Wind Engineering Joint Usage/Research Center
FY2014 Research Result Report

Research Field: Wind Hazard Mitigation/Wind Resistant Design
Research Period: FY2014～ FY2015
Research Number: 143002
Research Theme: 高層建築物に作用する風荷重に与える Interference Effect に関する研究

Representative Researcher: Achal Mittal : Central Building Research Institute

Budget [FY2014]: 410,000Yen

*If the research was not continuous, this will be the Final Result Report, so the contents of the report has to be detailed.
*There is no limitation of the number of pages of this report.
*Figures can be included to the report and they can also be colored.
*Submitted reports will be uploaded to the JURC Homepage.

1. Research Aim

Improved structural design systems and construction methods as well as enhanced structural material strengths have enabled construction of increasingly tall buildings. In addition, with the development of modern cities, large numbers of tall buildings are constructed in small zones. Wind loads on grouped tall buildings can be different from those on isolated buildings due to the effects of neighboring buildings, called interference effects. Interference effects have been studied by many researchers over the past several decades. However, most past studies have focused on overall wind loads, wind-induced responses on a tall building through high-frequency force balance and aeroelastic model tests. Although the equivalent static loading can be estimated by distributing the base moments to each floor, using local wind force spectra is the accurate way to analyze the dynamic response of a multi-degree-of-freedom system with non-linear or non-uniform mode shape. Further, local wind forces along height levels of a tall building due to a neighboring tall building may be different from those for an isolated building. The main aim of this study was to tackle the problem of interference for local peak pressures and overall wind loads on a tall building in order to establish a generalized set of guidelines.

2. Research Method

Interference effects between two buildings are investigated by high-frequency pressure measurement technique. For this study, the flow of the atmospheric boundary layer in the wind tunnel was interpreted as a geometrical scale of approximately 1:400. The approach flow represented an urban wind exposure with a power law exponent of 0.27. The wind speed and the turbulence intensity at the height of the study model were 8.2 m/s and 20%, respectively. The considered experimental model comprised two buildings: the pressure model, referred to as the principal building, and the other model, referred to as the interfering building. The principal building at a length scale of 1:400 was 70mm by 70mm in plan and 280mm in height. A total of 252 pressure taps, 63 on each of its four surfaces, were installed on the walls of the principal building. They were non-uniformly divided into nine measurement levels in the vertical direction. Further, the Reynolds number of the principal building was 3.44×10^4. Table 1 shows cases of the experimental models used in this study. As shown, two types of interfering buildings were considered, all with the same height as the principal building, but with different breadth. They were considered as breadth ratios ($B_r=B_i/B$), 0.7 and 1.5, where B_i is the width of the interfering building and B is the width of the principal building
Table 1. Experimental models.

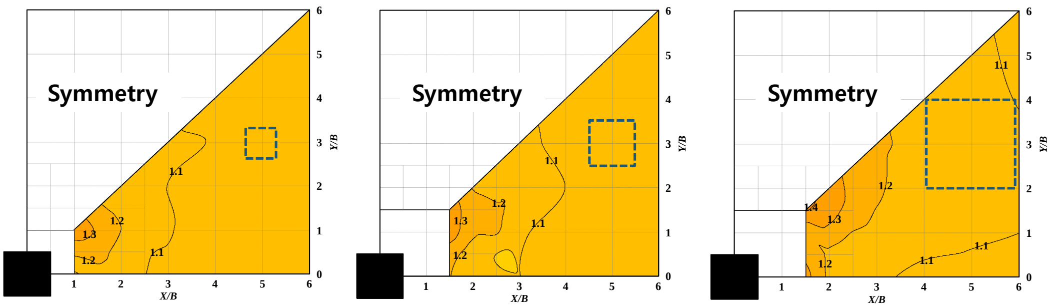
Experimental models	Dimensions (mm) ($B \times D \times H$) ($B_i \times D_i \times H_i$)	Height ratios ($B_r = B_i / B$)	Locations	Wind directions
Principal building	70×70×280	-	1	0^o – 355^o (5^o steps)
Interfering building	47×47×280	0.7	30	
	105×105×280	1.5	25	

3. Research Result

Figures 1 show contours of maximum interference factors (*IF*s) for mean along-wind base moment coefficients on the principal building with different breadth ratios of the interfering building for all wind directions. It should be noted that the effect of interference was increased with increase in the breadth ratio of the interfering building. Another interesting observation was that the highest value of maximum *IF* for mean along-wind base moment coefficient on the principal building occurred where the interfering building was placed in oblique arrangement, and the most critical location for the interfering building to generate high mean along-wind base moment coefficients was at (*X/B*, *Y/B*)=(1, 1) for Br=0.7 and (*X/B*, *Y/B*)=(1.5, 1.5).

Figure 2 show correlation of mean interference factors between different breadth ratios and the data are regressed as linear expression. The *MIF*s between different breadth ratios show good correlations. It is clear that *MIF*s increase rapidly with the increase of breadth ratio.

Figure 3 show span-wise coherence function and phase angle of across-wind local force coefficients between height levels (levels 9-8, 9-5, 9-3 and 9-1) of a principal building with and without an interfering building at significant locations of (*X/B*, *Y/B*) = (1.5, 1.5) for the specified wind directions at which RMS across-wind base moment become the maximum.



(a) B_r=0.7 (b) B_r=1 (a) B_r=1.5

Figure 1. Maximum Interference Factors for mean along-wind base moment coefficients between two tall buildings

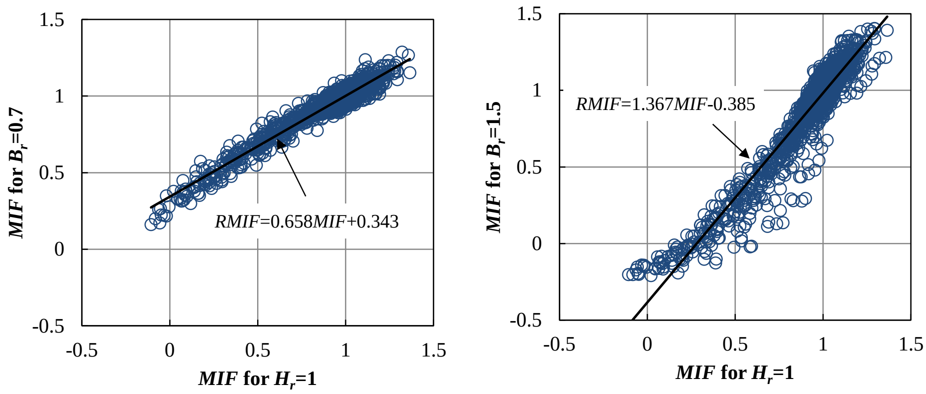
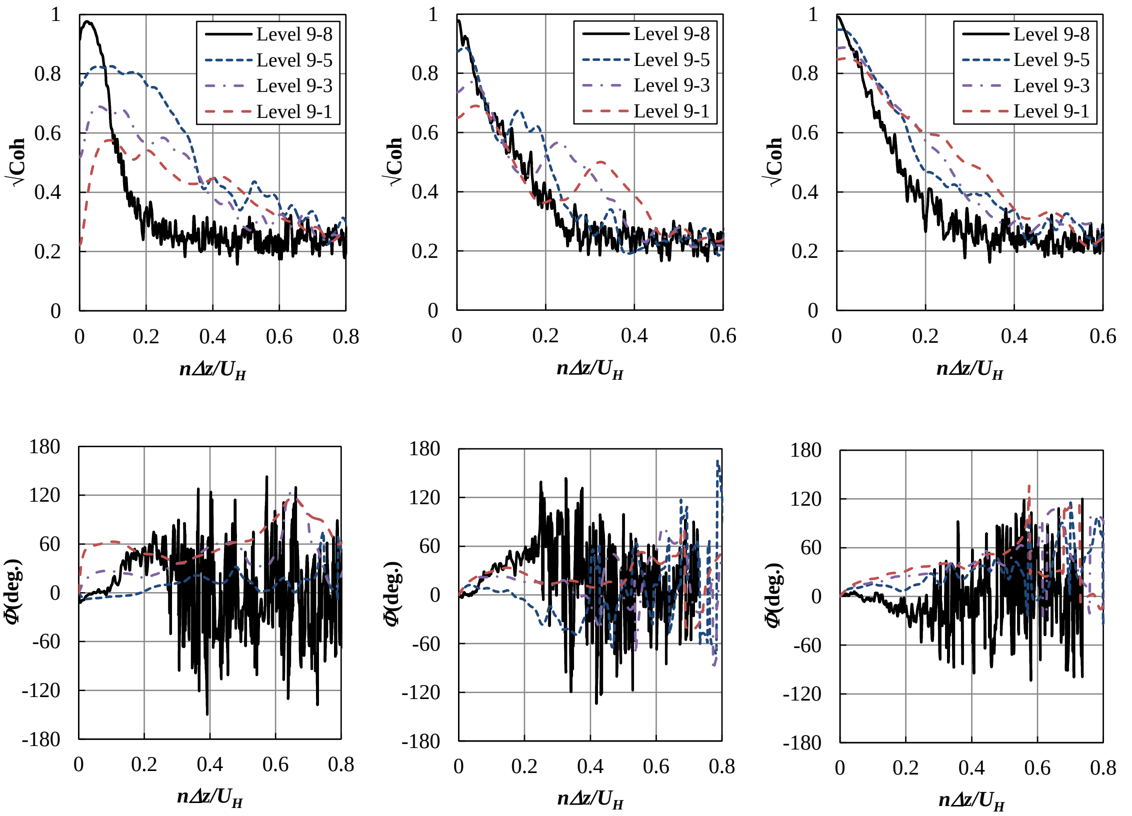


Figure 2. Correlation of mean interference factors between different breadth ratios

The coherence over intervals (Δz) from 1 to 9 height levels is analyzed. For the isolated building, the coherence for across-wind local force has a peak band which broadens with the increase in intervals and still has high coherence over a high reduced frequency range of 0.41, and it is clear that the phase for across-wind local forces increased with increase in interval as shown in Figure 3(a). From Figure 3(b) and (c), when the reduced frequency is zero, the coherence with the interfering building showed high correlation even for larger intervals, since the coherence for the isolated building is less than 0.4 for larger intervals. Further, the lager breadth of interfering building tended to decrease the phase angle.



(a) Isolated (b) B_r=0.7 (a) B_r=1.5

Figure 1. Span-wise coherence and phase angle of across-wind local force coefficients between height levels of principal building with and without interfering building located at (1.5*B*, 1.5*B*).

4. Published Paper etc.

[Underline the representative researcher and collaborate researchers]

[Published papers] (None)

[Presentations at academic societies] (None)

[Published books] (None)

[Other]

Intellectual property rights, Homepage etc.

5. Research Organization

1. Representative Researcher

2. Collaborate Researchers