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Numerical Investigation of the Effect of Sidewalls on Low-Speed Finite Width Cavity Flows

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Abstract : Rectangular cavities with a full-span or finite-width configuration have been the basis of much previous research on cavity flows. However, much less attention has been given to the influence of sidewalls, in particular, on low-speed cavity flows. In this study, the flow characteristics of two separate low-speed finite-width cavities with a Reynolds number of □□□ = 10^4 are examined using large eddy simulations. Two different lateral boundary conditions are used to investigate the influence of sidewalls on the self-sustaining oscillations and the three-dimensional flow fields inside the cavities. The results show that the full-span finite width cavities are less sensitive to the sidewall effect at a low length-to-width ratio □/□. The increase in □/□ leads to a departure from two-dimensional instability and results in the loss of spanwise homogeneity. The analysis of the spanwise flow structures shows that these effects correspond closely to the declination of the centrifugal force from the primary recirculation zone. Such effects are also reflected in the distinct modulation of the secondary vortices in the primary recirculation zone, which suggests that the instabilities observed in the full-span finite-width cavity flows are predominantly dependent on the secondary motion from the primary recirculation zone.

Keywords : LES, cavity flows, unsteady shear layer, instability modes, secondary flow
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