# Wind load parameters - Eurocode

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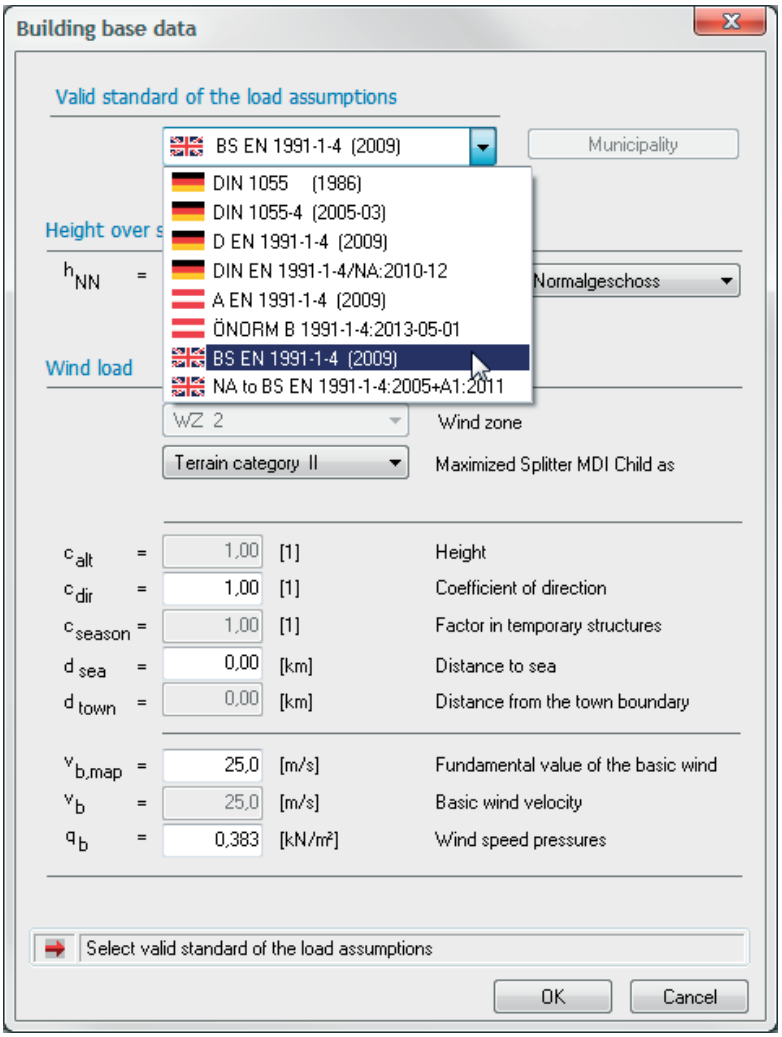

# Wind load parameters - Eurocode

*Note:* *This document describes the definition of the wind load parameters in the software applications GEO - Frilo Building Model and WL Wind Loads. The description is limited to the Eurocode-specific application. Documents referring to former standards are available in our document archive at www.frilo.eu Service >> Documentation >>Manuals >>Archive.*

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Software application with integrated graphical user interface:

FRILO Building Model

WL Wind Loads

# EN 1991-1-4

Currently (11/2014) the version EN 1991-1-4:2005 + A1:2010 + AC:2010 is implemented.

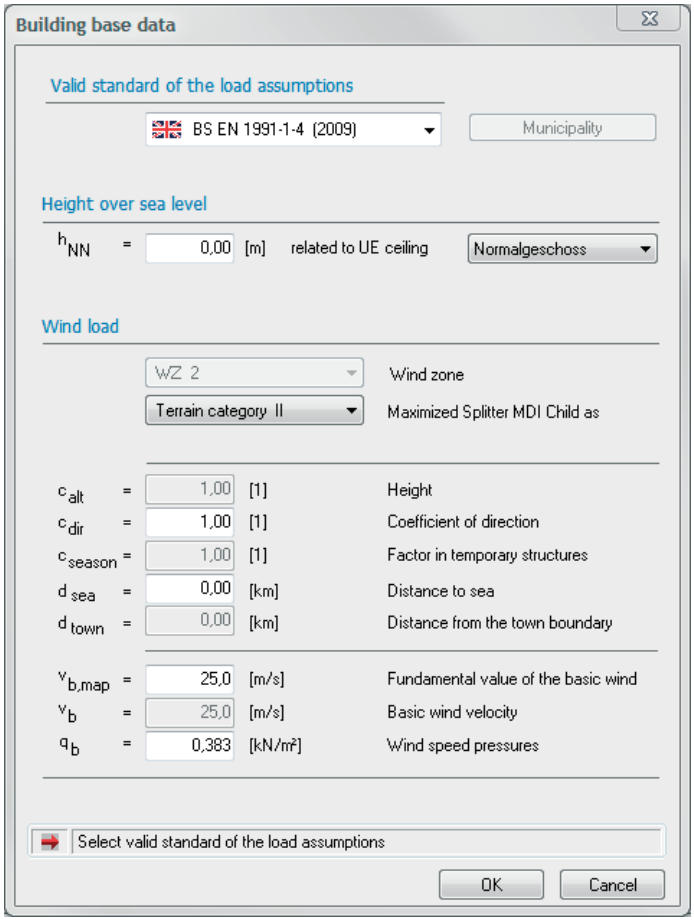
*Note: if no prefix "NA" (eg. „NA-7.1.2") is used, references are made to the document mentioned above.*

## DIN EN 1991-1-4/NA

Currently (11/2014) the version DIN 1991-1-4/NA:2010-12 is implemented.

Height above sea level **$h_{MSL}$**

As per annex NA-A A.2, an increase factor is to be taken into account for heights above $h_{MSL}$= 800 m.




**Wind zone**

To be selected in accordance with in the wind zone map in Annex NA-A, figure A.1.

**Terrain category**

As per annex NA-B

Tab. B1.

**Altitude factor $H_f$**

Increase factor for $h_{MSL}$ > 800m

$h_{MSL}$ < 1100 m as per Annex A A.2 (2)

$h_{MSL}$ > 1100 m as per Annex A A.2 (3)

The user should carefully consider this selection. A user-defined increase factor $H_f$ is allowed in accordance with Annex A.2.

**Directional factor $c_{dir}$**

Normally equal to 1.0, other factors can be determined in closer examinations.

**Fundamental value of the basic wind velocity $v_{b,0}$**

The value can be adjusted manually.

**Basic wind velocity $v_b$**

| | |
|---|---|
| $v_b = v_{b,0} \cdot c_{dir} \cdot c_{season}$ | equation 4.1 |
| $v_{b,0}$ | fundamental value of the basic wind velocity as specified |
| $c_{dir}$ =1.0 (NA-4.2.) | or direction coefficient as specified |
| $c_{season}$ = 1.0 (NA-4.2) | |

**Velocity pressure $q_b$**

| | |
|---|---|
| $q_b = 1/2 \cdot \rho \cdot v_b^2$ | equation 4.10 |
| $\rho$ | air density as per NA-4.5 $\rho$ = 1.25 kg/m$^3$ |

**Peak wind velocity $q_p$**

| | |
|---|---|
| $q_p = k \cdot q_b \cdot (z/10)^a$ | tables B.2 Annex NA-B |
| z | distance of the ordinate to the upwind base.<br>z > zmin as per table B.2 |
| k | coefficient depending on the terrain category as per table B.2 |
| a | exponent depending on the terrain category as per table B.2 |

**Topography**

Is currently not taken into account

**Wind force (external pressure)**

$F_{w,j} = c_{sds} \cdot \sum (c_f \cdot q_p (z_e) \cdot A_{ref})$ equation 5.4

$q_p$: Peak velocity pressure

Sectionalised calculation for a partial area Aref in accordance with 7.2.2 figure 7.4

Building with h <= b

$q_p = q_p$ (ze = h) const.

Building with b < h <= 2b

| | | |
|---|---|---|
| ze > b | $q_p = q_p$ (ze = h) | const. |
| ze <= b | $q_p = q_p$ (ze = b) | const. |

Building with h > 2b

| | | |
|---|---|---|
| ze > h - b | $q_p = q_p$ (ze = h) | const. |
| ze <= b | $q_p = q_p$ (ze = b) | const. |
| b < ze < h-b | $q_p = q_p$ (ze = zj) | const. for each partial rectangle |

In the area z > b, the wind pressure behaviour is determined by approximation with the help of partial rectangles, the top edges of which have the distance zj to the upwind base. A division into rectangles with a height hj of approx. 5 m has turned out to be sufficiently detailed.

The width *b* is calculated from the extent of the lowest storey perpendicular to the wind direction.

For buildings with non-rectangular floor plans or floor plans varying from storey to storey, the width is determined by approximation.

csds: structural factor

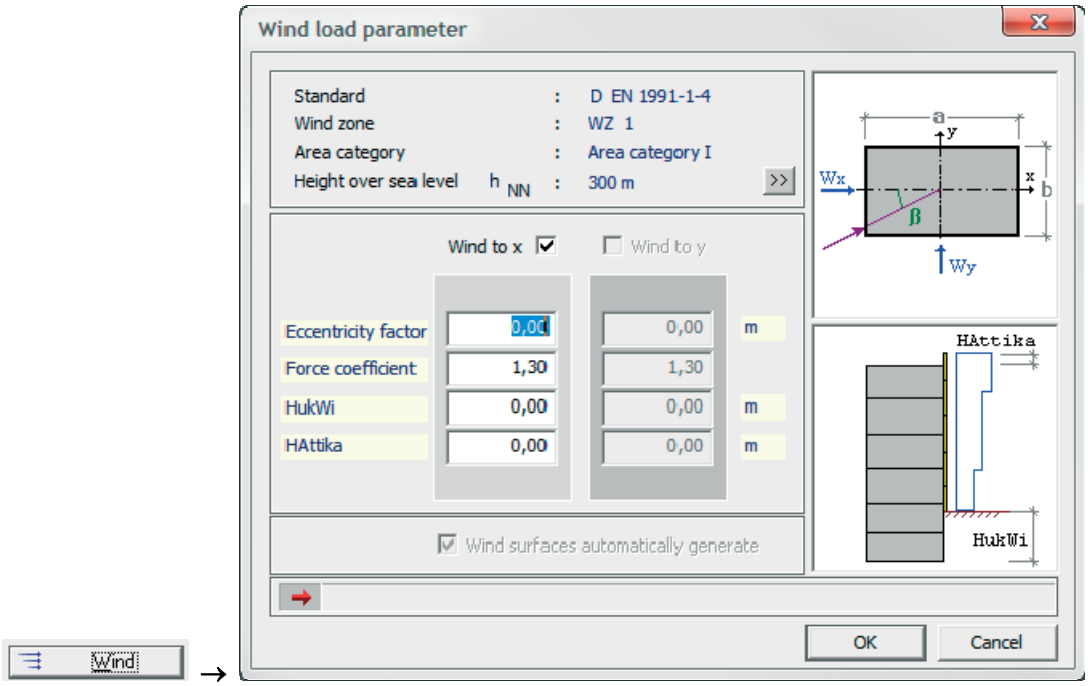
The structural factor takes an increase of the peak pressure due to dynamic influences (cd) into account as well as the fact that the peak pressure does not apply to the whole building at the same time. As prescribed by NA-4.42.1, the factor is calculated in accordance with NA-C. It is not separated into partial factors.

***!!** Attention: Currently this value is assumed equal to 1.0.*

In accordance with 6.2.c, the factor applies to braced buildings that are lower than 100 m and the height of which is smaller than the fourfold depth of the building. In all other cases, further considerations are required.

cf: aerodynamic shape coefficient.

To be calculated for rectangular buildings as per NA 7.2.2.




**Eccentricity**

According to NA 7.1.2, the eccentricity is determined from figure 7.1.

**Wind force due to internal pressure**

A portion due to internal pressure is not taken into account. Where permeable exterior walls as per 7.2.9 (1) are concerned, additional considerations are required in regard to a lump-sum increase of cf, for instance.

**Wind force due to friction**

A portion Fw,r as per equation 5.7 is not calculated. According to 5.3(4), this is suitable if the total area of all sides parallel to the wind direction is equal to the fourfold sum of the areas perpendicular to the wind direction. Otherwise, further considerations are required.

## ÖNORM B 1991-1-4

Currently (11/2014) the version ÖNORM B 1991-1-4:2013 is implemented.

*Note: The structure of the national annex has been changed.*
*Compared with the previous version, the wind loads are unchanched.*

After **selecting the municipality** in accordance with tab. A.1, the following values are taken over: Altitude $h_{MSL}$, basic wind velocity $v_{b,0}$ and basic wind velocity pressure $q_{b,0}$.

**Height above sea level $h_{MSL}$**

This manual adjustment is possible, if the condition $h_{MSL} > h_{MSL}(A1)+250$ m is satisfied as required by NA-6.2.2 $q_{b,0}$ table A.2.

**Terrain category**

Indicates the roughness of the terrain in accordance with table 41. of ÖNORM EN 1991-1-4.

NA 6.2.3.1 does not allow category 0 and 1.

**Directional factor $c_{dir}$**

Manual adjustment is possible, if the condition of NA 6.2.3 $c_{dir}$ =1.0 is satisfied.

**Fundamental value of the basic wind velocity $v_{b,0}$**

The value can be adjusted manually.

**Velocity pressure $q_b$**

The value can be adjusted manually.

**Basic wind velocity $v_b$**

| | |
|---|---|
| $v_b = v_{b,0} \cdot c_{dir} \cdot c_{season}$ | equation 4.1 |
| $v_{b,0}$ | fundamental value of the basic wind velocity as specified |
| $c_{dir}$ = 1.0 (NA-6.2.3) | or directional factor as specified |
| $c_{season}$ = 1.0 (NA-6.2.4) | |

**Wind velocity pressure qb**

| | |
|---|---|
| $q_b = 1/2 \cdot \rho \cdot v_b^2$ | equation 4.10 |
| $\rho$: | air density as per NA-6.3.2.1, $\rho$ = 1.25 kg/m$^3$ |

**Peak velocity pressure $q_p$**

| | |
|---|---|
| $q_p = k \cdot q_b \cdot (z/10)^a$ | NA-table 1 |
| z: | distance of the ordinate to the upwind base<br>z > zmin as per NA-table 1. |
| k: | coefficient depending on the terrain category as per NA-table 1 |
| a | coefficient depending on the terrain category as per NA-table 1 |

**Topography**

Is currently not taken into account as per NA 6.3.3

**Wind force (external pressure)**

$F_{w,j} = csds \cdot \sum (c_f \cdot q_p (ze) \cdot Aref)$ equation 5.4

$q_p$: Peak velocity pressure

sectionalised calculation for a partial area Aref in accordance with 7.2.2 figure 7.4

Building with h <= b

$q_p = q_p$ (ze = h) const.

Building with b < h <= 2b

| | | |
|---|---|---|
| ze > b | $q_p = q_p$ (ze = h) | const. |
| ze <= b | $q_p = q_p$ (ze = b) | const. |

Building with h > 2b

| | | |
|---|---|---|
| ze > h - b | $q_p = q_p$ (ze = h) | const. |
| ze <= b | $q_p = q_p$ (ze = b) | const. |
| b < ze < h-b | $q_p = q_p$ (ze = zj) | const. for each partial rectangle |

In the area z > b, the wind pressure behaviour is determined by approximation with the help of partial rectangles, the top edges of which have the distance zj to the upwind base. A division into rectangles with a height hj of approx. 5 m has turned out to be sufficiently detailed.

The width is determined from the extent of the lowest storey perpendicular to the to the wind direction.

For buildings with non-rectangular floor plans or floor plans varying from storey to storey, the width is determined by approximation.

csds: structural factor

The structural factor takes an increase of the peak pressure due to dynamic influences (cd) into account as well as the fact that the peak pressure does not apply to the whole building at the same time. As prescribed by NA-8.2, the factor is to be separated and calculated in accordance with Annex B.

***!!*** *Attention: Currently, this value is assumed equal to 1.0.*

In accordance with 6.2.c the factor applies to braced buildings that are lower than 100 m and the height of which is smaller than the fourfold depth of the building. In all other cases, further considerations are required.

cf: aerodynamic shape coefficient.

Value to be taken from table NA.5 for rectangular buildings.

## Wind load parameters 


**Eccentricity**

To be specified by the user. According to NA-9.1.1, an eccentricity of 1/10 of the ground floor dimension in question should be considered, when the load transfer of the wind action takes place near the centroidal axis.

**Wind force due to internal pressure**

A portion due to internal pressure is not taken into account. Where permeable exterior walls as per 7.2.9 (1) are concerned, additional considerations are required in regard to a lump-sum increase of cf, for instance.

**Wind force due to friction**

A portion Fw,r as per equation 5.7 is not calculated. According to 5.3(4), this is suitable, if the total area of all sides parallel to the wind direction is equal to the fourfold sum of the areas perpendicular to the wind direction. Otherwise, further considerations are required.

## NA to BS EN 1991-1-4

Currently (11/2014) the version NA to BS EN 1991-1-4 is: 2005 + A1: 2010 is implemented.

*Note: There were no different wind loads to the previous version..*

**Height above sea level $h_{MSL}$**

Value specified by the user for the calculation of factor $c_{alt}$ using equation NA 2.a and NA 2.b

**Terrain category**

To be specified in accordance with NA 2.11.

**Directional factor $c_{dir}$**

To be specified in accordance with NA.1.

**Distance to the coastline $d_{sea}$**

To be specified in combination with the categories Country terrain and Town terrain. The default value is $d_{sea}$=0.1 km (close to the sea).

**Distance to the urban boundary $d_{town}$**

To be specified in combination with the category Town terrain.

**Wind velocity $v_{b,map}$**

To be specified in accordance with figure NA.1.

**Velocity pressure $q_b$**

The value can be adjusted manually.

**Altitude factor $c_{alt}$**

$c_{alt} = 1+ 0.001 \cdot A$ z <= 10 m equation NA 2.a

$c_{alt} = 1+ 0.001 \cdot A \cdot (10/z)^{0.2}$ z > 10 m equation NA2.b

A: corresponds to the specified $h_{MSL}$

Z: distance of the upwind base to the considered building height.

**Fundamental value of the basic wind velocity**

$v_{b,0} =$ $v_{b,map} \cdot c_{alt}$ equation NA.1

$v_{b,map}$ wind velocity as specified

**Basic wind velocity $v_b$**

$v_b = v_{b,0} \cdot c_{dir} \cdot c_{season}$ equation 4.1

$c_{dir}$ directional factor as specified

$c_{season} = 1.0$

**Velocity pressure $q_b$**

$q_b = 1/2 \cdot \rho \cdot v_b^2$ equation 4.10

$\rho$: air density as per NA 2.18: $\rho = 1.226$ kg/m$^3$

Topo**graphy** according to fig. NA.2 significant for:
Location on a hill or ridge
upwind slope of $\phi > 0.05$
downwind slope of $\phi > 0.05$
Location at a slope
upwind slope of $\phi > 0.05$

**Peak velocity pressure $q_p$ without consideration of topography**

$q_p = c_e(z) \cdot c_{e,T} \cdot q_b$ equation NA.3.a and NA.3.b

$c_e(z)$: topography factor according to figure NA.7

Calculation with the help of the data given by FigureNA7.csv at www.istructe.org

and with the help of the values specified for $d_{sea}$ and $h_{dis}$.

$C_{e,T}$: correction factor for urban location as per figure NA.8.

Calculation with the help of the data given by FigureNA8.csv at www.istructe.org

and with the help of the values specified for $d_{sea}$ and $h_{dis}$.

A reduction of $q_p$ to compensate the missing correlation between wind on the windward face and the leeward face in accordance with 7.2 (3) is currently not taken into account.

**Peak velocity pressure $q_p$ without consideration of topography**

***!!*** *Attention: is currently not enabled in the software.*

**Wind force (external pressure)**

$F_{w,j} = c_{sds} \cdot \sum (c_f \cdot q_p(z_e) \cdot A_{ref})$ equation 5.4

$q_p$ peak velocity pressure

Windward face: sectionalised calculation for a partial area Aref in accordance with 7.2.2 figure 7.4

Building with h <= b

$q_p = q_p (z_e = h)$ const.

Building with b < h <= 2b

| | | |
|---|---|---|
| ze > b | $q_p = q_p (z_e = h)$ | const. |
| ze <= b | $q_p = q_p (z_e = b)$ | const. |

Building with h > 2b

| | | |
|---|---|---|
| ze > h - b | $q_p = q_p (z_e = h)$ | const. |
| ze <= b | $q_p = q_p (z_e = b)$ | const. |
| b < ze < h-b | $q_p = q_p (z_e = z_j)$ | const. for each partial rectangle |

In the area z > b, the wind pressure behaviour is determined by approximation with the help of partial rectangles, the top edges of which have the distance zj to the upwind base. A division into rectangles with a height hj of approx. 5 m has turned out to be sufficiently detailed.

The width is determined from the extent of the lowest storey perpendicular to the to the wind direction.

For buildings with non-rectangular floor plans or floor plans varying from storey to storey, the width is determined by approximation.

Leeward face: according to NA 2.26, a constant pressure distribution is to be assumed over the total building height with ce (z=h).

csds: structural factor

The structural factor takes an increase of the peak pressure due to dynamic influences (cd) into account as well as the fact that the peak pressure does not apply to the whole building at the same time. According to NA 2.20, the factor can be separated into a size factor cs (figure NA.3) and a dynamic factor cd (figure NA.9). Otherwise, it is to be calculated in accordance with BS EN 1991-1-4, chap. 6.3 and Annex B.

***!!*** *Attention: Currently, this value is assumed equal to 1.0.*

In accordance with 6.2.c the factor applies to braced buildings that are lower than 100 m and the height of which is smaller than the fourfold depth of the building. In all other cases, further considerations are required.

cf: aerodynamic shape coefficient.

Value to be taken from table NA.4 for rectangular buildings.

## Wind load parameters 


**Eccentricity**

Value to be specified, must correspond to the wind pressure distribution shown in figure NA.10 for the torsion load case.

**Wind force due to internal pressure**

***!!*** *A portion due to internal pressure is not taken into account*.

Where permeable exterior walls as per 7.2.9 (1) are concerned, additional considerations are required in regard to a lump-sum increase of cf, for instance.

**Wind force due to friction**

***!!*** *A portion Fw,r as per equation 5.7 is not calculated.*

According to 5.3(4), this is suitable if the total area of all sides parallel to the wind direction is equal to the fourfold sum of the areas perpendicular to the wind direction. Otherwise, further considerations are required.