Innovative rules in Eurocode 3

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Overview

- General
- Actions
- Resistances
- Brittle failure
- Connections
- Stability
- New developments

Eurocodes

EN 1990 - Basis of design

EN 1991	Actions
EN 1991-1-1	Selfweight – imposed loads
EN 1991-1-2	Fire
EN 1991-1-3	Snow
EN 1991-1-4	Wind
EN 1991-1-5	Temperature
EN 1991-1-6	Construction
EN 1991-1-7	Accidental
EN 1991-2	Traffic on bridges
EN 1991-3	Actions from cranes
EN 1991-4	Actions in silos, tanks
EN 1997	Geotechnical design
EN 1998	Seismic actions

EN 1992	Concrete

EN 1993-1	Steel – generic
EN 1993-1-1	General and buildings
EN 1993-1-2	Fire
EN 1993-1-3	Thin gauge
EN 1993-1-4	Stainless steel
EN 1993-1-5	Plate buckling
EN 1993-1-6	Shells
EN 1993-1-7	Plates and membranes
EN 1993-1-8	Connections
EN 1993-1-9	Fatigue
EN 1993-1-10	Fracture
EN 1993-1-11	Tension elements
EN 1993-1-12	High strength steels
EN 1993-2	Bridges
EN 1993-3	Masts and towers
EN 1993-4	Silos, tanks, pipelines
EN 1993-5	Steel piles
EN 1993-6	Crane supporting structures

EN 1994-1	Generial and buildings
EN 1994-2	Bridges

EN 1998-1	Seismic design and buildings
EN 1998-2	Bridges
EN 1998-3	Towers and masts
EN 1998-4	Tanks and silos

EN 1999	Aluminium

Overview of international Code Families

Globalisation

International Code Families

USA

International Code Council (ICC)
Building Officials & Code Admin. International
International Conference of Building Officials
Southern Building Congress International

↓

INTERNATIONAL BUILDING CODE

US-Standards ASTM

or

Nat. Fire Protection Association (US-NFPA)

↓

NFPA 5000 BUILDING CODE

US-Standards ASTM

EU

European Committee for Standardization (CEN)
Commission of the European Communities
European National Standard Bodies
International technical scientific organisations

↓

EUROCODES

EN – Product standards (500)
EN – Testing standards (700)
European Technical Approvals and Approval guidelines (170)

Essential requirements of the CPD

CPD – Construction **P**roduct **D**irective
89/106/EWG

Defines „Essential Requirements“
- Mechanical resistance and stability
- Resistance to fire

Eurocodes

EN – Product Standards

EN – Testing Standards

ETAs (European Technical Approvals)

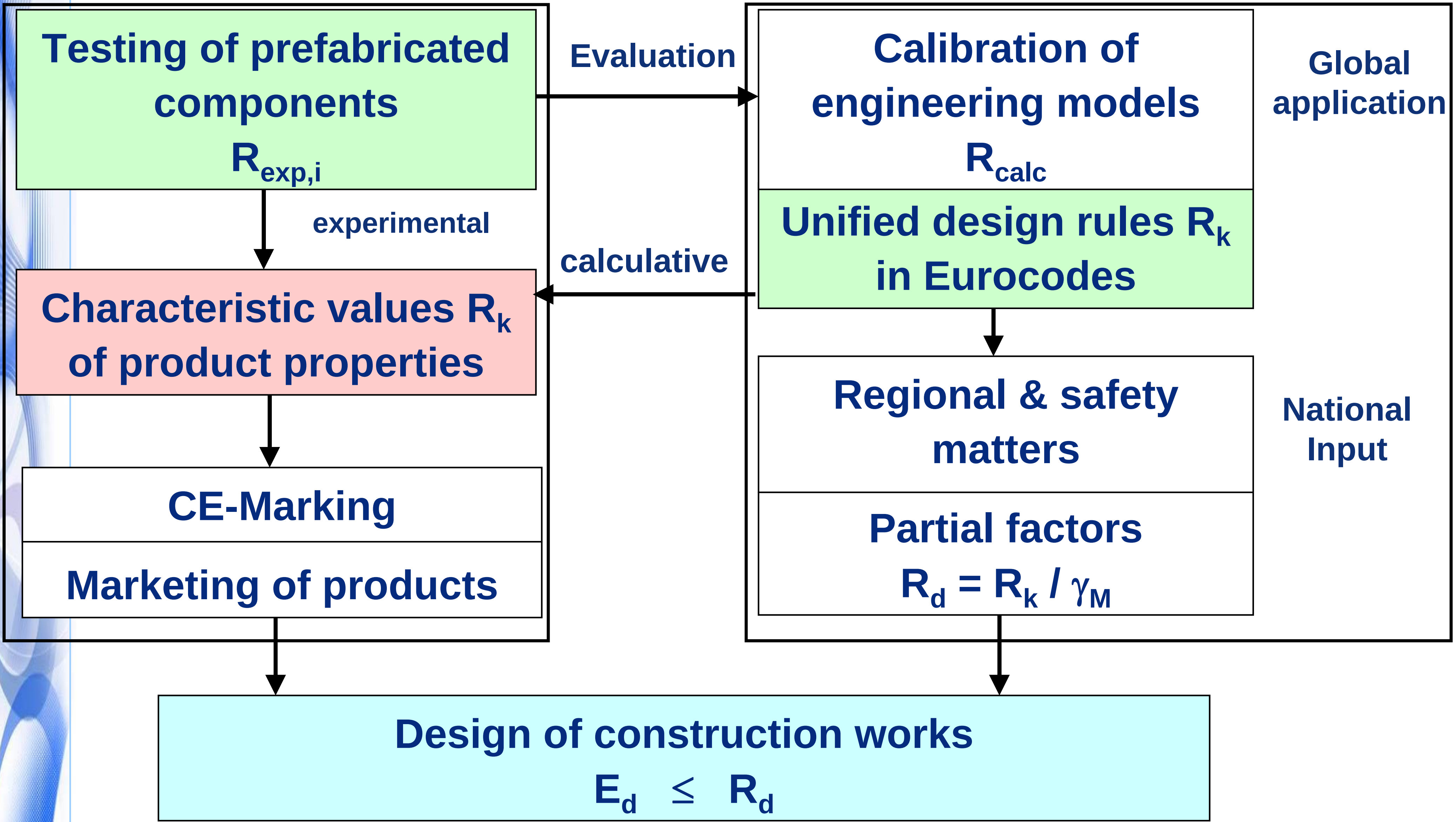
ETAGs (European Technical Approval Guidelines)

Tools to fulfil the Essential Requirements

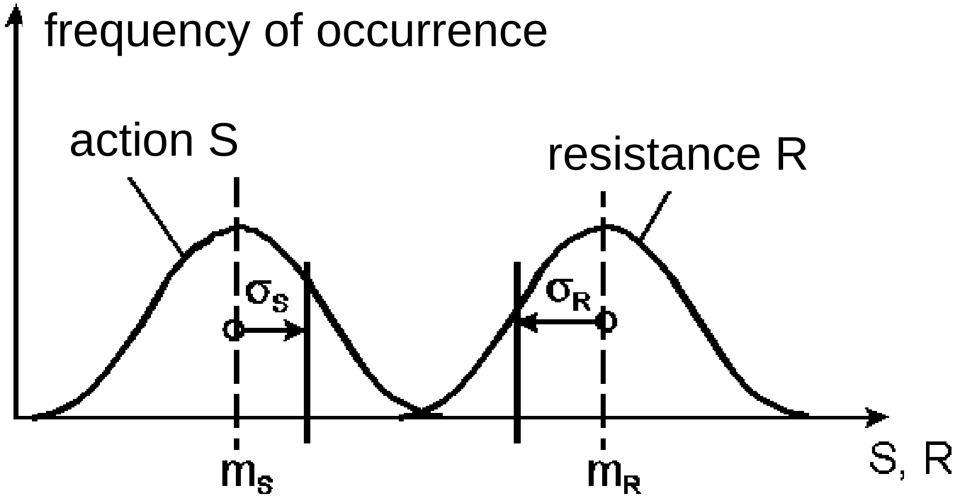
Conditions for implementation and application of Eurocodes

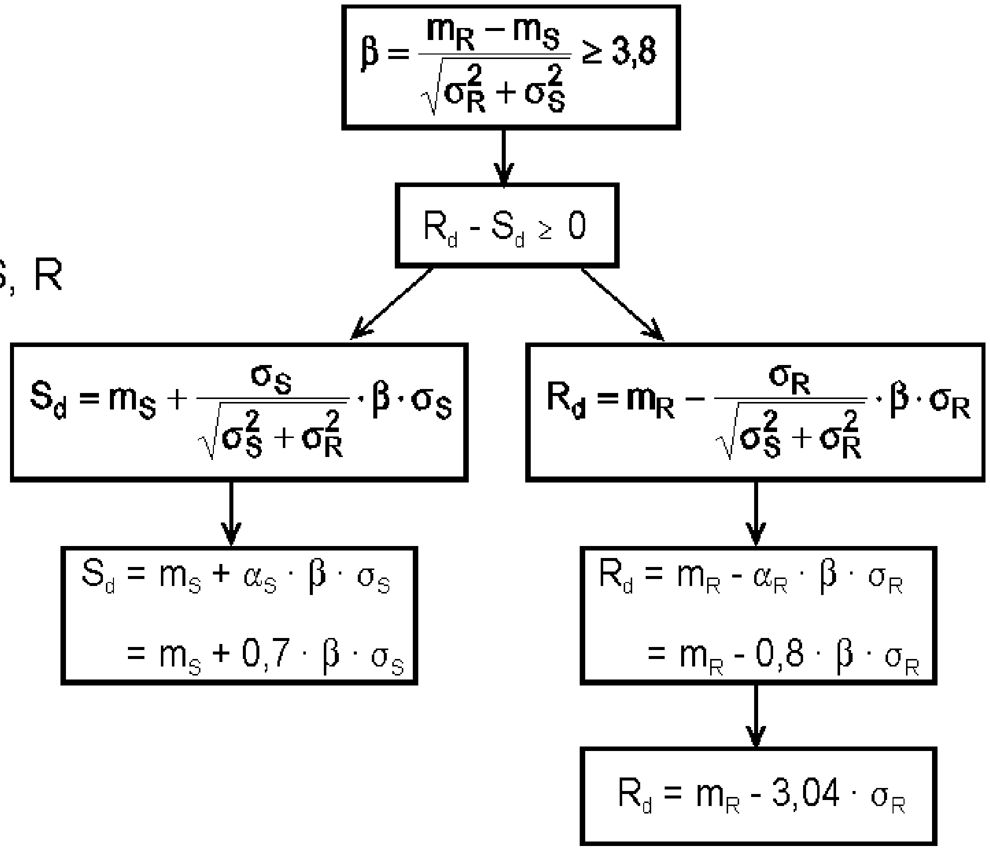
Guidance paper L: Application and use of the Eurocode

Testing of prefabricated components



Reliability basis





β = safety index
(reference period: 50 years)

α_i = weighting factors
(required due to mutual influence of S_d and R_d)

Standard system for steel structures

EN 1090 – Part 1 „Delivery Conditions for prefabricated steel components“

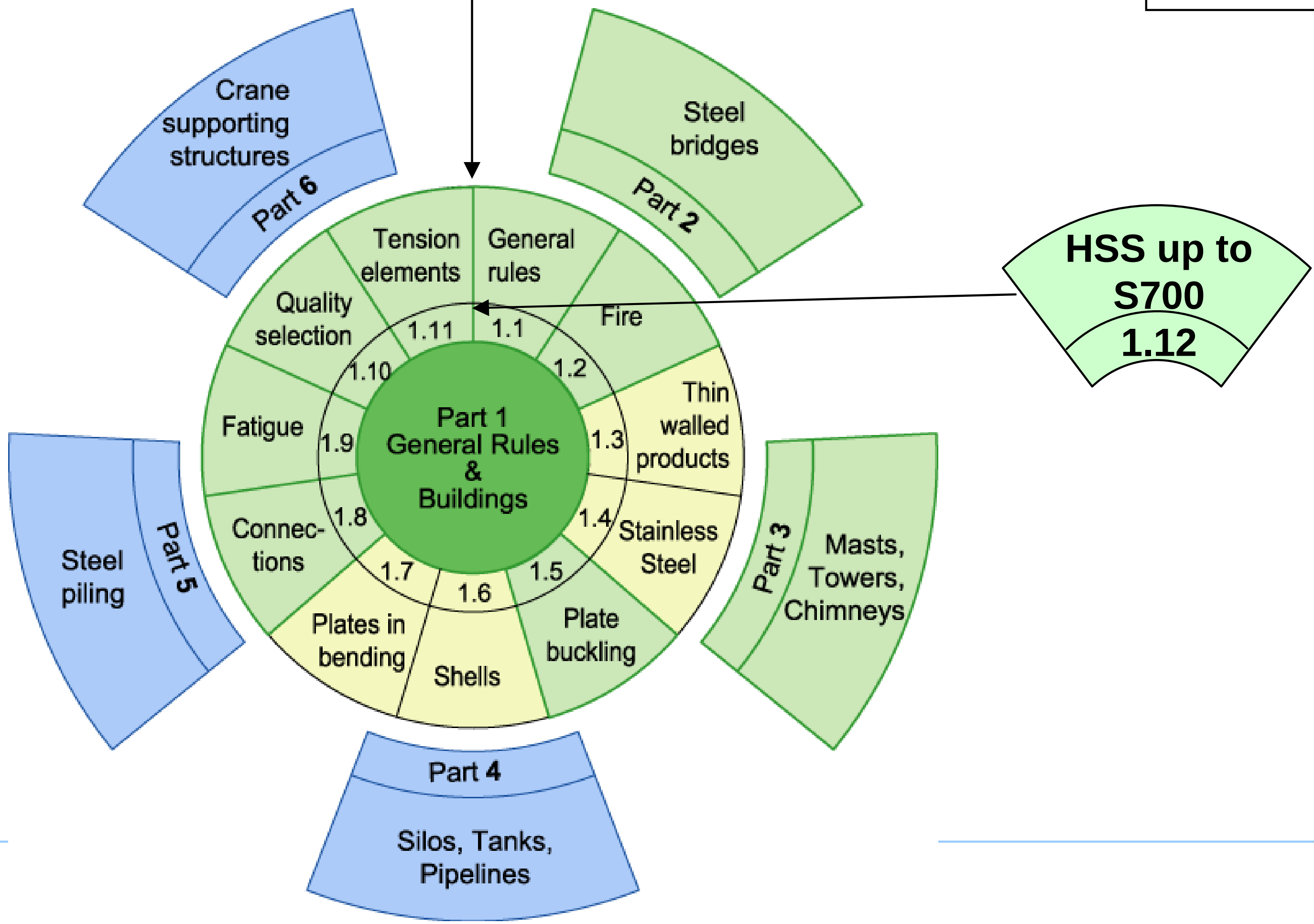
hEN product standards for steel materials, semi- finished products etc.

Eurocode: EN 1990 – „Basis of structural design“

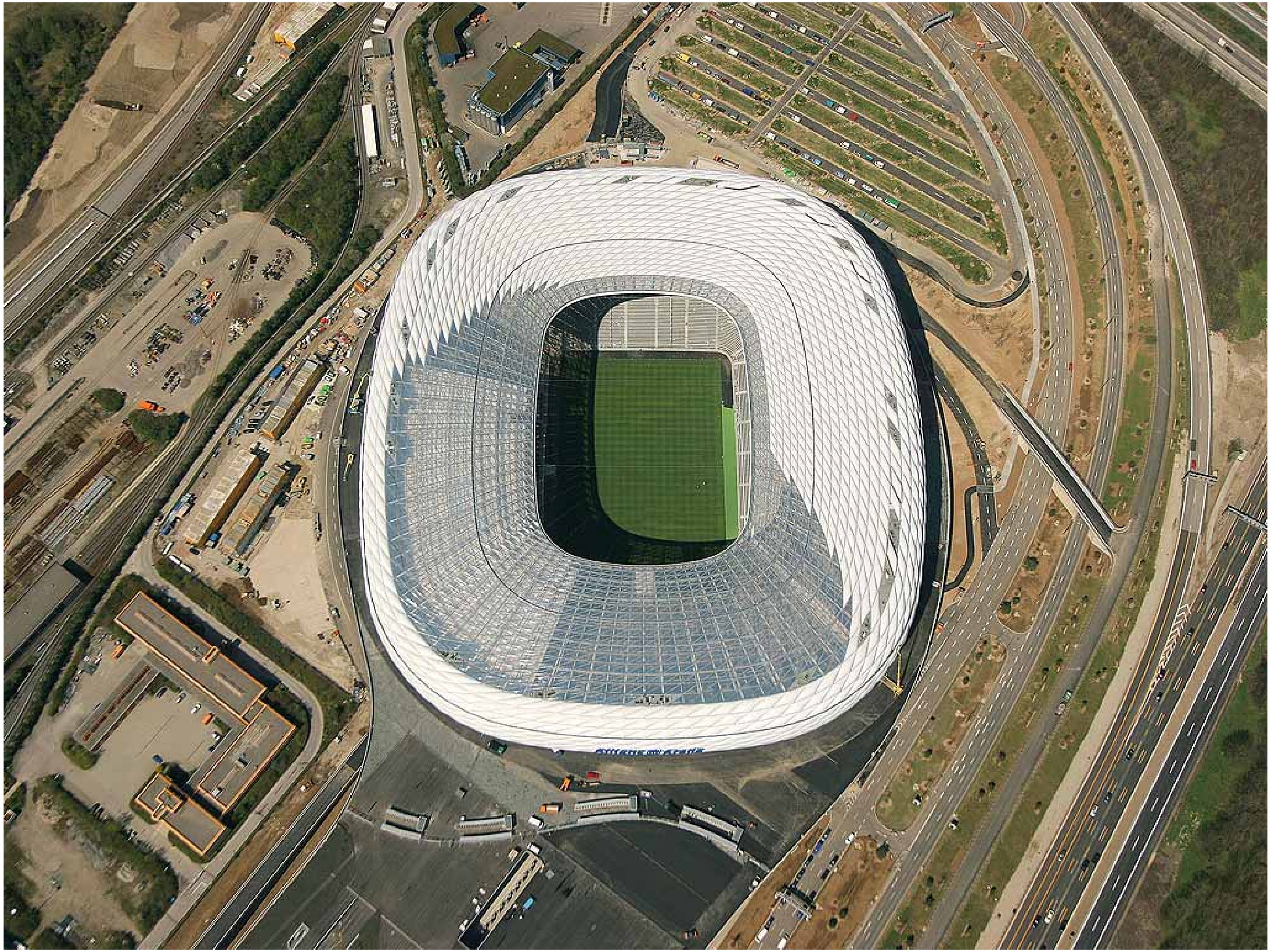
Eurocode 1: EN 1991 – „Actions on structures“

Eurocode 3: EN 1993 – „Design rules for steel structures“

EN 1090 – Part 2 „Execution of steel structures “



Allianz-Arena Munich



Definition of characteristic values of actions and action effects

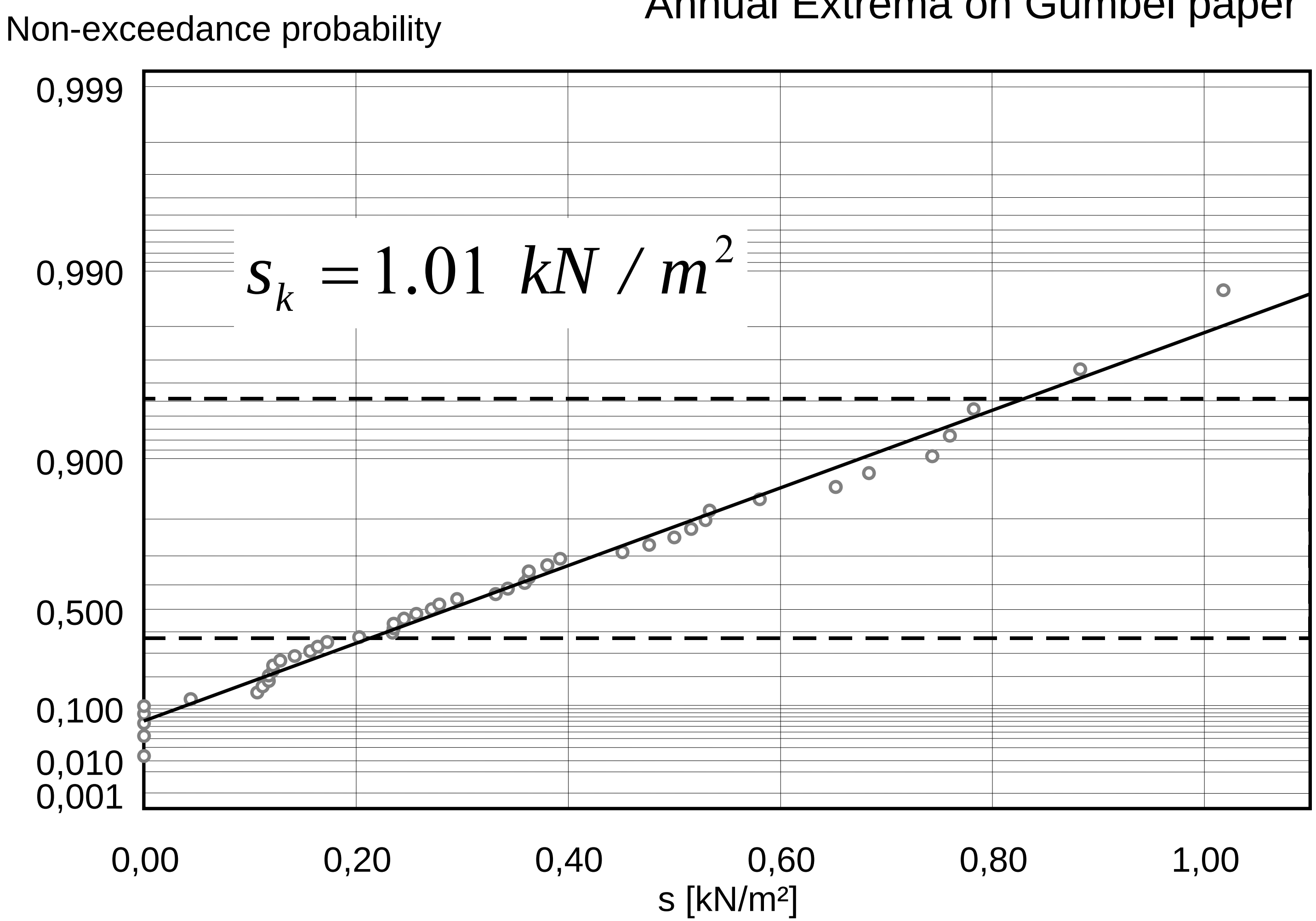
Action	Q_k	Definition	$\gamma_Q = Q_d / Q_k$
Permanent Climatic Traffic	G $s_k, w_k, \Delta T_k$ Q_k	Mean value T_{return} = 50 years T_{return} = 1000 years	1.35 1.50 1.35
Combination $E(Q_1 + Q_2)$			
Climatic Traffic	$E(s_k - \psi_0 w_k)$ $E(Q_k + \psi_0 w_k)$	T_{return} = 50 years T_{return} = 1000 years	

Snow load in Munich-Riem

Snow Load on the Ground

Location Munich-Riem

Annual Extrema on Gumbel paper



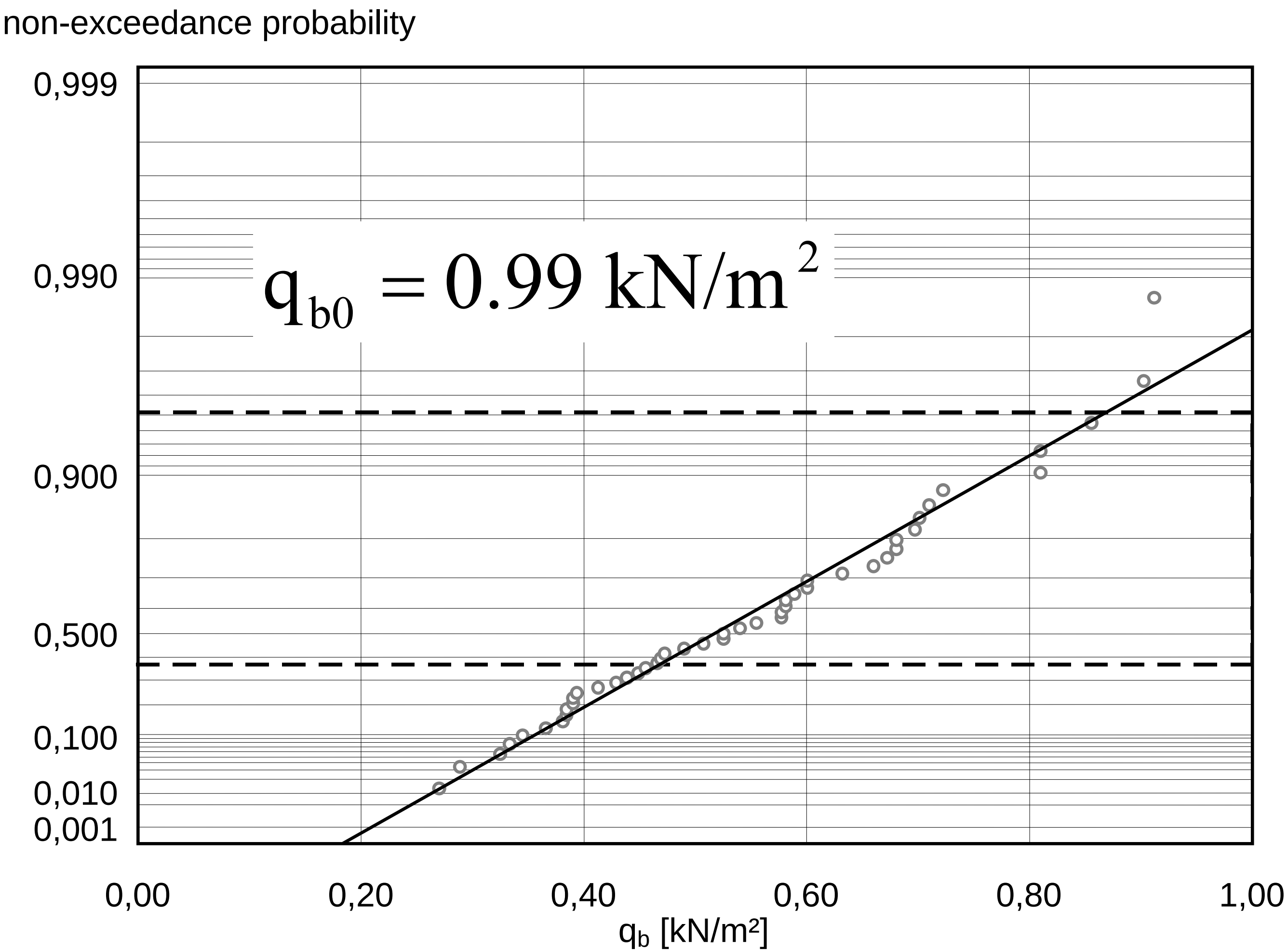
Allianz-Arena Munich

Wind Load in Munich-Riem

Peak velocity pressure q_b (2 sec)

Location Munich-Riem

Annual extrema (h =10 m) on Gumbel paper

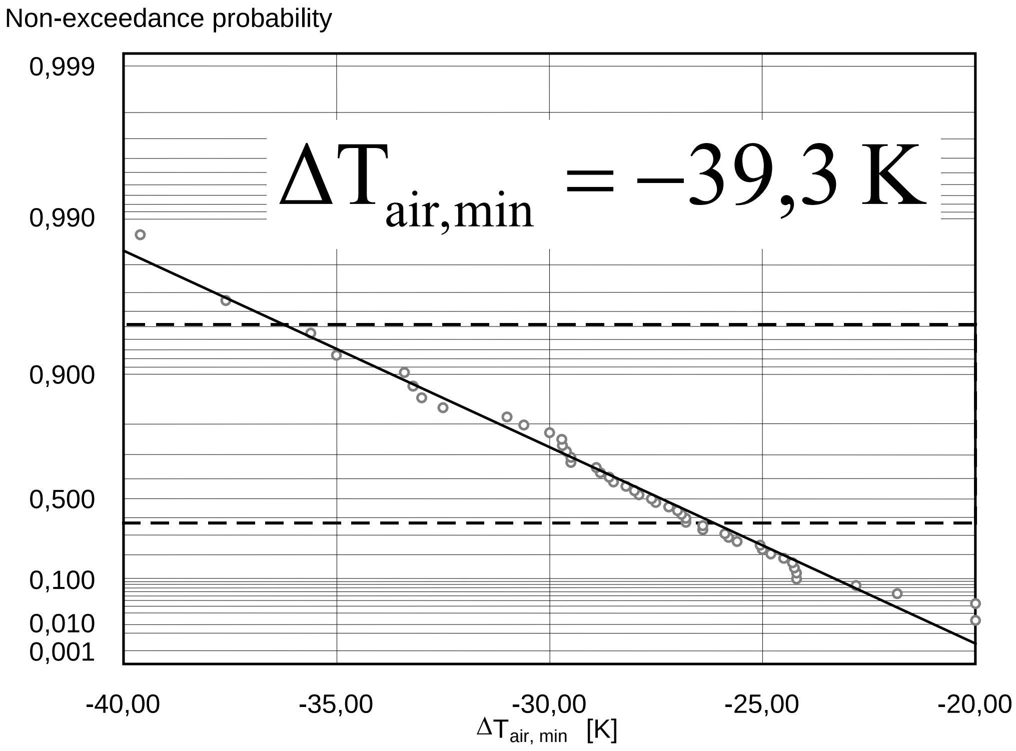


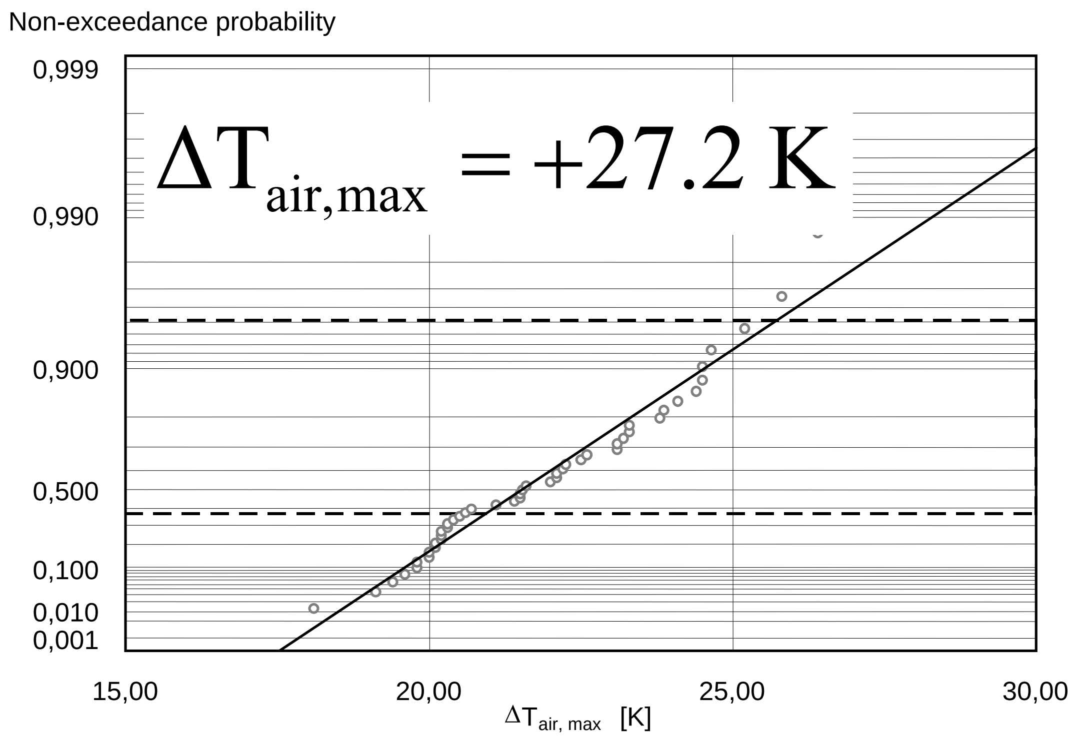
Air Temperature in Munich-Riem

Change of air temperature related to T_{ref} = 10°C

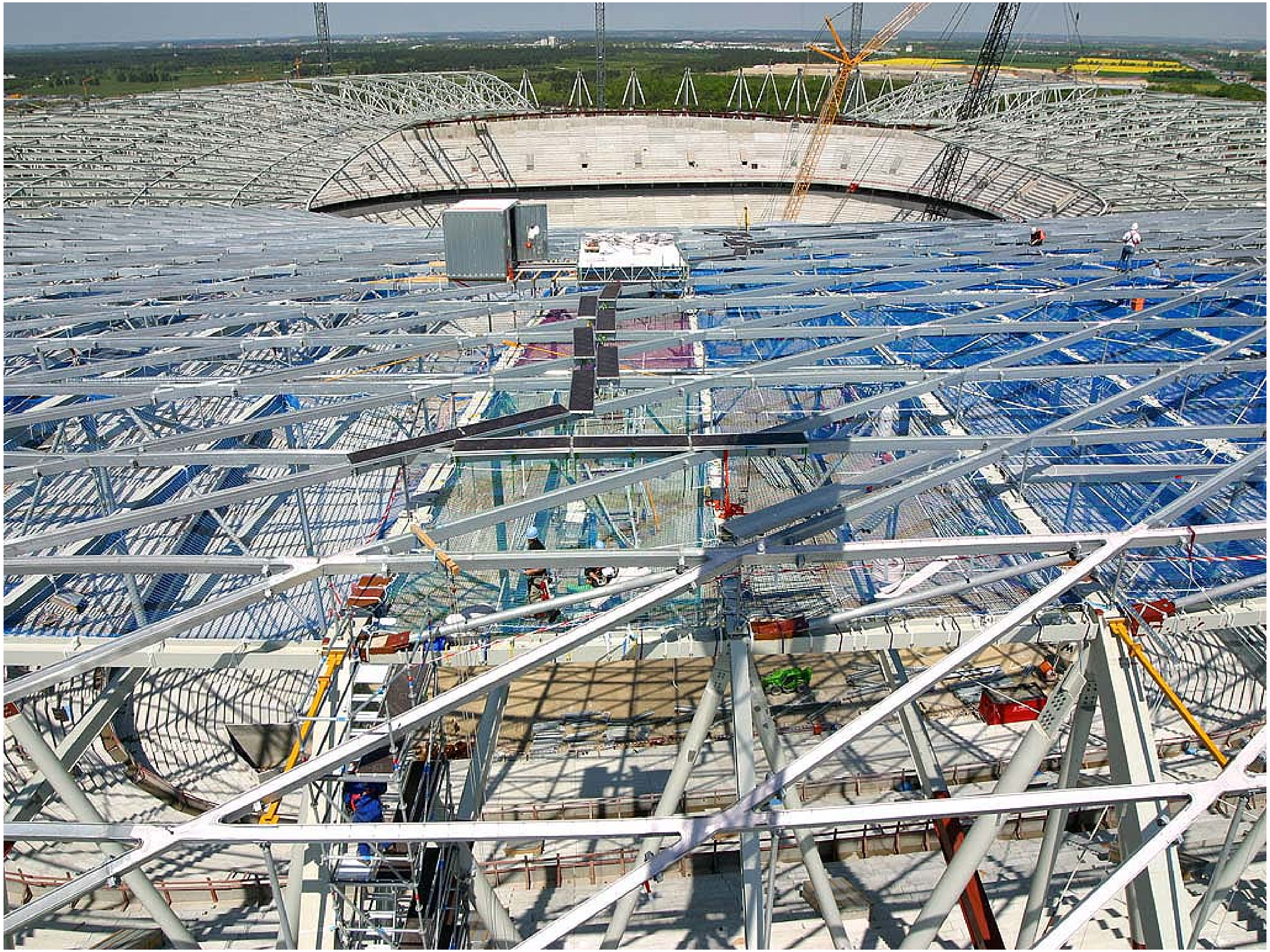
Location Munich-Riem

Annual Extrema on Gumbel paper





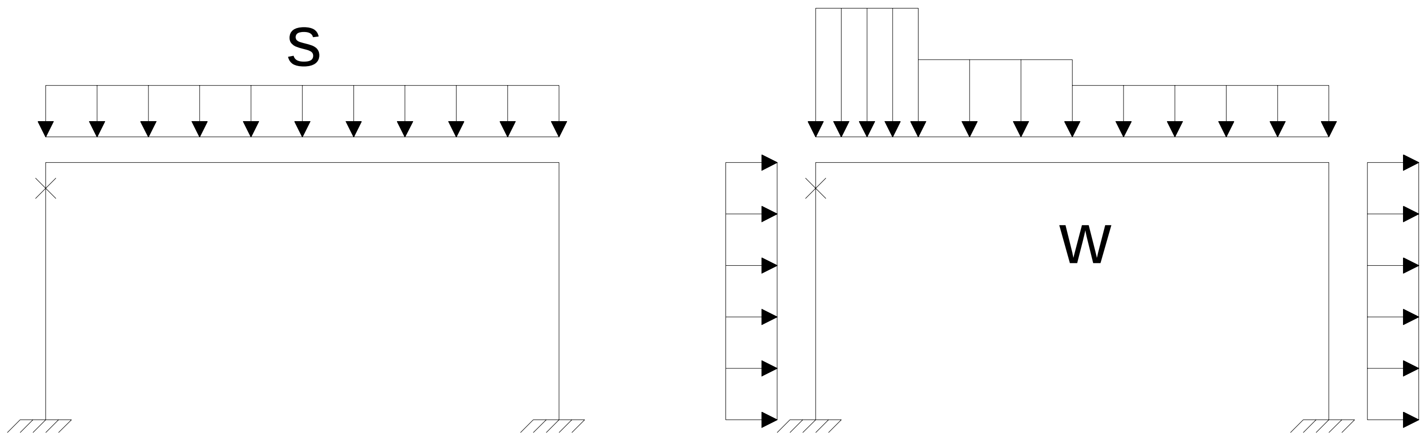
Allianz-Arena Munich



Evaluated climatic actions

Action	Characteristic value	Design value	γ_Q
snow	1.01 kN/m²	1.77 kN/m²	1.75
wind action q_{pb}	0.99 kN/m²	1.48 kN/m²	1.50
ΔT_{max}	27.2 K	33.1 K	1.22
ΔT_{min}	-39.3 K	-51.7 K	1.32

Combination rule of climatic actions

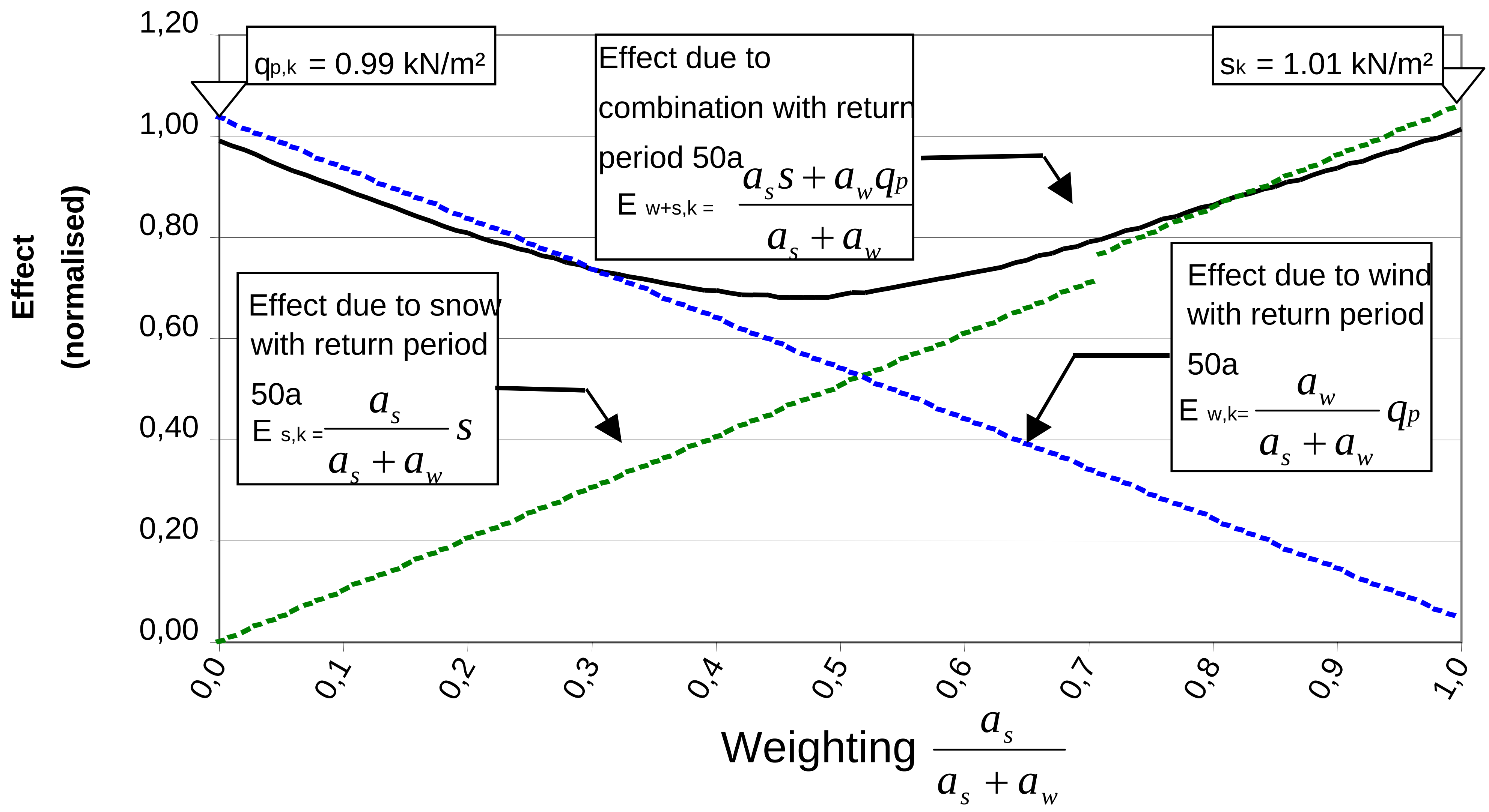


$$E_{W+S} = a_S \cdot s + a_W \cdot q_p \Rightarrow E_{W+S,k}$$

a_W → influence factor for wind

a_S → influence factor for snow

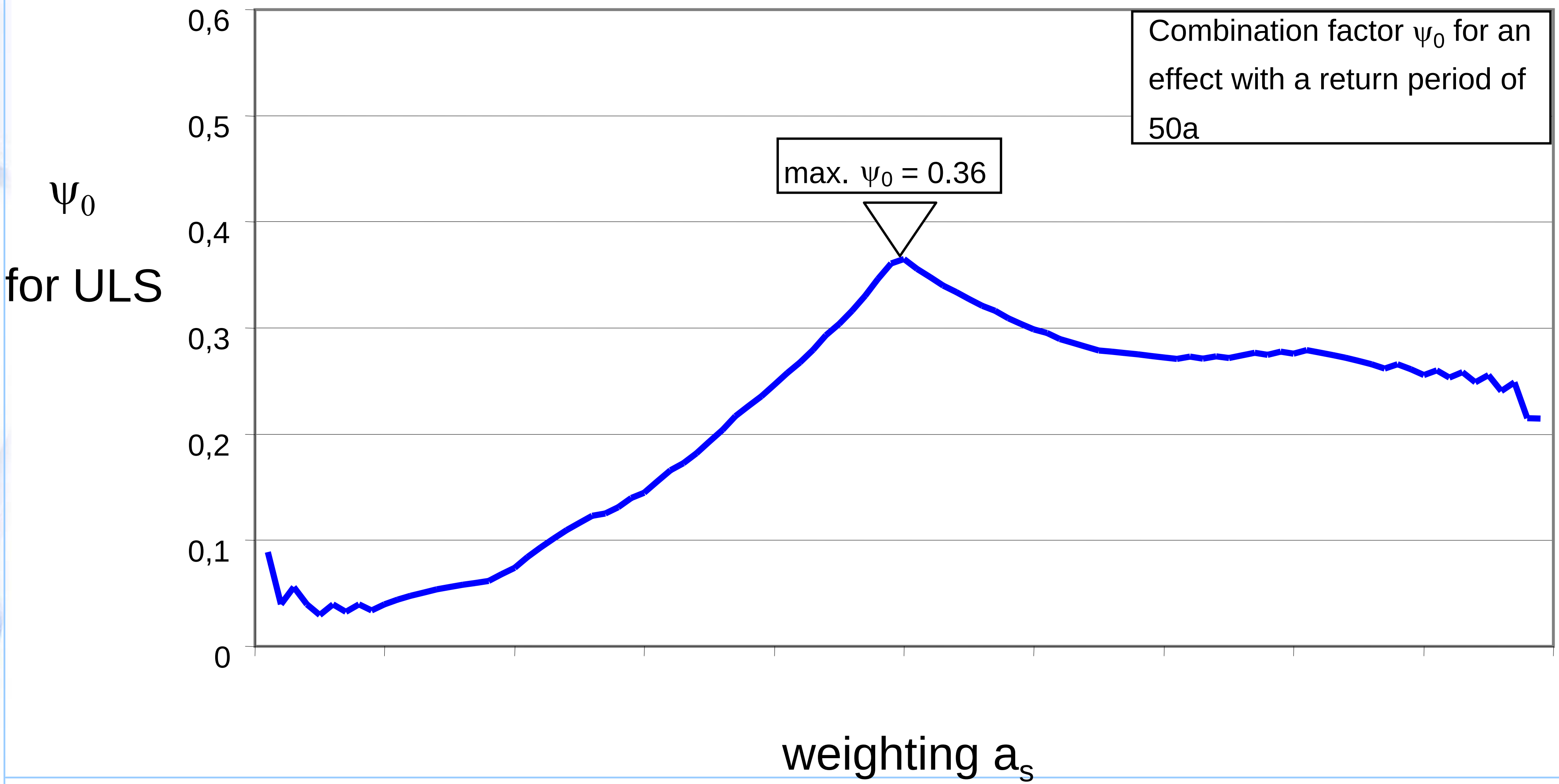
Characteristic values of effects of combined actions



Combination factor ψ_0

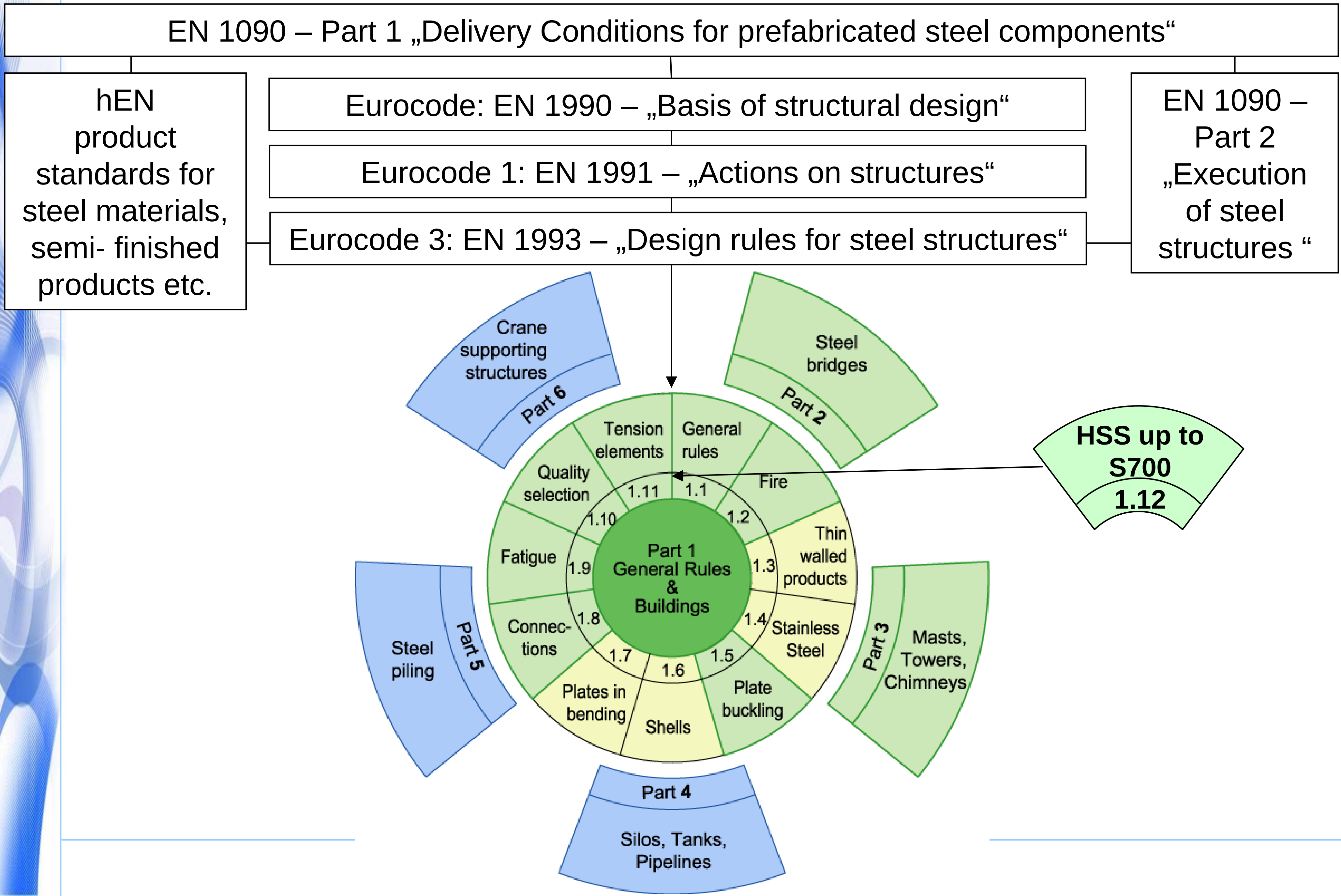
$$E_{w+s,k} = E_{s,k} + \psi_{0,w} \cdot E_{w,k} \Rightarrow \psi_{0,w}$$

$$E_{w+s,k} = E_{s,k} + \psi_{0,w} \cdot E_{w,k} \Rightarrow \psi_{0,w}$$



Allianz-Arena Munich

Standard system for steel structures



Determination of characteristic values R_k and γ_M values from tests

Conditions for numerical value of γ_M

Product standards for materials and semi-fabricated products EN 10025

Execution standard EN 1090 – Part 2

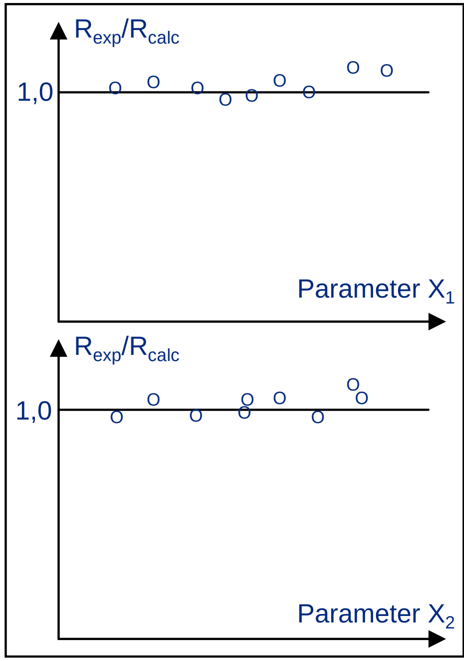
Design standard Eurocode 3

Prefabricated steel component for component testing

Component tests to determine R_{exp}

Engineering model to determine R_{calc}

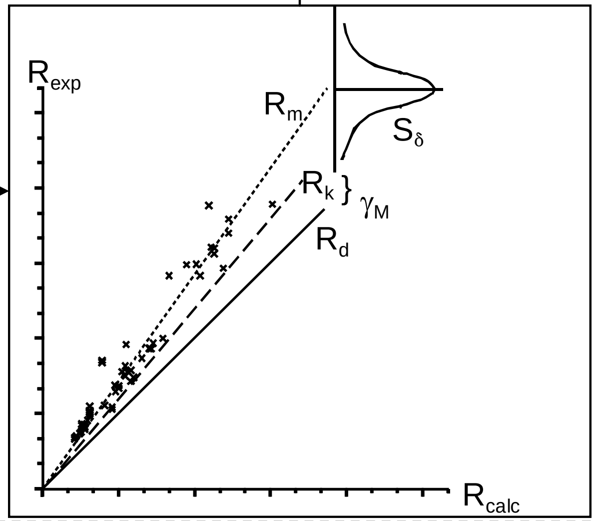
Test evaluation accord. to EN1990- Annex D



$R_k = \gamma_{Mi}\ R_d$

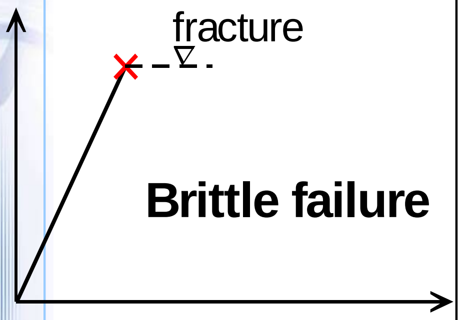
Classification accord. to γ_{Mi} (1,0; 1,10; 1,25)

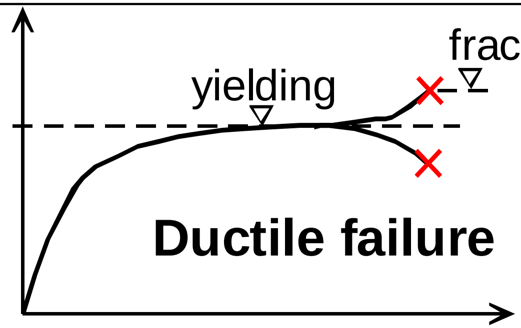
$\gamma_{Mi} = R_k / R_d$



Procedure to obtain reliable values R_k

Failure modes





Brittle failure: excluded by appropriate choice of material

1. Mode 0	Mode 1	Mode 2
excessive deformation by yielding e.g. tension bar	member failure by instability e.g. column buckling	fracture after yielding e.g. bolt
$R_d = \frac{R_k(f_y)}{\gamma_{M0}}$	$R_d = \frac{R_k(f_y, \bar{\lambda})}{\gamma_{M1}}$	$R_d = \frac{R_k(f_u)}{\gamma_{M2}}$

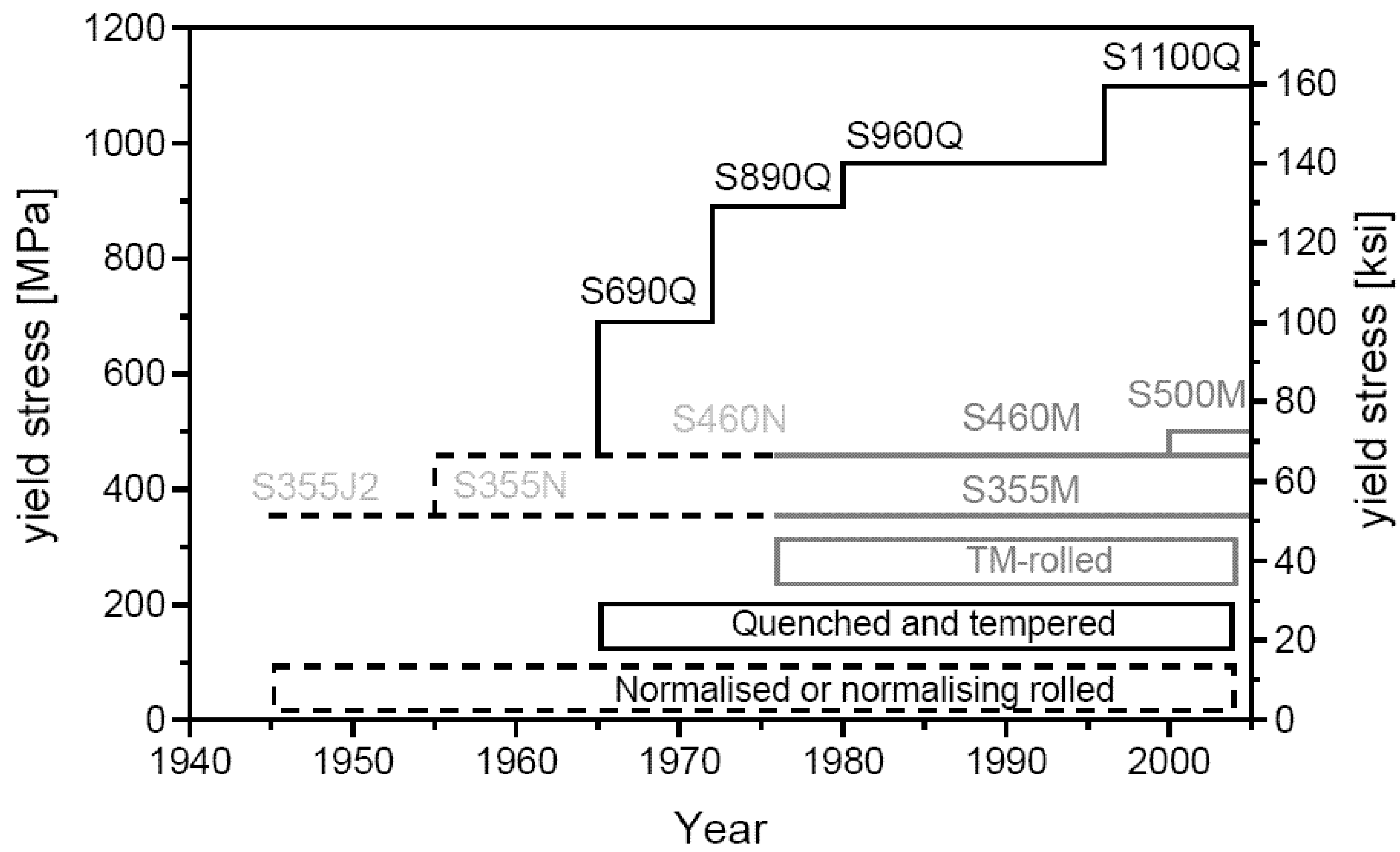
2. Test evaluation $R_d = m_R \exp(0{,}8\,\beta\,\sigma_R - 0{,}5\,\sigma_R^2)$; $\beta = 3{,}80$

3. Recommended values

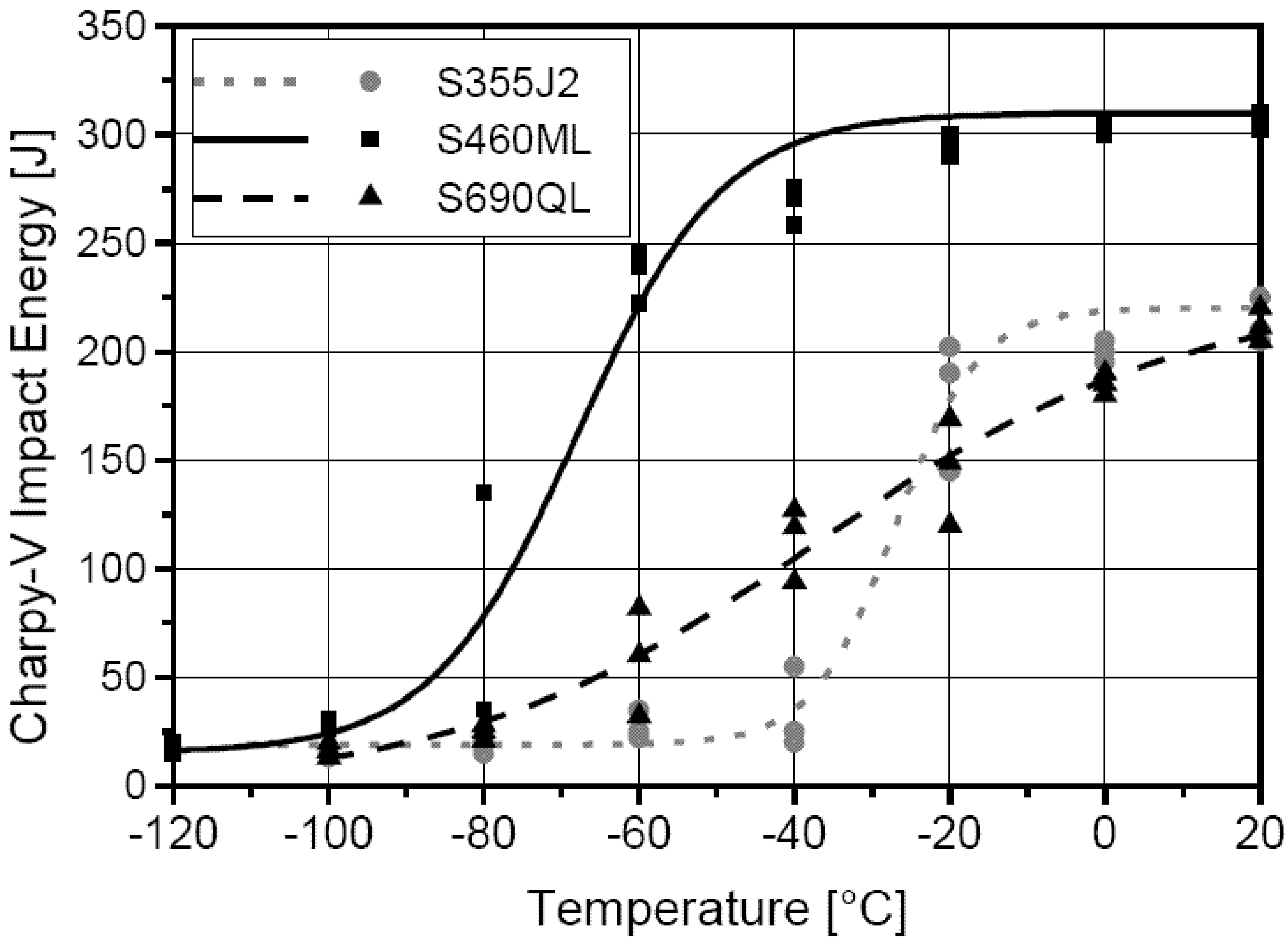
$\gamma_{M0} = 1{,}00$	$\gamma_{M1} = 1{,}10$	$\gamma_{M2} = 1{,}25$

4. Characteristic value $R_k = \gamma_M R_d$

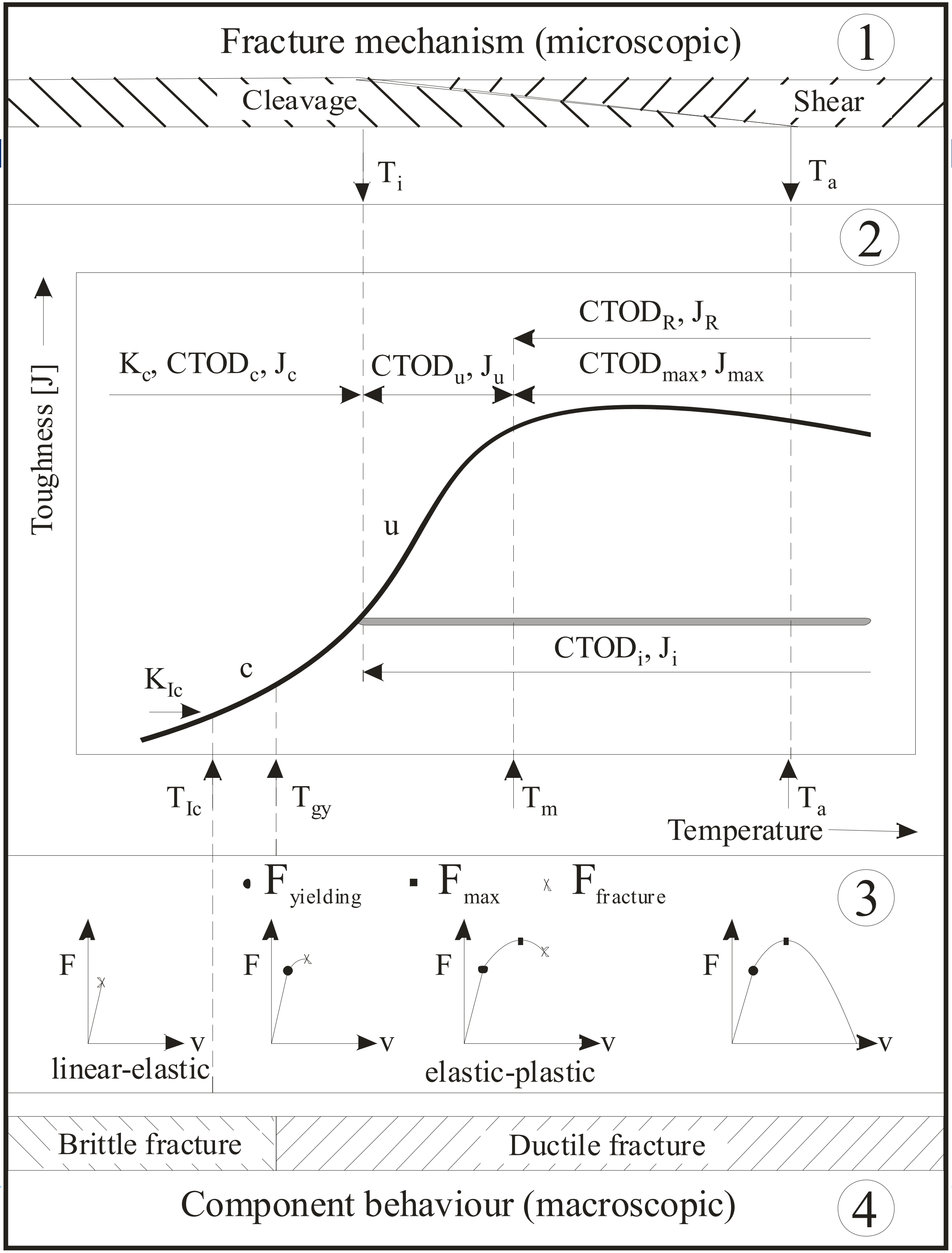
Historical development of production processes for rolled steel products



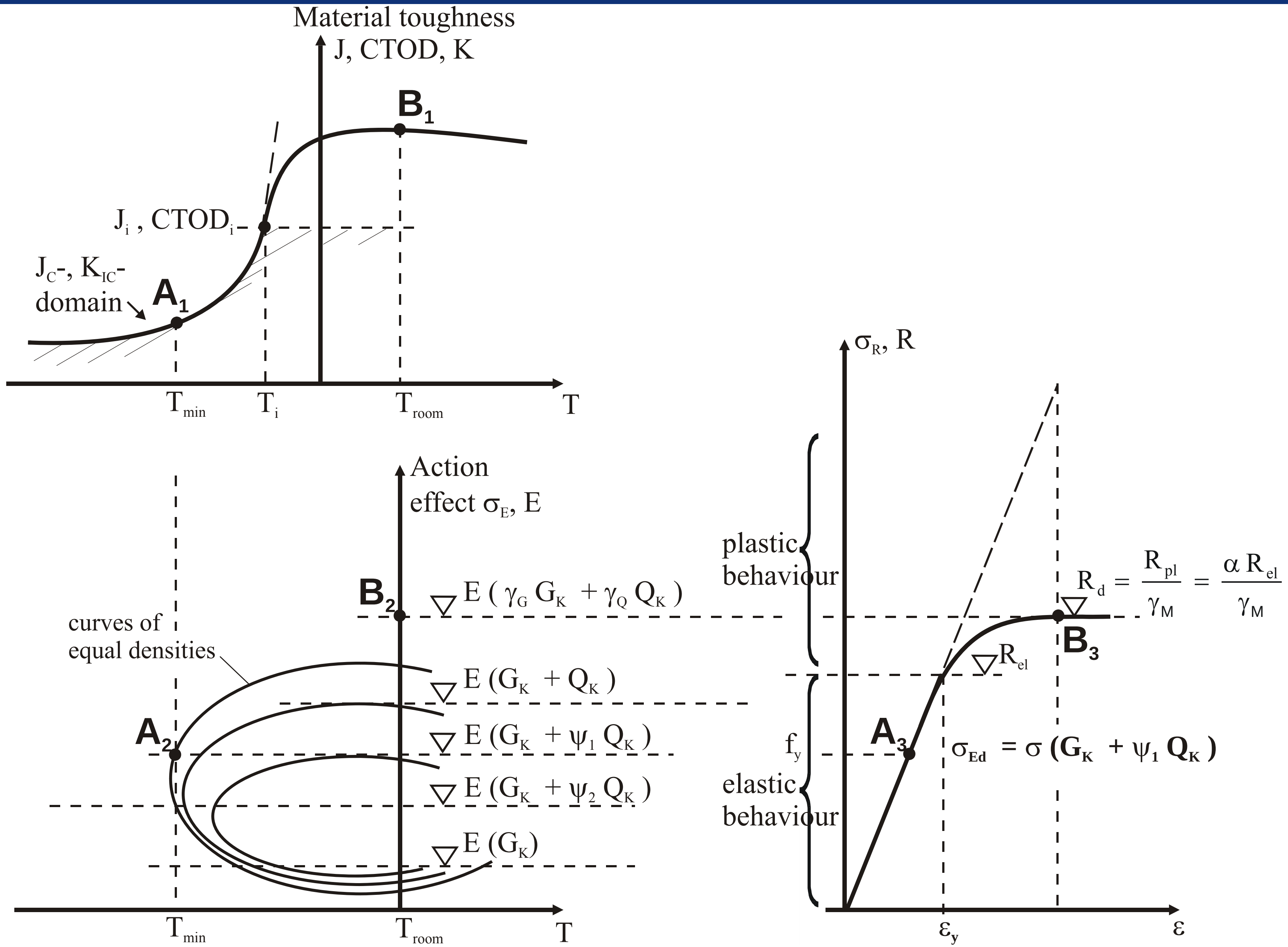
Charpy-V-temperature transition curves for S460ML and S690QL with S355J2 for comparison



Toughness-temperature-curve and related load-deformation curves for tension elements using various parameters for toughness properties

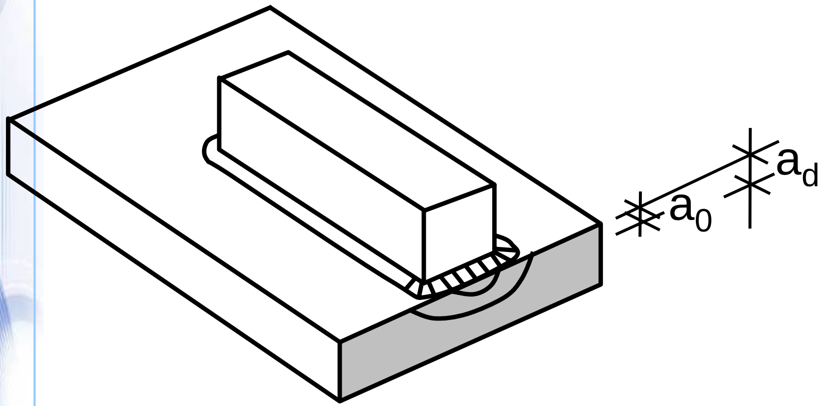


Design situation for choice of material in EN 1993-1-10



Choice of material

Assumption for a_0



$$a_d = a_0 \cdot f\left(\frac{\Delta\sigma_c^{\,3} \cdot 2 \cdot 10^6}{4}\right)$$

- fatigue loading
- initial crack
- design crack

Safety assessment based on fracture machanics

$$K_{appl,d} \leq K_{mat,d}$$

- $K_{mat,d}$ (T_{27J}, T_{Ed})
- $K_{appl,d}$ (member shape, a_d, $\psi_1 \cdot \sigma_{Ed}$)

Safety assessment

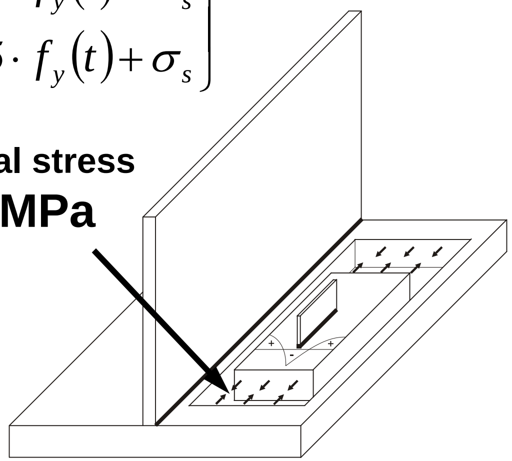
Determination of $K_{appl,d}^*$

$K_{appl,d}$ → **CEGB R6-FAD** / **Failure Assessment Diagram** → $K^*_{appl,d}$

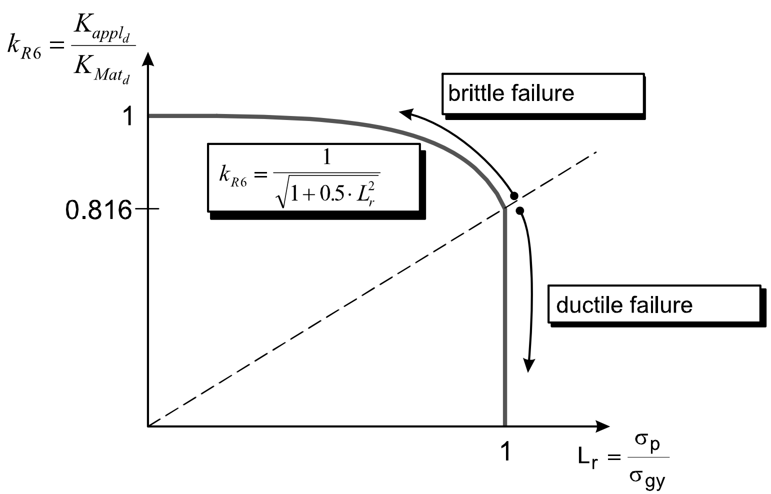
$$K_{appl,d} = \Delta K(a_d) \cdot \frac{\sigma_{Ed}}{\Delta\sigma}$$

$$\sigma_{Ed} = \begin{Bmatrix} 0{,}25 \cdot f_y(t) + \sigma_s \\ 0{,}50 \cdot f_y(t) + \sigma_s \\ 0{,}75 \cdot f_y(t) + \sigma_s \end{Bmatrix}$$

Global residual stress
σ_s = 100 MPa



$$K^*_{appl,d} = \frac{K_{appl,d}}{k_{R6} - \rho}$$

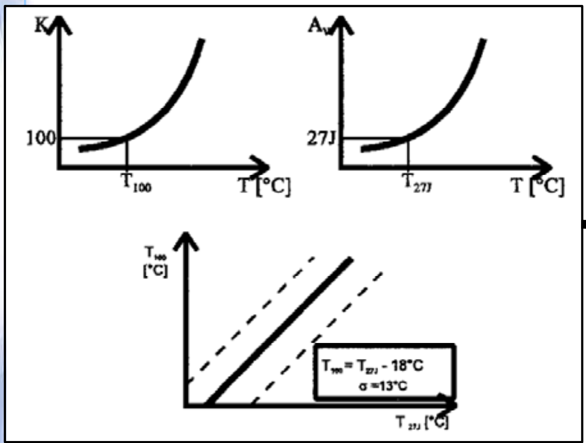


Determination of $K_{Mat,d}$ (T_{Ed})

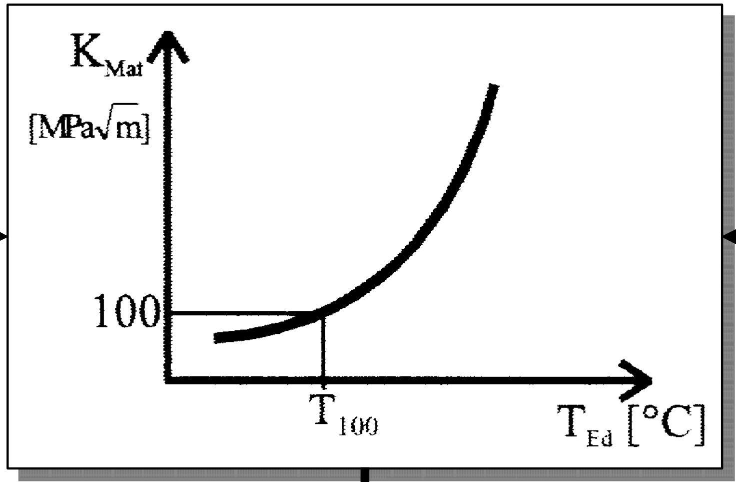
Material property
T_{27J}

Applied temperature
$T_{Ed} = T_{min} + \Delta T_r$

Modified Sanz-Correlation



Wallin-Toughness-curve



e.g.
T_{min} = ~25 °C
ΔT_r = ~5°C

$K_{Mat,d}$ (T_{Ed}, T_{27J}, ΔT_R)

$K^{*}_{appl,d} \le K_{mat,d}$ → **Transformation** → $T_{Ed} \ge T_{Rd}$

Assessment scheme

Safety assessment based on temperature

$T_{Ed} \ge T_{Rd}$

Action side

$$T_{Ed} = T_{min} + \Delta T_r + \Delta T_\sigma + \Delta T_R \left[+ \Delta T_{\dot{\varepsilon}} + \Delta T_{\varepsilon pl} \right]$$

- Lowest air temperature in combination with σ_{Ed}

  $T_{min} = -25° C$

- Radiation loss

  $\Delta T_r = -5° C$

- Influence of stress, crack imperfection and member shape and dimension

$$\Delta T_\sigma = -52 \cdot \ln \left[\frac{\left(\frac{K_{appl}}{k_{R6} - \rho} - 20 \right) \cdot \left(\frac{b_{eff}}{25} \right)^{1/4} - 10}{70} \right] \quad [° C]$$

- Additive safety element

  $\Delta T_R = +7° C \ (\text{with } \beta = 3{,}8)$

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may be supplemented by

- Influence of the strain rate

$$\Delta T_{\dot{\varepsilon}} = -\frac{1440 - f_y(t)}{550} \cdot \left(\ln \frac{\dot{\varepsilon}}{\dot{\varepsilon}_0} \right)^{1,5} \quad [° C]$$

with $\dot{\varepsilon}_0 = 0{,}0001 \ s^{-1}$

- Influence from cold forming

$$\Delta T_{\varepsilon pl} = -3 \cdot DCF \quad [° C]$$

with DCF = Degree of Cold Forming [%]

Resistance

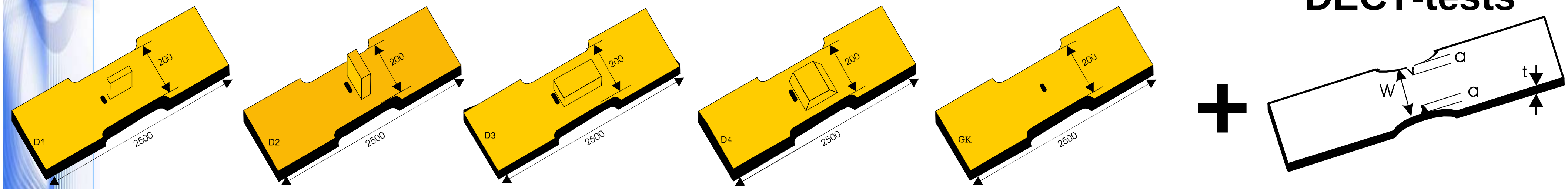
$$T_{Rd} = T_{100}$$

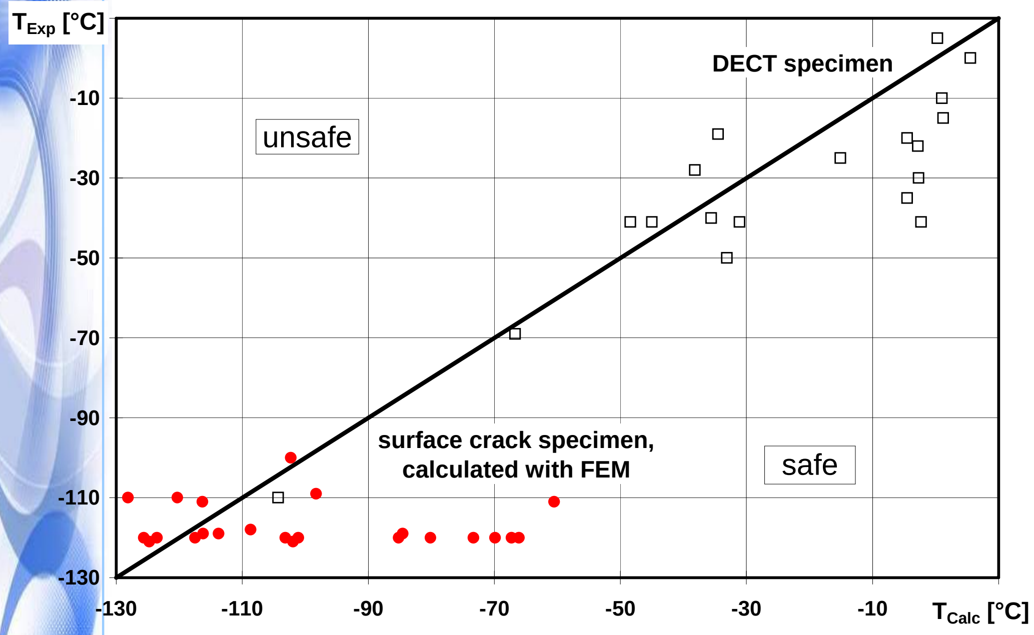
- Influence of material toughness

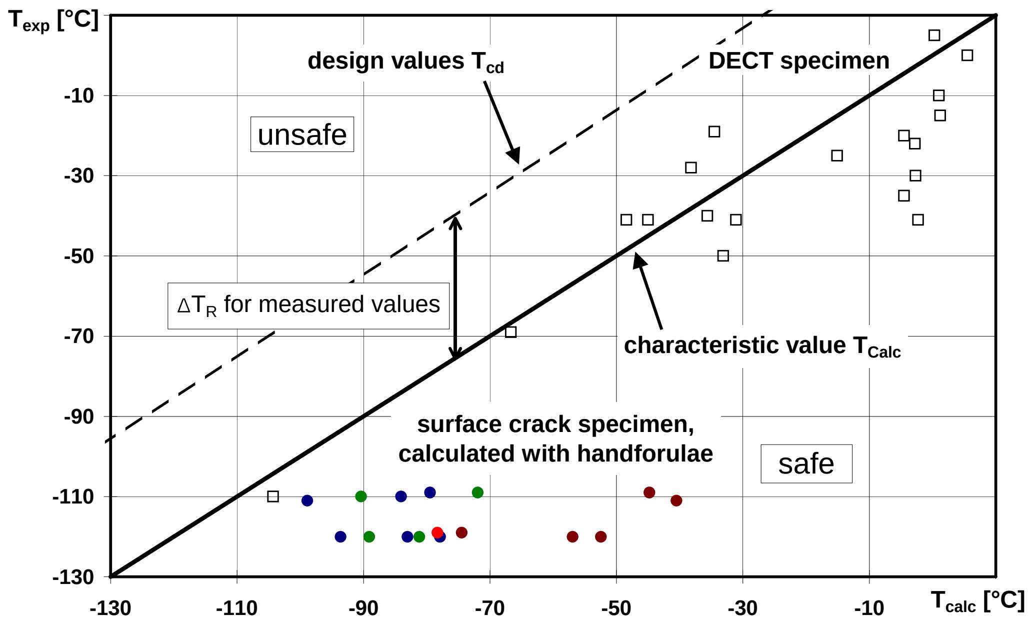
$$T_{100} = T_{27J} - 18 \quad [° C]$$

Evaluation of large scale fracture tests

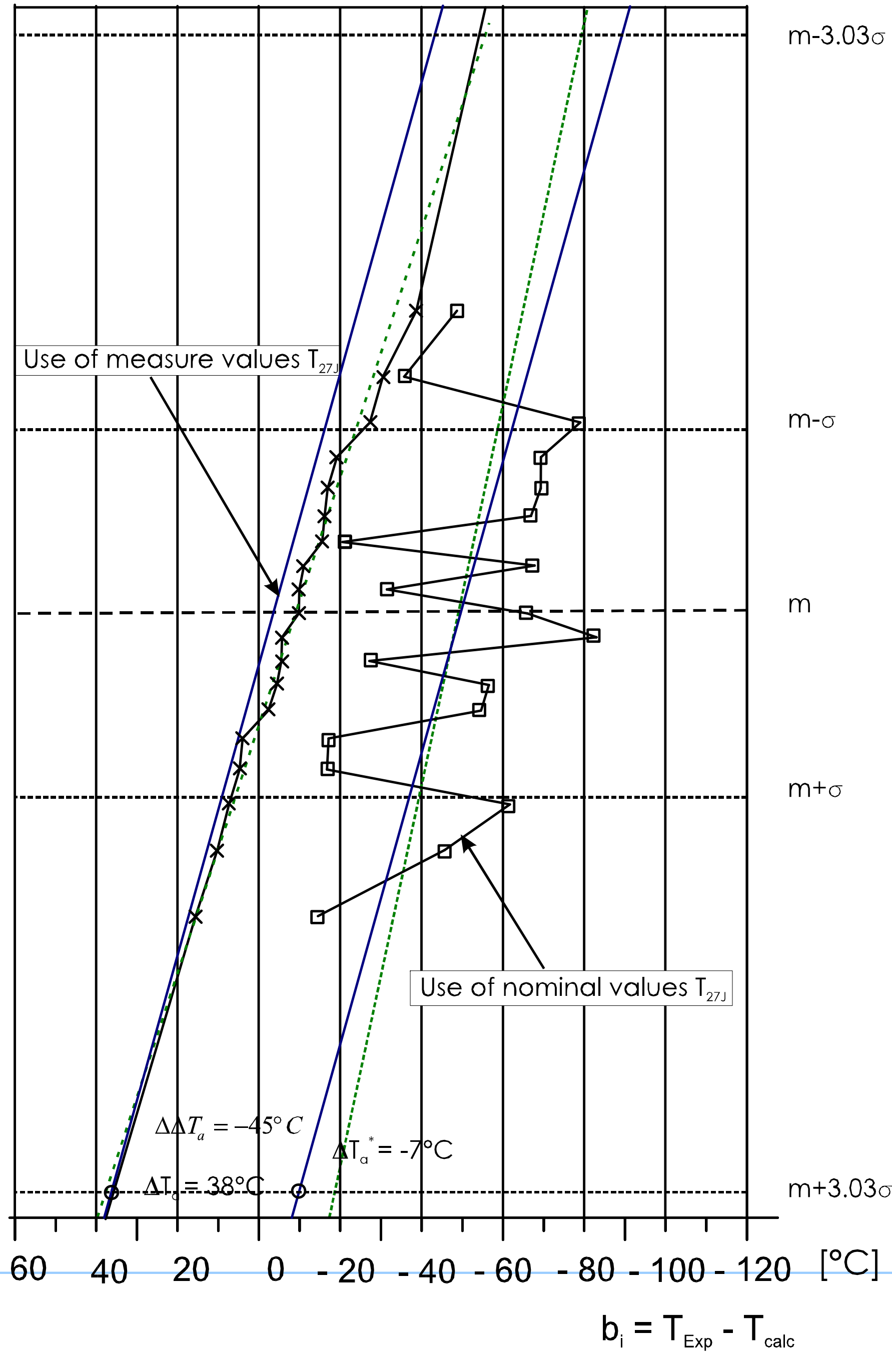
DECT-tests





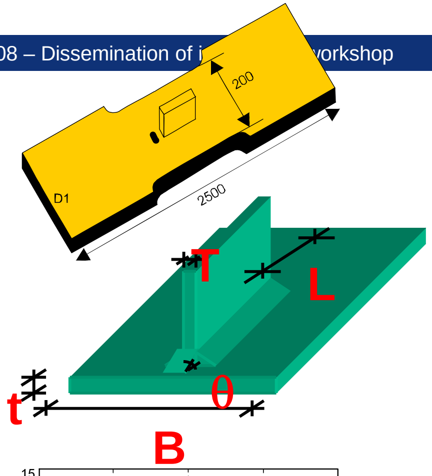


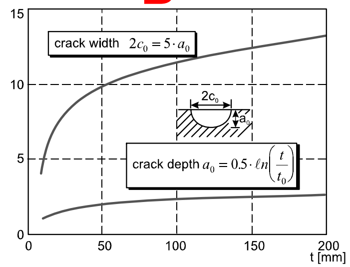
Determination of the safety element ΔT_R only for DECT-elements

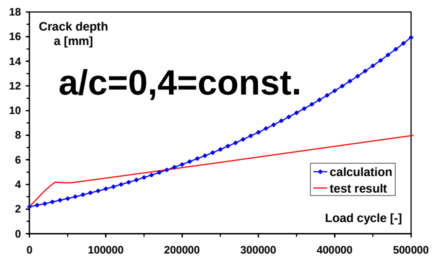


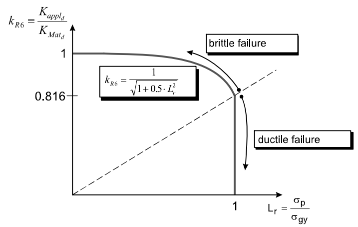
Value of the safety element (NDP) related to the use of nominal values (T27J and f_y) is therefore ΔT_R = [+7°C]

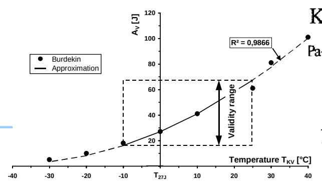
Example - Safety Assessment for a well known standard steel S355 N or M

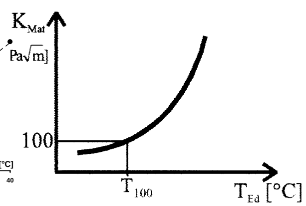












Lowest fatigue class
$\Delta\sigma_c$ = 56N/mm² (L >100mm)
acc. to prEN1993-1-9

Geometrical Parameter:
L/t = 8,2; B/t = 7,5;
T/t = 0,15; θ = 45°

e.g. t = 80 mm

a_0 = 2,19 mm and c_0 = 5,48 mm

Δσ = 56 N/mm²; LC = 500.000

a_d = 15,94 mm and c_d = 39,85 mm

$K_{appl,d}(\Delta\sigma)$ = 20,49 MPa√m

$\sigma_{Ed}=0{,}5\cdot f_y(t)+\sigma_s$; f_y(80mm)=335N/mm²

$K^*_{appl,d}(\sigma_{Ed})$ = 110,01 MPa√m

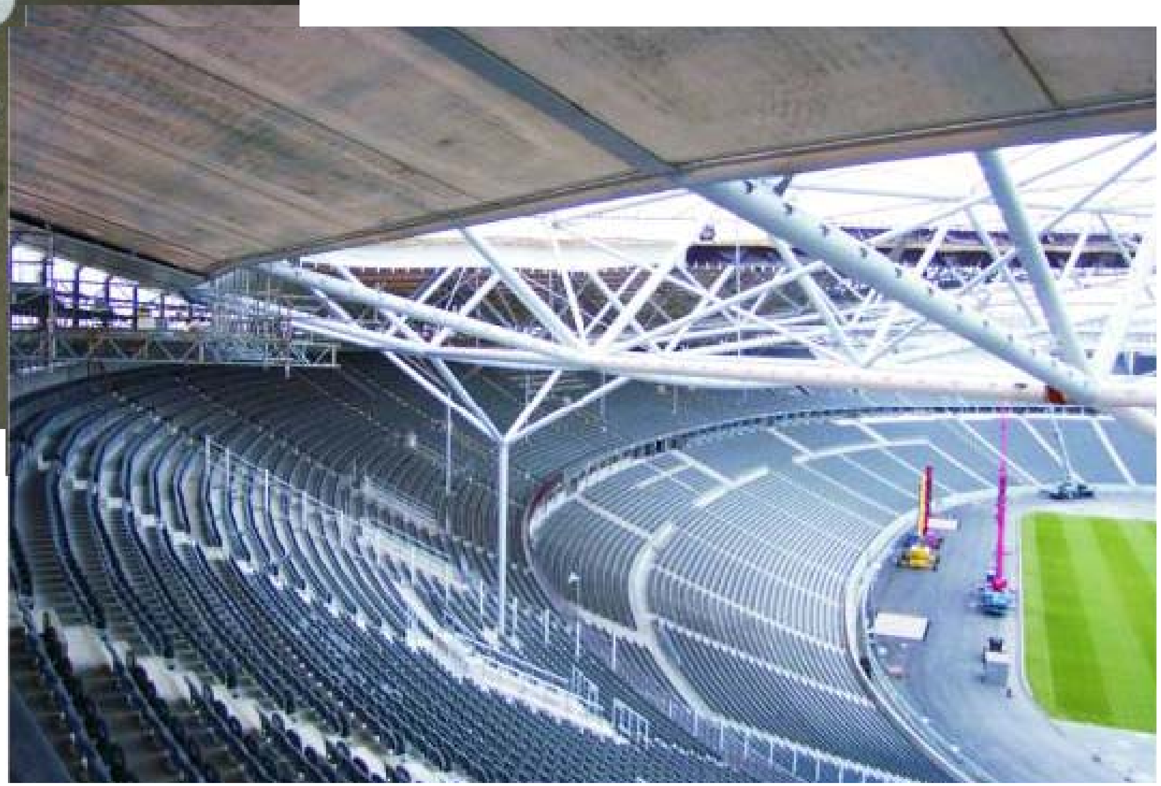
T_{Ed} = -30°C; T_{40J} = -20°C
☑ T_{27J} = - 30°C; ΔT_R = -7°C
$K_{Mat}(T_{Ed}; T_{27J}; \Delta T_R)$ = 112,21 MPa√m

Plates made of S355 N or M and thickness t ≤ 80mm could be used up to T_{Ed} = -30°C and $\sigma_{Ed} = 0{,}5\cdot f_y(t)+\sigma_s$

Table of permissible plate thicknesses

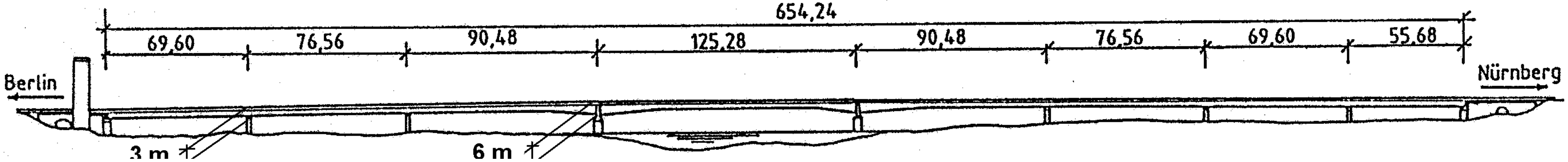
steel grade	charpy energy CVN		applied temperature T_{Ed} in °C																				
	at T °C	J min.	10	0	-10	-20	-30	-40	-50	10	0	-10	-20	-30	-40	-50	10	0	-10	-20	-30	-40	-50
			$\sigma_{Ed}=0,25*f_y(t)+\sigma_s$							$\sigma_{Ed}=0,50*f_y(t)+\sigma_s$							$\sigma_{Ed}=0,75*f_y(t)+\sigma_s$						
			max. permissible plate thickness t_z in mm (safety element ΔT_R included)																				
S235	20	27	135	115	100	85	75	65	60	90	75	65	55	45	40	35	60	50	40	35	30	25	20
	0	27	175	155	135	115	100	85	75	125	105	90	75	65	55	45	90	75	60	50	40	35	30
	-20	27	200	200	175	155	135	115	100	170	145	125	105	90	75	65	125	105	90	75	60	50	40
S275	20	27	125	110	95	80	70	60	55	80	70	55	50	40	35	30	55	45	35	30	25	20	15
	0	27	165	145	125	110	95	80	70	115	95	80	70	55	50	40	75	65	55	45	35	30	25
	-20	27	200	190	165	145	125	110	95	155	130	115	95	80	70	55	110	95	75	65	55	45	35
	-20	40	200	200	190	165	145	125	110	180	155	130	115	95	80	70	135	110	95	75	65	55	45
	-50	27	230	200	200	200	190	165	145	200	200	180	155	130	115	95	185	160	135	110	95	75	65
S355	20	27	110	95	80	70	60	55	45	65	55	45	40	30	25	25	40	35	25	20	15	15	10
	0	27	150	130	110	95	80	70	60	95	80	65	55	45	40	30	60	50	40	35	25	20	15
	-20	27	200	175	150	130	110	95	80	135	110	95	80	65	55	45	90	75	60	50	40	35	25
	-20	40	200	200	175	150	130	110	95	155	135	110	95	80	65	55	110	90	75	60	50	40	35
	-50	27	210	200	200	200	175	150	130	200	180	155	135	110	95	80	155	130	110	90	75	60	50
S420	-20	40	200	185	160	140	120	100	85	140	120	100	85	70	60	50	95	80	65	55	45	35	30
	-50	27	200	200	200	185	160	140	120	190	165	140	120	100	85	70	135	115	95	80	65	55	45
S460	-20	30	175	155	130	115	95	80	70	110	95	75	65	55	45	35	70	60	50	40	30	25	20
	-20	40	200	175	155	130	115	95	80	130	110	95	75	65	55	45	90	70	60	50	40	30	25
	-40	30	200	200	175	155	130	115	95	155	130	110	95	75	65	55	105	90	70	60	50	40	30
	-50	27	200	200	200	175	155	130	115	180	155	130	110	95	75	65	125	105	90	70	60	50	40
	-60	30	215	200	200	200	175	155	130	200	180	155	130	110	95	75	150	125	105	90	70	60	50
S690	0	40	120	100	85	75	60	50	45	65	55	45	35	30	20	20	40	30	25	20	15	10	10
	-20	30	140	120	100	85	75	60	50	80	65	55	45	35	30	20	50	40	30	25	20	15	10
	-20	40	165	140	120	100	85	75	60	95	80	65	55	45	35	30	60	50	40	30	25	20	15
	-40	30	190	165	140	120	100	85	75	115	95	80	65	55	45	35	75	60	50	40	30	25	20
	-40	40	200	190	165	140	120	100	85	135	115	95	80	65	55	45	90	75	60	50	40	30	25
	-60	30	200	200	190	165	140	120	100	160	135	115	95	80	65	55	110	90	75	60	50	40	30

Choice of material to EN 1993-1-10

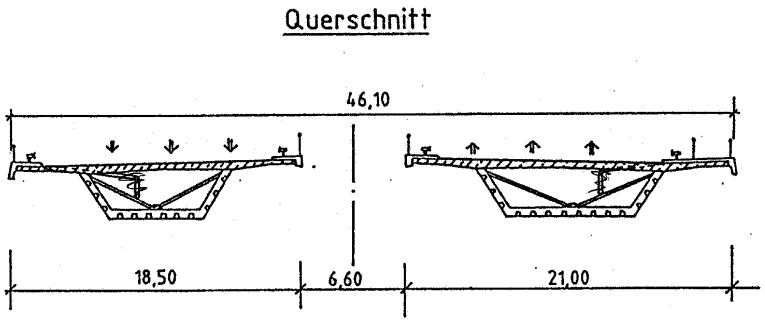


Olympic stadium Berlin

Elbe-bridge Vockerode



Bridge system and construction



Construction at supports

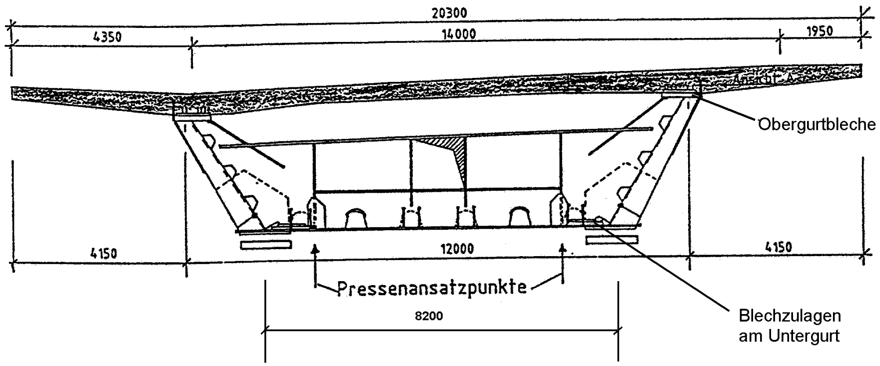
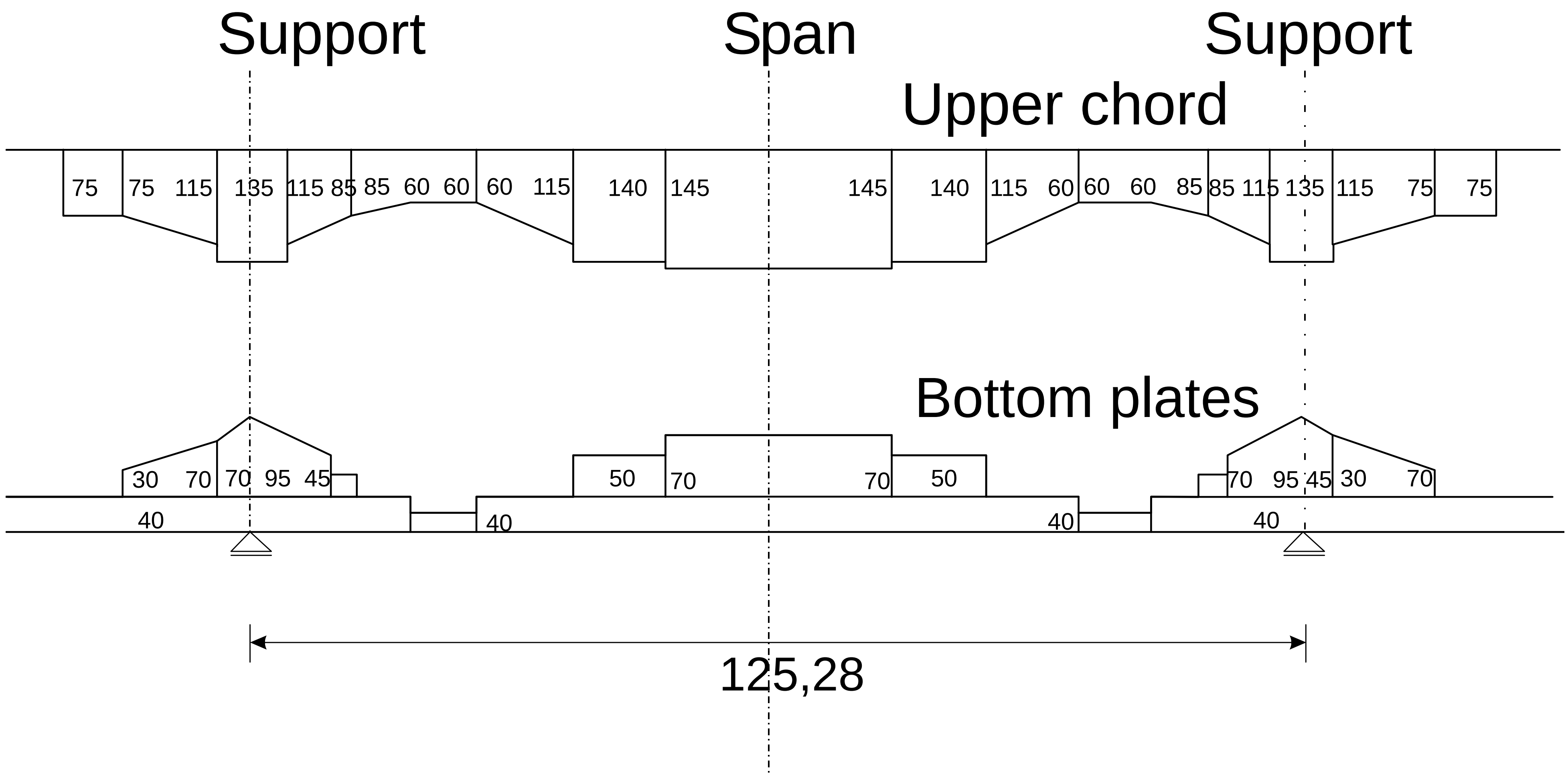
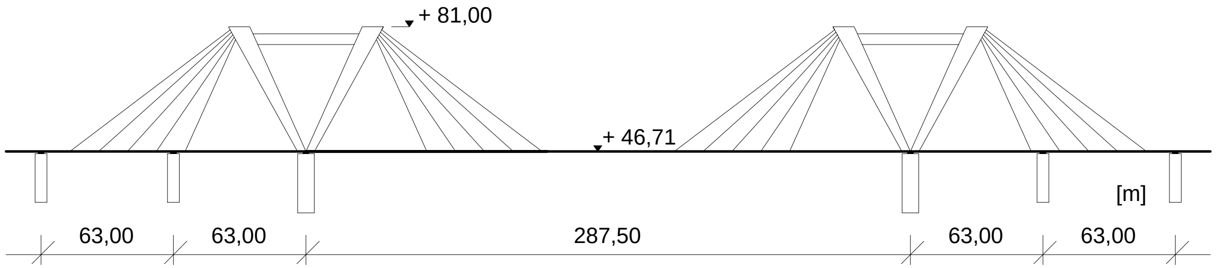


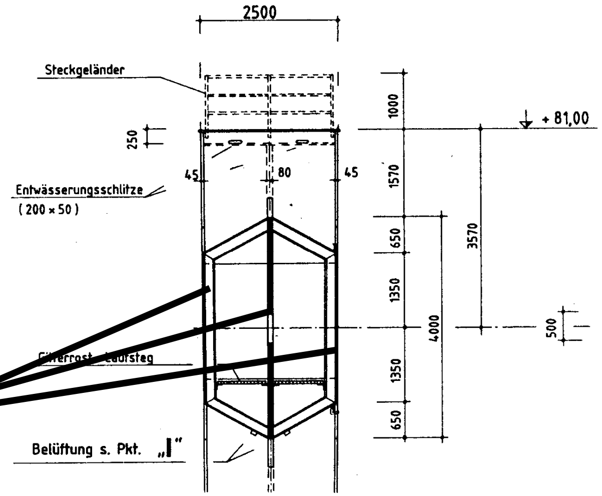
Plate thickness for S355 J2G3

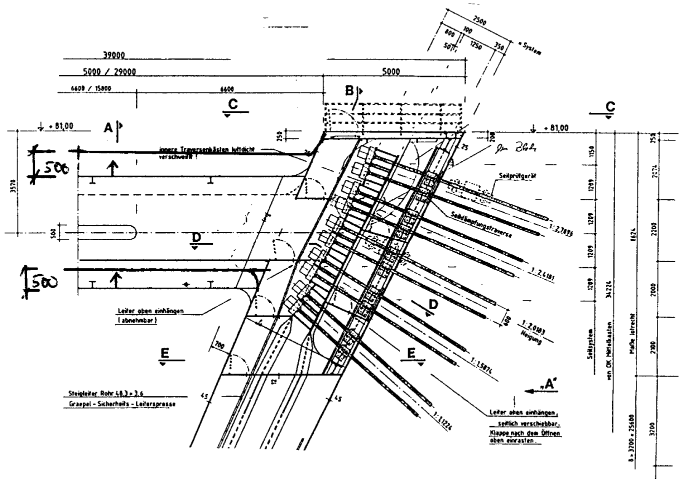


Rhine-bridge Ilverich (Düsseldorf)

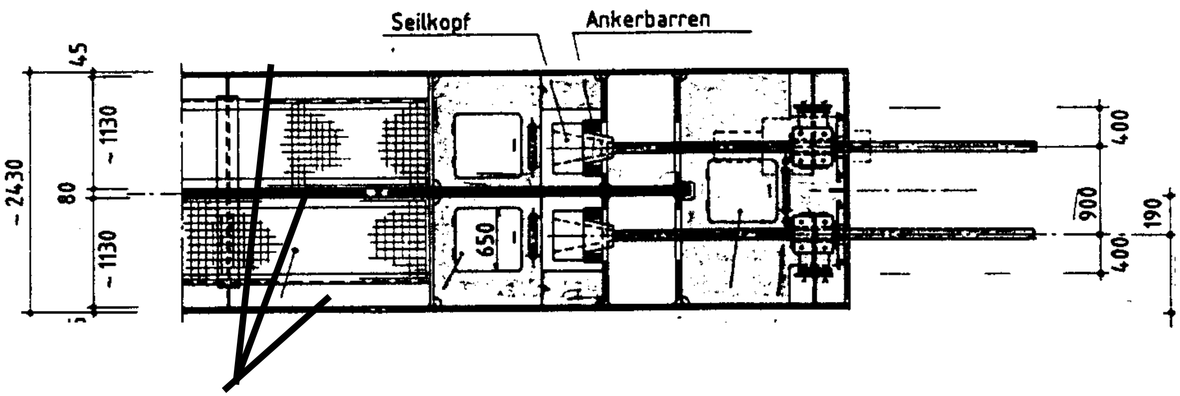
Rheinbrücke Ilverich





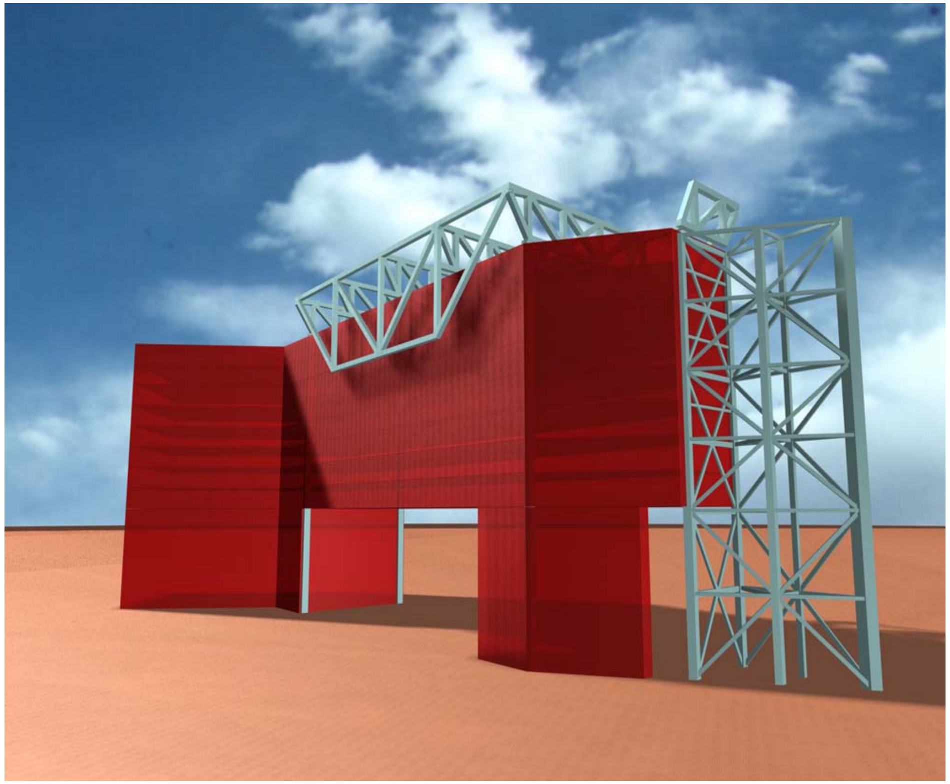


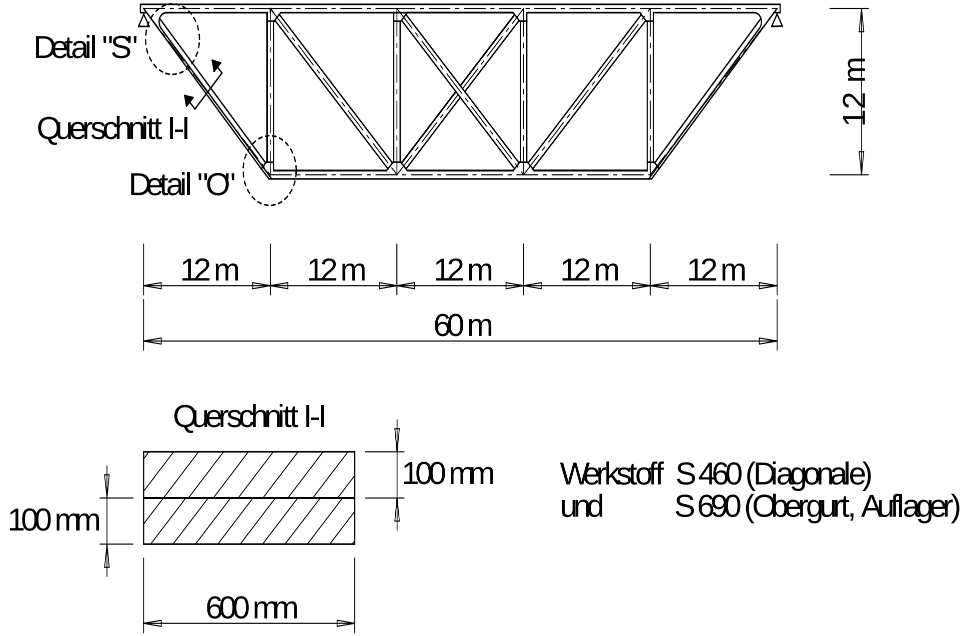
plates in S460 TM



plates in S460 TM

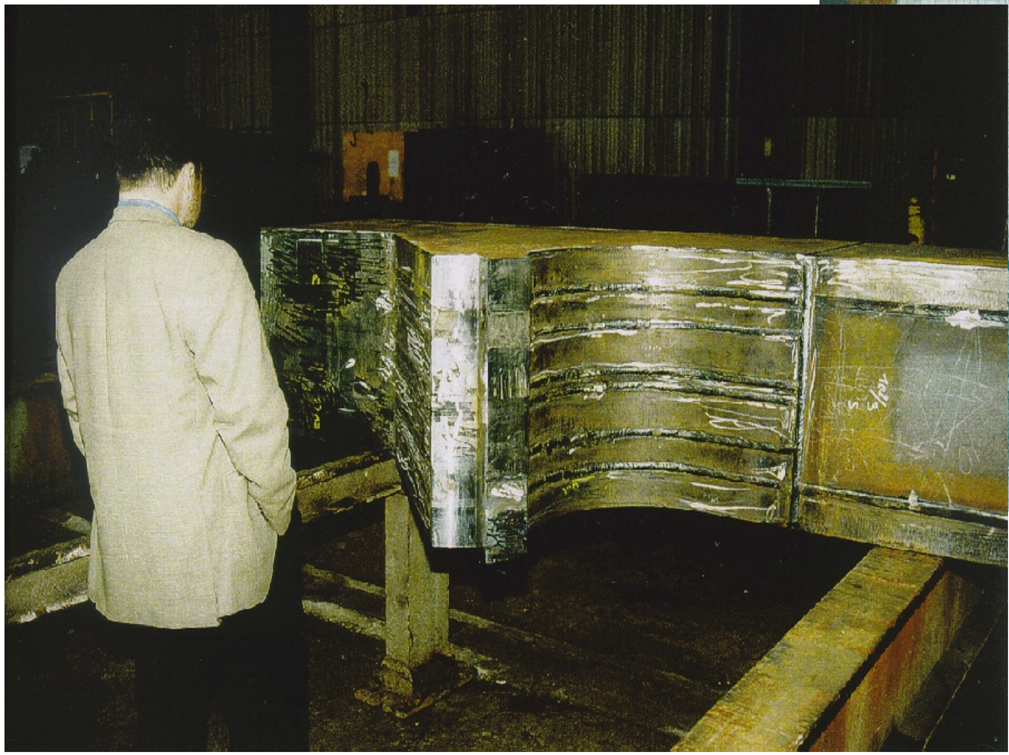
Roof truss for the Sony Center, Berlin

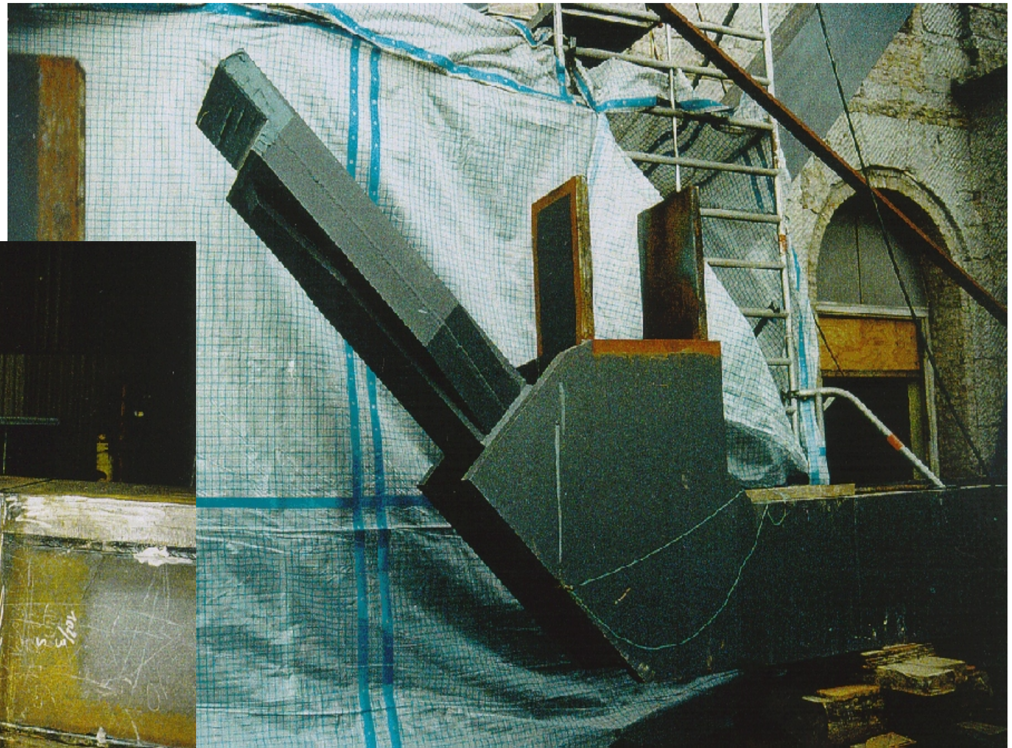




Roof truss for the Sony Center, Berlin - Details

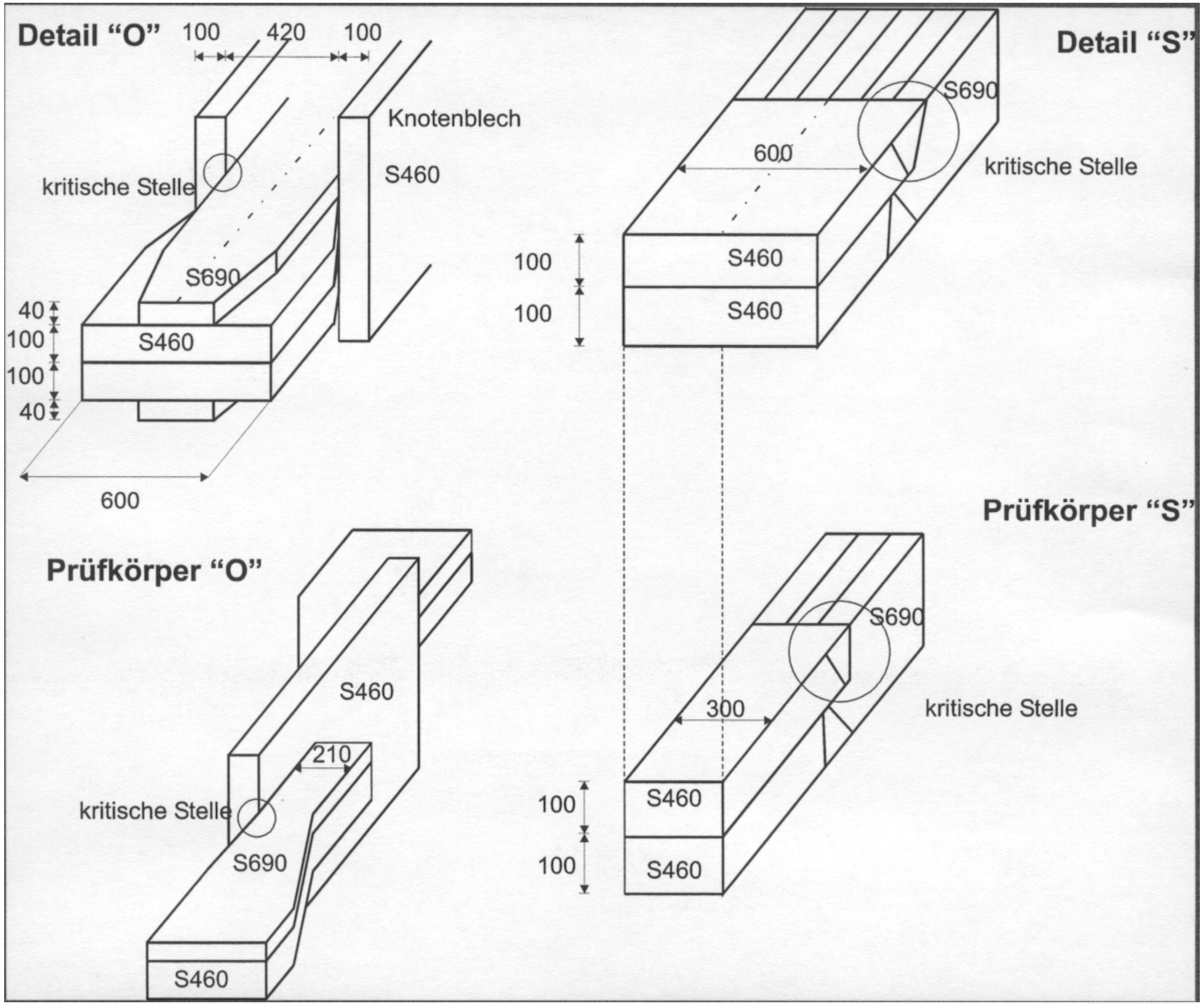
Upper chord S



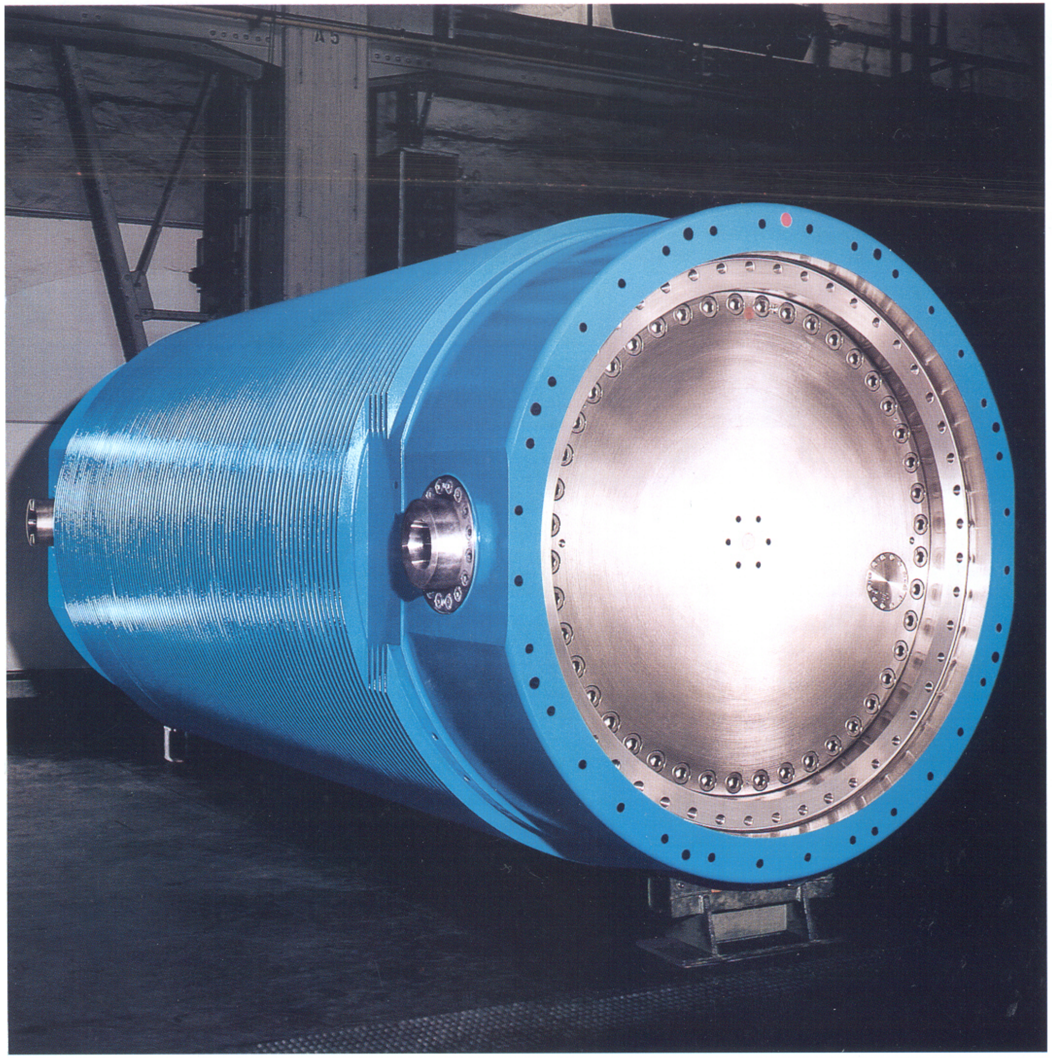


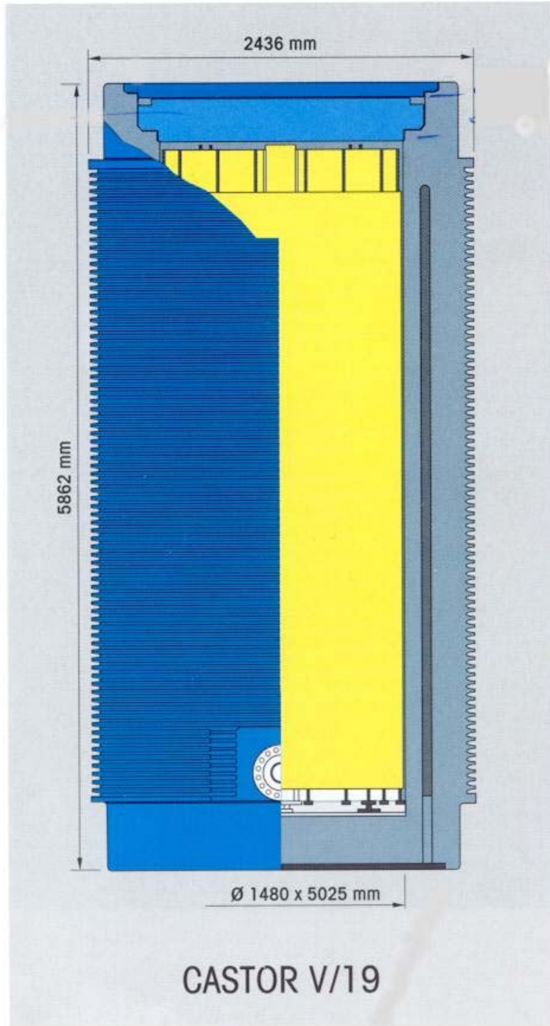
Lower chord O

Large scale test specimens for the roof-truss



Castor container

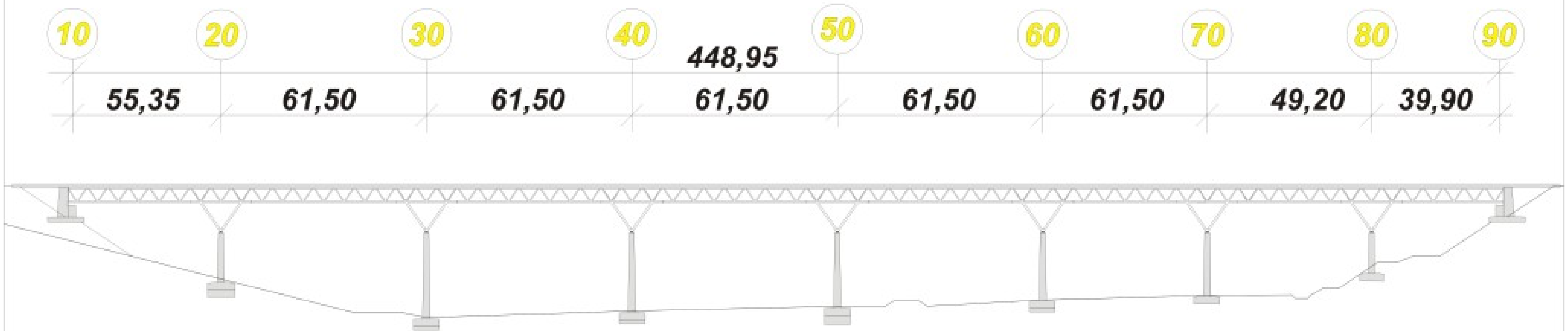




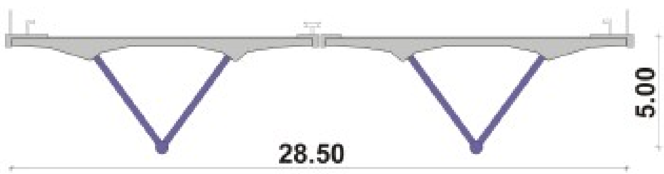
Bridge St. Kilian

Talbrücke St. Kilian

Ansicht



Regelquerschnitt

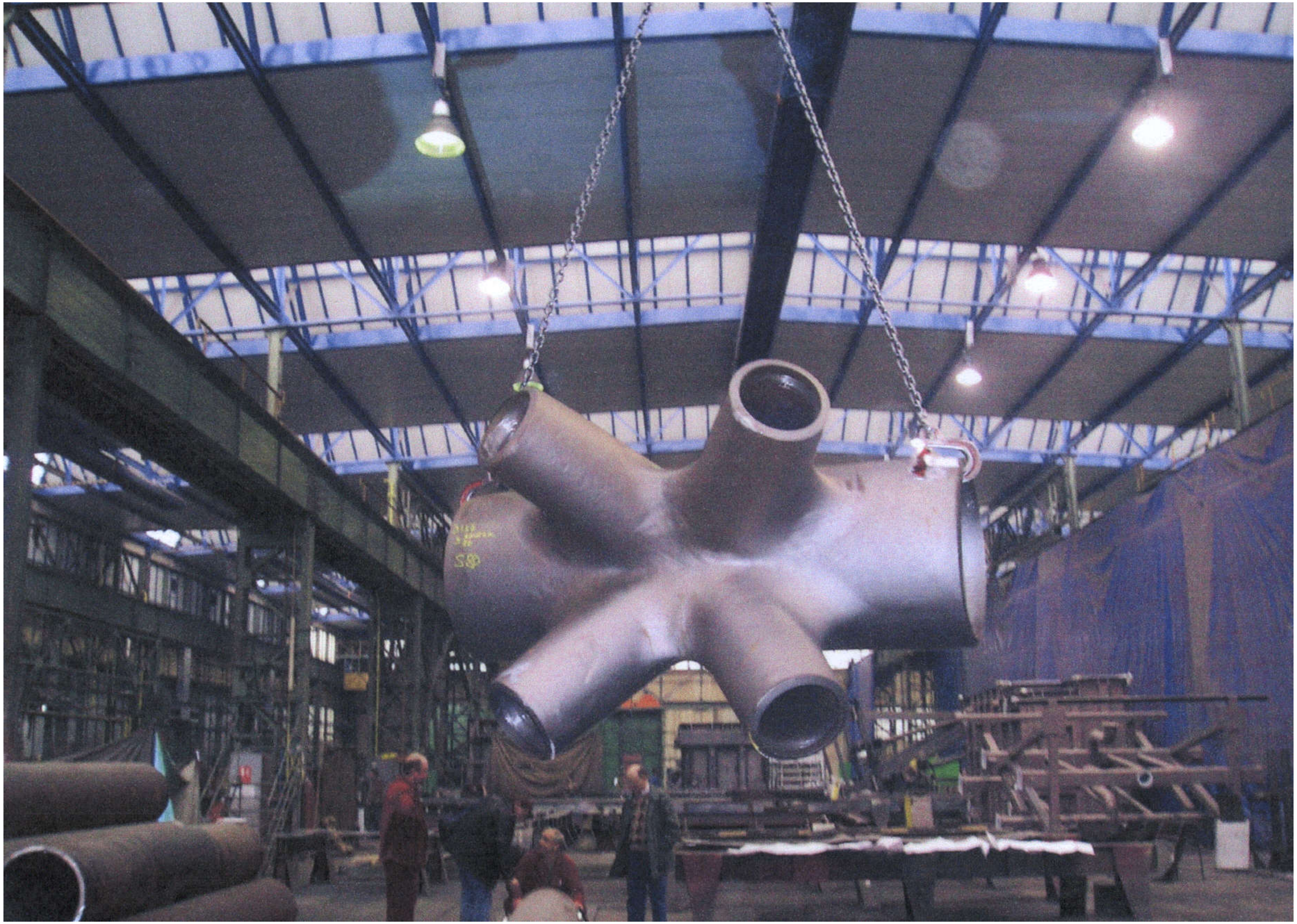


Systemskizze	BAB A 73 Talbrücke St. Kilian DEGES-Bauwerks-Nr. 5212/13

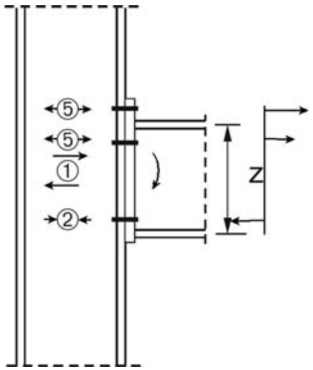
Bridge St. Kilian

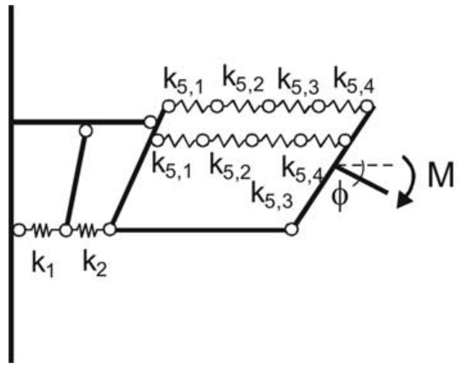
Cast node for the bridge St. Kilian

Cast node for the bridge St. Kilian



Modelling of joints

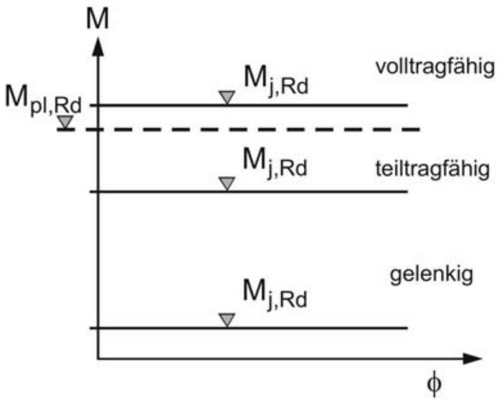


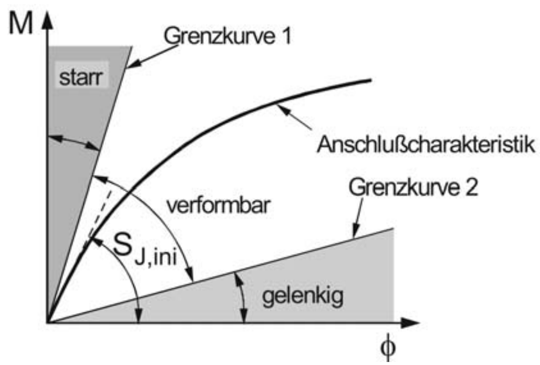


Klassifizierung nach der Tragfähigkeit

$M_{j,Rd}$ = Bemessungswert der Anschlußtragfähigkeit

$M_{pl,Rd}$ = Referenzwert

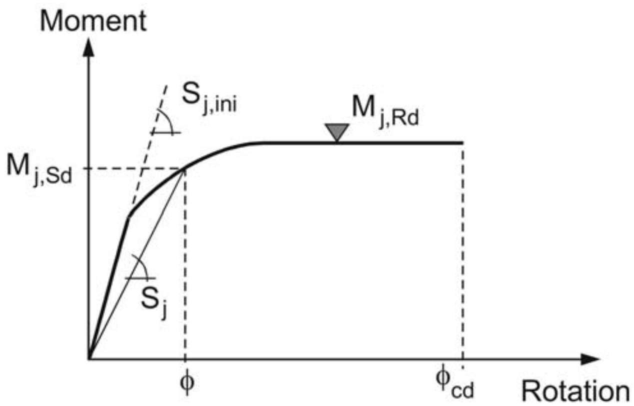




Klassifizierung nach der Steifigkeit

S_j = Anfangssteifigkeit

Momenten-Rotations-Charakteristik



$M_{j,Rd}$ = Tragfähigkeit

$S_{j,ini}$ = Anfangssteifigkeit

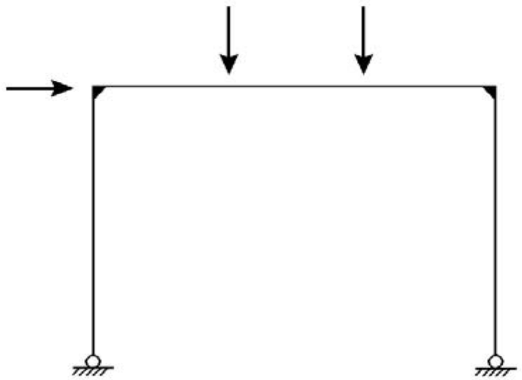
S_j = Sekantensteifigkeit

ϕ_{cd} = Rotationskapazität

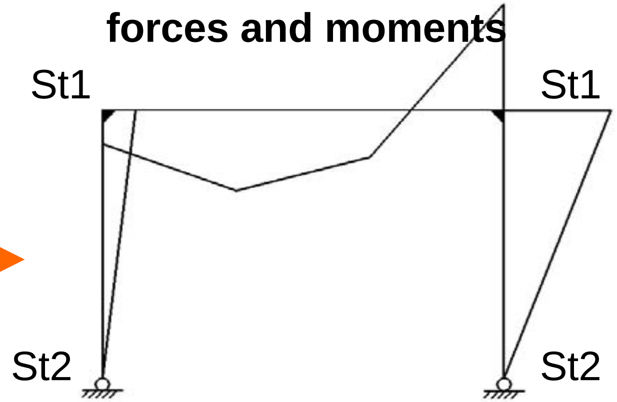
Strategies for optimization

1

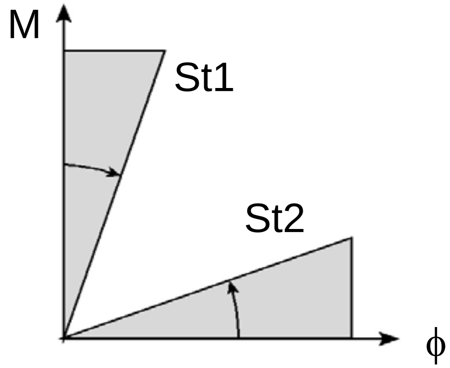
Structural system



Distribution of internal forces and moments

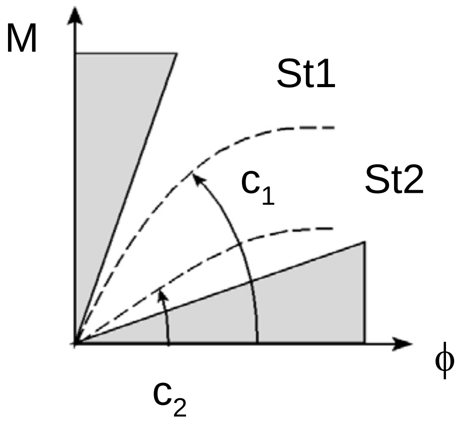


Optimised joint

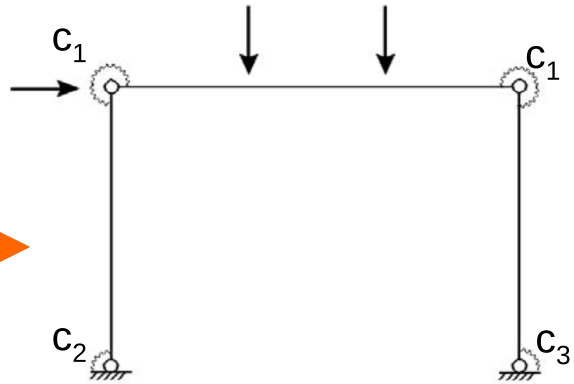


2

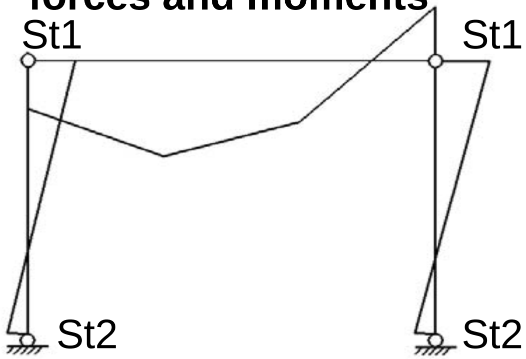
Optimised joint



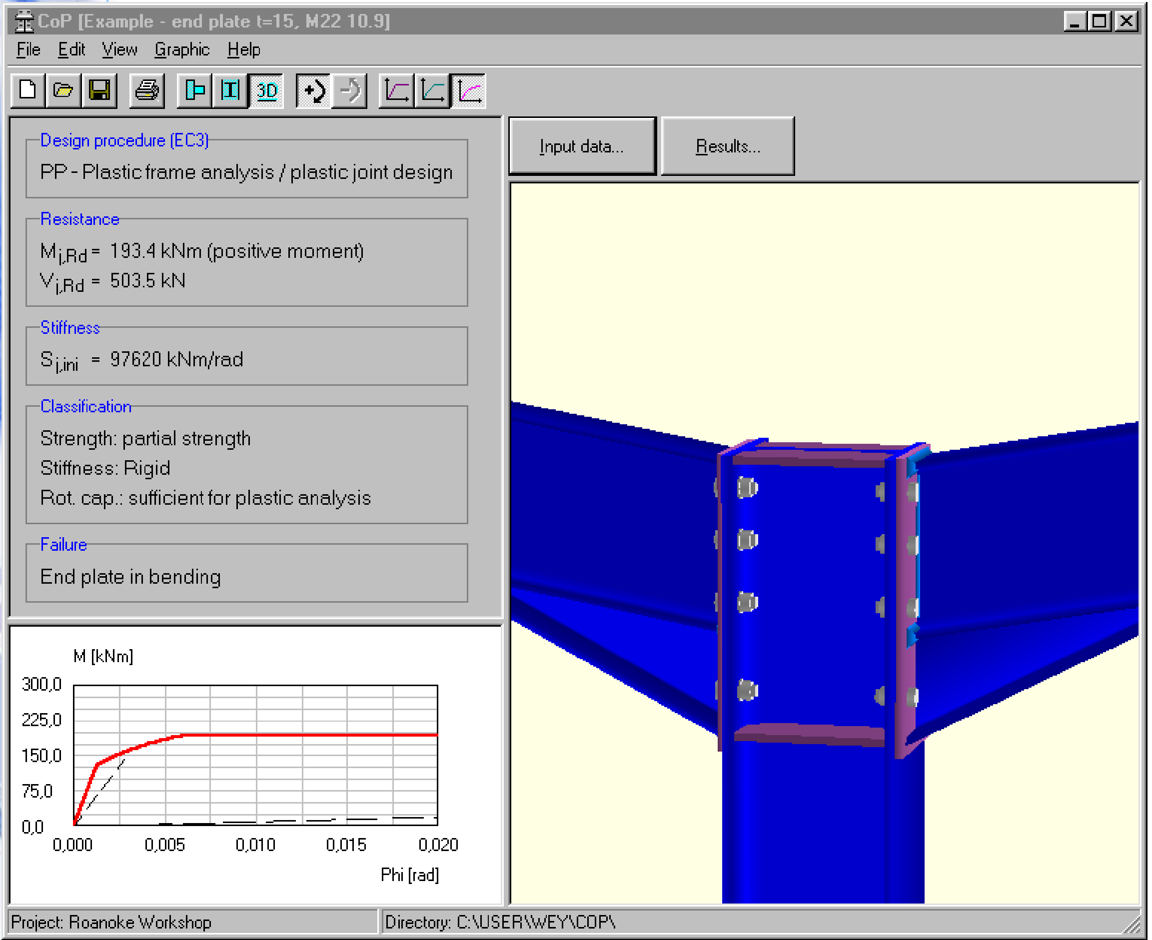
Structural system

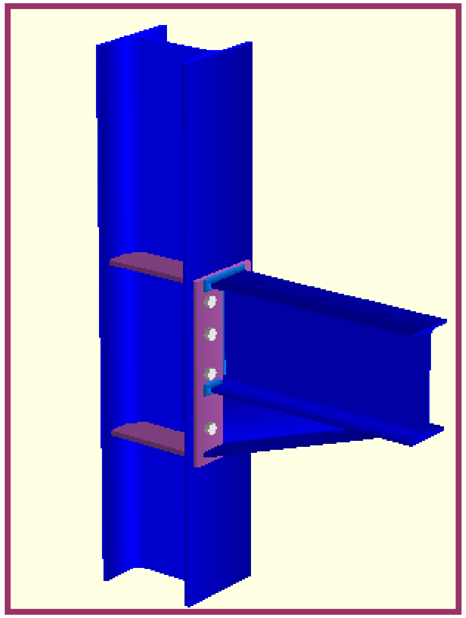


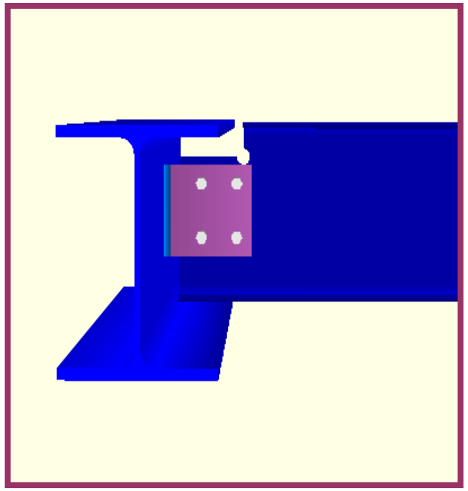
Distribution of internal forces and moments

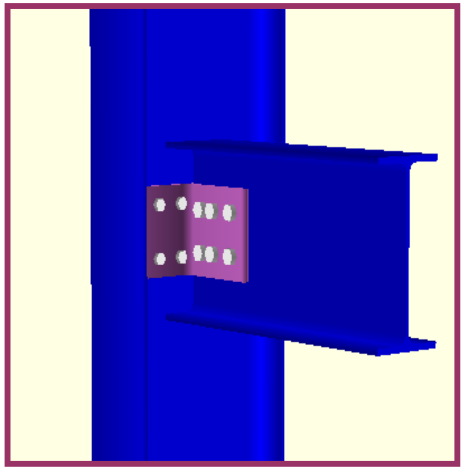


Design Tools

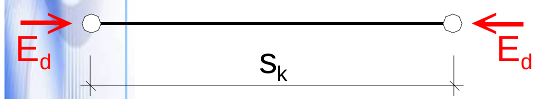




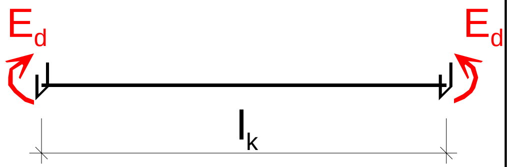




Common design rules for column, lateral torsional, plate and shell buckling



column buckling



lat. tors. buckl.

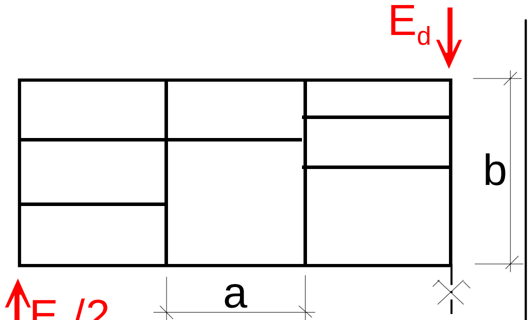
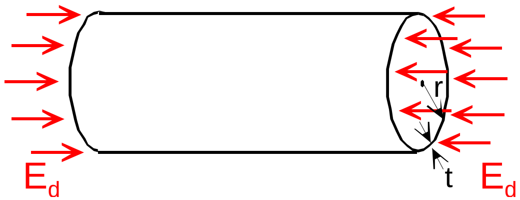


plate buckling



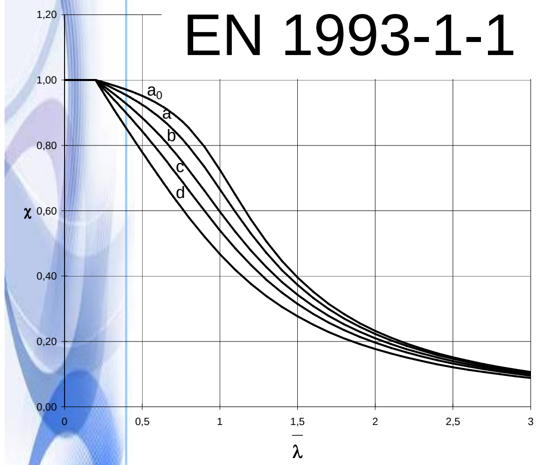
shell buckling

$$\alpha_{ult,k} E_d = R_k$$
$$\alpha_{crit} E_d = R_{crit}$$

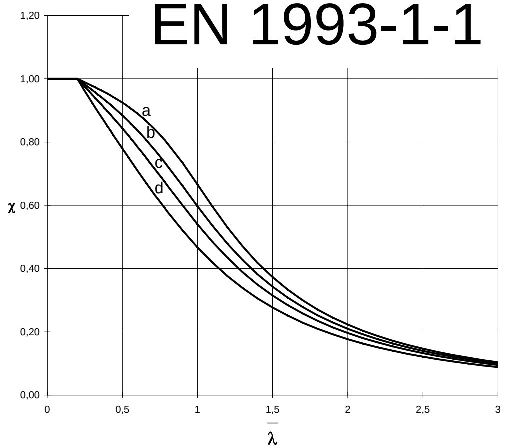
$$\bar{\lambda} = \sqrt{\frac{R_k}{R_{crit}}} = \sqrt{\frac{\alpha_{ult,k}}{\alpha_{crit}}}$$

$$\chi = \chi(\bar{\lambda})$$

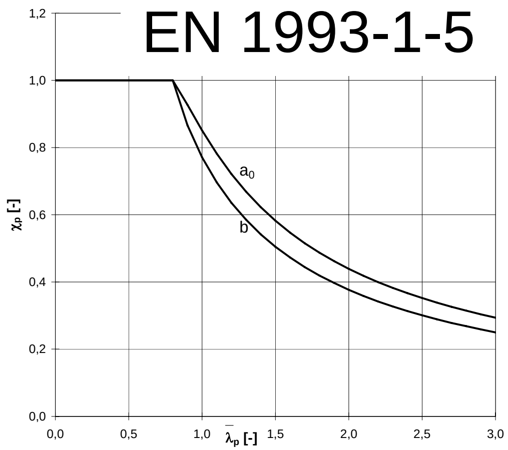
EN 1993-1-1



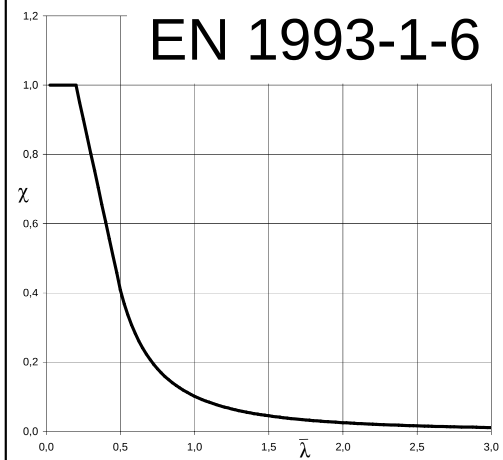
EN 1993-1-1



EN 1993-1-5



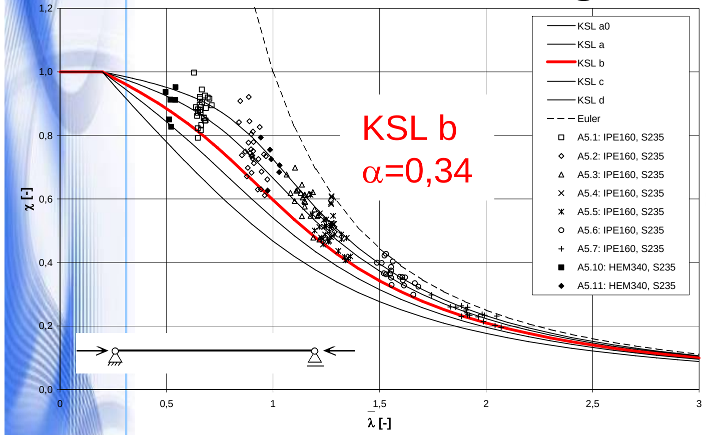
EN 1993-1-6



$$E_d \leq \frac{\chi R_k}{\gamma_M} \qquad 1 \leq \frac{\chi \alpha_{ult,k}}{\gamma_M}$$

Test evaluation for buckling curves and γ_M-values

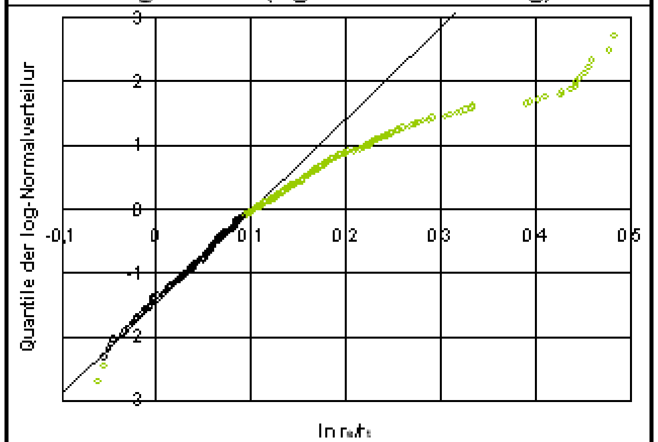
Column buckling



Eingangsdaten

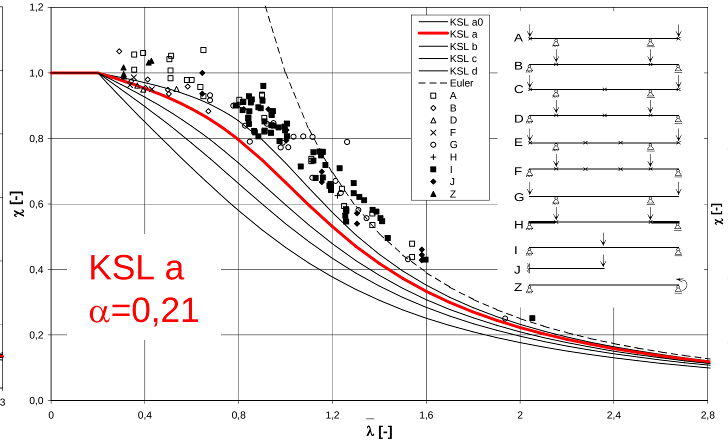
$V_{rt} = 0{,}08$ (Geometrie und Streckgrenze)
$V_{fy} = 0{,}07$ (Streckgrenze)

Ergebnisse (log-Normalverteilung)



$\bar{b} = 1{,}109$		$s_\delta = 0{,}077$
$V_\delta = 0{,}0698$ (Modell)		$V_R = 0{,}1062$ (gesamt)
$\gamma_M = 1{,}160$	$\Delta k = 0{,}935$	$\gamma_M^* = 1{,}085$

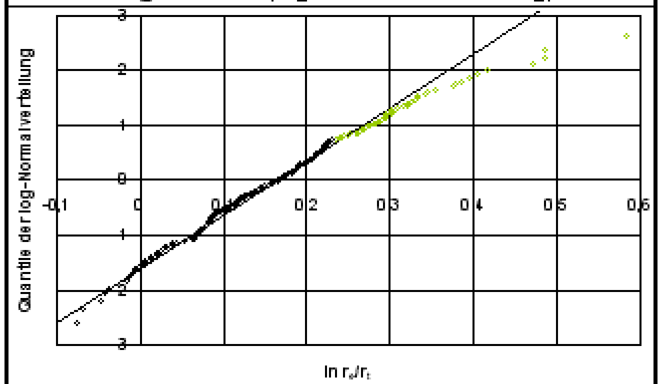
Lateral torsional buckling



Eingangsdaten

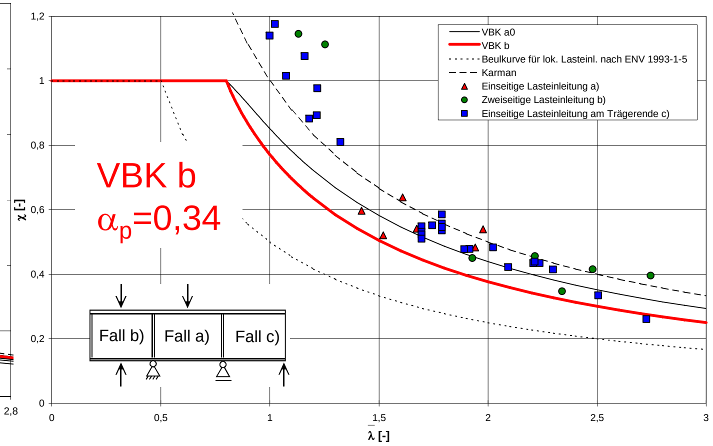
$V_{rt} = 0{,}08$ (Geometrie und Streckgrenze)
$V_{fy} = 0{,}07$ (Streckgrenze)

Ergebnisse (log-Normalverteilung)



$\bar{b} = 1{,}185$		$s_\delta = 0{,}121$
$V_\delta = 0{,}1024$ (Modell)		$V_R = 0{,}1300$ (gesamt)
$\gamma_M = 1{,}199$	$\Delta k = 0{,}912$	$\gamma_M^* = 1{,}094$

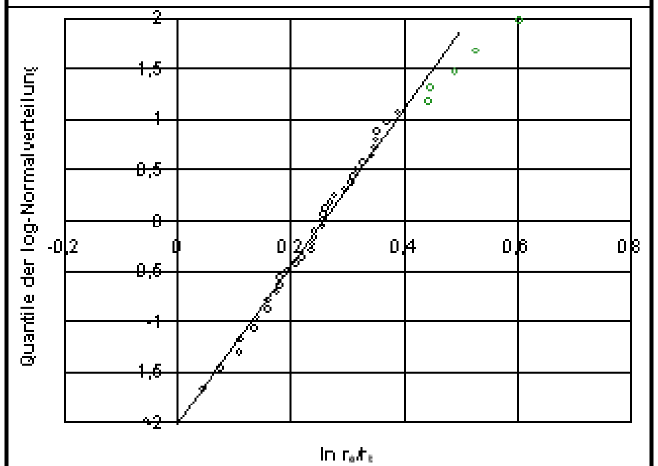
Plate buckling



Eingangsdaten

$V_{rt} = 0{,}08$ (Geometrie und Streckgrenze)
$V_{fy} = 0{,}07$ (Streckgrenze)

Ergebnisse (log-Normalverteilung)



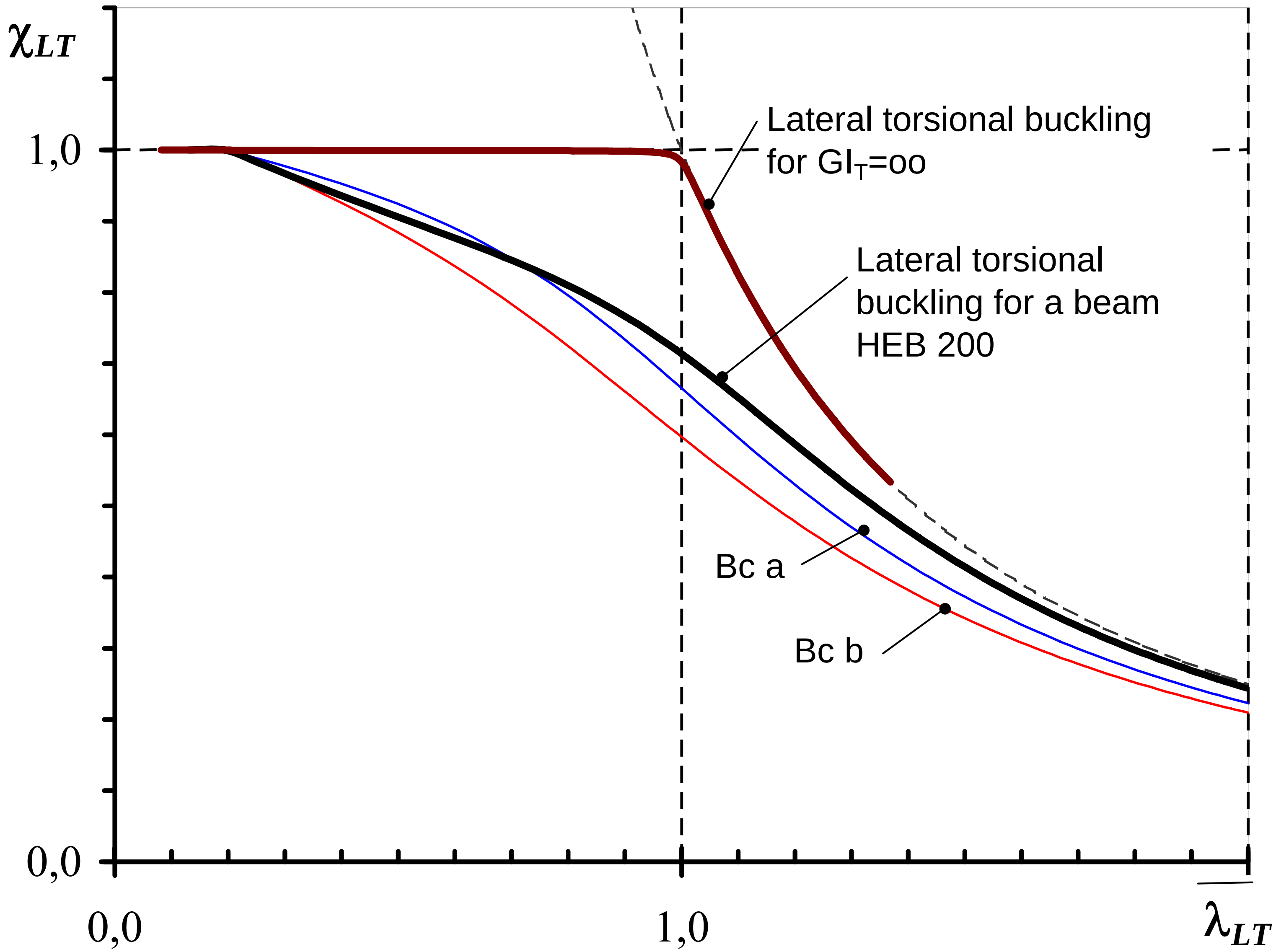
$\bar{b} = 1{,}305$		$s_\delta = 0{,}168$
$V_\delta = 0{,}1291$ (Modell)		$V_R = 0{,}1519$ (gesamt)
$\gamma_M = 1{,}235$	$\Delta k = 0{,}861$	$\gamma_M^* = 1{,}064$

Column buckling	Lateral torsional buckling
$\frac{N_{Ed}}{N_{pl,Rk}} + \frac{M_{Ed}}{M_{y,Rk}} = 1$	$\frac{N_{Ed}^{Fl}}{N_{pl,Rk}^{Fl}} + \frac{M_{y,Ed}^{Fl}}{M_{y,Rk}^{Fl}} = 1$
$\frac{N_{Ed}}{N_{pl,Rk}} + \frac{N_{Ed} e^*}{M_{y,Rk}} \frac{1}{1 - \frac{N_{Ed}}{N_{crit}}} = 1$	$\frac{M_{z,Ed}}{M_{z,Rk}} + \frac{M_{z,Ed}}{M_{z,crit}} \frac{N_{crit}^{Fl}}{M_{y,Rk}^{Fl}} e^* \frac{1}{1 - \frac{M_{z,Ed}}{M_{z,crit}}} = 1$
$e^* = \alpha\left(\bar{\lambda}_N - 0{,}2\right)\frac{M_{y,Rk}}{N_{pl,Rk}}$ $\chi_N + \chi_N \overbrace{\alpha}^{=\alpha} \left(\bar{\lambda}_N - 0{,}2\right) \frac{1}{1 - \chi_N \bar{\lambda}_N^2} = 1$	$e^* = \alpha\left(\bar{\lambda}_M - 0{,}2\right)\frac{M_{y,Rk}^{Fl}}{N_{pl,Rk}^{Fl}}$ $\chi_M + \chi_M \overbrace{\alpha \frac{\bar{\lambda}_M^2}{\bar{\lambda}_{Fl}^2}}^{=\alpha^*} \left(\bar{\lambda}_M - 0{,}2\right) \frac{1}{1 - \chi_M \bar{\lambda}_M^2} = 1$

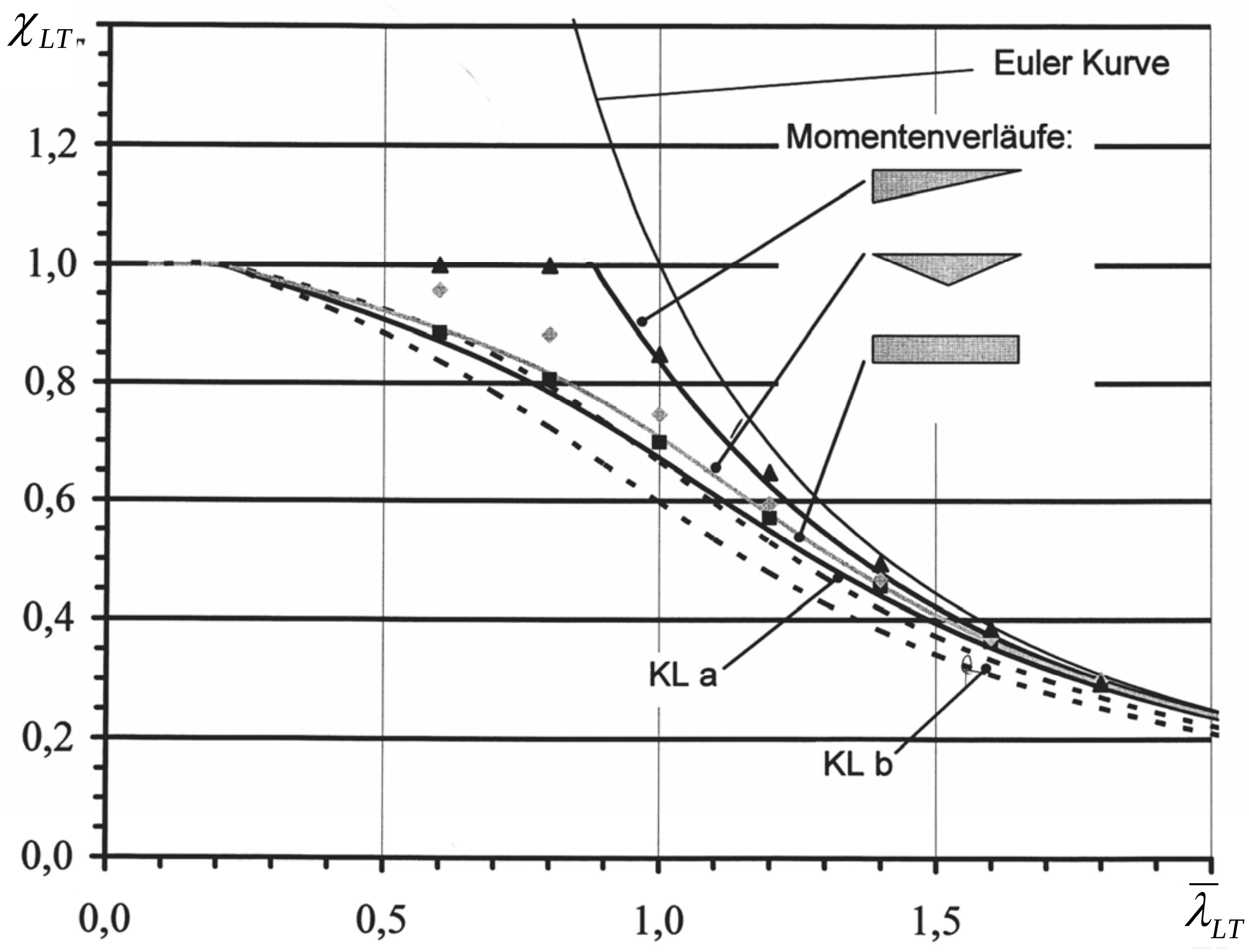
$$\chi = \frac{1}{\varphi + \sqrt{\varphi^2 - \bar{\lambda}^2}}$$

$$\varphi = 0{,}5\left(1 + \alpha\left(\bar{\lambda} - 0{,}2\right) + \bar{\lambda}^2\right)$$

Comparison of LTB-curves



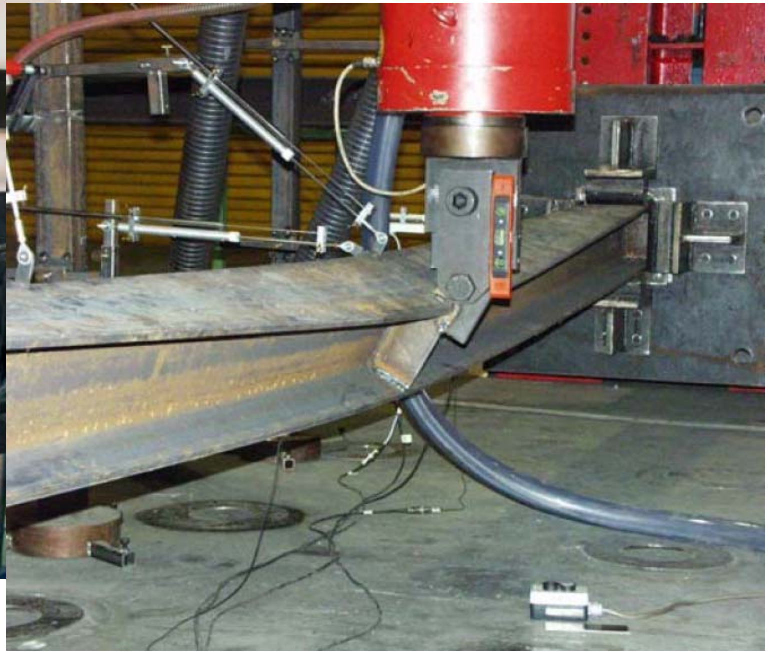
“New” lateral torsional buckling curves



Experiments

Experiments in Aachen

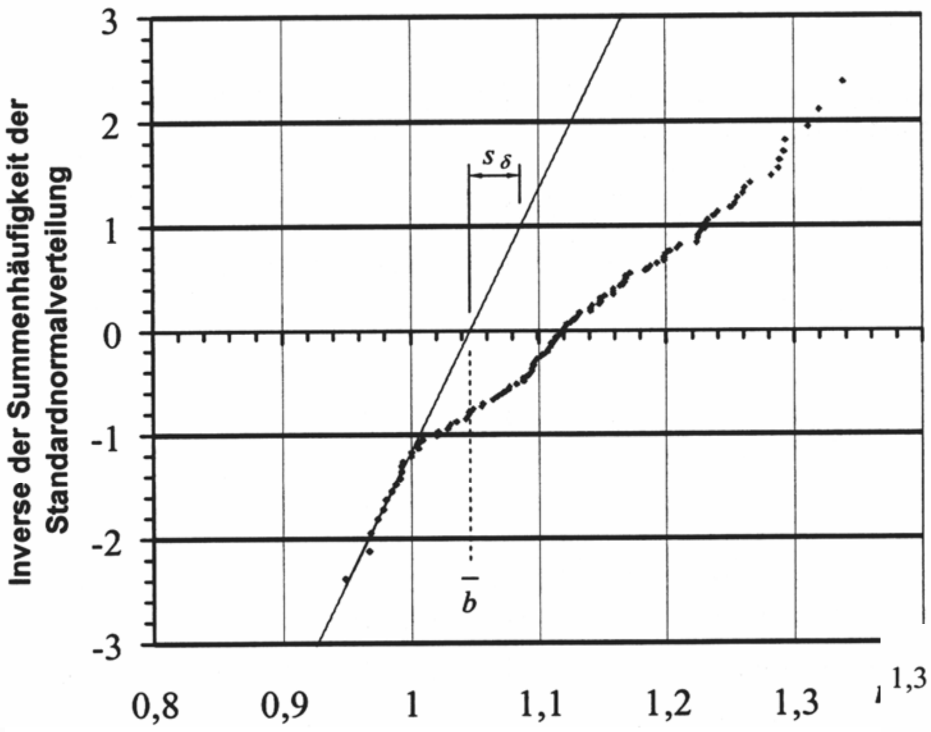
Experiments in Berlin



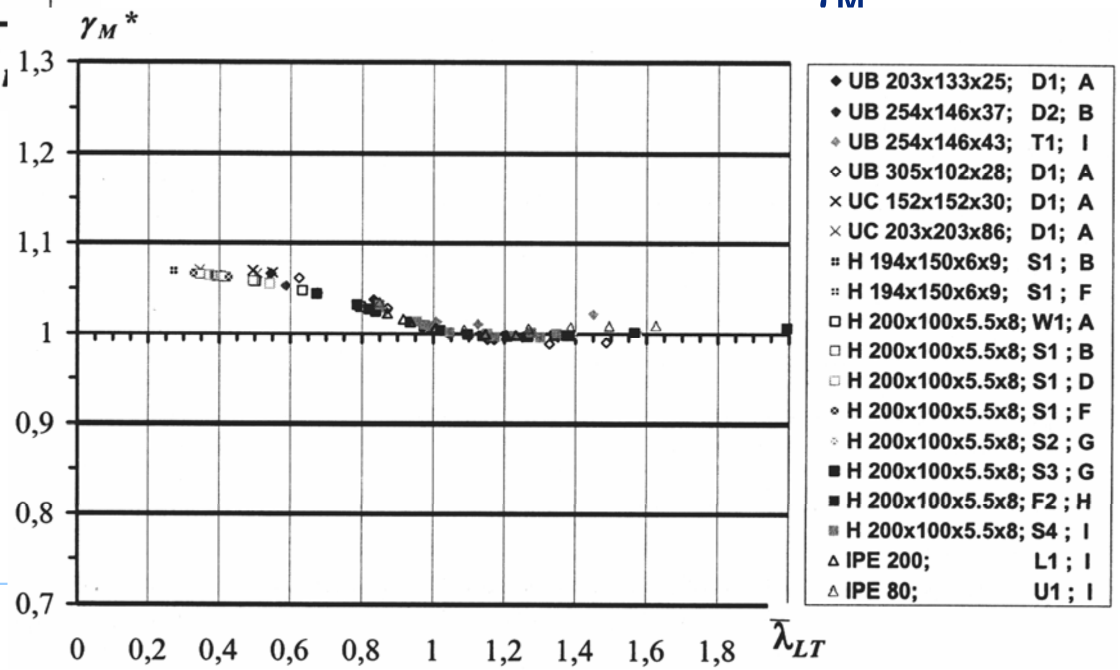
Experiments in Bochum

Results of test evaluations

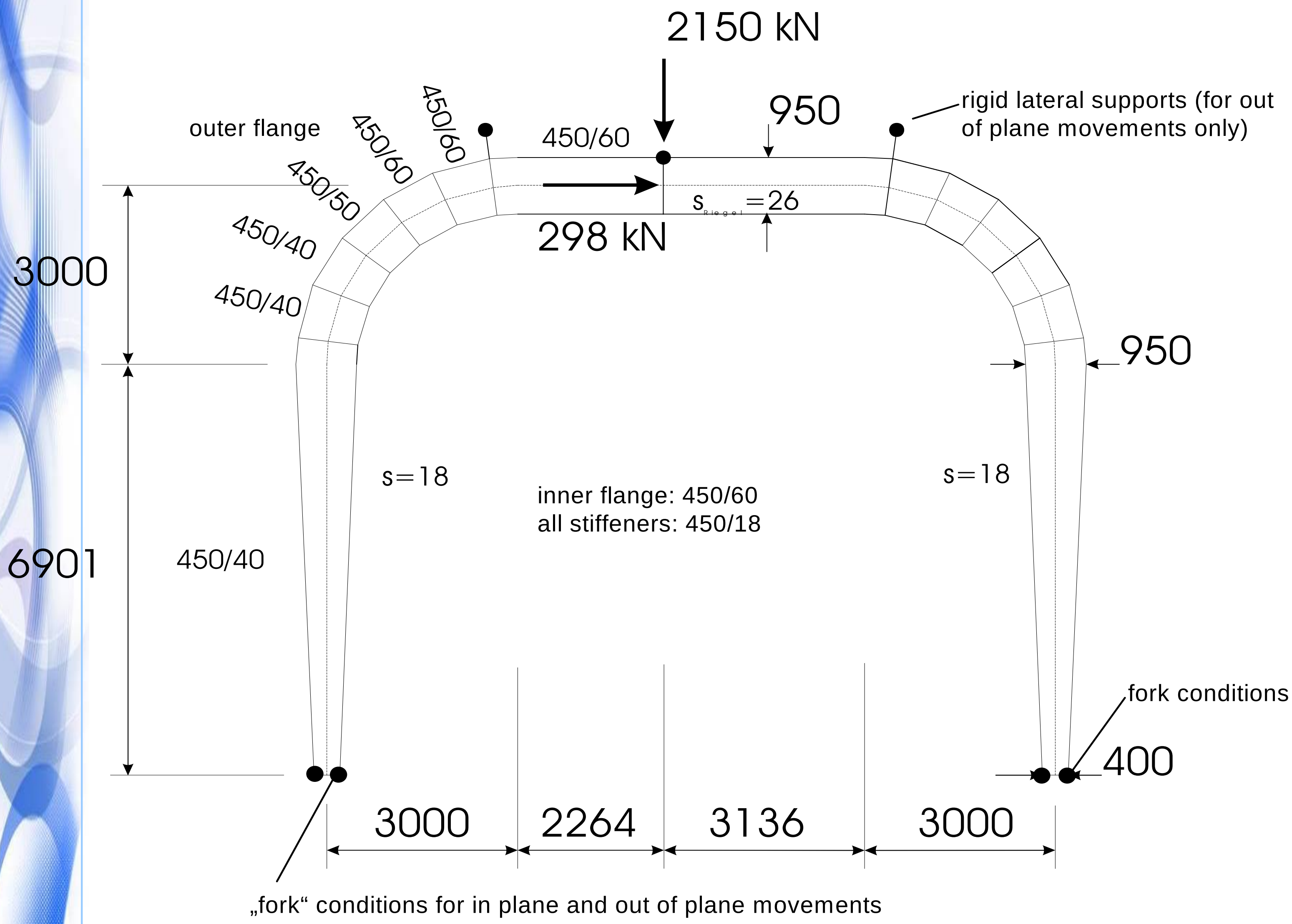
Test evaluation acc. to EN 1990-Annex D



Determination of γ_M-factors



Application of global slenderness concept for a bridge supporting frame



Results of FEM

$\alpha_{crit} = 3{,}41$

$\alpha_{ult,k} = 1{,}69$

Slenderness ratio

$$\bar{\lambda} = \sqrt{\frac{\alpha_{ult,k}}{\alpha_{crit}}} = \sqrt{\frac{1{,}69}{3{,}41}} = 0{,}70$$

$\chi_{LT} = 0{,}725$

Verification

$$\chi\, \alpha_{ult,k} \geq \gamma_{M1}$$

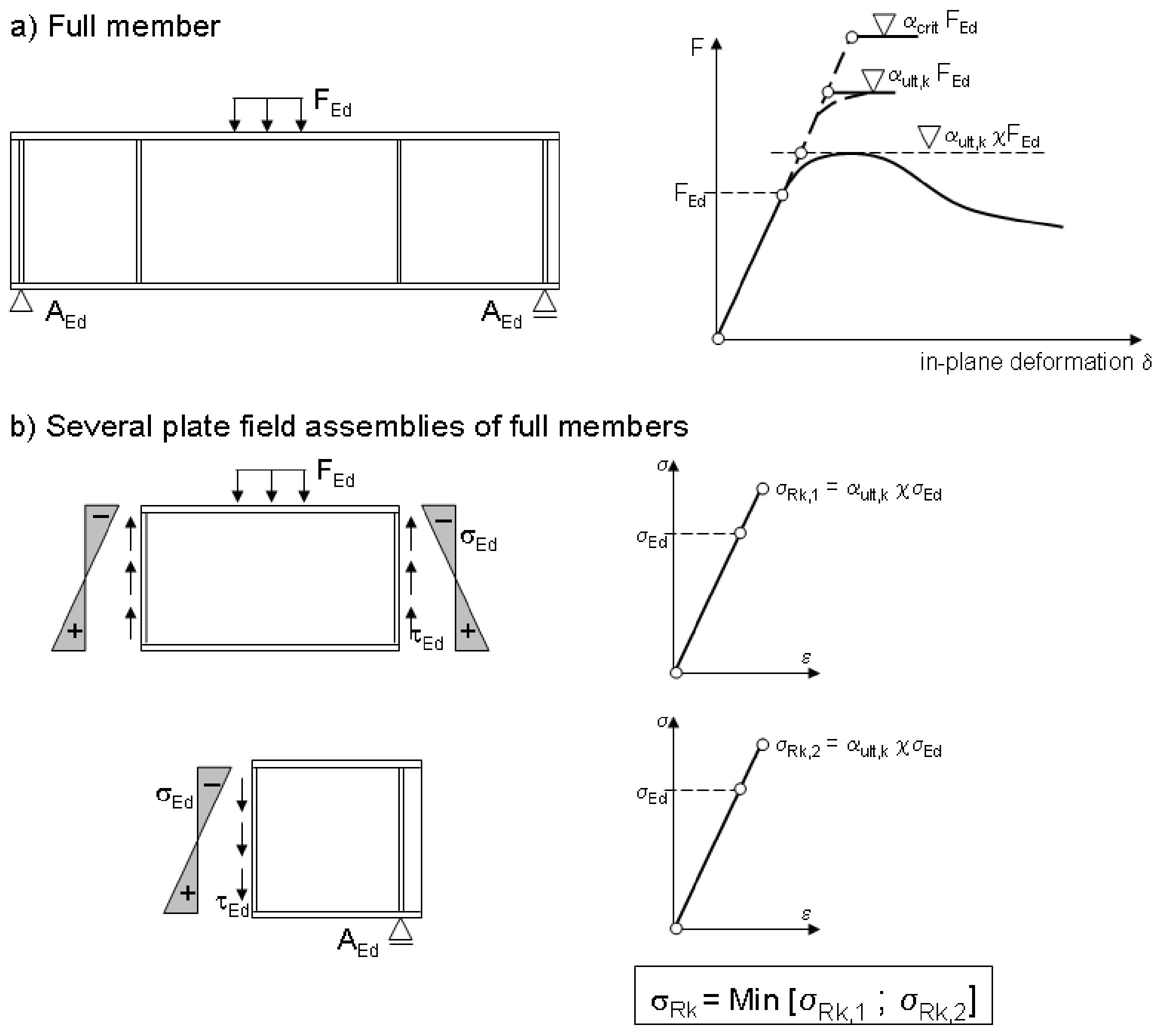
$$0.725 \times 1.69 = 1.11 > 1.10$$

General method

Verification of a full member or of various parts of a full member

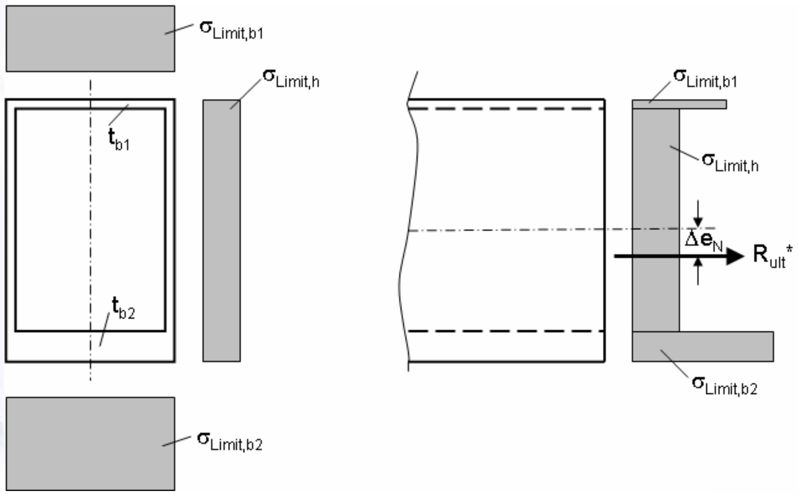
$$\bar{\lambda} = \sqrt{\frac{R_k}{R_{cr}}} = \sqrt{\frac{\alpha_{ult,k,Ed}}{\alpha_{cr,Ed}}} = \sqrt{\frac{\alpha_{ult,k}}{\alpha_{cr}}}$$

$$\chi = \chi(\bar{\lambda})$$

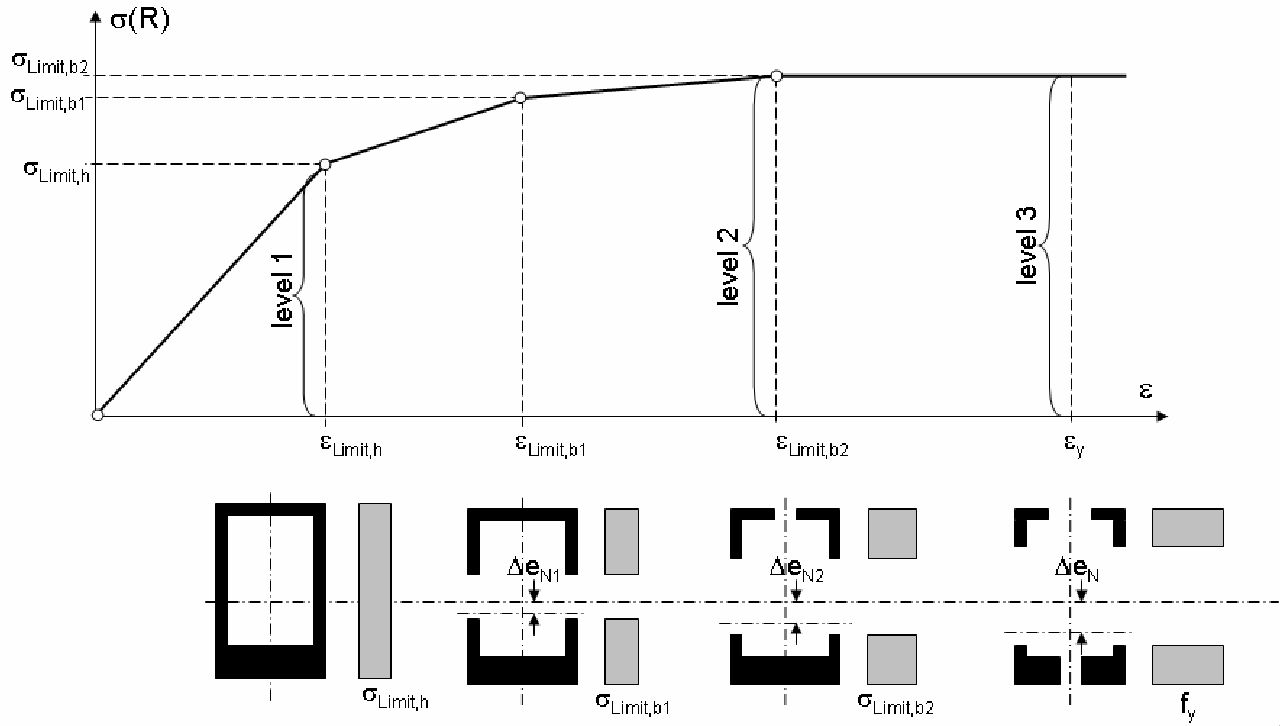


Singly symmetrical cross-section in compression

Stress limits

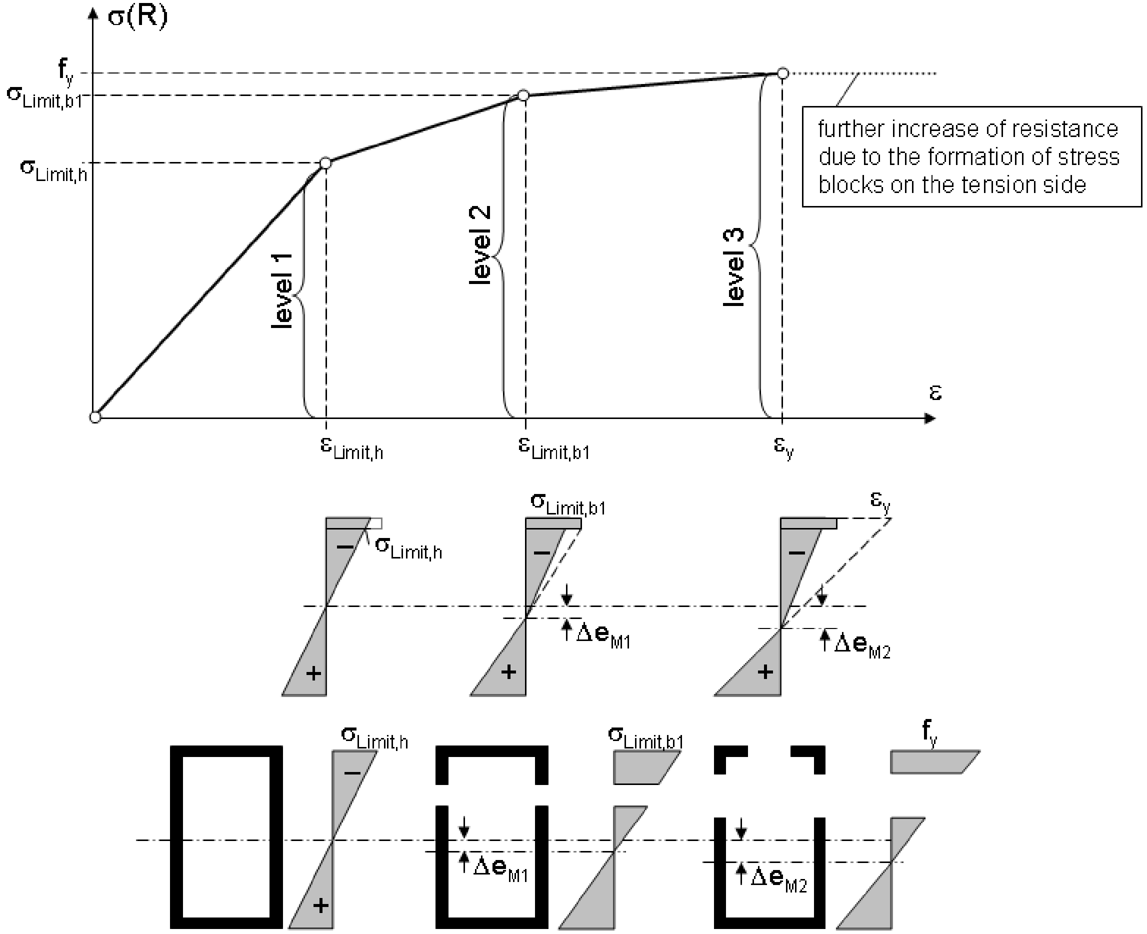


Effective widths

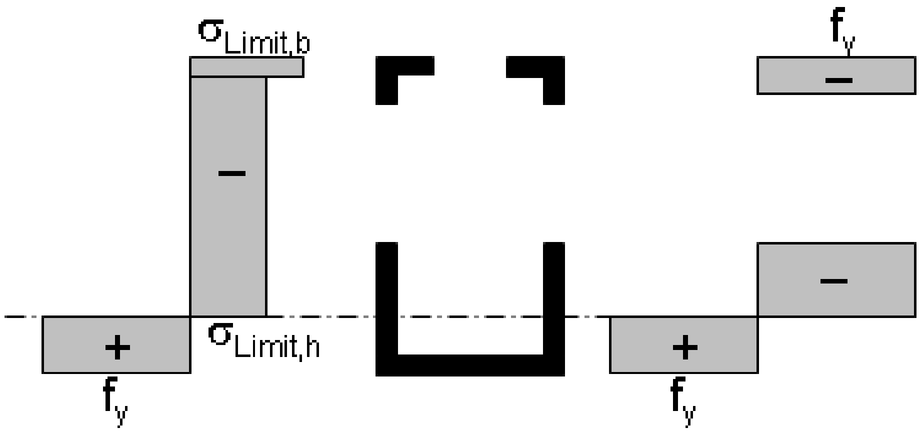


General method bending

Small compression strains

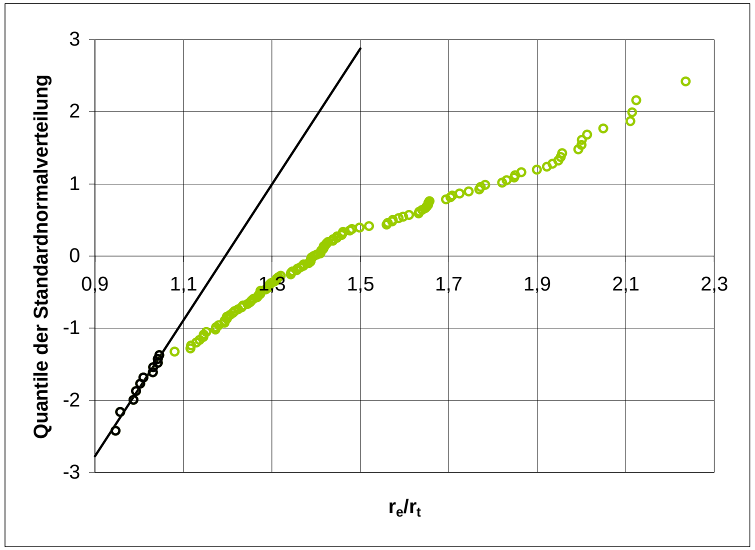
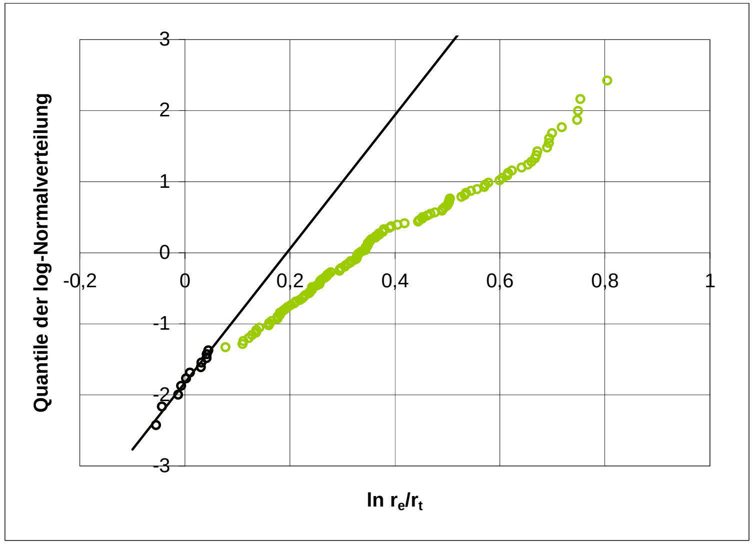


Large compression strains



Justification of general method

Safety evaluation for all tests on plated structures examined

<table>
<tr><td colspan="12">Input data</td></tr>
<tr><td colspan="12">$v_{rt} = 0,08$ (geometry und yield strength)
$v_{fy} = 0,07$ (yield strength)</td></tr>
<tr><td colspan="12">Results</td></tr>
<tr><td colspan="6">Standardnormal distribution</td><td colspan="6">log-normal distribution</td></tr>
<tr><td colspan="6">
</td><td colspan="6">
</td></tr>
<tr><td colspan="3">$\bar{b} = 1,195$</td><td colspan="3">$s_\delta = 0,106$</td><td colspan="3">$\bar{b} = 1,221$</td><td colspan="3">$s_\delta = 0,130$</td></tr>
<tr><td colspan="3">$v_\delta = 0,0888$ (model)</td><td colspan="3">$v_R = 0,1196$ (total)</td><td colspan="3">$v_\delta = 0,1065$ (model)</td><td colspan="3">$v_R = 0,1332$ (total)</td></tr>
<tr><td colspan="2">$\gamma_M = 1,263$</td><td colspan="2">$\Delta k = 0,890$</td><td colspan="2">$\gamma_M^* = 1,123$</td><td colspan="2">$\gamma_M = 1,204$</td><td colspan="2">$\Delta k = 0,890$</td><td colspan="2">$\boldsymbol{\gamma_M^* = 1,072}$</td></tr>
</table>

ECCS – New tasks – Responsibilities and activities

	Maintanance	Harmonisation	Promotion	Further development
Responsibilities				
Leading org. Support from	CEN / TC 250 JRC	Commission/JRC CEN / TC 250	Commission/JRC CEN / TC 250	CEN / TC 250 JRC
Activities				
Information	Member States Nat. Auth. / NSBs	Member States Nat. Auth. / NSBs	Member States Nat. Auth. / NSBs	Member States Nat. Auth. / NSBs
Realisation	CEN / TC 250	Commission/JRC	Commission/JRC	CEN / TC 250 Europ. Techn. Scient. Org.

Details of new tasks

CEN / TC 250 – Evolution Paper

1. **Envolvement in reaction to problems of use of ECs**
   ⇒ <u>Background informations</u> to National and CEN help desks
2. **Envolvement in mechanism for convergence of NDPs**
   ⇒ <u>Background informations</u> to JRC information platform
3. **Envolvement in promotion**
   ⇒ <u>Technical guidance, design aids, seminars, workshops</u>
4. **Envolvement in further developments:**
   ⇒ <u>starter drafts + background documents</u> for
   - extension of EN-Eurocodes to the assessment and refurbishment of existing buildings and engineering structures
   - new Eurocodes for new materials as glass and FRP
   - reduction of alternative methods by developing a unique European solution
   - unified testing procedures
   - rules for zinc coating
   - new materials for composite actions
   - pedestrian bridges

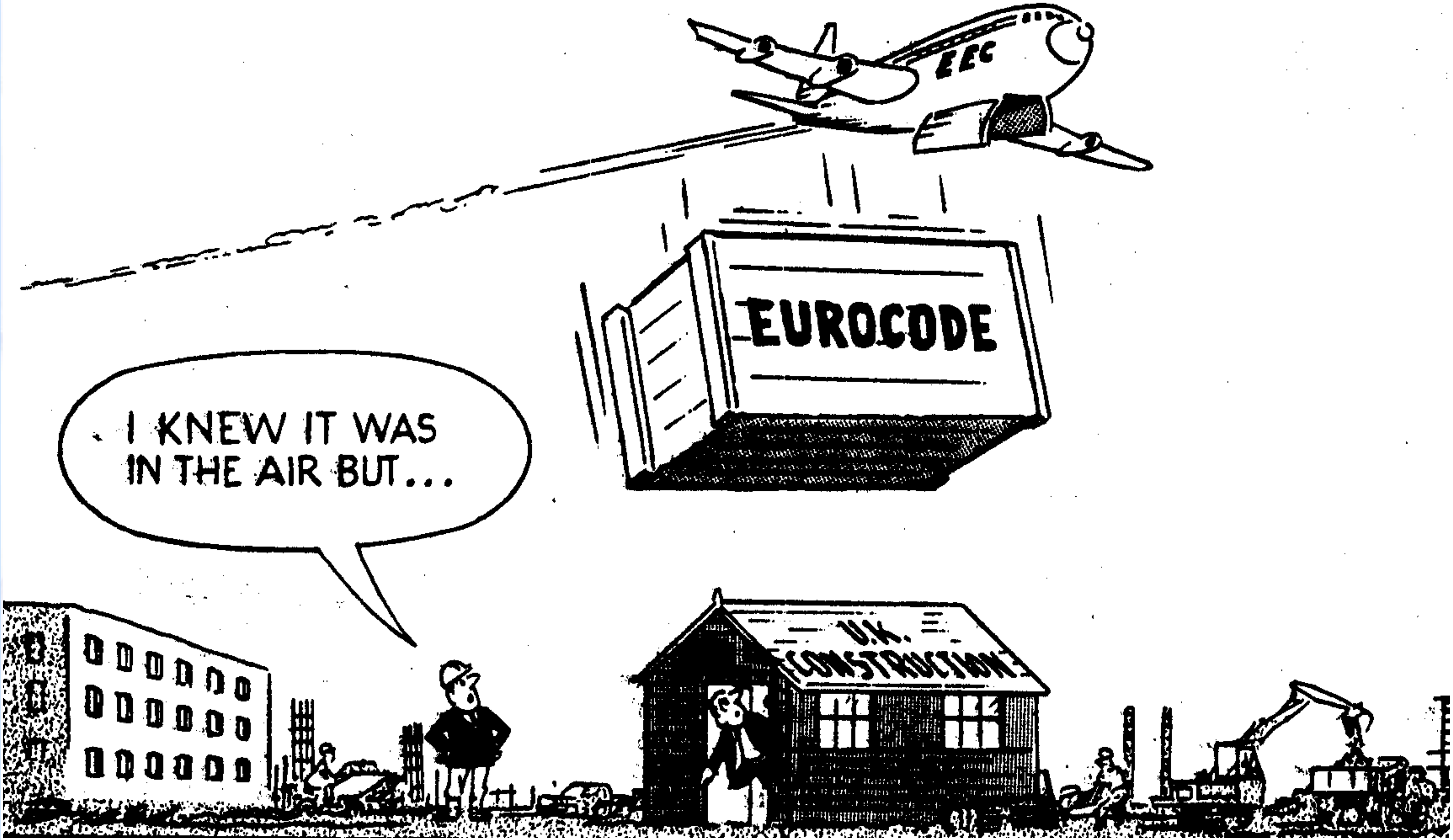
Hop dip galvanized structures

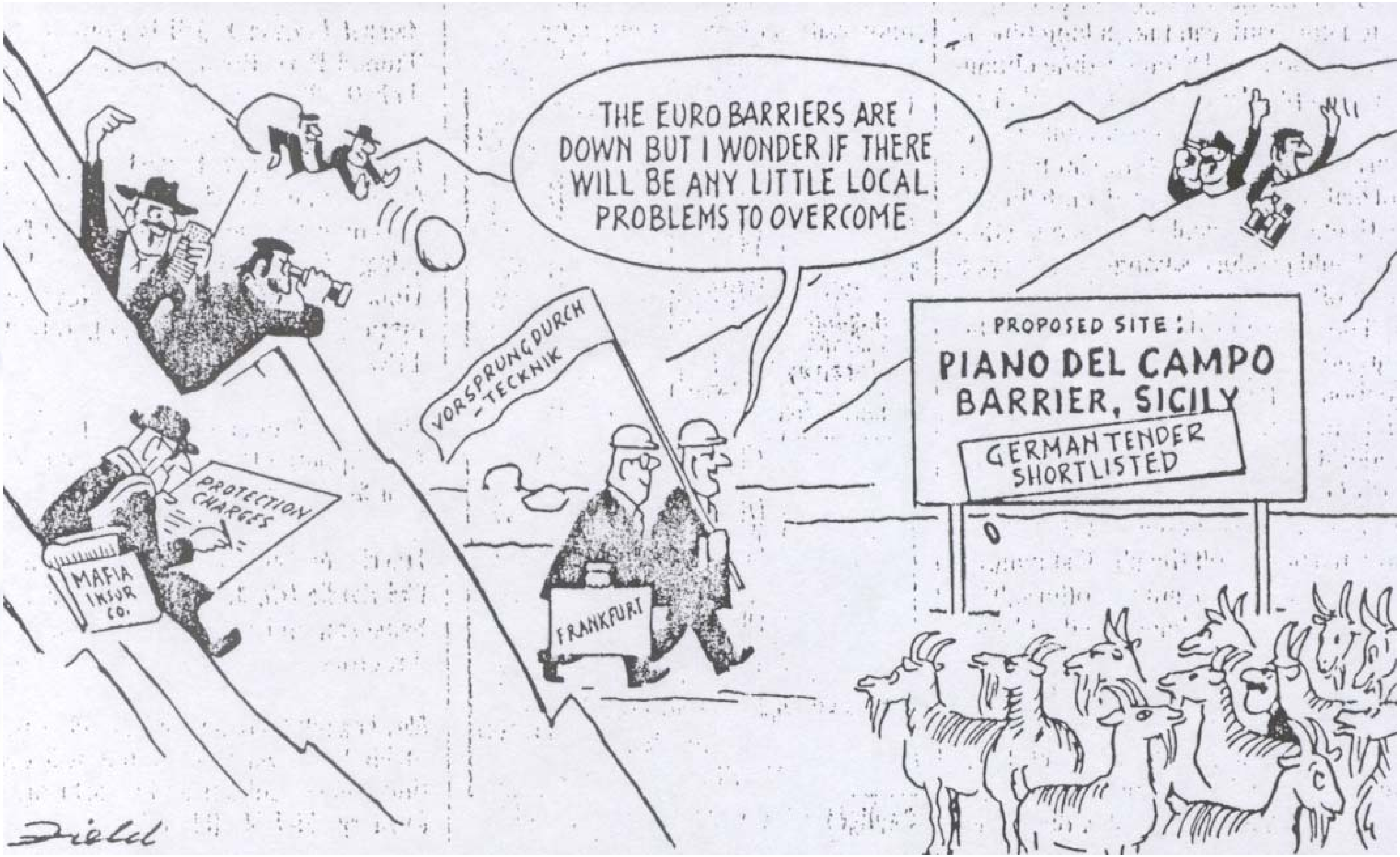
Modern glass structures

Tribunal de Grande Instance (TGI) de Bordeaux

Modern footbridges

Modern footbridges – Dynamic actions due to pedestrians


EEC
EUROCODE
I KNEW IT WAS IN THE AIR BUT...
U.K. CONSTRUCTION


THE EURO BARRIERS ARE DOWN BUT I WONDER IF THERE WILL BE ANY LITTLE LOCAL PROBLEMS TO OVERCOME
VORSPRUNG DURCH TECKNIK
FRANKFURT
PROTECTION CHARGES
MAFIA INSUR CO.
PROPOSED SITE:
PIANO DEL CAMPO BARRIER, SICILY
GERMAN TENDER SHORTLISTED