ABSTRACT

The present thesis deals with the development of high-performance brake block composite for railways. Brake block composition consists of different ingredients; each one has its unique properties towards the overall performance of the brake block composite in service. Different brake block compound formulations were prepared, and these compounds were tested to check their suitability as brake material through measurement of some unique set of properties required for brake block. The effect of individual ingredient e.g. aramid pulp, lapinus fiber, synthetic graphite powder, calcined petroleum coke (CPC) and aluminum chips as well as the judicial combination of these ingredients on the properties of the developed composite has been investigated. Further studies on the thermal degradation kinetics of the optimized composition have been carried out. The investigation presents systematic analyses of the results of friction and wear test and their correlation with the mechanical and thermal properties of the developed brake block composite. The morphological characterization of the worn surfaces of the composites provides some relationship among the friction and wear behavior with the other properties, and this can be used to predict the underlying wear mechanism. The aramid pulp was found to have more effect in controlling the friction coefficient of the composites compare to lapinus fiber. The underlying mechanism of wear also changes with the type of fibrous component used. The adhesive wear mode was found to be dominant when aramid pulp was used as the reinforcement in the composites whereas the abrasive wear was the principle mechanism of wear for lapinus fiber based composites. The graphite inclusion improves both the frictional stability and the wear resistance of the brake composites. The thermal stability of these composites increases with increasing amount of graphite in the formulation. The presence of graphite also reduces the fiber-matrix debonding during the friction test. On the other hand, the friction coefficient was found to be better stabilized with less tendencies of fluctuation, at higher CPC loading. But, with the increase in CPC loading frictional noise increases. The thermal conductivity of the composites increases significantly with the addition of CPC which could also be due to the improvement of the interfacial bond formation. The morphological analysis of the CPC containing composites showed less tendency of fiber-matrix debonding. However, the mechanical properties like hardness, flexural strength, and compressive strength reduced with the gradual increment in aluminum chips (metallic filler) concentration in the formulation. The resistance to thermal degradation as well as the thermal conductivity of the aluminum chips loaded composites improved due to the addition of aluminum chips. The thermal conductivity of the composites increases fivefold from 0.423 to 1.979 W/m-K with the addition aluminum chips. The morphological analysis of the abraded surfaces of the composites revealed a decrease in the tendency of surface damage and wear debris formation with the increase in metal content in the formulation. The friction coefficient of the aluminum chips containing composites changes almost linearly with sliding time. The addition of aluminum chips improves the wear resistance of the composites. The optimized composite exhibited an average friction coefficient of 0.52 and thermal conductivity of 1.3 W/m-K. The present study provides some guidelines for the improvement of brake block composite with respect to the different properties through individual variation of composition. Depending upon performance requirement of brake block optimized composition to achieve overall best properties can be made.