

A Model for Setting Credible Speed Limits in Urban Areas

This article presents a new model for setting credible speed limits exclusively in urban areas by setting limits from 25 to 43 mph by increments of 6 mph. The model is based on eight key parameters whose cumulative effects significantly affect the 85th percentile speed.

Background

Setting speed limits is essential for ensuring appropriate traffic speeds and, more broadly, for improving road safety. In Quebec, Canada, municipalities are responsible for managing speeds on their road network. Since 2007, the Highway Safety Code permits municipalities to adopt a by-law allowing them to change a speed limit in their road network without obtaining prior approval from the Quebec Ministry of Transport. Several municipalities have thus lowered posted speed limits in their road network, notably on collectors, urban arterial roads, or local streets, or close to parks and schools.

To document the impact of these practices on the driver's behavior, the Quebec Ministry of Transport mandated the Université de Sherbrooke to establish the conditions suitable for different speed limits in urban areas. An unanticipated outcome of this research was the design of a model for setting credible speed limits in urban areas.

The Model

This model for setting speed limits was designed to be a decision-support tool. It was developed to set a credible speed limit according to the roadway features and the roadway environment. Indeed, our research shows that some "natural conditions" are conducive to different speed limits.¹

A credible limit corresponds to the operating speed of the vast majority of drivers (85th percentile speed); this is the speed that drivers consider to be suitable given the roadway features and the roadway environment.

Credible speed limits were established by observing the driver's behavior under different conditions.² For more details, the methodological and statistical aspects were documented in an additional paper.³

Our model allows speed limits to be set from 25 to 43 mph (40 to 70 km/h) by in-

crements of 6 mph (10 km/h). The model is based on eight key parameters, among the 70 parameters in the study, whose cumulative effects showed a significant impact on the operating speed of Quebec drivers in urban areas. In decreasing order of importance, they are the number of lanes, the width of the lateral visual clearance, the length of the homogeneous zone, the number of commercial buildings, the type of surroundings, the number of institutional entrance/exit points, the percentage of the street with on-street parking that is continuously occupied, and the pavement width available. In fact, these parameters explain 84 percent of the variance of the 85th percentile speed, whatever the road hierarchy.⁴

To simplify its use, the model was designed as a point scale. Each parameter is given a score according to decision thresholds. The maximum score for each parameter is the result of statistical analyses (such as hierarchical regressions or discriminant analysis). With regard to the thresholds, they correspond to the interval of values obtained by natural statistical clustering from a sample of 100 experimental sites. Because the parameters have a cumulative effect, the user must simply add the score for each parameter and select the credible limit according to the result obtained.

Despite its simplicity, the model is versatile and it proposes credible speed limits for more than 550 possible combinations, representing as much as urban streets.

Model Parameters

The model has eight key parameters whose cumulative effect has a significant impact on the operating speed of Quebec drivers in urban areas.

Among these eight parameters, the number of lanes is the most important. It characterizes the size of the road, which is an indicator used to establish the road hierarchy. Here, the number of lanes is

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related to the width of the roadway. This number includes the lanes for motorized vehicles and lanes reserved for buses or other vehicles such as taxis and bicycles. It also includes the space for on-street parking, even if it is temporarily prohibited on certain arterial roads to facilitate the flow of through traffic during rush hour. The general rule is that the operating speed increases with the number of lanes.

The width of the lateral visual clearance is the second parameter. It is related to the openness of the visual field, which is determined by the presence of buildings lining the street and of which the driver is aware. In fact, drivers have a tendency to accelerate when they perceive that sources of potential conflict are distant from the lane in which they are driving. Inversely, if buildings are closer, drivers will spontaneously decelerate. In other words, the clearer the visual scene, the higher the operating speeds.

The length of the homogeneous zone is the third parameter. It corresponds to the distance along which a street has similar features. These features are associated with various uses (e.g., scholastic, commercial, industrial, residential, recreational), occupation density (low, medium, or high), and the characteristics of the road (such as its width or the presence of a median barrier). As soon as a visible and marked change occurs along the road—such as the reduction from four to two lanes, appearance of a traffic island, transition from a residential zone to an industrial park, or transition between different types of residential zone—the homogeneous zone ends. The general rule is that the longer the homogeneous zone, the higher the operating speeds.

The number of commercial buildings is the fourth parameter. Commercial activity attracts large volumes of traffic such as customer traffic or parking activity, which implies the presence of vulnerable road users of whom drivers are aware. In this case, it is not necessary to consider the types of businesses, the nature of the activity, or the surface area because of the design guidelines for businesses in urban areas. In fact, shopping centers, malls, and big-box stores are often set back from the street. Usually, they have large parking lots with controlled access such that their proximity has little influence on the operating speeds on the adjacent road. By contrast, shopping streets

Table 1. A model for setting credible speed limits in urban areas.

Parameters	Thresholds	Score
Number of lanes	1	50
	2 or 3	25
	4 or more	0
Width of the lateral visual clearance	less than 180 ft.	40
	180 to 330 ft.	20
	330 ft. or more	0
Length of the homogeneous zone	less than 820 ft.	40
	820 to 1,640 ft.	20
	1,640 ft. or more	0
Type of surroundings	urban	30
	mostly urban	15
	transitional	0
Number of institutional entrance/exit points	none	0
	1 or 2	15
	3 or more	25
Percentage of the street with on-street parking that is continuously occupied	less than 10%	0
	10 to 30%	15
	30% or more	25
Pavement width available	less than 20 ft.	10
	20 to 39 ft.	5
	39 ft. or more	0
Number of commercial buildings	none	0
	1 to 4	20
	4 or more	40
Cumulative score	Credible speed limit	
more than 170 points	25 mph (40 km/h)	
120 to 170 points	31 mph (50 km/h)	
80 to 120 points	37 mph (60 km/h)	
30 to 80 points	43 mph (70 km/h)	

lined with boutiques or local businesses create pedestrian activity in close contact with traffic; drivers are aware of this situation and adjust their speed accordingly.

The type of surroundings is the fifth parameter. It describes the environment around the road. The classification is based on the general appearance of the road section, and takes into consideration the layout and the density of buildings. In general, the operating speed increases going from an urban environment to a transition zone. When applying the model, the user refers to a series of photographs to identify the environment corresponding to the road for which the speed limit is being determined.

The number of institutional entrance/exit points is the sixth parameter. Here,

we include religious and educational institutions, recreational facilities such as parks and municipal pools, and community facilities like community centers. In addition to generating large volumes of traffic, these buildings or facilities imply the presence of vulnerable road users. We have observed that drivers tend to decelerate, notably when approaching schools and colleges, even if their speed remains generally above the permitted speed.

The occupancy rate of on-street parking is the seventh parameter. This rate indicates the percentage of a zone with on-street parking that is continuously occupied. On certain streets, on-street parking is authorized. But this is not sufficient to establish an appropriate speed limit. In

fact, if on-street parking is authorized but vehicles rarely use it, drivers may develop the impression that the roadway is wide and causes higher operating speeds. This is the reason why the occupancy rate for on-street parking that is continuously occupied must be taken into account.

The pavement width available is the last parameter. It is related to the width of the roadway minus the width of cycling lanes, the shoulders, and on-street parking spaces. Besides the number of lanes, the pavement width influences the operating speed. For example, a narrow roadway

less than 20 ft. (6 m) wide is generally associated with low speeds. Inversely, a wide road causes high speeds.

Three parameters are particularly associated with the edges of the road and activities along the road: the on-street parking occupancy rate, the number of institutional entrance/exit points, and the number of businesses. The other parameters are more related to roadway characteristics.

Conditions for Applying the Model

The proposed model for determining speed limits in urban areas requires consistency in its application. Neighboring streets that have similar conditions must have the same speed limits. The posted speed limits must be credible so that drivers do not doubt their relevance. In this regard, the model was designed such that the proposed limit should be the same for roads with similar roadway features and with similar roadway environments.

Furthermore, it is preferable to set a uniform limit for an entire road section or neighborhood where the roadway features and the roadside environment are similar. By doing so, drivers perceive the posted speed limit as being more credible and consistent. Different posted limits along homogeneous zones create confusion and lead to noncompliance with the posted limit.

In addition, the application of the model should not lead to frequent changes of the speed limit along a road section. If a road section is very short—for example, less than 820 ft. (250 m)—it is better to reexamine the limit proposed by the model by considering the posted limits in the adjoining sections. Drivers will have difficulty adjusting their speed if changes in the speed limit are too frequent.

Lastly, the model was designed to propose a credible limit according to the roadway features and the road environment. It is possible that the limit suggested by the model will differ from that expected by the user. It is important to understand that the model is based on respecting the operating speed of the vast majority of drivers (85th percentile speed). If the user chooses a speed limit lower than that proposed, without the presence of accompanying measures like traffic calming or police enforcement, it



Figure 1. Example of a road with a credible limit of 25 mph (40 km/h)



Figure 2. Example of a road with a credible limit of 31 mph (50 km/h)



Figure 3. Example of a road with a credible limit of 37 mph (60 km/h)



Figure 4. Example of a road with a credible limit of 43 mph (70 km/h)

is unlikely that drivers will respect the posted speed limit.

Favorable Conditions for Various Speed Limits

Our study, based on close to 100 experimental sites, allowed the identification of not only the key parameters for operating speeds but also the “natural” conditions that are conducive to speeds from 25 to 43 mph (40 to 70 km/h) by increments of 6 mph (10 km/h).

A limit of 25 mph (40 km/h) is appropriate for roads that are relatively short; that is, roads less than 660 ft. (200 m) long on average and that have one or two lanes. These roads are used for local traffic. The width of the driving lane used by motorized vehicle traffic is reduced, that is less than 20 ft. (6 m) wide, because of the narrowness of the road or intensive use of the roadside. On-street parking is permitted on one or both sides of the street and is continuously occupied by numerous vehicles, which reduces the pavement width available to the flow of traffic. These roads are usually lined by institutions or businesses, which leads not only to pedestrian activity but also to considerable parking activity. In general, the lateral clearance is less than 100 ft. (30 m) wide. Buildings are thus close to the road, which reduces the driver’s visual field. These roads are usually in historic downtown areas where the streets are narrow and the building density is relatively high.

A limit of 31 mph (50 km/h) is appropriate for relatively short roads; that is roads that are less than 980 ft. (300 m) long and have two lanes. The pavement width available is generally around 26 ft. (8 m) wide. On-street parking is permitted on one or both sides of the street but is rarely used, thus it does not reduce the width of the pavement available to the flow of traffic. This type of road is often lined by institutions but rarely by businesses. The lateral clearance visual (including the road) is up to 130 ft. (40 m) wide. These roads are found throughout cities, particularly in primarily residential areas.

A limit of 37 mph (60 km/h) is credible for relatively long roads, about 1,300 ft. (400 m) long on average and with several intersections. They are multi-lane

roads (four or more) and are often city boulevards. The pavement width available is approximately 65 ft. (20 m). On-street parking is often permitted, which reduces the roadway width. These roads are never lined by institutions but frequently by businesses. The lateral visual clearance (including the road) is 280 ft. (85 m) wide on average. These roads are generally associated with collectors or subarterials.

A 43 mph (70 km/h) limit is appropriate for roads with homogeneous zones that are relatively long; that is roads that are 1,640 feet (500 m) on average and rarely have intersections. They have multiple lanes (four or more) and often have a median barrier. The pavement width available is approximately 80 ft. (25 m), and on-street parking is rarely permitted. These roads are not lined by institutions and rarely by businesses. The lateral visual clearance (including the road) is wide, reaching 980 ft. (300 m) on average. The function of these roads is to assure the circulation of through traffic, and they have been designed accordingly. These roads are generally urban arterials connecting various districts in a city.

Advantages and Limits of the Model

Although several models⁵ have been developed that address all road types, including roads outside of cities, a major problem is that their parameters are not exclusive to urban environments. As a result, it is difficult for these models to precisely determine appropriate limits in urban areas. By contrast, the proposed model is specifically adapted to urban areas, and it was designed for setting credible limits by increments of 6 mph (10 km/h). In contrast to other models, which require a prior engineering study or which are based on a subjective evaluation, the proposed model is simple to apply and it consists of precise decision thresholds. Statistical analyses have shown that the model correctly sets appropriate limits in 84 percent of cases.

Certain situations can affect the performance of the model and do not allow it to set a limit corresponding to the observed 85th percentile speed. The model is not able to correctly estimate the limit in the presence of a radius of curvature less than 400 ft. (120 m), a street slope ranging

from 4 percent to 8 percent, or a dead-end. These conditions lead to deviations of 9 mph (15 km/h). Furthermore, during the statistical analyses, these parameters were not significant for explaining the 85th percentile speed. It also should be mentioned that the model is based on the observed speeds of Quebec drivers on a municipal road network where the road design corresponds to North American standards. ■

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