INTRODUCTION

Fluid flow past a circular cylindrical object generates vorticity due to the shear present in the boundary layer. This vorticity in the flow field coalesces into regions of concentrated vorticity known as vortices on either side of the cylinder. Flow above a threshold Reynolds number allows perturbations in the flow upstream to cause one of the vortices to grow larger. This vortex, with higher flow velocities and accompanying lower pressures, draws the smaller vortex from the opposing side across the wake centreline. The opposite vorticity from this smaller vortex severs the vorticity supply of the larger vortex, allowing it to convect downstream (Sumer and Fredsoe, 2007). This process is repeated in the reverse sense, leading to alternating vortex shedding from the cylinder.

When the cylinder is elastically restrained and natural frequencies are introduced, a fluid-elastic instability known as vortex-induced vibration (VIV) results. The time varying nonuniform pressure distribution around the cylinder resulting from the vortex shedding causes structural vibrations both inline and transverse to the flow (Hatton, 1999). Near the natural frequency of the structure, the vortex-shedding frequency synchronises with the natural frequency and the vibration frequency. One of the primary mechanisms responsible for this synchronisation is the change in hydrodynamic mass, as demonstrated in the experiments of Vikestad (1998). The range of reduced velocity over which this synchronisation occurs is known as the lock-in range. Mostly, the ensuing vibrations are undesirable, resulting in increased fatigue loading and component design complexity to accommodate these motions. The transverse vibrations also result in higher dynamic relative to static drag coefficients.

In an attempt to mitigate these VIV, the adoption of splitter plates has been proposed (Every, King and Weaver, 1982). A splitter plate is a rigid plate attached to a structure so that it splits the wake. The splitter plate falls within the category of devices termed wake stabilisers. The intention of these devices is to prevent the interaction of the shear developed in the boundary layer flow at either side of the cylinder (Sumer and Fredsoe, 2007). By limiting this interaction, the vortex shedding process is interrupted.

A number of stationary cylinder studies has been conducted to investigate the effectiveness of splitter plates in reducing vortex shedding and the accompanying hydrodynamic forces. (See, for example, Apelt and West, 1975, and Anderson and Szewczyk, 1997.) Roshko’s study (1954) reported that at splitter-plate ratios (i.e. the ratio of splitter-plate length to the cylinder diameter) greater than or equal to 5, vortex shedding was completely eliminated. The subcritical stationary cylinder experiments by Anderson and Szewczyk (1997) with splitter-plate ratios of 0.5 and 1 demonstrated significant reduction in vortex interaction and a delay in the formation of vortices by extension of the separated shear layers downstream of the trailing edge. This was also observed in the studies by Roshko (1954) and Bearman (1965). Gerrard (1966) reported that increasing plate length produced a decrease in the Strouhal number. The investigations by Apelt, West and Szewczyk (1973) and Anderson and Szewczyk (1997) concur, demonstrating that the variation of Strouhal number with splitter-plate ratio is nonlinear. These studies all agreed that even at small splitter-plate lengths (i.e. 0.25 < l/D < 1) the Strouhal number, drag coefficient and lift forces decreased. Kawai (1990) reported that a drag reduction of up to 36% was attained with the use of splitter plates on stationary cylinders. Studies of stationary cylinders with detached splitter plates have shown similar decreases in lift and drag forces (Hwang, Yang and Sun, 2003; Akilli, Sahin and Tumen, 2005).

There exists a limited number of studies where the effect of splitter plates is investigated when the cylinder is allowed to vibrate (i.e. the cylinder is elastically restrained). The recent