TECHNICAL SPECIFICATIONS FOR RAILWAY TURNOUTS

Finnish Rail Administration has confirmed these technical specifications 2446/731/06 to take effect on the Finnish state railway network from 1 January 2007. These terms shall be followed at procurements after this date.

These technical specifications replace the technical specifications 1420/731/03 dated 23 July 2003.

Technical Director

Markku Nummelin
1 General

The new turnouts for the rail types 54E1 and 60E1, to be purchased for the state railway network shall be delivered according to these technical specifications. These technical specifications define the requirements of mechanical turnout parts as well as the functional, material and dimension requirements of sleepers and bearers. The turnouts are:

- YV60-300-1:9 (Single turnout)
- YV60-900-1:15.5 (Single turnout)
- YV60-900-1:18 (Single turnout)
- YV60-5000/2500-1:26 (Single turnout)
- YV60-5000/3000-1:28 (Single turnout)
- SRR60-2x1:9-4.8 (Scissors crossover)
- YV54-200N-1:9 (Single turnout)
- KRV54-200-1:9 (Inside double slip)
- KV54-200N-1:9 (Non-symmetrical tandem turnout)
- TYV54-200-1:4.44 (Equal split turnout)
- TYV54-225-1:6.46 (Equal split turnout)
- RR54-1:9 (Diamond crossing)
- RR54-2x1:9 (Diamond crossing)
- SRR54-2x1:9-4.8 (Scissors crossover)

Requirements and definitions of European standard EN 13232 must be fulfilled.

Turnouts having a crossing relation of 1:9 or a sharper one are called short turnouts. Other turnouts are called long turnouts.

Turnout parts shall be designed for static axle loads according to the train speed (V) as follows:

- 60E1 turnouts
  - 300 (+10 %) kN, when V ≥ 100 km/h
  - 250 (+10 %) kN, when 100 km/h < V ≥ 120 km/h
  - 220 (+10 %) kN, when V > 120 km/h

- 54E1 turnouts
  - 250 (+10 %) kN, when V ≥ 120 km/h
  - 220 (+10 %) kN, when V > 120 km/h

Turnout parts shall be designed for highest permitted speeds as follows:

- Straight track of short 60E1 turnouts 220 km/h (+10 %)
- Straight track of long 60E1 turnouts 220 km/h (+10 %, fixed crossing)
- Straight track of short 54E1 turnouts 160 km/h (+10 %)
- Side track of short turnouts 40 km/h (+10 %)
- Side track of long turnouts 80 km/h (+10 %, 1:15.5, 1:18 turnouts)
- Diamond crossings 100 km/h (+10 %)

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All turnout parts shall be delivered for the temperature range -40...+50°C. Structures shall be designed in such a way that angles and holes accumulating snow and ice are so few as possible.

The life-time of turnouts based on gross tonnes passing along straight track, for 60E1 turnouts, shall be at least 450 million gross register tonnes, and for 54E1 turnouts, at least 300 million gross register tonnes.

The geometry, element lengths and bearer distribution of delivered turnouts, as well as the location of point machines and other equipment, are described in the track diagram of the turnout. A list of track diagrams is enclosed to these technical specifications.

The track gauge of turnouts is 1524 mm both on straight and side tracks, except for the bent switches of TYV (equal split) turnouts and KRV (inside double slip) turnouts, which have a gauge of 1534 mm. Track gauges have a manufacturing precision of ±1 mm. The gauge is allowed to change - except for the changes given in the track diagram - a maximum of 1 mm/m in 60E1 turnouts and a maximum of 2 mm/m in 54E1 turnouts.

Turnout parts shall work with concrete as well as wooden sleepers. All rail screw holes in turnout base plates shall fit exactly to the sockets of existing concrete bearers.

The rail inclination throughout 60E1 turnouts is 1:40; rails in 54E1 turnouts stand perpendicularly. The top surface of bearers is always horizontal.

Insulation joints are not included in the delivery, if not otherwise agreed. The insulation capacity of dry insulation joints shall be $50 \text{ M} \Omega$ and in rail $10 \text{ k} \Omega$ at 500 V DC. The dielectric strength shall be $\$ 4 \text{ kV/50 Hz}$ (5 x 1 sec/3 sec). The shortest insulation distance between the rail ends shall be 4 mm. Insulation joints shall be placed at the distance of 3.6 metres from rail joints. Insulation joints shall be suitable for CWR track.

2 Rails

Rails and tongue rails used in turnouts shall be of R260 quality in accordance with European standard EN 13674. In different parts of the standard normal rails, tongues and check rails are described. Turnouts shall be manufactured of 60E1 or 54E1 rails in accordance with track diagrams and the drawings appended to these technical specifications. However, the cross section tolerance of 60E1 rail head is ±0.3 mm. Rails of 60E1 1:9 turnouts shall be heat treated. The head hardness shall be in the range of 340...430 HB. Hardness test method for rails is specified in EN ISO 6506-1. Rails of longer 60 E1 turnouts and of 54E1 turnouts are not heat treated.

60E1A5 rails or alternatively 60E1A1 rails machined to have an inclination of 1:40 in rail head are used as a tongue rail in 60E1 turnouts. 54E1A1 rails shall be used as a tongue rail in 54E1 turnouts.
In all rails, only the innermost holes are bored (in 60E1 turnouts, at a distance of 230 \( mm \) 0.5 mm, and in 54E1 turnouts, 265 \( mm \) 0.5 mm from rail ends). The diameter of these holes is 30 \( mm \) 0.5 mm. Bored holes shall be bevelled.

If the delivery does not cover the entire turnout, middle area rails are not included in the delivery.

### 3 Fastenings

Spring attachments adapted to ribbed base plates are used in turnouts. Screws with special heads shall be of the type Hs 32x65 with a strength grade 5.6. M22 hexagonal nuts are used. These nuts shall be bonderized. The width across flats of nuts is 39 mm. Washers shall be used between springs and nuts. In places where normal spring fastening cannot be used, special clamping plates are used.

The compressive force of springs to the rail foot shall be 12-14 kN.

Stock rails of switches are fastened on the inside with springs installed inside the slide chairs or by them. The compressive force of a spring shall be 12-14 kN. The head of the stock rail is allowed to incline outwards by maximum 2.5 mm with the vertical force of 125 kN and the lateral force of 100 kN. The highest portion of the internal fastening shall be a minimum of 10 mm below the bottom surface of the tongue.

Stock rails of check rails can be fastened on the inside with springs which are mounted either inside or by the base plates or if there is enough room alternatively normal spring fastenings suitable for ribbed base plates. The compression force to the rail foot shall be 12 - 14 kN.

Fastening springs shall have smooth surfaces and no cracks, bulges, twists or other faults that could inhibit the use of the springs. Springs shall be marked with the last two digits of the year of manufacture and the badge of the manufacturer.

### 4 Turnout base plates

The delivery shall include all ordinary base plates with fastenings (fastening springs with possible screws, phosphatised nuts, washers, circlips and pads) needed between the front and back joints of a turnout, as well as all special base plates including fastening parts on the turnout area in accordance with the diagram, also in front of the front joint and in back of the back joint. If the delivery does not cover the entire turnout, ordinary base plates and their fastenings in the middle rail area are not included in the delivery.

Special base plates in the middle rail area (including fastening parts) installed towards the switches are always included in switch deliveries. Special base plates (including fastening parts) installed towards the crossing/check rails shall always be included in crossing/check rails deliveries.
Base plates which are mounted under obtuse crossings in double slip turnouts shall always be included in the delivery of switches.

Base plates may be roll-formed, forged or cast. The casting material shall be GGG 40.3. Roll-formed plates shall be of grade EN10025-S355J2G3.

The diameter of rail screw holes in base plates is 26 \( \text{\textmu} \) 0.5 mm.

The bottom surface of base plates shall be horizontal. The rail resting surface of base plates may be a maximum of 1.4 mm concave throughout the width of the resting surface. Convexity is not allowed. The upper and under surfaces of sliding plates shall be parallel and straight.

Turnout base plates are fastened to sleepers and bearers by R 170-p rail screws. Rail screws shall be included in the delivery only if the turnout is delivered installed on sleepers and bearers. Rail screws shall have a grade of 5.6. They shall be grooved when hot. Rail screws shall not be tempered or hot galvanized. The tightening torque of rail screws shall be approximately 250 Nm. Circlips (FE 6) of material 38Si7; however \( P_{\text{max}} \) is 0.035 %, in accordance with UIC leaflet 864-3V, 2nd edition, 1 1.1982, are used beneath the rail screws.

5 Pads

5.1 Pads between base plates and rails

There shall be flexible pads between base plates and rails. They shall be used on all sleepers and bearers, but not however under the moving parts of tongues and movable crossings, nor at possible movement stop bolts in 54E1 turnouts. Pads shall be manufactured in accordance with category 1 of UIC leaflet 864-5V, 1.1.1986, appendix 2.

Pads shall have corners that prohibit plates from moving along the length of the turnout. The thickness of pads shall be 6 mm in 60E1 turnouts and 4 mm in 54E1 turnouts.

5.2 Pads between concrete bearers and base plates

Pads between concrete bearers and base plates are included in the delivery only when the turnout is delivered installed on bearers. Cork rubber pads having a thickness of 4 mm shall be placed between concrete bearers and all steel parts (base plates, end and intermediate reinforcements, fastening plates of point machines and contacts). Pads shall be manufactured in accordance with category 1 of UIC leaflet 864-5V, 1.1.1986, appendix 3.
6 Switches

Definitions

a) Switch

A switch in a single turnout consists of two tongues, two stock rails, their mutual fastening and supporting parts, turnout base plates with rail fastenings under stock rails and tongues as well as end and intermediate reinforcements.

There are two switches in a double turnout.

b) Half set of switches

Half set of switches consists of one tongue, one stock rail, their mutual fastening and supporting parts and turnout base plates with rail fastenings under stock rail and tongue. End and intermediate reinforcements are not included in half set of switches.

c) Switch serial

There are two switch serials in a KRV turnout. One switch serial consists of four tongues, four stock rails, their mutual fastening and supporting parts, turnout base plates with fastenings under stock rails and tongues and end reinforcements.

Tongues in 60E1 turnouts are non-welded flexible tongues. 54E1 turnouts have flexible rail tongues. The gap of an open tongue in short turnouts measured at the tip of the tongue of turnouts equipped with clamp locking devices 170 " 2 mm and in others 160! 172 mm, except for TYV turnouts, where the gap shall be 140 " 2 mm when measured at the tip of the tongue. The smallest flange groove between a stock rail and an open tongue is 65 " 2 mm. In long turnouts, the gap at the tip shall be 143 " 2 mm, and the gap shall after this decrease evenly down to the smallest allowed flange groove of 65 mm, between the tongue and the stock rail. When the tongue is resting on the stock rail the force caused by the tension of the tongue and which is directed away from the stock rail, shall not exceed 300 N. The force towards the stock rail, caused by the tension in an open tongue, shall not exceed 300 N.

The inclination of rails of 60E1 turnouts 1:40 is realized in switches by leaning the stock rails on base plates and the upper part of the tongue either by using the profile 60E1A5 or by machining the leaning to the profile 60E1A1.

The tongues and stock rails of 60E1 1:9 turnouts shall be heat treated. The head hardness shall be 340...430 HB. Tongues and stock rails of longer 60E1 turnouts and of 54E1 turnouts are not heat treated.

Supporting clamps are delivered with one shaft and a single fastening. The following are used for fastening: M24 screws (strength grade 5.6), washers, wedge plates, ball plates and self-locking nuts (strength grade 8), which must
hold their locking ability after having been opened and tightened at least 20 times, and they shall have a 36 mm width across flats.

There shall be enough space (8 mm x 18 mm) for the electrical heating of turnouts in switch base plates and supporting clamps. Grooves needed for heating rods shall be machined to the tongues of 60E1 turnouts. Their depth is 6 mm, height 18 mm and the rounding of corners R6. The heating rod groove shall go round over the tip of tongue (R10). The lengths of heating rod grooves are defined in switch drawings. For tongues of 54E1 turnouts the heating rod grooves are made only by special order. Heating rods, heating insulation outside the stock rails and snow protection of bearers for switch point machine and end position detector are not included in the delivery if not separately mentioned.

The length movement of tongues and stock rails is hindered by the movement stops on two bearers between the tongue and the stock rail, their pivots have been fastened to tongues and heel parts to stock rails, or in 54E1 turnouts alternatively by pivots in base plates (Ø 34 + 0.5 mm / Ø 36 H11 mm), which fit into the holes machined on bottom surfaces of tongues and stock rails. M24 bolts with self-locking nuts (strength grade 8) are used to fasten movement stops. The bolts shall hold their locking ability after having been opened and tightened at least 20 times in sequence and the width across flats is 36 mm.

End and intermediate reinforcements shall have electrical insulation. The level of insulation shall under all circumstances be at least 10 k\(\Omega\) when the voltage is 500 V DC. The minimum insulation distance is 2.5 mm. The end parts of end and intermediate reinforcements must have provisions for fastening turnout point machines. The distances between reinforcements shall be 670 mm at the point machines.

Separate corner supporting plates are used in accordance with the drawings. They shall be fastened by using self-locking nuts (strength grade 8), which must hold their locking ability after having been opened and tightened at least 20 times in sequence. The screw wedges of corner supports shall have a tightening torque of approximately 180 Nm.

Cylinder bearing plates shall be installed on bearers as described in the drawings (generally on every third sleeper). Cylinder bearings shall always be included in the delivery. The cylinders shall lift the moving tongue 2-3 mm up from slide chairs. The closed tongue shall rest tightly on slide chairs. The cylinders shall have structure that does not require lubrication of axles/bearings.

In long turnouts, at the heel of tongues, the slide chairs shall be equipped with X-formed lubrication grooves across the gliding surface, from corner to corner. The depth of the groove is 2 -0,+1 mm and the width 10 -1 mm.

Machined corners shall be rounded and bore holes bevelled.

Beside the running edge of rails there shall be a vertical free space of minimum 50 mm to allow the wheel flange to move freely.
The connecting plates below the bearers for switch point machine and end position detector, at end and intermediate reinforcements, are included in the delivery of sleepers, not in the switch delivery.

Point machines, contacts, contact covers and spring mechanisms are not included in the delivery if not separately mentioned. The required machining and boring work, however, shall always be carried out in accordance with the drawings. Holes (Ø 34 H8 mm) shall be equipped with bushels (Ø 34 u7/ Ø 26 D9). The bushels shall be made of stainless steel and material AISI 304 or similar.

7 Crossings

Crossings shall be designed so that there is as little noise as possible when a wheel passes it.

Beside the running edge of rails there shall be a vertical free space of minimum 50 mm to allow the wheel flange to move freely.

7.1 Fixed common crossings

60E1 crossings shall be made of cast manganese steel according to UIC leaflet 866-V, 2nd edition, 1.1.1985. Joint rails of quality R260 shall be bond welded to the end parts. Alternatively, manganese steel can be replaced by special steel having similar properties. In 60E1 crossings, horizontal bolts which are joining the crossing parts are not allowed.

54E1 crossings are made alternatively according to the following points a)...c):

a) Crossings are made of cast manganese steel in accordance with UIC leaflet 866-V, 2nd edition, 1.1.1985. Joint rails of quality R260 shall be bond welded to the end parts.

b) The end part of crossings is made of full-profile rails and joint rails are welded to them. Full-profile rails, joint rails and wing rails shall be made of R260 steel.

c) The end part of crossings is made of forging and joint rails are welded to its ends which have been machined into rail-form.Forging, joint rails and wing rails shall be made of R260 steel.

Repair welding shall be possible in all crossings.

All crossing noses and wing rails of crossings, except for cast manganese crossings, must be heat treated in areas where wheels pass over them. The hardness shall be 360...425 HB. The heat treatment should primarily be fine pearlite treatment. It is possible to use explosion hardening in manganese crossings but it is not a requirement.

Possible horizontal screws shall be M27 screws (strength grade 10.9) and include self-locking nuts (strength grade 10), which must hold their locking ability after having been opened and tightened at least 20 times in sequence,
and they shall have a 36 mm width across flats. Because of the angle
differences between screws and wing rails washers, ball plates and wedge
plates shall be used, if necessary. Screws shall be tightened using a torque of
850 - 890 Nm, and the tightness shall be inspected one hour after tightening.
The diameters of screw holes must not exceed 29" 0.5 mm.

The wing rails in short turnouts shall be made elevated in order to optimize
wheel movement.

7.2 Fixed obtuse crossings

Crossing materials shall be identical to those mentioned in point 7.1. Other
rails than end and knee rails of manganese crossings shall be heat treated in
areas where wheels pass over. The hardness shall be 360...425 HB. Heat
treatment should primarily be fine pearlite treatment. It is possible to use
explosion hardening in cast manganese crossings but it is not a requirement.

The check rails of crossings shall be elevated 40 -1,+9 mm.

Fish-plate bolts in accordance with the crossing drawings are included in the
delivery of crossing.

Baseplates of obtuse crossings belonging to double slip turnout are always
included in the delivery of switches.

7.3 Movable crossings

Ends or end parts made of rail profiles or full-profile rails, forged end parts,
joint rails welded to their ends that have been machined into rail-form as well
as wing rails, are made of R260 steel. The movable point crossing can also be
made of manganese steel.

Repair welding shall be possible in crossings.

Ends of crossings and wing rails (if not made of cast manganese steel) must be
heat treated in areas where wheels pass over them. The hardness shall be
360...425HB. It is possible to use explosion hardening in manganese crossings
but it is not a requirement.

Point machines are not included in the delivery if not separately mentioned.
Fastenings, machining and boring that they require, shall always be made
according to drawings. Holes (Ø 34 H8 mm) shall be equipped with bushels
(Ø 34 u7/ Ø 26 D9).

Normal rails at movable crossings, including baseplates and fastening parts as
well as the reinforcements between these rails and crossings shall be included
in the delivery of crossings.

All special baseplates belonging to the crossing shall be included in the
delivery of crossing.
The distance between sleepers at point machines is 670 mm.

8 Check rails

33C1 check rail profile of steel grade R320Cr according to European standard EN 13674 is used as check rails. The upper surface of a check rail shall be 20 mm above the head of the stock rail.

Beside the running edge of rails there shall be a vertical free space of minimum 50 mm to allow free passage for the wheel flange. The flange groove has a width of 42 1 mm, except for TYV54-200-1:4.44 turnouts, where it is 50 1 mm. The entrance opening shall be 90 2 mm in short turnouts and 85 2 mm in long turnouts.

Check rail supports shall primarily be forged, but a welded structure is also acceptable.

9 Point lockings and contacts

The turnouts shall have facilities for the use of clamp lockings as well as for locks built into an electrically operated point machine. At the time of procurement will be decided whether clamp lockings and their rods are included in the delivery. 60E1 turnouts shall have facilities for the electrical control of the position of tongues and movable crossing, at intervals of approximately 4 meters.

9.1 Clamp locking

Clamp locking is placed at the sleeper interval of 670 mm, with a free space of minimum 380 mm, together with two possible control rods to be installed at the tongue end.

The clamp locking shall lock both an open and a closed tongue simultaneously. The turnout is turned at the end of the operating rod. The setting movement of the operating rod shall be 220-240 mm.

The lock is attached to the stock rail with screws.

The housing of the clamp locking is fastened to the stock rail. The evenness of the gliding surfaces of the clamp locking shall be Rz #12 (Ra #12.5). The gliding surfaces are lubricated with grease, which shall solidify at a lower temperature than -45°C. The gap between the tongue and the stock rail shall be adjustable by 0! 5 mm, as well as equipped with a reliable device for locking. Asymmetric bushings are used in the tongues of 60E1 turnouts. The tongues of 54E1 turnouts have straight bushings, but the joint pin is attached asymmetrically to the tongue. The clamp fastening holes in tongues are Ø 34 H8 mm.

The lock parts shall be protected so that snow, gravel dust, etc. does not prohibit the lock from functioning. No parts of the lock may protrude lower than 100 mm below the lower surface of the rail.
The lock shall bear up trailing the switches at 40 km/h in an operating condition.

The clamp locking shall have an electric insulation so that the operation of rail circuits will not be interfered with.

10 Sleepers and bearers

Sleepers and bearers are in each point installed in the direction of the bisectrix of the centre angle.

10.1 Concrete bearers

Normally concrete bearers are ordered in lengths matching the track diagram. The supplier calculates the locations of screw holes. If the turnout requires special geometry, the supplier shall also calculate the lengths of bearers. The location tolerance of screw holes is $1 \text{ mm}$. The holes shall be equipped with a plastic bushing for fastening rail screws R170-p.

10.11 Reinforcement and tension

A bearer shall be reinforced at upper and lower surfaces, and tensioning shall be carried out by using a method proposed by the supplier and approved by the purchaser. The properties of prestressing steel (for example chemical consistency, strength values, manufacturing method and possible surface finish) shall be provided in the product declaration certified by the Finnish Concrete Association. The supplier shall deliver the instructions to the purchaser before the steel is taken into use. Prestressing steel is tested in accordance with currently valid norms. Before the steel is used the supplier shall provide the purchaser or an inspector authorized by the purchaser, for each steel lot of maximum 25 tonnes, with research reports issued by an approved research institute, on dimension, bending and tensile stress tests, as well as the factory certificates given by the steel manufacturer and describing, among others, the consistency and strength values of the steel. Prestressing method shall have a certified product declaration. There shall be a steel around reinforced steels (closed $5 \text{ mm}$ profile cramps) against bearer split in both ends of a bearer. While the spacing between rail screw bushings is less than 150 mm, cramps $5 \text{ mm}$ shall be installed horizontally to bind the bushings pair-wise in direction $y$.

10.12 Acceptable tensions

Concrete bearers shall be designed so that torques along the torque plane of the external forces described below, do not cause neither tensile stress exceeding $3 \text{ MN/m}^2$, nor compressing tension exceeding $20 \text{ MN/m}^2$ in the concrete. At least a double security against breaking must be proven.
Bearers must be designed to stand dynamic bending tests, including:

**Test of static load on sleeper ends and dynamic fatigue test**

The bearer is loaded at the rail fastening point and supported symmetrically with respect to the point of load. Both ends are loaded simultaneously (figure below).

At the actual points of load, above the supporting bearings, of which the other is fixed and the other one is moving freely along the length, there are 25 x 100 mm steel plates and at the supporting points below the loading cylinders, there are 50 x 100 mm steel plates, which are taking the load and stretching across the bearer in a plane perpendicular to the length of the bearer. Before tests the surfaces which go against the steel plates of a bearer, are smoothed with a layer of 2! 5 mm gypsum, and the bearer is stored submersed completely in water for 48 hours. A microscope magnifying 50 times shall be used when measuring cracks and when searching for cracks a magnifying glass with 6-fold resolution.

The load test of a concrete bearer is started by increasing the static force first at a rate of 10 kN/min up to 150 kN, after which the force is increased in steps of 5 kN up to the upper limit 260 kN of the dynamic test. At each step one shall check and measure the width and side-wise lengths of cracks while the force stays constant for at least 10 minutes. After the dynamic test one shall continue the static loading up to the breaking point with a rate of 10 kN/min. The breaking load value and type of breaking are registered and the test sleeper photographed on both sides. The requirement for a static test is that the first crack may occur only when the force is higher than 210 kN. Permanent cracks (width ! 0.05 mm) are not allowed.

During the dynamic load the number of load changes corresponding to the first crack is registered, and after the test, the number of cracks, greatest
widths and side lengths at the upper load, and the width of a permanent crack. The load exchange rate of the dynamic test is 8 1/3 (10) Hz, the number of load exchanges 2,000,000, the upper limit of loading 260 kN and the lower one 50 kN. In the dynamic test permanent cracks (width $\leq 0.05$ mm) are not allowed.

10.13 Structural requirements

Concrete bearers shall be designed and manufactured in accordance with Finnish norms, structural class K60-1 and environmental class Y1 (water resistance and frost resistance required). However, the minimum accepted value of the concrete cover is 30 mm.

**Compression and bending tests of concrete**

Compression and bending tests of concrete are carried out in accordance with the currently valid norms. A test meeting the norms can however by a separate approval be replaced with a test, in which the test pieces will be manufactured and stored in the same way as a concrete sleeper. In that case 2 concrete cubes for each layout as well as 3 concrete cubes and 3 concrete sleepers are manufactured for each casting day. 2 of the concrete cubes shall be stored under the same conditions as the bearers. Before transferring the tension force only the first of these cubes is compressed and if this one does not meet the requirements, the second cube is also compressed later. The last 3 cubes are compressed when they are 7 days old. If the mean value of these does not meet the requirements 3 cubes are compressed when they are 28 days old. Concrete bearers shall be tested when they are 7 days old.

The bending test is carried out with the shortest concrete bearer once a week with a load of 225 kN so that the bearer is placed as in the following figure:

![Concrete Bearer Test Diagram]

The end to be tested is placed on two ball bearings having a distance of 600 mm and placed symmetrically on both sides of the resting surface of the rail foot. The bearings shall be equipped with cylinders with a diameter of 30 mm and bearing plates of 100 mm wide against the concrete. An approximately 5 mm thick rubber sheet shall be placed between the bearing plate and the concrete. A force corresponding to half of the bearer's weight is
directed upwards at the other end of the bearer. On the resting surface of the rail foot to be tested, shall be placed an approximately 5 mm thick rubber pad on which a 30 mm wide and 15 mm thick steel plate is placed exactly in the centre with respect to both bearings. The point load is directed towards the middle of the steel plate, using a controlled pin punch or a steel roll having a rounding of 15 mm. The load is increased gradually to 225 kN, and no cracks reaching the lowest steel row on the pulling side may appear.

The tension test of plastic bushings is done separately for each bushing by pulling straight upwards with a force of 50 kN. The plastic bushing may not rise at all during pulling, and no cracks may appear in the concrete.

Documents concerning calculations, description of the manufacturing method and its approval, concrete consistency and proportioning, and certified product declarations on the use of additives confirmed by the Finnish Concrete Association, as well as complete drawings, shall be appended to the offer. The proportions and materials must not be altered before the purchaser has approved the changes.

Finnish concrete norms valid at the time of the contract shall be applied in the procurement, if not otherwise stated in these technical specifications or the purchase contract.

The bending strength of concrete used in bearers shall at the age of 7 days, be at least 5 MN/m² and the compression strength 55 MN/m², or at the age of 28 days at least 60 MN/m². At the moment of transferring the tension force the compression strength shall be at least 30 MN/m². The frost resistance factor P shall be at least 25.

\[
P = \frac{100}{\Delta V/(50)} * 100\%,
\]

where \(\Delta V/(50)\) is the change in volume in a frost salt test after 50 freezing cycles (%). The frost salt test shall be repeated at three months intervals by an approved test laboratory. Test pieces are taken from a finished bearer which is at least 21 days old. The test is run on three pieces.

The microcracking index must not exceed 1.5 (the number 0 corresponds to concrete having little or no microcracking, and the number 3 to concrete with numerous microcracks). The cracking shall be investigated by an approved research laboratory using a microscope and thin slices. The upper surface and sides of bearers shall be as free from cracks as possible. Porosities functioning as water bags may not occur and porous cells are not accepted. The greatest diameter of a pore on the rail resting surface is 5 mm, and elsewhere 10 mm. The number of pores having a diameter greater than 5 mm must not exceed 20 per sleeper. The maximum acceptable depth of a pore is 5 mm.

Recrystallized ettring is not permitted at all. Investigations of ettrings shall be carried out by an approved laboratory, using analysis of thin slices and x-ray diffraction. The samples are taken from a ready-made bearer.
The surfaces of the bottom sides of the bearers must be rough planes, local deviations greater than \( 3 \) mm from the base level in the drawings, may not occur. On the lower edges of bearers no greater jaggs or spalls may occur. Corners and lower edges may contain maximum 10 mm deep and 30 mm long cracks.

The surface for the rail foot shall have well-formed side edges and an even carrying surface. Post-grinding is allowed only to remove minor irregularities from the rail carrying surface.

Reinforcement steels shall be cut near the bearer surface, the greatest acceptable protrusion being 3 mm.

10.14 Storing

When stored concrete bearers shall be supported about 0.5 meters from the end of the bearers or otherwise make sure that bearers won't be bended. Rail screw holes shall be plugged with temporary plastic plugs at the concrete bearer factory.

10.15 Markings

Factory badge, two last digits of the manufacturing year, manufacturing month and the number of the mould shall be marked on concrete bearers, at the place defined by the drawings. The date of manufacturing shall be stamped or printed at the ends of the bearers. The date marking must be readable for at least two months.

10.16 Manufacturing of bearers

The bearers shall be delivered exactly as specified by the approved drawings and the working method.

In heat treatments, the temperature of the concrete is adapted to the concrete consistency and to the heat treatment method. The temperature of the concrete during casting shall be maximum \(+30^\circ\text{C}\). Pre-storing after casting and before possible extra heating must take at least 3 hours. The highest acceptable temperature of the concrete is \(+55^\circ\text{C}\), but it should be kept at maximum \(+50^\circ\text{C}\). The highest rate of change shall be \(15^\circ\text{C}\) per hour. Bearers shall be protected against drying during pre-storing.

The bearers shall be stored in a mould tightly closed by plastic or in a humid space (relative humidity at least 90%), starting at the earliest \(\frac{1}{2}\) an hour after casting and continuing until the tension force is being transferred. Immediately after the first cutting bearers are protected by spraying 0.125 l/m\(^2\) Curing 101 agent or similar on bearer surfaces, except for the bottom side, or alternatively right after the final cutting so that watering is used between the cuttings. The temperature difference between the different parts of the bearer may not exceed \(20\)^\circ\text{C} during the first three days after casting. While the outdoor temperature is below \(+5\)^\circ\text{C} bearers must be stored indoors for at least
two days after casting and warm bearers shall be protected against sudden changes of temperature when taking them outside for storing.

Before installation in the mould and after casting plastic bushings to be inserted in the rail screw holes shall be cleaned from concrete and other materials that could hamper their function or from holding fast. They shall be well fastened during casting.

10.17 Measurements of finished bearers

In connection with the assembly of a turnout control measurements are taken of the coordinates of each bearer that have been manufactured by using a new matrix. Other dimensions are measured of at least one 7-day old bearer taken from each cast series.

In each shift all steel reinforcement tensions and locations are tested in at least four different rows of bearers.

The internal temperature of a bearer should be measured at least once a week, and the temperature is registered at least once an hour during the first 24 hours after casting. The humidity of the bearer storage shall be measured at least once a week. Reports shall be written on tests and inspections and signed by the supplier and the purchaser or the inspector authorized by him.

The purchaser or the receiver authorized by him will decide whether a defect is significantly negative with respect to the use of the bearer.

All the tests and measurements mentioned in these specifications as well as the additional measurements the purchaser may require, if those mentioned here do not give desired results, are paid by the supplier.

10.2 Timber sleepers made of Nordic pine

Instead of concrete bearers impregnated timber sleepers made of Nordic pine can be used in 54E1 turnouts. The must be manufactured according to European standard EN 13145.

10.21 Purchasing time and properties

Logs intended for sleepers shall be from living and straight pines. They shall be felled during the period 1 October - 15 April. The entire length of a sleeper, except for 300 mm at both ends, is considered the rail fastening area.

10.22 Wood properties and faults

The form of sleepers shall be regular, opposite sides parallel and joining sides at right angles to each other. The volume weight of sleepers shall be > 450 kg/m³, when they have a humidity of < 25 %. The standard SFS 4891 (RT 21-10188) is used for defining wood properties and faults.
No bark, damage by pests, rot or watercore, nor bluing which could prevent impregnation shall occur on sleepers. Cross-graining may not occur in the rail fastening area. On the upper side of sleepers maximum 50 mm large elevations or bark residues are allowed. Faults such as ring or through-going cracks that weaken strength, are not allowed. The maximum accepted inclination is 1:10. Neither saw dust nor soil shall occur on sleepers, and they shall not be treated with agents that prohibit the impregnation from penetrating the wood.

Horizontal crookedness not exceeding 60 mm is allowed in 7.5 meter long sleepers, but only on a half of the length of the sleeper. A maximum of 2 mm concavity or convexity may be present in the rail fastening area. The maximum crookedness in a length of 1 meter is 4 mm.

The number of healthy and solid branches is unlimited, but such branches that owing to size, form or grouping may weaken the strength of the sleeper, are not allowed. Single dry branches can have a maximum size of 50 mm. The size of single rotten branches or bark branches or of single branch cracks, may not exceed 10 mm in the rail fastening area, and elsewhere not 30 mm.

Sleepers shall be sawn from the material asymmetrically, so that the core of the tree comes closer to the bottom side of a sleeper.

10.23 Classification, measurement and form of sleepers

Sleepers have the following lengths 2.70; 3.00; 3.25; 3.50; 3.75; 4.00; 4.25; 4.50; 4.75; 5.00; 6.00 and 7.50 m.

The longitudinal tolerance of sleepers is " 20 mm. The cross section dimensions of sleepers are presented as follows.

All dimensions concern sleepers having dry weight humidity less than 25 %. Sleeper ends may not diverge more than 20 mm from the vertical plane. As to other dimensions please note the following:

Dimension a (160 mm) on the upper surface is the minimum length in the rail fastening area. Dimension c is maximum 40 mm in the rail fastening area and elsewhere maximum 60 mm. The cut side surface stretching from end to end shall be more than 50 %. The dimension b (200 mm) of the bottom surface is the minimum length along the entire length of a sleeper.
10.24 Drying and storing of sleepers

Sleepers are dried in staples by air. Different lengths shall be stapled in different stacks. The height of stored staples must not exceed 20 sleepers, and the width not 12 sleepers. Staples must be spaced at least 1 m from each other. After three staples one should leave a space of at least 2 m. The staples should be supported below by at least 300 mm high supports.

Sleepers shall be stored laying on their sides upper surface upwards with a gap of at least 100 mm between them so that the ends are even. Between each layer of sleepers one shall use even, at least 50 mm thick battens.

Sleeper storage shall be covered. The staples shall be marked with the month and year of sawing (for example 1/2004).

In the rail fastening area the longest allowed crack caused by drying is 400 mm and the width 5 mm. Large cracks that weaken the strength of a sleeper are not allowed elsewhere.

10.25 Acceptance and marking of sleepers

The quality inspection and classification of sleepers is carried out at the supplier's storing places before the sleepers are impregnated, and when the dry weight humidity is less than 25 %.

The length in centimeters is marked on sleepers by the supplier.

A measurement certificate is written based on the quantity inspection carried out at the impregnation plant. The supplier provides the stickers needed in the transportation of sleepers free of charge.

10.26 Impregnation

The dry weight humidity of sleepers shall be at least 25 % during impregnation. The sleepers are impregnated according to class A as defined by the standard SFS 3974/EN 351 (RT 21-10414), in which the protective compound penetrates through the whole sapwood down to the core.
As creosote distillate is used oil, which shall meet the requirements in the decision 1405/95 by the Council of State, on regulations concerning the use of creosote and wood treated with it, as well as on restricting its release to marketing. The decision is based on the European Parliament's and Council's directive (94/60/EC). The content of Benzo(a) pyrene can be at most 0.005 percentage by weight.

A diary shall be kept on the impregnation process, where the number of the impregnated lot, impregnation date as well as the number and volume of the sleepers are registered. Also the temperature and consumption of the creosote distillate is registered, as also the initial and impregnating pressures and the duration of the final vacuum. The consumption of creosote shall be at least 135 kg/m³ in the sapwood. The duration of the final vacuum shall meet the purchaser's requirements, 2–18 hours depending on the intended use.

During each shift at least ten drilling samples of the impregnated sleepers shall be taken in order to control the absorption of the impregnation agent. The drilling samples are taken in the rail fastening area, at the upper edge of sleepers. The drilled holes shall be plugged with impregnated wooden plugs.

10.3 Other wooden sleepers

Oak is also approved to be used in sleepers. Impregnated sleepers made of oak have to fulfill the requirements in point 10.2 in applicable parts.

11 Protection against corrosion

Machined surfaces, rail resting surfaces of turnout base plates and supporting surfaces of stock rails as well as counter surfaces of rails and tongues shall be protected with a zinc chromate primer.

All screws shall be dipped into oil, but not rail screws to be inserted in plastic bushings.

Gliding surfaces shall be greased with environmentally friendly grease.

12 Markings

Turnouts and their parts shall be numbered so that right-hand turnouts get even numbers and left-hand turnouts odd numbers. Right-hand turnouts are marked with letter O and left-hand turnouts with letter V.

Plate numbers are stamped on the baseplate ribs. Forged parts are forged with the number of the forgery, the forging month, except for concrete casting which has its own rules in point 10.

Tongues, end reinforcements, wing rails of crossings and check rails shall have a shield attached to telling the manufacturer's name, manufacturing year and month, rail profile, crossing relation, turnout number and the receiver. The number, manufacturing year and the name of the manufacturer shall also be stamped on the centre part of the end reinforcement, the base of the tongue.
rail, the upper surface of a wing rail and in the centre part of check rails. The stamped area shall be marked with white paint after priming against corrosion.

13 Package and transportation

A switch is loaded and delivered complete if not otherwise agreed. If a switch is delivered without sleepers, it shall be fastened at the factory to temporary wooden transportation beams prohibiting all sort of damage during handling and transportation. At the factory tongues shall be tightly fastened with steel wires to stock rails. All loose parts shall be packed at the factory in separate transportation boxes for separate turnouts.

Turnout parts must not get dirty during transportation.

14 Acceptance

The purchaser or the inspector authorized by him has always right to do acceptance inspections and have carried out those acceptance tests on the used materials he considers necessary. The supplier has the obligation to place personnel free of charge at inspectors' disposal, as well as all tools, devices and material they will need in order to carry out the necessary tests and inspections.

The tolerances defined in these technical specifications are used at the acceptance of a turnout.

The supplier shall produce an inspection report on all main parts of a turnout (switches, crossing, check rails). The form of the report shall be approved by the purchaser. Inspection reports shall be delivered to the purchaser. The supplier shall prepare an inspection scheme for a whole turnout delivered installed on sleepers, and the scheme shall contain all main dimensions (rail lengths, track gauges, crossing control distances, flange grooves of crossing), and the manufacturing numbers of main parts. Two schemes shall be prepared, one of which is delivered to the purchaser and the other one to the installation site.

Turnouts are inspected assembled at the factory. Switches are inspected assembled with possible clamp locking devices fastened in place. Crossings are inspected assembled on crossing base plates (except for obtuse crossings in crossing turnouts). Check rails are inspected together with stock rails and special base plates with fastenings attached.

Heat treated parts are always tested for hardness. Crossings are tested (not cast manganese steel) with a penetrating colour.

From the manufacturing batch of clamp parts of clamp locking is taken a 10% sample, which is tested for example with a penetrating colour. From each manufacturing batch of clamps at least one clamp, or one percent sample, is taken for ultra sonic testing. The clamp is to be tested at the shaft with a normal probe and a 45° angle probe.
Acceptance certificates shall be delivered for the used materials such as rails, tongue rails, crossing materials and supporting and intermediate cramps as well as fastening parts such as base plates, compression plates, springs, pads, screws, etc.

The acceptance inspection of mass produced materials is carried out by applying Wald's sampling method or some other statistical acceptance method approved by the purchaser.

15 Guarantee

The supplier shall give a guarantee of three years on raw materials and work, starting at the beginning of the year following the delivery. Tongue rails and rails shall be guaranteed for five years according to UIC leaflet 860-V, 8th edition 1.7.1986, with amendments of 1.9.1988. Small parts (for example fastening devices) shall be guaranteed for five years. The supplier accepts the obligation to replace at own cost without delay faults due to raw material, work or manufacturing methods.

16 Turnout drawings

16.1 Drawings to be used

Drawings to be used are presented as appendices to these technical specifications.

16.2 Drawings to be delivered

Before manufacture is started the supplier shall deliver to the purchaser two sets of complete drawings of the turnout parts he has designed, for inspection and approval. After the approval the supplier shall deliver the drawings in electrical form (Micro CADAM Release 14/AutoCAD Release 13) and one set of plastic prints for files.
The following purchaser's drawings shall be followed at the procurement:

<table>
<thead>
<tr>
<th>Track diagram</th>
<th>Scale</th>
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</tr>
</thead>
<tbody>
<tr>
<td>YV60-300-1:9</td>
<td></td>
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<td>4022-20-059G (Tampere design)</td>
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<td>4022-1-001B</td>
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<td>54E1A1-tongue rail</td>
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<td>60E1 1:15,5-crossing</td>
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<td>4022-165-008A</td>
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<tr>
<td>60E1 1:9-crossing, long wing rails</td>
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<td>4022-165-057</td>
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<tr>
<td>54E1 obtuse crossing</td>
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<td>4022-70-080B (crossing plates are included in the switch delivery)</td>
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<tr>
<td>or as alternative</td>
<td></td>
<td>4022-70-125C (crossing plates are included in the switch delivery)</td>
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54E1 9\(\text{E}^\circ\)6°30,6′ crossing 4022-41-001G
54E1 1:9-crossing, short wing rails 4022-41-013G
54E1 1:4,44 crossing 4022-90-051B
54E1 1:4,44 crossing 4022-90-104E (Tampere design)
54E1 1:6,46 crossing 4022-91-009C
54E1 1:6,46 crossing 4022-91-035B (Tampere design)
54E1 2x1:9 crossing 4022-42-002I
54E1 2x1:9 obtuse crossing 4022-42-001G
54E1 1:9 -crossing, long wing rails, right 4022-42-004C
54E1 1:9 -crossing, long wing rails, left 4022-42-003D
60E1 pare of switches 1:9 4022-165-004A
60E1 switches 1:18 4022-165-084A
54E1 switches 1:9 4022-31-082B
54E1 1:9, machining of heating rods 4022-30-140D (direct tongue)
54E1 1:9, machining of heating rods 4022-30-141F (bent tongue)
54E1 switches, KV, 2\textsuperscript{nd} turnout 4022-31-084D
54E1 KRV switches 4022-70-124F
54E1 KRV, machining of tongues 4022-70-141A
54E1 TYV 1:4,44 switches 4022-90-134C
54E1 TYV 1:4,44 switches 4022-90-133D (Tampere design)
54E1 TYV 1:6,46 switches 4022-91-052C
54E1 TYV 1:6,46 switches 4022-91-050F (Tampere design)
60E1 check rails 1:9 RL 4022-165-034
60E1 check rails 1:9 RR 4022-165-035
60E1 SRR 2x1:9 check rails 4022-165-009A
60E1 check rails 1:15,5 RL 4022-165-011
60E1 check rails 1:15,5 RR 4022-165-012
60E1 check rails 1:18 RL 4022-165-013
60E1 check rails 1:18 RR 4022-165-014
54E1 check rails 1:9 4022-50-038F
54E1 KRV check rails to be manufactured in accordance with the drawing YV 4022-50-038 F
54E1 check rails, KV 4022-51-027D
54E1 double check rails, KV 4022-51-014F
<table>
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<tr>
<td>54E1 TYV 1:6,46 check rails</td>
<td>4022-91-029G</td>
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<tr>
<td>54E1 TYV 1:6,46 check rails</td>
<td>4022-91-034G (Tampere design)</td>
</tr>
<tr>
<td>Installation of corner supports</td>
<td>4022-1-623A</td>
</tr>
<tr>
<td>Concrete bearer</td>
<td>4022-161-062C</td>
</tr>
<tr>
<td>Rail screw</td>
<td>4022-1-501B</td>
</tr>
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<td>Plastic bushing</td>
<td>4022-1-429B</td>
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<td>4022-1-087B</td>
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