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Aerodynamic Optimum Nose Shape Change of High-Speed Train by Design Variable Variation

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Abstract : Nose shape optimizations of high-speed train are performed for the improvement of aerodynamic characteristics. Based on the commercial train, KTX-Sancheon, multi-objective optimizations are conducted for the improvement of the side wind stability and the micro-pressure wave following the optimization for the reduction of aerodynamic drag. 3D nose shapes are modelled by the Vehicle Modeling Function. Aerodynamic drag and side wind stability are calculated by three-dimensional compressible Navier-Stokes solver, and micro pressure wave is done by axi-symmetric compressible Navier-Stokes solver. The Maxi-min Latin Hypercube Sampling method is used to extract sampling points to construct the approximation model. The kriging model is constructed for the approximation model and the NSGA-II algorithm was used as the multi-objective optimization algorithm. Nose length, nose tip height, and lower surface curvature are design variables. Because nose length is a dominant variable for aerodynamic characteristics of train nose, two optimization processes are progressed respectively with and without the design variable, nose length. Each pareto set was obtained and each optimized nose shape is selected respectively considering Honam high-speed rail line infrastructure in South Korea. Through the optimization process with the nose length, when compared to KTX Sancheon, aerodynamic drag was reduced by 9.0%, side wind stability was improved by 4.5%, micro-pressure wave was reduced by 5.4% whereas aerodynamic drag by 7.3%, side wind stability by 3.9%, micro-pressure wave by 3.9%, without the nose length. As a result of comparison between two optimized shapes, similar shapes are extracted other than the effect of nose length.

Keywords : aerodynamic characteristics, design variable, multi-objective optimization, train nose shape
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