

ON THE EXPECTED SAFETY CONSEQUENCES OF INCREASING THE POSTED SPEED LIMIT ON ONTARIO 400-SERIES HIGHWAYS FROM 100 TO 110 KM/H*

An evidence-based opinion piece authored by (in alphabetical order):

Geni Bahar, P.Eng., P.E. (Civil), RSP

Geni Bahar is President of NAVIGATS Inc. She has 40 years of professional experience as a researcher and a practitioner in road safety engineering. She has contributed extensively in the dissemination of evidence-based high-quality research results bringing them into practice.

Ezra Hauer, Ph.D., P.Eng.

Ezra Hauer, Professor (emeritus), Department of Civil Engineering, University of Toronto, has been active in road safety research and consulting since 1970. He has published extensively, with over 200 journal articles, reports, books or other scientific works.

Bhagwant Persaud, Ph.D., P.Eng.

Bhagwant Persaud is a Professor of Civil Engineering at Ryerson University, with a Ph.D. from the University of Toronto. He has been a road safety researcher for more than 30 years, during which time he has published more than 80 peer-reviewed journal papers.

Alison Smiley, Ph.D., CCPE

Alison Smiley is President of Human Factors North Inc. For more than 40 years, she has led research, taught human factors and traffic safety to students, engineers and police, and acted as a human factors expert witness in over 450 legal cases involving motor vehicle crashes.

Abstract

The Ministry of Transportation, Ontario is considering increasing the posted speed limit on its 400-series highways from 100 to 110 km/h and has initiated public consultations and a pilot study. This evidence-based opinion piece is intended to contribute to the discussion on the merits and demerits of this proposal from the point of view of four road safety experts representing academia and the consulting industry. It describes the thrust of the extant evidence from Canada and around the world on the likely safety consequences of the proposed speed limit increase. That evidence should be taken into consideration and influence the eventual decision in that it clearly suggests that crashes will be more severe, and that injuries and fatalities will be more numerous if such a measure is adopted.

What motivates this opinion piece?

The Government of Ontario is considering increasing the posted speed limit on its 400-series highways¹. Doing so will have diverse consequences, some beneficial, others harmful. In the short term, people will save time, trucks will be more productive, fuel consumption, and greenhouse gas emissions will increase, seniors may be even more reluctant to use these roads, crashes will be more severe, injuries and fatalities more numerous. In the long run, activities will become even more footloose, land use more decentralized and, as a result, car and truck travel distances will be longer. There is also evidence of spillover increases in speeds on the roads near to where the posted speed limit has been increased.

* This article appeared in the Fall 2019 edition of *The Safety Network*, the official newsletter of the Canadian Association of Road Safety Professionals, which was released on November 21, 2019

The authors' expertise is in road safety and our purpose is to put before the decision-makers and the public the extant evidence on what one should expect to be the safety effect of posted speed limit increases in general and the proposed one in particular. We recognize that when setting speed limits, complex considerations and tradeoffs in addition to safety come into play. We believe, however, that what is known about safety consequences should be taken into consideration and influence the eventual decision. This opinion piece is not an exhaustive literature review. Such reviews can be found in the scholarly literature².

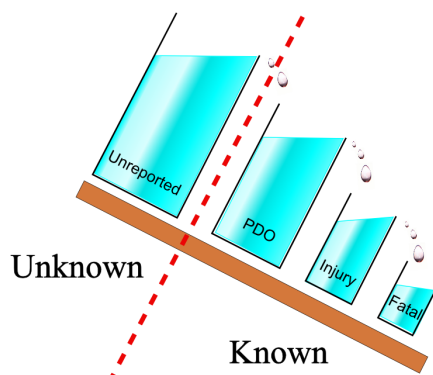
Do operating speeds increase when posted speed limits are increased?

The obvious effect of raising the posted speed limit is for some to drive a bit faster. Thus, e.g., Hunt et al.³ report that after Saskatchewan raised the speed limit on four rural highways, in 2003, from 100 km/h to 110 km/h, the average operating speed increased from 107 to 111 km/h. They called the increase “minimal” and “insignificant” and, at first sight, many readers might concur. However, as evidence shows, small increases in mean operating speed are associated with much larger increases in injury and fatal crashes. How much the increase was in Saskatchewan is unknown as, to our knowledge, there are no publicly available safety evaluations. How much the increase will be in Ontario is difficult to predict accurately. Experience elsewhere suggests that a 10 km/h increase in speed limit on high speed highways will result in a 3 – 4 km/h increase in mean operating speed. This is what should be expected. Another likely effect will be an increase in speed diversity. While one can convincingly argue that the more diverse the speeds the more frequent is lane changing and the related turbulence, the literature about the safety effect of speed variance has not yet arrived at a clear consensus.

The potential for safety consequences

It has been argued that faster travel increases the probability of crash occurrence. After all, the stopping distance increases with speed quite dramatically and thereby, so it seems, the ability to avoid crashes must diminish. This “mechanical” view of crash occurrence is overly simplistic. Drivers are not automatons and changes in alertness and other means of adaptation are difficult to observe. Be that as it may, the conjecture that the probability of being involved in a crash increases when speed increases has proven difficult to show by defensible science⁴.

On the other hand, there cannot be much doubt that the higher the speed the more severe the consequence of a crash tends to be. Momentum is proportional to speed, and kinetic energy to its square. Both are nullified in a collision when the brain crushes against the skull, the skull against the windshield, the heart and lungs against the ribcage and the body against the seatbelt, airbag or steering wheel. It is just the reality of physics and properties of materials; there is no room for behavioural adaptation. What happens to crash counts is shown in the figure below.



When posted speed limit is increased, and mean speed increases, some crashes that were “injury” before the increase become “fatal”, some that were “PDO” (property damage only) turn into “injury”, and some that would have been “unreported” (crashes with no injury and damage of less than \$2,000 do not have to be reported) spill into the “PDO” category. For every fatal crash in Ontario there are about 75 injury crashes and 320 PDO crashes. Given these proportions, one can see that due to the vessel-to-vessel spillage the number of fatal crashes is bound to increase, the number of injury crashes is likely to increase and what will happen to PDO (and therefore Total) crashes is unclear.

Irrefutable published evidence of negative safety consequences

These concepts are validated by irrefutable published evidence from around the world, including some from here in Canada. In British Columbia, posted speed limits were increased by 10 km/h on some 1,300 km of rural provincial highways. A rigorous before-after evaluation led by a prominent researcher using state-of-the art methods found a statistically significant increase in fatal-plus-injury (severe) crashes of 11.1%⁵.

Further afield, but as compelling, Elvik⁶ summarized and modeled the results of nearly a hundred scientific studies containing empirical estimates of the relationship between the change in mean operating speed and the associated change in crashes or crash victims. The Table below presents some of his results in simplified form.

| Outcome | % change in outcome for 1% change in mean operating speed |
|---------------------------|---|
| Fatal crashes | 4.21, 3.65* |
| Fatalities | 4.90, 4.90 |
| Serious injury crashes | 1.35, 1.59 |
| Seriously injured persons | 1.59, 1.76 |
| Slight injury crashes | 0.90, 1.05 |
| Slightly injured persons | 1.64, 1.56 |
| Property Damage Only | 1.70, 0.73 |

*The first entry is for “all studies”, the second for “well-controlled studies”

In a subsequent study for the Transportation Research Board⁷, more complex statistical models were fitted to Elvik’s data in which the percentage increase in crashes for a given increase in mean speed better reflects the original mean speed. If the contemplated posted speed limit increase were to be implemented on the 400-series highways and, as in Saskatchewan, the mean operating speed when traffic is light would increase by 4 km/h from, say, 110 to 114 km/h, these models indicate that injury crashes would increase by about 13% and fatal crashes by about 21%. What may seem to be a moderate increase in mean operating speed is likely to translate into a sizeable increase in fatalities and injuries. These are the facts, and this is what we should expect⁸.

Rebutting Counterarguments

Addressing the expected safety consequences of raising posted speed limits, the proponents offer a variety of arguments. Some are entirely without merit and do not deserve comment⁹. Other arguments may appear superficially plausible and require discussion.

One such argument is that the 400-series highways have a design speed of 120 km/h and therefore can safely accommodate the higher speed limit¹⁰. However, the Ministry of Transportation, Ontario's (MTO's) Design Supplement for the 2017 Transportation Association of Canada Geometric Design Guide for Canadian Roads, which MTO has now adopted, states that "For operational and safety considerations, the design speed should desirably be 20 km/h greater than the posted speed ..." and further acknowledges the "... additional margin of safety and capacity normally associated with the desirable design." It does suggest that "An acceptable relation is one where the design speed equals the posted speed" but specifies that "Every effort should be made to use the desirable standard on freeways, arterials and major collectors" (as opposed to the *acceptable* one).

The issue here is the relationship between the "design speed" and safety. The higher the design speed of a road, the more generous are its features, the larger are the radii of horizontal curves, the longer are the sight distances on vertical curves, the milder the grades, etc. Some of these features are explicitly designed so that the large majority of drivers can negotiate them safely. This, of course, does not mean that vehicles travelling below the design speed are not involved in crashes; nor does it mean that as long as the posted speed limit remains below the design speed it can be increased without paying the price of more fatalities and injuries. The opposite is true.

Occasionally, a related argument is advanced claiming that if a road is sufficiently improved the posted speed limit on it can be raised without harm to safety¹¹. This again is untrue. Raising posted speed limits causes speed to increase and this, in turn, inevitably increases crash severity. If the improvement to the road (such as twinning) enhanced safety this was a safety gain. If a subsequent increase in the posted speed limit undoes this gain, this is a safety loss. It is also sometimes argued that raising the posted speed limit will do no harm if by enforcement one ensures that there will be no speeding. That can be true. For example, there is some evidence that the introduction of automated speed enforcement has helped to reduce the number of crashes. However, for that to be true in the case of the proposed posted speed limit increase in Ontario one has to either commit to a comprehensive photo radar system on the 400-series highways or to a massive and sustained increase in the police force devoted to speed enforcement.

Summary

This evidence-based position paper is in response to an Ontario Government proposal to increase the posted speed limit on its 400-series highways from 100 to 110 km/h. Saskatchewan and B.C. have recent experiences with posted speed limit increases. In Saskatchewan, an increase from 100 to 110 km/h on four rural highways resulted in an increase in average operating speed of 4 km/h. The effect on safety there is unknown as, to our knowledge, there are no publicly available safety evaluations. Although there are good reasons to expect that increasing speed will increase the probability of collisions, this has been difficult to prove. What is indisputable, however, is that increased operating speed is associated with increased crash severity. The result is that some collisions that resulted in "non-fatal injury" become "fatal" and some "property damage only" become "injury". A rigorous evaluation led by a prominent researcher in B.C., where posted speed limits were increased by 10 km/h on some 1,300 km of

rural provincial highways, found a statistically significant increase in fatal-plus-injury crashes of 11.1%.

A Transportation Research Board study developed statistical models based on nearly a hundred studies, to estimate the relationship between the change in mean speed and the associated change in crashes and crash victims. If the contemplated posted speed limit increase were to be implemented on the 400-series highways and, as in Saskatchewan, the mean operating speed when traffic is light would increase by 4 km/h from, say, 110 to 114 km/h, these models indicate that injury crashes would increase by about 13% and fatal crashes by about 21%. Thus, what may seem to be a moderate increase in mean speed is likely to translate into a sizeable increase in injuries and fatalities.

Some argue that raising the posted speed limit will do no harm if by enforcement one ensures that there will be no speeding. However, past experience tells us that this would require a comprehensive photo radar system on the 400-series highways or a massive and sustained increase in the police force devoted to speed enforcement.

We recognize that when setting speed limits, complex considerations and tradeoffs in addition to safety come into play. We believe, however, that what is known about safety consequences should be given strong consideration and influence the eventual decision on raising speed limits on the 400-series highways.

¹ <https://www.ontario.ca/page/consultation-speed-limits-ontario-highways>

² See e.g., K. Kockelman, Safety Impacts and Other Implications of Raised Speed Limits on High-Speed Roads. NCHRP Web-Only Document 90 (Project 17-23): Contractor's Final Report, https://safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa1304/Resources3/22%20%20Safety%20Impacts%20and%20ther%20Implications%20of%20Raised%20Speed%20Limits%20on%20High-Speed%20Roads.pdf

or Charles M. Farmer, The Effects of Higher Speed Limits on Traffic Fatalities in the United States, 1993–2017 April 2019. Insurance Institute for Highway Safety <https://www.iihs.org/api/datastore/document/bibliography/2188>,

See also references in notes 5 and 6.

³ Hunt, P., B. Larocque and W. Gienow (2004). Analysis of 110 km/h Speed Limit: Implementation on Saskatchewan Divided Rural Highways, 2004 Annual Conference of the Transportation Association of Canada. Québec City, Québec. <http://conf.tac-atc.ca/english/resourcecentre/readingroom/conference/conf2004/docs/s16/p-hunt.pdf>.

⁴ See, e.g., quoting Shinar (D. Shinar. Speed and Crashes: A Controversial Topic. Appendix B in "Managing Speed, Special Report 254, Transportation Research Board, Washington D.C., 1998. pp. 221-276.) "From a very simplistic point of view it appears that as speed increases, the time to react to emerging dangers is shortened, and the likelihood of successfully coping with the imminent crash situation decreases. Also, even after the driver reacts by braking, the braking distance of the vehicle is proportional to the square of pre-braking speed. But reality is much more complicated, both theoretically and empirically." (5, p. 231). After reviewing the extant evidence Shinar concludes that: "In summary, with the exception of one small study ..., none of the observational/correlational studies that have been reviewed were able to measure empirically or statistically control for all the potential factors that mediate speed and crash probability." (5, p. 251).

⁵ Tarek Sayed, Emanuele Sacchi, Evaluating the Safety Impact of Increased Speed Limits on Rural Highways in British Columbia, Accident Analysis and Prevention 95 (2016) 172–177.

⁶ Rune Elvik (2005) Speed and Road Safety, Synthesis of Evidence from Evaluation Studies. Transportation Research Record: Journal of the Transportation Research Board, No. 1908, Transportation Research Board of the National Academies, Washington, D.C., 2005, pp. 59–69.

⁷ Harkey, D.L., et al., 2008. Accident modification factors for traffic engineering and ITS improvements. National Cooperative Highway Research Program (NCHRP) Report 617, Transportation Research Board. (Models cited are given in Equations 47 and 48 on page 47 of Appendix F.)

⁸ On September 26, 2019, as a “pilot” project, Ontario raised the speed limit to 110 km/h on three road sections 224 kilometers in length. Here, too, one should expect a sizeable increase in fatalities.

⁹ For example, a petition asking Alberta to adopt 120 km/h speed limits claiming to be endorsed by more than 11,000 signatories claims that “According to the studies done in province of British Columbia and all other places in United States, it was clearly revealed that when speed limits are increased, the amount of collisions go down significantly”. <https://www.change.org/p/government-of-alberta-raise-alberta-highway-s-speed-limit-to-120>

¹⁰ The Ontario Minister of Transportation is quoted saying that “Our roads are built and designed — the 400-series highways, provincial highways — to carry it at 120 kilometers an hour safely, so we’ve got to make sure that we keep that in mind with regards to speed limits.” <https://toronto.citynews.ca/2019/05/01/ontarios-transportation-minister-raises-possibility-of-higher-speed-limits/>. In announcing public consultations on the matter the MTO says “Safety is the government's number one priority and each pilot location was carefully chosen based on a number of factors, including its ability to accommodate higher speed limits.”

¹¹ Before raising the speed limit to 110 km/h the Saskatchewan transportation minister was quoted saying that “...the massive investment we’ve made to accelerate twinning means that our four-lane highways can accommodate an increased speed limit,” and that “Through this investment we are now in a position to move people and goods as quickly and efficiently as possible while, at the same time, ensuring safety.” (June 1, 2003 by Truck News, <https://www.trucknews.com/features/sask-speed-limits-increased-to-110/>)