Sustainable Refurbishment of Existing Bridges

Reza Haghani
CTH
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What is Sustainability?

The Common definition of Sustainability

“Development that meets the needs of the present without compromising the ability of future generations to meet their own needs”

(Our Common Future, The Brundtland Commission)
Sustainability is a process

- Vision
- Goals and objectives
- Indicators of progress
- Evaluation
- Repetition
Sustainability is a process

- From
  - Short-term thinking
  - An economy outside environment and society
  - Fossil fuel resources
  - Seeing society, environment and economic challenges as separate and competing

- To
  - Long-term thinking
  - An integrated economy
  - Renewable energy resources
  - Seeing society, environment and economic challenges as having connection
Sustainability pillars

- **Environment**: Less impact
- **Society**: Meet client demands
- **Economy**: Lower cost
Impact of construction industry on the environment

- Energy and water consumption
- CO₂ production
- Impacts on soil, ground water, wild life

- Mineral consumption (>50% of extracted minerals)
- Waste production (180 mT/year)
- Site related nuisance (traffic-noise-dust, etc.)
Participation of activities

- 26% - Housing
- 31% - Non-residential
- 20% - Civil engineering
  - Roads, railways, bridges, tunnels, hydraulic structures, etc.
- 23% - Rehabilitation and maintenance
  - Repair, life extension and maintenance of dwellings, non-residential buildings, etc.
Situation in Sweden - Some facts

- Ca. 20,200 bridges (16,000 road and 4,200 railway bridges)
- 10% of road bridges and 23% of railway bridges are in class 3
- During 1999-2009
  - 13 B€ investment (Road)
  - 49 M€ investment (Railway)
- Trend of increasing axel loads accelerates deterioration
Situation in Sweden - Some facts

- Cost of maintenance is considerable (ca. 37% of the total budget)

Strategic sustainable intervention programs are needed!!
FRP materials

- Very high specific strength and stiffness
- Very good durability-corrosion resistance
- Tailor-made
- Light-weight- Low installation cost-safer construction site
- Aesthetics
- Low thermal conductivity

- Stiffness governed design
- Lack of standards
- High cost
Common problems in concrete bridges

- Investigations show that 70% of problems are related to concrete edge beams and decks → loss of capacity, damage to girders and sub-structure
- Axel load increase → necessity for external reinforcement
- Synergy of overloading and deterioration and lack of proper maintenance → demolition
- According to the model code (2010), a good deal of residual capacity exists in most cases
SUREBRIDGE

SUREBridge intends to provide a sustainable technical solution and a design tool for refurbishment of old concrete bridges using FRP composites.

Possible necessary transverse reinforcement and protection in form of FRP laminates or reinforced polymer mortar.

Possible necessary longitudinal reinforcement in form of pre-stressed or passive CFRP laminates.
Innovative features

- A novel method to use pre-stressed CFRP laminates for strengthening in tension
  - No need for mechanical anchorage
  - Compensation for pre-stress loss in pre-stressed elements
  - Improved serviceability (deformation)
  - Better use of CFRP material (x2 utilization compared to passive strengthening)
  - Improved durability (crack pattern and width control)
Innovative features
Innovative features

- Tailor-made GFRP deck system
  - Light weight
  - Good durability characteristics
  - Flexibility in design
  - Robustness
Innovative features

- Tool for design
- Interactive interface
Final product..

Bonded GFRP deck panel