AD 554:
Internal pressure and large openings

SCI's advisory desk sometimes gets asked about calculating the internal pressure coefficients in buildings with large openings and whether the situation should be considered for the ultimate limit state or as an accidental design situation. The purpose of this AD Note is to provide clarification.

If a building has large openings then two checks must be made to determine how to calculate the internal pressure coefficient.

The first check (clause 7.2.9 (2) of BS EN 1994-1-1) should be completed for the ultimate limit state. The check is to determine whether there are openings in at least two sides of a building (including the roof) that amount to more than 30% of the area in each side or roof. If there are, then the building should be treated as either:

- a free standing canopy roof in accordance with clause 7.3 (if there are at least two open walls) or
- a free standing wall in accordance with clause 7.4 (if there is no roof such as a building during renovation).

The openings of a building include the background leakage through the building envelope. Clause NA.2.30 of the UK National Annex to BS EN 1991-1-4 provides typical values of permeability of construction in the UK but notes that modern construction methods are likely to lead to lower values.

The Designers' Guide to EN 1991-1-4 says that clause 7.3 of EN 1991-1-4 gives values only for the canopy roof, and not for any associated wall, which gives a problem for open-sided buildings such as grandstands. Clause 3.6 of PD 6688-1-4 (taken from BS 6399-2:1997) gives values of internal pressure coefficients for open-sided buildings that have a roof and at least one wall which may be used to make up deficiency of wall values.

The second check is to assess whether the opening is a dominant opening. In accordance with clause 7.2.9(3), where an external opening, such as a door or a window, would be dominant when open but is considered to be closed in the ultimate limit state, during severe windstorms, the condition with the door or window open should be considered as an accidental design situation. As noted in PD 6684-1-4, "Alternative verifications may be appropriate in particular cases, for example, where emergency services might need to have access even during extreme winds. In such cases where relevant, the effect of dominant openings will need consideration in conjunction with extreme winds".

As explained in clause 7.2.9(4), a dominant opening occurs if the area of openings on any one face is at least twice the area of openings in the other faces of a building including background leakage through the building envelope.

The internal pressure is taken as a proportion of the external pressure at the dominant opening. When the dominant opening area is twice the area of other openings, the internal pressure is 75% of the external pressure at the dominant opening. When the dominant opening area is three times the area of other openings, the internal pressure is 90% of the external pressure at the dominant opening. Values of dominant openings between two and three may be linearly interpolated. The position of the opening is therefore very important, resulting in increased internal pressures or suctions, depending on the wind direction.

The condition where the openings are closed should also be considered.

For further information, see BRE DG 436-1.

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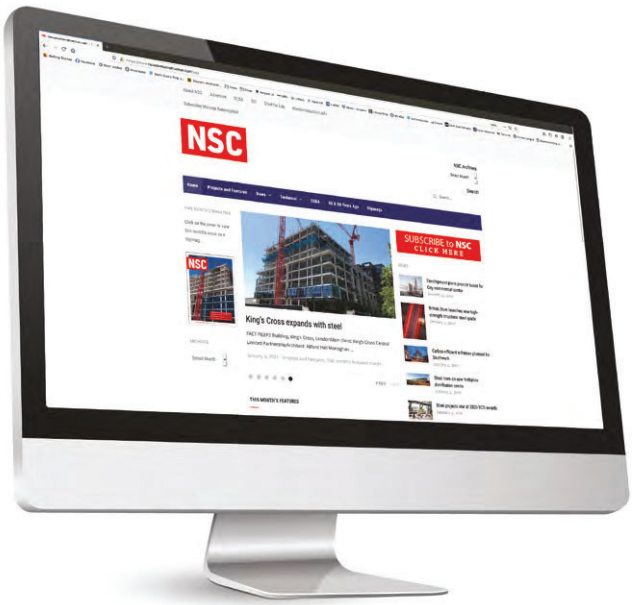

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