Experimental Measurement of Turbulence Intensity of Flow Over Two rod and Circular Cylinder in Tandem Arrangement

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Abstract The aerodynamic characteristics of two rod (cylinder with small diameter) and circular cylinder with different diameters were investigated experimentally in a uniform flow at a Reynolds number of 18900. The focus of this study was on the determination of the turbulence intensity in which rod is located in upstream flow. Results show that the rod located in up-stream flow causes to decrease the turbulence intensity.

Keywords: Circular Cylinders, wind tunnel, hot-wire anemometer, turbulence intensity.

Introduction

Determination of the characteristics of fluid flow around simple configuration of bodies is helpful for understanding the flow around more complex and larger-scale structures. A circular cylinder is one of the elementary shapes of structures used in engineering practice. A large amount of work has been developed to the study of the flow around circular cylinders [1-2]. Many researches were performed to evaluate the aerodynamic characteristics of two side-by-side circular cylinders [3-7].
Also, A number of approaches have been used in an attempt to classify the fluid behaviour of multiple circular cylinders in steady cross-flow, based on a combination of theory, measurement and observation of the flow. For two-cylinder configurations in steady mean cross-flow, the simplest of the approaches is the more theoretical treatment by Zdravkovich (1987), who classified the fluid behaviour into two basic types of interference, based on the location of the downstream cylinder with respect to the upstream one. An example of wake interference would be the widening of the two separated free shear layers from one cylinder located immediately upstream of a second cylinder, in a tandem configuration.
In the present paper, the idea is to influence the turbulence intensity, coming from the up-stream rod, in such a way that the separation process is dramatically altered.
Fig. 2 shows the schematic of the passive flow control is exerted by means of a rod located in up-stream flow.

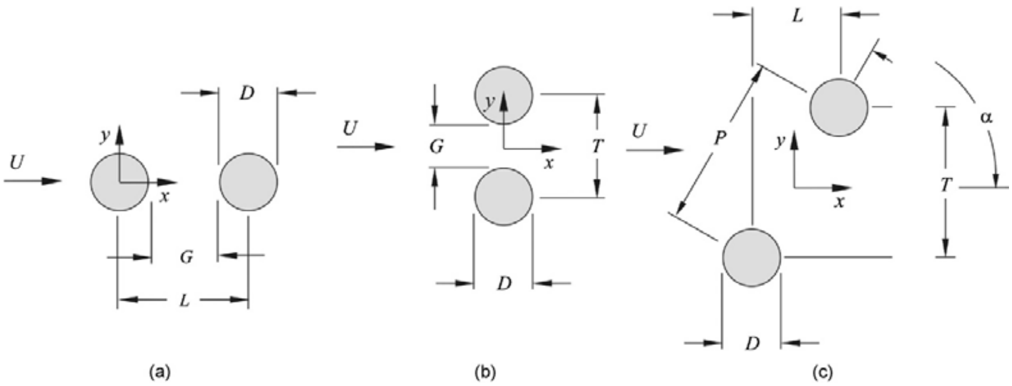

Figure 1. Two circular cylinders of equal diameter in cross-flow: (a) tandem configuration; (b) side-by-side configuration; and (c) staggered configuration.

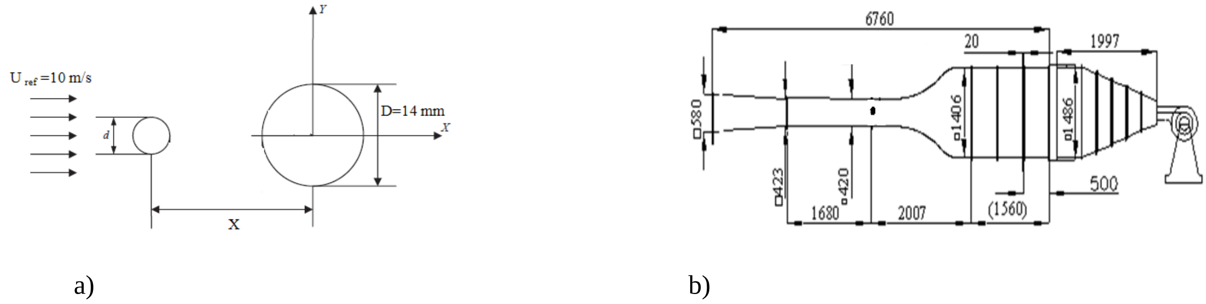

Figure 2. Schematic of a) passive flow Over the rod and Circular Cylinder , b) wind tunnel dimension.

Experimental details

Experiments were conducted in a open-circuit tunnel with a test-section of 40×40 cm. The cylinders spanned the horizontal 40cm dimension of the tunnel. The free-stream velocity (U_∞) in the tunnel was 10 m/s, giving a Reynolds number (Re) of 18900, based on a larger cylinder. Length of between the rod and cylinder is 28 mm. The turbulence intensity was less than 0.2% of the free-stream velocity. The geometric blockage ratio at the test section were 3.5%.

Results

Profile of percentage of turbulence intensity is created at first station (position) (exactly behind the prototype) due to low pressure and high pressure difference relative to the potential current. Also, velocity variation is severe from the wake to potential current at the top and bottom of the model. This velocity variation causes creation of fluctuations and consequently severe turbulence which is seen as two peaks in figures. Getting far from the model, turbulences become smoother and are observed more continuously. Because of pressure reproduction, the current and profile approach to equilibrium condition. In addition, turbulence profile would penetrate into the free flow steadily and this leads to increase the width of turbulence profile.

Paying more attention to the profile, we conclude that with getting far from the model, the turbulence sink would increase while the peak decreases steadily in a way that these two get closed. In other words, low-turbulent and low-energy fluid penetrates into the high-energy and high-turbulent fluid and takes its energy whereas high-energy fluid penetrates into the low-energy fluid and adds its energy and turbulence.

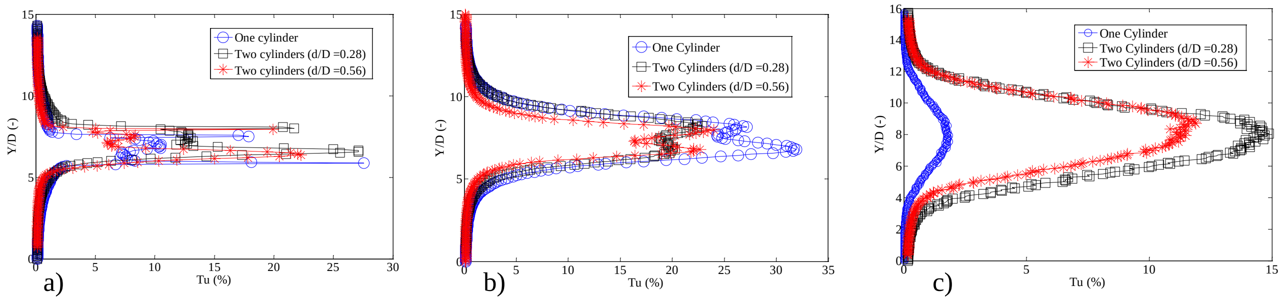

Figure 3. Turbulence intensity profile. a) Station X/D= 0.1, b) Station X/D =4, c) Station X/D =20.

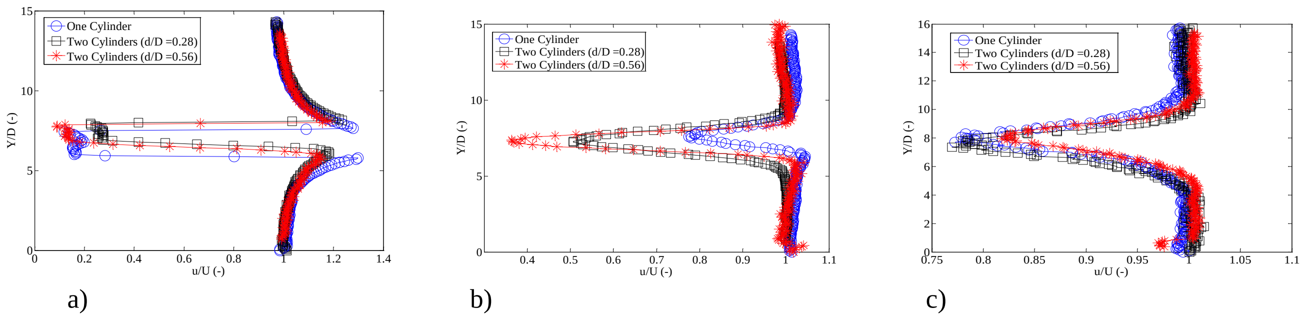

Figure 4. Velocity profile. a) Station X/D= 0.1, b) Station X/D =4, c) Station X/D =20.

Conclusion

The present work presents experimental results are uniform flow at Re = 18900. According to the results, we obtained that getting far from the model, turbulences become smoother and are observed more continuously and the rod located in up-stream flow causes to decrease the turbulence intensity.

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