Finite-Span Effect on Vortex-Induced Vibration Simulations

Xingeng Wu[1], Anupam Sharma[2,*]

Department of Aerospace Engineering, Iowa State University, Ames, Iowa, 50011

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1. Introduction

Introduction of VIV, review
Aspect ratio of cylinder, history
Motivation for this paper

Figure 1 presents a lift coherence contour for a $20 \times D$ static cylinder. As the figure shown, the cylinder is not corelated for the most frequency when it is long enough, exact for $St \sim 0.2$. In here, the peak frequency ($St \sim 0.2$) is the Kármán vortex shedding frequency. It is well known that the amplitude of rigit cylinder will significant increase if the natural frequency is close to the vortex shedding frequency.

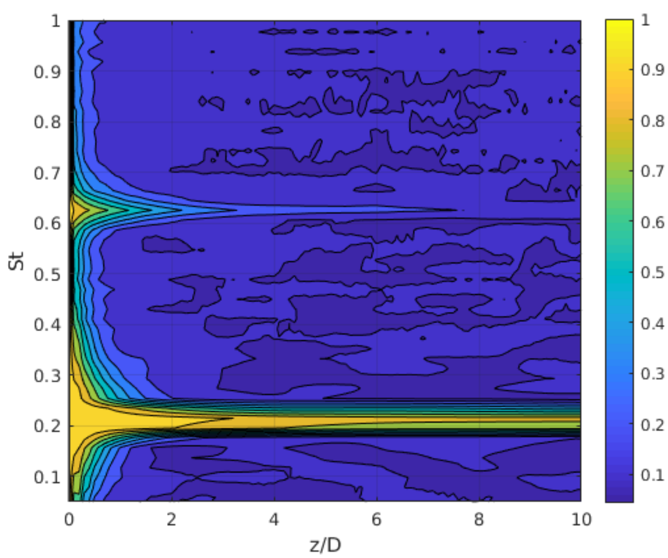


Figure 1: Lift coherence for static cylinder

change Z to L/D

*Corresponding author
Email address: sharma@iastate.edu (Anupam Sharma)
[1]Graduate Student
[2]Associate Professor, Iowa State University

2. Computational Methodology

add A schematic of the setup for the vortex-induced vibration(VIV) simulations As Figur 2 shown, an elastically-mounted cylinder with different aspect ratio is used in the simulations. The flow is considering as the incompressible flow since similar experiments were carried out in water runnel(ref).

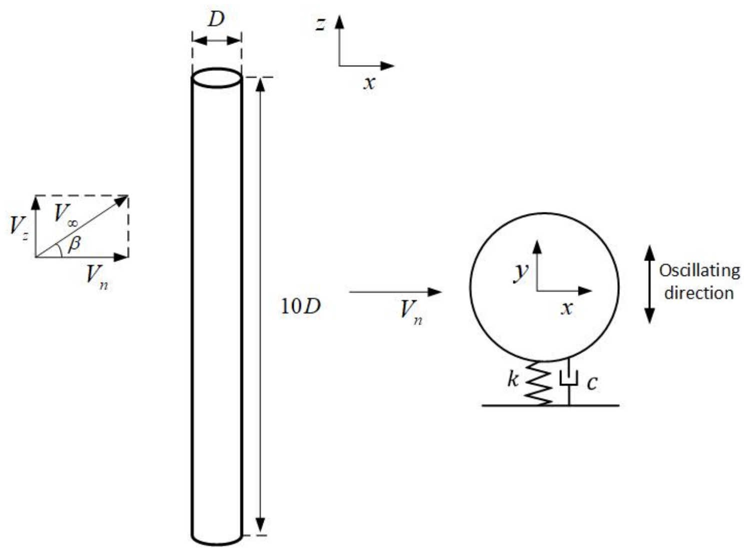


Figure 2: A schematic of the simulated setup for VIV simulations.

numerical method, mesh

In order to study the aspect ratio of the circular cylinder, four different aspect ratios ($L/D = 1, 2, 5$, and 10) have been chosen and simulated at reduced velocity $V_{R,n} = 2, 3, 4, 5, 5.9, 7, 8$. The averaged peak amplitude results are shown in

3. Numerical Results and Verification

Figure 3 compared the predicted non-dimensional mean amplitude for $10 \times D$ cylinder with the experiment (see e.g., Ref. [1]). Overall, the predicted amplitudes agree well with the experiment. Four branches can be identified on the experiment : initial excitation, upper branch, lower branch and desynchronization. All four branches are observed on the simulations. Therefore, the simulated method is able to simulate vortex induced vibration.

Figure 5 and 6 present force coefficients coherence for different spans cylinders ($Z = 1D, 2D, 5D$, and $10D$). For longer cylinders ($Z = 5D$ and $10D$) are only correlated to the peak vortex shedding frequency and its harmonics. However, the shorter cylinders ($Z = 1D$ and $2D$) have more wider coherence for more frequencies??

Figure 7 shows ... different peak value, wider, lower psd smaller L/D.

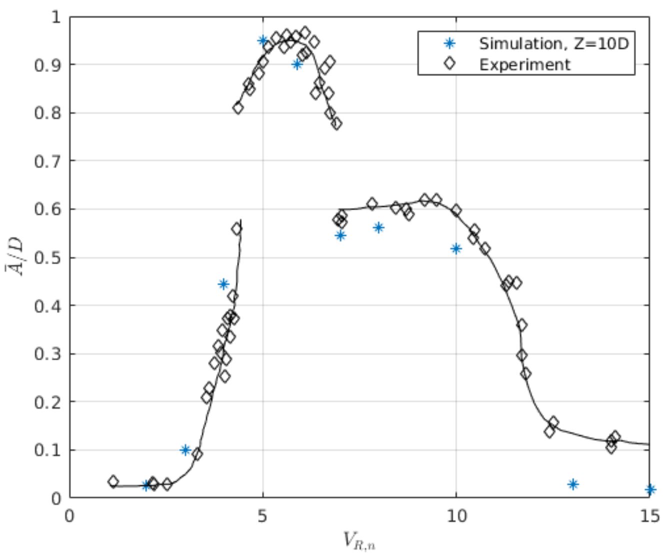


Figure 3: Comparison of predicted and experimental non-dimensional mean amplitude A/D for various reduced velocities $V_{R,n}$

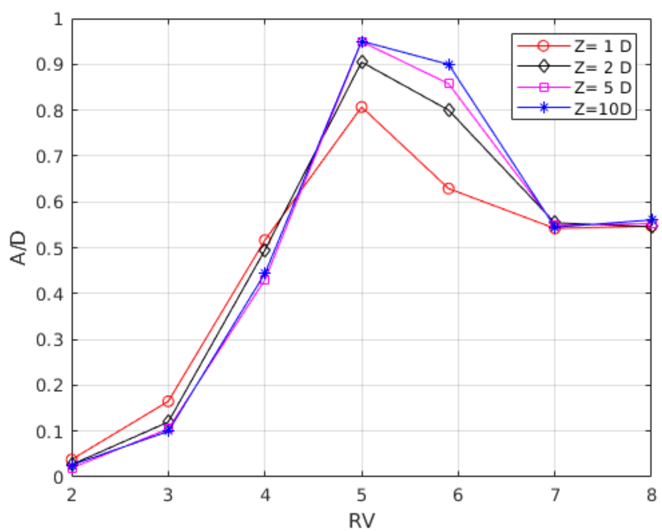


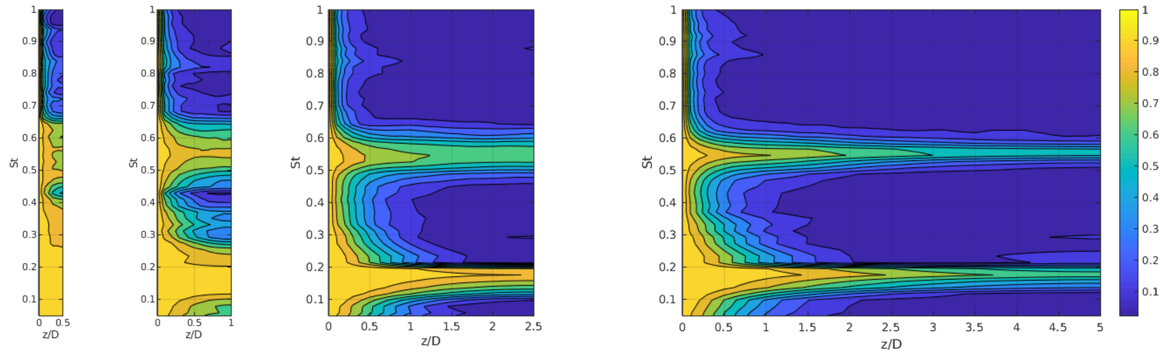
Figure 4: Comparison of predicted non-dimensional mean amplitude A/D for various reduced velocities $V_{R,n}$ for different span lengths

4. Conclusion

5. References

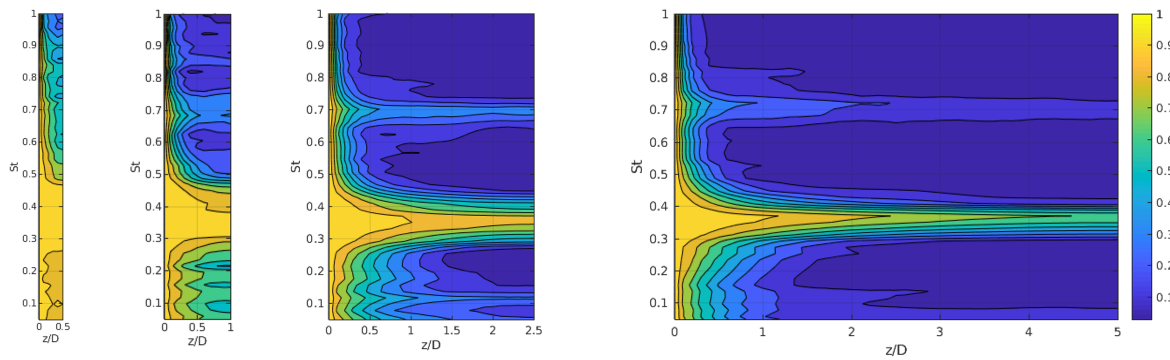
References

[1] Khalak, A., Williamson, C., 1997. Fluid forces and dynamics of a hydroelastic structure with very low mass and damping. Journal of Fluids and Structures 11, 973–982.



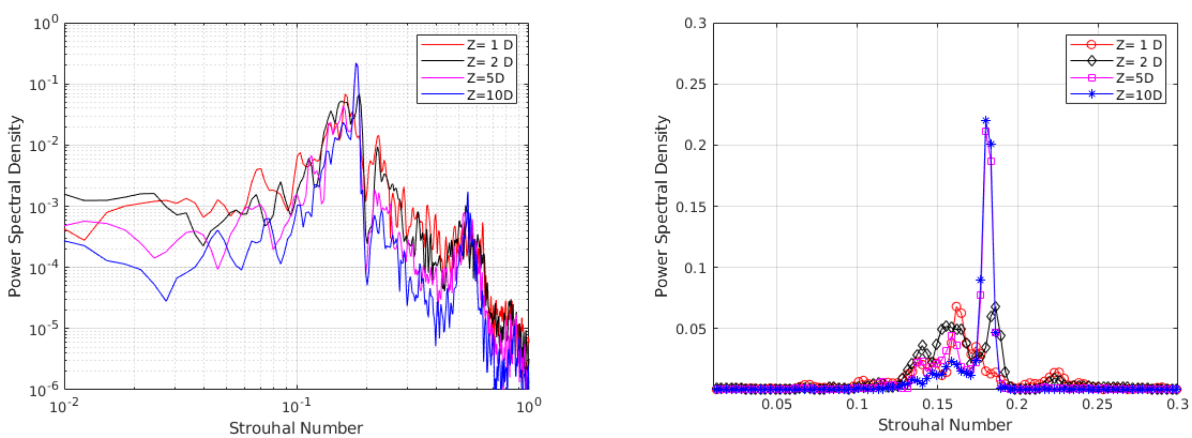
(a) $Z = 1D$ (b) $Z = 2D$ (c) $Z = 5D$ (d) $Z = 10D$

Figure 5: Lift coherence for various aspect ratio at $V_{R,n} = 5$



(a) $Z = 1D$ (b) $Z = 2D$ (c) $Z = 5D$ (d) $Z = 10D$

Figure 6: Drag coherence for various aspect ratio at $V_{R,n} = 5$



(a) Power spectral densities of C_l (b) Zoom-in

Figure 7: Comparison of predicted power spectral densities (PSDs) of C_l for various frequencies at $V_{R,n} = 5$.