# PIARC – TC 4.4, Task 1
# Improvement in Durability in Design and Construction

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# Task 1 Group Members

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| Tomas Wierzbicki | Poland |
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| Carlos Bicas | Portugal |
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# Background to Study

- History of design based on low initial cost
- High cost of common durability problems
- Durability problems occurring well within design life
- Recognition of need to consider “whole life costs”
- Major indirect costs of disruption of traffic

# Scope of Study

- Questionnaire proposed to pool knowledge of PIARC
- Current design, construction and maintenance practice
- Limit to common materials concrete and steel
- Short and medium span bridges (up to 150 m. span)

# Overview of questionnaire

- General information on network
- General information on bridge design standards
- Environmental conditions
- Materials data – concrete and steel
- Highlighted durability problems
- Design practice
- Detailing practice
- Developments relating to durability

# Responses received

- 25 responses returned (a number consolidated)
- Mainly from Europe reflecting committee membership
- Also from : Australia (3 States), New Zealand, Japan, Canada (2 provinces), South Africa, U.S.A.
- National and local networks represented
- More than 160,000 structures covered

# Detailed feedback: Networks

- National, provincial and local networks covered
- Size varied considerably  200 to 24,000
- Seven networks larger than 10,000 bridges
- Mix of concrete and steel varied considerably
- Definition of bridge 2m. to 15m. span.
- Culverts excluded in some data sets

# Detailed feedback: Design Standards

- All respondents have special bridge design standards
- Design life 75 to 100 years.
- Many design standards incorporate durability provisions

# Detailed feedback: Environments

- Most involved freeze thaw cycles
- Mainly relied on de-icing salts
- Some experimentation with other materials
- Marine conditions of some significance
- Seismic effects, pollution and other issues raised

# Detailed feedback: Materials - Concrete

- Indigenous problems mainly Alkali Aggregate Reaction
- Durability provided by strength and cover requirements
- Strength generally varied 35 to 65 Mpa
- Cover 30 to 70 mm (precast reduced by 5 mm.)
- Cover/strength related to environment and exposure
- Durability improvement by cement replacement
- Also coating buried concrete, coatings and impregnation

# Detailed feedback: Materials - Steel

- Mainly medium strength structural steel
- Paint systems remain most common protection
- Also galvanising and use of weathering steel

# Detailed feedback: Highlighted Durability Problems

- Problems ranked from given long list
- All can be critical in given case
- Major problems: deck joints, chlorides, concrete cover construction quality, deck waterproofing, design quality
- Other problems: works supervision, poor detailing, quality of materials, curing, regular maintenance
- Also: carbonation, alkali silica reaction, paint systems, quality of regular inspection

# Detailed Feedback: Design Practice

- Detailed design requirements embodied in standards
- Environment, service life and exposure considered
- Culverts and joint less frames favoured (short span)
- Integral and semi integral bridges prescribed
- Range of span limits 30 to 120 m. (200m. curved)
- Other trends: high performance steels, high performance concretes, increased use of weathering steels, prefabrication

# Detailed Feedback: Detailing Practice

- Wide variation, durability often explicitly considered
- Joints if necessary are minimised
- Inspectability and access particularly considered
- Maintenance and replacement considered in design
- Deck waterproofing, extensive but varied
- Adequate drainage systems vital
- Detailing guide lines widely used

# Detailed Feedback: Future developments

- Increased use of corrosion resistant reinforcement
- Development of High Performance Concretes (HPC)
- Development of Ultra HPC (>100Mpa)
- Corrosion inhibitors
- Increased use of High Performance Steels
- Increased use of Cathodic Protection
- Research on and wider use of Integral Bridges
- Special development of vulnerable members e.g. edge beams used

# Draft Conclusions

- Durability must be considered explicitly at all stages
- Relates to specification, conceptual design, detailed design, construction, inspection and maintenance.
- Traditional materials (concrete and steel) dominant
- Impact of new materials slight to date but increasing
- Main problems poor construction (leaking joints, low covers), chlorides and waterproofing failures
- General shift for short spans to integral bridges
- Design standards continue to respond to durability issues
- Value in scrutinising other countries practices