# Roles of FHWA, AASHTO, and TRB in Coordinating U.S. Participation in the WRA

- FHWA—First Delegate
  - Provides the U.S. First Delegate
  - Coordinates participation of Federal delegates
  - Provides support to technical committee and task force members, as needed
- AASHTO—U.S. National Committee to the WRA
- TRB—Technical Partner
  - An information resource for WRA committees; coordination is encouraged between WRA and TRB committees
  - Provides additional leadership and support for U.S. participation at the World Congresses

# PIARC TC D.5 Activities Webinar

The Goal of the Webinar is to present the work and achievements of the Technical Committee D.5 (TC-D.5), Road Tunnel Operations in 2016-2019 cycle

The goal of the Committee is to maintain and disseminate the state of practice information regarding sustainable road tunnel operations and development of relevant training and presentation materials.

Bijan Khaleghi, PhD, PE, SE, WSDOT -PIARC– USA, TC D.5 Member

# PIARC TC D.5 – Tunnel Operation

## Presenters:

- Marc Tesson - CETU/Chargés de Mission . PIARC TC D.5 Current Cycle Chairman
- Ingo Kaundinya, Head of Section B3 – Tunnel and Foundation Engineering, PIARC TC D.5 Next Cycle Chairman
- Bijan Khaleghi, PIARC– USA, TC D.5 Member

## Webinar Coordinators:

- Ms. Agnes R. Vélez: Multinational Relations Team Lead, FHWA
- Ms. Elaine Ferrell, Distance Learning Program Coordinator, TRB-NCHRP

# U.S. PIARC Representatives Meeting , TRB Washington D.C. - 2019

1. Thomas Everett, United States First Delegate
2. William “Bill” Anderson, TRB
3. King Gee, Secretary, U.S. National Committee
4. Patrick Malléjacq, Secretary General, WRA
5. Niel Pedersen, Executive Director, TRB
6. Jim Tymon, AASHTO, Executive Director, Chair of U.S. National Committee
7. Agnes Velez, FHWA, International Programs
8. William Bergeson, TRB, TC D.5
9. Leslie Wright, FHWA - International Programs
10. TC Members and Representatives

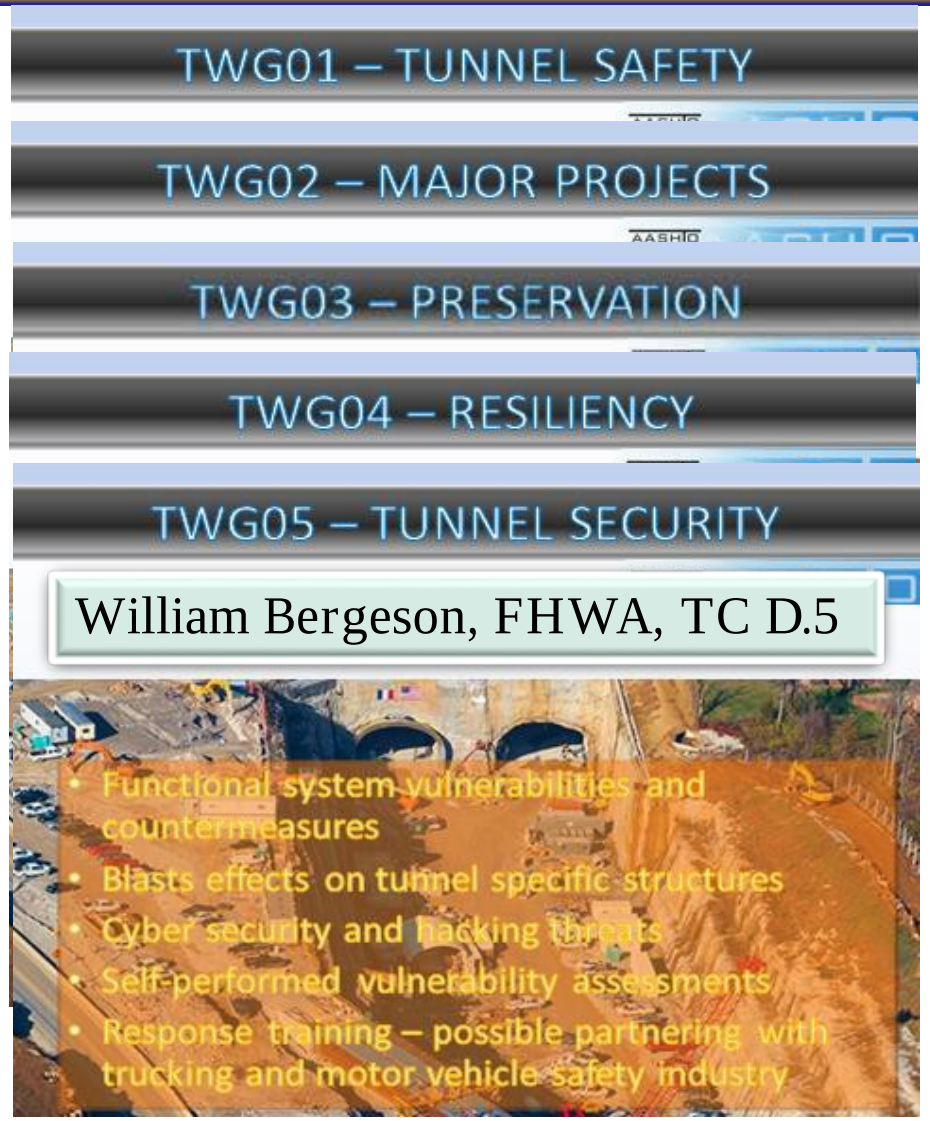
# AASHTO Committee on Bridges and Structures (COBS)

T-1, Bridge and Tunnel Security, T-2, Bearings and Expansive Devices,
T-3, Seismic Design, T-4, Construction,
T-5, Loads and Load Distribution, T-6, Fiber Reinforced Polymer Composites
T-7, Guardrail and Bridge Rail, T-8, Movable Bridges
T-9, Bridge Preservation, T-10, Concrete Design
T-11, Research, T-12, Structural Supports for Signs, Luminaires, and Traffic Signals
T-13, Culverts, T-14, Structural Steel Design
T-15, Substructures and Retaining Walls, T-16, Timber Structures
T-17, Welding, T-18, Bridge and tunnel Management, Evaluation,
T-19, Software and Technology

## T-20, Roadway Tunnels (Chair: Lou Ruzzi)

# AASHTO T-20 Objectives:

- Identify research opportunities and provide research and emerging technology to states and other users
- Work with FHWA, TRB, and other tunneling agencies to develop best practices/guidelines/specifications in design, construction, maintenance, inspection and operation of roadway tunnels
- Collaboration with other national and international tunnel groups



| Rank | Country | Total length (km) | Number of tunnels | Year |
|---|---|---|---|---|
| 1 | China | 15285 | 16229 | 2017 |
| 2 | Japan | 4026 | 9760 | 2012 |
| 3 | Norway | 1338 | 1400 | 2017 |
| 4 | Italy | 900 | | 2000 |
| 5 | Korea | 649 | 932 | 2011 |
| 6 | Switzerland | 403 | 468 | 2011 |
| 7 | Spain | 233 | 250 | 2015 |
| 8 | United States | 185.4 | 504 | 2018 |
| 9 | Germany | 183 | 243 | 2006 |
| 10 | Faroe Islands | 43.7 | 20 | 2018 |
| 11 | Netherlands | 34 | 38 | 2013 |
| 12 | Sweden | 20 | 21 | 2006 |

**Five States, CA, WA, MA, CO, and PA have ½ of all the tunnels.**

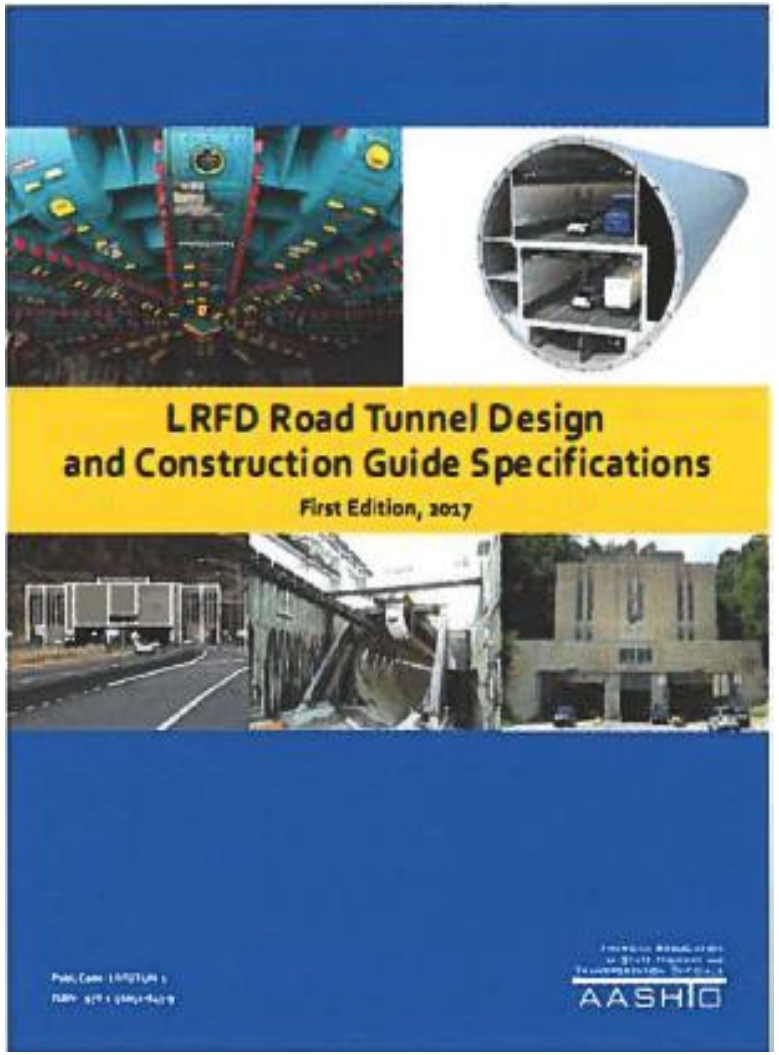
# AASHTO LRFD Road Tunnel Design and Construction Guide Specifications, 1st Edition 2017.

NCHRP 12-89 Project Objectives:

Develop LRFD-based Tunnel Design and Construction Specifications with Considerations for:

- Safety,
- Operations,
- Maintenance,
- Inspection

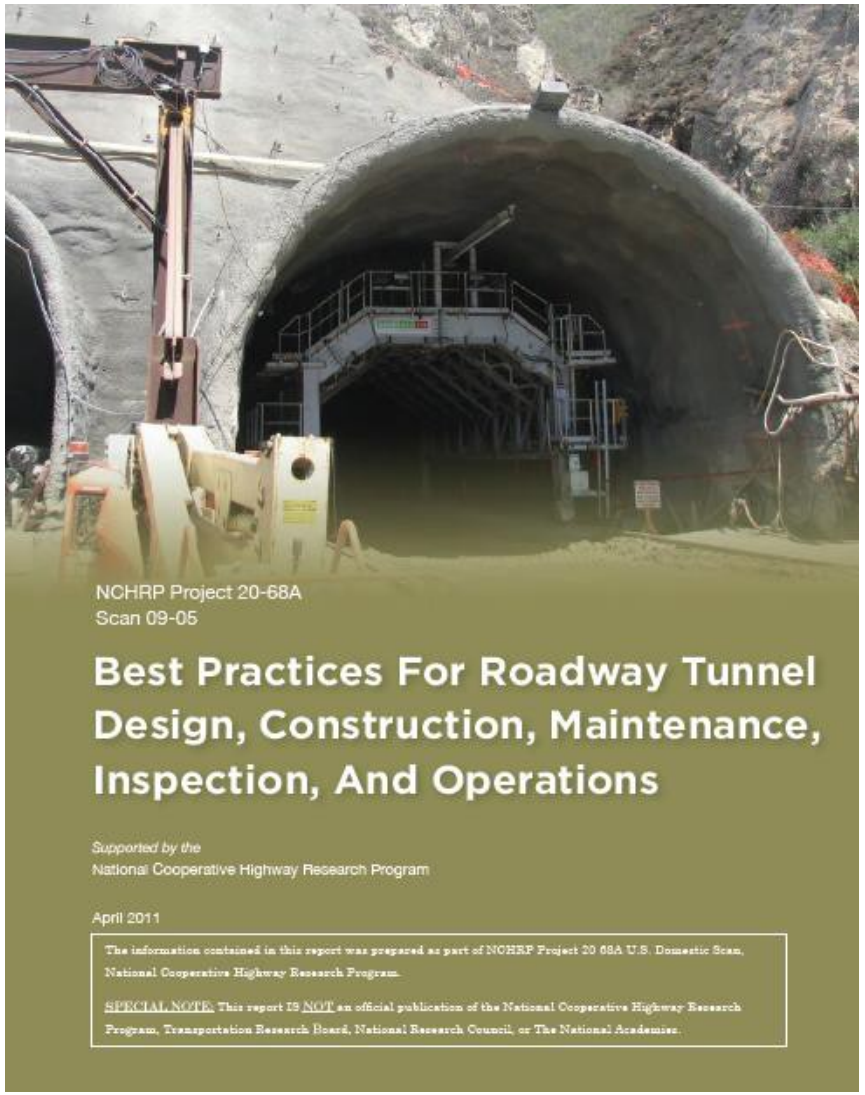
Comparison between International and AASHTO Tunnel Design and Construction Specifications – Discussions and Feedback



# National Cooperative Highway Research Program (NCHRP) – Tunnel Projects

- NCHRP 20-59(47) - Emergency Exit Signs and Marking Systems
- NCHRP 14-27 - Preservation Guide for Highway Tunnels.
- NCHRP 20-67 - Making Transportation Tunnels Safe and Secure
- NCHRP 20-07/Task 276 - Development of Guidelines for Rehabilitation of Tunnels
- NCHRP 20-07 - Best Practices for Implementing QC/QA for Tunnel Inspection
- NCHRP 20-07-Best practices for Coordinated Ventilation in Roadway Tunnel's
- NCHRP Synthesis 20-05 - Design Fires in Road Tunnels
- NCHRP 20-68A, Scan 09-05 - Best Practices for Tunnel Design, Construction, Maintenance, Inspection, and Operations

# U.S. Domestic Scan, NCHRP Project 20-68A, A team of DOTs, FHWA, Practitioner, and academia investigate the latest techniques and Findings



# TC D.5 – Road Tunnel Operations

D.5.1 Road Tunnels Manual:

D.5.2 Sustainable road tunnel operations

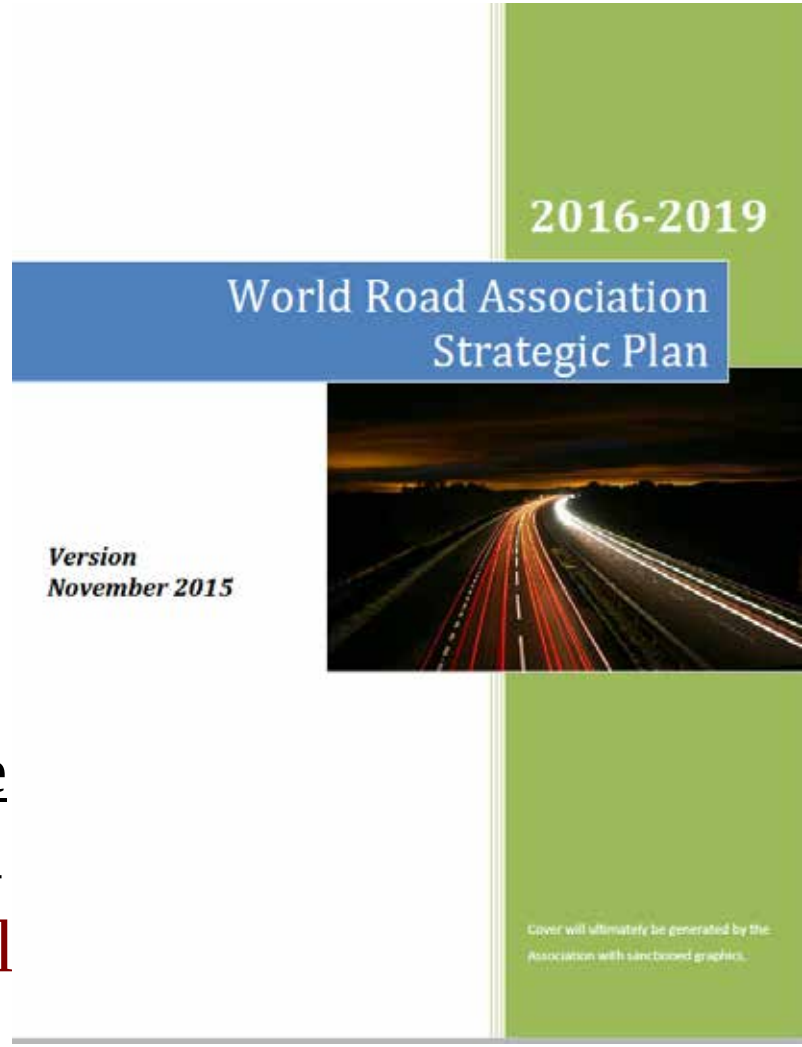
D.5.3 Integrated road tunnel safety

D.5.4 Large underground and interconnected infrastructure (Chair: Bernard Falconnat)

Maintain and disseminate current information regarding optimization of operational and safety strategies for large complex underground and interconnected infrastructures

D.5.5 Persons with reduced mobility in the tunnel

D.5.6 Road tunnel emissions



# Technical reports produced during the current 2016-2019 work cycle

"Large underground and interconnected infrastructures: specific analysis and recommendations" (to be published by end 2019)

Specific challenges of complex underground networks with recommendations in terms of ventilation, signage, operation and maintenance.

*To be downloaded on PIARC Website - 2019*

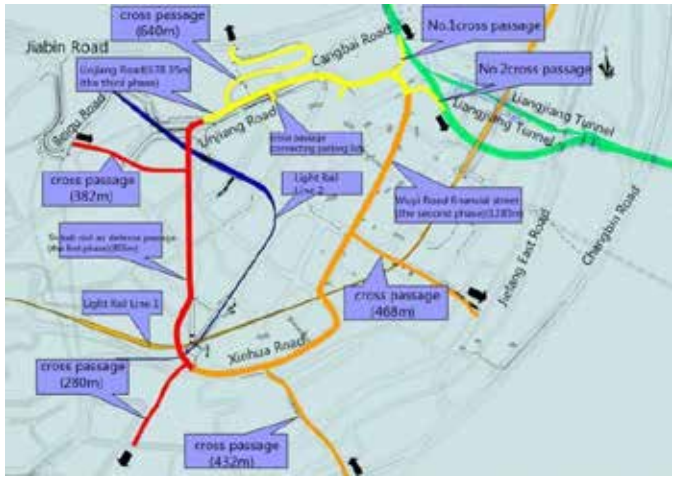
D.5.4 Large underground and interconnected infrastructure

# TC-D.5 - 4.a: Case Studies

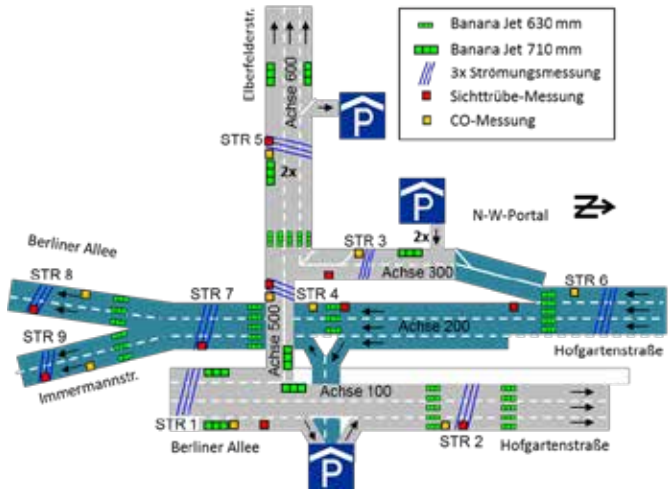
## Monographs

- ü 3 new monographs from the USA by Bijan
- ü 2 new monographs from Spain by Eva Montero
- ü 2 monographs received since the last session in Lyon

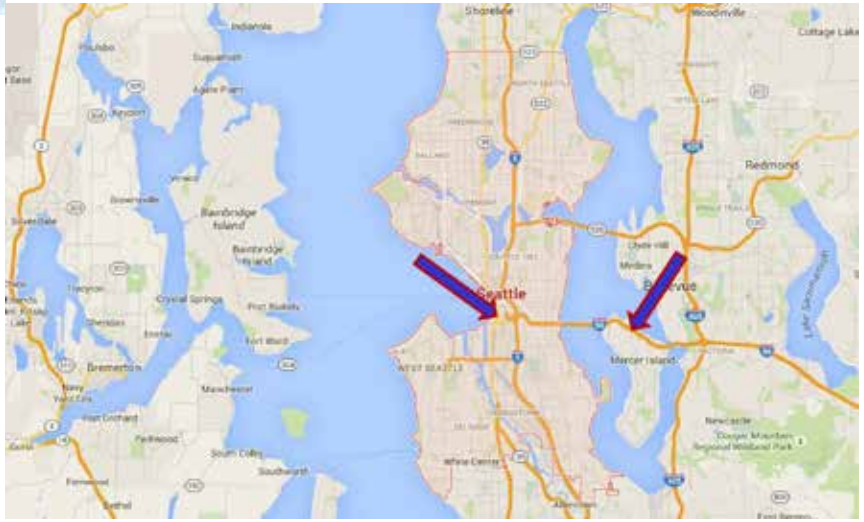
### Underground Ring Road-Chongqing




### Germany prepared by Matthias

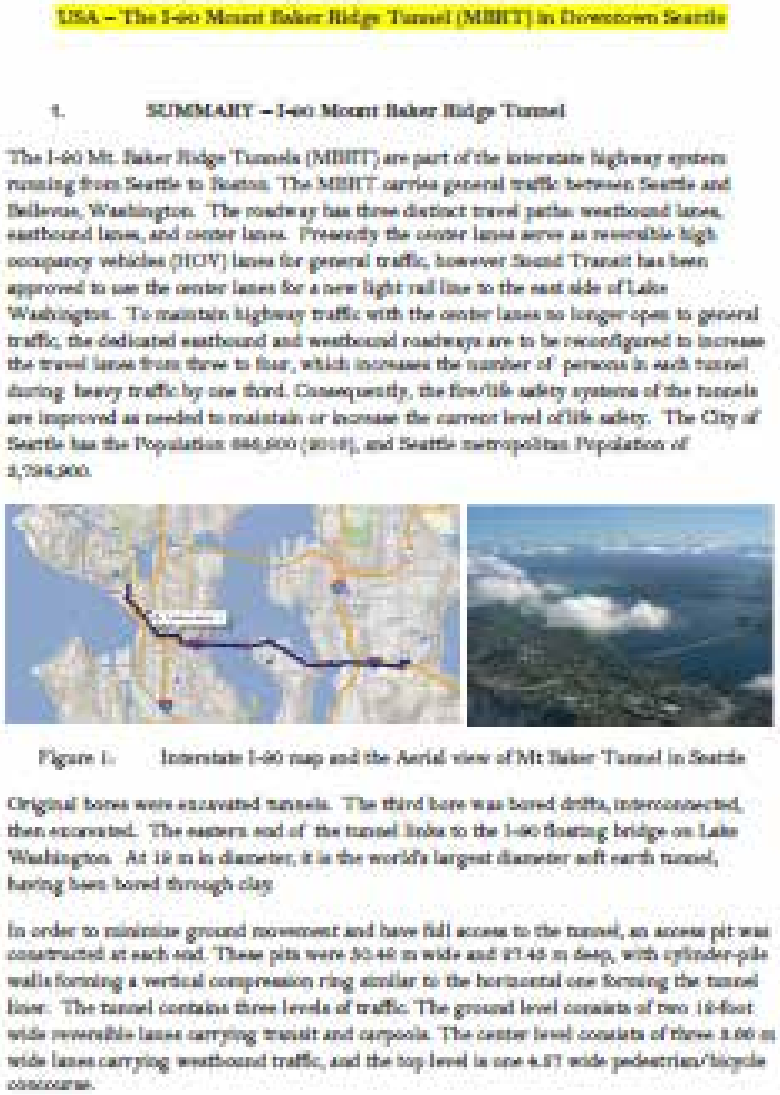



### Tunnels in Seattle, Washington



# Monograph Questionnaire:

- Summary
- Main Characteristics
- Geometry
- Cross Section
- Signaling
- Ventilation
- Environmental Issues – Air Quality
- Facilities And Operational Equipment
- Safety, Evacuation And Behavior
- Operation



USA – The I-90 Mount Baker Ridge Tunnel (MBRT) in Downtown Seattle

1. SUMMARY – I-90 Mount Baker Ridge Tunnel

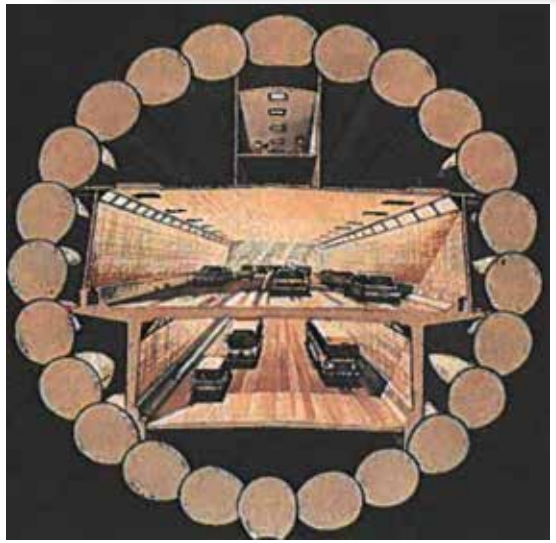
The I-90 Mt. Baker Ridge Tunnels (MBRT) are part of the interstate highway system running from Seattle to Boston. The MBRT carries general traffic between Seattle and Bellevue, Washington. The roadway has three distinct travel paths: westbound lanes, eastbound lanes, and center lanes. Presently the center lanes serve as reversible high occupancy vehicles (HOV) lanes for general traffic, however Sound Transit has been approved to use the center lanes for a new light rail line to the east side of Lake Washington. To maintain highway traffic with the center lanes no longer open to general traffic, the dedicated eastbound and westbound roadways are to be reconfigured to increase the travel lanes from three to four, which increases the number of persons in each tunnel during heavy traffic by one third. Consequently, the fire/life safety systems of the tunnels are improved as needed to maintain or increase the current level of life safety. The City of Seattle has the Population 686,800 (2018), and Seattle metropolitan Population of 3,798,900.

Figure 1: Interstate I-90 map and the Aerial view of Mt Baker Tunnel in Seattle

Original bores were excavated tunnels. The third bore was bored drifts, interconnected, then excavated. The eastern end of the tunnel links to the I-90 floating bridge on Lake Washington. At 16 m in diameter, it is the world's largest diameter soft earth tunnel, having been bored through clay.

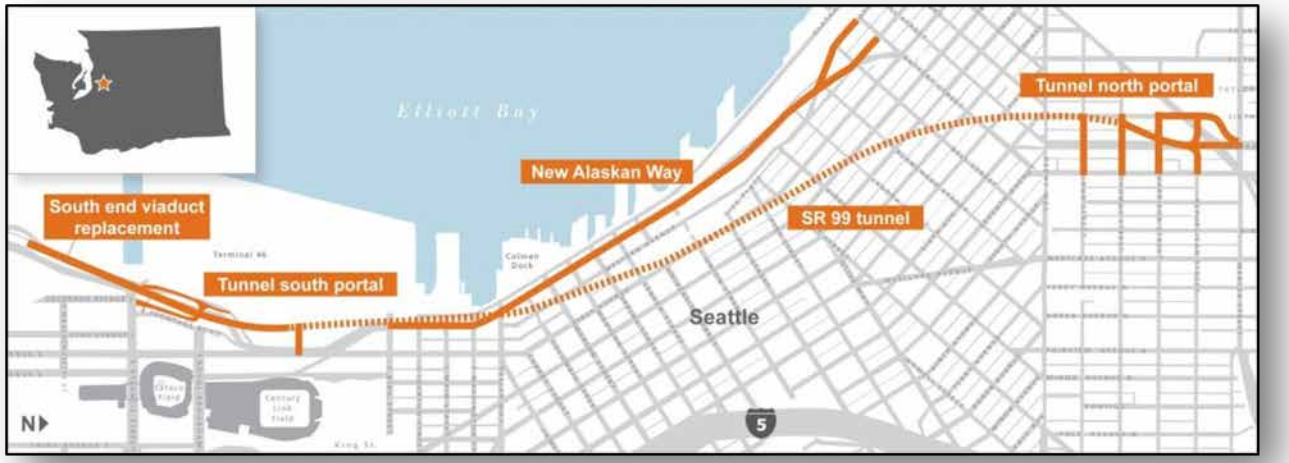
In order to minimize ground movement and have full access to the tunnel, an access pit was constructed at each end. These pits were 30.48 m wide and 97.48 m deep, with cylinder-pile walls forming a vertical compression ring similar to the horizontal one forming the tunnel liner. The tunnel contains three levels of traffic. The ground level consists of two 10-foot wide reversible lanes carrying transit and carpools. The center level consists of three 3.66 m wide lanes carrying westbound traffic, and the top level is one 4.57 wide pedestrian/bicycle concourse.

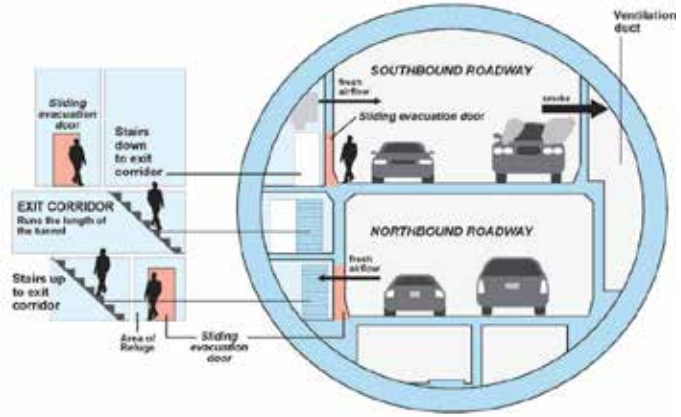
# PIARC Case Studies: Seattle Tunnels: Mt Baker Tunnel

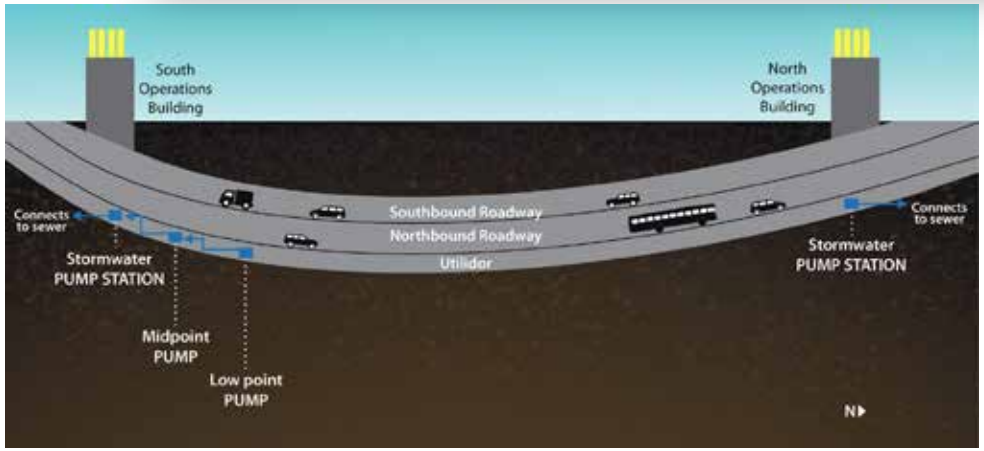


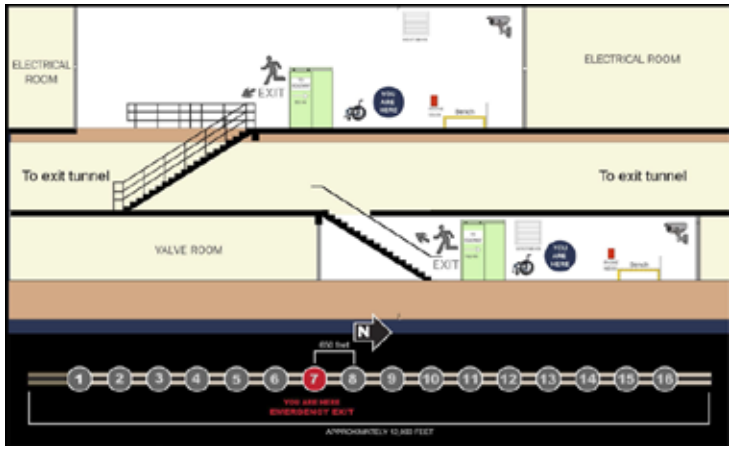


# PIARC Case Studies: Seattle, SR-99 AWV Tunnel



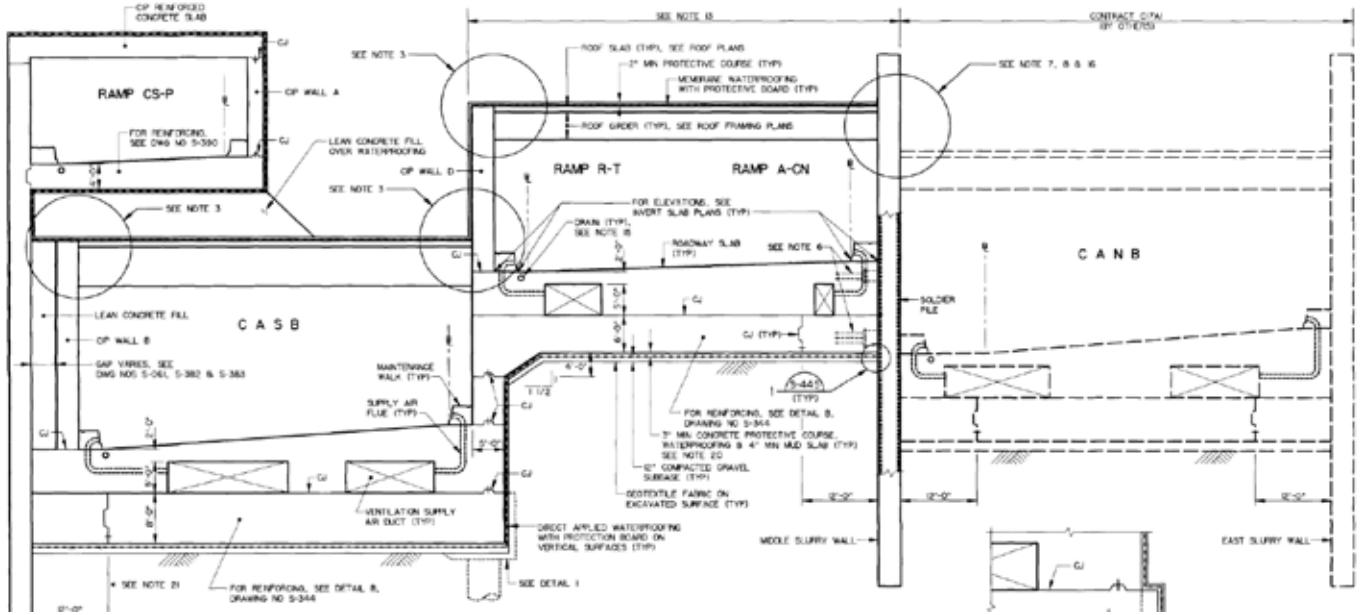



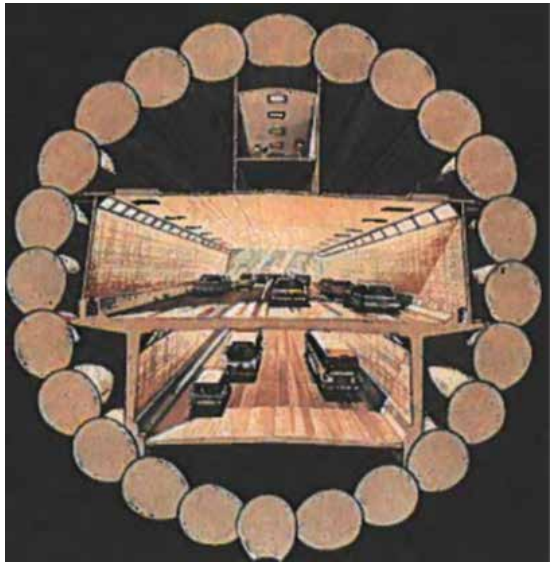



# PIARC Case Studies: Boston Central Artery Tunnels (CA/T)- Joseph Rigney

## Boston Tunnel Case Study Questionnaire - Monograph

# PIARC International - Japan Tunneling Delegation February 2018 - Dr. Nobuharu Isago



## *Seattle I-90 Mount Baker and SR 99 AWV Tunnels*

- Geotechnical Considerations
- Design & Construction Considerations
- Planned Operation and Maintenance

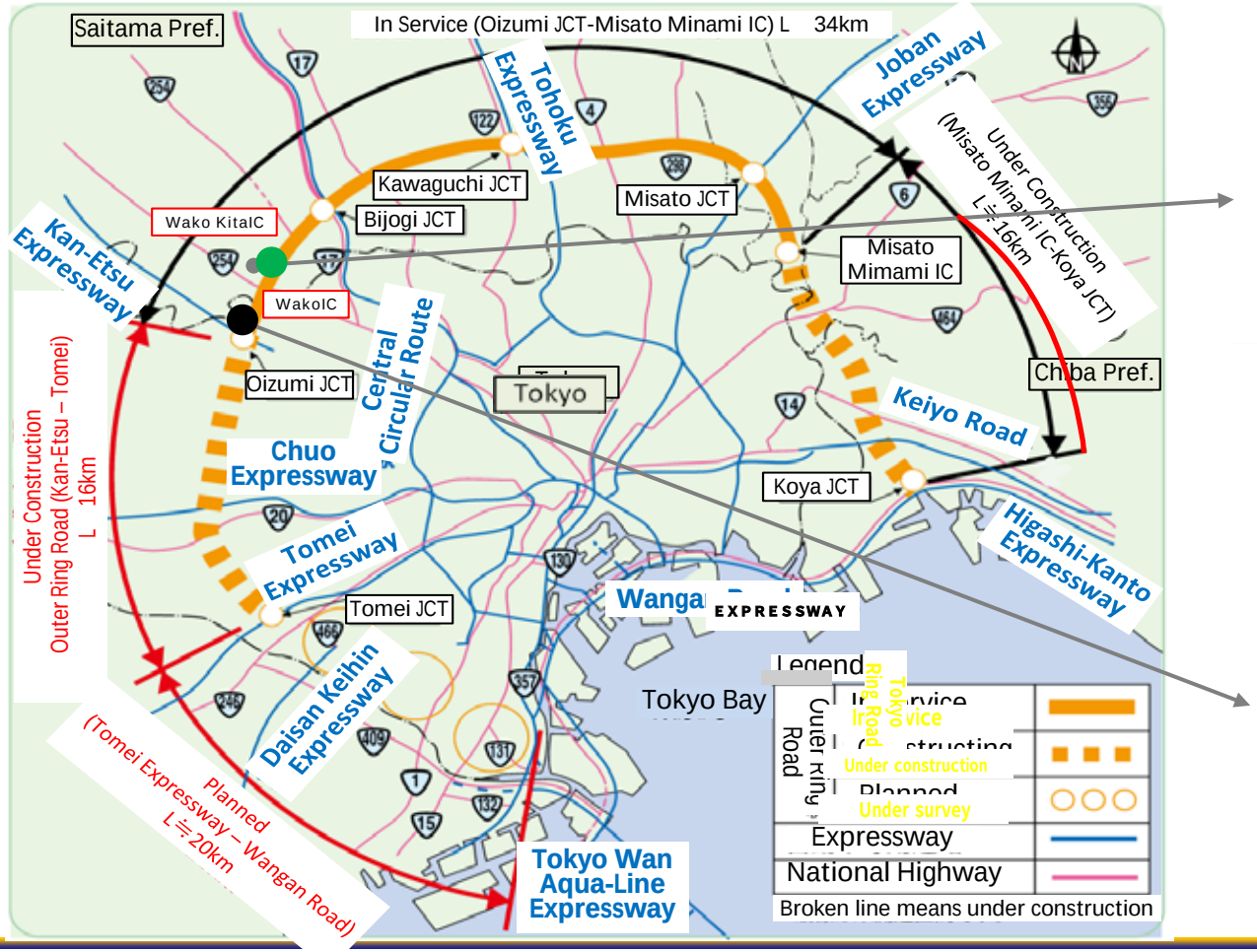
## *Japan Tunnels:*

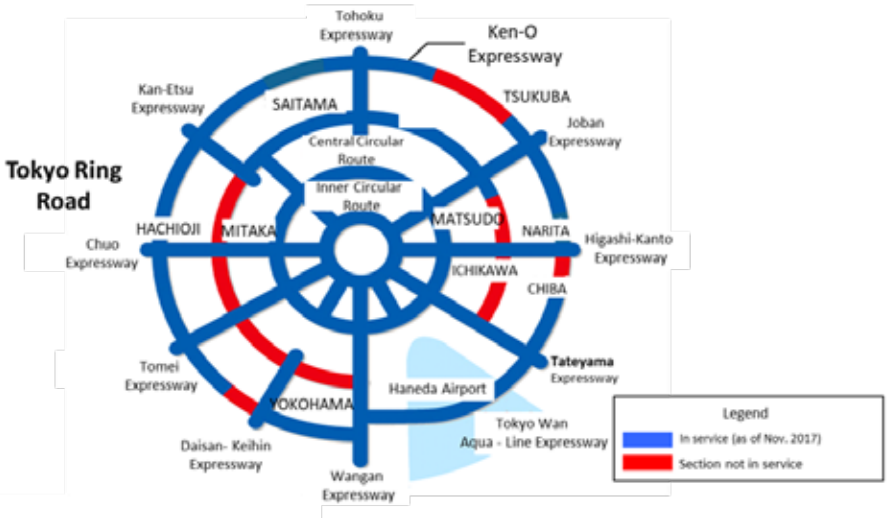
- Technological Trends Regarding Japanese Tunnels
- Construction of the Tokyo Ring Road

## *Site Visits:*

- SR 99 AWV and Mount Baker Tunnel Site Visits

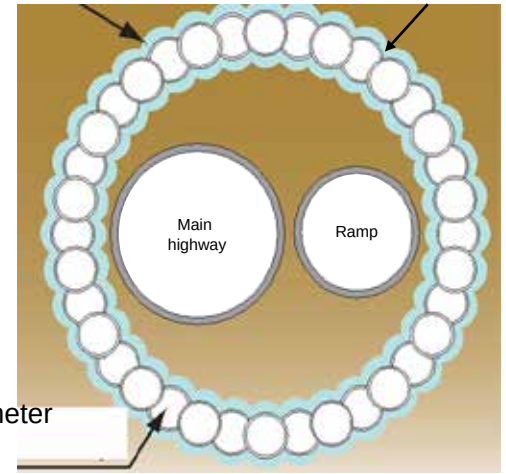
# Tunnel Workshop - Seattle




Waterproofing

Non-separated

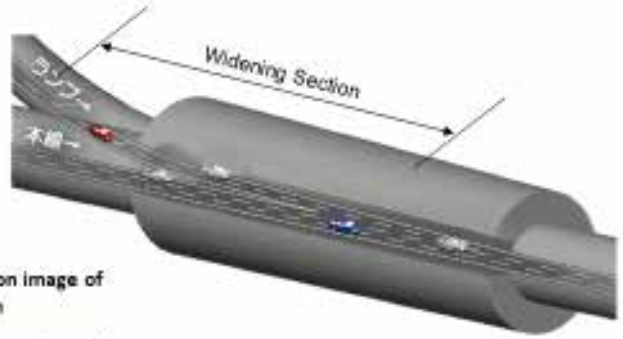



Small-diameter shield

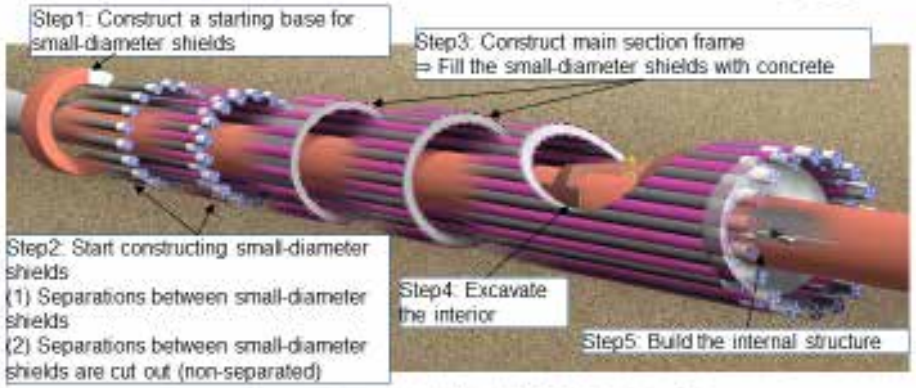
# Tunneling Workshop - Seattle

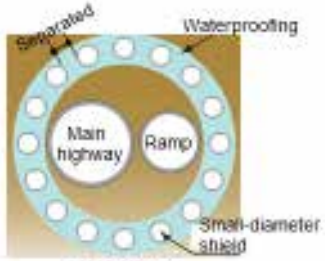
## 6. Construction image of underground widening section

○ Figure showing overall image of underground widening section




○ Figure showing construction image of underground widening section



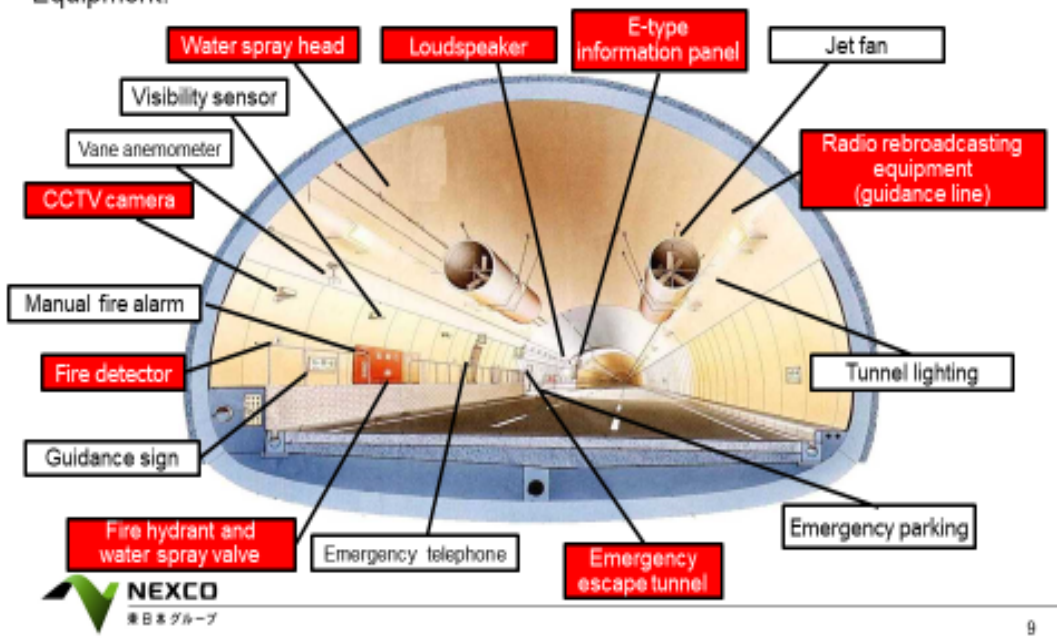

Assumed construction method for the TORR Widening Section

11

## 2. Expressway Tunnel Facilities, Installation Standards, etc.

NEXCO

(2) Installation Standards for Emergency Facilities in Tunnels
Facilities to be installed according to tunnel classification are divided into categories: Information and Alarm, Fire Extinguishing, Escape and Guidance, and Other Equipment.



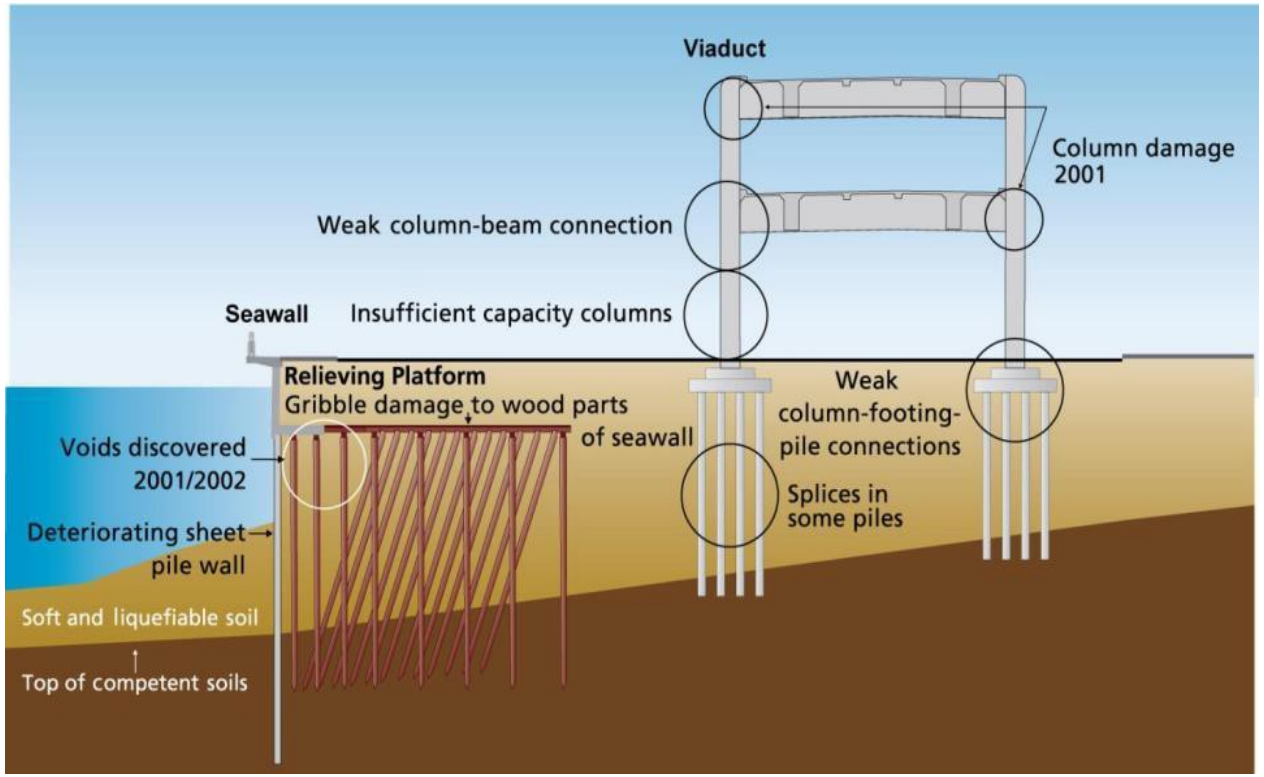

NEXCO 東日本グループ

9

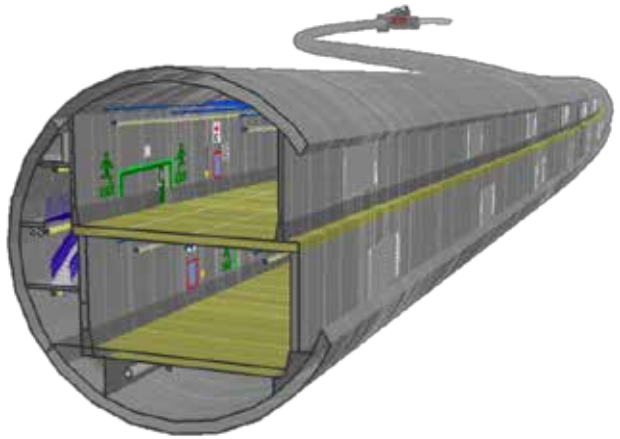
# Technical Committee D.5 – Road Tunnel Operations

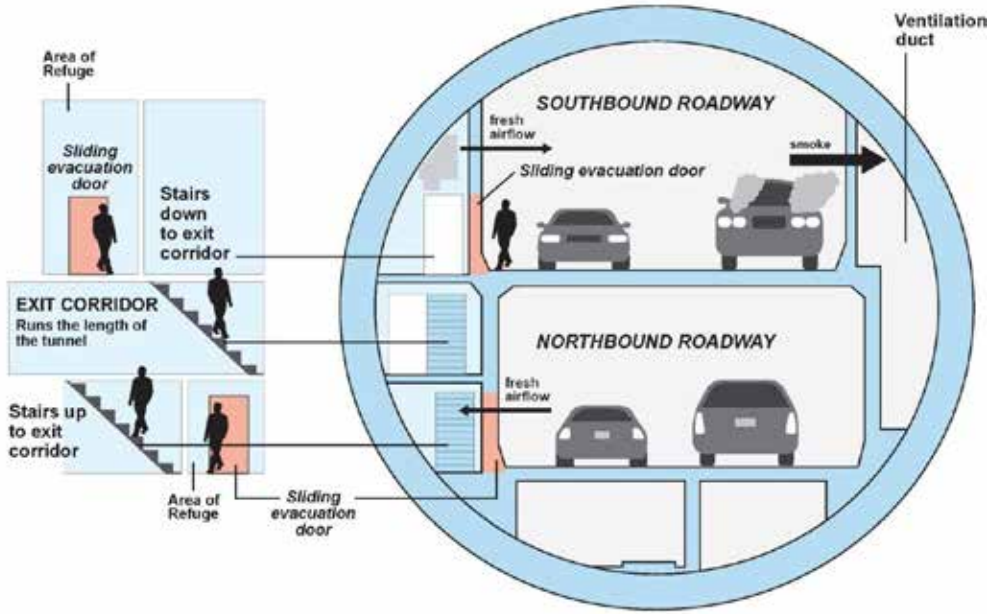
## TC-D.5 5th Meeting : June 2018, Seattle

- Working groups program and activities
- Other organizations activities and update (ITA, ITA-COSUF, CIE, IES, NFPA, AASHTO)
- Seminars in developing or transition countries
- International PIARC Conference on road tunnel operations and safety – Abu Dhabi
- Feature Presentations
  - AWV Tunnel Design and Construction
  - AWV Tunnel Safety and Operation
  - Seattle Waterfront Program
- Site Visit: AWV Tunnel Construction


## SR-99 AWV Tunnel

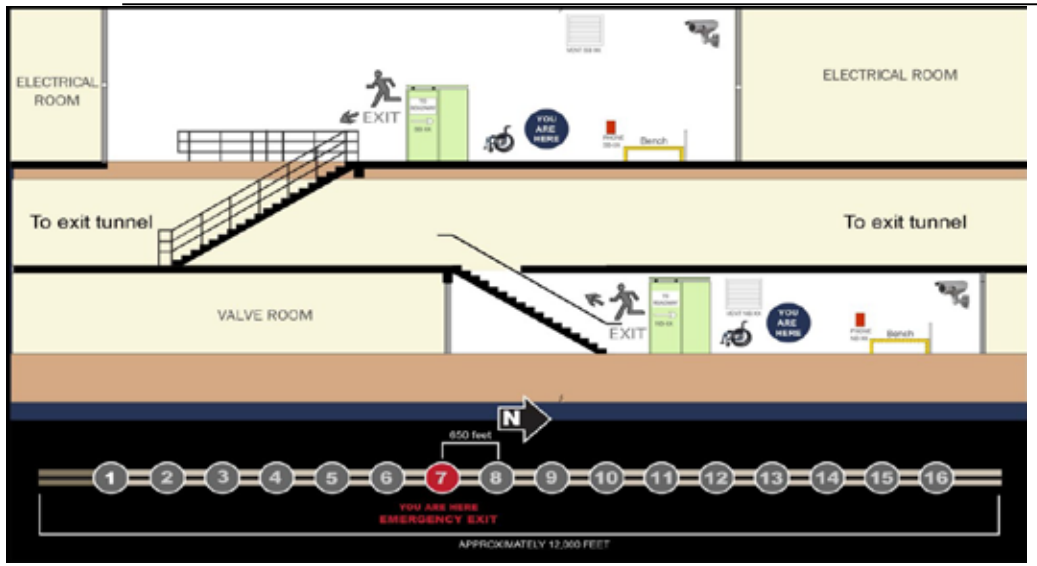






# Fire Life Safety provisions

- Egress doors every 198 m
- Smoke damper every  108 ft (6 dampers open)
- Portal jet fans
- Local extraction 283m3/s
- Sprinkler at 13mm/min



## Key tunnel system and life safety activities

- Tunnel life safety and security systems
- Fire System
- Ventilations system
- Electrical and ITS
- Control rooms
- Emergency coordination
- Emergency plan and scenarios
- Workshops and emergency drills
- Emergency power
- Incident response
- ITS

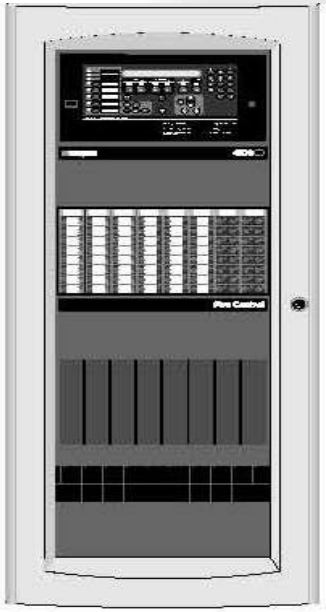

| Tunnel System Item | Quantity |
|---|---|
| Exhaust Fans | 8 |
| Jet Fans | 17 |
| Exhaust Dampers | 187 |
| Maintenance Air Dampers | 30 |
| CO and NOx Sensors | 10 |
| Deluge nozzles | 1308 |
| Deluge Valve Stations (208 valves) | 55 |
| Fire Hose cabinets | 97 |
| Storm Pumps 3 @ 50 HP, 2 @ 20 HP5 | 5 |
| Low Point Booster Pumps 4 @ 20 HP4 | 4 |
| Sewage Ejector Pumps | 2 |
| Generators, 1 @ 900 KW, 1 @ 600 KW | 2 |
| Tunnel Roadway Lighting Fixtures | 5700 |
| Roadway and Security CCTV Cameras | 301 |
| Color Matrix TC Signs & LCS | 66 |
| Roadway Emergency phone | 98 |
| Egress refuge - Emergency Exits | 32 |
| Lane Traffic Data Stations | 32 |
| Strobes and LED Light Strings (egress) | 34 |
| Roadway speakers (each egress exit) | 34 |

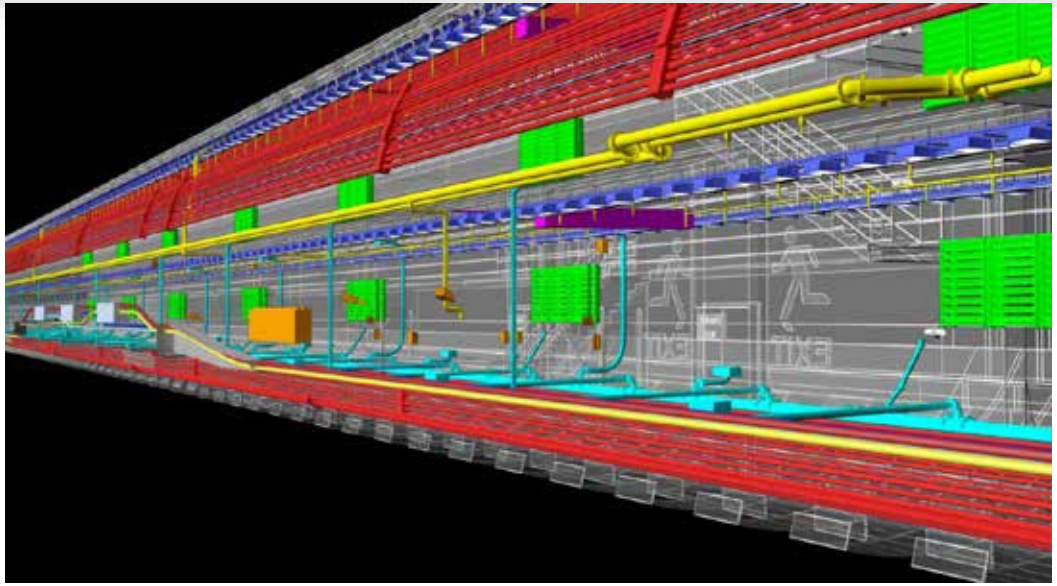
## Tunnel Operation Control Centers:

- Primary Control Room in TMC-Shoreline
- North and South Operations Building

## Tunnel Ventilation Fans:

- Centrifugal fans
- Jet fans
- Maintenance fans





## SCADA Systems Interface With:

- Maintenance management.
- Fire control.
- Security.
- Emergency


# Thanks for Your Attention

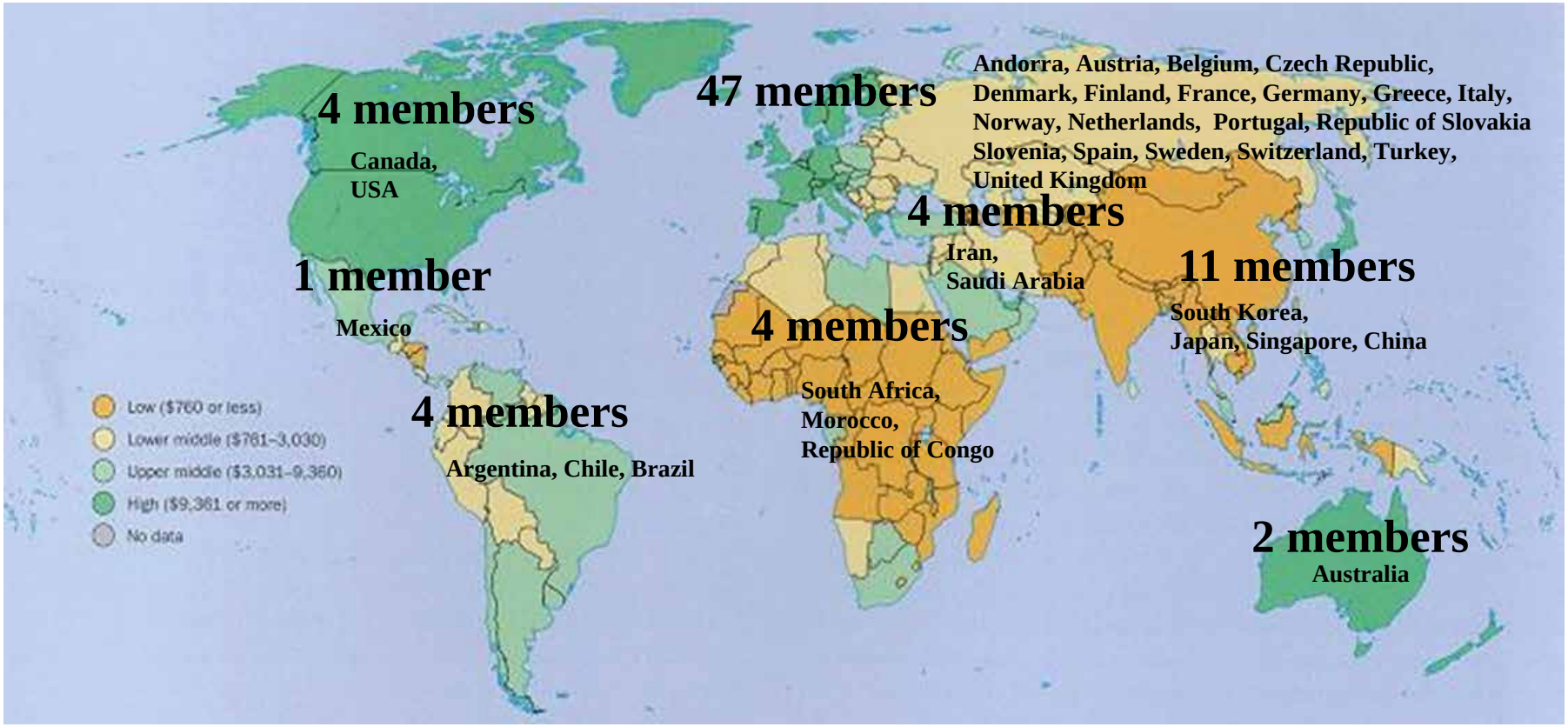

*Courtesy of Waterfront Seattle*

# PIARC TC D.5 activities

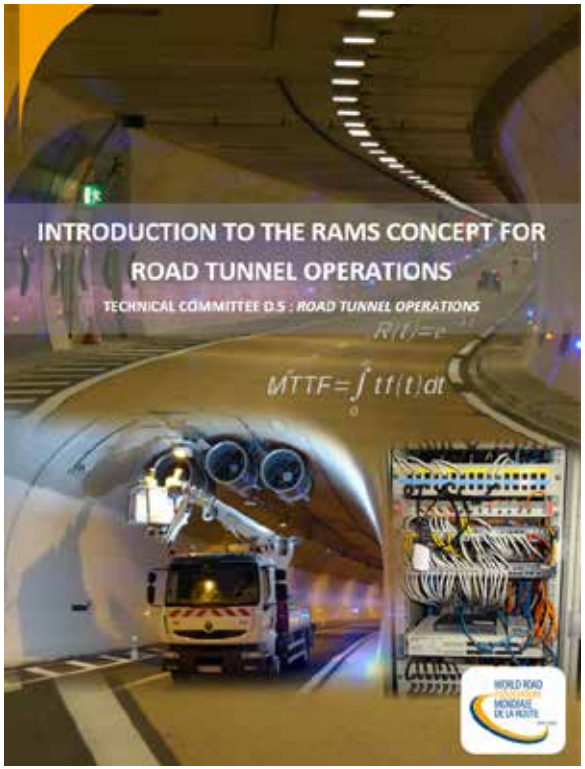
**Marc Tesson (TCD5 Chairman)**

# Technical committee D.5 “Road tunnel operations”

77 official members + 86 “associated members” of the Committee’s working groups



# Technical reports produced during the current 2016-2019 work cycle

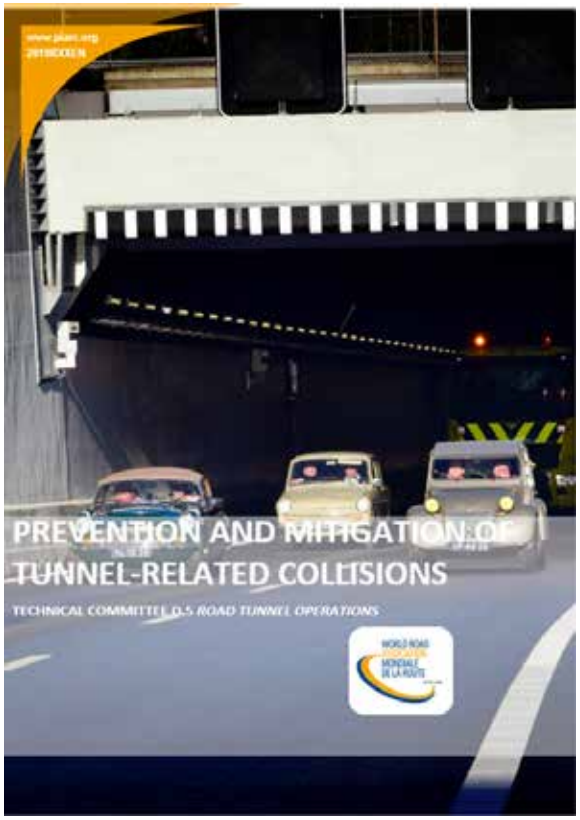



"*Introduction to the RAMS concept for road tunnel operations*" (published March 2019)

Examines how the "**R**eliability, **A**vailability, **M**aintainability and **S**afety of tunnel systems/equipment can be achieved by applying the methodology of standard EN 50126

*Published & to be downloaded on PIARC WebSite*

# Technical reports produced during the current 2016-2019 work cycle

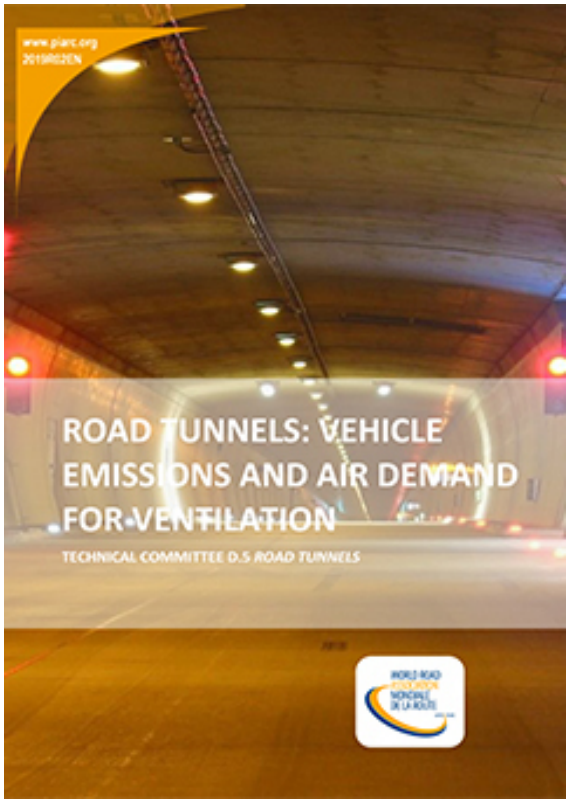



"*Prevention and mitigation of tunnel-related collisions*" (published March 2019)

Presents possible organizational and technical measures that can be implemented to prevent and /or mitigate collisions in which the specific characteristics of a tunnel play a role in either the cause or the effect.

*Published & to be downloaded on PIARC WebSite*

# Technical reports produced during the current 2016-2019 work cycle




"*Road tunnels: Vehicle emissions and air demand for ventilation"* (published March 2019)

Revised version of the 2012 report. Provides updated emission rates and an assessment methodology for establishing the minimum fresh-air demand for adequate in-tunnel air quality and visibility thresholds.

*Published & to be downloaded on PIARC WebSite*

# Technical reports produced during the current 2016-2019 work cycle


"*General principles for improving accessibility for persons with reduced mobility in road tunnels*" (to be published shortly)

Principles that can be adopted to make allowance for persons with reduced mobility when designing or refurbishing a road tunnel. Examples of implementations from various countries are presented.

*To be published & downloaded on PIARC WebSite*

# Technical reports produced during the current 2016-2019 work cycle

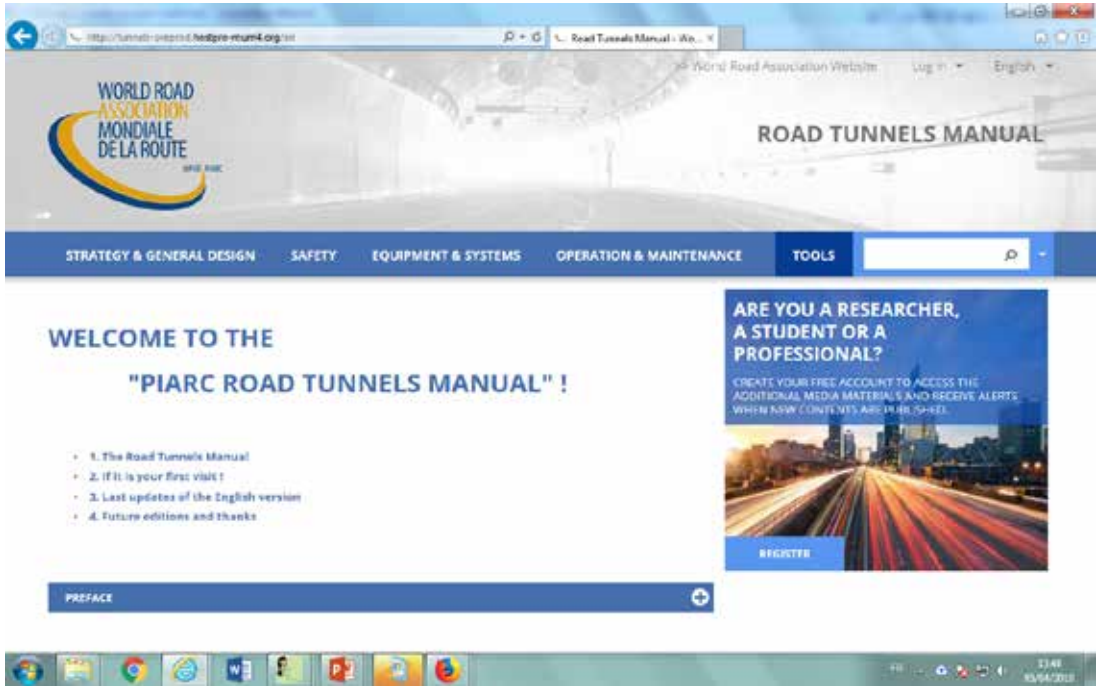
*"Large underground and interconnected infrastructures: specific analysis and recommendations" (to be published by end 2019)*

Specific challenges of complex underground networks with recommendations in terms of ventilation, signage, operation and maintenance.

*To be published & downloaded on PIARC WebSite*

# Other outputs from the current 2016- 2019 work cycle

Ongoing revision of the Road Tunnels Manual: new version to be published by end 2019




Current version available at:

**https://tunnels.piarc.org/en**

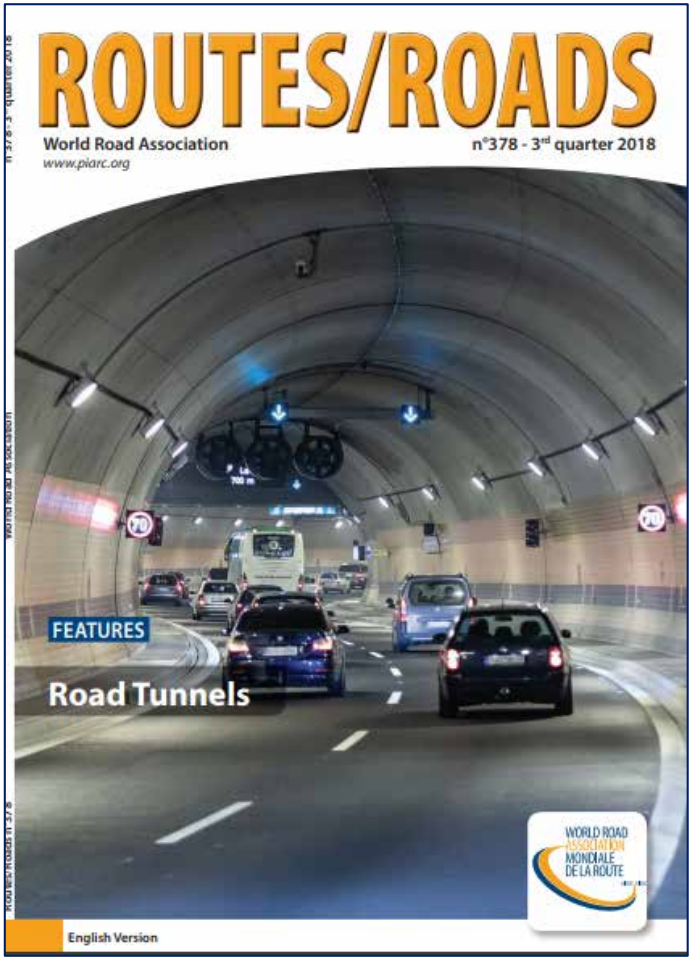
# Other outputs from the current 2016- 2019 work cycle

## Technology watch documents

Enable the Committee to undertake an initial study of a specific issue, with a view to further developing the topic in a technical report in the next PIARC cycle:

- Led lighting
- Intelligent Transportation Systems
- New propulsion technologies

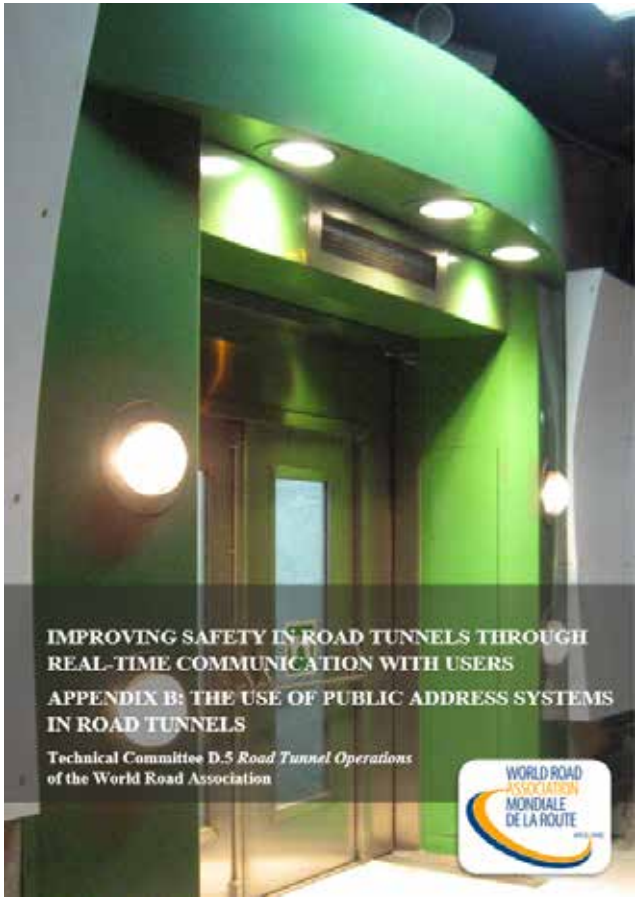
# Other outputs from the current 2016- 2019 work cycle




Special issue « road tunnels »
of Routes/Roads magazine:
autumn 2018

*Published on PIARC WebSite*

# Other outputs from the current 2016- 2019 work cycle




Internal surveys launched at the initiative of TC members

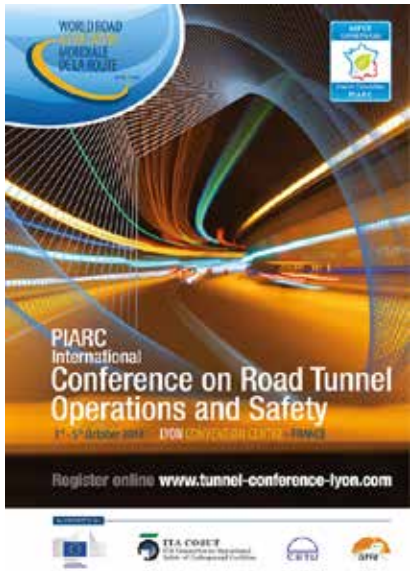
Example: The use of loudspeaker public address systems

Results published as an appendix to report on Real Time Communication with Users

*Published & to be downloaded on PIARC WebSite*

# Other outputs from the current 2016- 2019 work cycle

- Workshop, Montréal (April 2017)
- International seminar, Cape Town ( October 2017)
- 1st PIARC International Conference on Road Tunnel Operations and Safety , Lyon (October 2018)


# Thank you for your attention

**https://www.piarc.org/en/**

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