

AD 466:

Probability factors applied to characteristic wind and snow loads for non-standard return periods

Wind Loads

The SCI receives queries from time to time on the determination of design actions for wind load for design lives other than the usual 50 years. According to BS EN 1991-1-4:2005¹ para. 4.2, the basic wind velocity v_b is multiplied by the probability factor c_{prob} to give the 10 minutes mean wind velocity having the probability p for a given annual exceedance. Equation 4.2 in the para. named above is:

$$c_{prob} = \left(\frac{1 - K \times \ln(-\ln(1-p))}{1 - K \times \ln(-\ln(0.98))} \right)^n$$

The recommended values for K and n are 0.2 and 0.5 respectively. In substituting these values, the denominator gives the constant multiplier 0.75 and the formula becomes:

$$c_{prob} = 0.75 \sqrt{1 - 0.2 \ln[-\ln(1-p)]}$$

This is as given in SCI publication P394² Appendix B, where it is applied to the wind speed derived from the wind map for the UK (Figure NA.1 in the UK National Annex³) along with other factors to arrive at the design wind pressure q_p .

BS EN 1991-1-6⁴ gives appropriate return periods for the design of structures during execution which may be shorter than 50 years. Example values of the probability factor for other return periods are for a 10 year return period ($p = 0.1$), $c_{prob} = 0.9$ and for 60 years ($p = 0.0167$), $c_{prob} = 1.01$, leading to factors on wind loading

equal to 0.82 and 1.02 respectively.

Snow Loads

The adjustment of snow loads for different return periods is also allowed according to BS EN 1993-1-3:2003⁵ Annex D, but only for return periods longer than five years, according to the UK National Annex. Here, the characteristic snow load is adjusted for a recurrence interval different from that for the characteristic snow load s_k which is based on an annual probability of exceedance of 0.02 ie a return period of 50 years. The formula for snow load with a return period of n years is given in Annex D as:

$$s_n = s_k \left(\frac{1 - V \frac{\sqrt{6}}{\pi} [\ln(-\ln(1-P_n)) + 0.57722]}{(1 + 2.5923V)} \right)$$

V is the coefficient of variation for the probability distribution. In the UK V varies depending on location. When determining ψ factors for the UK National Annex to BS EN 1990, a range of values for V were considered⁶. Example values for the factor on characteristic snow load for specific return periods and coefficients of variation are given in the table.

Coefficient of variation V	10 year return period	60 year return period
0.1	0.9	1.01
0.3	0.8	1.02

For site-specific queries, the Meteorological Office should be contacted. The Met. Office suggests using the contact form on the web-page: <https://www.metoffice.gov.uk/services/research-consulting>

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- 1 BS EN 1991-1-4:2005+A1:2010 *Eurocode 1 - Actions on Structures Part 1-4: General actions - Wind actions*. BSI, 2011
- 2 A F Hughes, *Wind Actions to BS EN 1991-1-4*, SCI P394, 2014
- 3 *UK National Annex to Eurocode 1 - Actions on Structures Part 1-4: General actions - Wind actions*. BSI, 2011
- 4 BS EN 1991-1-6:2005 *Eurocode 1 - Actions on Structures Part 1-6: General actions - Actions during execution*. BSI, 2013
- 5 BS EN 1991-1-3:2003+A1:2015 *Eurocode 1 - Actions on Structures Part 1-3: General actions - Snow loads*. BSI, 2004
- 6 Brettle, M E, Currie, D M, Cook N J, *Snow loading in the UK and Eire: Combination of actions given in the Eurocodes*, The Structural Engineer, 18 June 2002

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