TRACK PROBLEMS ON THE SOUTHERN REGION OF BRITISH RAILWAYS

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So much has been heard from time to time about the difficulties involved in maintaining the permanent way of the Southern Region, that I feel many who have not experienced it imagine it is a tall story, or accept the information as true to a certain extent, but do not realise the full implications.

In the time available to me, I would like to give some information on this subject, as it is one which has interested me—in fact I have *had* to be interested in it—for many years. I do want to say straight away, however, that I know other Regions have difficulties which the Southern does not experience, such as subsidences, snow drifts, etc., and I do not belittle them.

The Southern is primarily a passenger carrying system, with the traffic divided generally into the following types :—

(*a*) Commuters, especially to the seven London Termini.
(*b*) Summer traffic to holiday resorts.
(*c*) Continental and Ocean Liner services to Dover, Folkestone, Newhaven, Southampton and Weymouth.
(*d*) Other passenger travel.

Freight traffic is peculiar insofar as the Region is chiefly residential with no intense industrial areas as on other Regions. The freight can be divided as follows :—

(*a*) Incoming domestic supplies and requirements for such industries as are in the area.
(*b*) Traffic from the Kent coalfields.
(*c*) Freight traffic from over the sea, via Southampton, Weymouth, Newhaven, Folkestone and Dover, including through traffic (especially perishable fruit, etc.) via the Dunkirk-Dover train ferry.

With such a preponderance of passenger traffic and light freight traffic, it is not economic to have separate lines on any route for the different types. In fact, on four track routes, although two are called " mains " and two " locals " (or similar names) all have generally to be maintained for the maximum speed on the route, to allow trains to be switched from their normal track to another according to traffic exigencies.

The biggest operating problem is dealing with the very heavy London commuter traffic in the morning and early evening. In a day, about 450,000 people are brought to London, 320,000 of them between 7.0 a.m. and 10.0 a.m. and 200,000 in the heaviest hour. Similar figures apply in the opposite direction in the evening.

Although the Southern has less running line mileage than any other region, it achieves a greater passenger train-mileage than any one of the others, even the very large London Midland Region, and its *average* number of trains per track per 24 hours is 47·4, while the average for the rest of British Railways is 29·6. There are about 300 miles of running line which carry 150 or more trains per day, and a short length between Borough Market and Metropolitan Junctions which carries about 370 on each track. Borough Market Junction has about 1,200 trains a day, with 80 per hour in the peak period.

This intense service is the result of the introduction and extension of electrification, which started in 1909 on the London, Brighton and South Coast line between London Bridge and Victoria, known as the South London line. Further extensions are being planned, but at present there are 2,279 electric track miles out of a total of 5,556, representing 41% ; 51% of the *running lines* are electrified. This is all on the third rail system using direct current at 660 or 750 volts, the conductor rail weighing either 100, 106 or 150 lbs. per yard, this last being required for heavy, high speed main line trains.

Although electric locomotives have been introduced since the war for certain services, by far the greater number of trains are of multiple unit stock. Main line and local diesel-electric trains of similar type having the same electric motors, have also been brought into use during the last few years.

I stress this point, because therein lies one of the great difficulties in maintaining our track. In steam engine days, the heaviest axles had large diameter wheels which rode easily over slight dips at rail joints.

With multiple unit stock, the heavy driving axles have smaller wheels, which drop further into any slight dip. The impact effect is made worse by the fact that, due to the method of suspending the motors, part of their weight is carried by the axle without any intermediary springs. This arrangement gives a tremendous impact, particularly at high speeds, at each rail joint, especially if the maintenance is not absolutely first class. In 1960, 65% of the train mileage was run by multiple unit stock, compared with 21% on the rest of British Railways.

For a quick terminal turn-round, this type of stock is by far the best. At Charing Cross, which has only 6 platforms, 20 trains in and 20 trains out are dealt with in one hour during the business peak.

The joint effect, however, is gradually becoming less severe, as the weight of the electric motors in stock that has been built during the last ten years or so is considerably less than it was previously.

The main difficulties, therefore, which apply more to Southern Region track maintenance than elsewhere are :—

(*a*) Intense traffic.

(*b*) Multiple unit stock.

(*c*) Presence of a live electric rail.

The track components are, of course, of standard B.R. types, but chosen to suit our conditions.

With the elastic spike fixing, we have always used the apron (or Polish) baseplate (B.R.3) in preference to the B.R.1 even though it requires more rail anchors in some locations. We consider it is better for maintaining good gauge, especially with heavy motor bogies, and it enables a rail to be changed more quickly. Further, as the fastening is a coach screw on the conductor rail side, there is no danger of a plate-layer's hammer glancing off a spike and touching the live rail.

Of the more recent types of fastenings, it is essential to have one which can easily be maintained when situated between the running and conductor rails, that is, one for which adjustment is by means of swinging a hammer or other tool parallel to the running rail. Consequently, increasing use is being made of such arrangements as the Heyback and Pandrol fastenings.

Rail wear is a big problem. Rapid acceleration and braking gives us heavy top wear in stations, but chiefly we suffer from sidewear. Mr. G. Ellson, one of my predecessors, set up, in the middle 1920's a Committee to study the question. Many alloy steel rails were tried, but the small increase in life did not justify the extra cost, except 14% manganese, which we use in certain circumstances, as I will detail later.

Sorbitically treated rails in the heaviest traffic areas gave up to 50% increase in life, but they developed severe corrugation under less frequent conditions. The L.P.T.B. grinding train was a temporary palliative, but most sorbitic rails had to be removed prematurely, and were re-used in places where heavy braking occurred or in terminal platforms where speeds were low.

The original cause of corrugation has never been quite clear, but the result was periodical high spots of martensitic structure, with the intermediate hollows more prone to corrosion.

On curves near London Bridge, rails have to be turned every 3 or 4 months and rerailed every 6 months. In a number of other places their life is little more than 12 months.

We therefore have the following principles concerning the type of rail in the track.

B.S.110A flat bottom rail is used generally on main lines, with B.R.3A baseplates on wood sleepers as standard. Concrete sleepers are not yet used in the electrified area as no satisfactory method has been evolved for fixing the insulator for the conductor rail to them. We think we have now solved this problem and are carrying out tests.

Where re-railing or turning is expected during the sleeper life, independent rail to baseplate fastenings are preferred as they avoid weakening the hold of spike when withdrawn and re-driven.

95 R.B.S. bullhead rail is still used on sharp curves and elsewhere where frequent turning or re-railing is required. It is quicker to release and fix than flat bottom rail and more easily lineable at joints in sharp curves. Speeds at such places are

usually moderate and dynamic loading correspondingly less, hence lower vertical strength is no disadvantage, particularly as the high rail, which under normal cant deficiency carries more load than the low rail, does not lose much depth before it has to be removed for sidewear.

The 95 lb. bullhead rail also has a great advantage in point and crossing work outside London terminal stations, where frequent replacement of wings, etc., is necessary. It is quick to change, and new wings can be made on the site without keeping a large and valuable stock to cover all the specials required.

For intense traffic at relatively low speeds, cast manganese crossings have the advantage of dispensing with the large number of bolts and blocks which require constant attention in such locations.

In order to ease the side thrust, curved switches are being used for the higher speed turnouts, and the chamfered type is giving better life than the undercut.

Since before the war, we have installed rail lubricators (now we have well over 1,000) and there is no doubt that they are invaluable and twice to four times the life of the rails is obtained as a rule. There is not only the resultant saving in cost of new rails, but also in manpower at night time rates for changing them.

An interesting case has occurred fairly recently. A certain switch rail had been subject to very heavy wear for a long time. Lubricators were therefore placed to ease the conditions, which worked quite satisfactorily when a fair number of steam engines used the route. Now, however, except occasionally, they never pass along that track, so that all wheels are of practically one diameter, and lubrication of the tip of the switch became poor. On carefully repositioning the apparatus the correct distance away, an improvement was obtained immediately, and now the switch point wear is far less, the life of these switches being increased four times.

We make considerable use of cast manganese layouts and high manganese switches, but not of high manganese running rails of any length, because the electric conductivity is so poor for the return current.

Borough Market Junction was the first heavy junction in which we designed a layout of cast manganese crossings and high manganese switches complete. It was installed in October, 1944. Before then, the complete layout was built up of bullhead rail, and the length gang was employed in tightening up fastenings for a considerable time each day, and nearly every weekend had to replace some part of the layout. Moreover parts of the built-up layout were constantly being knocked out of alignment, and crossing bolts were frequently bent.

With the new design, the constant attention almost ceased and although some parts (chiefly switch blades) had to be replaced, complete renewal was not carried out until March, 1954. With the increase in traffic and length of trains as well as replacement of steam traction by multiple unit sets, the wear since then has increased, and the next complete replacement was after a period two years shorter, that is in October, 1961. This cost about £35,000 but the saving in maintenance cost is well worth it.

The rate of wear of one switch tongue is interesting. Starting in April, 1947, the times elapsing between 12 successive replacements were as follows :—

22 months (High manganese)
21 ,, ,, ,,
22 ,, ,, ,,
17 ,, ,, ,,
13 ,, (Medium manganese—exceptionally long life)
17 ,, (High manganese)
10 ,, ,, ,,
9 ,, ,, ,,
5 ,, (Medium manganese)
3½ weeks ,, ,,
37 months (High manganese)

The long life of the last set of manganese switches is the result of repositioning the lubricator previously referred to.

I hope other Regions are not tired of hearing of our difficulties at Borough Market Junction. It is quoted so much because it is an outstanding case, but on the Southern there are many other very heavy duty connections, especially outside the main terminal stations. Waterloo is perhaps the next most difficult, due to the fact that the approach tracks are on a sharp curve (15 chains) and Westminster

Bridge Road underbridge is so near the ramp ends of the platforms, that there is not sufficient space for well designed connections to the platforms.

I trust I have not bored you with this recital of our difficulties, but it is essential as a background of the methods of day-to-day maintenance and complete or partial renewals of which I will now give you details.

The ordinary length gang work is, of course, very similar to that on other Regions, except that the conductor rail is a slight hindrance, but not as much as is often thought, and this additional rail is also the ganger's responsibility. At one time we used to have, under the control of the Chief Permanent Way Inspector, a separate organisation for the conductor rail maintenance, but this was changed some 12 years ago, as I considered the Ganger (and the Section Inspector) must be responsible for the whole of the track, not only part of it. They soon got used to the idea, which now works very well. All men, incidentally, in the gangs concerned receive an electrified lines allowance.

Measured shovel packing, using the flat-base or Scottish type of voidmeter is standard, and with the intense traffic it is not difficult to measure the voids in a reasonable time.

I am aware of the fact that all gangs do not make full use of voidmeters—in fact some, at the moment, do not possess their own set—but this is being investigated and I hope will soon be rectified.

The French method of "short" measured packing has been given a fairly extensive trial, but it has now been abandoned. With this method, chippings are spread only 8 inches either side of the rail instead of the usual 15 inches, the original idea being to make certain that the support to the sleeper is under the rail, and not nearer the ends or the middle. With our type of multiple unit stock with heavy driving axles on small diameter wheels, it was found that the short method would not hold the joint sleepers. Also, unless the formation was good, the packing up of other sleepers did not last as long as the older method.

As I have already explained, joints have always been particularly difficult on the Southern, but I must say that the majority of our gangers maintain them very well, and produce a top as good as on other Regions without such a preponderance of multiple unit trains.

In spite of this, we have less continuously welded track than most other Regions. We started experiments before the war, and in fact as a result of our tests and measurements, I believe the first published explanation of the limited expansion to be expected was an article of mine in the *Railway Gazette* in July, 1939. The war stopped our further tests, but in 1949 we installed a flash-butt welding machine at our depot at Redbridge, near Southampton. We first used it for long welded rails over bridges and for welding up shorts to make standard length rails.

Before embarking on an extensive scheme, our post-war electrification was started and it was realised that by welding conductor rails, we could save £900 per mile. This was an obvious saving, as compared with the then doubtful financial case for running rails.

With the completion of our present extensions, we are now reverting to running rail welding, but last year we completed 30 miles of track, using the thermit process in the District Engineer's depot or on site. This year it is hoped to do about double the amount. Our first long length, however, was put in near Crewkerne on our West of England main line in 1955, its continuous length being 1 mile. At the time it was the longest length on a fast (85 m.p.h.) main line on British Railways. This year it will be extended to 4 miles.

Returning to track maintenance, I would say that other length gang duties are similar to elsewhere, except that with shorter intervals between trains, the ganger has to plan his work very carefully and over a large part of the Region he cannot place a trolley on the line during normal working hours.

Permanent way renewals require very careful planning, as in most of the Region they can only be carried out at night, usually Saturday night, and the length of time for having possession of the line is often only 5 to 6 hours. As on other Regions, only a limited number of speed restrictions are allowed on a main route at a time, but with us the length of track to which each applies cannot be more than ½ mile, except occasionally in special circumstances. This sounds severe, but we can do it, and as long as we can, we must continue to do so, for it is so essential that trains should arrive in the London network of lines at the right time or the whole of our business train timings are upset.

As so much work must necessarily be carried out at night, preassembled relaying has been adopted wherever possible. Several of the former railway companies, including the Southern, did this by means of two cranes towards the end of the war, but although in 1946 we introduced a modified method using one crane only, we still had insufficient cranes to do as much as we wanted. In early 1948, when I was London East Divisional Engineer, we built in our divisional bridge shop, the first track relaying unit (excepting the pre-war Morris on the L.N.E.R.) from ideas and plans that had previously been formulated by Mr. C. W. King and Mr. J. D. West. Similar and modified units have since been built, but possession of two tracks is required when they are working. The Western and Eastern Regions are at present developing arrangements for units requiring single line only. We are also following up these ideas, but our third rail brings in an additional complication.

The conductor rail is never renewed at the same time as the running rails. It has a much longer life and therefore requires far less frequent replacement, but its renewal, although an easy operation by itself, would be an additional complication on the very few occasions when all three rails needed replacement together.

The conductor rails are not held down at all. They merely rest on a steel seating on the insulators, but on our newly electrified routes, where these rails are welded into quarter mile lengths, they are anchored against creep at the centre only, by spring steel anchors bearing against special toughened glass insulators.

For normal plain line track renewals, therefore, all that is necessary is for the third rail to be lifted off, moved over sideways and placed on the ballast. When the new track is in, it is replaced in the same way.

In order to be able to do this, I should explain that when taking occupation of a line, the normal procedure has to be adopted from a traffic point of view, but in addition prearranged possession of the "juice", as we familiarly call the electric current, must also be obtained.

To achieve this, the signalman in the rear of the section to be isolated, ensures that no electric train is in the section and advises other signalmen concerned. When it has been confirmed that the line is clear, the electric track lineman in charge requests the electric control room operator to open specified circuit breakers and confirms the numbers of the hook switches which he will open. A hook switch is an arrangement at the side of the conductor rail where the supply cable is connected, so that a man with a long handled hook can disconnect the power supply at that spot.

It is useful in local emergencies and also to ensure that if the control room erroneously closes that particular circuit, the rail is not livened up while men are still working on it. The hook switch may be a considerable distance away from the site of the work, and therefore the gang have a test box to put across the live rail and running rail, in which lamps light up if the current is not switched off.

The numbers of the circuits and hook switches which have to be operated are given in the details of the possession notices, so that the safety of men does not depend on the local man's memory of the circuits, although it is usually very good.

Apart from dealing with the conductor rails, plain line renewals are carried out generally as on other Regions. Please notice I have called it "pre-assembled" renewals, not "pre-fabricated". The materials are not fabricated in the depots; they are assembled.

The difficulties of carrying out major point and crossing renewals without undue interference with traffic is well known throughout British Railways. In order to be sure of completing the work in the very short time available, it has been standard practice on the Southern since before the war to assemble and line up accurately in the District Engineer's depot every job of this sort, except the like-for-like replacement of a standard half lead or crossover road. The layout is then marked, taken to pieces and loaded in the reverse order to that required on the site, which as you all know is most important.

With our modernisation programme, we have had several cases of major remodelling of important junction station layouts which have been most interesting to plan in detail. They often need a complete weekend occupation.

For the maintenance fettling of a junction, we use Kango hammers.

Rail-end stresses have called for special investigation by the Research Department at Derby. As a result of the battering of the joints by our multiple unit stock and because additional holes have to be drilled in the rail ends to take the copper bonds for the return electric current, it was particularly important for the Southern, and I was glad to provide a test length near Three Bridges.

Originally, we used two laminated copper bonds behind the fishplates, which, together, required two ⅞ inch diameter holes between the fishbolt holes in each rail end. Rail end failures occurred quite readily, particularly if the bond holes were badly spaced. In 1937 we started to use *one* of this type of bond with ⅞ inch terminals and one gas-welded " U " bond on the outside of the rail head. In order to ensure good electric contact, the copper terminals were expanded in the holes by means of a screw press, but this is now done by hammering a steel bullet into a central hole.

Even in a normal plated rail joint, the most common cause of failure originates from high fatigue stresses in the periphery of the bolt holes, usually the end hole in the running-on rail.

Since 1954, the Research Department has measured an enormous number of such stresses in track of different types and in varying conditions of maintenance under wheels of varying types of locomotives and rolling stock. For equal conditions of speed and track, it has been shown that wheels of most multiple unit electric motor bogies produce stresses greater than those of the average steam engines. Electric locomotives are still more punishing, although there are fewer of them.

Reducing the diameter of the fishbolt holes to 15/16 inch increases the fatigue strength by about 10%, but this would need special high tensile bolts. By retaining the standard size bolt holes and work hardening them, however, the strength is increased by about 50%.

As a result of this investigation, we are making a number of portable appliances designed by the Research Department, for work hardening the holes. Rails so treated will, we hope, be almost immune from bolt hole failures, except under abnormally corrosive conditions. We have been work hardening vulnerable P. & C. bolt holes at our works for some years.

A broken rail is not only a danger, but on the Southern even an interruption of 15 minutes can dislocate the service for some hours. When cracks are found, the rail can be changed at a time to suit traffic, and therefore it is most important to find the defects at this early stage. Systematic ultrasonic testing has been carried out since 1955, and our proportion of broken rails is very low.

On our electrified lines we had, in 1960, 30 rail failures per 100 miles of running line, compared with 2·9 for the rest of British Railways, but the number of *broken* rails was only :

5·0 per 100 miles on electrified lines	representing less than 17% of the total.
0·7 per 100 miles on non-electrified lines	

In the latest Research Department Report on the subject, the following appears:— " It is, however, most noteworthy that the Southern Region is the one Region which consistently reports fewer broken rails than cracked rails, both amongst plain rails and S. & C. rails ".

Lest I might be thought to have laid undue emphasis on the effect of broken rails on traffic, it is only fair to mention other occasional causes of interruption to our train services such as the displacement of the conductor rail, and short circuits.

In spite of the use of insulated tools and rubber mats or trough covers, a bar may be dropped or the exposed part of a shovel or fork may bridge the gap between the conductor rail and a chair, baseplate or the running rail itself, with the risk of burns or at least a temporary effect of the flash on the eyes.

Another cause of short circuits is unfortunately outside our control. While the Southern Region is not alone in being regarded as a convenient dumping ground for rubbish from adjoining property, our electrified track is particularly vulnerable. The irresponsible dropping of old bicycle wheels and other large metal objects on to the conductor rail can not only damage the running rail, but cause serious delay to thousands of passengers.

It is, however, in emergencies that our permanent way men always rise to the occasion whatever the weather and time of day or night, in order to get traffic running again, and I am glad to have this opportunity of paying tribute to them.

I have endeavoured to describe some of our problems, full well knowing that other Regions have some of them. We are all working together on them and a mutual interchange of information on our various attempts to combat them can do nothing but good.

Before closing, however, I must pay a tribute to my Assistant Engineer (Permanent Way)—Mr. L. G. B. Rock. He has helped me considerably in the preparation of many details in this paper, and put in a considerable amount of time in obtaining information—I am delighted he is your Chairman this year.