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MINISTRY OF TRANSPORT & CIVIL AVIATION

RAILWAY ACCIDENTS

REPORT ON THE COLLAPSE OF  
CLIFTON HALL TUNNEL

which occurred on  
28th April 1953 at  
SWINTON

near Manchester  
in the

LONDON MIDLAND REGION  
BRITISH RAILWAYS

LONDON : HER MAJESTY'S STATIONERY OFFICE

1954

PRICE 1s. 9d. NET

17th December, 1953.

SIR,

I have the honour to report for the information of the Minister of Transport and Civil Aviation, in accordance with the Order dated 1st May, 1953 the result of my Inquiry into the accident which occurred at 5.35 a.m. on 28th April, 1953 when part of the roof of the Clifton Hall Tunnel fell in and undermined the ground above it. This tunnel is on the double line branch between Patricroft and Molyneux Junction in the London Midland Region, British Railways. I was assisted throughout my Inquiry by Colonel W. P. Reed.

On 13th April, 15 days before the accident, some brickwork fell from the roof of the tunnel at a place over which an old and unknown constructional shaft had been filled in. Immediate steps were taken to stop rail traffic and arrangements were made to strengthen the tunnel at this point, but before the protective work had been completed, the roof collapsed in the early morning of the 28th April. The contents of the shaft poured into the tunnel, thus forming a crater on the surface of the ground, where a pair of semi-detached houses in Temple Drive collapsed and the end wall of a third one fell outwards. I regret to state that the five occupants of the first two houses lost their lives, but fortunately two others living in the third house were rescued, suffering only from minor injuries and shock.

The collapse was witnessed by Police Inspector K. McClennan who lived opposite, and he promptly summoned assistance which was quickly on the scene, the first ambulance arriving in about five minutes. Mr. V. Collins, Town Clerk of Swinton, arrived in less than an hour, and soon well organised teams were actively engaged in removing the debris and searching for victims. Four adjoining houses were evacuated as a safety measure. The railway authorities were notified at about 5.45 a.m. by Mr. T. Jones, Station Master, Whitefield, who also lived in Temple Drive, and Mr. A. L. Owen, the District Engineer, was in the tunnel by 6.15 a.m. making arrangements for sealing the fall.

#### DESCRIPTION

##### *The Site.*

1. The Clifton Hall double line tunnel is on a short branch linking Patricroft with Molyneux Junction. This line was opened in 1850 primarily to serve the collieries in the Clifton Hall district. A few passenger trains used the route for a short period before the 1939-45 war but since then it has been restricted to goods traffic only. During the war the tunnel was closed but the line was reopened for a limited service of freight trains in October, 1947.

2. When the tunnel was first opened the ground above it was pasture land crossed by two roads only as shown in Fig. 1 which has been compiled from the Parliamentary plan dated November 1844. This land has gradually been developed as illustrated in Fig. 2 and now forms part of the town of Swinton. Temple Drive crosses the tunnel diagonally and the positions of the houses directly over it are indicated in Fig. 5. Nos. 22 and 24 collapsed when the accident occurred, and the wall of No. 26 fell out. No. 20 and the remainder of No. 26 were subsequently demolished.

##### *Records and Drawings.*

3. Unfortunately all the tunnel records and drawings in the District Engineer's office were destroyed—some when the office was badly damaged in an air raid in 1940 and the remainder in a fire in 1952. The particulars of the tunnel given in this report have been compiled partly from the Ministry of Transport archives and partly from old plans in the Civil Engineer's office at Euston. The report about a previous defect in the tunnel, mentioned later on, was found in the office of the Railway Mining Engineer, Derby. None of this information was available to the District Engineer at the time of the accident and it only came to light afterwards.

##### *The Tunnel.*

4. The tunnel, which is 1,298 yards long, is straight throughout its length, and there are no ventilation shafts. It is lined with brick resting on a brick invert, as shown in the cross section in Fig. 4. The greatest width is 24 feet 9 inches and the height from the invert to the top of the arch is 22 feet 3 inches.

5. A good impression of its construction and of the type of formation through which the tunnel passes can be gained from the report, dated 1st January, 1850, of the inspection made by Captain G. Wynne, Inspecting Officer of Railways, on 29th December, 1849 :—

“I have the honour to acquaint you for the information of the Commissioners (of the Board of Trade) that on the 29th of last month I re-inspected the Clifton Branch of the London & North Western Railway . . . . .

The principal work on the line is a tunnel 1,298 yards in length the formation through which it passes is loose sand and marl lying over the coal measures, the sand in some places approaches the nature of a quicksand and in these parts a good deal of difficulty was experienced in making the tunnel and much water still passes through the brickwork.

The tunnel is of brick 3-brick thick and set in mortar of blue lias lime with the exception of the crown of the arch which is set in Roman cement, there is an invert two feet thick and the tunnel is drained by a central drain laid on the invert, the exterior appearance of the work gives every reason to suppose that it has been properly constructed".

6. The tunnel is still wet in places; it has been patched many times during the past 100 years and some large sections have been rebuilt. There are a few cracks in the lining and wooden wedges have been driven into them to take up the thrust and to arrest further movement. The shape also is irregular, and it is not possible to distinguish whether the slight changes are due to settlement or to inaccurate centering during construction. The face brickwork is by no means even, due in part to the patch repairs and in part to variations at the construction joints. The numerous irregularities and construction joints, combined with subsequent repairs, dripping water, and layers of soot from engine smoke, make inspection difficult and without a plan it was quite impossible to tell where the old construction shaft openings had been closed.

Eight shafts were sunk at the sites shown in Figs. 2 and 3 but they were filled in on completion of the tunnel. The ground above them has been built over in the course of urban development and as the position of the shafts was not marked on the sides of the tunnel, all traces of them were lost. The information about them was obtained from an old progress plan in the Civil Engineer's office and their positions were located by referring to the tablet numbers which were marked on the sides of the tunnel at 50 feet intervals. No. 3 shaft was directly under the place where No. 24, Temple Drive was afterwards built and it was here that the collapse of the tunnel roof occurred.

7. Extensive exploratory work was carried out after the accident in an endeavour to find the actual shafts. The ground under the collapsed houses in Temple Drive was excavated to a depth of 32 feet before the brick lining of No. 3 shaft was uncovered. It was approximately 8 feet in diameter and 9 inches thick, and traces were found of timber curbs such as were used in this type of construction when the tunnel was built over 100 years ago. Nos. 1, 4, 5 and 6 shafts were also located at varying depths from 3 feet to 14 feet below ground level. They were brick lined and varied from 9 feet to 10 feet in diameter. Nos. 2 and 5a shafts are apparently underneath existing buildings, and No. 1a, which is under a playing field, could not be found.

The progress plan found in the Civil Engineer's office indicated that the brick lining and invert in the shaft sections of the tunnel were thicker than elsewhere. This was confirmed by making a boring through the roof at No. 4 shaft, where the brickwork was found to be 3 feet thick compared with 2 feet 3 inches as shown on the standard cross section and mentioned in the Inspecting Officer's report of 1850.

#### *Mining subsidences.*

8. The tunnel was built over the coal measures, but these lie at a considerable depth, the shallowest working being 1,500 feet down. There has been some settlement in the course of time amounting in the past 22 years to a maximum of 5 feet 4½ inches at the Patricroft portal. The subsidence at No. 3 shaft in the same time has only been 11 inches and this gradually decreases till it disappears at a point 17 chains (384 yards) further inside the tunnel. The last annual check was made on 9th March and the measurements taken since the accident show that no further settlement has occurred.

9. The coal was first worked from the seams underneath the tunnel at the Molyneux Junction end, and although no subsidence was recorded, additional support was given to the roof by erecting steel ribs made of old rails at 5 feet spacings. The work was done in 1901 and extended for a distance of 617 yards from the Molyneux Junction portal. In 1926 similar ribs at similar spacings were put in for 500 yards from the Patricroft end when the coal in this part of the field was being worked. There was thus a length of 282 yards inside the tunnel without ribs, including the sections under Nos. 3 and 4 shafts. The ribs were erected purely as a precautionary measure to strengthen the tunnel against mining subsidence, but this has been so slow and regular that the failure of the tunnel cannot be attributed to this cause.

### REPORT

#### *Action before the accident occurred.*

10. The first sign of trouble was noticed on the morning of 13th April (15 days before the accident) when Ganger E. C. Nash found a small amount of brick rubble lying in the Up track between tablets 29 and 30. He shone a Tilley lamp on to the tunnel roof and saw that the brickwork was peeling off badly at one place. He arranged forthwith to stop all rail traffic and then he informed his inspector. He had been working in that tunnel for 12 years but he had not previously seen any falls of brick from the roof.

11. Prompt action was taken by the responsible officers. District Works Inspector J. W. Glass, accompanied by the Permanent Way Inspector, went into the tunnel on the same morning and reported the trouble to the District Engineer's office. Chief Works Inspector Ashall then came out and made a further inspection. In the afternoon Mr. E. F. Boivic, the Assistant District Engineer, inspected the tunnel from track level, the District Engineer, Mr. A. Lloyd Owen, being away on holiday.

Mr. Boivie decided to keep the tunnel closed until the repairs had been carried out because it was little-used and its closure meant little inconvenience to the operating department.

12. The next day on his return Mr. Owen, with Mr. Boivie and several members of their staff made a detailed examination from the top of an inspection wagon. Two blocks of brickwork had fallen from the roof of the tunnel directly over the Up line and had left gaps in the face ring each about 3 feet 6 inches long, with a length of about 4 feet 6 inches of brickwork between them (see Fig. 6). There were signs of butt joints across the crown of the arch at the ends of the damaged section and there was an area of patched brickwork at one end. The crown of the arch between the butt joints was about 2 inches lower than the general level of the tunnel.

The gaps were about 9 inches deep and 10 inches wide and they exposed to view a partly rotted timber. After scraping away some of the decayed pieces it was seen that the timber was about 9 inches deep by 6 inches wide and that there was more brickwork behind it. It would seem, therefore, that behind the face ring of the arch there was a piece of timber 11 to 12 feet long lying longitudinally in the second ring and extending from one butt joint to another.

13. As a result of this examination it was decided that the tunnel at this place should be strengthened with rail ribs in a manner similar to the existing reinforcement but of a better design. Whereas previously the rails forming the ribs had been curved on their minor axis, it was proposed now to curve them on their major axis, thereby giving them greater resistance to buckling. They were to rest on longitudinal rails supported by "putlogs", which were short lengths of rail cemented into the tunnel ring, the design being generally as shown in Figs. 7 and 8.

A draughtsman was sent to take profiles of the tunnel on the same day, 14th April, and he took his measurements at a point a few feet to one side of the defective brickwork. He had to go out with Mr. Boivie on a track inspection later in the week and hence he did not finish his drawings until the following Monday, 20th April, when an order for the rails was placed on the Gorton works, though the putlogs had been put in two days' earlier by Inspector Glass. Difficulty was experienced in bending the rails and on Tuesday, 21st April, Mr. Owen asked the Gorton Manager to arrange for overtime to be worked so as to get the job finished as soon as possible.

14. Bridge Examiner Kelly was instructed to take daily measurements to see whether there was any movement of the defective brickwork. He did not notice anything of import until Tuesday, 21st April, when he recorded a drop of  $\frac{3}{8}$  inch in the crown of the arch. The next day the brickwork alongside one of the gaps dropped a further  $\frac{1}{4}$  inch and on the 23rd another  $\frac{1}{4}$  inch; two diagonal cracks starting from the outer end of one of the gaps had also appeared.

Mr. Boivie was not particularly disturbed when he learned that the brickwork had dropped  $\frac{3}{8}$  inch but when on Thursday, 23rd April, he received the third consecutive adverse report, indicating a drop of nearly 2 inches in three days, he immediately examined the tunnel again from the inspection wagon. There was not very much change on the Up side but he noticed that the brickwork on the Down side opposite the gaps was cracking and flaking in places and he saw the two diagonal cracks already mentioned. Mr. Boivie decided that some timber props should be put in as soon as possible so as to support the roof until the rail ribs arrived. He intended to place four props underneath the gaps on the Up side and another four to support the crown on the Down side. He prepared a sketch and placed an order on the Engineers Joinery Shop for the material to be got ready and sent down to the site.

15. Mr. Boivie also told Mr. Owen, and later in the day they visited the site together. Mr. Owen saw the defects already mentioned and also noted that the gap between the face and centre rings had increased so much that he could get his hand between them. This led him to think that the face ring only was moving, but at the same time he felt that he must wedge the centre ring so as to hold that in position and he instructed Bridge Examiner Kelly accordingly. Kelly misunderstood this instruction and put the wedge in the bottom instead of in the middle row of brickwork, but this seemed to be effective since no further movement of the arch ring was recorded.

Mr. Owen had heard by this time that three sets of rail centres would be ready by the weekend so he decided to drop the emergency plan for propping the tunnel and he arranged with Mr. Boivie for the rings to be placed in position on Sunday, 26th April. The plan was to place them under the centre of the damaged arch at 3 feet centres in positions 6, 7 and 8 shown on Fig. 10. Mr. Boivie intended to erect the three sets on two wagons, from which they would be dropped into position. Unfortunately the men were not used to the work and they had great difficulty in assembling the rings, so much so that the first one was not ready till 4.0 p.m. The wagon was pushed into the tunnel and Mr. Boivie then realised that the ring could not be placed under the defective brickwork because it began to bear against the sides and roof before it reached this spot; finally, after a good deal of trouble it was put in position 4, about 12 feet from its intended place. The original profile had been taken at a point a few feet clear of the damaged brickwork, the variations in the shape of the lining had not been noticed, and insufficient allowance had been made for settlement; consequently the ring was a little too large.

Mr. Boivie thought about getting flame cutting equipment and altering the rings on site but he decided that this would be impracticable. It was getting late by this time, and since his men had been on duty for 12 hours, he stopped work. He sent a draughtsman into the tunnel on the following morning to take fresh profiles and he arranged for the other rings to be altered at the Gorton works. He expected them to be ready by Wednesday, 29th April, but by then it was too late.

### *The Accident.*

16. At 5.35 a.m. on the morning of Tuesday, 28th April, Police Inspector K. McClelland, who resides at No. 21 Temple Drive, was awakened by hearing a very sharp cracking noise underground. He rushed to the window and saw the two houses (Nos. 22 and 24) suddenly collapse into the ground and the end wall of No. 26 fall outwards. There was a violent rush of air and clouds of dust and soot. The Inspector took prompt steps to summon assistance and to help in the rescue of the occupants from the damaged house.

Station Master T. Jones, who resides at No. 11 Temple Drive, was also awakened "by a peculiar loud noise of something crunching". He got up immediately and saw from his bedroom window that the houses on the opposite side of the road were falling in. He assisted in releasing the occupants from No. 26 and then reported the accident to the Chief Controller at Manchester.

### *Action after the Accident.*

17. Mr. Owen was advised immediately, and he arrived on the scene 40 minutes after the occurrence. He found the tunnel completely blocked with sand, and loosened brickwork was still falling from the hole in the roof. The sand at the bottom was very wet and was mixed with lumps of clay; the rest of it was fairly dry. Mr. Owen arranged for the tunnel on either side of the fall to be packed solidly with ashes and for stout timber bulkheads to be erected as shown in Figs. 9 and 10. This work was completed by 6th May and since then the bulkheads have been further strengthened with additional filling as shown on the drawing.

18. The debris from the fallen houses was removed by the Railway engineers who, as already described in paragraph 7, excavated to a depth of 32 feet before they found the original brick shaft. Quantities of broken furniture, timber and brickwork from the demolished houses were removed during the course of the work, and the whole area was thoroughly probed for voids which might cause further settlement. None was found but as a check the volume of the cavity which was formed on the surface was calculated and compared with the quantity of sand which had fallen into the tunnel. This balanced within a reasonable margin and it can be accepted that there are no cavities over the tunnel. The whole area has now been filled in.

During the search for the other shafts, quantities of very wet sand were found in No. 4 and the tunnel roof under it was tapped to see whether any water could be released. None came through but the borings confirmed that the shaft was filled throughout its length with wet sand and that the ground around it was made up of similar material.

19. During the search for old tunnel records, a report dated 10th February, 1913 was found in the Railway Mining Engineer's office at Derby. This report dealt with a previous defect in the tunnel and the following extract is of particular interest :—

"This tunnel is 1,299 yards long; it was constructed in 1846 under Easements with various Owners.

At this date the Contract plan shows that there was very little house property in the vicinity of the Tunnel.

According to this plan dated March, 1846, temporary shafts were intended to be sunk for the purpose of the construction of the Tunnel, some of the excavated material from the works being apparently spread on the surface above.

These temporary shafts are now non-existent, and there is now no shaft to the tunnel.

Examination of this Tunnel is made every year, and for some years past the portion between 17 and 18T has been reported to be in an unsatisfactory condition.

In March (1912) further defects became apparent, and after a detailed examination it was decided to rebuild certain lengths of the Tunnel between 8 and 9T and 17 and 18T which practically covers the site of two of the temporary shafts (Nos. 1 and 2, see Figs. 2 and 3). Iron rib centres were put in at each of these places in April/12, and the first length of old brickwork was broken into on August/12, and the old arch and side walls were removed, and the length rebuilt in blue brickwork in cement, the work of rebuilding being carried out as shown on cross section attached, the black lines being the profile of the old work in May/12. *Certain old timber partially decayed (no doubt forming the base of one of the old temporary shafts) was found built in the brickwork as shown on the drawing.* The position of this length practically agrees with the site of one of the shafts shown on the Contract plan, and this is apparently below the green-houses of "Kingslea". The ground through which the Tunnel is constructed is of sand, and the Tunnel is very wet in places.

No difficulty was met with in dealing with this work between 17 and 18T and there has been no run of sand or any settlement during the progress of the work, the whole of the ground was carefully close poled with 6 inches by 1½ inches boards 3 feet long, with 8 inches by 8 inches bars further supported off the iron ribs. The work is carried out by the special Tunnel Gang employed on this Division, who are experts at this class of work".

20. Unfortunately the drawings mentioned in the above report could not be found but further research suggested that the shafts had been supported during construction by timber shoring which was replaced by a wooden frame built into the brickwork when the shaft sections of the tunnel were lined. It is thought that the decayed timber which was found in the roof under No. 3 shaft was probably one of the longitudinal members of the frame and that it was left embedded in the brickwork when the shaft opening was finally closed on completion of the construction work. It seems likely that the other timber on the Down side of the frame was also left behind.

21. The possibility of timbers having been left in the arch rings under the other construction shafts cannot be discounted and steps have been taken to strengthen the tunnel roof where considered necessary. At No. 4 shaft where there was no reinforcement, eleven pairs of steel ribs made of rails bent on the major axis have now been placed on putlogs at 3 feet intervals and they have been packed tightly with wooden lagging to the sides and roof of the tunnel. At Nos. 5 and 5a shafts, where the existing rail reinforcement was over 50 years old, the brick lining has been further supported by placing pairs of the improved type of rib between the existing rails.

The lining under Nos. 1 and 2 shafts was rebuilt in 1912 with brick in cement and the old timbers were removed as indicated in the report quoted above. Rail ribs at 5 feet centres were also put in, and the tunnel at these places appears to be amply strong enough to carry any additional loads produced by the construction shafts.

Shaft No. 1A is under a playing field and the tunnel at this point is also strengthened with steel ribs at 5 feet centres which were put in 25 years ago. No. 6 shaft is under a scrap iron yard and here again the tunnel was strengthened with similar steel ribs, though these were fixed over 50 years ago. Special attention is being paid to the inspection of the lining at these places and no further trouble is anticipated.

#### *Inspection and Maintenance.*

22. Assistant Chief Works Inspector H. Bradley was responsible for making an annual inspection of the tunnel, and he first undertook this work in 1947. He kept detailed notes of the condition of the lining in each 50 feet section which he recorded in his note book under the appropriate tablet numbers. These reports showed that the brickwork required attention in many places. No. 3 shaft was between Nos. 29 and 30 tablets, and in his 1948 report Inspector Bradley referred to hollow and perished brickwork on the Up side, and to a vertical crack in the arch, which had been wedged on the Down side. This was close to but not actually under the shaft opening. Similar reports were made each year up to 1952, and the Inspector had recommended annually that the unreinforced section of the tunnel should be relined and strengthened with rail ribs.

These reports were considered by the Divisional Engineer who, after inspection, decided that the provision of rail ribs was not necessary at present as there was little mining settlement in this section and the brickwork was not in bad condition. Proposals for partial patching and refacing in other places were included in the 1951 and 1952 works programmes. The work was postponed, however, since the condition of the tunnel did not seem to be deteriorating. Funds for the necessary repairs were included in the current year's budget, but the work had not been carried out because the District Engineer did not consider it immediately necessary; he also had difficulty in getting skilled tunnel men and the question of singling or closing the line was under consideration.

#### CONCLUSION

23. The roof of this tunnel caved in at a point directly underneath an old brick-lined construction shaft, the contents of which must have fallen in one mass into the space below. The surrounding soil, which was a loose mixture of sand and clay, poured into the hole and formed such a large cavity underneath the foundations that the two houses collapsed without warning to the unfortunate inhabitants. Police Inspector McLennan's eye witness account of the rush of air which accompanied the collapse indicates clearly the violence of the movement.

The failure of the roof was in no way attributable to mining subsidence but was due to an inherent weakness in the construction of the tunnel. As already stated, the exposed timber on the Up side appears to have formed part of the framework used to support the shaft and there was probably a similar one on the Down side also. The tunnel is wet in places and no doubt, as stated by Captain Wynne in his report of 1850, considerable difficulty was experienced in its construction, especially when the conditions of work and the equipment available in those days is taken into consideration. It seems reasonable to assume, therefore, that when the shaft was finally filled in the longitudinal timbers of the supporting frame were left embedded in the arch ring, as in the case of shaft No. 2 (see paragraphs 19 and 20). In the course of the past 100 years the timbers gradually decayed so much that lines of cleavage were created in the arch ring at a place where it had to carry the full weight (nearly 200 tons) of the column of wet sand in the shaft in addition to withstanding the stresses from tunnelling through unstable ground.

Although most of the movement reported by Bridge Examiner Kelly was probably in the face ring only, as suggested by Mr. Owen, it seems likely that by this time the whole of the arch was unstable. In these circumstances, pressure on the rotted timbers would increase progressively as they were crushed, till they finally collapsed. When this occurred the plug of brickwork could no longer withstand the pressure of the load above it, and once it fell out there was nothing to stop the contents of the shaft dropping precipitously.

24. Prompt steps were taken to protect rail traffic as soon as the first signs of the defect were noticed by Ganger Nash on the 13th April and I am satisfied that Mr. Owen and his staff were fully alive to the need for early action, but none of them knew of the existence of the construction shaft and so they did not appreciate the very dangerous conditions which were set up when the initial brickwork fell. I feel sure that if they had known about this shaft, much more urgent steps would have been taken to deal with the damage.

The proposed repair plan was a sound one, and although there was delay in ordering the work and executing it, I believe the movement of the arch might have been arrested if the three rail rings had been placed in position when Mr. Boivie and his men attempted to do this two days before the accident. It is indeed unfortunate that so much difficulty was encountered and that the rail ring was too large when at last it was erected.

Timber props would have been easier to place but it is by no means certain that the accident would have been averted if Mr. Boivie's original plan had been carried out. The props would have been replaced by the rail rings in due course, and with the arch ring in such an unstable condition it might well have fallen with equally serious results when this delicate and difficult operation was undertaken.

25. The brick lining in this tunnel is poor in a number of places and repairs will be needed if it is to be reopened again. But there was nothing in its condition to suggest that any part of it was in imminent danger of collapse and I am confident that this would not have occurred but for the presence of the unknown shaft.

#### REMARKS AND RECOMMENDATIONS

26. In view of the conditions disclosed by the initial investigation, considerable exploration was undertaken in order to trace the other disused shafts, and additional protective works were erected, as already described in paragraph 21. These proved to be lengthy and difficult tasks but I am satisfied that the results achieved should ensure that adequate protection has been provided against any future trouble which might arise from other similar defects in the tunnel. The question of its permanent closure is still under consideration but I have been assured that steps will be taken to preserve the stability of the ground over the tunnel even if it is abandoned.

27. As already explained, the loss of the tunnel records contributed materially to this accident, and the events leading up to it have shown only too clearly the danger which arises when vital knowledge is not readily available. The maintenance staff should know of the existence of old shafts and other features which may cause weaknesses but in many cases the only records are the original construction drawings which, with the growth in the number of documents to be preserved in the engineers' offices, may possibly be overlooked, though in this case they were burnt in circumstances over which the staff had no control. I recommend, therefore, that all tunnel records be reviewed and that any special features be brought to the notice of the maintenance and examining staff. It is also desirable that the position of disused shafts should be permanently marked in the tunnels themselves, so that these places can be particularly watched. I understand that instructions to this effect have already been issued by the Civil Engineer, London Midland Region and I recommend that similar action be taken elsewhere.

I have the honour to be,

Sir,

Your obedient servant,

C. A. LANGLEY,

*Brigadier.*

The Secretary,

Ministry of Transport and Civil Aviation.

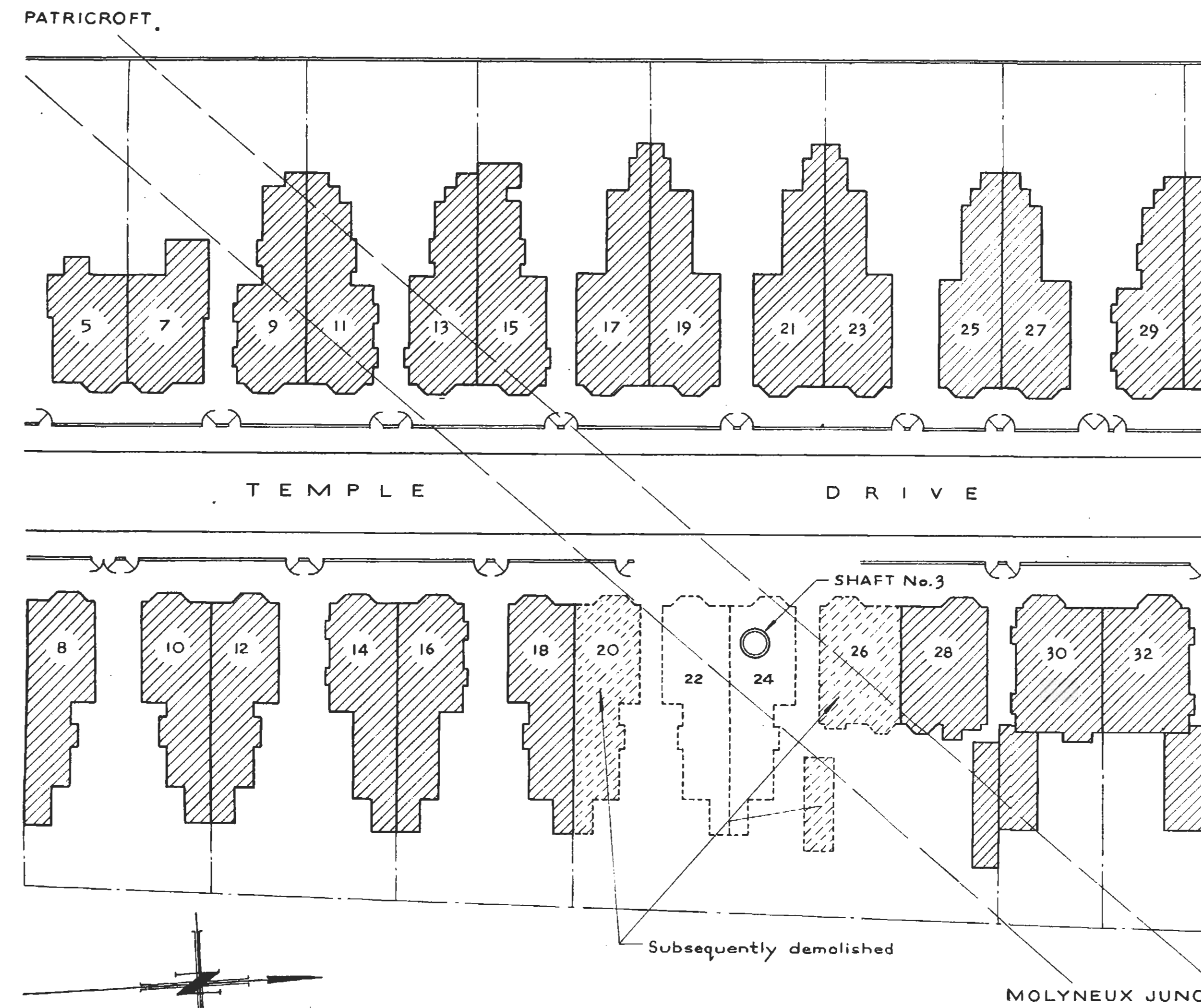
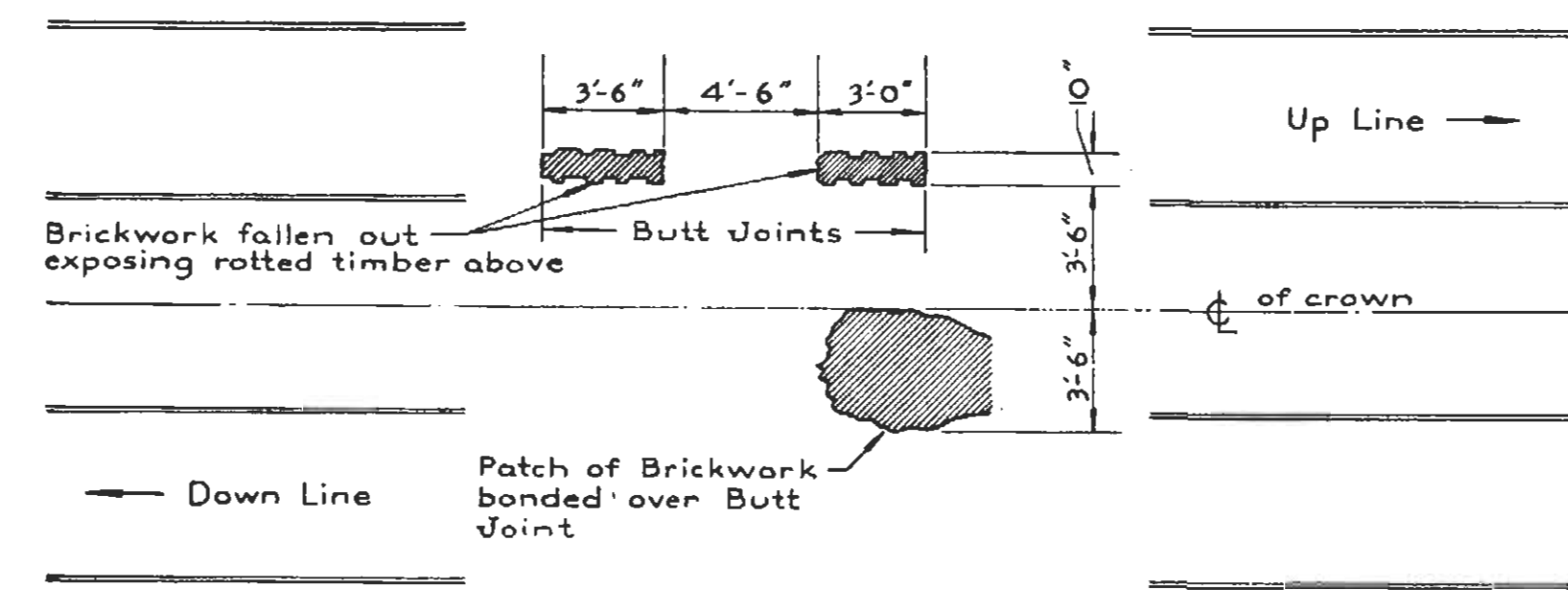


FIG. 5 POSITION OF SHAFT No.3 AND OF THE HOUSES IN TEMPLE DRIVE  
SCALE: 40 FEET TO 1 INCH

FIG. 6 SKETCH SHOWING DAMAGE TO TUNNEL ROOF UNDER SHAFT No.3



FIGS. 7 & 8 DETAILS OF STEEL RIBS DESIGNED FOR REINFORCING THE TUNNEL AT SHAFT No.3

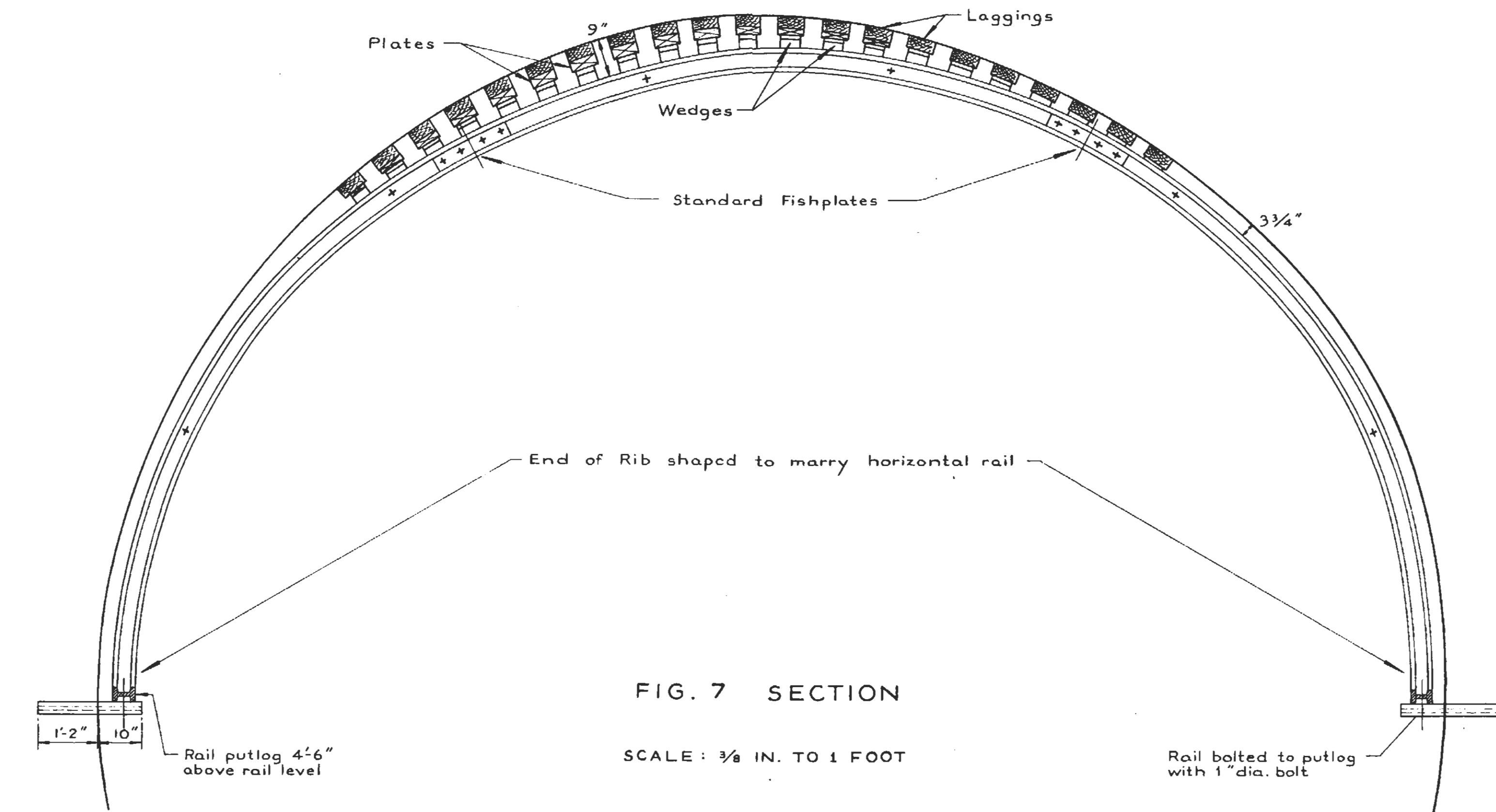


FIG. 7 SECTION

SCALE: 3/8 IN. TO 1 FOOT

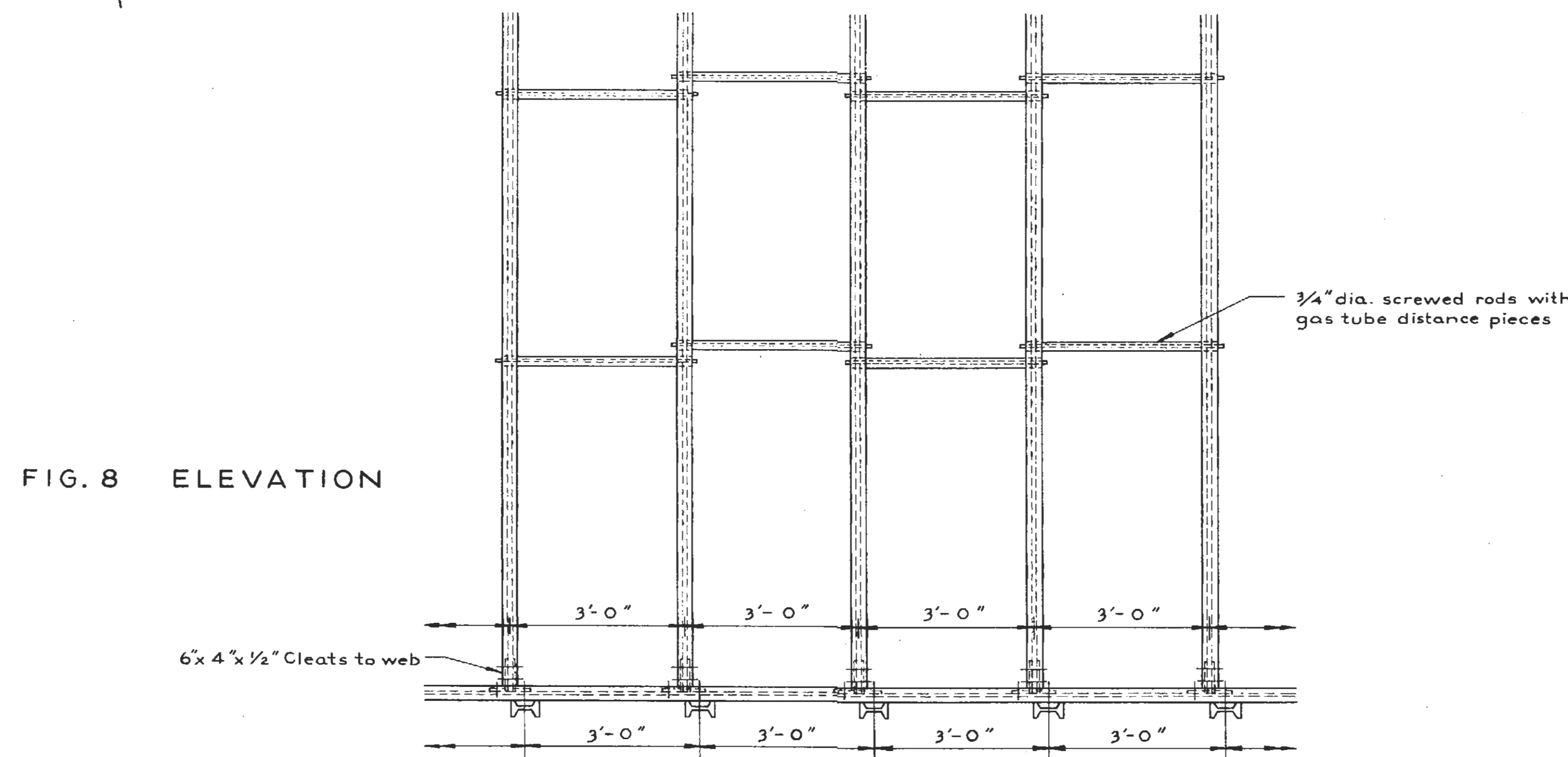


FIG. 8 ELEVATION

FIGS. 9 & 10 PLAN AND SECTION OF THE TUNNEL AT SHAFT No.3 AFTER THE ACCIDENT SHOWING TIMBER BULKHEADS

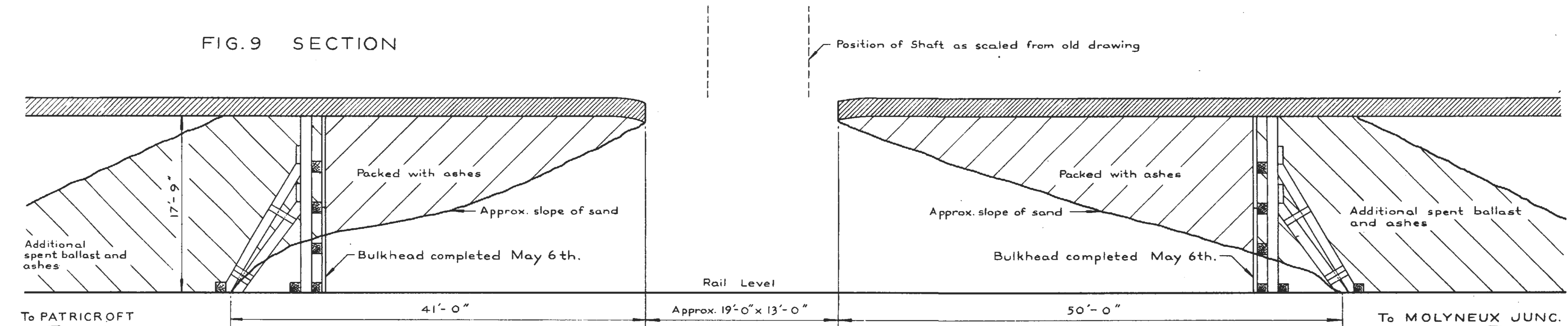


FIG. 9 SECTION

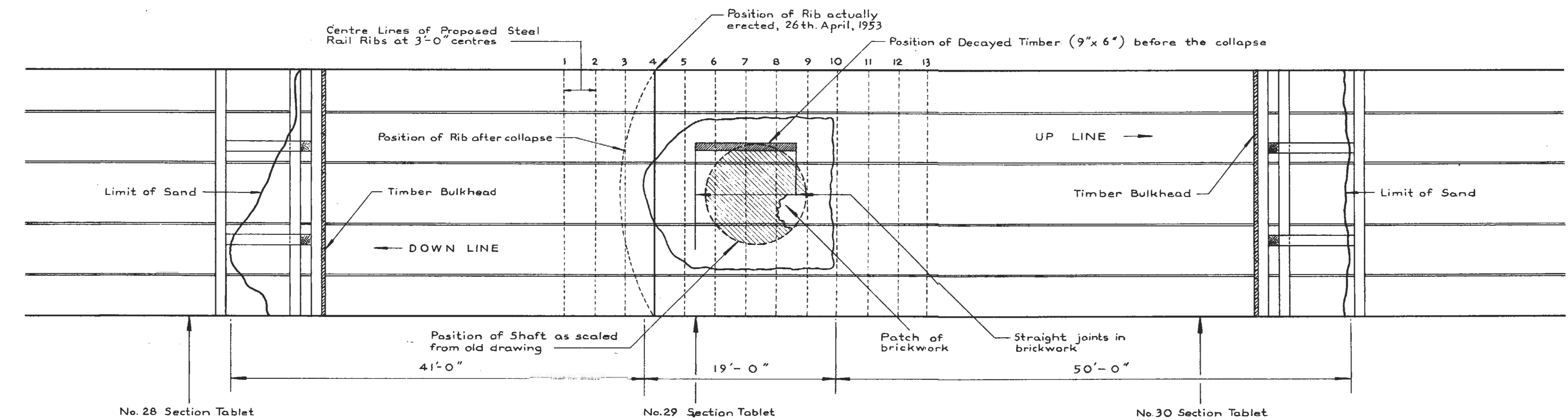


FIG. 10 PLAN

SCALE: 10 FEET TO 1 INCH

LONDON MIDLAND REGION  
**COLLAPSE OF CLIFTON HALL TUNNEL**  
 SWINTON, NR. MANCHESTER  
 28th. APRIL, 1953.

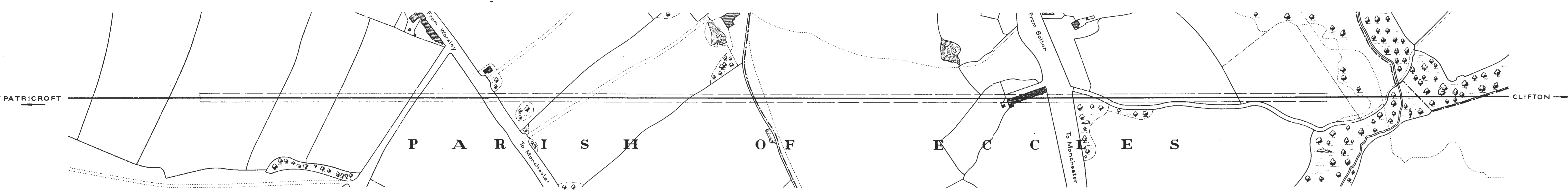


FIG. 1 PLAN OF SITE — 1844

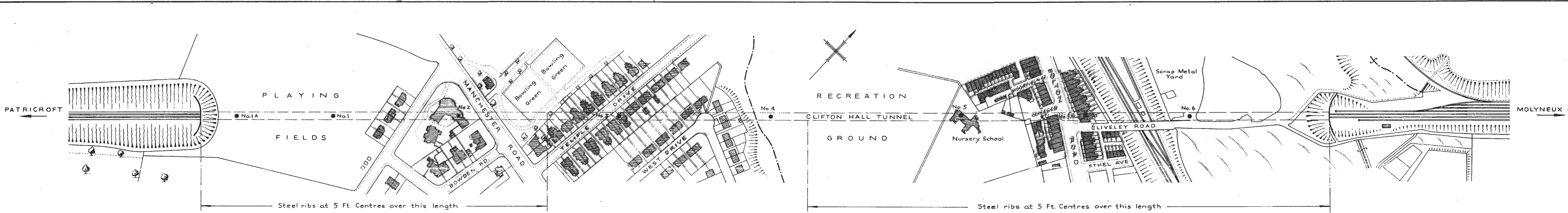


FIG. 2 PLAN OF SITE — 1953

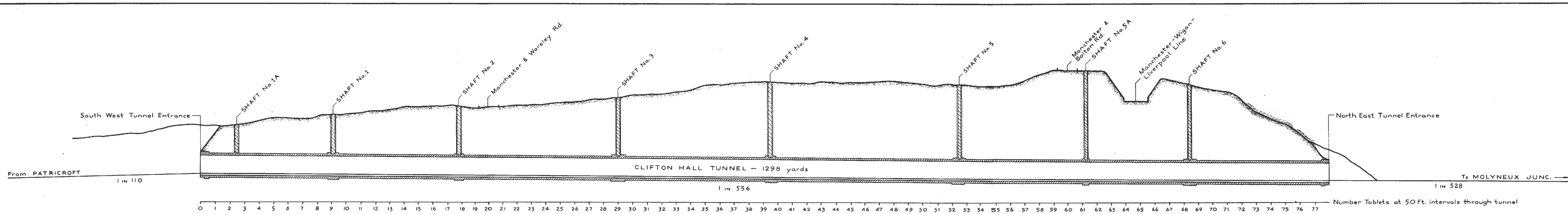


FIG. 3 LONGITUDINAL SECTION THROUGH TUNNEL SCALE: HORIZONTAL — 1/2500 VERTICAL — 66 FEET TO 1 INCH

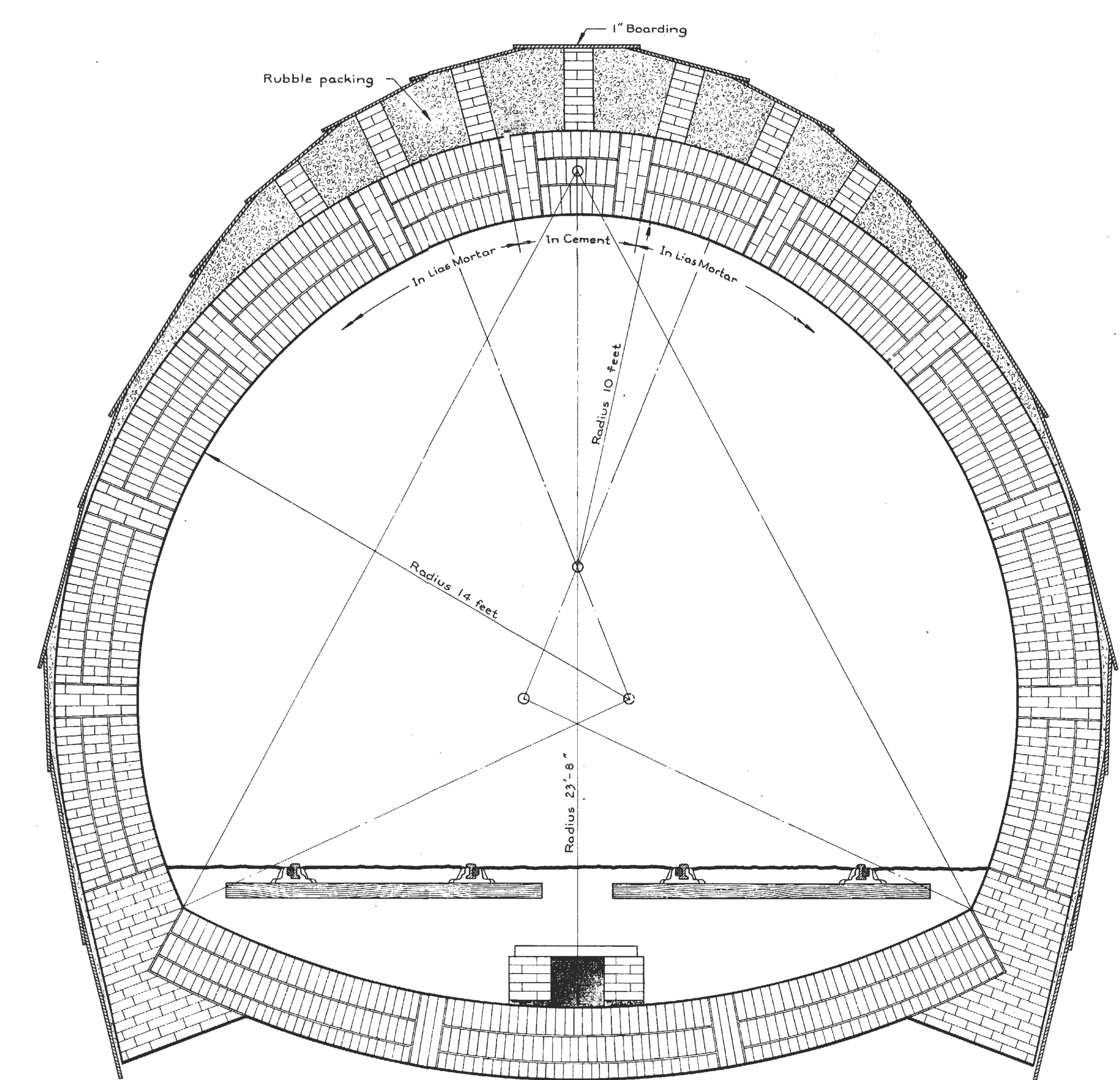


FIG. 4 TYPICAL CROSS-SECTION OF TUNNEL TAKEN FROM THE PARLIAMENTARY PLAN SCALE: 1/3 INCH TO 1 FOOT