге. В транспортных условиях с малыми объемами (q < 800 трс/ч) налево поварачивающих и прямолинейных транспортных потоков на второстепенной дороге и большими объемами (q = 2200 – 2800 трс/ч) прямолинейных транспортных потоков на главной дороге нетипичные развязки всем транспортным потокам обеспечивают лучшие сервисные уровни, чем соответствующие типичные развязки. Узлы разделительной полосы – поворотного маневра являются более подходящими для перекрестков со сравнительно равными объемами налево поварачивающих транспортных потоков на главной и второстепенной дороге. Узлы типа *Суперстрит* являются более подходящими для перекрестков, в которых объемы налево поварачивающих транспортных потоков на главной дороге гораздо больше, чем на второстепенной дороге.