ÖBB Infrastruktur

Railway Bridge Brunngraben

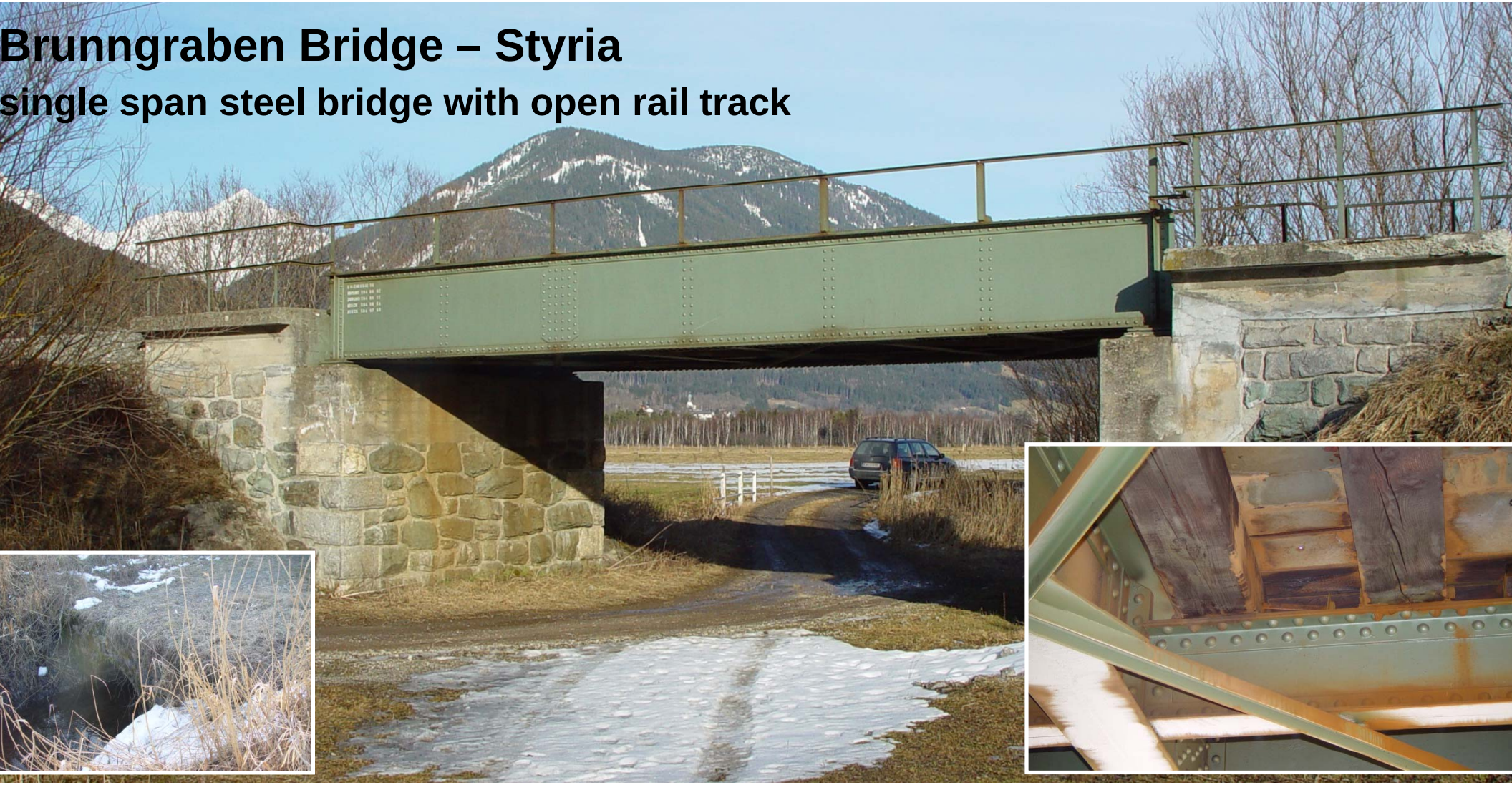
Special Session:

Austrian experience of using Eurocodes for bridge design

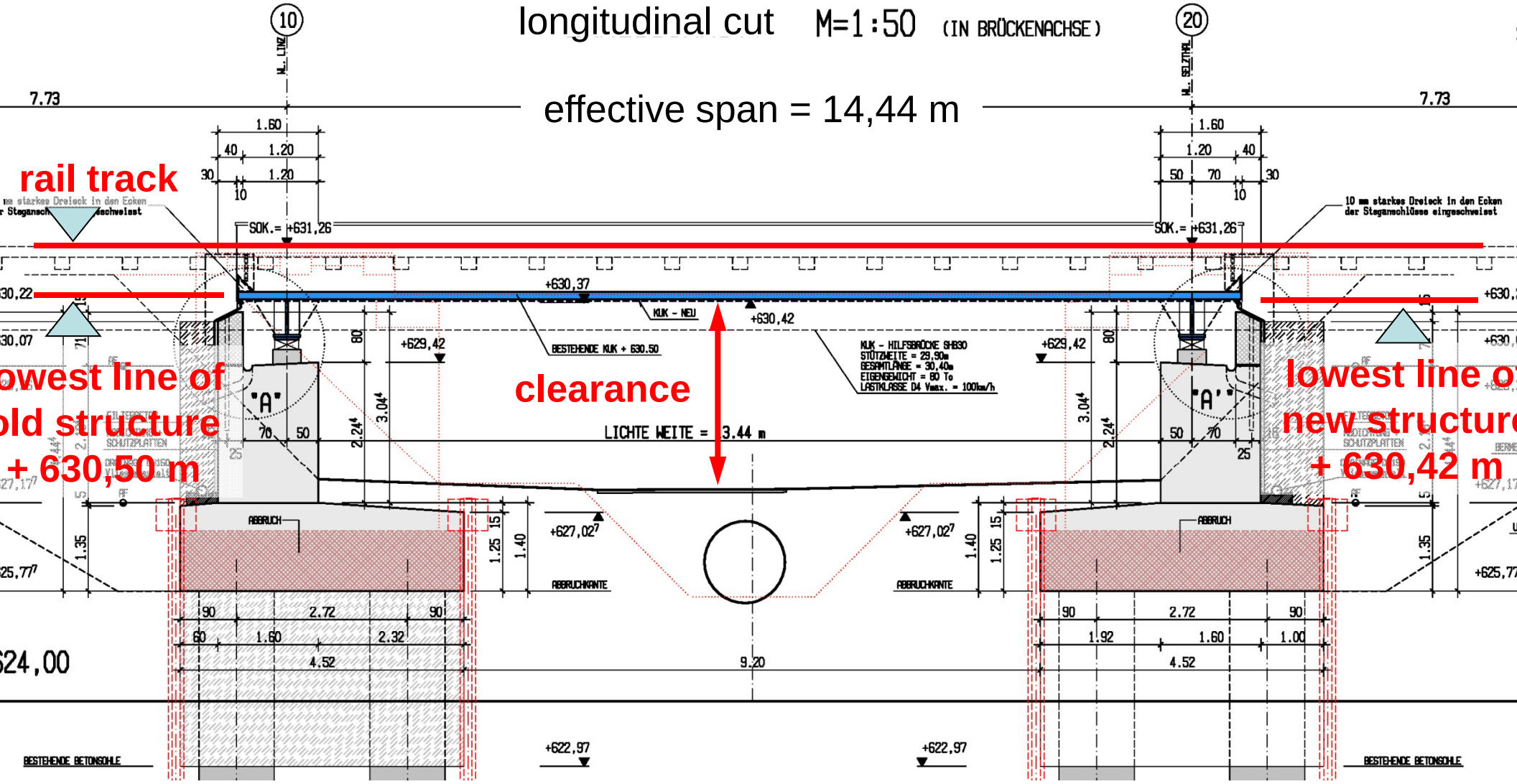
Challenges and opportunities

Brunngraben Bridge – Styria

single span steel bridge with open rail track

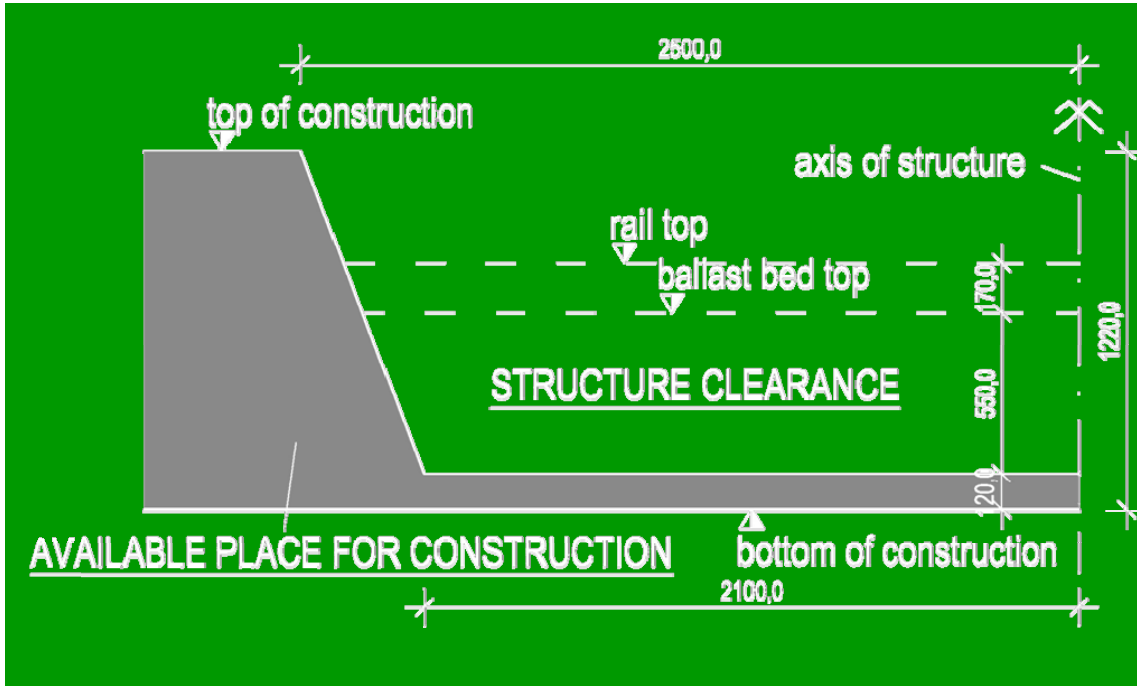


Introduction

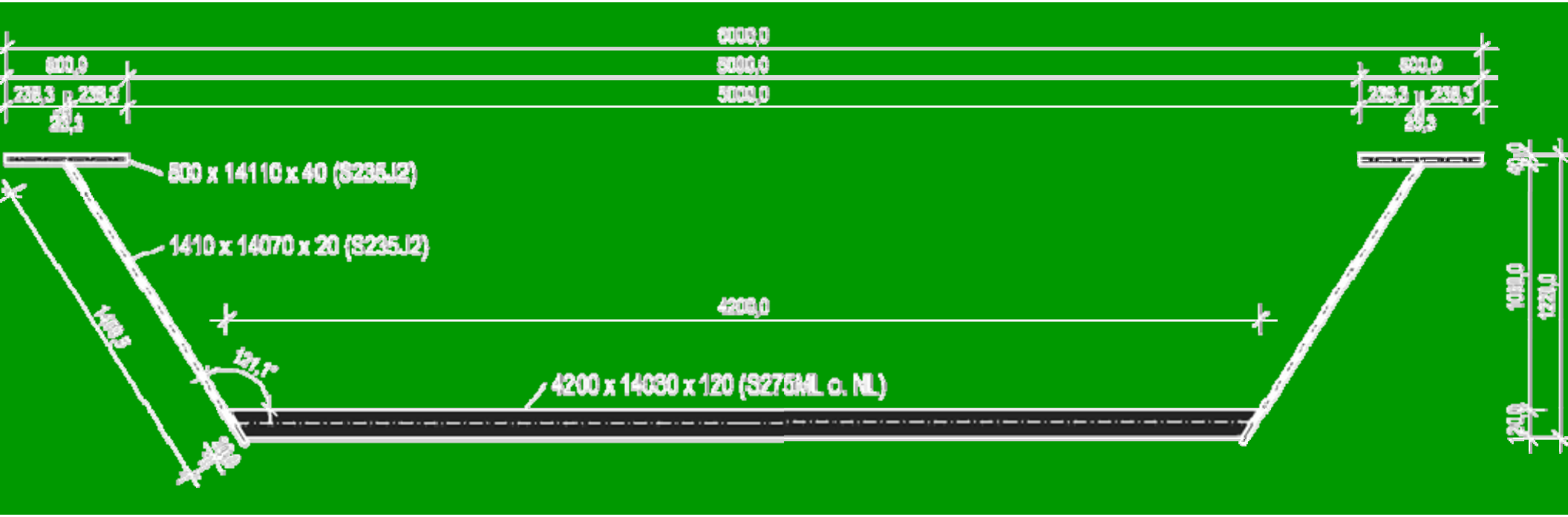


Initial Situation

- straight bridge with straight and curved railway track
- min. 5000 mm clear width between top flanges
- max. construction height 1220 mm
- width of top flanges 500 mm
- lack of stiffeners
- span range from 10 – 20 m



[Fink J., Kuss St., *NEW RAILWAY TROUGH BRIDGES*, 2007]

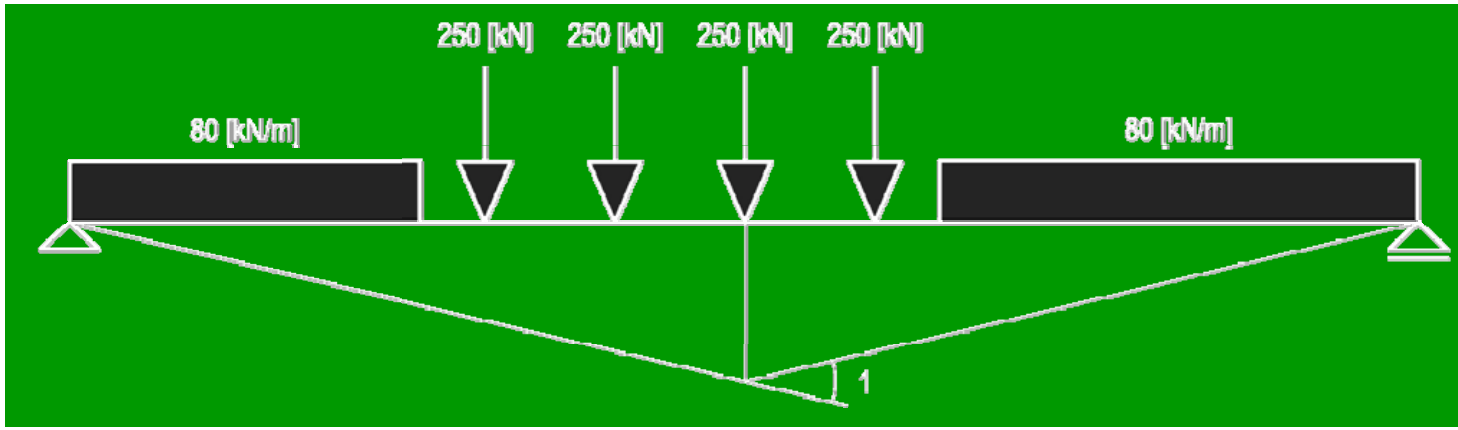


principle cross section for a span range of 10 – 20 m

[Fink J., Kuss St., *NEW RAILWAY TROUGH BRIDGES*, 2007]

Statics

- self weight an dead loads (road bed, sleepers, rails)
- load model LM71, SW/2 and “unloaded train”
- starting and breaking force
- nosing force
- wind force
- temperature
- derailment force
- earthquake force

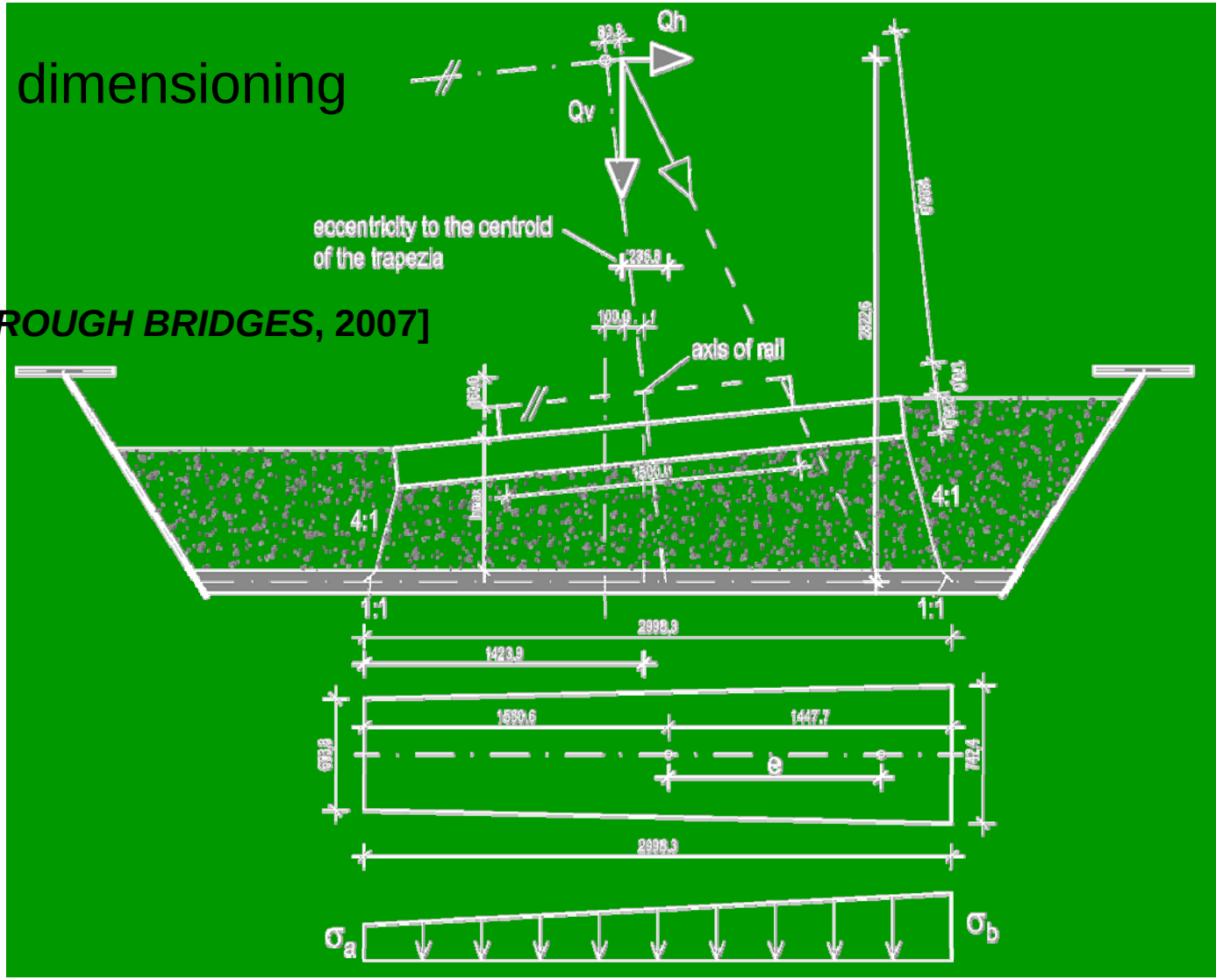


– defined in EN 1990, 1991 and 1998 (comprising NAD)

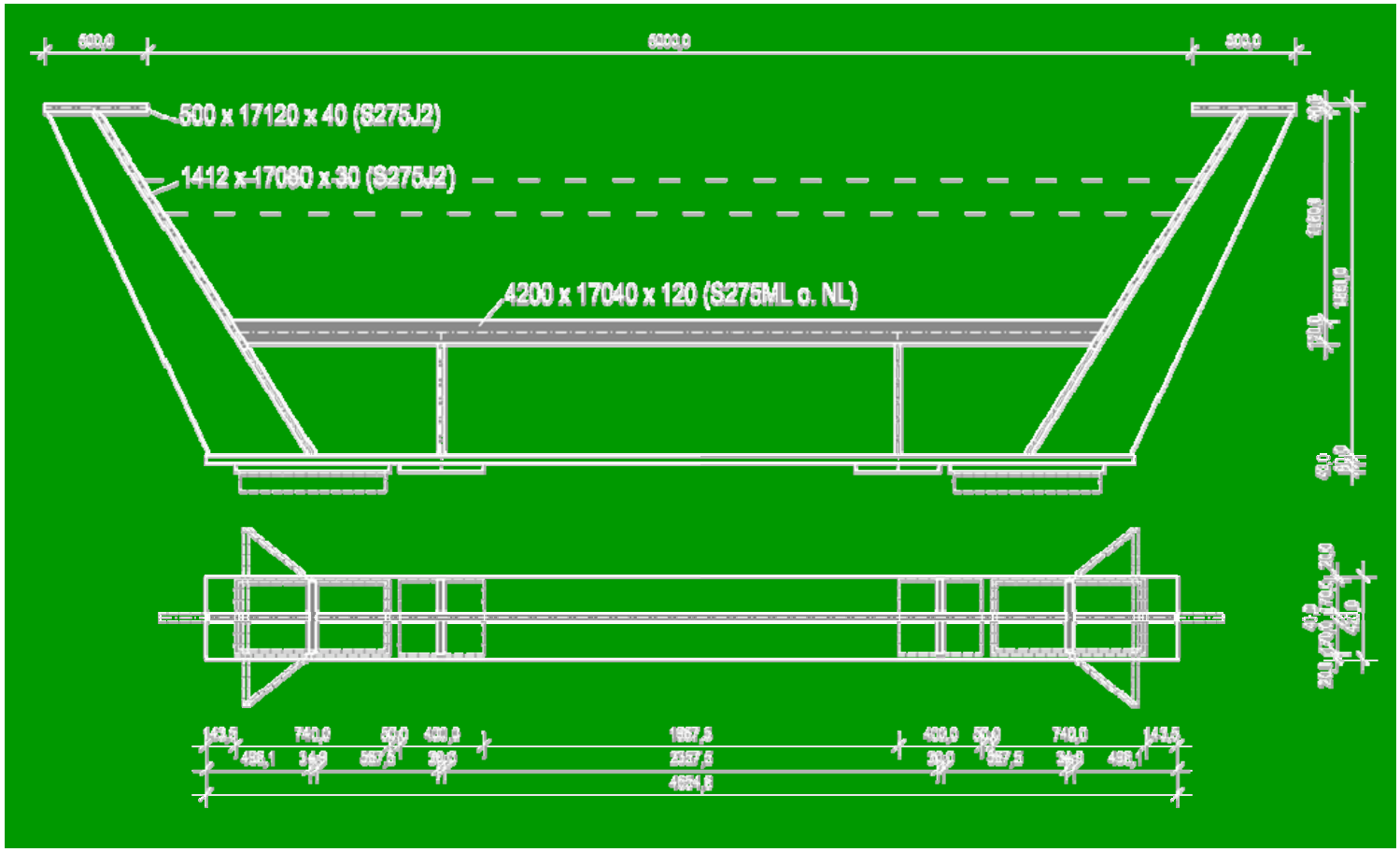
[Fink J., Kuss St., *NEW RAILWAY TROUGH BRIDGES*, 2007]

load model LM71 for local dimensioning

[Fink J., Kuss St., *NEW RAILWAY TROUGH BRIDGES*, 2007]

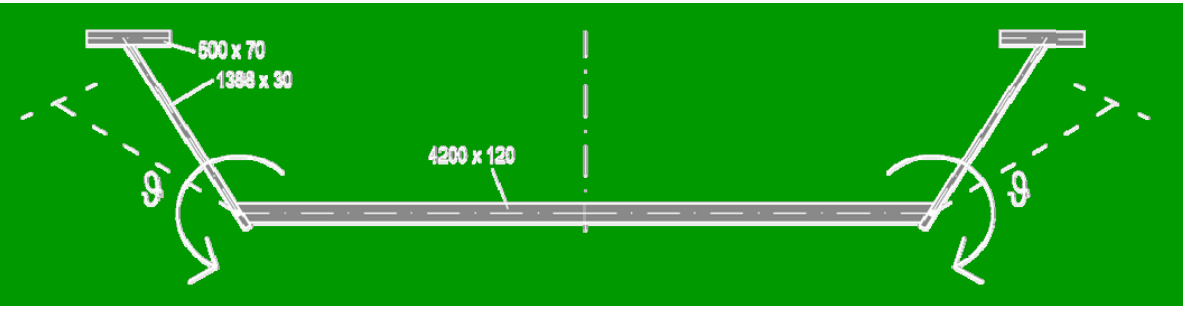


standard cross section - end supporting detail

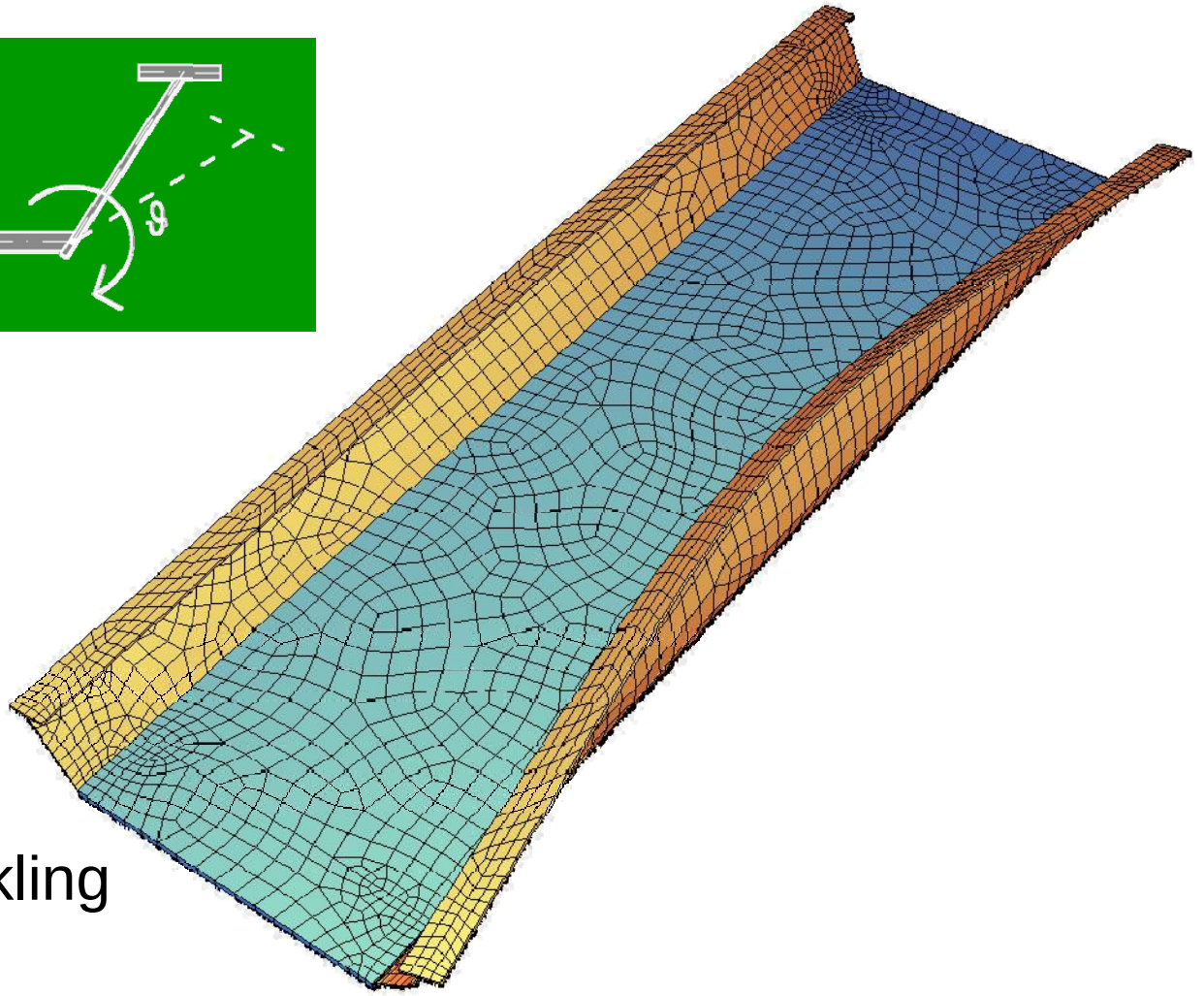


[Fink J., Kuss St., *NEW RAILWAY TROUGH BRIDGES*, 2007]

Non deformability



additional degrees of freedom



natural mode for
lateral torsional buckling

[Fink J., Kuss St., *NEW RAILWAY TROUGH BRIDGES*, 2007]

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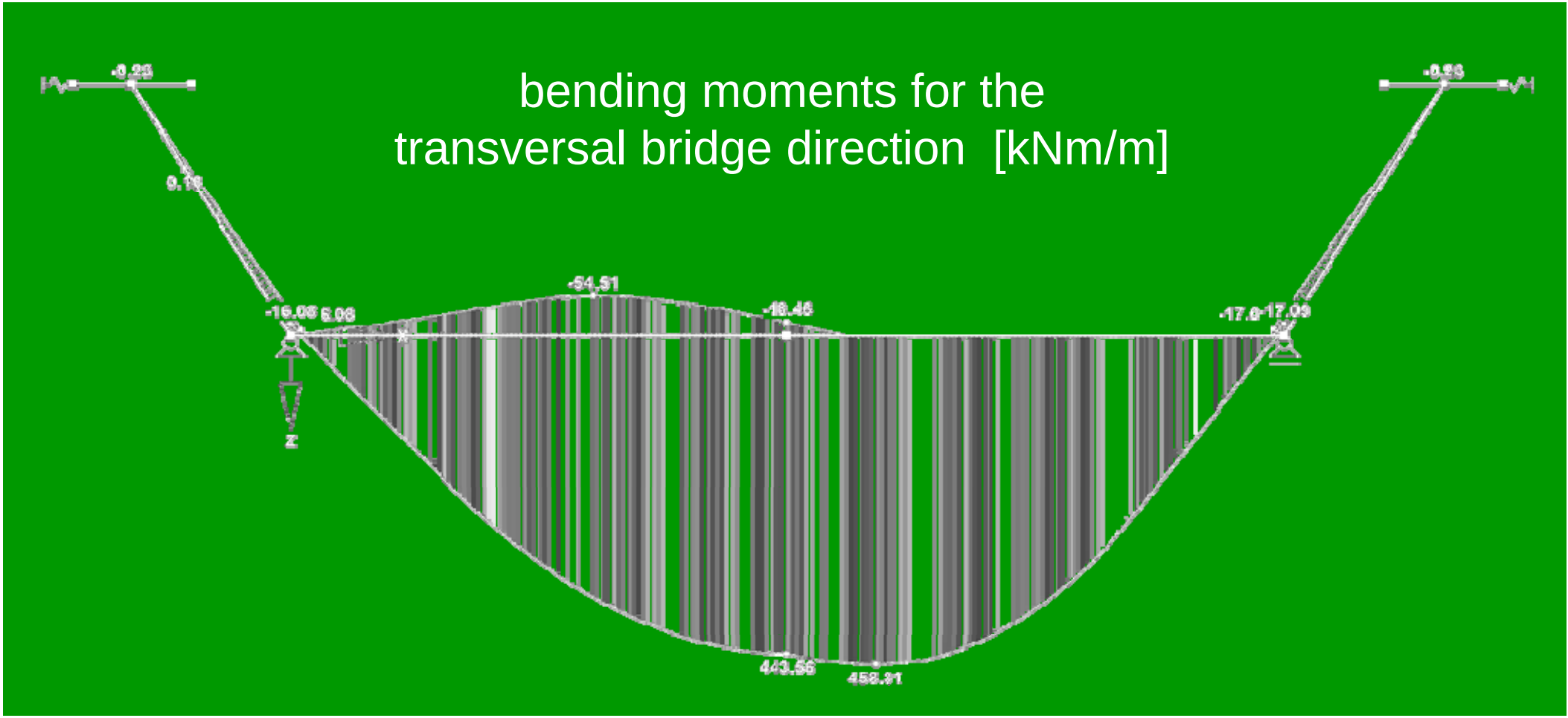
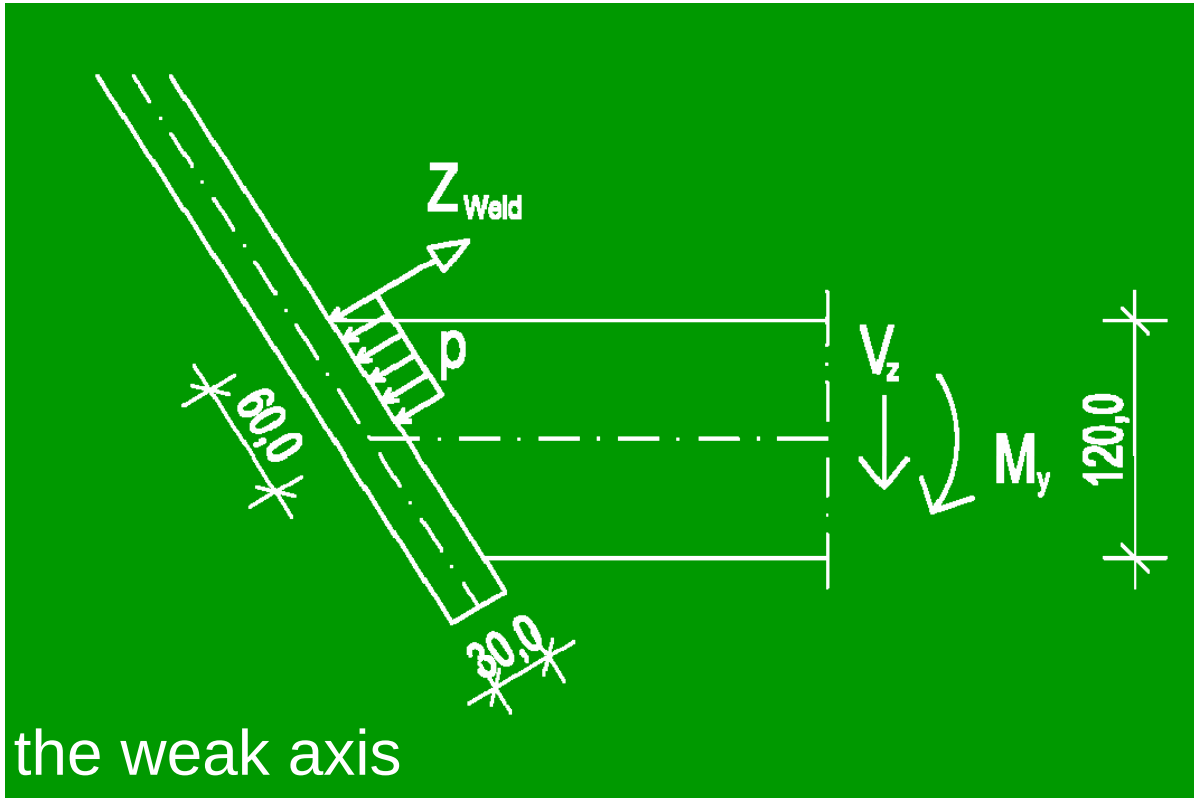
Secondary moments



[Fink J., Kuss St., *NEW RAILWAY TROUGH BRIDGES*, 2007]

Secondary moments



three critical problems

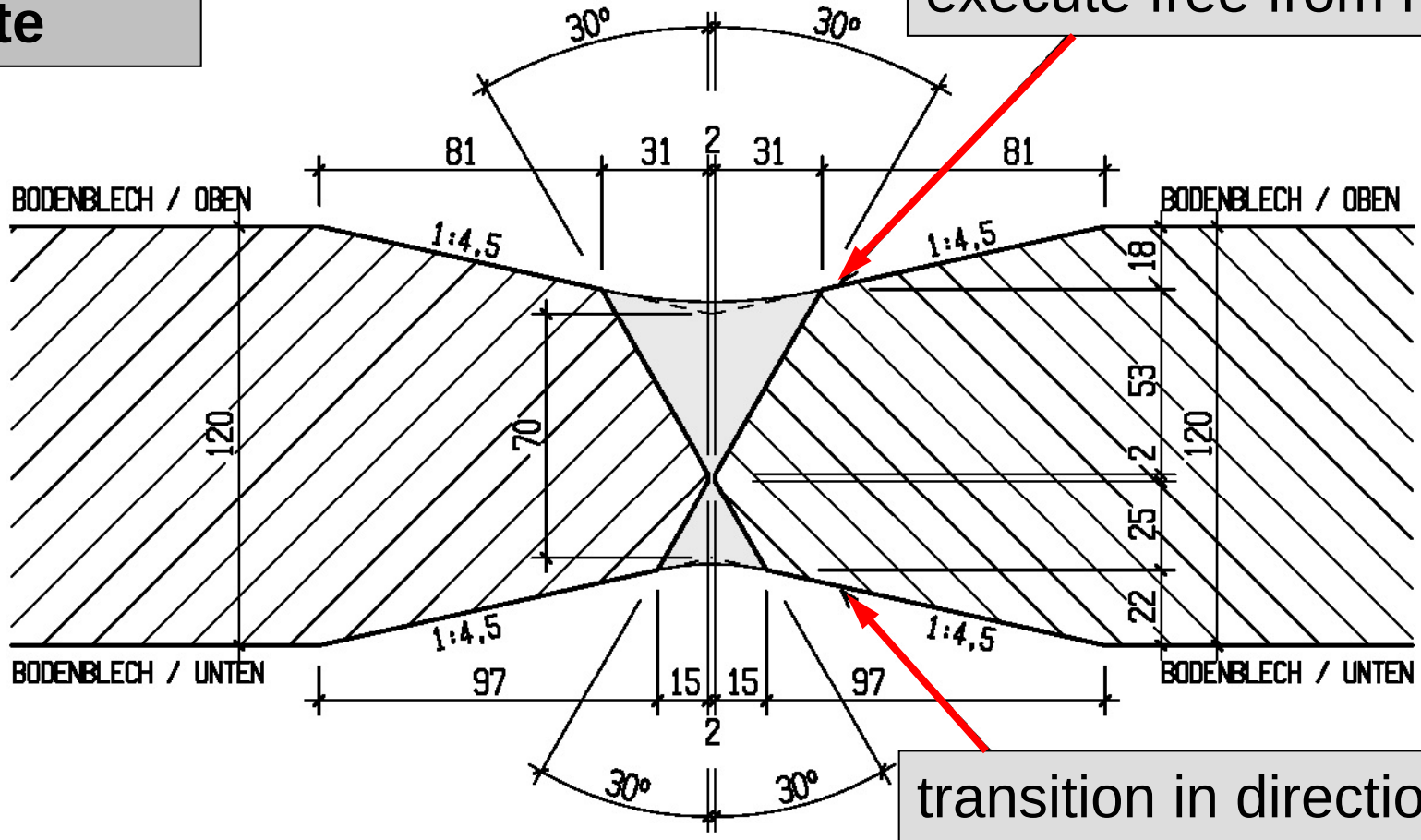
- loading of the web about the weak axis
- filled welds are stressed about their weak axis
- much severe detail category for the weld

[Fink J., Kuss St., *NEW RAILWAY TROUGH BRIDGES*, 2007]

Detailed planning

welding detail deck plate

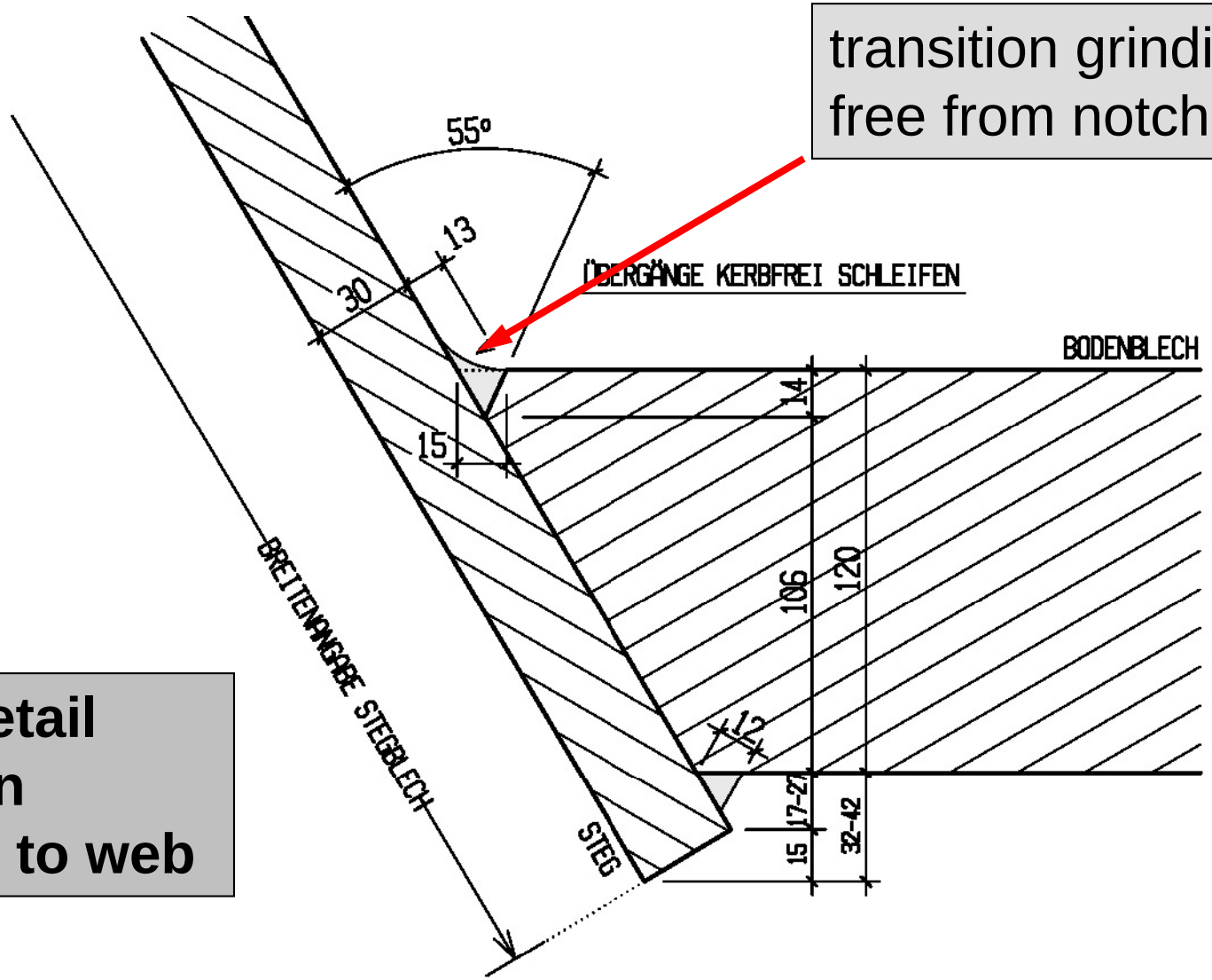
transition in direction of force execute free from notches



transition in direction of force execute free from notches

Detailed planning

transition grinding
free from notches



welding detail
connection
deck plate to web

Global family of standards for steel constructions

Eurocodes	Execution-standards	Materialstandards
EN 1990-EN 1999	z.B. EN 1090	z.B. EN 10025-2
Design	Specification of components	Material, products, testing methods

Specifications and dokumentation

EN 1090-2, 4.1.1: Execution Specification – General

The necessary information and technical requirements for execution of each part of the works shall be agreed and complete before commencement of execution of that part of the works.

- additional information, as listed in A.1
- options, as listed in A.2
- execution classes, see 4.1.2
- preparation grades, see 4.1.3
- tolerance classes, see 4.1.4

EN 1990

Inspection during execution	Design supervision differentiation	Reliability Class	Consequences classes	Description	Examples of buildings and civil engineering works
IL 3	DSL 3	RC 3	CC 3	High consequence for loss of human life, or economic, social or environmental consequences very great	Grandstands, public buildings where consequences of failure are high (e.g. a concert hall)
IL 2	DSL 2	RC 2	CC 2	Medium consequence for loss of human life, economic, social or environmental consequences considerable	Residential and office buildings, public buildings where consequences of failu are medium (e.g. an office building)
IL 1	DSL 1	RC 1	CC 1	Low consequence for loss of human life, and economic, social or environmental consequences small or negligible	Agricultural buildings where people do not normally enter (e.g. storage buildings), greenhouses

EN 1090-2

Consequenc classes	CC 1	CC 2	CC 3	Suggested criteria for service categories
Service categories	SC 1	SC 1	SC 1	Structures and components designed for quasi static actions only (Example: Buildings)
				Structures and components with their connections designed for seismic actions in regions with low seismic activity and in DCL
				Structures and components designed for fatigue actions from cranes (class S0)
	SC 2	SC 2	SC 2	Structures and components designed for fatigue actions according to EN 1993. (Examples: Road and railway bridges, cranes (class S1 to S9)**, structures susce to vibrations induced by wind, crowd or rotating machinery)
				Structures and components with their connections designed for seismic actions in regions with medium or high seismic activity and in DCM* and DCH

Suggested criteria for production categories		CC 1		CC 2		CC 3	
Non welded components manufactured from any steel grade products	PC 1	EXC1	EXC2	EXC2	EXC3	EXC3	EXC3
Welded components manufactured from steel grade products below S355							
Welded components manufactured from steel grade products from S355 and above	PC 2	EXC2	EXC2	EXC2	EXC3	EXC3	EXC4
Components essential for structural integrity that are assembled by welding on construction site							
Components with hot forming manufacturing or receiving thermic treatment during manufacturing							
Components of CHS lattice girders requiring end profile cuts							

Matrix for choice of executio clas

EN 1990, Annex B

Inspection during execution	Design supervision differentiation	Reliability Class	Consequences classes	Description	Examples of buildings and civil engineering works
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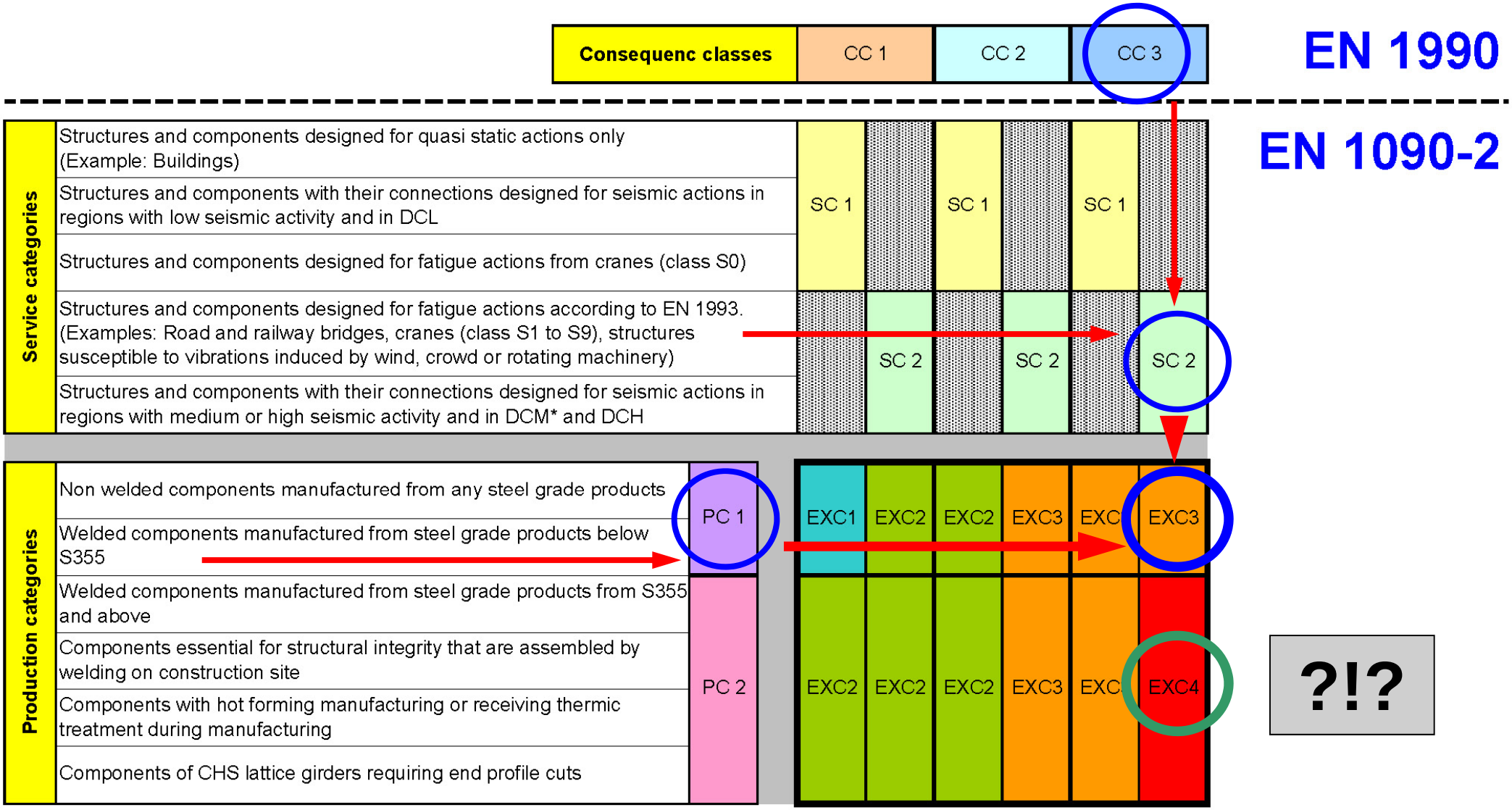
EN 1090-2


Consequenc classes
CC 1
CC 2
CC 3
EN 1990
EN 1090-2
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SC 1
SC 1
SC 2
SC 2
SC 2
Production categories
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Welded components manufactured from steel grade products below S355
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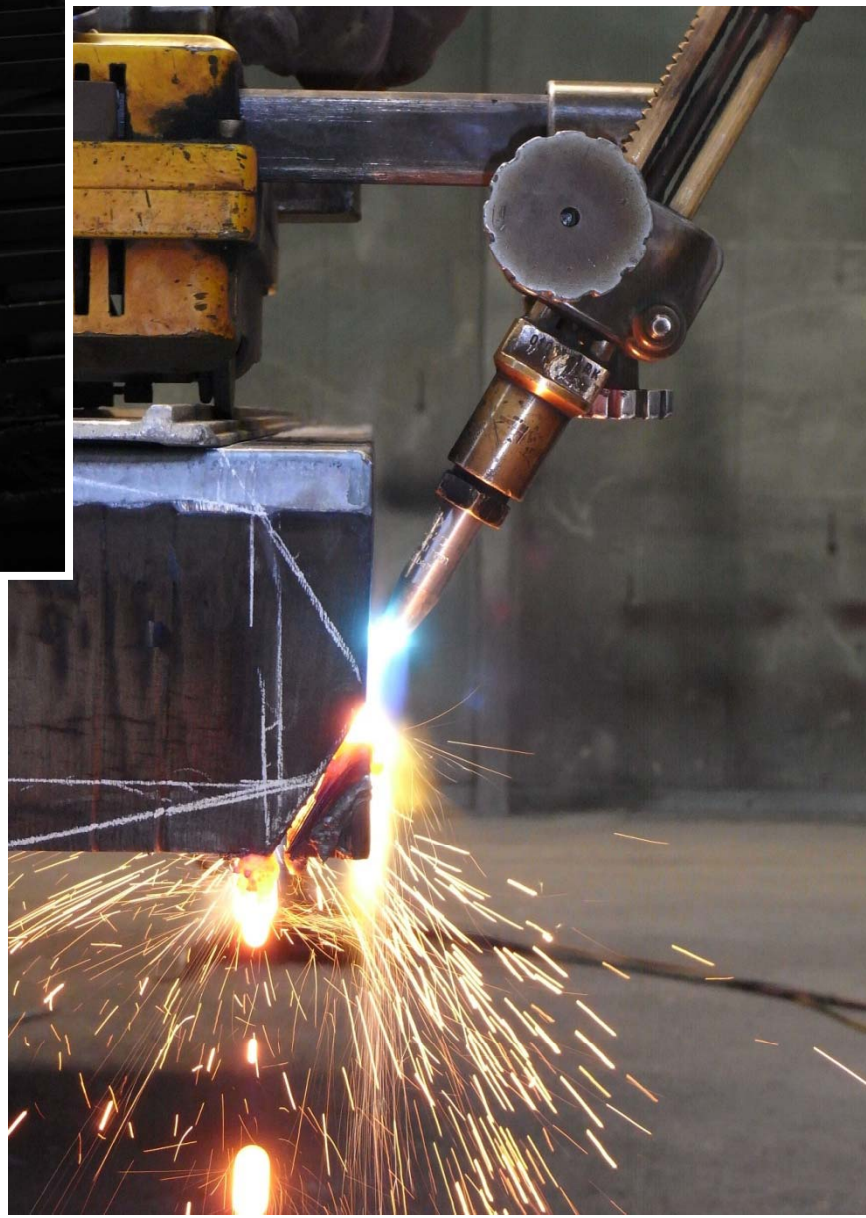
Components essential for structural integrity that are assembled by welding on construction site
Components with hot forming manufacturing or receiving thermic treatment during manufacturing
Components of CHS lattice girders requiring end profile cuts
PC 1
PC 2
EXC1 EXC2 EXC2 EXC3 EXC EXC3
EXC2 EXC2 EXC2 EXC3 EXC EXC4
?!?

Execution



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Execution

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Execution

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Conclusions