RIDBA
Rural & Industrial Design & Building Association

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Wind Loading on Agricultural Buildings

All buildings and other external structures are subjected to wind loading which, over the 20 to 50 year design life of the building, may on occasion be sufficiently strong to cause damage to the cladding and even the building structure. It is therefore essential that this loading is properly accounted for during the design and construction of the building. It is not uncommon to see news footage of roof and wall cladding being ripped off and blown about during severe winter storms and of structural damage to temporary structures and older buildings. It is thankfully rare for modern buildings to fail structurally due to wind loading alone, although this is no reason to be complacent. RIDBA is aware of several instances where buildings have swayed excessively during high winds, resulting in complaints from concerned building owners. Excessive deflections can lead to damage to the building envelope and ancillary components attached to the frame, requiring costly remedial action that could have been prevented by proper consideration of the likely wind loading at the design stage.

Wind forces on buildings

When the wind blows over or around a building, it is forced to change direction and either speed up or slow down depending on the shape and orientation of the obstruction. This causes either an increase or decrease in the external air pressure. When combined with changes to the internal air pressure the result is either a net positive pressure (on windward facing walls and the windward slopes of steep roofs) or a net suction (on leeward facing walls, walls parallel to the direction of the wind and on roofs generally). Importantly, the magnitude of the pressure is proportional to the square of the wind speed, so doubling the wind speed will produce four times the wind loading on the building.

From a building design point of view, the most important point to understand is that wind speed varies enormously with location and building geometry, meaning that wind loading is site and building specific, so should be calculated for each and every building project. Since the magnitude of the wind loading has a direct bearing on the design of the frame (e.g. column and rafter sizes), it follows that the design of every building is unique and should be calculated or at least regularly checked. It should come as no surprise that a 15m barn designed for a sheltered location in Oxfordshire may not be adequate if placed on a hilltop overlooking the coast of Cornwall.

Factors affecting the wind speed

Location

Some parts of the country tend to experience higher wind speeds than others and this needs to be taken into account when calculating the wind loading on a building. To enable engineers without specialist meteorological expertise to judge the likely wind speed at a particular location, the available meteorological data has been analysed to produce a contoured “wind map” of the UK, which is published as part of the UK National Annex to BS EN 1991-1-4 and is reproduced over the page. The values shown on the map are magnitudes of the “basic wind speed” to which correction factors may be applied to take account of wind direction, altitude and exposure conditions.

Altitude

Wind speed naturally increases with altitude and this is accounted for by a correction factor that is applied to the “basic wind speed”. This is especially important for agricultural buildings since many are constructed at altitudes greater than 200m above sea level, where wind speeds are significantly higher than those in low-lying locations.

Distance to sea

The shorter the distance to the sea, the greater the wind speed, since the wind loses energy and speed as it blows across land. The greatest reduction in wind speed occurs over the first few miles, meaning that locations on the coast experience much higher wind loading than sites only 1 or 2 miles inland. Clearly, cliff top sites that combine a coastal location with altitude experience particularly high wind speeds.

Town or country

Agricultural buildings are generally built in exposed locations that do not benefit from the shelter provided by a surrounding town or city. This results in higher wind speeds than would be experienced by comparable buildings located on an urban site.

Topography

Topographical features such as hills can increase wind speed as the air is forced over them. For this reason, it is important for the person calculating the wind loading to have some familiarity with the site and not simply rely on a postcode.

Wind direction

Wind speed is dependent on direction, with the strongest winds generally blowing from the south west. For this reason, when considering other factors such as distance to the sea or to the edge of town, it is important to consider the direction in which this distance is measured. A common approach adopted by engineers is to consider the wind blowing from several points around the compass and to calculate the wind speed for each direction.

Building height

Taller buildings are exposed to stronger winds and this needs to be reflected in the wind loading calculations. For single storey buildings it is common practice to calculate the wind speed for the ridge height.

Standards and software

Wind loading should be calculated using a recognised code of practice, which in the UK means BS EN 1991-1-4. This is one of the structural Eurocodes and is applicable across Europe, although each country has its own National Annex containing nationally determined parameters and specific national recommendations. The calculation method in BS EN 1991-1-4 is complex and requires specialist technical knowledge, so it is essential that wind loading calculations are undertaken by a qualified structural or civil engineer.

By far the simplest approach is to use one of the many software tools currently available. These range from commercially available packages that take account of all of the factors noted above to free online tools that produce reasonable but conservative results with minimal input from the user. Several steel purlin manufacturers include wind loading tools as part of their specification software (free to customers). In many cases, the precise site location may be specified in the software by its postcode or grid reference. Alternatively, various online resources may be used to obtain the grid reference, altitude and other location data. Thanks to Google, even the local topography and surrounding terrain may be surveyed without leaving the office.

Concluding remarks

The design of any steel or timber framed building is dependent on the magnitude of the wind loading acting on the building. Without knowledge of the wind loads, it is impossible to design the frame or to specify the fasteners for the roof and wall cladding. Since the wind loading depends on so many geographical factors in addition to the shape and size of the building, it should be calculated for each and every building project, since no two buildings will be identical. A Eurocode standard (BS EN 1991-1-4) provides recommendations for the calculation of wind loading on structures, but these calculations need to be performed by a qualified engineer. Alternatively, the wind loading may be calculated using software, including free online tools.

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For further information, contact:

Dr Martin Heywood, RIDBA Technical Consultant
6-8 Bonhill Street, London, EC2A 4BX
0844 249 0043
admin@ridba.org.uk
@RIDBA_Office

Notes to Editors

1. The Rural and Industrial Design and Building Association (RIDBA) is the recognised trade association for the modern agricultural and industrial buildings industry.

2. RIDBA represents contractors, designers, colleges, surveyors, land agents and manufacturers involved in rural and industrial construction. The details on joining RIDBA can be found on the RIDBA website.