ANNEX 5

NATIONAL ANNEX

TO STANDARD

EN 1991-1-4 EUROCODE 1: ACTIONS ON STRUCTURES

Part 1-4: General actions. Wind actions

Preface

This National Annex is used together with standard SFS-EN 1991-1-4.

This National Annex provides national parameters and supplementing guidelines to the following clauses of SFS-EN 1991-1-4:

- 1.1 Scope, paragraph (11) Note 1
- 4.2 Basic values, paragraph (1)P Note 2
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- 4.3.3 Terrain orography, paragraph (1)
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The recommendations provided in SFS-EN 1991-1-4 are complied with in the following clauses where the determination of national additional instructions would be permitted.

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1.1 Scope

1.1(11), Note 1

Persistent thermal surface inversion occurs in the northern part of Finland every winter. This phenomenon is occasionally met also in other parts of the country. A stratified flow condition may arise during thermal inversion such that high wind velocities prevail above a layer of moderate or no wind. Therefore, additional guidance is given later for the orography factor (clause 4.3.2) and for the calculation of the cross wind amplitude due to vortex shedding (clause E.1.5).

Explanation:
Temperature inversion is very common in the mountain areas of the Northern Finland. A measurement on a guyed mast indicates that this phenomenon can be met also in the southern part of the country. Inversions typically persist over the season of the highest upper air winds, so that they affect also the wind speeds that correspond to the return period of 50 years. Therefore, the stratified flow condition that is associated with the temperature inversion is considered by the Finnish National Annex.

4.2 Basic values

4.2(1)P, Note 2

Following values are used in Finland for the fundamental value of the basic wind velocity $v_{b,0}$:

Mainland in the entire country	$v_{b,0}$ = 21 m/s
Sea areas: open sea, scattered islands out in the open sea	$v_{b,0}$ = 22 m/s
In Lappland: at the top of mountains	$v_{b,0}$ = 26 m/s
In Lappland: at the bottom of mountains	$v_{b,0}$ = 21 m/s

Explanation:
On the mountainsides wind velocity depends on average altitude above sea level, on vertical distance of the considered site from the bottom of mountain, on the inclination angle and the amount of forest and additionally on the surroundings of the mountain. On mountainsides the fundamental value of the basic wind velocity can be calculated either by using simplified flow models or complete flow calculation software with the initial value $v_{b,0}$ *= 26 m/s on the top of the mountain.*

4.3.2 Terrain roughness

4.3.2(1)

The roughness factor, $c_r(z)$ shall be determined by using equations (4.4) and (4.5) of standard SFS-EN 1991-1-4 and terrain parameters that are given in Table 4.1 of the standard. For the terrain category 0, however, the terrain factor is taken as k_r = 0,18 instead of the value arising from Eq. (4.5).

Explanation:
The wind velocity would be underestimated in sea areas if Eq. (4.5) is used to obtain the terrain factor. Therefore, the value of k_r *= 0,18 arising from the data analysis is used for the terrain category 0.*

4.3.3 Terrain orography

4.3.3(1)

Where orography increases (e.g. hills, cliffs etc.) wind velocities by more than 5% the effects should be taken into account using the orography factor $c_o(z)$. If the height of the building or structure is smaller than 100 m, the orography factor can be determined using the model that is described in Annex A.3 of standard EN 1991-1-4. Alternatively, a conservative value can be used by determining the orography at the height of z = 10 m, defined at the site of the buiding.

The possibility of a thermal surface inversion should be considered while designing high-rise structures (h > 100 m). Meteorological data on local conditions can be used in the design. In absence of appropriate data, consequences of the thermal inversion can be considered by defining an additional loading case. The velocity profile $v_m(z)$ of this loading case is calculated in accordance with EN 1991-1-4 by defining first the orography factor $c_o(z)$ for the site of the structure. The function $c_o(z)$ is then replaced by the function $c_{INV}(z) \cdot c_o(z)$ where z is the vertical distance from ground level of the site and

$$c_{INV}(\eta) = 1 + \frac{H}{H_{ref}} \cdot 0{,}80 \quad \text{for } \eta > H \qquad \text{(1a-FI)}$$

$$c_{INV}(\eta) = 0{,}50 \quad \text{for } \eta \leq H \qquad \text{(1b-FI)}$$

where $\eta = z + H_s$ and:

H is the height of the feature as defined in A.3 of standard EN 1991-1-4 and H_{ref} = 400 m,

H_s elevation of the site in comparison with the average terrain elevation.

Explanation:

The velocity profile shows an abrupt change in the condition where a stratified wind flow arises due to temperature inversion. An additional loading condition is defined to take account of this phenomenon in the design of high-rise structures. This loading case is defined by considering long-term meteorological data compiled in Sodankylä, where a maximum wind speed of 42 m/s has been measured during an event of temperature inversion.

4.5 Peak velocity pressure

4.5(1), Note 2

While designing slender special structures (e.g. transmission lines), the value of the air density ρ shall be calculated at the temperature and altitude relevant to the site and load conditions concerned. The density is then obtained from the expression:

$$\rho = 353/T * e^{-0{,}00012\,H} \qquad \text{(2-FI)}$$

where

ρ is the air density (kg/m^3) at the load condition concerned

T is the absolute air temperature (K) at the load condition concerned

H is the altitude (m) above the sea level at the site

Explanation: The recommended value of 1,25 kg/m^3 of the air density applies for most structures. As an alternative, a more accurate method provided by Eq.(2-FI) can be used. This method is compatible with guidelines for some special structures (transmission line, masts).

Annex A
Terrain effects

A.2 Transition between roughness categories 0, I, II, III and IV

In transition between terrain categories the procedure 1 is followed.

Explanation:

The recommended values of the upstream distance can be redefined if reliable data is available on the wind speeds in the transitional area between two terrain categories.

The procedure 1 described in A.2 is a very simple and is, therefore, the preferred method to deal with the transition between roughness categories. In coastal city areas, however, this method may lead to discrepancies in design of wind actions on adjacent buildings. In such conditions, the concept of the displacement height described in A.5 of standard EN 1991-1-4 can be applied. The transitional area of the terrain categories can also be specified by using reliable data on wind velocities.

Annex E
Vortex shedding and aeroelastic instabilities

E.1.5.1 General

E.1.5.1(1), Note 2

A stratified flow condition is possible in the most parts of the country. Therefore, the method in Annex E.1.5.3 to standard SFS-EN 1991-1-4 must be used for all structures it is suitable for.

Explanation:
The dynamic excitation due to vortex shedding can be amplified if the wind flow is laminar. This kind of conditions that promote large amplitude vibrations have been met in Central Europe. Laminar wind flows are typical in conditions of temperature inversion, which is common in Finland. The design formulas shown in E.1.5.3 consider the amplification concerned whereas the method described in E.1.5.2 does not take account of this effect. Therefore, the method described in E..1.5.3 is preferred in Finland.

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