

VORTEX-INDUCED VIBRATIONS OF WIND TURBINE TOWERS

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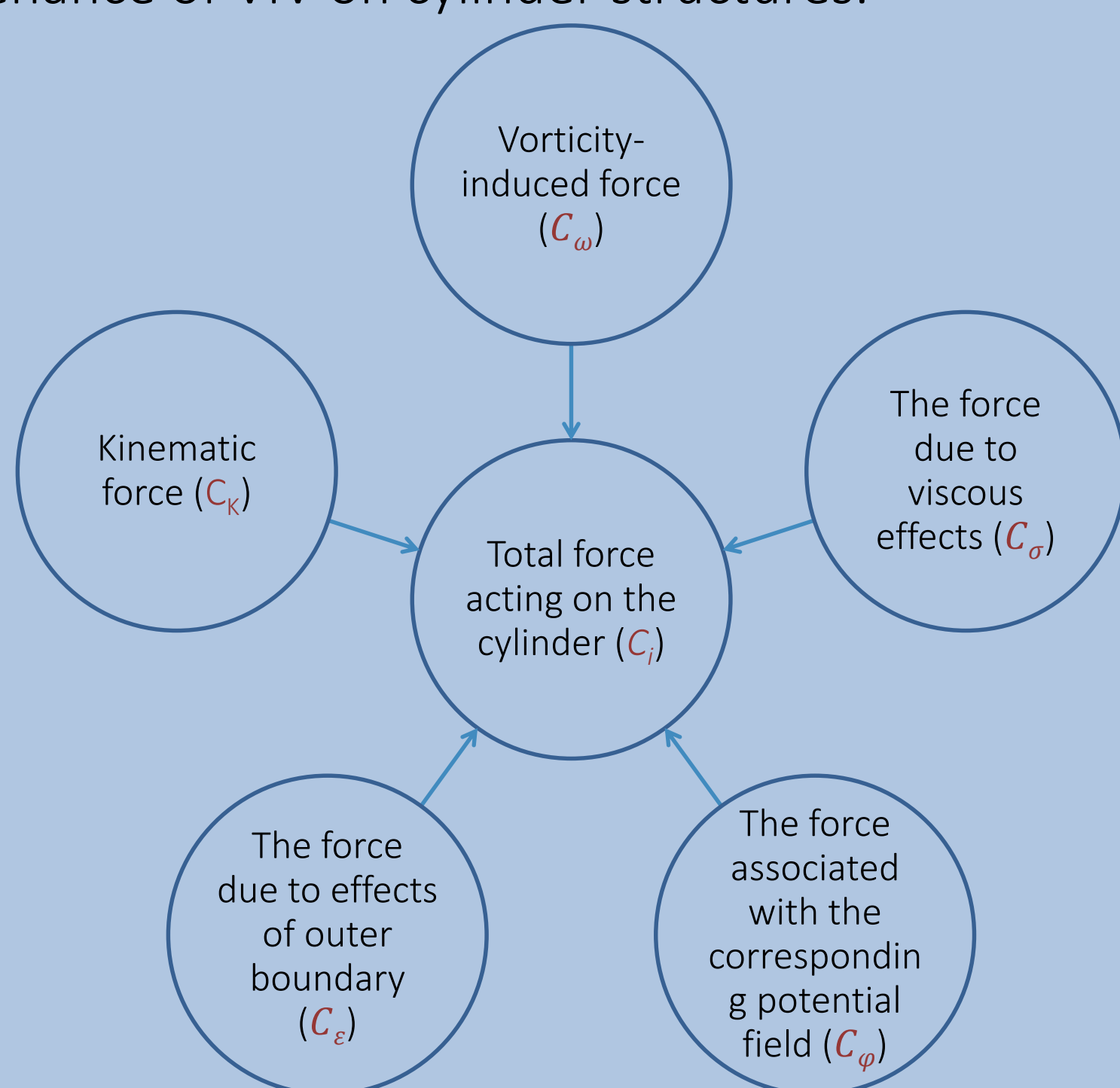


Introduction

As a larger wind turbine can help to increase the maximum power production per turbine, the wind turbine size has been on the rise due to the greater demand for wind energy. One of the consequences of designing a larger wind turbine is taller turbine towers. Many physical phenomena are to be taken care of during the design process, where vortex-induced vibration (VIV) is one such major aerodynamic phenomenon. In this research, further analysis is carried out to study VIV of wind turbine towers for realistic environmental conditions.

Methodology

The research initially focuses on understanding different physical mechanisms that lead to the initiation and sustenance of VIV on cylinder structures.



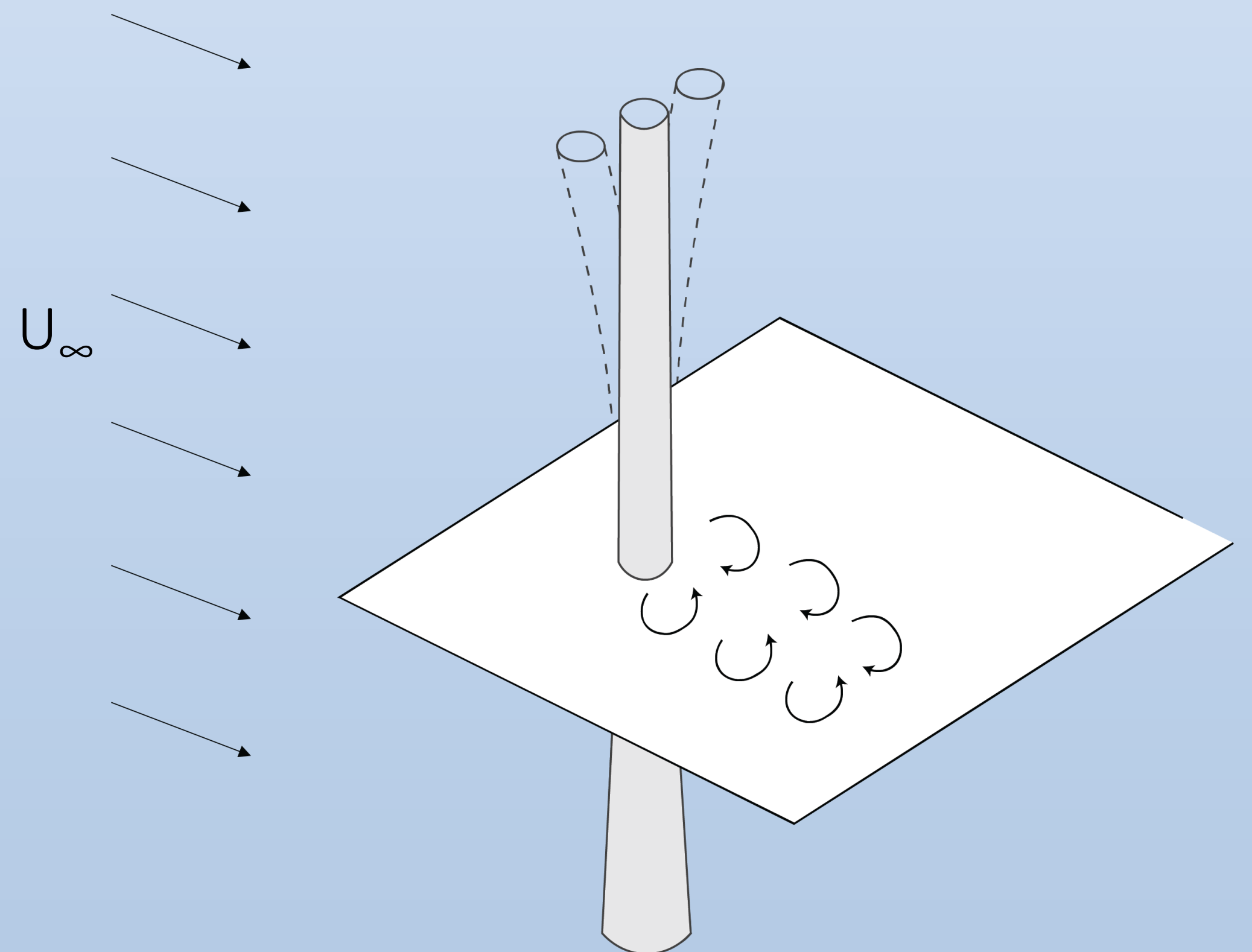
$$C_K^{(i)} + C_w^{(i)} + C_\sigma^{(i)} + C_\phi^{(i)} + C_\epsilon^{(i)} = C_i; C_i = \frac{F_i}{\frac{1}{2}\rho U_\infty^2 D}$$

→ Modelled in OpenFOAM and uses pimpleFOAM solver for the initial 2D numerical simulations.

→ The influence of different force mechanisms is analysed for a Reynold's number of 100.

References

- [1] Menon, K., & Mittal, R. (2021). On the initiation and sustenance of flow-induced vibration of cylinders: Insights from force partitioning. *Journal of Fluid Mechanics*, 907, A37. doi:10.1017/jfm.2020.854
- [2] Zhang, C. (2015). Mechanisms for aerodynamic force generation and flight stability in insects. (Doctoral dissertation). Retrieved from <http://jhir.library.jhu.edu/handle/1774.2/37840>



Results

→ The dominating force components in the initiation of VIV are:

- the force due to vorticity,
- viscous effects, and
- the kinematic force.

→ Vorticity-induced force contributes to the majority of the force.

→ Kinematic force coefficient and viscous force coefficient follow a sinusoidal behaviour, but the maximum amplitude is much smaller than that of C_w .

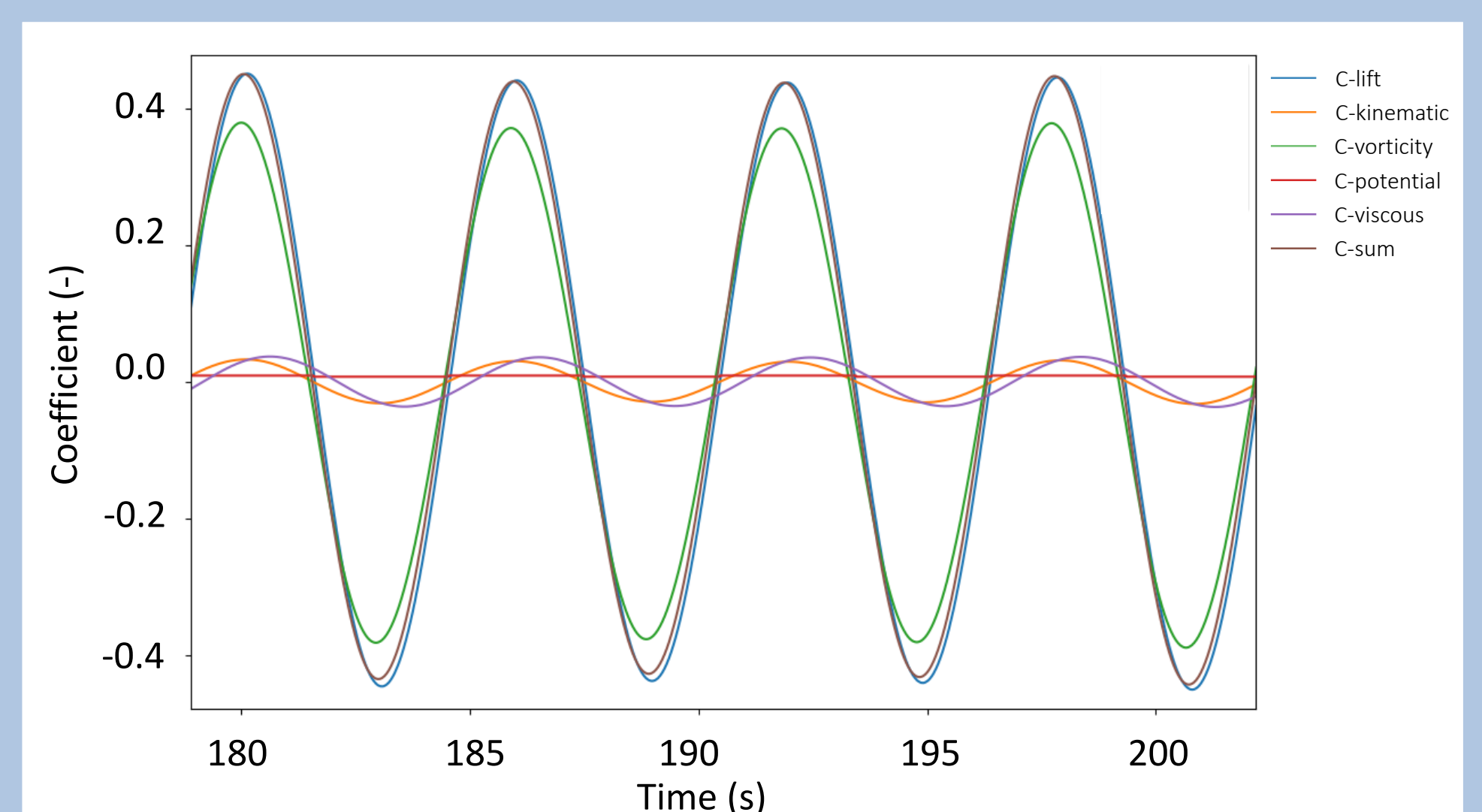


Figure 1: Force partitioning of lift force on a 2D cylinder section with oscillation frequency of 0.164. (Figure produced in collaboration with Simon van Hulle)