JCSS PROBABILISTIC MODEL CODE
PART 2: LOAD MODELS

2.12 SNOW LOAD

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List of symbols:

C_e = exposure coefficient
C_r = redistribution (due to wind) coefficient
C_t = deterministic thermal coefficient
d   = snow depth
h   = altitute of the building site
h_r = reference altitude
k   = coefficient for altitude conversion
r   = conversion factor of snow load on ground to snow load on roofs
S_r = snow load on the roof
S_g = snow load on ground at the weather station
$\gamma(d)$ = average weight density of the snow for depth d

η_a = shape coefficient

2.12   SNOW LOAD

2.12.1.   Basic Model for Snow Load on roofs

The snow load on roofs, S_r, is determined by the relation

$$S_r = S_g \ r \ k^{h/h_r} \tag{1}$$

where

S_g is the snow load on ground at the weather station
r   is a conversion factor of snow load on ground to snow load on roofs (see 2.12.3).
h   is the altitute of the building site
h_r is a reference altitude (= 300 m)
k   is a coefficient: k = 1.25 for coastal regions, k = 1.5 for inland mountainous regions

The snow load S_r acts vertically and refers to a horizontal projection of the area of the roof. S_g is time dependent but not space dependent within a specified region with similar climatic conditions and with approximately the same altitude.

The characteristics of the ground snow load S_g should be determined on the basis of observations from weather stations. The results of such observations are either water-equivalents of snow or depths of snow. In the first case the values can be used directly to determine the ground snow load. In the second case the data on snow depth must be converted to snow load by the relation

$$S_g = d \ \gamma(d) \tag{2}$$

where

d   is the snow depth
$\gamma(d)$ is the average weight density of the snow

The density $\gamma(d)$ follows from:

$$\gamma(d) = \frac{\lambda\gamma(\infty)}{d} \ln\left\{1 + \frac{\gamma(0)}{\gamma(\infty)}[\exp(\frac{d}{\lambda}) - 1]\right\} \tag{3}$$

where

$\gamma(\infty) = 5 \text{ kN/m}^3$, $\gamma(0) = 1.70 \text{ kN/m}^3$ and x = 0.85 m

2.12.2. Probabilistic model for S_g

A probability model of the ground snow load S_g is presented by:

- a probability distribution function for the total duration T of the load
- a probability distribution function for the maximum load S_{gmax} within one year.

The distribution function $F_{sg\,max}$, its mean μ and its coefficient of variation V are denoted as:

for maritime climate : F_{s1} , μ_1 , V_1
for continental climate : F_{s2} , μ_2 , V_2

The probability distribution functions in these two cases are gamma distributions. The parameters should be based on local observations. As prior distribution a vague prior should be used. In some cases data from "similar stations" can be used as prior with n' = 3 and ν' = 2.

In those cases when the climate is a mixture of maritime and continental climate, a part p of the observations are associated with a continental climate and a part 1-p with a maritime climate. The combined probability distribution function F for the mixed climates can then be written as $F_s \ = \ (1 - p)\, F_{s1} \ + \ p\, F_{s2}$.

2.12.3. Conversion ground to roof snow load

2.12.3.1 General

The conversion factor r is subdivided into a number of factors and terms according to the expression

$$r \ = \ \eta_a\, C_e \ C_t \ + \ C_r \tag{6}$$

where

η_a is a shape coefficient, a random variable according to 2.12.3.2
C_e is a deterministic exposure coefficient according to 2.12.3.2
C_t is a deterministic thermal coefficient according to 2.12.3.3
C_r is a redistribution (due to wind) coefficient, a random variable according to 2.12.3.4. If redistribution is not taken into account $C_r = 0$

2.12.3.2   **The exposure coefficient C_e and shape factor η_a**

The exposure coefficient, C_e and the shape factor η_a are a reduction coefficients taking account of the exposure to wind of a building and the slope of the roof α:

$\alpha = 0^o$	$C_e \eta_a = 0.4 + 0.6 \exp(-0{,}1\ u(H))$
$\alpha = 25^o$	$C_e \eta_a = 0.7 + 0.3 \exp(-0{,}1\ u(H))$
$\alpha = 60^o$	$C_e \eta_a = 0$

$u(H)$ is the wind speed, averaged over a period of one week, at roof level H.
For intermediate values of α linear interpolation should be used.

2.12.3.3   **The thermal coefficient C_t**

The thermal coefficient, C_t , accounts for the reduction of snow load on roofs with high thermal transmittance, in particular glass covered roofs. C_t is equal to 1.0 for buildings which are not heated and for buildings where the roofs are highly insulated. A value of 0,8 shall be used for most other cases.

2.1.3.4   **The redistribution coefficient C_r**

The redistribution coefficient, C_r , takes account of the redistribution of the snow on the roof caused by wind but in some cases also by other causes.

For monopitch roofs the redistribution of snow load may be neglected.

For symmetrical duopitch roofs the coefficient C_r is assumed to be constant and equal to $\pm\ C_{ro}$ for each half of the roof according to FIG 1. C_{ro} has a β-distribution with $\mu(C_{ro})$ according to FIG 2; the coefficient of variation of C_r is equal to 1.0. For other types of roofs the numerical values given in ENV 1991-2-3 and ISO 4355 shall be used. These values can assumed to correspond to the mean value plus one standard deviation.
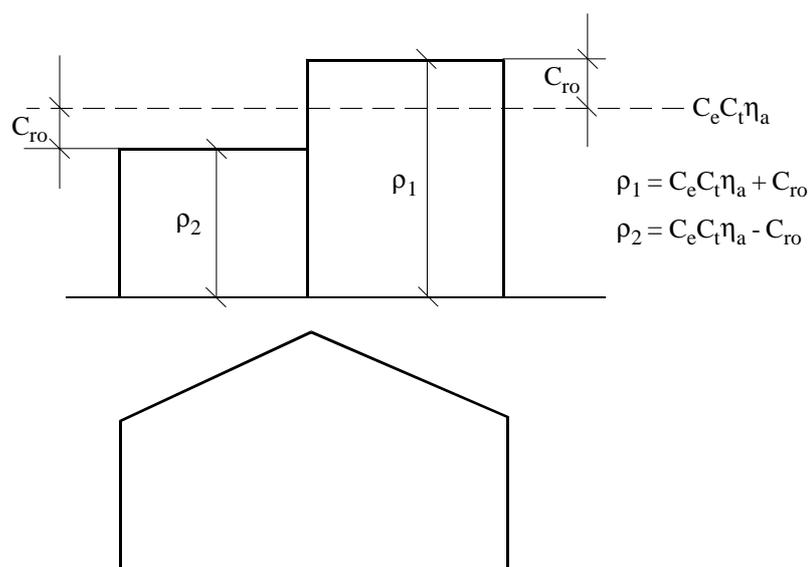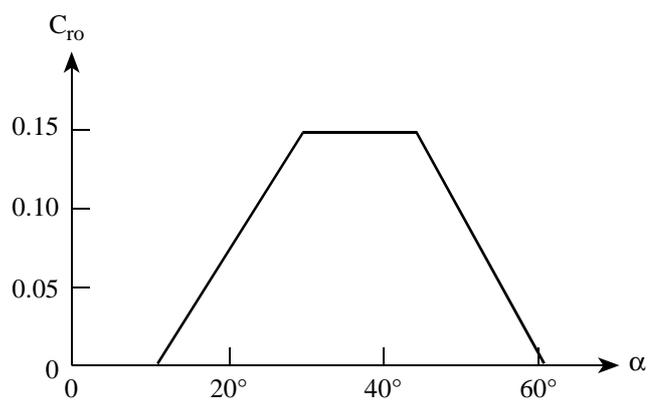
Figure 1: The redistributed snow load on a duopitch roof

$$\rho_1 = C_e C_t \eta_a + C_{ro}$$
$$\rho_2 = C_e C_t \eta_a - C_{ro}$$

Figure 2: C_{ro} as function of the roof angle

Summary of snow load variables

X	designation	distribution	mean	scatter
S_g d_g	snow depth on the grund snowload on the ground	gamma	observation[1]	observation[1]
ρ	climate type parameter	det	observation	observation
k	parameter	det	1.5/1.25 m	-
h_r	reference height	det	300 m	-
$\gamma(0)$	unit weight at t = 0	det	1,7 kN/m^3	-
$\gamma(\infty)$	unit weight at t = ∞	det	5.0 kN/m^3	-
λ	parameter	det	0.85 m	-
$C_e\eta_a$	shape coefficient	beta	2.13.3.2	V = 0.15
C_t	insulation parameter	det	0.8-1.0	-
C_{ro}	redistribution coefficient	beta	Fig. 2	V = 1.0

[1] Data from similar stations can be used as prior with n' = 3 and ν' = 2.