Combined portal frames for signalling and overhead contact line

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Summary

Technical equipment for the renewal and upgrading of railway lines is generally complex, because the supporting structures for various electrical devices are independent. Overhead lines are fixed to steel frames or individual columns, separated from the fixed signals. During the upgrading of the suburban railway network around Brussels, the idea of combined portal frames for all rail equipment was implemented. The frames can be adapted to the total width of the track area and consist of 3 steel tubes joined by welded connecting plates to a spatial truss.

Since the frame span varies, for larger portals the deformation criterion for overhead line alignment is more important than strength. The frames are fixed to the foundations by threadbars and earthed. The type of foundations varies with soil conditions and can be diaphragm walls, as well as concrete blocks cast on site. In a few particular cases the frames are supported by steel corbels fixed to bridges or earth retaining walls.

As the signalling is also installed on the vertical and horizontal members of the frames, simulations have been used to verify sufficient visibility for train conductors, both in straight alignment and bends. The system allows better view of the railway line than classical equipment. The frames also continue functioning in the event of train car derailment. At present 70 of these adaptable frames have been installed and the experience has been positive.

Keywords: Railway lines; steel frames; Technical equipment

1. Introduction

In the context of Infrabel's RER programmes (Regional Express Network) to increase the capacity of the railway lines that converge to Brussels. These works involve:

- the redevelopment of the existing lines and lines converted to high speed, hence the necessity for straightening particular curves and completely renovating the infrastructure of the catenary (poles, contact wires, carriers, etc.) dating from the 1950s so that the maximum speed can be increased to 160 km/h (instead of 130 km/h).
- and the widening of the existing railway platforms allowing two additional tracks thus enabling both fast and slower trains to be operated simultaneously and efficiently.

Infrabel has firmly undertaken not to widen the footprint of the tracks, which makes it necessary to use some state-of-the art structures: viaducts and corbelling, covered trenches, green walls and paving at the approaches to some stations. So widening the platform has been investigated to minimise:

- interruptions and slowing down of the rail traffic on the existing tracks;
- compulsory land purchase in densely-populated areas;
- damage caused by the works on Infrabel installations, on the areas adjacent to the tracks (to people and housing) and on the green spaces adjacent to the line.

Hence, the solution of portal frames spanning all 4 tracks appeared the best solution.

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2. Integration of the supports into the railway environment

The foundations of the supports had to be conceived to accommodate existing civil engineering constructions while respecting the phasing of the works. There are traditional foundations dedicated to portal frames located in open areas which can be bolted to reinforced or open excavations. Individual solutions have been developed for areas where civil engineering is more complex.

3. Design of the supports

To ensure the good performance of the supports throughout their respective lives the SAMCEF programme was used to model the finished elements.

A calculation of the maximum stresses and deformations due to the catenary loads were also performed to check that they did not exceed the allowable stresses and deformations respectively at the ultimate and service limit state.

In order to confirm the results obtained by the Samcef modelling and following a close collaboration between the TUC RAIL research department and Ghent's University, a life size bending test was performed at the Gentbrugge workshop on a test portal frame.

4. 3D numerical simulation: problems with clearing the catenary cables and the visibility of signals

Different numerical simulations have been carried out to verify whether the new catenary supports do not obstruct the train drivers' field of vision.

The obstacles to visibility are mainly all the catenary infrastructure, the signalling boxes, the trains travelling on adjacent tracks and the retaining walls along the tracks.

These simulations have demonstrated the importance of studying the environment of the portal frame both transversally and longitudinally and incorporating the constraints of each technique.

5. Conclusion

The design of the RER portal frame appeared immediately to be the best solution taking into account all the technical constraints of the project. RER portal frames enable us to limit:

- compulsory land purchases in densely-populated areas;
- the impact on town planning due to their light structure;
- design efforts, thanks to general and upstream coordination;
- simplify the phasing of work;

They also allow us to:

- respect the different standards and regulations of the various railway infrastructures;
- improve the visibility of the signals for the train drivers;
- clearly identify the sections of RER line and the rules to follow for the train drivers;
- unify the civil engineering works on all the lines by standard solutions that repeat RER portal frames;
- increase the safety, maintainability, reliability and the availability in the event of a train derailment;
- facilitate the maintenance of the different railway infrastructure;

This solution nevertheless requires significant upstream coordination of all the technical details and the various teams involved in the project.