Large Eddy Simulation of Flow around a Square Cylinder

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Abstract

The three dimensional turbulent flow around a square cylinder at Reynolds number of 22,000 is numerically studied by large eddy simulation (LES). The mixed finite-volume finite-element method with unstructured tetrahedron elements is used to solve the filtered compressible Navier-Stokes equations at low Mach number. The preconditioning method, the character length in outlet boundary condition and the sub-grid models are tested through 6 test cases (denote T1~T6). It is found that by properly setting the computational parameters, the recirculation length, the drag coefficient and the recovery velocity, which supposed to be highly sensitive to spatial resolution, can be predicted with sufficient accuracy with the relatively coarse grids. The bulk mean parameters obtained in present simulations are shown in Table 1, in which St denotes the Strouhal number, Xr the recirculation length, $\bar{C}_L$ and $\bar{C}_D$ represent the time-averaged lift and drag coefficients, C'_L and C'_D the root-mean square of the lift and drag coefficients, respectively. The present results are in good agreement with the literature results

Table 1 Bulk mean parameters

Case	St	Xr	$\bar{C}_L$	C'_L	$\bar{C}_D$	C'_D
T1	0.133	1.38	-0.019	1.06	2.13	0.18
T2	0.134	2.03	0.027	0.50	2.00	0.12
T3	0.121	1.44	-0.014	1.07	2.17	0.29
T4	0.129	1.21	-0.079	1.22	2.22	0.23
T5	0.128	1.38	0.015	1.12	2.12	0.18
T6	0.134	1.23	-0.065	1.18	2.16	0.15
Lyn [5]	0.132	1.38			2.1	
Luo [7]	0.13			1.21	2.21	0.18
Grigoriadis [3]	0.132	1.35	-0.004	1.03	1.95	0.111

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