European Commission

EN 1991
Elaboration of NA

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Introduction
Work organization in CSI (HZN)

- *TC548 was founded in Croatia as mirror Committee of CEN/TC250.*
- *SC1 was founded for EC 1.*
- *One institution/firm may have had more members in Committee/Subcommittee, but only one vote.*
- *Problem! Academic institutions were allocated only one vote the same as a firm with only one employee (democracy at work?).*

Introduction

Work organization in CSI (HZN)

- *The least members in Committee/Subcommittees came from industry and construction companies.*
- *They consequently contributed the least to the process of enactment of National Annexes.*
- *Most active members were prominent structural designers and members of academia.*

Introduction

Work organization in CSI (HZN)

- *Proposal for a National Annex was made within SC1.*
- *TC548 adopted or rejected (never) a proposal for particular National Annex.*
- *Public inquiry was held.*
- *Study of comments/objections was done in SC1.*
- *Final adoption of NA in TC548.*

Introduction

Time frame for drafting National Annexes

- *Most important and time-consuming was the work in SC1, particularly on climatic actions.*
- *Lengthy period after final adoption of a National Annex (language-editing, text processing, announcement in Croatian Standards Institute (HZN) official gazette, finally availability of a National Annex).*
- *National Annexes were released (2012) only in Croatian (translation into English is in progress).*

List of EN 1991 standards

STANDARD	ACTION
EN 1991-1-1	*GA – Densities, self-weight, loads for buildings*
EN 1991-1-2	*GA – Actions on structures exposed to fire*
EN 1991-1-3	*GA – Snow loads*
EN 1991-1-4	*GA – Wind actions*
EN 1991-1-5	*GA – Thermal actions*
EN 1991-1-6	*GA – Actions during execution*
EN 1991-1-7	*GA – Accidental actions*
EN 1991-2	*Traffic loads on bridges*
EN 1991-3	*Actions induced by cranes and machinery*
EN 1991-4	*Silos and tanks*

Croatian National Annexes

- ***Main features:***
  - *More detailed elaboration of particular clauses;*
  - *Various more detailed classifications;*
  - *Choice of just one design procedure, where more are offered;*
  - *Additional NCCI pertaining to items not covered in original EC 1 standards or clarifying given clauses.*

Number of total, accepted and modified NDP (+ NCCI)

Standard	NDP				NCCI
	Total	Accepted	Modified	Accepted in %	
EN 1991-1-1	10	4	6	40,0	0
EN 1991-1-2	7	5	0	100,0	0
EN 1991-1-3	32	12	20	37,5	0
EN 1991-1-4	77	53	24	68,8	5
EN 1991-1-5	24	20	4	83,3	0
EN 1991-1-6	24	21	3	87,5	0
EN 1991-1-7	43	28	15	65,1	12
EN 1991-2	89	72	17	80,9	26
EN 1991-3	7	7	0	100,0	0
EN 1991-4	7	7	0	100,0	0

HRN EN 1991-1-1/NA: Densities, self-weight, loads for buildings
modified NDP

- *Loads for buildings are specified in more detail than in the original standard.*

- *Tables 6.1, 6.2 & 6.3 are replaced and supplemented by Table 6.1(HR).*
- *Tables 6.4, 6.8, 6.10 & 6.12 on imposed loads are replaced and supplemented by corresponding Tables 6.4(HR), 6.8(HR), 6.10(HR) and 6.12(HR), respectively.*

HRN EN 1991-1-1/NA: Densities, self-weight, loads for buildings
modified NDP

- *Table 6.1(HR) – Imposed loads on floors, balconies and stairs in buildings*

Column	1		2	3	4	5
Row	**Category**		**Specific Use**	**Example**	q_k [kN/m²]	Q_k[a] [kN]
1	A	A1	Nonresidential attics	Unsuitable for dwelling but accessible attics with clearing up to 1.8 m in height	1,5	1,0
2		A2	Areas for domestic and residential activities	Floors with satisfactory lateral distribution of loads[b] in residential buildings and houses, bedrooms, hospitals (wards), bedrooms in hotels and hostels and kitchens and toilets belonging to.	1,5	-
3		A3		A2, but without satisfactory lateral distribution of loads	2,0[c]	1,0
4	B	B1	Office areas, working areas, hallways	Hallways in office buildings, offices, dispensaries without heavy equipment, hospital departments, waiting rooms, stables with small livestock	2,0	2,0
5		B2		Hallways and kitchens in hospitals, hotels, nursing homes, hallways in boarding houses, etc., areas for medical treatments in hospitals including surgeries without heavy equipment, basement areas in residential buildings	3,0	3,0
6		B3		All areas in B1 and B2 but with heavy equipment[d]	5,0	4,0

HRN EN 1991-1-1/NA: Densities, self-weight, loads for buildings

modified NDP

Column	1		2	3	4	5
Row	**Category**		**Specific use**	**Example**	q_k [kN/m²]	Q_k^a [kN]
7	C	C1	Conference rooms, areas where people may congregate (with the exception of areas defined under category A, B and D[1)])	Areas with tables, e.g. kindergartens, nurseries, schools, classrooms, cafes, restaurants, dining halls, reading rooms, receptions, staff rooms	3,0	4,0
8		C2		Areas with fixed seats, e.g. areas in churches, theaters, cinemas, conference rooms, lecture halls, waiting rooms	4,0	4,0
9		C3		Public areas, e.g. museums, exhibition areas, access areas in public buildings and hotels, basement floors which are under the patio (courtyard) where the vehicles are not allowed, hallways of the categories C1 to C3	5,0	4,0
10		C4		Areas for sport and play, e.g. dancing halls, sport centers, gymnastic and weight-lifting rooms, stages	5,0	7,0
11		C5		Areas intended for large crowds, e.g. in buildings like concert halls, terraces, access areas, stands with fixed seats	5,0	4,0
12		C6		Areas for frequent gathering of the large crowds, stands without fixed seats	7,5	10,0
13	D	D1	Shopping areas	Shopping areas up to 50m² surface area in residential, office and similar buildings	2,0	2,0
14		D2		Areas in shops and department stores	5,0	4,0
15		D3		Areas as in D2 but with larger loads because of the high storage racks	5,0	7,0

HRN EN 1991-1-1/NA: Densities, self-weight, loads for buildings
modified NDP

Row	Category		Specific use	Example	q_k [kN/m²]	Q_k[a] [kN]
16	E	E1.1	Storehouses factories and workshops, stables, storage areas and access areas	Areas in factories[e] and workshops[e] with light production machinery, stables for large livestock	5,0[f]	4,0
17		E1.2		General storage areas, including libraries	6,0[f]	7,0
18		E2.1		Areas in factories[e] and workshops[e] with moderately heavy or heavy production machinery	7,5	10,0
19	S[g]	S1	Stairs and stair platforms	Stairs and stair platforms in residential and office buildings and dispensaries, without heavy equipment	3,0	2,0
20		S2		All stairs and stair platforms which cannot be categorized as S1 or S3	5,0	2,0
21		S3		Access areas and stairs leading to stands without fixed seats, used as emergency exits	7,5	3,0
22	P[g]		Access areas, balconies, etc.	Roof terraces, porches, balconies, exit platforms	4,0	2,0

HRN EN 1991-1-1/NA: Densities, self-weight, loads for buildings

modified NDP

[a] If local verification of bearing is necessary (e.g. for the parts of the system without satisfactory lateral distribution of loads), verification is carried out with characteristic values of the concentrated load Q_k without combining with uniformly distributed load q_k. Concentrated load Q_k is distributed on the square 50 mm width.

[b] Floors with satisfactory lateral distribution of loads are reinforced and prestressed concrete solid, hollow-core and ribbed slabs.

[c] For the transmission of the forces from the floors without satisfactory lateral distribution to the supporting elements, given value may be reduced by 0,5 kN/m^2.

[d] These values are minimum values. If, according to the clause 6.1(4) of the HRN EN 1991-1-1:2012, larger values are defined, such defined values are relevant.

[e] Imposed loads in factories and workshops are considered as mostly static. In some cases the effect of fluctuating load should be considered (see clause 2.2(3) of HRN EN 1991-1-1:2012).

[f] These values are minimum values. In cases where larger load is expected, it should be determined for each case separately.

[g] These categories apply for all types of structures or parts of the structures. Factor for combination value of variable action in accordance to HRN EN 1990, Table A1.1, for these categories are defined according to the category (A-E) of the structure or part of the structure.

HRN EN 1991-1-2/NA: Actions on structures exposed to fire

- *This standard gives general principles and rules, independent of material.*
- *Standards for particular materials „Structural fire design”:*

Concrete structures:	*EN 1992-1-2*
Steel structures:	*EN 1993-1-2*
Composite structures:	*EN 1994-1-2*
Timber structures:	*EN 1995-1-2*
Masonry structures:	*EN 1996-1-2*
Aluminium structures:	*EN 1999-1-2*

HRN EN 1991-1-2/NA: Actions on structures exposed to fire

- *All recommended NDP are accepted.*

Croatian NA to climatic actions

- *HRN EN 1991-1-3/NA: Snow loads*
- *HRN EN 1991-1-4/NA: Wind actions*
- *HRN EN 1991-1-5/NA: Thermal actions*
- *These NA were made in close collaboration with Meteorological and Hydrological Service of Croatia (DHMZ), which provided snow zonation maps, wind zonation maps of fundamental value of basic wind velocity 20-48 m/s and zonation maps of max/min shade air temperatures.*

HRN EN 1991-1-3/NA: Snow loads
modified NDP

- *Applies also for sites at altitudes above 1500 m.*
- *Annex A – „Design situations and load arrangements to be used for different locations" is applied for all locations.*
- *Annex B – „Snow load case coefficients for exceptional snow drifts" is not to be used.*
- *Exceptional snow loads and exceptional snow drifts are not treated as accidental actions.*

HRN EN 1991-1-3/NA: Snow loads
modified NDP

- *No reference is made to Annex C – „European ground snow load maps".*
- *Possible rainfalls on the snow are already included in characteristic values.*
- *Characteristic value of snow load on the ground is defined in snow zonation maps by Meteorological and Hydrological Service of Croatia (DHMZ) after lengthy discussions with SC1 members.*

HRN EN 1991-1-3/NA: Snow loads
modified NDP

- *Characteristic snow load on the ground s_k*
- *1. zone: 0,50 kN/m^2 up to 800 m altitude – coastal areas and islands*
- *2. zone: 0,75 kN/m^2 up to 300 m altitude – hinterland of Dalmatia, Primorje and Istria*
- *3. zone: 1,00 kN/m^2 up to 100 m altitude – continental Croatia*
- *4. zone: 1,25 kN/m^2 up to 100 m altitude – mountainous Croatia*

HRN EN 1991-1-3/NA: Snow loads
modified NDP

- *Zonation of characteristic snow load on the ground s_k*

HRN EN 1991-1-3/NA: Snow loads
modified NDP

Values from Table 1(HR) are used for higher altitudes.

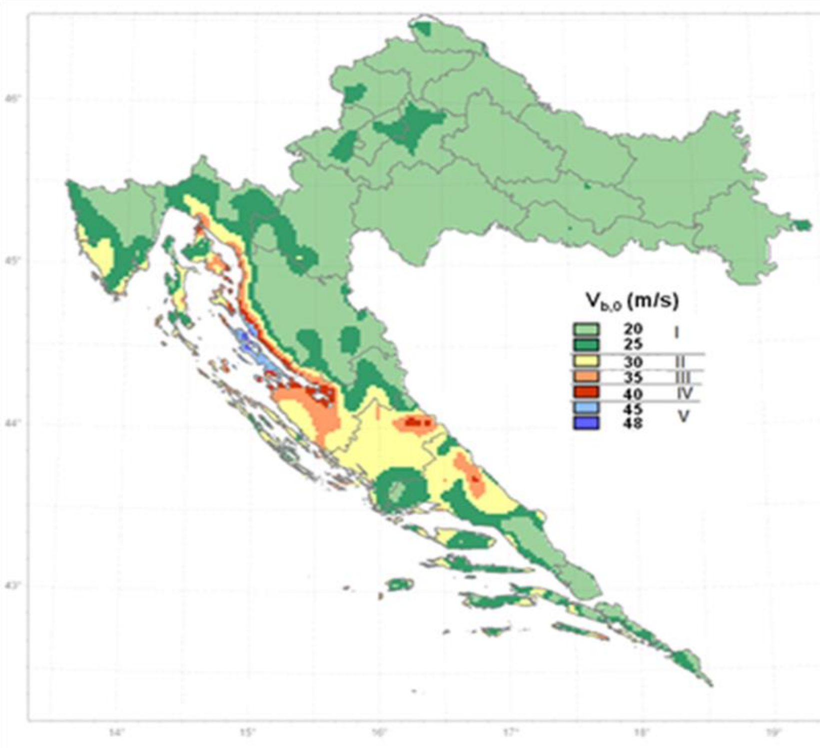
Altitude (above sea level) (m)	1. zone - Coastal areas and islands 0,50 (kN/m²)	2. zone - Hinterland of Dalmatia, Primorje and Istria 0,75 (kN/m²)	3. zone – Continental Croatia 1,00 (kN/m²)	4. zone - Mountainous Croatia 1,25 (kN/m²)
100	0,50	0,75	1,00	1,25
200	0,50	0,75	1,25	1,50
300	0,50	0,75	1,50	1,75
400	0,50	1,00	1,75	2,00
500	0,50	1,25	2,00	2,50
600	0,50	1,50	2,25	3,00
700	0,50	2,00	2,50	3,50
800	0,50	2,50	2,75	4,00
900	1,00	3,00	3,00	4,50
1000	2,00	4,00	3,50	5,00
1100	3,00	5,00	4,00	5,50
1200	4,00	6,00	4,50	6,00
1300	5,00	7,00		7,00
1400	6,00	8,00		8,00
1500		9,00		9,00
1600		10,00		10,00
1700		11,00		11,00
1800		12,00		

HRN EN 1991-1-4/NA: Wind actions
modified NDP

- *Extensive National Annex of 32 pages*
- *Contains 77 NDP clauses and 5 NCCI clauses*
- *Comprehensive work on wind velocities was produced by Meteorological and Hydrological Service of Croatia (DHMZ) after numerous objections from SC1 members.*
- *Wind zonation maps are provided by DHMZ - fundamental value of basic wind velocity 20-48 m/s.*

HRN EN 1991-1-4/NA: Wind actions
modified NDP

- *Fundamental value of basic wind speed $v_{b,0}$*



HRN EN 1991-1-4/NA: Wind actions
modified NDP

- *Exceptionally, for antenna towers and masts built outside the settlements at the locations without presence of people (except for authorized personnel) and for the fundamental value of the basic wind velocity $v_{b,0} > 30$ m/s, following expression for the peak velocity pressure $q_p(z)$ may be used:*

  $q_p(z) = k_B(z) \times c_e(z) \times q_b \; ; \; k_B(z) = z^{\beta}$

  β values for different values of $v_{b,0}$ are specified

HRN EN 1991-1-4/NA: Wind actions
modified NDP

- *Largest values of basic wind velocity are in regions of „bora" wind on the Adriatic coast.*
- *For vertical walls of rectangular plan buildings Table 7.1 is replaced by Table 2(HR).*
- *For effective slenderness λ and end-effect factor ψ Table 7.16 is replaced by Table 4(HR) defining effective slenderness λ.*

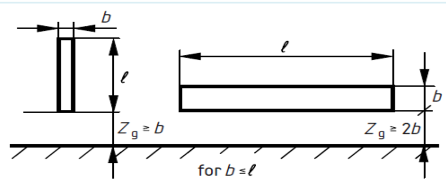
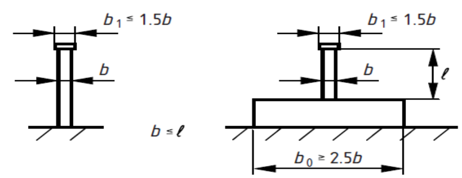
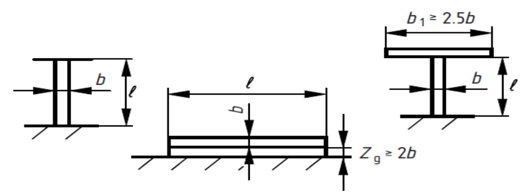
HRN EN 1991-1-4/NA: Wind actions
modified NDP

- *Modified values of external pressure coefficients for vertical walls of rectangular plan buildings in Table 2(HR)*

Zone	**A**		**B**		**C**		**D**		**E**	
h/d	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$
≥ 5	-1,4	-1,7	-0,8	-1,1	-0,5	-0,7	+0,8	+1,0	-0,5	-0,7
1	-1,2	-1,4	-0,8	-1,1	-0,5		+0,8	+1,0	-0,5	
≤ 0,25	-1,2	-1,4	-0,8	-1,1	-0,5		+0,7	+1,0	-0,3	-0,5
NOTE: For individual buildings on open terrain on leeward side larger forces may occur. For intermediate values, linear interpolation may be applied. For buildings with *h/d* > 5, the total wind loading should be determined based on the provisions given in 7.6 to 7.8 and 7.9.2.										

HRN EN 1991-1-4/NA: Wind actions
modified NDP

- *Table 4(HR) - Values of effective slenderness λ for cylinders, polygonal sections, rectangular sections, sharp edged structural sections and lattice structures*

<table>
<tr><th>Position of the structure, wind normal to the plane of the page</th><th>Effective slenderness λ</th></tr>
<tr><td>
</td><td>$\lambda = (l/b)(2/c_{f,o})$</td></tr>
<tr><td>
</td><td>$\lambda = (2l/b)(2/c_{f,o})$</td></tr>
<tr><td>
</td><td>$\lambda = \infty$</td></tr>
</table>

HRN EN 1991-1-4/NA: Wind actions
modified NDP

- *Conditions to be fulfilled are specified so that tests to determine wind load on structures which are not susceptible to vibrations (statically loaded structures) are correctly conducted.*

- *Additional tests to be fulfilled are specified so that tests of response of structures which are susceptible to vibrations (dynamically loaded structures) are conducted correctly.*

HRN EN 1991-1-4/NA: Wind actions
modified NDP

- *Influence of altitude on basic wind velocity v_b is included in fundamental value of the basic wind velocity $v_{b,0}$.*

- *Maximum value of the peak velocity pressure $q_p(z)$, where road traffic is considered to be simultaneous with the wind, should be limited to* 640 Pa *(corresponds to relevant peak wind velocity of* 32 m/s *at the level of the traffic lane).*

HRN EN 1991-1-4/NA: Wind actions
modified NDP

- *Maximum value of the peak velocity pressure $q_p(z)$, where railway traffic is considered to be simultaneous with the wind, should be limited to* 760 Pa *(corresponds to relevant peak wind velocity of* 35 m/s *at the level of the traffic lane).*
- *For normal track width and for the cant u=0, characteristic wind action on empty train is obtained as* w_k=1.17 kN/m^2.

HRN EN 1991-1-4/NA: Wind actions
modified NDP

- *Dynamic response along the wind direction (x – direction) usually should not be checked for the finished (bridge during service) road and railway bridges with the span less than 200 m.*
- *Conditions are specified, which if fulfilled allow dynamic effects due to vertical response to wind to be neglected.*
- *Criteria which should be used to assess whether a bridge is susceptible to aerodynamic excitation are specified.*

HRN EN 1991-1-4/NA: Wind actions
modified NDP

- *Values of the wind load factor C for bridges are specified in Table 5(HR).*

b/d_{tot}	$z_e \leq 20$ m	$z_e = 50$ m
≤ 0,5	7,4	9,1
≥ 4,0	4,0	4,9
NOTE: Tabulated values of C are simplification of the product c_e and $c_{f,x}$. Generally, individual values of c_e and $c_{f,x}$ shall be taken.		

HRN EN 1991-1-4/NA: Wind actions
modified NDP

- *In order to take into account transition between different roughness categories when calculating peak pressure q_p and structural factor $c_s c_d$ the Procedure 1 should be used.*
- *For the calculation of cross wind amplitude, which is caused by turbulence, recommended Approach 1 from clause E.1.5.2 in 1991-1-4:2012 should be used.*
- *Approach 2 should not be used.*

HRN EN 1991-1-4/NA: Wind actions
modified NDP

- *Annex A – „Terrain effects" may be used.*
- *Annex B – „Procedure 1 for determining the structural factor $c_s c_d$" may be used.*
- *Annex C – „Procedure 2 for determining the structural factor $c_s c_d$" should not be used.*
- *Annex D – „$c_s c_d$ values for different types of structures" should not be used.*

HRN EN 1991-1-4/NA: Wind actions
modified NDP

- *Annex E – „Vortex shedding and aeroelastic instabilities" may be used, except clause 1.5.3 which should not be used.*
- *Annex F – „Dynamic characteristics of structures" may be used.*

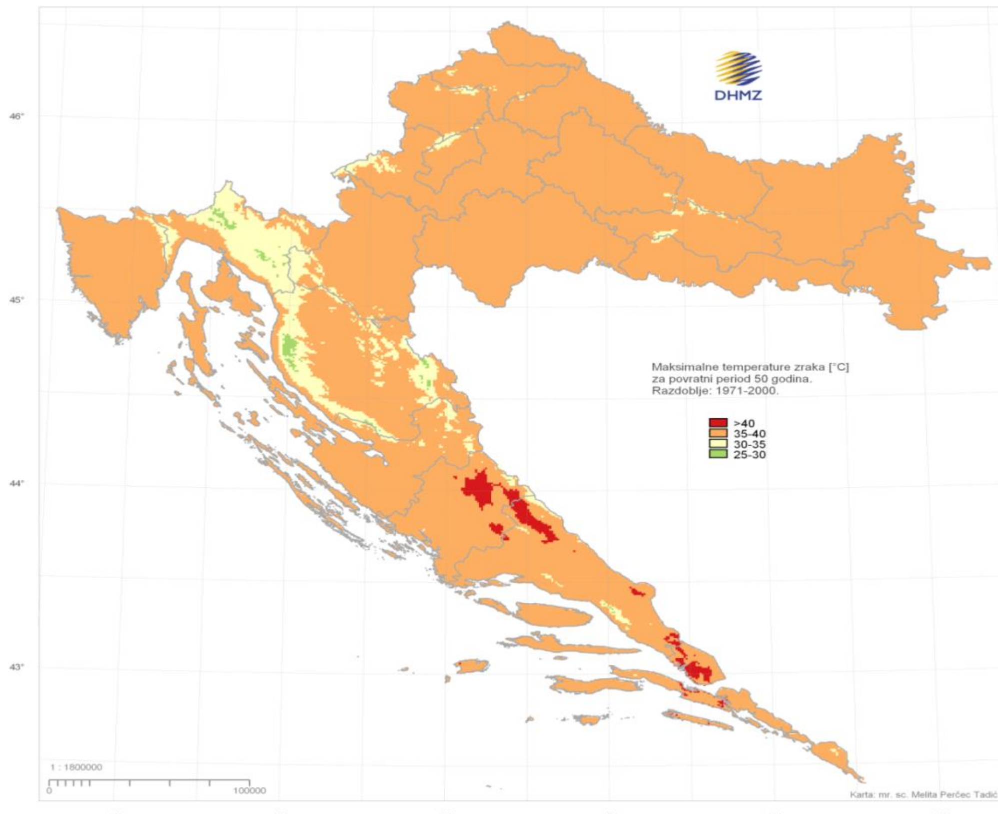
HRN EN 1991-1-4/NA: Wind actions
NCCI

- *Structures and parts of the structures are considered as not sensitive to vibrations caused by dynamic wind action if deformation caused by wind effect is not increased more than 10% due to turbulence in resonance with the structure.*

- *For residential, commercial and industrial buildings and other similar buildings with heights up to 25 m it may be assumed, without special checks, that they are not sensitive to vibrations.*

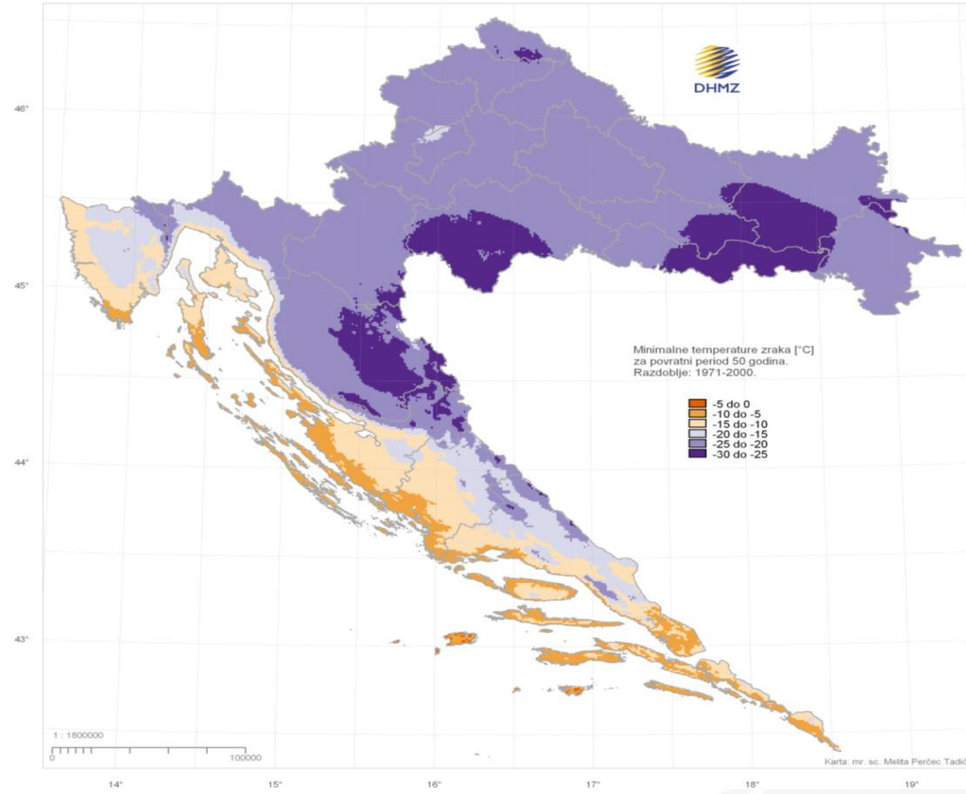
HRN EN 1991-1-5: Thermal actions
modified NDP

- *Map of maximum values of shade air temperatures* T_{max}



HRN EN 1991-1-5: Thermal actions
modified NDP

- *Map of minimum values of shade air temperatures T_{max}*



HRN EN 1991-1-5: Thermal actions
modified NDP

- *Alternatively, as simplification, for whole territory of the Republic of Croatia maximum values of shade air temperatures* T_{max}*=+40° C and minimum shade air temperatures* T_{min}*=-25° C may be used, except for the Adriatic islands where* T_{min}*=-10° C.*

HRN EN 1991-1-5: Thermal actions
modified NDP

- *In design of bridges Approach 1 is adopted (vertical linear component of temperature difference).*
- *In design of bridges differences in uniform temperature component between different structural elements are taken into account by an increase of 15°C.*

HRN EN 1991-1-6: Actions during execution

- *Recommended return periods for climatic actions depending on nominal duration of execution phase t:*

Nominal duration of execution phase *t*	**Return period *T* (years)**	**Annual probability of exceedance *p***
≤ 3 days	2 (a)	$p = 0{,}5$
3 days < t ≤ 3 months	5 (b)	$p = 0{,}2$
3 months < t ≤ 1 year	10	$p = 0{,}1$
t > 1 year	50	$p = 0{,}02$

(a) Nominal duration 3 days – reliable weather forecast
(b) Nominal duration up to 3 months – appropriate seasonal and short-term meteorological climatic variations

HRN EN 1991-1-6: Actions during execution

- *Reduction factors for actions $Q_{k,R}$ for various return periods T and coefficient of variation v = 0,2 (return period 5 years):*

Return period *T*	*p*	Reduction factor *k*			
		Thermal action $T_{max,R}$	Thermal action $T_{min,R}$	Snow load $s_{n,R}$	Wind load $v_{b,R}$
2	0,50	0,80	0,45	0,64	0,77
5	0,20	0,86	0,63	0,75	0,85
10	0,10	0,91	0,74	0,83	0,90
50	0,02	1,00	1,00	1,00	1,00

HRN EN 1991-1-6: Actions during execution
modified NDP

- *Combination values Ψ for accidental actions on buildings:*

Variable loads	ψ_0[a]	ψ_2[b]
Working personnel and small equipment (Q_{ca})	0,5	0,2
Storage of movable items (Q_{cb})	0,5	0,2
Temporary equipment (Q_{cc})	0,5	0,2
Movable heavy machines and equipment (Q_{cd}) frequent usage periodical usage	 0,6 0,6	 0,5 0
Temperature actions[b]	0,5	0
Wind actions[b] (Q_{wn})	0,5	0
Snow actions[b] (Q_{sn})	0,5	0
Water actions[b] (Q_{wa})	0,5	0
[a] To take into account only when simultaneity is possible. [b] To apply only on representative values.		

HRN EN 1991-1-6: Actions during execution
modified NDP

- *Combination values Ψ for accidental actions on bridges:*

Variable loads	ψ_0[a]	ψ_2[b]
Working personnel and small equipment (Q_{ca})	0,4	0,2
Storage of movable items (Q_{cb})	0,4	0,2
Temporary equipment (Q_{cc})	1,0	1,0
Movable heavy machines and equipment (Q_{cd})	To be specified in technical requirements for the individual project	
Horizontal forces (F_h)	1,0	0
Wind actions (where simultaneity is possible) (Q_{wn})	0,8	0
Snow loads (where simultaneity is possible) (Q_{sn})	0,8	0
Temperature and shrinkage[b]	0,6	0
Water actions (Q_{wa})	To be specified in technical requirements for the individual project	
[a] To take into account only when simultaneity is possible. [b] To apply only on representative values.		

HRN EN 1991-1-7: Accidental actions

- *Contains concepts of safety, risk and hazard (like EN 1990)*
- *Gives strategies and rules for safeguarding buildings and other civil engineering works against identifiable and unindentifiable accidental actions*
- *Defines strategies based on:*
- *Identified accidental actions (design for sufficient robustness, protection measures, design to sustain the action)*
- *Limiting the extent of localized failure – unindentifiable accidental actions (enhanced redundancy, integrity and ductility, key element designed to sustain accidental action)*

HRN EN 1991-1-7: Accidental actions

- *Typical examples of identifiable accidental actions are fire, some explosions, earthquakes, impacts, floods, avalanches and landslides.*
- *Unindentifiable accidental actions include human errors in design and construction, improper use, exposure to aggressive agencies, failure of equipment, terrorist attacks, warfare, etc.*
- *Only general guidelines are given and hence Croatian NA contains many specific supplements.*

HRN EN 1991-1-7: Accidental actions

- *Typical examples of identifiable accidental actions are fire, some explosions, earthquakes, impacts, floods, avalanches and landslides.*
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- *Only general guidelines are given and hence Croatian NA contains many specific supplements*

HRN EN 1991-1-7: Accidental actions
modified NDP

- *Consequence classes for buildings are defined.*
- *Equivalent static impact forces from road vehicles are defined.*
- *Criteria for classification of the superstructures above or besides railways according to the safety requirements are defined.*
- *Equivalent static impact forces from railway vehicles for superstructures without overheads outside the railway station areas are defined.*

HRN EN 1991-1-7: Accidental actions
modified NDP

- *Equivalent static impact forces from railway vehicles for superstructures with overheads and structures inside the railway station areas are defined.*
- *Procedures for internal explosions are given and rules for an adequate tie system are specified, including tie design forces, tie positioning and detailing.*

HRN EN 1991-1-7: Accidental actions
modified NDP

- *Table 1(HR) - Categorisation in respect to consequence classes*

Consequence classes	Types of the buildings[a]
CC1	- buildings up to 7 m in height[b] - agricultural buildings
CC2.1	- buildings from 7 m to 13 m in height[b]
CC2.2	- buildings which can not be categorized as consequence class 1, 2.1 or 3 and all buildings categorized as consequence class 3, up to 13 m in height[b]
CC3	- tall buildings (buildings more than 22 m in height[b]) - buildings more than 22 m in height[b], as follows: - shopping centers with shops and streets with the total area more than 2000 m^2 - buildings for more than 200 people, except residential and office buildings - other public buildings where, because of their purpose, large crowd may sometimes congregate and where the area of the largest story is greater than 1600 m^2 - buildings with areas whose purpose is connected with the usage or storage of explosive materials or materials with increased risk of fire

[a] If the listed building in the table can be categorized into several consequence classes, the highest class is relevant.
[b] Height is distance from the upper edge of the finished floor of the highest residence story to the average ground level.

HRN EN 1991-1-7: Accidental actions
modified NDP

- *Table 2(HR) – Equivalent static impact forces from road vehicles*

	1	2	3
	Category	**Equivalent static impact force [MN]**	
		F_{dx} in the direction of normal travel	**F_{dy} perpendicular to the direction of normal travel**
1	roads outside the settlements	1,5	0,15
2	roads in the settlement for the velocity $v \geq 50$ km/h[a]	1,0	0,5
	roads in the settlement for the velocity $v < 50$ km/h[a,b]		
3	- with projected building corners	0,5	0,5
4	- any other case	0,25	0,25
5	traffic areas where lorries operate (e.g. yards), i.e. buildings for the traffic of personal vehicles > 30 kN	0,1	0,1
6	traffic areas for the personal vehicles	0,050	0,025
7	- with the speed limit $v \leq 50$ km/h	0,015	0,008
8	canopies of the gas stations[b,c]	0,1	0,1
	-garages for personal vehicles ≤ 30 kN - single/double garage		
9	-any other case	0,01	0,01
10		0,04	0,025

[a] To be used only if supporting element is exposed to the danger of direct impact of the road vehicles.
[b] To be used only if the safety of the building/canopy is compromised due to failure of supporting element.
[c] To be used only if the supporting elements are not near the continuous traffic, otherwise same as rows 1 to 4.

HRN EN 1991-1-7: Accidental actions

modified NDP

- *Table 3(HR) – Criteria for classification of the superstructures according to the safety requirements*

Type and position of superstructure	Normal safety requirements	Increased safety requirements
Superstructures without overhead (Class B)		
-above the railway platforms	if $v \le 120$ km/h[c]	if $v > 120$ km/h[c]
- above the railway station areas[a] outside the railway platforms	if $v \le 160$ km/h[c]	if $v > 160$ km/h[c]
- outside the railway station areas[a]	see clauses from 4.5.1.2 to 4.5.1.4 and Table 4(HR)	
Superstructures with overhead (Class A)		
all types irrespective of the position		all superstructures with overhead, additional condition: if $v \le 120$ km/h[b]

[a] Railway station areas are the ones between the entrance signals.
[b] For the speeds higher than 120 km/h the safety concept should be determined.
[c] v is local allowable train speed.

HRN EN 1991-1-7: Accidental actions
modified NDP

- *Table 5(HR) - Equivalent static impact forces for superstructures without overheads outside the railway station areas*

Track zone	Clearance from supporting structure to the track centerline	Type of the supporting structure (conditions)	Equivalent static force	
			F_{dx} [MN]	F_{dy} [MN]
without shunts	$a \leq 3,0$ m (3.2 m)[a]	all types, if train speed ≤ 120 km/h and if the supporting structure is secured by guiding devices in the track zone	-	-
		- individual columns - edge columns[b] of the piers - internal columns[b] of the piers with clearance $a_s > 8,0$ m - ends of the membrane walls (2 m in longitudinal direction)	2,0	1,0
		- internal columns[b] of the piers with clearance $a_s < 8,0$ m	1,0	0,5
		- middle areas of the membrane walls	-	0,5
	$a > 3,0$ m (3.2 m)[a]	all types	-	-
with shunts	$a > 3,0$ m (3.2 m)[a]		-	-
	3,0 m (3.2 m) $\leq a < 5,0$ m	- individual columns - edge columns[b] of the piers - internal columns[b] of the piers with clearance $a_s > 8,0$ m - ends of the membrane walls (2 m in longitudinal direction)	2,0	1,0
		- internal columns[b] of the piers with clearance $a_s < 8,0$ m	1,0	0,5
		- middle areas of the membrane walls	-	0,5
	$a \geq 5,0$ m	all types	-	

[a] Distance a = 3,0 m applies for track radiuses R ≥ 10 000 m. If R < 10 000 the increased distance a = 3,2 m applies.
[b] Failure of individual column should be additionally checked.

HRN EN 1991-1-7: Accidental actions
modified NDP

- *Table 6(HR) - Equivalent static impact forces for superstructures with overheads and structures inside the railway station areas*

Clearance a from supporting structure to the track centerline	Type of the supporting structure	Safety requirement			
		normal		increased	
		Equivalent static force			
		F_{dx} MN]	F_{dy} [MN]	F_{dx} [MN]	F_{dy} [MN]
***a* < 3,0 m (3.2 m)[a]**	- ends of membrane walls if there is no impact block - impact block	4,0	2,0	10,0	4,0
	- ends of membrane walls or piers behind the impact block	2,0	1,0	4,0	2,0
	- middle areas of the membrane walls (distance > 2 m from the end of the wall)	-	1,0	-	2,0
3,0 m (3.2 m)[a] ≤ *a* < 5,0 m (6,0)[b]	- ends of membrane walls if there is no impact block - impact block	2,0	1,0	4,0	2,0
	- ends of membrane walls or piers behind the impact block - internal columns of the piers with clearance a_s ≤ 8,0 m without elevated foundations - ends of the membrane walls and columns on platforms or on foundations h ≥ 0.55 m above the upper edge of the rail	1,0	0.5	2,0	1,0
	- middle areas of the membrane walls (distance > 2 m from the end of the wall)	-	0,5	-	1,0
5,0 m (6,0m)[b] ≤ *a* < 7,0 m (6,0)	ends of the walls, piers	no impact		2,0	1,0
***a* ≥ 7,0 m**	all types	no impact			

[a] Distance a = 3,0 m applies for track radiuses R ≥ 10 000 m. If R < 10 000 the increased distance a = 3.2 m should apply.
[b] Distance a = 5,0 m is used for the tracks without shunts and for the track zones if the guidance of the traffic is technically secured. If the shunts are without technical security, e.g. in the railway station areas, distance should be increased to a = 6,0 m.
Shunt zones are defined in Figure 1(HR).

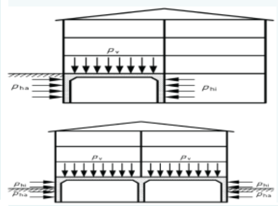
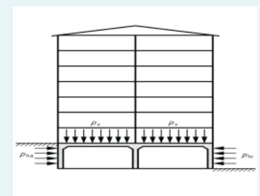
HRN EN 1991-1-7: Accidental actions
modified NDP

- *Table 7(HR) – Ship impact velocities for dynamic analysis*

CEMT classification (see Table C.3)	I	II	III	IV	Va-Vc	VIa-VIc	VII
impact velocity in km/h	6,0	7,0	8,0	10,0	12,0	13,0	15,0

HRN EN 1991-1-7: Accidental actions
NCCI

- *Table 8(HR) – Actions from ruins*

Actions from ruins		Number of stories	
		$n \leq 5$	$n > 5$
			
vertical uniformly distributed load on floors	p_v	10,0 kN/m²	15,0 kN/m²
horizontal uniformly distributed load on perimeter walls which are not in contact with ground	p_{hi}	10,0 kN/m²	15,0 kN/m²
horizontal uniformly distributed load on perimeter walls which are in contact with ground, depending on the type of soil:			
sand and gravel	p_{ha}	4,5 kN/m²	6,75 kN/m²
clay of medium consistency	p_{ha}	6,0 kN/m²	9,0 kN/m²
clay of soft consistency and loam	p_{ha}	7,5 kN/m²	11,25 kN/m²
floors in groundwater	p_{ha}	10,0 kN/m²	15,0 kN/m²
NOTE: These actions should be additionally taken into account with permanent and/or variable actions (e.g. self-weight, imposed and traffic loads, soil pressure and eventually hydrostatic pressure) for the design of structural elements in order to ensure that the traffic route remains opened.			

HRN EN 1991-2: Traffic loads on bridges

modified NDP

- *Extensive National Annex of 28 pages.*
- *Contains 89 NDP clauses and 26 NCCI clauses.*

Road Bridges

- *On highways, motorways and all roads with special heavy traffic, Load Model 3 (special vehicles) should be accounted for as standardized basic model* 3000/200 *with gross weight of* 3000 kN.

HRN EN 1991-2: Traffic loads on bridges
modified NDP

Road Bridges

- *Vehicle collision forces on structural members beside the roadway are defined as* 1000 kN *frontally and* 500 kN *laterally, not acting simultaneously.*
- *For bridges on local roads only model LM1 (Load Model 1) should be used.*
- *Characteristic value of uniformly distributed loads of pedestrian and cycling lanes on road bridges is defined as* 2.5 kN/m^2.

HRN EN 1991-2: Traffic loads on bridges
modified NDP

Road Bridges

- *Values of adjustment factors for Load Model 1 a_{Qi}, a_{qi} and a_{qr} are all taken as* 1,0. *(Note that in NA of Germany and Holland a_{Qi}* =1,0, *but* α_{q1}=1,33; α_{q2}=2,4; α_{q3}=1,20; α_{qr}=1,2.*)*
- *For fatigue load models only one lane is for heavy vehicle traffic and all other lanes are fast lanes.*
- *Fatigue Load Model 5 is, generally, not applied.*

HRN EN 1991-2: Traffic loads on bridges
modified NDP

Railway Bridges

- *Factor α to obtain „classified vertical loads" by multiplying characteristic values of Load Model 71 is specified as α=1,21 (UIC Code 702 recommends α=1,33 for lines with freight traffic and international lines)*

HRN EN 1991-2: Traffic loads on bridges

Railway Bridges

- *Following actions shall be multiplied by the same factor α:*

➢ *Equivalent vertical loading for earthworks and earth pressure effects*

➢ *Centrifugal forces*

➢ *Nosing force*

➢ *Traction and braking forces*

➢ *Combined response of structure and track to variable actions (mistake in the standard – factor α shall always be α = 1,0, because for the structure this is SLS)*

➢ *Derailment actions from rail traffic for accidental design situations*

➢ *Load Model SW/0 for continuous bridges*

HRN EN 1991-2: Traffic loads on bridges
modified NDP

Railway Bridges

- *Dynamic factor Φ which enhances the static load effects under Load Models 71, SW/0 i SW/2 is taken as Φ_3 for track with standard (poor) maintenance*
- *For modeling the excitation and dynamic behavior of the structure factor $(1 + \varphi'')$ is accepted for track with standard (poor) maintenance*

HRN EN 1991-2: Traffic loads on bridges

NCCI

Road bridges

- *Adjustment factors for transient design situation "reparation" (e.g. when traffic is maintained only on half of the bridge width) for uniformly distributed continuous load of Load Model LM1 may be reduced to 0,8 ($a_{qi}=a_{qr}=0{,}8$).*
- *Guiding rails and movable concrete safety barriers are not considered to be rigid safety systems.*

HRN EN 1991-2: Traffic loads on bridges

NCCI

Road bridges

- *Accidental axle load should be placed up to the edge of the deck, regardless of the type of safety system, in order to take into account possible future repair.*
- *For the calculation of maximum and minimum stresses due to FLM3 (single vehicle model) only one (the most unfavorable) traffic lane is loaded.*

HRN EN 1991-2: Traffic loads on bridges

NCCI

Pedestrian Bridges

- *Pedestrian bridges in city areas are, in general, designed for crowd loading* → q_{fk}=5,0 kN/m^2.

Railway bridges

- *Concentrated forces and continuous loads of the Load Model 71, which act favorably, should be neglected.*
- *For fatigue assessment heavy traffic mix with 25t axles is used.*

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

- *All recommended NDP are accepted.*

HRN EN 1991-4: Silos and tanks

- *All recommended NDP are accepted.*

Amendments or corrigenda to EN 1991 standards

- *It should be noted that all EN standards are subject to permanent reviews, which sometimes result in certain necessary amendments or corrigenda to the original documents.*
- *Since the release of HRN EN 1991 standards in 2012, amendments or corrigenda (AC) have been released for standards:*

EN 1991-1-1, EN 1991-1-2, EN 1991-1-3,

EN 1991-1-6, EN 1991-1-7, EN 1991-3, EN 1991-4

Additional literature (in lieu of Conclusion)

- *Implementation of Eurocodes, Handbook 3, Action Effects on Buildings (2005).* Leonardo da Vinci Pilot Project, Aachen
- Gulvanesssian H., Formichi P., Calgaro J.A. (2009). *Designers' guide to Eurocode 1: EN 1991-1-1 and -1-3 to -1-7.* Thomas Telford, London
- *Eurocodes – Background and applications, Dissemination of information workshop (2008).* Brussels

Additional literature (in lieu of Conclusion)

- Lennon T., Moore D.B., Wang Y.C., Bailey C.G. (2006). *Designers' guide to EN 1991-1-2, EN 1992-1-2, EN 1993-1-2 and EN 1994-1-2, Handbook for the fire design of steel, composite and concrete structures to the Eurocodes.* Thomas Telford, London
- *Cook N. (2007). Designers' guide to EN 1991-1-4, Eurocode 1: Actions on structures, general actions part 1-4. Wind actions.* Thomas Telford, London