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Translation

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Infrastructure for tilting trains

Infrastructure pour les trains à caisse inclinable

Infrastruktur für Neigezüge



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Summary

Work was launched in early 1999 as part of a UIC study on reducing journey times on conventional lines. Following initial discussions, it was decided that the rules governing infrastructure for tilting trains would be harmonised on a documentary basis.

The project partners involved comprised not only railways already with tilting trains in operation but also ones which had plans to introduce tilting trains in the future.

Two significant results were produced: a list of essential parameters to be taken on board and the establishment of limit values. A list of parameters not affected by tilt was also drawn up.

For the sake of clarity, the leaflet also contains some explanations on basic technical subjects such as the impact of tilting trains on wheel/rail interaction. A table has been appended to the leaflet summarising all the rules adopted by the railway companies that were members of the working party. The table is therefore the starting point for the work carried out.

The most important considerations are the range of definitions (basic parameters such as maximum and minimum speeds, axle loads, track layout, cant deficiency to be applied, etc.), kinematics, track equipment and track geometrical quality, interface parameters track/train, etc.

Maintenance-related topics were not covered by the work. Some railways have advocated carrying out studies with a view to determining speed increases that could be achieved by running tilting vehicles on high-speed lines.

1 - General

Body tilting is a design technique for railway passenger vehicles. It enables the bodies of coaches to be tilted about a longitudinal axis thus limiting the lateral acceleration of the vehicle body and its effect on the perceived comfort of the passenger. This makes it possible for vehicles with tilting bodies to negotiate curves at higher speeds than conventional coaches, without adversely affecting passenger comfort.

The objective of this Leaflet is to pool knowledge concerning the conditions recognised as necessary in order for the track to be used to carry tilting trains on conventional lines.

This definition reflects the needs expressed by the UIC railways in the course of the joint work on the state of the art of tilting train technology.

In the interests of efficiency, this Leaflet only covers measures relating to use of tilt technology and not those relating to the increase in speed. Nor does it cover, at least not in the initial stage, the effect of tilt on signalling (control-command). Work on this Leaflet has been carried out in close coordination with the work on vehicle type approval carried out to adapt *UIC Leaflet 518* to include tilting body stock (*UIC Leaflet 518-1*).

This Leaflet relates to the track design parameters for operation of tilting trains. The impact of this type of traffic on track maintenance is not addressed. Railways operating tilting trains may adapt the design parameters in the light of any acceptable additional maintenance.

2 - Basic parameters used

2.1 - Revenue speeds of tilting trains

For the most part the railways operate tilting trains at speeds of between 70 km/h and 230 km/h. However, there is no objection to considering a starting speed as low as 50 km/h.

This lower limit of 70 km/h is dictated by the tilt control systems. In fact these systems do not trigger the body tilt mechanism at lower speeds chiefly because, when negotiating switches onto a turnout, the tilt system accentuates movement in the vehicle body. What is more, there does not appear to be a great deal of commercial value to be gained from using this technology at low speeds.

The upper limit (230 km/h) corresponds to the speed normally reached on lines carrying conventional trains with cant deficiencies of 150 mm.

For information, two revenue speed ranges may be considered for the different types of tilting trains:

- one from 70 to 160 km/h for regional trains requiring tilting stock suitable for service on very sinuous lines;
- the other from 70 to 230 km/h for national trains requiring rolling stock suitable for use on sinuous lines but also on lines with alignment designed for high speeds.

R 2.2 - Maximum axleloads

Tilting trains operate with higher cant deficiencies than those required for conventional trains and normally exert heavier loads on the track. It is therefore advisable for axleloads to be lower and for the suspension to be of high quality.

The restriction on axleloads has a significant effect on whether the limits of the Y and Q forces relating to track fatigue are adhered to, and to a lesser degree on the slewing (lateral displacement) of the track.

The track slewing limit is governed by Prud'homme's formula:

$$\Sigma Y = \alpha (10 + P / 3),$$

expressed in kN, the constant term of which corresponds to the strength of the unloaded track. The lighter the axleload, the greater the relative effect of this term.

It is recommended not to exceed an axle load of 180 KN.

Furthermore, if the value of the Y and Q forces is associated with the axleload, the dynamic component of these forces will depend on the geometrical quality of the track and on the quality of the suspension systems which filter the track geometry defects to a greater or lesser degree. The quality of the suspension also has an effect on the transverse force Y and consequently also on whether the Prud'homme and Y / Q criteria are satisfied.