Installation Quality of Slab Track – A Decisive Factor for Maintenance

Slab track is being adopted in ever increasing volume as the preferred form for new construction and for major track renewal. Its first cost is generally higher than for ballasted track types, but RAMS analysis shows that there are economic advantages in using slab track, provided that maintenance costs are kept at a very low level by a high quality of first construction.

Slab Track Types

A few years ago, slab track was seen in Europe as a risk-laden and probably very expensive solution for especially difficult situations in railway infrastructure. This was due partly by the limited extent of experience in ballastless track construction, and also by the lack of optimisation of the construction process, as nearly every project seemed to be an experimental task.

However since those times a whole range of ballastless track types has been developed, proving their worth in daily railway operation. On the Japanese Shinkansen system, pre-cast slab units predominate now as they did in the past. In Europe, as well as the pre-cast slab types (ÖBB-Por, Bögl), designs with concrete sleepers in in-situ concrete (Rheda variations) and rail support blocks (LVT) are to the fore. Fig. 1 gives a summary of the various types.

Slab track has further advantages: it allows the full width of the track to be used by road vehicles. In tunnel situations this can be used for safety and rescue
purposes. Special forms of slab track are effective at minimising noise and vibration emission from railway operation.

Where the maintenance requirement for slab track is really significantly lower than for traditional ballasted track, then in certain situations it can provide an economic technical alternative.

Quality of Execution and Life Cycle Costs

Although the technical aspects of slab track have been optimised, the cost of actual construction has barely been reduced. Neither the cost of materials nor the labour cost has been significantly reduced.

Inevitably this has resulted in installation of slab track in Germany being confined mainly to high speed routes until recently, such as the major high speed routes Hanover–Berlin, Cologne–Frankfurt and Nuremberg–Ingolstadt. A decisive factor in that decision was the requirement for smooth running of the trains.

However other factors like high availability, and above all ground condition and trackside issues are increasingly taking prominence. In particular, in areas where access is especially difficult, such as in tunnels, slab track is being increasingly installed even on routes without high-speed.

This is not only the case for new construction, but increasingly during major track renovation works, where the formerly existing ballasted track is replaced with slab track. In Austria, standards for design on high capacity routes require slab track to be installed in tunnels, in low-lying route sections, and on bridges over 500 m in length. In Switzerland too, ballastless track finds widespread application.

This is not based on the technical advantages of slab track, but on considerations of cost. Whereas formerly only the capital cost was considered, the operational and maintenance costs of a route throughout its life cycle are now taken into account.

The increasing requirements for new and upgraded routes, and above all novel forms of project structure force a whole-life analysis of railway infrastructure costs. In the so-called Public-Private Partnerships (PPP), the construction company has to guarantee operation over a long period; and to a large degree their profit depends on achieving levels of availability of the infrastructure. Consequently not only the construction cost but also the economic upkeep of the infrastructure in operation has to be evaluated precisely.

For this reason, RAMS-analysis (reliability, availability, maintainability, safety) is increasingly used. General contractors have to make all their specifications and designs comply with RAMS phases 1 to 14 under Standard EN 50126, dealing with the long-term operational maintenance of a system; this deals with the life cycle (concept, construction, testing, decommissioning). For the major project Gotthard-Basistunnel for example, phases 1 to 4 were required for the description of the railway technological elements from Alptransit Gotthard AG. Where construction involves the integration of telecommunications, signalling technologies and data processing, the CENELEC standards apply to RAMS.

For purely economic evaluation of the various construction types, life cycle costs (LCC) also have value. Slab track, because of its very low maintenance requirement, has an advantage over traditional ballasted track that has been long understood, but only recently evaluated. An example of the development of the evaluation of ballasted and slab track types using discounted cash flow methods is shown in fig. 3.

![Fig. 2: Slab track construction LVT in the Loetschberg base tunnel](Photo: Rhomberg Bahntechnik Gruppe)

![Fig. 3: Time depending value, ballasted track and slab track](Graph: time depending value, ballasted track and slab track)
Whether slab track will live up to its promise of being almost maintenance free, and whether the hoped-for financial advantages will actually accrue, depends on several factors. The most frequently asked question in this context is which type of slab track is best for particular circumstances. Especially in Germany there seems to have been a real mushrooming of slab track types in the last fifteen years. As already suggested, variants with pre-cast slabs or with sleepers fixed in in-situ concrete, or using individual rail supports have prevailed. Other types have either been used in much reduced volumes, or completely abandoned.

The causes of this are not so much the functionality or the structure of the respective track type, but the speed and quality of execution. Many design types which seemed to offer so much promise from their basic concept, lost ground because of poor construction quality and the resulting maintenance costs. In addition, there is still plenty of opportunity for error at the installation stage of the “established” systems, and this can easily negate the hoped-for goal of zero maintenance, undermining at the same time the planned beneficial cost projections.

The selection of a design brings with it not just the quality of installation but also subsequent maintenance requirement, so that as well as considerations like “top-down or bottom-up?” issues like ease of replacement and reparability come into question.

Equally important are the issues of carrying capacity and deformation of the sub-grade, as slab track has only a very limited scope for vertical adjustment. In the case of systems that have sleepers or support blocks directly fixed into in-situ concrete, loosening or breaking out is possible; the development history of these types confirms this observation. Construction processes like the placing, curing and subsequent working of the concrete must have the most careful supervision, as subsequent re-work to rectify errors can be hugely expensive and difficult.

For the reasons given, it is not possible to give a generally applicable recommendation for a “best-buy” slab track type. The selection process must give close attention to the planned use of the track, local conditions and project structure.

Construction of slab track needs the highest levels of supervision, and this is very often underestimated. Construction quality is decisive in maintenance requirements of all track types.

Carefully carried out using high quality standards, slab track offers considerable advantages over ballasted track types, from both economic and technical standpoints. Slab track that is installed using high quality processes can deliver economic advantages that repay the high initial cost: and it has beneficial application in a much wider range of situations than was the case a few years ago.