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Collapse of the Loddon Road Viaduct, 1972 – Fifty Years On

It is fifty years since the collapse of the Loddon Road Viaduct. Incidents can be summarised in very different ways. The articles below are taken from:

- a government-commissioned technical inquiry (published many months later); and
- a local newspaper (with the story covering the immediate recovery operation and those affected).

The tragedy that unfolded are analysed in very different ways. In either case, the human suffering can not be overlooked; nor should it be forgotten.

Summary of reports of the failure of falsework for the viaduct over the river Loddon, Berkshire 1972

General

On 24 October 1972 the temporary structure supporting a road bridge under construction over the river Loddon at Woodley, near Reading, Berkshire, collapsed killing 3 men and injuring 10 others.

The investigation was particularly difficult because a good deal of the falsework was buried in the river bed and under reinforced concrete which had fallen on top of it and set hard.

A concrete viaduct of the post-tensioned type and continuous over 13 spans formed part of the A329 Relief Trunk Road which is a link road to the M4 motorway.

The viaduct had two separate carriageways each 53 ft 8 in wide with a gap of 2 ft 10 in between each carriageway. The north carriageway span which collapsed was being constructed over the river Loddon. At that place and time the river was approximately 90 ft wide and 2-3 ft deep. The distance between and normal to the piers was 93 ft and each pier was 35 ft 6 in wide at approximately 33 ft above the water level. The deck of the viaduct was to be formed by *in-situ* concrete 4 ft deep over the 31 ft 6 in wide main central 'spine' section and of a mean depth of 1 ft at either side which cantilevered from the spine. The deck was skewed longitudinally in relation to the piers at an angle of approximately 37 degrees and had a 1 in 29·25 crossfall; sketches on pages 112 [General Site Plan] and 113 [Part Section Through Finished Bridge] show the arrangement.

Falsework

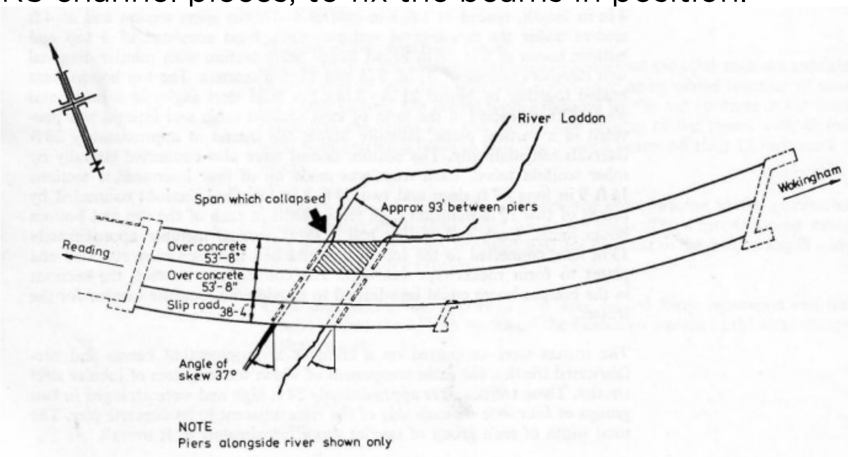
The falsework over the river consisted of fabricated steel lattice trusses 98 ft 4 in in length, spaced at 1 ft 8 in centres under the spine section and at 4 ft centres under the cantilevered sections. Each truss consisted of a top and bottom boom of 6 in x 6 in broad flange beam section with tubular diagonal web members mainly of 3½ in, 3 in and $1^7/_8$ in diameters. The top booms were braced together by bolted 2½ in x 2 in x $^3/_8$ in mild steel angles in a horizontal plane. Other bracing in the form of steel scaffold tubes and fittings, was provided in a vertical plane, laterally across the trusses at approximately 20 ft intervals longitudinally. The bottom booms were also connected laterally by other scaffold tubes. Each truss was made up of four intermediate sections 14 ft 9 in long x 7 ft deep and two 19 ft 8 in long end sections connected by means of two $1^3/_8$ in diameter high tensile bolts in each of the top and bottom boom joints. Each end section had a short vertical member approximately 13 in long connected to the top flange, attached to which were rounded end plates to form rocker-type bearings. The connections between the sections in the bottom boom could be adjusted to provide the requisite camber for the trusses.

The trusses were supported on a complex arrangement of beams and prefabricated trestles, the main component of which was a system of tubular steel trestles. These trestles were approximately 24 ft high and were arranged in two groups of four, one on each side of the river adjacent to its concrete pier. The total width of each group of trestles was approximately 62 ft overall.

The base of the trestles sat on parallel 33 in x 11½ in steel beams approximately 80 ft in length. These in turn rested on short 10 in x 10 in x 12 in x 12 in universal columns standing on the permanent pile caps (the foundations) of the bridge piers. The 33 in x 11½ in universal beams were at 3 ft 4 in centres and their top flanges supported the outer legs of all the trestles. Inner trestle legs were supported on numerous 8 in x 4 in x 17 in RSJs placed at intervals between the beams.

Forkheads with $2^3/_8$ in diameter jacking screws were fitted to the top of the trestles. The uprights of the trestles were of 4 in diameter tubes with telescopic sections inserted at their bases and mid heights, perforated by $1^1/_8$ in diameter holes at approximately 4 in centres to receive 1 in diameter steel fixing pins. Thus the height of the trestles was adjustable by means of the forkheads and the perforated insert tubes within the main trestle members, which were actuated by hydraulic jacks fitted on the outside of main members. Fine adjustments of the trestle heights were generally made by means of tapered steel plate clamps bearing against the fixing pins in the perforated legs.

In order to distribute the load carried by the 26 trusses over 16 pairs of forkheads, each end of the trusses rested on a two-layer grillage of steel beams placed on top of the trestles. (See page 114 [Part Side Elevation of Trestle System]). Each upper layer of this grillage consisted of header beams of 10 in x 10 in x 49 lb universal column sections, with special bearing pads 12 in long x 12 in wide on the top flanges. the upper surfaces of which mated with the rocker bearings of the trusses. These bearing pads were either tack welded, or clipped by bolted steel flats, to the upper universal column sections. The latter were supported on short lengths of 12 in x 6½ in x 31 lb universal beams at right angles to the 10 in x 10 in x 49 lb header beams, and spaced generally at intervals of approximately 3 ft 6 in along the top of the trestles either side of the river and rested in the trestle forkheads at 2 ft 4 in centres. Short lengths of 5 in x 2½ in rolled steel channels were fitted inside the forkheads to centralise the 12 in x 6½ in x 31 lb universal beams over the backing screws. Tapered timber packings were also used with the centralising RS channel pieces, to fix the beams in position.



General Site Plan [p112]

Movement of falsework

Early in 1972 the steel falsework for the construction of the span of the southern carriageway [Westbound] over the River Loddon had been erected without incident and used to support the full weight of the concrete deck. In August 1972 operations were commenced to move the falsework to the corresponding span of the northern carriageway [Eastbound].

Skates were fitted under the trestle legs and single rows of sheet piles were placed horizontally on top of, and welded to, each 33 in x 11 ½ in steel foundation beam, forming a flat track along which the assembly was hauled to its new position by means of a pulling device, operated from each bank of the river.

Checks were made after every foot of travel and no difficulties were experienced.

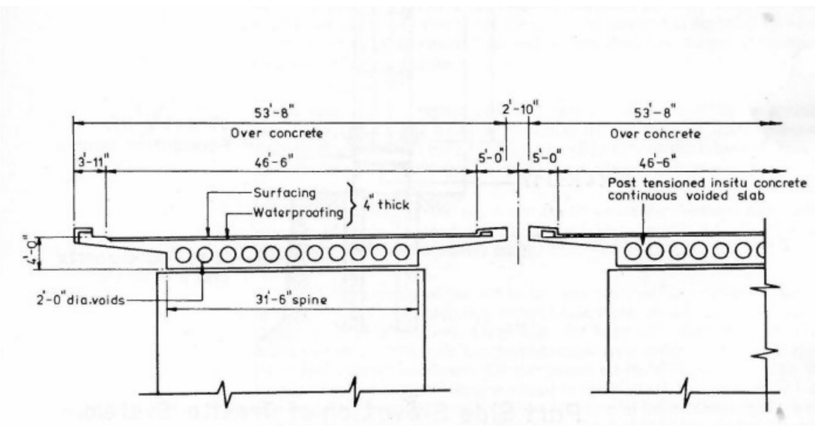
The falsework for the southern carriageway of the river span had been thoroughly inspected by an experienced person before concreting of that span took place. This inspection had revealed many bracing members missing and some bolts not properly tightened; these defects were rectified before the concrete was poured. A thorough check was made and certain defects were rectified before the concrete was poured on the falsework for the northern carriageway.

Concreting operations

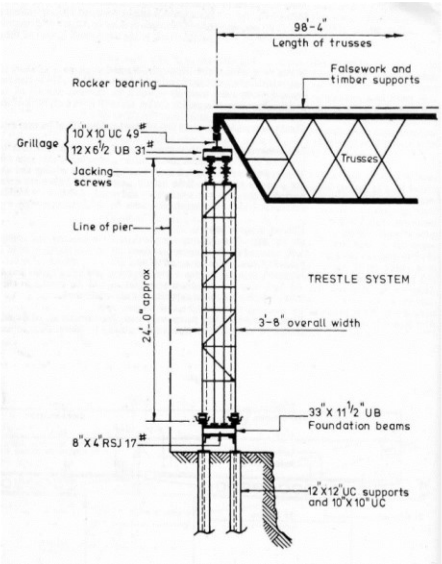
On the day of the collapse the pouring of the concrete had commenced at 8.30 a.m. and the intention was to complete the continuous pour of 750 cubic yards by 6 p.m. on the same day. Of this, 500 cubic yards would be carried by the falsework between the piers. The remaining 250 cubic yards, was to extend the deck over the permanent piers just beyond the trestles to the adjacent spans, where it would be supported by other falsework.

Four reciprocating type pumps were used. The concrete was conveyed from the pumps, through flexible pipes to the placing positions. Four separate gangs totalling 30 men were attending to the placing of the concrete in the formwork. Concrete was first deposited near the centre of the span, then pouring proceeded outwards towards the piers. The rate of pour during the first hour was 84 cubic yards dropping to 53 cubic yards in the second hour, after which it rose to 88 cubic yards an hour prior to the collapse.

Consolidation of the concrete was by means of 14 poker vibrators.



Part Section Through Finished Bridge [p113]



Part Side Elevation of Trestle System [p114]

The collapse

At about 13.35 a downward movement occurred (one estimate being of 6 in) towards the east end of the span. A few seconds later the span collapsed into the River Loddon. From an inspection of the damage it appeared that the falsework deck fell in the line of the skew, the trusses overturning sideways. The trestles at the east side of the river overturned and fell on top of the trusses, whilst at the west side, only one of the trestles overturned, namely that at the south end. The others at the west side remained vertical but in places had moved laterally 12 in towards the adjacent concrete pier. All the grillages of steel beams at the east side of the span were badly twisted or buckled, particularly the 12 in x 6½ in x 31 lb universal beams which sat in the trestle forkheads. Some of the grillage beams at the west end remained in position on the trestles but were damaged.

Possible causes of the accident

Having eliminated the possibility of foundation movement or defective formwork as potential causes of the accident, attention was concentrated on the steel falsework. The overall stability of the falsework was suspect in that the pin-jointed type of framework was not firmly anchored. In other words, although the uprights were standing freely on the foundation beams at their bases and the trusses were merely resting on the bearer plates at the top, the uprights were not tied back to or braced against the concrete piers alongside them. In addition, the lateral stability of the connected trusses was doubtful. However, there was insufficient evidence to suggest that these two factors substantially reduced the stability of the structure.

It was noted that the system had been used without incident on the southern carriageway span under a heavier load than that on the span which collapsed.

Thus weaknesses might have been introduced in moving the falsework from its first position and re-arranging it under the northern carriageway.

During the striking of the north-east trestle under the southern carriageway span two of the lower legs had been damaged. However, the actual loads in the legs of this trestle were relatively small.

Although the moving of the falsework was reported as a relatively smooth operation it had been necessary to weld side plates at the rocker bearings to maintain them in position. There had also been difficulties in aligning the trestles when the falsework was re-assembled. As a result of these alterations the actual support conditions for the trusses on the grillage beam assemblies bore little resemblance to those assumed in calculations, namely vertical loads applied centrally on the bearings without horizontal forces. Other effects which had not been allowed for included frictional forces in the rocker bearings, the inadequate fixing and the eccentricity of the bearing pads on the 10 in x 10 in x 49 lb header beams, and the poor seating of the grillage beams in the forkheads.

No calculations were available from the contractor in respect of the buckling and twisting effect of the thin webs of the grillage beams.

Although the bracing was typical of the standard found generally in falsework it was not sufficient to ensure the high standard of stability necessary to cater for the horizontal and dynamic forces likely to occur. It was not however considered that this caused the collapse.

Although the trusses buckled and twisted, they had withstood the effects of the collapse very well except for the weld failure in one of the top boom connections and the detachment of one of the diagonal tubular members.

Conclusions (All opinions are those of HM Factory Inspectorate)

It may never be possible to establish the precise order of events in the collapse. The fact that only part of the final load was sufficient to cause the collapse is significant and indicates defective construction or inadequate strength. On the basis of the evidence so far established, defects in the grillage and its immediate supports probably led to the successive failure of parts of the grillage as the load was applied. If the grillage had started to collapse, the trusses would have bowed and buckled and become displaced. The complete collapse of the structure would then have been inevitable. The factor of safety of 1.3 in the grillage, which was revealed by tests carried out after the accident, was too low when the possiblity (sic) of horizontal forces being applied under site conditions is taken into account.

The sliding of the falsework from under the completed southern carriageway to the site of the northern carriageway was not undertaken with sufficient care and weakened the structure. The final examination of the falsework, before pouring commenced, was also open to criticism.

The deficiencies enumerated below indicate that insufficient consideration had been given to the design and construction of this falsework and that the combined effect of these deficiencies reduced the theoretical overall factor of safety below that acceptable for such temporary structures in which there are many unknown factors relating to design and construction:

(a) The clearance between the trestles and the adjacent concrete piers was appreciable. It is considered that the trestles on one side of the span should have been positively anchored to the adjacent pier and movement at the opposite side restricted.

(b) The damaged legs of the trestles were straightened and re-used instead of being replaced.

(c) Many of the bolts connecting the component parts of the trestles were missing and others were not sufficiently long to accommodate a full depth of nut.

(d) There were no stiffeners fitted to the thin webs of the 10 in x 10 in x 49 lb universal coloumns (sic) and 12 in x 6½ in x 31 lb universal beams of the mild steel grillage assemblies supporting the trusses. These were subject to considerable buckling and twisting loads.

It is considered significant that in the only place where a web stiffener was fitted (because slight damage had occurred before use to one of the 10 in x 10 in x 49 lb universal columns) no distortion of the adjacent web or flanges occurred.

(e) The ends of some of the 12 in x 6½ in x 31 lb universal beams had been tapered by flame cutting, so reducing the effective web areas by approximately 30 per cent at points of appreciable loading

(f) The bearings of the 12 in x 6½ in x 31 lb universal beams in the forkheads on the trestles were not flat as had been assumed in the design. In many cases, deformation of the bases of the forkheads over the jacking screws had resulted in near knife-edge supports, thus reducing the buckling and twisting strengths of the universal beams.

(g) The bearing pads on some of the 10 in x 10 in x 49 lb universal column sections in the grillage assemblies were only clipped or tack-welded in position. This was not good practice bearing in mind the horizontal forces they had to sustain.

(h) Some of the bearing pads on the 10 in x 10 in x 49 lb universal column sections were found to be eccentrically located by up to 1½ in. Such eccentricity was not allowed for in the design and resulted in unintentional eccentric loadings.

(i) The main design assumption of pin joints at the bearings between the trusses and the trestles was not realised due to the crudity of the rocker arrangement. This relied on two rough curved surfaces, exposed to the elements and not lubricated which did not provide the low resistance to rotation assumed in the design.

(j) The diagonal bracing provided between the trusses was not sufficient to ensure the high standard of stability necessary to resist the horizontal and dynamic forces which may have occurred.

Additional comments

It was considered that the flexural shortening of the compression boom of the trusses would have applied a horizontal force to the top of the trestles.

There was some concern over the variation in dimensions caused by inaccurate rolling of some of the steel sections.

The verticality of the structure after the moving operation was questioned.

The effects of vibration from a nearby railway were considered but were not thought to contribute to the failure.

Although German and French operatives were involved in the erection of the falsework no language problem was evident.

Source:

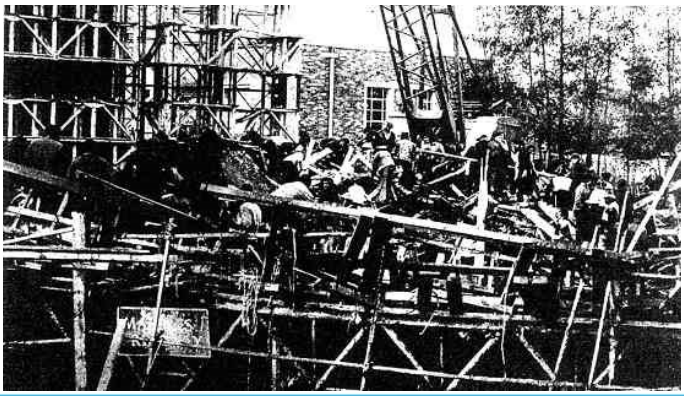
Final report of the Advisory Committee on Falsework – Appendix 1, Case Studies, pp 112 to 117 - June 1975, HMSO, ISBN 0 11 880347 6 ("The Bragg Report")

'Digging for dear life . . .'

From the 'Wokingham Times', 26th October 1972:

by Times News Team. Reporters: Malcolm Deacon, Quentin Falk, Eileen Sheridan, Ian Soutar; Photographers: Bob Bodman, Clive Postlethwaite.

Like so many ants, rescue workers swarm over the wreckage feverishly searching for survivors. Every now and then there is a pause as they listen for cries from the injured. But there is silence except for the drone of generators as fire engines pump out brown, murky water to reduce the level of the river. So the search continues.



This was the scene at the Loddon Bridge disaster on Tuesday when three men died and 10 were brought out injured after being trapped in the tangled mesh of girders, rods and splintered wooden frames. Hundreds of tons of concrete, wood and steel had crashed 40ft down when the span between two concrete pillars was on the point of being cemented.

The contractors, Marples Ridgway, say they do not know why it collapsed, and Berkshire County Council are to hold an inquiry. A 999 call by a 14-year-old Winnersh schoolboy seconds after the crash first alerted the police and set the massive emergency rescue operation in motion.

Meanwhile fellow-workers of the trapped men ran over and began clawing at the wreckage. As one of them, Mr. Tom Murphy of Finchampstead Road, Wokingham, whose brother Joe was slightly injured as he jumped clear, said: “Everyone helps – you do, don’t you, because they’re your mates”.

FOREST Grammar schoolboy Roger Laitt (14) at the scene of the disaster. Roger was the first person to raise the alarm after the bridge collapsed. He phoned for the police and rescue services from his home even though he was in a state of shock after seeing 20 men plunge to the ground from the bridge.
With Roger is Mrs Alice Guntrip whose 21-year-old son George had just returned to work on the site. He escaped uninjured.

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With Roger is Mrs Alice Guntrip whose 21-year-old son George has just returned to work on the site. He escaped uninjured.

From the window of his home in Loddonbridge Road, Roger Laitt, a Forest Grammar School pupil, saw the viaduct collapse. “I heard a noise like a terrible clap of thunder. It was indescribable”, he said. “I saw the whole lot go down. There were about 20 men on top of the bridge and I saw them go down with it. My hand just reached for the ‘phone and I managed to dial for the police. I was shaking all over at the time. The whole site was covered in clouds of dust and I could hear people screaming. It was the workmen. Even they were screaming. After I rang the police, I rang my mother and she came home from work.”

Roger, who was at home on half-term holiday, said “It seemed ages before they came. I thought they could have been much quicker, especially when there is a Fire Station just around the corner”.

Roger’s next-door neighbour, Mrs. Alice Guntrip, also saw the bridge collapse. Her 21-year-old son, George, was working on the site at the time, and she has been dreading an accident like this. “As soon as I heard it I knew what had happened”, she said, Mrs. Guntrip screamed for her husband Earnest, who was asleep upstairs.

“I just didn’t know what to do first. I ran down the garden yelling “Georgie, Georgie”. I met some of his workmates and asked them “Have you seen Georgie?” They told me he was all right, but I wouldn’t stop until I had seen him for myself. He had only gone back to the site five minutes before the bridge fell. He stopped for a chat on the way back, and if he hadn’t done that he would have been on the bridge. After I saw him he went back to the rubble and tried to help pull people clear”.

Shocked as she was, Mrs. Guntrip still managed to make tea for helpers. “I’ll never forget what I saw”, she said.

During the morning there were some 40 men working on the span, but it was lunch-time when the disaster struck and half of them were having their lunch-break. Mr. Tom Murphy of Finchampstead Road, Wokingham, was near the canteen 75 yards away. He heard the crash and turned round in time to see the span hit the water. His brother Joe was one of the men working in the other shift and was slightly injured as the scaffolding plummeted down.

Tom Murphy rushed over to the bridge and together with many other site workers clawed at the wreckage to try and free trapped men. He said, "Everyone helps – you do, don't you, because they're your mates." Both he and his brother had been working at the A329 Relief Road site for some weeks. "There was a terrible noise and I just saw the thing crumble into the river", he said.

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Mr. Murphy said that the span had been checked and that the men on top were pouring concrete into it. "We've finished several spans which are exactly the same. I've worked on hundreds of them before. I can't understand it".

Scaffolder Mr. Freddie Singh, 26, said that the span "crumbled like a pack of cards". He said that there had been two minutes' warning of the impending disaster. "There was a lot of creaking and groaning and some men on top jumped off. But there was so little time that the ones in the middle were not so lucky and had no room to move."

WEARY rescue workers carry out one of the badly injured on a stretcher to a waiting ambulance as some of the man's mates stand-by.

One holds his hands to his head in horror as he discovers the identity of the victim.

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One holds his hands to his head in horror as he discovers the identity of the victim.

Workman John O'Connor was near the works canteen, about 75 yards from the bridge. "I did not see it, but I heard it – there was an almighty bang and a crash and all of us ran over to the bridge."

Two of the shocked and injured men are helped to a waiting ambulance.

As the alarm was raised at 1:15, every available ambulance in Reading was ordered to the scene. They were soon joined by ambulances from Bracknell and Wokingham until over 20 were ready. At that stage, nobody knew how many men were trapped. Reports ranged from "under ten" to "about 20". Everywhere workers were asking each other "have you seen John?" or "has anyone seen Mick?"

In the canteen on the site, roll calls were taken. A group of men, covered in mud and grime, answered as their names were called. There were embarrassed coughs and nobody dared look at each other as the foreman called out a name and there was no reply. A cross was put by the name and the foreman read on.

The ambulance man were soon joined by firemen from Reading, Wokingham, Sonning and Pangbourne. Said one fireman, "God – it looks like a scaffolder's nightmare". Said another – if there's anyone down there he can't have much of a chance.

Nurses and doctors were quickly on the scene carrying boxes and bundles of life-saving equipment to tend to the injured men and exhausted rescuers.

They worked alongside the fire brigade and police in the feverish atmosphere of the disaster area, seeing the stretchers into the ambulances and doing on-the-spot treatment for bruised and cut workers who continued to claw at the wreckage.

Mr. Chipper said that one man was pinned by a steel bar. “It had to be cut away before he could be freed”, he said. Chain gangs of rescue workers were formed to cart away the debris. Over 300 workmen, police and ambulance men clambered over the scaffolding while behind them cranes were being started up to help lift the large pieces away.

Among the confusion nurses and Red Cross workers stood ready with supplies of plasma. Men started cutting away the metal with oxy-acetylene cutters, sending showers of sparks in all directions and a policeman stood by with a fire extinguisher. Much of the wreckage was in the water – four feet of fast-running brown muck churned up by all the rescue work. Fireman worked frantically to get their pumps going in a desperate attempt to lower the level. Everywhere was a maze of hoses and equipment. Police and firemen directed operations with walkie-talkie radios.

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Nearby, women neighbours valiantly started making cup after cup of strong, sweet tea and weary rescue workers snatched time off for quick breathers. The whole area around the bridge had been churned up by the hundreds of pairs of feet trampling around and soon became a sea of mud.

A GENERAL view of the tons of crumbled scaffolding which crashed forty feet into the River Loddon.

A general view of the tons of crumbled scaffolding which crashed forty feet into the River Loddon.

'Disaster Toll'

Three Wokingham men were among the injured workers.

Bill Cumming (40) of 11 Firs Close, Nine Mile Ride, Wokingham, was detained in Battle Hospital, Reading, with injuries to his legs and arms.

Thomas Ford (20) of the Caravan Site, Loddon Stud Farm, Winnersh, was detained in Battle Hospital with a back injury.

The third local man, Angus Macdonald (26) of The Farm, Watmore Lane, Winnersh, was discharged from Battle Hospital after receiving treatment.

One of the three men killed was a Berkshire County Council inspector who was on top of the bridge supervising the pouring of liquid concrete into the mould. He was 50-year-old Mr. Derek Thomas of Burbage, near Swindon, in Wiltshire.

Another man who died in the bridge collapse was Mr. Derek Cooper (40) of Fleet in Hampshire.

The other inured were: Jim Bugner (20) of Chiswick, and David Clifton (30), Thomas Connoran (21), Francis Cox (36), Richard Matthews (20), Joseph Murphy (29) and John Noble (31), all of Reading.

The name of the third man had not been released at the time of going to press.

'It is all a complete mystery'

Berkshire County Surveyor, Mr. Edward Davies, said yesterday morning that the cause of the tragedy was "A complete mystery".

RESCUE workers, police and firemen are sternfaced as the task of pulling away wreckage above the trapped men goes grimly on. A crew with oxy-acetylene burning equipment is seen moving in.

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"We are mystified", he said at a Press conference at Marples-Ridgway site headquarters. "The number of things which could lead to the collapse is infinite", said Mr. M. Simpson, the county council's resident engineer on the site. Both, however, strenuously denied that the design of the bridge, or its method of construction, was in any way to blame. "This has been done since the 1850s", said Mr. Davies. "There is no reason at all to suggest that the design was in any way inadequate".

The collapse happened when tons of liquid concrete was being poured into the bridge "false work" – a temporary bridge of steel piles and girders. After the concrete has set, the falsework is taken away and a bridge of concrete is left.

This falsework had previously been used on the west-bound bridge at the beginning of August and was due to be moved along the river to help construct the lower slip road. "We had no other problems with it at all", said Mr. Simpson. Altogether there will be 33 spans in the viaduct and the one which was being constructed was the eighth.

Reconstruction work started immediately, but Mr. Davies said that work could be delayed by anything up to several months. The viaduct was due to be completed in January, at a cost of over £1½ million.

Most of the 500 tons of concrete – a completed span has 1,000 tons – is now lying in the river. Mr. Davies admitted that there might well be problems in one already drained area, and added that the contractors might resort to blasting to get it out.

He again repeated that the cause of the tragedy was a mystery but said: "We all want to find out. The engineers will want to find out, the department will want to find out and the contractors certainly will".

DT, 22.8.22