

# Multi-objective aerodynamic optimization design of high-speed train head shape

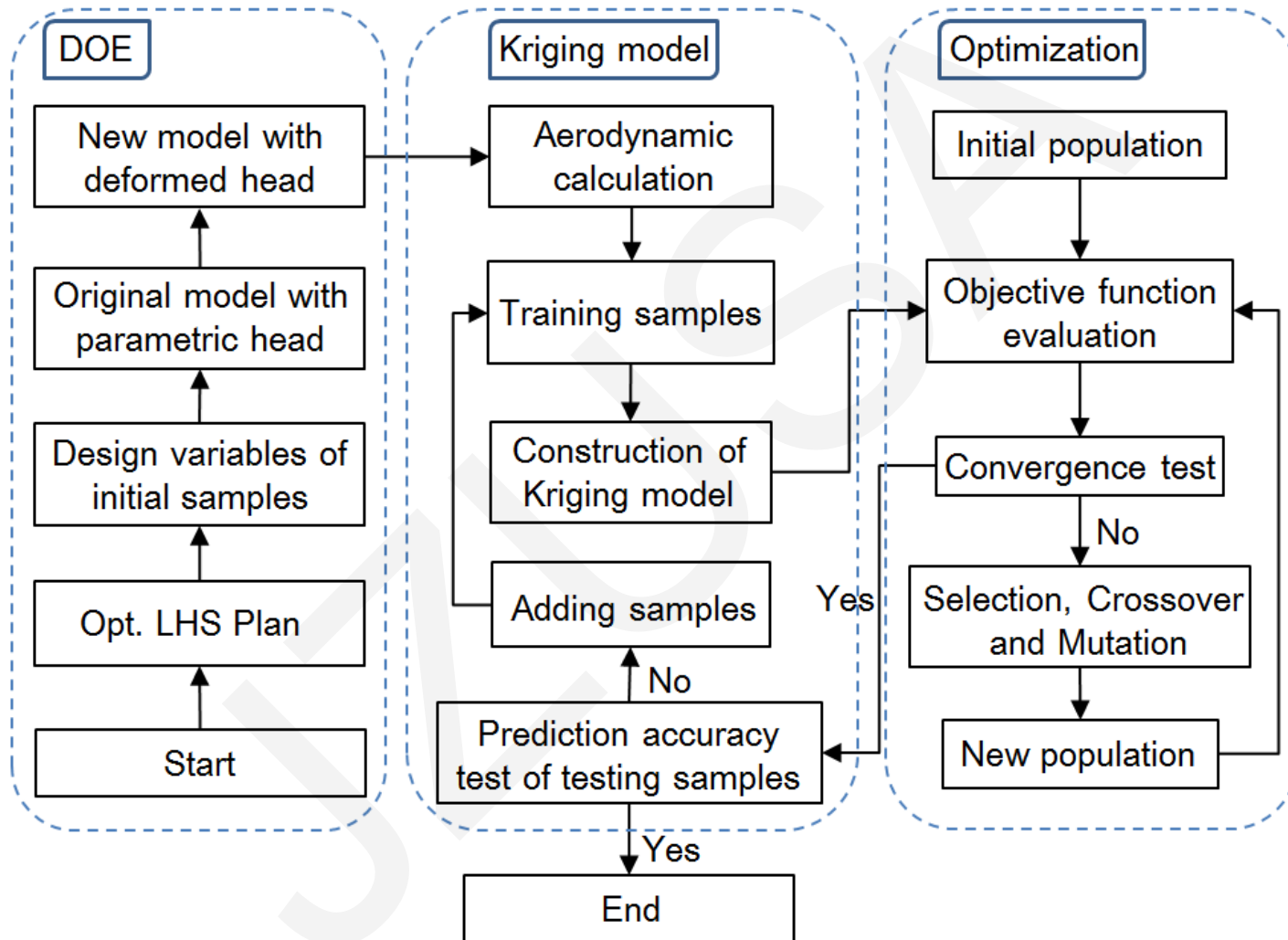
Liang ZHANG, Ji-ye ZHANG, Tian LI, Ya-dong ZHANG

**Key words:** HST, Multi-objective optimization, Aerodynamic performance, Parametric model, Kriging model, Genetic algorithm

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# Optimization Design Process



**Fig. 1. Schematic representation of the whole optimization design process**

# Parametric Method of Train Head

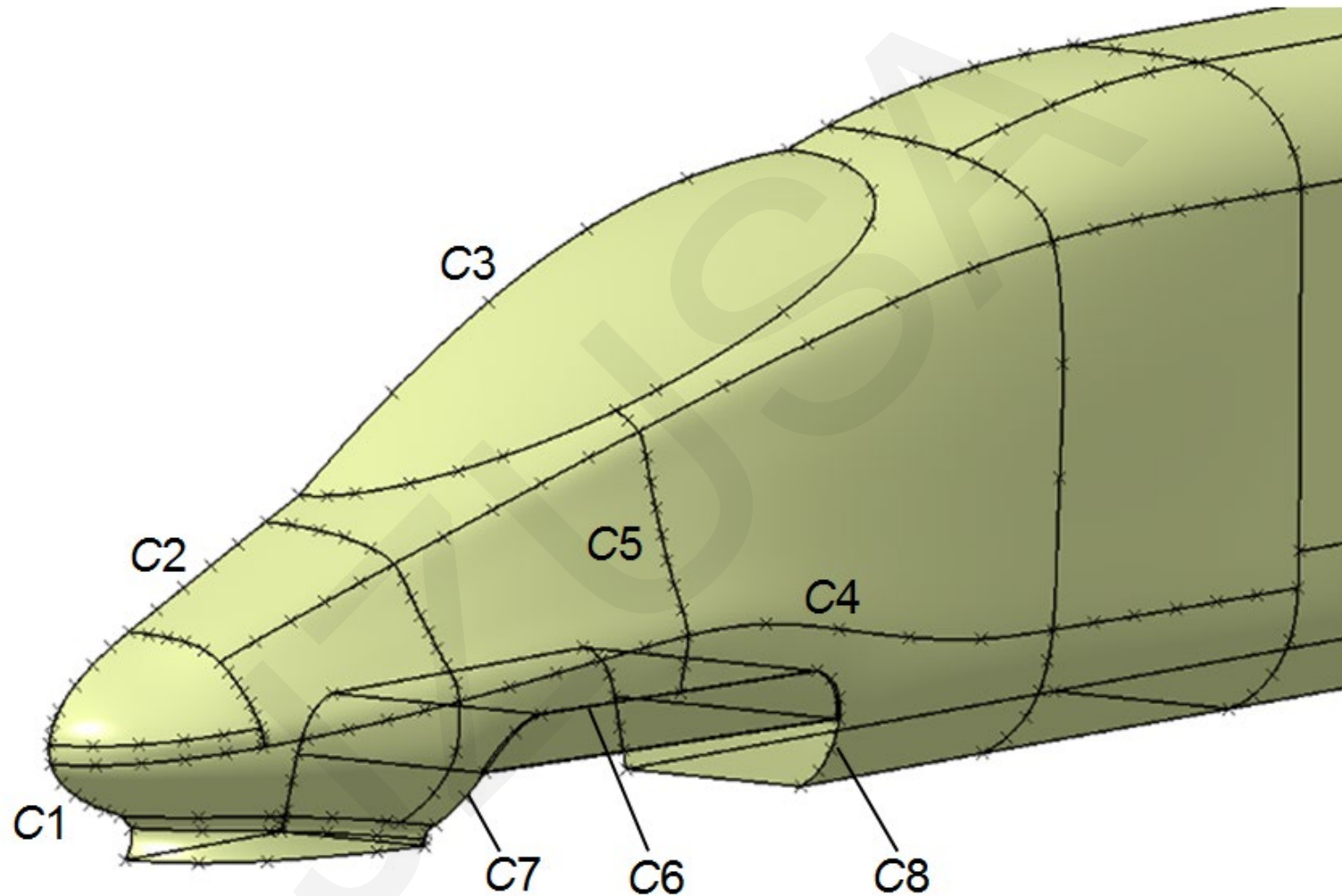
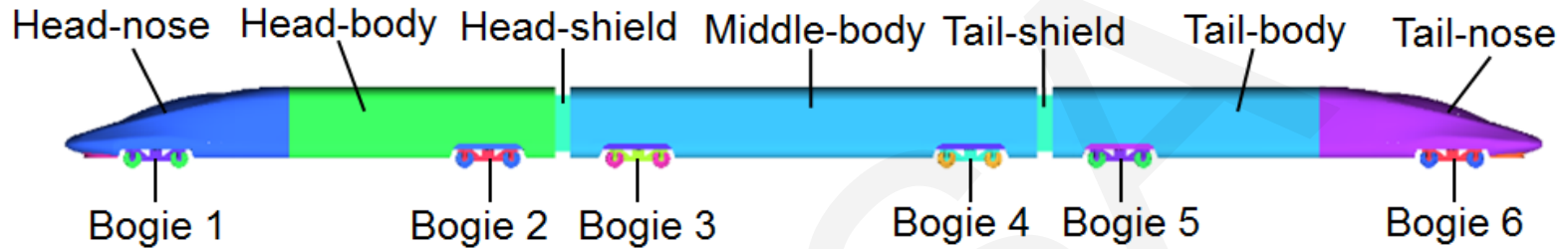
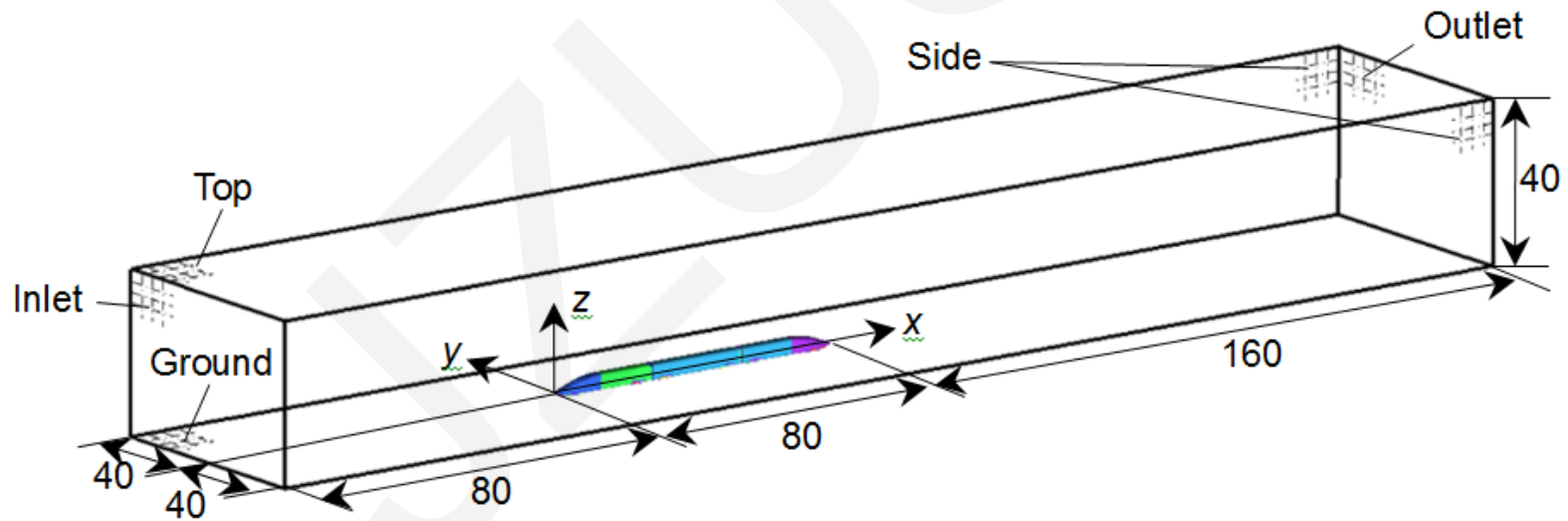


Fig. 2. Numbers of the main control curves of the streamlined head

# Computational Model & Domain



**Fig. 3. Train model**



**Fig. 4. Computational domain (m)**

# Results and Discussions

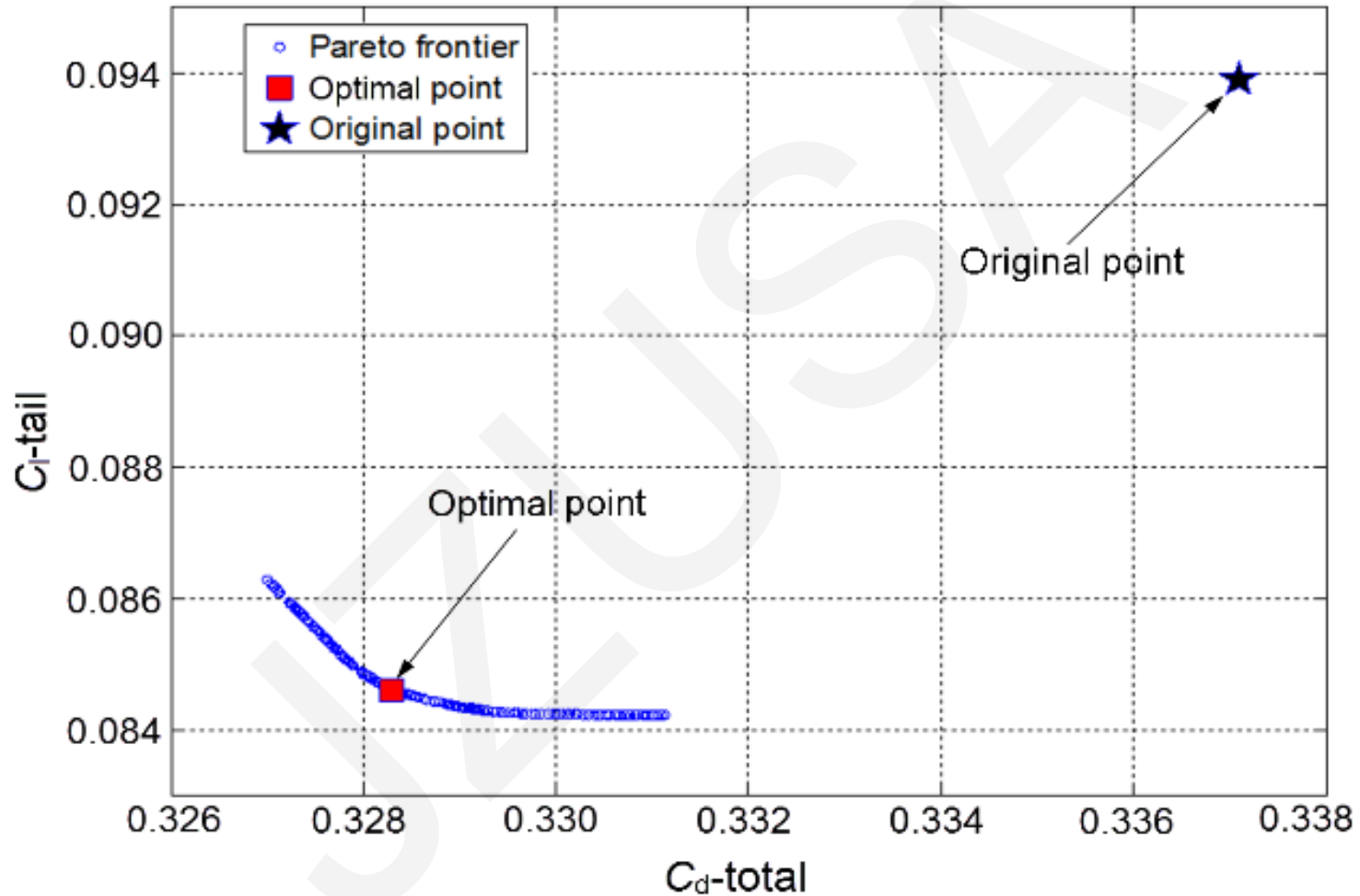
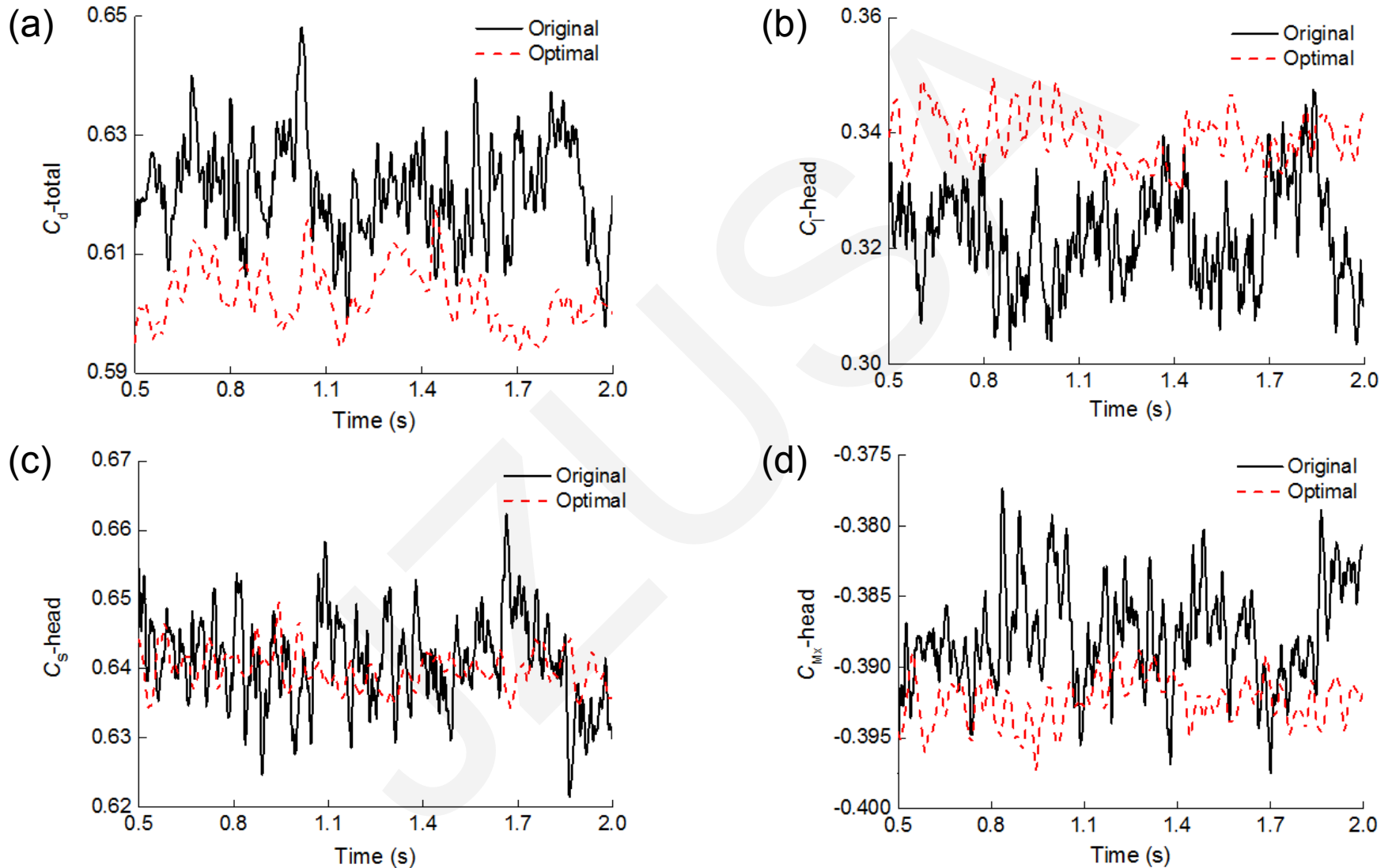


Fig. 5. Pareto front based on total  $C_d$  and  $C_l$  of the tail coach



# Results and Discussions



**Fig. 7. Time history of  $C_d$ -total (a),  $C_l$ -head (b),  $C_s$ -head (c),  $C_{Mx}$ -head (d) in crosswind conditions before and after optimization**

# Conclusions

- A multi-objective aerodynamic optimization design method of a HST head shape is presented in this paper. The multi-objective aerodynamic optimization design of the HST head shape combining NSGA-II and a Kriging model was performed, taking the total aerodynamic drag coefficient ( $C_d$ ) and the lift coefficient ( $C_l$ ) of the tail coach as the optimization objectives. In conditions without crosswind, after optimization, the total  $C_d$  is reduced by 2.61%, and the  $C_l$  of the tail coach is reduced by 9.90%. In crosswind conditions, the total  $C_d$  is reduced by 2.98% and the side coefficient ( $C_s$ ) of the head coach is slightly reduced by 0.24%. In addition, the HST with the optimal head benefits from low fluctuations of the aerodynamic loads in crosswind conditions.