Road Line Traffic Control System - Experiences in testing operation

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ABSTRACT
One of the most significant road structures completed in 2010 was the construction of southern part of the Bypass around Prague (BPAP), where technological equipment was designed and installed and Road Line Traffic Control system implemented. In the Czech Republic is this system is absolutely innovative and brings new organizational and regulation elements into operation. The system is primarily intended for traffic flow harmonization. It is based on usage of variable message signs to affect the traffic flow so the fluency, security and communication permeability is increased. Thank to automatic speed reduction by defined traffic data is traffic flow is more fluent, distances between vehicles are smaller and throughput of communication increases. RLTC system can identify traffic excesses on communication thanks to vehicle queue detection.

All algorithms were designed and tested under project of science and research of Ministry of Transport of the Czech Republic, project INEP, n. CG944-033-120 (inep.eltodo.cz). In current time testing operation on BPAP and on a part of D1 Highway is proceeded. System is monitored and all functionalities are evaluated for further debugging and adaptation of system for local conditions.

KEYWORDS: Road Line Traffic Control System, highway, traffic flow, harmonization

1. Introduction

Outstanding increase of traffic volume during the last years reflects in more often traffic congestions. Their sources are besides high traffic loads both incidents, which substantially increase the risk of traffic accidents.

Last year a long-awaited construction of the southern part of Prague Ring road was completed in the Czech Republic. This built has significant importance not only in terms of Prague city area, where significantly decreases traffic, but for entire state because of cross connection of important highways. Traffic forecasts predicted traffic load up to 60 000 vehicles per day at this important construction. For this reason the first Road line traffic control system in the Czech Republic was installed at the southern part of Ring road and part of D1.

General supplier of the technological equipment was ELTODO group, which has an experience with similar implementations. It supplied Road Line Traffic Control System, Tunnel control system and technological equipment in tunnels and highway technological equipment. Southern part of RRAP measures 30 km. during the construction was necessary to build 70 bridges in total length of 6,7 km, two road tunnels Cholupice and Lochkov with length 1937 m and 1661 m. Road Line Traffic Control System is installed in both directions on RRAP marked as motorway R1, between intersections with D1 and D5 highways and on D1 highway between intersections Mirosvice and RRAP.
2. Road Line Traffic Control principle

Road Line Traffic Control System (RLTC) was supplied for open route and cooperates closely with control systems of both tunnels. Based on measuring traffic flow parameters system affects flow fluency, increases communication permeability and security of traffic flow. Based on timely provision of information drivers may adapt their driving way and substantially reduce the risk of traffic accidents.

2.1 Range of functions

In cases when the situation requires, variable message signs (VMS) with warning symbols, prohibitory signs limiting maximum allowed speed or prohibiting drive of trucks outside of right lane are displayed on control profiles of RLTC system. Important parts of each control profile (RLTC Gantry) are detectors measuring volume, speed, traffic flow composition and other parameters. Based on these data system is able to perform these proceedings automatically, without system operator intervention.

Thanks to RLTC system it is possible to extend highway capacity during the peak hours and reduce creation of congestions, which often causes traffic accidents. During high traffic volumes “Stop and Go” waves occur, which are typical with high differences in speeds in the downstream sections. Consolidation of these speeds on the same level reduces accumulation of these waves together with increasing communication permeability. At lower speeds spaces between vehicles are minimized which leads to higher road capacity. The traffic flow harmonization is assured by Road Line Traffic Control system by reducing maximum speed using variable message signs (VMS) installed on control profile gantries, which are located on regularly spaced locations. Further RLTC system detects formation of vehicle queue and warns concerned drivers against these drivers using VMS. Another important feature is warning against meteorological states inconvenient for traffic and based on dangerousness traffic flow speed is reduced. In this case system collects data from meteosensors on the highway, which are automatically processed and evaluated. Of course there is a warning before accident, work or obstacle on the road, for example debris or animals. In case of restrictions on driving in selected lanes it is possible to activate light arrow, which ordered to leave the driving lane.

2.2 Control Algorithm

All algorithms were designed and tested under project of science and research of Ministry of Transport of the Czech Republic, project INEP, n. CG944-033-120, whose main solutionist is ELTODO group. During the
Traffic solution design algorithms were applied on particular conditions and in some cases were modified based on experiences from real operation.

Together with algorithms for evaluation of untypical traffic states was necessary to develop principles of application of single action on multiple sections simultaneously. Traffic precaution is applied on one particular profile or a group of profiles, but during operation there are situations, when it is necessary to combine more precautions together with preserving the rules of reducing speed on highways and avoiding to display speed steps on subsequent profiles. In order to avoid step changes of speed, which has negative influence on flow fluency, special smoothing algorithms were developed. Smoothing algorithms manage displayed symbols in consecutive profiles with regard to exact profile location on the route.

Finally, it is necessary to activate the maximum speed limits in time shifts instead of simultaneously. This provides so-called dynamic sequences, which reduces speed on requested level in the shortest time so that drivers actually moving on route are not forced to slow down sharply on low speeds. RLTC system doesn’t forget on extreme event of driving in inverse direction. Although this is not very frequent, but may have fatal consequences. In case of detected inverse driving event, RLTC system automatically detected and evaluated this accident and slowed down traffic both on profile close to accident and on previous profiles. Operator both reacted to this state by finding accident source thanks to video surveillance by sending police patrol to the accident and supplemented speed symbol on gantry.

Information between these systems must be shared with regard on a good coordination of all precautions.

Road line traffic control system is connected to newly constructed supervisory centre SSUD Rudná, where proceeds uninterrupted surveillance of the completed part of the Prague ring road. Systems are monitored and during test operation are adjusted for having most fluent and safety traffic.

3. Results from operation

RLTC system is in operation more than half year and during this time its function is very carefully controlled and results are examined by representatives of both the National highway provider (ŘSD) and by our company. With regards to complexity of system and quantity of its functions number of parameters can be evaluated.

3.1 Traffic harmonization

Main parameters for traffic flow harmonization are speed and traffic volume. These parameters are showed in Fig. 4. RLTC system functionality is clear from upper bold red line, which shows adjustment of maximum allowed speed in time. From traffic volume graph is nicely visible day flow including morning and afternoon peak hours. Because of high traffic volume before eight o’clock was during morning peak hours the maximum allowed speed was reduced to 80 km/h and after volume decrease at 8:30 a.m. was increased.

From further detail speed evaluation in driving lanes explicitly results, that most of drivers respect actual traffic notation on VMS and differences between lanes are minimal. This is apparent from speed flow showed with orange spline in Fig. 4. Traffic is effectively homogenized and beyond ensuring smooth traffic flow and extended road capacity the risk of traffic accidents is substantially reduced.

3.2 Emergency situations

During the system operation also such situations happened, when system reacted to occurred situations much earlier than surveillance operator, who is warned on exceptionalities by this system. It sometimes happens, that drivers are forced to react to small traffic accident event by speed reduction. RLTC system automatically detected and evaluated this accident and slowed down traffic both on profile close to accident and on previous profiles. Operator both reacted to this state by finding accident source thanks to video surveillance by sending police patrol to the accident and supplemented speed symbol on gantry.

Fig. 4. Volume and speed evaluation included adjustment of maximum allowed speed from 24th February 2011 on RLTC Gantry on R1 17 km right

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profiles by warning symbol on VMS. Thanks to this proceeding risk of another accident was substantially reduced by preserving traffic flow continuity and speeded up liquidation of incurred situation.

4. Conclusion

Although the RLTC system is brand new issue in the Czech Republic, despite the generally lower respect of Czech drivers on VMS road signs, we can see its big benefits. Homogenization of traffic flow by speed limits is explicitly positive and risk of traffic accident is further reduced by activating warning symbol on VMS. An important factor influencing the proper system functionality is operator, who confirms selected events and sets other setting directly into the system. Overall, we can say, that system performs its function, and significantly contributes to rising traffic flow fluency and safety. The trend of steadily increasing traffic volumes, both financial and time-consuming constructions of new highways, and finally increasing demands for transport security, we can assume, that telematics systems for increasing throughput and safety of routes will continue to be developed and improved.

Bibliography