Design development of lightweight disc brake for regenerative braking finite element analysis

Abstract:

The automotive industry has for many years identified weight reduction as a way of improving product competitiveness and thus the ability to make profits. One area that has been examined for weight reduction is vehicle with regenerative braking system (RBS). The greatest advantages of electric vehicles (EVs), and hybrid electric vehicles (HEVs) is their ability to recover significant amounts of braking energy using a RBS. Regenerative braking is an effective method to extend brake disc life, minimise disc rotor weight, minimise brake pad wear and to extend the working range of an EV or HEV. Regenerative braking would extend the working range of an EV or HEV provided that any extra energy consumption e.g. from increased vehicle mass and system losses did not outweigh the saving from energy recuperation, also reduce duty levels on the brakes themselves, giving advantages including extended brake rotor and friction material life, but more importantly reduced brake mass, minimise brake pad wear. The objective of this research is to define thermal performance on lightweight disc brake models. Thermal performance was a key factor which was studied using the 3D model in Finite Element Analysis simulations. Ultimately a design method for lightweight brakes suitable for use on any car-sized hybrid vehicle was used from previous analysis. The design requirement, including reducing the thickness, would affect the temperature distribution and increase stress at the critical area. Based on the relationship obtained between rotor weight, thickness, undercut effect and offset between hat and friction ring, criteria have been established for designing lightweight brake discs in a vehicle with regenerative braking.