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HOMOGENIZATION OF SPEED ON SECONDARY AND LOCAL ROADS IN THE FLANDERS REGION: AN EXPLORATORY STUDY MAKING USE OF A TRAFFIC SIGNS DATABASE

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Abstract

Speed is an important factor of road accidents. This paper focusses on changes and differences in speed of the traffic flow and on speed differences between different vehicles. Based on an international literature survey the relevance of the speed related factors for road safety are described. Road categorization and delineation of speed limit zones are identified as the most important tools to obtain a more homogeneous speed pattern. Based on a series of case studies including the different urbanization typologies, it is shown that regarding the implementation of these two planning concepts, little has been achieved in Flanders. The scattered and ribbon shaped urbanization along the secondary and local roads and the step by step adaptation of speed limits on road segments by the different road authorities, give rise to a manifest lack of homogeneity . Based on the Flemish Road Signs Database a quantitative analysis (e.g. relating to the length of segments, number of speed limit changes on a road section, etc.) could be carried out. The database contains all traffic signs relevant for speed limits on the entire road network in Flanders, including the road sign position and the description of its characteristics. Based on the case studies both an analysis of the existing situation as well as an explorative assessment of a generic scenario (entering a general speed limit of 70 km/h in non-built up areas instead of the current limit of 90 km /h were described. By implementing this scenario, six out of seven speed limit signs can be removed and the workload for the drivers can be reduced proportionately. So speed limit policy and zoning can be regarded as key instruments for more road safety on local and secondary roads.

Keywords: road safety, speed limits, Flanders Region, secondary roads, traffic signs database

1 Introduction

Assuring the ability to maintain high speeds can be seen as an important quality criterion of the mobility system: higher speeds reduce travel time and increase accessibility. But having higher speeds in road transport also has negative impacts, namely on road safety. Changes and differences in the traffic flow speed and speed differences between different vehicles also increase the risk of accidents. In addition there is the need for sufficient simplicity in the traffic tasks to be carried out by drivers - in particular because of the restrictions of the road user abilities. Concerning the vehicle characteristics, the mass and the speed together with the directions in which the traffic participants are moving, determine the degree of homogeneity. By means of a larger homogeneity the chances of conflicts in traffic can be reduced, so the more homogeneous the traffic flow, the more limited the chances of a conflict or accident. Because of the characteristics of both road users and vehicles, there is a need for uniformity in the traffic and it is not desirable to change speed limits or any change to the features of the road and its surroundings.

The Flanders region is located in the north of Belgium. Within the process of further decentralisation of political powers within the federal state structure, the regional Ministry of Mobility and Public Works has been obtaining more and more responsibilities for the mobility policy, including traffic regulation in the region from June 2014 on. On the secondary and local roads In Flanders special attention is needed for the 'environmental capacity' and for the safety of the most vulnerable road users. Indeed the spatial structure of Flanders is characterised by ribbon developments of housing and other buildings along these roads. Apart from the highly dispersed spatial urbanisation pattern, also the presence of schools and other functions along secondary roads, crossing towns and villages, attract a lot of people walking or biking along these roads or trying to cross the streets. Within this context a multitude of speed limits have been introduced on a step by step basis, each of the limits responding to a local concern, but without taking care of the overall continuity of speed patterns for car drivers that follow a certain route. In this paper we discuss the importance and opportunities to come to more homogeneous speed zones in the Flemish road network The paper builds on a research report [1] on the homogenization of speed zones, made by researchers from the Institute for Sustainable Mobility at the Ghent University.

2 Road safety as structuring principle for road network management and design

2.1 The road safety – speed relation

From road safety point of view establishing a speed limit is largely related to firstly avoiding the risk of an accident and, secondly, to limit the consequences of an accident, which could occur. In both cases, the type of vehicle is a major determinant. A loaded vehicle reacts differently when driving and braking. The severity of the accident is related to both the speed and the weight of the vehicle. For this reason, the relationship between general speed limits and specific speed limits in road segments (through additional regulations) and vehicle-related limits (e.g. 60 and 75 km/h respectively for trucks and buses on 1x2 roads in Belgium) are equally important. As related vehicle speeds differ greatly from the general speed limit on secondary and local roads, there is even more potential for conflict because of the lack of homogeneous speed in traffic flows on these types of roads. General as well as specific speed limits differ in European countries. In Belgium the general speed limit on 1x2 secondary and local roads in non-built up areas is 90 km/h, vehicle-related limits are 60 and 75 km/h respectively for trucks and buses. Because of a road safety concern, the Flemish Road Agency, responsible for the road management of regional roads, adopts as a general rule a lower limit (i.e. 70 km/h) than the one established in the national traffic regulation. On the other hand many local authorities stick to the 90 km/h limit. The general speed limit in Belgium in built-up areas is 50 km/h. As many secondary and local roads passing through town and village centres, on segments of these roads a 50 km/h limit is established.
Speed is generally accepted as a major factor in road accidents. Regardless of the exact circumstances of the accident, the speed factor is always present. In the study by Finch et al. [2], several European studies on the effect of increases and reductions in accidents at speeds are summarized. The researchers reached the conclusion that an increase in the average speed by 1 km/h results in an increase in the number of accidents by 3%, while a reduction of 1km/h leads to a decrease in the number of accidents by 3%. For more serious accidents even greater effects of the speed factor were found. Nilsson [3] presented the main results of the so-called 'power model' in which the speed-road safety is presented in a synthetic way, Figure 1.

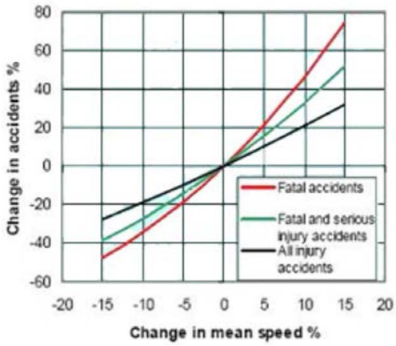

Figure 1 The power model of Nilsson: relation speed and traffic insecurity.

In a study by Taylor et al. [4] , the research by Finch et al. was refined. Taylor et al. note that in addition of a reduction of the mean speed in particular the reduction of the higher speeds (e.g. the number of drivers exceeding the speed limit) has an impact on the number of accidents. In addition, they found that the road type and the road environment are key regulatory factors for the effect of a speed reduction on road safety.

2.2 Road categorisation as a tool for road safety

Road categorisation is seen as a structuring factor for road safety. In the Netherlands, with its so called 'sustainable road safety' concept, one of the most advanced road categorisation systems in Europe is implemented [5]. The system relies on strict design standards per category in order to create 'recognition' of the road type by the road users (stimulating readability of driver tasks to be fulfilled), but also on functional use of the road system (e.g. long distance travel on the main and not on the local roads). The latter in order to contribute to a more homogeneous traffic flow.

The Flemish system of road categorisation on the contrary is a rather open system: it leaves space for interpretation of the general guidelines defined in the Flemish Spatial Structure Plan for different actors, as well for the selection of secondary and local roads by Provinces and Municipalities (resp. for the selection of secondary and local roads, based on the administrative EU-principle of subsidiarity), as for the road design (as there are no fixed design standards per road type). The advantage is that the road layout can be adapted to local spatial conditions (e.g. the design of road passages of secondary roads through town centres can take into account quality of life standards and traffic safety standards for pedestrians and cyclists). The disadvantage is that it may be contradictory to one of the main purposes of road categorisation: making the expected driver behaviour clearer to the road user by means of recognisable road types [6] [7].

This approach, with design guidelines based on the road categorisation and on the other hand the possibility to deviate from the guidelines due to local conditions and thus to a "partitioning " of a road, leading to several successive segments with a different road layout (including those based on different design speeds), was developed in a study report on the design of secondary roads [8].

The compartmentalization is a principle that is based on the concept of the design of road passages through towns and villages used in Flanders since the eighties of the last century. It is based on a spatial and functional analysis of the road environment. By partitioning the road into segments, a speed differentiation and spatial differentiation of a road is obtained. However the intention remains to achieve the preferred situation, based on the general design guideline according to the road category. Such an approach is seen as a key to achieve road safety by tuning the road function, its actual use and its design to each other.

3 The Flemish Road Signs Database

The road sign database is an inventory of all traffic signs along the roads of Flanders . A total of ± 62,000 km of paved roads is inventoried, including ± 7,500 km along regional roads and ± 54,000 km along local roads. The Flemish road signs database contains several parameters: for the location of each sign , the x and y coordinates are tracked. Furthermore, there is information about the orientation (left or right side of the road), the street name and town, and the date of recording. Data of the type of traffic signs (according to the traffic signs classification in the national traffic regulation) are of course also inventoried with the dimensions of the plate and a picture of the set-up. Reference can also be made to the European project ROSATTE in which a methodology is developed to provide the data (relevant for road safety) to digital road map providers, used in GPS.

This road sign database can easily be turned into a speed management tool. It delivers the information on existing speed limits established all over the road network. Secondly this traffic signs database can be used to rationalize the location of the speed limit signs and guaranteeing safer traffic conditions by creating larger homogeneous speed zones. The concept of speed zones is the basis to rationalize the road management (as well for the road design as for the speed enforcement and also contributes to safer and easier driving. Traffic signs are an important source of information for the road user, determining the “conventions” and “rules” to behave in traffic. Moreover, the digital information of the speed limit signs can be converted into a digital speed map. The absence of a reliable digital speed map is one of the main technical barriers for the implementation of Intelligent Speed Adaptation (ISA). If vehicles are equipped with ISA and the system is implemented, not only a huge drop of the number and severity accidents can be achieved, but at the same time the driving task can be made considerably lighter.

4 Feasibility of more homogenous speed zones in Flanders, based on generic scenarios

The theoretical approach to the homogenization of speed zones can be tested in a case study on the Flemish secondary and local roads. In order to assess the consistency of the current speed limit policy in relation to the road functions as complete as possible for the Flemish region, it was decided to apply the choice of research areas according to the spatial classification of the different urbanisation typologies. The case study is limited to three types of analyses:

1. A first scenario examines what impact it can have on the number of road signs when the speed limit standard regime of 90 km/h in non-built up areas is reduced to 70 km/h. Main roads and primary roads for which the use of a higher speed limit than 70 km/h is believed , are excluded.
2. The second scenario analyses the length of the road segments along which a speed regime of 90 km/h is installed (as this is the standard regime, along this road segments there are no speed limit signs present) but that are surrounded by roads with a lower speed regime. In these cases it is examined whether the change in speed limit between these roads is justified.
3. In a third scenario an analysis is carried out of the extent to which the speed regimes correspond to the roads categorisation proposed in the local spatial structure plans.
4. These generic scenarios explore, within the limited nature of the cases, the possibilities offered by the road signs database to investigate the feasibility of a consistent speed limit policy.

4.1 Scenario 1: reduction standard regime 90 to 70 km/h

The assumption of this lower standard speed limit makes it unnecessary to provide speed signs type C43 (and C45 - end speed limit) and zone 70 signs (ZC43 and ZC45), as defined in the Belgian road signs code. It concerns all C43 and C45 speed limit signs along roads not located in built-up areas, where a lower speed regime is in force (zone 30, zone 50, ...), as well as roads that are not part of the road categories "Highways" or "Primary roads". Table 1 shows all the signs (S) C43 and (Z) C45 again with inscription 70 km/h. Under "Current signs" shall mean all signs (70 km/h), including those in built-up areas.

Table 1 Number of 70 km/h limit signs

TOWN	Number of signs (Z)C43 en (Z)C45 indicating 70 km/h					
	redundant signs (non built-up areas)			current signs (built-up and non built-up areas)		
	regional roads	local roads	total	regional roads	local roads	total
Lebbeke	19	55	64	19	55	74
Gent	99	70	169	166	70	236
Destelbergen	16	69	85	16	85	101
Wetteren	83	66	149	83	74	157
Aalst	59	1	60	59	1	60
Denderleeuw	20	2	22	28	2	30
Dendermonde	45	43	88	49	43	92
TOTAL	**341**	**306**	**637**	**420**	**330**	**750**

The redundant signs are each of the 70 km/h road signs, which might disappear if the standard speed limit regime is reduced to 70 km/h. This analysis does not account that possibly new speed signs should be added in order to install the 70 km/h speed regime. Further research could determine whether additional signs can be avoided. By applying zone indications systematically, a large number of road signs can be avoided. For a total of seven municipalities, changing the default regime to 70 km/h would make it possible to eliminate 637 signs, it is 85% of the total number of the currently installed 70km/h signs.

4.2 Scenario 2: Determining the length of reduced 90 to 70 km/h segments

The purpose of this analysis is to determine what the length of the segments with the same speed regime is after reducing isolated 90 km/h segments to 70 km/h. Two possibilities are considered:
1º continuous: segments along a single continuous path have different speeds. A road user goes straight ahead without having to carry out a manoeuvre or to turn left or right (see Figure 2).

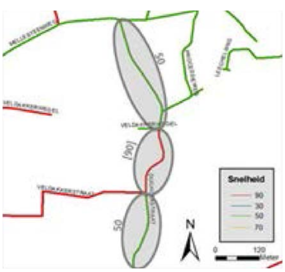

Figure 2 Continuous road: 50-[90]-50

2° road changing on the intersection: in these cases, the road is adjacent to road with a different speed regime, being no continuous road (Figure 3) or it can concern a zone that one cannot leave without crossing a 90 km/h road.

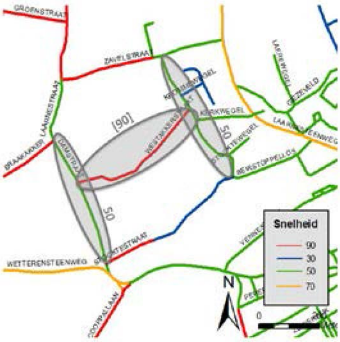

Figure 3 Road changing via intersections: 50-[90]-50

The column "speed regime" in Tables 2 and 3 clarifies the maximum speed admitted on the adjacent road segments. The entry "70 - [90] -70" thus indicating a road where 70 km/h is allowed in a first segment, then 90 km/h and further on 70 km/h. The segment that caused the speed limit change is indicated between square brackets "[ ]", only for this segment, the average length is displayed in the tables. Zone30 regulations in school areas are not taken into account in this study because their large number and because of the absence of dynamic signs (30/50).

4.2.1 Continuous roads

In table 2 it can be seen that the speed limit changes along a continuous road usually occur in steps of 20 km/h. However, there are also roads where a speed limit change of 50 - [90] -50 occurs. The 50 km/h limit point in this cases roads passing through built-up areas. (this also applies to the more common 50 - [70] -50 combination). Speed limit changes of type 70 - [50] -70 indicate approaching intersections, and have an average length of 635 meters. Furthermore the transition segment to proceed from a standard speed regime 90 to 50 (for example, built-up area) can be implemented on the basis of a short section (on average 685 m) with a speed limit of 70 km/h (type 50 - [70] -90) areas.

Table 2 Length of road segments by speed limit regime

speed limit regime	number of segments	average length (m)	median length (m)
50-[90]-50	8	714.64	719.85
50-[90]-70	1	219.0	219.0
70-[90]-70	5	893.42	918.0
50-[70]-50	11	812.0	809.5
70-[50]-70	2	635	635
50-[70]-90	4	685.1	571.6
70-[50]-30	2	444.1	444.1
TOTAL	**33**	**737.4**	**695.9**

The average speed limit change runs over a length of 737 meter. If one takes into account the time which the vehicle requires to slow down or to accelerate, the higher speed limits on such short distances, can be called into question.

4.2.2 Road changing via intersections

In Table 3, the results of this part of the scenario are displayed. The individual road segments of 90 km/h roads adjacent to a lower speed road are at average 682 meters long. These are usually rural roads that fall outside a specific speed limitation indication.

Table 3 Length of road segments by speed limit regime

speed regime	number of segments	average length (m)	median length (m)
50-[90]-50	5	714.4	603.1
50-[90]-70	5	570.648	711.5
70-[90]-70	4	895.025	1044.9
30-[90]-50	1	227.6	227.6
TOTAL	**15**	**682.1**	**711.5**
speed regime	**number of zones**	**average length summed length road segments in zone (m)**	**median length summed length road segments in zone (m)**
[90] omsloten door 70 en 50	1	4674.9	4674.9
[90] omsloten door 70	4	3634.9	3734.7
[90] omsloten door 50	3	2420.6	3072.7
TOTAL	**8**	**3309.5**	**3072.7**

In some cases also groups of roads(zones) surrounded by roads with a lower speed occur. This cases usually also consist of local country roads or forest roads, where no specific speed regime is applied, and therefore the speed limit is 90 km/h. In total, this applies in eight areas with an average total length of roads is 3.3 kilometres.

4.2.3 Scenario 3: Road categorisation speed limits implementation

The extent to which the speed limits currently applied coincide with the desirable limits according to road classification was examined for two municipalities (Wetteren, Destelbergen), for these municipalities the current road categorization is known and shown in the local mobility plans. The effective speed limit which is displayed in the traffic signs database, and hence on the field, can be either equal to, greater than or less than the preferred limit according to the road categorisation standards. The most desirable is, of course, an equal speed limit. When the preferred speed is less than the actual speed, it does not rhyme with the desired function of the road and road safety is compromised. It is also possible that the preferred limit is higher than the actual speed limit. In that case, the comparison must be of the preferred speed with effective speed approached with caution, since the possibility of the introduction of the partitioning of the road based on the vulnerability or the surrounding functions and activities is not taken into account in the standard.
Table 4 shows for ‘Main roads’ and ‘Primary roads I’ a continuing compliance with the guidelines regarding the preferred speed limits. For roads within the category of ‘Primary road type II’ abnormalities are well established. For 27% of the Primary II roads the preferred limit is higher than the actual speed limit. It comes to roads not equipped with a physical traffic flow separator, so that the implemented speed limit of 70 km/h is indeed justified. For ‘Secondary roads’ in all studied cases the applied speed limit complies with the preferred limit according the road category. In contrast, the practice differs sharply for ‘Local roads Type III’, this type shows the largest share of deviation (48%). This is due to the standard regime speed of 90 km/h, which is in force when no specific speed limit sign is installed. On the other hand derogations in which the effective speed is lower, occur (in 14 % of the cases). This is due to the assignment of the 30 km/h speed limit instrument. This partitioning is often required in school environments or other vulnerable areas, and can hardly be labelled as undesirable.

Table 4 Comparing preferable speed limit according road categorisation and current limit

Road-category	preferable limit = current limit	preferable limit › current limit		preferable limit ‹ current limit		Total (km)
	Total road length (km)	Total road length (km))	Average deviation speed limit (km/h)	Total road length (km)	Average deviation speed limit (km/h)	
Main road	15,3	–	–	–	–	15,3
Primary I	10,4	–	–	–	–	10,4
Primary II	2,2	2,8	-23	5,6	+10	10,7
Secondary I	0	–	–	–	–	0
Secondary II	9,8	–	–	–	–	9,8
Secondary III	1,3	–	–	–	–	1,3
Local I	20,1	2,2	-20	2,9	+20	25,2
Local II	21,3	3,8	-25	4,2	+23	29,3
Local III	96,9	35,5	-20	124,4	+38,5	256,8

5 Conclusions

Both the speed level and the (lack of) of homogeneity in the traffic flow are major road accidents factors. Belgium applies outside the vehicle-related speed limits, also limits which are related to the type of road and which are determined by the responsible road authorities (regional or local). Determining permitted speeds on 2x1 roads outside built-up areas either within the framework of the existing general speed limits (90 km/h) or in the context of any newly introduced overall lower speed limit level (70 km/h), should be assessed on its effects on road safety, driving comfort and traffic flowing.

On the basis of seven cases, spread over different spatial types of municipalities, the effect of decreasing the overall speed limit of 90 to 70 km/h was studied. Although the use of generic scenarios (much effect may be expected on the implementation of speed regime zone road signs) depend on the application of the zone, using the road signs data base offer only a first, rough analysis, it can be concluded that, in the lowering of the speed limit of 90 to 70 km/h on local and secondary roads in Flanders, 6 of every 7 speed limits signs can be removed. This does not only mean that the homogeneity of the traffic is going to increase on these roads but it can also reduce the workload for the driver and the costs for the road authorities, as the length with the same speed limit would increase substantially.

The case studies therefore indicate that the deployment of this scenario over the entire road network in Flanders, supported by the use of the Road Signs Database, offers an interesting research track to assess more in depth.

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