Operational Safety

- Introduction
- Accidents – lessons learnt and open points
- L-surF – a European initiative for safety
- ITA-COSUF – an international platform

Introduction

Operational Safety
- Underground infrastructures are complex environments, in which – usually because of the great number of users - the risk of tragedy is ever present.
- Operation and maintenance are increasingly complex and expensive.
- In confined spaces, safety is an ongoing concern.

Responsibility for Safe Operation:
- The owner / operator of an infrastructure is responsible for safe operation in normal, maintenance and emergency conditions.
  - be aware of his responsibility (organisation)
  - analyse and to recognise hazards and risks
  - plan according to the rules of technology (standards)
  - realise safety measures according to the state of the art of safety measures during the entire life time of the facility
  - account for the cost-benefit relation of measures
  - know about the residual risks

Safety Parameters

- Tunnel users
- Infrastructure
- Operation
- Vehicles

Safety in Tunnels

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Lessons learnt and open points

Overview on safety measures:

- **Active safety** - through prevention measures to prevent critical events
- **Passive safety** - through well adapted safety measures to mitigate / limit the consequences / damage (construction, technical equipment, organisation)
- **Operational measures** – supervision, alerting, fast intervention and immediate incident response

Lessons learnt and open points

Prescription for safe operation

- **Safety Objectives:**
  - **Primary objective:**
    - to prevent critical events that endanger human life, the environment or the installations.
  - **Secondary objective:**
    - people involved in the incident to rescue themselves
    - immediate intervention of (road) users to prevent greater danger
    - ensuring efficient action of emergency services
    - protecting the environment
    - limiting infrastructure damage

Lessons learnt and open points

The key to success in case of an incident

- **Key requirements:**
  - Rapidity
  - Reliability
  - "Failure safe" mechanisms
  - The operators / owner’s responsibility:
    - Appropriate equipments and systems (design, realization, renewal)
    - Maintenance
    - Innovation!
    - Organisation, instruction and exercises
- **Requirements and approach very similar for road, rail and metro tunnels**

Lessons learnt and open points

Road tunnels - generally a well-solved issue:

- **Technologies:**
  - „Linear“ thermal detection systems (temperature measurement)
  - Optical smoke detectors
  - Video-based systems (image analysis)
- **Issues and need for action:**
  - Sensitivity and velocity of detection
  - Reliability: detect always but prevent false alarms – „intelligent“ cross-check!
  - Cost reduction

The important issues:

- **Rapid detection** (fire, smoke, incident, direct user information etc.)
- **Automatic response** of key safety systems („tunnel reflexes“):
  - Signalisation of escape routes, tunnel closure etc.
  - Ventilation (smoke extraction, control of longit. air velocity)
  - Lighting of escape routes
  - Fire supression systems etc.
- **Warning and instructions** to tunnel users
- **Alarming** of intervention services and operators
- **Evacuation** (human behaviour, capacities of escape routes, safe havens)
- **Communication** (fire services, technical services, ambulances, police)

Fire and smoke detection
Lessons learnt and open points

Fire and smoke detection

Railways & Metros - very heterogenous state-of-the-art:

- Technologies:
  - Detection in vehicles (passenger compartments \(\rightarrow\) Metros)
  - Detection in tunnel less frequent
  - Fixed detection systems for hot train components (brakes, axle boxes, ...)

- Issues and need for action:
  - Standards required
  - New technologies for the infrastructure (espec. hubs)

Lessons learnt and open points

Ventilation

Road tunnels - state-of-the-art well established and advanced:

- Technologies:
  - High to very high level in several countries
  - Requirements / safety levels too heterogeneous in different countries

- Issues and needs for action:
  - International harmonization required, e.g.
    - Applicability of longitudinal ventilation, smoke extraction rates
    - Optimum ventilation control for bi-directional tunnels
    - Interaction with other equipment (e.g. extinction systems)
    - Excessive requirements on operator's capabilities
    - New visions for preventing very expensive retrofits

Lessons learnt and open points

Ventilation

Long Railway tunnels: State-of-the-art too heterogeneous

- Technologies:
  - Safety stations, safe havens (fresh air, smoke extraction), typically every 20 km
  - Cross passages (typically 300 to 500 m)
  - Sometimes longitudinal ventilation of tubes (e.g. Eurotunnel)
  - Requirements too heterogeneous in different countries

- Issues and needs for action:
  - More detailed data on combustion characteristics of modern vehicles
  - More international harmonization required

Lessons learnt and open points

Evacuation

New road tunnels - typically excellent standard:

- Technologies:
  - Separated escapes to the exterior
  - Cross-connections between tubes
  - Safety tunnel with cross-connections
  - Walkways in the tunnel
  - Maximum distance typically in the range of 300 – 500 m
  - Older tunnel have frequently a much lower standard – Retrofit is very expensive.

- Issues and need for action:
  - User information and education!
  - Cost-effective retrofit technologies

Lessons learnt and open points

Ventilation

Metros

Very heterogeneous situation - Local standards often more history-than technology-dominated:

- Typical ventilation strategies:
  - Comfort ventilation in stations
  - „Push – pull“ between stations, longitudinal ventilation with jet fans
  - Ventilation and smoke extraction in stations

- Issues and need for action:
  - More detailed data on combustion characteristics of modern vehicles
  - Homogenization of strategies
  - Homogenization in application of design tools (CFD)
Lessons learnt and open points

Evacuation

Metros – more and more deep stations:

- Safety concept:
  - Definition design fire & number of people in the station
  - Safe escape routes (2 independent ways)
  - Safe havens in the shaft: overpressure > critical velocity
  - Safety case: fire modelling and evacuation simulation
  - Ventilation in the running tunnel
  - Protected fire compartments

- Issues and action needed:
  - In vehicles: fire detection and FFSS (water mist)
  - Deep stair cases plus long ways to surface
  - Mezanine level with high safety requirements
  - Harmonization of strategies is required

Example: Metro Barcelona (1)

Metro Line 9 Barcelona - deep shaft stations:

- Fire compartments

Example: Metro Barcelona (2)

Metro Line 9 Barcelona - deep shaft stations

- Design fire

Example: Metro Barcelona (3)

Ventilation (example)

Example: FFSS (1)

Road tunnels:

- Technologies:
  - Fixed fire supression systems for road tunnels quite effective
  - Different techniques (water mist, sprinkler, foam, …)
  - Choice of technology difficult
  - Expensive in long tunnels

- Issues and need for action:
  - Reliability is still an issue (depending on technology)
  - Activation strategy and mode
  - Interaction with other safety equipments needs careful design
  - Define rules for application: where needed, rather than in all tunnels!
Example: FFSS (2)

Road, rail and metro tunnels and infrastructures, rolling stock:

- Research projects showed effectiveness of FFSS (water mist) for tunnel applications (e.g. UPTUN (EU), SOLIT (D))
- Water mist technology highly accepted: in road tunnels, railway / metro vehicles, technical rooms and platforms
- Positive effects on
  - Evacuation of persons,
  - Safe conditions for intervention services
  - Protection against structural damage
- Further research activities are in preparation (SOLIT II)

Example: FFSS (3)

Example: FFSS (4)

Issues, need for action:

- Reliability is still an issue
- Activation strategy and mode
- Better cost-effectiveness for long tunnels
- Dependencies with ventilation situation
- Interaction with other safety equipments need careful design
- Define rules for application: where needed, rather than in all tunnels!
- High accuracy to combine fire detection and localisation systems

Lessons learnt and open points

Immediate response (operator)

In general:

- Technologies:
  - Tunnel management system to bring together many subsystems of the infrastructure
  - Scenarios-based pre-defined response plans
  - Alarming and warning also to users
  - Formation and training of operators

- Issues and need for action:
  - Adequate response in different situations:
    - all emergencies and special situations
    - traffic diversion, maintenance,

Lessons learnt and open points

First responders and intervention forces

In general:

- Adequate equipment (interruption of event chain, cooling, self-protection)
- Formation (specific hazards in long tunnels during intervention, reaction to special situation)
- Intervention plans
- Exercises!

- JANUS (Mont Blanc road tunnel)
- Extinguishing & rescue trains
- LUF 60 (rail, road tunnels)

Lessons learnt and open points

First responders and intervention forces

In general:

- Adequate equipment
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Lessons learnt and open points

Conclusions

Operational safety / safe exploitation needs
- Adequate planning during design phase
- Adequate safety measures
- Complex infrastructures need more and more smart systems for underground intelligence
- Maintenance + continuous modernisation!
- Exercises!

Therefore innovation & research efforts should aim ...
- to reach high safety level with good cost-benefit ratio
- to develop & optimize smart and robust systems for safe underground infrastructures

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L-surF – An European Initiative for Safety

Content
1. L-surF Project
2. Partners
3. Business Scenarios
4. L-surF Foundation
5. Outlook

What is (was) the L-surF project?

1. Design study within the Sixth Framework Programme of the European Community
2. Cooperation of 5 European leading Institutes on safety and security for underground facilities

L-surF – An European Initiative for Safety

Objectives of the project

1. Feasibility study
   for harmonisation and coordination inclusive feasibility of R&D facilities [layout, R&D needs, activities, clients, partners etc.]
2. Scientific and technological research
   technical specifications for a convertible contour, shape and size scheme (CCSS) and innovative 2D and 3D measurement sensors
3. Business plan
   including users, customers and financial options for the different business scenarios
4. To establish legal entities called L-surF
L-surF – An European Initiative for Safety

L-surF’s strategy – Base of the Scenarios

Theoretical approach:
• Need for European harmonisation
• Collaboration and exchange in desk research

Experimental approach:
• Existing R&D facilities require standards for test and research activities
• Need for a ‘Gap’ facility and/or a groundbreaking new research facility was identified

Business Scenarios

A – Harmonisation / Coordination
B – Collaboration among existing
  • research organisations (RO) and
  • research infrastructures (RI)
C – Collaboration among existing RO / RI plus implementation of ‘gap facility’
D – Groundbreaking new research facility

Business Scenario A
• Coordination and harmonisation
• Networking between existing research infrastructures and other key players in safety and security for underground structures
• Service for the design and execution of large scale experiments
• Translate research questions and requests into research programmes and coordinate the SRA

Business Scenario B
• Use of the existing research facilities (L-surF partner facilities – present and future)
• Integrated approach to safety and security research
• Offering a ‘one stop shop’ for large scale experimental services
• Increase the efficient use and sustainability of the L-surF partner facilities within the European Research Area

Business Scenario C
• Completion of the existing research facilities with a ‘Gap facility’
• Possible gaps to be bridged could be:
  • Hub – vertical connection between different means of transportation
  • Versatile cross sections for experiments in underground environment
  • Boundary conditions relevant for human behaviour research
  • Flexible ventilation for the whole Research Infrastructure (RI)
• to answer new R&D questions

Business Scenario D
• The groundbreaking new research infrastructure
• Flexible cross sections, shapes and sizes (CCSS)
• Meeting all requirements worked out during the L-surF project
• Satisfying environmental criteria (waste water treatment, waste air treatment, e.g.)
Description of the Scenario D-facility

- Core element is CCSS (Convertible Contour and Shape Scheme)
- Lay out of civil works
- Definition of auxiliary rooms and installations
- Environmental aspects and site check

Purpose of L-surF

- L-surF will be a strong player in the European Research Area
- Collaboration and harmonisation in the field of underground safety and security research
- To provide a pan European network of facilities and scientific personnel to the research community

L-surF - Foundation and L-surF - Services

Continuation of activities on results of the L-surF project:
- L-surF - Foundation
- L-surF - Services

L-surF - Foundation

L-surF Foundation has been established jointly by the L-surF project partners. It holds the IR of the L-surF project.

The operational branch of the L-surF Foundation is L-surF services.

L-surF - Services

L-surF services is the jointly developed activity of the L-surF Foundation and its partners, offering:
- Expertise on testing and safety R&D
- Training and education
- Support in the implementation of standards as an activity of the L-surF entities.

Outlook

- Legal entities are active according to business scenarios and business plans
- Partners, collaborators, co-operators, associates etc. are welcome
- Private and public (both national and international) funding are raised
- 'Lobbying' for business scenarios C and D (ESFRI, EU nations)

www.l-surf.org
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1. Origin, Scope and Objectives of ITA-COSUF
2. Structure of ITA-COSUF
   - Activity Groups
   - European Forum of Road Tunnel Safety Officers
   - Membership
3. Activities

Scope

The scope of ITA-COSUF is:

- Safety in tunnels and other underground facilities in operation, not during construction.
- Safety during construction is covered by ITA WG 5 „Health and Safety“
- Security is considered as part of safety.

Objectives (1)

Objectives of the activities of ITA-COSUF are:

- Maintain and develop a network to:
  - exchange knowledge
  - encourage collaboration
  - create dedicated teams for specific research activities
- Facilitate co-operation world-wide
Objectives (2)

• **Promotion of safety (and security)** by:
  – fostering innovation
  – raising public awareness of current and newly developed safety (and security) issues

• **Raising** of national, European and international funds
• Promoting of **financial support**
• Supporting the **development of improved regulations**

Addressees

ITA-COSUF addresses the following categories of people, organisations and bodies:

- decision makers, 
- professional end-users, 
- consultants and risk managers 
- contractors, manufacturers and suppliers 
- operators 
- financers 
- first responders 
- international forums and other stakeholders.

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3. **Activities**

Basic Structure

COSUF is structured in 3 Activity Groups (AG):

- **AG 1:** Interaction with European and International Initiatives
- **AG 2:** Regulation and Best Practice
- **AG 3:** Research and New Findings

Led by Coordinators the AGs get their strategically advice and support from the SB. The SB reports to the annual ITA-General Assembly.

The Activity Groups (1)

The objectives of the AGs are:

• to contribute to sufficient safety and security for tunnel users, operator-staff and rescue personnel
• to support and develop cost efficient solutions
• to respect life-cycle aspects, economical and societal demands
• to combine innovation and visions of future needs and technical possibilities

The Activity Groups (2)

The AGs themselves do not conduct studies, research or similar commercial work which could be done by institutes or companies.

They should develop to **Centers of Excellence** for world-wide exchange of information and know-how regarding safety and security of tunnels.
Activity Group 1
Interaction with European and International Initiatives

Scope:
• Take and keep contact with external institutions, groups, and projects like ECTP, ETPIS, PIARC, ISO, fib, RILEM, TUNCONSTRUCT, and EuroTAP
• Avoid duplication of activities
• Give externally information about COSUF
• Influence activities of third parties

Activity Group 2
Regulations and Best Practice

Scope:
• Cover regulations, state-of-the-art and best practice in various countries world-wide
• Discussion and comparison of regulations and practice procedures of different owners, operators, networks, projects

Activity Group 3
Research and New Findings

Scope:
• motivate to relevant research
• encourage the use of research results and findings to improve safety and security in underground facilities
• specify needs of new research

European Forum on Road Tunnel Safety Officers

• EU Directive 2004/54/EC introduced Safety Officers. They are in charge of …coordinating all preventive and safeguard measures to ensure the safety of users and operational staff.
• Since 2004 a lot of such Safety Officers have been appointed
• The ITA COSUF Forum will offer a platform to exchange experiences, know-how etc among the Safety Officers

Membership

• Invitation to all parties world-wide interested in operational safety and security of tunnels and other underground facilities
• Exclusively corporate members, no individual members
• COSUF membership does not require ITA membership
• Membership in both association is possible and welcome

Members of COSUF (status September 2008)

57 Members from 15 Countries
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Activities 2006 - 2009

- 11 Workshops on i.e.:
  - Fire protection engineering for new and existing Tunnels
  - New aspects in tunnel safety
  - Safety in metro and railway tunnels
  - Emerging technologies for tunnel safety
  - New energy carriers and tunnel safety

Activities 2006 - 2009

- 7 presentations i.e. on:
  - Fire in tunnels – design options and possibilities
- 4 General Assemblies
- 11 AG and SB meetings

Activities 2009 onward

- Workshop 5.10.2009, Lyon, France on Safety Challenges
- 1. European Forum for Road Tunnel Safety Officers, 4.10.2009, Lyon, France
- Workshop and GA 2010, 17.-19.3.2010, Frankfurt, Germany

Mission Statement ITA-COSUF

ITA COSUF, the Centre of Excellence
for world-wide exchange of information and know-how regarding safety and security of underground facilities
Thank you for your attention!