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要約（様式自由）
Thesis Outline（free format）

LES Study of Aerodynamics of Two-dimensional Bluff Bodies in Crossflow at Very High Reynolds Numbers

There are increasing challenges for the safe and long-lasting structures or structure elements, including the less stiffness of structures and the increasing extreme weather events. The further knowledge of flows past bluff bodies is required to reduce the potential wind damages to such structures as high-rise buildings and bridge cables. Among others, Reynolds number (Re) effects are of great practical significance since the aerodynamic characteristics could be very different varying with Res. Unfortunately the previous studies mostly focused on the subcritical or lower Res, which are far from those encountered by structures in reality. Considering the feasibility of large-eddy simulation (LES), this thesis aims to clarify the aerodynamics of two-dimensional bluff bodies at very high Res which are close to the reality of structures. Specifically it includes:

(1) To explore three-dimensional wake patterns and their effects on aerodynamic forces and pressure on long-span circular cylinders at upper subcritical Res when vortex-induced vibrations of bridge cables happens in the field observations;

(2) To investigate supercritical-Re flows around square cylinders with rounded corners which are closer to the reality of high-rise buildings with corner modifications;

(3) To discover the effects of shear inflow on supercritical flows around a rounded-corner square cylinder, as an example of external effects.

The outline of the thesis is shown in the following schematic. Firstly the numerical methods are validated systematically in Chapter 3 based on unstructured-grid LES and structured-grid LES for predicting unsteady flows around a square cylinder at the high subcritical Res. In particular, the numerical schemes for convective terms, meshing strategies and spanwise lengths are examined for the unstructured-grid LES. On the whole, LES based on both grid systems are able to provide fairly accurate prediction of time-averaged and r.m.s quantities. The appropriate numerical schemes and meshing strategies are suggested for simulations of subcritical flows. Moreover, the spanwise length plays an important role in obtaining reasonable spanwise correlation of pressure and consequently the overall fluctuating lifts. Unstructured grids will be used in Chapter 4 for the subcritical flows past a circular cylinder with strongly vigorous vortex shedding, while structured grids will be applied in Chapter 5 & 6 for supercritical flows with complicated flow development near the cylinder wall.

Following that, the aerodynamics of circular cylinders at upper subcritical Res is studied in Chapter 4, with a focus on three-dimensional vortex shedding. It was found that even at such high Res, a three-dimensional pattern of vortical field is also present in the wake with a large phase lag in primary vortex shedding. The development process of three-dimensional wakes starts from local phase variations in primary vortex shedding, which are induced by the "irregular" streamwise vortex. The followed wake is associated with a successive evolution composed of certain stages in order, e.g., oblique vortex shedding. Moreover, such three-dimensional patterns also weakens vortex shedding in cross sections perpendicular to the axis of the cylinder, leading to modulations of sectional lift coefficients.

Finally the supercritical flows past a square cylinder with modified corners under uniform and shear inflow are investigated in detailed in Chapter 5 & 6. The systematical results and discussions could be accessed in the thesis.

To summarize, the findings and the systematical explanations about the very-high-Re flows around the typical bluff bodies will benefit greatly the understandings of wind forces acting on structures in architectural and civil engineering.