

Slab Track Development for the UK Rail Network

An article by Heather Ceney and David Bateman

Ballastless track or concrete slab track has been established in use throughout the world for over 30 years, with Japan and Germany in particular demonstrating widespread successful application of concrete track forms for high speed lines. However, the UK has yet to see the installation of significant continuous lengths of slab track on Network Rail infrastructure. UK railway culture does not encourage change or advances in technology, by its use of complex product approvals on the grounds of maintaining safety.

In the UK, application of concrete track forms has principally been limited to light rail such as on-street tram systems, London Underground, and Docklands Light Rail. For heavy rail, despite sound engineering reasons why alternative concrete track forms may be suitable for a project, they are often discounted in the very early stages, with clients lacking the confidence to accept slab track solutions. At present in the UK, slab track tends only applied where structure gauge clearance issues dictate that it is the only viable solution.

The common reasons given for not selecting slab track and opting for ballast are:

- Too expensive when compared with conventional ballasted track, frequently quoted as two to three times the cost;
- Limited maintenance experience of concrete track systems;
- Risk of track failure and limited ability to repair or understand the failure;
- Noise and vibration concerns, inappropriate specifications leading to poorly delivered systems;
- Cannot be installed in the renewals environment over short possession periods, say 24/72 hours.

Recent work by Britpave (the British In Situ Concrete Paving Association) and Arup has shown that this is a simplistic view of the issues and relies on perception rather than hard facts. Slab track is not one product, but in fact a range of engineering solutions ranging from basic direct fixing, where the rail is simply fastened to a concrete slab, through to floating track slabs with their noise and vibration mitigating properties.

The last three years have seen some notable applications of slab track on Network Rail infrastructure. Prior to this the BR Research/MacGregor track was installed including long lengths in the Glasgow Tunnels and at Stanstead. This was accepted in the 1970s as “best practice”.

In 2003, a Rheda track system was installed by Nuttalls/Heitkamp in the Hibel and Prestbury Tunnels, and a section of Balfour Beatty embedded rail (BBEST) track was constructed on the Crewe Kidsgrove line. In 2004, slab track using Vossloh fasteners was installed in the Ipswich Tunnel. For the Channel Tunnel Rail Link booted sleeper track is being installed in the London Tunnels. To date these installations have used Vossloh products. However, suitable Pandrol fasteners are available.



Rheda concrete slab track in Prestbury Tunnel

Of these, the Rheda and BBEST systems were installed as “test track” sections. This has not yet led to product approval by Network Rail, although approval is being sought.



BBEST rail section

However, this progress by Network Rail in the use of slab track on the heavy rail network has not yet been followed by widespread acceptance of the alternative track form. Ballast still remains the preferred option for most projects, new build as well as renewals. Britpave remains optimistic that the change will come; following the examples and experience of the European and Japanese rail networks, concrete track forms have become the solution of choice for higher speed strategic routes. This experiences has shown the following locations should use concrete slab track:

- Tunnels

Where maintenance access is restricted, low maintenance requirement of slab track is a major advantage over traditional ballasted track forms for maintaining high quality track standards. Slab track systems typically have a shallower construction depth than the equivalent ballasted track and therefore allow maximisation of clearances in existing tunnels, and reduction in tunnel bore diameter for new-build. Due to the alignment fixity of concrete track, structure gauge is reduced and controlled when compared to ballasted track.

- Viaducts

Restricted access to long viaduct structures means that the low maintenance requirement of slab track systems is beneficial. Reduced dead load of the slab track structure compared to ballasted track, can also lead to savings in the capital cost of structures.

- High speed lines

Construction in concrete slab track ensures maximum availability of the line with minimum maintenance. This is a key issue on a network where “Red Zone” working is not permitted and all maintenance must take place under possession conditions. For high speed lines, concrete slab track avoids considerable rail head damage caused by turbulent air flow lifting ballast from the track bed.

Comparisons between ballasted track and the equivalent slab track forms need to overcome politics and negative perception. The industry needs a truly impartial voice if the culture is to change and allow alternative track forms to be evaluated for their engineering and commercial performance.

Britpave is a not-for-profit trade association comprising members of the UK construction industry. Members include consultants, suppliers, manufacturers, universities and specialist contractors. Within Britpave task groups have been set up to focus on particular market sectors: Road, Rail, Airfields, Specialist Applications, Environment, Soil Stabilisation. Participation in the task groups is open to all Britpave members.

Since 2000, Britpave has been promoting the use of slab track on the UK rail network. The Rail Task Group is made up from members of Britpave and comprises representatives from concrete and equipment suppliers, rail contractors, manufacturers, academic institutions and consultants. It is concentrating primarily on developing the markets for concrete slab track and guided bus. Arup provides impartial advice to Britpave to ensure objective consideration of the technical, economic and operational issues surrounding the application of slab track.

Britpave's work to promote slab track has included lobbying parliament and senior rail officials, and arranging workshops to bring the technical specialists, installers and suppliers together with client organisations. Britpave does not support or favour any one manufacturer's products or system. The objective is to draw together cross industry expertise and experience for the benefit of the UK construction and rail industries.

The most recent initiative undertaken by the Rail Task Group has been the development of a series of documents to support the case for the use of slab track on the UK rail network, and inform the UK rail industry about the technology and products on offer. The aim is to ensure that alternative track forms are fully evaluated and an engineering solution designed. In 2003, Britpave's Rail Task Group commissioned two scoping studies, prepared by Arup, to explore the implications of slab track in terms of safety and building a commercial case to justify selection of track form for a project.



Slab Track
Safety: A scoping study



Slab Track
The commercial case: A scoping study

Following this work, Autumn 2004 saw the publication of Slab Track Development: Guidance on relevant standards and sources of information, again prepared for Britpave by Arup.

Slab Track Development
Guidance on relevant standards
and sources of information

Slab Track Development:
Guidance on relevant standards and sources of information

This latest report has been developed as an aid to designers and draws on Arup's experience in designing the concrete track slab on major projects such Channel Tunnel Rail Link and West Coast upgrade work.



Balfour Beatty slab track installation on Crewe-Kidsgrove line

In 2003 Arup carried out the design of the concrete slab structure for the Balfour Beatty embedded rail installation at Crewe-Kidsgrove. The project ran to exceptionally tight timescales. This necessitated innovative design solutions. However, to ensure acceptance of the design by Network Rail, the structural design of the slab and transition elements was also conservative. Arup feels there is scope to

optimise the design of slab track structures irrespective of the rail support, and standardise the approach to simplify the approvals process.

Design of slab track for the Network Rail infrastructure currently requires compliance with a large number of disparate standards and codes of practice. This latest Britpave slab track publication provides a reference source listing relevant standards for all aspects of slab track design. The guidance sets out the relevant available standards and procedures that should be used, and highlights areas where standards are currently unavailable and engineering decisions have to be made on a case by case basis.

The document has been written as a forerunner to a proposed series of technical guidance notes to be published by Britpave. Each will concentrate on a particular area of slab track design. The aim is to build the technical guidance into a design manual for slab track. Ultimately Britpave will put forward this technical design manual as a standard, ensuring consistency throughout the industry. The first four technical guidance projects are currently under development:

1. Geotechnical investigations, foundations and drainage design;

addressing aspects such as laboratory testing and site investigations, soil structure interaction and stiffness modelling, and sustainable drainage solutions.

2. Loading;

will consider adoption of existing bridge loading standards for application to slab track design.

3. Noise and vibration;

will deal with ground borne noise and vibration as well as air borne noise. The available slab track systems will be discussed particularly with reference to their acoustic performance and scope to mitigate ground borne noise and vibration. This last aspect is of key importance in design for track sections in tunnel, viaducts and bridges.

4. Maintenance, monitoring, control and inspection.

will address the maintenance requirements giving suggested recommendations for maintenance regimes for various forms of slab track and describe transition arrangements.

Where UK and European rail standards exist, the technical guidance will reference these. Where additional guidance is required, the technical guidance will discuss the issues and give recommendations to assist the designer.

There are two significant projects in the planning and design stage for which slab track may bring significant benefits: Crossrail, with its extensive tunnel sections sensitive to ground borne noise and vibration; East London Line with reuse of existing tunnels with restricted headroom and clearances, and long sections of viaduct. Slab track could be designed for these schemes to offer:

- Low maintenance requirements, high availability;
- Consistent track quality and retention of design alignment;
- Improved gauging and clearances;
- Reduced dead load;
- Fixity of alignment;
- Extended track design life;
- Noise and vibration control.

Projects that involve construction of significant lengths of new track, outside the constraints of the track renewals regime, or under blockade conditions, provide the ideal opportunity to adopt innovative and technologically advanced engineering solutions. These technologies have been proven and developed for over thirty years in Europe and Japan. The future must see the implementation of more concrete slab track on the UK rail network, to keep pace with track performance requirements.

Biographies:



Heather Ceney is a chartered civil engineer specialising in railways both in the UK and overseas. She has a particular interest in innovative and alternative track technology, including ballastless systems. She has been a member of the Britpave Rail Task Group since 2000 and has chaired the group since early 2004. She is a Senior Engineer with consultant Arup and has previously worked for British Rail and Deutsche Bahn AG.

David Bateman is a chartered engineer and Fellow of the Institution of Civil Engineers with considerable railway construction and maintenance experience. He has been involved in new railway construction for important projects such as Jubilee Line and Heathrow Extensions for London Underground and Channel Tunnel Rail Link. He is currently head of track engineering for Arup and has worked for British Rail, Railtrack/Network Rail and Nederlandse Spoorwegen.