

## Mesh Independent Analysis

In mesh independent analysis, 5 different mesh models in fluid domain were created for each of CB's modifications (in a total of 4 CB's modifications), caused 20 models in total for models A - D. Figures A – D show lift ( $C_l$ ) and drag ( $C_d$ ) coefficients for the mesh independent analysis. We found that all mesh models are adequate for use in the simulation as the differences of both coefficients are at the 3<sup>rd</sup> decimal places. For example, in Figure A, the initial mesh model gives rise to the  $C_l$  of -0.246 and the  $C_d$  of 0.238, but for the finest mesh model, both values are at -0.248 and 0.229 which exhibit the differences of 0.002 and 0.009, respectively. For models B-D, the behavior of both coefficients shows a similar trend as mentioned above. Therefore, only one model was sufficiently chosen as the proper suitable mesh model for each case considering the quality of the calculations, computational times, and required resources. The number of elements and nodes for the proper mesh model is given in Table 1. Using the mesh independent analysis and our mentioned process, we are confident that these models give sufficiently accurate results. All proper mesh models provide the final  $C_l$  and  $C_d$  reported in Table 5.

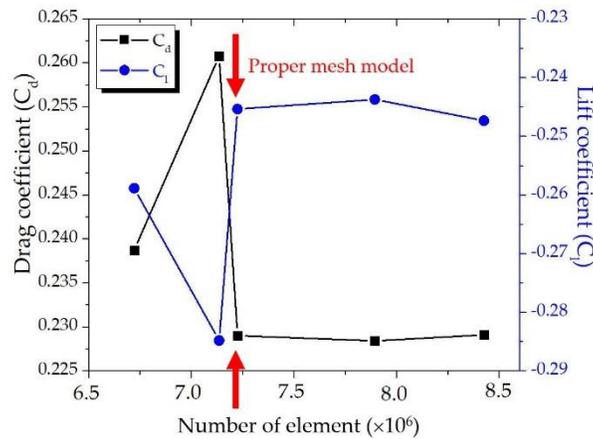


Figure A. Drag and lift coefficients of model A obtained from mesh independent analysis

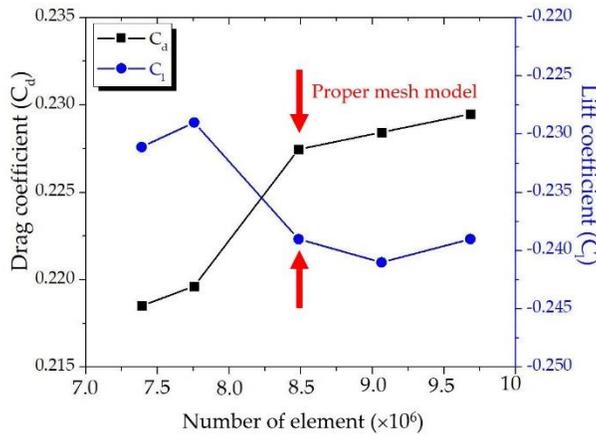


Figure B. Drag and lift coefficients of model B obtained from mesh independent analysis

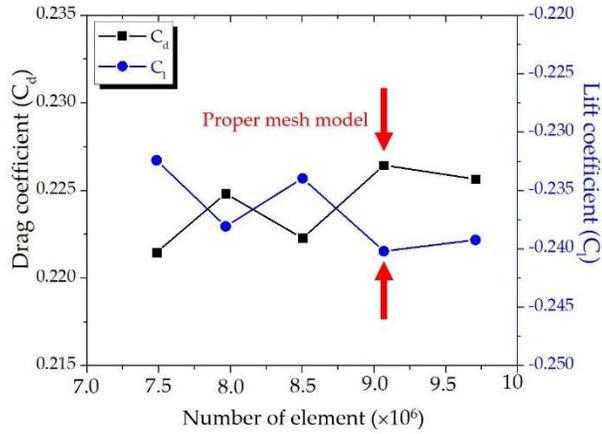


Figure C. Drag and lift coefficients of model C obtained from mesh independent analysis

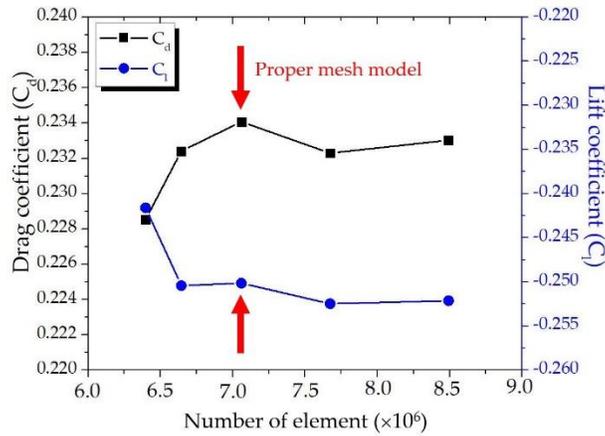


Figure D. Drag and lift coefficients of model D obtained from mesh independent analysis