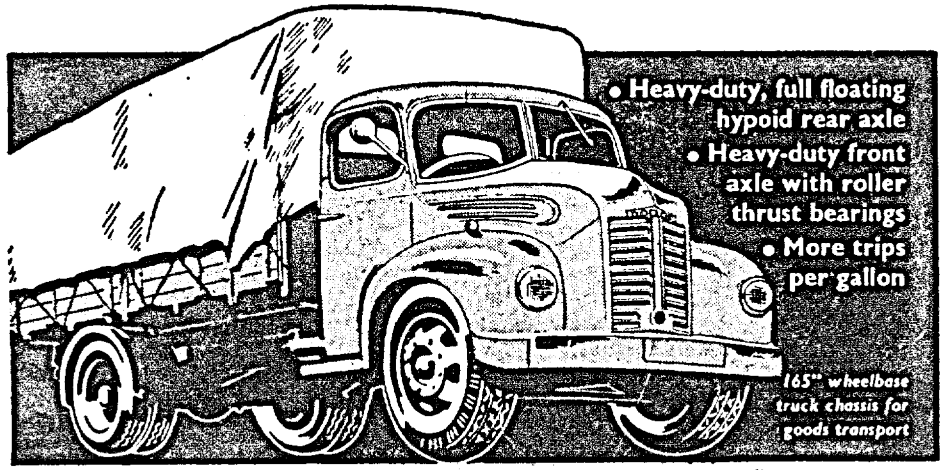
TRANSPORT-COMMUNICATIONS

MONTHLY REVIEW

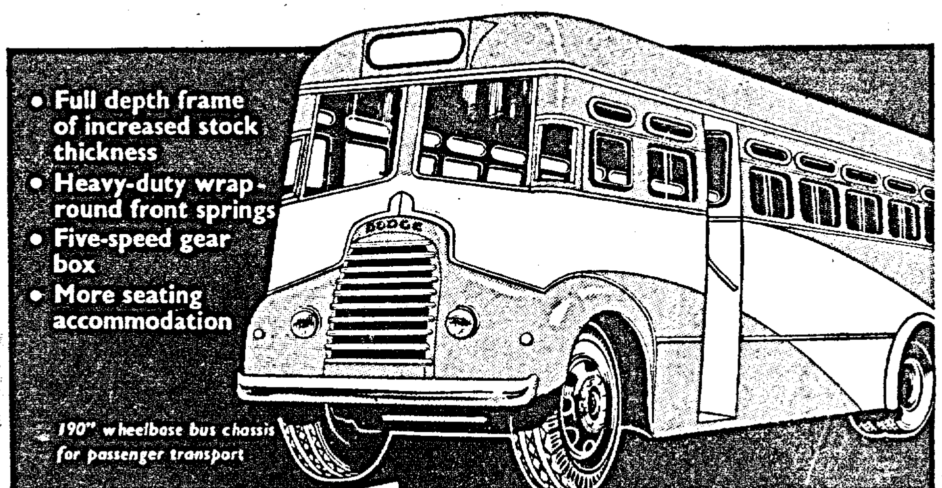
OCTOBER 1957—No. 126

INDIAN ROADS CONGRESS, NEW DELHI.



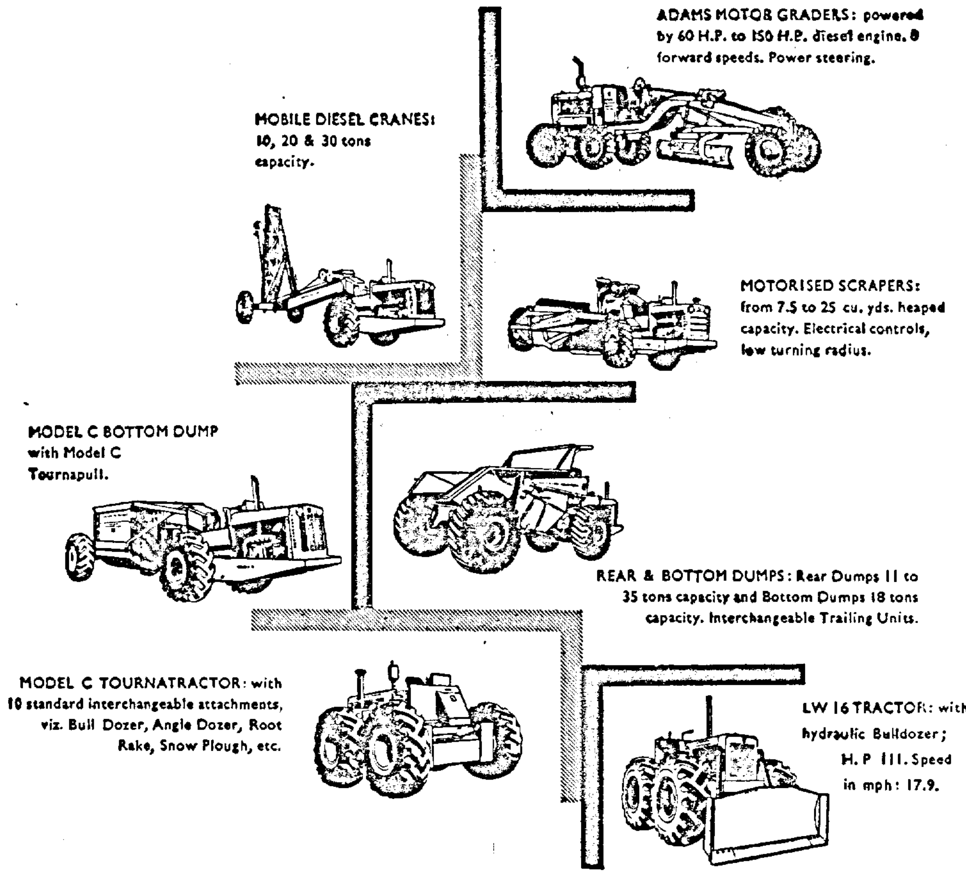
DODGE

DIESELS



Progressively manufactured by
THE PREMIER AUTOMOBILES LTD.
BOMBAY

Contact your nearest dealer.



Changing the face of India

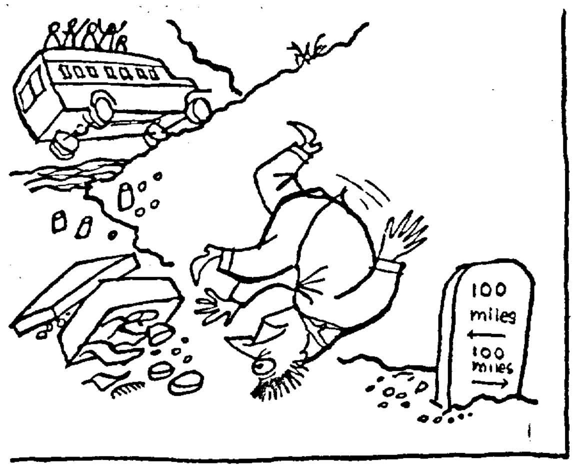
Hundreds of miles of irrigation canals and national highways, mighty dams, new industrial townships, and innumerable other nation-building projects are today changing the face of India. Travelling from project to project under its own power, rubber-tyred LeTourneau-Westinghouse earth moving equipment is bringing speed and efficiency to this mighty work of national reconstruction.

For the full range of
LeTOURNEAU – WESTINGHOUSE EARTHMOVING MACHINERY

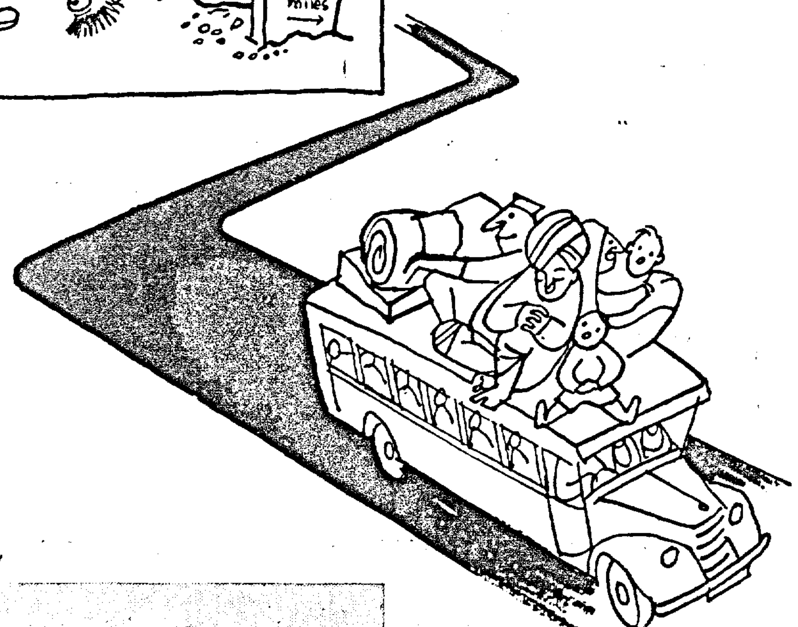
Ask Jacks about it

William Jacks & Co. Ltd.
(Incorporated in England. Liability of Members Limited.)
Calcutta Bombay Madras

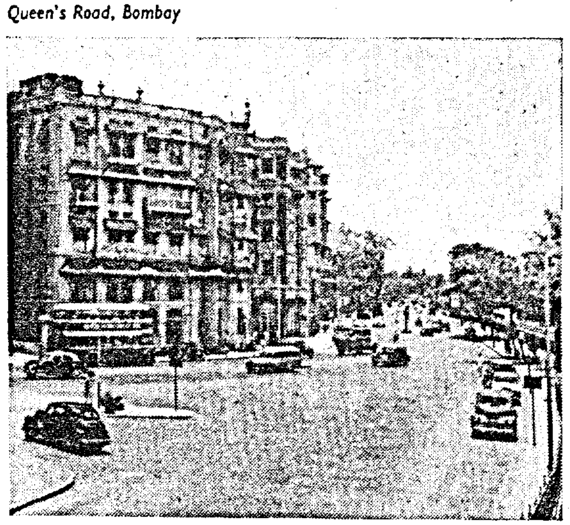
WJC-265A



Mexphalte and Shelmac are easy riding



Queen's Road, Bombay



Modern Flexible *"Black Top"* roads are easy riding, durable, anti-skid and tough. They can be made with Mexphalte and Shelmac Bitumen marketed by Burmah-Shell.

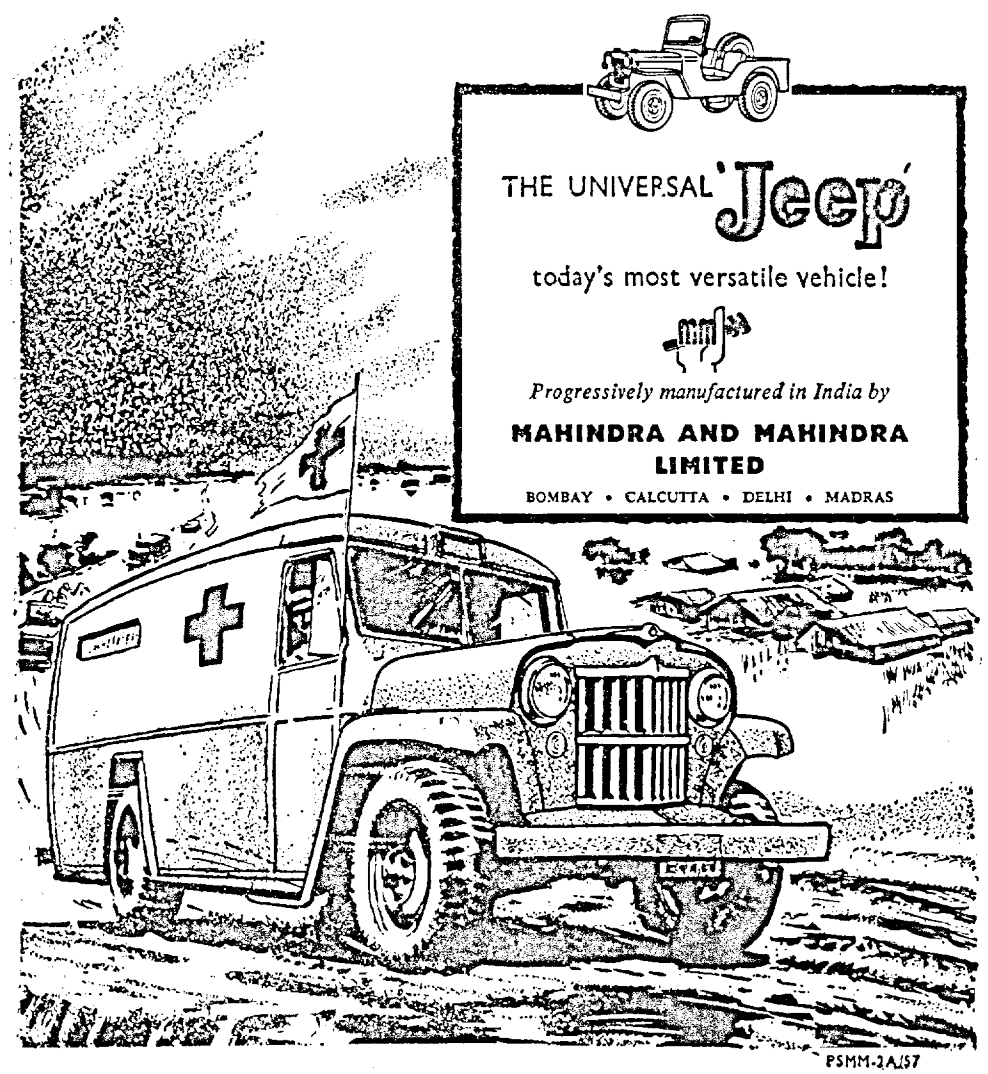
Burmah-Shell

FOR BETTER ROADS

FIGHT THE FLOODS...

Swirling rivers, flooded countryside... drowned cattle and homeless people...but the fight for better flood control methods goes on every year.

Helping keep a watch on rain swollen rivers...bringing relief to the stranded... carrying medical aid, food and clothing in the wake of receding waters through mud and slush...these are jobs that only the Universal 'Jeep' with the extra traction of 4-wheel drive can do.



TRANSPORT-COMMUNICATIONS
MONTHLY REVIEW

OCTOBER 1957—No. 126

TABLE OF CONTENTS

Transport - Communications Monthly Review is published on the 25th of each month by the **Indian Roads Congress, New Delhi.**

This Review is sponsored by the Roads Wing of the Deptt. of Transport, Ministry of Transport and Communications, but the Government of India accept no responsibility for any views or opinions expressed.

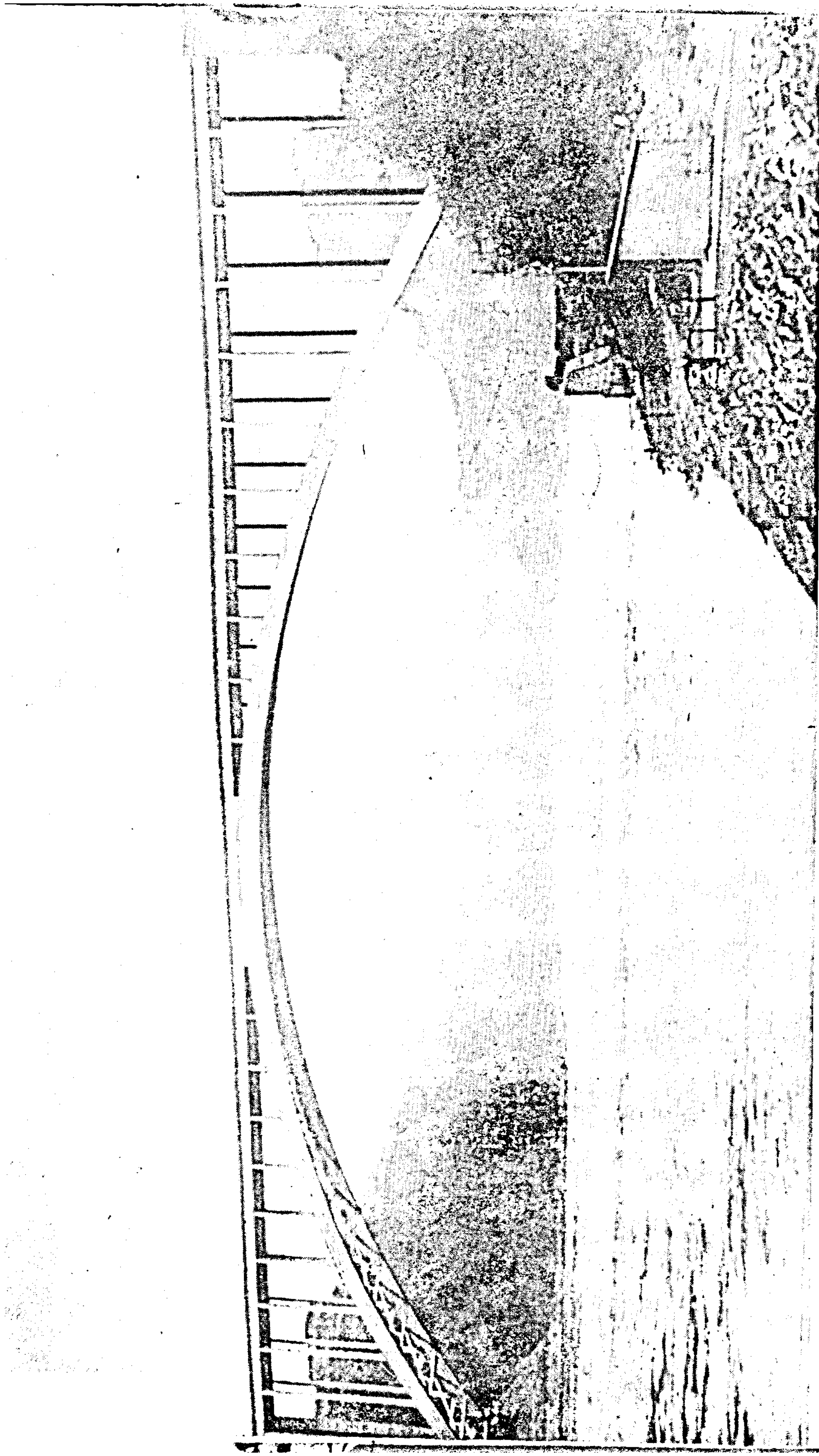
Subscriptions. Annual subscription including postage is Rs Fourteen. Single copy including postage is Re one and annas four.

To members of the Indian Roads Congress, Engineering personnel below the rank of an S. D. O. and Engineering students a special reduced subscription rate of Rs eight per annum is offered. Students are required to apply through the Principal of their College.

Advertisements. Advertising rates per insertion

	Full Page	Half Page
Inside front cover	Rs 100/-	—
Inside back cover	100/-	—
Outside back cover	120/-	—
Ordinary position	75/-	45/-

Detailed rate card can be had on application to the Secretary, Indian Roads Congress, Jamnagar House, Shahjahan Road, New Delhi-2.



RAINBOW BRIDGE—Steel Arch bridge over Niagara River, between Niagara Falls, New York, and Niagara Falls, Ontario, Canada; Span length; Main span—hingeless arch—960 feet. Total cost, 4 million dollars

TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

A REVIEW OF
ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

OCTOBER 1957 50

ECONOMY IN ENGINEERING

AT the Sixteenth session of the Indian Roads Congress held at Simla in 1952, Shri. G. M. McKelvie in his Presidential Address* said: "Let us always think of economy in the execution of our works. An engineer is a man who can do for one rupee what any fool can do for two. Let us be engineers." This remark provoked a retort from Shri Chandulal Trivedi, the then Governor of the Punjab, who declared the Session open. His Excellency in his Inaugural Address said: "You have observed, Sir, that an engineer is a man who can do for one rupee what any fool can do for two. Let this be the constant ideal of every engineer. Might I, in this connection, voice the feeling that I have come across that an engineer is sometimes, if not often, a man who can do for one rupee and eight annas what an ordinary man with common sense can do for himself for one rupee!" It was interesting to listen to this wordy battle at the Simla session between a distinguished administrator and a no less distinguished engineer. Shri. McKelvie did not stay quiet at that. In his concluding remarks, he gave this rejoinder: "We appreciate what you have said about the necessity for economy in design and construction. May I say, Sir, that the engineer does not claim to buy his materials at half the market price or to pay his workers half the normal wages. What he should do, and generally does, is so to design and construct his structures that the minimum of labour and materials are used."

We would have believed that the battle had once for all successfully ended at Simla, had not the matter come up again during the Shillong session of the Indian Roads Congress in May last. In concluding his Inaugural Address, Shri Saiyid Fazl Ali, Governor of Assam, stressing the need for economy in construction and design, quoted again from the speech of Shri Chandulal Trivedi on the question of economy. Further, he asked the engineers to assess whether and to what extent such a feeling might yet prevail and to do their best to remove any impression of this nature. His Excellency admitted that "costs were high and with the increasing tempo of our national economy they might even tend to rise, but by the exercise of a little initiative in the judicious use of the local available

*Journal of the Indian Roads Congress, Vol. XVI-4. October 1952, p. 432.

materials without detriment to quality and if possible enlisting some measure of voluntary offer from the people in the locality, it should not be impossible to effect some economy in what is undoubtedly a costly venture."

The President of the Indian Roads Congress at Shillong ably answered these points in his concluding remarks. He said that efficiency cannot be produced without proper tools. The engineer is asked to mend a pencil with a blunt knife. How can he produce good results unless his tools are changed? A complete reorientation of outlook towards the engineer is required. Some clarifications regarding factor of safety and endurance of structures were also made subsequently by correspondence to clear misunderstandings, if any. If we venture to offer any remarks on the subject it is not with a view to stir controversial embers but merely because the subject is an important one and of vital interest to the country, and any observations like the ones made by two distinguished and revered public servants should only make us disposed to a little reflection which is a healthy exercise.

Engineers always design and construct structures with economy in view. That is why before blue prints for any project are finalised, no efforts are spared to work out in detail several alternatives, and generally the most economical one is adopted. Local materials are also increasingly used with a view to economy. Modern developments in prestressed concrete and soil stabilization are nothing but examples of adoption of economical designs and economical use of local materials to the best advantage. Economy figures prominently in engineering design and construction and down through the ages all the advances in these fields have been principally motivated by economy. As regards voluntary effort, as already said previously, it is a most welcome contribution, but it has its limitations in engineering works. It is useful in simple engineering works where highly technical processes and skill are not involved and where the overflow of routine practices can be utilized with advantage. However, more than on engineers, the success in this direction depends on the popular will. If engineers can play a part in training this effort, they will not be found wanting to make their contribution.

As to the method by which the engineers are working today, this is rather a wide subject and we would not like to rush in where we should fear to tread. However, concerning its technical aspect, it may be briefly stated that in executing any work, big or small, engineers have to follow methods in accordance with the scientific standards which have been tested in practice. This is so not only in the case of engineers but other professionals also. Scientific methods by their very nature are costly. For example, it would be costly to seek recognised medical advice for a minor ailment just as it would be expensive to have recourse to a lawyer for a routine court case. Unlike these cases, no trust in the natural development of the issue may be relied upon in the case of engineering structures as for obvious reasons this could be risky. It would, therefore, be unjust to single out engineers for blame in this respect. Concerning the general aspect of the question, which is more of an administrative rather than a technical matter, it may be stated that engineers have to follow the procedure or set of rules laid down for strict observance, from which they cannot make departures at their own will. Any departure would be an irregularity requiring explanation. If this method does not produce quick and economical results

specially in case of small works which, it is said, could be done quicker and cheaper by other methods, it would be unfair to lay the blame at the door of the engineers. The engineers do not work in isolation; they form part of a bigger machinery. The scope for economy by engineers is thus limited to their personal initiative in organization and supervision of works. The engineers are aware of their responsibility in this direction and will not shirk it as they have not done in the past. Here again, there is sometimes lack of understanding towards their efforts. It has to be remembered that engineers cannot perform miracles; they have to work with the tools and raw materials with which they are provided and better tools and raw materials no doubt produce better results.

Lastly, special mention should be made about the technical point regarding 'factor of safety' employed in design of engineering structures about which there are some misconceptions. According to convention followed by all the countries of the world, structures are designed with a margin of safety, generally 4 and often less, which is meant to cover any unforeseen or abnormal contingency either during the construction of the structure or its later life. However, research is continuously going on to effect economy in the design of structures by adopting higher working stresses as a result of improved techniques of construction and quality of materials. Even then a factor of safety is necessary. Structures have to be built with a view to endurance. Many of the old structures are standing safely today against the ravages of time and nature because of the factor of safety. If, today, we feel grateful to our forefathers for their foresight in bequeathing us sound and durable structures, can we, on our part, under pretence of economy, forget our obligations to posterity?

It cannot be too strongly emphasised that the sacrifice of professional ideals to save money is false economy.

— *N. H. Stockley.*

(From a Paper to the Institution of Municipal Engineers at Blackpool, June, 1957)

BRIDGING INDIA'S RIVERS

PRESTRESSED GIRDERS OF NAGI BRIDGE*

GENERAL DESCRIPTION OF BRIDGE

THE Nagi Bridge is situated in Mile 14 of Jamui - Jhajha - Chakai road in Monghyr District of Bihar State. This road serves as a link between Patna-Monghyr - Bhagalpur Road and Assam consists of 22 feet clear roadway with 9 in. wide R. C. curbs and 3 feet high railings on either side. The 6 inch R. C. slab is carried by 3 main 68 feet span prestressed girders spaced at 7 feet 9 inches centres and having cantilevers 2 feet 9 inches on either side. The cross-section of the bridge is shown in Fig 2.

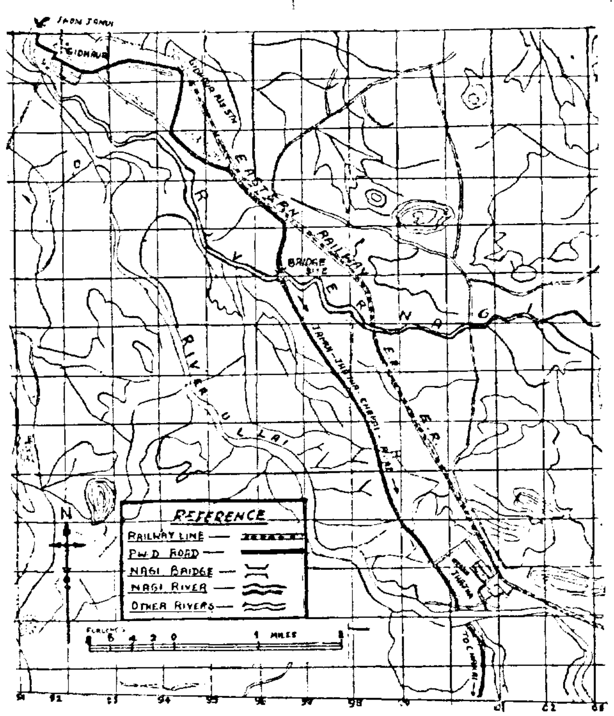


Fig. 1

Access Road and serves completely an aboriginal area. The site of the bridge is shown in Fig 1.

The bridge consists of 4 spans of 68 feet each. Well foundations have been adopted for the bridge. The two separate wells have been joined at the top by an R.C. well cap 2 feet thick. The prestressed girders transmit the load through roller bearings to the mass concrete piers resting on the well cap. The superstructure

Freyssinet system was adopted for prestressing the girders of the superstructure which are described below.

PRESTRESSED GIRDERS

Concrete

Black stone granite was available at Pananwa hill quarry at a distance of 10 miles from the bridge site and was used for this work. Very good coarse sand was available just in the river bed.

*From a report by Shri R. D. Sharan Singh, P. W. D., Bihar.

The mix adopted was 1: 1¼: 3 by weight. To ascertain the correct proportion of mix for the specified strength, cubes 4 in. × 4 in. were taken and tested at Mokamah Bridge Laboratory. The results of the test cubes taken out while concreting the girder showed consistently good results with an average strength of above 6000 lb per square inch at 28 days, the water cement ratio being kept at 0. 42.

High tensile steel

The type of wire used for prestressed concrete work in Nagi Bridge consists of 6 cables of 12 wires per cable, each wire having a diameter of 7 mm.

It is a cold drawn wire having ultimate tensile strength of 95 to 110 tons per square inch. The final working stress should not be taken greater than 0.66 of the ultimate tensile strength.

The cables were encased in sheathing before placing them in forms. This was done to prevent the cement concrete from coming in contact with the cables. The cables were circular in section and were held separately by means of a central helix of fine wire coiled like a spring.

The springs are inserted to prevent wires from crossing each other and to keep them in round position as the high tensile wires are arranged all round the spring. The spring also facilitates injection of the neat cement grout after the cables are fully stressed.

Freyssinet Cone Anchorages

Freyessinet anchor cones consisting of 2 concrete cones which fit one inside the other were used. The main function of these cones is to hold the high tensile wires in position after they are stressed so that they are not allowed to shrink back.

Casting

(a) *End Blocks* :—The female cones were precast into special end blocks 9 inches wide and then fixed at the ends of the shuttering of the girders (Fig 3). The concrete used was high grade concrete and care was taken to ensure the accurate position of female cones in the precast end blocks. Vibrators were used for compaction. Precast end blocks were used because stressing was done through these end blocks and they were subjected to high stress due to localisation of the loads.

Care was taken to ensure that the cone and cable axes coincided. They were cast at least 8 days before the construction of the girder so that by the time they were fixed in position they were fully matured.

(b) *Girders* :—The design of girders was based on Freyssinet method of prestressing with the following assumptions :

(1) Maximum allowable compressive stress—5000 lb per square inch.

(2) Maximum allowable tensile stress at jack—100 tons per square inch and for high tensile steel—62.5 tons per square inch.

(3) Maximum loss in prestress—15 per cent.

(4) The girders were designed for 2 lanes of Class "A" or one lane of Class "AA" whichever produced maximum loading.

Shuttering

The shutterings were made of well seasoned teak wood 1½ in. thick and were joined by tongued grooving. Rubber packings were also adopted at the joints. Horizontal runners and vertical posts were tied to these shutterings and also to each other by means of bolts and nuts. At both the ends, the end blocks served the purpose of end shutterings.

Reinforcement

Six cables of high tensile steel consisting of 12 rods each having a diameter of 7 mm. were placed in the forms. Four cables passed through the ends and the remaining two cables over the top. (Figs 4 & 5).

To secure the cables in their proper position, mild steel suspenders were placed at intervals of 10 feet. The cables were placed in the hooks welded to the suspenders and tied with binding wire.

The suspenders of course got embeded in the concrete. The web-reinforcement being of ¼ inch and 3/8 inch diameter had a tendency to wobble too much while concreting.

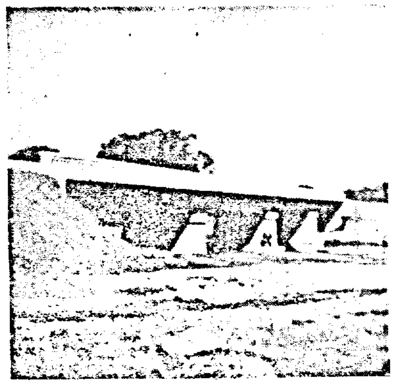


Photo 1. **A view of the completed Bridge**

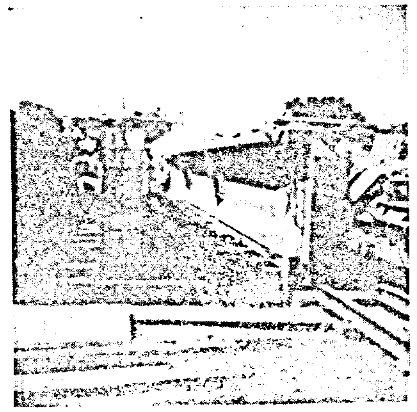


Photo 2. **Stressing in progress**

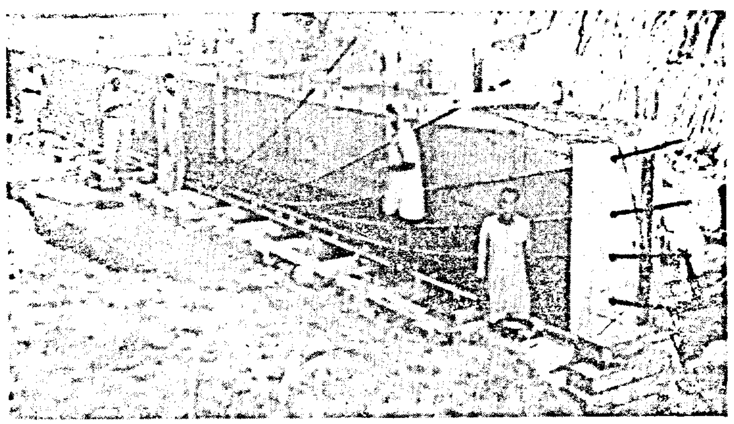


Photo 3. **High tensile steel cables in position**

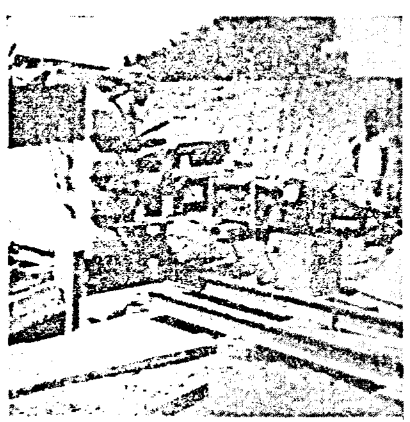


Photo 4. **Jack fitted in position and stressing in progress**

Photo 5. **Male cone is being inserted and helical spring is being taken out for inserting Jack**

To ensure proper cover, vertical timber spacers were introduced. Those spacers were removed as the concreting progressed.

Four hours after concreting, the cables were hammered from one end to loosen any grout that might have entered the casting. The same operation was repeated from the other end next morning.

Concreting of Girder

The girders were cast on the approach road leading to the bridge. The bank was thoroughly rolled in 6-inch layers with a 10-ton road roller. A cement concrete platform was made to prevent further settlement of ground.

One-inch camber was provided in the bottom of the centering and the girders were raised 3/8 inch in stressing and thus a total camber of $1\frac{3}{8}$ inch developed in the girder. The water cement ratio was controlled by an automatic device fixed at the top of the concrete mixer. Water was pumped to an overhead tank 40 feet high from the river bed and carried to the site by a gravity pipe.

The coarse aggregate and sand were proportioned by weight. A swing type weighing machine was used. Cement was weighed accurately with a spring balance. Arrangement for carrying the concrete was made through manual labour. Care was taken to place the concrete quickly. Vibrators were used from inside to consolidate the concrete. The casting of one girder took 3 to 4 hours and the following materials went in the making of one girder:

1. Stone Chips $\frac{3}{4}$ inch size......350 lb.
2. Stone chips $\frac{1}{4}$ inch size......130 lb.
3. Sand................210 lb. } per trip.
4. Cement.............168 lb. } per trip.
5. Labour...............50
6. Mild Steel.........14 Cwt. } for one complete girder.
7. High tensile Steel 0.5 tons. } for one complete girder.
8. Total cement.......110 bags of one cwt each. } for one complete girder.

(The concrete proportions were by weight.)

Castellations

9-inch wide and one inch high castellations were provided on the top flange at intervals of 1 ft 9 in. They were provided to give a bond between the prestressed girder and the deck slab and for shear.

Stressing the cables

The cables were stressed in turn as noted below:

1. 3rd cable
2. 2nd cable
3. 1st cable
4. 4th cable
5. 6th cable
6. 5th cable after the slab was cast.

There was no visible sign of gaining camber in the stressing of 3rd cable. The girders were found leaving the ground after stressing of the 2nd cable. Hogging of 3/8 inch was generally observed when all the five cables were stressed after 5 days. Sometimes only $\frac{1}{4}$ in. hogging was observed. This was due to the fact that concrete as it becomes old loses elasticity. This was the case with girders which were stressed after 9-10 days of concreting.

Method of Stressing

About 4 feet length of the spring was first taken out from the cable and the male cone was inserted by striking the end with a wooden handle and it went inside the female cone loosely. The next operation was to fix the clamp of the jack touching the female cone and then fixing the jack itself at each end of the cable. The arrangement to hold the jack in correct position was made by hanging it through ropes tied at the top in R. S. joists fixed for launching of the girder. The head of the jack was pushed through the middle of the wires and was kept touching the female cone.

The 12 wires of the cables were adjusted over the 12 grooves of the jack and were tightened by inserting steel wedges. The wedges were perfectly tightened to avoid slip of the rods due to loose fittings while in process of stressing. Thereafter the jack was connected to the pump. The lead from the pump was attached to the jack to stress the wires only. The valve of the front lead was closed and that of the rear one was opened. The arrangement for taking up the stressing was complete and the pump and the jack were ready for stressing.

A little pressure was applied to the jack and by so doing the slackness, if any, found in the fittings of the cables and the jack was removed The next operation was to mark the wires 20 inches from the end of the beams to facilitate measurement of the elongation of high tensile steel in each operation.

The pressures applied to both the ends of the cables and the elongation in the wires were noted.

Thus there was a double check on the stress on the cables, viz.,

(1) by watching the pressure on the hydraulic pump,

(2) by measuring the length of the wire which was stretched.

The specified elongation of 5 in. ($2\frac{1}{2}$ inch on each end) was reached after raising the pressure on the pump to 5000 lb. The elongation noticed for cables 1, 2, 3, and 4 was $5\frac{1}{4}$ inch and $3\frac{1}{8}$ inch for cable 6. After this the valve on the lead was closed. The next operation taken in hand was to anchor the male cone in the female cone at each end. This was achieved by attaching the second lead from the pump to the jack and opening the valve. Slightly higher pressure than 5000 lb. was needed to insert the male cone into the female cone. It was found to be 5100 lb. At this pressure the male cone finally went into the female cone and the wires were firmly gripped between the male and female cones. The valve of the front lead was then closed to maintain the full pressure on the male cone. Thereafter the main release valve on the pump was opened to allow the oil flow back. The elongation of the high tensile wire was checked and a slip of $\frac{1}{2}$ inch ($\frac{1}{4}$ inch on each end) was noticed which was within permissible limit.

The jack was then removed.

Grouting and Finishing Operation

The purpose of grouting is:

(i) To protect the steel from corrosion;

(ii) To provide extra anchorage by bond between concrete and steel;

(iii) It is essential that the pipe is completely filled with grout.

The projecting high tensile steel wires were then cut leaving about 8 inches outside. These wires were turned down all round and were jammed by cement mortar. The next operation was to force water into cables through the central hole left in the male cone to drive out all the dirt etc., from the cables. The water in the beginning appeared dirty but after a while clear water was visible.

The grout was prepared of neat cement in a colcrete mixture and was screened before injecting into the cables. The injection of grout was done under pressure and when the duct was full, the ends were plugged. After the grouting was completed the recess was filled with a stiff mortar.

There is always some clearance between the female cones and male cones; unless this clearance is closed, the grout comes out during grouting operation. In order to prevent this, the clearance should be closed with cement mortar as soon as the wires are bent.

While plastering care was taken to see that the hole for grouting was not closed. The following proportion for grout was used:

50 lb of cement.

28 lb of water.

The grouting was done under a pressure of 100 lb per square inch.

The girder was then launched in position by rolling on rails.

Cost

The details of cost are noted below:

(1) Total cost of the Bridge (total length 274 ft face to face.) Rs 3,50,600/-

(2) Cost of Sub-Structure ...Rs 2,21,457/-

(3) Cost of Superstructure ...Rs 1,29,143/-

(4) Cost per running foot ...Rs 1,297/-

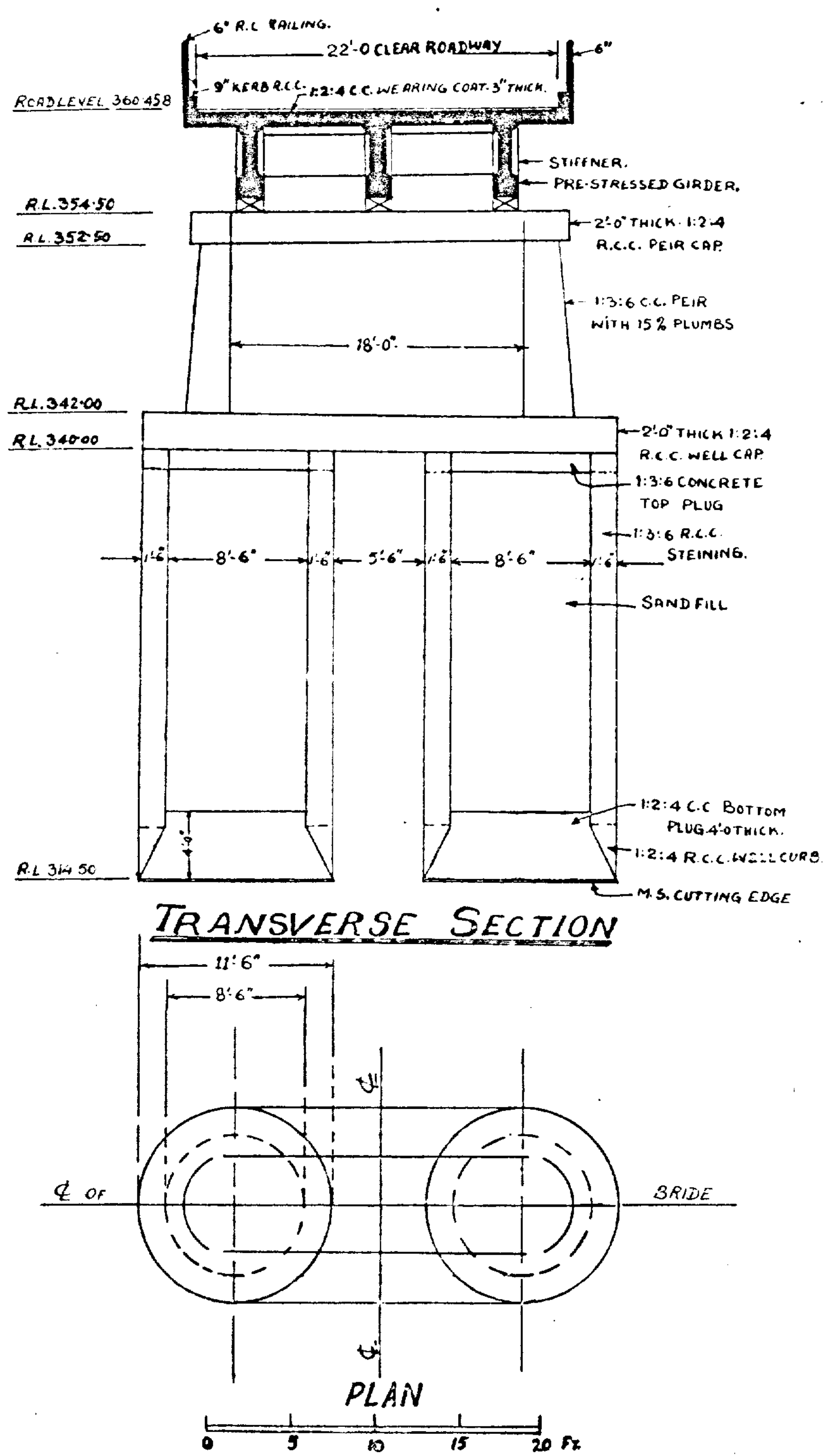


Fig. 2

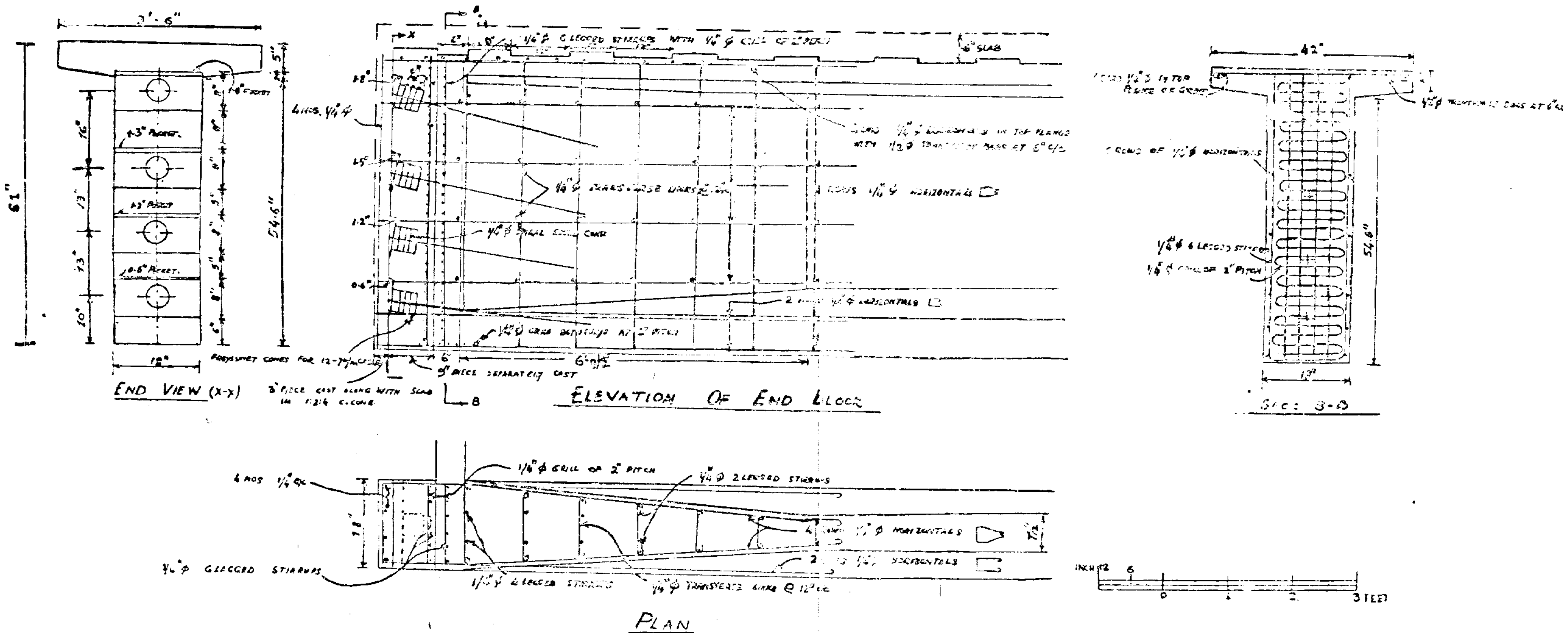


Fig. 3

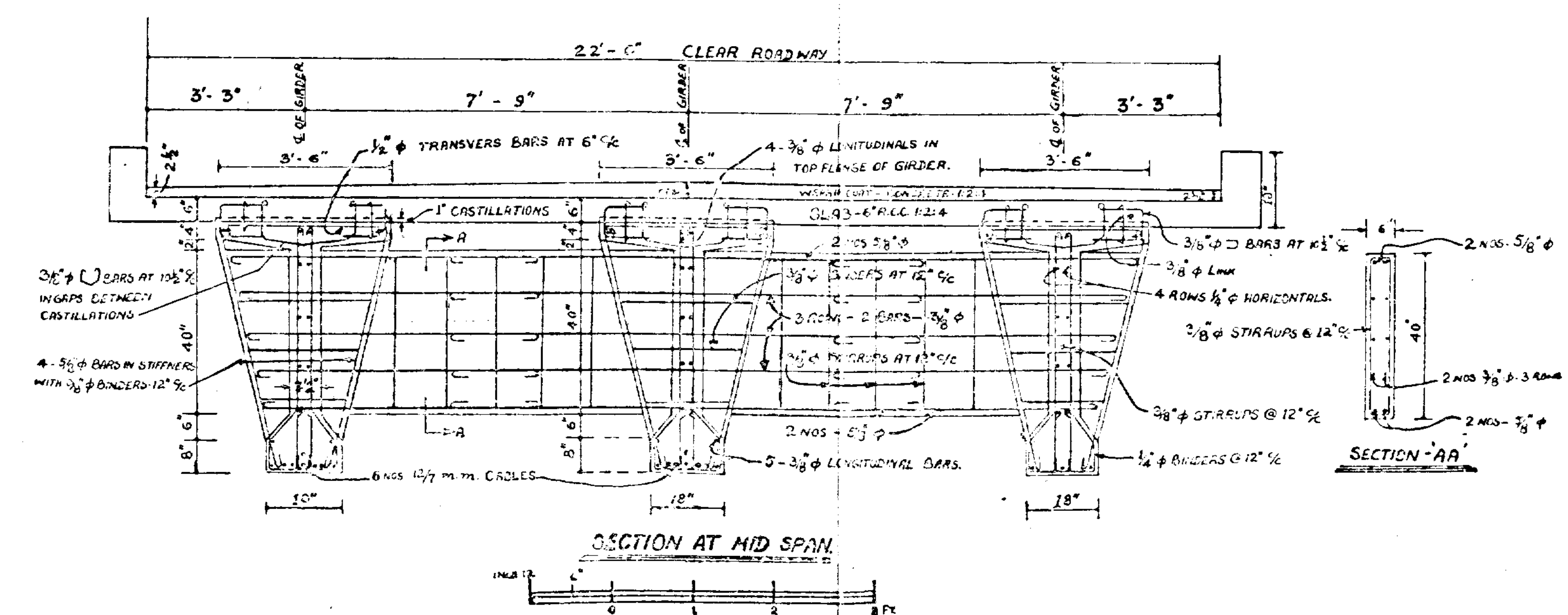


Fig. 4

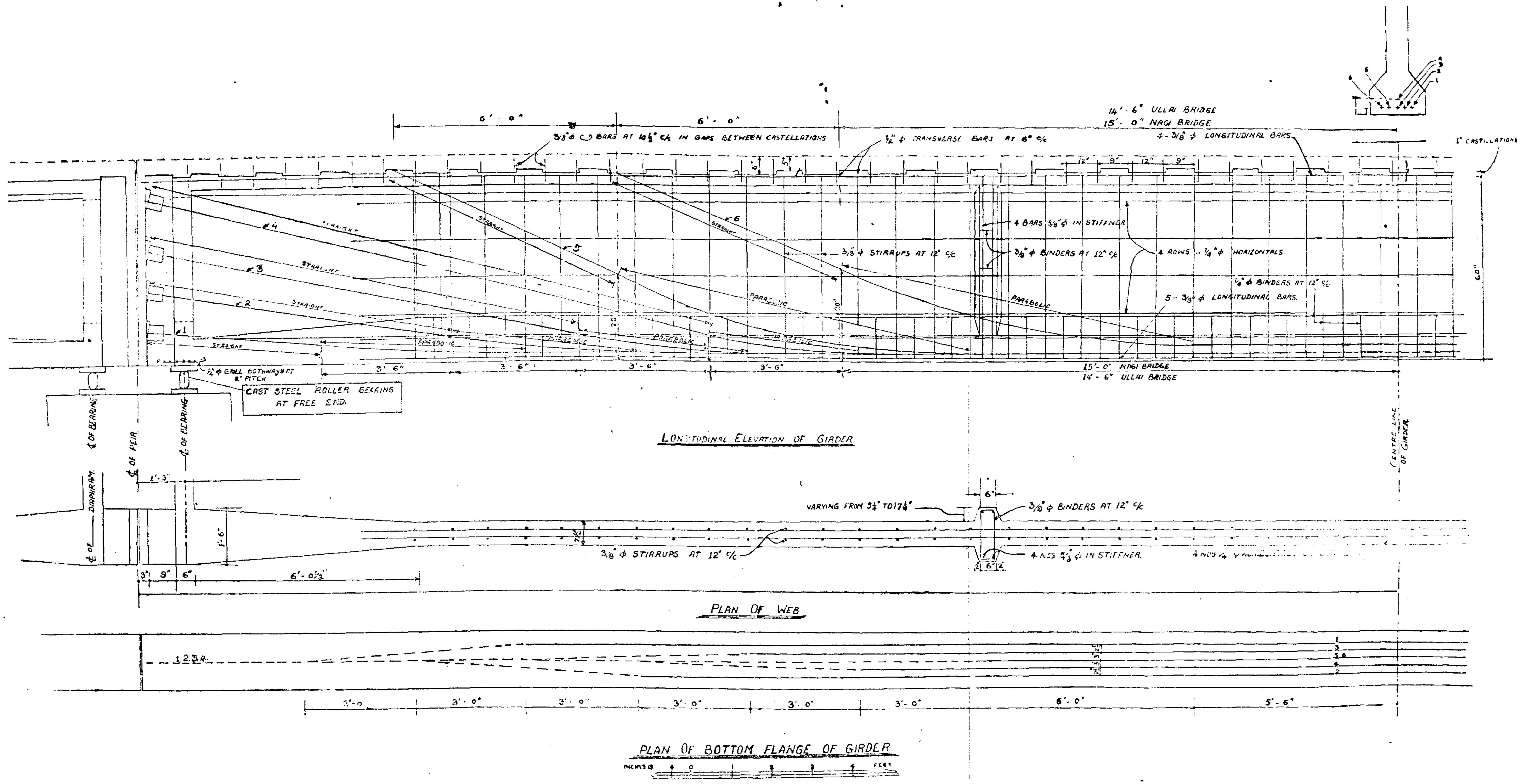

14'-6" ULLAI BRIDGE
15'-0" NAGI BRIDGE
4-3/8" ϕ LONGITUDINAL BARS
1" CASTELLATIONS
1/2" ϕ TRANSVERSE BARS AT 6" c/c
4 BARS 5/8" ϕ IN STIFFNER
3/8" ϕ STIRRUPS AT 12" c/c
3/8" ϕ BINDERS AT 12" c/c
4 ROWS - 1/4" ϕ HORIZONTALS
1/4" ϕ BINDERS AT 12" c/c
5-3/8" ϕ LONGITUDINAL BARS
STRAIGHT
PARABOLIC
CAST STEEL ROLLER BEARING AT FREE END
15'-0" NAGI BRIDGE
14'-6" ULLAI BRIDGE
LONGITUDINAL ELEVATION OF GIRDER
CENTRE LINE OF GIRDER
PLAN OF WEB
VARYING FROM 5 1/4" TO 17 1/4"
3/8" ϕ BINDERS AT 12" c/c
3/8" ϕ STIRRUPS AT 12" c/c
PLAN OF BOTTOM FLANGE OF GIRDER

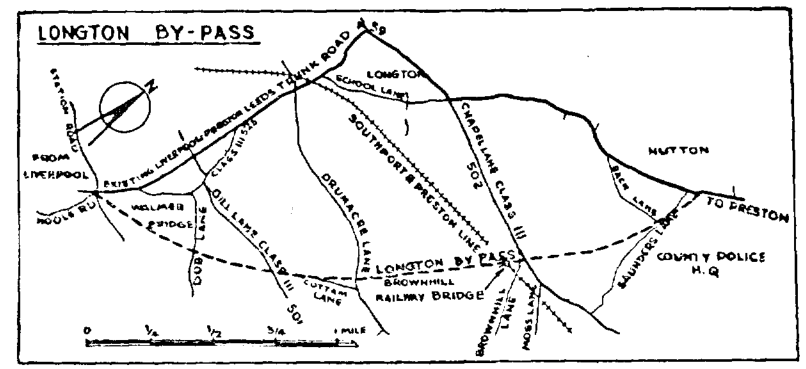
Fig. 5

PRESTON AND LONGTON BY-PASSES ROAD AND BRIDGE WORKS

THE Longton by-pass is on the Liverpool-Preston-Leeds trunk road, A. 59, some four miles west of Preston. It is 2.56 miles in length and by-passes a length of 2.9 miles of existing narrow and tortuous road which passes through the straggling village of Longton.

The layout of the by-pass provides dual carriageways 24 ft wide, with a central reservation varying in width from 10 ft at the south end to a nomial width of 26 ft at the north end, widening at one point to 40 ft to avoid excessive tree felling.

The central reservation is widened to 26 ft at two junctions with Class III



roads and one junction with an unclassified road. As two of these junctions occur at the north end, in a length on which the Preston Southern by-pass will eventually commence, the 26 ft width is maintained between the two junctions. At these junctions acceleration and deceleration lanes are also provided. At two other junctions with unclassified roads which carry very light traffic, no widening of the central reservation or carriageways is provided.

A new roundabout, with a 180 ft diameter island, is provided at the south end of the by-pass, where it meets the existing trunk road, and the existing roundabout at the north end is being slightly modified. To meet local conditions there is one footway on two thirds of the length and two footways on the remainder. A short length of two-way cycle track is provided for the benefit of pupils attending a nearby grammar school.

Curvature of the by-pass varies from a radius of 3183 ft to 40,000 ft and the design speed is 60 m. p. h.

Gradients vary from 1 in 250 to 1 in 30, the latter being on the approaches to the bridge which carries the by-pass over the Preston to Southport railway.

Preston by-Pass Roadworks

The horizontal and vertical alignment of the Preston By-pass have been designed to current motorway standards, and have also been co-ordinated to produce a pleasing "free-flowing" road ribbon.

The standards laid down for motorways by the Ministry of Transport and Civil Aviation are as follows :

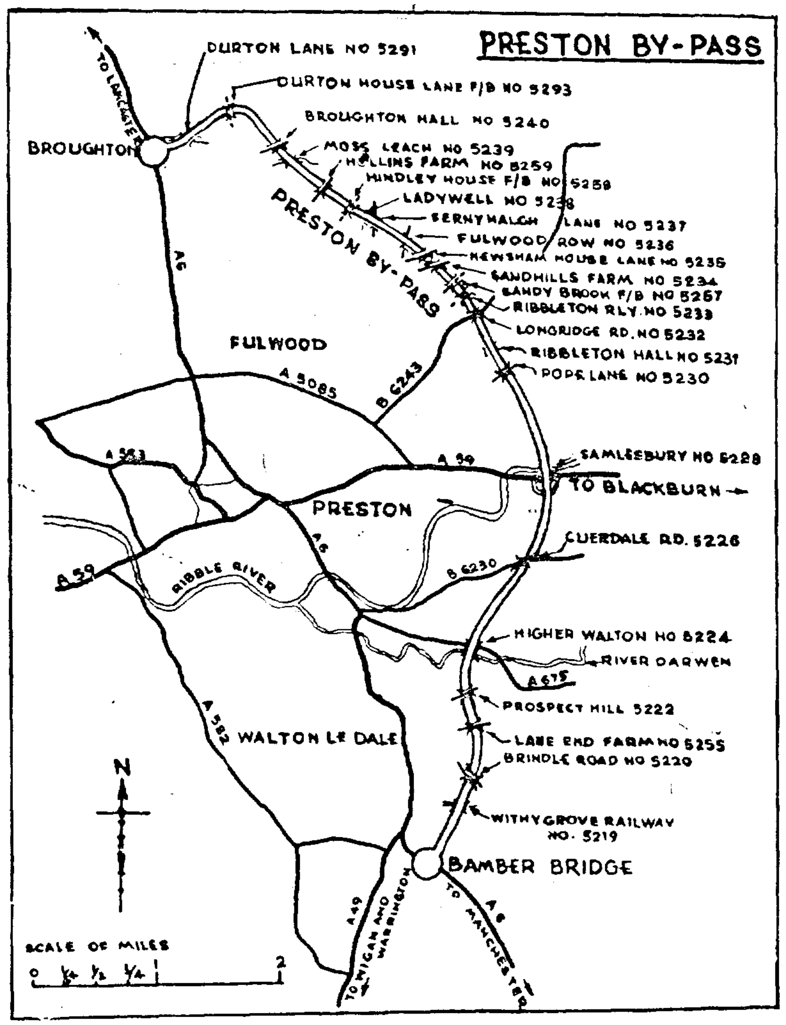
Straights.–Minimum 400 yd., maximum 1000 yd.

Minimum sight line 650 ft

Minimum radius of horizontal curves.- 2° (2865 ft radius).

Maximum gradient :—$3\frac{1}{2}$ per cent normal with up to 5 per cent in hilly country.

Curves of a shorter radius than 5730 ft (1°) are approached at each end by a transition curve, the length of the spiral



being such that the rate of change of centripetal acceleration does not exceed 1 ft per sec.² per sec.

A design speed of 70 m. p. h. has been adopted for superelevations, and, in general, this has been developed uniformly along the length of the spiral.

The use of contrasting marginal strips as a "haunch" to the edges of the carriageway instead of the more conventional kerb, has enabled vertical curves of very large radius to be employed, drainage gradients being unimportant as all surface water flows off the side.

The Preston by-pass has been designed for ultimate dual three-lane carriageways. The Ministry of Transport and Civil Aviation's standards provide a 112 ft width between hedges, with 36 ft wide carriageways and a 1 ft wide contrasting marginal strip along the edges (giving an effective width of 38 ft). A 13 ft wide central reservation is provided and 11 ft 6 in. wide outer verges, an 8 ft width of the outer verge adjacent to the carriageway being constructed to form a "hard shoulder" sufficiently strong to carry vehicles leaving the carriageway in an emergency.

The Ministry's standards quoted above were not finalised until a very late stage in the design of the Preston by-pass. No change was, therefore, made in the agreed layout, which provided 34 ft wide carriageways, plus 1 ft wide contrasting marginal strips, a 12 ft wide central reservation and

14 ft wide outer verges incorporating the 8 ft wide hard shoulder.

Although a hard shoulder is provided for emergency use, it is not intended to encourage parking along the side verges other than at established lay-bys. These will be sited at approximately one-mile intervals along the road, and will be constructed to the normal dimensions and design adopted for trunk roads.

To economise on bridge construction, the width of the side verges at bridges with spans or widths greater than 20 ft has been reduced to 4 ft, plus a 1 ft marginal strip. To prevent vehicles from running on to the verges at these spots a 6 in. × 12 in. concrete kerb has been provided for a distance of 175 ft before and 75 ft after the bridge.

Although the ultimate traffic capacity will warrant a dual three-lane layout the road is being constructed initially with dual two-lane carriageways (24 ft wide), the width of the central reservation being 32 ft. This will enable the ultimate widening of the carriageways to be carried out on the centre of the road without decreasing the width of the outer verges.

On embankments the general overall width is increased to 118 ft between tops of slopes to allow for the planting of quickthorn hedges.

The terminal junctions of the by-pass with the existing road system are surface roundabouts with a minimum diameter of 240 ft. These will ultimately form two-level interchanges when the motorway is continued southwards to Cheshire, and the Broughton Link continued through as a motorway to Blackpool.

At Samlesbury the junction with the Preston-Whalley trunk road, A. 59, presents a problem in that the "ramps" had to be wholly on one side of the trunk road owing to the proximity of the River Ribble. The design here is in the form of a U-type junction with roundabouts of 180 ft diameter on the trunk road.

Bridges on Preston By-Pass

Various types of structure have been chosen for the bridges, with one, three or four spans. For overbridges, i.e., bridges over the motorway, the four-span type of bridge has usually been adopted, as this gives a minimum depth of construction and is, therefore, generally more economical, particularly where the road being taken over the motorway has to be raised on an embankment in order to make the crossing. There were, however, certain conditions under which it was considered advisable to adopt alternative types to the four spans. For example, where the motorway is on a curve, a pier in the central reserve may interfere with the sight lines of the traffic ; in these cases a single-span bridge has been adopted. In another case, at Pope Lane, the motorway is in a deep cutting, and here a three-span bridge has been adopted.

For the underbridges, i.e., bridges under or carrying the motorway, single-span bridges have normally been used as the spans have not been very large. In two cases, however, major crossings are involved—namely, at Samlesbury over trunk road A.59 and the River Ribble, and at Higher Walton over Class I road A. 675 and the River Darwen. At Samlesbury a three-span structure with spans of 120 ft, 180 ft and 120 ft giving an overall length of 420 ft has been adopted, while at Higher Walton a six-span structure with four spans of 97 ft 6 in. each and two end spans of 40 ft gives an overall length of 470 ft. At D'Urton Lane, where the motorway is carried over the Class III road at a considerable skew, a three-span bridge has been adopted in order to reduce the tunnel effect and to give added light under the bridge.

For small streams box culverts are being constructed, while for footbridges a three-pin arch type bridge has been chosen.

The occupation bridges, all of which are being built over the motorway, are of four-span construction.

Of the 23 bridges, 12 have a prestressed concrete deck, five use steel beams with a reinforced concrete slab and six are of reinforced concrete throughout.

For both the prestressed construction and the steel types where a reinforced concrete slab is supported by beams composite construction is allowed for in the design, and interaction between the slab and beam is ensured by shear connectors.

Prestressed Concrete

In most of the prestressed concrete decks the beams are of such a size and weight that they can be produced in a factory under strict and rigid control and then transported to, and erected on, the site. In these cases the beams are being precast on the long-line system, the high tensile wires being stressed before casting and then, when the concrete has reached the required strength, released to give the necessary prestress. In one case, however, the beams were cast in the works and then post-tensioned by means of Macalloy bars.

Where larger spans are in prestressed concrete, the beams are cast either in place or adjacent to the site and then post-tensioned. In the latter case they are then moved into their final position.

In all cases where prestressed beam construction is used, the deck, after erection of the beams and the casting of the *in-situ* concrete, is transversely prestressed in order to obtain better load distribution.

Steel and Concrete

Steel girder construction with reinforced concrete decking has been utilised for five of the bridges on the Preston by-pass. These are the two major bridges—at Samlesbury and at Higher Walton–and the bridges at Cuerdale Road, at Longridge Road and at Ribbleton. At Cuerdale Road, where there is a large angle of skew (44°), the steel girder construction is continuous over four spans. At Longridge Road provision for large water mains serving Preston required deep girders, and as the motorway is on a curve a single span has been used. The bridge carrying the railway over the motorway at Ribbleton is a through girder type of single span.

Reinforced Concrete

The footbridges are being constructed as three-pin arches, the ribs being precast in reinforced concrete. The bridges over the smaller streams are being constructed as reinforced box culverts.

(From "Contractors Record and Municipal Engineering", May 22, 1957.)

DEFINITIONS OF HIGHWAY ENGINEERING TERMS

BITUMEN CONCRETE SURFACING: A type of construction in which coarse and fine mineral aggregates are mixed with bitumen and laid hot to desired thickness.

BITUMEN OR TAR MACADAM: A type of construction in which the fragments of coarse aggregate are bound together either by bitumen or tar applied either by the premix or the grouting method.

MECHANICAL STABILIZATION WITH SOIL-AGGREGATE MIXTURES

by

ALAM SINGH*

&

CHANDRA PRAKASH GOVIL*

The article describes briefly the principle and technique of mechanical soil stabilization, which is so very important for cheap road construction. Results of laboratory investigations and the proposed mix design for base course construction with the available local materials are given.

Introduction

MECHANICAL stabilization is probably the simplest, cheapest, and the most commonly used method of soil stabilization. It is a process based on 'the principle of controlled grading' in which a soil, deficient in certain desirable soil constituents, is supplied with these constituents as admixtures, so that the resulting construction is mechanically stable i.e., it has the property of resistance to deformation and displacement under applied loads. Thus cohesionless granular soils are stabilized with admixtures of binder soils containing silt and clay, while soils containing an excess of silt and clay are stabilized with admixtures of granular materials. The principal applications of mechanical stabilization are for the construction of bases, subbases and surfacings of roads and also for improving sub-grade soils of low bearing capacity.

Materials and their important characteristics

Materials used in mechanical (granular) stabilized roads are classified as aggregate and soil. Aggregate is that part of a natural deposit or of a granular stabilized mixture which is retained on a No. 200 sieve. In a mixture it is called the "granular fraction". Soil is a general term covering naturally-occurring materials which contain some aggregate and a fine soil fraction which provides the soil binder. This "fine-soil fraction" is the part passing the No. 200 sieve and consists of silt and clay. Thus the significant parts of a soil-aggregate mixture are the granular fraction and the fine-soil fraction. In a stable soil mixture the granular soil fraction is assumed to furnish strength, internal friction, hardness and otherwise to function much the same as aggregate in a portland-cement-concrete mixture, whereas, the fine-soil fraction serves as a filler for the aggregate fraction, provides capillary or water-holding properties, and acts as a cementing medium to bind all the particles into a strong durable mass.

Factors affecting mechanical stability

The three principal factors controlling the stability of soil-aggregate mixtures are: (a) the gradation of the particles, (b) the binding properties of the fine-soil fraction, and (c) compaction.

Gradation

To achieve mechanical stability it is necessary to have a well proportioned aggregate fraction containing some amount of fine-soil fraction for providing necessary cohesion. The principle is that the voids between the larger particles should be filled with smaller particles, resulting in high density. According to Fuller, for obtaining the maximum density, the particle size distribution

* M. B. M. Engineering College, Jodhpur.

should follow the following empirical expression:

Percentage passing any sieve

$$= 100 \sqrt{\frac{\text{Aperture size of that sieve}}{\text{Size of largest particle}}}$$

Experience shows, however, that to obtain sufficient cohesion, it is usually necessary to have a greater proportion of the material passing No. 200 sieve than is given by the formula, especially for surfacings. 'Fuller' curves of grading can be drawn for aggregates of different maximum particle size. Based on satisfactory results in practice, limits of size distribution have been recommended by a number of authorities. In nearly all cases they have been found to approximate to the 'Fuller' curves. As an illustration, the recommendations of the Road Research Laboratory, London, for particle size distribution are shown in Table No. 1.

Table No. 1

PROPOSED LIMITS OF PARTICLE - SIZE DISTRIBUTION FOR BASES AND SURFACINGS WITH TOLERANCES

B. S. SIEVE SIZE.	Cumulative Percentage Passing					
	Base			Surfacing	Base or surfacing	
	Nominal Maximum Size			Nom. Max. Size.	Nom. Max. Size	
	3 - in.	$1\frac{1}{2}$-in.	$\frac{3}{4}$-in.	$\frac{3}{4}$ - in.	$\frac{3}{8}$-in.	$\frac{3}{16}$-in.
3 in.	100	—	—	—	—	—
$1\frac{1}{2}$ in.	80–100	100	—	—	—	—
$\frac{3}{4}$ in.	60–80	80–100	100	100	—	—
$\frac{3}{8}$ in.	45–65	55–80	80–100	80–100	100	—
$\frac{3}{16}$ in.	30–50	40–60	50–75	60–85	80–100	100
No. 7	—	30–50	35–60	45–70	50–80	80–100
No. 14	—	—	—	35–60	40–65	50–80
No. 25	10–30	15–30	15–35	—	—	30–60
No. 52	—	—	—	20–40	20–40	20–45
No. 200	5–15	5–15	5–15	10–25	10–25	10–25

Note:

1. Not less than 10 per cent should be retained between each pair of successive sieves specified for use, except the largest pair.
2. The two smaller sized materials (3/8 and 3/16 in.) may have upto 35 per cent of stones not larger than $1\frac{1}{2}$-in., provided that the material passing the 3/16-in. sieve is within the limits specified.

Binding Properties

The binding properties of the fine-soil fraction are determined by the tests for liquid limit, plastic limit and plasticity index, the tests being performed on the portion of the mixture passing the No. 36 B.S. sieve. The results obtained are dependent on the amount and type of clay present.

The recommendations are:

For bases – Liquid limit not exceeding 25 per cent
Plasticity index not exceeding 6 per cent

For Surfacing – Liquid limit not exceeding 35 per cent
Plasticity index between 4 & 9 per cent.

The higher liquid limits and plasticity indices are desirable in the surfacing in order to provide greater cohesion and to help offset the moisture lost by evaporation. They are, however, quite undesirable in the base, and should not be permitted in any temporary surfacing that is

intended ultimately to receive some other, more permanent, surfacing.

Use of Available Local Materials

The various specifications for materials are based upon experience and are wholly empirical. It has also been found that many materials which fall outside the recommended specification limits have been found suitable under local conditions. Local practice and experience should be the best guide upon which to rely for the choice of materials. Granular soil stabilization practice is not a matter of writing a specification and then obtaining material in conformity with that specification from any distance and at any cost. The problem is rather to make satisfactory use of materials available immediately at hand. The nearby sources of materials should be explored and the materials obtained tested in the laboratory. Sometimes the native material on a road or runway is itself in a naturally stable mixture form; otherwise, it may be necessary to combine two or more materials from different sources in order to obtain the desired result for the purpose in hand.

Laboratory Investigations

Three materials locally available at Jodhpur have been tested by the authors for base course construction; the results obtained and the design suggested are summarised below:

Table No. 2

MATERIAL "A"

B. S. Sieve size	Percent passing	Size fraction in per cent
3/4″	100	Coarse aggregate =99
3/8″	37	
3/16″	10	Fine aggregate = 1
7	1	(PI) = 0
25	0	Silt & clay = 0

NOTE:

1. Coarse Aggregate (C.A.) fraction is the material retained on No. 7 B. S. Sieve.
2. Fine Aggregate (F.A.) fraction is the material passing No. 7 B. S. sieve but retained on No. 200 B. S. Sieve.
3. Silt & Clay fraction is the material passing No. 200 B. S. Sieve.

Table No. 3

MATERIAL "B"

Sieve size	Percent passing	Size fration per cent	
3/4″	—	C.A. = 12	Plasticity index = 0
3/8″	—		
3/16″	100	F.A. = 87	
No. 7	88	Silt & Clay = 1	
No. 25	42		
No. 200	1		

Table No. 4

MATERIAL "C"

Sieve size	Per cent passing	Size fraction per cent	
3/4″	—		
3/8″	—	C.A. = 0	
3/16″	—	F.A. = 75	Liquid limit = 19
No. 7	100	Silt & Clay = 25	Plastic limit = 15
No. 25	93		Plasticity Index = 4
No. 200	25		

Proportioning of Materials

The three materials were combined together to get as far as possible the grading specified in table No. 1. The proportions of the materials required for the final mixture were determined by means of a triangular chart method developed by the Indiana State Highway Commission (U.S.A.). The desired specifications are shown in table No. 5 (reproduced from table No. 1.)

Table No 5.

DESIRED SPECIFICATIONS FOR MATERIAL MAXIMUM SIZE 3/4-IN. FOR BASE COURSE CONSTRUCTION

Sieve size	Percentage passing	Average percentage passing	Size fraction Percentage	
3/4"	100	100		
3/8"	80–100	90	C.A. = 52	LL ≯ 25 percent
3/16"	50–75	62	F.A. = 38	PI ≯ 6 percent
No. 7	35–60	48	Silt & clay = 10	
No. 25	15–35	25		
No. 200	5–15	10		

In the triangular chart (Fig No. 1) the three sides of the triangle represent the three size fractions—coarse aggregate, fine aggregate and silt & clay.

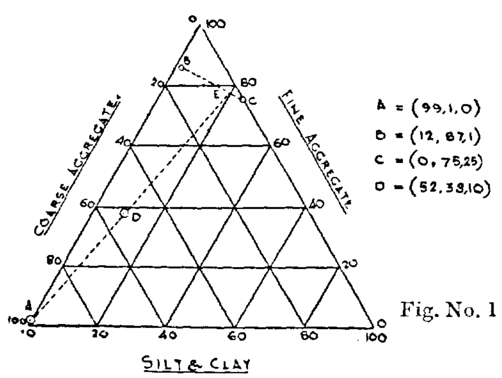


Fig. No. 1

CHART FOR COMBINING THREE MATERIALS

Three points A, B and C are plotted on the triangular chart to represent the respective materials. Also, point D is plotted to represent the specified grading desired. Points B & C are joined and a line is drawn from A through D to meet BC in E.

The following lengths (in cm.) are measured from the Figure No. 1.

Line	Length	Line	Length
AE	8.85	EC	0.40
DE	4.55	BC	2.07
AD	4.30	BE	1.67

The proportions of the materials A, B and C in the final mixture are obtained from the following expressions:

A = DE/AE = 4.55/8.85 = 51.4 per cent

B = EC/BCxAD/AE = 0.4/2.07x4.30/8.85 = 9.4 per cent

C = BE/BCxAD/AE = 1.67/2.07x4.30/8.85 = 39.2 per cent

100.0 per cent

The values adopted for final design are: A = 51 per cent, B = 10 per cent and C = 39 per cent.

Final mixture was prepared by combining the three materials in the abovementioned proportions and then tested for sieve analysis. The results obtained are shown in table No. 6.

Table No. 6

GRADATION OF THE FINAL MIX

Sieve Size	Percentage passing	Size fraction percentage
3/4"	100	
3/8"	69	C.A. = 51 per cent
3/16"	53	F.A. = 40 per cent
No. 7	49	Silt & clay = 9 per cent
No. 25	32	
No. 200	9	

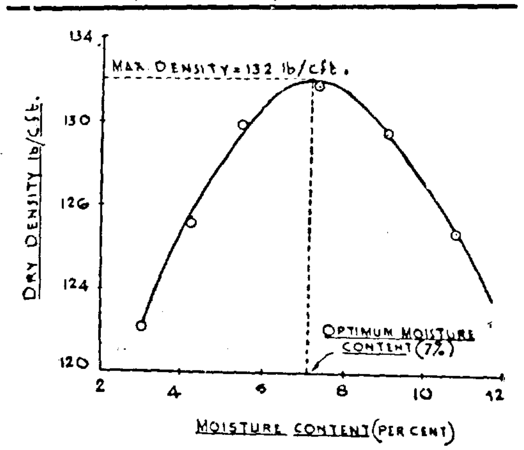


Fig. 2

RELATIONSHIP MOISTURE-DENSITY.

It will be seen that although the final mix does not satisfy strictly the specifications for all the sieves the size fractions are, however, nearly the same as desired.

Plasticity Characteristics

The plasticity tests are performed on the portion of the final mixture passing No. 36 B. S. sieve. It is found that liquid limit is 15 and plasticity index is 2 which are well within the specified limits; or otherwise, the mix design would have needed some modification.

Compaction

Adequate compaction is very important when constructing granular stabilized roads. Standard Proctor Test was performed on the final mixture and a moisture-density relationship established which is represented by Figure No. 2.

It will be found that an optimum moisture content of 7 per cent is necessary to obtain a maximum dry density of 132 pounds per cu. ft.

Conclusion

Mechanical stablization affords a very cheap way of road construction programme so essential for the development of the country. Local experience guided by laboratory investigations helps in making maximum use of the available local materials.

Selected Bibliography

(1) "Soil Mechanics for Road Engineers" (pp. 220–231) H.M.S.O. London, 1952.

(2) "Soil Engineering", by M.G. Spangler (pp. 206–226) International Text-book Co. U. S. A. 1951.

(3) "Stabilization with Soil, Lime or Calcium Chloride as an Admixture". Woods and Yoder, Soil Stabilization Conference M.I.T. (U.S.A.) June, 1952.

(4) "Soil Stabilization Techniques", A. Singh (under print).

WILL POWER

Twenty million young women rose to their feet with the cry "We shall not be dictated to" and proceeded to become shorthand typists.

A German inventor has developed a multiple unit garage shaped like a huge revolving drum. The drum has six gondolas, each holding one car. It occupies an area of 16 by 20 feet. More than 50 of these garages are to be built in German cities.

RECONSTRUCTION OF BRIDGES IN FRANCE DURING AND AFTER THE 1939/45 WAR, WITH PARTICULAR REFERENCE TO SITE, ORGANIZATION AND CONDITIONS

By

RENE BREFFEIL

IN June 1940, France was suddenly invaded. In endeavouring to stem the German advance and cover its retreat the French Army demolished the bridges, first over the Meuse, then over the Marne, the Seine, the Loire, the Rhone, and their tributaries. The invaders hastily made temporary repairs, with their pioneers, of the bridges which interested them, but within several days after the Armistice the French Administration resumed its authority, and under severe control applied themselves to the re-establishment of the roads.

The number of works to be undertaken at the same time was far too large to permit of the normal procedure of tendering to be applied; the S. N. C. F. and the Ponts et Chaussees therefore proceeded by direct allotment of works to specialist contractors according to their capacity and means. In this way, works were put in hand before final designs were made or contracts were signed.

The Viaduc de Longeray was the most important destroyed in 1940, and is

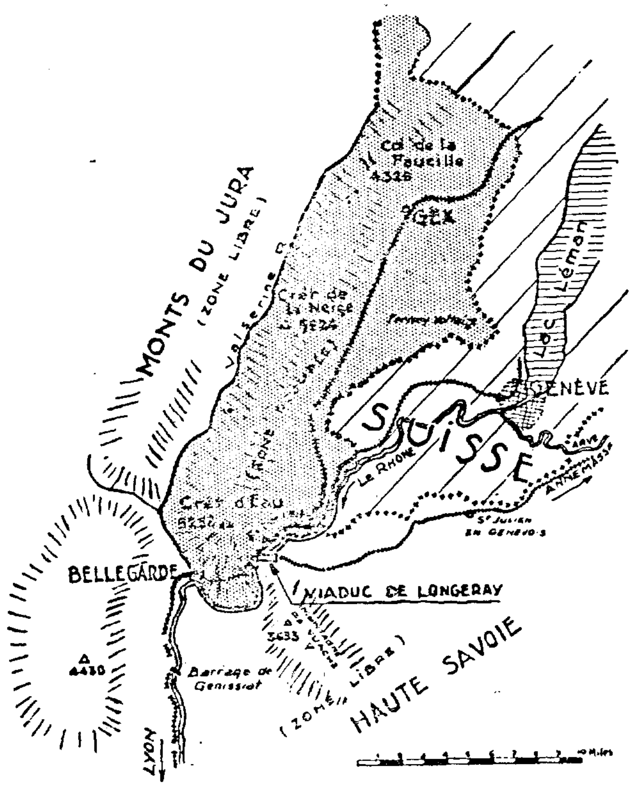


Fig. 1.—Map of site

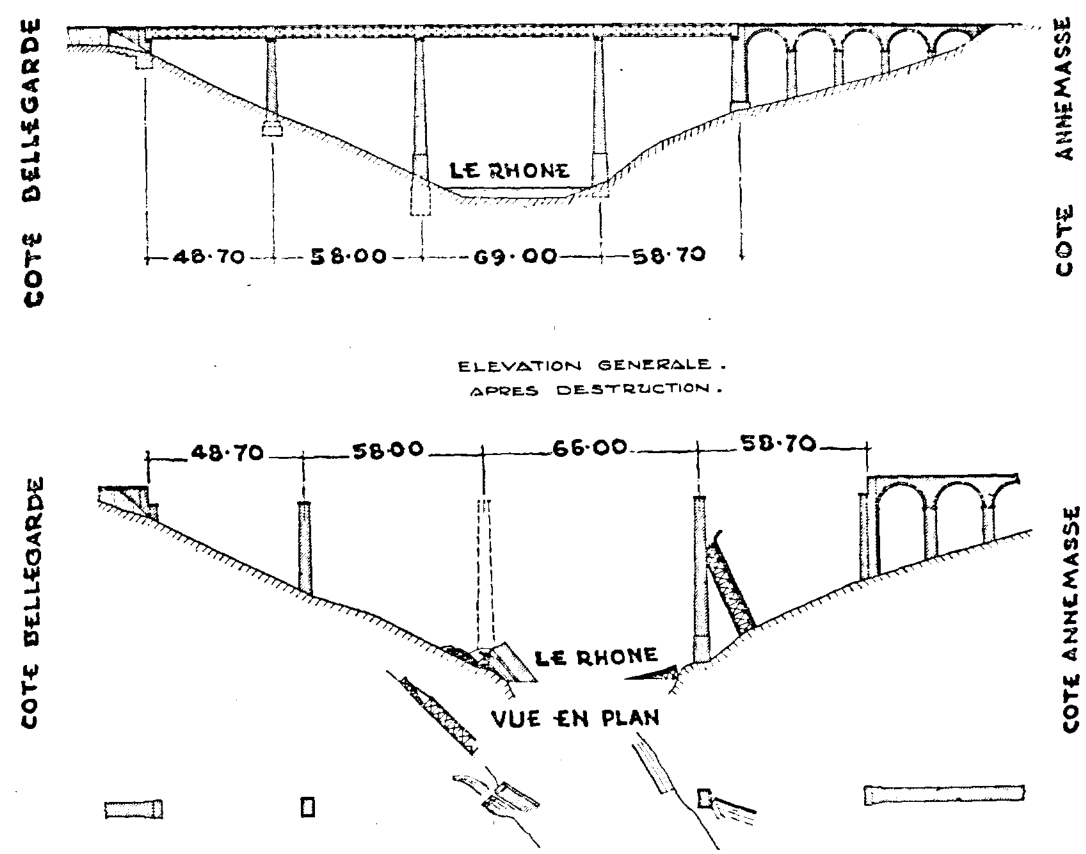


Fig. 2.—Longeray Viaduct. Elevation of old bridge—before destruction & Elevation of old bridge—after destruction

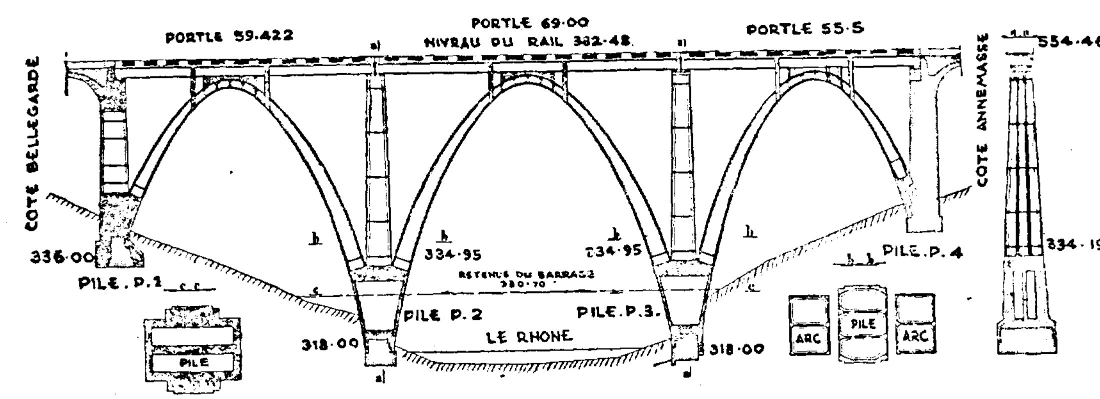


Fig. 3—Sections through Arches, etc.

described below as an example of reconstruction undertaken during the German occupation.

The Longeray Viaduct

The Longeray Viaduct is located near to the Swiss Frontier. It crosses over the Rhone with a skew of 45 degrees and forms the only rail link between Bellegarde and Annemasse, giving access to the French side of Lake Geneva (Lac Leman), Fig. 1. It is one of the two tourist lines connecting Paris and Mont-Blanc. The Bridge spans the Rhone Gorge at an altitude of 1,050 ft at the southern extremity of the Jura Mountains and between mountains rising to 5,500 ft and 3,200 ft.

The Old Bridge and Its Destruction

The old bridge consisted of four steel spans, totalling 260 yards, with a curved approach viaduct on the left bank, of five masonry arches each of 50 ft span. The steel deck was supported on three masonry piers, of which the two tallest (212 ft) bordered the river, Fig. 2.

The gorges through which the railway passed from Lyon to Geneva were defended by the fort de l' Ecluse, normally disposed for an enemy approaching from Switzerland, but in 1940 the small garrison had to turn its cannons towards France to carry out instructions to cut the viaduct, thus provoking the ruin of the right bank pier and the total collapse of the steel girders into the bed of the Rhone, where it formed a veritable barrage. There remained standing only the approach viaduct and two piers.

Site Conditions

Contrary to the cases of the majority of destroyed railway bridges, the construction of a temporary bridge was not feasible owing to the length of the breach. Again, the location of the work with respect to its alignment imposed quite unusual conditions.

In fact, in the partition of France into three zones, the viaduct occurred in the prohibited occupied zone, i.e., the zone which comprised the regions of the north and the east which commenced at Calais and finished here in such a manner that assured the Germans control of the principal access to Switzerland by the railway Lyon-Geneva. From the beginning of 1941 the limit was modified and constituted by the Rhone River itself, thus cutting the site into two with a German military post and requiring special permits for passing through.

Technical Considerations in the Reconstruction

The Reconstruction in steel could not be considered. None of the old steel work was usable and it would have been impossible to find 1,200 tons of the necessary sections. It was therefore decided to reconstruct in reinforced concrete.

The destruction of the right bank pier had not extended to the underwater foundation, built on a caisson. The other piers were standing, though badly damaged, and had to be demolished. Their foundations, however, were re-usable.

It would have been possible to cross the Rhone in one span of 230 ft with approches of small spans on each bank, but at the price of new foundations difficult to found in the glacial alluvium forming the banks. It was therefore preferable to adopt a scheme of three arches of slightly different spans, namely, 198 ft, 230 ft and 178 ft, supporting a deck on straight beams. Fig. 3.

The shape of the arches approaches that of a pointed or gothic arch which supports a deck directly at the crown. The deck has no intermediate points of support on the arch and spans the 85 ft interval between the piers and the crown. The arches, the piers and deck main beams are hollow, which provides the maximum rigidity required by the great height of the work, which is exposed to violent winds sweeping along the valley. Equally by this means, the weight of the new work has not appreciably exceeded that of the original.

Site Installation

The banks of the Rhone are precipitous and accessible only by footpaths. A light suspended footbridge of 180 ft was constructed solely for the use of personnel crossing the river.

The workshops were only able to be installed at the level of the railway, some 215 ft above the level of the river. Consequently, it was necessary to install cableways capable of distributing material and placing formwork at all levels.

Demolition and Clearing

Demolition of the old masonry did not present any particular problem except for the left bank pier which was standing with a part of the old deck leaning against it. It was necessary to take special precautions in order to ensure that it fell away from the river so that it would not add obstruction in the river bed. The pier had to be divided into sections and each portion felled by suitably placed explosive charges.

The old steel girders that had fallen in the river were not able to be removed until after completion of the bridge.

Renewal of Foundations

The renewal of the foundations would appear to be relatively simple above low water level. Unfortunately, owing to difficulties due to the zone boundaries, the work could not be commenced until November 1940. Installation and general clearing occupied the winter—very rigorous from the point of view of temperature—which corresponded with low water in the Rhone. When the time arrived to undertake foundations the period of high water had arrived and it was necessary, working between floods, to build cofferdams in concrete and sheet piles around the ruins on the right bank in order to connect up for a new pier. The old cofferdam of the first bridge under the pier on the left bank rested directly on rock and was easily uncovered and raised in height.

Arch Centering

For the centre arch it was impossible to provide supports in the river, and it was therefore necessary to use a retracted centre formed by an arch in timber trellis bearing on reinforced concrete corbels at their springings. The two piers were therefore constructed first, with extensions both sides forming the arch springing and corbels.

When erecting, each frame was divided into two half-frames, each of which was again subdivided into a certain number of elements corresponding to the capacity of the cable transporters. Each element was prepared from working drawings, then taken out and fixed vertically up the pier, which served at the same time as a support and guide during assembly, photo 1. Each frame was braced by a covering of two crossed layers of planks. When fully assembled, each half centre then stood vertically up each pier, resting on metal, hinges formed of 6 in. diameter steel pins supported on cast-iron bearings secured to the concrete ends of the timber trellis, photo 2.

The junction of the two half-centres, each 165 ft high and weighing 120 tons, was effected by lowering them by rotation at the pins until the frames met at the centre after starting by pushing with jacks because the centre of gravity of each half was behind that of the pin of the hinge, photo 3. Four sets of tackle, provided with blocks of six pulleys and operated by hand-winches, were sufficient to provide the necessary restraint of 32 tons and to regulate the two frames when meeting at the junction. The complete manoeuvre, including adjustments, took five hours. Keying of the frames was effected by nailing pieces of timber to give continuity and by bolted steel plates to ensure rigidity. On account of the great height of the centre, lateral stays were also provided.

The two adjoining arches did not present the same difficulty, since it was possible to use intermediate points of support from the ground below, and the more usual type of centre was employed. In this case the cube of timber used is relatively greater than for the central arch, but the erection is much simpler. In periods of normal supply it would certainly be cheaper to use tubular scaffolding.

Decking and Approach Viaduct

After concreting the arches the construction of the deck did not present any particular difficulty, all the formwork being prepared in sections able to be placed by the transporters.

Stages of the Reconstruction

The destruction of the bridge occurred in June 1940, but reconstruction was not commenced until November. The year 1941 was occupied principally by renewal of foundations and the execution of the approach viaduct on the right bank.

The lowering of the centres took place on 24th July 1942. At that time it was feared that the works would be closed down as the Germans had prohibited the continuation of works that did not interest them directly. Happily, however, the Longeray Viaduct was not included in this order, so that the central arch and its deck were completed at the end of 1942, photo 4. The bridge was put into service on 1-8-1953.

Quantities and Data

Earthworks and excavation	10,000 cubic yards
Demolition of old masonry	6,500 ,, ,,
Reinforced concrete	10,000 ,, ,,
Plain concrete	3,200 ,, ,,
Reinforcement	550 tons
Timber for formwork and centres	3,200 cubic yards
Maximum compressive stress in concrete	1,060 lb per sq. in.
Ground pressure	7.4 tons per sq. ft.
Average labour force	90
Total man-hours	750,000 hours

Reconstruction in 1944

During the course of 1944, destruction was even more widespread than in 1940, in fact, aerial bombardment was added to demolitions carried out unsparingly by the Germans in retreat. The organization of works was often more difficult than in 1940, since stocks of material were almost non-existent or dispersed. Timber was very scarce and, above all, transport was paralysed by the cutting of railways and certain roads, through the requirements of the Allied Armies.

The two following examples relate to two different problems:

1. *The Montlouis Bridge*—where a provisional bridge was indispensable and of prime urgency;
2. *The Nogent Viaduct*—where immediate and final reconstruction was undertaken without the provision of a temporary connection.

The Montlouis Bridge

This important bridge carries the railway between Paris and Bordeaux over the Loire near Tours. The old bridge was in masonry, constructed in 1845, of 12 arches of 75 ft span. The 1870 war had cost it one arch; in 1940, two arches; the aerial bombardment of 1944 destroyed four or five arches, and the Germans before leaving demolished the remainder at the end of August.

All the bridges over the Loire, both railway and road, were destroyed as far as Roanne, that is to say, over a length of some 450 miles. Even for the provisional re-establishment of the bridge, French Army material was almost non-existent because the Germans had sent it to Russia. The S.N.C.F. possessed only a little first aid decking and it was necessary to use it on their first job, namely, the the Orleans Bridge, completed in December 1944. However, we were successful in procuring the units of a military bridge, 200 yards long, hidden from the Germans during the Occupation, providing spans for half the width of the Loire; the remainder was completed with steel beams 75 ft long, photo 5.

The construction of provisional piers was very difficult, since the 'regime' of the Loire is very irregular; the bed of the river being practically dry in summer, while floods are sudden and rapid, and in 1944 they occured from November onwards. Moreover, when the winter is hard, floating ice is very dangerous to timber piles, and the winter of 1944–45 brought down successive floods with icefloes. Nevertheless, the circulation of trains was re-established on 10th February 1945 through the cooperation of several contractors and a company of French Army Engineers. On the average, 230 workmen were employed for five months.

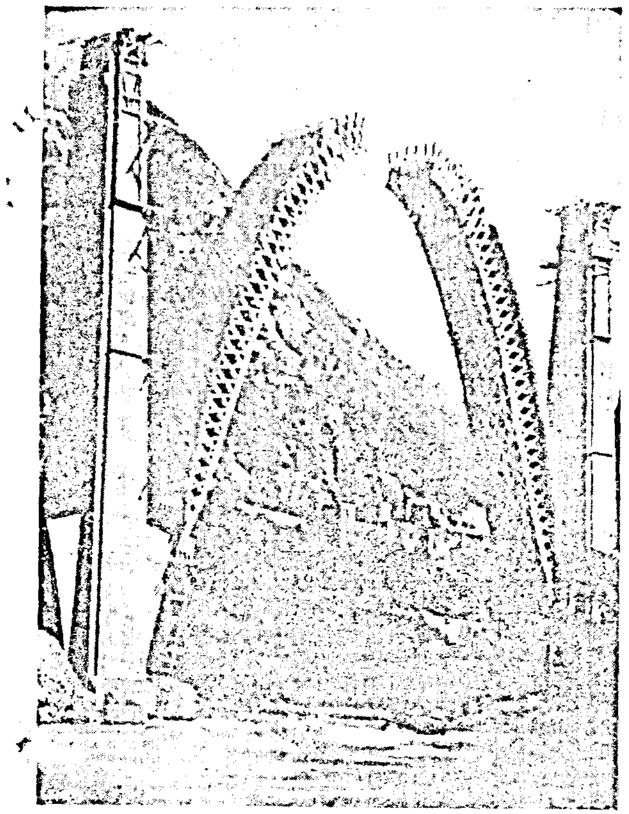


Photo 1. Arch centres during lowering

Photo 2. Hinges

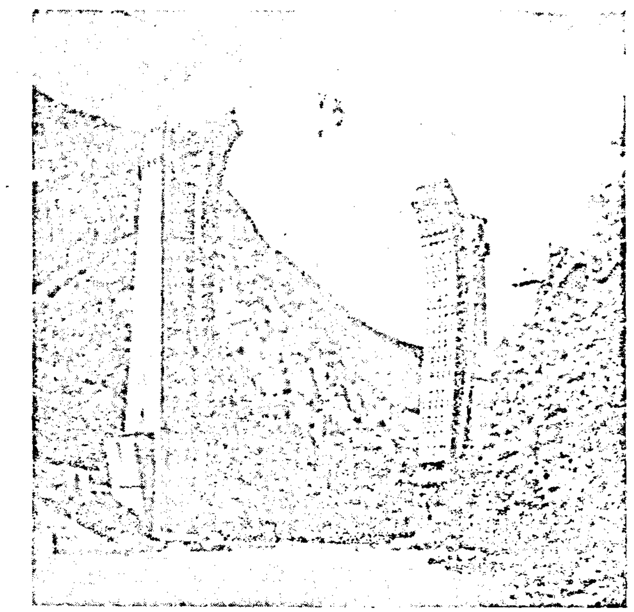
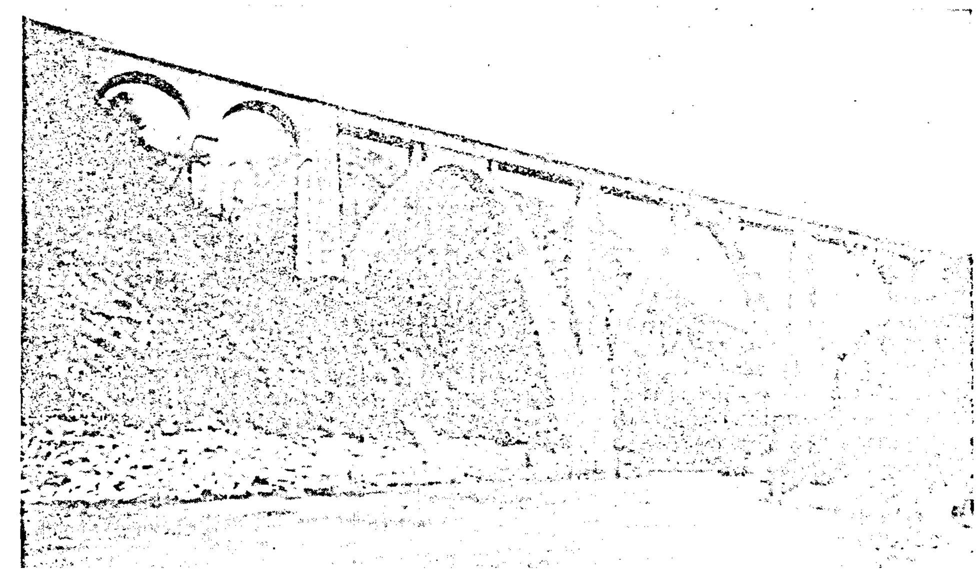


Photo 3. Centres before lowering

Photo 4.
Longeray Viaduct.
Finished structure



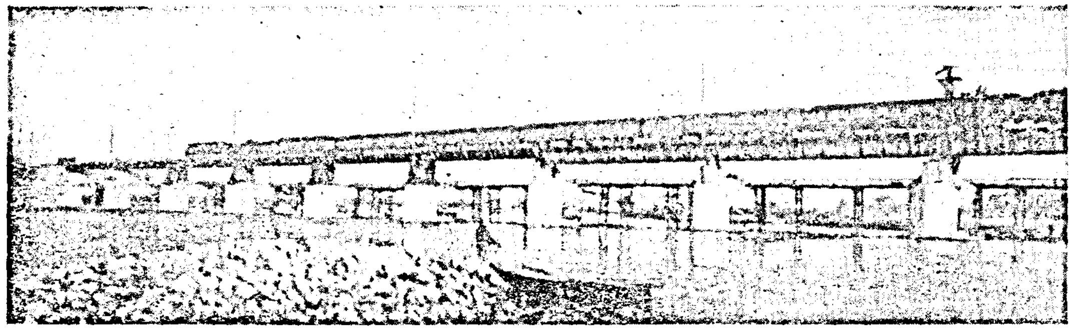


Photo 5. **Temporary bridge in service—Construction of piers**

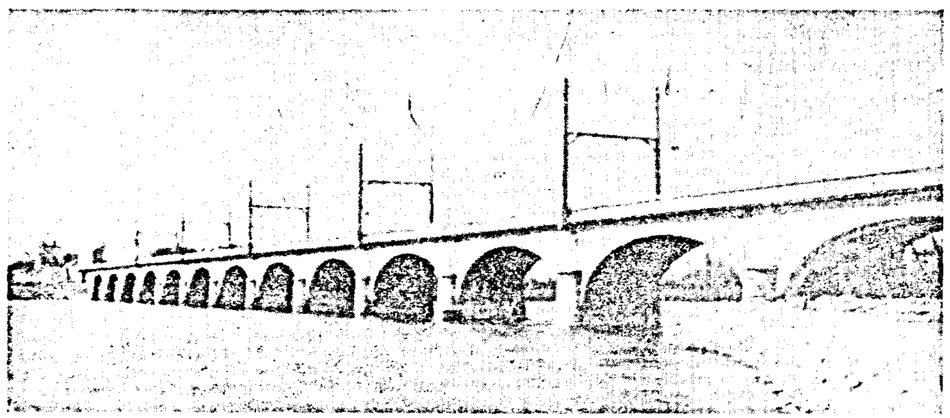


Photo 6. **Montlouis Bridge completed**

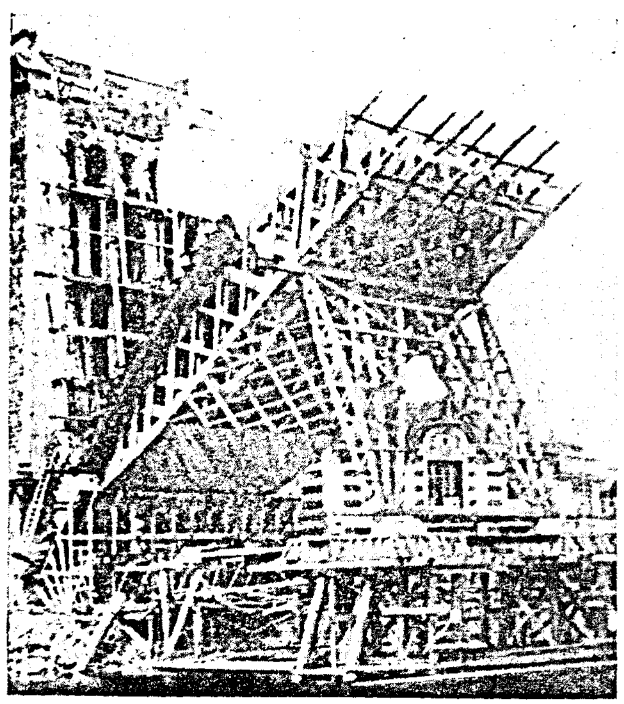


Photo 7. **Timber centre over larger branch of the Marne—Springing and lower section**

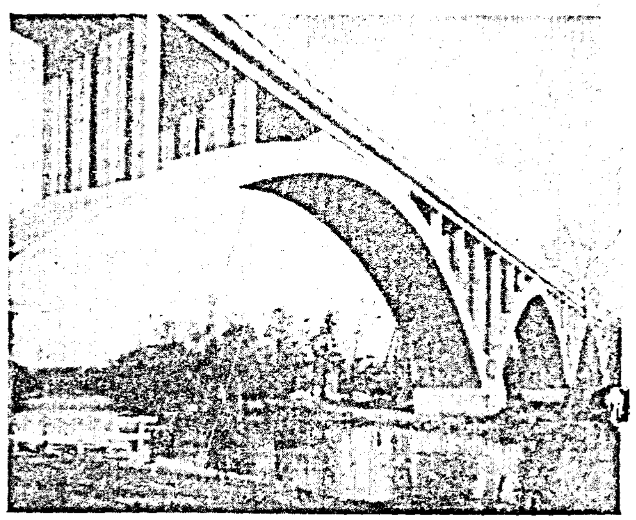


Photo 8. **Nogent Viaduct. Finished bridge**

The final bridge was reconstructed to the general appearance of the old, but the arches were cast in concrete. Only the spandrils were in freestone. In general, the old foundations were re-used after cutting down and repair. This repair was rendered difficult owing to the urgency of putting the temporary bridge into service. It was necessary to make new provisional piers, then the final piers on the old foundations, afterwards to place the provisional bridge on the final piers and eventually to demolish the provisional piers and clear away the debris.

The first half width of final bridge was put into train circulation on 4th June 1946, and the completed work, with two tracks, on 18th December 1946, photo 6.

The Nogent-sur-Marne Viaduct

This viaduct is situated on the outskirts of Paris and provides rail connection between Paris and Bale. The old bridge, carrying two tracks, was entirely in masonry and had a length of 900 yards. It comprised four large arches of 165 ft span and crossed the Marne Valley 90 ft above the river, which flows there in two streams with an island between. The masonry, constructed in 1855, was of excellent quality millstone grit and freestone.

On the 24th August 1944, at the time of the liberation of Paris, the Germans demolished the four arch spans by explosive charges disposed around the arches. They were completely demolished, creating a breach 720 ft long. The debris comprised 26,000 cubic yards of material obstructing the two arms of the river.

The building of a provisional bridge was envisaged at one time by the Americans and the S.N.C.F., but the shortage of timber did not permit the quick provision of timber trestling, and in any case it would have been necessary to have built it outside the area of the bridge, so as not to obstruct final reconstruction, and it would have been some 800 yards long. Fortunately, the secondary suburban line, Paris-Bastille-Verneuil L'Etoag, of which the bridge over the Marne had not been destroyed, was able to be used as a diversion, at the cost of lengthening the journey, which was, however, acceptable. On the other hand, local transport would suffer the annoyance of trans-shipment during the reconstruction of the bridge. The first onslaught was, therefore, the clearing of the bed of the river to re-establish navigation and to ease flooding, thus at the same time helping the final reconstruction.

In a continuation of the co-operative spirit between the organizations previously described, the work was entrusted to the company which had completed the Longeray Viaduct. The personnel and materials required were analogous to the conditions here, and the S.N.C.F. similarly placed their same inspection personnel so that the group was identical.

It was not possible to reproduce the old bridge in its original form for several reasons, amongst which were that the quarries, already overworked, were not able to deliver fast enough, and one of the old piers occuring in the wider arm of the river was required by the navigation authorities to be removed. It was therefore decided to provide a bridge with three parabolic arches supporting continuous cellular beams. The inequality of the three spans, 260 ft, 230 ft and 220 ft, was not sufficient to influence the appearance of the bridge, because by reason of restrictions on the site it is not possible to view the whole bridge from any point in open elevation.

Site Installation

Clearance of the river bed was carried out by floating machines and powered barges. The workshops used the approach viaduct on the Paris side for stacking materials arriving by rail, concrete mixers and bar bending sheds. Only the island provided suitable ground for the preparation of arch centres and formwork. The cable transporters formerly used at Longeray were used in the same manner, and thanks to them, unity of the construction yards was assured and at certain times work proceeded day and night.

Foundations

Two new foundations were made on the island. In order to reach compact chalk at a depth of 40 ft below the level of the water, cofferdams in sheet piles were used and the piers brought up within them.

Centering

On account of the scarcity of timber, only the centre for the largest span was made in nailed timber. The lesser height of the piers did not allow of the same method of erection as at Longeray, and the centre was accordingly constructed in three phases :

1. The lower portion near the springing was constructed alongside the pier, resting on a metal hinge and lowered down and held temporarily by inclined struts supported from a platform carried on timber piles, photo 7.
2. These sections were then lengthened by cantilevering out, by adding further units brought by the transporter.
3. The fabricated centre section was floated out underneath, then raised into place by the transporter cables, and the whole connected up, wind braced and covered with crossed diagonal planking

By virtue of the width of this centre, sufficient for two railway tracks, it was not necessary to tie it laterally by cables. Regarding the two other arches, it was possible to support these directly on the island, leaving only a small navigation passage, 65 ft wide, over the smaller branch of the river, so that tubular scaffolding was employed.

Casting of the Arches, and De-centering

The arches were cast in sections in wrought timber forms, and the concrete face was left as cast, without re-touching. De-centering was carried out by means of the method of jacking at the key, or crown.

Progress Record

Clearing of the river and the island did not commence until 5th June 1945, but by 15th December 1946 the bridge was put into service with two tracks working, i.e., within a period of seventeen months, photo 8. This result was attained, in some measure, by working from two stations.

Quantities and Data

Clearance of debris	26,000	cubic yards
Excavation	7,500	do
Concrete in foundations	4,300	do
Reinforced concrete	8,900	do
Steel reinforcement	700	tons
Timber for formwork and centres	2,600	cubic yards
Steel scaffolding	250	tons
Labour-Clearance	220,000	hours
Reconstruction	765,000	hours

(Extracted from "The Structural Engineer", October, 1956)

CUTENESS

Then there's the cute little nurse who deducts 10 beats from the patient's pulse to allow for her looks and personality.

HERE AND THERE

1. TRAFFIC CONGESTION IN CITIES

"MOST cities present an amazing paradox of a highly developed industrial and business activity which depends on an outdated, cluttered and economically wasteful street network. Moving thousands of people with safety and despatch cannot be done by guesswork, but calls for scientific determination of traffic needs and selection of right tools to meet them," so said Shri E. A. Nadirshah, speaking on behalf of the Indian Roads and Transport Development Association, at a symposium held in Bombay on the 11th July on the subject of "Traffic Congestion in Bombay City—Causes and Cures." Shri Nadirshah, who began by explaining to a packed audience at the B.E.S.T. Hall the type of traffic investigation needed, went on to the modern remedies for different urban traffic problems and indicated the organizational changes needed for a satisfactory programme of planning and engineering.

Traffic engineering investigations consisting of volume studies, origin and destination studies, speed and delay studies, cordon counts, parking and loading, etc., said Shri Nadirshah, revealed the changing travel habits of people, varying characteristics in the traffic stream and shifting traffic patterns. Referring to urban traffic problems, Shri Nadirshah mentioned those of (a) intersections, (b) individual streets and (c) city-wide problems. Traffic lights, police control, creation of one-way streets, installation of pedestrian barriers, intersection widening and channelization as also regulation of turning manoeuvres, parking, loading and bus stops were primary remedies for intersection problems, but when the capacity of intersection was overtaxed by increase in traffic, the construction of grade separations became essential so that opposing streams of traffic could move on different elevations at the same time.

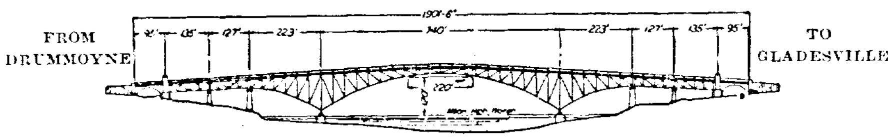
The problem of slow-moving bullock carts, victorias, handcarts, bicycles, etc., and the sub-standard condition of our roads were factors which made traffic congestion in Indian cities graver than in Western countries, observed Shri Nadirshah. The surface of roads in Bombay City in spite of adequate widths was not uniformly good throughout, with the result that all forms of traffic competed for space at the centre. Besides urging that the standards of roads should be up graded, Shri Nadirshah stated that plans should be made for the terminal requirements of mass transport and truck transport and of parking of private cars for the projected needs of 20 to 25 years. To carry forward a programme of traffic relief in line with a broad plan, a full-time organization which could closely co-ordinate the engineering and regulatory activities of the traffic problem was absolutely necessary. Such a combined authority should be founded on proper legislation and supported by adequate laws attuned to the present traffic needs.

The suggestions made at the symposium included staggering of working hours in industries and offices, construction of subways, overbridges and an underground railway, spacious parking places for cars, widening of roads, a subway connecting Marine Drive with Princess Street or Dhobi Talao, construction of an Expressway to connect the suburbs directly with the Fort area without passing through the city and a special freightway to carry heavy goods vehicles from the docks and railway goods depots to industrial areas.

(From "I. R. T. D. A. Newsletter", July 31, 1957).

2. PROPOSED NEW BRIDGE OVER THE PARRAMATTA RIVER AT GLADESVILLE

THE Department of Main Roads has invited tenders both overseas and in Australia, for the construction of a large new bridge over the Parramatta River at Gladesville. The carriageway will be 72 feet 6 inches. The carriageway will be 72 feet wide between kerbs, and the footways each 8 feet wide. To provide required clearance for shipping, the underside of the bridge will be at least 120 feet above



Sketch elevation of the proposed bridge showing principal dimensions.

The design of the proposed new bridge at Gladesville as prepared by the Department of Main Roads provides for a steel double cantilever truss bridge with a suspended truss span between the two cantilever arms and two balancing anchor arm shore spans. Including the approach spans and abutments, the overall length of the proposed bridge is 1,901 feet high water level for a width of 200 feet at the middle of the bridge. To obtain the height necessary to provide this shipping clearance the bridge will be graded up to the centre from each approach, the maximum grade being 6 per cent.

(From "Main Roads", June, 1957).

3. THE NEW PARK LANE SCHEME

THE new Park Lane scheme has been approved in principle by the Government, with the addition of an under-pass linking Piccadilly and Knightsbridge. The scheme, which is being prepared by the L.C.C. as the improvement authority, will cost, including the underpass, some 3 million pounds, towards, which the Ministry will make a grant of 75 per cent. It provides for the complete reorganisation of the road system on the eastern side of Hyde Park and important alterations at both Hyde Park Corner, which is the busiest road junction in London, and at Marble Arch, which is the third busiest. It is hoped that it will have the effect of relieving congestion in Oxford Street, Piccadilly, Knightsbridge and other main streets in London.

There is provision for Park Lane being used for southbound traffic only, and the construction of a second carriageway for north-bound vehicles near the line of the East carriage Road of the Ring in Hyde Park. A tree-lined grass reservation will separate the two carriageways and thus form a fine boulevard suited to modern traffic requirements. In addition to the provision of the underpass linking Piccadilly and Knightsbridge, details of which are being prepared, there will be a substantial enlargement and improvement of the round-about at Hyde Park Corner, and the introduction of an additional roundabout to the immediate north. The Decimus Burton Screen, which now forms an entrance to Hyde Park, will be retained but the gateways will not be used by vehicles except for ceremonial purposes; similarly the road through the main island to constitution Hill will be retained for processional use as at present. The roundabout system at Marble Arch will be considerably modified and arrangements will be made for access to and from Mayfair to the boulevard at Grosvenor Gate and Stanhope Gate.

The solution to the very difficult traffic problems in this part of London has been under review since 1948 and has required the detailed consideration of a number of possible plans. The Government has now decided in favour of the scheme outlined above. Since 1954 there has been an increase of 12 per cent in the number of vehicles using Hyde Park Corner each 12 hour day, the average having risen from 81,446 to 91,010 in 1956.

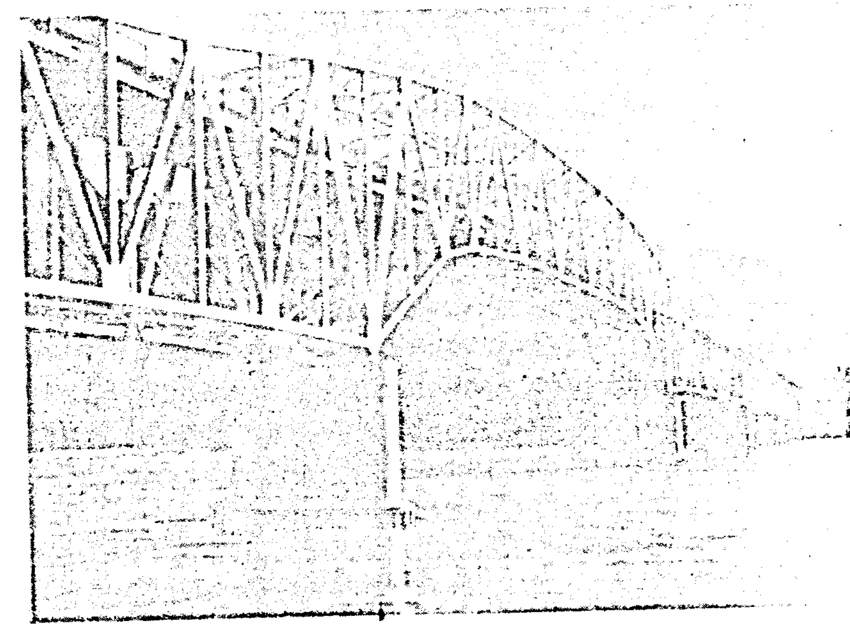
(From "Roads and Road Construction", May, 1957.)

4. ROADS AND BRIDGES IN CANADA

A YEAR-END summary released by the Canadian Good Roads Association stated that "The year 1956 was the biggest road construction year in Canadian history." A substantial mileage of new modern roads was added to the nation's highway system. A year of peak activity was forecast for 1957.

have spent more than 700 million dollars at the end of that period, 31 March, 1957.

The report on highways, for the year 1954 showed a grand total of 524,055 miles of roads in Canada at the end of that year, 192,616 of which were surfaced roads. According to an un-official Good



The Agassiz-Rosedale bridge in Vancouver, has a total length including approaches of 6127 ft, with a centre span of 1859 ft.

The most recently published full Dominion Bureau of Statistics report on highways was for the year 1954. This had shown expenditures during that year on highway bridges and ferry construction of 429 million dollars. Compared with this, all provinces budgeted a total of some 722 million dollars for highway development during the fiscal year of 1956, an all time high. According to the Canadian Good Roads Association, they would actually

Roads Association estimate, mileage of all roads today totals some 538,000 miles, 210,000 of which are totally surfaced roads. Probably a little more than half of the two-year growth, or some 8,800 miles of all classes of highway were thus added during the year 1956, some 7,000 miles of which were surfaced.

(From "The Engineering Journal," Vol. 40, No. 5, May, 1957.)

5. IRAQ ROAD PROGRAMME

THE Iraqi Public Works Department has been authorized to contract for the construction of 374 kilometers of highway costing an estimated (U.S.) 19,600,000 dollars in the next 18 months.

Currently, 19 road projects are under construction totalling 510 kilometers in length and including 19 bridges. Estimated cost of these projects is 16,240,000 dollars.

Road construction in Iraq for the financial years 1952 through 1960 will total an estimated 266 million dollars, of which about 42 million dollars have so far been assigned to the Public Works Department.

The Iraqi Development Boards, which receives 70 per cent of the Oil revenues of the country, is responsible for building the main highways and bridges.

(From "World Construction", May, 1957.)

6. DEVELOPMENT OF ETHIOPIAN ROADS

THE Imperial Highway Authority of the Ethiopian Government have sanctioned the survey, design and supervision of road construction totalling 900 miles at an estimated cost of about 10 million pounds and in seven projects or sections of roads.

The country through which the roads will pass is high, mountainous plateau, 7000-9000 ft above sea level, and one stage involves crossing the gorge of the Blue Nile. Use will probably be made of local volcanic and other rock for road foundations. The wet season in Ethiopia is from June to September, and the construction programme—which has an estimated completion time of three to four years—has taken this into account.

Aerial surveying for the projects is being carried out to supply air cover on the scale 1 : 20,000. The management of the Ethiopian Imperial Highway Authority is provided by the U. S. Bureau of Public Roads.

Details of the proposed road-building programme are :

Project No.	Road	Length (kms.)	Cost (Ethiopian thousand dollars)
1.	Jimma-Gore	318	14,687
2.	Jimma-Saca	102	4,600
3.	Jimma-Bonga	120	6,000
4.	Blue Nile-Dangila	284	12,592
5.	Miesso-Asbe Teferi-Deder-Harrar	250	12,937
6.	Sabata-Hossanna	200	13,390
7.	Assela-Doio	161	5,257
	Totals	1,435	69,463

Apart from the 1435 km. of road to be designed, a further programme of 1887 km. is also being financed by the proposed second loan to Ethiopia from the International Bank for Reconstruction and Development.

(From "Contractors Record and Municipal Engineering", May, 1957.)

THE MENU

A cannibal child on a South Sea Island pointed to an aeroplane flying overhead and asked his mother what it was. "It's a little like lobster," she explained. "You eat only what's inside."

A little girl was explaining to her young brother that it was wrong to work on Sundays. But he saw a flaw in the argument.

"What about policemen?" he asked. "They work on Sundays." Don't they go to heaven?"

"Of course not", his sister replied. "They're not needed there."

CURRENT LITERATURE

ABSTRACTS

PLAIN AND REINFORCED CONCRETE FOR GENERAL BUILDING CONSTRUCTION. Indian Standards Institution, New Delhi.

THE Indian Standards Institution has just issued Revision of the Indian Standard Code of Practice for Plain and Reinforced Concrete for General Building Construction (IS : 456–1957).

This Code which was prepared originally in 1953 has found wide acceptance in the country and over 90 per cent of reinforced cement concrete work done in the country is done by following this Code. This revision which is limited in its scope takes note of improvements and technological knowledge which has become available during this period. It also includes sections on composite columns, concentrated loads and staircases.

In such structures as tanks, reservoirs, chimneys, bridges, steel structures, etc., where the speciality of the structure relates principally to the mechanics of design, the general provisions of this code may be applied with such modifications as found necessary to suit the special conditions of the case under consideration.

The code includes specification for materials, design, stresses, control of quality, method of design, workmanship and inspection and testing.

THE KELOWNA FLOATING BRIDGE by W. Pegusch,-- Engineering Journal, Montreal, Vol. 40 ; No. 4, April 1957.

THIS paper, presented at a meeting of the Engineering Institute of Canada in 1957, describes the design and construction of a floating bridge across the Okanagan Lake in British Columbia. The complete structure has a total length of over 2 miles, consisting of a one-mile approach road on the west side, a 1400 ft rock fill embankment, a 175 feet transition span, a 2100 feet pontoon section, a 175 feet transition span, a 260 feet lift span, a 175 feet approach span, 300 feet of rock fill and a 500 ft approach road. The floating section consists of 12 reinforced concrete units, rigidly connected together to form one continuous-span pontoon. The bridge carries a 36 feet carriageway, flanked by two 6 feet footways. Mercury vapour lighting is being installed, the lamp standards being set on top of the two 1 foot wide solid concrete handrails. The bridge will be operated under the toll system.

DRIVER CHARCTERISTICS. BULLETIN 152. Highway Research Board, Washington, D.C.

THIS bulletin contains four papers on driver characteristics as presented at the 1956 Annual Meeting of HRB.

The first, on "Personal Characteristics of Chronic Violators and Accident Repeaters," describes the findings of 2½ years of operation of the New Jersey Accident Prevention Clinic, set up by the Motor Vehicle Division in October 1952.

The second deals with "Dynamic Visual Fields," particularly with regard to vehicle accident experience, driver training, vehicle design, and highway planning.

A third paper describes the first phase of a special study at Iowa State College on "Effect of Rest Pauses and Refreshment on Driving Efficiency."

The fourth paper, a report by the Committee on Road User Characteristics, presents a pilot study investigation of information on driver behavior and other factors from reports of "near accidents."

A PROCEDURE FOR DETERMINING THE THICKNESS OF FLEXIBLE PAVEMENTS, William H. Mills. Highway Research Board, Washington, D.C.

THIS report was presented at the business meeting of the Flexible Pavement Design Committee, Department of Design, at the 36th Annual Meeting of the Highway Research Board January 7-11, 1957 and was recommended by the Committee for publication.

The procedure described herein was devised by the Author during a three-year period of service as a consultant on pavement design and construction in Brazil. It was developed primarily to provide field engineers with a definite and simple procedure for applying the results of tests, made in field laboratories, on samples of subgrade soils and the soils or other materials available for subbase or base courses. Because of the frequency with which incompatible test data were encountered, it was considered advisable to use some safeguards and not depend entirely on any one test or procedure for estimating the thickness of pavement.

The allowance for poor drainage was invented in an effort to obtain a balanced design throughout the length of a project. It aims to provide pavements of equal load capacity by using extra thickness of subbase over bad subgrade soils where natural drainage is poor.

A SYMPOSIUM ON HIGHWAY SHOULDERS—Bulletin 151. Highway Research Board, Washington, D. C.

FOR a long time, research on the design, performance, and maintenance of highway shoulders has been insufficient and inadequately correlated.

This symposium, which was solicitated and organized by the Board's Department of Design, was developed to bring together, from all departments, the most recent thinking on shoulder problems and to try to single out specifically needed research. Thirteen contributors, each representing a separate committee, participated.

These statements regarding many facts and principles that are presently applicable, and the ideas expressed concerning what is still desired to be learned in order to make shoulders function more nearly satisfactorily, deserve much serious thought. These writings leave little doubt that there is need for more research, both nationally and regionally, on this important feature-highway shoulders.

ORGANIZATION AND CONTROL OF HIGHWAYS MAINTENANCE—By William John Hiscock*. Proceedings of the Institution of Civil Engineers, London, April 1957.

The Paper describes the organization of highways maintenance work and the methods adopted in a large county borough where the Highways Department is a separate unit and where the Highways Engineer is responsible to a Highways Committee

Some difficulties of a local authority's direct-labour organization are described and some of its achievements mentioned.

The relation of highways-maintenance duties to the full duties of the department are described.

The functions and duties of the main sections of the staff are set out under three headings:

Technical:—Planing of works of reconstruction, resurfacing, and surface dressing. Preparation of plans, specifications, and estimates. Making site line-and-level surveys, and setting out works.

Administrative:—An efficient indoor organization being essential to a works department, the importance of expenditure control, costs, and statistical information, giving an up-to-date picture of progress in comparison with estimates is discussed.

Operative:—The following are dealt with: employment of direct labour and its limitations; district organization under central control; human relations, incentives, mechanization, and their relation to efficiency; and control and operation of plant, vehicles, stores, and depots.

A description is given of the work of routine and specialist gangs, and the personnel involved. Flexibility of plant and labour is discussed, and central asphalt- and concrete-making plants and testing of materials are described.

*Executive Officer and Highways Engineer, City of Leeds Highways Department.

SELECTED RECENT LITERATURE IN ENGINEERING JOURNALS

1. GENERAL

1. **Rating the Sufficiency of Roads with a Low Traffic Volume**; George O. Grant, *Roads and Engineering Construction*, September, 1956, pp. 98-110, 148-162.

2. **Current Practice in Snow and Ice Control in Canada**; Olier Mathiew, *Roads and Engineering Construction*, October, 1956, pp. 210-222.

3. **Shoulder Construction and Maintenance on Canadian Roads**; J. A. Knight, *Roads and Engineering Construction*, October 1956, pp. 232-234, 253-254.

4. **"Piecemeal and Intermittent" Road Construction a Costly Policy**; *The Surveyor, Vol. CXV, No. 3372*, December 8, 1956, pp. 981-984.

5. **An Australian National System of Interstate and Defence Roads**; *Main Roads, Vol. XXII, No. 2*, December 1956, pp. 33-34.

6. **Toll Highways, Their Economics and Construction**; H. D. Morgon, V. F. Bartlett, H. S. Smith and E. E. W. Richards, *Proceedings of the Institution of Civil Engineers, World Construction, Paper No. 32-Part III, Vol. 5*, December 1956, No. 3, see also pp. 575-624.

7. **Essentials for a Modern Engineer**; A.S. Turner, *The Journal of the Institution of Municipal Engineers, Vol. 83, No. 6*, December 1956, pp. 181-194.

8. **Modern Trends and Developments in Road Maintenance**; J. R. Musgrave and J. V. Leigh, *The Journal of the Institution of Municipal Engineers, Vol. 83, No. 6*, December 1956, pp. 204-220, see also *Roads and Road Construction, Vol. 34, No. 408*, December 1956, pp. 380-383.

9. **Planning for Snow and Ice Removal**; *Better Roads, Vol. 26, No. 11*, November 1956, pp. 29-31 and 60.

10. **The Calculation of Probabilities and the Vehicular Traffic on a Two Lane Road, Complementary Note**; A. Schuhl, *Annales Des Ponts et Chaussies, Vol. 126, No. 6*-November-December 1956, pp. 821-824 (in French).

11. **American Practice in the Design of Major Highways**; E. W. W. Richards, *Roads and Road Construction*. see also *Highway Bridge (contd.)-Vol. 34, No. 408*, December 1956, pp. 376-379. *Highway Bridge (contd.)-Vol. 35, No. 409*, January 1957, pp. 4-8.

12. **Ermine Street Diversion**; *Roads and Road Construction, Vol. 35, No. 409*, January 1957, pp. 14-16.

13. **Accident Rates on German Expressways in Relation to Traffic Volumes and Geometric Design**; Dr. F. Bitzel, *Roads and Road Construction, Vol. 35, No. 409*. January 1957, pp. 18-20.

14. **The Influence of Road Layout on Speeds and Accidents In Rural Areas**; G. Charlesworth and T. M. Coburn, *The Journal of the Institution of Municipal Engineers, Vol. 83, No. 7*, January 1957, pp. 221-240.

15. **Analysing Data for Decisions—Examples of Operational Research**; R. Solt, *Engineering, Vol. 182, No. 4733*, November 23, 1956, pp. 652-653.

16. **Runoff Dynamics**; F. V. Appleby. *Civil Engineering, Vol. 51, No. 602*, July 1956, pp. 772-775—part I.

17. **Setting out for Civil Engineering and Building Works**; H. B. Duff, *The Surveyor, Vol. CXVI, No. 3378*, January 26, 1957, pp. 81-84—Part II.

18. **Psychological Factors of Importance in Traffic Engineering**; R. L. Moore, *Roads and Road Construction, Vol. 35, No. 410*, Feb. 1957, pp. 51-52.

19. **Study of the Petit-Clamast Intersection;** R. ALEXANDRA AND G. BATSCH, *Roads and Road Construction, Vol. 35, No. 410,* Feb. 1957, pp. 52-54.

20. **Snow;** E. W. H. VALLIS. *Roads and Road Construction, Vol. 35, No. 410,* pp. 55-56. see also *The Surveyor, Vol. CXVI, No. 3379,* January 26, 1957, pp. 77-79.

21. **Foreign Operations of the U.S. Bureau of Public Roads;** A. C. TAYLOR, *The Surveyor, Vol. CXVI, No. 3375,* Dec. 29, 1956, pp. 1047-1048.

22. **Basic Theory of Urban Storm Drainage Area;** C. H. MUNRO, *The Journal of the Institution of Engineers, Australia, Vol. 28, No. 12,* Dec. 1956, pp. 301-314.

23. **Building of the Main and Developmental Road System in Western Australia 1926-1956;** J. D. LEACH, *The Journal of the Institution of Engineers, Australia, Vol. 28, No. 12,* Dec. 1956, pp. 317-326.

24. **A County Plant Depot and the Organisation and Maintenance of County Plant;** J. H. H. WILKES AND F. B. KELLY, *The Journal of the Institution of Municipal Engineers, U. K. Vol. 83, No. 8,* Feb. 1957, pp. 253-271.

25. **Preston and Lancaster By-Passes;** J. DRAKE, *The Journal of the Institution of Municipal Engineers, U. K., Vol. 83, No. 8,* Feb. 1957, pp. 272-278.

26. **Ontario Adopts Prequalification for Highway Contractors;** HON. JANES N. ADAN, *Roads and Road Engineering Construction,* Jan. 1957, pp. 56-124.

27. **Quarter-way Stage in a County Road Plan;** JAMES DRAKE, *The Journal of the Institute of Highway Engineers, U. K., Vol. IV, No. 1,* January 1957, pp. 13-26.

28. **A Contractor's View of the Construction of Special Motorways;** P. R. S. BERRIDGE AND J. H. W. TURNER, *The Journal of the Institution of Highway Engineers, Vol. IV, No. 1,* January 1957, pp. 27-38.

29. **Some Measurements on Traffic in Scottish Cities and on Narrow Highland Roads;** J. W. TYLER, *The Journal of the Institution of Highway Engineers, U. K. Vol. IV, No. 1,* January 1957, pp. 39-55.

30. **Commercial Vehicles and the New Motorways-Design Requirements to be met;** D. M. CLAPP AND J. A. PROUDLOVE, *Engineering, Vol. 183, No. 4745,* Feb. 15, 1957, pp. 206-209.

31. **Design Standards for Interstate Roads;** DUANE L. CRANK, *Roads and Streets,* Oct. 1956, pp. 93, 94 & 99.

32. **Controlling Highway Access;** *Traffic Quarterly,* Oct. 1956, pp. 529-546.

33. **Snow-Slide Factors;** *Better Roads, Vol. 27, No. 1,* January 1957, pp. 10.

34. **Wing Creeper Lanes for Trucks on West Virginia Turnpike;** Elmer K. TIMBY, *Traffic Quarterly, Vol. XI, No. 1,* January 1957, pp. 114-125.

35. **The Benefit Ratio of the By-Pass Road at Lyngby, Denmark;** PROF. DR. P. H. BENDTSEN, *Roads and Road Construction,* March 1957, *Vol. 35, No. 411,* March 1957, pp. 87-90.

36. **Efficiency and Health of Draughtsmen—Influence of Drafting Equipment;** *Engineering, Vol. 183, No. 4750,* March 22, 1957, pp. 364-365.

37. **Building Skid Resistant Road Surfacings, Addition of Silica Sand to the Mix;** *Highways and Bridges and Engineering Works, Vol. XXIV, No. 1185,* April 10, 1957—pp. 1, 3 & 8.

RECENT ADDITIONS TO THE LIBRARY OF THE INDIAN ROADS CONGRESS

1. **An analysis of Taxation for Highway Purpose in California, 1895-1946, Oct. 1, 1946;** Richard M. Zettel, California State Printing Office, Sacramento, California, U.S.A.

2. **The University of Tennessee Record—Conference on the Immediate Highway Program, July 1946,** The University of Tennessee, Knoxville, U.S.A.

3. **Preliminary Report of the Development of Suburbs and Town Planning Panel Bombay City & Suburbs Post-War Development Committee.** Bombay City & Suburbs Post-War Development Committee Bombay.

4. **Report of the Health Survey and Development Committee, Volume II Recommendations (1946);** The Manager of Publications, Delhi.

5. **Study of Some Variables Affecting Retention of Aggregate by Asphalt Surface Treatments, Reprint No. 33 (April 1954) From Roads & Streets** Fred J. Benson & Bob M. Gallaway. Texas Engineering Experiment Station, College Station, Texas, U.S.A.

6. **Soil Stabilisation in Germany—** Reprint from Engineering August 27 1954. K. E. Clare & R. A. Foulkes Road Research Laboratory, Middlesex (England.)

7. **Some Traffic & Driving Conditions which Influence Petrol Consumption;** K. D. Lister and R. N. Kemp. Reprint from Bull. Mot. Ind. Res. Ass. 1954 (2) pp. 19-26. Road Research Laboratory, Middlesex (England).

8. **Locating Steel Reinforcing Bars in Concrete Slabs.** A. C. Whiffin, Reprint from the Engineering June 18, 1954, 197(5134) pp. 887-8. Road Research Laboratory, Middlesex (England).

9. **The Effect of Curing Temperature on the Compressive Strength of Soil-Cement Mixtures —** Excerpt, from Geotechnique September 1954. K. E. Clare & A E. Pollard. Institution of Civil Engineers, Great George Street, London, S.W, 1.

Man is, I believe, an unwilling victim of today's environment, caught up in a system which places an inordinate premium on speed, a system with little patience and less reward for a man known to be given to reflection. Tension has become the badge of initiative, nervous restlessness the emblem of useful drive. Certainly an earlier grave is not the goal : men only behave as if it were.

—Mason G. Lockwood.
(Presidential Address at the Buffalo Convention).

BUDGETS AND ADMINISTRATION REPORTS

GOVERNMENT OF BOMBAY BUDGET FOR 1957–58

The following extracts have been taken from the Civil Works Budget of the Government of Bombay for the year 1957–58.

Revenue (Civil Works)

Heads	(In lakhs of rupees) Budget Estimate 1957–58
Rents	19.63
Ferry receipts	0.44
Tolls on Roads	0.25
Receipts from self-supporting workshops	0.65
Recoveries of expenditure	3.30
Miscellaneous	29.66
Deduct—Refunds	-0.17
Total	53.76

Heads	(In lakhs of rupees) Budget Estimate 1957–58
Expenditure (Civil Works)	
Buildings	
Original works	48.14
Repair	71.91
Communications	
Original works*	429.86
Repair	201.49
Miscellaneous	
Repair	2.21
Establishment	209.49
Tools and Plant	42.84
Grants-in-aid	12.97
Suspense	550.01
Deduct—Recoveries adjusted in the accounts for reduction of expenditure	—1197.82
Total	371.10

* Some of these works form part of Central Plan for Road Expenditure.

(Continued)

Capital account of civil works outside the revenue account

Heads	(In lakhs of rupees) Budget Estimate 1957–58
Original Works	
Buildings	552.73
Communications*	313.98
Establishment	63.55
Tools and Plant	15.89
Deduct—Recoveries adjusted for the reduction of expenditure	–119.66
Total	826.49
Revenue from Roads	
Receipts under the Indian Motor Vehicles Act	20.00
Receipts under the State Motor Vehicles Taxation Act	325.00
Fees and other receipts	0.40
Deduct—refunds	-8.23
Total	337.17

* Includes Rs 99.50 lakhs under Central Aid Road Development Programme works.

GOVERNMENT OF BOMBAY BUDGET 1957—58

(A brief review with reference to civil works)

TOTAL revenue receipts of the Government of Bombay for the year 1957-58 are estimated at Rs 10631.43 lakhs and revenue expenditure at Rs 10868.91 lakhs, indicating a deficit of Rs 237.48 lakhs.

Revenue expenditure on civil works is estimated at Rs 371.10 lakhs. The important provisions included under this head are Rs 264.45 lakhs for National Highways, Rs 117.23 lakhs for Central Road Fund Works, Rs 86.58 lakhs for road works under the West Coast Road Programme and Rs 22.44 lakhs for State roads of economic and inter-State importance. The above items of expenditure are entirely financed by the Government of India. The credit from the Central Government for these works is taken in reduction of expenditure. Expenditure on capital account of civil works outside the revenue account is estimated at Rs 826.49 lakhs. Buildings and communications form the main items of expenditure.

LIST OF APPROVED WORKS ON NATIONAL HIGHWAYS

S. No.	Job No.	Name of Work	Amount Rs lakhs
		ASSAM	
1.	1777 AS 37	Widening and improving miles 2 to 9 on National Highway No. 37, Assam Trunk Road West in Gauhati West Sub-Division.	1.55
2.	1781 AS 37	Construction of approaches to the proposed bridge in place of level crossing at Pandu in 5th mile of Assam Trunk Road.	5.92
		BOMBAY	
3.	1779 BM 3	Construction of a bridge across Wanki Khadi in mile 149 of National Highway No. 8 on proposed diversion outside Bulsar Town.	3.13
4.		Four works each costing less than 2 Lakhs.	3.34
		JAMMU AND KASHMIR	
5.	1785 JK 1-A	Construction of Snow-Chutes and drift sheds on the south side of Jawahar Tunnel on the Jammu-Srinagar-Uri Road, National Highway No. 1-A.	1.28
		MADHYA PRADESH	
6.	1778 CP 26	Construction of a bridge over Narmada river at Burmanghat on Saugar-Narsinghpur Road, National Highway No. 26.	9.52
7.	TA 94 CP 3	Retreatment with 3/4 in. carpet of miles 27/0 to 41/0 of National Highway No. 3 in Indore Division No. 1.	1.72
		PUNJAB	
8.	1776 PB 1-A	Providing Diversion in mile 17/1 of Jullundur-Tanda Section of National Highway No. 1-A.	0.14
		UTTAR PRADESH	
.		Three works each costing less than 2 lakhs.	3.90

AR 25/X

A limited n[illegible] copies of the following publications of the Indian Roads Congress are available for sale.

	Publications.	Price inclusive of postage, etc. Rs.	A.	P.
1.	Volume IX—Part 4—October 1945	3	0	0
2.	Volume IX—Bound—1945	10	0	0
3.	Volume X—Part 4—August 1946	3	0	0
4.	Volume XI—Part 4—May 1947	3	0	0
5.	Volume XII—Part 2—January 1948	3	0	0
6.	Volume XII—Part 3—April 1948	3	0	0
7.	Volume XII—Part 4—March 1948	3	0	0
8.	Volume XII—Part 5—September 1948	3	0	0
9.	Volume XII—Bound—1947-48	12	0	0
10.	Volume XIII—Part 1—December 1948	3	0	0
11.	Volume XIII—Part 2—January 1949	3	0	0
12.	Volume XIII—Part 3—January 1949	3	0	0
13.	Volume XIII—Bound—1948—49	11	0	0
14.	Volume XIV—Part 1—September 1949	3	0	0
15.	Volume XIV—Part 2—December 1949	3	0	0
16.	Volume XIV—Part 3—December 1949	3	0	0
17.	Volume XIV—Part 4—July 1950	3	0	0
18.	Volume XIV—Bound—1949-50	8	0	0
19.	Volume XV—Part 1—August 1950	3	0	0
20.	Volume XV—Part 2—November 1950	3	0	0
21.	Volume XV—Part 3—January 1951	3	0	0
22.	Volume XV—Part 4—August 1951	3	0	0
23.	Volume XV—Bound—1950-51	9	0	0
24.	Volume XVI—Part 2—March 1952	3	0	0
25.	Volume XVI—Part 3—April 1952	3	0	0
26.	Volume XVI—Part 4—October 1952	3	0	0
27.	Volume XVI—Bound—1951-52	8	0	0
28.	Volume XVII—Part 1—December 1952	3	0	0
29.	Volume XVII—Part 2—January 1953	3	0	0
30.	Volume XVII—Part 3—January 1953	3	0	0
31.	Volume XVII—Part 4—December 1953	3	0	0
32.	Volume XVII—Bound—1952-53	9	0	0
33.	Volume XVIII—Part 3—January 1954	3	0	0
34.	Volume XVIII—Part 4—March 1955	3	0	0
35.	Volume XVIII—Bound—1953-54	9	0	0
36.	Volume XIX—Part 2—May 1955	3	0	0
37.	Volume XIX—Part 4—Sept. 1955	3	0	0
38.	Volume XIX—Bound-1954-55	10	0	0
39.	Volume XX—Part 1—October 1955	3	0	0
40.	Volume XX—Part 2—November 1955	3	0	0
41.	Volume XX—Part 3—December 1955	3	0	0
42.	Volume XX—Part 4—January 1957	3	0	0
43.	Volume XXI—Part 1—February 1957	3	0	0
44.	Volume XXI—Part 2—March 1957	3	0	0
45.	Volume XXI—Part 3—April 1957	3	0	0
46.	Road Research Bulletin No. 1	5	0	0
47.	Road Research Bulletin No. 2	5	0	0
48.	Proceedings of the Chief Engineers' Conference at Nagpur on the Post-war Road Development in India	2	10	0
49.	Paper No. 167—Design of Small Bridges and Culverts by Goverdhanlal ...	2	0	0
50.	Dimensions and Weights of Road-Design Vehicles	0	8	0
51.	Recommended Practice for the Location and Layout of Roadside Motor Fuel Filling Stations	0	8	0
52.	Type Designs for Furlong and Boundary Stones	0	8	0
53.	Route Marker Signs for National Highways	0	8	0
54.	Type Designs for Highway Milestones	0	8	0
55.	Standard Specifications and Code of Practice for Road Bridges—Section I—General Features of Design	0	12	0

plus packing and postage (items 50–55)

Copies can be had from the Secretary,

INDIAN ROADS CONGRESS,

JAMNAGAR HOUSE, SHAHJAHAN ROAD,

NEW DELHI-2.

Printed by K. S. Krishnan at the Progressive Printers, 17, Coral Merchant Street, Madras-1 & Edited and Published by A. J. D'Costa, Hony. Secretary, Indian Roads Congress, Jamnagar House, Shahjahan Road, New Delhi-2—950.