MINISTRY OF TRANSPORT

RAILWAY ACCIDENT

Report on the Failure of an Overbridge that occurred on 10th May 1965 at Clapham Junction

IN THE
SOUTHERN REGION
BRITISH RAILWAYS

LONDON: HER MAJESTY'S STATIONERY OFFICE

PRICE 3*s.* 6*d.* NET

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1965

MINISTRY OF TRANSPORT,
ST. CHRISTOPHER HOUSE,
SOUTHWARK STREET,
LONDON, S.E.1.

25th August, 1965.

SIR,

I have the honour to report for the information of the Minister of Transport, in accordance with the Order of 13th May, 1965, the result of my Inquiry into the cause of the failure, at 08.36 hrs on Monday, 10th May, 1965, of a steel overline bridge, carrying among other things a signalbox, on the London side of Clapham Junction in the South Western Division of the Southern Region, British Railways.

The bridge which is some 60 years old and comprises two 120 ft long main girders spans the Up and Down Windsor Through and Local lines, the two Kensington lines and three sidings. As a result of very heavy corrosion an end diagonal tension member in the London side girder failed, and the girder jack-knifed and fell some 4ft at a point about 9 ft from the end bearing; it thus became foul of some of the running tracks below it. It was only the stiffness of the end panel joints and the strength of other members that prevented the girder's complete collapse. Photograph 1 shows the result of the failure.

The signalbox, Clapham Junction 'A' box, is located between the main girders and rests on a deck supported by cross-girders between the lower flanges of the main girders. This box deals with some 1250 train movements a day and is among the busiest on British Railways. The signalmen realised that something was seriously amiss when they heard the noise of the failing girder and found their box tilting, and they immediately placed all the signals at Danger and sent the Obstruction Danger signal in all directions before evacuating the box. Fortunately all the trains approaching the bridge were sufficiently far away to be stopped by the signals. There were no casualties.

Attached to the girder that failed at the end remote from the failure is a signal gantry which spans the Up and Down Main Through and Local lines. It was found after inspection that this gantry was not damaged and for a short while trains were allowed to pass under it at very slow speed. Subsequently, however, even these movements were stopped because it was considered that vibration might cause the failed girder to collapse completely.

The effect of the sudden and complete stoppage of trains at this hour of the morning on such extremely busy lines, and the resulting closure of Waterloo Station which is served exclusively by these lines and which is used by some ¼ million passengers a day, resulted of course in a large number of passengers being very seriously delayed; the situation was aggravated by the fact that the failure occurred on a Monday when the morning peak traffic is heavier than on other days. So far as was possible, endeavours were made to prevent further passengers entering trains bound for Waterloo, but owing to the severe congestion on the communications system, which is inevitable when such an incident occurs, they were not all successful.

Initially, passengers in Up Main and Local line electric trains were detrained at Wimbledon and diverted to the Central Division and to the services of London Transport which themselves became very congested; that station is not equipped to deal with such an emergency and I have heard nothing but praise from passengers who had to detrain there for the way in which the station staff and the officers of the South Western Division handled the difficult situation. Passengers in steam trains between Woking and Wimbledon were also detrained at Wimbledon but trains that had not at the time reached Woking were terminated there; the Southampton boat trains however were diverted via the Central Division lines to Victoria. Later, a restricted number of electric trains were run between Wimbledon and Clapham Junction.

Trains that run over the Windsor lines through Clapham Junction, i.e. those from Windsor, Richmond, Reading, Hounslow etc, were as far as possible terminated at Barnes where passengers transferred to London Transport services, as did the passengers at Clapham Junction from trains that had passed Barnes. A shuttle service was however run between Barnes and Clapham Junction.

It soon became clear that the necessary repairs to the failed girder could not be completed in time for the evening return services from Waterloo, and plans were made to start trains from those stations at which they had been terminated, but all steam trains to Southampton and Bournemouth were started from Woking. The evening service arrangements generally ran smoothly, although considerably prolonged journeys were inevitable.

In the meantime, the Chief Civil Enginer arranged for a 75 ton diesel-hydraulic crane to be sent from Nine Elms Motive Power Depot and this was used to support the girder and prevent it from falling further. Steel trestling, of a type developed for use by the Army, was positioned under the fractured portion and the girder was gradually raised by jacks. Helped by fine weather, this work was completed by 06.00 hrs on Tuesday, 11th May, when all the passenger running lines, except the Up Windsor Local line, were reopened for traffic, trains being passed at restricted speed. The Up Windsor Local Line was reopened for traffic that evening, and all the speed restrictions were removed on Tuesday, 18th May.

The power frame in the signalbox lies parallel to the tracks and, as a result of the failure, the London end dropped considerably, and some of the levers, fortunately not the signal levers, were put out of action. The frame remained rigid and after the initial lift of the girder all the levers were again capable of being operated.

Description

The site

2. Sheet 1 of the attached drawings shows the layout of Clapham Junction and the location of the overline bridge, and it includes a site diagram showing the lines of the South-Western Division that were affected by the failure. This drawing and diagram show that the Main lines and the Local lines from the South-West and the suburban lines from Windsor, Richmond, Ascot, Reading, Hounslow, etc. converge just beyond Clapham Junction station which has separate platforms for each set of lines, and that all the trains on these lines are signalled by Clapham Junction 'A' signalbox, 2½m short of Waterloo, which is situated on the overline bridge that failed. The next box towards Waterloo is West London Junction, 1,079 yards distant, while the boxes on the country side are Earlsfield, 1¾m towards Wimbledon, and Clapham Junction 'C' box, some 325 yards towards Barnes.

The signalling

3. Clapham Junction 'A' signalbox is equipped with a power frame with 103 levers which was installed in 1936. All the running line signals are colour lights.

The overline bridge

4. The overline bridge (no. S14B) on which Clapham Junction 'A' signalbox is situated, spans nine tracks which are, from North-West to South-East, Up and Down Kensington lines, Up Windsor Local, Up Windsor Through, Down Windsor Through, Down Windsor Local, and three carriage sidings. Attached to the south-east end of the London side main girder of this bridge is a signal gantry which spans four tracks which are, again from North-West to South-East, Up Main Through, Down Main Through, Up Main Local and Down Main Local.

5. The bridge, which was erected in 1906 for the purpose of locating a signalbox on it, comprises two steel lattice main girders, 120 ft span, of the 'hog-backed' type, set 30 ft apart and connected at their lower flanges by steel cross girders which support a deck on which the signalbox and some other structures are located. The deck is mainly of timber which, where not covered by structures, is clad with asbestos cement sheeting. At the south-east end, however, i.e. the end away from the failure, the deck is of concrete.

6. Sheet 2 of the drawings shows the girder that failed. The top and bottom chords each comprise two 5 in x 5in x ⅝ in angles and a 16 in x ½ in flange plate: the vertical members two pairs of two 5 in x 5 in x ½ in angles, the angles in each pair being rivetted together: and the diagonal tension members two flats of various sizes, those in the end panels being 14 in x ½ in. Inserted between the two angles and the two pairs of angles of the top and bottom flanges and vertical members respectively at the appropriate corners of each panel are ⅝ in thick gusset plates, through which the angles and pairs of angles are rivetted together. Each plate of the diagonal tension member is rivetted to an outside surface of the gusset plates, and there is thus an air space of ⅝ in between the plates. It was the diagonal member of the north-west end panel of the London side girder that failed.

7. The main girders are supported at each end by a steel stanchion and the steel stanchions at each end are cross-braced. Adjacent to the north-west side stanchion of the London side girder is a 'run' of heavy cables which are lead to the signalbox in conduits along but not too close to the inside of this girder. The timber deck, which, at this end of the bridge, is clad with sheeting, abuts the diagonal member at a point about 6 ins above the top of the lower gusset plates.

8. During 1940, steel portals were attached to the vertical members across the top of the buildings and clad with ⅜ in steel plates, as a protection against incendiary bombs and shrapnel. The weight of the portals and cladding was about 30 tons.

9. The total weight of the structure including the steel roof was approximately 200 tons. The original calculations for the structure are not available, but calculations made subsequent to the failure indicate that the total tensile load in the end diagonal member that failed was 52.5 tons, with a designed stress of 3.75 tons/sq inch.

Examination of bridge after failure

10. An examination of the bridge after the failure showed that the lower ends of the diagonal members at the south-east end of the London side girder and both ends of the country side girder had at some time been strengthened by the rivetting of additional steel plates to the gusset plates and diagonal members. The diagonal member at the north-west end of the London side girder, which failed, had however not been strengthened.

11. An examination of the diagonal member that failed indicated that there was probably an almost unbroken skin of paint on the outside surface of the outer plate, although there was evidence of corrosion holes right through this plate at the point of fracture which was along the upper edge of the gusset plate to which it was attached. The inner surface of this plate bore no evidence of paint and was very severely corroded along the edge of the gusset plate and for some distance above it. The outer surface of the inner plate bore no evidence of paint near the line of fracture, which was below the level of the deck, where there was deeply pitted corrosion over an area of about 6 sq ins. The inner surface of this plate was practically completely corroded away at the line of fracture and, again, the corrosion extended for some

distance above it. The Upper edge of the gusset plate was heavily corroded and had the appearance of a spongy mass of rust flakes some of which had dropped from the diagonals. Throughout their length there was little evidence of paint on the inside surfaces of the diagonals which were rusting throughout. When struck with a hammer some distance from the gusset plate much rust fell away. The photographs 2-6 show the extent of the corrosion and photograph 2 shows where the deck abutted the diagonal.

12. The effective sectional area over which the two plates were intact was found to be only about 1.13 sq ins, as against the sectional area of 14 sq ins when new; of the 1.13 sq ins, about 1.0 sq ins was in the outer plate and about 0.13 sq ins in the inner plate. The theoretical stress in the intact metal was therefore of the order of 40 tons/sq in, as against its designed stress of 3.75 tons/sq in.

13. Sample pieces of metal from the diagonal members were sent to Messrs. Sandberg, Consulting, Inspecting and Testing Engineers, for metallurgical examination. This showed that the material in the members was mild steel with no unusual features, but with a slightly lower carbon content than is the present day practice as laid down in British Standard Specification 15. The yield points varied from 13.6 to 16.3 tons/sq in, not unlike the minimum specification of 16.0 tons/sq in for modern mild steel. The ultimate strength varied from 21.4 to 22.8 tons/sq n which was well below the minimum specification of 28 tons/sq in in B.S.S. 15. It is therefore quite clear from the above that some considerable redistribution of stresses had taken place before the final failure and that this bridge must have been in a precarious condition for some considerable time.

Instructions

14. Civil Engineering Handbook No. 6, entitled 'Examination of Structures', which was issued by the British Transport Commission (now British Railways Board) in 1952 and was reprinted in 1961, lays down the frequency of examination of different types of structures and the detailed duties of the Examiners. In general, it requires a structure of the type of the overline bridge concerned to be given a superficial examination every six months by the Permanent Way Inspector and a complete inspection at intervals of not less than 3 years. It also states that 'Advantage should be taken whenever scaffolds are erected for any purpose to carry out detailed inspections'.

15. The Handbook lays down the trades from which 'Appointed Examiners' are to be recruited and it states 'They must be competent at ladder work, conscientious and work with the minimum of supervision'. It details the duties and the responsibilities of Appointed Examiners as follows:—

> 'To examine such bridges and structures as the District Engineer directs. To draw the attention of their supervisor to all defects and irregularities found during the course of their examination, including those noted in parts of the structure which do not fall within the normal field on which they report in detail, and to make a written report.
>
> The report is to conform to the system of reporting laid down by the Chief Civil Engineer and is to contain a brief description of the structure under examination together with a list of defects, observations on 'tell-tales', check readings of plumbings, notes on the conditions of paint, and simple records of the extent of corrosion or deterioration of sections.
>
> Where in the opinion of the examiner, condition calls for urgent action, the normal written report should be preceded by a direct message from the examiner at the site to his supervisor.
>
> If, in the opinion of the examiner the condition is such that the safe capacity of the structure to carry full and unrestricted loading is in question, the examiner may take steps with local permanent way staff to block a line until the arrival of his supervisor, or the District Engineer'.

The Handbook contains 'Instructions to Appointed Examiners of Structures' the relevant extracts from which are attached as an appendix. Among other things, it requires him to draw the attention of the supervisor to any decking etc. that needs to be removed to enable a complete examination of the essential parts of a structure to be made.

16. The Handbook also defines the responsibilities of the District Engineer and the appropriate Supervisor. The District Engineer is given the responsibility of ensuring that inspections are carried out at the proper intervals and that reports are submitted, and it is also his responsibility to arrange for the adequate scrutiny of all reports. The appropriate Supervisor is given the responsibility of arranging that decking etc. is removed if required by an Examiner and of ensuring that the Examiners 'adequately fulfil their duties and carry out the examinations and complete their reports thereon at the appointed intervals, and that such reports are forwarded to the District Engineer'. It is also his responsibility 'on a report made to him by an appointed Examiner of the existence of a defect in a structure which appears to require urgent attention or further investigation, to report the matter personally to the District Engineer'.

17. The Handbook also includes samples of standard forms to be used by appointed Examiners when preparing reports. The forms which are issued to the Examiners detail a list of all the main members of different types of structures against which the Examiner is required to describe their condition using the letters 'G' for good, 'F' for fair and 'P' for poor. There is a space for Remarks in which he is required to amplify the above general description when necessary and blank sheets are also provided for this purpose. The main form also has horizontal columns at the bottom for 'Comments —by the Examiner', 'Recommendations—by the Supervisor' and 'Action to be taken—by the District Engineer'.

18. On the Southern Region, the Handbook was issued to all District Engineers in 1953 with instructions that endeavours should be made to inspect all bridges such as this overline bridge every two instead of every three years. The 'appropriate Supervisor' referred to in the Handbook is the District Steelwork Inspector. In the Woking Engineering District, in which this bridge lies, the arrangement was for all examination reports on a particular structure to be studied by the Steelwork Inspector and then for one copy to be placed on his particular file, and for another copy to be forwarded by him to the District Engineer's office. Here, the reports were scrutinised first by the District Engineer personally and subsequently by the Assistant District Engineer and the Technical Assistant, and they were then placed on the particular file for the structure concerned.

Report

Bridge no. S14B Clapham Junction (in which the failure occurred)

19. This bridge was examined on 5th February, 1961, by *Examiner L. Avins*. His general description of certain members was as follows:

Cross girders	P
Stiffeners	F
Tie bars	F
Main girders	G
Bracings	G
Rivets and bolts	F
Painting	P

He did however record the following in the Remarks:

'London girder, starting from the Up Ludgate side generally the bends of the double 5" x 5" x ½" angle stiffeners are thin or perforated at one place over the U.W.L. (Up Windsor Local) the flange of one angle is wasted away 6" long. The first 14" x ½" flat tie bar is eaten away 6" long near bottom connections also the one inside the bridge is perforated'.

He included a sketch to illustrate the corrosion in the tie bar and marked the affected portion in red.

20. Commenting on the cross girders between the main girders, Avins said

'These are generally pitted, the worst ones are over U.W.L. and sidings No. 1, 2, 6. Cross-girder No. 3 U.W.L. generally deteriorated web thin (perforated with inspection hammer London end)'.

He also commented on some defects in the trestles (and stanchions), staircase angles and steel roof plates.

21. *Mr J. Taylor, Steelworks Inspector*, made no comment in the 'Recommendations' column of the front page of the report but on the last page of the remarks he wrote, on 8th February, 1961, the following:

5" x 5" x ½" Angle stiffeners	For attention
14" x ½" Flat ties	" "
Rivets over tracks	" "
Cross girders	" "
Trestles and stair treads	" "
Steel roof plates	" "

22. This report was not seen by *Mr R. A. Hamnett, the District Engineer*, nor by any other Engineer in his office before the failure. After the failure it was found on the proper file.

23. This bridge was again examined on 3rd May, 1964, by *Examiner W. Shelley*. His general description was as follows:

Main girders	F.
Cross girders	G.P.
Bearings	G
Bracings	G
Rivets and bolts	G
Welds	G
Trestles	F
Painting	F

24. He expanded on the above by drawing attention to heavy corrosion throughout and several perforations in a cross girder (no. 5) and to heavy corrosion at the base of the vertical members over the Up Windsor Local and Through lines and to a tee bracing over the former. He did not comment on the diagonal member that failed.

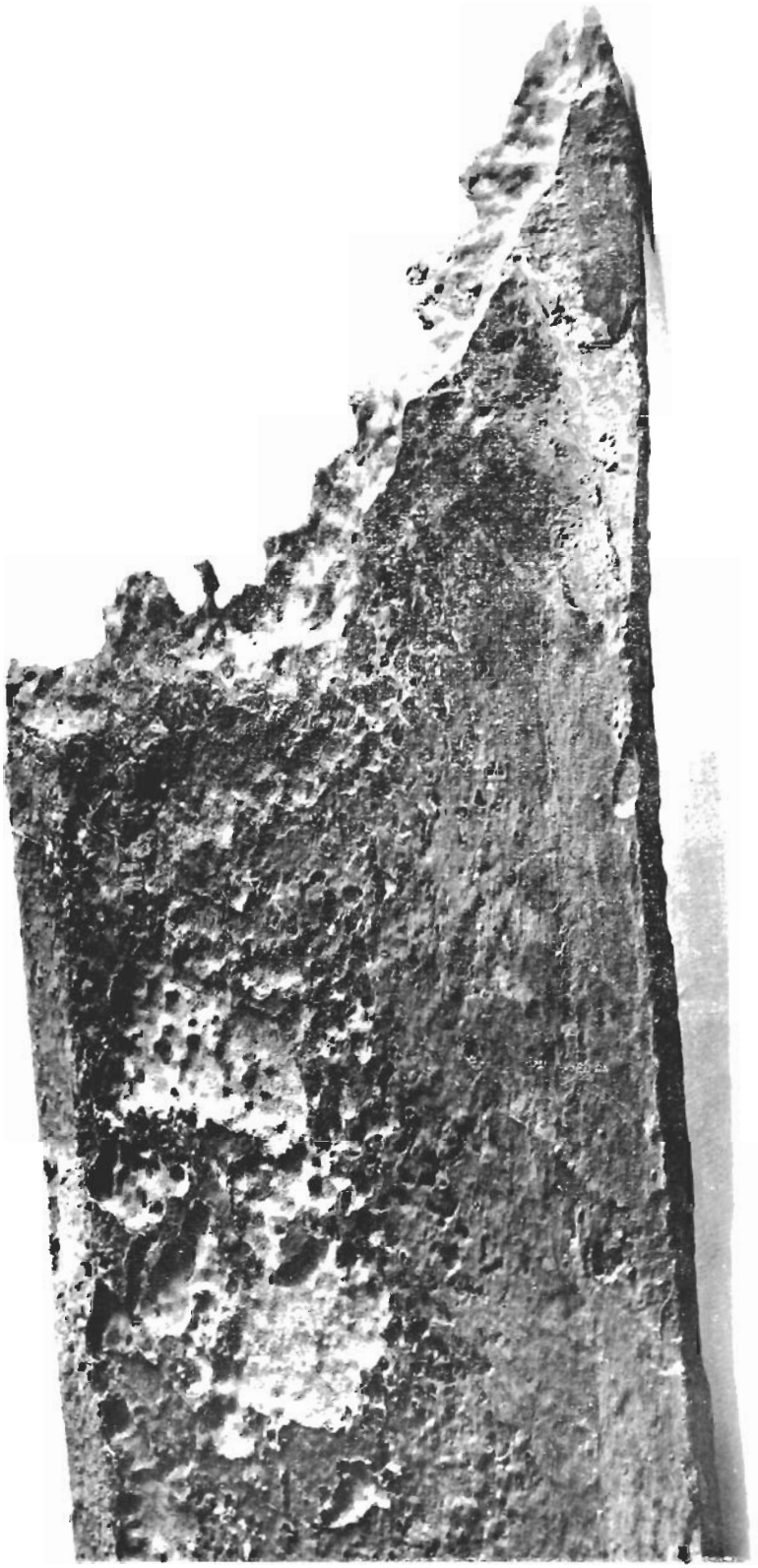
25. Mr Taylor forwarded the report on 2nd June, recommending the defects referred to above 'for attention'. Mr. Hamnett initialled the report on 9th June, and made no comment.

Evidence

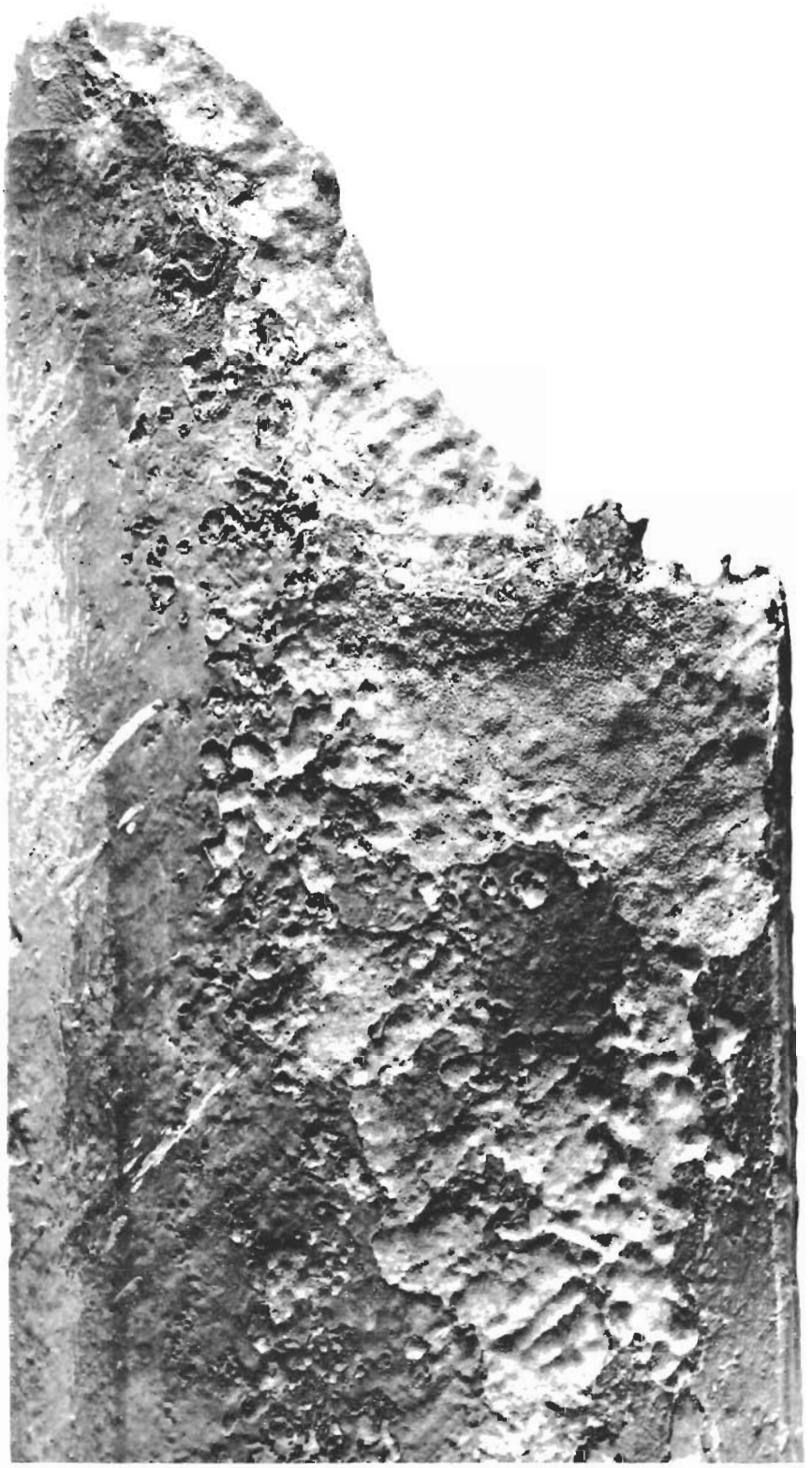
26. Examiner L. Avins is 55 years of age and has been an examiner for 11 years, having previously been a chargeman plater. He said that he usually inspected station and motive power depot roofs and other high buildings, but he undertook the inspection of Clapham Junction bridge no. S14B in 1961 because all the arrangements had been made for track possessions and Examiner Shelley, who usually

Photograph No. 1
The bridge at Clapham Junction after the failure.

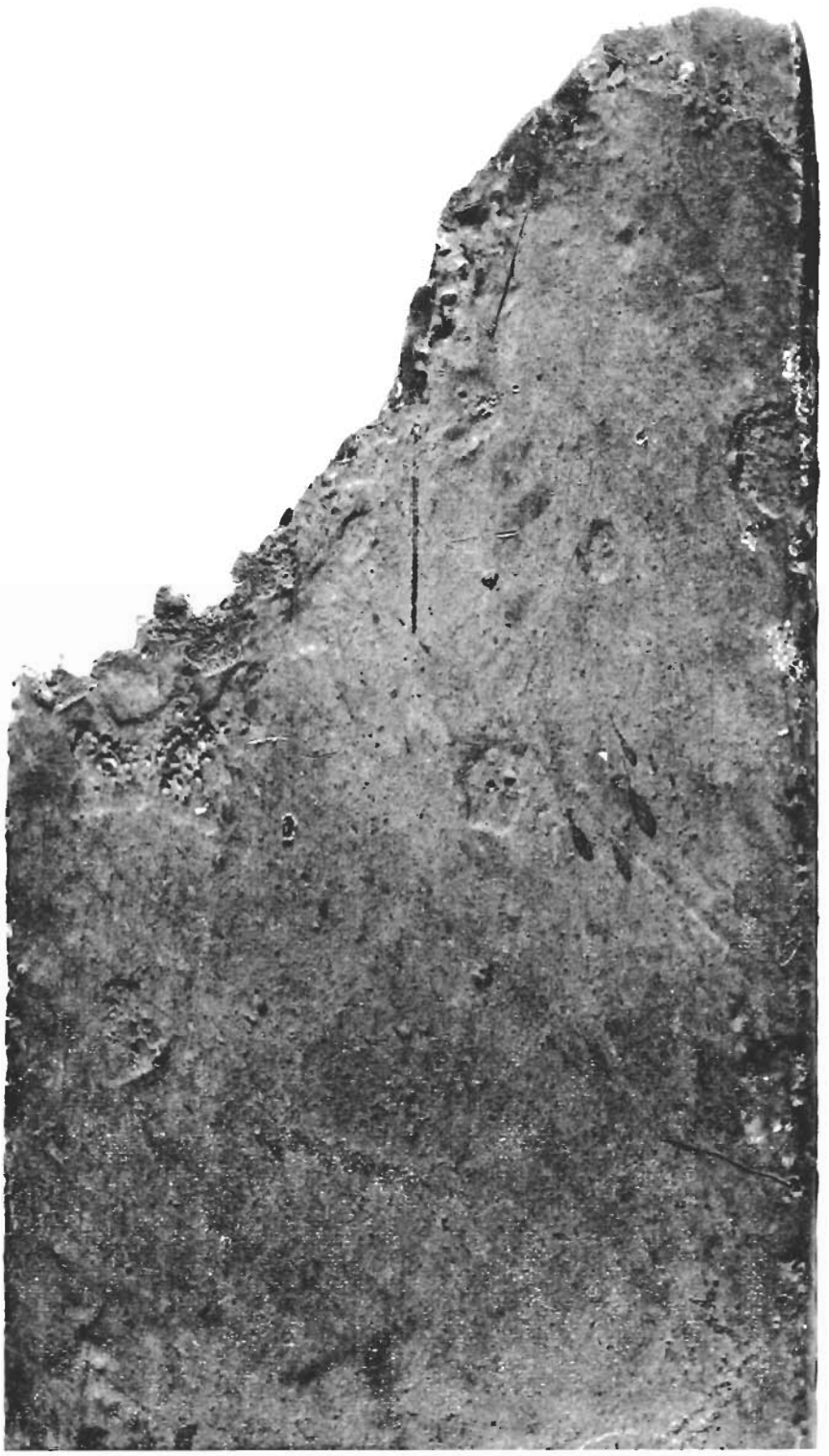
Photograph No. 2
Outer face of inner plate of end diagonal member.



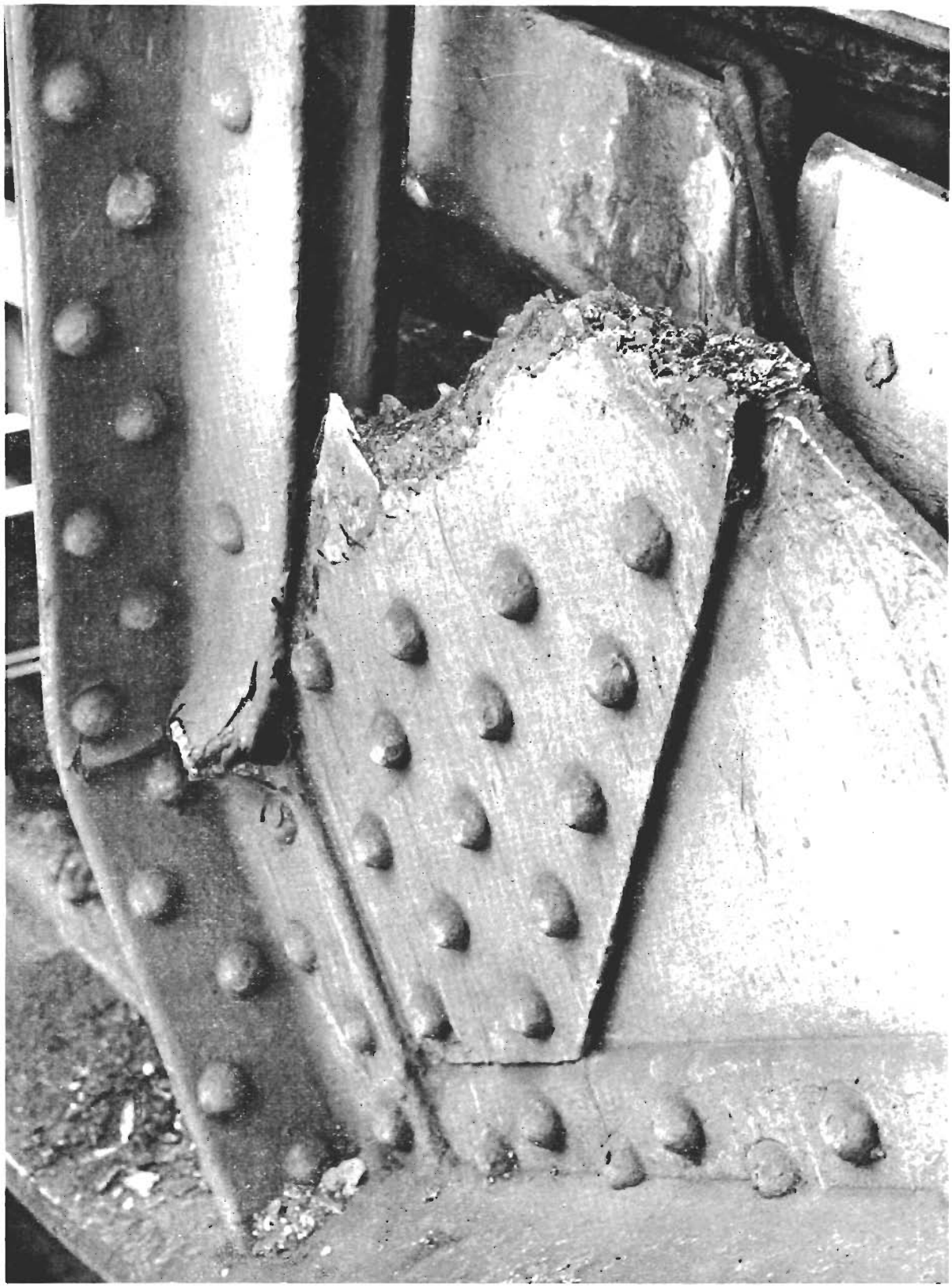
Photograph No. 3
Inner face of inner plate of end diagonal member.



Photograph No. 4
Inner face of outer plate of end diagonal member.



Photograph No. 5
Outer face of outer plate of end diagonal member.



Photograph No. 6
Gusset plate and remainder of end diagonal member of connection.

did the inspection of bridges, wanted the week-end off (the necessary possessions can only be given at night at week-ends). Avins had not examined this bridge before, and had not seen any examination report on it.

27. Avins said that he had a good ladder, a Tilley lamp and a light hammer, but no scraper or prober, and a man to help in moving the ladder. A possession of one hour had been given on each passenger running track, from, he thought, 03.00 hrs to 07.00 hrs on the Sunday. He took each line in turn placing the ladder first under the bridge and then outside it, and all the inspection he did that night was from the ladder. He said that he had plenty of time to do 'this sort of inspection' but that there would not have been enough time if he had had to do any scraping, which he knew should have been done. No pressure was however put on him to do the job too quickly. He had not been to see the bridge in daylight before starting the inspection but he thought that he may have visited it on the following day, Monday, to make an inspection from on top. He explained that he had agreed to do this inspection only 2-3 days beforehand.

28. Avins was questioned closely about his report on the end diagonal (tie bar) that failed (see paragraph 19). He remembered that both the 14 in x ½ in bars were corroded and that the inside one was perforated. He said that he could not have seen these defects by looking upwards at night because a Tilley lamp did not make that possible, and he thought he must have seen them on the Monday. He added that he used his hammer which 'went into it' but he thought that it was only the surface that was affected; a short distance away the bar seemed quite sound. He thought that there was still plenty of steel in the bars and that the defects were not sufficiently serious to draw the special attention of the Inspector to them. He agreed that the inside surfaces of the two bars could not be painted and that consequently they were places to watch particularly. He had not asked for the decking which covered the corroded area on the inside bar to be removed, because, as mentioned above, he had not seen the bridge beforehand.

29. Avins said that he had been dealing with steelwork for 40 years. In 1964 he attended a course at the school for Bridge Examiners at Darlington which, he said, was very comprehensive. A point was made of explaining the weak spots of different types of structures that need special watching, and the causes of previous failures were covered very fully. I have seen the notebook Avins kept on this course and it is very thorough.

30. Bridge Examiner W. A. Shelley was 65 years of age at the time of the failure and had been a bridge examiner for 14 years. He is allotted the task of inspecting all bridges in the Woking District of which, he said, there are some 800. He makes his own programme of inspections which he said were now about a year in arrears, his last inspection of Clapham Junction bridge no. S14B being carried out on 3rd May, 1964, 3 years and 3 months after Avins' inspection; the reason for this was, he said, that he had so many special and frequent inspections to make of structures known to be overstressed. His arrangements and equipment for the inspection were much the same as those mentioned by Avins except that Shelley also had an electric head torch. Also, he said, he did the examination of the underside of the structure from the ladder by night and of the rest from on top in daylight afterwards.

31. Shelley said that he had done the inspections of this bridge in 1954, 1956 and 1958 and he therefore knew the bridge well. He realised that part of the decking prevented a proper examination of the diagonal members, but he had not asked for it to be removed since his inspection in 1954 when he had discovered the defects that had led to the strengthening of some members (see paragraph 10). He said that it was his practice to ask for decking, etc. to be removed only if he suspected that a member that it covered was failing.

32. Shelley said that before examining a bridge he usually looked at the notes he made in his field-book on the previous inspections. He did not, however, in 1964 look at Avins' 1961 report, and he agreed that it would have been advisable to have done so. Shelley said that he inspected the lower ends of the diagonal tie bars by placing the ladder outside the main girders and that he also examined them from on top. He thought that he must have noticed the defects in the tie bar that failed and recorded it in his field-book and omitted to record it in his report. A subsequent examination of his field-book (it was not available at the time) revealed however that the defect was not recorded. He said that he had plenty of time to carry out the inspection properly. He agreed that as this was the only end diagonal member that had not been strengthened, he should have examined it particularly carefully but, he said 'from the outside it looked quite all right'.

33. Shelley also has been working on steel structures for many years. He attended a Bridge Examiner's course at Woking in 1952, but had not been to the Darlington school. He knew, however, of the details of some previous failures, notably the collapse in 1952 of a footbridge at Bury, in the London Midland Region, which resulted from the failure to remove cladding for the inspection of iron brackets.

34. Steelwork Inspector J. Taylor is 54 years of age and has been an inspector since 1958, having previously been a steelwork sub-inspector for 7 years and connected with steel bridge work since 1932. He said that he was responsible for 914 bridges. Normally he dealt with examiners' reports on their face value and only referred back to earlier reports if the bridge concerned was known to be overstressed, or if the current report was serious. He kept a record of defects reported and, in consultation with the staff of the District Engineer's office submitted a yearly repair programme.

35. Mr Taylor said that 'if an examiner examines something and is worried at all about it, I personally go and have a look'. But Avins had not spoken to him after his examination of the Clapham Junction Bridge in 1961 nor had he made any special comment that any member was in a dangerous condition, and consequently he, Mr Taylor, did not inspect the bridge then; he did, however, enter the defects in his record. When he saw Shelley's report on this bridge in 1964, he did not refer back to Avins' report.

36. Mr Taylor had seen the member that failed and said that it would have been necessary to remove the decking to enable it to have been examined properly. He had not been asked for this to be done and, so far as he knew, the decking had never been removed. He implied, in reply to further questions, that the place where the member failed was no more of a danger spot than others and said that the removal of decking would involve a considerable amount of work and money.

37. Mr Taylor did not know, before its failure, that some strengthening had been done to the Clapham Junction bridge in 1954. He said that he frequently walked past the bridge and gave it a casual glance, especially at the stanchions. He had not mounted the bridge for 4-5 years, and then he did so in connection with 'some small thing that wanted doing'. He said that on an occasion like that he did not take the opportunity of having a general 'look-round'; he did not have time to spare for that.

38. Continuing his evidence Mr Taylor said that he had learnt, since its failure, that the Clapham Junction bridge had been painted in 1962. The painting was not his responsibility and he did not know about it; consequently no arrangements had been made for the bridge to be examined at that time.

39. Mr Taylor said that although Avins only had a Tilley lamp to carry out the inspection in 1961, arrangements had since been made for Examiners to be provided with electric head torches as well. He emphasised that he had had no pressure put on him to economise on bridge examinations. He did not think that he had enough staff; he was, however, empowered to engage more staff, but found it very difficult to do so.

40. Mr R. A. Hamnett, District Engineer, Woking, since 1957 is responsible for 330 route miles of track, which includes 914 steel bridges. He said that there had been occasions when his Steelwork Inspector had sent reports to him which included references to serious defects in a bridge; he had discussed them with the Inspector and he or one of his assistants had then made an inspection. He examined reports individually, not on the file, and frequently at home or on train journeys; he did not compare them with previous reports. After examining the reports, he passed them to his Assistant, and then to the Assistant for Bridges.

41. Mr Hamnett could not explain how it had come about that he had not seen Avins' 1961 report on the Clapham Junction bridge, but he said that he was very much occupied with other important work at the time (this was in fact a serious embankment slip on the main line between Woking and Basingstoke). He added that if he had seen it he might have asked the Inspector to look at the bridge He considered that it was his responsibility to see all such reports first, and to pass them on to his assistants for any action that he considered necessary.

42. Mr Hamnett said that he had seen Shelley's 1964 report on this bridge but, from the Inspector's comments, he did not consider any immediate action was necessary; he had, of course, still not seen the previous report.

43. Regarding painting, Mr Hamnett explained that bridges carrying signalboxes were painted by the Building Department under a station painting programme. He agreed that there was a lack of co-ordination between that department and the Inspector responsible for steel structures and that the bridge should have been carefully examined when it was painted in 1962.

44. Mr Hamnett concluded his evidence by saying that he did not know why the member that failed had not been strengthened along with the other similar members in 1954; it was before he took over the District. He had the highest confidence in Inspector Taylor and in his bridge examiners, Avins and Shelley, and he could not explain Shelley's failure to report in 1964 on the defective member of Clapham Junction bridge. He thought that two examiners were sufficient to do the work in his District, but said that he was experiencing difficulty in finding a replacement for Shelley who was already over age.

Examination of Other Bridges

45. As a result of the failure of the Clapham Junction bridge, the Chief Civil Engineer, Southern Region, ordered an immediate and detailed examination of other bridges of similar construction. It was found that certain members of the bridge (no. S9C) carrying the West London Junction signalbox (see paragraph 2) were in a precarious condition.

46. This bridge had been examined in 1961 by Shelley, who reported certain serious defects. As a result, it was examined by Mr Taylor and also by Mr McArthur, then Assistant to the Senior Engineering Assistant, Bridges, Woking District. The latter's report was the result of a brief inspection and was to the effect that the bridge was in a bad state of repair and needed attention. It was marked in the District Engineer's office to be included in the 1964 repair programme, but this was not done.

47. This bridge was again inspected in January 1965 and some serious defects were reported. Mr Taylor recommended that the repairs be carried out 'in 1966 or 1967' and Mr Hamnett, without having seen Mr. McArthur's report, endorsed the report for the repairs to be done in the 1967 programme.

Conclusions

48. The failure of this important bridge should not have occurred. It was fortunate that the adjacent and equally important bridge at West London Junction did not fail also. The failure of the one bridge and the near failure of the other was, in my opinion, the result partly of lax examination, partly of errors of judgment by the examiners and steelwork inspector, and partly a lack of proper organisation in the office of the District Engineer, Woking.

49. The corrosion in the Clapham Junction bridge diagonal member that failed was such (see paragraphs 11 and 12) that it must have taken place over a long period of time; indeed, the bridge must have been in a dangerous condition for several years. The member that failed was probably in much the same condition as the other diagonal members when they were strengthened in 1954, and I could not discover why it had not been strengthened at the same time. The fact that it was seriously corroded could have been seen with the deck (see paragraph 7) in place, but the full extent of the corrosion could not have been seen without removing the deck.

50. Examiner Avins found defects in the particular diagonal member in this bridge in 1961, and he commented on them, but he clearly did not realise how serious they must then have been; consequently he did not draw special attention to them in his report. He had not inspected the bridge before, but he did not look over it before he started his inspection, which had to be done at night; as a result, he had not asked for the decking to be removed.

51. Examiner Shelley had inspected the bridge on several occasions and he therefore knew it well. It was, in fact, as a result of one of his reports that the end diagonal members, except the one that failed, were strengthened in 1954. It seems extraordinary therefore that, when he inspected the bridge in 1964, he did not pay particular attention to the one that had not been strengthened. Even without this previous knowledge, however, there can be no excuse for his failure to notice the serious condition of the member when he inspected it, even without the removal of the decking. He knew that the decking had not been removed for a long time and he certainly should have asked for it to be removed on that occasion.

52. I think that Inspector Taylor committed an error of judgment in not taking more positive action on Avins' 1961 report. Had he even questioned Avins on it he would probably have learnt enough to make him decide to examine the bridge himself, and if he had done that, he would surely have realised that the situation was serious and would have taken immediate steps to rectify it.

53. I do not think that Mr Taylor exercised the necessary supervision over the bridge examiners as required by the Handbook on the Examination of Structures (paragraph 16). He knew the design of the Clapham Junction bridge and he knew that the decking had not been removed for a number of years, yet he did not question the examiners about it. Also, contrary to his evidence (paragraph 36), I am sure that he must have realised that the member that failed was particularly subject to corrosion in the area where the failure occurred, but he had not drawn the special attention of his bridge examiners to the importance of examining that area very carefully.

54. As I have said, I think that the cause of the failure of the Clapham Junction bridge and the near failure of the West London Junction bridge lies partly in the lack of proper organisation in the District Engineer's office. Because of that organisation, the 1961 report on the Clapham Junction bridge was not seen by any engineer, and when the District Engineer himself saw the 1964 report, he still did not know that he had not seen the previous one. He agreed that if he had seen the 1961 report, he might have asked for a special examination of the bridge to be made, and if this had been done the seriousness of the situation would surely have come to light. Also because of that organisation, repairs to the West London Junction bridge, that should have been done in 1964, were not done.

Remarks and Recommendations

55. The failure of the bridge at Clapham Junction fortunately resulted in no casualties at all. This was fortuitous and heavy casualties such as occurred in the Lewisham disaster, when a bridge collapsed on a train after a collision, might have resulted.

56. With the present organisation in the Woking District, which I am told is not exceptional on the Southern Region, the District Engineer himself is the first person to see the examination reports on some 900 bridges, and he initiates action on them. This is, in my opinion, not a satisfactory arrangement. A District Engineer in charge of any district, particularly one as busy as the Woking District, must decentralise his work. I think that bridge reports should therefore be seen first by the engineer responsible for bridges who should be given the responsibility of assessing the reports, and if necessary of arranging special examinations. It should only be necessary for reports indicating some serious situation to be placed before the District Engineer himself who can then, with all the facts before him, take a considered judgment. I understand that this is the standard procedure on other Regions and that it will now be adopted generally on the Southern Region.

57. As a result of the Assistant Engineer's report in 1961 (paragraph 46), the West London Junction bridge was endorsed in the District Engineer's office for repairs to be carried out in 1964. But the repairs were not in fact programmed for that year. When the report made in January, 1965, was considered, it was endorsed, without reference to the earlier report, for the repairs to be carried out in 1967; by that time that bridge also might have collapsed. This also indicates an unsatisfactory state of affairs which needs to be rectified.

58. Under the present arrangements in the Woking District there is no regular 'follow-up' procedure for bridge reports, which are generally dealt with 'in vacuo' and without reference to previous reports. I think that it is essential that the Inspector, and the Engineers in the District office should compare current reports with previous ones. Unless this is done, I do not see how the rate of corrosion in members can be assessed, or how it can be ensured that a member that has been found defective has been properly examined subsequently. I think also that it is for consideration as to whether it is desirable that an examiner, before examining a bridge for the first time, should see the last examination report.

59. In June 1963, a heavy girder, carrying signals, collapsed at Ferryhill, in the North Eastern Region. No formal Inquiry was held into this failure, but it was discussed in detail with the Regional Officers. One of the main conclusions reached was that it occurred largely owing to a lack of any such 'follow-up' procedure from previous inspection reports. The results of these discussions were sent to the Chief Civil Engineer, British Railways Board, and it is unfortunate that they were not circulated by him to other Regions. The Instructions in the Handbook are very comprehensive but, as it seems that the importance of this point is not generally appreciated, I think that they should be amplified to cover it.

60. In this connection, I think also that the Instructions in the Handbook requiring the condition of the various members of a bridge to be classified at an examination as G (good), F (fair), and P (poor) could be improved, and I suggest that an additional classification such as R (requires urgent attention) be added. The possibility of allotting to each classification a rough yardstick in terms of the percentage of metal wasted has been considered, but it was thought by the Chief Engineer, Way and Works, British Railways Board, that it was beyond the field of the present Examiners and could be misleading.

61. The Handbook clearly requires decking, cladding etc. to be removed, 'as may be necessary to enable an examination to be made of all structural members not fully encased', whenever a bridge etc. is to be examined. It places the responsibility for asking for it to be removed on the examiner. I would suggest, however, that the removal of all such decking may not be necessary on every occasion that an examination is made; on some bridges it is a tedious and expensive job. It is however essential that it should be removed periodically, and the frequency of removal should depend on the type of the structure and the rate of deterioration of its members. If this procedure were to be adopted, it should not then be left entirely to the judgment of examiners as to when the decking should be removed, and this decision should, I think, be taken at least by the Inspector, who can, if in doubt, consult the technical staff in the District Engineer's office. I suggest also that examination reports on a structure should include information on whether any decking, cladding, etc. prevents the proper examination of certain members and the extent to which it was removed for the examination.

62. It was indeed unfortunate that when scaffolding was erected for the Clapham Junction bridge to be painted in 1962, it was not examined, as required by the Instructions in the Handbook. The painting was arranged by the District Engineer's building section, and there was clearly no liaison between that section and his steelwork section which is responsible for the safety of the structure. If the member concerned had been examined then, when it had been scraped for painting, I am sure that the seriousness of the defects would have been noticed. I have been assured by the Chief Civil Engineer, Southern Region, that this unsatisfactory state of affairs has since been rectified.

63. Neither of the two examiners who had recently examined the Clapham Junction bridge had visited it in daylight before starting their inspection at night. I think that on a bridge of this type it would have been sensible for this to be done, especially as one of the examiners was examining the bridge for the first time and the other was examining it after a gap of a number of years, and I suggest that this procedure be adopted generally on such bridges. The army maxim that 'time spent on reconnaissance is seldom wasted' is very sound. It would of course be better still, when part of an examination can be done in daylight without track occupations, for that part to be done before the night examination.

64. In conclusion I would mention that for some years steel structures have been designed so as to eliminate parts that are inaccessible to easy inspection. I have been assured by the Chief Engineer, Way and Works, that special attention is being paid to all the older structures in which this feature of design does not obtain. He tells me that the problem is very large and that the whole question of bridge examination was discussed at the Civil Engineering Committee meeting held on 28th April last—that is, before the Clapham Junction failure. The need for a high standard of bridge examination and reporting was emphasised and the question of bringing young technical staff more actively into contact with structural examinations was considered. A major reorganisation of the Civil Engineering Department of British Railways is now taking place and I suggest that the time is opportune for the introduction of a scheme whereby much of the actual bridge examination is done by technical staff, as is the practice on many other railway systems.

I have the honour to be,

Sir,

Your obedient Servant,

D. McMULLEN,

Colonel.

The Secretary,
Ministry of Transport.

Instructions to Appointed Examiners of Structures

Printed on card for issue to appointed examiners

1. It is the duty of an examiner appointed for the examination of structures to familiarise himself with the list of structures given to him, being those which he is to examine at stated intervals and to make report on the condition of each one as noted, and he will carry out the examinations at intervals not greater than those laid down.

2. In good and sufficient time ahead of the dates on which it is programmed for him to examine any structure he will draw the attention of his Supervisor to any gutters, lagging, decking, glazing or roof cladding, smoke plates, which must be removed to enable a complete examination to be made of the essential parts of a structure. . . .

4. An examiner will thoroughly examine all parts of a structure by visual examination, sounding with appropriate tools, scraping and cleaning locally as required and will carefully note all wastage of metal due to corrosion; he will note the evidence given by any 'tell-tales'; take plumb readings where instructed to do so, or where a change in vertical alignment of a girder, abutment, pier or wall is suspected. He will seek for evidence of deterioration of all units, joints, and bearings in a structure, and will faithfully record the results of his examination on the forms provided. He will check on each and every examination that he has examined all the parts of the structure.

5. An examiner will carefully note the condition of the paint or other protecting coatings on all metal-work, and record in his report.

8. An examiner will forward the reports of his examinations to the Supervisor as laid down. He will take immediate steps to inform his own Supervisor or such other Supervisor or Technical Assistant as may be laid down to him in the event of serious development having been noted in a structure which appears to call for urgent attention.

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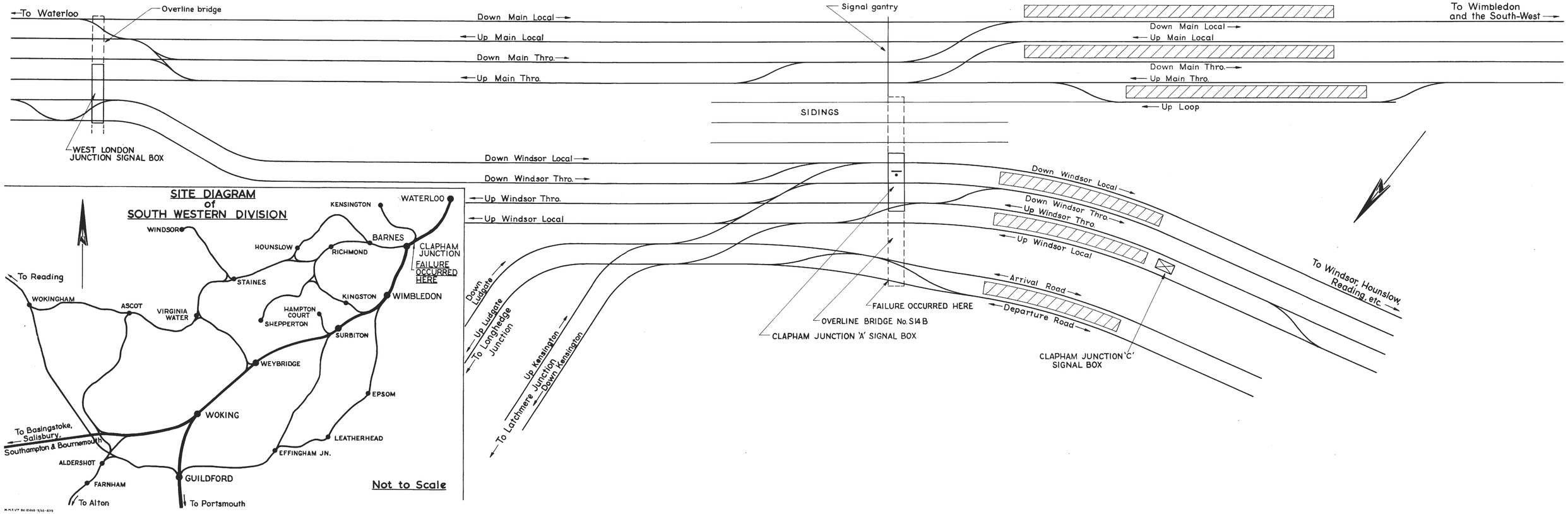
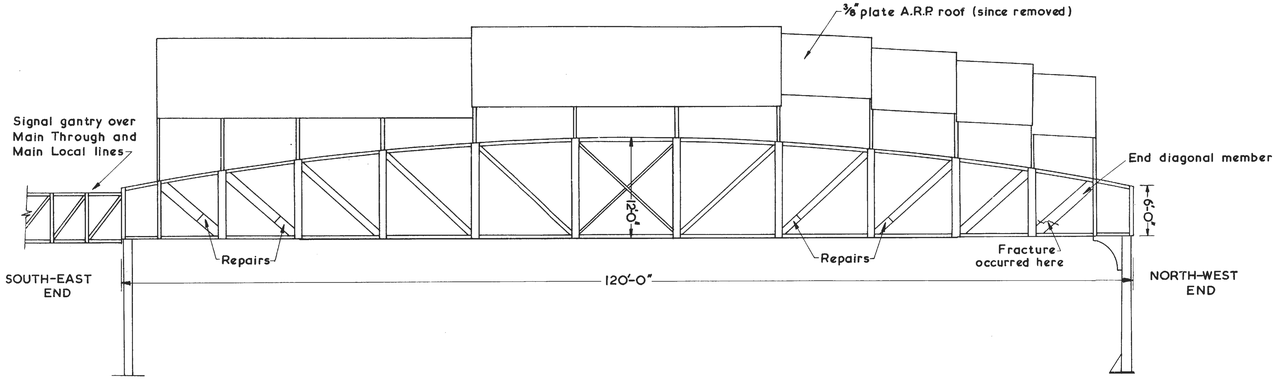
CLAPHAM JUNCTION — FAILURE OF OVERLINE BRIDGE ON 10th. MAY, 1965



SITE DIAGRAM of SOUTH WESTERN DIVISION

CLAPHAM JUNCTION FAILURE OF OVERLINE BRIDGE ON 10th. MAY, 1965

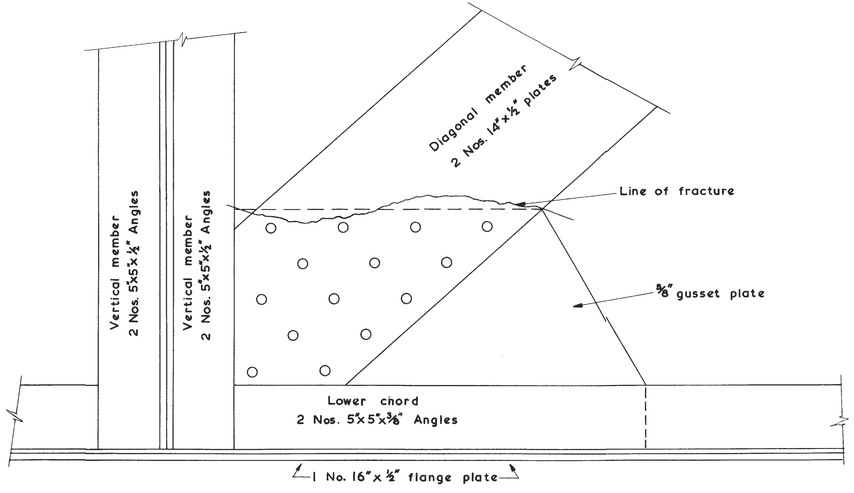
MAIN GIRDER IN OVERLINE BRIDGE No. S14B



ELEVATION

LOOKING TOWARDS THE COUNTRY

SCALE: ⅛" = 1"



ENLARGEMENT OF JOINT WHERE FRACTURE OCCURRED

NOT TO SCALE

K.H.