New generation of Eurocodes – with comparisons of selected NDPs

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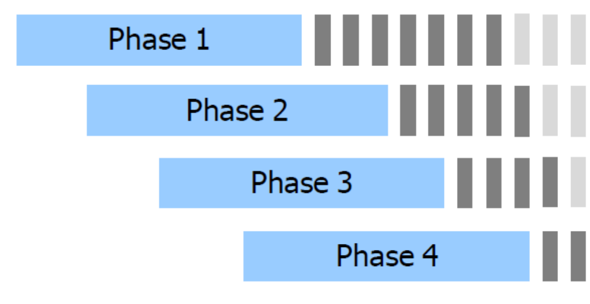
- Introduction
- EN 1990 Basis of design
- EN 1991 Actions
- Further development and expected changes



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Some difficulties with application of current generation of Eurocodes

- Greater climatic actions
- Greater partial factors
- Alternative design procedures
- Fatigue of structures, mostly of bridges
- Traffic load on bridges
- Assessment of existing structures
- Some operational procedures still missing (for actions, material properties, new materials)
- Ambiguous or unclear provisions

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Basic aims of evolution of Eurocodes

- **Harmonisation**
  - *Among Parts of Eurocodes* – to reduce the number of NDPs and enable better consensus on values adopted by MS
  - *With other European standards*

- **Simplification**
  - Removal of provisions with little practical sense
  - Better explanation
  - Simplification mainly for common types of buildings
  - Transfer of non operational provisions to backgrounds

- **Development of new provisions** for actions, for new materials (glass, FRP polymers), improvement of analytical models

- **Development of background materials**

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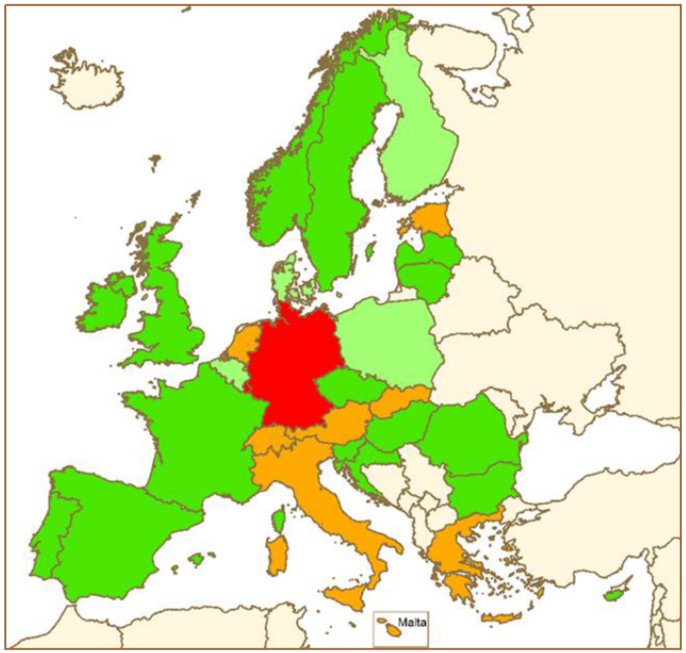
Database NDPs in JRC supporting further evolution of Eurocodes

CEN/TC 250 N 1864

NDPs database – uploading by country

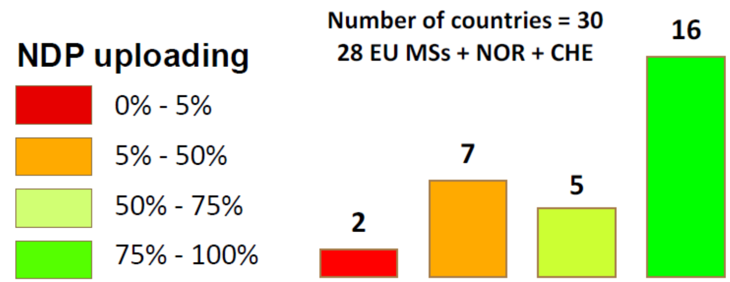


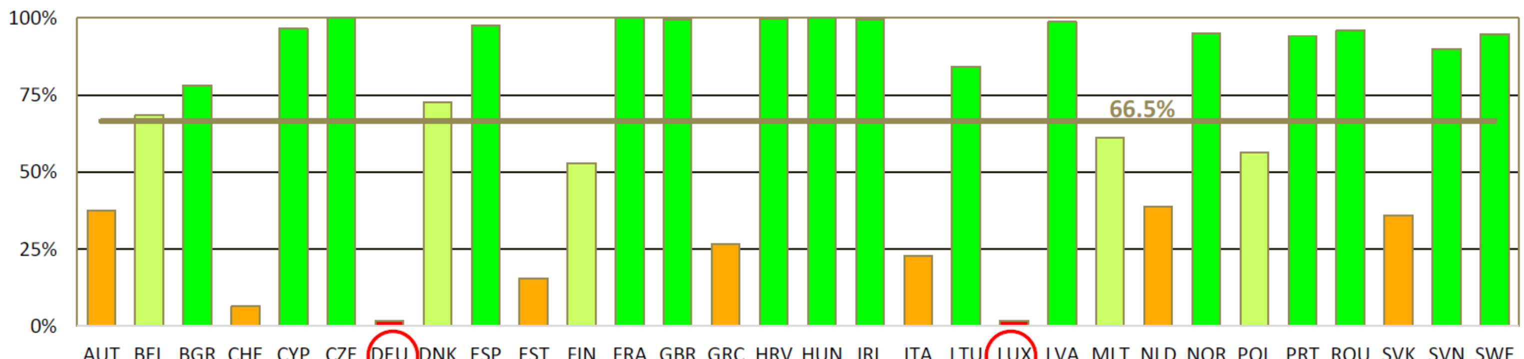
by 7 November 2017

NDPs uploaded: 25808 (66.5%)

16 countries with more than 75% NDPs uploaded

% calculated on published NAs





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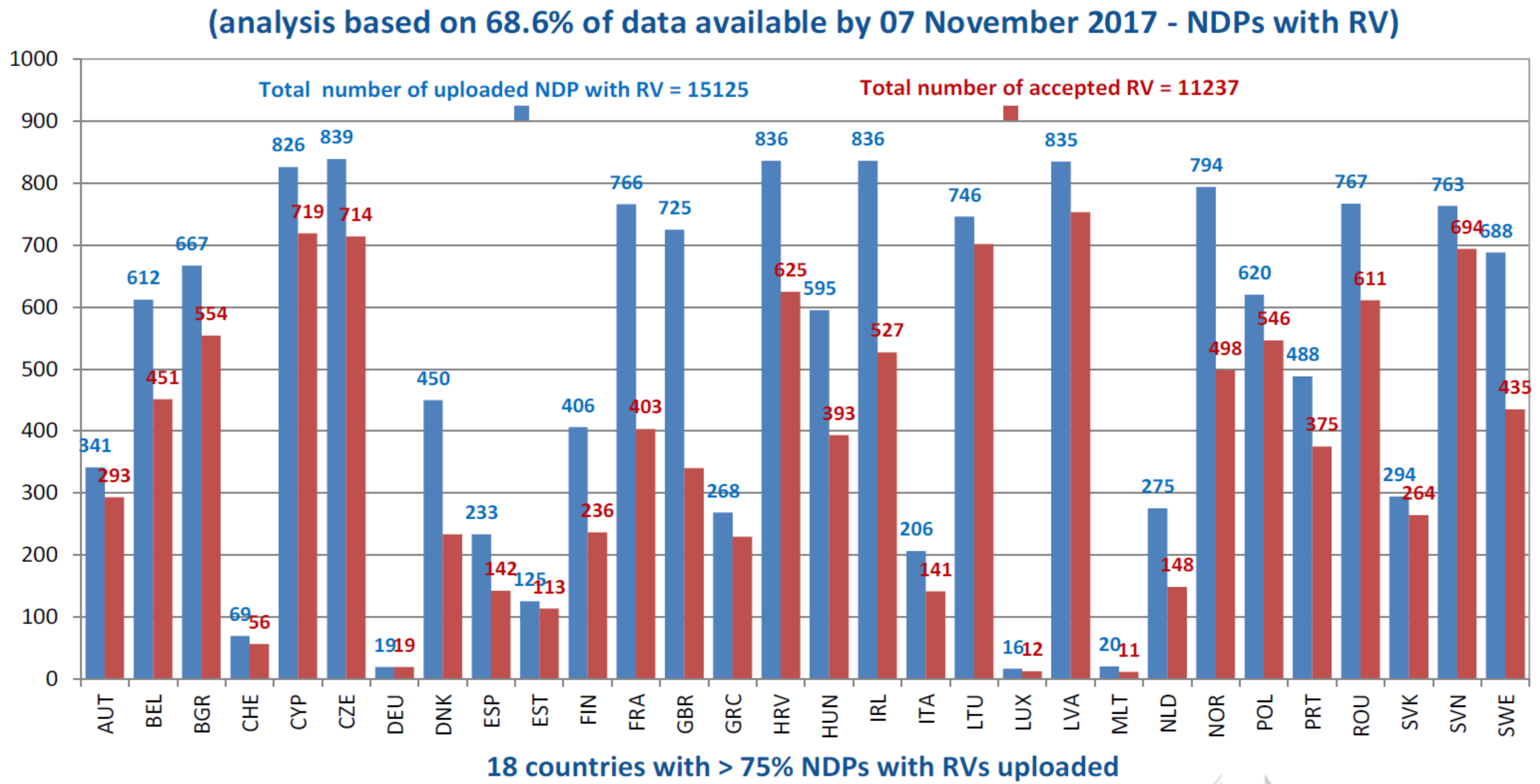
Number of accepted recommended values (RV) of NDPs in CEN countries



18 countries accepted more than 75 % RV NDPs

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Selection of basic load combination

MS	Type of combination	EN 1990 expression (6.10) – „a“	EN 1990 expression (6.10a) & (6.10b) „b“	Factor ξ	Partial factor γ_G	Partial factor γ_Q
CEN	a, b, c	x	x	0,85	1,35	1,5
BEL	a + b	x	x	RV	RV	RV
BGR	a	x		-	RV	RV
CYP	a	x		-	RV	RV
CZE	a + b	x	x	RV	RV	RV
DNK	c		x	1	1,2/1	RV
FIN	c		x	1	1,2/1,0 K_{FI}	1,5 K_{FI}
FRA	a	x		-	RV	RV
GBR	a + b	x	x	0,925	RV	RV
HRV	a	x		-	1,1/1,35	RV
HUN	a + b	x	x	RV	RV	RV
IRL	a + b	x	x	RV	RV	RV
LUX	a + b	x	x	RV	RV	RV
LVA	a + b	x	x	RV	RV	RV
PRT	a	x		-	RV	RV
SVN	a	x		-	RV	RV
SWE	b		x	0,89	RV	RV

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Uniform imposed load q_k

MS	Category of imposed loads								
	A	B	C1	C2	C3	C4	C5	D1	D2
CEN	1,5 – 2	2 – 3	2 – 3	3 – 4	3 – 5	4,5 – 5	5 – 7,5	4 – 5	4 – 5
BEL	RV	RV	RV	RV	RV	RV	RV	5	RV
BGR	RV	RV	RV	RV	RV	RV	7,5	RV	RV
CYP	RV	RV	RV	RV	RV	RV	RV	5	RV
CZE	1,5	2,5	RV	RV	RV	RV	RV	5	RV
DNK	1,5	2,5	2,5	RV	RV	RV	RV	RV	RV
FIN	RV	2,5	2,5	3	4	RV	6	RV	RV
FRA	1,5	2,5	2,5	RV	4	RV	RV	5	RV
GBR	1,5-2,5	2,5/RV	2-RV	3/RV	3-7,5	RV	RV/7,5	RV	4
HRV	1,5/RV	2/RV	RV	RV	RV	RV	RV	2	RV
HUN	RV	RV	RV	RV	RV	RV	RV	RV	RV
IRL	1,5/RV	RV	RV	RV	RV	RV	RV	RV	RV
LTU	1,5	2	RV	RV	RV	RV	RV	RV	RV
LUX	RV	RV	RV	RV	RV	RV	RV	5	RV
LVA	RV	2,5	2,5	3	4	RV	6,0	RV	RV
NLD	1,75	2,5	4	RV	RV	RV	RV	RV	4
NOR	RV	RV	RV	RV	RV	RV	RV	5	RV
PRT	RV	RV	RV	RV	RV	RV	6,0	RV	RV
SVK	RV	RV	RV	RV	RV	RV	RV	RV	RV
SVN	RV	RV	RV	RV	RV	RV	RV	RV	RV
SWE	RV	2,5	2,5	2,5	3	4,0	RV	RV	RV

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Reliability analysis of steel tie (β) – cat. A

χ and β	χ_{min}	β_{min}	$\beta_{/\chi=0,3}$	$\beta_{\|\chi=0,4}$	χ_{max}	β_{max}
CEN	0,7	3,8	4,7	4,3	0,25	5,7
BEL	0,7	3,8/3,7	4,7/4	4,3/3,8	0,25/0,2	5,7/4,1
BGR	0,7	4	5	4,7	0,25	5,2
CYP	0,7	3,8	4,7	4,3	0,25	5,7
CZE	0,7	3,6/3,5	4,5/3,8	4,3/3,8	0,25/0,2	4,7/4
DNK	0,1	2,9	3,8	4,1	0,4	4,1
FIN	0,1	3,2	4	4	0,35	4,1
FRA	0,7	3,6	4,5	4,3	0,25	4,7
GBR	0,7	3,8/3,7	4,7/4,4	4,6/4,3	0,25/0,2	4,8/4,7
HRV	0	2,8	4	3,9	0,3	4
HUN	0,7	3,8/3,7	4,7/4	4,3/3,8	0,25/0,2	5,7/4,1
IRL	0,7	3,8/3,7	4,7/4	4,3/3,8	0,25/0,2	5,7/4,1
LTU	0,7	3,2/3	4,3/3,6	4/3,5	0,2/0,1	4,3/3,8
LUX	0,7	3,8/3,7	4,7/4	4,3/3,8	0,25/0,2	5,7/4,1
LVA	0,7	3,8/3,7	4,7/4	4,3/3,8	0,25/0,2	5,7/4,1
NLD	0,7	3,5	4,5	4,4	0,3	4,5
NOR	0,7	3,8	4,3	4,2	0,3	4,3
PRT	0,7	3,8	4,7	4,3	0,25	5,7
SVK	0,7	3,8	4,7	4,3	0,25	5,7
SVN	0,7	3,8	4,7	4,3	0,25	5,7
SWE	0,7	3,8	4,3	4,2	0,3	4,3

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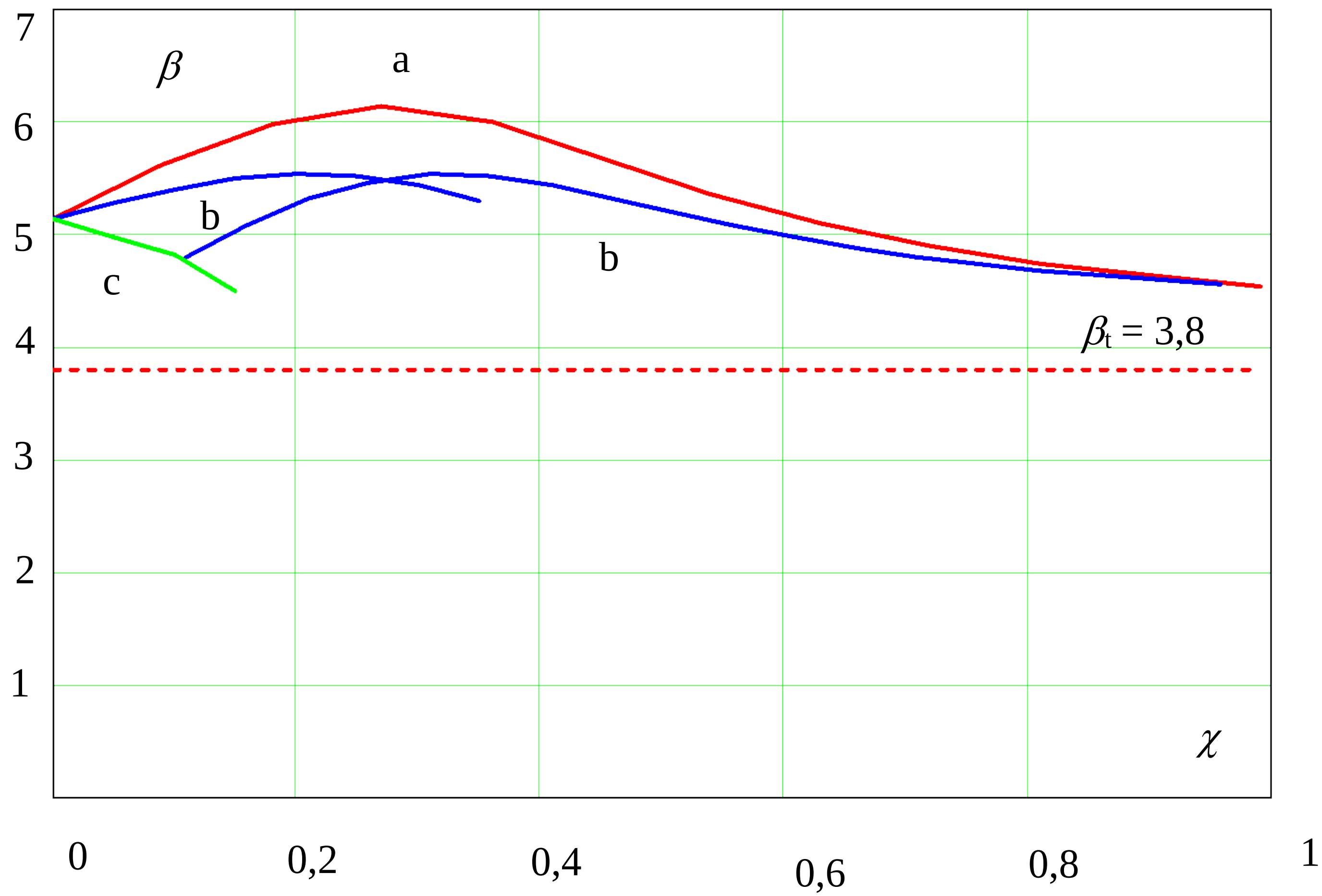
Reliability analysis of reinforced slab



Reliability index β of reinforced slab for load ratio χ (characteristic value of imposed load to total loads), category B according to EN 1991-1-1, selected upper bound of the interval of imposed loads

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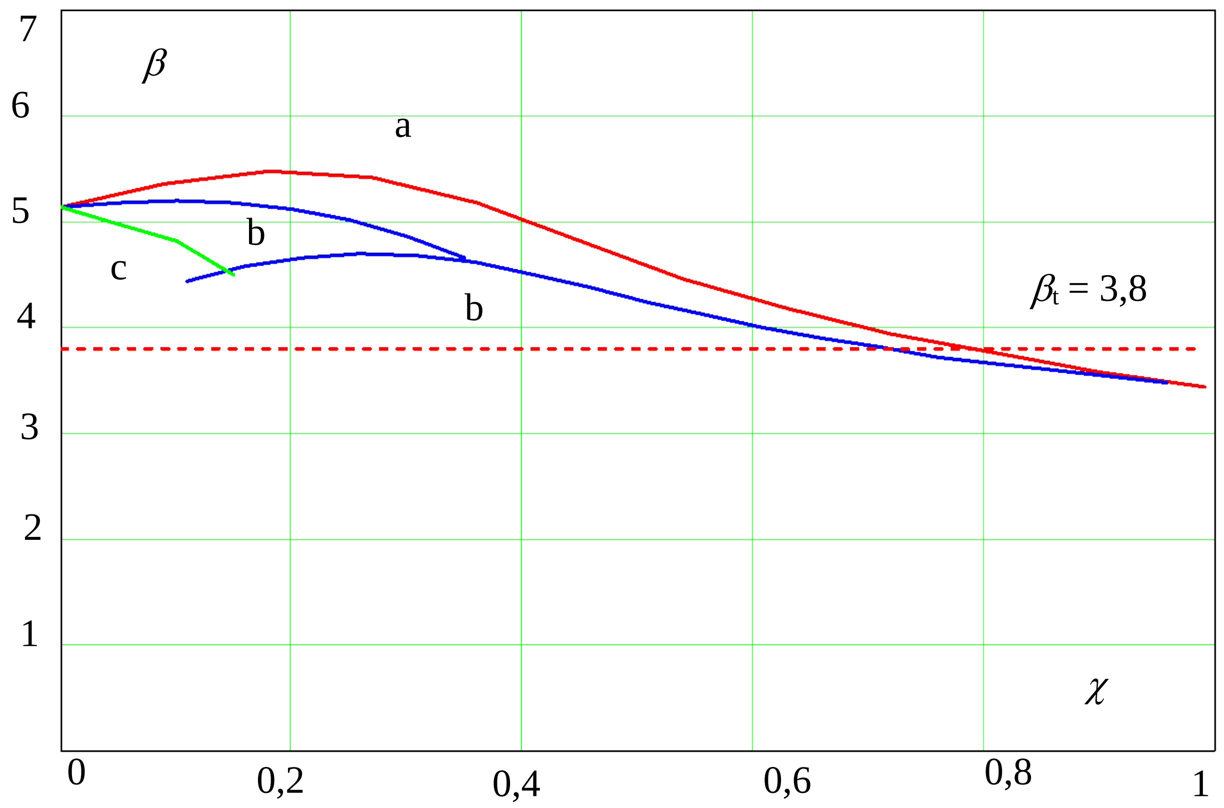
Reliability analysis of reinforced slab



Reliability index β of reinforced slab for load ratio χ,
selected lower bound of the interval of imposed loads

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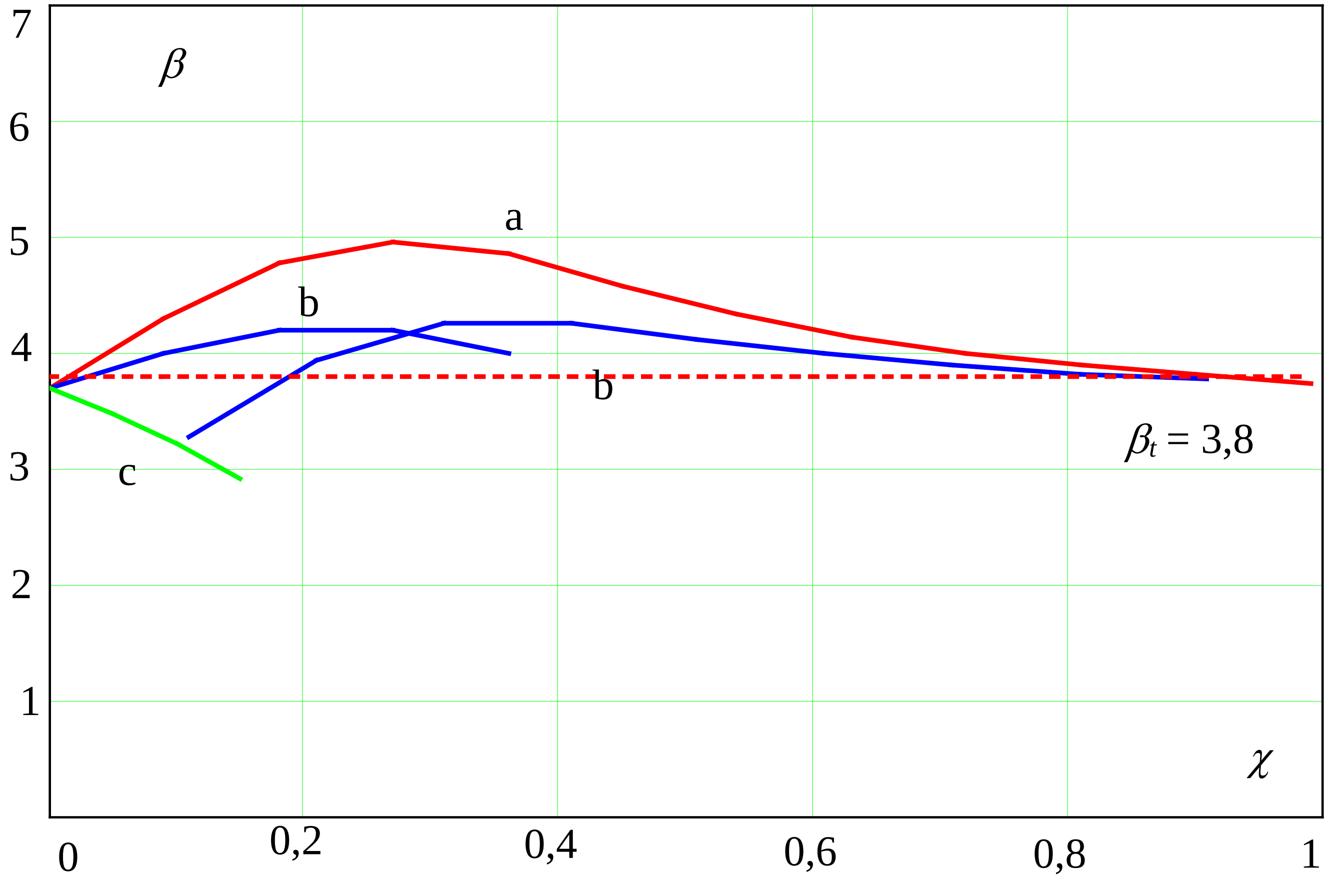
Reliability analysis of steel tie



Reliability index β of steel tie for ratio χ,

selected upper bound of the interval of imposed loads

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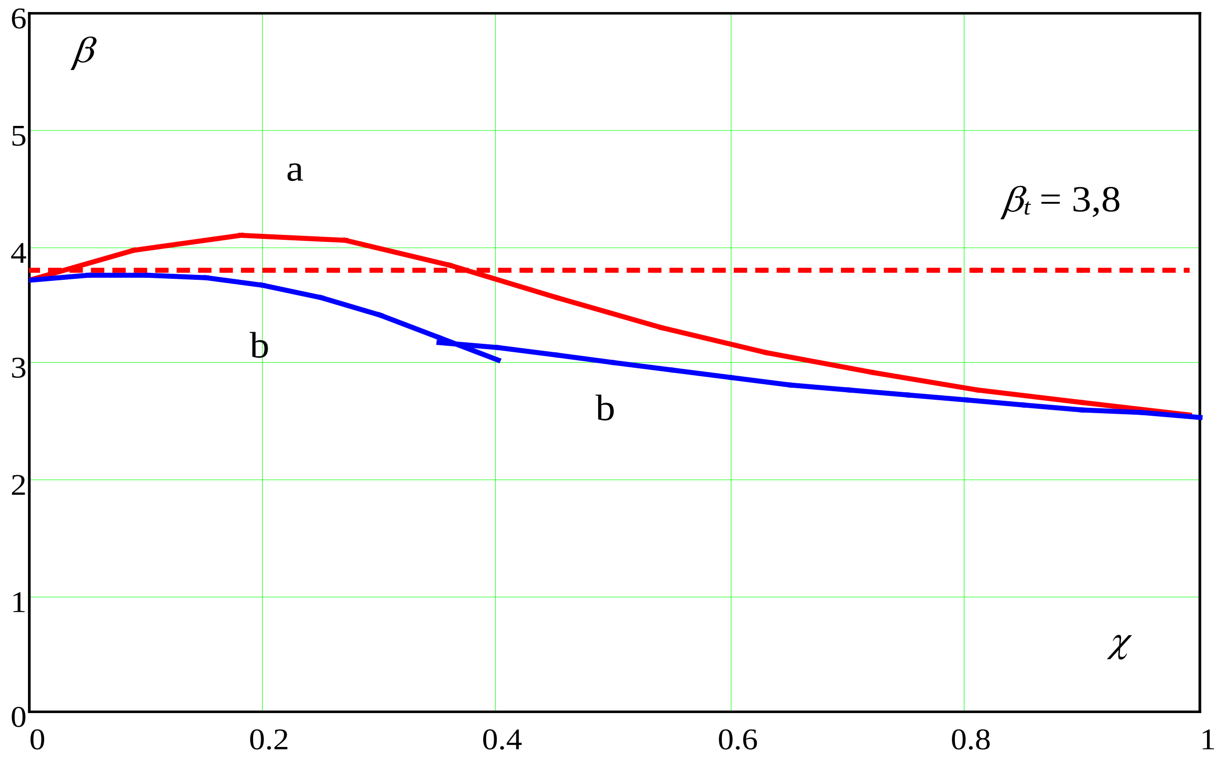
Reliability analysis of steel tie



Reliability index β of reinforced slab for ratio χ,
selected lower bound of the interval of imposed loads

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Presently available NDPs in JRC database of selected Balkan countries

EC/MS	BGR	GRC	HRV	ROU	SRB	SVN
EC0	exp	exp	46	n.a.	26	46
EC1	245	exp	348	n.a.	76	243
EC2	214	195	221	n.a.	177	219
EC3	405	exp	430	n.a.	91	431
EC4	52	exp	52	n.a.	46	52
EC5	33	exp	33	n.a.	30	33
EC6	58	exp	58	n.a.	exp	n.a.
EC7	4	55	55	n.a.	exp	55
EC8	59	142	140	n.a.	12	141
EC9	66	exp	89	n.a.	75	90

n.a. – not available

exp – expected to be uploaded

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Available NDPs for EN 1990 in JRC database

- Combination factors ψ: RV accepted by SVN and HRV (not accepted by RO)
- Fundamental load combination for ULS (6.10) – BLG, HRV, RO, SVN
- Load partial factors - RV accepted by SVN (not accepted by HRV)
- Geotechnical approaches – HRV selected approach 2 and 3, SVN approach 1

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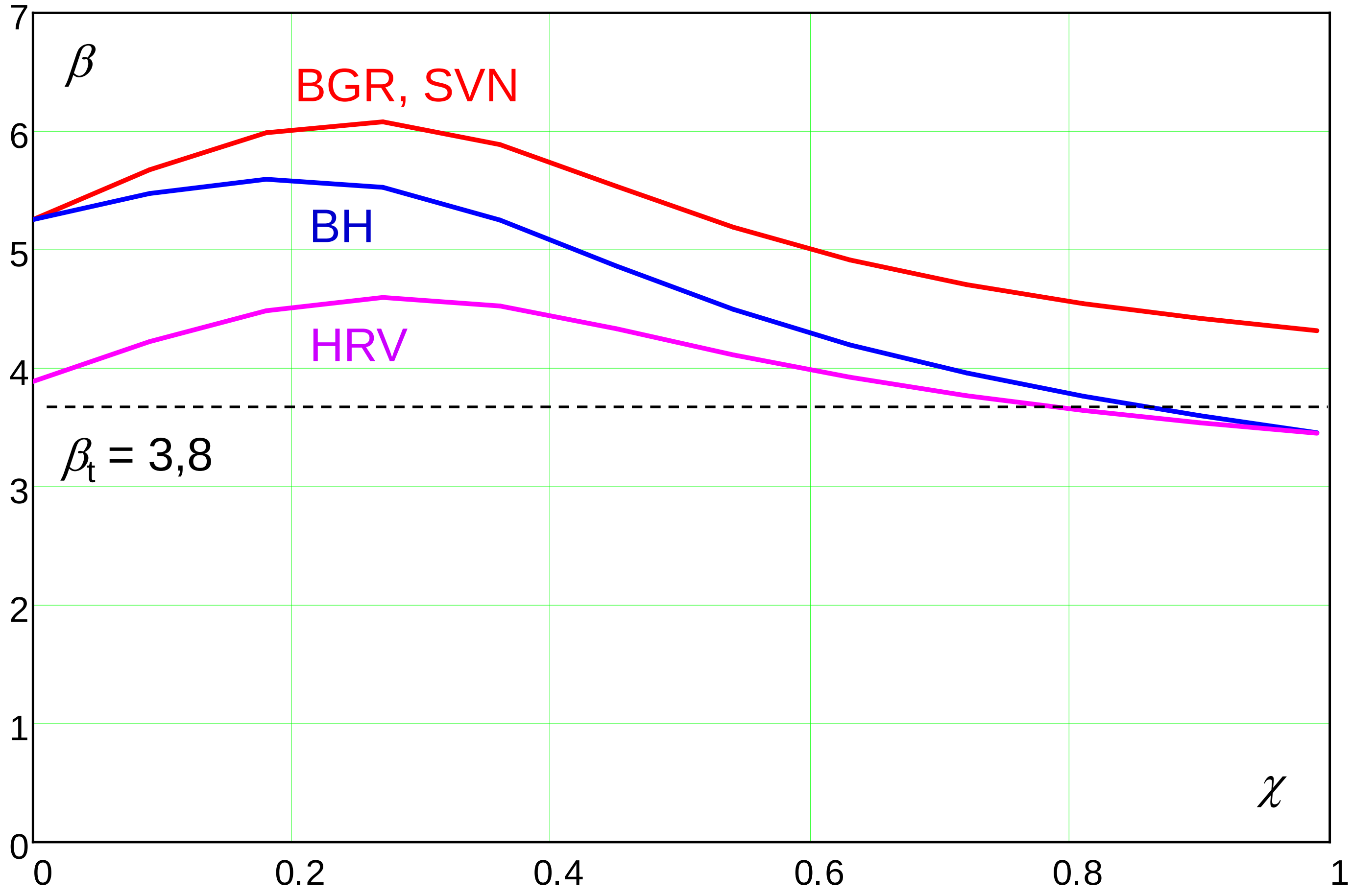
Reliability analysis of reinforced concrete beam of selected countries



Reliability index β of reinforced concrete beam versus load ratio χ for NDPs of Bosnia and Herzegovina, Bulgaria, Slovenia and Croatia.

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Development of EN 1990 for basis of structural design

SC10 – Paolo Formichi (It), SC10.T1 and T2

PT 1 convenor - Pierre Spehl (Be)
PT 2 convenor - Mungo Stacy (UK)

To final draft of prEN 1990 was sent 1124 comments of CEN MS.

Country	Number of comments	Country	Number of comments
Great Britain	261	Ireland	38
Germany	232	France	31
Denmark	104	Italy	31
Norway	80	Switzerland	27
Finland	63	Czech Republic	23
Netherlands	61	Belgium	15
Sweden	52	Spain	13
Portugal	49	Roumania	2
Austria	42	**TOTAL**	**1124**

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EN 1990 Basis of design

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Consequences of failure

Consequence class	Description of consequence	Loss of human life	Economic, social or environmental consequences
CC4	Highest	Extreme	Huge
CC3	Higher	High	Very great
CC2	Normal	Medium	Considerable
CC1	Lower	Low	Small
CC0	Lowest	Very low	Insignificant
CC1-CC3 can be devided into upper and lower sub-classes in some other Eurocodes.			

Recomended values of the reliability index are not given for the consequence classes CC.

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Methods for structural design and verifications in Eurocodes

- Partial factor method is the basic method.

- Alternativelly the probabilistic methods or methods of risk engineering can be applied (ISO 2394, PMC JCSS).

- For verification of existing structures commonly supplementary provisions are needed.

- Final version of technical specifications (TS) are presently available for the assessment of existing structures.

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Load combination for verification of Ultimate Limit Sstates (ULS)

$$\sum F_d = \sum_i G_{d,i} + \sum_j Q_{d,j} + (P_d) + (A_d \; or \; A_{Ed,ULS}) \qquad (9.27)$$

$G_{d,i}$ represents the design value of a permanent action;

$Q_{d,j}$ represents the design value of a variable action;

P_d represents the design value of any pre-stress applied to the structure, if present;

A_d represents the design value of an accidental action, if present;

$A_{Ed,ULS}$ represents the design values of a seismic action, if present;

Σ denotes the combination of the enclosed variables;

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Combination for ULS

- Permanent and transient design situation

main and accompanying variable actions

(A) $$\sum_{j\geq 1}\gamma_{Gj}G_{kj} + \gamma_P P_k + \gamma_{Q1}Q_{k1} + \sum_{i>1}\gamma_{Qi}\psi_{0i}Q_{ki} \qquad (9.28)$$

(B) • or $$\sum_{j\geq 1}\gamma_{Gj}G_{kj} + \gamma_P P_k + \sum_{i\geq 1}\gamma_{Qi}\psi_{0i}Q_{ki} \qquad (9.29a)$$

$$\sum_{j\geq 1}\xi_j\gamma_{Gj}G_{kj} + \gamma_P P_k + \gamma_{Q1}Q_{k1} + \sum_{i>1}\gamma_{Qi}\psi_{0i}Q_{ki} \qquad (9.29b)$$

(C) • or $$\sum_{j\geq 1}\gamma_{Gj}G_{kj} + \gamma_P P_k \qquad (9.30a)$$

$$\sum_{j\geq 1}\xi_j\gamma_{Gj}G_{kj} + \gamma_P P_k + \gamma_{Q1}Q_{k1} + \sum_{i>1}\gamma_{Qi}\psi_{0i}Q_{ki} \qquad (9.30b)$$

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Combination for accidental and seismic design situations

- Accidental design situation

$$\sum_{j\geq 1} G_{kj} + P_k + A_d + (\psi_{11}\ or\ \psi_{21})Q_{k1} + \sum_{i>1} \psi_{2i} Q_{ki} \quad (9.31b)$$

- Seismic design situation

$$\sum_{j\geq 1} G_{kj} + P_k + A_{Ed} + \sum_{i\geq 1} \psi_{2i} Q_{ki} \quad (9.32b)$$

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Partial factors for buildings – Annex A1

Action or action effect				Partial factors γ_F for design cases DC1 to DC4				
Type	Group	Symbol	Effect	DC1	DC2		DC3	DC4
				all	EQU		GEO	
Permanent action G_k	All actions (excl. water)	γ_G	Unfav.	1,35 K_F	1,35ρK_F	1	1	-
	Water pressure	$\gamma_{G,W}$		1,2 K_F	1,2ρK_F	1	1	
	All actions	γ_G	Favour.	1	1	1	1	
Variable action Q_k	All actions (excl. water)	γ_Q	Unfav.	1,5 K_F	1,5K_F	1,5K_F	1,3	1,1
	Water pressure	$\gamma_{Q,W}$		1,2 K_F	1,2K_F	1,2K_F	1,0	1,0
	All	$\gamma_{Q,\mathrm{fav}}$	Favour.	0				
Load effects E		γ_E	Unfav.	Not used				1,35 K_F
		$\gamma_{E,\mathrm{fav}}$	Fav.					1

coefficient $\rho = 0,85$

Consequence class CC	Description	Coefficient K_F
CC3	High	1,1
CC2	Moderate	1,0
CC1	Low	0,9

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Target reliability in ULS

Current state - EN 1990

Reliability class	Minimum values β	
	1 year reference period	50 years reference period
RC3	5,2	4,3
RC2	4,7	3,8
RC1	4,2	3,3

prEN 1990 – reference period one year

Reliability indices	Consequence class CC		
	CC1	CC2	CC3
$P_{f,a}^{tgt}$	10^{-5}	10^{-6}	10^{-7}
β_a^{tgt}	4,26	4,75	5,20

Currently not recommended indices for serviceability limit states.

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Newly introduced serviceability criteria

Recommended values of vertical deflections

Combination of actions	Characteristic (without damage of secondary elements)
Not accessible roofs	<u>Roofing</u> - rigid $w_2 + w_3 \leq L/250$ - resilient $w_2 + w_3 \leq L/125$ <u>Ceiling</u> - plastered $w_2 + w_3 \leq L/350$ - false ceiling $w_2 + w_3 \leq L/250$ 
Floors, accessible roof	<u>Not reinforced partition walls</u>: - brittle material $w_2 + w_3 \leq L/500$ - non-brittle material $w_{max} \leq L/400$ Reinforced walls: $w_2 + w_3 \leq L/350$ Removable walls $w_2 + w_3 \leq L/250$ <u>Flooring:</u> - tiles rigidly fixed $w_2 + w_3 \leq L/500$ - small tiles $\leq$ 0,1 m, or deflection not fully transmitted, $w_2 + w_3 \leq L/250$ - resilient flooring $w_2 + w_3 \leq L/250$ <u>Ceiling</u> - plastered $w_2 + w_3 \leq L/350$ - false ceiling $w_2 + w_3 \leq L/250$

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Indicative critical values of natural vertical vibration frequencies for buildings

Structures	Critical values
Hospitals, laboratories	10Hz
Gymnasia and sport halls	8 Hz
Dance rooms, concert halls without permanent seating	7 Hz
Concert halls with permanent seating Floors, staircases and balconies in general	5 Hz

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Annex B – Management measures to achieve the intended structural reliability

Management measures should cover

- competence of designers
- design checking
- execution quality
- inspection during execution

to ensure adequatelly that a structure designed or executed according to Eurocodes achieves the intended level of structural reliability.

Structural class	Level of difficulty	Characteristics
SC 3	Structures with high level of difficulty	• Complex statically indeterminate structures • Structures with non-trivial load scenarios and action effects • Highly complex structural systems requiring e.g. non-linear calculations or dynamic effects to be considered • Complex structures requiring new design techniques or design assisted by testing • Prestressed and post tensioned structures • Difficult stability considerations required
SC 2	Structures with medium level of difficulty	• Difficult statically determinate or statically indeterminate regular structures built with common construction techniques
SC 1	Structures with low level of difficulty	• Simple statically determinate structures built with common construction techniques.

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Levels of design checking

DCL1 to DCL3

Design check level	Charakteristics	Minimum design checking
DCL3	Independent extended	To be defined on national level
DCL2	Independent normal	
DCL1	Self-checking	

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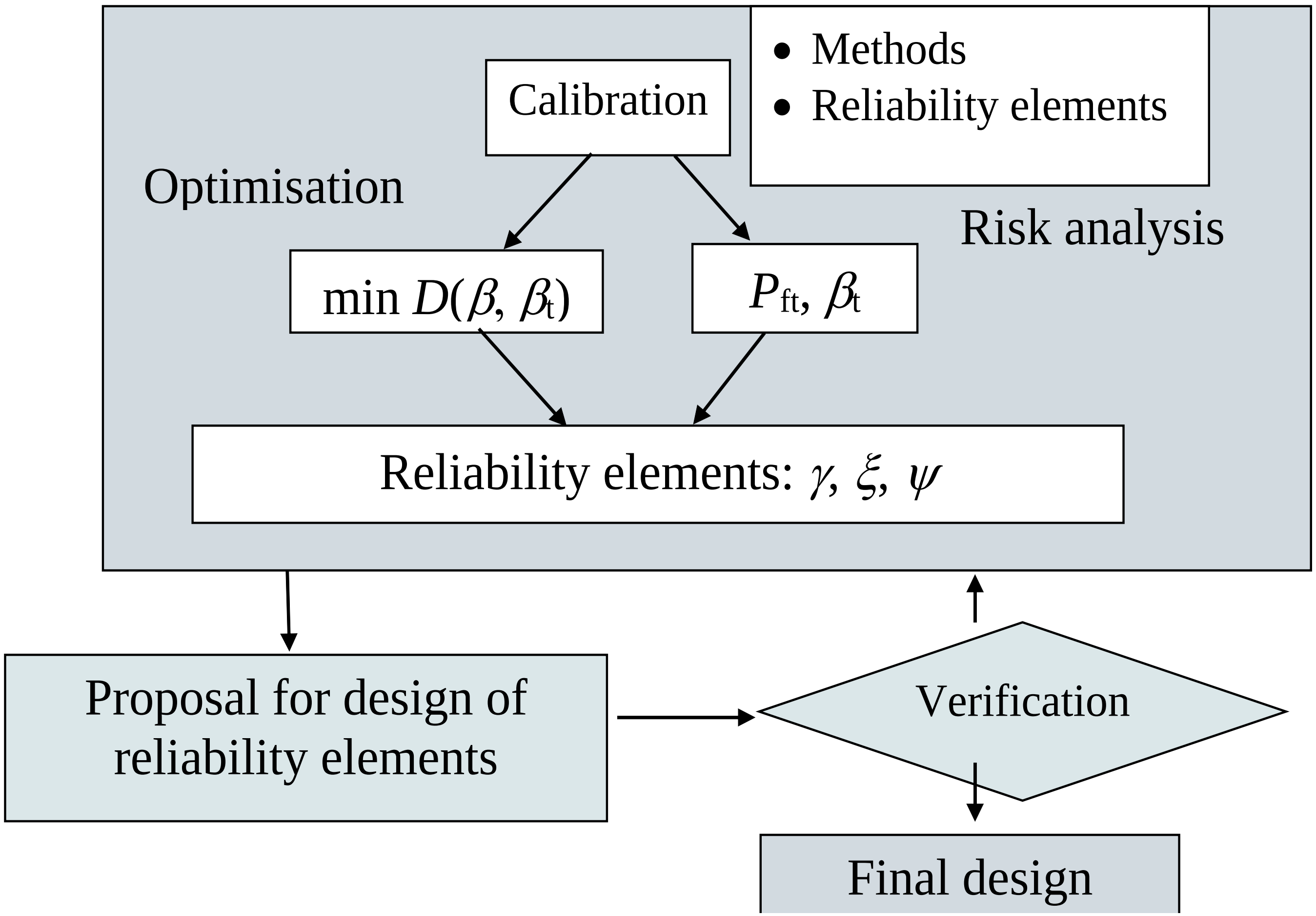
Annex C – Calibration of reliability elements



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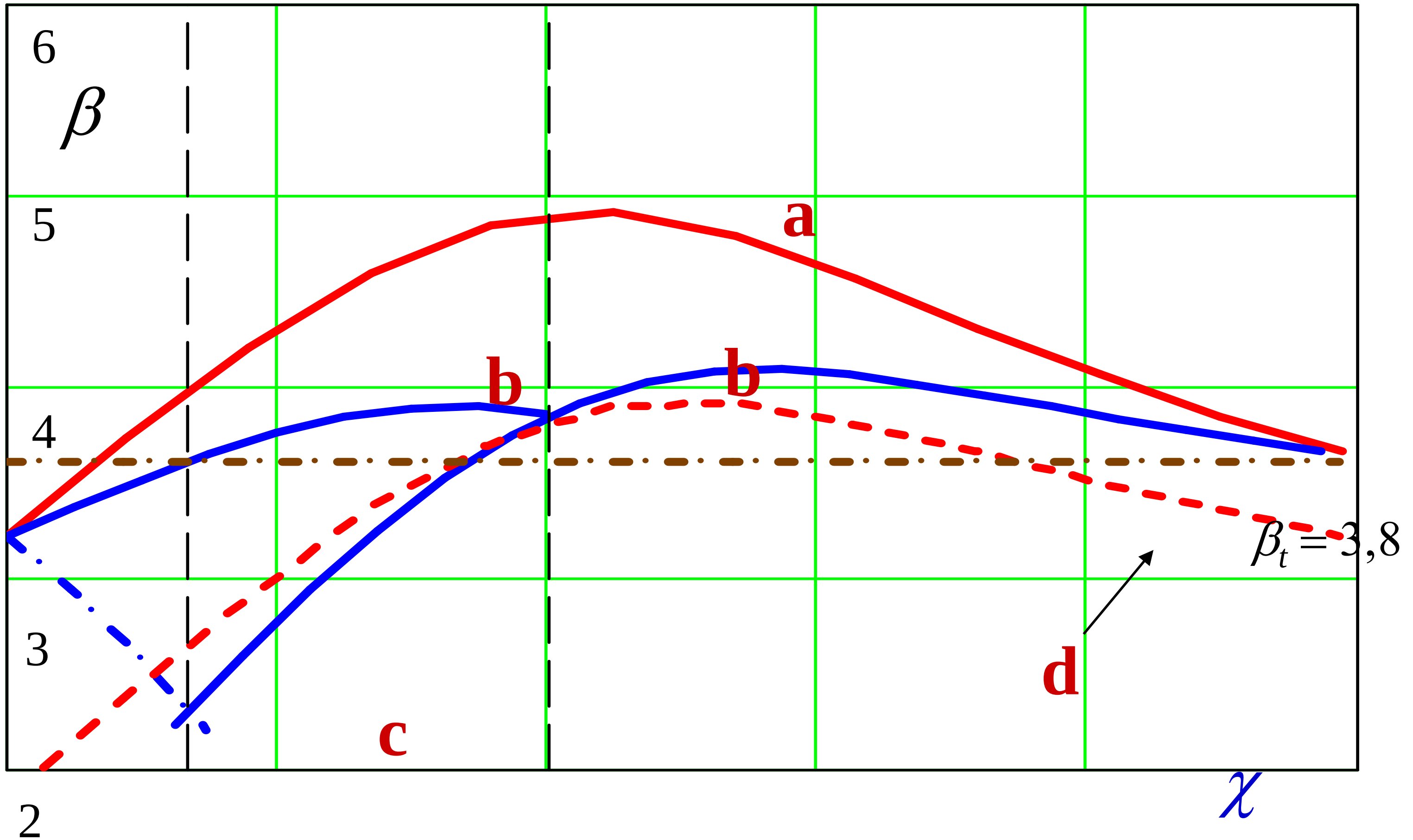
Reliability analysis of concrete member



A to C – combinations according to EN 1990 (γ_G = 1,35, γ_Q = 1,5), D is combination A with decreased factors γ_G =1,2, γ_Q =1,4, where $\chi = Q_k/(G_k+Q_k)$ (D was combination D in NAD to ČSN ENV 1991-1).

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Structural robustness

- Structure should be designed to have adequate level of robustness therefore not to collapse during its design working life by adverse events (e.g. failure, collapse) in the extent non adequate to original cause.
- Responsability of designer on robustness level has been broadly discussed.

Recent sudden failure of Prague pedestrin bridge connecting Prague zoo with Stromovka park which despite of continuous monitoring suddenly felt down.

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EN 1990, A.2 for bridges

- Basis of load combinations
- Bridge bearings and expansion joints
- Requirements on robustness of bridges
- Combinations of actions
- Categorisation of bridges
- Bridges for road/railway traffic
- Fatigue and vibrations

Consequence class	**Description of consequence**	**Examples**
CC3a	Higher, where an increased level of reliability is required	When specified by the relevant authority or agreed for a specific project by the relevant parties
CC3b	Higher	Railway bridges, bridges over or under railways or major roads.
CC2	Normal	Medium-span bridges
CC1	Lower	Short-span structures such as culverts, short river crossings

EN 1990, A.3, A.4, A.5

Towers and masts, silos and tanks, cranes

Establisment of 3 Adhoc groups under CEN/TC 250 - coordination works, achievement of consistency across all Eurocodes, supplementary load combinations, verification of specification of consequence classes

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Technical Specifications (TS) for existing structures

PT - WG2.T1

Prepared final working dratf of TS (10/17), based on ISO 13822

- 1 General - assessment value, utility plan, reliability plan
- 2 General requirements
- 3 General framework of asessment
- 4 Basic variables and updating
- 5 Structural analyses
- 6 Verification - semi-probabilistic (partial factors, assessmen value method), probabilistic methods, risk assessmentk
- 7 Assessment based on satisfactory past performance
- 8 Interventions
- Annex A Flowchart of the assessment of existing structures
- Annex B Updating procedure
- Annex C Target reliability and partial factors
- Annex D Heritage structures

National Annex should be developed for operational application.

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Evolution of EN 1991 for actions

- **Bases of design will be transferred from EN 1991 to EN 1990**
- **1. phase of further evolution** – presently final working drafts
  - SC1.T1 EN 1991-1-2 fire design
  - SC1.T5 climatic changes
  - SC1.T9 EN 1991-2 traffic loads on bridges
- **2. phase of further evolution** – available 1st drafts of prEN 1991
  - SC1.T2 EN 1991-1-3 snow
  - SC1.T3 EN 1991-1-4 wind
  - SC1.T4 EN 1991-1-5 temperatures
  - SC1.T7 EN 1991-1-8 water currents and waves
  - SC1.T8 EN 1991-1-9 icing
  - SC1.T10 EN 1991-4 silos and tanks

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prEN 1991 Actions

Working groups WG – cooperation with relevant PTs

- WG1 Climatic actions – snow, wind, temperature
- WG2 Icing
- WG3 Bridges
- WG4 Fire design
- WG5 Silos and tanks
- WG6 Currents and waves

Presently selection of new PTs for phases 3 and 4:
interaction of climatic actions, imposed loads, actions during execution, accidental actions

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Climatic changes – SC1/WG5

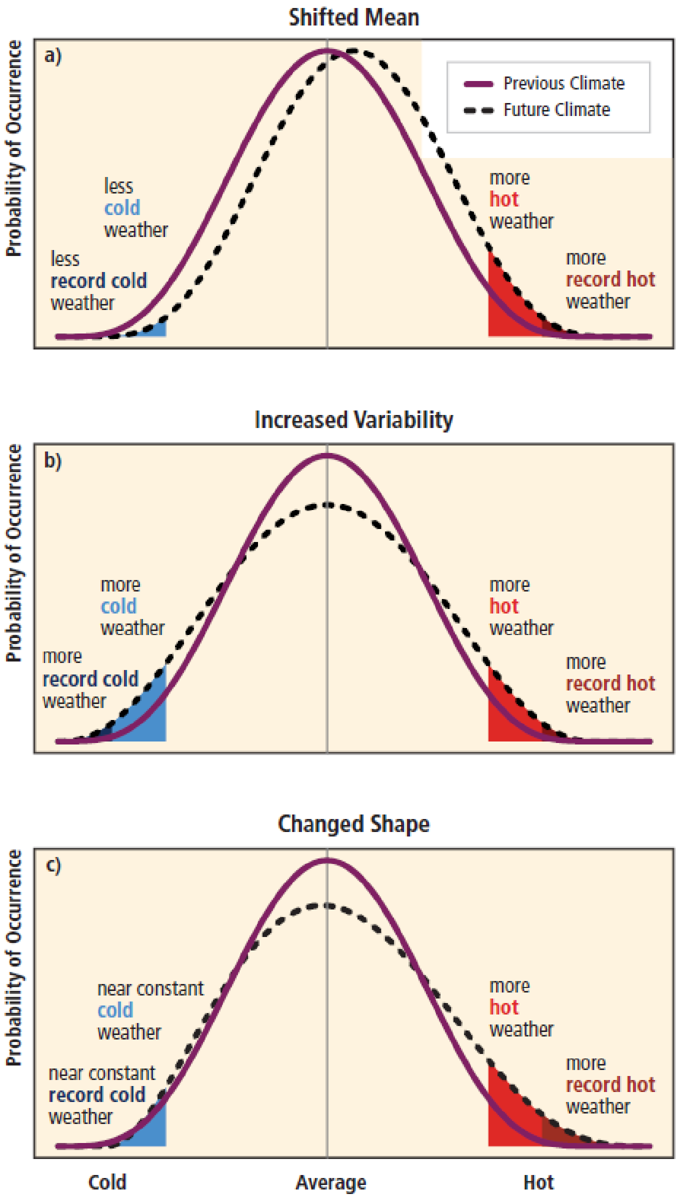
Shift of mean – still normal distribution

Air temperature is the main factor for development of climatic changes (influnced by solar radiation).

Change of variance - still normal distribution

Shape of bell-shape curve is sloped
- here not normally distributed

extremal probabilistic distribution is needed



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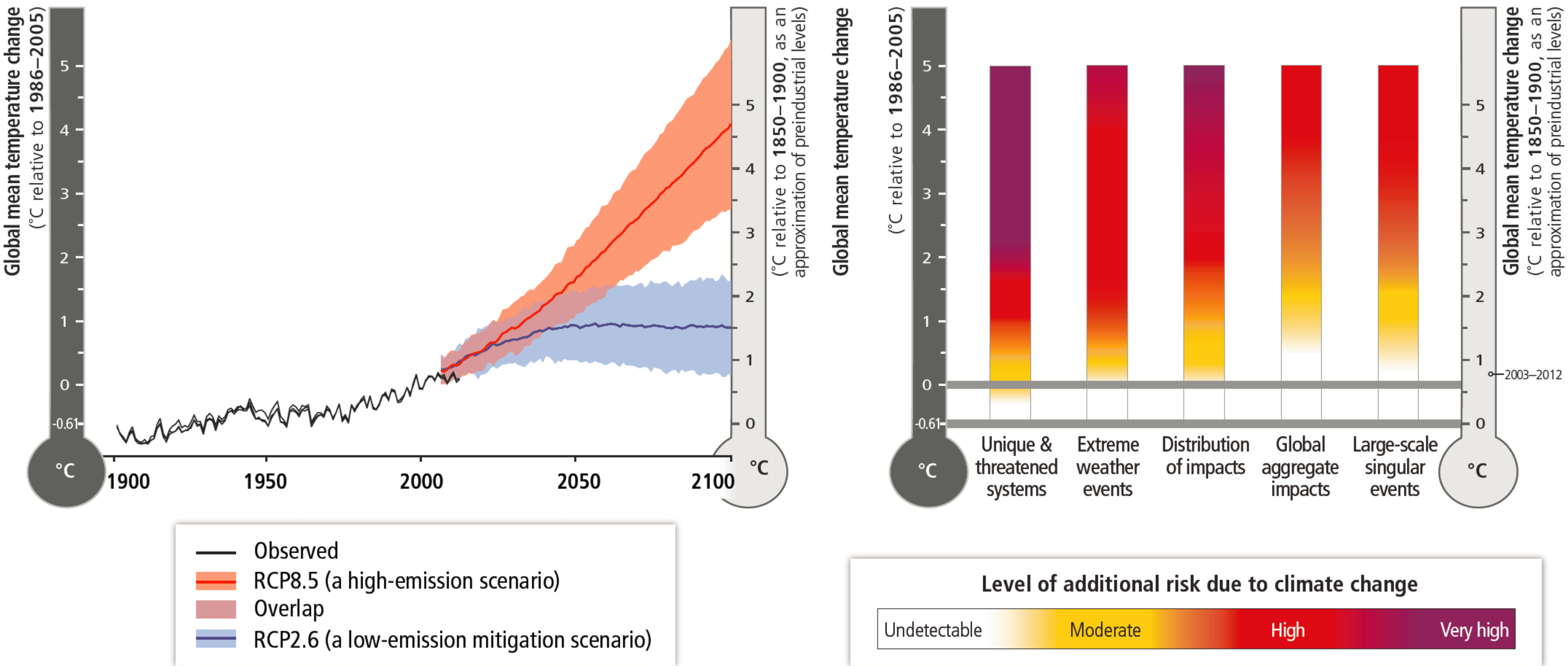
Diferences in climatic predictions



Extreme values in future climatic systems (with assessed design value) should be not considered as static values in time and space, however as dynamics parameters regarding to climate changes.

Conclusions on climatic changes

- Current models for prediction of climatic variables include various uncertainties, thus prediction of their further evolution in a longer time horizon (about 100 years) is very difficult.
- Significant parameters should be regularly assessed, probably in 10-15 years intervals.
- If needed the design values of climate actions should be updated.
- Presently the introduction of the safety factor for potential climatic changes is not needed.

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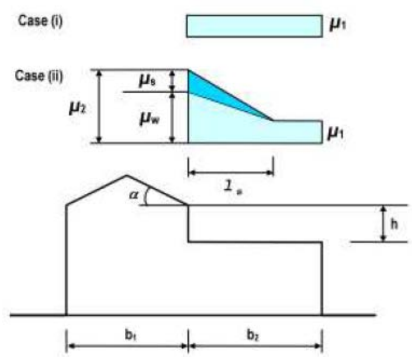
prEN 1991-1-3 Snow actions

- Snow actions on the ground, unconsistencies on boards of CEN countries, evaluation of questionnaire focused on snow maps and their applications in countries

- Verification or supplement of shape factors, consideration of size effect of building

- Persistent and accidental design situations



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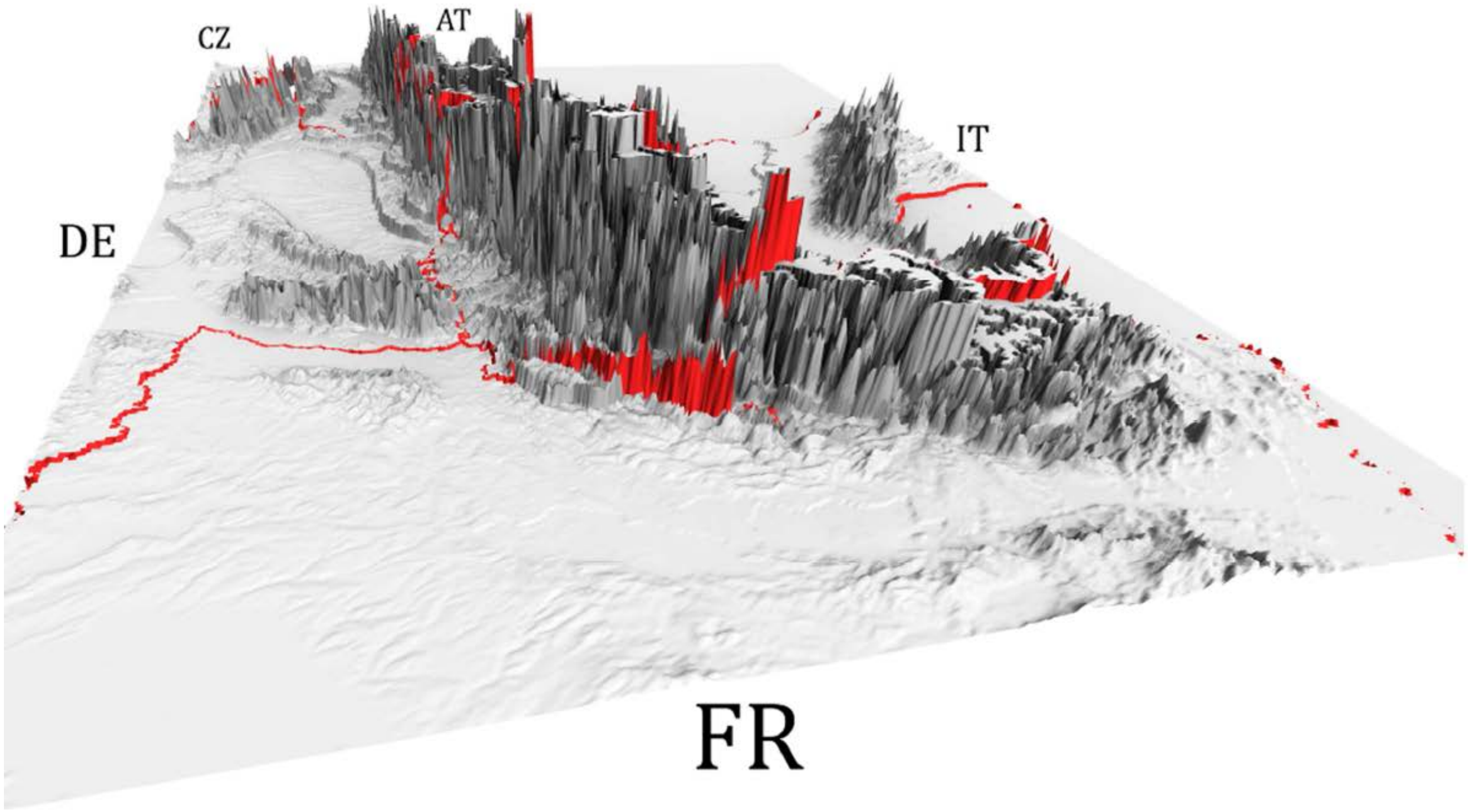
Comparisons of inconsistencies in snow loads



Red areas indicate non consistencies of snow loads at boarders of individual countries.

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prEN 1991-1-4 Wind actions

- Analyses of wind maps of MS, analyses of non consistencies
- Revision of force coefficients and wind pressures
- Revision of wind models
- Supplementary provisions for aeroelastic instability, wind actions on bridges, towers, masts and chimneys (transfer from EN 1993-2-1 and EN 1993-3-2)

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prEN 1991-1-5 Thermal actions

- Supplementary rules for buildings
- Uniform and non uniform course of temperatures
- Definition of initial temperature, specification of T_0
- Analyses of non consistencies of shade air temperature on boarders of MS
- Interpretation of characteristic values of temperatures

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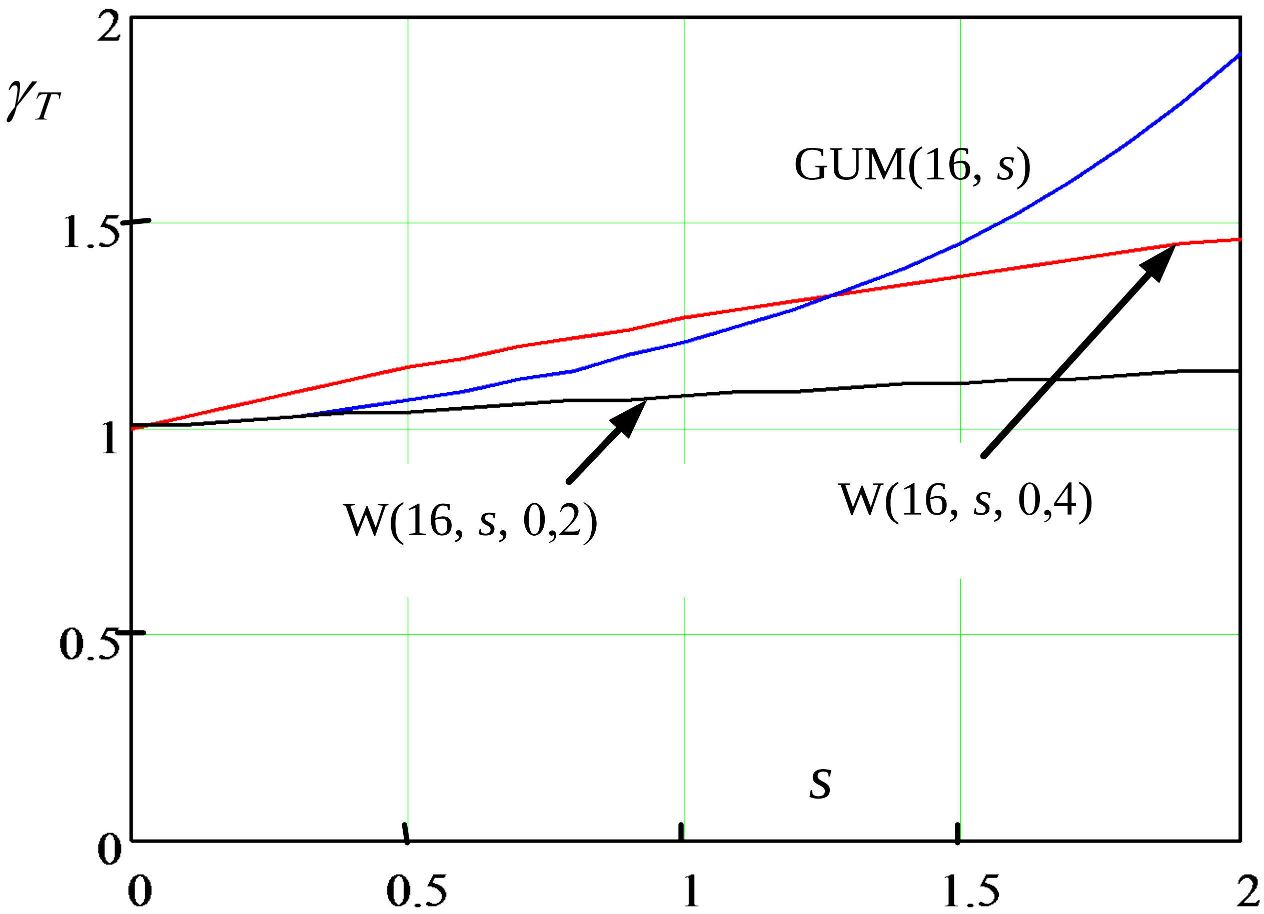
Analyses of partial factors for temperatures



Partial factor versus standard deviation for Gumbel and Weibull distributions.

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Comparative analyses of inconsistencies at borders

Germany – Czech Republic:

- Niedereinsiedel (CR)

Type of bridge		DE	CZ	Difference
	T_{min}	-24°C	-33°C	9°C
	T_{max}	+37°C	+37°C	0°C
Type 1	T_{min}	-27°C	-36°C	9°C
	T_{max}	+53°C	+52°C	1°C
Type 2	T_{min}	-20°C	-28,5°C	8,5°C
	T_{max}	+41°C	41,5°C	0,5°C
Type 3	T_{min}	-16°C	-25°C	9°C
	T_{max}	+39°C	+38,5°C	0,5°C

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Comparisons of maxima Czech Republic - Austria

At boarders

Alt. in m	CZ- T_{max}	A - T_{max}	ΔT_{max}
600 - 900	38 - 36°C	35,4 - 33,6°C	2,6 - 2,4°C
470 - 500	40 - 38°C	36,2 - 36°C	3,8 - 2°C
400 - 500	38 - 36°C	36,6 - 36°C	1,4 - 0°C
200 - 250	40 - 38°C	37,8 - 37,5°C	2,2 - 0,5°C

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Comparisons T_{min}

CZ– Austria – at boarders:

Alt. v m	CZ- T_{min}	A - T_{min}	ΔT_{min}
600 - 900	-32 - 34°C	-19,6 – 21,4°C	12,4 - 12,6°C
470 - 500	-32- 30°C	-18,8 - 19°C	11,2 - 13°C
400 - 500	-30 - 28°C	-18,4 - 19°C	9,6 - 11°C
200 - 250	-30 - 28°C	-17,2 – 17,5°C	10,8- 12,5°C

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Comparisons of max. isotherms Czech Republic - Slovakia

Values of maximum shade air temperature with annual probability of being exceeded of 0,02

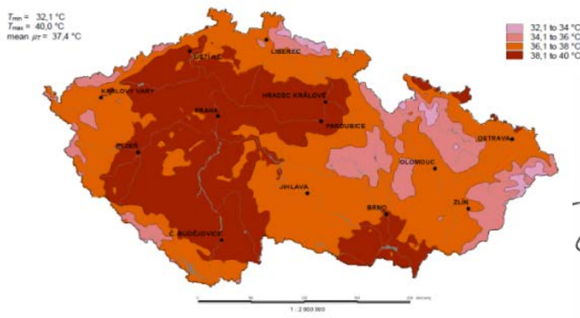

Figure NA.1 – Map of maximum shade air temperatures

Region	CZ- T_{max}	SK - T_{max}	ΔT_{max}
1 - S	40 - 38°C	40°C	2 - 0°C
2 - M_S	38 - 36°C	40°C	2 - 4°C
3 - M_N	36 - 34°C	40°C	4 - 6°C
4 - N	34 - 32°C	40°C	6 - 8°C

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Comparisons – maps of minimum isotherms

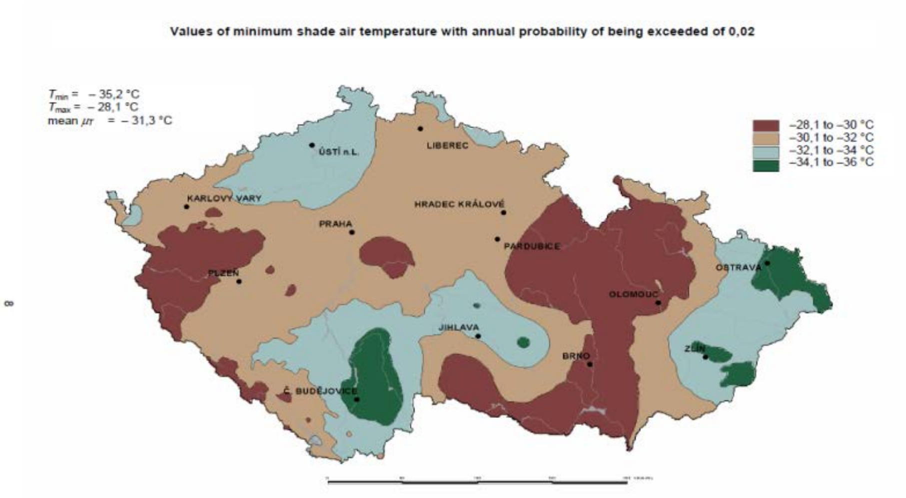
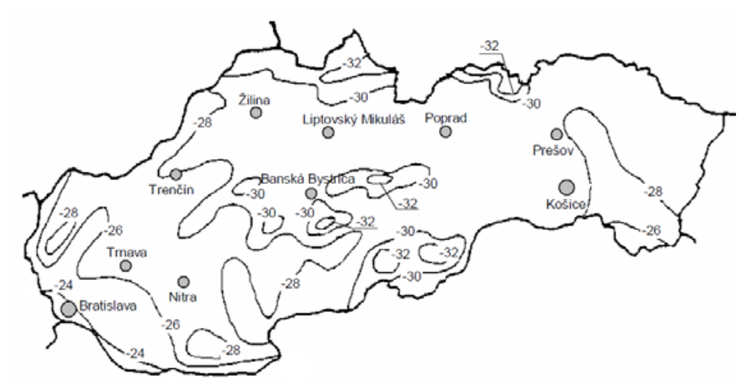


Figure NA.2 – Map of minimum shade air temperatures



Region	CZ- T_{min}	SK - T_{min}	ΔT_{min}
1 - S	-30 - 32°C	-28°C	2 - 4°C
2 - M	-32- 34°C	-28°C	4 - 6°C
3 - N	-36 - 34°C	-30°C	4 - 6°C

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prEN 1991-2 Traffic loads

- Railway bridges – supplementary models for trains, also in cooperation with European Railway Agency (ERA), aerodynamic effects
- Road bridges – new models for traffic loads, e.g. models LHV (Long and Heavy Vehicles), trams
- Pedestrian bridges – dynamic loads, vibrations
- Models for fatigue loads on bridges
- Bearings – load combinations, basic principles

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Comparisons of coefficients α

Country	Adjustment factors				National choice LM3
	α_{Q1-3}		α_{q1} α_{qn}	α_{q2}	
Austria	1	1	1	1	Highways 3000/200
CR – existing: Valid:	0,8 **1**	0,8 **1**	0,8 **2,4**	0,8 **1,2**	- 1800/200, 3000/240
France, Italy	1	1	1	1	Not defined
Germany	1	1,33	2,4	1,2	Not defined
Finland	1	1	1	1	UDL
UK	1	0,61	2,2	2,2	SV 80,100,196, SOV 250,350,450,600
Netherlands	1 1,15	1,15 1,4	1,15 1,4	1,15 1,4	≤ 200 kN

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EN 1991-1-9 Icing

- ISO 12494 podkladem
- Need for harmonisation of models in CENELEC and ISO
- Simplification of text, in style of Eurocodes
- Most tables removed and calculation expression given only
- Analysis of interaction of wind with icing, reduction coefficient *k*
- Combination of loads will be moved to EN 1990, Annex A.3

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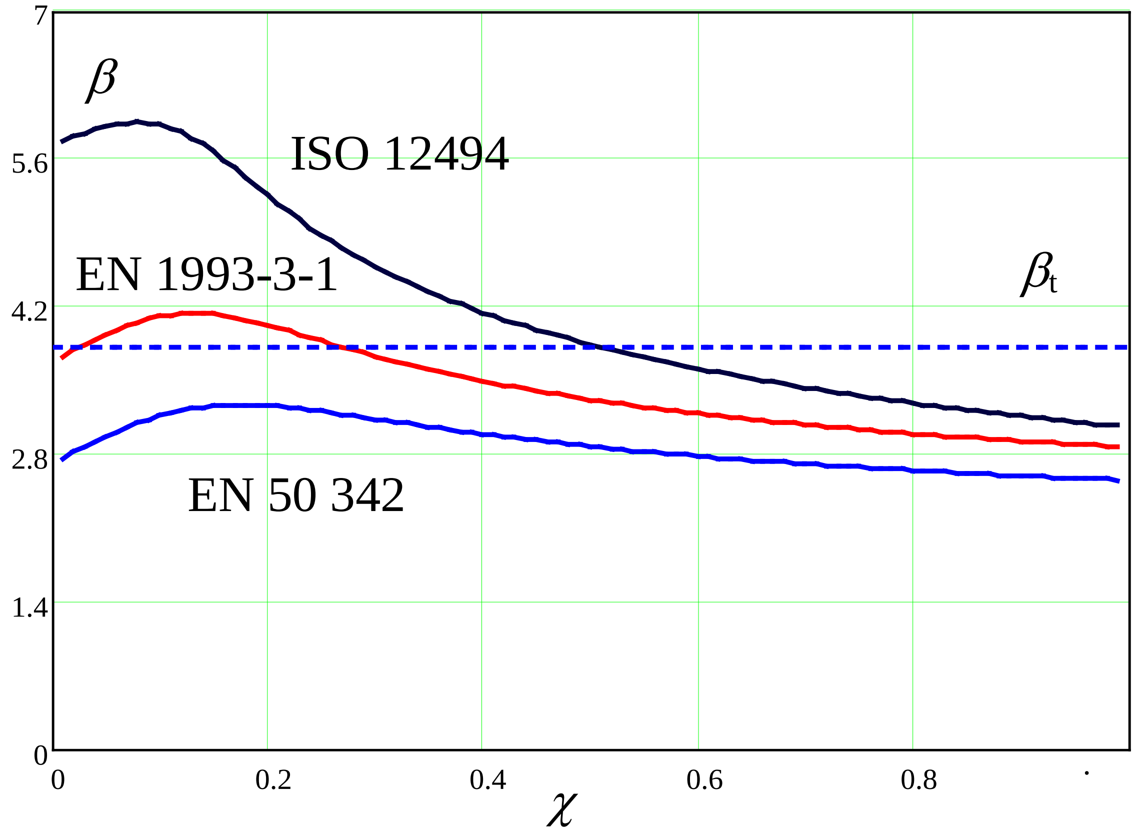
Comparative study of reliability of the structural member designed for icing



Reliability index β versus load ratio χ for combination of permanent loads and wind for the reliabity class CC2 when applied partial facors according to EN 50541, EN 1993-3-1 and nationally introduced ISO 12494.

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prEN 1991-4 Actions on silos and tanks

- Specification of reliability categorisation of silos on the basis of their geometric and material characteristic.
- Improvements of load combinations, values of partial factors
- Operational conditions, combination of pressures, symetrical and non symetrical discharge

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Concluding remarks

- New generation of Eurocodes should be more user-friendly, containing some still missing guidance and background materials with supplementary procedures for applications.
- Final draft of prEN 1990 for basis of structural design still contain some not fully solved aspects.
- It is expected need to develop new, operational National Annexes to EN 1990 a EN 1991 in cooperation of technical committees with practice.
- NDPs should be properly selected including partial factors and other reliability elements.

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Requirements on structures can change in time …

Thank you for your attention

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