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6 TEN-T RAILWAY AXES: AN OVERVIEW OF THE EU TECHNICAL REQUIREMENTS

Resume

Abstract
The paper provides an overview of the most important technical requirements for railway infrastructure as regulated by the standards proposed by the European Union. More precisely, the paper gives an insight into the following Trans-European Transport Network (TEN-T) requirements: track gauge, axle load, train length, electrification and speed. In addition, each parameter is illustrated by a practical case where appropriate.

Keywords
Trans-European Transport Network – track gauge – axle load – train length – electrification – speed

TEN-T-Schienenachsen: Ein Überblick über die technischen Anforderungen der EU

Kurzfassung
Der Beitrag gibt einen Überblick über die wichtigsten technischen Anforderungen an die Eisenbahninfrastruktur, die durch europäische Normen geregelt sind. Der Beitrag ermöglicht einen Einblick in die folgenden Anforderungen des Transeuropäischen Verkehrsnetzes (TEN-V): Spurweite, Achslast, Zuglänge, Elektrifizierung und Geschwindigkeiten. Jeder der genannten Parameter wird gegebenenfalls durch ein Beispiel veranschaulicht.

Schlüsselwörter
Transeuropäisches Verkehrsnetz – Spurweite – Achslast – Zuglänge – Elektrifizierung – Geschwindigkeit

1 Objectives and boundary conditions

The European Union (EU) aims for the technical harmonization of railway lines on its territory, in particular on the main cross-border axes, in order to strengthen the role of railways as an alternative to road transport. The concept is based on different EU regulations – starting with early measures in the 1990s (Decision 1692/96/EC), across the amendments from the 2000s (Decision 884/2004/EC), up to the current ones (Regulation (EU) 1315/2013; Regulation (EU) 1316/2013). The target is a harmonized European railway network, which allows cross-border train services without any problems or time lags. In this way, the EU defines some technical conditions to make this aim possible.

The TEN-T requirements and the financial support for their fulfillment in the development of the TEN-T axes of the EU ensure that the most important routes from a European perspective are the first to be equipped in such a way. The railway infrastructure companies involved (in Germany "DB Netz AG") can then gain experience which they may also use on other suitable non-TEN axes. The national rail supply industry will benefit from this.

2 Track gauge

The **1435 mm gauge** is already harmonized, except in peripheral areas such as Spain/Portugal or Finland and some Baltic states. At the system boundaries, it is possible to exchange the wagons or only the axles. Talgo in particular builds vehicles with adjustable axles, which adjust to the approaching track width when driven at low speed.

In this respect, a track gauge specification is not explicitly required for TEN axes.

3 Axle load

Axle load specifications are important for the wagon design and the weight of the superstructure and for bridges. For a maximum axle load of 22.5t, specified in regulation (EU) 1315/2013, the superstructure must have heavy UIC60 rails (60kg/m) according to UIC standard, preferably B70 concrete sleepers and corresponding rail fastenings. Most of the freight wagons currently in use are now four-axle and designed for 22.5t axle load, i.e. 90t per wagon when fully loaded.

Another recommended specification for the permissible load of bridges or passages is a **permissible meter load of max. 8t/m** for trains. This criterion is not explicitly required by the EU for TEN-T lines. However, new bridges along the TEN-T axes should at least be designed for this. With four axles per freight wagon and 8t/m permissible load per meter, the minimum length of such freight wagons is approximately 12m (4*22.5t/8t/m = 11.25m).

Some steep sections also limit the total mass per train in order to minimize the risk of a train separating on a slope. The superstructure can adjust to a maximum axle load of 22.5t and equip the relevant sections with proven techniques (Lübke 2008).

4 Train length

While the technology of freight wagons has changed considerably in many rail systems focused more on freight traffic, most of the design principles of European freight wagons are based on the Berne agreements of 1905, when **screw coupling and the Berne area** were defined and implemented throughout Europe. This was a major step at that time but is slowing down the effectiveness of rail freight transport today.

The screw coupling and the side buffers can only transmit relatively low tensile and compressive forces. The air hoses must be connected at each coupling, and valves must be opened because the coupling itself cannot do this, as all automatic couplings (AC) can. UIC's AC specifications from the 1960s have ensured that almost every European freight car is now ready for AC, but the installation of AC itself has only been undertaken by a few freight railway companies. The disadvantage of a mixed clutch could be eliminated by the Faiveley clutch, which is only in operation with a few heavy ore trains today.

In addition to the limits caused by coupling and the permissible towing capacity by traction and the lines to be travelled on, the working length of the train formation tracks and overtaking tracks also limit permissible train length for freight trains. Although large train formation stations ensure the formation of train lengths of up to 740m, many overtaking tracks on the line do not have this working length today. This may be a problem for the dispatcher on lines with mixed traffic.

In the case of freight trains, it is planned in advance where the train is scheduled to be overtaken, but in the event of unusual deviations from the timetable another overtaking track should also be available. The EU prescribes a working length of 740m for the TEN-T lines, thus all overtaking tracks should also have this working length.

Even better would be long multi-track sections in each direction of travel, e.g. **crossed three-track sections** as can be seen on the route between Hamburg-Harburg and Lüneburg. This would allow the freight train to continue its journey despite being overtaken by faster trains and would save time and above all energy.

It would be a big step forward for European rail freight traffic if 740m long freight trains could be run throughout. In France, however, radio-controlled intermediate locomotives are already being experimented with to allow for freight trains twice as long. This is a good solution for the future on routes that are largely used only by freight traffic.

Train formation, including manual coupling of the wagons to each other, requires train formation tracks in or near the loading processes, in a so-called train formation station (TFS) or in ports. For on-route overtaking and breaks for changing traction units

(TU) or waiting for the next available train paths, train-length tracks with a real working length of 740m are required. To this end, the complex switch lines in these TFS must be expanded accordingly.

The block length, i.e. the distance between two fixed signals, is set at a minimum of 1,000m to achieve high performance. Together with a 200m overlap behind a signal and various other protection zones, this results in exactly the 740m permissible length for trains in the German network. This generally also applies to central Europe.

With even longer and heavier pulls, the breaking load of the screw coupling would probably also be reached more quickly. Only on flat lines like Hamburg-Flensburg, DK have there been tests with 825m long freight trains. For this purpose, the forces in each section of the train should be checked so that there are no derailments due to the length during forced braking or emergency braking in curves. The same applies to starting with a leading locomotive. These problems would be considerably less if freight cars were converted to automatic coupling (AC). For the time being, however, retrofitting by freight car operators seems unaffordable by the market without state aid.

Here, too, an AC would help, as it could also connect an electric cable which enables electric-pneumatic braking and thus allows all brakes to respond simultaneously, like in passenger traffic. Today, a freight car brake only works when there is a sufficient pressure drop in the main air pipe, which can be up to seven seconds later than on the first car behind the locomotive. This leads to constraints, possibly also to the climbing up of wheels in curves and derailments, which should of course be avoided. Therefore, the speeds of the freight trains may be reduced in corresponding curve areas. However, since the implementation of the freight car fleet with AC is not in sight, the standardization of the permissible train length to a maximum of 740m would be a big step.

Nevertheless, there will be narrower limits on steep sections, where heavy trains have to be pushed in a complicated manner. This problem could also be solved by AC in the vehicle fleet. In addition, by means of cabling or, if necessary, by radio, an unmanned remotely operated traction unit (TU) could be controlled by the leading TU in a train, which has long been the practice with highly productive railways in the USA, Canada, Australia and Africa, but mostly on pure freight traffic routes, of which there are very few in Europe.

5 Electrification

As a result of the development of multi-system locomotives that can switch to different power systems during travel, the problems of different power systems have now been marginalized. The use of diesel locomotives would not only be less environmentally friendly on site but, due to the lower tractive power per locomotive compared to modern electric traction, also generally less economical, because two diesel locomotives would have to be used for trains of the same weight as one electric locomotive. The EU demand for electrification is justified because it increases the economic efficiency of freight trains on TEN-T lines and also ensures a better environmental balance in passenger transport. The nuisance to local residents with regard to noise and exhaust fumes is significantly reduced.

6 Speed

For freight traffic, a speed of 120km/h is required as permissible speed, which is in line with most national plans. Today, many freight cars can only be transported at 100km/h due to the design of their bogies or single axles. The aim in the freight car fleets is 120km/h as Vmax and the current orders are linked to this aim.

Tests with faster rail freight traffic (e.g. as a freight train up to 160km/h) were soon stopped due to the considerably higher energy consumption. The non-streamlined wagon constructions, gaps in the loading conditions, etc. increase the wind resistance enormously.

These tests were carried out at night, when passenger traffic is only marginal, in order to make better use of the high-speed lines. After some dangerous situations between freight and passenger trains on high speed lines in Germany, a ban on freight trains was imposed in tunnels with two tracks in one tube. Freight traffic on such lines was brought to a standstill in combination with fast passenger trains.

Only where a separate tunnel tube is available for each direction and where special streamlined wagons are used can freight traffic on high-speed routes still be considered. An example of this would be the replacement of air freight traffic in modified passenger trains like the so-called InterCityExpress Freight (ICE-G).

7 Conclusion

EU requirements for the TEN axes are designed to increase the efficiency of passenger trains and rail freight transport on these axes and do not unduly overload the infrastructure or the railway undertakings (RUs). Railway operations can also live in mixed traffic and largely with the current station layout.

Above all, adjustments will be necessary for the effective lengths of passing and train formation tracks and in the superstructure, even if this is different in each country along a corridor.

The TEN axes can play a strong role in European commercial transport and thus fulfill the task desired by the EU. The regulations will also result in many additional national expansions, bringing the goal of a uniform European rail system closer.

While the railway lines in Germany and Austria are already largely in line with EU requirements or are being upgraded, there is still considerable backlog demand for the Corridor Hamburg–Athens in the Balkans and in Greece. An appropriately developed main line, however, holds great potential for more effective rail freight transport.

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