

The fire risk of heavy vehicles in high gradient road tunnels

TØI Report 2017/2024 • Authors: Tor-Olav Nævestad, Alena Katharina Høye, Jenny Blom, Lars Even Egner
• Oslo 2024 • 72 pages

The report examines the relationship between high gradients in road tunnels and the risk of fire in heavy vehicles. Especially subsea tunnels have long steep gradients. Our analyses show that the fire risk increases most from a gradient of 7 per cent, and we regard a maximum gradient of 7 per cent as a "breaking point". The length of high gradient distances is also related to the fire risk. The longer distances with a high gradient, the more fires there are in the tunnel. This applies both to gradients from 5 per cent and to gradients from 7 per cent. However, the length effect is significantly higher for the length of gradients above 7 per cent. Subsea road tunnels have a higher risk of vehicle fires than other tunnels. This can mainly be explained by the fact that they have long and steep gradients. The four most fire exposed have almost 5,500 meters in average with a gradient of more than 7%. This applies to the Oslofjord Tunnel, the Eiksund Tunnel, the Bømlafjord Tunnel and the Byfjord Tunnel. The cause of heavy vehicle fires in long and steep tunnels is primarily technical problems, primarily related to the engine. The engine becomes very hot when using the retarder downwards, and even hotter when driving uphill. The retarder is an independent braking system, operated with a lever on the steering wheel, which slows the engine downhill. Insufficient vehicle maintenance is often an underlying cause of fires. We discuss various measures to reduce the risk of fire, including experiences from measures in tunnels in alpine countries, and how new types of fuel and energy carriers in the next 10-20 years can influence the risk of fire. The most relevant measure to prevent fires in heavy vehicles in Norwegian road tunnels is to avoid building long and steep road tunnels, whenever possible. The other most relevant measures that we identify in the study seem to be technology for automatically extinguishing fires in engine compartments, vehicle maintenance, technical inspections of vehicles, thermoportals and cooperative ITS.