

Systematic wrenching: automated, economic and user friendly

Technological development of wrenching, a core task during construction and maintenance of the track



Fig. 1: Fully electric precision wrench 30.76 E³

Source for all figures: Robel Bahnbaumaschinen GmbH

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The well-known power wrench has changed. New technologies are used for handling, drive and control; more and more machines are zero-emission. Due to their electric motor, they develop their high power with little noise and vibrations and thus protect the operator and environment. The new machines are more ergonomic, automated and economically efficient. They make it possible to document every single screw connection in detail. Taken together, this leads to a new dimension of wrenching on the track.

Power wrenches with the E³ symbol

For more than ten years, Robel has been increasingly looking to battery-electric drives for hand-guided machines. Various types are now established in the market, including compatibility across all battery versions. Since 2021, these machines have been designated E³ (Economic - Ecologic - Ergonomic), which was initially introduced to railway construction by Plasser & Theurer and which

stands for economically efficient, environmentally friendly and ergonomic solutions for working on track.

Fully electric, intuitive precision wrenching

The fully electric precision wrench 30.76 E³ (Fig. 1) presented at iaF 2022 achieves a high level of work efficiency: the battery with a capacity of 2300 Wh enables up to 4000 wrenching operations. This equates to about 1200 m of rail and thus covers more than the scope of a normal work shift. If four machines are used simultaneously on the track, this means 2.4 km of track are tensioned, without the need for any recharging. Even after 1000 wrenching cycles, the efficiency of the battery does not reduce noticeably. Furthermore, the battery can be replaced quickly and easily if a higher performance or longer operating periods are required. If the wrench is not switched off manually, it will shut down automatically after four hours. The maintenance-free brushless DC motor with an output of 7.5 kW as well as the controller are supplied by Robel's partner company Vogel & Plötscher.

On start-up, two presses of the button, which are required on purpose, start the digital components. These simplify operation and make the operation more precise. Despite the diverse uses, operating elements and display are clearly designed so that even semi-skilled staff achieve the specified results. In the end, only two fingers are required to operate the machine. The control is intuitive; the clear display supports the work steps. Several languages are available to support universal usability. The fully electric precision wrench is self-learning. It bases the tightening torque on previous wrenching operations and controls the output via speed and torque. The machine detects defective bolts, broken spring clips and damaged threads via the load curve. If required, the operator can shear off seized nuts and bolts without any additional effort. This is done very simply: The machine responds at the press of the button and either loosens the bolt (or nut) as intended or shears it off - at the first attempt. The high force required (Fig. 2) by the machine is neither noticed nor heard.

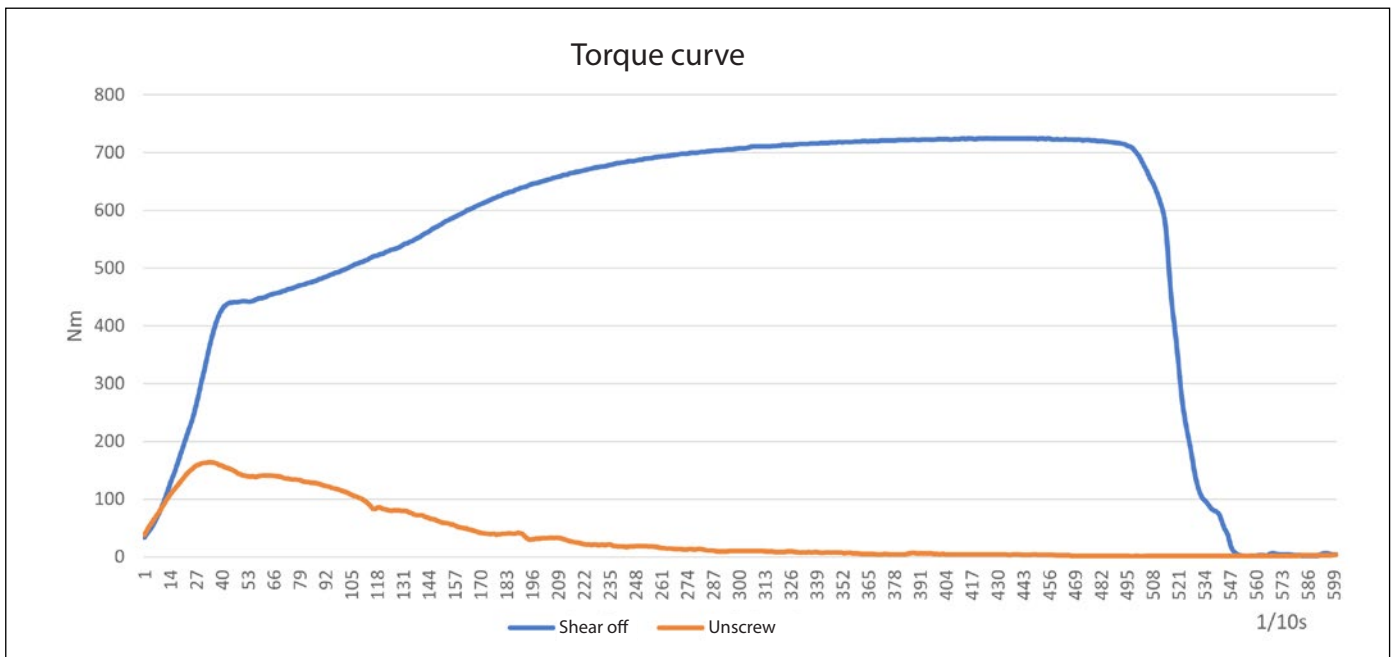


Fig. 2: Comparison: Curve of the torque applied by the machine when loosening a screw connection and when shearing off a screw in a K-type track (torque over time).

The ergonomics start even before the actual work. The carefully balanced machine with a weight of about 80 kg plus one or two detachable batteries of 16 kg each is lighter than a comparable machine with a combustion engine. Four operators can quickly set it on the track using the folding handles; an anchor point/lifting point is available for crane loading. The operator handles can be individually height-adjusted. In transport position, with the frame pushed together, the machine can be loaded onto a Euro pallet (Fig. 3). In working position, the front part of the machine can be extended in stages, and the weight transfer relieves the operator noticeably. Transverse bogies and outriggers are available for all track gauges. Using the transverse bogie, the wrench can be moved to the other rail by the operator without an aid. The machine is ready for operation at the press of a button. Two LEDs illuminate a large work area brightly and without glare.

GPS documented wrenching result

The hydraulic precision wrench 30.73 PSM, optionally with electric motor or petrol engine, is equipped and can be operated largely in the same way as the 30.76 E3 model described above. Both types provide consistently high wrenching precision, i.e. a consistently precise tightening torque. The type of track can be selected on the display as can the wrenching sequence (alternating inside / outside of rail, left / right rail). This is all shown on the display; the operator follows the graphic (Fig. 4). As an option, the measurement data together with the GPS position of the respective screw connection can be documented. The machines intended for this have a GPS receiver. The generally acces-

sible GPS location data used is so accurate that the position of each sleeper and thus, in combination with the wrenching sequence, each individual screw connection can be clearly identified. Skipped, spinning or otherwise defective or failing bolts are recorded in the report. In addition, integrated sensors show faults, if any.

Documentation, Guideline 824.5050 and traceability

Digitisation of the wrench is not an end in itself; there is a more important background: Nowadays, it is essential for many types of

work on a track that the tasks and results are documented in detail. In this way, every screw connection is completely traceable; verifiable performance protects against future claims. Appropriate records provide proof, if required, that it is not a faulty or too tightly bolted connection that is responsible for sleeper damage or sleeper failure.



Fig. 3: In transport position, the machine fits onto a Euro pallet.



Fig. 4: The display shows the wrenching sequence inside / outside of rail, left / right rail.

As part of the “Concrete Sleeper Quality Initiative”, Deutsche Bahn AG (DB) provided detailed recommendations for the wrenching process as early as 2017. At that time, 78 % of the approximately 100 million sleepers in the DB network were made of pre-stressed concrete. In addition to quality assurance during sleeper production, particular attention is paid to handling and work during installation and maintenance. Insufficient monitoring of the applied maximum torque during tensioning of the rail fasteners can be a cause of cracks in sleepers [1]. Continuous checking and documentation of the applied torques has now been specified in DB regulation Ril 824.5050 [2]. It is a binding part of the contract for the contractor. In accordance with it, the torque has to be tested at the start of work and for test wrenching operations with a warm machine and with the torque wrench. This has to be documented for at least 1 % of sleepers (hydraulic power wrench) and for at least 5 % of sleepers (mechanical wrench and machine without recording the tensioning torque). The compliance of these tests with the specification has to be recorded in writing as proof for every 20th or 100th sleeper. All this means additional expense and loss of time. The only time-saving alternative is a complete and fully automatic documentation of the wrenching process.

Cost and time savings due to digitisation

The 30.76 E3 and 30.73 PSM precision wrenches are exempted from the binding one-percent rule. The digital equipment records every individual wrenching operation reliably and automatically in the background. Thus, one of the specifications for exemption from the rule is met during wrenching without any additional effort. A second condition for the exemption is an annual calibration. This may be carried out by the manufacturer or - after training - by a member of the operating company's staff.

Maschinen N 30.73-0036				Verspannung Moment							
Nr.:	Feld / Spur:	Datum:	Zeit:	IST Nm:	Min:	Max:	Oberbau:	Wertung:	GPS Breite:	GPS Laenge:	Code:
1		03.11.2016	11:03:37	237	223	250	K	OK	N47.8462328	E12.9630676	7799
2		03.11.2016	11:03:42	236	223	250	K	OK	N47.8462323	E12.9630675	7884
3		03.11.2016	11:03:48	240	223	250	K	OK	N47.8462326	E12.9630663	8095
4		03.11.2016	11:03:53	234	223	250	K	OK	N47.846233	E12.9630648	8075
5		03.11.2016	11:03:59	240	223	250	K	OK	N47.8462325	E12.9630633	8328
6		03.11.2016	11:04:05	237	223	250	K	OK	N47.8462306	E12.963061	7133
7		03.11.2016	11:04:10	234	223	250	K	OK	N47.8462291	E12.9630581	7176
8		03.11.2016	11:04:16	236	223	250	K	OK	N47.8462285	E12.9630568	7345
9		03.11.2016	11:04:21	234	223	250	K	OK	N47.8462268	E12.963056	7409
10		03.11.2016	11:04:27	232	223	250	K	OK	N47.8462275	E12.9630561	7494

Fig. 5: The record of the wrenching operations carried out with data on the wrenching mode and the relevant GPS coordinates (location and kilometre marking in the header of the record)



Fig. 6: Power wrench 30.20 E3 can be adjusted for horizontal or vertical work

It is not necessary to take the machine to a workshop for this, as it can be calibrated in a few minutes on the track. This reduces any downtime to a minimum. On top of this it does away with any logistics costs. The gain

in efficiency is clear.

The precision power wrenches use a patented procedure for the direct electronic measurement of the tightening torque via the reaction moment of the torque sup-

port on the machine. The work result is fully documented as every individual wrenching operation with its characteristic data is recorded. In addition to the wrenching frequency, the machine also records kilometre marking (after a relevant starting input) and wrenching mode ("code") as well as - if required - the GPS coordinates (Fig. 5).

The structure of the record was developed jointly with DB. It contains an encryption line which rules out any possible manipulation and inconsistencies. The record is stored as a csv file on a USB stick. This is inserted underneath a water-tight screwed cap so that it is protected from adverse weather conditions. It does not have to be read out after each work shift. The data can be transferred easily for external storage, archiving and evaluation. The data stored on the USB stick can then be used in common programs such as word processing or spreadsheets and can also be used as proof of work.

E³ upgrades for proven power wrenches

The electric impact wrench 30.20 was one of the first battery powered machines of Robel and in railway construction in general.



Fig. 7: The newly developed transverse bogie of the 30.82 HKS with connection to the dead man's handle.



Fig. 8: The conversion kit for converting a machine with combustion engine enables battery-electric working without purchasing a new machine.

Today, the 30.20 E3 model can be adjusted horizontally so that it can be used ergonomically for horizontal wrenching operations as well (Fig. 6). It can also be fitted with batteries of three power levels.

In addition to the new electrical models, a large number of models with combustion engine continue to be used on the track. Machine types 30.82 RKS (since 2008) and 30.82 HKS (since 2017) are widely used. At about 92 kg, both machines have approximately the same weight. Type 30.82 has been updated to be more ergonomic, which can be seen from the height-adjustable handles.

These can now be folded to reduce the space required during transport. Another improvement is the well protected, bright LED illumination of the complete work area. The dead man's brake on the traverse bogie is new but already a legal requirement in some countries. This new traverse bogie (Fig. 7) and its connection to the dead man's handle (on the left in the picture) are designed in such a way that they can be used with all wrenches. During an update, the 30.82 RKS version was given an extended controller which is similar to that of the precision wrench and therefore easy to use. This controller can be retrofitted

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Benefits of electric track maintenance machines

In operation, electrically powered machines are very quiet and zero-emission. This makes them particularly suitable for use during the night, in urban environments and in tunnels. They are almost free from vibrations which noticeably relieves the operator from hand-arm vibrations. Electric machines are maintenance-free. There are no leaks of liquids, and there are no longer any activities related to their handling and storage which reduces time and costs.

However, the benefits of electrical operation go even further: It was, for example, not necessary to obtain an official permit for a night-time deployment of the 30.76 E3 precision wrench at the in-town station of Freilassing as the "noise pollution" was too low.

to existing machines. The 30.82 HKS power wrench on the other hand can not only be converted to battery-electric drive with DC motor with the conversion kit (see below or Fig. 8) within about half an hour but is also available with this drive fitted in the factory.

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Fig. 9: Due to the parallelogram suspension, the tool of the combined power wrench and drilling machine 30.83 always stands vertically.

Battery conversion kit:

From combustion engine to electric machine

Power wrenches for track construction are a long-lived asset. A large number of machines sold over the last few decades are still in use. Now, a conversion kit specially developed for these machines with internal combustion engine makes it possible to work with battery power without having to acquire a completely new machine. Thanks to standardised interfaces, it is possible to replace the petrol or diesel engine with an electric drive (Fig. 8). This is quickly fitted to the machine. It uses exactly the same attachment points as the existing drive and works with the existing coupling. This replacement is highly sustainable with regard to environment and resources and continues to use existing assets while improving the ergonomics. Although the electric drive has slightly different characteristics, this is regarded as very acceptable due to the smoother motor start and the effortless power development, amongst other things. Moreover, electric drives are obviously more energy efficient

than internal combustion engines, even when retrofitted.

The 30.83 power wrench and drilling machine can also be converted. It is used for the renovation of wooden and concrete sleepers and corrugated dowels. Due to the parallelogram suspension, the tool always stands vertically (Fig. 9). Moreover, like the machines of type 30.82, it can also be used for horizontal wrenching tasks, for example on fishplates. Special interchangeable tool sets are available which can be fitted in a few easy steps. This machine, too, can be powered with petrol, from the mains or, as described above, with batteries.

The following applies to wrenching - as well as to an increasing number of tasks on the track: The battery-electric drive on the track worksite becomes the rule when all areas of hand-guided machines are optimised with regard to economic efficiency, environmental sustainability and ergonomics. ■

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