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RESEARCH

Road safety in motorway and road tunnels

In recent years, an average of around 280 casualties and about 8 fatalities have occurred each year in more than 600 tunnel accidents. Although tunnels are among the safest stretches of road, the effects of an accident are frequently worse than on open roads. A study conducted by the Swiss Council for Accident Prevention bfu describes and analyses accidents in tunnels in the national road network and issues recommendations for optimising safety.

Problem and Objective

While motorway and road tunnels were clearly safer than open roads at the end of the 1980s, the gap between the two categories in terms of accident-victim rates and the severity of accidents has closed today. In contrast, accident rates in tunnels have still remained much lower. In recent years, the annual averages for more than 600 tunnel accidents were around 280 persons injured and about 8 fatalities.
The aim of this study by the bfu was to identify measures to increase road safety in tunnels as a supplement to the recommendations made by the Tunnel Task Force.
For this purpose, it was necessary to compare the level of safety in Swiss tunnels with safety levels on open stretches of road. In addition, the investigation aimed to provide information on the operational and infrastructure factors that substantially affect safety in tunnels.

Procedure

Alongside a survey on the causes of accidents conducted among cantonal authorities responsible for tunnels, an accident analysis was carried out that included a statistical evaluation of tunnel features (length, number of tunnels, lane width, shoulder design,

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height, longitudinal inclination, bends in the tunnel and light density) and of operational features (average daily traffic [ADT], proportion of heavy goods vehicles, maximum speed limit). The statements were supplemented with psychological observations based on perception.
In an initial step (bivariate analyses), a check was made on whether design and operational features were significantly connected with accidents. Tunnel features that proved to be significant within the framework of the bivariate analyses were examined in greater depth in a second step using a multivariate process, i.e. the influence of several independent variables (design and operational features) on a target variable (accidents) was checked simultaneously. The multiple Poisson regression method was selected for the multivariate analyses.

Results

The effects of operational and design features on accident and casualty risks are summarized in the following table:

Summary of the multivariate results: Risk changes in percent when predictor features are doubled

Independent variable	Valid value range	Accident risk	Casualty risk
Tunnel length [1])	200 to 17,000 m	-32%	-20%
ADT [1])	2,000 to 100,000	+77%	+38%
Tunnels [2])	2 versus 1	-45%	-53%
Heavy goods vehicles (% share of ADT)	2.5 to 23%	n. s.	+31%
Shoulder width	0.5 to 2.8 m	-43%	n. s.

[1]) The percentages represent the influences adjusted for exposure
[2]) The percentages refer to twin tunnels (in comparison to single tunnels)
n. s. = Effects are statistically not significant

The results are as follows:
- In longer tunnels, the risk of suffering an accident or being injured is reduced per unit of length as opposed to shorter tunnels (increased attention paid by motorists when driving through long tunnels).
- An increase in traffic density increases the risk of collisions and the risk that persons will be injured since the gaps between vehicles are shorter.
- Compared with single tunnels with bi-directional traffic, twin tunnels have half the risk of accidents and casualties.
- An increase in the proportion of heavy goods vehicles in ADT also increases the risk of accidents in a tunnel (the rigid bodywork and large bulk of heavy goods vehicles represents a greater risk of danger since little energy is absorbed in an accident).
- Wide road shoulders reduce the probability of an accident (in narrow tunnels with limited shoulder widths, motorists tend to drive down the middle of the road, which increases the risk of collisions).

Conclusions

Tunnels are safer than open stretches of motorways. Nevertheless, safety in specific problem areas can and must be further improved. On the basis of the investigation, various individual measures are proposed in the areas of optical design, shoulder widths as well as traffic and breakdown management that are intended to increase safety levels in tunnels. The most important are optical lane guides with marker lights or reflectors on the shoulder, shoulder widths in new tunnels to exceed the standard width (> 1m), as well as setting an upper limit on and, wherever possible, reducing the number of heavy goods vehicles. However, optimum safety can only be achieved by a combination of safety measures at various levels.

Source

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