THE NEW SWISS DESIGN GUIDELINES FOR ROAD TUNNELS AND HOW THEY ARE BEING IMPLEMENTED

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Synopsis

• Background
• New Swiss guidelines – ventilation, escape facilities, etc
• How they are being implemented:
  - in tunnels being designed
  - in tunnels being constructed
  - in tunnels being refurbished
• What if they cannot be implemented in full?
• Conclusions
Background

Road Users

Operation

Safety in road tunnels

Infrastructure

Vehicles
Factors affecting choice of ventilation concept

• Primary:
  - Traffic characteristics:
    – 1-way with little congestion
    – 1-way with regular congestion
    – 2-way
  - Tunnel length

• Secondary:
  - Traffic flow; Number of trucks; Tunnel gradient
Ventilation guidelines – Classification of type

1-way traffic with low frequency of congestion

- traffic flow
- % trucks
- gradient

Natural ventilation
Without smoke extraction
With smoke extraction

2-way traffic and 1-way traffic with high frequency of congestion

- traffic flow
- % trucks
- gradient
Escape Facilities
– twin tube tunnels

• Regularly spaced cross connections (max. 300 m)

• Every third one capable of passage by emergency vehicle

• Self closing door(s)
Escape Facilities
– single tube tunnels

• Without smoke extraction
  \(L_{\text{tun}} < 1 \text{ km}: \text{none}\quad L_{\text{tun}} > 1 \text{ km}: \text{one mid-tunnel}\)

• With smoke extraction
  - \(L_{\text{tun}} < 1.5 \text{ km}: \text{none}\)
  - \(1.5 \text{ km} < L_{\text{tun}} < 3.0 \text{ km}: \text{one, mid-tunnel}\)
  - \(3.0 \text{ km} < L_{\text{tun}} < 4.5 \text{ km}: \text{two}\)
  - \(4.5 \text{ km} < L_{\text{tun}} < 6.0 \text{ km}: \text{three}\)
    - etc.

• Must be to the open (safety rooms not acceptable)
Other facilities

• Linear temperature/fire detection (if mechanical ventilation)
  – detect within 1 minute, locate within 20 m
• Visibility measuring instruments
  – max spacing 1000 m in 1-way tunnels with low congestion
  – max spacing 500 m in all other tunnels
• Air velocity measuring instruments
  – in each section
  – if smoke extraction, sufficient to control jet fans
• Traffic signalling equipment
• Loudspeakers not required
Implementation of the guidelines

• Tunnels being designed
• Tunnels currently being constructed
• Tunnels being refurbished
In construction, implemented with design changes
- Flimserstein Tunnel

- Single tube
- 2.9 km long
- Gradient 5.5%
- Construction started end 1999
- Ventilation redesigned 2002
- Opened to traffic in 2007
Flimserstein Tunnel – original design

- Continuous smoke extraction (minimum 80 m³/s,km) through a separate ventilation duct along the tunnel, OR
- Smoke extraction from centre of the tunnel (minimum 200 m³/s) plus two escape ways to the open plus reversible jet fans
Flimserstein Tunnel – guidelines-compliant design

- Smoke extraction system with twin fans AND
- Regularly spaced escape routes to open (parallel tube)
In construction, guidelines cannot be fully implemented - Spier Tunnel

- Twin tube
- 1.6 km long
- Gradient ±3%
- Construction started 1996
- Ventilation redesigned in 2001
- Opened in 2004
Spier Tunnel

- Cut & cover tunnel
- Built in stages to keep motorway open
- Longitudinal ventilation with jet fans planned
- New guidelines require:
  - smoke extraction system (not feasible)
  - cross connections every 300 m
- Safety improved by:
  - more jet fans
  - more cross connections
  - kerbside guidance lighting
  - traffic management system to minimise congestion
Spier Tunnel
Conclusions

• The requirements of new guidelines can be incorporated into tunnels at any stage of their life

BUT

• The requirements may not be able to be fully implemented and the required level of safety has to be achieved using alternative measures
Thank you for your attention
