Rotational planing - a new technology of rail machining for turnouts

Dieter Hartleben,

Until recently, grinding, milling and planing were the only technologies available for machining rails in track. All of these are also used by Schweerbau. These technologies are able to remove rolling contact fatigue as well as periodical longitudinal and transverse profile deformations. In the past two to three years, Schweerbau, a very innovative company, together with his partners developed two new rail machining technologies – rotational planing and high speed milling. Rotational planing is not only suitable for machining rails in track but especially for machining rails in turnouts. This paper will describe the rotational planing technology with reference to the subject of this seminar.

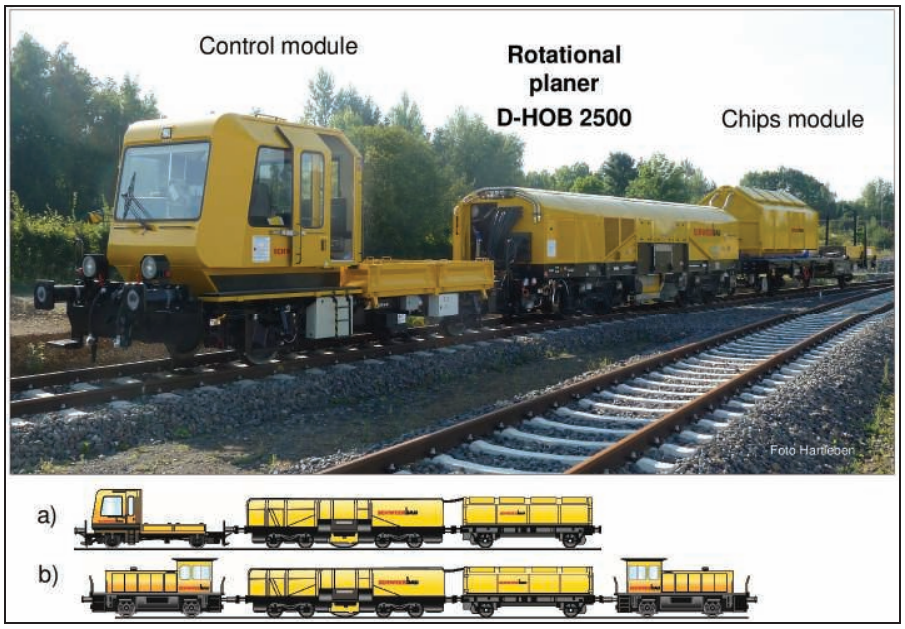
The rotational planer D-HOB 2500 is operated as a stand-alone machine complemented by a control module and a chips module (Fig. **1**).

Mode of operation of rotational planing

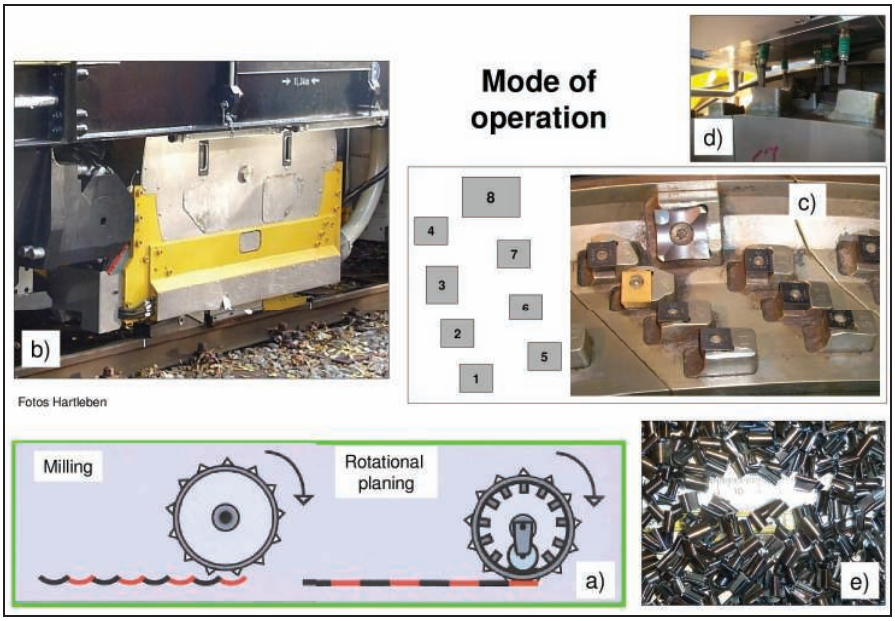
Rotational planing is innovative in two ways: first, in that it combines milling and planing into a single technology and second, in the further development of the previously used tools. Both milling and planing contributed their specific characteristics. Milling achieves a high amount of metal removal, produces an exact transverse rail head profile, requires a large diameter of the milling unit and achieves the target result in one or possibly two passes. Planing offers the advantage of a very high metal removal and – apart from a precise transverse profile – a very accurate longitudinal rail head profile. The new technology successfully combines the advantages of the two methods while eliminating disadvantages such as the restriction of both methods to predetermined fixed target profiles and the fact that planing occasionally is not within the clearance gauge. The rail is treated in synchronous machining operation. A first characteristic feature of this technology is that each of the tools performs a rotational movement that is superimposed by a short-time uniform movement parallel to the running surface of the rail. A second feature is that the target profiles can be continuously changed during the rotational planing process and that these changes can be made independently for both rails (Fig.**2**). The D-HOB working unit has a diameter of 1,400 mm, carries 32 cartridges and is equipped with 6 square inserts plus 1 rectangular and 1 radial insert per cartridge. As a whole, they describe the target contour of the rail head transverse profile to be produced.

The machining of the rail head extends from Z-21 via the comparison point Z-14 on the gauge side to Y+14 on the field side and then gradually decreases tangentially. Especially the second innovation for the first time permits a continuous machining of both full-rail and switch-blade profiles. The working speed is 300 to 1,500 m/h. The lateral scanning of the rail is made either on the gauge side or the field side. The machine has one working direction.

Chips are sucked off immediately at the rotational planing tool and are conveyed into a chip container. The planing process does not generate any sparks or dust. The tools are within the clearance gauge during



***1**. Rotational planer D-HOB 2500. a) mainline version, b) metro version*



***2**. Rotational planing – a new rail machining technology. a) mode of operation, b) rotational planing unit, c) rotational planing tools, d) positioning measurement devices, e) planing chips*

Technical specifications of the D-HOB 2500 (vehicle)

Drive compartment - rotational planing compartment - control compartment

Clearance gauge	G1 UIC 505-1, different Metro networks, e.g. LUL London
Number of wheel sets	4 traction axles
Axle load	12,0 t
Length over buffers	11.340 mm
Width	2.450 mm
High above top of rail	2.868 mm
Minimum curve radius	30 m
Maximum track gradient	40 ‰
Self-propelled travel speed	15 km/h
Max. travel speed (trailed)	60 km/h
Permitted track superelevation	180 mm

+ Diesel-electric unit
+ Soot particle filter
+ Compressor for chip evacuation
+ Tight couplings

***3**. Technical specifications of the D-HOB 2500 (vehicle)*

Technical specifications of the D-HOB 2500 (mode of operation)

Processing method	Computer-controlled synchronized rotational planing; free of dust, sparks, and interference with the clearance gauge
Rotational planing units	2 working units, Ø 1.400 mm
Tools	Unit equipped with 32 cartridges with square (6 tracks), rectangular (1 track), and radial (1 track) inserts
Operating speed	300 – 1.500 m/h
Metal removal	Top of the rail: 0,2 – 1,8 mm per pass Gauge corner: up to 2,5 mm per pass
Working area	Full gauge side - 7° field side
Rail head profiles	Machining of different rail head profiles on the out- and inside rail of a curved track. Continuous machining of different rail head profiles without interrupting the work process (e. g. between 60 E2 and AHC).
Chip collection	Chips are sucked off directly at the planing unit and transported to a chip container.
Min. working radius	35 m
Max. track gradient	40 ‰
Working direction	One direction

***4**. Technical specifications of the D-HOB 2500 (machining method)*

the machining process as well as during the transport of the machine. No track switching and signalling equipment must be removed. Per pass, up to 1.8 mm of metal will be removed on the top of the rail and up to 2.5 mm at the gauge corner.
Y et, it is also possible to remove as little as 0.2 mm.

Technical parameters of the D-HOB 2500

The D-HOB 2500 is a vehicle with two two-axle bogies and has a length of 11,340 mm. Vehicle clearance, axle loads and driving power were designed to allow working on the railway network of Deutsche Bahn (DB) as well as on various metro networks. The clearance gauge corresponds to G1 (UIC 505-1). The machine consists of a drive compartment (dieselelectric unit), a control compartment (electrical cabinets and control systems) and the rotational planing compartment including the chip suction system (Fig.**3**). The machine has a self-propelled speed of 15 km/h and can be towed at a maximum speed of 100 km/h. The machine-specific track geometry limits for the use of the rotational planer are as follows: working radius ≥35 m, track gradient ≤40%, permitted track superelevation ≤180 mm. The machine can be used without any constraints or special considerations related to the distances to the operated neighbouring track. The diesel engine of the machine is also equipped with a diesel particulate filter. The D-HOB 2500 has been approved by the German Railway Authority EBA and may also be used on high-speed lines of up to 300 km/h (Fig.**4**).

Scope of application of the D-HOB 2500 and performance

Preferably, the D-HOB 2500 is used for removing rolling contact fatigue and geometrical defects in the longitudinal and transverse rail head profiles of any sizes. While geometrical rail head defects increase the maintenance expenses for track and vehicles, impair the travelling comfort, and result in higher levels of noise vibration, there is a direct relationship between rolling contact fatigue and ensuring the operational safety. The machining of new rails is a further application. In general, rotational planing may used for initial, preventive and corrective machining of rails in tracks and turnouts. The machine can also be used in tunnels, on bridges, and in tracks with side contact rails. There are no limitations on working on sections with track switching and signalling equipment, check rails, or track covering.

The use of rotational planing is focused on work in turnouts. Why? First, because it is possible to machine both full-rail and switch-blade profiles. Second, because the technology is free of dust, sparks, and slag. For the first time, an almost complete machining of turnouts can be achieved. Only the frog, the area from the end of the wing rail to the neck, is left out.

The stock rail and the blade zone of the tongue are machined too. Rotational planing has several advantages over grinding: almost complete machining of turnouts, working area always from Z-14 (or to a limited degree from Z-10) to Y+14, and no sparks, no dust and no slag. It is not necessary to clean and lubricate the slide plates or roller bearings. That means extended machining areas, time savings and cost savings. Additionally, it makes a big difference that the work is usually done in one pass and not in 15, 20 and more passes. The machine is capable of machining single turnouts and turnouts in track connections. For each location of the turnout with respect to the position of the machine that could be encountered in actual practice, there is a specific program for machining the turnout. This means: Does one have to plane the main track or the diverging track? Does one have to start from the end or the beginning of the turnout? Or, does one have a right or a left hand turnout? (Fig. **5**)

The performance of rotational planing, expressed in finished turnout metre per hour, depends on the required metal removal, namely the metal removal on the top of the rail, and the size of the turnout. The specified accuracy of the transverse profile has

no effect on the performance.

The performance is e.g. 110 metres per hour for a turnout with a radius of 1,200 m of the diverted track, a radial deviation at the gauge of up to 3.0 mm and on a main track rated for a permissible speed of 200 km/h. In this case, the required metal removal may be up to 2.8 mm on the top of the rail.

Machining results accomplished with the D-HOB 2500

The results achieved by rotational planing as regards the longitudinal rail head profile, the transverse rail head profile, the roughness and the removal of head checks are demonstrated on the example of the rotational planing of turnouts (Fig. **6**). The conclusions are:

- Rotational planing ensures a very high metal removal per pass and an accurate transverse profile.
- Rotational planing satisfies the European norm EN 13231-3:2012 (the strictest in respect of the longitudinal profile) and the DB norm (the strictest in respect of the transverse profile) for rail machining.
- Rotational planing reliably removes head checks in one or two passes.

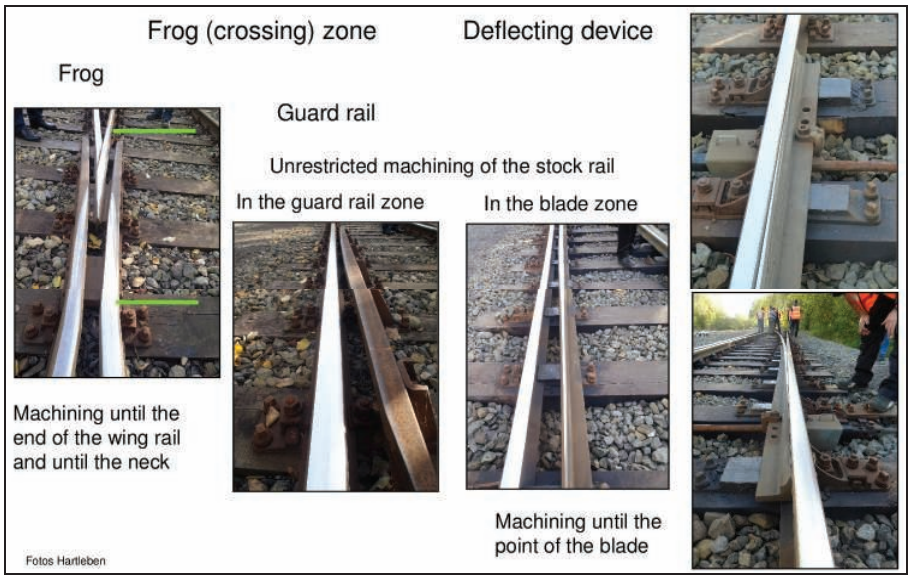
Apart from the measurement results, it should be pointed out that it is not necessary to protect the slide plates or roller bearings. The slide plates remain clean since no dust is generated by the planing process. During grinding, on the other hand, the slide plates are covered and must be cleaned and lubricated after grinding.

Furthermore, the machining of insulated joints poses no problem and does not require any special considerations. Finally, the beginning and the end of the machined sections are very fine, very smooth.

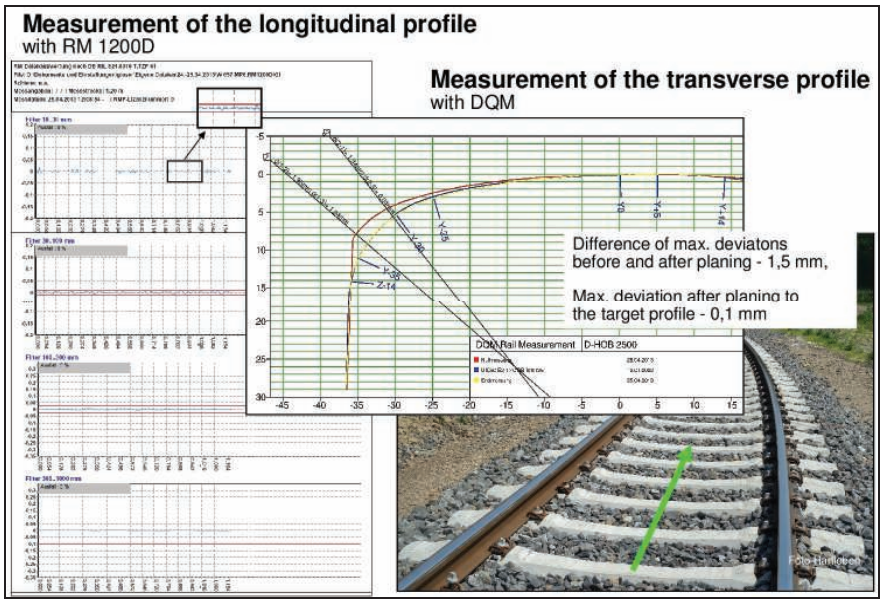
Concluding remarks

Schweerbau started working with the rotational planer in December 2012. After short introduction period since then, the machine is fully booked. The new technology proved successful from the very first day and is appreciated among the purchasers of these services. Therefore, Schweerbau last year decided to order a second machine. The D--HOB 2500 II received the approval of Deutsche Bahn on 21 May and started working two weeks ago (Fig. **7**).

We are sure: these two machines will be followed by more. The interest is clearly there. Various machine configurations around the D-HOB 2500 or the individual rotational planer unit are possible. ◀



***5**. Turnout machined with D-HOB 2500*



***6**. Measurement of the transverse and longitudinal rail head profiles after machining with D-HOB 2500*

***7**. D-HOB 2500 II*