

PIARC first results on complex underground road networks

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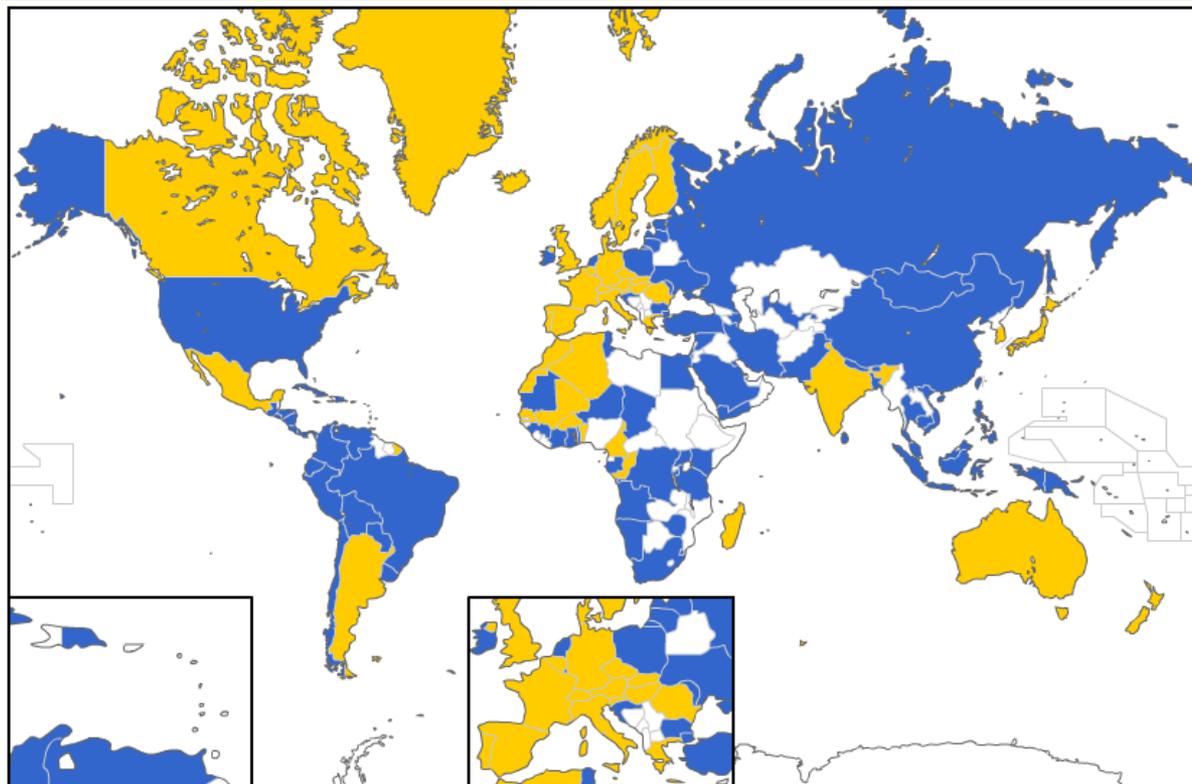
- ▶ 50 years ago road underground infrastructures were short tunnels, essentially for transit traffic or underpasses
- ▶ 40 years ago infrastructures become more complex with ramps for connection with surface streets network
- ▶ Since about 20 years underground infrastructures become complex road networks with main interchanges and accesses to underground facilities (parking lots)
- ▶ increasing of the construction of new underground urban infrastructures (road – subway) due to:
 - Large development of the urban metropolises
 - Huge increase of the mobility
 - Shortage of space on ground level
 - Environmental pressure and requirement

- ▶ Underground transportation networks raise numerous questions like:
 - Management of the underground space
 - Interaction with the urban development
 - Construction methods with reduced impact on the ground level, the buildings and the urban activities
 - Ventilation and safety
 - Sustainable and safe operation
 - Etc.

- ▶ My presentation is focussed on the mission of PIARC and on road tunnels concept, operation and safety

Who is PIARC – which mission ?

- Association Mondiale de la Route – World Road Association
- 118 member governments



- Member Country with a National Committee
- Member Country
- Non Member Country

► Strategic Plan 2012-2015 - Strategic Themes

- Strategic Theme 1: Management and Performance
- Strategic Theme 2: Access and Mobility
- Strategic Theme 3 : Safety
 - TC 3.1 National Road Safety Policies and Programs
 - TC 3.2 Design and operation of Safer Road Infrastructure
 - **TC 3.3 Road Tunnels Operation**
 - TF 1 Road Safety Manual Task Force
 - TF 2 Security Task Force
- Strategic Theme 4 : Infrastructure
- 18 Technical Committees and 2 Task Forces regrouped in one of these 4 Strategic Themes.
- Committee on Terminology.

► Technical Committee TC 3.3 Road Tunnels Operation

- ◉ WG 1 – sustainable road operation
- ◉ WG 2 – feedback from experience on tunnel safety
- ◉ WG 3 – interactions with users
- ◉ WG 4 – best practices for fixed fire fighting systems
- ◉ **WG 5 – complex underground road networks**
- ◉ WG 6 – knowledge management

► At present there are no detailed guidelines or set of recommendations concerning the design and operation specific to “complex urban underground road networks”

- ◉ PIARC has included this task in its strategic plan and entrusted TC 3.3 with this mission
- ◉ TC 3.3 has created a new WG in charge of this mission

- ▶ Missions of PIARC in the field of tunnels concern:
 - Functional and strategic concepts,
 - Operating and safety facilities,
 - Safety policy, risk management, safety procedures, organisation and management,
 - Operation, maintenance, heavy repairs and upgrading

- ▶ PIARC is not involved in the fields of geology, structures, construction methods and construction risks, which are part of the AITES / ITA scope

- ▶ M.O.U between PIARC and ITA specifies the particular missions of each and the missions carried out within a tight cooperation

- ▶ Representative of PIARC Tunnel Technical Committee by ITA-COSUF

▶ PIARC's mission

- Organize international forums
- Disseminate best practices
- Promote efficient tools for decision making
- Special emphasis for Developing Countries and Countries with Economies in Transition

▶ See website for more information

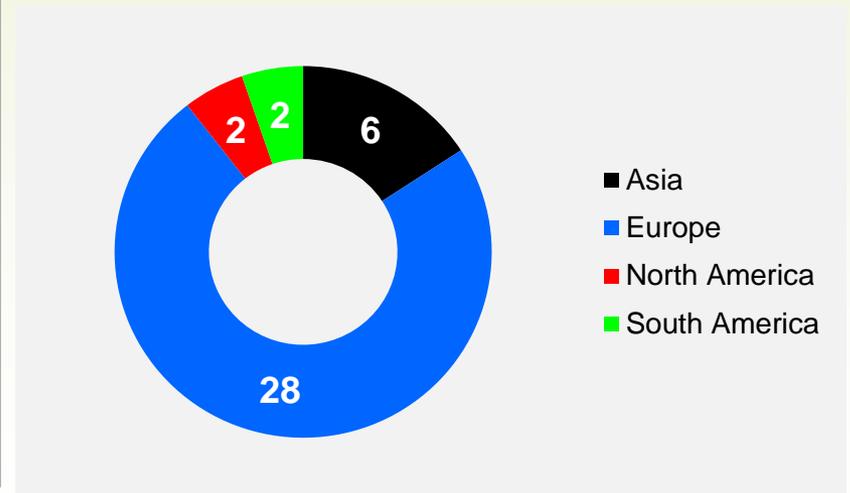
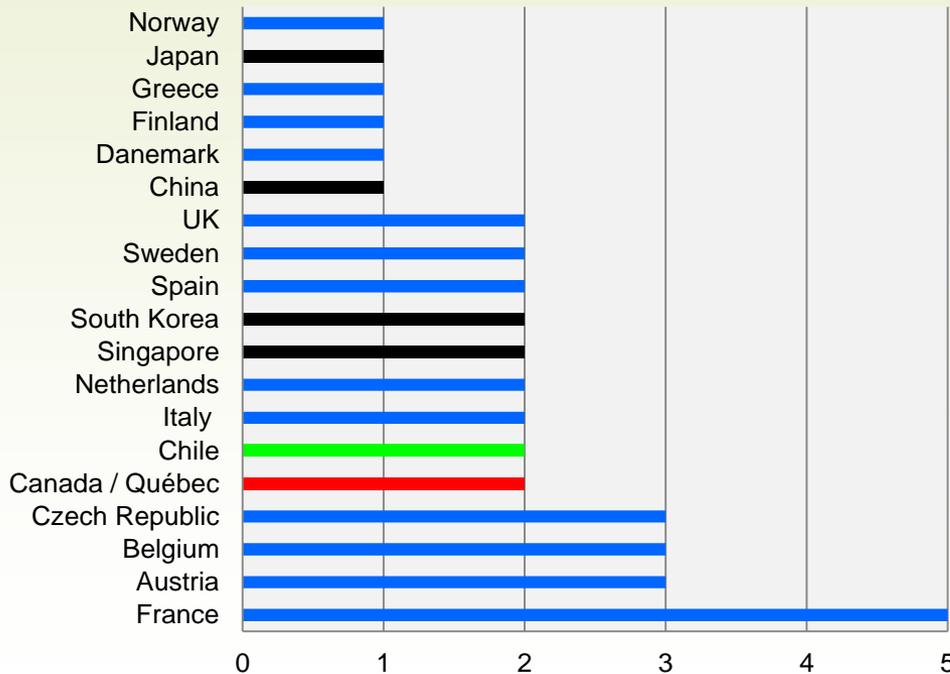
www.piarc.org

▶ See also the publications online concerning the tunnels

- Tunnel Manual
- 35 technical reports
- Tunnel glossary

WG5's membership

- 38 members and peer reviewers from 19 countries
- Mission starts in June 2012
- Deadline: publication for Seoul congress 2015



► Analysis of the existing structures shows

- A large disparity concerning the concepts and requirements
- Rare national or international specific guidelines
- A saturation of the traffic with recurrent jams
- Major issues at the interfaces with ground networks or underground facilities
- Recurrent « black points » for accidents
- Ageing of the facilities
- In some countries a lack of maintenance & heavy repairs
- Many tunnels do no more comply with the minimum safety requirements in particular the oldest tunnels

- ▶ Length of the underground infrastructures
 - More than 10 km long for the major ones

- ▶ Important traffic volume
 - 500 to 750 passengers / km could be trapped in case of accident or fire: escape – access – information to prevent panic
 - Traffic jam / collision at tail of jam
 - Essentially commuters traffic which behaviour may increase the risks

- ▶ Numerous branches of the network
 - Smoke management to keep branches independent
 - Efficient emergency accesses and escape routes
 - Interfaces between traffic space and underground facilities like parking lots, stations

- ▶ Major interactions between underground infrastructure and streets networks in open air
 - Queuing at the connexion exit ramp / urban street may increase the risks of collision inside the tunnel
 - imperious necessity to fluidify the exit traffic in case of fire in order to make traffic free downstream of the fire
 - Access time for the emergency services according to the ground traffic – specific procedures and means

- ▶ Interactions with the buildings above the tunnel or surrounding the portals or the ventilation stacks
 - Structure stability in case of fire
 - Emission of smoke and toxic gases in case of fire: eventual procedures of evacuation

- ▶ Mandatory to organise an integrated management in order to solve all the interfaces issues
 - Single global management
 - Multiple operators with
 - ◐ exchange of information in real time
 - ◐ strict procedures,
 - ◐ clear definition of leadership and priority in case of accident or fire

- ▶ Urban underground road networks are more and more complex
 - Increase of the construction and operation costs
 - Financing becomes more and more difficult even with PPP or concession process and toll
 - As consequences: some projects are no more feasible

- ▶ Urban traffic is essentially passenger cars and vans (>98%)
 - Functionality of the infrastructure has to be analysed
 - Possible optimisation of the clearance and the width according to the vehicles characteristic
 - Saving of 20% (3,2 m clearance compared with 5,0m) to 25% (2,7m clearance) on the construction costs could make the project financed (recent analyses for urban projects in South America and Eastern Europe)

WG 5 - Underground road networks

▶ WG5's mission includes four main tasks

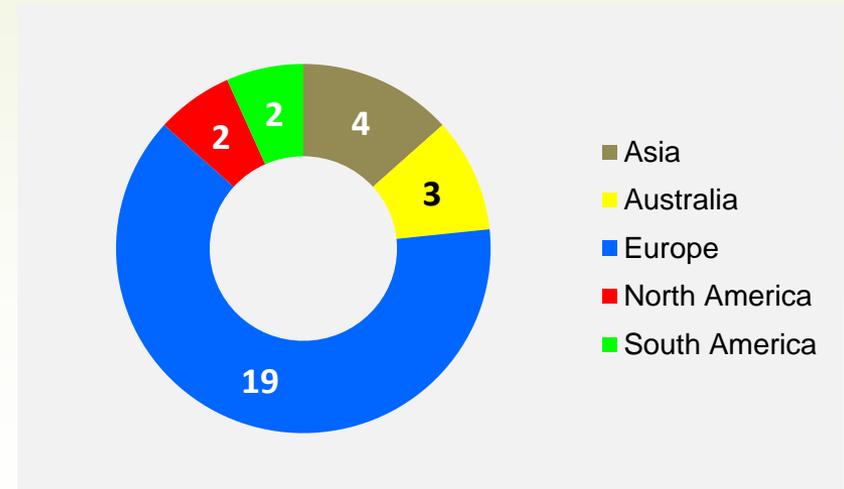
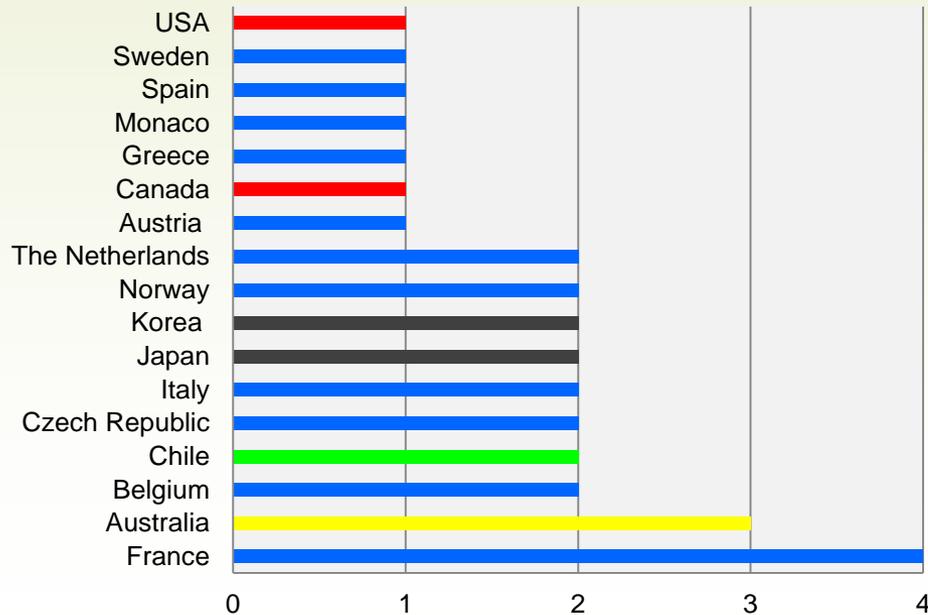
- Task 1 - State of the situation around the world (case studies)
- Task 2 - Specific analyses and R&D actions
- Task 3 - Development of guidelines and recommendations
- Task 4 - Dissemination

▶ Task 1 – case studies which objectives are

- to list and analyse representative underground road networks
- to collect detailed informations by interviews
 - existing design and operation dispositions
 - return of experiences concerning the main issues, the good practices, the major malfunctioning, the reasons of accidents
 - needs of improvement or upgrading

Task 1 - case studies

- 28 tunnels from 17 countries are under investigation
- With variable ageing: 40 years to tunnels under construction
- Investigation is carried out with interviews between a local WG 5 member and the owners, operators or designers



► Present situation

- Interviews have started two months ago
- 6 interviews are completed at present and 20 are going on
- Deadline of the interviews September 2013
- analysis will be carried out during autumn 2013

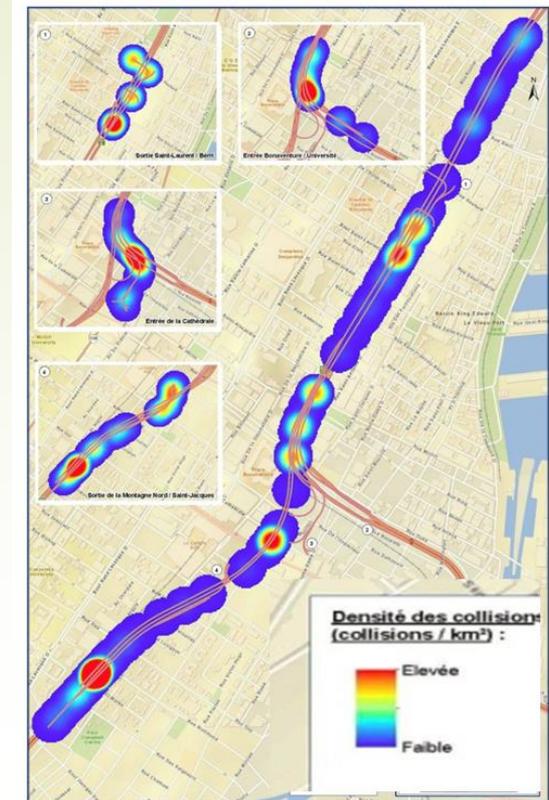
► First results

- No particular surprise
- Main of the issues are part of the developments that will be carried out within Task 2

Task 2 – specific analyses

- Existing tunnels do not reflect the whole problematic and issues of complex underground road networks
- Specific analyses and R&D are required and carried out simultaneously in particular:
- Geometry
 - Functional geometry
 - Geometry of the underground interchanges
 - Traffic – capacity – breakdowns
 - Signalling of the interchanges
 - Low clearance tunnel
 - Escape routes

Entrances, merging or exits lanes are often “black points” as shown on the picture



► Task 2 – specific analyses (follow)

○ Ventilation

- Management of the smoke inside a complex network – aerodynamic independence of the “tunnel branches”

This independence is rarely assured for existing tunnels

- Ventilation and sustainable development
- Polluted air discharge – state of the art relating to air cleaning (efficiency – costs – reliability)
- Smoke and toxic gases discharge in case of fire
- Specific conditions for tunnel with low clearance
- Evolution with the increasing of e-vehicles

○ Specific operating and safety equipments

- New requirements for real time communication with the drivers
- Development of the concepts and the architecture in order to reduce and make easier the maintenance

○ Problematic of the multimodal tunnels

- ▶ Task 2 – specific analyses (follow)
 - Specific issues and organisation concerning the safety
 - Time for the access to the tunnel under very dense urban traffic
 - Emergency services accesses to a complex network under traffic saturation or blockage
 - Escape routes: legibility – management under safe conditions of the volume of peoples
 - Interfaces between underground network and ground network
 - Interactions in particular in case of fire
 - management of the whole system in case independent operators in order to
 - assure the users safety
 - optimise the conditions of global traffic flow

► Tasks 3 & 4 – publications and dissemination

○ Deadline: World Road Congress 2015 in Seoul

- Publication on the PIARC website

○ Nature of the publications

- Monographs of the 28 tunnels investigated
- Synthesis of the return of experience concerning these 28 tunnels
- Technical reports concerning the specific analysis
- Recommendations to tunnel owners, designers and operators concerning
 - Tunnel upgrading
 - New tunnels under design

- ▶ Underground road networks are complex systems
- ▶ Several existing tunnels present some dysfunctions and risky situations that are very difficult to face
- ▶ The objective of PIARC is
 - Carry out detailed analyses and launch R&D actions
 - Propose recommendations in order to:
 - ◀ Settle a basis of international good practices,
 - ◀ Make these complex system more safe and reliable
 - ◀ Improve the sustainable development policy
 - Deadline autumn 2015 World Road Congress in Seoul



Thank you for your attention

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