Implicit LES for Two-Dimensional Circular Cylinder Flow By Using COMSOL Multiphysics® Software

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Abstract

In this paper, implicit Large Eddy Simulation (LES) based on finite-element analysis is performed in order to investigate two-dimensional circular cylinder incompressible flow. Implicit LES attempts time-dependent flow computation with no explicit turbulence model. Here, two types of circular cylinder with/without surface roughness, are treated. The Reynolds number Re based of the diameter of circular cylinder is ranged from 1,000 to 10,000,000. The dependence of the drag coefficient Cd on the Reynolds number is shown in Fig.1. Drag crisis of the smooth circular cylinder, which means the sudden loss of drag coefficient, was observed numerically around the Reynolds number of 100,000. This Reynolds number called as critical Reynolds number agrees with the results reported by existing literatures including third-order upwind finite-difference scheme of Hashiguchi and Kuwahara (1996). With surface roughness which is defined as shown in Fig.2, the critical Reynolds number was reduced to around 10,000. This reduction of the critical Reynolds number due to surface roughness is also well known in fluid dynamics. Flow patterns computed are also displayed in Fig.1. The movement of flow separation point according to the change of flow regime form laminar to turbulent, was clearly captured in this implicit LES. The flow patterns shown here are snapshots at dimensionless time of 100.

Reference

M. Hashiguchi and K. Kuwahara, http://www.kurims.kyoto-u.ac.jp/~kyodo/kokyuroku/contents/pdf/0972-21.pdf (1996)

Figures used in the abstract

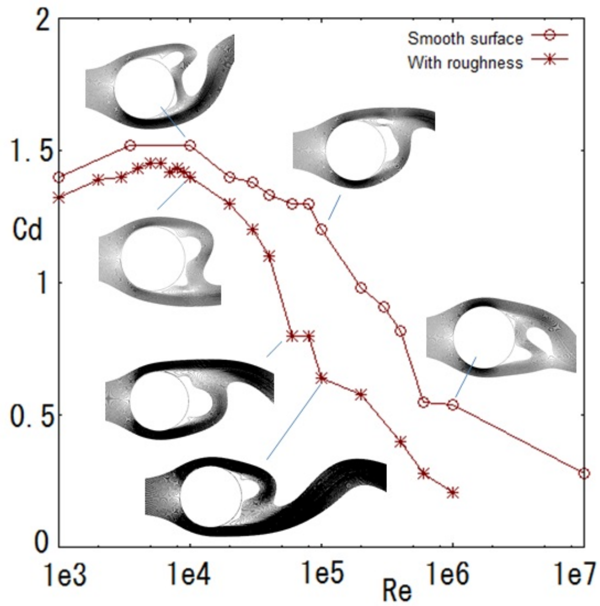

Figure 1: Drag coefficient vs. Reynolds number.

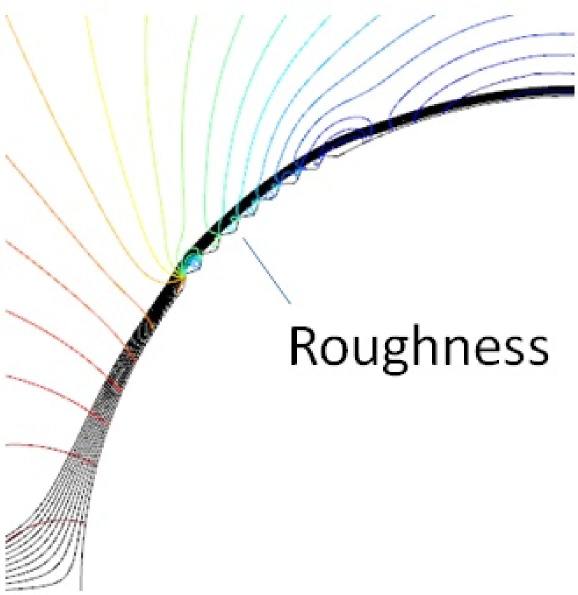

Figure 2: Surface roughness and flow of Re=1e5.