European Rail Infrastructure Managers
EIM

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Position Paper

On the design and use of magnetic track brakes

Rue de la Loi 28 • B -1040 Brussels • **Tel**. +32 (0)2 234 37 77 • **Fax** +32 (0)2 234 37 79 • info@eimrail.org
www.eimrail.org

On the use of magnetic track brakes

Introduction

The EIM position regarding the use of magnetic track brakes, i.e. solutions acting directly on the rail head, in relation to the rolling stock TSIs is the following:

EIM recognizes that the use of brake systems that are independent of adhesion between wheel and rail improve safety by enabling shorter stopping distances when applied by giving a reduced dependency between stopping distance and adverse adhesion conditions (caused by moisture, ice, leaves or other pollution on the top of the rails).

With increased train speed magnetic track brakes add braking power by not having the thermal capacity limitations of the friction wheel brakes that would necessitate expensive solutions or lead to excessive wear from harder use.

The rolling stock TSIs shall allow the use of magnetic track brakes for emergency braking or for parking (if it can be demonstrated that this is a safe alternative to current methods) and routine train/vehicle system tests (power up tests etc). The overall braking shall not exceed an equivalent deceleration of 2.5 m/s2 over the train length.

However, depending on type of infrastructure installations, magnetic track brakes may also have disadvantages that can impair/affect both safety and technical reliability - usually mechanical incompatibility between the magnetic track brake and track designs.

Because of this, infrastructure managers must have the possibility to restrict the use of magnetic track brakes and this shall be supported by safety considerations. If the use is restricted, this shall be stated in the infrastructure register.

Why infrastructure managers need to be able to restrict the use of magnetic track brakes:

The use of magnetic track brakes may cause problems because of:

- bridging of isolated joints (track circuits and booster transformers)
- incompatibility with train detection systems (axle counters etc) working on magnetic principles
- excessive longitudinal track forces in track with low longitudinal resistance or prone to rail creep
- incompatibility with S & C (switches and crossings), check/guard rails and other track design features or permanent way installations

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BACKGROUND

Magnetic track brakes have been in use on rail guided transport since the early 1900's. It was first introduced on trams in urban service because of the short stopping distances in street traffic. In railway applications it was first considered when speeds began to reach 120 km/h in the mid 1930's. With today's signalling distances and brake systems this limit is around 160 km/h.

The use of magnetic track brakes is mainly to boost emergency brake performance for the higher speed brackets. Although it can be used for secondary purposes like holding the train while performing system tests, use as a parking brake and also for cleaning the rail head for adhesion in for instance leaf fall conditions. The magnetic track brake is generally used on Multiple Units and Coaches and in rarer cases on locomotives, due to the space limitations in locomotive bogies.

The magnetic track brake is normally mounted and attached to the frames of a bogie and the magnetic track brake shoe or sledge, as the case may be, is positioned between the wheels on each side. The bogie wheel base is usually between 1.8 and 2.5m for coaches and between 1.5 and 3.0m for locomotives, which limits the effective length of the braking surface. The braking surface is of steel alloy and is usually built up of sections with gaps between the sections and these are mounted to a sledge, which is can be lowered from a parking position in the bogie or other vehicle part above the rail. The braking surface is flared at the ends in order to negotiate discontinuities in the rail head. The general features of magnetic track brakes can be seen in UIC 541-06 applicable to railway vehicles in general and the German DIN 25108 and DIN 43201 applicable to suburban and tram applications. The application force is generated by magnetic activation and DIN 25108 states the variation in application force to 52 – 70 kN.

The braking action is achieved the brake shoe acting directly on the rail head and through the friction between the shoe and the rail generating a brake force on the vehicle. The downward force acting on the rail is the sum of the weight of the sledge/shoe and the attracting force between the brake shoe and rail. The attracting force is generated either by permanent magnet or electromagnetic effect of the magnetic brake shoe.

The braking force per shoe for a normal vehicle installation (on a coach 4) is between 4 – 10 kN.

Track geometrical interface

The interface with the rail head and track features like S&C (Switches and Crossings), check/guard rails etc is important as misalignments will result in increased wear or damage to both the track and the magnetic track brake shoe/sledge. For these reasons the geometrical characteristics of the braking surface including end elements of the magnetic track brake shall always be compatible with the track design of the network.

The width and length of the magnetic brake shoe is critical for example for the safe passage of S & C installations. The width is critical. If too wide, parts of the frog can be hit outside the normal wheel-rail contact area or, in the extreme, fouling check rails. UIC 541-06 specifies the width of the braking surface (called friction plate in UIC 541-06) to 65 – 72 mm, which is within the railhead width of UIC 46 to UIC 60 rails. The DIN 25108 states the variation in width to 56 – 72 mm, but this includes tram applications. It must be noted though that the practical adhesion width will be narrower than this and depending on the shape of the rail head and brake surface of the magnetic track brake shoe.

The length is critical in relation to the safe passage over the unguided area of S & C. For compatibility with S&C and other track design features, see UIC 541-06 and DIN 25108. Further compatibility aspects can be drawn from wheel compatibility documents like UIC 510-2.The minimum length of the braking surface must be kept equal to or above 1000 mm, see UIC 541-06.

The end elements of the brake shoe shall be designed with the appropriate geometry to accommodate both the characteristics of crossings with a tangent above or equal to 0.034 and the check rails. In UIC 541-06 appendix 3 approved types of end elements for magnetic track brake shoes for international service can be found.

Track compatibility considerations

The friction principle of the magnetic track brake will lead to abrasion of primarily shoe material, which gives rise to negative effects. One is the possible bridging of isolated rail joints for track circuits and the other is the formation of ridges on the shoe surface leading to reduced performance. Since the 1960's when the first fleet use of magnetic track brakes started in Europe the research into better shoe material has led to a reduction of the adverse effects related above, but they have not yet been eliminated. The friction principle giving rise to elevated temperatures in the rail head is considered to be in the same order as wheel braking action, but this has to be explored in areas prone to high numbers of successive emergency brake applications where these may have an accumulated effect. Although it must be stated that, if this is the case, then there are other operational issues that have to be addressed.

The application principle of the magnetic track brake by using a magnetic field may affect the function of rail mounted track equipment such as axle counters working with magnetic fields. The adverse effect depends on the individual type of equipment and has to be addressed in the planned operation of the vehicle. For general use the magnetic track brake is ideally equipped with shields to reduce the adverse effects.

Operational considerations

The primary benefit of the magnetic track brake is to enhance brake performance of the vehicle in emergency situations and is therefore applied in the emergency brake position of the driver's brake handle or commanded by the ATP (Automatic Train Protection) or ETCS (European Train Control System) as the case may be. This means that braking up to full service brake shall not normally result in application of the magnetic track brake.

For other reasons the magnetic track brake can be applied as a cleaning device improving adhesion in adverse braking conditions, i.e. leaf fall, but it is then understood that this is usually done on plain line with a small number of S&C and track circuits (insulated rail joints).

In yards and station areas, where the number of track circuits and consequently insulated rail joints is high, the application is assumed to be in emergency situations only. This is mainly due to the low speeds of trains/vehicles in these areas, but again if it is a station with through services at line speed, the plain line situation as per above is applicable.

CONCLUSION

The rolling stock TSIs shall allow use of magnetic track brakes in case of emergency braking or for stationary applications like parking and systems tests on the train/vehicle.

Maximum capacity and frequency of use must be considered in order to ensure compatibility with infrastructure installations.

The network statement shall specify limitations in the operational use or to the interface with the infrastructure either geometrical, EMC or otherwise of magnetic track brakes.

The infrastructure managers may accept use of magnetic track brakes as a service brake or cleaning device for adhesion purposes to the extent the magnetic track brakes are considered compatible with specific infrastructure-installations. If so, this shall be stated in the infrastructure register.