Implementation of the Eurocodes in the Regulatory Framework – Guidance and best practices in Czech Republic

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Requirements for national implementation

Needs for preparation of national conditions

- national amendment of regulations for operational applications of Eurocodes

Development of National Annexes (NA)

- selection of NDPs (National Determined Parameters) based on comparative analyses with respect to national codes

Revision of national standards

- some topics not fully covered by Eurocodes – needs for residual national codes with non contradictory information

Dissemination activities, teaching, National help desk

- courses, teaching basis of Eurocodes in Technical Universities, development of handbooks and softwares

Development of National Annexes

- Tasks for selected experts with knowledge of basis of national codes and Eurocodes
- Co-operation with National technical committees and UNMZ
- Calibrations, analysis of NDPs, comparative studies
- Development of non contradictory information (if needed)

Changes in national regulations

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MINISTERSTVO PRO MÍSTNÍ ROZVOJ

Ministerstvo dopravy

New Building regulation – town and country planning and building code, and its implementary regulations where references on CPD and application of Eurocodes is given.

Responsible for preparation of new regulation - Ministry of Regional Development (http://www.mmr.cz) and Ministry of Transport (http://www.mdcr.cz)

New non-contradictory Technical conditions of the Ministry of Transport might be issued if needed (http://www.pjpk.cz, quality management of highways and roads).

Czech building regulations

Reg. 268/2009 on technical requirements on construction works

- Construction works shoud be designed and executed according to „standardised values" to comply with seven Basic Requirements.
- Eurocodes are referenced in Annex of Reg. 268/2009
- „Standardised value" represents specific technical requirement, design method, NDP, technical properties of structures and products
- Reg. 26 on technical requirements on construction works in Prague – Eurocodes are referenced there as „appointed standards"

Development of Czech National Annexes

- National Annexes were developed on the basis of shedule given by CEN/TC 250.
- National Annexes are drafted by selected responsible experts (from Universities, experienced engineers).
- The first oficial draft is approved by ÚNMZ (Czech Office for Standards, Metrology and Testing) and then sent for comments of the relevant National Technical Committee (TNK).
- Information concerning new National Annex is published in official journal of ÚNMZ (Vestnik) enabling participation of interested experts, companies or authorised bodies in comments.
- All National Annexes are translated to English.

Example of National foreword

- National Annex gives NDPs in those Clauses of EN 1990 in which national choice is allowed.
- The NDPs have normative character for the territory of the Czech Republic.
- National Annex gives information on status of informative annexes given in Eurocodes and provides additional information for application of Eurocode EN1990 in the Czech Republic.

Details of national implementation

- Eurocodes have the status of the Czech technical standard (CTN) by publication of an identical text (conflicting national standards were withdrawn by 1st April 2010).
- The full text of the Eurocode (including any annex) as published by CEN and
  - ✓ a National title page
  - ✓ a National foreword
  - ✓ the link of the National Annex in the National foreword.
- When the Eurocodes are used in the Czech Republic for the design of construction works, the Czech National Determined Parameters (NDPs) have to be applied.
- Members of the Czech Chambre of Civil Engineers (CKAIT) were obtained special conditions for website access for all Czech standards including Eurocodes.

Some problems during implementation

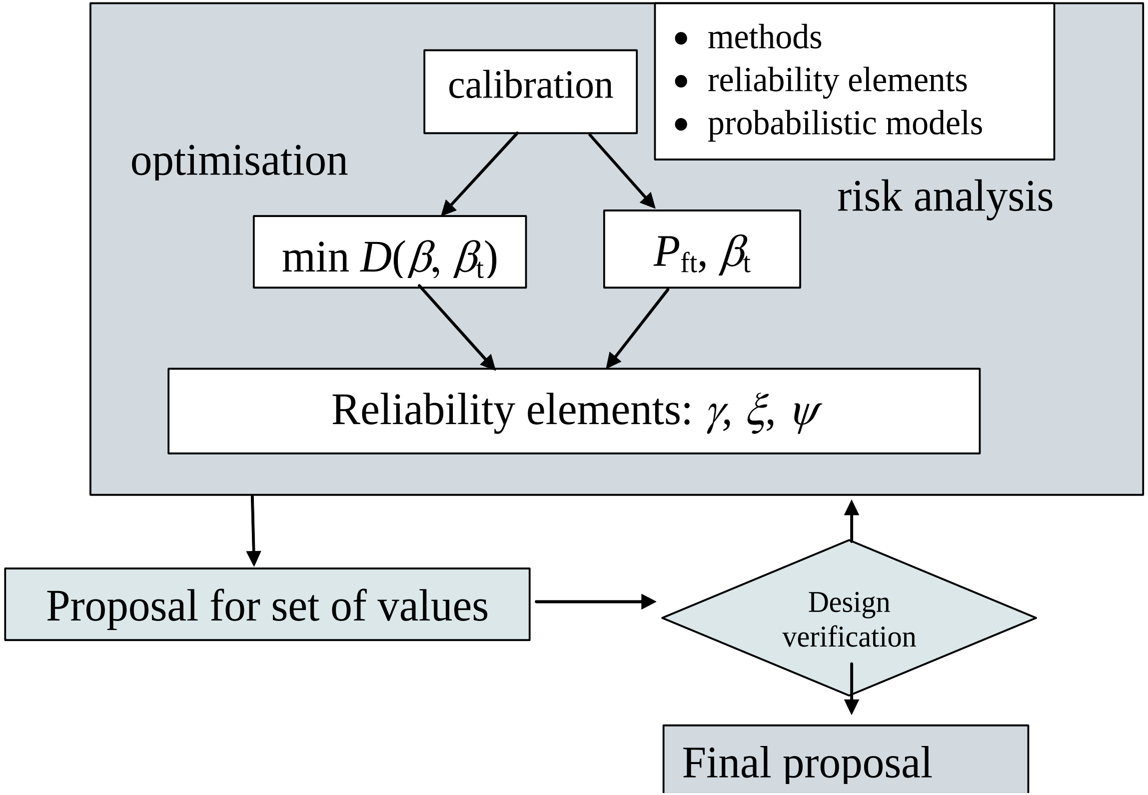
- Czech National Annex for design of geotechnical structures gives rather general provisions while Czech original codes with usefull information on classification of soils were withdrawn.

- Design of structures against fire – mutual connection with Czech national regulations was needed (revisions of national regulations).

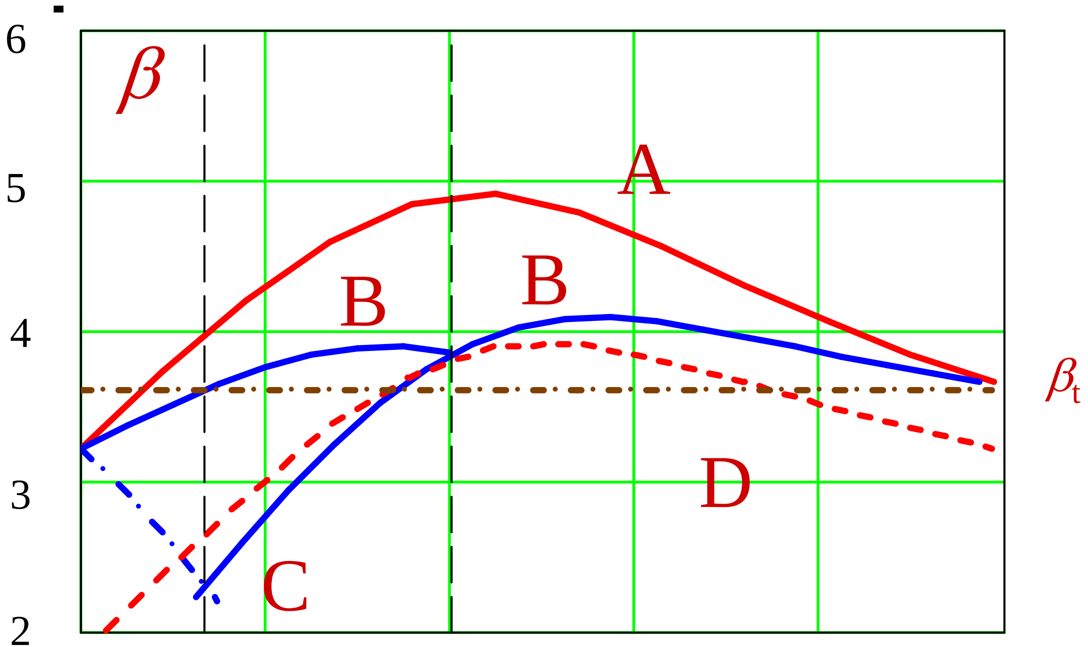
- Some inconsistencies, errors, misunderstanding had to be clarified – technical support from CEN/TC 250/SCs was in specific cases important (for the development of NA).

- Some Parts of Eurocodes could be more user-friendly and their rules simplified or better explained (Czech designers complained about EN 1991-1-4 for wind actions).

Calibration of reliability elements in Eurocodes



Reliability analysis of concrete member



A to C denotes combinations according to EN 1990 (γ_G = 1,35, γ_Q = 1,5), D is combination A with reduced factors γ_G =1,2, γ_Q =1,4, where $\chi = Q_k/(G_k+Q_k)$
(Note: D was given in Czech NAD to ENV version).

Implementation of EN 1998 in CR

Six Parts of EN 1998 implemented as

CSN EN 1998-1 (09/2006)

CSN EN 1998-2 (05/2008)

CSN EN 1998-3 (05/2008)

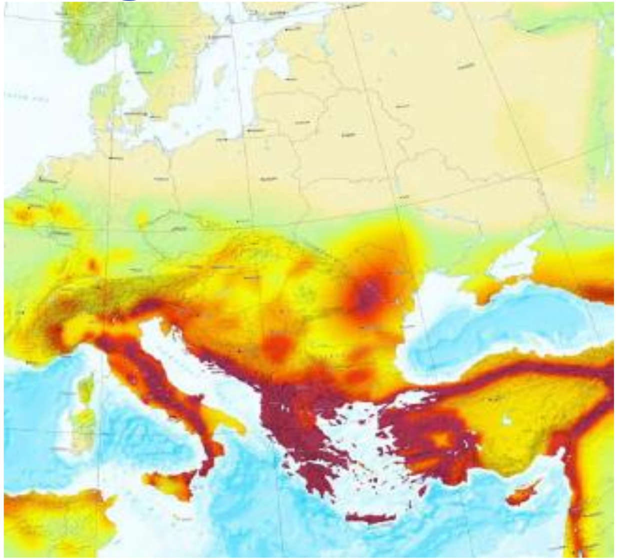
CSN EN 1998-4 (03/2008)

CSN EN 1998-5 (12/2007)

CSN EN 1998-6 (09/2007)

in total

> 500 pp.



- Translation works, co-ordination of terminology
- Development of NA, new map of seismic zones, selection of NDPs, corrections of inaccuracies or errors
- Co-operation of the Technical Committee TNK 38 with the national standardization body ÚNMZ and Klokner Institute, Faculty of Civil Engineering CTU and Czech Academy of Science

Seismic actions in CR and national codes

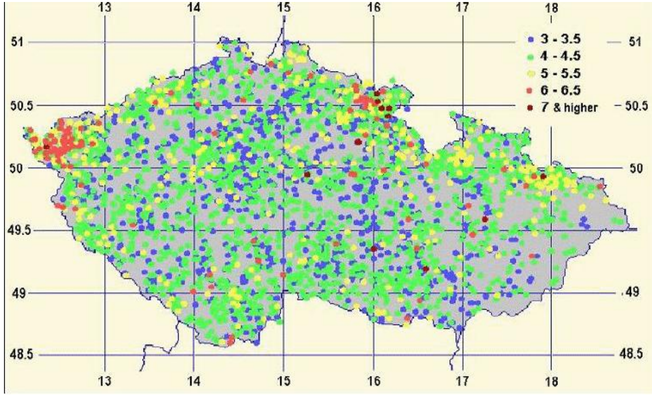
- Seismic activity in West and North-East Bohemia and North Moravia
- Technical seismicity in mining areas

Last quakes in the West Bohemia reached about 4,5 degrees on Richter scale (05/2018).

Past experience from Slovakia (Komárno, Žilina), from projects for other countries.

Czech national standards for seismic loads:

- ČSN 73 1310, 1953, 4 pp.
- ČSN 73 0036 Seismic actions on buildings, 1973, natural and technical seismicity, 46 pp.



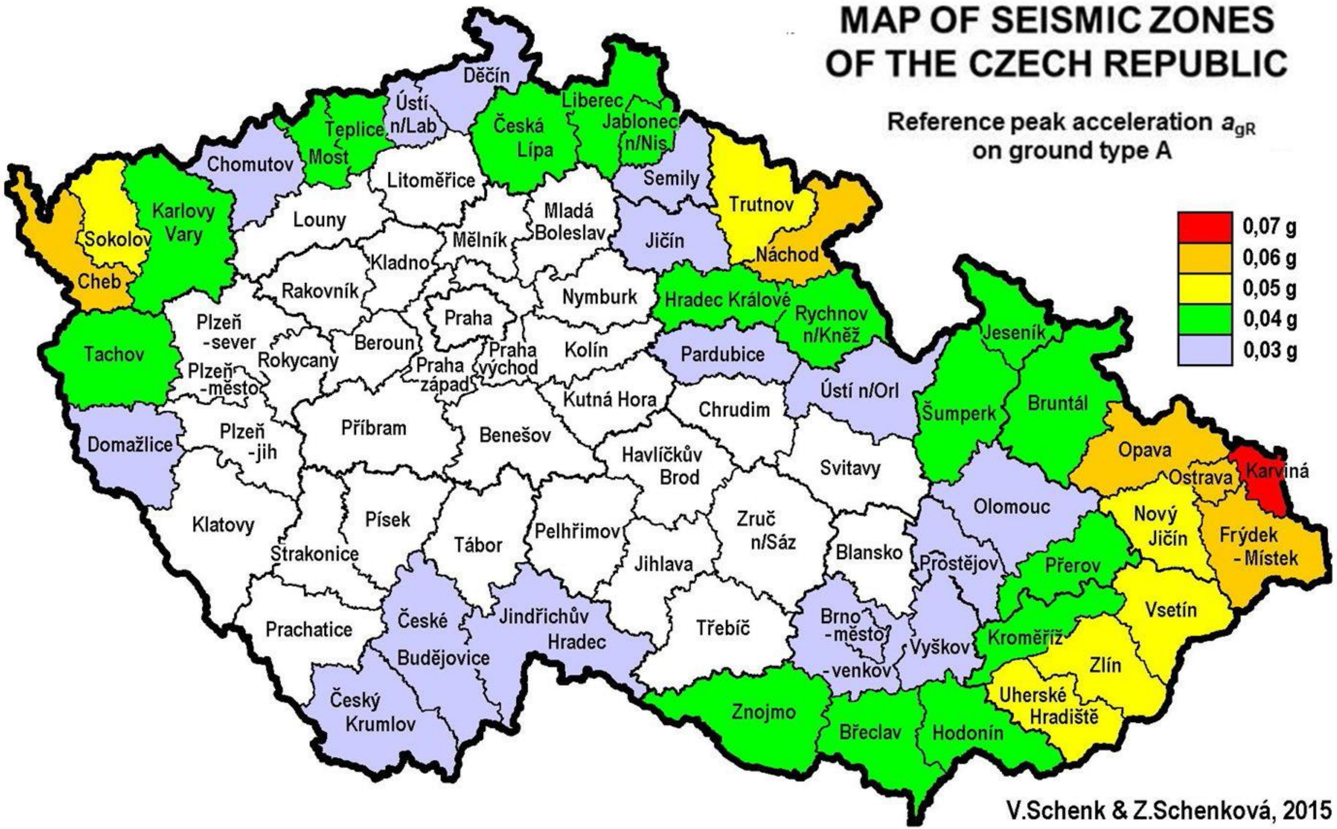
Map of seismic zones

The map of seismic zones of the Czech Republic is based on the reference peak ground acceleration a_{gR} of type A ground.

Low seismicity zones: $a_g \cdot S < 0{,}10\ g$

Very low seismicity zones: $a_g \cdot S < 0{,}05\ g$

Recently developed new seismic map

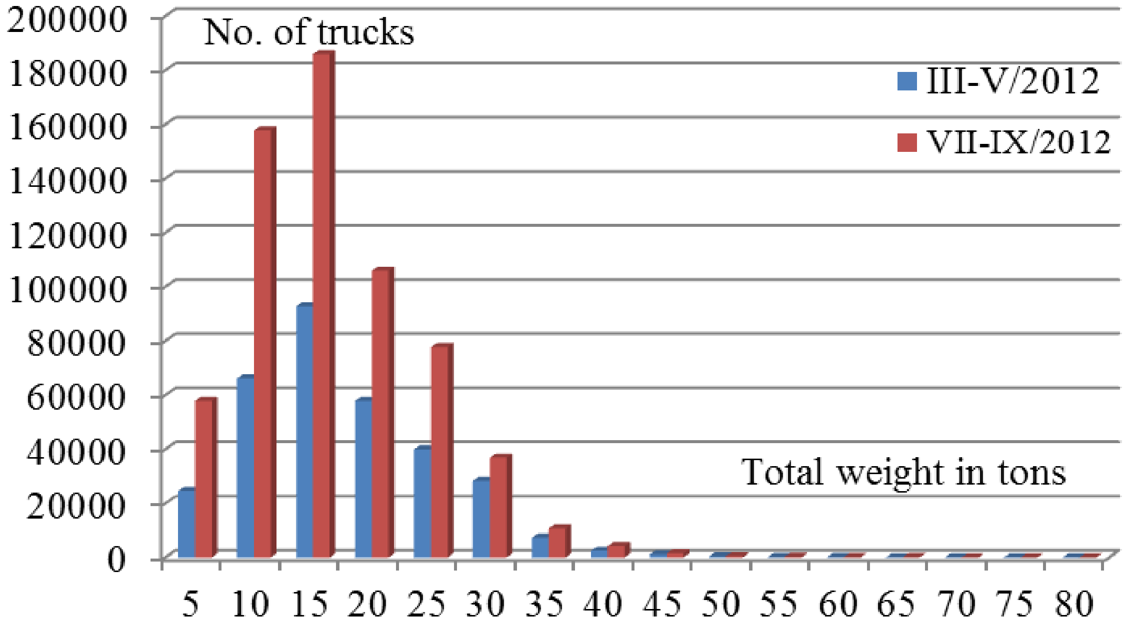


ANALYSIS OF TRAFFIC LOADS ON ROAD BRIDGES FOR CSN EN 1991-2

Analyses and measurements

- » Application of Eurocodes for bridge design
- » Calibration of NDPs in traffic models
- » Proposal for Amendment of National Annex to EN 1991-2

Monitoring of traffic loads



Histogram of a number of vehicles with respect to their total weight considering spring and summer 2012.

Analysis of Load Model 1

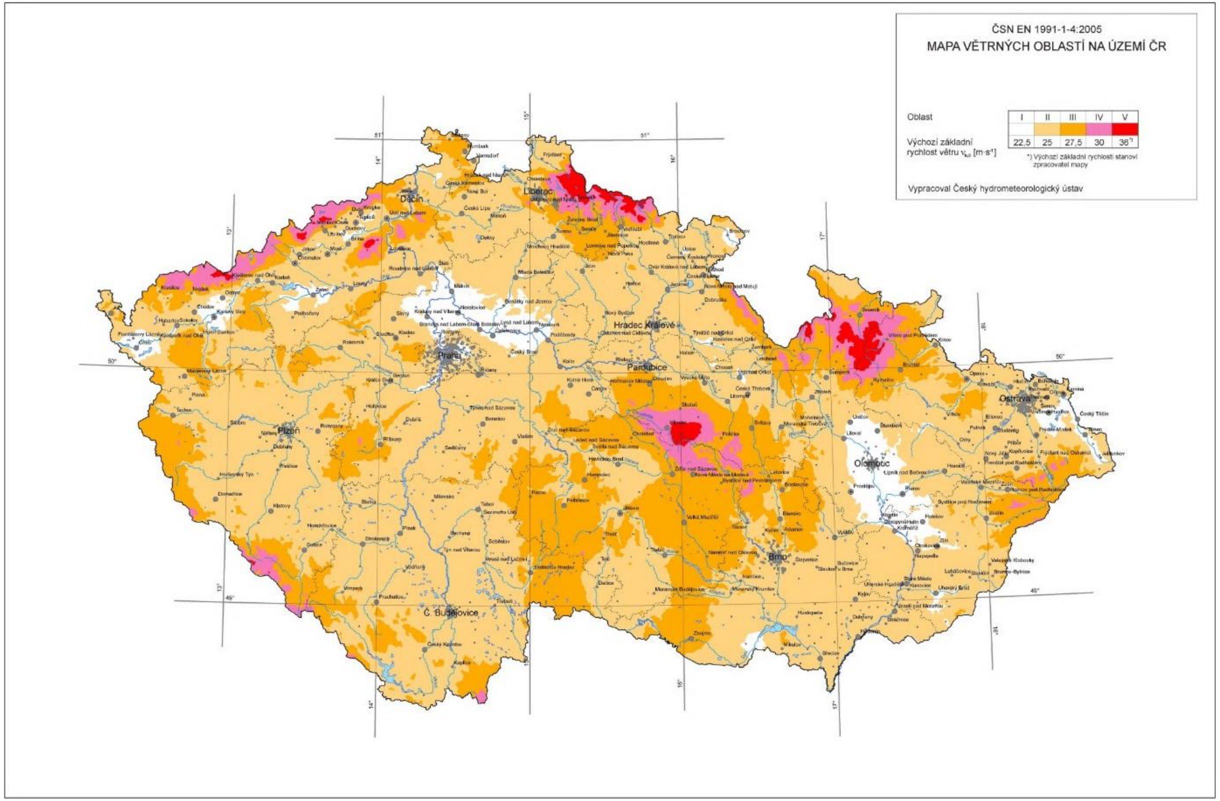
Country	Adjustment factors			
	$\alpha_{Q1\text{-}3}$	α_{q1}	α_{q2}	α_{qn}
Austria	1	1	1	1
Czech Rep.	0,8	0,8	0,8	0,8
- 1st road group	**1**	**1**	**2,4**	**1,2**
France, Italy	1	1	1	1
Germany	1	1,33	2,4	1,2
Finland	1	1	1	1
UK	1	0,61	2,2	2,2
Netherlands	1	1,15	1,15	1,15
	1,15	1,4	1,4	1,4

LM3: Recommendation of special vehicles

Type	1800/200	3000/240
Axles	$n = 9 \times 200$ kN, $e = 1{,}50$ m	$n = 1 \times 120 + 12 \times 240$ kN, $e = 1{,}50$ m
Load arrangement	Special vehicle moves in one notional lane (No. 1). LM1 shall not be simultaneously applied on this lane along the whole bridge.	Special vehicle of the width ≤ 4,5 m moves in the ideal track in the range of all notional lanes.
Load combination	UDL is applied only in the notional lane No. 2.	All other traffic is excluded from the whole bridge.
Speed	Normal (≤ 70 km/h)	Low (≤ 5 km/h)
Dynamic factor	$\delta = 1{,}25$	$\delta = 1{,}05$
Additional requirement	No vehicles with the gross weight ≥ 50 kN may simultaneously move on the bridge.	The load on the bridge consists of one vehicle only.

Comparison of wind actions in Czech original standard CSN 73 0035 versus Eurocode EN 1991-1-4

Map of wind actions of the Czech Republic



Study Case - Determination of wind pressure on attic of industrial hall based on ČSN 73 0035 and ČSN EN 1991-1-4

ČSN 73 0035

III. region, basic wind pressure w_0

$$w_0 = 0{,}45\ \text{kN/m}^2$$

$$w_n = w_0\, \kappa_w\, C_w$$

$$\kappa_w = \left(\frac{z}{10}\right)^{0{,}26} = 1{,}05$$

shape factor $C_l = 2{,}0$

$$w_n = w_0\, \kappa_w\, C_l = 0{,}45 \times 1{,}05 \times 2 = 0{,}945\ \text{kN/m}^2$$

$$\gamma_f = 1{,}2$$

$$w_d = \gamma_f\, w_n = 1{,}2 \times 0{,}945 = 1{,}13\ \text{kN/m}^2$$

ČSN EN 1991-1-4

II. Terrain category

$v_{b,0} = 25\ m/s$

max. dyn. pressure

$$q_p(12\ \text{m}) = [1 + 7I_v(z)]\ 0{,}5\rho\, v_m^2(z) =$$
$$= [1 + 7 \times 0{,}182] \times$$
$$\times\ 0{,}5 \times 1{,}25 \times 26{,}025^2 = 0{,}96\ \text{kN/m}^2$$

regions A to D, $c_{pe} = 2{,}1$ to $1{,}2$

$$w_{pe} = q_p\, c_{pe} = 0{,}96 \times 2{,}1 = 2{,}02\ \text{kN/m}^2$$

$$\gamma_Q = 1{,}5$$

$$w_{pe,d} = \gamma_Q\, w_{pe} = 1{,}5 \times 2{,}02 = 3{,}03\ \text{kN/m}^2$$

Assessment of existing structures – verification of main hall of football stadium in Liberec

Assessment is based on EN 1990 and nationally implemented ISO 13822 with several NA in CSN 73 0038

❖ presently valid standards shall be applied

- Degradation of structural steel
- Detailing
- Change of requrements for loading
- New requirements for snow and wind in Eurocodes
- Different load combinations and reliability elements

Reliability analysis of main existing tribune

Wind based on national codes

Total height of stadium is about 20 m.

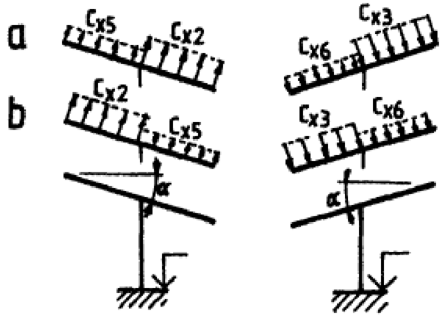
The basic wind pressure for the region class A (CSN 73 0035): $w_0 = 0{,}55\ \mathrm{kN/m^2}$

The characteristic value of pressure on the roof:

$w_k = w_0\, k_w\, C_w$

where k_w - is the height factor, for class A is $k_w = (0{,}1z)^{0{,}26}$

C_w the wind shape factor (tabelised in ČSN 73 0035).



The partial factor for wind $\gamma_W = 1{,}2$.

The characteristic value of pressure on the roof:

$w_k = 0{,}55 \times 1{,}19 \times C_w = 0{,}66\, C_w$ [kN/m²]

The design value of wind pressure on the roof

$w_d = g_w \times w_k = 1{,}2 \times 0{,}66 \times C_w\ \mathrm{kN/m^2} = 0{,}792\, C_w$ [kN/m²]

α	C_{x1}	C_{x2}	C_{x3}	C_{x4}	C_{x5}	C_{x6}
0°	−0,8	−1,2	+1,2	+0,8	−0,8	+0,8
30°	−0,5	−1,5	+1,5	+0,5	−1,1	+1,1

Wind based on Eurocodes

The mean wind velocity $v_m(z)$ at a height z above the terrain depends on the the terrain roughness and orography expressed by factors $c_r(z)$ and $c_o(z)$:

$v_m(z) = c_r(z)\ c_o(z)\ v_b$ where $c_r(z) = k_r \ln(z / z_0)$ for $z_{min} \leq z \leq z_{max}$, and $c_r(z) = c_r(z_{min})$ for $z \leq z_{min}$

Stadium is situated in terrain of type IV (roughness length z_0 = 1 and minimum height z_{min} = 10 m).

Wind turbulence I_v and maximum wind pressure $q_p(z)$ at height z is given as

$$I_v(z) = \frac{k_I}{c_0(z)\ln(z/z_o)} \qquad q_p(z) = [1 + 7I_v(z)]\ 0{,}5\rho$$

where $c_e(z)$ is the exposure factor, $q_b = 0{,}5r\ v_b^2$ is the basic velocity pressure and ρ is the air density, ρ = 1,25 kg/m^3.

Wind based on Eurocodes

Considerably different exposure coefficients in EN 1991-1-4 !

When numerical values of stadium are considered then the maximum dynamic pressure q_p is given

$k_r = 0{,}19\,(z_0 / z_{0,II})^{0{,}07} = 0{,}234$

$c_r = k_r \ln(z / z_0) = 0{,}702$

$v_m = c_r(z)\, c_o(z)\, v_b = 17{,}55$

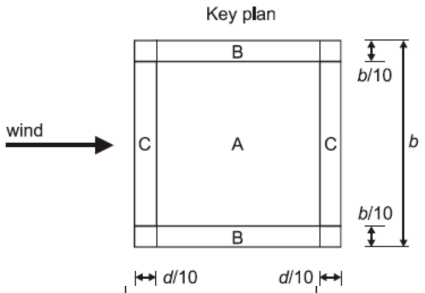
$I_v = 0{,}33$

$q_p = [1 + 7I_v(z)]\, 0{,}5\rho = 0{,}642 \text{ kN/m}^2$

$w_k = q_p(z)\, c_p = 0{,}642\, c_p$

$w_d = g_w\, q_p(z)\, c_p = 1{,}5\; 0{,}642\, c_p = 0{,}963\, c_p$

Net Pressure coefficients $c_{p,net}$



Roof angle α	Blockage φ	Overall Force Coefficients c_f	Zone A	Zone B	Zone C
	Maximum all φ	+ 0,4	+ 0,8	+ 2,1	+ 1,3
5°	Minimum $\varphi = 0$	- 0,7	- 1,1	- 1,7	- 1,8
	Minimum $\varphi = 1$	- 1,4	- 1,6	- 2,2	- 2,5

Examples of development of national vocational training materials

- Leonardo da Vinci Guidebooks in English (including software tools in Excel, Mathcad)

- Handbooks for Eurocodes EN 1990 to EN 1999 in Czech and in English

- Development of softwares for design of structures according to Eurocodes

Current activities of Czech experts in CEN/TC 250 and its SCs

- Active participation in the development of new provisions for EN 1990 and EN 1991 focused on

- *the basis of structural design*

- *assessment and strengtenning of existing structures*

- *robustness of structures*

- *actions - icing, climatic actions (snow, wind, temperatures).*

- Participation in harmonisation of some NDPs within CEN/TC250, mainly focused on reliability elements and rules for combination of actions.

Concluding remarks

Implementation of Eurocodes into the system of national codes brings various advantages for trade, co-operation, availability of advance system of standards with regular maintenance.

National resources are needed for effective implementation of Eurocodes.

For operational applications of Eurocodes, basic requirements on construction works should be given in national regulations with references to Eurocodes

Theoretical bases of Eurocodes should be taught at Technical universities.

Availability of National Annexes and software tools facilitate effective application of Eurocodes.

Thank you for your attention!

Stay in touch

http://eurocodes.jrc.ec.europa.eu/