

**World Road Association (PIARC)
Technical Committee 4.4: Road Tunnels
Meeting: 23 – 28 October 2022**

Strategic Theme 4: Resilient Infrastructure

Goal

The goal of Strategic Theme 4 is to improve the quality and efficiency of road infrastructure through the effective management of assets in accordance with user expectations and government requirements. TC 4.4 has been formed to focus on road tunnels within Theme 4.

Overview

This was the sixth meeting of the full Technical Committee and was held in-person in Granada, Spain. The purpose of this TC 4.4 meeting was to present and discuss the main activities and products of the TC 4.4 Work Groups, discuss preparations for the next meeting in India which will include a second international seminar and preparations for the World Road Congress. I did not attend in-person and was later provided with a briefing on the key outcomes of the meeting.

23 October 2022

Mr Ingo Kaundinya (Chair of TC 4.4) opened the meeting and 31 members participated.

TC 4.4 has 73 full members, including corresponding members and 17 Associate members. There are also 84 Associate members in our Work Groups.

Work Groups

Work Group 1 – Best Practices in Urban and Heavily Trafficked Tunnels

This Group is working on best practices in management (maintenance and traffic operations) in urban and heavily trafficked tunnels. It has prepared and published a Case Study Report in April 2022.

The full technical report will include the case studies and analysis of each case study leading to recommendations for traffic operation, maintenance, and refurbishment strategies. It includes an update of the PIARC report from 2008, titled “Urban tunnels – recommendations to managers and operating bodies for design, management, operation and maintenance”. A draft version of the full technical report has been prepared and is being reviewed by the whole Technical Committee. Publication of the report is expected in early to mid- 2023.

Work Group 2 – Tunnel Resilience

The Work Group is developing a report on increasing tunnel resilience with the aim of increasing the availability of tunnels, safely. The Group’s literature review has been completed and a report published by the WRA in March 2021. The Group has prepared 18 case studies on tunnel resilience from 13 countries (including one case study from Australia). The case studies together with the literature review, form a briefing note report, which was published in March 2022.

The final full report will include a road map to manage and improve resilience. Detailed measure sheets will also be included for operational recovery measures describing advantages/disadvantages, points of attention for implementation and an assessment of cost effectiveness. The final Technical Committee version of the full report will be available for the World Road Congress in 2023. Approval of the report by PIARC and its publication are anticipated in late 2023 or early 2024.

I am a member of this Work Group.

Work Group 3 – Intelligent Transport Systems in Tunnels

This Work Group is examining ITS developments for road network management and what could be applied in tunnels to improve safety and traffic flow efficiency. This Group is using surveys to obtain some of the information for its report.

The structure of the technical report has been developed, but data collection is on-going. Aiming to complete the full report with the required approvals to present the report at the World Road Congress. If the report is further delayed, the Work Group will consider preparing a technology watch document.

Work Group 4 – Impact of New Propulsion Technologies

This Group is studying the impact of new propulsion technologies on road tunnel operations and safety and how to prevent and mitigate the potential consequences of incidents involving alternative fuel vehicles. A collection of case studies has been completed and presented in a report which was published in 2022.

A full technical report is being prepared. Data for fire risks involving electric passenger vehicles is available but data is lacking for electric heavy vehicles with large batteries.

Draft full technical report is expected to be ready for review by April 2023 and submission to PIARC General Secretariat for approval by June 2023.

The Work Group is finding that there is much new development and research on this topic. Hence, this topic may continue into the next PIARC cycle.

Task Force – International Conference

The 2nd international road tunnels conference was held successfully in Granada immediately following the Technical Committee meeting.

Task Force – DGQRAM

DG-QRAM is software that is used to classify tunnels for use by particular dangerous goods vehicles. In the current cycle, the software has been further upgraded to better meet user's needs. The upgraded tool is expected to be ready for use in early 2023. Training sessions for the new DG-QRAM software will be organized in 2023. Further modules could be developed for DGQRAM, but further funding is required.

Task Force – Knowledge Management

This Task Force continues to progressively update the manual with new content from the last cycle and the current cycle expected. Case study reports prepared by the Work Groups will be included in the appropriate sections of the manual.

International Seminars in Developing or Transition Countries

Our 2nd International Seminar in a developing or transition country will be held in Dehradun, India during the third week of April 2023. Approximately 1,000 people are expected to attend.

The main topics of the seminar are design, construction, safety, operation and maintenance of road tunnels. Consideration is being given as to which of the Technical Committee members will make presentations at the seminar.

24 October 2022

World Road Congress 2023 – Prague

Our Technical Committee is invited to make presentations at the World Road Congress on the following topics.

Topic 47 – Digitalisation of road tunnel design and management.

Topic 48 – Road tunnel operation and safety issues related to the usage of new energy carriers in road vehicles.

Abstracts for papers for the Congress have been submitted and reviewed.

Review of full papers by our Technical Committee in Feb-April 2023.

We expect our Technical Committee will have three hours of content to present on:

- Reports from each of our four Work Groups
- Possibly present on DGQRAM
- Paper(s) prepared on road tunnels by an author from outside our Technical Committee on Topics 47 & 48.

Liaison with other organisations

ITA and ITA Cosuf

ITA Cosuf aims at being the center of excellence for world-wide exchange of information and know-how regarding safety and security of underground facilities. In ITA, its work groups focus on planning, engineering and construction of tunnels.

ITA and ITA Cosuf have been working closely with PIARC at work group level on key road tunnel issues. They would like to extend the partnering to include presentations at various road tunnel seminars and conferences around the world.

NFPA & AASHTO

AASHTO Tunnel Committee is currently working on:

- Update on NCHRP 20-07/task 425 emerging LED technologies.
- Large diameter tunnel lining research.
- FHWA tunnel research update
- Department of Energy update on alternative fuel vehicles.
- Update of fixed fire suppression system research.

NFPA 502: Standard for Road Tunnels, Bridges, and other Limited Access Highways, includes:

- Fire protection and fire life safety,
- Structural fire protection,
- Automatic fire detection systems by fire alarm and signaling code.

CIE-International Commission on Illumination

Only one committee of this organisation is currently active. This is the committee dealing with tunnel lighting evolution.

It is revising CIE 88: 2004, Guide for the lighting of road tunnels and underpasses and it is currently finalising the following topics in the guide:

- Methodology for lighting short tunnels
- Dynamic control of a LED lighting system
- Energy saving

CENELEC

A CENELEC working group is writing a new standard on the "Measurement of Road Tunnel Air Quality" (EN 50545-2).

Some observations of its work so far on the status of air quality:

- Carbon monoxide (CO) concentrations have fallen sharply and visibility levels have improved.
- Nitrogen monoxide (NO) concentrations are generally less than 5 ppm and can rise to 10 ppm in certain tunnels depending on the proportion of heavy goods vehicles.
- The most critical pollutant in road tunnels is nitrogen dioxide (NO₂). Concentrations of NO₂ observed are a few hundred ppb (200 to 400 ppb generally).

Potential Topics for the Next Cycle

Possible topics for the next cycle of the Road Tunnels Committee were discussed at the last meeting and again at the meeting in Granada. We considered the following topics to be worthy contenders and will be submitted to PIARC for consideration.

- Road tunnel operations and safety issues related to the usage of new energy carriers in road vehicles.
Consider collecting data relating to incidents. Currently, relatively little is known about the frequency and nature of incidents.
Possibly prepare advice for first responders.
Heavy goods vehicles using hydrogen.
New developments in battery technologies.
Recognition of new energy carrier vehicles and dangerous goods vehicles.
- ITS in tunnels. Consider preparing a briefing note to provide an update on developments.
- Sustainable tunnels.
Decarbonisation of tunnel system equipment and tunnel operation and maintenance.
Energy efficiency.
Use of prefabrication techniques.
Use of innovative materials and equipment.
Increase of tunnel equipment and tunnel system lifecycle.
Condition monitoring of tunnel equipment.
Focus on new and existing/refurbished tunnels.
Tools and methods for assessing the sustainability in the planning/design phase.
- Cybersecurity: practical approaches for road tunnel operation.
- Equipment asset management: renewal planning, lifetime optimisation.
- Further development of DG-QRAM.
- Continuous update of the Road Tunnels Manual.
- Digitalisation of road tunnel design and management. Application of artificial intelligence. Live monitoring of operations.
Digital twins for life cycle management, the support of fast and smooth commissioning of a new or renovated tunnel and its equipment or the use of digital twins in the training of tunnel control center staff, first responders and stakeholder management.
- Consider setting up a Task Force to review PIARC reports relating to road tunnels and decide which reports to retire because they are outdated.

Technical Presentations

Lessons learned about breakdowns, accidents and fires in road tunnels

A study of crashes in 96 road tunnels in France over a 10 year period (2002 – 2011) resulted in the following conclusions:

- Accident rates and casualty rates are lower in tunnels than in open air.
- The tunnel slope influences 3 types of incidents. The crash rate increases with an increase in slope. The crash rate on a 5% slope is 1.35 times the rate on a 1% slope.
- Unidirectional tunnels influence accidents due to human behavior and the influence of the number of lanes.
- The HGV rate influences breakdowns, accidents resulting in injuries and fires.
- Interchanges (in tunnels and less than 500m from tunnels) influence accidents.

Critical findings for tunnel functional systems

AASHTO undertook a study to identify methods and practices employed by state DOTs to identify critical findings of tunnel functional systems. A tunnel functional system includes electrical, mechanical, fire suppression, ventilation, lighting, communications, monitoring, drainage, traffic signals and emergency response. Several conclusions were drawn from the study and a key observation seems to be the importance of establishing Minimum Operating Requirements for each system in each tunnel to identify when closure of the tunnel is required due to loss of functionality or failure of a functional system.

Air curtains to retain the smoke released by fire

A paper on this topic was presented by Joao Carlos Viegas. The paper analyses the possibility of using air curtains to prevent smoke flow from fire compartments. It includes the results of tests and develops an analytical tool for predicting the performance of air curtains. It is concluded that it is possible to achieve smoke-tightness using a cold air curtain.

Next Meetings

At this time, we have planned the following meetings of the Technical Committee:

April 2023: Seminar in Dehradun, India and TC meeting.

October 2023: World Road Congress in Prague, Czech Republic and a TC meeting.

25 – 28 October 2022 – 2nd International Conference on Road Tunnel Operations and Safety

Our 2nd International Conference on Road Tunnel Operations and Safety brought together nearly 700 participants in Granada.

There were 7 sessions:

- Session 1: New challenges on tunnels for the 2030 target.
- Sessions 2 & 5: Operation and sustainable management of tunnels.
- Session 3: Management of urban and high traffic road tunnels.
- Session 4: New vehicle propulsion energies and their impact on road tunnels.
- Session 6: Ventilation and lighting.
- Session 7: Current situation of tunnels in relation to standards.

Two technical visits followed, one in Madrid for the 30 Tunnel, and the other for the Oriental Tunnel in Andalusia.

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November 2022