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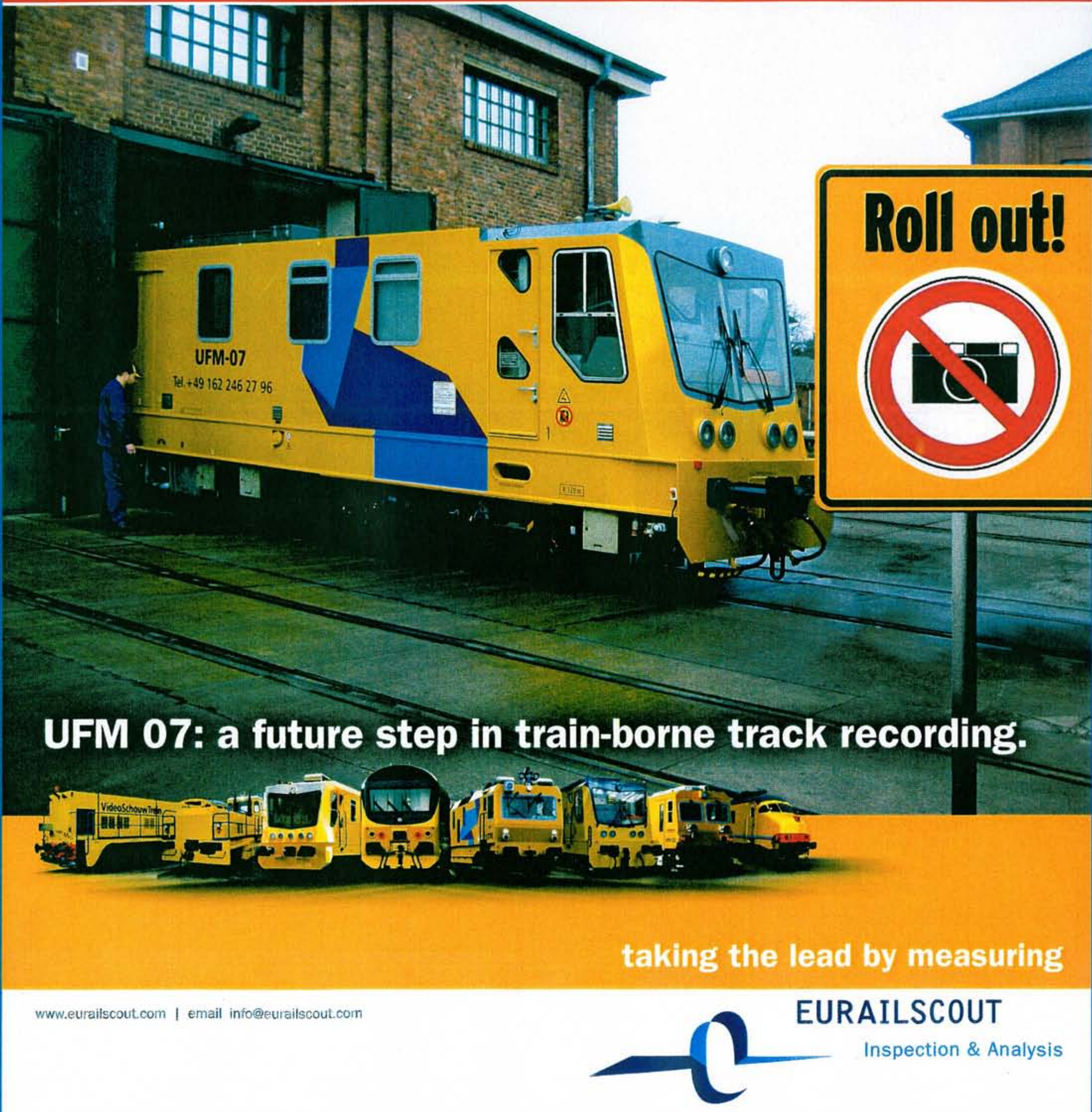

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UFM07

To meet the rising demand and qualifications for track geometry measurements Eurailscout introduces its new universal measuring train UFM07.
For the basic setup the train is utilised with systems for track geometry measurement i.e. track gauge, vertical profile (top), horizontal profile (alignment, shift), super elevation (cant), twist (arbitrary base, ORE twist), track quality numbers, standard deviations etc. (both inertial and chord parameters), according to EN 13848.
Additional systems for corrugation and catenary measurement and video inspection will be integrated during 2008, in order to be able to offer the full range of contact-less track quality parameters.
www.eurailscout.com

The Coradia Lirex train for Stockholm – the world's longest articulated multiple unit for urban/suburban regional-express services *see Page 38*

Durflex – a new track-bed system

Durflex is a new system for constructing track beds. It reduces operating costs and emissions, without introducing any fundamentally different or novel railway technologies.

1 Introduction

Noise (including structure-borne noise) is increasingly becoming a problem for the railway on account of statutory requirements, and noise barriers (particularly in residential districts) can be considered as no more than a partial solution. Against this background, the new track-bed system presented here is pursuing the objective of optimizing ballasted track. This is one way of tackling the problem of noise and structure-borne emissions at source and also of bringing down the operating costs and life-cycle costs of the railway tracks.

The traditional track systems that are still used most frequently worldwide today include ballasted tracks, in combination with either timber, concrete or steel sleepers. With these track types, however, the bed of ballast does not have a rigid particle structure. Ballast has no problem with the static element when it comes to dispersing the loads induced by passing trains, but the dynamic loading, that trains also cause, leads to noise emissions and vibrations. Changes in the particle structure of the ballast are the result. The ballast's sharp edges become blunt and, gradually, it is completely rearranged. That is why ballast needs to be tamped and put back into shape every four to six years, which are further operations that also cause noise, vibrations, interruptions to railway services and costs and which eventually lead to the final destruction of the ballast.

All this explains why there was such great interest when the research partnership of Frenzel-Bau, Bayer MaterialScience and Hennecke presented Durflex, its innovative track-bed system, to the general public for the first time at the start of April 2007. To begin with, this system was only applied to a short test section of track, with the main aim of testing and optimizing the machines and materials before the system was inserted into the chosen pilot section of track between Hamburg and Hanover in June 2007.

The conventional stages of track replacement on the test section near Uelzen were carried out by the Schweerbau company as part of a planned renewal project and were completed without any sort of problem. The work done by Schweerbau involved:

- ▷ removal of the old track,
- ▷ removal of the old ballast and the substructure,
- ▷ insertion of the new substructure,
- ▷ insertion of the new drainage mats,
- ▷ distribution of the new ballast, and
- ▷ laying and tamping of the new track.

After that, the new track was formally accepted.

It is important to stress at this stage that the whole sequence of operations up to acceptance of the track can be carried out:

- ▷ using familiar construction methods, and
- ▷ with mechanized techniques already very widely available.

There are thus no problems with migrating to new technologies, and the time required for all the named operations remains within the established orders of magnitude.

Once the track has been accepted, there now comes a new step – the insertion of foam into that part of the ballast intended to dissipate loads. The material used is a PU foam called Bayflex. The planning aim is to have this phase of work fit 1:1 with


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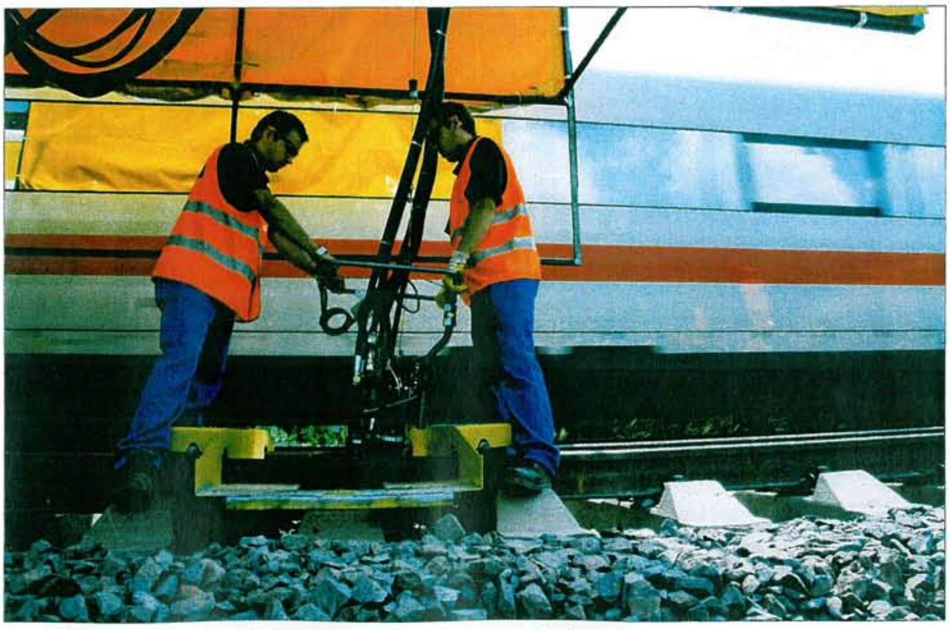

Fig. 1: High-pressure applicator machine applying raw material

Fig. 2: The foaming result seen under a glass sleeper

Fig. 3: Insertion of the drainage mats

Fig. 4: Prototype of the foam-applying train

the overall cyclical advance rates of track relaying.

Under the load of a passing train, the ballast/foam system yields and, once the train has gone by, it returns to its original position. The individual ballast stones are not rearranged, but keep their initial position for a long time, thereby eliminating the need for corrective tamping and also extending the service life of the track. A further advantage is that a faulty lie of the track is less likely to evolve, which, in turn, leads to fewer breakages of sleepers or rails. On the whole, Durflex achieves a significant improvement in the availability of the railway network and its efficiency.

The Durflex track-bed system could be described as the first "quasi-slab" one that very significantly reduces both structure and air-borne noise. Further, it needs only a very short time to produce it, the production process is economical, and it can be operated with little maintenance. Another of Durflex's advantages is that the system can be inserted in either new track beds or existing ones.

2 System structure

Durflex is a track-bed system in which the cavities between the ballast stones in the load-dispersing zones are completely filled with flexible Bayflex foam. The formulation is poured between the ballast stones in liquid form (Fig. 1). This liquid then reacts to form an elastic foam, which expands to occupy a multiple of its original volume and elastically fills the cavities in a durable manner (Fig. 2). In addition, a rubber drainage mat needs to be inserted under the ballast and this acts as both an insulating and separating element (Fig. 3).

Working on the knowledge accumulated from the numerous series of tests during the development work, a high-pressure applicator machine from Hennecke, which was modified specifically for this project, was installed in a railway container provided by Deutsche Bahn (Fig. 4).

This machine is fed with the appropriate PU components directly from large tanks. The chosen mixing head for these PU components is one with a three-way deflector (Figs. 5 to 7). The three-way deflector achieves an optimum mixing of the raw material prior to its injection into the ballast. A Wintronic control module was enhanced and adapted specifically for the project. This control unit sets the formulation for online batch production – which means that it is possible to influence the starting time for the reaction between the liquid Bayflex input materials. This facilitates ensuring that different types of ballast bed are completely filled with foam. In addition, this control module is able to manage and record the amount of foam applied per sleeper.

3 Practical test

Im June 2007, a 330-metre-long test section of track filled with Durflex foam (as just described) was created on the main railway line between Hamburg and Hanover in Lower Saxony. This line carries mixed traffic, including heavy freight trains (with axle loads of up to 25 tonnes) and fast passenger trains (with top speeds of up to 200 km/h, Fig. 8). All those involved in the project expected a confirmation under practical conditions of the very good preliminary results obtained in the laboratory as regards stability and the reduction in air and structure-borne noise. That is indeed what happened.

Fig. 5: Conditioning

Today, after more than 30 million tonnes of loads have passed over this test section of track, the situation is as follows:

- ▷ The track bed is in a very good condition;
- ▷ The emission of vibrations has been reduced by approximately 40%;
- ▷ The lateral resistance is eight times higher than for a normal ballasted track, and
- ▷ Air-borne noise has been reduced by at least 2 db.

4 Concluding summary

Contrary to an opinion frequently voiced, the technology of railway tracks resting on a bed of ballast is not one that has reached the end of its development potential.

The Durflex trackbed system today already satisfies all the requirements of an efficient, modern means for laying track, without causing any incompatible technical departure from existing systems. It does not in any way impair the safety of people, goods and the environment. In its approach to the further development of ballasted track, Durflex offers an alternative to slab track in several highly interesting aspects.

The fact that the EBA (Eisenbahn-Bundesamt, German Federal Railway Authority) gave its approval for a test on a railway line carrying mixed traffic and with top speeds of 200 km/h shows clearly that the tests performed and the evidence produced (but especially the very idea underlying the track-bed system) have led to that authority being convinced.

The dependability of positional stability has been demonstrated in a long-term [single-]

Parameter	Ballasted track	Durflex®	Slab track
Laying time	Short	Slightly longer than for ballasted track on account of the extra time needed for the foaming process; no curing time required	Long, very long setting times for concrete
Repair concept	No problem	No problem	Time-consuming
Special engineering procedures	None	None	Numerous, for points, bridges and inserts, EBA approvals required
Flying ballast in tunnels	Problematical	None if the entire track bed is filled with foam	No ballast
Recycling	No problem	No problem	Labour-intensive
Costs of site security / supervision of works	Low	Only marginally higher than for ballasted tracks	Very high on account of the long time needed for completing the track
Outlay on surveying	Low	Low	Very high
Lateral resistance	Low	Very high	Very high
Ballast application beyond the ends of the sleepers	≥ 40 cm	≥ 25 cm thanks to the high lateral resistance	Not necessary
Compressive stress on the track formation	Very high	Low, possibility of doing with a sublayer	Low
Thickness of track bed Thickness of load-bearing layers	30 cm / 35 cm 30-50 cm	Reduction possible thanks to better load distribution (must be calculated first)	Overall structural height higher than for ballast or Durflex
Stress under sleeper	High	Significantly lower, possibility of laying shorter sleepers with a smaller contact surface (must be calculated first)	Depends on the particular system
Filter stability at interface with soils having similar grain structures	No, only achievable with special measures (such as insertion of a sublayer)	Yes, no special measures required if subsoil has adequate load-bearing properties	Always requires special load-bearing layers as a foundation, expensive and time-consuming
Quantity of ballast	Large	Less, since less ballast is needed beyond the ends of the sleepers and depth of bed is also less	–
Width of the ballast bed	Large	Narrower, since less ballast is required	Concrete slab, less width required
Heat-insulation effect of the ballast	Low	High, no need for frost-protection layers (provided this is documented)	–
Settlement	Considerable, in both the ballast and the substructure	None, or at most in the substructure only	None
Noise emission	High	Low, possible to do without noise barriers	Very high, hard reflection surfaces
Possibility of retrofitting cable ducts in the side path	Usually only possible if the track formation is widened, (for instance by enlarging an embankment or by erecting supporting structures); acquisition of land may be necessary.	Possible without any additional measures given the narrower width of the track bed (installation of electronic interlocking systems)	–
Vibrations in the substructure	High	Very low and it may thus be possible to do with protective measures for the substructure	High
Planning permission required for conversion work	No	No, since only additional quantities of environmentally-compatible building materials are used (cf. BEVAR report)	Planning procedures and approvals absolutely essential
Vibrations	High	Low, low-cost installation on bridges	High
Risk of pollutants contaminating the track bed	Possible	Generally impossible	–
Development of cavities	Very problematical	None	Rigid system, problems at transitions
Reaction to temperature effects	Track buckling possible	Track buckling impossible	Large temperature stresses built into the system, impact on service life
Conversion of the track bed to alternative systems	–	Can be done very quickly with the existing large machines	Very costly and time-consuming, long track closures, high additional operating costs, need to make extensive adjustments to timetables

Table 1: Comparison: ballasted track, Durflex® and Slab track

Figs. 6 and 7: Application of raw materials

Fig. 8: The finished track

sleeper test at the MPA Braunschweig. In this test, the maximum elastic deformation measured on the sleeper next to the rail was 0.3 mm. Moreover, there was no evident sign of material fatigue or material damage after five million load cycles.

There were calls for tests to be carried out into the durability of the track-bed system. They took the form of freezing-and-thawing cycles and also tests of the system's behaviour in embankment and liquid fires and were performed at the MPA Braunschweig. The first of these were carried out with at a cycle rate of 25, determined by the EBA and simulated a temperature difference of 40 Kelvin. The test piece showed no changes worth mentioning as a result of these particular tests. The tests with the embankment and liquid fires led to the conclusion that no damage, no other changes and no propagation of the fire were to be expected. The target set for safety, durability and protection of the environment has thus been attained.

5 Prospects

The further development of the Durflex track-bed system ought to continue in the light of the good results obtained with it so far. The work still to be done includes:

- ▷ optimizing the individual components,
- ▷ possibly changing the sleeper material from concrete to plastic,
- ▷ determining the oscillation components in the system scientifically,
- ▷ investigating surface bonding with a view to reducing the amount of fine dust blown up by turbulence,
- ▷ developing a lower noise barrier to be installed close to the track, and
- ▷ optimizing the ballast grading line.