

## Phase-Averaged Analysis of Three-Dimensional Vorticity in the Wake of Two Yawed Side-By-Side Circular Cylinders

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**Abstract :** The wake flow behind two yawed side-by-side circular cylinders is investigated using a three-dimensional vorticity probe. Four yaw angles ( $\alpha$ ), namely,  $0^\circ$ ,  $15^\circ$ ,  $30^\circ$  and  $45^\circ$  and two cylinder spacing ratios  $T^*$  of 1.7 and 3.0 were tested. For  $T^* = 3.0$ , there exist two vortex streets and the cylinders behave as independent and isolated ones. The maximum contour value of the coherent stream-wise vorticity is only about 10% of that of the spanwise vorticity. With the increase of  $\alpha$ , increases whereas decreases. At  $\alpha = 45^\circ$ , is about 67% of. For  $T^* = 1.7$ , only a single peak is detected in the energy spectrum. The span-wise vorticity contours have an organized pattern only at  $\alpha = 0^\circ$ . The maximum coherent vorticity contours of and for  $T^* = 1.7$  are about 30% and 7% of those for  $T^* = 3.0$ . The independence principle (IP) in terms of Strouhal numbers is applicable in both wakes when  $\alpha < 40^\circ$ .

**Keywords :** circular cylinder wake, vorticity, vortex shedding, side-by-side

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