

**ECCS course « Fatigue Design Of Steel And Composite Structures »**

Reference book : A. Nussbaumer, L. Borges, L. Davaine, *Fatigue Design of Steel and Composite Structures: Eurocode 3: Design of Steel Structures, Part 1-9 Fatigue; Eurocode 4: Design of Composite Steel and Concrete Structures*, ECCS Eurocode Design Manuals, 2<sup>nd</sup> edition, John Wiley & Sons, 2018.

Speakers: Prof. Luis Borges, University of Coimbra, Portugal and Structurame, Geneva, Switzerland  
Prof. Johan Maljaars, TU Eindhoven and TNO Delft, The Netherlands  
Prof. Alain Nussbaumer, EPFL, Lausanne, Switzerland

<u>Date</u>	<u>Topic</u>	<u>Content</u>	<u>Comment and possible exercises</u>
<b>DAY 1</b>			
10 -11AM	<b>Introduction</b>	<ul style="list-style-type: none"> <li>- Content, objectives</li> <li>- Logic of the book and of the lectures</li> <li>- Structures at risk, examples of cracking</li> </ul>	<p>Must follow ECCS manual logic, at least for some regrouping of topics.</p> <p>Inclusion of design examples within lectures</p>
11AM-1PM	<b>Basis of fatigue design</b>	<ul style="list-style-type: none"> <li>- Concept of S-N curves, main parameters</li> <li>- S-N curves: experimental determination, definitions of stress range and nb of cycles</li> <li>- Terminology (in relation to Eurocodes)</li> <li>- Variable amplitude, damage sum and equivalent damage concept</li> <li>-</li> </ul>	<p>Introduce main concepts to put all participants at same min., level of understanding.</p>
2 -4PM	<b>Basis of fatigue design (cont.)</b>	<ul style="list-style-type: none"> <li>- Variable amplitude, damage sum and equivalent damage concept (cont.)</li> <li>- Verification methods (with stress ranges, with nb. of cycles, with damage sum)</li> <li>-</li> </ul>	<p><i>Exo damage sum calculation</i></p>
4 -6PM	<b>Codes of practice</b>	<ul style="list-style-type: none"> <li>- Different existing codes : Eurocodes, IIW, DNV, ...</li> <li>- Separation between action effects and resistance</li> <li>- Application and limitation range : materials, corrosion</li> <li>- Fabrication and quality assurance, EXC classes</li> </ul>	<p>Show where information can be found, also outside of Eurocodes, similarities between all codes.</p> <p>Sensitization wrt fabrication (EN 1090-2)</p>
<b>DAY 2</b>			
9AM -1PM	<b>Actions and action effects</b>	<ul style="list-style-type: none"> <li>- Fatigue loads, fatigue load models (general)</li> <li>- Road bridges load models (FLM1 to FLM5), railroad models (UIC 71, ...)</li> <li>- Service life, new vs existing bridges</li> <li>- Damage equivalent factors, « span » or critical length, simultaneity (multiples charges)</li> <li>- Combination road and railway traffic</li> <li>-</li> </ul>	<p>Go beyond strict application of Eurocodes, consider practical questions often asked</p>
2 – 6PM	<b>Determination of stresses and stress ranges</b>	<ul style="list-style-type: none"> <li>- Calculation of stresses: nominal, modified nominal, geometric</li> <li>- Calculation of stress ranges: in bolted, welded connections, multiaxial cases</li> <li>- In steel-concrete composite bridges</li> </ul>	<p><i>Exo determination of stress in bolted detail, in welded detail</i></p>



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DAY 3

9AM -1PM	<b>Fatigue strength and detail categories</b>	<ul style="list-style-type: none"> <li>- Catalogue of construction details</li> <li>- Classification by identification, by analogy</li> <li>- Fatigue strength modifications: size effect, mean stress and residual stresses,</li> <li>- Hot spot stress method for fatigue design</li> <li>- Special details: orthotropic plates, tension elements (EN1993-1-11), reinforcing steel (EN1992-2)</li> <li>-</li> </ul>	<i>Exo detail classification</i>
2 - 5PM	<b>Safety and design methods</b>	<ul style="list-style-type: none"> <li>- Steel quality choice: link between fatigue and brittle fracture (EN 1993-1-10)</li> <li>- Design methods: safe life, damage tolerant</li> <li>- Partial factors for fatigue determination</li> <li>- Evolution of reliability index during life wrt fatigue, influence of inspections, inspection interval determination</li> <li>-</li> </ul>	<i>Exo verification of a detail in a bridge</i>

