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Measurement of Lateral Distance of Vehicles while Avoiding Bicycles and Speed of Bicycles in Road Traffic

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Abstract: ***Aim of the article is to deal with the issue of cycling traffic in urban traffic on a particular model situation. At the same time, characteristic features of cycling are explained. A number of factors affect the cyclist as a road user when driving in traffic, which in the end is particularly manifested by accidents. The article analyzes research, which aims to perform partial measurements that clarify characteristics of the cyclists´ movement characteristics in a particular urban traffic and partial measurements are processed using the model situation. The research sample presents accidentally cruising vehicles, cycling speed and model situation.***

Keywords: cycling transport, motion of cyclists, research, model situation

1. Introduction

With increasing standard of living, the need for people to transport to the destination as quickly and economically as possible is increasingly linked. Over the last decades, people's physical activity, both pedestrian and cycling, has been greatly reduced. As a result, the physical and mental state of population is deteriorating and, of course, negative impact on environment is also present. In developed countries, therefore, emphasis is placed on the development of environmentally friendly modes of transport. These countries have developed non-motorized traffic, mostly cycling. For example, in the Netherlands, the proportion of cycling is 35 to 40% out of all journeys. The development of cycling is supported by all interested institutions in order to ensure the sustainable development of mobility. This will require greater support for cycling. The aim is to equalize cycling with other types of transport so that it becomes a fully fledged part of urban transport. Cycling should become an equivalent transport and cyclists should be a fully fledged road users. It should be noted that if cycling is not determined by special lanes and is implemented in road traffic together with motor vehicles, there are certain risks arising from differences in the characteristics of motor vehicles and their movement and the cyclists and their movement. Approximately half of cyclists killed each year on European roads are recognized as the offenders of road accidents in which deaths have occurred, if total number of accidents include accidents resulting from the crash of a bicycle with a pedestrian.

2. Characteristics of riding a bicycle

Direction of motion

The cycling movement consists of the so called microwaves and macrowaves. The measurements, the he made showed that the trajectory - of macro wave, its wavelength, and amplitude can be affected by his own will. He called microwave the bicycle and its oscillation around the trajectory of motion and is influenced by the style of ride, terrain profile, pedaling frequency, surface roughness, or weather conditions.

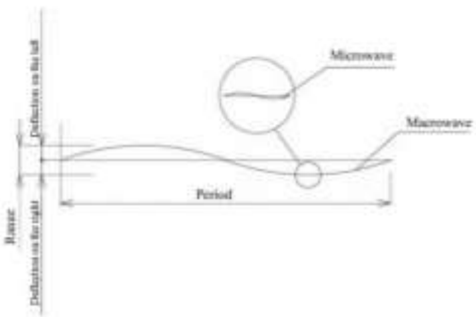

Figure 1: Shows characteristic movement of the bicycle

The size of the transverse deflection, as shown by research, is the sum of amplitude macro and microwaves and was determined by the range of experienced cyclists of 0.5 m and by less experienced cyclists and children of 1.5 m. The size of the transverse deflection is the sum of both sides of amplitudes from the motion axis when watching the ride ahead. Another significant increase is when a cyclist watches traffic in that moment, when he turns his head back. Experienced cyclists may increase this by 1 meter and less experienced cyclists by up to 2 meters. Another factor that also affects the size of microwaves amplitude is speed of a cyclist. When riding downhill, if the speed is more than 15 mph and without pedaling the micro deflections almost disappear, and the trajectory of motion is in this case characterized by a extending macro wave.

Unexpected relocation of a cyclist.

The cause may be psychic, cyclist will be scared of vehicle that overtakes him, or of the road user or to avoid obstacle. Another cause may be the aerodynamics of overtaking vehicle. A very important term in mentioned area is so-called aerodynamic resistance. It is a resistance against the movement of vehicle and at a speed of 40 mph, it prevails over the rolling resistance. Aerodynamic resistance can be divided into several parts. For this issue, the most important is induced resistance. It is the result of aerodynamic buoyancy, which makes the air move from a higher area to a lower pressure area. By connecting the air flow moving on

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the side of the bodywork and the air flow below the vehicle, side vortices are created.

Their intensity and size depends mainly on bodywork shape and vehicle speed. The figure shows the induced resistance on the side of the motor vehicle. This resistance may interfere with cyclist´s stability in the event of insufficient lateral separation from the cyclist.

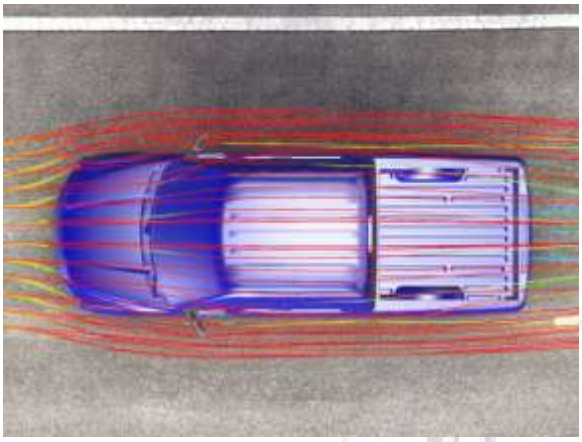

Figure 2: Aerodynamic induced vehicle air resistance

3. Necessary and Safe Distance of Vehicles

a) Necessary lateral distance between cyclist and overtaking motor vehicle - this is the distance between overtaking vehicle and cyclist, in which the cyclist will not be at risk and at the same time feel no risk, that is, a distance where no danger arises, neither direct or of psychological reasons. This particular distance depends on trajectory of movement of the two passing road users, vehicle and cyclist and their aerodynamics and psychics.
b) The safe lateral distance between cyclist and overtaking vehicle - is such a distance that will always be greater than the necessary lateral distance. It depends on the same factors as necessary distance, but here is added dependency on transverse relocation (e.g. looking back, avoiding an obstacle, get scared) and eventually fall of a cyclist.

4. Measurements Made

4.1 Determining the distance between vehicles in road traffic

When measuring, we focused on the lateral distance of motor vehicles from cyclist when moving in city traffic. We made measurements during holidays due to assumed higher road safety and lower frequency of motor vehicles on the road. Within measuring itself, we used basic devices for measuring lateral distance of motor vehicles, such as graphical representation of the line by chalk on the road in the required spacings, so as to determine which of the vehicles adhere to a lateral distance of 1 meter from vehicle and which not. The original intention was to carry out the measurement in motion to record more relevant values. In our first attempt to measure lateral distance of the motor vehicle, this attempt failed. Despite the fact that using of Bosch Measuring Laser Device was highly sophisticated and the meter was set to full automatic, electronics of the measuring instrument were not fast enough to record overtaking vehicle in the ride. That's why we've made the measurement simple. We used the person as a figurine simulating a ride on a bicycle, so that we were at the roadside and the measurement was done in a static way. The distance we identified as the corridor we would move when riding was set at one meter from the roadside (defined by 2 green lines, Fig. 3).

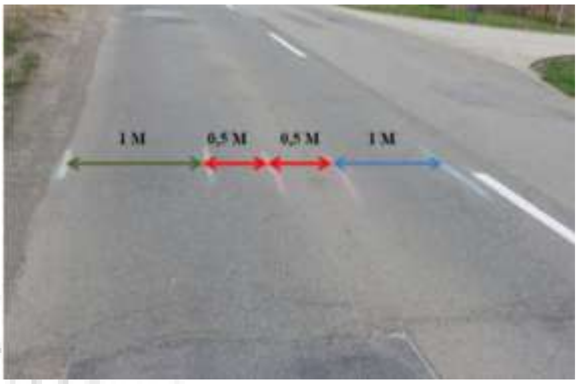

Figure 3: Defined distances

We derived this dimension from the width of handlebars (46 cm) and estimated macro wave at which the cyclist moves when riding on straightaway. Accurate determination of macro and microwaves is very difficult. And that for a few reasons. Of course it is about the experience of a cyclist and his holding of the body, setting and type of bicycle, physical fitness, side or impact wind. The possibilities are countless and determination of exact macro or micro wave would require a GPS device with precision used for military purposes. It is impossible to show waves on common GPS devices. Their recording range is very inaccurate. For these reasons, the macro wave size was set to 1 meter. The other red lines marked with chalk were half a meter away, and the last blue line showed an approximate 3-meter road width. The central dividing line itself was 3.2 meters from the imaginary sidewalk. Therefore imaginary, because there was a lot of spreading material on the roadside, still from winter months and the roadside was not visibly marked with white line. The measurement itself took place by recording vehicles on camera (camcorder mode) during overtaking maneuver, and we consequently subtracted their lateral distance from slow recording on the recording equipment (camera with recording function). With recording slowed down, it was very easy to determine which vehicle adheres to a lateral distance and which not.

Figure 4: Distance of vehicles

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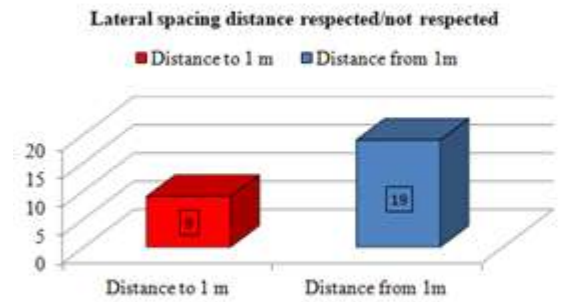
After counting the vehicles which adhered 1 meter lateral distance and which not, we entered these values in table no. 2 and showed them in graph no. 6. For refinement, 47.37% out of respondents from examined sample did not adhere to a 1 meter safe distance while overtaking a cyclist. Of course, these vehicles did not commit an offense, as the Road Act says that a sufficient lateral distance from overtaking vehicle must be kept.

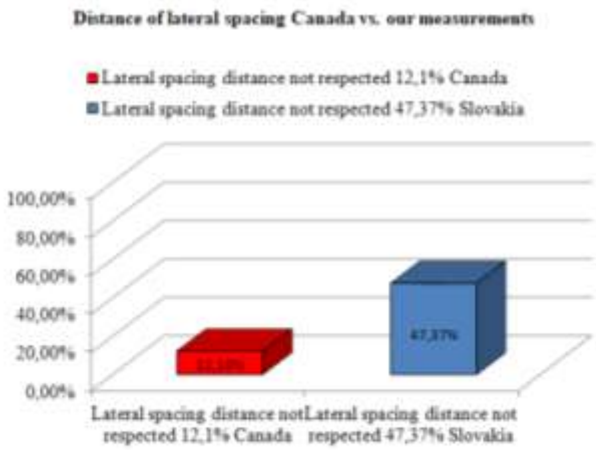
Table 2: Results of lateral spacing measurement

Distance (m)	Number of vehicles
0,5 - 1	9
1 and more	19



Graph 1: Lateral spacing measurement results

For comparison, we have shown a graph where we can compare the previously documented research done by Mehta Kushal (2014) in Canada. In his sample, 12.1% out of vehicles did not respect lateral distance, while our measurement was 47.37%.



Graph 2: Comparison of lateral spacing distances

From the measurement results, we found that our hypothesis that more than 20% of road motor vehicles in urban traffic did not respect the lateral distance 1 meter from a cyclist was correct. 47.37% out of vehicles in sample did not respect it.

4.2 Speed measurement

Cyclist as part of road traffic while riding and moving in urban traffic, is one of the most vulnerable moving object on the road. The speed that a cyclist can develop on today's modern bicycles almost corresponds to and exceeds the speed of a small AM class motorcycle with a manufacturer's maximum speed of 28 mph.

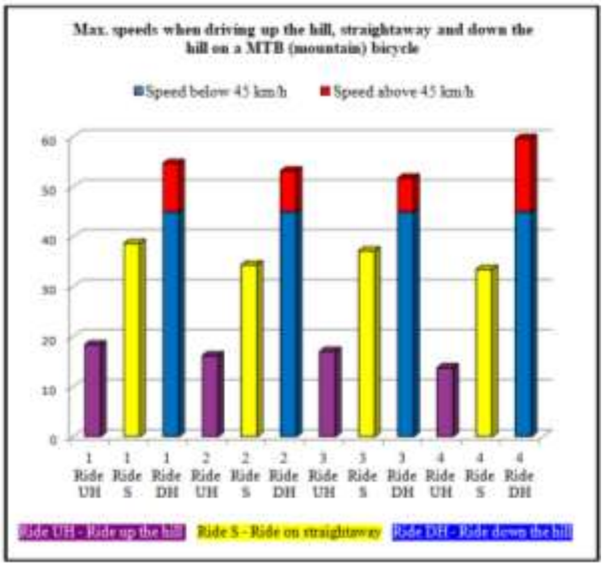
In research of maximum speed that a cyclist can achieve when driving in an urban agglomeration, we used a Garmin speed meter on Fig. 5, which was installed in the middle of the bicycle handlebars.

Figure 5: Garmin Speed Meter

Individual measured speeds achieved on straightaway, up the hill, down the hill were processed in the table, and then we have graphically depicted them in graph 8.

Table 3: Measured maximum speed of MTB (mountain) bicycle

Order of rides.	Ride up the hill mph	Ride on straightaway mph	Ride down the hill mph
1.	11,4	24,0	34,0
2.	10,0	21,4	33,1
3.	10,6	23,11	32,2
4.	8,57	20,8	37,1



Graph 3: Maximum measured speeds on MTB bicycle

As can be seen from the table and graph, speed of a biker on a mountain bicycle along the straightaway almost approximates manufacturer's maximum speed of a small AM class motorcycle. When riding down the hill, he even exceeds this speed.

When using a road bicycle with the same Garmin measuring device on the same route, we recorded individual speeds in the same structured chart and table so that it is easier to compare both rides on bicycles and their maximum speeds achieved in individual driving sections.

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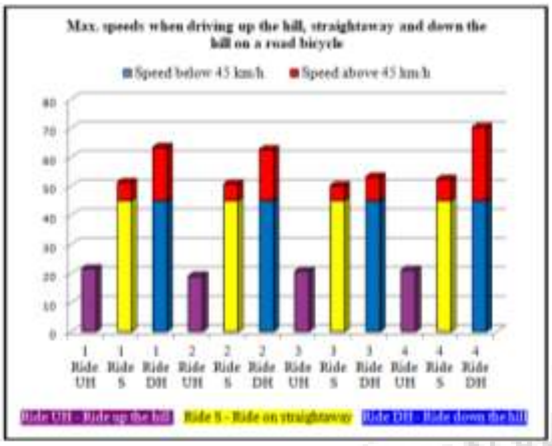
Table 4: Measured maximum speed of road bike

Order of rides.	Ride up the hill mph	ride on straightaway mph	ride down the hill mph
1.	13,4	31,9	39,4
2.	11,9	31,6	38,9
3.	12,9	31,2	39,3
4.	13,2	32,6	43,7



Graph 4: Maximum measured speeds on road bicycle

5. Conclusion

Vehicle lateral distance measurements and bicycle speeds were performed in normal road traffic, which has limited the number of measurements as it led to dangerous situations putting the figurine's safety in risk. This fact itself tells of cyclists´ position in the road traffic with motor vehicles, when they are often threatened because of insufficient lateral distance of vehicles that bypass them, since to injure the cyclist, it is enough to fall on the road without vehicle impact.

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