Development of novel concept of engineered layered composites

Ferenc Sarka[1 *], Betti Bolló[1], Dirk Drees[2], Lais Marcos Lopes[2], László Kuzsella[1], Csaba Felhő[1]

[1]University of Miskolc, Faculty of Mechanical Engineering and Informatics, Miskolc, Hungary

[2]Falex Tribology NV, Rotselaar, Belgium

* presenting author e-mail: ferenc.sarka@uni-miskolc.hu

A significant part of Europe's freight transport is carried out by rail. The safety of rail transport is of fundamental importance. The basis of safety is a well-functioning brake system. Failure of railway brake systems is usually caused by issues with the brake blocks. Additionally, the conventional cast iron brake systems are under pressure because they generate undesired noise in highly populated areas. A composite brake solution reduces this noise but leads to new problems. Failures can often be traced back to high temperatures generated by friction and the geometric and material structure changes they cause. The objective of the project is to create a simplified test procedure that, with the help of laboratory experiments and numerical simulations, can make suggestions for improving heat distribution of brake blocks through macrostructural changes. We use AM technology to produce prototype test specimens, so that a variety of geometric possibilities can easily be realized.

During the work, the University of Miskolc (UM) prepared laboratory test specimens from real brake materials, cast iron and composite blocks. These were subjected to tribological and thermal conductivity tests by FALEX TRIBOLOGY (FALEX) and UM. In parallel, UM determined a mathematical model with FEM boundary conditions for which physical experiment and mathematical simulation showed good agreement. This defined the initial state. UM prepared test specimens of several different material grades using AM technology, on which FALEX also performed tests to find the material grade that is closest to the behavior of the current conventional cast iron brake block materials. After the first round of tests, we designed CAD models of macrostructural blocks with six different geometric modifications. We performed the FEM tests on these, using the experimental results of Falex. Out of the six versions, the two best performers, in terms of heat distribution, were recommended for production using AM technology. We performed further simulation studies on the two selected types to optimize the size, distribution, and number of geometric modifications. The results achieved so far have been reported in several scientific articles (10.1088/1742-6596/2848/1/012004), including one with Q2 qualification (10.3311/PPtr.36938).

In the oral presentation and on the poster, we will show the results achieved to date. We demonstrate the good correlation between the thermal characteristics of real brake blocks (minimum-maximum temperature, temperature increase as a function of time) and the developed experimental and simulation tests. We point out that we have created the basis of a test method where it is possible to quickly and inexpensively simulate different configurations and geometries, to manufacture the best versions with AM and confirm by physical testing, so that better railroad brake blocks can be designed.

Funding agencies: National Research, Development and Innovation Office (Hungary), Flanders Innovation & Entrepreneurship (Belgium)