

Innovation boost in track maintenance

The developments in track maintenance on show in Münster at iaf 2017 were fully dedicated to INNOVATION FOR YOU.

► The International Exhibition for Track Technology “iaf” is the world’s largest of its kind. It provides the ideal forum for presenting innovations in track maintenance. Four years have passed since the iaf was last held. Since then, so many developments have been made that it is fair to speak of a boost in innovation. However, the innovations are not an end in itself. They are based on the analysis of the needs of railways, infrastructure operators and the operators of track maintenance machines.

In addition to new developments in machine technology, such as the electric operation, this article focuses on the rapid evolution of the entire machine industry. The topics range from digitisation and automation to ergonomic design and ecology, training and service, and the further development of maintenance technologies in this field.

ELECTRIFYING TRACK MAINTENANCE

At the Convention of ÖVG (Austrian Society for Traffic and Transport Science) held in Salzburg in September 2015, track maintenance machines with hybrid drive technol-

ogy were introduced for the first time. Under the E³ brand, a continuous action 4-sleeper tamping machine and a ballast management system were operated. The machines can be powered with the electricity from the overhead line, meeting the requirements of the DB2020+ corporate strategy of Deutsche Bahn (German Railway). The strategy aims at promoting a sustainable, strategic development in the interplay of economic, ecologic and social aspects [1]. The hybrid machines have been designed to reduce emissions, increase energy efficiency and lower noise.

Measurements undertaken as part of a master’s thesis [2] focussed on the noise emitted by diesel operation and electric operation.

In idle mode the reduction in the tamping machine section was 6.1 to 7.9 dB (A), in the stabiliser section it was 2.0 to 2.9 dB (A). During work in electric operation, a reduction of 4.6 dB (A) was measured in the tamping machine section at a distance of 7.5 m.

Another machine from the E³ series, the Unimat 09-32/4S Dynamic E³ universal tamping machine, was supplied to the track contractor Krebs Gleisbau AG as early as in 2016. For this machine model, a 10-year con-



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tract has already been concluded with SBB. For winning this contract, ecological aspects were crucial. From 25th November 2016 to 10th March 2017, the electrical performance data of the machine were analysed. During this time, the machine was operated electrically for 110 hours and consumed 44,420 kWhr (energy recovery deducted already). Powered via the diesel engine, the machine would have consumed 12,548 litres. This results in cost savings of more than € 100 per hour in electric operation and enables CO₂ to be reduced by 31,5 tonnes in total.

ELECTRIC DRIVE FURTHER EXPANDED

The machine design with hybrid drive is further expanded. One example is the Unimat 09-4x4/4S E³, a universal tamping machine for fully electric operation and diesel-electric operation, i.e. in diesel operation, a diesel-electric drive is available. For operation in tunnels, the machine is fitted with a PURITECH filter system. The new vibration drive of the tamping unit provides the following benefits:

- increased energy efficiency
- precise control mode
- faster response characteristic
- more compact design
- further increases in process reliability

FIG 1: The new Unimat 09-4x4/4S E³ universal tamping machine has been designed for fully electric or diesel-electric operation



VEHICLE WITH BATTERY TECHNOLOGY

The HTW 100 E³ catenary maintenance machine is operated completely differently (fig. 2). Using the diesel drive, the machine travels to and from the work site. On the work site, the machine is powered electrically. For this purpose, the machine is fitted with accumulator units, designed for two shifts. During the journey using the diesel drive, a generator charges the accumulators. In addition, the braking energy is used to charge the accumulators. External power supply via a shed socket is possible as well. Benefits of battery working mode:

- the exact amount of energy required for a certain task is used
- no emissions during work
- the machine works quietly and is suited for night-time operation
- unrestricted operation in tunnels

Further interesting details on the machine: To control the machine, a speed controller function can be used. During measuring runs, it ensures more precise results. When the battery power level has reached 30%, the automatic start of the diesel engine is recommended. The diesel engine is equipped with a particulate filter.

The HTW 100 E³ is equipped with many work units to ensure a high level of productivity during inspection, maintenance and installation of the overhead line: column lifting platform, railway loading crane with work basket, contact wire and carrying cable holding device, earthed pantograph, workshop cabin, and measuring equipment for the contact wire position.

TAMPING AND STABILISING IN NEW DESIGN

The aim of track maintenance is to produce a durable, high-quality track geometry. Tamping and stabilising in combination with precise measuring systems have made it possible to reach this aim to a large extent today. Plasser & Theurer tamping units have been continuously further developed since the introduction of the non-synchronous uniform-pressure tamping technology in 1953. Today, they are the standard in development [3]. New control technology for vibration and multiple-sleeper tamping complements the well-proven hydraulic squeeze technology, which ensures uniform squeeze pressure underneath the sleepers.



FIG 2: The new HTW 100 E³ catenary maintenance machine is equipped with batteries for electric working operation

ROTATION SPEED MODULATION FOR TAMPING UNITS

The rotation speed modulation makes it possible to change the vibration frequency during tamping in a controlled manner.

At a higher frequency (45 Hz), the tamping tines penetrate highly compacted ballast beds more easily. During squeezing, the optimum frequency of 35 Hz is used. When the tamping tines have been raised, they vibrate at an idling frequency of ≤ 28 Hz. The vibration drive of the eccentric shaft ensures a constant vibration amplitude of ± 4 to 5 mm. This is crucial to achieve a high tamping quality and process reliability.

Good experiences have been gained with the rotation speed modulation technology. The reaction forces from vibration and penetration resistance are reduced. Wear on the tamping units is further reduced. Due to the good experiences with the reliability of the units, the warranty period for new tamping units and following a general overhaul of tamping units has been extended to cover 24 months or a maximum number of 500,000 tamping insertions (with and without rotation speed modulation) [4].

GRADUAL 2-SLEEPER TAMPING

In highly compacted ballast beds, the tamping tines of multiple-sleeper tamping machines must meet a high level of penetration resistance. The new development for 2-sleeper tamping units is a major improvement. Split in longitudinal direction, the tamping units are lowered gradually. This

gradual technology significantly reduces the number of tamping tines penetrating the ballast at the same time. As a result, the penetration resistance is reduced. Gradual lowering causes hardly any loss in performance. In hard ballast beds, gradual tamping enables the working speed to be increased significantly compared to standard 2-sleeper tamping.

TRACK STABILISATION WITH IMBALANCE REGULATION

Dynamic track stabilisation has become indispensable in track maintenance.

Track stabilisation following tamping is crucial to ensure optimal and durable work results. This technology has been a success for four decades. More than 900 machines operated in 45 countries demonstrate this [5].

The effect of track stabilisation is shaped by the stabilisation frequency, vertical load, working speed and the dynamic impact force. The first three parameters are modified during machine operation. The impact force is determined by the eccentric flyweights. The required settlement of the track is controlled by the levelling system; modifications of the vertical load regulate the longitudinal level. However, the imbalance affects the track settlement the most. This is why the DGS can be equipped with an adjustable imbalance enabling the track settlement (and the levelling of the track) to be regulated by adjusting the imbalance. This is of particular interest for track sections, in which the vertical load does not suffice to »



FIG 3: The new 8x4 tamping unit



FIG 4: The Italian State Railway RFI will receive a fleet of Plasser & Theurer's Unimat Combi 08-275

regulate the track position. Moreover, the improved adjustment benefits buildings requiring particular care. When the machine stops, the imbalance is immediately reduced to zero. Therefore, there is no need to reduce the frequency. Resonance vibrations are avoided.

UNIVERSAL TAMPING MACHINES

When tamping turnouts, it is crucial that the tamping tines reach as many areas as possible. To ensure this, the tamping units of the "4x4" series have been developed. They are fitted with individually tilting double tines and designed as Split Head units, with one unit half to the left, and one to the right of the rail. Each tamping unit half is fitted with four tines, hence "4x4". The units are used on cyclic action

08 machines and continuous action 09 machines (fig. 3).

UNIMAT COMBI 08-275

The Unimat Combi was developed for the operation in the regional sector and for spot fault repair. In Germany, the machine model is known as Unimat Sprinter. The Unimat Combi 08-275 for the Italian Railway Infrastructure Company RFI is a universal tamping machine with ballast profiling trailer (fig. 4). The Unimat Combi 08-275 exhibited in Münster was the 16,000th machine to be manufactured by Plasser & Theurer. This "multipurpose tool" combines the following technologies: tamping machine for plain track and turnouts, integrated ballast plough and sweeper brush, complete inertial track geometry measuring system. Its

modern design is exemplary for machines of this kind. Following extensive testing of a sample machine, RFI decided to acquire a large number of machines of this model. One machine from this series is in E³ design. It will be the first machine to be operated using direct current from the overhead line system.

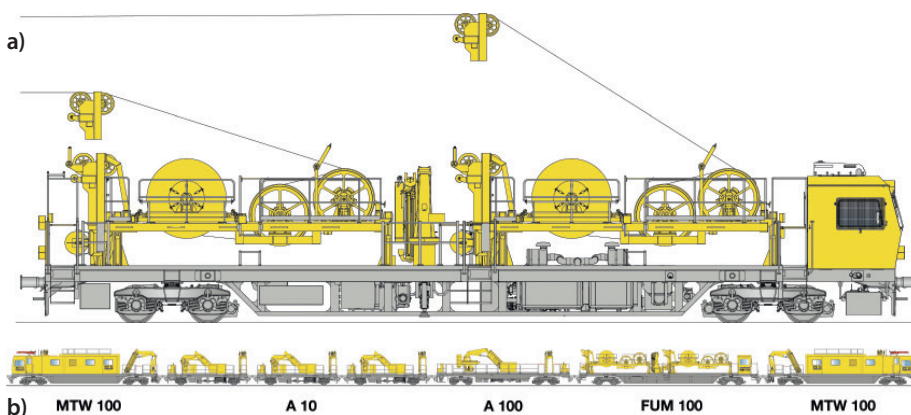
OVERHEAD LINE INSTALLATION WITH TOP QUALITY

THE PREMIUM PROGRAMME FOR OVERHEAD LINE INSTALLATION IN DENMARK

Under an electrification programme of Banedanmark, 1,500 kilometres of new overhead contact lines will be installed in Denmark by 2026. For the overhead line concept Sicat SX of Siemens AG used on this project, a new concept for the installation and machine technology has been developed. Overhead line installation poses considerable challenges to be met by the machines used, such as the FUM 100.260 catenary installation and renewal machine in particular (figure 5). Both a RiM 80 contact wire with a nominal tension of 15 kN and a carrying cable of aluminium alloy with a nominal tension of 30 kN must be installed in one pass. For both operations, a tolerance of +/- 5% of the nominal tension must not be exceeded. In addition, the FUM 100.260 must allow the installation of a RiM 150 contact wire with a nominal tension of up to 33.75 kN.

The FUZ catenary renewal train consists of several machines. Together, they form a system. The FUM catenary renewal machine

FIG 5 a und b: The FUM100.260 installation machine is part of the FUZ 100.273 catenary installation train



simultaneously installs the carrying cable and contact wire with final tension – and the proven high level of quality [6]. All machines are fitted with a work drive enabling them to be operated separately. In Denmark, the overhead line is installed in tight curves on superelevated tracks. Here, the machines' stability is of utmost importance.

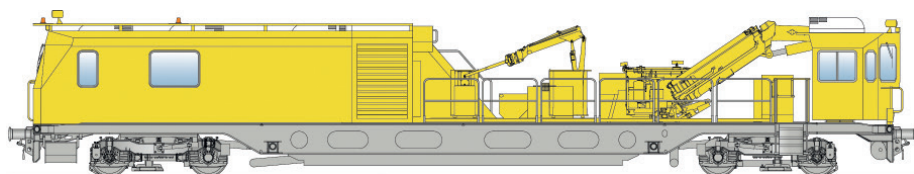


FIG 6: TIF-LAE tunnel inspection vehicle

MANUFACTURING QUALITY IN SERIES

Deutsche Bahn is striving for the standardisation of multi-purpose vehicles. Since 2014, DB Netz AG has received a standardised vehicle generation. Five carrier vehicles for measuring equipment were the first machines to be supplied. They have been operated successfully. A time-consuming quality assurance process confirmed the high production standards at Plasser & Theurer's Linz factory.

Despite many new challenges to be met, the project implementation confirmed Plasser & Theurer's outstanding manufacturing quality. The contract was based on specifications with 4,000 required items and seven quality gates to be met. All quality gates were passed successfully.

Martin Allweil, Head of Rail Vehicle and Machinery Fleet, DB Netz AG, Berlin, explains: "It is the core responsibility of DB Netz AG to provide around 400 railway undertakings with high-quality infrastructure and to ensure a high level of availability to enable them to operate it.

To perform the relevant maintenance works, we looked for machines that enable implementing a forward-thinking and demand-responsive maintenance strategy.

Plasser & Theurer fully implemented the complex technical requirements and developed a uniform vehicle design. Thanks to the use of standardised components in the differing vehicle types, we see savings potential in maintenance costs, spare parts stocking and training of the operating staff." [7]

ADDITIONAL CARRIER VEHICLES FOR DB

The principle of "quality in time" will also be applied in future: four tunnel inspection vehicles will be supplied. Comprehensively equipped, the TIF-LAE (fig. 6) makes it possible to work at several positions at the same time. Its equipment includes:

- roof platform with hydraulically folding railing
- hydraulic crane with 3.7 mt and a work basket suited for 170 kg
- hydraulic crane with 25 mt and a work basket suited for 330 kg

- sound-insulated cabins with vibration decoupling
- mounted parts for snow clearance

TECHNOLOGIES 4.0

THE SMART MACHINE

New research findings constantly shape the further development of track maintenance machines, enabling machines to be further improved.

The new smart technology is setting the course for Industry 4.0.

This has an effect on the machines' operation:

- The cabins' interior design has been adjusted to take advantage of the new digital opportunities (fig. 7).
- Touch screens make it easier to operate the machine. Menus provide access to all machine elements.
- Work sequences have been automated to a large extent.

DATA MANAGEMENT AND DIGITAL SERVICES

PlasserDatamatic and PlasserLiveInfo open new dimensions for the efficient management of individual machines and entire

machine fleets. Working parameters and status messages of the machines or even the direction of work or transport can be accessed easily using a tablet or smart phone. Networking enables digital services. The data acquired can be further processed to optimise the machines. Established in January 2017, P&T Connected Gesellschaft mbH, takes care of this.

SUMMARY

Considering the high number and wide range of innovations presented at the International Exhibition for Track Technology (iaf), it's fair to speak of a boost in innovation. This time, a particular focus was placed on the opportunities opened by digitisation. ◀

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FIG 7: Digital control elements and touch screens enable ergonomic operation and shape the cabin design on the latest generation of track maintenance machines

