Calibration and validation of an engineering model for vortex induced vibration prediction in wind turbine towers

The paper presents complex theories in a clear and comprehensive language. It addresses an important issue for wind turbine towers, namely the modelling of vortex induced vibrations. The authors apply the Hartlen–Currie model for vortex-induced vibrations. The model is based on two equations, one for the structural motion and one for the lift force. The two equations are coupled, meaning that the lift force depends on the structural oscillation. This is the aeroelastic effect. However, the wake oscillator, i.e. the second equation of motion, needs to be calibrated. The calibrated system is validated first in a 2D framework, and then it is applied in 3D. Here, the lift-oscillator model is integrated within the multibody finite element structural solver previously developed by the authors.

The goal of the method is to replicate the vibrations in the lock-in range. Some questions arise and are addressed in the paper, such as the modelling of wake oscillator parameters (calibration constants) in the lock-in range and the sensitivity of the calculation to the actual calibration-case used for the calibration of the parameters.

Here there are some comments:

1. The use of the term onset velocity in the context of vortex-induced vibrations (VIV) appears somewhat unconventional. Typically, onset velocity is associated with aeroelastic instabilities that continue to grow beyond their onset. In contrast, lock-in is a resonant phenomenon that occurs within a limited range of wind velocities. Moreover, if an onset velocity is to be defined, it should, in principle, be specified for each vibration mode. At the same time, the reviewer acknowledges that there is a lack of well-established and consistent terminology for VIV phenomena. The critical velocity is usually defined based on the Strouhal number and the natural frequency; however, it does not necessarily correspond to the actual onset or termination of the lock-in range. Additionally, within the lock-in range, there exists a velocity at which the maximum oscillation amplitude is attained. This velocity is generally higher than the critical velocity, particularly for low Scruton numbers. For these reasons, the definition of a clear and consistent nomenclature would be highly beneficial. The reviewer's main concern remains the appropriateness of the term onset when referring to VIV.
2. Line 48: "cross-flow direction – the direction of the lowest aerodynamic damping". This is an important statement, however, this is not further addressed or discussed in the paper. Maybe the authors want to comment on that?
3. Line 78: "The primary advantage …". The reviewer agrees that the wake oscillator models are valuable models for VIV. However, 1-dof systems based on the negative aerodynamic damping have also been shown to accurately predict the entire lock-in range (see e.g. literature by Kurniawati and/or Livanos). Therefore, the reviewer does not agree with the implication that this is an exclusive advantage of wake oscillator models. Perhaps this sentence can be reformulated.
4. It is recommended to reflect and better specify the criteria that an experiment has to fulfil to be considered appropriate for calibration purposes. Among others, the Scruton number and the turbulence intensity are the governing parameters for VIV. Therefore, experiments that match these criteria could in principle be suitable for being used for the calibration of any other experiment in the same range. The Reynolds number is of course another parameter to be considered. The turbulence intensity does not appear to be included in the present investigation. This could explain the differences between the experiments presented in sections 2 and 3.

5. It is recommended to explain the physical background of the constants G and H in equation 2. This would also allow the reader to better understand why 4/3 in the equation 2.
6. Experiments show that Umax might not be in the middle between Ulow and Uhigh. One could say: Ulow = 0,9Ucrit and Uhigh = 1,3Ucrit or 1,5Ucrit. Umax typically varies between 1 and 1,2 depending on the Scruton number. Maybe it could be useful to at least let the possibility open, that Umax might not be in the middle between Ulow and Uhigh.
7. Are there physical upper boundaries to the values that the constant G and H can take? Or is any numerical value physically possible?
8. Figure 3 could also be differently interpreted. A single fitting curve could be drawn between Feng results and Belloli's result for the smallest Sc. The value at Sc = 4 remains as outlier.
9. Line 236: the use of numbers [5.5 9] implicitly means having defined a value for the Strouhal number. However, the value of the Strouhal number may vary with the surface roughness, the Reynolds number, etc... Therefore, 5.5 could be slightly higher or lower than the reduced critical velocity, depending on the value assumed by the Strouhal number. For this reason, it is recommended to define the lock-in range with reference to U/Ucrit. In this way, the value of Ucrit is influenced by the Strouhal number, but the lock-in phenomenon does not change. For example, it starts slightly before Ucrit and terminates when U = 1,8 Ucrit (corresponding to 9 if St = 0,2).
10. It would be interesting to provide a physical, plausible explanation for the linear decreasing trend of G and H in the lock-in range.
11. cL0 = 0,3 might be high for wind turbine towers. Literature values from full-scale experiments are around 0,1 (standard deviation). Is 0,3 a standard deviation or a peak value?
12. Figure 4: y-axes have different scales, it is recommended to apply the same scale. The same is recommended for Figure 6.
13. Can you comment on the trends of G' and H' in Figure 7? What does this mean from the physical point of view? Furthermore, what should one expect for increasingly small Sc or increasingly large Sc (rigid case)?
14. The correlation length defined by the Eurocode implicitly includes the peak factor. The value of 6 corresponds to an actual correlation length of 2 and a peak factor of 3. The value of 12 is associated to harmonic motion and thus peak factor $\sqrt{2}$. The reason for applying the peak factor is that clat in the Eurocode method is the standard deviation of the lift coefficient. This can be found in the literature by Ruscheweyh. In the approach of the paper, it should be explained if c,L0 is amplitude (peak value) or standard deviation. Perhaps the peak factor could be considered separately or not considered at all if there is no need to calculate peak amplitudes from standard deviation of forces.
15. Also the graphics in figure 9 have different scales for the y-axis. It is recommended to uniform it.
16. The method in Appendix C is the Eurocode model Nr. 1. The Eurocode has two models.