SIST

SLOVENSKI STANDARD
SIST EN 1991-1-7:2006/A1:2014

01-julij-2014

Evrokod 1: Vplivi na konstrukcije -1-7. del: Splošni vplivi - Nezgodni vplivi

Eurocode 1 - Actions on structures - Part 1-7: General actions - Accidental actions

Eurocode 1 - Einwirkungen auf Tragwerke - Teil 1-7: Allgemeine Einwirkungen - Außergewöhnliche Einwirkungen

Eurocode 1 - Actions sur les structures - Partie 1-7: Actions générales - Actions accidentelles

Ta slovenski standard je istoveten z: EN 1991-1-7:2006/A1:2014

ICS:

91.010.30	Tehnični vidiki	Technical aspects

SIST EN 1991-1-7:2006/A1:2014 en,fr,de

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 1991-1-7:2006/A1

June 2014

ICS 91.010.30

English Version

Eurocode 1 - Actions on structures - Part 1-7: General actions - Accidental actions

Eurocode 1 - Actions sur les structures - Partie 1-7 : Actions générales - Actions accidentelles

Eurocode 1 - Einwirkungen auf Tragwerke - Teil 1-7: Allgemeine Einwirkungen - Außergewöhnliche Einwirkungen

This amendment A1 modifies the European Standard EN 1991-1-7:2006; it was approved by CEN on 6 February 2014.

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Ref. No. EN 1991-1-7:2006/A1:2014 E

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Foreword

This document (EN 1991-1-7:2006/A1:2014) has been prepared by Technical Committee CEN/TC 250 “Structural Eurocodes”, the secretariat of which is held by BSI.

This Amendment to the European Standard EN 1991-1-7:2006 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2015, and conflicting national standards shall be withdrawn at the latest by June 2015.

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1 Modification to 5.3, Principles for design

In Paragraph (1), replace the existing Note by the following one:

"

NOTE The National Annex may give the procedures to be used for the types of internal explosions. Guidance on dealing with the following specific types of explosion is given in Annex D:

– gas and vapour/air explosions in rooms and closed sewage basins;

– dust explosions in rooms, vessels and bunkers;

– gas and vapour/air explosions in road and rail tunnels;

– dust, gas and vapour/air explosions in energy ducts.

The values presented in Annex D of this part may be considered as nominal values given that the explosion occurs.

When calculating the structural response, dynamic and nonlinear behaviour may be taken into account. A load duration of 0,2 s may be adopted and damage is acceptable provided it does not lead to disproportional collapse.

The load-time function may be assumed triangular. A sensitivity study on the load-time function should be performed to identify the peak load time within the 0,2 s duration.".

2 Modification to Annex D (informative), Internal explosions

Replace the existing Annex D with the following one:

"

Annex D
(informative)

Internal explosions

D.1 Natural gas explosions

(1) For buildings which might have piped natural gas installed, or where gas canisters can be present, the structure may be designed to withstand the effects of an internal natural gas explosion using a nominal equivalent static pressure given by Formulae (D.1) and (D.2):

$$p_d = 3 + p_{stat} \tag{D.1}$$

or

$$p_d = 3 + p_{stat} / 2 + 0{,}04 / (A_v / V)^2 \tag{D.2}$$

whichever is the greater;

where

p_d is the nominal equivalent static pressure to design the structure in [kN/m^2];

p_{stat} is the uniformly distributed static pressure at which venting components will fail in [kN/m^2];

A_v is the area of venting components in [m^2];

V is the volume of rectangular enclosure in [m^3].

Formulae (D.1) and (D.2) are valid for a single room up to 1 000 m^3 total volume.

NOTE 1 The pressure due to deflagration acts effectively simultaneously on all of the bounding surfaces of the room.

NOTE 2 Multi-room explosions may give much higher pressures. The pressures are difficult to calculate as they are not simply limited by the strength of the vent panels; therefore, for this type of explosion, the strategy based on limiting the extend of localized failure (see Figure 3.1) should be adopted.

(2) Where building components with different p_{stat} values contribute to the venting area, the largest value of p_{stat} should be used. No value of p_d greater than 50 kN/m^2 need be taken into account.

(3) The ratio of the area of venting components and the volume should comply with Formula (D.3):

$$0{,}05\ \text{m}^{-1} \leq A_v / V \leq 0{,}15\ \text{m}^{-1} \tag{D.3}$$

NOTE Natural gas is a gaseous fossil fuel consisting primarily of methane but including significant quantities of ethane, butane, propane, carbon dioxide, nitrogen, helium and hydrogen sulfide. Before natural gas can be used as a fuel, it undergoes extensive processing to remove almost all materials other than methane.

D.2 Dust explosions in rooms, vessels and bunkers

(1) The design value p_d for the maximum pressure developed in vented cubic and elongated rooms, vessels and bunkers for dust explosions within a single room may be determined from the empirical Formula (D.4):

$$A_v = [4{,}485\times10^{-8}\ p_{\max}\ K_{st}\ p_\text{d}^{-0{,}569} + 0{,}027(p_{stat} - 10)p_d^{-0{,}5}]V^{\,0{,}753} \tag{D.4}$$

where

A_v is the venting area [m^2];

V is the volume of room, vessel, bunker [m^3];

K_{St} is the deflagration index of a dust cloud [kN/m^2] (see Clause (2));

p_{max} is the maximum pressure of an explosion of the dust [kN/m^2] (see Clause (2));

p_{stat} is the static activation pressure of the vent areas [kN/m^2];

p_d is the design value of the pressure in the vented vessel [kN/m^2].

(2) Values for p_{max} and K_{St} may be experimentally determined by standard methods for each type of dust.

NOTE 1 The value of K_{St} depends on factors such as the chemical composition, particle size and moisture content. Indicative values for p_{max} and K_{St} are given in Table D.1.

NOTE 2 For standard methods, see for instance EN 14034–1:2004 and EN 14034–2:2006.

(3) Formula (D.4) is valid with the following restrictions:

- $0{,}1 \text{ m}^3 \leq V \leq 10\,000 \text{ m}^3$;
- $L_3 / D_E \leq 2$, where L_3 is the largest dimension and $D_E = 2(L_1 \times L_2/\pi)^{0,5}$, where L_1 and L_2 are the other two dimensions of the room;
- $10 \text{ kN/m}^2 \leq p_{stat} \leq 100 \text{ kN/m}^2$, rupture disks and panels with low mass which respond almost without intertia;
- $10 \text{ kN/m}^2 \leq p_d \leq 200 \text{ kN/m}^2$;
- $500 \text{ kN/m}^2 \leq p_{max} \leq 1\,000 \text{ kN/m}^2$ for $1\,000 \text{ kN/m}^2\text{(m/s)} \leq K_{St} \leq 30\,000 \text{ kN/m}^2$;

  $500 \text{ kN/m}^2 \leq p_{max} \leq 1\,200 \text{ kN/m}^2$ for $30\,000 \text{ kN/m}^2\text{(m/s)} \leq K_{St} \leq 80\,000 \text{ kN/m}^2$.

(4) For elongated rooms with $L_3/D_E \geq 2$ the following increase for the venting area should be considered:

$$\Delta A_v = A_v\,(-\,4{,}305 \log p_d + 9{,}368) \log L_3/D_E \qquad \text{(D.5)}$$

where

ΔA_v is the increase for venting area in [m^2].

NOTE In dust explosions, pressures reach their maximum value within a time span in the order of 20 ms to 50 ms. The decline to normal values strongly depends on the venting device and the geometry of the enclosure.

Table D.1 – p_{max} and K_{St} values for dust explosions

Type of dust	p_{max} kN/m²	K_{St} kN/m²
Brown coal	810 to 1 000	18 000
Cellulose	800 to 980	27 000
Coffee		9 000
Corn, corn crush		12 000
Corn starch		21 000
Grain		13 000
Milk powder	810 to 970	16 000
Mineral coal		13 000
Mixed provender		4 000
Paper		6 000
Pea flour		14 000
Pigment	650 to 1 070	29 000
Rubber	740	14 000
Rye flour, wheat flour		10 000
Soya meal		12 000
Sugar	820 to 940	15 000
Washing powder		27 000
Wood, wood flour	770 to 1 050	22 000

D.3 Explosions in road and rail tunnels

(1) In case of a detonation in road and rail tunnels, the pressure time function may be determined using Formulae (D.6) to (D.8), see Figure D.1(a):

$$p(x,t) = p_0 \exp\left\{-\left(t - \frac{|x|}{c_1}\right)/t_0\right\} \text{ for } \frac{|x|}{c_1} \le t \le \frac{|x|}{c_2} - \frac{|x|}{c_1} \quad \text{(D.6)}$$

$$p(x,t) = p_0 \exp\left\{-\left(\frac{|x|}{c_2} - 2\frac{|x|}{c_1}\right)/t_0\right\} \text{ for } \frac{|x|}{c_2} - \frac{|x|}{c_1} \le t \le \frac{|x|}{c_2} \quad \text{(D.7)}$$

$$p(x,t) = 0 \text{ for all other conditions} \quad \text{(D.8)}$$

where

- p_0 is the peak pressure (= 2 000 kN/m² for a typical liquefied natural gas);
- c_1 is the propagation velocity of the shock wave (approximately 1 800 m/s);
- c_2 is the acoustic propagation velocity in hot gasses (approximately 800 m/s);
- t_0 is the time constant (= 0,01 s);
- $|x|$ is the distance between the pressure sampling point and the centre of the explosion;