COMPARISON OF END BAY LOADS ON AN ISOLATED INDUSTRIAL BUILDING

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Introduction

The 1980 edition of the National Building Code of Canada [1], and the 1983 revisions to AS 1170/2 [2], both introduced significant reductions to frame loads on low-rise industrial buildings based on recent wind tunnel data. In the case of the Canadian Code, the revisions were based entirely on data obtained from the University of Western Ontario on isolated building models.

During a recent study of multi-span low-rise buildings at CSIRO, a span module identical to one of the UWO models was chosen and a few comparisons with the UWO test results were made. The case chosen is shown in Figure 1 - a case very typical of a modern steel frame industrial building. Peak net vertical uplift and horizontal forces on the windward end bay of a low pitch building, for three different wind directions in rural terrain were determined. The CSIRO results were obtained using the coincident peak technique [3], and represent expected peaks in a sample time of about 10 minutes in full scale. The CSIRO tests were conducted at 1/200 scale, compared with 1/250 scale for the UWO tests.

The comparisons are shown in Tables I, II, together with values derived from the latest editions of the Canadian and Australian Codes.

Discussion

The wind tunnel results for vertical forces agree well, with slightly lower values occurring in the CSIRO tests. However for the horizontal forces, the agreement is not good with the UWO values being about 30% lower than those from CSIRO. The differences appear to come from the lower windward wall pressures recorded at UWO, but it is not clear why this should be the case when the roof pressures appear to agree well.

The Australian Standard is a little conservative in comparison with the highest wind tunnel uplift data, and CSIRO horizontal thrusts. A value of $(\hat{u}/\bar{u})^2$ of 2.75 was used to convert AS 1170/2 values, based on the peak gust at eaves height, to the mean wind speed at eaves height in the wind tunnel tests and Canadian Code. An area reduction factor of 0.8 was used in the vertical force calculations, but none was used in the horizontal force estimation. No directionality reduction was made.

The Canadian Code gives force coefficients which apparently include some implicit reduction for wind directionality effects. However, although conservative with respect to the UWO results, the NBCC underpredicts the horizontal thrusts measured at CSIRO. Although not shown here, the NBCC also underpredicts the UWO data for uplift on low pitch roofs with higher h/d ratios; this ratio is not included as a variable in the NBCC Table.

Conclusions

(a) Some disagreement is apparent between windward wall pressures and horizontal thrusts measured in wind tunnel tests at CSIRO and UWO, although good agreement has been found between roof pressures and vertical uplift forces.

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(b) Although the Australian Standard [2] appears to be conservative in this case, it should be noted that it is unlikely to be so in the case of suburban and urban terrain for which the velocity multipliers appear to be too low at present.

(c) The Canadian Code appears to have no margin of conservatism for open country conditions, but it is likely to be conservative for built up terrain for which the same loads are specified as for the open country case.

References

1. National Research Council of Canada, 'National Building Code of Canada', Commentary B to Part 4, Design, 1980.

2. Standards Association of Australia, 'SAA Loading Code, Part 2 - Wind Forces', AS 1170 Part 2-1983.

3. J.D. Holmes, 'A new technique for the determination of structural loads and effects on low-rise buildings', in Wind Tunnel Modeling for Civil Engineering Structures, ed. T. Reinhold, Cambridge University Press, 1982.

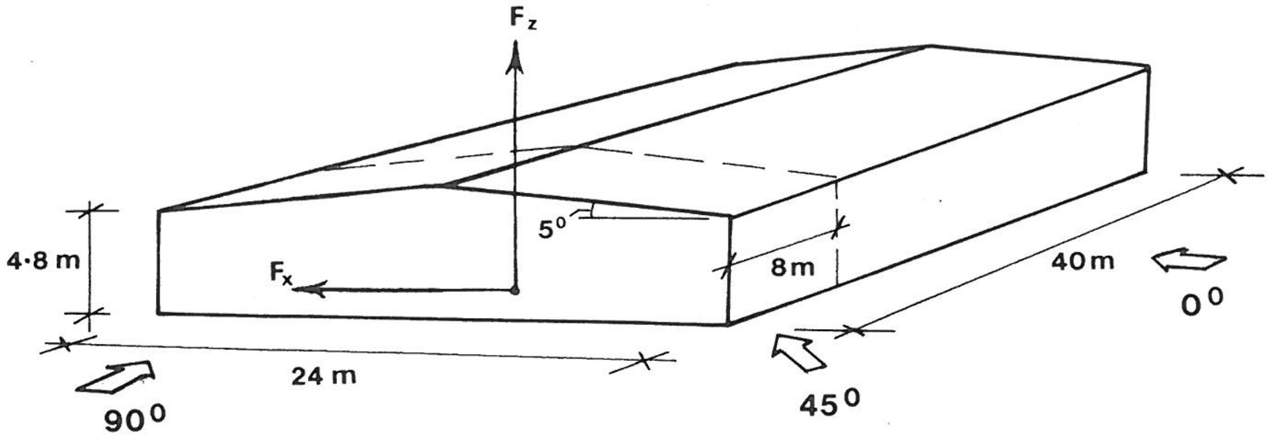

Figure 1 Building geometry and load cases

TABLE I
COMPARISON OF PEAK VALUES OF C_{F_z}

Wind direction, θ	UWO wind tunnel	CSIRO wind tunnel	AS 1170/2 ($G_u^2 = 2.75$)	NBCC
0^o	0.9	0.87	0.84	1.5 ↓
45^o	1.1	1.03	-	↑
90^o	1.33	1.17	1.63	1.5

TABLE II
COMPARISON OF PEAK VALUES OF C_{F_x}

Wind direction, θ	UWO wind tunnel	CSIRO wind tunnel	$AS_2 1170/2$ ($G_u^2 = 2.75$)	NBCC
0^o	1.5	2.09	2.48	1.95 ↓
45^o	1.63	2.41	-	↑
90^o	0.5	-	0	0