“The way forward for the Eurocodes implementation in the Balkans”

10-11 October 2018, Tirana

Views from the European Council of Engineers Chambers & the Serbian Chamber of Engineers

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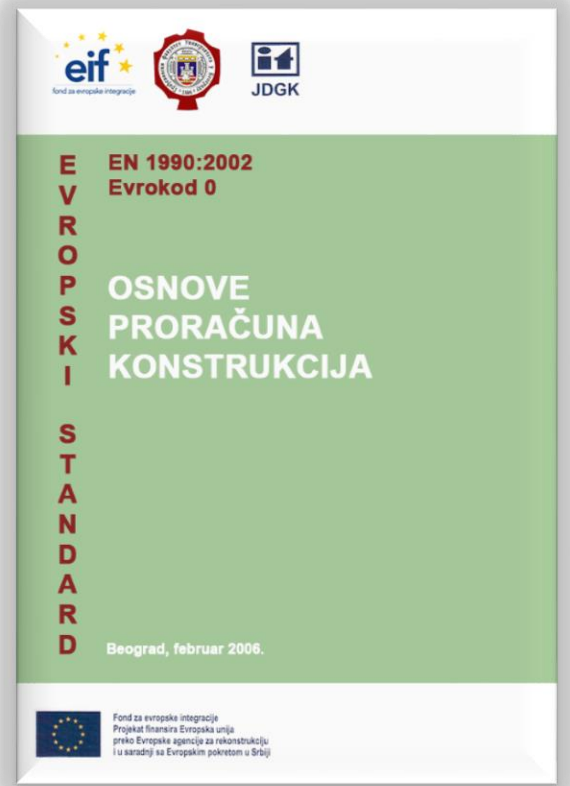
Serbian Chamber of Engineers

LITERATURE IN SERBIAN

From 2006 to 2009, the **Serbian Chamber of Engineers** supported **the translation of the following Eurocodes**, issued by **the European Integration Fund, the Faculty of Civil Engineering in Belgrade, JDGK and DGKS.**



„Basics of structural design“

European standard EN 1990:2002, Eurocode 0

„Actions on structures"

European standard EN 1991-1-1:2002, Eurocode 1
Part1-1: Volume weight, weight, useful loadings for buildings

„Actions on structures"

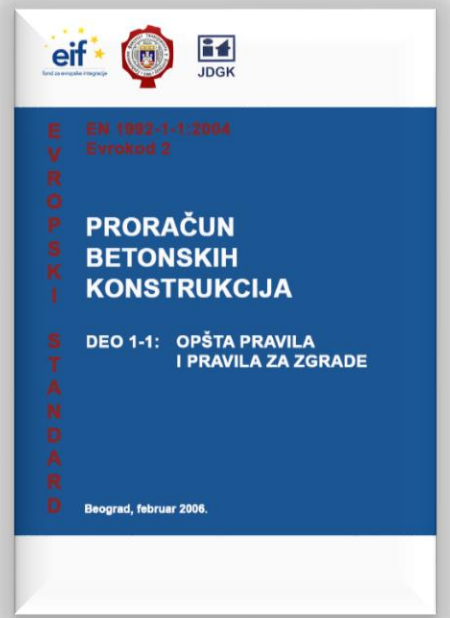
European standard EN 1991-1-3:2003, Eurocode 1
Part1-3: Snow actions

„Actions on structures“

European standard EN 1991-1-4:2005, Eurocode 1
Part1-4: Wind actions

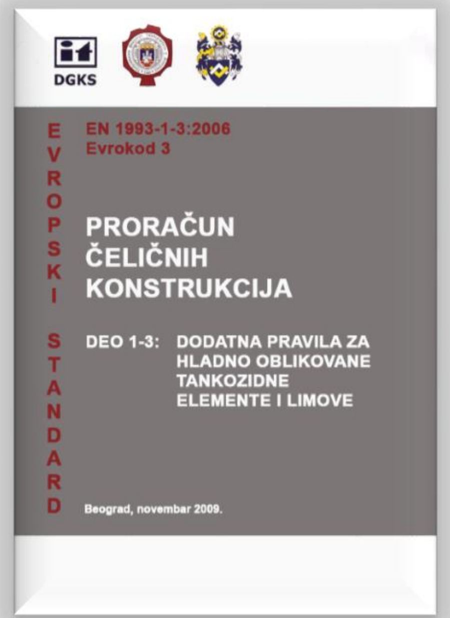
„Actions on structures“

European standard EN 1991-1-5:2003, Eurocode 1
Part 1-5: Thermal actions



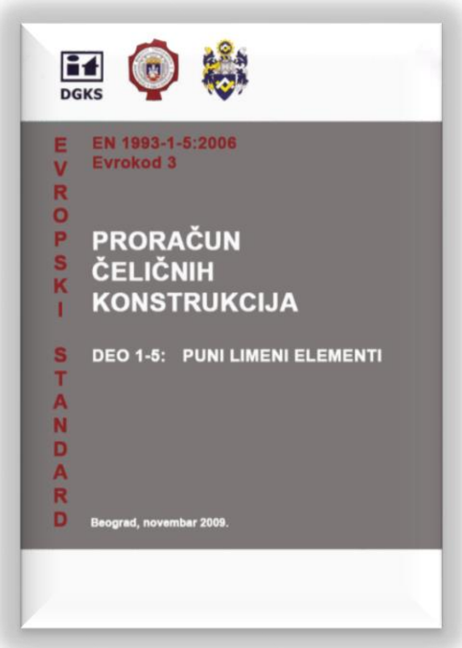
„Design of concrete structures"

European standard EN 1992-1-1:2004, Eurocode 2, Part1-1: General rules and rules for buildings



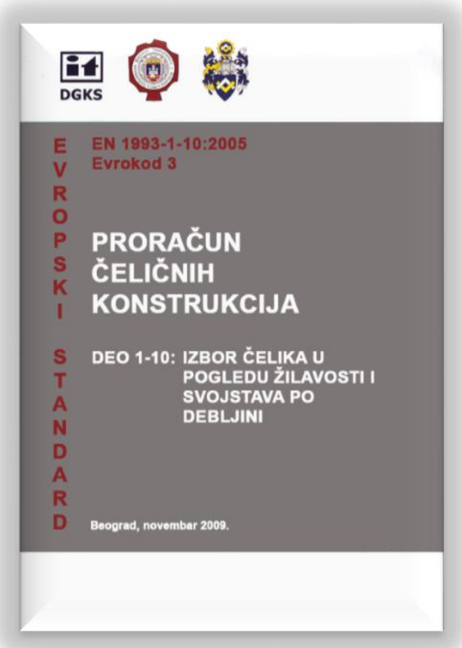
„Design of steel structures"

European standard EN 1991-1-3:2006, Eurocode 3 Part1-3: Additional rules for cold forming thin-walled elements and sheets



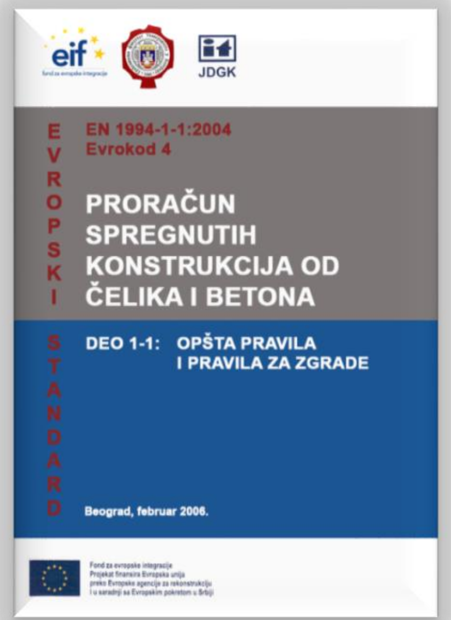
„Design of steel structures"

European standard EN 1993-1-5:2006, Eurocode 3 Part 1-5: Full tin elements



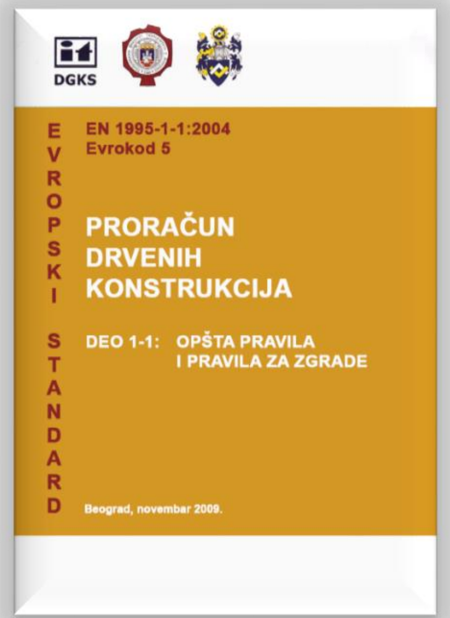
„Design of steel structures"

European standard EN 1991-1-10:2005, Eurocode 3, Part1-10: Steel selection in terms of toughness and thickness properties



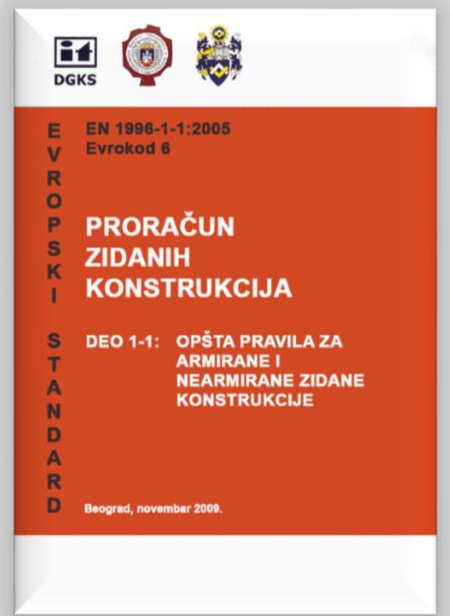
„Design of composite steel and concrete structures "

European standard EN 1994-1-1: 2004, Eurocode 4, Part1-1: General rules and building rules



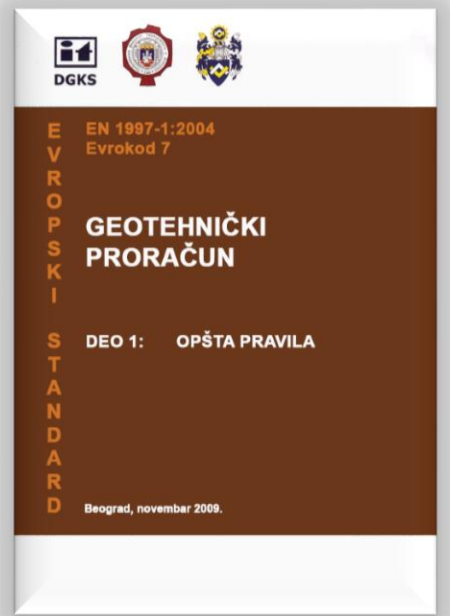
„Design of timber structures"

European standard EN 1995-1-1: 2004, Eurocode 5, Part1-1: General rules and rules for buildings



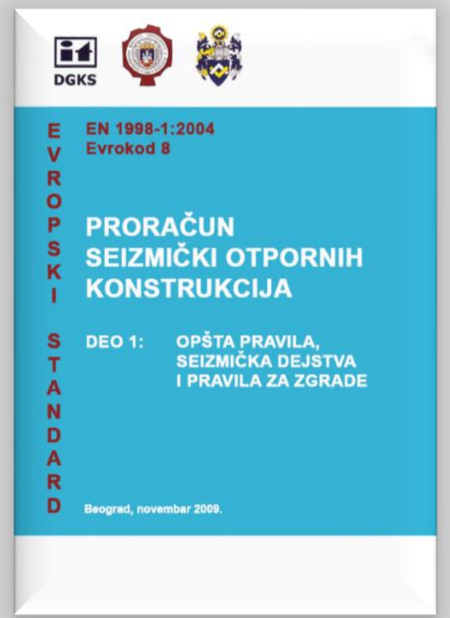
„Design of masonry structures“

European standard EN 1996-1-1: 2005, Eurocode 6, Part1-1: General rules for reinforced and unarmed masonry structures



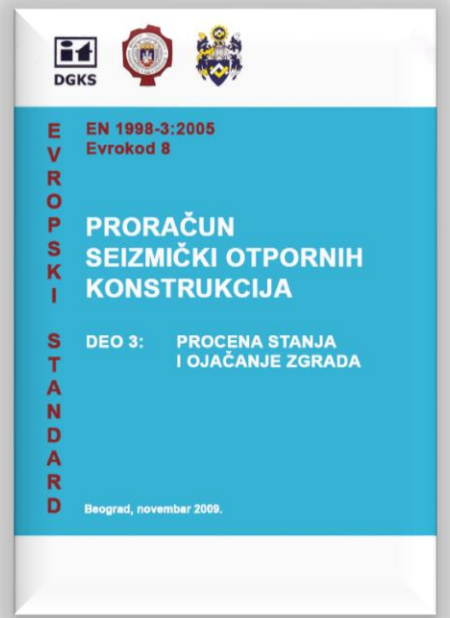
„Geotechnical design“

European standard EN 1997-1: 2004, Eurocode 7, Part1: General rules



„Design of structures for earthquake resistance"

European standard EN 1998-1: 2004, Eurocode 8, Part 1: General rules, seismic effects and rules for buildings



„Design of structures for earthquake resistance"

European standard EN 1997-3: 2005, Eurocode 8, Part 3: Condition assessment and building reinforcement

Implementation of Eurocodes training conducted by the Serbian Chamber of Engineers

Within the framework of the joint European professional development program, **the Serbian Chamber of Engineers**, in cooperation with **the European Council of Engineers Chambers (ECEC)** since 2014, organized several lectures on **the application of eurocodes** for its members. The lecturers were **prominent professors** and **experts** from various fields.

Experiences of Hungarian engineers in the application of THE EUROCODES

Lecture on the topic **"Experiences of Hungarian Engineers in the Application of Eurocodes"** (lecturers **Ph.D.Hovanj Lajoš, Šugar Đerđ** M.Sc.Civ.Eng., **Bodor Dežo** President of the County Chamber in Čongrad, **Tornai Laslo** M.Sc.Civ.Eng.) was held on 25.04.2014. in the Serbian Chamber of Engineers in Subotica.

The purpose of this lecture was to get acquainted with the methodology and methods of work of colleagues from the neighboring country, and to start **the realization of the idea of mutual cooperation** between the two regional centers, which are also territorially connected.

Design of concrete road bridges in Slovakia in accordance with Eurocodes

In cooperation with the Serbian Chamber of Engineers and the Slovak Chamber of Engineers, **Ph.D.Jaroslav Halvonik** from the University of Bratislava, Slovakia, gave a lecture on **"Designing concrete road bridges in Slovakia in accordance with the Eurocodes"**.

The lecture was held on 12.06.2014. in the premises of **the Slovak Chamber of Engineers** in Bratislava live, and with a video link transmission, it was followed in chambers, members of the European Council of Engineers Chambers.

During the lecture, all relevant parts of the Eurocodes required for the construction of **concrete bridges** were considered, except for those related to geotechnical design.The lecture was attended by 112 engineers at the headquarters of the Serbian Chamber of Engineers.

Professor Jaroslav Halvonik, who participated in the webinar organized by the Engineering Chambers of Serbia and Slovakia in June 2014, also participated.

The emphasis of the lecture was on and **reinforced pre-stressed concrete**, which is today the most used material in the construction industry, while **Eurocode 2 (EC2)** is the most commonly used standard in designing constructions from this material.

The lecture was focused on two of the most discussed topics that are related to design in accordance with **EN-1992-1-1,** such as the design of lean columns and punching of panels.

The lecture was attended by 150 engineers.

The lecture which held in Bratislava, was directly transmitted to regional offices of the Chamber in **Novi Sad, Nis, Kraljevo, Valjevo** and **Bor** (followed by 150 engineers) and **Belgrade** too, and it was also transferred to the engineering chambers of **Austria, Slovenia, Macedonia and Bulgaria.**

The Working Group of the Assembly of the Serbian Chamber of Engineers for the implementation of the Joint European Program of Continuing Professional Development of the members of the Serbian Chamber of Engineers has organized and conducted 5 lectures on the topic of **Eurocodes** as part of this Program since its establishment in April 2014 to October 2015.

Generally

Design of bearing structures in Slovakia should be performed using Eurocodes since April 2010

Eurocodes are common European standards **EN199X-Y** for design of buildings and engineering works

National designation of Eurocodes is **STN EN 199X-Y** in SK

Eurocodes have 58 parts and together more 5000 pages

For preparation and maintenance of Eurocodes is responsible technical commission **CEN/TC 250** Structural Eurocodes with its subcommissions SCX

Design of concrete bridges

STN EN 1990 Eurocode: Basis of Structural Design
Annex A2: Applications for bridges (normative)

STN EN 1991 Eurocode 1: Actions on structures,
- Part 1-1: General actions – densities, self-weight
- Part 1-4: General actions – Wind actions
- Part 1-5: General actions – Thermal actions
- Part 1-6: General actions – Actions during executions
- Part 1-7: General actions – Accidental actions
- Part 2: Traffic loads on bridges

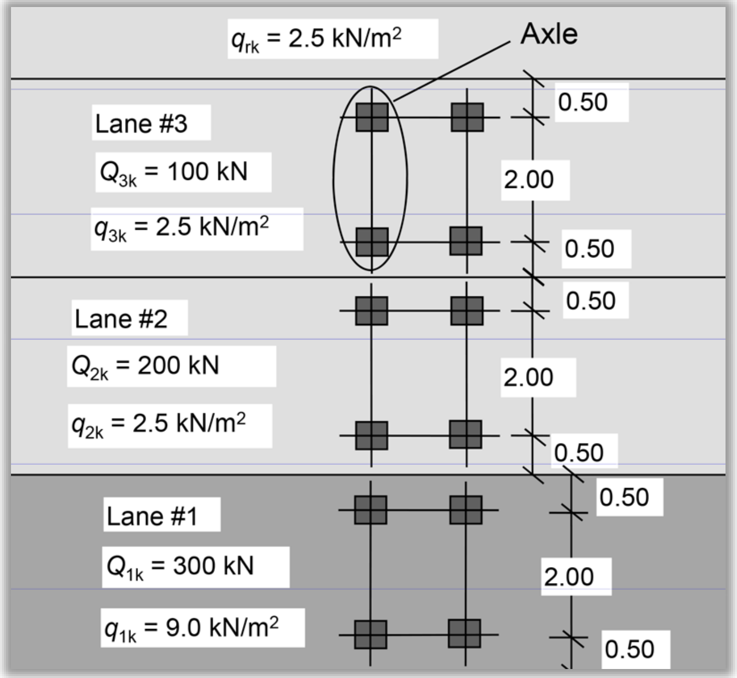
STN EN 1992 Eurocode 2: Design of concrete structures
- Part 1-1: General rules and rules for buildings
- Part 2: Concrete bridges - Design and detailing rules

Load Model 1 (LM1)

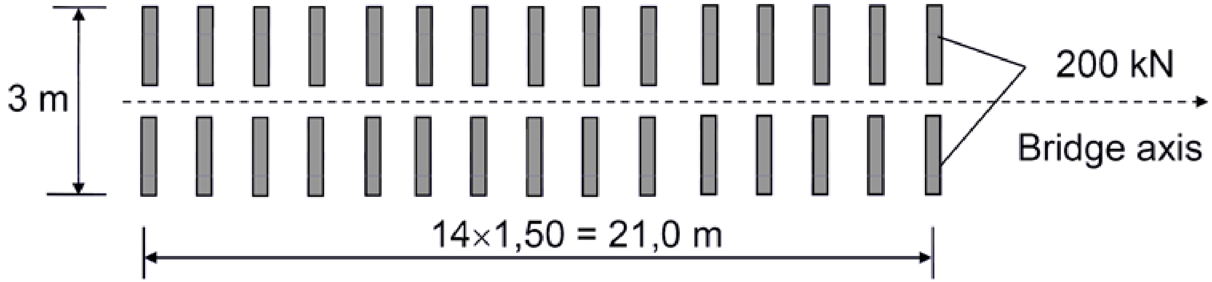
1st part: Double-axle concentrated load (**T**andem **S**ystem - TS), where each axle as the weight of $\boldsymbol{\alpha_{Qi}.Q_{ik}}$. (amplification is included)

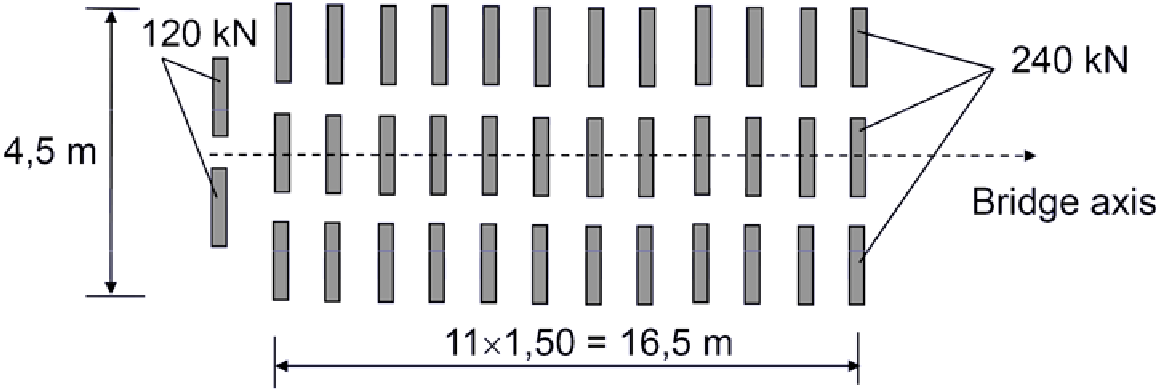
2nd part: Uniformly distributed load **UDL** having weight per square meter αqi.qik

Adjustment factors αQi, αqi are selected depending on the expected traffic and on different classes of routes.



Models of special vehicle 3000 kN (National Annex)





Specific rules for road bridges are introduced in STN EN 1990
Basis of Structural Design, Annex A2: Applications for bridges (normative)

1. Neither snow loads nor wind actions should be combined with:
   a) Braking and acceleration forces on road bridges, or centrifugal forces or the associated group of loads **gr2** (important for design of substructure)
   b) Loads on footways and cycle tracks or with assoc. group of loads **gr3**
   c) Crowd loading on road bridges (LM4), or with assoc. group of loads **gr4**

2. Snow loads should not be combined with Load Models 1 and 2 or with associated groups of loads **gr1a** and **gr1b** except for roofed bridges.

3. Wind actions and thermal actions should not be taken into account simultaneously (important for design of bearings and expansion joints)

Specific rules for road bridges

4. No wind action, greater then smaller value of $\mathbf{F_{w*}}$ and $\boldsymbol{\psi_0 . F_{Wk}}$ should be combined with Load Model 1 with the associated group of loads **gr1a**.

where:

$\mathbf{F_{W*}}$ is wind action on the bridge computed with basic velocity of wind 23 m/s
$\mathbf{F_{Wk}}$ is wind action on the bridge computed with wind velocity based on local conditions

EN 1990, Basis of structural design, EN 1991 (Eurocode 1), Actions on structures

The Serbian Chamber of Engineers in cooperation with the European Council of Engineers Chambers (ECEC) organized a lecture on **the topic "EN 1990, Basis of structural design, EN 1991 (Eurocode 1), Actions on structures", by Rüdiger Höffer Ph.D.**, CE, Ruhr-Universität, Bochum, DE. The lecture was held on 15.05.2015.

The lecture, which was organized in 4 segments, provided insight into the important basic characteristics of European norms EN 1990 and EN 1991, as well as examples and instructions for optimizing the practical application of these norms.

EN 1990 - Basics of designing structures

EN 1991 Part 1-1: General effects - Density, weight of construction, imposed loads

Part 1-3: General effects - Snow load

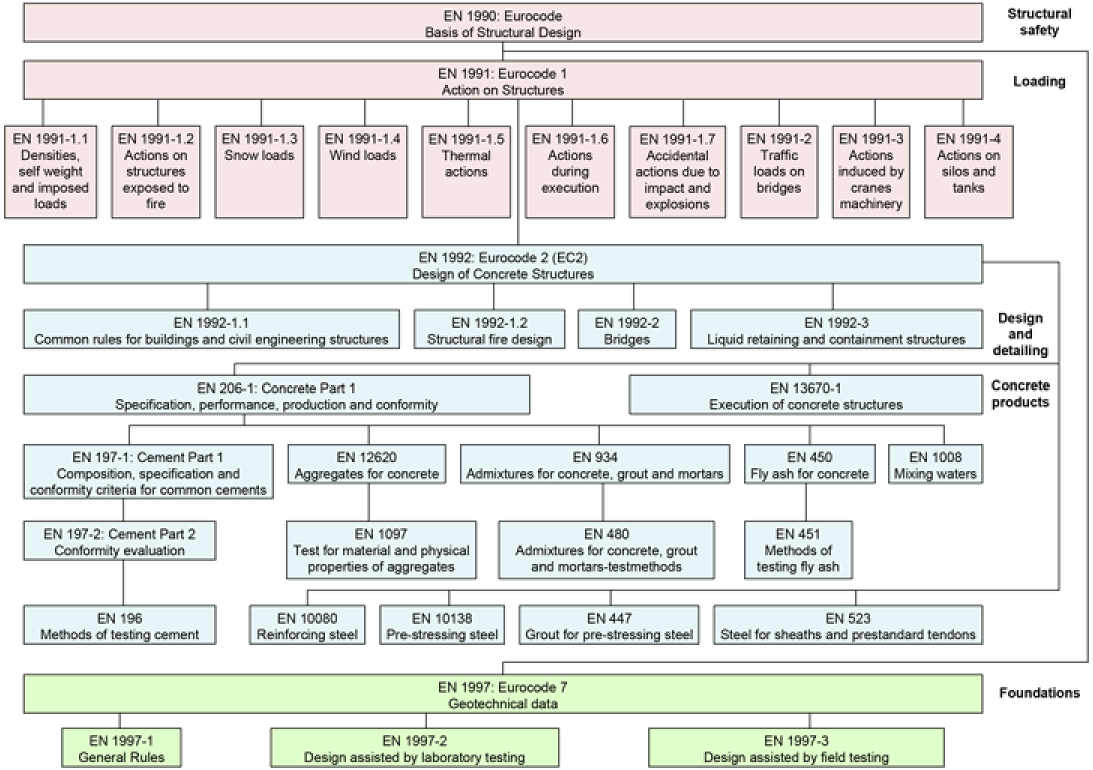
Part 1-4: General effects - Wind load

Part 1-7: General facts - Random loads.

The lecture in the form of a **webinar** was available in the chambers of **Austria, Italy, Montenegro, Slovenia, Slovakia** and **Bulgaria.**

In the Serbian Chamber of Engineers, the lecture was attended by 225 engineers.

Structural Eurocodes



Eurocode 1: Actions on Structures

EN 1991-1-1	General actions – Desities, self-weight, imposed loads for buildings : 2002 + Correction AC:2009
EN 1991-1-3	General actions – Snow loads : 2003 + AC:2009
EN 1991-1-4	General actions – Wind actions : 2005(E) Amendment A1:2010 Correction AC:2010
EN 1991-1-5	General actions – Thermal actions : 2003 Correction AC:2009
EN 1991-1-6	General actions, Actions during execution : 2005 Correction AC:2008
EN 1991-1-7	General actions – Accidental actions : 2006 Correction AC:2010

EN 1991-2 Traffic loads on Bridges : 2004

EN 1991-3 Actions induced by cranes and machinery : 2006

EN 1991-4 General actions – Silos and tanks : 2006

EN 1991-1-2 General actions – Actions due to fire : 2003

Risks in Civil Engineering

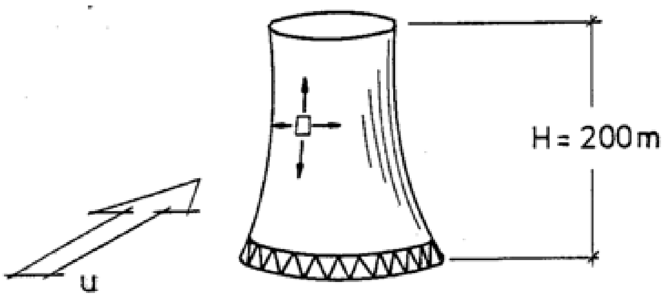
Storm

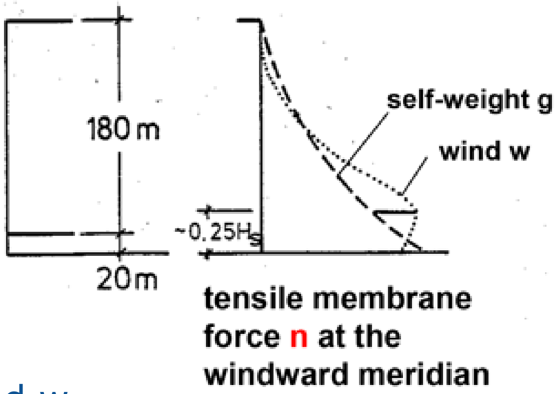
Earthquake

Fire

Water

Partial Factor Concept in EN 1990





Actions: self weight g, wind load w

Resistance: yield strength of the reinforcement $A_s \cdot \beta_s$

Global safety factor γ_{tot} applied to design the shell for tensile strength:

$$\gamma_{tot} \cdot (n_w - n_g) \leq A_s \cdot \beta_s$$

Self-weight is compressive, it diminishes the tensile wind force:

The shell cannot carry $\gamma_{tot} \cdot w$ when designed with a global factor.

Such a goal would be achieved by the following design equation:

$$\gamma_{tot} \cdot n_w - n_g \leq A_s \cdot \beta_s$$

Partial Factor Concept in EN 1990

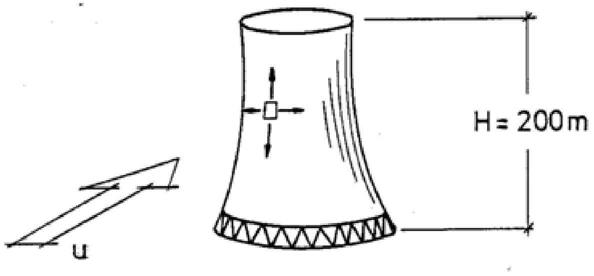
5.11.1965.

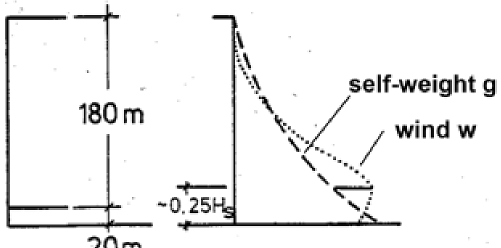
In a strong gale, three Cooling Towers at the Ferrybridge Power Station, UK, collapse due to tensile failure of the reinforcement at the windward side

Principal failure causes

1. Small shell bending stiffness due to Single layer reinforcement, low natural frequencies, increase of resonant response to turbulence;
2. Load amplification due to flow Interference;
3. **Unified safety factor instead of partial concept**

Partial Factor Concept in EN 1990





Concept of partial safety factors

$$\gamma_w \cdot n_w - \gamma_g \cdot n_g \leq A_s \cdot \beta_s / \gamma_M$$

VGB-BTR 2005:

$$1.6 \cdot n_w - 1.0 \cdot n_g \leq A_s \cdot \beta_s / 1.15$$

The shell is now designed to carry 1,6-times the nominal wind load against 1/1,15 times the nominal tensile strength.

Partial Factor Concept in EN 1990

EN 1990 does not apply directly the ***design values*** but utilises the ***partial factor design*** consisting of the following steps:

(1) **Characteristic values** of the basic variables actions F_k, and of the material properties X_k are introduced.

Characteristic values are typically:

- for variable actions Q:	Q_k is the 0,98-quantile of the yearly extremes;
- for permanent actions G:	G_k is the mean value;
- for accidental actions A:	A_d is a nominal value used as design value;
- for strength of materials X:	X_k is the 5%-quantile.

(2) **Design values of actions F** are specified by using partial load factors γ_F:

$F_d = \gamma_F F_k$ for a leading action, or

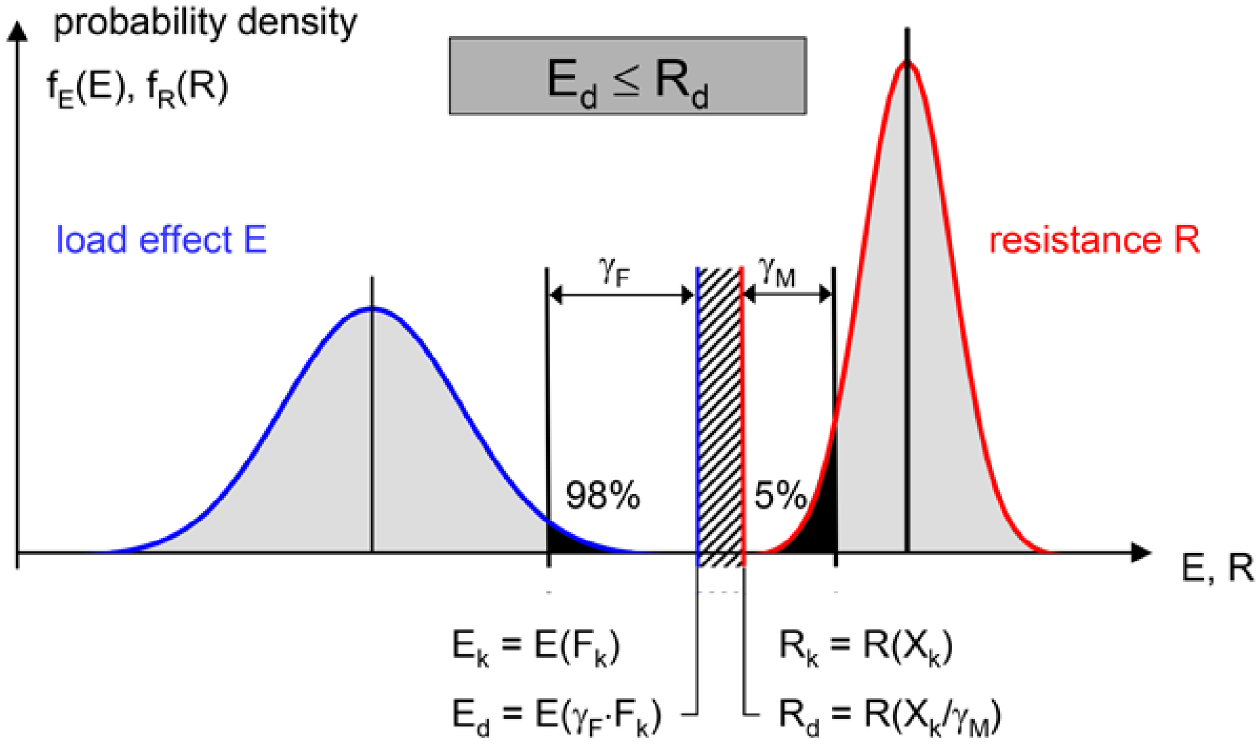
$F_d = \gamma_F \cdot \psi \cdot F_k$ for an accompanying action;

Design values of material properties X are specified by partial material factors γ_m : $X_d = X_k / \gamma_m$

(3) The **design values of action effect and resistance** are calculated as

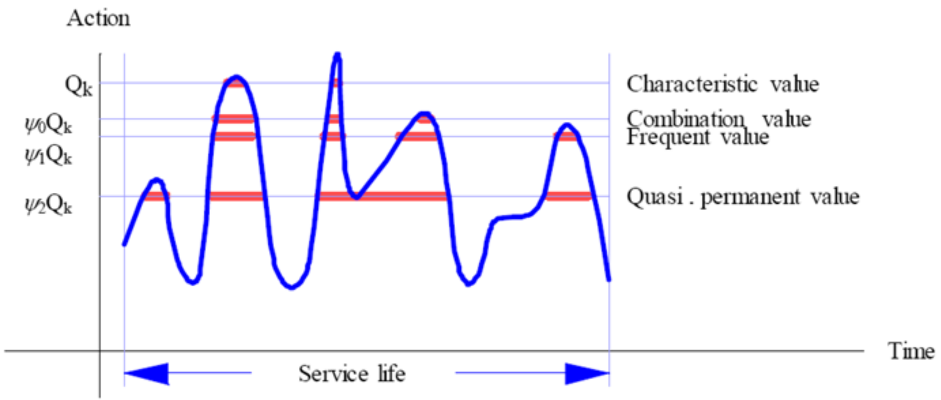
$$E_d = E\{\gamma_F \cdot F_k; \gamma_F \cdot \psi \cdot F_k \} \leq R_d = R\{X_k/\gamma_m\}$$

Partial Factor Concept in EN 1990
Summary of Verification Procedure



Partial Factor Concept in EN 1990

If **several variable actions** have to be considered, the combination of actions consists of the **leading action Q_{k1}** and the **accompanying actions $\psi \cdot Q_{kj}$**, where ψ is the factor for accompanying actions, $\psi \leq 1$



The factor ψ, covers the following situations:

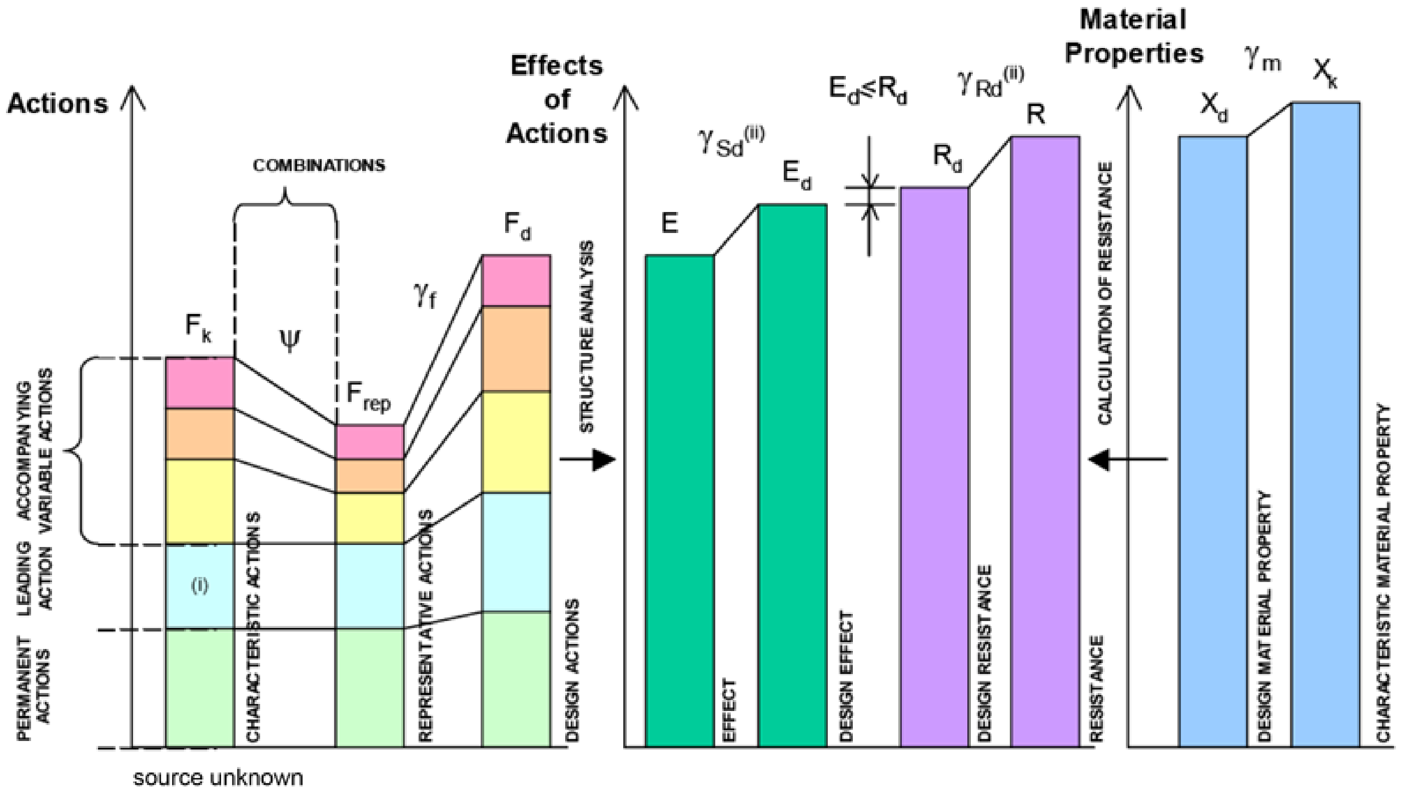
- the combination value of a variable action $\psi_0 \cdot Q_k$
- the frequent value of a variable action $\psi_1 \cdot Q_k$
- the quasi-permanent value of a variable action $\psi_2 \cdot Q_k$

Partial Factor Concept in EN 1990

Variable loads and related ψ-factors

Action	ψ_0	ψ_1	ψ_2
Imposed loads in buildings, category (see EN 1991- 1.1)			
Category A: domestic, residential areas	0,7	0,5	0,3
Category B: office areas	0,7	0,5	0,3
Category C: congregation areas	0,7	0,7	0,6
Category D: shopping areas	0,7	0,7	0,6
Category E: storage areas	1,0	0,9	0,8
Category F: traffic area, vehicle weight ≤ 30kN	0,7	0,7	0,6
Category G: traffic area, 30kN < vehicle weight ≤ 160kN	0,7	0,5	0,3
Category H: roofs	0	0	0
Snow loads on buildings (see EN 1991-1-3)			
– Finland, Iceland, Norway, Sweden	0,70	0,50	0,20
– Remainder of CEN Member States, for sites located at altitude H > 1000 m a.s.l.	0,70	0,50	0,20
– Remainder of CEN Member States, for sites located at altitude H ≤ 1000 m a.s.l.	0,50	0,20	0
Wind loads on buildings (see EN 1991-1-4)	0,6	0,2	0
Temperature (non-fire) in buildings (see EN 1991-1-5)	0,6	0,5	0
Note: The ψ values may set by the National annex.			

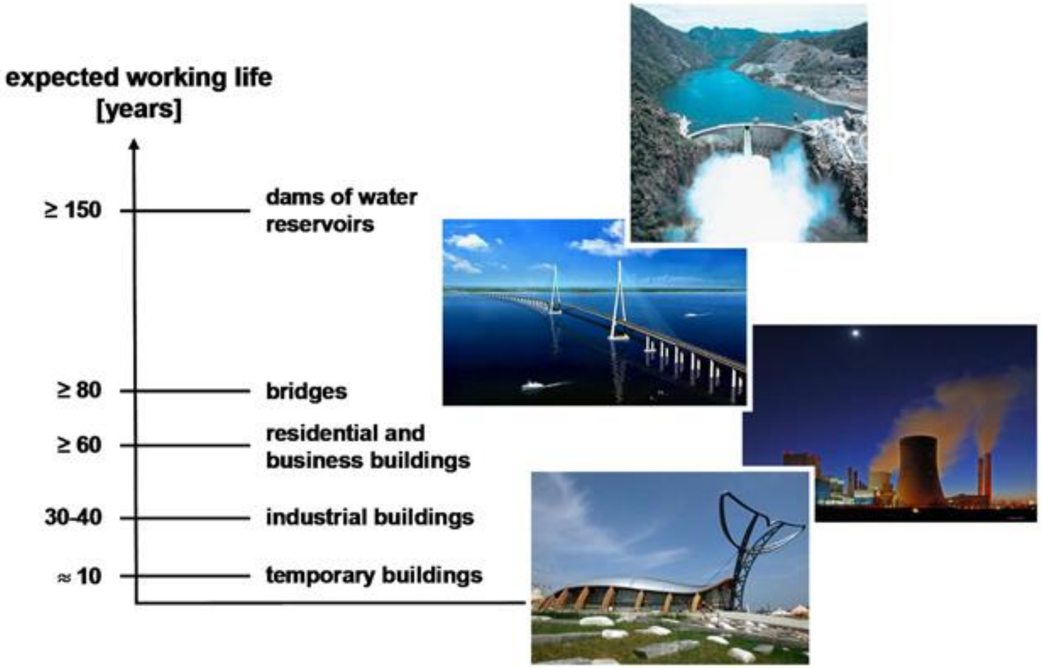
Partial Factor Concept in EN 1990



Design working life

Definition in EN 1990

assumed period for which a structure or part of it is to be used for its intended purpose with anticipated maintenance but without major repair being necessary



Design working life

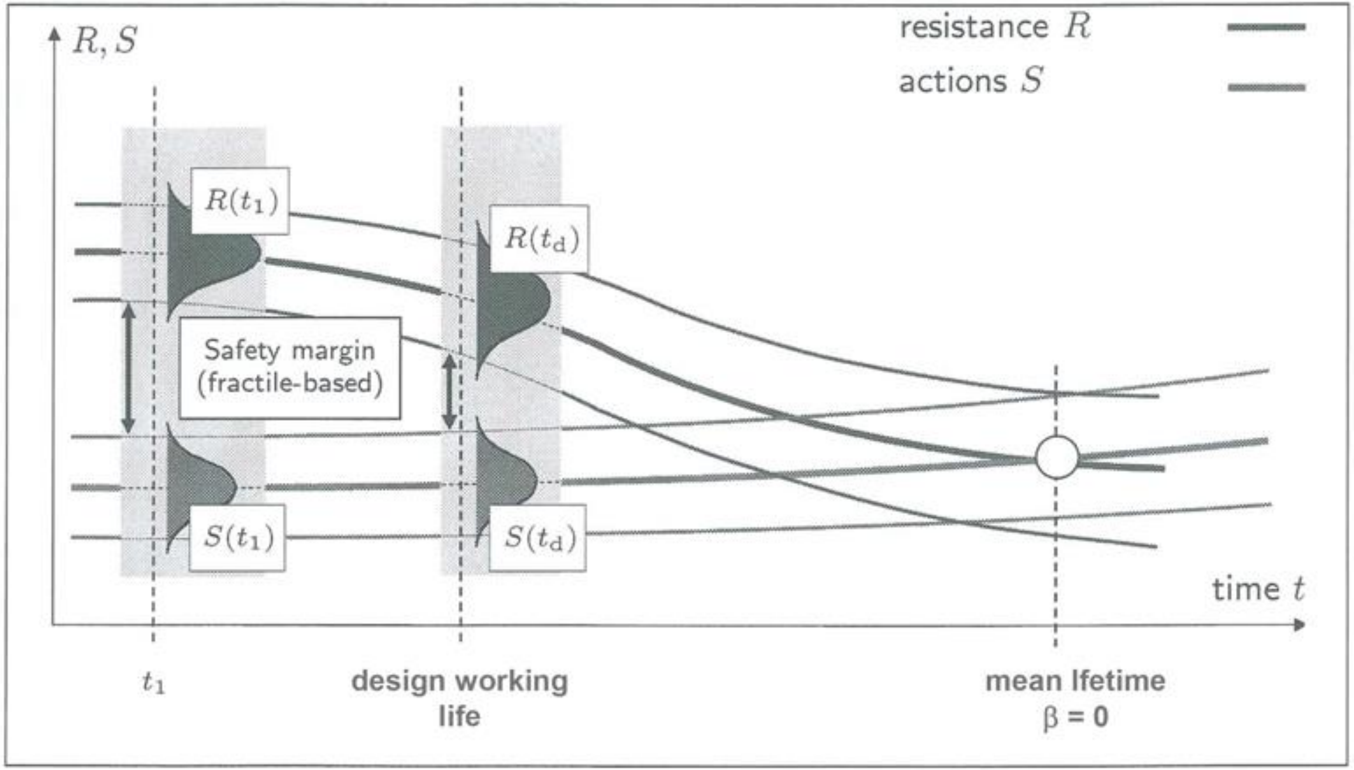
(1) The design working life should be specified.

NOTE Indicative categories are given in Table 2.1. The values given in Table 2.1 may also be used for determining time-dependent performance (*e.g.* fatigue-related calculations). See also Annex A.

Table 2.1 - Indicative design working life

Design working life category	**Indicative design working life (years)**	**Examples**
1	10	Temporary structures (1)
2	10 to 25	Replaceable structural parts, e.g. gantry girders, bearings
3	15 to 30	Agricultural and similar structures
4	50	Building structures and other common structures
5	100	Monumental building structures, bridges, and other civil engineering structures
(1) Structures or parts of structures that can be dismantled with a view to being re-used should not be considered as temporary.		

Design working life



EN 1991-1-1 Densities, self weight, imposed loads for buildings

EN 1991-1-1 gives design guidance and actions for the structural design of buildings and civil engineering works including some geotechnical aspects for the following subjects:

- densities of construction materials and stored materials

- self-weight of construction works
- imposed loads for buildings

Background documents:

- ISO 9194 Basis for Design of Structures – Actions due to Self - Weight of Structures, non Structural Elements and Stored materials – Density;
- CIB Report 115/89 Int. Council for research and innovation in building and construction Actions on Structures, Self-Weight Loads;
- CIB Report 116/89 Int. Council for research and innovation in building and construction Actions on Structures, Live Loads in Buildings;
- National Standards of CEN member states;

EN 1991-1-1 Densities, self weight, imposed loads for buildings

National annex for EN 1991-1-1

This standard gives alternative procedures, values and recommendations for classes with notes indicating where national choices have to be made, therefore the National Standard implementing EN 1991-1-1 should have a National Annex containing all Nationally Determined Parameters to be used for the design of buildings and civil engineering works to be constructed in the relevant country.

National choice is allowed in EN 1991-1-1 through:

2.2(3)	Dynamic effects due to rhythmical movement of people
5.2.3(1) to 5.2.3(5)	Non-structural parts and ballast on bridges
6.3.1.1 (Table 6.1)	Residential, social, commercial, administration areas
6.3.1.2(1)P (Table 6.2)	Values of imposed loads on floors, balconies, stairs
6.3.1.2(10) & (11)	Reduction factor αA
6.3.2.2 (1)P (Table 6.4)	Values of imposed loads on floors due to storage
6.3.2.2 (3)	Horizontal forces due to stored materials after Annex A
6.3.3.2(1) (Table 6.8)	Imposed loads on garages and vehicle traffic areas
6.3.4.2 (Table 6.10)	Imposed loads on roofs of category H
6.4 (1)(P) (Table 6.12)	Horizontal loads on partition walls and parapets

EN 1991-1-1 Densities, self weight, imposed loads for buildings

National choice is allowed in EN 1991-1-1 through:

2.2(3)	**Dynamic effects due to rhythmical movement of people**
5.2.3(1) to 5.2.3(5)	Non-structural parts and ballast on bridges
6.3.1.1 (Table 6.1)	**Residential, social, commercial, administration areas**
6.3.1.2(1)P (Table 6.2)	**Values of imposed loads on floors, balconies, stairs**
6.3.1.2(10) & (11)	**Reduction factor**
6.3.2.2 (1)P (Table 6.4)	**Values of imposed loads on floors due to storage**
6.3.2.2 (3)	Horizontal forces due to stored materials after Annex A
6.3.3.2(1) (Table 6.8)	**Imposed loads on garages and vehicle traffic areas**
6.3.4.2 (Table 6.10)	**Imposed loads on roofs of category H**
6.4 (1)(P) (Table 6.12)	**Horizontal loads on partition walls and parapets**

Snow Loads on the Ground

s_k – characteristic snow load on the ground

The characteristic value at a location is determined from snow load records as the value having a return period of 50 yrs.

The National Annex specifies the values to be used, e.g. in form of a snow map.

$s_d = \gamma_s s_k$ – design snow load on the ground

The partial factor for the persistent/transient design situation is typically $\gamma_s = 1{,}5$

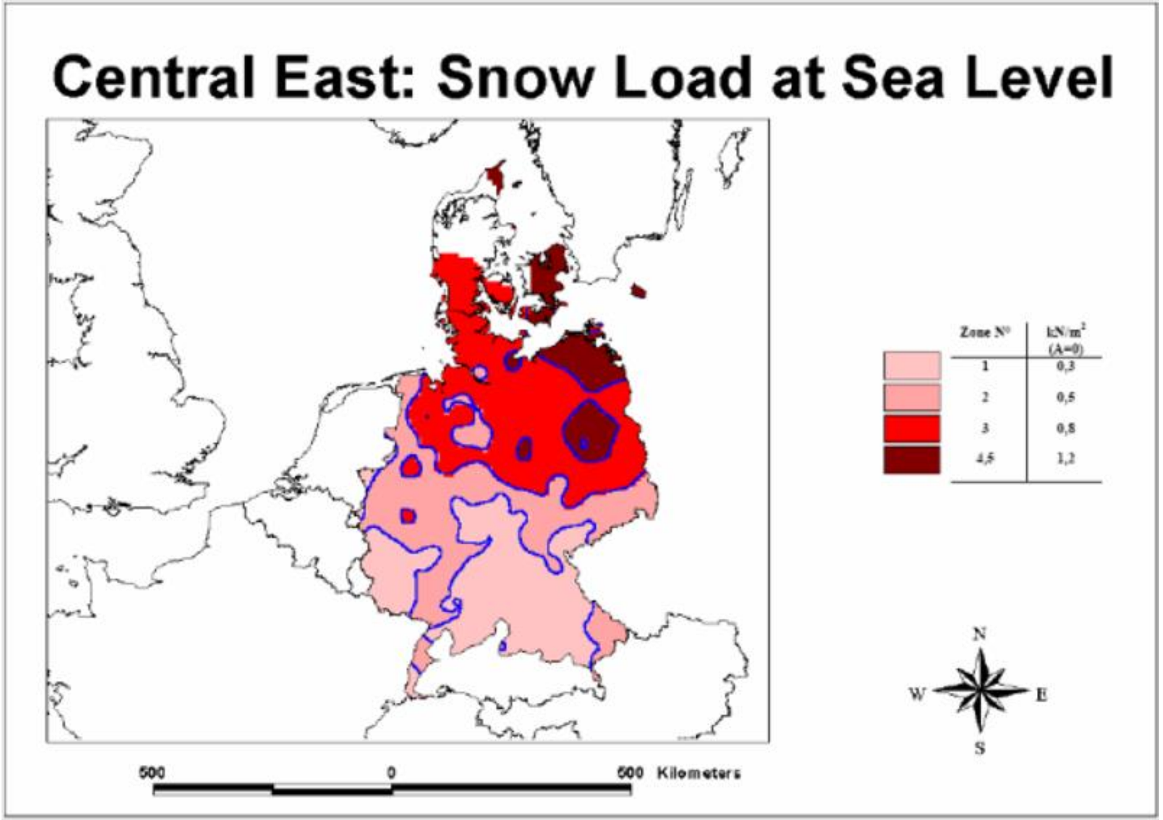
$s_{Ad} = C_{esl} s_k$ – accidental snow load on the ground

At particular locations, exceptionally high snow loads may occur which do not match with the statistical parameters obtained from the other data (outlier). Then

(1) The characteristic value is determined removing the outlier from the records;

(2) The outlier is taken into account by an accidental design situation with $s_{Ad} = C_{esl} s_k$

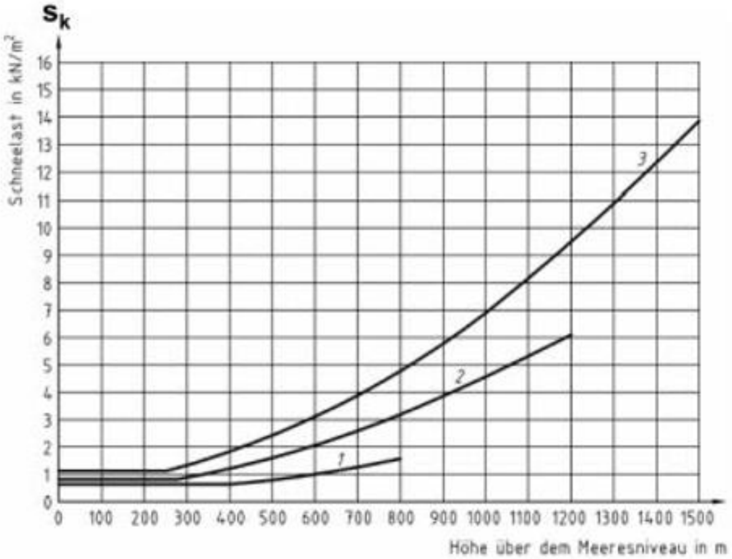
(3) The recommended value of is $C_{esl} = 2{,}0$



Annex C (informative):
European Ground Snow Maps

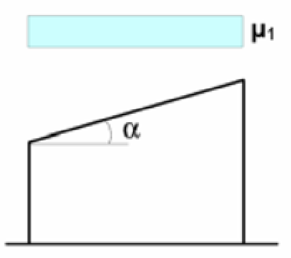
Ground Snow Load Map of Germany

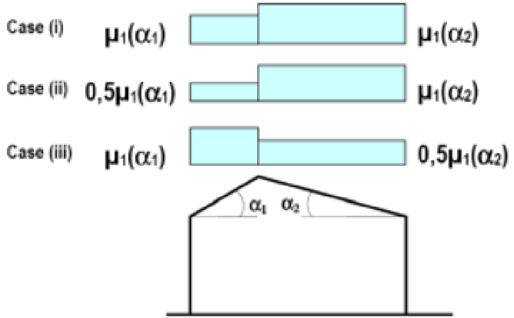
Bild 1 — Schneelastzonenkarte



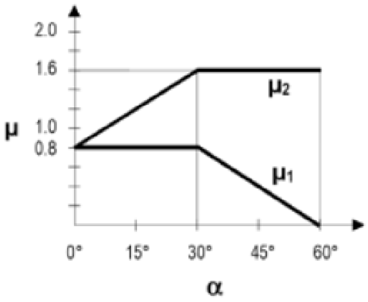
Snow Loads on Roofs: Roof Shape Coefficients μ

Load cases to be considered for single span roofs without snow fences

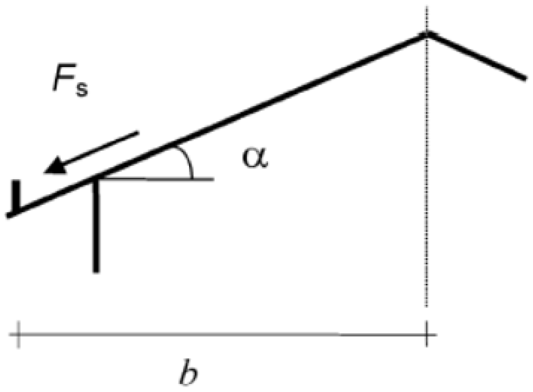




Roof shape coefficients μ



Snow Loads on Roofs: Local effects



$$F_s = \mu_i \cdot s_k \cdot b \cdot \sin \alpha$$

(3) Snow on snow guards or fences due to snow sliding down a pitched or curved roofAt projections and obstructions

Exceptional Snow Drifts
Annex B gives additional snow load arrangements for cases of exceptional snow drift. This load case is treated as an accidental design situation.

Ice Pavilion Bad Reichenhall: Roof Failure under Snow Load
2. January 2006

Ice Pavilion Bad Reichenhall: Roof Failure under Snow Load 2. January 2006

Possible Causes of the failure

The roof structure was designed in 1975 as timber box girders.
The design was to carry a characteristic snow load of $s = 1{,}2$ kN/m² in accordance with DIN 1055-5 (1975)

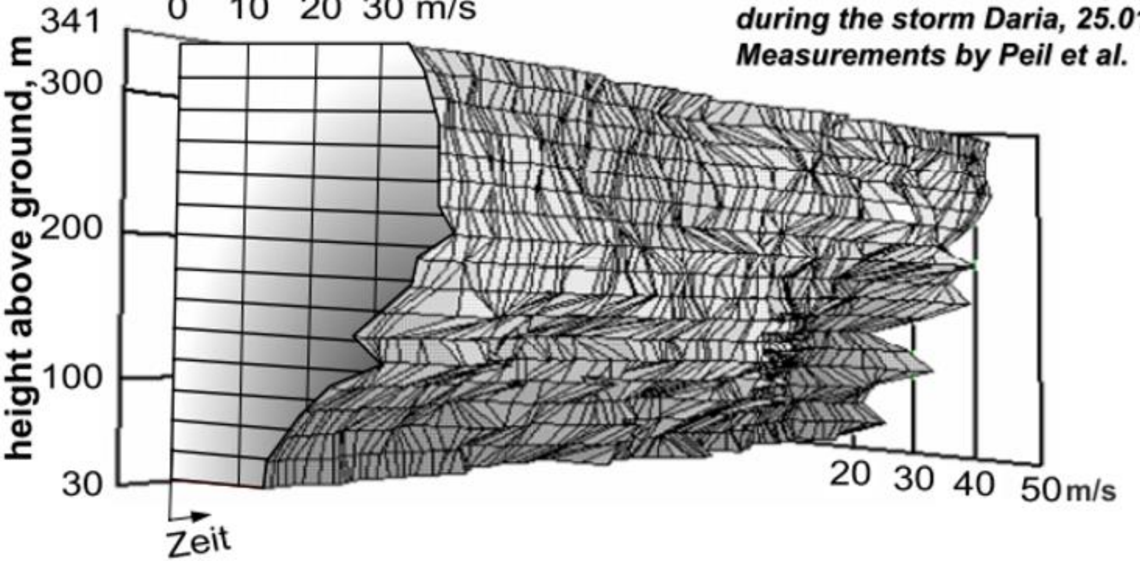
In 2006, a new DIN 1055-5 code became effective requiring a snow load of $s = 1{,}75$ kN/m² for new structures and buildings.

The real snow load at the time of the failure was estimated from preceding precipitation, resulting in $s = 0{,}9$ kN/m²

Clearly, the failure was not caused by too small a design snow load.
The timber box girders of the roof failed due to

- applying inappropriate wood glue in the fabrication;
- insufficient maintenance.

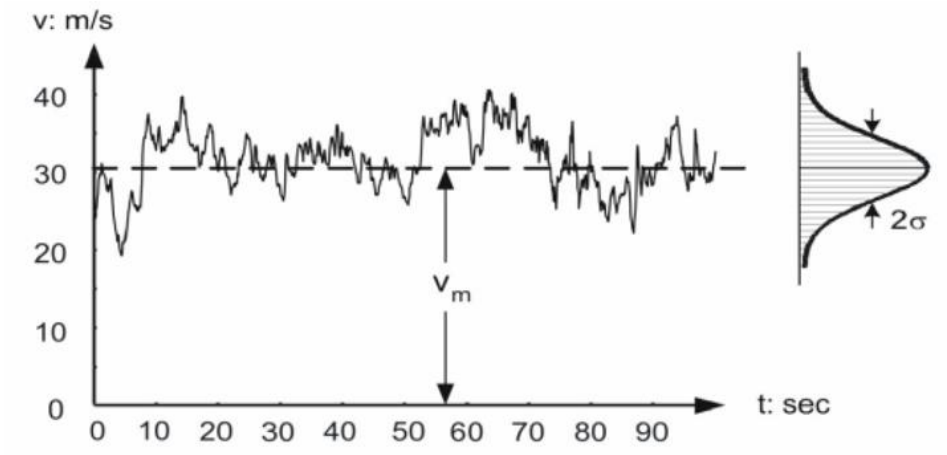
Wind Speed and Turbulence



20 s interval of the wind speed during the storm Daria, 25.01.1990 Measurements by Peil et al.

The atmospheric wind is a stochastic process, described by its statistical parameters:
point parameters: mean value, standard deviation, spectra ;
field parameters: correlations, cross-spectra.

Wind Speed and Turbulence



Time series of the wind velocity at a point

Statistical point parameters

v_m - the mean wind velocity;
σ_v - the standard deviation of velocity fluctuations due to wind turbulence;
I_v - the intensity of wind turbulence,
$I_v = \sigma_v / v_m$.

Wind Speed and Turbulence

Windzone	$v_{b,0}$	$q_{b,0}$
WZ 1	22,5 m/s	0,32 kN/m²
WZ 2	25,0 m/s	0,39 kN/m²
WZ 3	27,5 m/s	0,47 kN/m²
WZ 4	30,0 m/s	0,56 kN/m²

Wind Pressures

Wind Pressures have to be applied if the structural stresses are not correctly reflected when using *wind forces* in the static calculations.

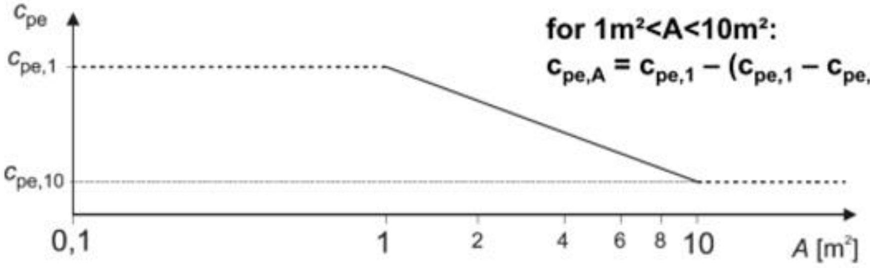
Examples:
Wind forces are adequate for chimneys, whereas pressure distributions are required to calculate the load effects on cooling tower shells, silos, frames …

Wind Pressures are calculated based exclusively on the *peak velocity pressure* q_p. Dynamic effects are not considered.

The size effect is taken into account in the pressure coefficients for loaded areas only in the range between 1 m² and 10 m².

Wind Pressures – Effect of Loaded Area

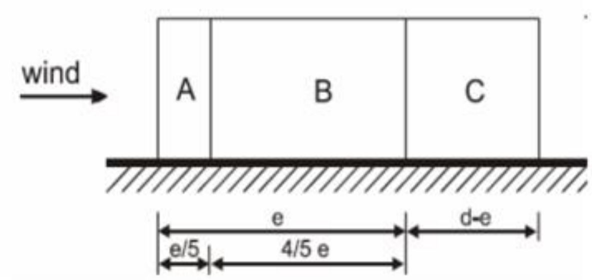
The size effect is considered for loaded areas A up to 10m².



for 1m²<A<10m²:

$$c_{pe,A} = c_{pe,1} - (c_{pe,1} - c_{pe,10}) \cdot \lg A$$

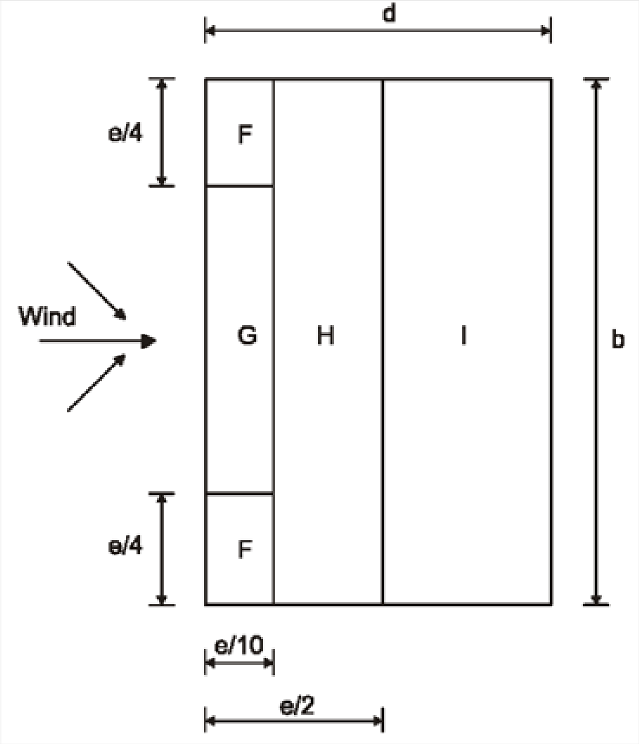
Example: Vertical walls of rectangular plan buildings

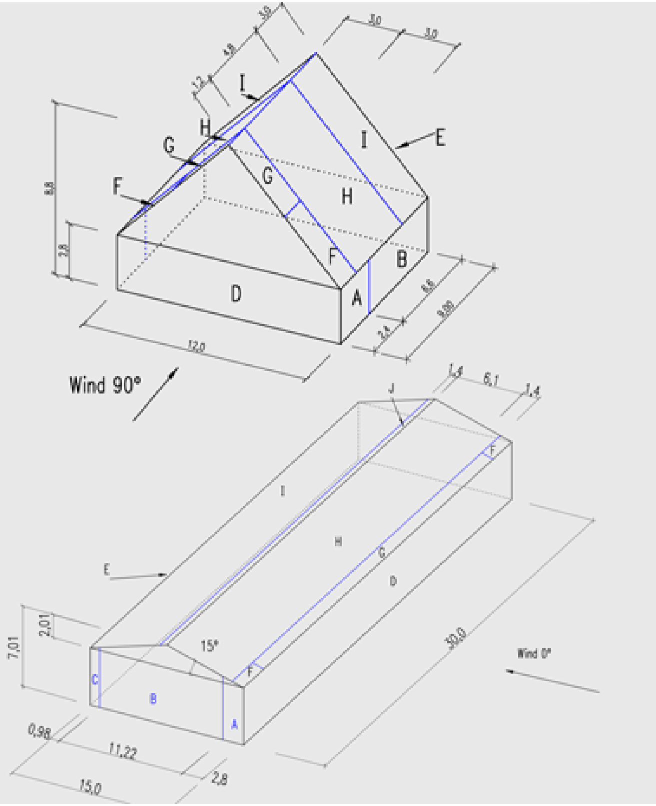


e=b or 2h whichever is smaller

Zone	A		B		C	
h/d	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$
5	-1,2	-1,4	-0,8	-1,1	-0,5	
1	-1,2	-1,4	-0,8	-1,1	-0,5	
≤ 0,25	-1,2	-1,4	-0,8	-1,1	-0,5	

Wind Pressures – Effect of Loaded Area (cont.-d)





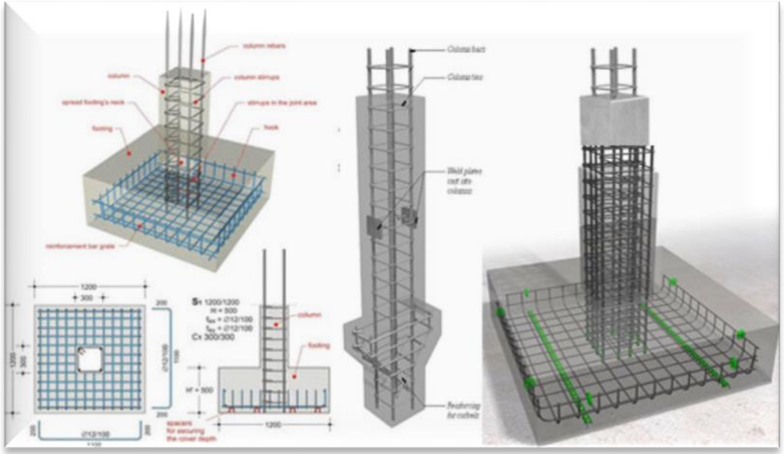
Wind Pressures on Large Roofs –Effect of Loaded Area

MSV Arena Duisburg

Windkanaleinbauten

BayArena Leverkusen

Design of reinforced concrete structures according to EN 1992-1-1, Eurocode 2



In the organization of the Serbian Chamber of Engineers, the Chamber of Engineers of Slovakia and the European Council of Engineering Chambers in the Chamber's premises via video transmission, on September 16th, the lecture was held in Bratislava on the topic **"Design of reinforced concrete structures according to EN 1992-1-1, Eurocode 2".**The lecturer was **Ph.D. Vladimir Benko**, Civ.Eng., Full Professor at the Faculty of Civil Engineering, University of Bratislava, and President of the Engineering Chamber.

Cross-section of the situation and application of Eurocodes in Serbia from EN 1990 to EN 1999

The lecture on the topic **"Cross-section of the situation and application of Eurocodes in Serbia from EN 1990 to EN 1999"** was held on 04.12.2014. in the Serbian Chamber of Engineers in Novi Sad.

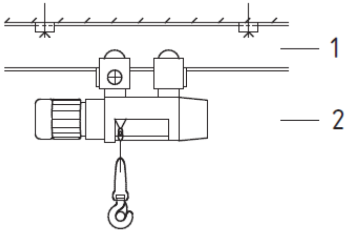
The lecture was given by **Ph.D. Zlatko Marković, civ.eng**.

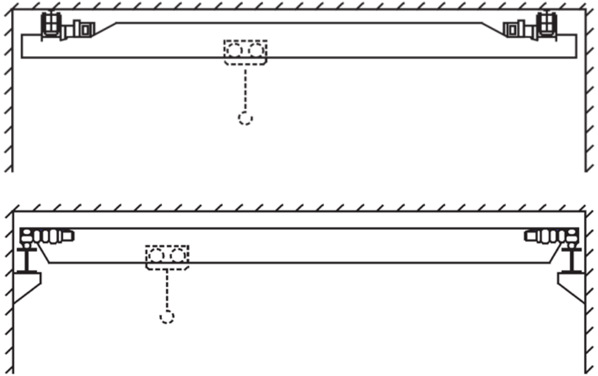
The aim of this lecture was to get acquainted the professional public with the current situation in the construction regulations in Serbia, regarding the **introduction of eurocodes** in our construction practice.

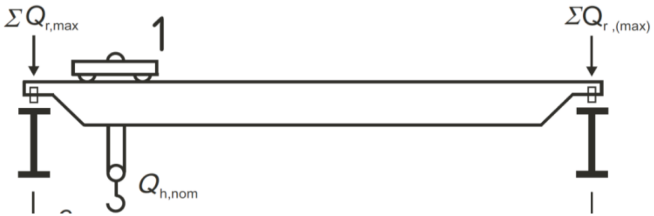
Eurocodes for the calculation of steel structures

"Eurocodes for the calculation of steel structures - current state" lecture was held on 16.04.2015. in the big conference hall at the Fair in Belgrade.

Ph.D. Zlatko Marković, civ.eng., was engaged as a lecturer.







Thank you for your attention!

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