We appreciate the referee's careful review of this manuscript and helpful comments that we have used to improve the quality of the work. We provide the referee comments in italics and our response in standard font. Proposed manuscript changes (if substantive) are in color and describe changes made in response to each comment.

Referee Comment: *The authors have done an academic study of unsteady aerodynamics of a symmetric airfoil in inflow with transverse gust under attached flow conditions in 2D. They are considering the plunge and pitch (blade torsion) of the airfoil, and the Theodorsen effect of shed vorticity on the circulatory lift and Sears function for the unsteadiness of the lift variation from the transverse gust variation.*

We agree with the referee's summary of the scope of the work. As we will emphasize in our responses below, studying the superposition of transverse-gust and airfoil-oscillation disturbances is relevant and important to the wind energy community.

Referee Comment: *The authors claim that their model "could yield far-reaching benefits to the operational longevity of wind turbines by better accounting for unsteady fatigue loads in the design process." However, the authors seem to be unaware of the status of the art within aeroelastic modelling of wind turbines. The last 25 years we have had research and commercially available aeroelastic codes that include the Theodorsen effect in the unsteady aerodynamic lift models, and we have shown that these codes are able to predict the blade and turbine component fatigue loads within 5% relative error to measurements for each wind speed over the entire operational range.*

We agree with the referee that it has been shown that Theodorsen theory successfully predicts airfoil quantities far outside the strict regime it was formulated for; however, the Theodorsen function and related analytic functions are not universally utilized in the wind energy field. For example, the work of Madsen *et al.* (WES, 2020), which is used by the QBlade tool, specifically states that they do not consider Theodorsen effects. While the HAWC2 and OpenFAST modeling frameworks use semi-empirical Beddoes-Leishman inspired models to capture these effects, even research-grade large-eddy simulations (LES) of wind turbines and wind farms, such as the LESGO or Nalu-Wind codes, use actuator-disc models (ADM) and actuator-line models (ALM). Such LES employ quasi-steady aerodynamics *e.g.* a constant specified thrust coefficient (for ADM) or airfoil lift-drag polars from steady-flow measurements (for ALM).

Since turbines in LES are, by definition, exposed to inflow turbulence and time-varying disturbances, such as yaw misalignment and wind shear, the development of parsimonious unsteady models aiming to better capture the full unsteady turbine response to these factors is pertinent. A novelty of this work is examining *superposed* effects for such models, which are difficult to produce in lab experiments, and not only of

Theodorsen-type effects. To this end, we are unaware of work that examines this richer parameter space at the blade section level.

In our revised manuscript, we have tempered verbiage, better clarified our contributions, and offered commentary on limitations and advantages of our chosen problem setup.

Referee Comment: *The biggest uncertainty in these predictions is not the lack of transverse gust modelling (which is mainly important when the gust "wave-lengths" are of the order of the blade chord) in these codes, but the uncertainty in the inflow modelling. To capture the flapwise fatigue loads on the blades, it is very important include the deterministic components of the inflow (vertical and horizontal shear profiles, veer profiles, and yaw and upflow angles) as well as the structures of the turbulence (at least the intensity variation with height, but new methods also include turbulence reconstruction).*

We agree with the referee that inflow modeling is essential to fully characterizing wind turbine loads, but that we do not directly investigate this broader question does not diminish the relevance of our study. Indeed, atmospheric turbulence, wind shear, yaw misalignment, and wind veer represent disturbances that inform boundary conditions to our setup in the reference frame of each blade section. Even with perfect representation of inflow conditions, our study demonstrates that there is still a significant gap between the quasi-steady and unsteady lift predictions. Thus, it is important to capture unsteady aerodynamics at the blade section level in addition to inflow effects.

With respect to wind structures of the order of the blade chord that may affect turbine aerodynamics, we expect such disturbances will likely come from atmospheric boundary layer turbulence in the inflow, and will therefore appear in our modeling framework as transverse gusts (modeled by the Sears function). However, rotor-scale effects such as shear, veer, and yaw misalignment will create time-varying oscillations in the effective angle of attack at each blade section, which may be modeled by the Theodorsen function. These considerations, therefore, underscore the need for investigations of combined Sears/Theodorsen-type disturbances for wind energy applications.

In our revised manuscript conclusion section, we will more explicitly list effects that we could consider in the future to model the realistic turbine problem, including shear profiles, yaw, and stratification.

Referee Comment: *The authors exclude the edgewise (lead-lag) motion of the airfoil (affecting the downwash of the shed vorticity, an effect included in some aeroelastic codes). Edgewise blade vibrations due to negative aerodynamic are often driving the blade design. They are highly affected by the coupling between the edgewise airfoil motion and its pitch (blade torsion) through the lift force. An unsteady aerodynamic* *model for wind turbines must therefore include the effect of edgewise airfoil motion on the unsteady lift.*

We appreciate the concerns of the referee and acknowledge the importance of edgewise dynamics. However, we do not intend this work to be a complete, all-inclusive model for blade design. We want to demonstrate how reduced-order potential-flow models could easily be incorporated into existing BEM / ALM simulations in order to better capture certain types of unsteady flow effects currently unaccounted for. As many base versions of these approaches assume two-dimensional sectional turbine-blade aerodynamics and do not comprehensively treat spanwise dynamics, we do the same here and leave edgewise couplings as a subject for future work.