

Report 48

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Traffic lights: A configuration-specific study of safety-related aspects at four-arm urban junctions

Summary

Of all accidents recorded by the police, only about 3 per cent occur at traffic lights. Nevertheless, junctions controlled by traffic lights are often considered to be dangerous, i.e. localized accident spots. The purpose of this study was to provide information about why accidents occur at these junctions despite the protection that traffic lights are intended to offer. It followed a pilot study with the same objective, although of smaller scope and which primarily served to provide rough indications of possible contributory factors.

This study was conceived as a retrospective observation study in which a random selection of traffic lights formed the sample. This was acquired as follows: a total of 16 cantonal (civil engineering departments, road transport departments) and 20 municipal authorities (police, traffic and construction departments, etc.) were asked to supply details about existing traffic lights and the associated accidents. Inclusion in the investigation was restricted to traffic lights that were located within city limits, had 4 approach roads and were unaffected by any rail systems (trams, railways). In the years covered by the investigation, consideration was given solely to traffic lights to which no technical alterations had been made. An additional criterion was that at least 1 accident had to have occurred at these locations in the 4 years preceding the period of observation. Potential traffic lights were then put in sequence with the help of an electronic random number generator. Those that were given rankings between 1 and 130 were then investigated for their conformity with the predetermined criteria. The final result consisted of 87 traffic lights (2 had to be eliminated at a subsequent date) with a total of 346 approach roads, which formed the random sample.

A survey of data relating to the accidents that occurred at the selected traffic lights was carried out and configuration-specific features were recorded. Owing to the indisputed influence of exposure in road accidents, additional traffic censuses were conducted.

Only those types of accident were included in the analysis that suggested a connection between the occurrence of the event and the configuration-specific features. This was the case with full green signal accidents (collisions with conflict green at full green traffic lights), green arrow accidents (collisions with conflict green at green arrow traffic lights), rear-end collision accidents (rear-end collisions at all types of traffic lights) and red light running accidents (collisions caused by ignoring red lights at all types of traffic lights). Accidents in which it was obvious that there was no connection with the traffic lights (e.g. drunk drivers) were excluded.

In the case of the configuration-specific features, the characteristics of the geometry and the equipment were extended by the characteristics of the immediate surroundings. Variables in the following feature categories were recorded in the analysis: traffic lights (type of traffic lights, number of traffic lights, etc.), traffic lanes (number of lanes at the intersection, width, etc.), road signs (number of signs at the intersection, posted speed, etc.), signposts (their number at the intersection and in their range of recognizability), perceptibility (distance of first visual identification, obstructed vision, etc.), conflicts (number of possible conflicts, type of conflicts) and road layout (topography).

The average daily traffic (ADT) served as the measure of exposure for the approach roads. The ADT was calculated for each approach road using the traffic census at 2 peak hours and one interim hour and the allocation of a daily load graph.

In all, 346 approach roads were surveyed, of which 103 (29.8 per cent) had a green light that was full (i.e. unmasked) whereas 243 (70.2 per cent) featured a green arrow. Approach roads with a full green

traffic light had an accident rate of 4.4 accidents per 10,000 vehicles, roughly 50 per cent more than approach roads with a green arrow traffic light (2.95 accidents per 10,000 vehicles) (RR = 1.49; 95 %-CI 1.28–1.73). By using the statistical method known as Poisson regression, an attempt was made in each case to develop a model that would enable the dependency of the accidents on various contributory factors (configuration-specific features and exposure) to be represented and forecast. It turned out that accidents at traffic lights are difficult to predict based on configuration-specific features alone; no model could be found that explained more than 50 per cent of the variance in the accidents actually observed. This means that other factors not included in the analysis must make a contribution towards explaining how the accident occurred (for example, characteristics of the driver involved, such as age, gender, etc. and/or circumstances, such as time of day, road conditions, etc.).

In the models found for the various types of accident 4 characteristics stood out. These occurred repeatedly as predictors for the accident frequency – irrespective of the type of traffic lights: the average daily traffic (ADT), possible obstructed vision due to vehicles turning off, the topography of the approach roads and the presence of side roads in the zone where the traffic lights are recognizable. When the traffic volume increases, so does the accident risk in all the accident categories surveyed; traffic volume has the greatest amount of influence in the case of rear-end collisions (at green arrow traffic lights with conflict: RR = 6.5; 95 %-CI 4.0–10.7; at green arrow traffic lights without conflict: RR = 2.9; 95 %-CI 1.7–4.9). A marked increase in accident risk also occurs when vehicles turning off can obstruct vision, which, particularly in accidents caused by vehicles from conflict traffic flows (green arrow accidents: RR = 3.6; 95 %-CI 1.7–7.7; full green accidents: RR = 8.1; 95 %-CI 3.7–17.8) plays a significant role but not in the case of rear-end collisions or red light running accidents, however. Furthermore the influence of the topography of the approach roads to traffic lights was evident: there is an increased risk of green arrow (RR = 5.6; 95 %-CI 3.0–10.2) and rear-end collision accidents (RR = 1.7; 95 %-CI 1.1–2.7) at green arrow traffic lights involving a conflict situation on approach roads which slope downwards. A similar situation applies to accidents occurring after a red light had been run on approach roads that slope upwards (RR = 2.0; 95 %-CI 1.3–3.2; generally for green arrow traffic lights). Finally, the existence and number of side roads in the zone where the traffic lights are recognizable has an effect on accident frequency: the accident risk increases in the case of green arrow traffic lights as the number of side roads (in the approach zone) increases (RR = 2.2; 95 %-CI 1.3–3.6)

Recommendations concerning how the incidence of accidents could be reduced were drawn up for the most significant predictors per accident type. These can be used as a planning tool by those who plan traffic lights in order to assess the safety level of the traffic lights before they are commissioned. Furthermore these recommendations can be applied when existing traffic lights are checked and/or updated. The most important recommendation is that:

Wherever possible, full green (i.e. unmasked) traffic lights should be avoided!

Further recommendations are in Table 31, arranged by type of accident and problem involved.

Table 31:

Important problems for accident events and recommendations for their solution

Type of accident	Problem involved	Recommendation
Green arrow accidents	Slope inclination of the approach road	<ul style="list-style-type: none"> § Measures to reduce speed § Possibly adjust slope inclination in the traffic light approach zone § Examine type of operation (eliminate conflict)

	Obstructed vision caused by vehicles turning off	§ Improve the layout § Examine type of operation (eliminate conflict) § Examine measures to reduce speed
	Large number of approach roads in the zone of recognizability	§ Examine recognition and view of approach roads § Close approach roads or make one-way
	Few signposts in the zone of recognizability	§ Examine signpost concept § Coordinate signposts and road surface markings
	Few signposts at the intersection	§ Examine signpost concept § Coordinate signposts and road surface markings
Full green accidents	Obstructed vision caused by vehicles turning off	§ Improve the layout § Examine type of operation (eliminate conflict) § Examine measures to reduce speed
	Large number of road signs and signposts in the zone of recognizability	§ Examine signpost and road sign concept § Coordinate signposts and road signs with road surface markings
Rear-end collisions	Existing red light surveillance camera	§ Examine course of phases § Examine the recognizability of the traffic lights § Examine coordination with other traffic lights (green traffic flow) § Examine measures to reduce speed
	Approach roads that slope downwards	§ Examine measures to reduce speed § Examine course of phases (amber phase)

Red light running accidents	Approach roads that slope upwards	§ Examine sensor allocation to traffic lane § Examine the recognizability of the traffic lights § Examine use of red light camera § Examine measures to reduce speed
	Large number of traffic lights at the intersection	§ Examine sensor allocation to traffic lane § Clear separation of traffic lanes § Examine the routing