

## CHAPTER THIRTEEN

# Specification of Railway Trackwork

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THE specifying of railway trackwork can be conveniently broken down into three main processes: (1) preliminary work, (2) track materials and (3) laying the trackwork or permanent way.

The preliminary work consists of site preparation, excavation and fill, drainage, compaction and grading. The materials consist of ballast, sleepers of timber, concrete or steel; rails (bull-head or flat-bottom); chairs; fishplates and ancillary fixing items. More complicated items of equipment such as points and crossings may be specified by referring to specific products of a certain manufacture.

The clauses covering the laying of the permanent way must include reference to all the labours involved in laying the track to the required lines, levels and curves. These clauses are usually followed by information on measurement aspects to simplify the subsequent process of measurement and valuation of the work, and to draw the Contractor's attention to all the matters for which he is to make allowance in his prices.

Typical railway trackwork specification clauses follow. It is hoped that these will form a useful guide in the drafting of specification clauses for this class of work.

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#### PRELIMINARY WORK

##### Site preparation

The whole of the area of the site as shown on the Drawings shall be cleared of all obstructions, including trees and	The whole of the site, including the area occupied by slopes to cuttings and
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undergrowth with their roots, rubbish, etc. The resultant debris shall be burnt or removed from the site and the whole of the area left to the satisfaction of the Engineer.

#### Excavation

Topsoil shall be stripped and stacked for subsequent re-use on the slopes to cuttings and embankments.

Excavation shall be performed to the dimensions shown on the Drawings or as directed by the Engineer or his representative on the site. Suitable excavated material shall be used as fill in embankments and all surplus removed from the site.

The Contractor shall not excavate below formation level, except to cut out soft spots. The soft spots shall be refilled with selected and approved material.

#### Surface-water drainage

The Contractor shall keep the formation free from water by pumping, provision of sumps and drainage channels, etc., all to the approval of the Engineer. Open trenches shall be cut and porous drains laid in the positions and to the details shown on the Drawings.

#### Compaction of formation, etc.

The formation of the track and the fill to embankments, deposited in 225 mm (9 in.) layers, shall be adequately consolidated with a smooth-wheeled roller weighing 8000-10,000 kg (8-10 tons).

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embankments, needs to be cleared of obstructions. In particular the roots of trees and undergrowth must be removed.

The reader is referred to Chapter IV for more detailed specification clauses covering excavation. The Engineer usually aims at equalising the amounts of cut and fill as far as possible, although this is more difficult in railway trackwork than with roads, due to the flatter gradients and slower changes of grade involved.

The formation must be kept clear of water to prevent softening and damage. Open trenches or land drains will be needed on each side of the track in cuttings to intercept and take away the water running down the slopes.

The formation and layers of filled material in embankments must be adequately compacted. The number of passes of the roller will depend on the weight of roller and type of fill.

**Grading of formation and slopes**

The formation and slopes to cuttings and embankments shall be accurately graded to the required lines and gradients. Sloping surfaces shall be covered with 150 mm (6 in.) of suitable topsoil and seeded, as previously specified, or covered with a 100 mm (4 in.) layer of approved ballast.

Culverts and pipes under the track shall be completed before the final preparation of the formation is carried out.

The treatment of the sloping surfaces to cuttings and embankments may take one of several forms:

- (1) left as excavated or filled;
- (2) soiled and seeded;
- (3) covered with ballast or other suitable material.

Intercepting trenches or land drains will probably be needed at the tops of cuttings and bottoms of embankments.

**TRACK MATERIALS****Ballast**

Ballast for permanent way construction shall consist of clean, hard crushed stone or other suitable material approved by the Engineer. Bottom ballast shall be evenly graded from 200 mm (8 in.) to 100 mm (4 in.) and top ballast from 60 mm (2½ in.) to 25 mm (1 in.). Stones used as ballast shall be roughly cubical in shape and the use of flat stones will not be permitted.

Hard, clean stones are normally required for ballast, although slag and clinker are occasionally used. It is desirable to select a material which will drain satisfactorily and will not break down into dust. The life of sleepers is affected by the quality of the ballast.

**Timber sleepers**

Timber sleepers shall be of creosoted Douglas fir, Scots pine or other approved timber. They shall be straight, sound, square cut and free from injuries, waney edges, shakes, large and dead knots, decay, insect attack and other

Sleepers may be in timber, steel or concrete. There are British Standards covering the latter two categories but there is not one for timber sleepers. Nevertheless, steps

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serious defects, and shall contain not more than 15 per cent sapwood taken as an average of both end sections.

The moisture content of timber sleepers shall not exceed 22 per cent of the dry weight at time of use. The timber shall, unless otherwise specified, comply with B.S. Code of Practice 112 (Table 1, Group 1) and the measurable characteristics and moisture content shall be assessed in accordance with B.S. 1860: Structural Timber: Measurement of Characteristics affecting Strength.

Timber sleepers shall be not less than 2.6 m (8 ft 6 in.) long and 250 mm × 125 mm (10 in. × 5 in.) in section. Unless suitably finished the top faces of sleepers shall be dressed under each rail for a width of at least 225 mm (9 in.), where the rails rest directly on the sleepers, and for a width suitable for chairs or bearing plates where these are used. Special creosoted timbers of larger section and greater length shall be used at points and crossings, as directed by the Engineer, and these shall be dressed or finished as specified for sleepers.

All timber sleepers shall be creosoted under pressure in accordance with B.S. 913: Pressure Creosoting of Timber, and the creosote shall comply with B.S. 144: Coal Tar Creosote for the Preservation of Timber.

Holes shall be bored in sleepers and crossing timbers to receive coachscrews, bolts and spikes and the holes shall be 5 mm ( $\frac{1}{4}$  in.) less in diameter than the coachscrews, etc. The bolts and coachscrews shall be screwed up tight and the spikes hammered home until a firm bearing on the rails or chairs is obtained, all to the approval of the Engineer.

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have been taken in the accompanying specification clauses to make the maximum use of all relevant British Standards, for the sake of uniformity and to ensure the use of good quality materials.

Sound and suitable timber, creosoted under pressure, is an essential requirement, with the object of securing sleepers with a minimum life of from 10 to 20 years, depending on the volume of traffic carried.

Some engineers specify joint sleepers of 300 mm × 125 mm (12 in. × 5 in.) cross section, whereas others require two sleepers of normal section to be positioned close to the joint.

The requirements relating to the characteristics of the timber vary appreciably. For instance, some engineers permit up to 25 per cent sapwood and waness on each of the two edges of the wide face.

**Steel sleepers**

Steel sleepers for flat-bottom rails shall comply with B.S. 500, and be of inverted trough form, 280 mm (11¼ in.) wide × 85 mm (3½ in.) deep overall and not less than 8 mm ( $\frac{5}{16}$  in.) thick. The chairs shall be an integral part of the sleeper or shall be held in position by suitable metal clips welded to the sleeper. The weight of steel sleepers shall be not less than 25 kg/m (140 lb per length of 8 lin. ft).

B.S. 500 gives details of test samples, templates and gauges, methods of manufacture, cleaning and dipping, and inspection during manufacture. It does not however specify any standard dimensions.

**Concrete sleepers**

Concrete sleepers shall comply with the requirements of B.S. 986: Concrete Railway Sleepers, for reinforced concrete sleepers for secondary tracks and may be of either block or transverse type.

This Standard covers both ordinary reinforced and prestressed sleepers for standard gauge railway tracks for sidings, tertiary, secondary and primary tracks.

**Rails**

Rails shall comply with the requirements of B.S. 9 for bull-head rails and B.S. 11 for flat-bottom rails. Rails shall weigh 47 kg/m (96 lb/lin. yd) and shall be supplied in 18 m (60 ft) lengths and laid to a gauge of 1½ m (4 ft 8½ in.).

These Standards cover the quality of material, chemical composition and mechanical properties, conditions of finished rails, locations of holes, and dimensions, shapes and weights. Bull-head rails range from 30 to 50 kg/m (60 to 100 lb/yd) and flat-bottom rails from 12 to 55 kg/m (25 to 110 lb/yd).

**Fishplates**

Fishplates shall be of mild steel of the shallow type to suit the section of the rails and of sufficient length to take four bolts, all in accordance with B.S. 47:

Two fishplates are required to each joint between lengths of rail, made up of one plate on each side of the rail. B.S.

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Steel Fishplates for Bull-head and Flat-bottom Railway Rails. They shall weigh not less than 14 kg (32 lb) per pair.

47 covers quality, tests, punching of holes, dimensions and weights.

**Rail fixings**

All rail fixings shall be of mild steel and shall be of the types and dimensions shown on the Drawings or as directed by the Engineer. Bolts and nuts, coach-screws and spikes, etc., shall comply with B.S. 64: Steel Fishbolts and Nuts for Railway Rails, where applicable, shall be forged from the solid and cleanly cut and, where appropriate, have Whitworth standard threads of uniform pitch. All nuts shall accurately fit the threads of the bolts and shall be hand-tight. The bolts shall be of sufficient length to project from one to four clear threads beyond the nuts when tightened up. The shoulders of the heads shall be truly concentric with the axes of the bolts.

Coachscrews shall be of adequate length to penetrate the various members to be joined together, and shall have a large domed head with a square nut projecting from it. The heads shall be truly concentric with the axes of the coachscrews.

Dog spikes for fixing flat-bottom rails shall be of mild steel, 16 mm × 15 mm ( $\frac{5}{8}$  in. ×  $\frac{9}{16}$  in.) in section and 125 mm (5 in.) long with cup-shaped heads and be suitably pointed for driving. The head shall be formed with a 20 mm ( $\frac{3}{4}$  in.) projection with the required inclination to give a satisfactory grip on the rail, and with suitable ears to facilitate withdrawal.

After manufacture and before any rusting has taken place, bolts, nuts,

This clause covers all the components needed for fixing the rails. The dimensions of the various items will be obtained from the Drawings. Common sizes are for fishbolts 24 mm ( $1\frac{5}{8}$  in.) in diameter and 120 mm ( $4\frac{3}{4}$  in.) long and for chairbolts 22 mm ( $\frac{7}{8}$  in.) in diameter and 180 mm ( $7\frac{1}{4}$  in.) long.

Reference to B.S. 64 enables the length of the specification clause to be reduced considerably. B.S.64 provides for 22 mm ( $\frac{7}{8}$  in.) and 24 mm ( $1\frac{5}{8}$  in.) bolts and nuts for use with standard bull-head rails, and a range of ten bolts and nuts from 12 mm ( $\frac{1}{2}$  in.) to 28 mm ( $1\frac{1}{8}$  in.) for use with standard flat-bottom rails. This Standard also specifies the quality of steel and the tests on the finished bolt, as well as giving requirements for weight margins, marking, gauging and protection.

Note the application of hot linseed oil to facilitate removal and prevent rusting.

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coachscrews, etc., shall be heated and dipped in hot linseed oil.

#### Cast iron separators

Cast iron separators, securing check rails to running rails, shall be of approved pattern and of the required size to fit accurately into the webs of the rails and of the appropriate width to give a clearance of 45 mm ( $1\frac{3}{4}$  in.) between the inner edges of the running and check rails. The separators shall be holed for 22 mm ( $\frac{7}{8}$  in.) diameter distance bolts.

#### Bearing plates

Mild steel bearing plates, 300 mm × 200 mm × 12 mm thick (12 in. × 8 in. ×  $\frac{1}{2}$  in. thick), shall be placed between the rails and sleepers on each side of rail joints where directed by the Engineer. Bearing plates shall comply with B.S. 751: Steel Bearing Plates for Flat-bottom Railway Rails, and each plate shall be suitably holed to permit four fixings being screwed or driven into the sleeper to hold the rail.

#### Chairs and keys

Chairs shall be of cast iron, weighing not less than 20 kg (46 lb) each, to take bull-head rails, and of a pattern approved by the Engineer. Chairs shall be of the three-hole type and they shall be secured to the sleepers with three coachscrews or spikes or with three bolts inserted through the full thickness of the sleeper, with the nut screwed down tight on to the chair.

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Cast iron separators are needed to hold the check rail in the correct position relative to the running rail on sharp curves.

Bearing plates are used to give additional support to rails at joints. B.S. 751 specifies the quality of the steel, the tests to be performed, the method of manufacture, holding, freedom from defects, and branding, cleaning and dipping.

Chairs are needed to fix each bull-head rail to each sleeper. Keys are used to wedge the rails in the chairs. Oak keys of good quality English oak, chamfered and tapered as required are an alternative to steel spring keys.

Special double cast iron

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Keys shall be steel spring keys to railway standard pattern.

chairs will be needed with bull-head rails where a check rail is used.

LAYING PERMANENT WAY

**Laying ballast**

The ballast shall be laid after the formation has been brought to the correct level and profile and well consolidated with a roller weighing not less than 5000 kg (5 tons), and be cleared of all rubbish and loose material. The width of the ballast for a single track shall be 3.5 m (11 ft), and the level of the formation after consolidation shall be 450 mm (18 in.) below the top of rail level.

Prior to the laying of sleepers, bottom ballast shall be laid to a consolidated thickness of 150 mm (6 in.). The permanent way shall then be laid and the sleepers packed up with top ballast for a width of 375 mm (15 in.) on each side of each rail. After the rails have been accurately adjusted, lined and surfaced, the top ballast shall be filled to the correct dimensions and neatly trimmed and boxed flush with the sleepers. Any settlement of the ballast prior to the expiration of the maintenance period shall be made good at the Contractor's expense and to the approval of the Engineer.

Ballast is laid in two layers, the bottom ballast of larger gauge material being consolidated to a depth of about 150 mm (6 in.) to receive the sleepers. The remaining space to the top of the sleepers is made up with top ballast of smaller material.

The accompanying specification clauses detail the ballast-laying process quite fully, and include making up any areas which have settled by the end of the maintenance period.

**Laying track**

The rails shall be accurately laid to line and level, to a gauge of  $1\frac{1}{2}$  m (4 ft 8½ in.) and to the true radii of the respective curves, with such super-elevation

The track must be laid to the lines, levels, curves and super-elevation shown on the Drawings or as directed by



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on the outer rail on curves as required by the Engineer, and no addition to billed rates for tracklaying will be allowed to cover any extra cost involved in setting out and laying the track to the required elevation and curvature.

On straight sections of line the rail joints shall be positioned exactly opposite one another, while on curves the lengths of rails shall be so arranged that no joint shall have a lead of more than 100 mm (4 in.) over the joint of the opposite rail. The Contractor shall, where necessary to suit these conditions, cut the rails and bore new holes for the fishbolts and the cost of this work shall be included in the tracklaying rates. On curves less than 240 m (12 chains) in radius, the rails, prior to laying, shall be set by the Contractor to the required curvature with the use of a press.

The sleepers on each side of rail joints shall be placed close to the joints. The remainder of the sleepers in each length of rail shall be spaced equidistantly and they shall be so arranged that the distance between the centres of sleepers shall not exceed 750 mm (2 ft 6 in.).

The rails shall be laid as nearly as possible in correct alignment before they are secured to sleepers or chairs. One of the rails shall then be fishjointed and secured with the required number of fixings, keys, etc., as shown on the Drawings, after which the other rail shall be laid in its correct position with the use of a standard gauge, and then secured progressively to the sleepers or chairs. Metal slips, 7 mm ( $\frac{5}{16}$  in.) thick, shall be inserted in the rail joints to provide expansion spaces and shall be kept in the joints until the rails have been lined

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the Engineer. Furthermore, the track must be laid accurately and precisely. Billed rates for tracklaying must cover all the work entailed.

Sleepers are normally placed close to the joint on either side of rail joints, although an alternative procedure is to use a larger section sleeper in this position (often 300 mm  $\times$  125 mm (12 in.  $\times$  5 in.)). The spacing of sleepers (centre to centre) is usually about 750–850 mm (30–34 in.).

Note the sequence of operations adopted for tracklaying work as detailed in the accompanying specification clauses. There are three principal methods of fixing rails, using bolts and nuts, chair-screws, or spikes. With flat-bottom rails no chairs will be needed as the rails will be fixed direct to the sleepers.

Bull-head rails have a head and base or foot of the same width (about 70 mm ( $2\frac{3}{4}$  in.)) and a height of about 140 mm ( $5\frac{1}{2}$  in.). With flat-bottom rails the width of the base is just over twice the width of the head. For example, a common section, weighing 47 kg/m (95 lb/lin. yd), has a base width of 140 mm ( $5\frac{5}{8}$  in.), a head width of 65 mm ( $2\frac{1}{8}$  in.) and a height of 145 mm ( $5\frac{3}{8}$  in.). The bull-head type of rail is the most

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and secured. Closing lengths of rail shall not be less than 4.5 m (15 ft) and all cuts in rails shall be square and clean. The Contract rates shall include for all cutting and waste resulting from the track-laying. All the tracklaying shall be carried out in accordance with present-day first class railway practice.

Unless otherwise specified, there shall be at least six steel fixings securing the rails or chairs to each sleeper (i.e. at least three to each rail or chair). The fixings may consist of bolts and nuts, coachscrews or spikes, or a combination of them in the case of flat-bottomed rails, all as shown on the Drawings or as directed by the Engineer. The bolts and coachscrews must be screwed tight and the spikes hammered home until a firm bearing on the rails or chairs is obtained, all to the approval of the Engineer.

Any loose coachscrews or spikes that have been rejected by the Engineer shall be removed and new holes drilled in the sleepers. New coachscrews or spikes shall then be screwed or driven at the Contractor's expense and to the approval of the Engineer. Steel spring keys shall be used to secure the rails to each chair and they shall be driven securely home after the rails have been gauged and lined.

Should any part of the permanent way settle, move or stretch prior to the expiration of the maintenance period, the Contractor shall perform the necessary remedial works to ensure that the track is left to the correct level, line and gauge, at his own expense and to the approval of the Engineer.

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commonly used in this country.

Steel and precast concrete sleepers are particularly useful in tropical and sub-tropical regions, where timber sleepers are subject to attack by white ants.

**Check rails**

Check rails shall be provided on all curves of radius sharper than 120 m (6 chains) or where directed by the Engineer. They shall consist of a rail of the same section as the running rail, except that in the case of flat-bottom rails one flange shall be planed off as necessary to allow 45 mm (1½ in.) clearance between the check rail and the running rail for the flanges of wheels.

Where bull-head rails are used, the check rails shall be secured to sleepers with special cast iron chairs, and in the case of flat-bottom rails by dog spikes or coachscrews and cast iron separators, and bolts and nuts between the webs of running and check rails at 1.5 m (5 ft) centres.

**Points and crossings**

Points and crossings, together with check railing, point rods and lever boxes complete, shall be manufactured by a firm of repute in this class of work. The rails shall be of the same section as previously specified. Prices shall include for all cutting and waste.

Points and crossings shall be accurately made to the particulars and drawings prepared or approved by the Engineer, and before construction is commenced the Contractor shall submit detailed working drawings to the Engineer for approval. Points and crossings shall be carefully and accurately laid to ensure the safe and smooth running of traffic.

Hand-lever boxes and tie rods of a pattern approved by the Engineer shall

Check rails are needed on tracks laid to sharp curves as an additional safeguard to super-elevation to prevent locomotives leaving the track due to centrifugal force.

The form of check rail and the method of fixing varies according to whether the track is of bull-head or flat-bottom rails.

With these more specialised forms of equipment, the Contractor is usually required to produce detailed drawings based on the information supplied by the Engineer. In fact the supply and fixing of points, crossings, buffer stops and associated items are frequently covered by a prime cost item in the Bill of Quantities. It is essential that this equipment should be in sound working order and produce safe running conditions.

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be provided to work the points. They shall be properly fitted up and securely fixed to a pair of timber sleepers, all to the approval of the Engineer. Lever boxes and tie rods shall be painted with two coats of red lead paint and all moving parts and sliding plates shall be well greased and left in good working order.

### Measurement of railway work

The billed rates for the supply of railway materials shall include all the costs involved in the supply, transporting, unloading, handling, stacking, storing and protection of the materials on the site. Payment will be made on the net theoretical or calculated weights of materials actually used in the Works in accordance with the Drawings or as directed by the Engineer.

The billed rates for ballasting shall include the cost of packing, surfacing, trimming and maintaining. No allowance will be made beyond the required dimensions for the extra material used in making up any settlement. The ballast displaced by sleepers will be deducted.

The billed rates for tracklaying shall include the cost of handling, selecting, fixing, lining and gauging rails, and also bending rails in the case of curved track, the handling and laying of transverse or block type sleepers, and all expenses connected with laying and fixing the permanent way complete, other than ballasting. The measurement of tracklaying will be taken in metres (linear yards) of completed track (two rails, all fixings and sleepers, etc.). The billed rates for check rails shall include the cost of handling, selecting and bending

It is advisable to indicate exactly what the billed rates for supply of railway equipment and ballasting and laying track, check rails and points and crossings are to cover, supplementing the information given in the Standard Method of Measurement of Civil Engineering Quantities. For instance, tracklaying is measured by the metre (yard) of track complete, including the assembly of all the component items. The billed items for points and crossings are also comprehensive items.

Payment for steel rails and other metal work, will be on the basis of theoretical or calculated weights as detailed by the manufacturer, and not on the basis of the actual weight of metal used on the job. The separation of the supply and the fixing of items is peculiar to railway construction work. Points are often referred to as switches.

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rails, fixing with keys, spikes or coach-screws, drilling running and check rails for distance pieces, and fixing bolts and separators.

The billed rates for supply of points and crossings shall include for the supply of all necessary materials and for their manufacture complete, with the check rails, cast iron separators, bearing and joint plates, lever boxes, tie rods, etc., whilst the billed rates for laying points and crossings shall include the delivery, handling, laying in position, jointing up to the permanent way and fixing of all check rails, lever-boxes, etc., greasing and painting, and all cutting, drilling, machining and fitting of rails, rods and timbers which may be necessary for the complete erection of the points and crossings, measured as 'extra over' the laying of plain track.