

Summary

In-depth analysis of speed-related road crashes

TØI Report 1569/2017

Author: Alena Høy

Oslo 2017 109 pages Norwegian language

The report summarizes detailed results of in-depth investigations of speed-related fatal car crashes that were conducted by crash investigation teams of the Norwegian Public Roads Administration. It summarizes detailed results for 107 speed-related fatal crashes involving passenger cars with sober drivers that occurred in Norway during 2011-2015. Results of in-depth investigations of all 577 speed-related fatal crashes with passenger cars that occurred in Norway during 2005-2015 are summarized as well. Speed-related fatal crashes in this study include crashes where a passenger car had excessive speed (speed that normally leads to license revocation) or inappropriate speed (too high speed under the current driving/ traffic conditions, but not necessarily above the speed limit). Typical characteristics of crashes with excessive speed are: Single vehicle crash, more than one fatality, weekend and nighttime crashes, older cars, side impacts, roof crush, young male drivers, and low seat belt use. In a large proportion of these crashes, road characteristics may have contributed to the driver misjudging safe speed. Drivers in such crashes were also more often than others under peer pressure, racing or overtaking. Typical characteristics of crashes with inappropriate speed are older cars, cars without stability control, inappropriate tires, loss of control, young male drivers, more often than others under time pressure or with a lack of experience with winter conditions. Large proportions of crashes with inappropriate speed occurred in winter, on wet or slippery roads, and/ or in difficult curves. A number of safety measures are proposed that may prevent speed related (and other) serious crashes. Examples are increasing the pace of replacing old vehicles, intelligent speed adaptation, increased police enforcement, removing or protecting hazardous road side objects, more consistent and predictable road design, and improved curve warning.

The aim of the present study was to identify typical characteristics of speed related car crashes, with a main focus on crashes with sober drivers. Speed related cars crashes are crashes in which are car had:

- **Excessive speed:** Speed above the limit for license revocation
- **Inappropriate speed:** Too high speed in curves or under the current driving or traffic conditions.

The analyses are based on in-depth investigations of fatal crashes conducted by crash investigation teams (CIT) of the Norwegian Public Roads Administration in 2005-2015:

- General characteristics of speed related fatal crashes with passenger cars are investigated for all such crashes that occurred in 2005-2015, based on a database assembled by the CIT. This analysis comprises 226 fatal crashes where a passenger car had excessive speed (115 of these with a sober driver) and 351 fatal crashes in which a passenger car had inappropriate speed (272 of these with a sober drivers).
- More detailed analyses were made for speed related fatal crashes with a sober driver in 2011-2015. These analyses are based on the crash reports by the CIT of 37 crashes with excessive speed and 70 crashes with inappropriate speed.

The results of both types of analyses are summarized in the following. All results refer to speed related crashes with **passenger cars** with **sober drivers** (unless intoxication is mentioned explicitly). All percentages refer to the years **2011-2015** (unless mentioned otherwise).

Typical characteristics of crashes with excessive speed

Excessive speed crashes (with sober drivers) have several characteristics that clearly distinguish them from other fatal car crashes. Some of the results summarized below are based on the analysis of CIT-reports and refer consequently only to differences between excessive speed and inappropriate speed crashes. Typical characteristics of excessive speed crashes can be summarized as follows:

- **Higher speed:** «Excessive speed» is considerably higher than in other car crashes. Average speed is above 100 kph, almost independent of the speed limit (50 kph or above). «Inappropriate speed» is on average at or somewhat above speed limit, while the average speeds of cars that had neither excessive nor inappropriate speed is well below the speed limit.
- **More single vehicle crashes:** Almost half of all excessive speed crashes are single vehicle crashes (47%), compared to 22% among inappropriate speed crashes and 11% among other car crashes.
- **More fatalities:** Among all those involved in fatal car crashes, the proportion of fatalities is highest in excessive speed crashes in which 57% of all involved persons were killed, compared to 50% in inappropriate speed crashes and 44% in other car crashes.
- **Most fatalities in the own car:** In car collisions with excessive speed, more fatalities occur in the car that had excessive speed than among collision partners. While this indicates that driving at excessive speed is most risky for those who drive too fast, collision partners (who in most cases not had contributed to the crashes) are killed in almost half of all such crashes.
- **Nighttime and weekend crashes:** Excessive speed crashes accumulate on weekends and at night, especially on Saturday nights (21% of all excessive speed crashes occurred on Saturday nights). Inappropriate speed crashes also occur somewhat more often than other at night and on weekends, but the difference to non-speeding crashes are considerably smaller.
- **More crashes in the dark:** The proportion of crashes that occurred in the dark was 47% among excessive speed crashes, 37% among inappropriate speed crashes, and 27% among other car crashes.
- **Older cars:** Cars in excessive speed crashes were on average 1.6 years older than cars in inappropriate speed crashes, and the latter were on average 2.5 years older than cars in non-speed related fatal crashes.
- **Unaccustomed cars:** Drivers that had excessive speed had more often than others a car they were unaccustomed with.
- **More side impacts and more roof crushes:** Cars that had excessive speed and a fatality in the own vehicle, had more often had a side impact (54%) and/or roof crush (39%) than others. Among cars that had inappropriate speed, 34% had a side impact and 13% roof crush. Side impacted cars had far more often reduced survival space in the car than cars that only had a frontal impact.
- **Younger drivers:** The drivers' average age is more than 10 years lower among those who had excessive speed (27.6 years) than among those who had inappropriate speed (39.8 years) and other fatal crash involved car drivers (49.3 years).

- **More male drivers:** The proportion of women who had either excessive or inappropriate speed is only about 12%, compared to 30% of car drivers in non-speed related crashes.
- **Fewer belted occupant fatalities:** Among all fatally injured occupant of cars that had excessive speed, 29% had not been belted. In cars with inappropriate speed the proportion was 18% and in other cars only 13% of all fatalities were unbelted.
- **Some cases of peer pressure, racing and overtaking:** These three factors were almost exclusively found among drivers who had excessive speed (among 14% of these, one of the three factors were found). Time pressure and a lack of winter driving experience have contributed only to a few crashes with inappropriate speed.
- **More crashes in curves:** Over half of all excessive speed crashes occurred in curves (58%). Among crashes with inappropriate speed and non-speed related car crashes, 52% occurred in curves.
- **More road-related crash contributing factors:** In the majority of excessive speed crashes (92%) at least one road-related factor was found that may have contributed to the crash. The most common factor is a discrepancy between apparent and actual safe speed. Such discrepancies may be a consequence of unexpected change in road geometry or sight obstructions and were found in 62% of excessive speed crashes and in 25% of inappropriate speed crashes. Examples of other road related crash contributing factors in excessive speed crashes are curves with inappropriate visual guidance (23% of excessive speed crashes), curves with varying radius and a number of factors that only were found in one or a few crashes, such as uneven road surfaces, steep downhill slopes in tunnels, paved shoulders with large height differences.

No differences in driver state: The proportions of drivers who had been tired, sick, distracted or suicidal are about the same among the different kinds of speed related crashes.

Drivers license: Among drivers in speed-related crashes (both groups) there were some more without a valid license, but differences between the groups and differences between drivers in speed-related and other crashes are only small and unsystematic.

Typical characteristics of inappropriate speed crashes

Comparing inappropriate and non-speed related fatal crashes, one finds about the same differences as between excessive speed and non-speed related crashes. However, the differences are for the most part considerably smaller. In short, typical characteristics of inappropriate speed crashes are (compared to non-speed related crashes):

- Higher speed
- More single vehicle crashes
- More fatalities (and more fatalities in the own car than among collision partners in collisions)
- Nighttime and weekend crashes (but without accumulation on Saturday nights)
- Older cars
- Young drivers
- More male drivers (no difference between inappropriate and excessive speed crashes)
- More unbelted fatalities.

No or only small differences were found between inappropriate speed crashes and non-speed related crashes for:

- Cars the driver was unaccustomed with
- Proportion of crashes in curves

- Unlicensed drivers.

The following factors are common in inappropriate speed crashes (but not in excessive speed crashes):

- **More crashes with vulnerable road users:** Most speed-related crashes with vulnerable road users (pedestrians, cyclists, skiers) occurred at inappropriate speed (and almost none of them at excessive speed).
- **Triggering party:** In almost all motor vehicle collisions involving a car at inappropriate speed, the speeding car had been the triggering party. Excessively speeding cars had only been the triggering party in about two third of motor vehicle collisions. In collisions between a vulnerable road user and a car at inappropriate speed, the vulnerable road user has in most cases been the triggering party.
- **More crashes in winter:** Most inappropriate speed crashes occurred in winter (72%) and in 37% of those crashes snowy/icy roads had contributed to the crash (compared to 8% among excessive speed crashes).
- **More cars without stability control and more loss of control:** Among cars that had inappropriate speed, only 24% had stability control (ESC) and 52% of crashes involved loss of control. Among excessively speeding cars, 29% had ESC and 46% had lost control.
- **More vehicle related crash contributing factors (especially tires):** Among cars that had inappropriate speed, 33% had at least one vehicle related factor that has contributed to the crash, for the most part worn, bad or wrong type of tires (26% of cars). Among cars that had excessive speed, the respective proportions were 28% and 22%.
- **Some cases of time pressure or lacking winter experience:** In 6% of inappropriate speed crashes the driver was under time pressure and the same proportion of drivers had no winter experience (in crashes on snow-/ice covered roads). These two factors were not found among any of the excessively speeding drivers.
- **Some crashes with delayed emergency response:** In five of the inappropriate speed crashes (7%) emergency response was considerably delayed and in three or four cases the delay may have contributed to the fatal outcome of the crash. Emergency response was not delayed in any of the excessive speed crashes. The difference between the two speed groups may be due to random variation.
- **Fewer crashes at intersections:** Among inappropriate speed crashes, fewer occurred at intersections (11%, compared to 18% of excessive speed crashes and 12% of non-speed related crashes).
- **More crashes on wet or slippery roads:** A large proportion of inappropriate speed crashes occurred on roads covered by snow or ice (43%) or on wet roads (27%). The respective proportions are 8% and 37% among excessive speed crashes and 22% and 27% among non-speed related crashes.
- **More crashes in difficult curves:** Among inappropriate speed crashes 58% occurred in curves that were sharper than curves on neighboring road sections, 53% occurred in curves with inadequate visual guidance, and 17% occurred in curves with a difficult geometry (e.g. varying radius). Sight obstructions, misleading placement of chevron signs, side roads and changes in road width were factors that contributed to inadequate visual guidance.
- **Changes in road standard, high pavement-edge drop, and inadequate design for pedestrians or cyclists:** Each of these factors has contributed to three to four of inappropriate speed crashes.

Changes over times

Among all passenger cars with sober drivers that were involved in fatal crashes, the proportion that had inappropriate speed, has decreased from 19% in 2005-2010 to 13% in 2011-2015, while the proportion that had excessive speed is about unchanged (7%). The prevalence of inappropriate speed has also changed when all passenger cars involved in fatal crashes are regarded together (including those with intoxicated drivers). The following characteristics of fatal speed related car crashes were found to have changed over time (from 2005-2010 to 2011-2015):

- **Older cars:** Average car age has increase by about half a year.
- **More cars with ABS, ESC and airbags:** The proportions of cars with each of these safety measures has increased. The increase of ESC equipped cars is a likely explanation of the decrease of fatal crashes with inappropriate speed.
- **Lower speed:** Average speed of fatal crash involved cars has decreased by about 18 kph among those with excessive speed and by about 10 kph among those with inappropriate speed. These results are uncertain because speed measurements are missing for many cars, especially in the earlier years. However, a decrease of the general level of speed on Norwegian roads was found by Sagberg & Bjørnskau (2016).
- **More vehicle related crash contributing factors:** The results indicate that the proportion of speed-related crashes with vehicle-related crash contributing factors has increased over time. Being consistent with the finding of increased vehicle age, the result may still be a consequence of increased reporting.
- **Older drivers:** The drivers' average age has increased by 1.4 years among drivers how had excessive speed and by 1.1 years among drivers with inappropriate speed.
- **Fewer unbelted drivers:** Among fatally injured drivers who had excessive speed, the proportion who was unbelted has decreased from 40% to 29%. Among those who had inappropriate speed, the proportion is about unchanged (23% and 21%).

Proposed measures

Based on the results of the in-depth studies a number of measures are proposed that have a potential to reduce the number of speed related car crashes, or the severity of such crashes. The proposed measures are summarized in table S.1, in decreasing order of the number of potentially affected crashes.

Table S.1: Summary of proposed measures.

Type of measure	Measure	Comment	N of crashes	Share
Vehicle	Newer cars	Average age of cars in speed related crashes is higher than in other crashes (unspecified number of crashes)	?	
Vehicle/ driver/road	ISA / increased enforcement	Refers to all crashes in which a passenger car had driven above the speed limit	57	53 %
Vehicle	ESC	Crashes with non-ESC equipped cars and loss of control	43	40 %
Road	Median barriers	Head-on collisions (installation of median barriers is probably unrealistic at most crash sites)	42	39 %
Road	Removal/protection of hazardous road side objects	Crashes in which the speeding car was damaged in collision with a road side object	34	32 %
Vehicle	Improved crashworthiness in side impacts	Crashes in which an occupant of the speeding car was fatally injured and in which the car was seriously damaged in a side impact	31	29 %
Road	More consistent and predictable road design	Crash sites with a discrepancy between apparent and actual safe speed	29	27 %
Road	Improved curve warnings	Crashes in curves that are sharper than preceding curves (incl. 17 crashes in curves with inadequate visual guidance)	28	26 %
Vehicle	Improving tire state and quality	Crashes in which the speeding vehicle had bad, worn or inadequate tires and in which the type or state of the tires contributed to the crash	26	24 %
Road	Improved visual guidance in curves	Crashes in curves with inadequate visual guidance	25	23 %
Vehicle	Lane departure warning	Single crashes and head-on collisions without loss of control, inadequate speed in a curve or passing	23	21 %
Road	Improved winter maintenance	Crashes in snow-/ice covered road where road conditions contributed to the crash (not incl. crashes on roads that were only locally icy)	19	18 %
Vehicle	Pedestrian/cyclist warning	Collisions with pedestrians/cyclists (highly uncertain whether these could have been avoided)	15	14 %
Driver	Increased seat belt use^a	Non-users of seat belts (in speeding cars) who might have survived with a seat belt	14	13 %
Road	Road construction to avoid locally icy conditions	Crashes at sites that were locally icy due to frozen meltwater (two crashes) or a water course under the road	6	6 %
Vehicle	Improved securing of cargo	Crashes in which a fatally injured person in a speeding vehicle might have survived if cargo had been properly secured	4	4 %
Vehicle	ACC+FCW+AEB^b	Rear-end collisions in which the speeding vehicle was the billet vehicle	4	4 %
Road	Improved road design for pedestrians and cyclists	Collisions with pedestrians/cyclists in which inadequate road design for pedestrians/cyclists may have contributed to the crash	4	4 %
Road	Avoid high pavement-edge drop	Crashes in which a high pavement-edge drop contributed to loss of control	4	4 %
Vehicle	Automatic crash notification	Crashes with considerably delayed emergency response in which the delay may have contributed to the fatal outcome	3-4	3 %
Road	Avoid or improve guardrail ends	Crashes involving guardrail-end collisions	3	3 %
Road	Avoid changes in crossfall in curve with side roads	Crashes in curves where a change in crossfall at a side road contributed to the crash	2	2 %
Road	Dimming of tunnel lighting at night	A night-time crash in which the driver is assumed to have had problems with dark adaptation after driving in a tunnel	1	1 %

^a Refers only to occupants of the speeding vehicle, not collision partners in collisions.

^b Automatic cruise control with forward collision warning and automatic emergency brake.