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Difference in Velocity of Persons on Pedestrian Crossings

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ABSTRACT

Abstract-Pedestrian crossings constitute an essential part of traffic infrastructure. This article deals with velocity of persons on pedestrian crossings. The pedestrians are divided into several groups in order to capture their different velocities. To define a group of persons with limited movement and orientation abilities we use the applicable legislation of the Czech Republic. We further describe in detail technical parameters of the pedestrian crossings and other factors influencing in a significant way velocity of persons on pedestrian crossings. A throughout understanding of velocity of persons on pedestrian crossings can influence the duration of the green light and as such play a role in designing light signal plans or in Smart Cities applications.

KEYWORDS pedestrian crossing, velocity of person, limited movement, parameters of pedestrian crossings

INTRODUCTION

Intersection is from the point of view of traffic infrastructure a complex place and from the point of view of traffic its bottleneck. Intersections need to satisfy the requirements of both traffic of vehicles and pedestrians. The needs of both groups usually differ, for example when demanding to prefer one group over the other. If we focus on the group of pedestrians, their main requirement is to cross the street safely and quickly with minimal delay. The crossing of the street is, however, subjected to multiple factors. These factors can be divided into three basic types:

- capacity and ability of the pedestrian;
- influence of technical parameters of the given street for vehicles – identical for all pedestrians;
- subjective factors influencing the pedestrians – different for each pedestrian.way in this case.

A more detailed understanding of these influences helps to better understand different velocities of the movement of pedestrians. Their application on a specific pedestrian crossing helps to determine the different velocities for different pedestrian crossings for different groups of persons.

For the purposes of computing signal plans on intersections equipped with light signal in the Czech Republic, a normative average velocity of a pedestrian on a pedestrian crossing 4.5 km per hour is used. This value is stated in the norm no. ČSN 73 6110 [1] and takes into consideration a quality of movement of pedestrians (number of persons per m^2) in a cluster and in a stream.

Division of pedestrians into groups

For a detailed analysis of velocity of movement of persons on pedestrian crossings, we divided the pedestrians into several groups in order to cover the demographic trends in the Czech Republic, as well as groups of pedestrians with disabilities. As a basis we used groups of persons defined in the legislature of the Czech Republic, specifically in the Ordinance No. 398/2009 Coll. [2] as "persons with limited movement and orientation abilities." According to this Ordinance, these are persons who are physically handicapped, visually and hearing-impaired, persons of high age, mentally ill, pregnant women and accompaniment of children younger than three years or carriages.

For the purpose of a more complex division we added or divided some groups to cover the entire spectrum of persons, where various velocity of movement can be anticipated.

The resulting division of groups of pedestrians is as follows:

- Persons in wheelchairs
  - Persons in electric wheelchairs
  - Persons in mechanized wheelchairs without accom paniment
  - Persons in mechanized wheelchairs with accompa niment
- Blind and visually impaired with remnants of sight
- Older seniors
- Persons with carriages
- Persons accompanying children younger than three years
- Persons using walking aid tools
  - Persons with walking sticks
  - Persons with crutches
  - Persons with walker
- Persons with oversize luggage
  - Persons with suitcase
  - Persons with heavy bags
  - Persons with large objects
- Persons without any apparent movement restrictions.

Defining parameters of pedestrian crossings

Each pedestrian crossing has its own characteristic properties, which can pose obstacles to individual pedestrians or groups of pedestrians. Persons in a wheelchair without accompaniment can be exposed to a sharp step at the end of the pave-

ment, uneven surface or tram tracks. These parameters exert an influence on the velocity of crossing.

The list of parameters, which were considered for all the pedestrian crossings, is as follows:

- length [m]
- lengthwise incline [%]
- crosswise incline [%]
- incline of adjacent connecting surfaces [%]
- surface
  - asphalt surface
  - concrete surface
  - cobblestones
- tram tracks at pedestrian crossing
- signal light controlled pedestrian crossing
  - no
  - yes – without countdown
  - yes – with countdown

Table 1 displays specific values, including measurement location. Another important parameter is the direction of measurement and the corresponding suggestion of descent (minus) or ascent (plus). The convention of measurement is important in order to obtain identity in measurements in the future.

TABLE – 1
MEASURED PARAMETERS OF PEDESTRIAN CROSSING IN THE KRAKOVSKA STREET

Length of pedestrian crossing [m]	10.8
Lengthwise incline [%] – at the beginning	-3.9
Lengthwise incline [%] – in the middle	-7.9
Lengthwise incline [%] – at the end	-5.1
Crosswise incline [%] – at the beginning	-0.3
Crosswise incline [%] – in the middle	-0.7
Crosswise incline [%] – at the end	-0.6
Incline of adjacent connecting surfaces – at the beginning	11.6
Incline of adjacent connecting surfaces – at the end	13.6
Surface	asphalt
Light signal system	no
Tram tracks at pedestrian crossing	no

Figure 1: Krakovska Street

Sources: Google maps

Parameters of a pedestrian crossing in relation to the measured velocities are subject to more research at present and will be published in an upcoming article.

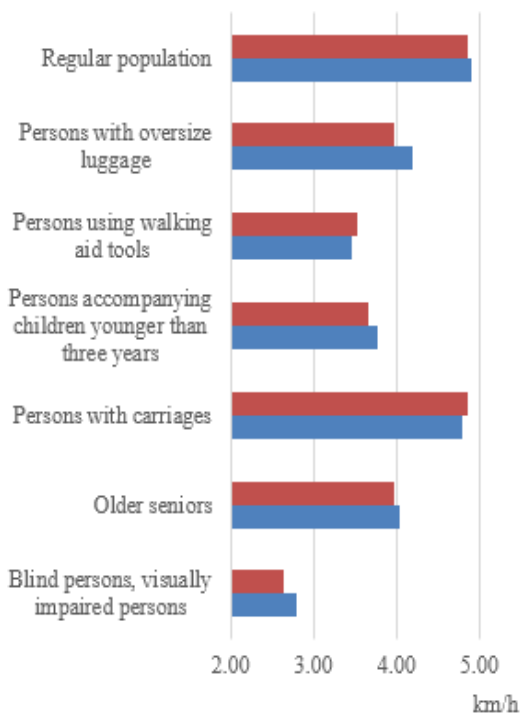
Measuring at pedestrian crossings

In order to obtain information about the velocity of movement of different groups of pedestrians, extensive measurements were taken at several pedestrian crossings in Prague, Czech Republic. Specifically, measurements were taken at six pedestrian crossings, where higher probability of presence of individual groups of pedestrians was expected. Unfortunately, despite the effort, the observations did not yield statistically significant amount of data for all the groups. A total of pedestrians, whose velocity of crossing was measured, was 800 [3].

Results of measured velocity for some groups

First, we will look at the velocity of crossing in Krakovska Street (see Table 1). This pedestrian crossing lies in Prague downtown and is used also by blind persons, as it is located near the headquarters of the United Organization of Blind and Visually Impaired of the Czech Republic. No person in a wheelchair was crossing at the time of measuring.

GRAPH – 1
VELOCITY OF GROUPS OF PERSONS ON PEDESTRIAN CROSSING IN KRAKOVSKA STREET

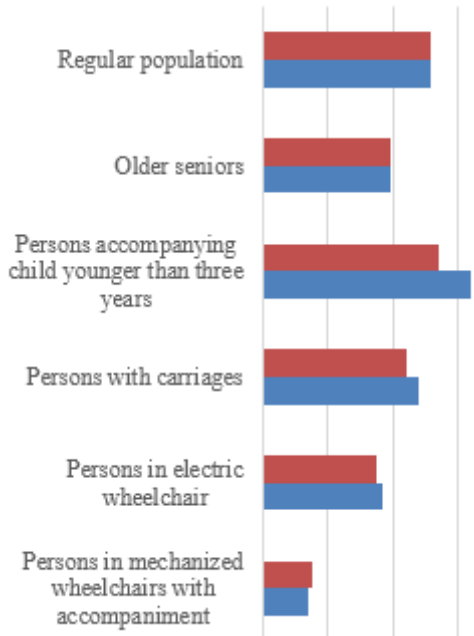


As graph 1 shows, different groups of person move on the pedestrian crossing with different velocity. Blind persons move at an average velocity of 2.80 km per hour and median velocity 2.65 km per hour. On the contrary, persons belonging to the regular population move at an average velocity 4.90 km per hour and median velocity 4.85 km per hour.

Another pedestrian crossing is located in U Kunratickeho lesa Street near a protected housing for persons in a wheelchair. This crossing is thus used by different types of pedestrians compared to the previous one.

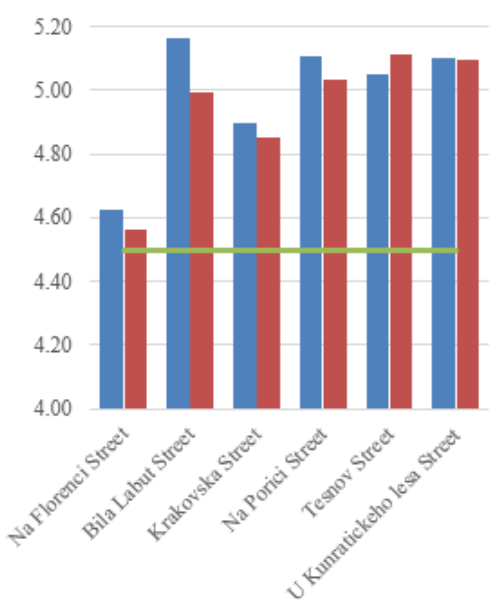
As Graph 2 suggests, persons in a mechanized wheelchair with accompaniment have an average velocity on this pedestrian crossing 3.21 km per hour and median velocity 3.26 km per hour and persons in an electric wheelchair have an average velocity 4.34 km per hour and median velocity 4.24 km per hour.

GRAPH – 2
VELOCITY OF GROUPS OF PERSONS ON PEDESTRIAN CROSSING IN U KUNRATICKEHO LESA STREET



When we compare velocities of different groups of persons on all measured pedestrian crossings, different results are yielded. Graph 3 shows a group of regular population as representatives of a group that was measured on all pedestrian crossings.

GRAPH – 3
MEASUREMENTS FOR REGULAR PEDESTRIANS GROUP



Should we want to obtain one value for each group, it would be sufficient to compute an average of all measurements for each group. This computation would yield an average velocity 5.0 km per hour (median 5.0 km per hour) for the average population group, which is considerably higher velocity than is the norm.

As Graph 3 suggests, however, velocities vary and are different at each pedestrian crossing (this is similar for other groups as well). This difference can be attributed to the above mentioned parameters of the pedestrian crossing. We should not forget, however, also additional influences, incl. the subjective ones.

Additional parameters influencing walking velocity
Influences not explicitly mentioned are subjective in their nature. They differ for each person/pedestrian and mostly cannot be exactly measured. Among such influence are:

- psychology (stress from crossing the street, fear from a larger group of people)
- need to hurry (work day vs. holiday)
- weather etc.

These influences can impact the walking velocity of a person in a group and it is impossible to find out whether or not they are present without direct inquiry.

CONCLUSIONS
The article examines the issue of different velocities of persons on pedestrian crossings relative to the velocity established in the Czech Republic at 4.5 km per hour. Different groups of pedestrians have been defined, based on the anticipation of their different walking velocities. When conducting the measuring, each pedestrian was assigned into one specific group. Velocities of these persons on a specific pedestrian crossing were then measured. The measuring yielded different velocities within the group, suggesting that computing an average velocity could yield an inaccurate result. We attribute the different velocities largely to construction properties of the given pedestrian crossing. For this reason, parameters of each pedestrian crossing were measured and their impact on the walking velocity will be further examined.

Knowledge of velocities of different groups of persons on pedestrian crossings will be further used to define velocities of movement and to compute the time required for transiting among different means of transportation [4]. The first measuring results suggest that movement when transiting should reflect the premises of the behavior of persons on pedestrian crossings.

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