



Technical specification

Tracks

Part 1: Vignole rails of 46 kg/m or more

DBS

918 254-1

Supersedes January 2014 issue

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1 Foreword

This DB Standard was prepared by DB Netz AG, Technical Dept. and Rail Maintenance Management, I.NPF 121(S), in cooperation with DB AG Quality Assurance (QA), FS.EI 21, and DB Systemtechnik GmbH, Materials and Joining Technology, I.T-IVI 3.

It supersedes DBS 918 254-1, January 2014 for track rails.

DBS 918 254-2 applies to switch rails and DBS 918 254-3 applies to running rails adjacent to the check rail.

2 Introduction

This DB Standard governs the qualification and quality assurance of Vignole rails of 46 kg/m or more. It specifies and supplements the requirements of Deutsche Bahn AG regarding manufacturing and delivery on the basis of DIN EN 13674-1:2011+A1:2017 as well as the applicable European standards and national regulations.

3 Scope

This DB Standard contains specifications for Vignole rails with a length-related mass of 46 kg/m or more under the working conditions of Deutsche Bahn AG. It shall be applied to rail manufacturers within the framework of quality assurance, manufacturer-related product qualification and for proof of conformity of the products/building materials used for the Deutsche Bahn AG network.

4 Normative references

This DB standard contains stipulations from other publications in the form of dated or undated references. These normative references are quoted at the relevant places in the text, and the publications are listed thereafter.

In the case of dated references, subsequent amendments or revisions to these publications only belong to this DBS if they have been incorporated by means of amendment or revision. In the case of undated references, the latest version of the referenced publication (including amendments) applies.

The following standards apply in addition to DIN EN 13674-1:2011+A1:2017.

DIN EN 13018	Non-destructive testing. Visual testing. General principles
DIN EN ISO/IEC 17025	General requirements for the competence of testing and calibration laboratories
DIN EN ISO 9712	Non-destructive testing – Qualification and certification of NDT personnel

5 Technical requirements

5.1 General

The following specifications apply notwithstanding/in addition to DIN EN 13674-1:2011+A1:2017 and refer to the ordinal numbers specified therein.

The information on the required minimum rolling lengths and permissible joint welds in the rail lengths from Guideline 820.2010 and DBS 918 255-1 also apply.

Within the framework of quality assurance, Guideline 120.0381 V15 in the currently valid version shall be applied.

5.2 Steel grades

Re 5 DB Netz AG only uses the rail steel grades R260 and R350HT in accordance with the equipment standard. Steel grades from DIN EN 13674-1 deviating from the above require a user declaration by I.NPF 121(S) for field testing. Steel grades not listed in DIN EN 13674-1 also require approval by the German Federal Railway Authority (EBA). The application for approval shall be sent to the following address:

Eisenbahn-Bundesamt
Außenstelle München
Referat 21
Arnulfstraße 9/11
80335 Munich, Germany

5.3 Production

- Re 7.3.3 The diameter of the straightening rollers for straightening the rails in head and base direction shall be at least 800 mm.
- Re 7.4.4 Rails with 60 E2 and 54 E4 profiles are always used in straightness/evenness class A/X. It is not necessary to mark the ends of the rails in green. At least one hot stamp per rail shall be painted over with white paint.

6 Qualification and quality assurance

6.1 Qualification of the product

- Re 8.1 Procedure
- Re 8.1.6 All tests shall be carried out by a laboratory accredited to ISO/IEC 17025. In justified exceptional cases, individual tests may be carried out in non-accredited testing laboratories following approval by I.NPF 121(S).
- Re 8.1.7 The reports on the qualification tests shall be sent to the QA department of Deutsche Bahn AG (Infrastructure Procurement, Supplier Management and Quality Assurance (FS.EI 21), Deutsche Bahn AG, Caroline-Michaelis-Strasse 5-11, 10115 Berlin).
- Re 8.1.8 The test reports shall be sent to the QA department of Deutsche Bahn AG as PDF files.
- Re 8.4.1 In the event of the contract being awarded, fatigue strength tests in accordance with Annex A of this DB standard shall be performed on each rail profile for each steel grade to be supplied. These tests shall be performed in addition to the tests in accordance with ISO 1099 within the first nine months of the contract period without additional qualification criteria having to be met. If the tests have already been completed within the last ten years, they may be waived. Additional tests shall be carried out in the event of significant changes to the manufacturing process.
The test reports shall be sent to the QA department of Deutsche Bahn AG as PDF files.
- Re 8.5.1 In the event of the contract being awarded, residual stresses shall be tested in accordance with Annex B of this DB standard on each rail profile for each steel grade to be supplied. These tests shall be performed in addition to the tests in accordance with Annex C within the first three months of the contract period without additional qualification criteria having to be met. If the tests have already been completed within the last ten years, they may be waived. Additional tests shall be carried out in the event of significant changes to the manufacturing process.
The test reports shall be sent to the QA department of Deutsche Bahn AG as PDF files.
- Re 8.9 For rail steel grades supplied by the manufacturer to DB Netz AG for the first time, the following tests shall be carried out on behalf of the manufacturer in the laboratory of DB Systemtechnik GmbH:
1. Trials with three rails on the wheel-rail test rig (100,000 rollovers)
 2. Chemical analysis, microstructure examination, tensile test, hardness test and impact test on another rail. The impact test shall be performed in accordance with Annex C of this DB Standard.

For this purpose, five rails, each 3.2 m in length from the same rolling length, shall be sent to the laboratory of DB Systemtechnik GmbH. The 3.1 certificate in accordance with EN 10204 shall be sent for the selected rail. The sample sections will be marked by the QA department of Deutsche Bahn AG in the factory. DB Netz AG reserves the right to perform further tests in accordance with DIN EN 13674-1.

After 3 years at the earliest, DB Netz AG may request that the above laboratory tests be repeated.

When testing steel grades in accordance with DIN EN 13674-1, roller rig tests are considered successful if the test rails do not show values for wear and RCF (rolling contact fatigue) more than 5% higher than the reference rails made of the same rail steel grade.

Test criteria shall be agreed with the supplier for new rail steel grades.

In addition, testing in DB Netz AG tracks shall be successfully completed. Testing will be supervised by employees of DB Netz AG and DB Systemtechnik GmbH and must satisfy the following boundary conditions:

1. A minimum of 480 m of test rails shall be installed on a line on which
 - the speed of the fastest trains is at least 160 km/h
 - the maximum axle load of the vehicles is at least 200 kN.
2. At least two thirds of the rail length shall be installed in a full curve.
3. At least 50% of the test rails shall be installed as an outer rail.
4. The duration of testing shall be equivalent to the time required for a traffic volume of 50 million gross tonnes worked (200 million gross tonnes worked for new rail steel grades).
5. The testing duration shall not be less than one year. For new rail steel grades, the duration shall normally be 3 years.
6. To achieve an evaluable test result, a damage depth of at least 0.8 mm shall be reached – on the basis of results of eddy current testing by means of an ECT system – on rails made of steel grade R260 (reference or test rails) and at least 0.5 mm damage depth on rails made of steel grade R350HT.
7. After the minimum damage depth has been reached, four samples shall be taken from the test and reference rails at each location with the maximum eddy current indication for a destructive follow-up examination.

When testing steel grades in accordance with DIN EN 13674-1, tests are considered successful if the test rails do not show values for wear and RCF (rolling contact fatigue) more than 5% higher than the installed reference rails made of the same rail steel grade. In the case of new rail steel grades, the test criterion shall be agreed with the supplier and appropriate provisions set out in a test contract.

Note on evaluation:

Wear and RCF are subject to natural variation. On the test rails, individual values of the test criteria (wear or RCF) may therefore exceed the 105% threshold compared to the mean value of the reference rails. However, if at least one individual value of a test criterion is above the limit of 105% of the mean value of the reference rails plus the threefold standard deviation 3σ of the criterion for the same rail steel grade, the test shall be regarded as having been failed. The standard deviation of the criteria is known from past experiments. The limit factors for wear and RCF determined in this way shall be communicated to the manufacturer prior to the tests and apply to all bidders until a new award is made. The limit factors differ for the tests on the wheel-rail test rig and the track test.

For the wheel-rail test rig, the mean wear area on all three test rails shall be determined by measurements on at least three cross-sections per rail.

RCF shall be determined on all three test rails using at least one sample per rail

For the track test (post-inspection of the samples), wear and RCF shall be considered standardized to 100 million gross tonnes worked. The wear shall also be standardized to a 1000 m curve for each measuring point (MP) in accordance with the following formula:

$$A_{\text{normV}}(\text{MP}) = A_{\text{istV}}(\text{MP}) * R(\text{MP}) / 1000,$$

whereby

$A_{\text{normV}}(\text{MP})$ is the wear area standardized to a 1000 m curve at a measuring point [mm²]; $A_{\text{istV}}(\text{MP})$ is the measured wear area at a measuring point [mm²] and $R(\text{MP})$ is the radius at the position of the measuring point [m].

The mean wear area shall be determined by measurements on at least ten cross-sections of the test rails and also on the reference rails.

RCF shall be determined on at least four samples. Samples shall be taken from different points on the curve with maximum eddy current signal.

6.2 Qualification of the manufacturer/supplier

Prior to the first delivery to Deutsche Bahn AG, suppliers must prove their ability to manufacture the rails to be delivered in accordance with the contract under the conditions of series production in the form of a manufacturer-related product qualification (HPQ) (see DB's list of products subject to quality inspection: Permanent way material). The HPQ shall be carried out by the QA department of Deutsche Bahn AG. The costs of the HPQ shall be borne by the manufacturer/supplier.

6.3 Quality assurance

6.3.1 General

Contractors shall be responsible for the quality of the delivery/service provided. In particular, they shall carry out the tests necessary for quality assurance or have them carried out.

6.3.2 Type and scope of the tests by Deutsche Bahn AG

The scope of the tests shall be based on the most recent versions of DB's list of products subject to quality inspection: Permanent way material and Deutsche Bahn AG's supplementary contractual terms for quality assurance. The scope shall be specified by the Quality Assurance department of Deutsche Bahn AG.

6.3.3 Test levels

Tracks are assigned to Test Level II in accordance with DB's list of products subject to quality inspection: Permanent way material. Within the framework of a supplier assessment, Deutsche Bahn AG's Quality Assurance department shall check the production and qualitative capability of suppliers and classify them in category Q 1, Q 2 or Q 3 if a contractual relationship exists with Deutsche Bahn AG.

The acceptance tests are based on the contractually agreed conditions, on DIN EN 13674-1 as well as on this DBS and the acknowledged rules of technology.

Statistical methods may be used to determine whether the quality conditions set out in the contract have been met.

6.3.4 Performing tests; test location and test equipment

If quality inspection/external monitoring is required in accordance with DIN 18200, this shall be carried out on the manufacturer's premises if no provisions to the contrary are contained in the contract or in the technical specifications. The manufacturer shall provide proof of the suitability of all test equipment used.

6.3.5 Testing within the scope of manufacturer-related product qualification

The results of the qualification tests can be approved by Deutsche Bahn AG's Quality Assurance department if they comply with the specifications made under Item 8 of DIN EN 13674-1.

Likewise, the automatic testing equipment in the production line can be approved by Deutsche Bahn AG if it complies with the provisions of the delivery specification agreed with QA.

7 Testing methods

7.1 Acceptance testing

Re 9.1.5 DB Netz AG requires a metallographic determination of the surface decarburization.

Re 9.3 The acceptance test gauges shall be inspected in accordance with the applicable DB drawings before initial use, but at least once a year, by Deutsche Bahn AG, Testing Equipment Quality Assurance in Chemnitz, T.TVI 54.

For the measurement procedures other than those stated in Annex E, the manufacturer shall provide proof of measuring equipment suitability. This proof must be approved by Deutsche Bahn AG. Please note: Acceptance test gauges including test certificate can also be purchased from T.TVI 54, Emiliestraße 45, 09131 Chemnitz.

- Re 9.4 The manufacturer shall provide proof of the suitability of the measuring equipment for any other measurement procedures. This proof must be submitted to Deutsche Bahn AG for approval.
- Re 9.4.1 Requirements for ultrasonic and eddy current testing
- Re 9.4.1.1 Irregularities determined by ultrasonic testing extending internally to ≥ 2 mm in length shall be detected by the applied testing system at the usual testing speed (recording limit).
- The procedure for ultrasonic and eddy current testing shall be laid out in a works-specific test instruction. These test instructions require recognition by DB Netz AG, Rail Technology Competence Unit, I.NPF 121(S). The personnel operating the equipment shall meet the qualification requirements of at least Level 1 in accordance with DIN EN ISO 9712 in the respective process. Furthermore, a testing center shall be established in accordance with GL 826.3000.
- Re 9.4.1.3 The test sensitivity described in 9.4.1.3 of the EN shall be specified for the test facility at the manufacturer's site and shall be clearly defined in the factory-specific test instructions to be drawn up in accordance with Item 9.4.1.1. The criteria for the recording limit and the admissibility limit shall be defined.
- Re 9.4.1.4 The test rails shall be used at the normal operating test speed at least every 8 hours or at the beginning of a shift and at each profile change to check that the system is in correct working order.
- Re 9.4.2.1 a) The defect depth of heat damage and burr-like imperfections, as defined in EN 10163-1, shall not be greater than:
- 0.30 mm on the running surface of the rail.
- Indentations or impressions made on the warm rail head shall not exceed 3 per 40 m.
- Re 9.4.2.1 b) Addition: Transverse grooves made on the cold underside of the rail base are not permitted.
- Cold damage is scraping in the longitudinal or transverse direction made on the cold rail. The defect depth shall not be greater than:
- 0.25 mm on the running surface of the rail.
- Cold defects shall not exceed 3 per 40 m, even if the limit depth in accordance with 9.4.2.1 is not reached.
- Cold defects that are completely removed after machining are not counted here. The maximum permissible number of defects according to 9.4.2.3 remains unaffected.
- Re 9.4.2.3 Addition: Only cold defects with defect depths up to 0.45 mm or raised defects may be machined on the running surface. On the remaining rail surface, all defects up to a depth of 0.6 mm may be machined. They shall be machined in the longitudinal direction of the rail in compliance with the permissible tolerances.

8 Ordering information

- Re 4a The following rail profiles will be ordered by Deutsche Bahn AG in accordance with the applicable DB drawings.
- 49 E5, log 49.10.0002
 - 54 E4, log 54.10.0002
 - 60 E2, log 60.10.0001
- Re 4c Profile class X applies to profiles 60 E2 and 54 E4.
Profile class Y applies to profile 49 E5.
- Re 4d Straightness class A applies to profiles 60 E2 and 54 E4.
Straightness class B applies to profile 49 E5.
- Re 4f, g, h Does not apply to DB AG

Annex A - Fatigue strength tests

The following specifications apply notwithstanding/in addition to DIN EN 14730-1:2006 and refer to the ordinal numbers specified therein.

Fatigue strength test perpendicular to the longitudinal axis of the rail

The tests shall be carried out based on Annex K of the DIN EN 14730-1:2006 standard staircase method, provided that the specifications do not contradict the characteristic of an unwelded rail.

Re K.4.2.1. The samples shall be produced from newly rolled rails; the rail surface shall be untreated. The peak-to-valley height shall be determined in accordance with EN ISO 4287: 1998 in the center of the sample over a measuring distance of at least 100 mm along the center of the rail base before the fatigue test. The mean peak-to-valley height (R_a) of the individual measuring distances and the centering of the individual measuring distances shall be documented.

Re K.4.2.2 The average fatigue strength shall be determined and documented. A minimum fatigue strength is not required. If the decision is taken not to determine a calibration curve, the force levels for each selected span shall be determined in such a way that the rail base edge stress is obtained in increments of 10 N/mm² for the theoretical moment per unit area of the nominal profile. The tests shall be started with the following maximum stresses:

R260: 400 N/mm²

R350HT: 400 N/mm²

Re K.4.2.2.3 The sinusoidal cyclic load shall be applied with controlled force.

Fatigue strength test horizontal to the longitudinal axis of the rail

The tests shall be carried out based on Annex K of the DIN EN 14730-1:2006 standard staircase method, provided that the specifications do not contradict the characteristic of an unwelded rail. However, they shall be performed with modified support conditions.

Re k.2.1 In addition, the rail shall be supported rotated 90° around its longitudinal axis. The inner and outer spans shall remain unchanged (see Figure 1/2). The supports as well as the force application points shall be designed according to the contour of the rail over the entire profile height, thereby ensuring positive contact. Instead of variant 1 (Figure 1), variant 2 (Figure 2) can also be used as an alternative. Conventional supports shall be used with the latter variant, whereby a surface is positioned at right angles to the web (base and head removed). Approval shall be obtained from I.NPF 11 (S) for other alternative support designs

The following applies to the inner span W : $150 \text{ mm} \leq W \leq 190 \text{ mm}$ and

the following applies to the outer span L : $1250 \text{ mm} \leq L \leq 1450 \text{ mm}$.

Re K.3.3 Notwithstanding the above, the strain gauge shall be attached centrally to the lateral rail base flank of the side facing away from the load.

Re K.4.2.1. The samples shall be produced from newly rolled rails; the rail surface shall be untreated. The peak-to-valley height shall be determined in accordance with EN ISO 4287: 1998 in the center of the sample over a measuring distance of at least 100 mm along the edge of the rail base before the fatigue test. The mean peak-to-valley height (R_a) of the individual measuring distances and the centering of the individual measuring distances shall be documented.

Re K 4.2.2.2 The average fatigue strength shall be determined and documented. A minimum fatigue strength is not required. If the decision is taken not to determine a calibration curve, the force levels for each selected span shall be determined in such a way that the rail base edge stress is obtained in increments of 20 N/mm² for the theoretical moment per unit area of the nominal profile.

The tests shall be started with the following maximum stresses:

R260: 400 N/mm²

R350HT: 400 N/mm²

Re K.4.2.2.3 The sinusoidal cyclic load shall be applied with controlled force.

Re K 4.2.2.5 The increase or decrease in the nominal stress at the edge of the rail base is 20 MPa.

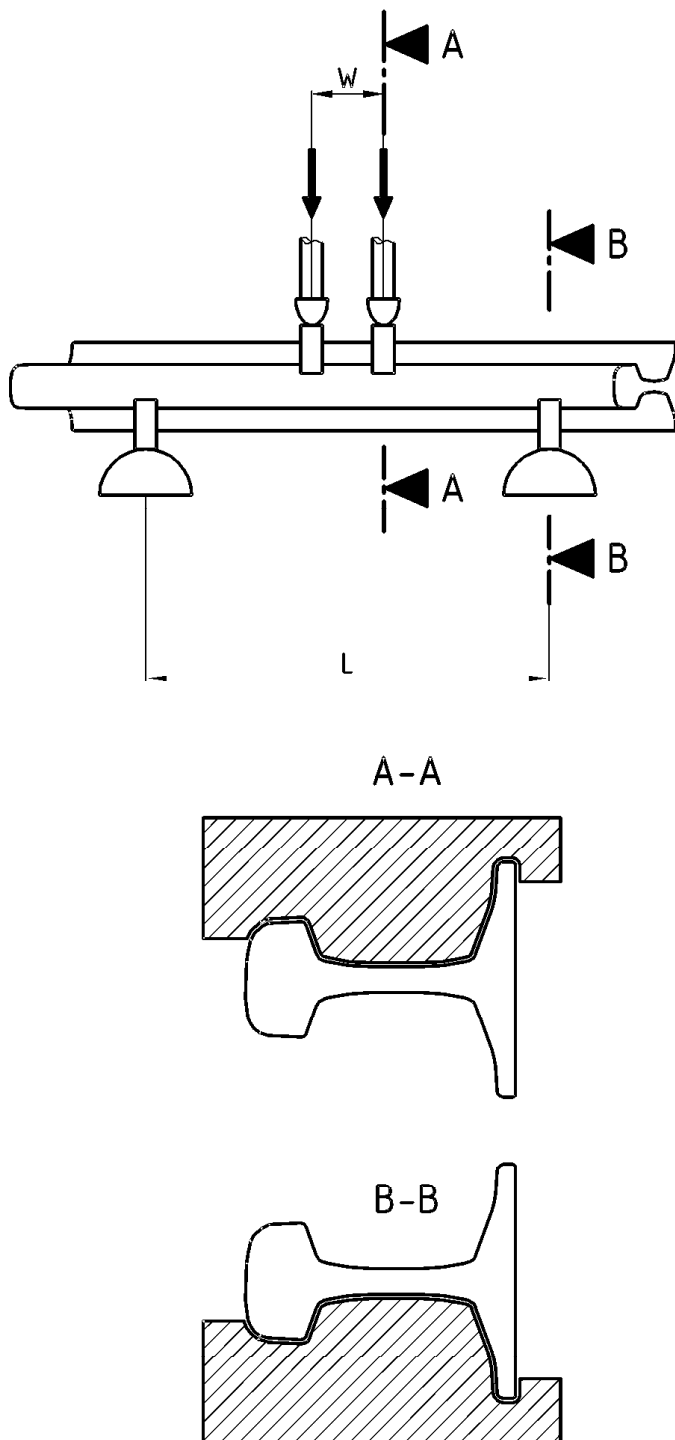


Figure 1: Schematic diagram of variant 1 of the test set-up for fatigue strength tests horizontal to the longitudinal axis of the rail

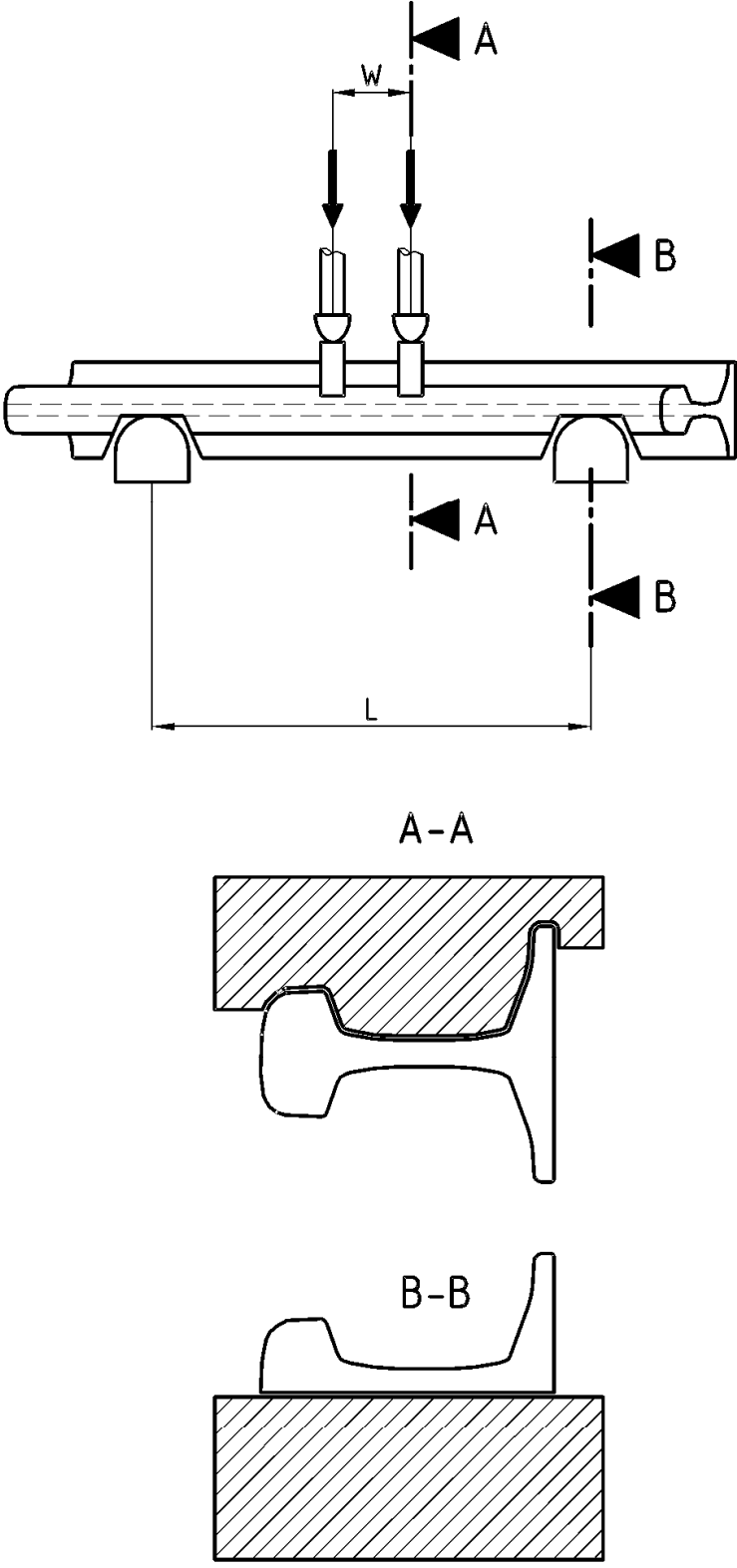


Figure 2: Schematic diagram of variant 2 of the test set-up for fatigue strength tests horizontal to the longitudinal axis of the rail

Annex B - Residual stress tests on rail cross section

The residual stresses shall be determined in accordance with DIN EN 13674-1. In addition to the examination of the residual stresses in the center of the rail base, the residual stresses in the longitudinal direction shall be determined in the same way at the points marked for the 60 E2 rail sections (Figure), 54 E4 (Figure) and 49 E5 (Figure) in the following sketches:

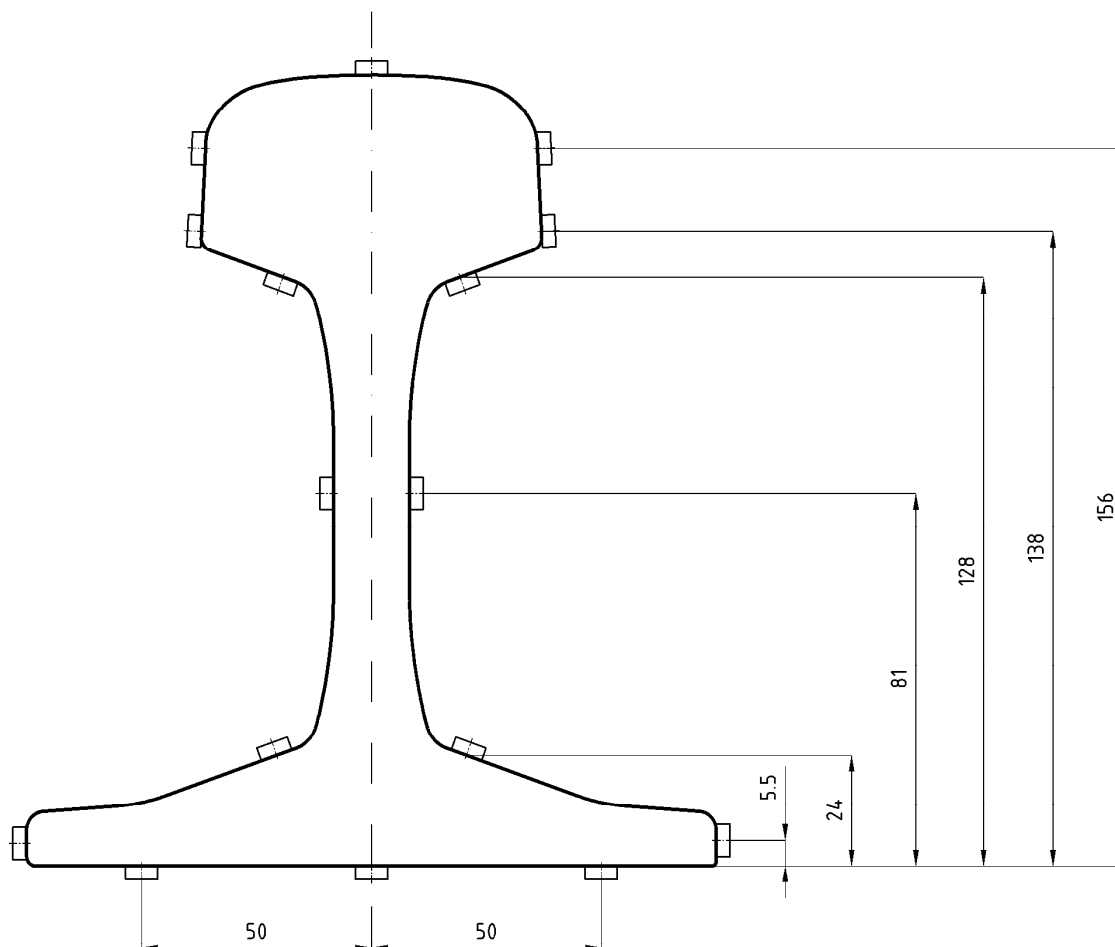


Figure 3: Positions of the strain gauges (box) for the residual stress test on profile 60 E2

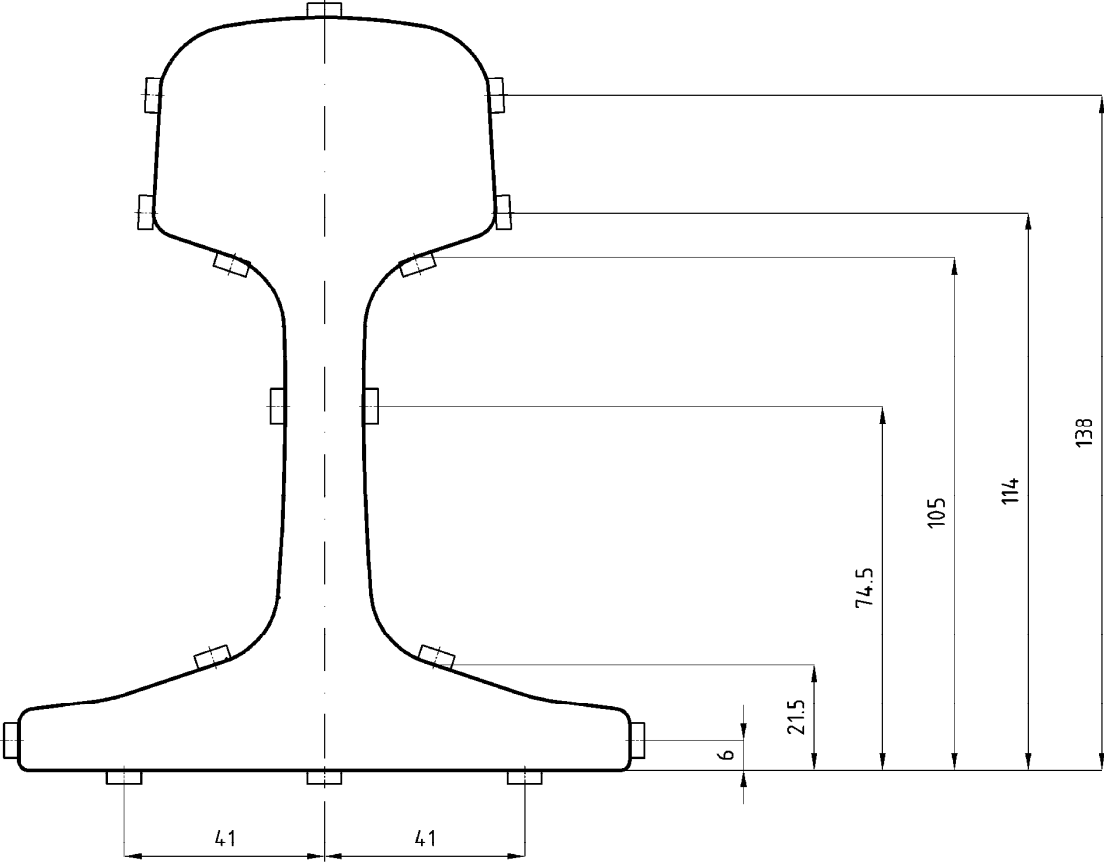


Figure 4: Positions of the strain gauges (box) for the residual stress test on profile 54 E4

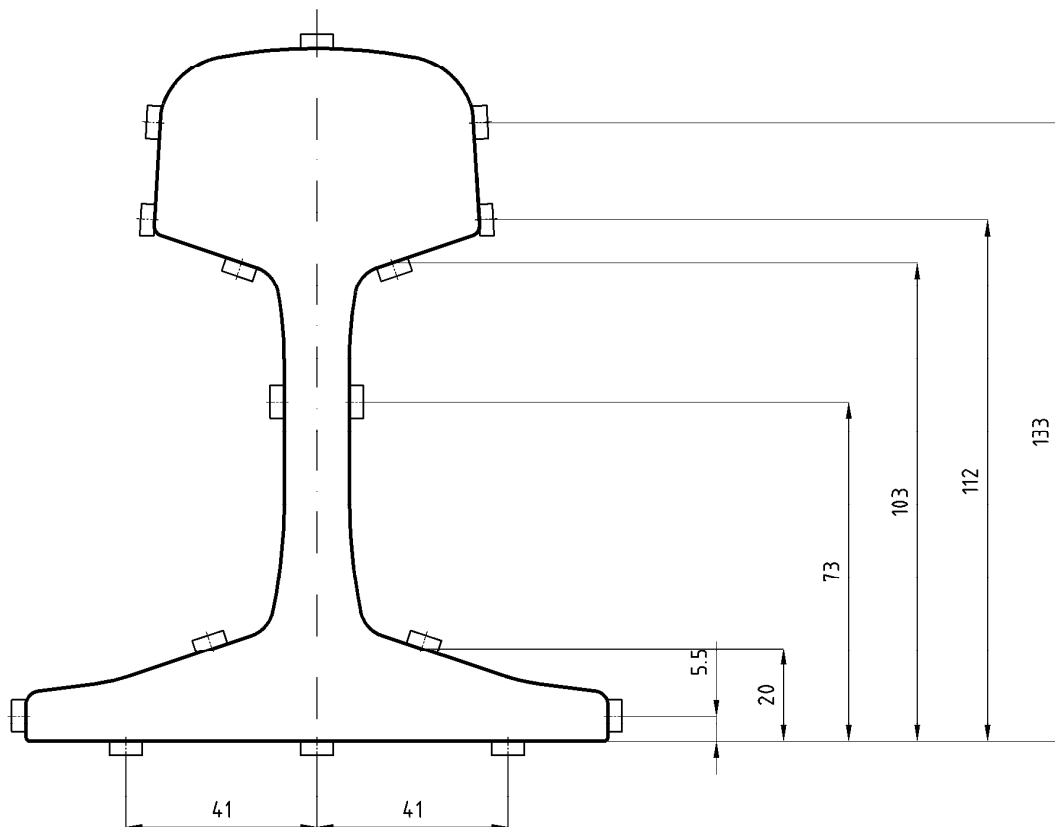


Figure 5: Positions of the strain gauges (box) for the residual stress test on profile 49 E5

Re C.2 The saw cuts shall be made using a low-stress cutting method with low cutting speed. Cooling shall prevent the temperature from exceeding 150°C.

Annex C - Charpy impact test

One set of impact test samples with a V-shaped notch shall be taken from both the rail head and rail base as shown in Figure 6. The Charpy impact test shall be performed at both room temperature and at -20°C. The notch shall be cut into the underside of each sample.

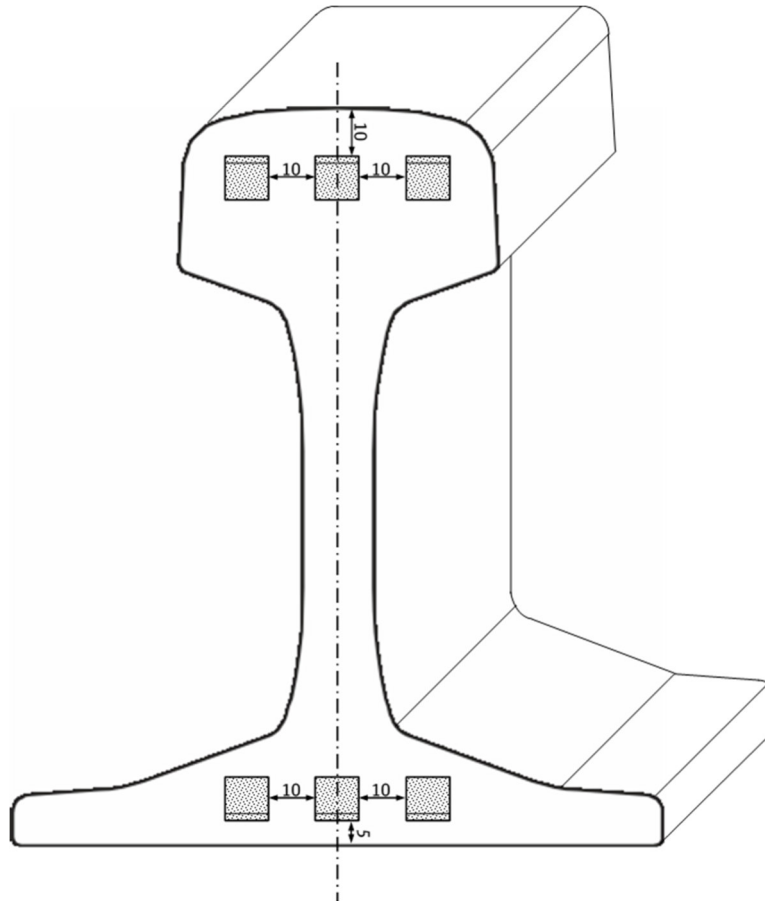


Figure 6: Diagram showing removal of samples for the impact test (V-shaped notch, dimensions in mm)