THE GREAT NORTHERN RAILWAY.

ENGINEER'S OFFICE,
KING'S CROSS, LONDON, N.
2nd June, 1905.

MY DEAR SIR,

Railway Engineers' Association.

STANDARDIZATION OF PERMANENT-WAY.

At a meeting held on the 27th January, 1905, a Committee, consisting of :—

Mr. J. BELL ; Mr. W. MELVILLE ;
„ W. J. CUDWORTH ; „ A. ROSS ;
„ A. GORDON ; „ E. B. THORNHILL ;
Mr. W. B. WORTHINGTON ;

was appointed to consider "RAILWAY JOINTS," as the first step towards the above ; and, subsequently, I was appointed Chairman of the Committee.

On the 9th March I communicated with the members, asking them to kindly let me have full particulars and drawings of the Joint now in use by each of their Companies, with any proposals they might wish to advance with a view of improving the Joint, and I have pleasure in acknowledging the courteous and full manner in which that communication has been replied to.

I have had bound up, and send you herewith, a complete set of the drawings returned by the members, and the following are extracts from the communications received by me.

STANDARDIZATION OF PERMANENT WAY RAIL JOINTS.

Remarks, in reply to circular letter of the 9th March, 1905, by the Engineers of :—

No. of Drawing referred to.

3. Great Central Railway.

4. Great Eastern Railway.

In my opinion, the ordinary fishplate joint is simple and effective, and where the same has not been satisfactory, it is owing to faulty design in the rail or fishplate, or in both.

The quality of the ballast, and the number of sleepers in a length of rail, are also very important factors.

The ordinary fishplate can be improved:—

(*a*) By substituting two 12 ins. × 6 ins. timbers at the joints, instead of two ordinary sleepers.

(*b*) By using timbers and special joint chairs in order to reduce the spacing at the joints.

(*c*) By cross jointing the road, as the solid rail on one side undoubtedly helps the joint, and has the advantage of preventing creeping.

5 to 17. Great Northern Railway. (See report).

18. Great Western Railway.

In some recent drop tests of rail joints with ordinary fishplates (particulars of which are given) "in only one instance out of the six tests did the fishplate break, whereas the rail broke four times."

I am of the opinion that the suspended type is the best, approximately as nearly as possible to the strength of the rail itself, and capable of passing on without check the curvature of the wave motion of the rail itself. I am of the opinion that such type of joint is superior to the bridge or supported type, and tends not only to smoother running but to the maintenance of the road itself.

The comparatively large space which exists between our present type of fishplate and the rail itself, admits of the fishplates closing in as natural wear takes place between the fishing angle of the rail and the top of the fishplates, and so obviates the possibility of a fishplate standing out clear of the head of the rail and so fouling the flange of the wheel.

19. Hull and Barnsley Railway.

20 to 23. Lancashire and Yorkshire Railway.

I have recently adopted a heavier plate as shown on drawing (No. 21.)

Drawing (No. 24) shows Hart's joint, a few of which have been on trial for a number of years, but they were made at great expense by machinery. It is believed that the joint can be made by stamping, and the drawing shows the form it would take if so made.

24 and 25. London and North Western Railway.

The first deep fishplates, see drawing No. 25, were used experimentally about 1873, and came into general use three years later for main lines only, but they did not give such good results as anticipated, and were abandoned in 1897 in favour of shallow fishplates of the previous section.

The fishplate now in use gives general satisfaction.

26 and 27. London and South Western Railway.

Deep fishplates were discontinued about four years ago, being found in practice to be unsuitable.

The principles of the Bonzano joint are approved. Experiments have been made recently with a long outside (but short inside) fishplate of the ordinary section, carried through the jaws of chairs on each side of the joint and with six bolts instead of four.

The obvious defect of the present joint is the impossibility of preventing the movement between the rail and the fishing surfaces, however well the plates may be bolted up.

This movement must be due as much to tendency on the part of the joint plates to buckle as anything else, and it would therefore seem that the only means of getting over this weakness would be to give the plate greater depth and thickness towards the centre, but no doubt the bridge principle, which has not been adopted hitherto, would be an extra source of strength.

28. London, Brighton and South Coast Railway.

The present joint is a satisfactory one, as far as it goes, but I think it might probably be improved if the fishplates were lengthened and six bolts were used instead of four, as by so doing there would be a larger bearing area between the fishplates and the rail; and to this extent, it would, in my opinion, make the joint work better, and keep it effective longer than with the present fishplates.

The only drawback to the latter suggestion is the increased spacing that would be entailed between the two sleepers, and I question very much if the extra benefit obtained from the longer fishplates would not be lost by the increased bearing.

29. London, Tilbury and Southend Railway.

30 and 31. Midland Railway.

It would be an improvement if the fishing angle were 20 degrees (as in British standard section of rail); also if the plates were shorter, say 17 inches, so that the chairs on each side of joints might be brought closer together.

A further improvement would result from the use of 12 or 13in. timbers on each side of joint.

Deeper and stiffer fishplates—as shown on drawing No. 31—are proposed to be used.

32 to 34. North Eastern Railway (York).

The experimental joint shown on drawing 33 has been laid down two years, and that shown on drawing 34 about 6 months, and so far the results have been satisfactory.

Twelve-inch sleepers on each side of suspended joints would be a great advantage, but unnecessary for the span or bridge joints shown on drawings 33 and 34.

The defect of the present joint is its weakness, which results in the wear of the fishplates and parts of the rail in contact therewith, causing the joint to become loose, and so destroying the continuity of the surface of the rail during the passing of vehicles over it. This leads to shocks at the on-going ends of the rails, increasing in severity as the wear increases. The shocks loosen the on-going sleepers, and render the rails more liable to fracture near the joint.

During the last four years, of the broken rails reported to me 60 per cent. of the fractures had taken place within four feet of the joint; and of the rails that broke at the on-going half 70 per cent. of the fractures were within four feet of the joint.

The conditions I should lay down for an ideal joint would be :—

(1) The prevention of any up and down motion of the rail ends whilst vehicles are passing over them.

(2) Sufficient elasticity to prevent hard riding over the joints, and to bring them into uniformity with the rest of the rail.

(3) The least expensive method of obtaining the above results.

In the supported joint we are experimenting with, the rail is allowed full freedom to expand, contract or creep, and I am of opinion that the many failures of supported joints have been caused by the support being attached to the rail, which when the rail creeps, carries the attachment with it, and interferes with the road bed.

35. North Staffordshire Railway.

We have tried various kinds of joints, notably the joint chair and clip fishplates, but we have found in practice that the latest system is the best.

36 and 37. South Eastern and Chatham Railway.

On the South Eastern section the ordinary middle chair is used upon each side of the suspended joint, as shown on drawing No. 36.

On the Chatham section the joint chair is used under the joint. The chair is secured to the rail with two through joint bolts.

Previously to the introduction of these joint chairs great difficulty was experienced in keeping a top on the road.

Since their introduction there has been a great improvement in this respect, pointing to the fact that joint chairs do strengthen the road and at the same time minimise the creep.

38. Caledonian Railway.

The necessity of there being a gap to allow of expansion results practically in there being a "step," this arising by depression at the ends of the rails with the load. This "step" is accentuated by unequal wearing of the rails at their ends.

An ideal joint would be one of strength equal to the other parts of the rail; and everything points either to a continuously supported joint, or to a lessening of the lengths between the points of bearing on either side of the expansion gap.

Then the importance of having the bearing surfaces perfectly and continuously tight fitting cannot be over-estimated; and the bolts should be of the most improved description, without tendency to get slack.

39. Glasgow and South Western Railway.

The defect of the ordinary type of joint might be overcome by a heavier sleepering at the joint and also by laying the joint sleepers closer, together with stronger and sufficiently long fishplates to transmit the load from the rail through the fishplates on to the sleepers or chairs adjoining.

40. Great North of Scotland Railway.

An inquiry made of the various Railway Companies in 1898 as to their preference for deep or ordinary fishplates received numerous replies, the great majority giving preference to the ordinary fishplate, many having tried the deep fishplates and given them up.

An objection to the ordinary fishplate joint (and one for which it is difficult to suggest a remedy) is that if the bolts are tightly screwed, as they ought to be, so that the fishplates may act as a proper support to the rails, there is the risk of the expansion of the rails being prevented during sudden increases of temperature and of the rails being in consequence displaced by the heat.

To avoid this risk our practice is to slightly slacken the bolts previous to the hot weather setting in, so as to provide for the free expansion of the rails in hot weather, but this necessarily renders the fishplates less effective for properly supporting the rails at the joints.

An ideal joint, in my opinion, would be one that while effectively providing against an undue deflection, either vertically or laterally, of the rails, would also permit of the free expansion and contraction of the rails.

41 and 42. Highland Railway.

I prefer, for the running road, a suspended joint. We only use the joint chair (shown in Drawing No. 42) in yards and cross-overs, to save cutting of rails, and on bridges with longitudinal beams carrying the rails.

43 to 45. North British Railway.

The present form of joint, while extremely convenient and suitable, is lacking in stiffness, both vertically and horizontally.

The best form of joint is got by a compromise between the suspended and the supported form.

Drawings No. 44 and 45 show three forms of such joint, with which I have been experimenting.

In the first, guard chairs are shown ; but the arrangement with ordinary chairs is exactly similar. A number of these joints, near Edinburgh, give every satisfaction.

I consider the third form of joint, viz., that with a special steel plate, the best.

The points to be aimed at are :—

(1) That the fishplates be made practically equal in strength to the rails they are connecting.
(2) To minimise the strain on the bolts.
(3) That the joint have as much lateral strength as the unbroken rail.
(4) To prevent the creeping of the rails.

46 to 48. Great Northern Railway of Ireland.

I have tried many kinds of rail joints, both supported and suspended, but none of them have given such satisfaction as the system I have introduced of placing a timber, say 9ft. long, or ordinary 10in. × 5in. sleeper, in a longitudinal position under the rails either under or over the ordinary transverse sleepers as shown on Drawings No. 46 and 47.

I find this system makes the best support and assistance to our ordinary fish joint.

49. Great Southern and Western Railway (Ireland).

In an ideal joint :—

(1) Its strength and stiffness should be equal to that of the rail itself.

(2) With wear, these qualities should deteriorate no faster for the joint than for the rails which are joined.

The practical difficulty of obtaining perfect fitting of the fishing surfaces of both rails and fishplates is an inherent defect which cannot well be avoided.

50. Midland Great Western of Ireland.

51. Midland Railway Northern Counties Committee.

In the present system of joint, the fishplates are too short.

Four fishbolts in a rail joint are not sufficient. I have been using six bolts with good results.

In order to bring the fishplates close to the jaws of the chairs, a small piece is cut out of the fishplate : (clip fishplates are used).

The rails used are 60ft. long, and break joint. The result has been highly satisfactory.

SUMMARY.

All the Companies use bull-headed rails, with the exception of the Midland Great Western (of Ireland) Railway, which uses a flange rail.

SUSPENDED JOINTS.

The South Eastern and Chatham Company use a suspended joint on its South Eastern section only.

The Highland Railway uses a suspended joint for all running roads, but not for yards.

All other Companies use the suspended joint exclusively.

SUPPORTED JOINT.

The South Eastern and Chatham Company use a supported joint on its Chatham Section.

At the present time it is considering a new standard joint for use over both sections of its line.

Thinks that joint chairs strengthen the road and minimise creeping.

The Highland Railway uses a supported joint for yards, cross-overs, and on bridges with longitudinal timbers.

SPAN JOINTS.

The Great Northern, London and South Western, North Eastern, and the North British Companies send drawings of span joints which they are testing experimentally.

The Caledonian and the Glasgow and South Western Companies also mention, with approval, some form of span joint.

DEFECTS OF THE PRESENT JOINT.

The defects in the ordinary suspended joint to which attention is called are :—

(*a*) The fishplates are too weak ; they should be deeper and thicker.

(*b*) The fishplates are too short, and afford insufficient bearing area of the fishing surfaces.

(*c*) The fishplates do not properly support the rails when bolts are slackened to provide for free expansion of rails in hot weather.

(*d*) It is difficult to obtain and maintain a perfect fit of the fishing surfaces

(*e*) There is too much strain on the fish bolts.

(*f*) Four fish bolts are insufficient.

(*g*) Sleepers are not close enough at the joints.

(*h*) The joint is not so strong as the rail.

(*i*) Creeping of rails is not prevented.

SUGGESTED IMPROVEMENTS.

To remedy the above, the following suggestions have been advanced :—

(*k*) Strengthen the fishplates by making them thicker and deeper.

(*l*) Lengthen the fishplates.

(*m*) Use stronger bolts.

(*n*) Use six bolts instead of four.

(*o*) Increase the clearance between fishplate and rail to $\frac{7}{32}$in., so as to give greater latitude for tightening up after wear.

(*p*) Use special chairs on each side of joint.

(*q*) Use special timbers, 12 or 13ins. wide instead of ordinary sleepers on each side of the joint.

(*r*) Bring the sleepers or timbers closer together at the joints.

(*s*) Place longitudinal sleepers under the joints, in addition to the ordinary transverse sleepers.

(*t*) Let the rails break joint.

(*u*) Use longer rails, and thus, fewer joints.

CONCLUSIONS.

From the above it would appear that while there exists a diversity of practice as to detail, there is a preponderance of opinion in favour of a suspended joint.

It is evident that were it not for the necessity of making provision for expansion and contraction, a joint could be fitted up without difficulty that would be as strong as the rails; and an ideal joint may be described as one, which, while equally strong as the rails, would also provide against undue deflection of the rails either vertically or laterally, and at the same time permit such expansion and contraction of the rails as may be due to changes of temperature.

An enquiry into the subject of joint construction must, as a matter of necessity, involve consideration being given to :—

(*a*) The support on each side of the joint.

(*b*) The design of the fishplates.

(*c*) The means of securing the fishplates to the rails.

(a) The support on each side of the Joint.

With either a suspended or a span joint, cross sleepers or timbers will be required on each side, and in most cases chairs overlying the sleepers or timbers; and to meet the difficulty of shortening the span of the joint in consequence of the keys in the chairs abutting against the ends of the fishplates, the bases of the chairs may be cast extending underneath the rail and the carry of the joint reduced.

(b) The Designs of the Fishplates.

These are various, but preference seems to be given to short parallel plates held in place between the top and bottom tables of the rails by four steel bolts and nuts; deep fishplates have been used in many instances, but have now been almost entirely discarded on account, it is said, of their being a bad fit.

A pair of parallel plates to a joint, considered as a girder, will not, owing to want of depth, give a strength equal to that of the rail, but this desirable end can be attained by using deep fishplates, clearly pointing to the desirability of a deep fishplate being designed that will give the necessary strength, and at the same time be a good fit.

There are a number of special forms of bridge joints advanced which deserve careful consideration, particularly that introduced by Mr. Bell, and the Bonzano joint.

A distinctive joint, that of Messrs. Holmes, Hart and Watson, where the ends of the rails themselves are shaped to form a splice joint united by bolts and nuts demands full consideration.

(c) **Means of securing the fishplates to the rails.**

This part of the enquiry seems to me to be one of the utmost importance.

Considering an ordinary pair of fishplates fastened by four bolts and nuts, in the past the holes in the web of the rails have either been oval or circular. If oval, the bolt may be nearly a fit in the vertical direction, but if circular the holes are usually $\frac{5}{32}$in. greater diameter than the bolts, and with a rolling load passing over these, one end of the plates is depressed, while the load continuing, depresses the other end, causing a continuous see-saw motion as the wheels and trains pass over the joint, and from this consideration it would appear that an oval hole in the rails is preferable to a cylindrical one.

At the same time, with all bolts and bolt holes, where provision is made for expansion and contraction, there must be some more or less room for play left.

In the past the allowance for the expansion and contraction has been made in the web of the rails; the play might be mitigated by making the bolts on one side of the joint a tight fit, giving all the play to those on the other side; or why not make all the bolts through the web of the rails a fit and give the allowance for movement in the fishplate holes?

Consideration should be given to the number of bolts and nuts, whether four or six; indeed, it seems well worth consideration whether the fishplates should not be secured by means of five bolts and nuts.

Fishplates most frequently give way by buckling slightly at the joint, and to prevent this, a centre bolt might be used for keeping the plates together at that point, and the side bolts might then be made a perfect fit in the holes in the web of the rail, the allowance for expansion and contraction being given in the fishplate holes.

As to the holes in the fishplates, consideration should be given as to whether these should be square, round, or pear-shaped; or whether the plate itself should be grooved to keep the bolt from revolving.

I trust I have made myself understood in my remarks on these various matters. There is much to be thought of before we come to an agreement on a Standard Joint, and I intend, after I have given the members of the Committee sufficient time to consider the drawings and documents placed before them, to suggest a meeting to discuss the various points raised.

I am,

Yours very truly,

A. Ross

To W. D. Cudworth Esq
York

G.N. A 144—75-5-05