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Extreme-value analysis for observed peak pressures on the Silsoe cube

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Abstract

The application of the type III extreme-value distribution to wind engineering problems is discussed critically. Recent studies of aerodynamic coefficients from wind tunnel experiments show that the extremes of some local pressures and some global forces follow a type III distribution. The actual study therefore intends to investigate if a type III distribution can be fitted to the full-scale data from the 6 m Silsoe cube. Since the independent runs may vary with the mean wind speed, adjustments to the data become necessary to ensure that the sampled peaks from different runs can be compared.

Keywords: Peak pressures; Silsoe cube; Extreme value analysis

1. Full-scale measurements

A 6 m cube (Fig. 1) has been constructed at Silsoe Research Institute in an exposed position. The building is instrumented with surface tapping points positioned along the centre line section and over one-quarter of the roof. Upstream of the building, at a distance of approximately 22.8 m from the centre of the cube, a sonic anemometer measures the three components of the wind speed vector at the height of the cube.

For the basic data recording, measurements are made with a sampling frequency $f_s = 5$ samples per second. A single run has a duration of 1 h; at the beginning and the end of the

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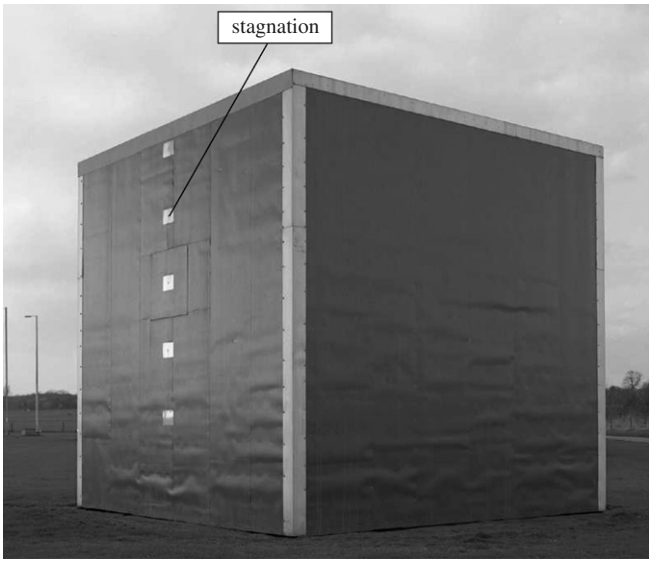

Fig. 1. The Silsoe 6 m cube.

1-h record, zero and calibration checks are applied. The calibration method introduces for the air density ρ a fixed value of $1.226\,\mathrm{kg/m^3}$. The raw data records are processed by subtraction of zeros and application of calibration values to give the time series of 16 local pressures and three components of the wind speed.

In this study, pressure coefficients are obtained by normalizing the measured pressures p to the velocity pressure corresponding to the mean wind speed at building height:

$$c_{\mathrm{p}}(t) = \frac{p(t)}{\frac{1}{2} \cdot \rho \cdot \bar{u}^2}, \tag{1}$$

$\bar{u}$-mean wind speed at building height, averaged over 1 h.

The u-component of the wind speed is obtained from a vectorial addition of the measured wind speed components by demanding that the u-component follows the mean wind direction. Then, the mean value of the v-component becomes zero.

2. Extreme-value statistics

2.1. Sampling of extremes and order statistics

From the 1-h records containing 18 000 continuous data points, sub-sets with a specific duration T_{sample} are separated. The appropriate choice of T_{sample} is discussed in Section 3. From each sub-set, the largest and smallest values are extracted, thus forming the basic data to collect ensembles for the maximum and minimum pressure coefficients. Only sampled peaks from runs with similar basic conditions are collected in the final ensemble. Sorting criteria are the mean wind direction and the mean wind speed over the total length of the run.