Road Tunnel Operations Management and Safety
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Runehamar Test Tunnel

R&D of Tunnel Technology and the Need of Full Scale Tests

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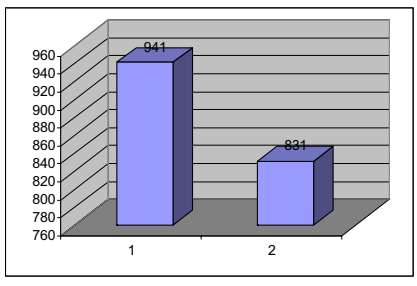
Number/lenght of tunnels in Norway



Statistics of Tunnel Fires

- 57 fires the last 7 years
- Predominance of HGV
- 1/3 due to accident
- Predominance of elderly vehichles
- Internationally ca 40 – 50 ”cathastrophy fires”
- 3 - 5 dangerous goods involved

International Tunnel Fires

Tunnel Fires in Norway

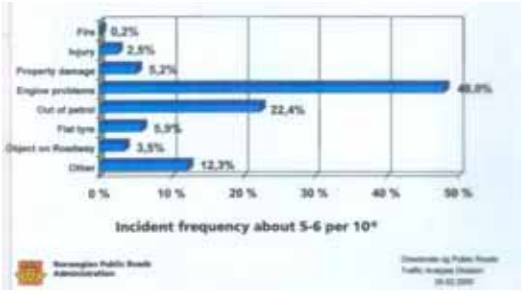
Tunnel Safety

- Few fires
- Few accidents

- More safety
- More equipment
- Higher reliability
- Less acceptance of down time

- Consequences can be cathastrofatic if ……

Incidents in Road Tunnels



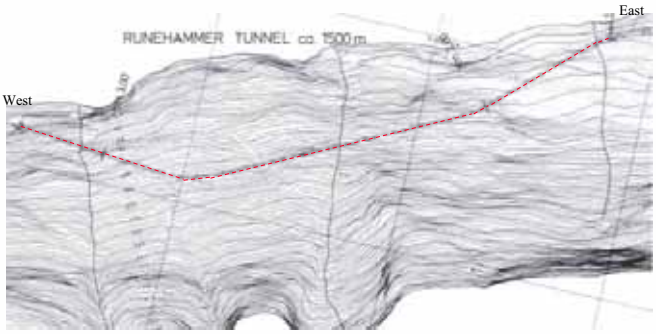
Available as a future site for full scale fire testing and other tunnel safety tests

Runehamar Test Tunnel

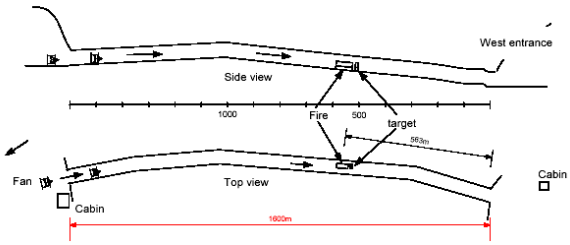
Runehamar Test Tunnel

RUNEHAMAR 2003

Open for traffic up to 1990



Large scale fire tests 2003



The purpose of the Runehamar tests

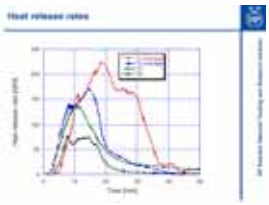
- Fire development in semi-trailers (HGV)
- Influence of ventilation on peak HRR and fire growth rate
- Production of smoke nad toxic gases from various goods
- Fire spread between vehicles
- Possibility for rescue services to fight HGV fires
- Temperature development in ceiling

Tunnel protection

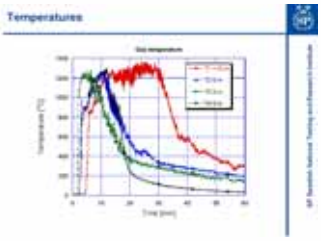
Wood and plastic pallets

Furniture and plastic/cardboard cartons

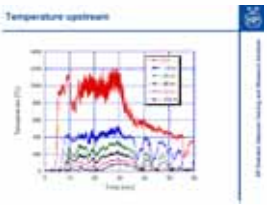
- ”Ordinary” goods leads to very high HRR

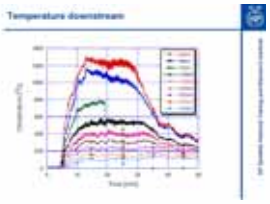


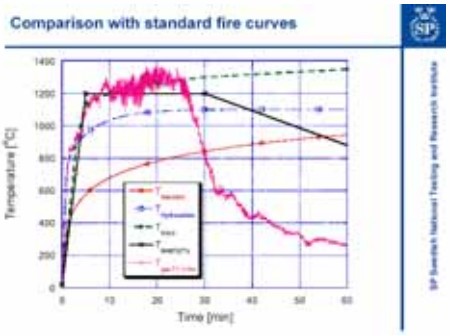
- The HRR from a semi-trailer with wood pallets is equeal with a HGV fire after a very short time



The extension of the ”non-rescue zone”





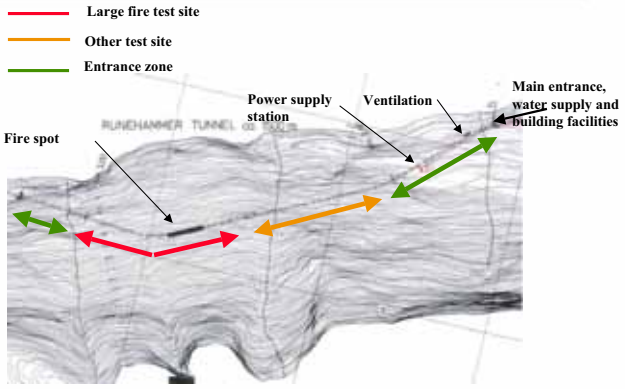


Conclusions Fire Tests 2003

- Four tests, mixture of cellulose and plastics, with different heat release curves
- Ordinary commondities can give heat release rates equal to those in tank fires
- HRRmax > 200 MW
- Very high temperatures > 1350º C
- Pulsations
- Increasing intensity of the fire caused decrease of velocity leading to backlayering

Runehamar Test Tunnel 2005

Runehamar Test Tunnel



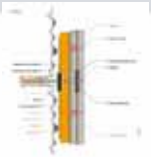
Full Scale Test 2005

- PVC membrane (water-protection)
- Diesel-pool 600 l in 12 sqm
- HRR aprox. 20 MW (contribution from membrane 40% the first 15 min.
- 60 min
- Gas temp. aprox. 1100 º C (peak)

Full scale test I 2006

- Complete lining PE-foam protected with 80 m.m. sprayed concrete with PP-fiber

  Steel-fibre reinforcement
- 6000 l Diesel in a 20 sqm pool



Full scale test I 2006

- 90 min. fire
- HRR aprox. 5o MW
- Gas temp aprox. 1250ºC
- No spalling

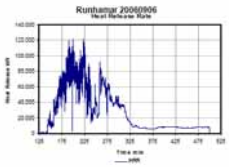
Full scale test II 2006

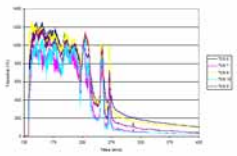
- 20 m complete lining PE-foam protected with 80 m.m. sprayed concrete with PP-fibre

  Mesh reinforcement
- 11000 l Diesel in a 40 sqm pool

Full scale test II 2006

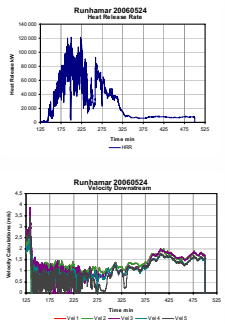
- HHR aprox. 100 MW
- Gas temp aprox. 1250 ºC
- Large areas exposed for 1100 ºC for more than 2 hrs.
- Almost no spalling





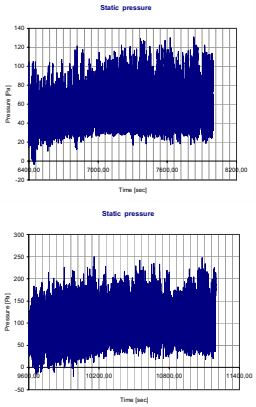
Static pressure in large fires

- The frequency of the pressure oscillation is about 0.5 Hz, and the amplitude is about +/- 100 Pa. The elevated static pressure is reaching 100 Pa, which gives the maximum peak pressure of about 200 Pa.
- An elevated pressure of 100 Pa, will provide a velocity of about 14 m/s (50 km/h) to the ambient pressure.



Static pressure in large fires

- 100 Pa is probably at the limit for human to open hinged doors.
- The static pressure is depending on the pressure provided by the ventilators, temperature rise in the tunnel and the length.
- This numbers are very preliminary and they are subjected to be adjusted during more detail data processing from the experiment.



Why full scale tests?

- Verify controllable laboratory tests
- The only way to test a complete consept!
- Verify reliability under realistic conditions -transferring industrial technology into tunnels
- Testing materials in ”real life” environment and surroundings

Why Do Full-Scale Fire Testing?

- Lab-scale testing gives controlled test conditions for classification
- Lab-scale testing is limited to test small segments (tset specimen)
- Full-scale testing allows verification of laboratory tests on real constuctions and installations
- Hazard load from real fires are different compared to lab-scale fires (e.g. heat load, pressure and smoke conditions)
- Full scale testing is very costly, but on sevearl matters, there are no alternatives, either small-scale testing or by mathematical simulations (e.g. spalling of concrete or fire suppression)

Runehamar Test Tunnel – The Future

- Large scale fire tests
- Size of fires influencing accept criterias
- Size of fires and structural response
- Accept criterias for evacuation in tunnel smoke
- Static pressure of large fires – influence on design of escape ways??
- Tests of insulation materials
- Mitigation measures

Conclusions

- Equipment based on neccesary needs
- Documentation
- Full scale tests
- Maintainability

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- The reliability chane