論文の内容の要旨

論文題目　CHARACTERISTICS OF WIND PRESSURE FLUCTUATIONS ON DOME-LIKE STRUCTURES
（ドーム構造物に作用する変動風圧力に関する研究）

氏名　羅　元隆

This research intends to investigate the general characteristics of wind pressure field on various domed roofs, and the estimation of wind loads and dynamic responses. A common range about 10^5 of Reynolds number is assumed in this research. Turbulent boundary layer flow is simulated by barriers and roughness blocks in the wind tunnel. Testing models of domed roofs are composed of a curved roof acrylic model and a circular cylinder acrylic model. By changing the height-span ratio (roof height to span) and the wall-span ratio (cylinder height to span), various geometric models are obtained to include almost all kinds of dome structures. Dynamic wind pressures on the surface then measured and analyzed. The outline of each chapter is briefly introduced.

In Chapter 1, historical background of dome structures is briefly introduced. Published researches regarding hemispherical domes or various domed roofs are mentioned for the background knowledge of this research. Then the construction of this thesis is shown in flowchart diagram.

In Chapter 2, turbulent flow is simulated by barriers and roughness blocks to fit the urban terrain with power law index equals 0.27. The characteristics of oncoming wind are examined in detail to show the construction of wind profiles similar to those simulated in previous literatures. Specifications of devices for pressure measurements and acrylic models of domed roofs for experiments are introduced. Basic data processing is then explained and aerodynamic parameters in this thesis are briefly introduced.

In Chapter 3, distributions of wind pressure field on domed roofs are first examined by observation of aerodynamic parameters. Mean and R.M.S. wind pressure coefficients are calculated to show the general characteristics of wind flows on various domed models (including flat models and domed models with curved roofs) due to geometric changes. Correlations between any two pressure taps along the meridian parallel to the wind direction are then discussed to indicate the possibility of region zoning of domed roofs.

In Chapter 4, non-Gaussian features of wind pressure fluctuations are also discussed along the meridian. Peak factors based on the observation of higher moments are estimated and compared with other proposed methods in literatures.

In Chapter 5, power and cross spectra of wind pressure fluctuations are investigated to show the discrepancies in each region on various domed roofs. Models for fitting power spectra are then proposed by three main patterns in three regions. Weighting of each pattern is then indicated. Cross spectra within each region or across two regions are also investigated to show that only one model of cross spectrum for one domed roof is insufficient.

In Chapter 6, theoretical background of dynamic response estimation is briefly introduced. According to the approximation models proposed in Chapter 5, dynamic response can be estimated more precisely with the consideration of the discrepancies in power and cross spectra. Fundamental structural frequencies and vibration modes of domed roofs are then applied to the construction of finite element models. Wind loads with or without the considerations of cross spectra are estimated and dynamic responses are then calculated. Local wind loads in certain area are further conducted by integrating wind pressure cross spectra to show the significant discrepancies between regions.

Chapter 7 summarizes remarks in each chapter and suggests the possible extensions of related researches.

In summary, through the zoning of domed surface, understanding of wind flow changes on the surface is distinct. Based on the zoning results, not only the characteristics of wind pressure coefficients were well categorized, modeling of power and cross spectra in each zone was conducted and shower good agreement with the experiment results. For the power spectrum characteristics, transition of turbulence energy from zone to zone is clear and explained by observation of weighting factors of typical spectrum characteristics. For the co-coherence, a significant phase shift at zero frequency was indicated when wind flow converts from positive to negative values. Root-coherence and phase models were further improved for good agreements of modeling. Finally, the modeling results of power and cross spectra were utilized for calculation of generalized wind forces or integrated wind loads for claddings to verify the improvement of modeling quality.