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CLASSIFICATION OF GAP FLOW REGIMES IN TWO SIDE-BY-SIDE CIRCULAR CYLINDERS

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Abstract

The behavior of the flow around two circular cylinders arranged in a side-by-side configuration strongly depends on the transverse center-to-center gap spacing ratio (T/D) where D is the cylinder diameter (Fig.1). Based on the observed wake structure [13, 15], the flow pattern that emerges when the gap spacing is varied is conventionally classified into three flow regimes: single bluff body, biased flow and symmetric flow. The single bluff body flow regime is defined when the gap spacing is *small* e.g., $T/D < 1.2$. The wake pattern, as illustrated in Fig.1(a), is an asymmetrical single vortex street with vortices shed alternately from the outer surfaces of the cylinders. The non-dimensional shedding frequency, i.e., Strouhal number $S = (f2D/U_\infty)$ is approximately 0.2 where f is the shedding frequency and U_∞ is the free stream velocity. In this regime, the characteristic length of $2D$ agrees with the Strouhal number that is typical calculated for single bluff bodies with a diameter of $2D$ [12]. The biased flow regime is observed at an *intermediate* gap spacing ranging between e.g., $1.2 \leq T/D \leq 2.2$. The flow passing between the cylinders - *gap flow* - is biased towards one cylinder (Fig.1.(b)). The wake pattern behind that cylinder has a narrow near-wake (n) with a higher vortex shedding frequency $S_n = (f_nD/U_\infty) \sim 0.3$ while the other cylinder has a wider near-wake (w) and a lower shedding frequency $S_w = (f_wD/U_\infty) \sim 0.1$ [15]. The wake is asymmetrical and bi-stable because the gap-flow switches direction between cylinders. The time intervals between the switching or flopping events are several orders of magnitude greater than the vortex shedding period [9, 16]. Due to the relatively large timescale of the switches, the switching might be described as the behavior of a dynamical system with two quasi-stable states [9].