ABSTRACT

This thesis reported author work on how to passively control flow around a bluff body. This flow need to be controlled so that it can reduce drag of the bluff body structure. To passively control such a flow, two methods can be employed. The first method is geometrical modification of the bluff body and secondly is installation of a small size of disturbance body in front of the bluff body under investigation. Based on previous research (Igarashi and Shiba (2006) and Tsutsui and Igarashi (2002)), those two methods were usually employed independently. As its consequences, they cannot be used to thoroughly investigate how efficient is the passive flow control and flow phenomenon around the bluff body. This is the identified gap of the research in this area. To fill the identified gap, the author proposed to use combination of the two methods of controlling flow around bluff body. The main contribution of this proposed work by author is that the combined method can be used as a tool to better understand the fluid flow interaction (separation and reattachment) around the bluff body. An elliptical and circular cylinders were employed in this research as the upstream disturbance body and the main bluff body respectively.

The research reported in this thesis is consisted of two main works, which are experimental and numerical simulation. The author arranges the upstream disturbance body and the main bluff body in tandem so that it can be used to investigate three different parameters. The three parameters to be investigated are longitudinal distance between the two bodies (G/D), front side cutting (a) and axis ratio (AR) of the upstream disturbance body. Three values of G/D was chosen, G/D = 0.5, 1 and 1.5, while for the front side cutting, four values are used (a = 0%B, 5%B, 10%B, and 15%B). The AR used in this research are (A/R) = 1/3 and (A/R) = 1/4. Those parameters are chosen as the author believes that they have significant effects on boundary layer transition acceleration occurred on the two bodies in tandem configuration. Moreover, those three parameters can be used to explain flow phenomenon usually occurs on the tandem bodies, which are the separation and reattachment phenomenon. The experimental study was carried out in sub-sonic open-circuit wind tunnel while for numerical simulation, CFD software Fluent 6.2 solver with turbulent viscous Reynolds Stress models was employed. Velocity profile (u/U), turbulence intensity, shape factor (H), pressure coefficient distribution (Cp) and flow visualization were selected to investigate physical phenomenon of fluid flow interaction on the two bodies in tandem. It is expected that the experimental and numerical simulation will provide a substantial contribution to knowledge, specifically on “how to enhance the effectiveness of passive flow control using the upstream disturbance body boundary layer with cut off front side contour”.

Based on the experimental and numerical simulation, it can be found out that there is an existence of a thick and long separation bubble on the upstream disturbance body contour. The separation bubble can be utilized to increase the effectiveness of shear layer agitation developed on the boundary layer. It can be described as follows. The separated shear layer with divergence pattern which occurs at the very front of elliptical cylinder cutting point, soon after premature massive separation occurred, has a very strong turbulence intensity. This strong turbulence intensity subsequently will induce a very intense vortices into the free
stream flow shear layer. This phenomenon was found on upstream disturbance body with cutting front side (a = 15%B) with longitudinal distance (G/D) = 1.5. In this tandem configuration the effectiveness of the agitation the flow around main bluff body indicate the best results. All the physical phenomena exploration was conducted on Reynolds number (Re\textsubscript{A}) = 1.6x10\textsuperscript{4} based on a minor axis (A) of a single elliptic cylinder, and to be in tandem arrangement are running on Reynolds number (Re\textsubscript{D}) = 6.4x10\textsuperscript{4} based on circular cylinder diameter.

**Keywords:**
bluff body, elliptic cylinder (AR = 1/3) and (AR = 1/4), circular cylinder, upstream disturbance body, separation-reattachment, separation bubble, massive separation.