Issues of using Longer Heavier Vehicles on Roads

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Issues of using Longer Heavier Vehicles on Roads

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Abstract. Many logistics companies aim to save on freight costs. Recently, not only on Czech roads and on motorways, longer and heavier vehicles that exceed dimensions' limits appeared. For these vehicles, it is necessary to apply for a special permit, which is, however, much more liberal than the permit for oversized and overweight load transport. This paper informs about checking routes of these vehicles by swept path analysis and finding locations on roads that can generate both safety risks and traffic fluency problems.

1. Introduction

Companies are trying to save their costs when transporting freight, which is the reason why we have more and more frequent encounters with vehicles exceeding weight and dimension maximum allowed limits on the motorway and road network. Thanks to these vehicles, road and motorway pavements are being damaged faster and the necessary repairs of the roads are required more frequently. "The crossing of one axle of 10 t has approximately the same effect as 125 axle crossings of 3 tons" [1]. The damages done by overloaded trucks are mainly ruts or longitudinal depressions. According to the Act 13/1997 Coll. on Roads as amended is a fine for exceeding the permitted values during the weighing control from CZK 15,000 to CZK 500,000 [2].

The possibility to increase the statutory limits is an oversized and overweight load transport vehicle in accordance with Act No. 341/2002. However, obtaining a one-off permit is a relatively demanding process and has a number of conditions (such as transport escorts) that have to be met to pass through. That is why companies have recently begun to use an intermediate level between standard freight transport and oversized load transport. Using vehicles exceeding the permitted dimensions, but all other parameters are in accordance with the legal conditions. There is no uniform name for heavy long cargo vehicles; they are called Road Train, LCV, LHV (Longer Heavier Vehicle), Gigaliner, EuroCombi or Megatruck, but there are many others. In the Czech Republic the maximum allowed length of the road vehicle is 22 m, LHV usually has 25.25 m [3]

For these vehicles, the weight of the load is distributed between more axles, and therefore the axle pressure on the road is much smaller. Using LHV will due to that save not only the costs of the number of used vehicles and drivers for transport, but also the costs of repairing damaged roads. With the LHV, every third ride is saved comparing to a standard heavy truck, but it is worth mentioning that it will increase the investment in the trailer and suspension equipment and will increase the fuel consumption by 15 to 20%, but the transport costs are still lower than using ordinary heavy truck [3].

When using LHVs, however, there is a problem with their dimensions, as most junctions on the motorway and road network are not designed to enable passing such long vehicles. This paper deals with the issue of passing LHVs through selected junctions using swept path analysis.

2. Formatting the title, authors and affiliations

The use of LHVs is common in the US, Canada, or Australia, where lengths of such LHVs are up to 50 m and weight up to 100 tons. In most European countries, however, they are forbidden or allowed only as exception with necessary permit. LHVs are permitted in Scandinavia and the Netherlands, their permitting is considered in Belgium [3].

The Ministry of Transport grants permissions for such vehicles longer than allows the Decree on Technical Approval and on Road Vehicle Technical Conditions No. 341/2014 Coll. Operators of these vehicles must submit application. Permitting conditions include the static test, i.e. the inspection of individual vehicle parts with a focus on the coupling. The maximum weight must not exceed 48 tonnes. The LHV may only use directionally divided roads and the arrival at the point of loading or unloading must be within 10 km of the motorway and the route must not intersect with the railroad at-grade.

After fulfilment of all requirement and payment of administrative fee of 6,000 CZK, the license to operate LHV is granted for a maximum of 3 months. [4] By September 2017, the 46 LHVs were allowed to operate.

Many initiatives are against the inclusion of extra-long trucks into normal traffic, including railway organizations. The most common reason is that the LHVs are non-ecological because their permission would bring an even greater freight transport from trains and boats to roads. Traffic safety may also be a problem, for example overtaking LHvs may be a problem or driving in urban areas. The question is also the unsatisfactory infrastructure and the high cost of its rebuilding, like the construction of parking lots with different parameters or the reinforcement of the bridges [3].

3. Analysis of critical location

During the task, critical locations were identified on the routes of these vehicles. Swept path analysis was done by using the AutoTURN software created by Transoft Solution. Swept paths are enveloped by curves that result from the vehicle's external contours and axles' position. Their particular shape, depends on the position and layout of the axles, on the position of the coupling points, on the type of trailer and, to a great extent, on the assumption of behaviour of the drivers.

3.1. Vehicle used for simulation

One of the companies producing such vehicles is Krone. Company Hesti, the importer of Krone vehicles to the Czech Republic, provided detailed drawings of their LHV for this paper.

The vehicle assembly consists of a 10.17 meter truck with a 13.65 meter long trailer coupled by a drawbar, a clear gap between cargo spaces is 1.10 meters. The width of the vehicle without mirrors is 2.55 meters with a total height of 4 meters. The vehicle is 24.92 meters long when connected. The internal radius of rotation is 5.3 m and the outer radius of rotation is 12.5 m.

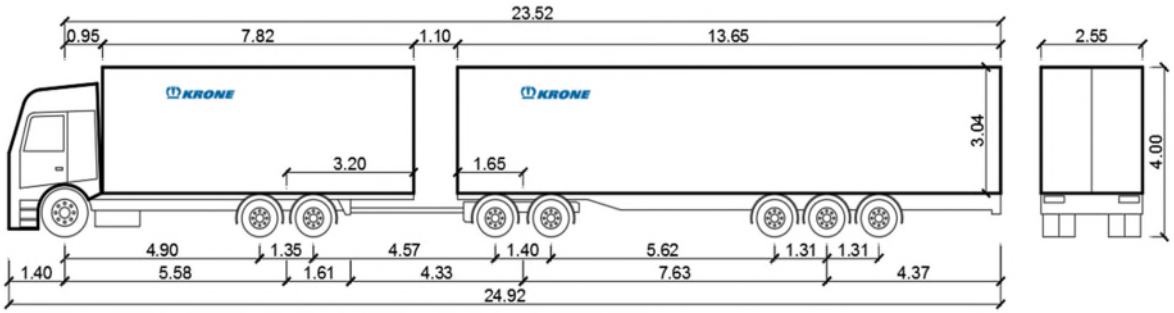

Figure 1. KRONE LHV dimensions.

3.2. Critical locations

Approximately 40 critical locations were selected, located on our well-known LHVs' routes, and located also on the important nodes of the Czech Republic's road network, such as arrivals to production halls or airports.

Figure 2. Selected interchanges and intersections.

3.3. Inputs of simulation

At junctions, the emphasis was on the requirements of the Police of the Czech Republic, which in most cases do not allow the overhanging of the swept paths to the opposite traffic lane or the contour of the body outside the pavement. Overlaps are only allowed in the case of oversized or excessive loads under a special permit. However, these types of vehicles are not considered.

In addition, the rounding of the pavement at intersections, the widths of traffic lanes in the curves, the width of the pavement at the point of directional islands were examined. Width of the lanes, ring's width, ramps' width and roundabout junctions.

Vehicle characteristics in the software were set according to the production drawings provided by the vehicle manufacturer, and a speed of 15 kmh^{-1} was set as the driving speed for the LHV, without the possibility of turning the wheels at zero speed. 20 different simulations were performed at each junction for each movement, and the individual differences in the problem spots were then averaged.

3.4. Analysis evaluation

Of all the examined junctions, the following examples appeared to be interesting, demonstrating problematic locations at junctions. The first example is the intersection of the Svedske valy street and Vlastimila Pecha street in Brno city, which is located in a technology park that grows every year with new companies. If the LHV's effort is to stay in its traffic lane and not to interfere with other traffic lanes, there is a problem with the right turning, where the vehicle interferes the pedestrian lane, exactly on the pedestrian crossing. The overhang of the pavement is up to 1.5 m. If the LHV tries to avoid walkways, which is more likely solution, it will have to use the space of other traffic lanes, which will increase the risk of traffic accidents.

A similar example is another roundabout junction at the intersection of road II/183 and B. Nemcova street in Rokycany city, which is located near the industrial area and transfer the traffic from the D5 motorway to the area. There is a similar problem as in the previous case, the LHV is forced to drive over the sidewalk to miss the dividing island at the pedestrian crossing.

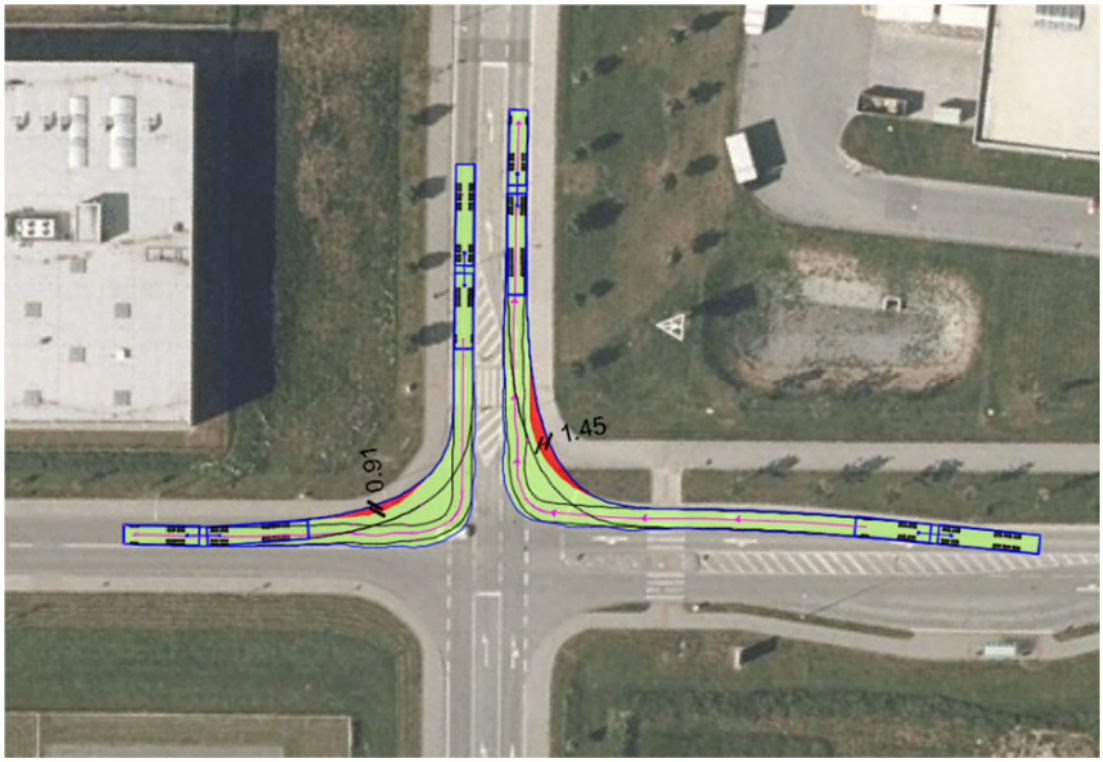

Figure 3. Intersection of Svedske valy street and Vlastimila Pechy street in Brno city.

Figure 4. Roundabout junction of road II/183 and B. Nemcova street in Rokycany city.

Another example is a set of intersections near the Skoda Auto complex in Mlada Boleslav city. There is a roundabout junction and a turbo roundabout junction. At an interchange junction, designed according to CSN standards, there was no problem with the passing of LHV. At the roundabout junction, which has two traffic lanes, there was a significant interfering of LHV from one traffic lane to another, up to 3 meters. However, this type of roundabout junction with two traffic lanes is not

suggested to use in the Czech Republic, as drivers do not use the potential of the second lane. Therefore, interference with the minimally used second lane does not mean a very high safety risk due to the minimal traffic intensity on the second traffic lane.

Figure 5. Roundabout junction of road I/38 and Škoda Auto's grounds road in Mlada Boleslav city.

However, the turbo roundabout intersections can be a major safety risk, where the inner lane is used to a by much higher percentage of vehicles. Such a junction is in Figure 6, where the LHV overlaps to the adjacent traffic lane by width of up to 3 m.

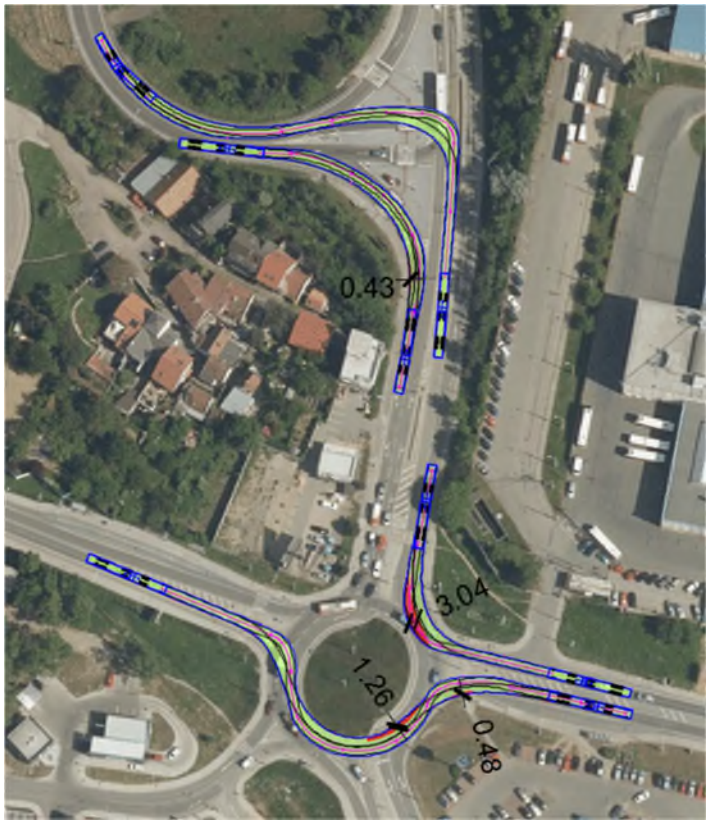

Figure 6. Roundabout junction of road II/430 and road I/50 entry ramp.

4. Conclusion

In the case of interchange junction, it is possible for LHV to pass through both directional and non-directional ramps without any problems, but the problems arise at intersections. At these places, when turning right the rear part of the LHV gets over the edge of the pavement, even when comfortable radius of corner rounding is used and vehicle is not entering opposite traffic lane. Overlap of the vehicle at selected intersections was up to 1 meter. A slight improvement occurred where compound curve is used to round the edge of pavement, but even in that cases the outline of the vehicle sometimes exceeded the pavement. The possibility is to allow LHVs to enter the opposite traffic lane, which, however, generates safety risk and worsen the traffic flow of the junction during not-restricted traffic.

The LHVs passing is also not being easy due to dividing and directional islands. Which, for normal traffic, regulate traffic and improve the junction clarity. Islands also prevent oversized vehicles to adjust the trajectory, so that the rear part of the vehicle can stay on the pavement or in case of left turn do not hit the traffic island itself.

Another problem occurred at roundabouts especially on the spiral (turbo) roundabout arrangement where the LHV overlap to the next traffic lane, which again causes a safety risk and slows the traffic flow of the junction.

The solution to these problems is to change the design elements of the junctions, like changing the approach to directional islands design, roundabout intersections and lane widths. However, this change would subsequently affect the driving habits of other drivers, who could then pass the junctions at greater speeds while rising traffic safety risks.

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