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A two-dimensional computational study of a single right trapezoidal cylinder subjected to unsteady laminar flow regime at low Reynolds number

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Abstract. A right trapezoidal cross-section cylinder is used as guided bars for a barred tee in long piping or pipeline system to prevent the passing of pigs through branch pipe. The cylinder must have integrity against to fluids flow induced vibration which concerns to the synchronization between natural frequency of the cylinder with vortex shedding frequency of fluid flow. Therefore, this article aims to numerically investigate the vortex shedding frequency responses which are in term of Strouhal numbers, flow force coefficients, flow structure and to provide additional applicable data for engineering design of the single right trapezoidal cylinder in aspect of structural integrity. In this article, the simulation of a single right trapezoidal cylinder immersed in a uniform oncoming laminar flow regime with low Reynolds number, *Re* = 100, with various sharpening angles, defined as angle which is measured from virtual line parallel with height base side to slant side or (90^o- *acute angle*^{o}) of the cylinder, in the range of 0^o, 15^o, 22.5^o, 40^o and 60^o accompany with the cylinder side ratio (*B*/*A*) which is the ratio of the longest base side-to-height base side, in the range of 1, 2, 3, 4, 5, 6 and 7 was performed. In the simulation, the Direct Numerical Simulation (DNS) with a finite volume method and an incompressible flow with constant fluid properties were employed. The computational results were validated against with the published data. The effect of sharpening angle and side ratio on the response of the single right trapezoidal cylinder were presented and discussed. The Strouhal numbers and flow force coefficients of fully saturated flow were calculated. The simulated results show that, increasing of sharpening angle, the Strouhal numbers slightly increases whilst the RMS lift coefficients significantly increase. Additionally, as the side ratio increases, the Strouhal numbers and the RMS lift coefficient decrease.

Keywords: right trapezoidal cylinder, unsteady flow, incompressible flow, laminar vortex shedding.