"Experience with Significant Incidents in Road Tunnels"

Findings from the new PIARC report

presented by

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Role of PIARC in road tunnel safety

- The World Road Association PIARC is a non-profit organisation established in 1909
- PIARC’s mission: to improve international co-operation and faster progress in the field of roads / road transport
- Since several working cycles the Technical Committee „Road Tunnel Operations“ is dealing with tunnel safety issues

Technical Report:

“Experience with significant Incidents in Road Tunnels” as output of WG “Feedback from Experience in Tunnel Safety to be published soon in the PIARC virtual library www.piarc.org
Quantitative information in earlier PIARC publications is quite old (e.g. report 05.05B “Fire and Smoke Control in Road Tunnel” from 1999).

EC-Directive 2004/54/EC established requirements for a systematic incident data collection and evaluation.

In many countries a lot of experience / data on aspects regarding tunnel safety has been collected.

PIARC is able to collect information from many countries to provide an international perspective.

A more complete and more specific incident data set enhances tunnel safety management tools (like risk assessment).

Incident evaluation is important element of feedback chain in an integrated approach to road tunnel safety.
• Role and importance of “new lessons learned” - highlighted in PIARC report 2007/R07 “Integrated Approach to Road Tunnel Safety”
• “new lessons learned” can be a result from incident evaluation as well as risk assessment
General Approach

Basic concept of report:

Basis:

• Reports, studies, national statistics provided / evaluated by members of working group
• Interviews with tunnel operators, information on real incident provided by tunnel operators
General Approach

• Report is addressing **significant incidents**

• **Definition:**
  Significant incidents have the potential to **develop into events with serious consequences** to the health or life of people, to property, to infrastructure or to the environment
Collisions within Road Tunnels

Specific tunnel influence

acts on occurrence & consequences of tunnel collisions:

• Specific types of collisions cannot occur in tunnels; others have a reduced probability of occurrence in tunnels

• Specific types of collisions have an increased probability of occurrence

• The consequences of collisions in tunnels may be increased, mainly caused by space limitations

• Emergency response may be impaired, due to impeded access to an incident for the emergency services
Collisions within Road Tunnels

Relevant parameters - influencing collision rates in road tunnels

- Basic tunnel configuration (unidirectional/bidirectional)
- Horizontal and vertical alignment
- Driving lanes: number, width, distance between lane and wall
- Presence, distance of lay-byes, emergency lanes
- Tunnel length / tunnel zone
- Traffic load, composition and characteristics (share of HGV)
- Intersections and ramps
- Speed
- Quality of tunnel lighting, optical guidance
- Driver information and traffic management systems
- Technical standards of the vehicles in use
- Cultural factors: driving habits
Results of PIARC studies on tunnel collisions

- Problems in assessing the influence of these parameters
  - Combined influence of parameters is complex
  - Little evidence that influence of parameters can be addressed individually
  - Complex interaction impedes simple conclusions – hence quantification of parametric influence is challenging
  - Studies providing more specific information are available, but great care has to be taken when discussing and comparing results

- Estimation of collision rates for various countries (coll. with casualties)
  - Vary within a range of 2-12 collision per 100 Mio.veh.km
  - Are not necessary representative of all tunnels of a country
  - Are therefore depicted in relation to the corresponding traffic
  - Cover a certain period of time, which differs from country to country
  - Decreasing over time, when data was covering a longer period
Collisions within Road Tunnels

Total number of collisions with casualties in relation to the corresponding traffic - **unidirectional tunnels**

![Graph showing collisions within road tunnels.](image)
Collisions within Road Tunnels

Total number of collisions with casualties in relation to the corresponding traffic - bidirectional tunnels
Tunnel fires

- **Objectives of PIARC activities**
  - Compiling **new information on fire incidents** and fire rates based on tunnel incident statistics from 12 countries around the world
  - **Focus on likelihood** of tunnel fires rather than on consequences

- **Definition of tunnel fire – relevant for data collection:**
  - Unwanted or uncontrolled combustion process characterized by heat release and accompanied by smoke flames or glowing
  - Smoke releases without fire are not addressed as fire
Tunnel fires

- Types of tunnel fires distinguished with regards to their characteristics:
  - **Fires resulting from vehicle defect**: in most cases shielded fires, developing slowly in the first phase, with progressive development in later phase
  - **Fires triggered by a collision**: often accelerated by (limited amounts) of fuel that has leaked as a result of the collision
  - **Flammable liquid fires**: pool fires with large amounts of flammable liquids

- Estimation of fire rates for various countries:
  - Vary within a range of 5 and 20 fires per billion veh.km
  - Are not necessarily representative of all tunnels of a country
  - Are therefore depicted in relation to the corresponding traffic
  - There is a significant uncertainty associated with recording of tunnel fires
Total number of fires in relation to the corresponding traffic – all tunnels
Objectives of PIARC activities:

Provide a realistic and illustrative picture of incidents happening in road tunnels (in addition to statistical approach), based on

- Information on real incidents randomly selected worldwide by TC3.3 members (with interviews on the basis of a questionnaire)
- 34 case studies from 16 countries – documented in appendix 5
- Information gathered on:
  - Type of incident
  - Type of vehicles involved
  - Main tunnel characteristics
  - Main lessons learned from the incident from different points of views
- For some incidents pictures and/or videos are available
Real incidents

Example: HGV producing smoke stops inside tunnel
Due to a Turbo compressor failure a HGV is producing large amounts of white smoke, while driving through a tunnel with bidirectional traffic

• It finally stops (1)
• All other vehicles are passing by, nobody assists
• All kinds of forbidden behaviour can be observed, such as
• overtaking (2), driving backwards (3), making U-turns(4)
Real incidents

Results of PIARC studies:

Set of conclusions of general interest regarding human behaviour, tunnel operation, emergency response and tunnel infrastructure and equipment

- Example of findings useful in a broader sense – human behaviour
  - Inadequate behaviour of car drivers: the most common cause of tunnel incidents, may also cause problems in incident management
Real incidents

Example of inadequate behaviour of car drivers
Real incidents

Results of PIARC studies:

Set of conclusions of general interest regarding human behaviour, tunnel operation, emergency response and tunnel infrastructure and equipment

- Example of findings useful in a broader sense – human behaviour
  - Inadequate behaviour of car drivers: the most common cause of tunnel incidents, may also cause problems in incident management
  - In a fire, drivers often pass by the vehicle on fire as long as they think it is possible to do so, despite of the potential danger
  - Evacuation instructions (through broadcast, loud speakers and/or message signs) are often followed by road users, when provided in an understandable manner.
Real incidents

Adequate and inadequate human behaviour in a bus fire
Real incidents

Results of PIARC studies:

Set of conclusions of general interest regarding human behaviour, tunnel operation, emergency response and tunnel infrastructure and equipment

Example of findings useful in a broader sense – human behaviour

- **Inadequate behaviour of car drivers**: the most common cause of tunnel incidents, may also cause problems in incident management
- In a fire, **drivers often pass by the vehicle on fire** as long as they think it is possible to do so, despite of the potential danger
- **Evacuation instructions** (through broadcast, loud speakers and/or message signs) are often followed by road users, when provided in an understandable manner.
- **Traffic management measures** (such as closing of the tunnel by traffic lights) are often neglected if not enforced by additional means (like barriers)
Data Application

■ Application of data – at local level (specific tunnel)
  • Supports detection of any deficiencies in a specific tunnel
  • Supports prioritization and characterisation of pragmatic risk management strategies
  • May provide input to safety relevant decisions (design, procedures)
  • May contribute to a realistic planning of scenarios for emergency exercises

■ Application of data at national / international level
  • To obtain specific incident rates for different types of incidents / different types of tunnels
  • To provide input data for quantitative risk analysis
  • To provide a basis for establishing a reference framework
Conclusions

- The **data already existing** provides a broad and informative basis for safety-relevant studies – operators are encouraged to make use of it.

- A better knowledge about benefits / results of incident data evaluation **enhances quality and motivation** for incident data collection.

- **Requirements for incident data evaluation influence** scope, content and degree of detail of *data collection*.

- There is a **need for** further and **more specific studies** in particular with respect to *tunnel collisions*.

- Hence the **focus of the new PIARC cycle 2016 – 2019** will be on this topic.
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Thank you for your attention!

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