Bridge over Södertälje Channel

# CIR-dagen 2014

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*Market Manager Bridges, Ramböll Sweden*
*Input from Robert Hällmark, Trafikverket/LTU*
*+Laurence Davaine, Ingerop, France*

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# Faster bridge construction by prefabrication

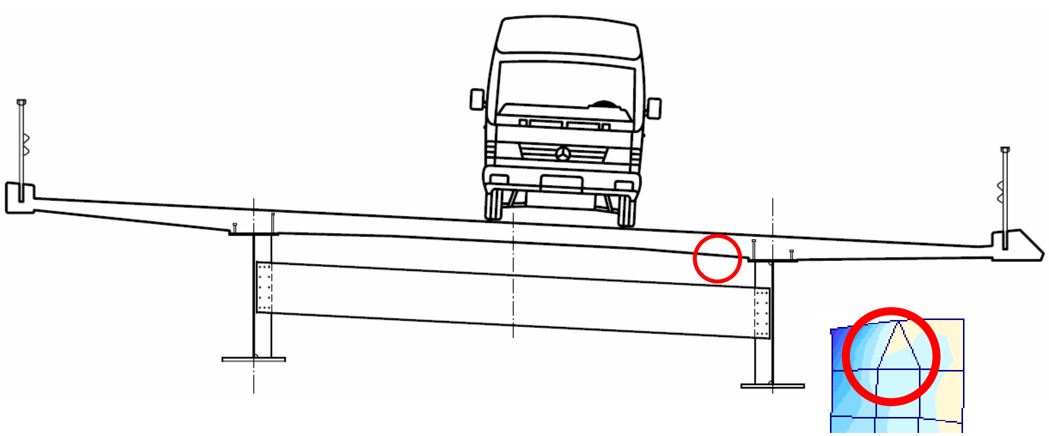
- Prefabricated solutions can save time and money for the contractor as well as the bridge user

- The upper picture shows a bridge replacement where the road was closed for 30 hours. The backwalls, piers and dry joint slabs were prefabricated

- Ramböll/LTU have carried out the EU-project ELEM, coordinated by RWTH Aachen, and made tests in-situ as well as in the lab. KTH also contributed with tests on water proofing over the dry joints.

- Robert Hällmark presented his Licentiate Thesis on this subject.

# Fatigue of steel bridges (part of project BriFaG)



Bridges in e. g. Sweden, Austria have showed deformation induced fatigue cracks in the welds. EC4-2 6.6.1.1(13) indicates this phenomenon.

This Swedish bridge on E4 was instrumented and monitored **both** with free flow traffic and with a weighed truck overpassing during night time.

Comparisons with FE-analysis indicate that stiffness concrete-steel is of outmost importance to the stresses in the weld.

Laboratory tests have been performed at LTU,are planned and Mattias Nilsson has presented his Licentiate Thesis.

# Integral Abutments saving money

Bearings and expansion joints are costly to install and maintain. By using steel piles directly connected to the back walls these and the piers near the abutments can be excluded.

The bridge over Leduån had a budget for 1 MEuro as two span concrete bridge with 3 piers. Our alternative composite bridge in one span, with no piers, was realized for 600 kEuro. The bridge was monitored with in the RFCS-project INTAB, for both thermal- and traffic loading.

Hans Petursson will present his PhD thesis on this subject.

# Earlier International Workshops at Ramböll

*Bridges with integral abutments*

*Strengthening of steel bridges*

*Element bridges*

# International Workshop on EC4-2, March 2013

**Program**

| | | |
|---|---|---|
| 10.00 | Peter Collin | Introduction, presentation of participants |
| 10.15 | Lahja Rydberg | The Eurocodes from the clients point of view |
| 10.30 | Gerhard Hanswille | EC4-2 Background and rules |
| 11.15 | Break | |
| 11.30 | Joel Raoul | EC4-2 Background and rules |
| 12.15 | Laurence Davaine | Worked example+French experience from EC4-2 |
| 13.00 | Lunch | |
| 14.00 | Chris Hendy | British experience from EC4-2 |
| 14.30 | Robert Hällmark | Swedish experience from EC4-2 |
| 15.00 | Coffee | |
| 15.30 | Luigino Dezi | Italian experience from EC4-2 (+creep and shrinkage) |
| 16.00 | Ulrike Kuhlmann | Innovative developments for composite bridges |
| 16.30 | All | Discussion on R&D for further improving EC4-2 |
| 17.00 | Closure | |
| 18.30 | Dinner in Old Town (for speakers) | |

Participants from 11 countries

Proceedings available on LTU.se

# Membership in July 2013



| No. | Name | | Representing | E-Mail adress |
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| 5 | **Davaine*** | Laurence | France | laurence.davaine@ingerop.com |
| 6 | Eltvik | Liv | Norway | liv.eltvik@aas-jakobsen.no |
| 7 | Ermopoulos | ? | Greece | ? |
| 8 | Greiner | Richard | Austria | r.greiner@tugraz.at |
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| 15 | | | | |
| 16 | | | | |
| 17 | | | | |

- Ongoing nominations of members by NSB (e.g. by Poland)
- Steadily increasing number of members (232 in April 2013 for all the SC3 Evolution Groups!)

# Evolution Group of EN 1994-2

| IName | Contact details | Nominated for | Nominated by | Confirmed to |
|---|---|---|---|---|
| Peter COLLIN (Chairman) | peter.collin@ramboll.se | EN1994-2 | SIS | Chairman of shadow committee |
| Joel RAOUL | jflraoul@yahoo.fr | EN1994-2 | AFNOR | French mirror group Greenley |
| Roger JOHNSON | r.p.johnson@warwick.ac.uk | EN1994-2 | B/525/4 | Greenley |
| Javier JORDAN | jjordan@pedelta.es | EN1994-2 | AENOR | Greenley |
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| Ms. Laurence DAVAINE | laurence.davaine@ingerop.com | EN1994-2 | AFNOR | Greenley |
| Mr. Mladen LUKIC | mlukic@cticm.com | EN1994-2 | AFNOR | Greenley |
| Prof Dr.-Ing Gerhard HANSWILLE | stahlbau@uni-wuppertal.de | EN1994-2 | DIN | Greenley |
| Prof Dr.-Ing Ulrike KUHLMANN | u.kuhlmann@ke.uni-stuttgart.de | EN1994-2 | DIN | Greenley |
| Dr.-Ing Markus PORSCH | m.porsch@hra.de | EN1994-2 | DIN | Greenley |
| Mr Alberto VINTANI | vint@bcv.it | EN 1994-2 | UNI | Greenley |
| Jean-Paul LEBET | Jean-paul.lebet@epfl.ch | EN 1994-2 | SIA | Greenley |
| Dr Martin MENSINGER | m.mensinger@bv.tu-muenchen.de | EN 1994-2 | SIA | Greenley |
| Mr Ilkka VILONEN | Ilka.vilonen@ramboll.fi | EN 1994-2 | CFCI RT | Greenley |
| Runar SORENSEN (unconfirmed) | Runar.sorensen@ramboll.no | EN 1994-2 | | |
| Dr-Ing Aristidis ILIOPOULOS | aristidis.iliopoulos@peikko.com | EN 1994-2 | Hellenic Organization for Standardization | Malcolm Greenley |

*I have personally recruited members to EG 1994-2. In both cases we are lacking members from e.g. UK.*

## EN1994-2 Evolution Group, Kick-off meeting agenda

1. **Welcome (10:00)**

2. **Presentation of delegates**

3. **Work context** for our EN1994-2 Evolution Group as part of CEN/TC250/SC4

   - Mandate M/515 from European Commission
   - Maintenance and future of all the EC4 parts in a global view (link with other EGs)

   …

4. **Future of EN1994-2** (new version scheduled in 2019!)
   - …

5. **Our work organization** within the EN 1994-2 Evolution Group
   - ECCS documents platform
   - Priorities? Project Team?
   - Next meeting: date and place?

6. **Input from the delegates; national experiences**

7. **Closure (17.00)**

# Global analysis

- Another difference is how we are dealing with concrete of varying age.
  - Previously, as soon as composite action is achieved, the concrete has been given its long term stiffness (one third of the short term stiffness).

    -This stiffness has been used for all long term loading (concrete dead load, shrinkage, non-structural bridge equipments etc.)

  - Today, the bridge designer must estimate the construction procedure on an early stage, since the concrete long term stiffness is treated as time dependent.

    -The construction procedure and time schedule is often not known on an early stage. Therefore the bridge designer has to estimate how long time it takes to cast each segment.

    -For concrete dead loads, one mean value of the concrete age is used to model the concrete stiffness.

    A small sensitivity analysis gives $\Rightarrow$ A bad guess will not effect the design of the bridge significantly.

# Global analysis

**5.4.2.2 Creep and shrinkage**

(3) For permanent loads on composite structures cast in several stages one mean value *t*0 may be used for the determination of the creep coefficient. This assumption may also be used for prestressing by imposed deformations, if the age of all of the concrete in the relevant spans at the time of pre-stressing is more than 14 days.

The Book "Designer´s Guide to EN 1994-2" (C.R Hendy&R.P Johnson) expresses this in the following way;

*Clause 5.4.2.2(3)* permits an assumed 'mean' value of $t_0$ to be used throughout. This simplification is almost a necessity as it is rare for the designer to have sufficient knowledge of the construction phasing at the design stage to be more accurate than this, but some estimate of the expected timings is still required.

'First loading' could occur at an age as low as a week, for example, from erection of precast parapets, but the mean age for a multi-span bridge is unlikely to be less than a month.

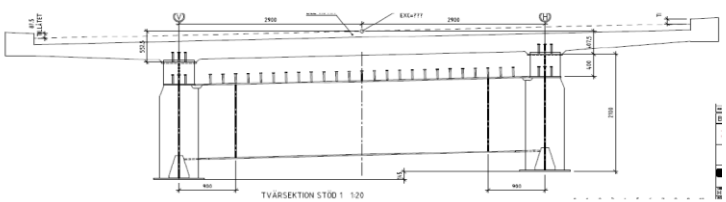
The creep coefficient depends also on the effective thickness of the concrete element considered, $h_0$. There is no moisture loss through sealed surfaces, so these are assumed to be at mid-thickness of the member. After striking of formwork, a deck slab of thickness, say, 250 mm, has two free surfaces, and an effective thickness of 250 mm. The application of waterproofing to the top surface increases this thickness to 500 mm, which reduces subsequent creep. The designer will not know the age(s) of the deck when waterproofed, and so must make assumptions on the safe side.

Fortunately, the modular ratio is not sensitive to either the age of loading or the effective thickness. As resistances are checked for the structure at an early age, it is on the safe side for the long-term checks to overestimate creep.

# Global analysis

### 5.4.2.2 Creep and shrinkage

For a studied 3 span bridge a mean value $t_0$=42 days was used. A change to $t_0$ = 84 days only gives 6% decrease on nL, and 2 % on the moment of inertia for the composite section. The influence on the distribution of moments in midspan and supports will be much smaller than this.




# Global analysis

- One of the largest differences in Sweden, is how we are dealing with the cracked concrete, at internal supports ( 5.4.2.3).

Swe. code

Eurocode

In midspan we (always) have cross-section class 1, and a possible failure is expected to be very ductile.

It is unexpected that the simplified method seems to decrease the support moments and lower the safety margin at internal supports, where we have possible failure modes that can occur more suddenly. (lateral torsional buckling of bottom flanges, stiffeners etc.)

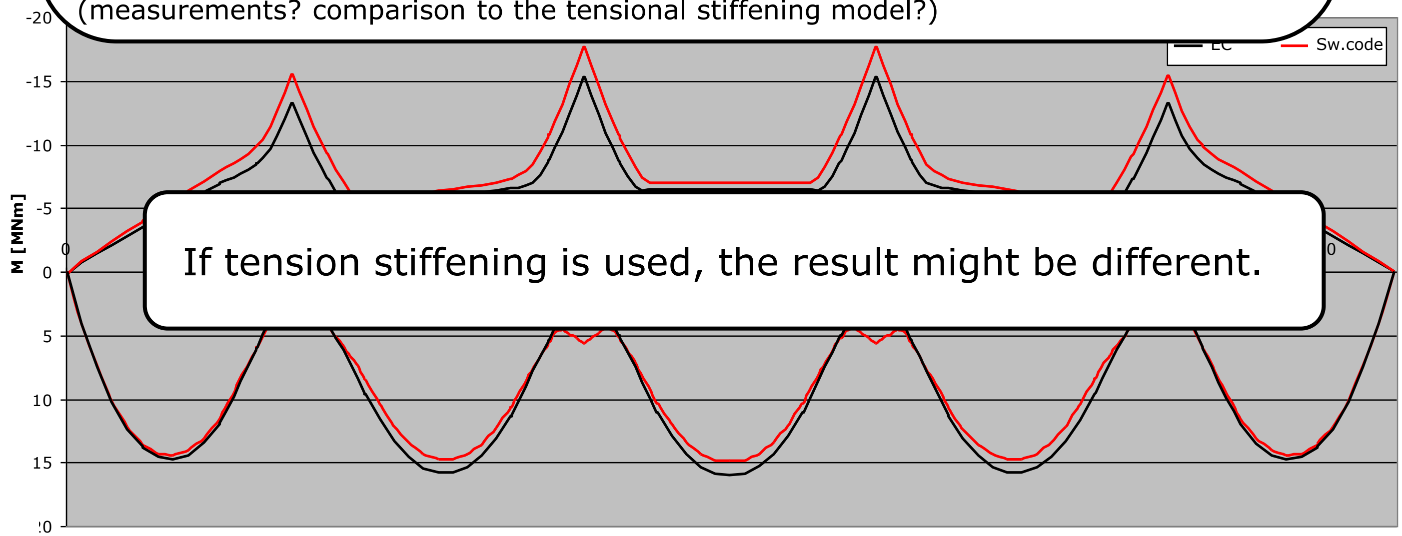
Why was exactly 15% chosen?

(measurements? comparison to the tensional stiffening model?)

*<u>Result from Bridge 2</u>*

The support moments decreases by ~10 %.

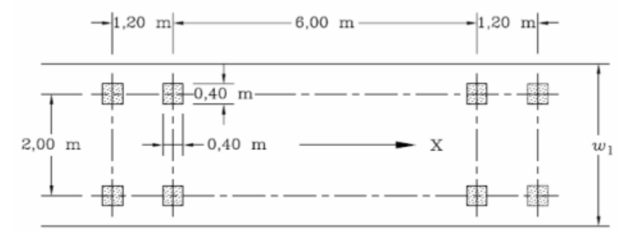
The field moments are increased by ~10 %.




If tension stiffening is used, the result might be different.

# Some Swedish comments
# FLS – Fatigue Limit State

- The simplified method ( $\lambda$-method) for road bridges up to 80 m is still the only method we have used.




- FLM 3 is used to calculate the stress amplitude (4 x 120 kN)

## *Old code*

- Generally, fatigue was not governing the design of the structural elements in road bridges.
- The number of shear studs was usually the only detail that was limited by the fatigue limit state.
- In road bridges, the flanges were often made in S420/S460, since fatigue was not a problem.

## *Eurocode*

- Fatigue will govern the design of quite a lot of details in a road bridge.
- The number of shear studs is nowadays often governed by the ULS and SLS.
- It will not longer be economical to use S420/S460 in the same extent as earlier, since we do not manage to fulfil the fatigue requirements in the steel girders at midspan.

# Fatigue

- As the heavy vechicles in Sweden are > 18 metres, EC is punishing especially short bridges severely, by the short length of FM 3 (8.4 metres).

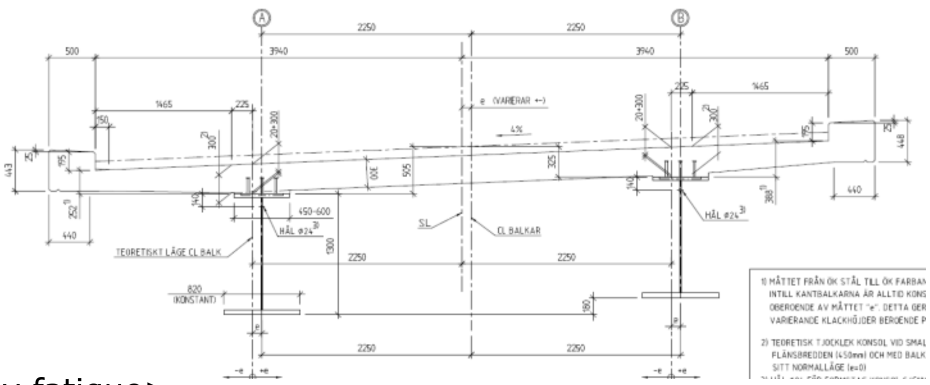
- For really long spans, the eigenwight and lane loading are dominant>Fatigue no problem

# Fatigue, Swedish points of view

- What does $\lambda_1$ really represent?
- Why does $\lambda_1$ differ from support to midspan?
- Example: UK have 260 kN in FM3, and $\gamma_{Mf}$ = 1.15.
  Sweden have 410 kN, and $\gamma_{Mf}$ = 1.35.
  Should all countries have 1.35 or 1.15?

# FLS – Fatigue Limit State

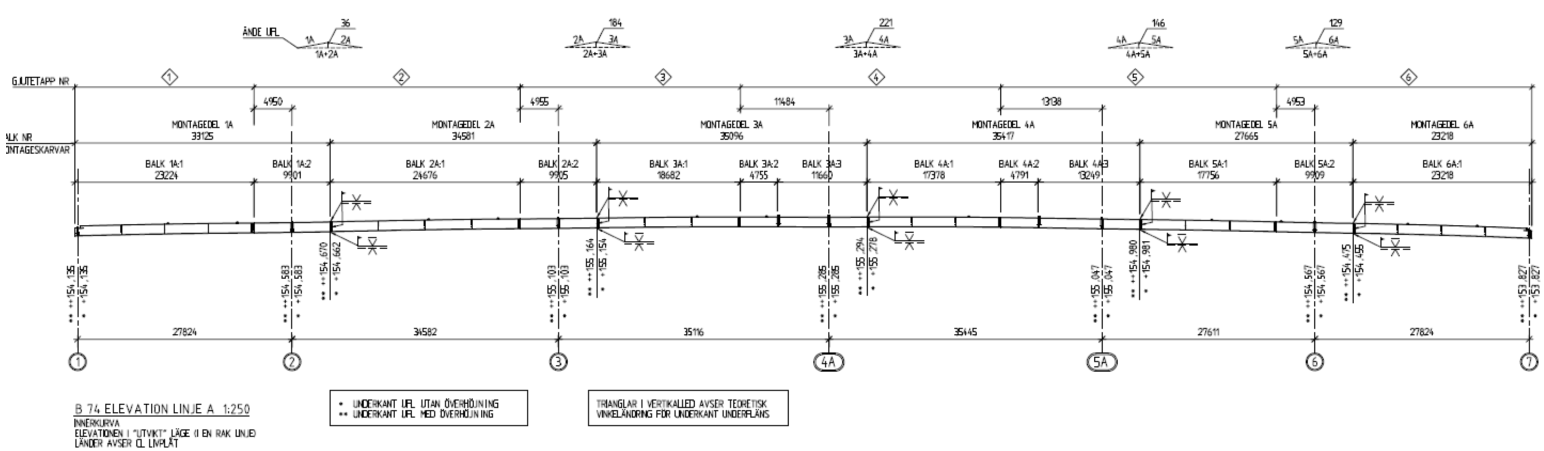
Swedish Bridge, 190 m in 6 spans




Calculated according to Old Code and EC
$\lambda^{midspan} = 1.59$
$\lambda^{support} = 1.15$

New code gave 110% heavier flanges in midspan.
32*600 S460 > 50*820 S355
With steel price taken into account:
+85 % material cost in these flanges.
Webs, support section, top flanges not governed by fatigue>
Totally +20 % material cost

Assume the material is 40% of steel contract>+8%
Assume steel contract is 40% of bridge cost>+3%



# SLS – Serviceability Limit State

- *Breathing*

  Previously, breathing has quite often been governing the web thickness in the area where the bending moment is shifting from positive to negative. (concrete shrinkage ⇒ compression over the whole web height)

  For a road bridge with a span of 50 m, and a web height of 2,0 m, the web plate can be as thin as 9 mm without problems with breathing.

  $b/t < 30+4,0\ L < 300$ (6 mm)

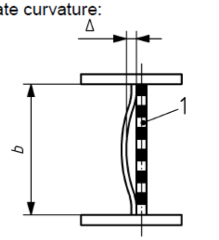
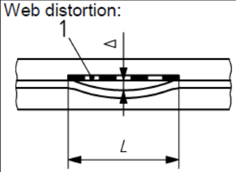
  For a rail bridge, we get 10 mm for the same geometry

  $b/t < 44+3,3\ L < 250$ (8 mm)

# SLS – Serviceability Limit State

- How do we check the size of buckles arising from welding, casting and shrinkage?

According to EN 1090-2 Annex D1.1 Essential tolerances:

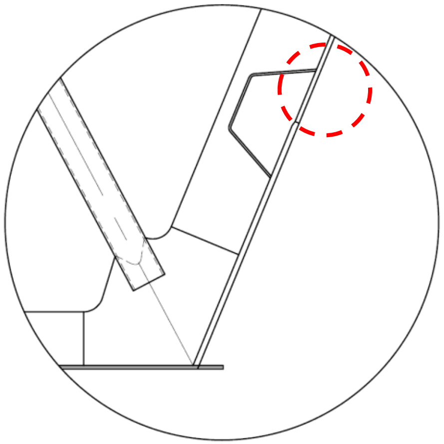
| | | | |
|---|---|---|---|
| 4 | Plate curvature:   | Deviation Δ over plate height *b*: | $\Delta = \pm b/200$ if $b/t \leq 80$<br>$\Delta = \pm b^2/(16\,000\,t)$ if $80 < b/t \leq 200$<br>$\Delta = \pm b/80$ if $b/t > 200$<br>but $\lvert\Delta\rvert \geq t$<br>($t$ = plate thickness) |
| 5 | Web distortion:   | Deviation Δ on gauge length *L* equal to web height *b* (see (4)): | $\Delta = \pm b/100$<br>but $\lvert\Delta\rvert \geq t$<br>($t$ = plate thickness) |

(The previous version had Δ = b/100)

Using b= 2000
t = 16 mm
gives
$\Delta = 2000^2/(16000*20) = 15$ mm

# A research proposal

- In the conceptual design of 2 large bridges we have struggled a lot with patch loading. A small example from one of them:



- the contractor would like to launch the steel-girders together with the prefabricated concrete deck elements (except in the cantilevering part)

- we have suggested to use two different plate thickness in the same web

  - the lower 1,3 m would have a permanent thickness of 28 mm

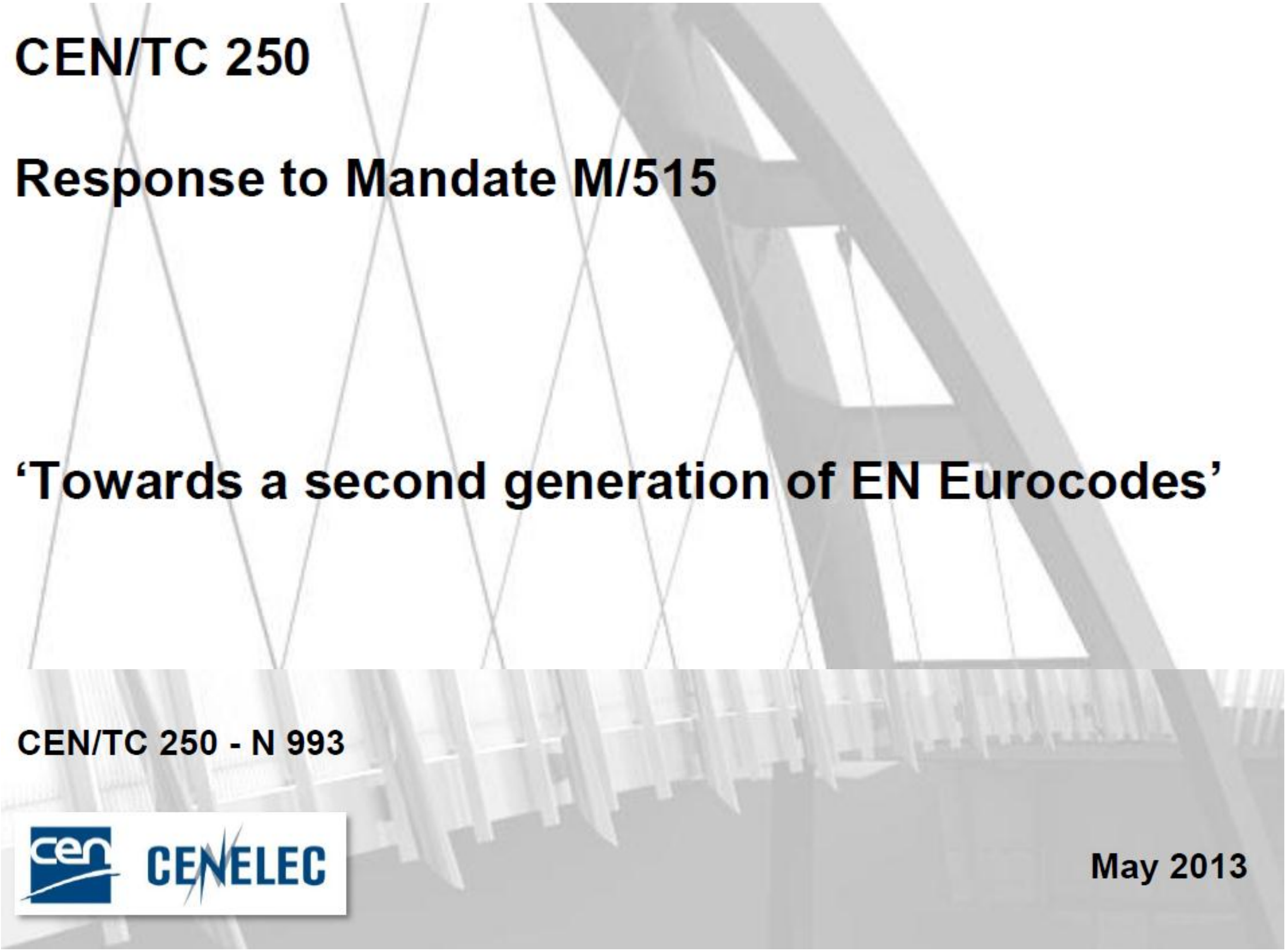
  - the upper 3,2 m would have a varying thickness (from plate to plate) between 15 - 28 mm

- since some of the Nordic steel producers have a limitation of their plate width to ~3,2 m. It might be economic to use different web-thickness when a longitudinal butt weld is already necessary.

- it would be nice with some guidelines how to deal with varying web thickness

Maybe this is a possible research topic!

# Tasks second generation of EN Eurocodes



CEN/TC 250

Response to Mandate M/515

'Towards a second generation of EN Eurocodes'

CEN/TC 250 - N 993

May 2013



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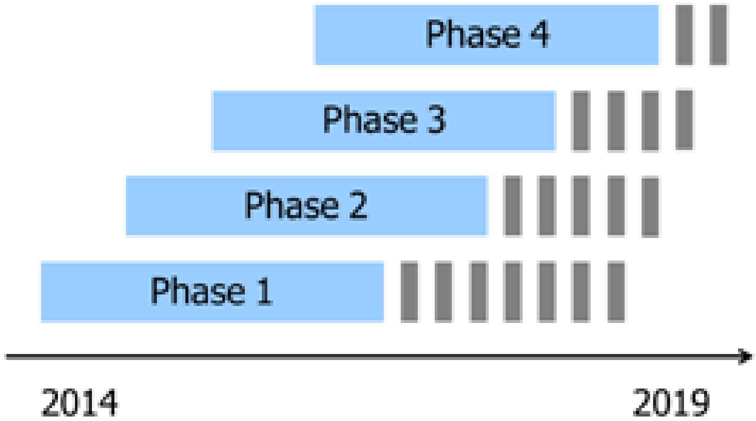
# Report CEN/TC250 Meetings

Madrid 15th – 16th November 2012 --- Lisbon 7th – 8th March 2013

## (3) Key issues of updated version of Mandate M/515

- Total work programme is split up into 4 over-lapping phases

- Duration of 5 year, equal to official CEN review period of Eurocodes




- Phase 1 will include those parts of the work programme upon which other activities are primarily dependent for reasons of overall coordination, technical scope or because they are essential to achieving the target dates for delivery of the next generation of Eurocodes

# Report CEN/TC250 Meetings

Madrid 15th – 16th November 2012 --- Lisbon 7th – 8th March 2013

## (3) Key issues of updated version of Mandate M/515

- Reduction of nationally determined parameters (NPDs) of existing Eurocode parts
- Enhancing 'ease of use' of existing Eurocode parts by:
  - (i) improving the clarity
  - (ii) simplifying routes through the Eurocodes
  - (iii) limiting, where possible, the inclusion of alternative application rules; and
  - (iv) avoiding or removing rules of little practical use in design
- Creation of new Eurocodes parts, e.g. "Glass" or "Existing Structures"

# Tasks second generation EC 4-2 SC4T1

| Sub-task Ref. | Sub-task name | Brief description, background and reasons for the work<br><br>(including any additional comments / notes) |
|---|---|---|
| 1 | Reduction in number of National Choices (NDPs) | Review the contents of all Countries' National Annexes and supporting documents, where they provide information needed to implement the Eurocode Part. Compare the values or choices made by all Countries in their relevant National Annex, using if possible, the JRC database of collected National values and choices. Where little or no variation exists between Countries, eliminate the NDP; where there is good consensus, but not unanimity, seek to persuade those not using that value or choice to adopt it. In cases of wide variation between Countries, seek the reasons for them and try to eliminate them so that consensus can be achieved, for example by use of international studies and research. |
| 2 | Enhanced ease of use | Enhance ease of use by improving clarity, simplifying routes through the Eurocode, avoiding or removing rules of little practical use in design and avoiding additional and/or empirical rules for particular structure or structural-element types, all to the extent that it can be technically justified whilst safeguarding the core of essential technical requirements. Take into account feedback from users of the Eurocode. |
| 3 | Identification and analysis of paragraphs, clauses and formulae that require simplification, clarification, correction or harmonisation | Groups were formed during 2012 to consider the evolution of all three parts of EN1994. They have already begun to gather feedback from industry (through NSBs, workshops, known experts) to identify those clauses etc that need new consideration, and to identify solutions. It is very important that such comments made by industry are addressed. |
| 4 | Compilation of outcomes of sub-task 3 into codified rules | Once the needs for each part have been identified in sub-task 3 the resulting solutions need compiling and presenting in a suitable format |
| 5 | Repeat sub-task 3 at the start of Phase 4 to pick up any consequences for harmonization of changes that have taken place to EN1992 or EN1993 during earlier phases. | As sub-task 3, but a revisit to ensure that any changes made to EN1992 and EN1993 during the evolution process do not adversely affect harmonisation with EN1994 |
| 6 | Compilation of outcomes of sub-task 5 into codified rules | As for sub-task 4 |

# Tasks second generation EC 4-2 SC4T6

| Sub-task Ref. | Sub-task name | Brief description, background and reasons for the work<br><br>(including any additional comments / notes) | Interdependencies<br><br>Identify known Task (sub-tasks) that must be substantially completed before this sub-task can commence.<br><br>(Independencies within individual Tasks do not need to be identified) | Key benefits | Output<br><br>(e.g. new Eurocode part; new or modified clauses in existing Eurocode part) | Priority item for EC contract |
|---|---|---|---|---|---|---|
| 1 | Consideration of the load-slip behaviour of new types of shear connector, and development of appropriate design procedures | The current scope of EN1994 is limited to welded headed shear studs. As the market continues to innovate to find more effective solutions it is important that codified guidance is available to assure safety, without stifling innovation. | - | Extend scope of EN1994 to cover current construction practice. Facilitate the uptake of good solutions through the provision of generic guidance. | Modified clauses in EN1994-1-1 and possibly EN994-2 | ✓ |
| 2 | Identification of resistance of shear connectors in various conditions, and development of appropriate design procedures | Combined axial and shear loading of a shear connector may adversely affect its resistance, in ways that are not recognised by the current rules in EN1994. The same is true for connectors that are subject to fatigue damage. | SC3 Task 8.10 | Ensure that the rules given in EN1994 can safely cover all likely scenarios. | Modified clauses in EN1994-1-1 | ✓ |
| 3 | Development of design rules for high strength materials used in composite construction | High strength steels and concrete are commonly used in modern construction but not adequately covered by the current scope of EN1994. Their safe adoption should be encouraged, as higher strength can result in lower environmental impact through clever design. Rules are needed to allow safe innovation, and ensure that EN1994 does not lag too far behind current practice. Coordination with SC2 and SC3 will be essential. | - | Extend scope of EN1994 to cover current construction practice. | Modified clauses in EN1994-1-1 and possibly EN1994-1-2 and EN1994-2 | ✓ |
| 4 | Compilation of design procedures into codified rules | Present the results of sub-tasks 1, 2 and 3 in the correct format. | - | As above | Modified clauses in EN1994-1-1 and possibly EN1994-1-2 and EN1994-2 | ✓ |
| 5 | Production of background documentation | Production of complementary information to facilitate correct use of new procedures. Note this is dependent on industry funding being provided for the earlier sub-tasks | - | As above | | |

# Tasks second generation EC 4-2 SC4T6

| Sub-task Ref. | Sub-task name | Brief description, background and reasons for the work<br><br>(including any additional comments / notes) |
|---|---|---|
| 1 | Consideration of the load-slip behaviour of new types of shear connector, and development of appropriate design procedures | The current scope of EN1994 is limited to welded headed shear studs. As the market continues to innovate to find more effective solutions it is important that codified guidance is available to assure safety, without stifling innovation. |
| 2 | Identification of resistance of shear connectors in various conditions, and development of appropriate design procedures | Combined axial and shear loading of a shear connector may adversely affect its resistance, in ways that are not recognised by the current rules in EN1994. The same is true for connectors that are subject to fatigue damage. |
| 3 | Development of design rules for high strength materials used in composite construction | High strength steels and concrete are commonly used in modern construction but not adequately covered by the current scope of EN1994. Their safe adoption should be encouraged, as higher strength can result in lower environmental impact through clever design. Rules are needed to allow safe innovation, and ensure that EN1994 does not lag too far behind current practice. Coordination with SC2 and SC3 will be essential. |
| 4 | Compilation of design procedures into codified rules | Present the results of sub-tasks 1, 2 and 3 in the correct format. |
| 5 | Production of background documentation | Production of complementary information to facilitate correct use of new procedures. Note this is dependent on industry funding being provided for the earlier sub-tasks |

# Tasks for Evolution Group EC4-2

Collecting NA documents from all countries

Presenting in an Excel sheet to compare and identify similarities and large differences.

Get contact with all countries designers/researchers if possible

Collect input from designers concerning in order to

Correct errors
Clarify where necessary
Enhance the ease of use
Catch up suggestions for improvement
Suggest a Project Team of 4-6 people and support them

Next meeting:
Stockholm, 16-17 June, 2014

# 4. COMMENTS, DOUBTS, OR TOPICS TO STUDY FOR THE NEXT GENERATION OF EN 1994-2. GENERAL COMMENTS (III)

## COMMENT

There are no recommendations for the design of a double composite deck neither for a lower composite deck slab nor for a lower concrete slab

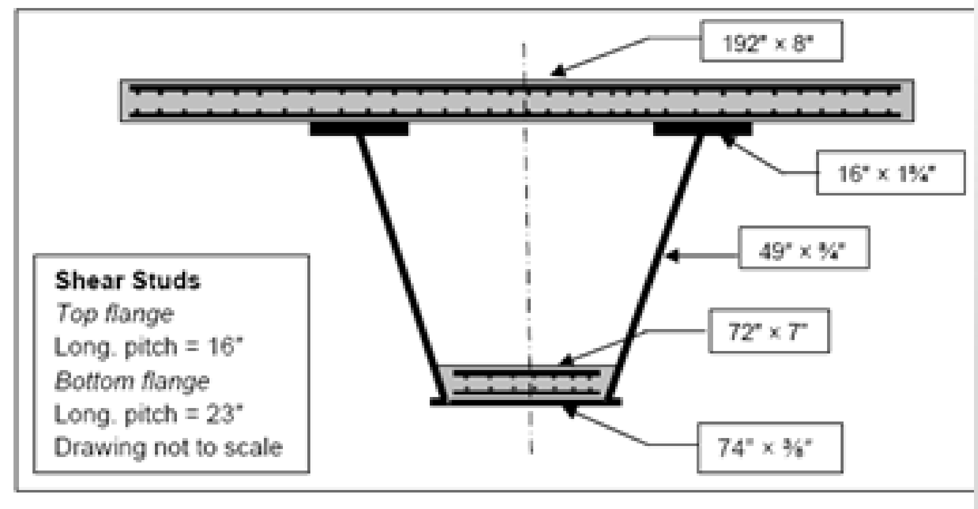
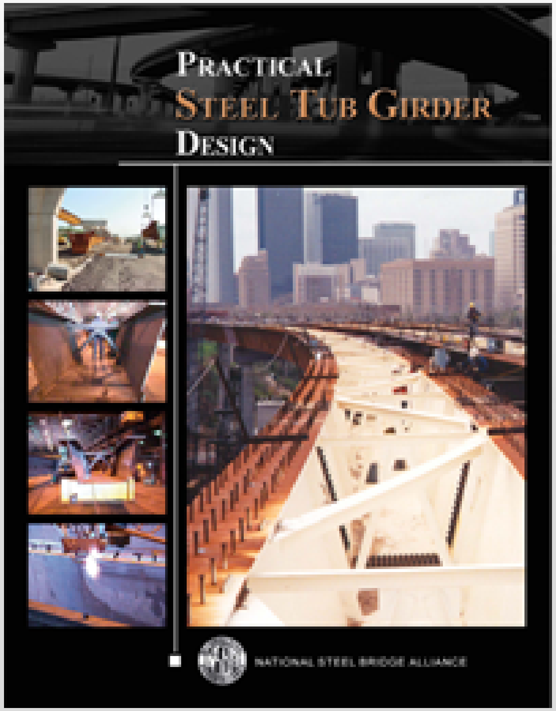



**Figure 1.1** Typical Cross-Section of Test Specimen



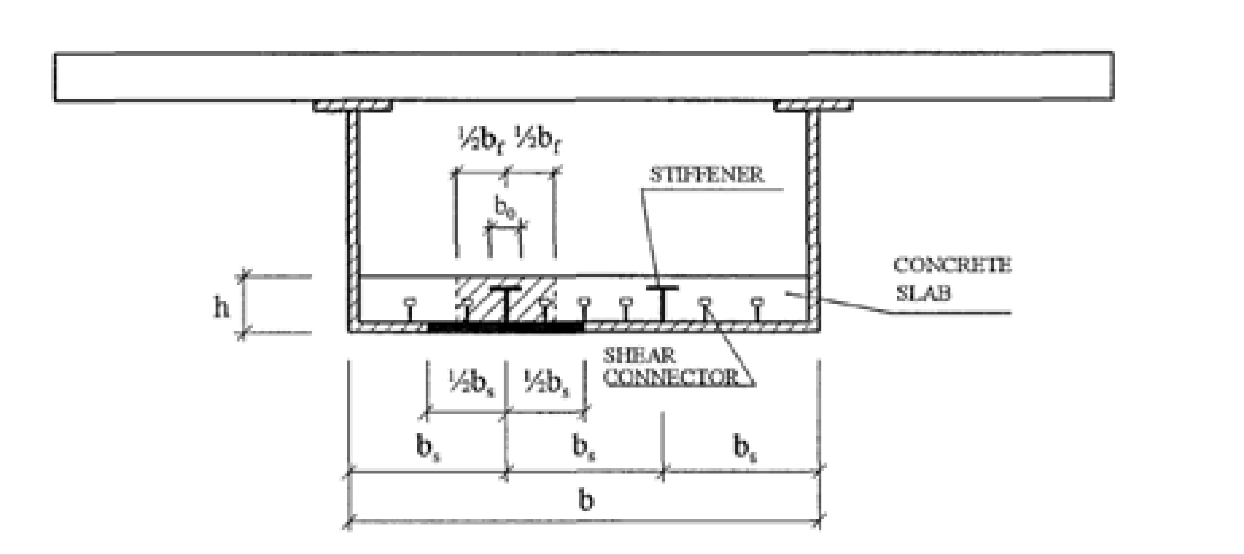

## SUGGESTION

Recommendations, updated and harmonized to the Eurocodes frame, from the Spanish document RPX-95 could be included for the design of lower composite slabs in compression

# 4. COMMENTS, DOUBTS, OR TOPICS TO STUDY FOR THE NEXT GENERATION OF EN 1994-2. GENERAL COMMENTS (IV)

## COMMENT

There are no clear recommendations for a composite plate with longitudinal and transverse stiffeners filled in concrete. Reduction in strength due to second order effects should be considered according to 5.8 of EN 1992-1-1:2004, but it leads to instability considerations in the lower concrete slab in compression in hogging sections while this has not to be considered in the upper slab in positive bending.




## SUGGESTION

Make it coherent with EN1992 and avoid instability problems in the lower slab under compression if some geometrical criterion are fulfilled.

# 4. COMMENTS, DOUBTS, OR TOPICS TO STUDY FOR THE NEXT GENERATION OF EN 1994-2. SIMPLIFICATION COMMENTS (VIII)

## COMMENT

**Clauses 5.4.2.3, 6.6.2.1 and 6.6.2.2: For the distribution of shear forces at the interface between concrete and steel for Serviceability Limit States, an uncracked analysis should be performed. It is not coherent with the other ULS and SLS verifications.**

(2) In general the elastic properties of the uncracked section should be used for the determination of the longitudinal shear force, even where cracking of concrete is assumed in global analysis. The effects of cracking of concrete on the longitudinal shear force may be taken into account, if in global analysis and for the determination of the longitudinal shear force account is taken of the effects of tension stiffening and possible over-strength of concrete.

## SUGGESTION

**Define a homogeneous calculation model for all the SLS and ULS verifications. Affect, if necessary, the stud resistance by a safety factor.**

# 4. COMMENTS, DOUBTS, OR TOPICS TO STUDY FOR THE NEXT GENERATION OF EN 1994-2. COHERENCE COMMENTS (XV)

## COMMENT

Clause 6.6.3.2: It is stated that if the traction force in a shear stud is greater than 10% of its shear resistance, the connection is not within the scope of EN 1994 even though formulation for studs in tension is well known and can happen in bridge design.

## SUGGESTION

Include formulation for studs in tension.

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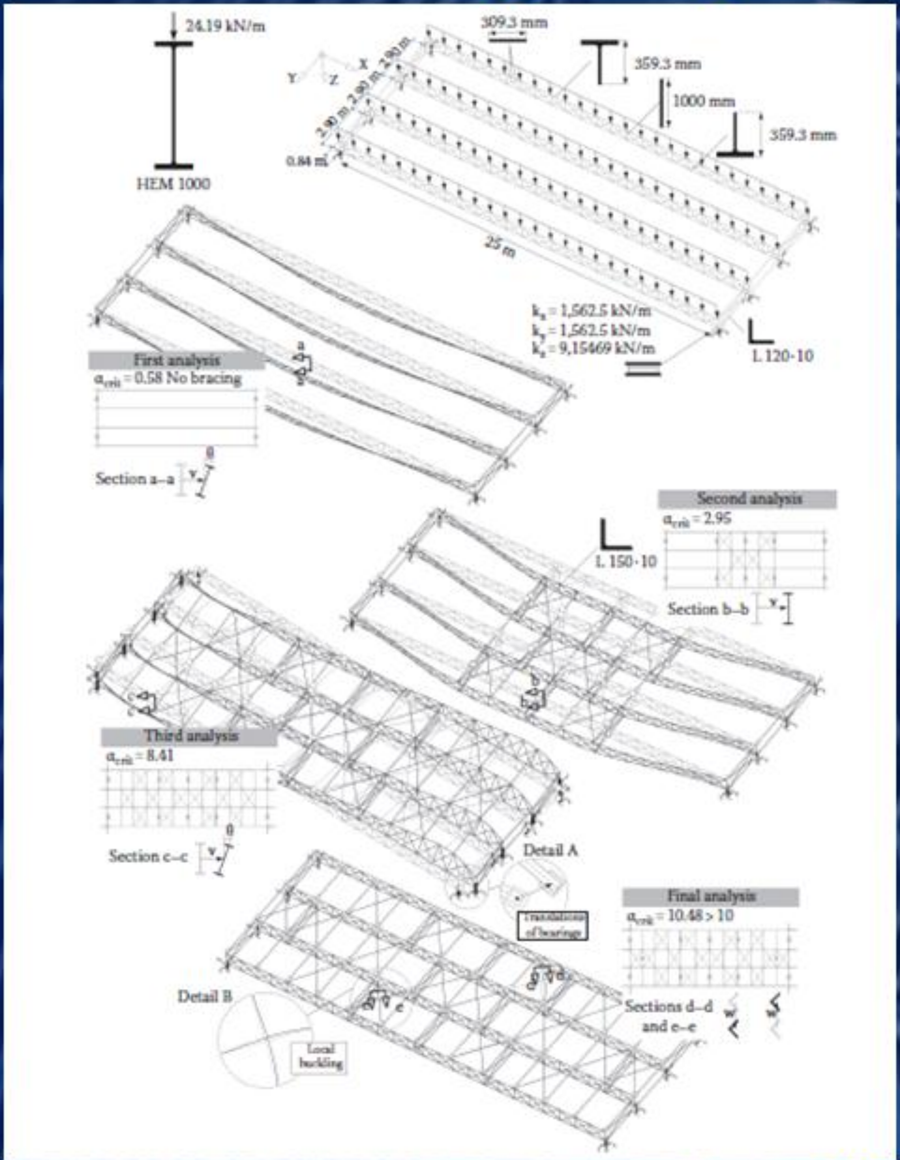
# Amendments for EC 4-2

- safety Concept for the non-linear design of columns and compression members
- serviceability and fatigue limit states for composite compression members in Bridges
- determination of internal forces for semi-integral and integral structures
- global imperfections for the columns for semi-integral and integral structures – different rules in EC 2 and EC 3
- Harmonisation of the stress-strain relation for concrete between EC 2 und EC 4 ($\alpha_c$= 0,85 or 1,0)
- Headed studs in tension and interaction shear and tension
- Introduction length for the design of shear connectors in case of concentrated longitudinal shear forces
- Influence of cracking of concrete on the buckling resistance in regions of contraflexure

# Concreting sequence

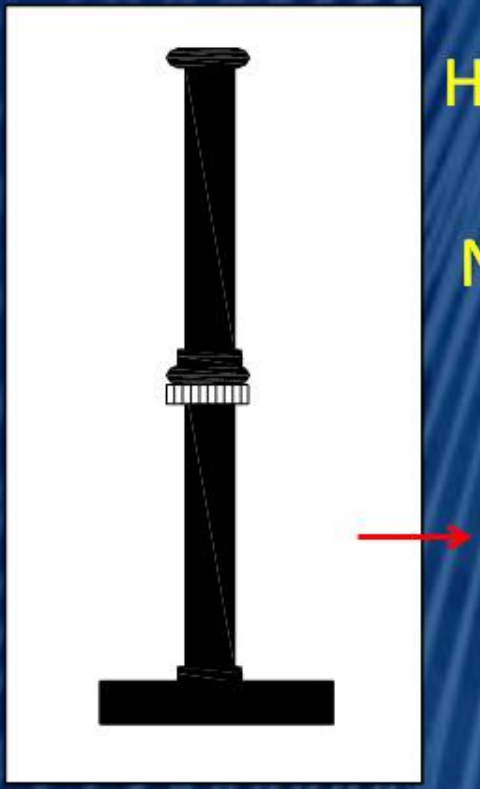



Stability analysis leads to a lot of bracings!

This damages the aesthetic of the bridge (Industrial looking)!

Recommendations for min/max spacing of bracings, type of cross-sections would be nice to have in the Code!

# Double Headed Studs



How do we treat double headed studs?

No recommendations in the Code!

Two concreting phases in vertical direction! Solution against buckling phenomena during concreting.

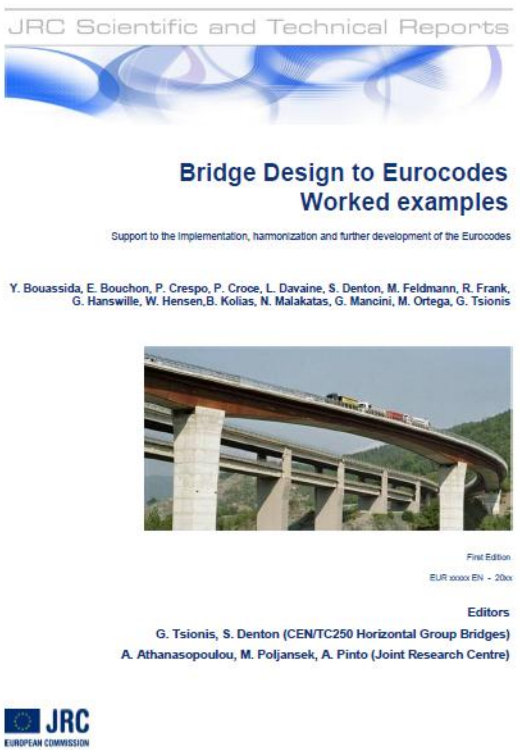
# HGB Connection

Consultation with the National Contacts during the JRC Vienna Workshop in October 2010 to identify research needs. Items have been prioritised:

| **Priority 1 items** | **Priority 2 items** |
|---|---|
| - Design of integral bridges<br>- Fatigue verification in bridge design<br>- Bridge bearings and expansion joints<br>- Robustness requirements in bridge design<br>- Lateral Torsional Buckling in bridge design<br>- Partial prestressing and crack control requirements in bridge design | - Footbridge vibrations<br>- Impact of climate change on environmental actions<br>- Light rail and tram loading models<br>- Combination rules for rail / light rail and highway traffic loading<br>- Loadings of noise barriers due to passing trains and related fatigue effects<br>- Simplification and improving ease of use at a European level<br>- New materials |

# HGB Connection

The item "existing steel bridges" will be included in a new Eurocode. See also the specific WG in ECCS/TC6 chaired by B. Kühn




HGB produced 2 JRC reports:

- October 2011 : "The evolution of Eurocodes for bridge design" to better explain (with more details and items) the research needs in bridge design, but not in the formal frame of the Mandate M466
- November 2011 : Bridge worked example (Vienna Workshop)


Tack för mig!