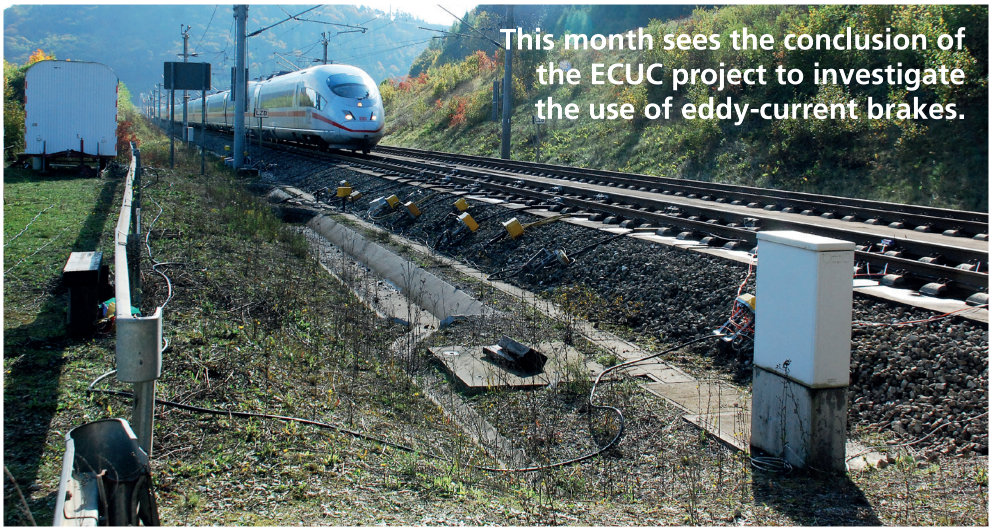
Studying the compatibility of eddy-current brakes



Practical tests in Germany were used to verify the EMC modelling and demonstrate the compatibility of eddy-current brakes with lineside signalling equipment.

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Eddy-current brakes have proved to be a highly effective way of increasing the braking capacity of high speed trains, but to date they have not been widely adopted in Europe, mainly because of concerns over electromagnetic compatibility and thermal effects on the track (RG 5.08 p301).

Co-funded by the European Commission under FP7 Transport (contract 314244), the ECUC collaborative research project on Eddy Current Brake Compatibility has brought together eight European partners to investigate these concerns and look at ways of alleviating them. The project has been co-ordinated by CEIT in Spain, working with UNIFE, Knorr-Bremse, Alstom, SNCF, DB, Network Rail and Frauscher Sensortechnik.

Over the past three years, ECUC has developed new electromagnetic and thermal models for eddy-current brakes, new brake designs and test procedures, and recommendations for the correct interoperable functioning of ECBs in a complex railway system.

Simple principles

The linear ECB is based on a simple principle: a magnetic field across an air gap between bogie-mounted magnets and the rail head produces a braking force. As there is no mechanical contact between the brake and track, there is no wear, smell or dust emissions. The use of linear ECBs can help to shorten the stopping distance of trains, while reducing the dependency of the braking capability on wheel/rail adhesion. Using ECB brakes for regular service braking can considerably reduce the need to rely on friction braking, extending brake block or pad life, saving maintenance and reducing life-cycle cost to a significant extent.

ECBs have been used successfully in Germany for many years, notably on high speed trainsets. The main hurdle to extending their use to other countries are concerns over electromagnetic compatibility with wheel sensors located along the track and the risk of buckling due to increased rail head temperatures which increase longitudinal forces and introduce vertical forces.

The ECUC project therefore used computer modelling to study the worst case conditions for wheel sensor and track interaction, using Knorr-Bremse´s L4 and L5 linear ECBs as the base case.

The EMC model was built using CST Microwave Studio. The tests looked at the interaction with Frauscher's RSR 123 and RSR 180 axle counters in three cases:

- an ECB passing the signalling device, where the presence of a metallic mass can be interpreted by the axle counter as a 'wheel';
- an energised ECB with low frequencies (Hz) coming from the induction caused by a fast moving DC source;
- an energised ECB with high frequencies (kHz) emanating from the harmonics of the power supply.

Comparing the modelling results with data obtained through a measurement campaign, the worst interference conditions can be anticipated.

Using finite element modelling, the thermal model considers the temperature in the rail after the use of ECB, and compares this to the maximum temperature levels permitted in the various technical specifications. All kinetic energy is assumed to be converted into heat and introduced to the rail. Different scenarios were considered, varying the velocity of the trains, the frequency of operation, the initial rail temperature and the ambient temperature. The thermal calculations were undertaken for UIC60 profile rails. Using experimental results, various parameters were added to reflect the evacuation of heat through convection or radiation from the lateral surface.

Developing guidelines

Based on this modelling work, the project team was able to develop a test set-up and testing procedure that could be used in the definition of approval tests for linear ECBs. This test procedure would seek to recreate the worst-case conditions for compatibility with axle counters.

With the modelling and test procedures in place, ECUC moved on to develop new design, engineering and operational guidelines for ECBs and lineside signalling equipment to provide technical support and a proper input to future standardisation.

All of the project results and recommendations will be presented at the ECUC final conference taking place in Wien on August 27. Further details of the event and a registration form can be found on the project website. ■

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Finite element modelling was used to investigate the impact of thermal stresses at the wheel-rail interface.