Reply to Referee 2 Comments

March 2026

The authors would like to thank Referee #2 for their careful assessment of the manuscript and for providing insightful comments. These remarks will be used to refine the final version of the paper. Below, we provide detailed responses to the primary comments. Technical corrections will be updated directly in the manuscript.

1. The authors agree that the use of the term 'onset velocity' is misleading in the present version. A more accurate phrasing, which we will include in the updated version of the paper, is 'the velocity at which maximum response occurs'. Indeed the onset velocity refers more to the velocity where VIV starts and this is not the meaning of U^*_{max}. The term 'critical velocity' is used in this paper to refer to the velocity at which the Strouhal shedding frequency is equal to the first natural frequency of the structure.

2. Line 48: The cross-flow direction is prioritized because cross-flow force fluctuations are significantly more pronounced than drag force fluctuations. Additionally, flow-directed (fore-aft) vibrations are subject to significant aerodynamic damping. While an idling turbine with blades pitched at 90° experiences some aerodynamic damping from the rotor, it remains low in both directions. Substantial damping is only introduced in the fore-aft direction when the turbine is operational and generating thrust.

3. Line 78: The authors agree with the Referee that this statement does not take into account more recent advances in single equation models. We will rephrase in the final manuscript to indicate that this is not an exclusive advantage of wake oscillator models.

4. In principle any VIV experiment could be considered valid for calibration of the model. The single degree of freedom experiments are the most attractive computationally for calibration since the system of equations that has to be solved is simpler than a 3D elastic setup. However, calibration of the model within a specific Reynolds number regime limits also its usage to corresponding values of Re. In addition to the mass ratio m^*, the turbulence intensity has not been taken into account. The authors acknowledge that its effect could be significant.

5. The coefficient $\frac{4}{3}$ was originally derived by assuming a harmonic response of the lift coefficient and ensuring that the net work done by the damping terms over one period is zero for a stable limit cycle [1]. The constant H' represents the feedback from the structural motion to the aerodynamic force coefficient. The constant G' by being always positive ensures the presence of negative aerodynamic damping ($-G'C_{L0}$) which adds energy into the system. It also scales the non-linear self-limiting term ($G'(4/3)(C_L'/\omega_s^2)$ which is always positive.

6. U^*_{max} is not assumed to lie in the middle of the critical range. The selection of the upper and lower bounds of the critical range is separate from U^*_{max} which comes directly from the measured maximum amplitude. Upper and lower bounds are selected to roughly match the experimental measurements.

7. During the calibration process we observed that both these parameters are limited in values ($G' < 20$) and ($H' < 10$). We also take them to be always positive since negative G' leads to an always positive aerodynamic damping which is of no interest to VIV predicton and $H' < 0$ would not make a physical sense in terms of scaling of the structural velocity. However, we have not carried out a rigorous mathematical assessment to support a definitive claim as to their boundaries and we suspect these boundaries to be associated with the value of C_{L0}.

8. The decision to not use a single regression line for both curves comes from the difference between m^* and the turbulence intensity of these two setups. With the exception of $Sc \approx 4$ both experiments show a very similar trend close to the theoretical prediction even though they represent different setups.

9. In determining these ranges we have assumed Strouhal values around 0.2, as also reported by the experiments. However, in case St differs this could render our assumption more or less conservative. We agree that the approach suggested by the Referee is more straightforward and does not assume a value for St when assessing the critical lock-in zone.

10. During the calibration phase, we attempted to calibrate and obtain a detailed $G'/H' - U^*$ map. It quickly became apparent that no sensible regression could be carried out across U^* and Sc. This led us to employ the most straightforward approach that gave reasonable results. The linear decay has proven to give accurate results for the single degree of freedom setups. One plausible physical explanation could be that the decrease of both these parameters is associated with a less pronounced lock-in effect. In the final manuscript we will address the physical meaning of the calibrating parameters more carefully.

11. In this work we take C_{L0} equal to the standard deviation of the lift coefficient. At $Re \approx 20,000$ this is sensible based on the relevant literature [2]. Facchinetti et al. [3] also use this value of C_{L0} for a similar Re regime. In general, there is significant scattering in the values of $C_{L,std}$ measured in experiments and the corresponding peak amplitudes. Since these are not as often reported we choose $C_{L0} = C_{L,std}$. We note however, that the value of C_{L0} is not significant quantitatively since it is implicitly taken into account during the calibration. The resulting $[G'_{max}, H'_{max}$ for a given Sc are produced by assuming a value for C_{L0}.

13. These values result from the optimization procedure on the selected experimental data. A preliminary comment for H'_{max}can be made in that as the structure becomes more damped (increasing Sc), the effect of the structures' vibrations requires the use of an increasing scaling factor H' to scale the forcing of the lift coefficient. Increasing values of Sc correspond to lower vibration amplitudes. The limited vibration amplitudes are in turn associated with a reduction of the negative aerodynamic damping term $-G'C_{L0}$.

14. In this work we use the simplified linear version for the calculation of the correlation length with respect to the vibration amplitude. We would like to note that this is done dynamically. At each iteration, depending on the maximum displacement amplitude the length of the tower on which we apply the aerodynamic force -correlation length is updated. We do not consider the peak factor, instead we take the value of y_{max}/D_{ref} directly.

16. We will update the manuscript with the results from EUROCODE Approach 2 and also include it in the Appendix.

References

[1] Robert D. Blevins. *Flow-Induced Vibration.* Van Nostrand Reinhold, New York, 2nd edition, 1990.

[2] C. Norberg. Fluctuating lift on a circular cylinder: review and new measurements. *Journal of Fluids and Structures*, 17(1):57–96, January 2003.

[3] M.L. Facchinetti, E. de Langre, and F. Biolley. Coupling of structure and wake oscillators in vortex-induced vibrations. *Journal of Fluids and Structures*, 19(2):123–140, 2004.