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Present and future in the design, construction and maintenance of bridges

Versailles
2006, November, 21st – 22nd
Marcus Vitruvius Pollio

Art of Building

Firmitas
- Robustness and safety

Utilitas
- Serviceability and functionality

Venustas
- Elegance and beauty

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After more than twenty centuries those principles are still valid, although the increased importance of economy.

A new more general concept has been focused during the last two decades.

Sustainability
Construction process has been substantially influenced by sustainability concept (fib, Bull. 28)
Sustainability:

Satisfaction of the needs of the present without compromising the ability of future generations to meet their own needs

Analysis of complete life-cycle

...... ...... Durability ...... ......
Design for durability
Verification of
Robustness
Safety
Serviceability

New trend for the future
Guidance paper for durability

*fib* Model Code for Service Life Design
(Bulletin 34 – February 2006)

Four options

- Full probabilistic design approach
- Partial factor design approach
- Deemed to satisfy design approach
- Avoidance of deterioration design approach
Model Code for Service Life Design
Main parameters influencing durability

- Conceptual design
- Detailed design
- Technology concept
- Construction process
- Use
- Maintenance
- Repair

Design

Construction

Utilization
A typical engineering approach

Learn by the past experience

For the future avoid to spend the resources essentially in repairing the effect of the errors of the past
Present and near future for bridges

A lot of investments in repair, strengthening and upgrading of existing bridges

Significant amount of investments in new bridges

Avoid to repeat the errors made in the past
A case study of damaged piers (H= 150 m, built in 1973)

Construction with self-launching formwork
(3 m/day, continous launching, wrong mix design)

Cover cracked and very permeable

Spalling and reinforcement corrosion

Carbonation

Chlorides attack
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Spider system suspending the facilities from the top of the pier

- Hydrodemolition (60÷80 mm; p=1000÷1200 bars)

- Adding of reinforcement

- Casting (80÷100 mm) with S.C.C. (pumped from the bottom)

reconstruction speed: 1.8 m/day
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A case study of damaged beams

a) Very thin webs in combination with pretensioned and postensioned prestressing

- High stress level in compressed stress field
- Fatigue
- Tensile stresses transversely to the tendon profile, without local reinforcement
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b) Tendons corrosion by insufficient or missing grouting

Adding of external prestressing

Now a fib document available
(Bulletin 33, December 2005)
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Durability of post-tensioning tendons
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- Improvement of durability and aesthetics
- In small span recent bridges
- Continuity
- Prestressing protected with plastic ducts (HDPE)
- Massive structures (cast in situ slabs)
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a) Corrugated metal duct and sleeve (one end before and one after application of tape): For PL1 only.
b) Corrugated plastic duct and coupler: For PL2 and PL3
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Continuous beams
(current span 40\textendash100 m)

Box girder section
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18 External tendons 1940.6’’
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A recent solution for spans up to 160÷170 m

Composite box girder deck with external prestressing
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Advantages

Velocity in construction
Economy
Durability
External prestressing
15% reduction of dead weight
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Conclusions

Sustainability ↔ Durability

Full integration

Research  Design  Construction
New solutions for concrete bridges using the composition with steel

Composite box girder
(slabs in concrete)

External prestressing

Corrugated webs
Himi bridge

Structural Concrete
Vol. 7, n. 3, September 2006
Thank you for the kind attention