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TRANSPORT-COMMUNICATIONS

MONTHLY REVIEW

SEPTEMBER 1957—No. 125

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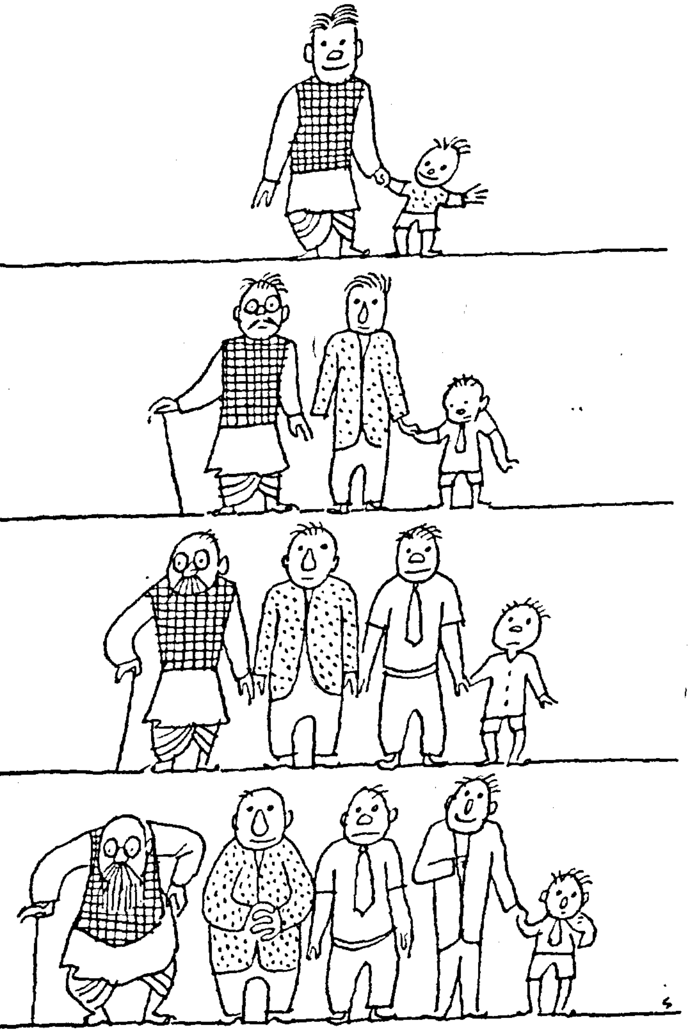
INDIAN ROADS CONGRESS, NEW DELHI.



It lasts....

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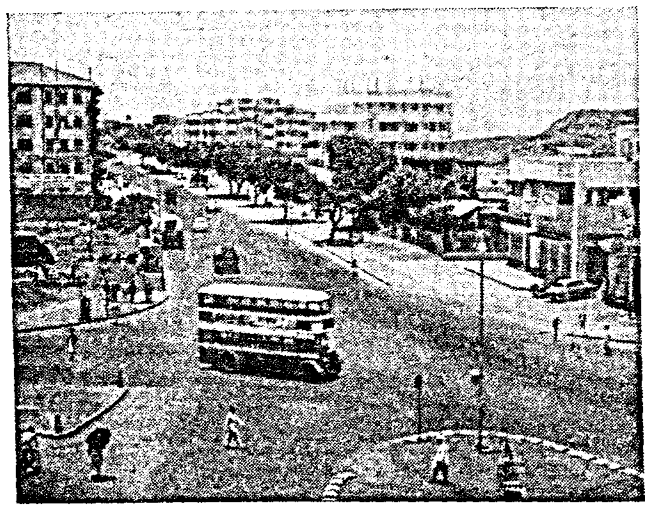

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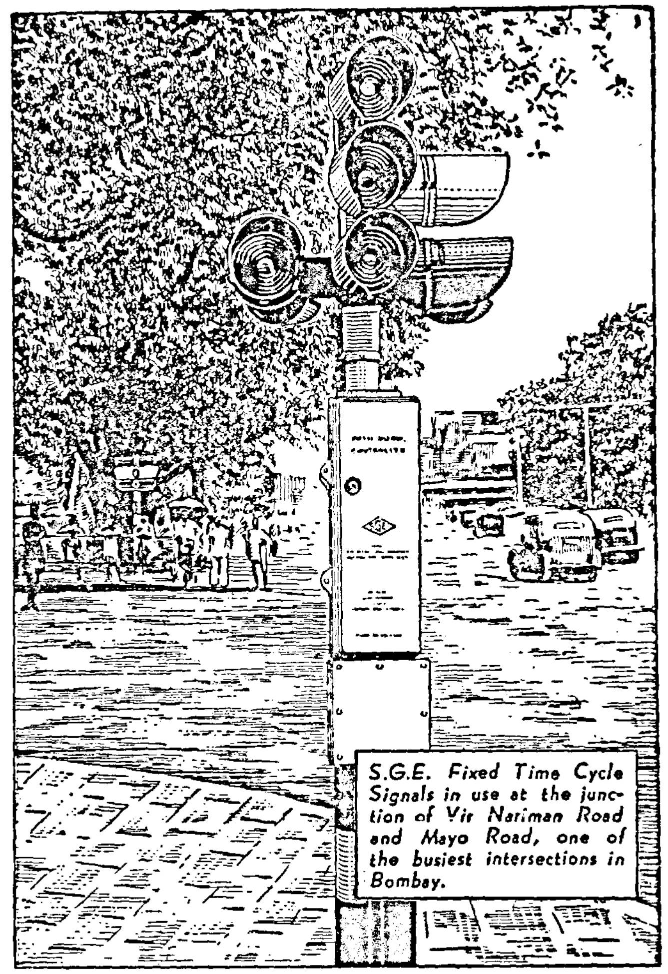

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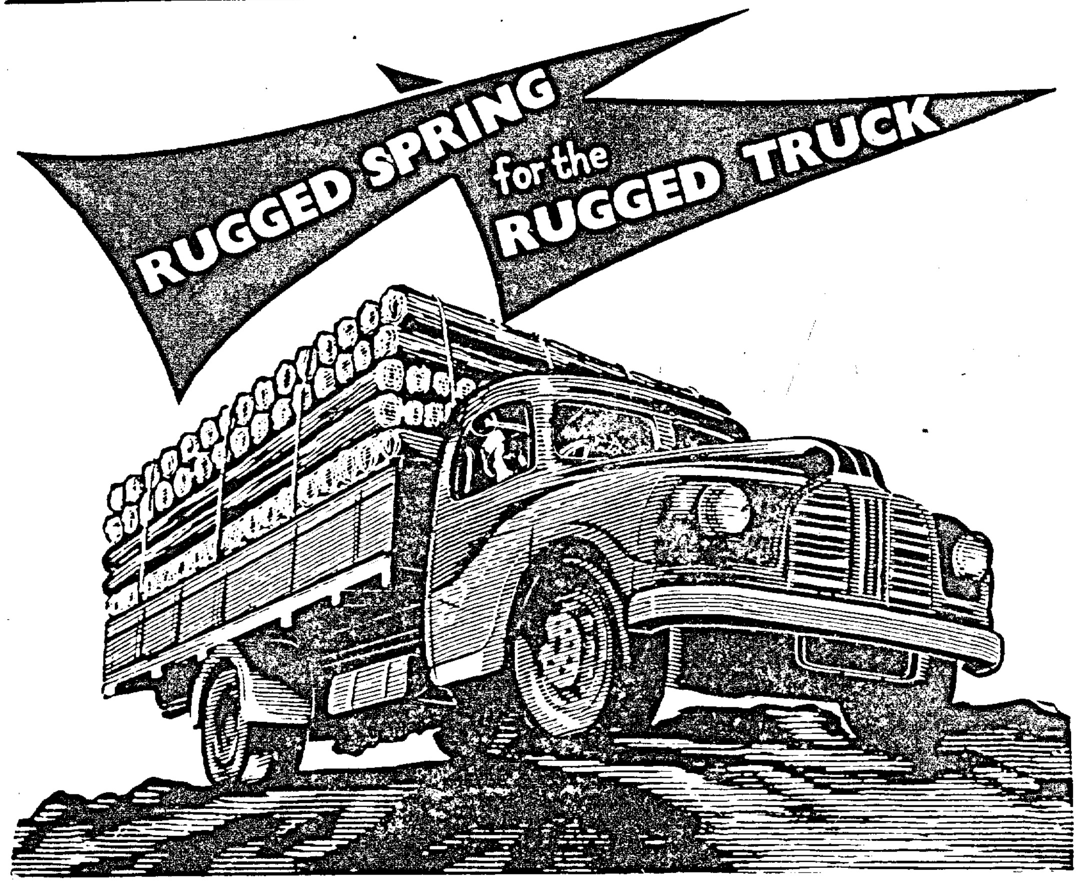

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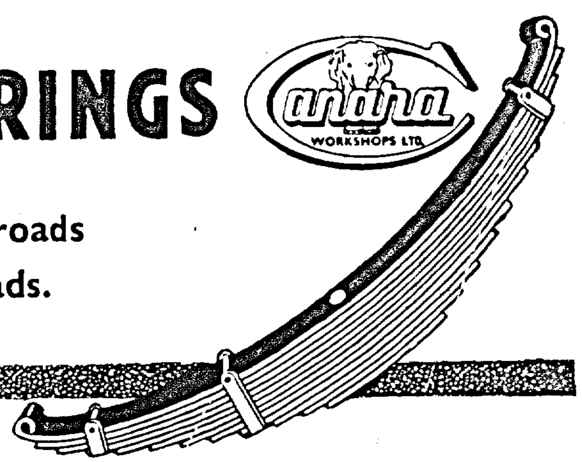

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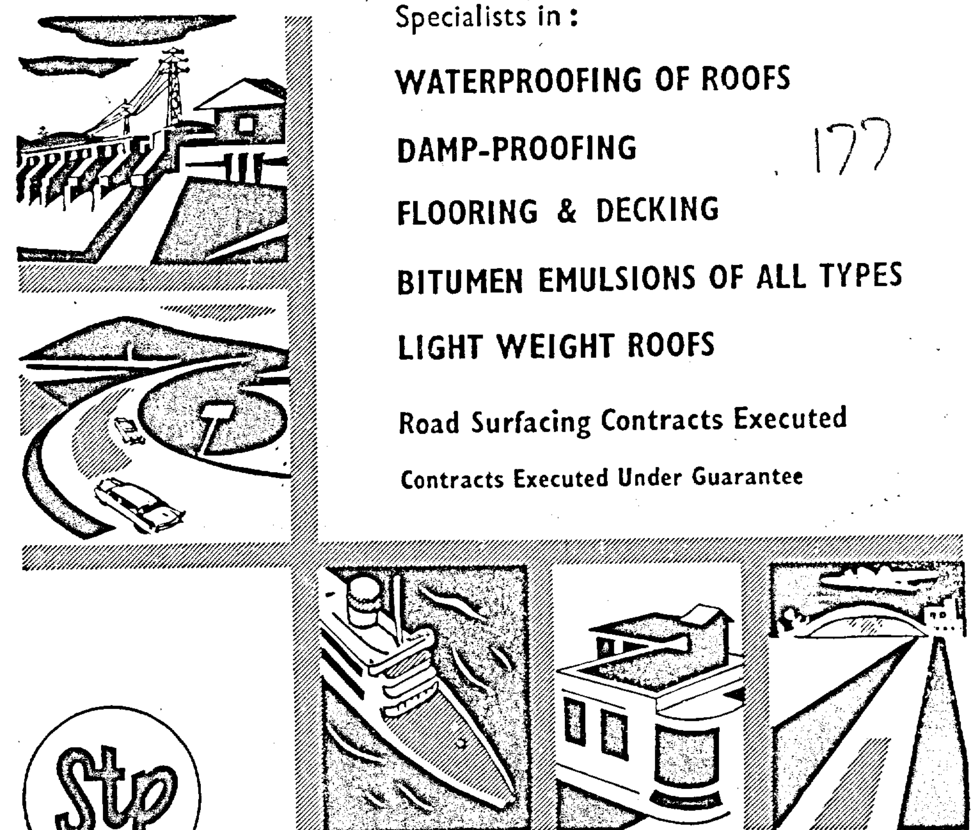

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TRANSPORT-COMMUNICATIONS

MONTHLY REVIEW

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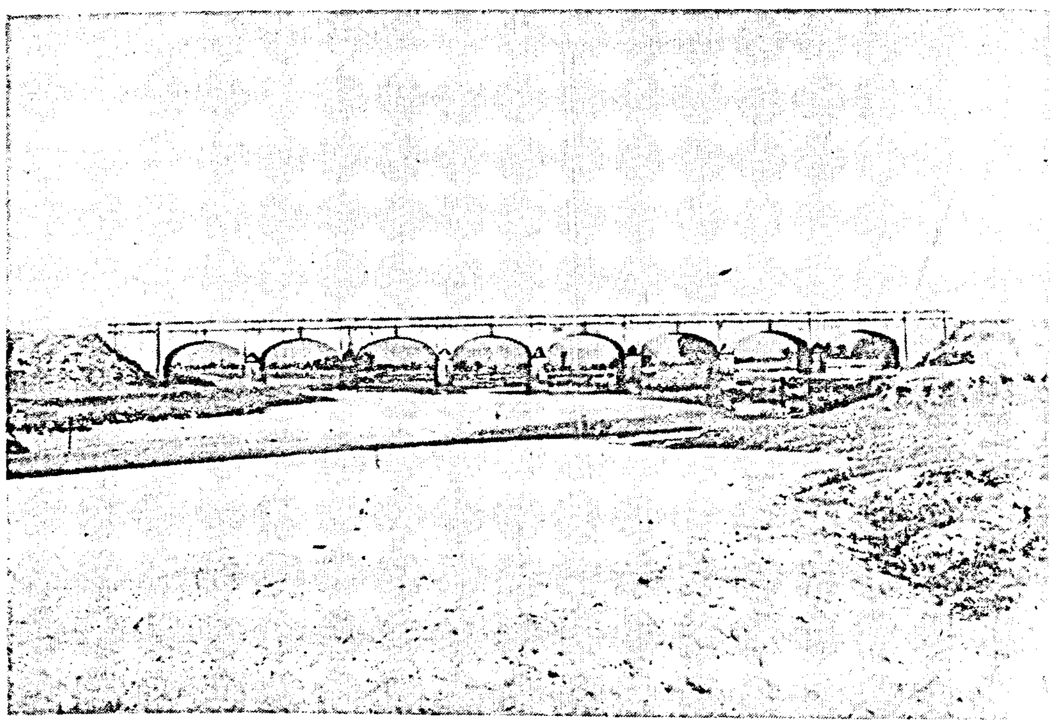
ORDEI BRIDGE ON JARADA-CHAMPUA MAIN ROAD (ORISSA)



ORDEI BRIDGE ON JARADA-CHAMPUA MAIN ROAD (ORISSA)

TRANSPORT-COMMUNICATIONS
MONTHLY REVIEW

A REVIEW OF
ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

SEPTEMBER 1957

LOW COST ROADS

THE International Road Congress at its sessions both in Lisbon and Istanbul considered in detail the subject of low cost roads. At the latter session the Congress was confronted with the need of defining low cost roads, for what may be termed a low cost road in one country or region may not be so in another on account of diverse factors involved. The Congress at Istanbul in 1955 after a careful consideration of the problems came to the conclusion that a low cost road in under-developed areas is one which, having regard to considerations of climate and traffic, has been located and built to geometrical standards commensurate with future requirements, but it has been constructed with bases and surfacings to meet the present traffic requirements. It is, however, one which should be so designed, constructed and maintained that it allows for stage construction when traffic requires it and improvement in economic conditions permit.

It is obvious, therefore, that as in the case of any other engineering structure low cost roads should be built on soundly planned foundations. It is not difficult to realise the wisdom of this policy. Road construction is linked up with road transport and vehicle operation, and it has been conclusively proved that adoption of proper geometrical standards secures low cost transportation, safety, and fast communication. In other words, properly designed roads are not only economical to the nation in the long run on fuel consumption, wear and tear of motor vehicles, and speed but they are also less hazardous to human life which is a no small consideration.

It is true that a road is a progressive creation capable of improvement in stages according to increase in traffic, but certain basic elements have to be invariably provided to start with as it is both difficult and costly to introduce them later on. Take, for example, the alignment of a new road in a rural area. Unless this is determined by sound engineering criteria, there is a tendency for adopting the alignment of old village roads and footpaths for new motorable roads, either because it is easier to do so or to avoid the alterations required for improvement. The old village roads and footpaths are generally crooked and are to be avoided in the interest of a straight alignment. There is very little room for compromise on any point concerning the utility of new motorable roads in rural areas and particularly in the plains. These should invariably be direct as much as possible after making due allowance for obligatory points, and follow set geometric standards particularly in respect of curvature and grade; otherwise, it would be both difficult and expensive to provide them at a later stage. It is seen that improvements for safety and economy of vehicular operation become necessary with increase in traffic and this takes place much quicker than anticipated in the beginning. In case of a new road alignment in rural areas, the best choice between one or more alternatives needs to be based on sound engineering pattern and not left to be decided by limited local interests.

Another fundamental point which requires attention is provision of sufficient road land width with a view both to allow for future widening of the road and to prevent ribbon development which in the past has marred the utility of many a road as development of the area took place. The requirements under this head are likely to be overlooked at the level of the rural population under pressure of immediate local interests, not through any deliberate ill intention but by a lack of appreciation of real implications. Engineering guidance is, therefore, indispensable in such cases.

The other aspects of low cost road construction centre round the use of local materials to the best advantage. The main considerations here are traffic density, topographical conditions of the terrain, engineering properties of available materials, drainage conditions, moisture control, and possibility of future development. The aim is to create at a low cost an economic net work of roads in rural areas.

Soil is the cheapest local material available and soil stabilisation can be successfully employed in the construction of low cost roads. The economical methods of construction and maintenance of soil stabilised roads would vary according to climate, location, materials, and traffic in a particular area. Experience of soil stabilised roads in India both at the Alipur test-track and in field trials chiefly in the Punjab and Madras has shown that a 7 to 9 in. thick soil-sand or sand-moorum stabilised base compares favourably with two layers of brick soling and, although a $1\frac{1}{2}$ in. thick carpet can be laid directly over it, a 3 in. thick consolidated layer of water bound macadam course in between the surfacing and the stabilised base gives better results. Sand-soil-cement stabilised base has also given satisfactory results; however, more work for evolving a correct type of surfacing for this type is still required. Also detailed specifications for stabilised soil base and wearing courses are accordingly to be evolved.

Unlike roads, bridges are not capable of progressive development and it is, therefore, advantageous to construct all bridges to a final standard, except in special cases where temporary superstructures as short term measures may be considered. In this connection, provision for future extension of rural areas has to be made and so a judicious adoption of loading and other standards for design of bridges is called for.

And lastly, a word about the way of associating the community with the work of construction of roads in rural areas. Labour is a significant item in the cost of construction of roads and anything that mobilises people's efforts and enthusiasm towards this worthy cause is a healthy and welcome contribution. A further favourable circumstance is that, unlike other complicated engineering structures, road formation particularly in case of village roads is by and large a work of un-specialised nature involving simple standardised processes and routine operations. And in most of the works of such nature, once a process or a design or an operation has been established, by its very repetition over and over again, it passes into common usage and is capable of execution by less specialised agencies. However, it is important to bear in mind that the success of rural development work would depend not only on the overflow of routine engineering practices into the masses of the rural population, but also on an increasing knowledge of new methods and techniques that are being developed.

From whatever aspect we consider this problem of providing adequate roads for modern transport, we come to the same conclusion. Whether it be with the object of reducing accidents and saving life, reducing costs for industry, saving time, avoiding congestion or facilitating the export trade, there is a sound case for the improvement of our out-of-date roads on a national scale. This also is the considered opinion of industrialists, economists, scientists and highway engineers. It is not sufficient to provide the capital to finance road improvement work. We need a road plan.

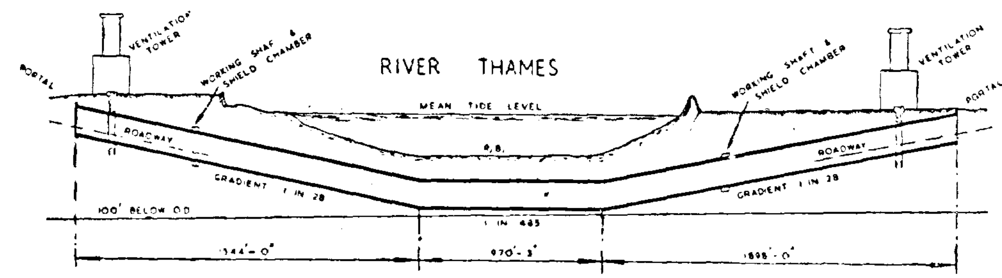
—John Brierley on 'A Road Plan for Great Britain'.

THE DARTFORD-PURFLEET TUNNEL

DRIVING OF THE MAIN TUNNEL COMMENCED

THE driving of the main tunnel under the Thames between Dartford and Purfleet on the Kent and Essex sides of the river was begun on April 21 last. The driving of the main tunnel, nearly a mile long, is the major task in the scheme to provide a direct road link between Kent and Essex 15 miles to the east of London. At present the only river crossings below the Blackwall tunnel are the Woolwich ferry and Gravesend/Tilbury ferry.

The scheme will cost 6,000,000 pounds for the driving and lining of the main tunnel and for constructing its immediate approaches which run for almost a third of a mile in cuttings.



Longitudinal section

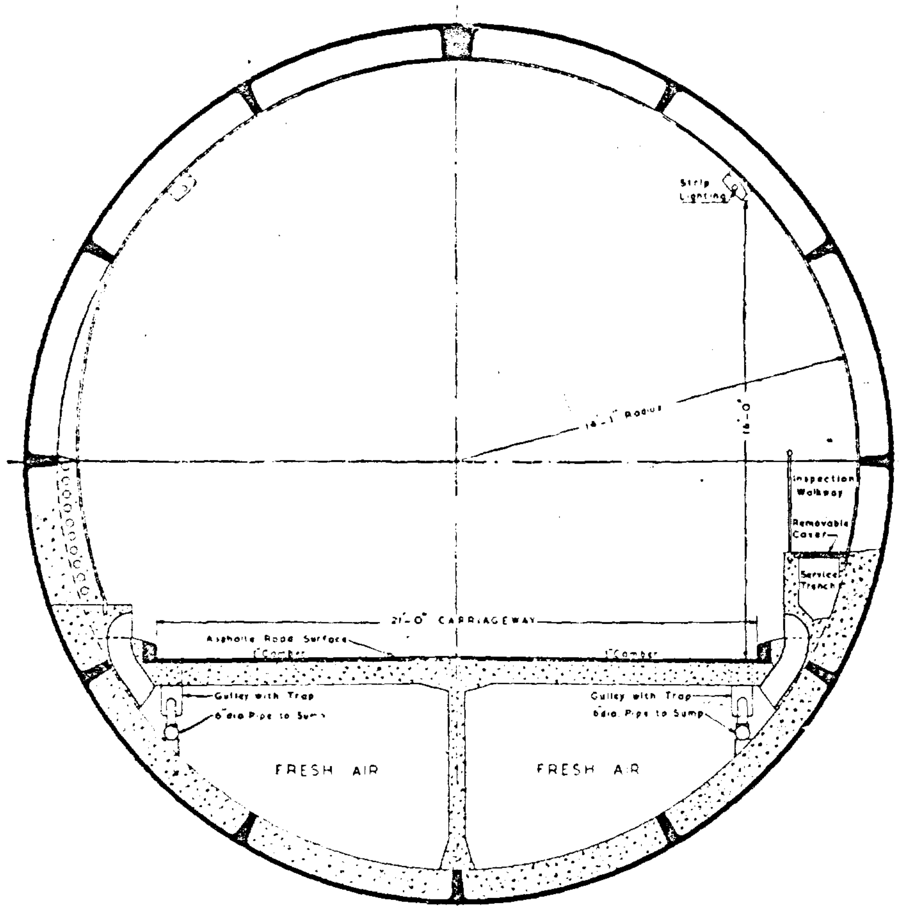
Shield Tunneling

The excavation of the tunnel face and the erection of the cast iron lining are carried out under the protection of the shield, which gives constant support to the ground until the permanent lining is erected. The internal structure of the shield consists of a heavy steel framework arranged in such a manner as to divide the shield into sixteen cells or working compartments in which the excavation of the face is carried out. When the whole face has been excavated to a depth equal to the width of a ring of the cast iron lining, the shield is moved forward. This is done by means of a series of forty-two hydraulic rams mounted peripherally inside the shield. These rams bear on the last ring of the tunnel lining to have been erected, and jack the shield bodily forward by the exact distance required to allow another ring of lining to be built after the rams are withdrawn.

The hydraulic rams are designed to operate at a maximum pressure of 6,000 lbs per square inch. The shield can exert a total thrust of over 6,000 tons if required. The power for this is generated by electrically driven Tangye hydraulic pumps at two surface stations, one on each side of the river, and transmitted to the shields through hydraulic pipe lines. A series of secondary hydraulic rams, operating at a lower working pressure, are used for supporting the tunnel face, and for other subsidiary purposes, including the hydraulic erectors, which lift the cast iron segments as the latter are delivered at the rear of the shield and place them each weighing 1 ton or more—in position for bolting up to the tunnel lining.

Pressurised Work

The existing shield chambers, placed at the bottom of 80 ft shafts on each side of the river, had been sealed at their working faces by reinforced concrete bulkheads 6 ft thick. Because water seeps through the crevices of the chalk, an awkward substance in which to work below water level, the chambers will have to be pressurised before the concrete seals are removed and excavation can begin. When the pressure is applied men will only be



Cross-section of the underwater tunnel

able to enter the chambers through twin-doored boiler-shaped air locks, which are situated at the top and bottom of the shafts, an additional lock of larger size being sited at the shaft top for introducing the iron segments of the lining and other bulky materials.

Air-compressing machinery has been installed at the working shafts on each side of the river. The main plant is electrically driven and consists of two sets of three compressors, each with a capacity of 5,000 cu. ft. of air per minute and driven by 750 h. p. motors. There are also diesel-operated compressors for use in emergency, and subsidiary plant for supplying the high pressure air required for pneumatic tools and equipment.

The main tunnel is circular, the diameter being 28 ft 2 in. inside the lining, permitting a 21 ft wide carriageway with a minimum vertical headroom of 16 ft. The structural lining of the tunnel consists of flanged cast iron segments, built up in rings, and varying between 1 ft 6 in. and 2 ft 6 in. in width according to the type of ground to be supported. The flanges of the segments, which will be 14 in. deep and up to $2\frac{1}{2}$ in. thick, will be bolted together with $1\frac{1}{2}$ in. diameter steel bolts.

As the cast iron lining is erected it will be grouted solidly into the ground by means of liquid cement injected under pressure. In order to make the tunnel watertight, the joints between the segments will be subsequently caulked with metallic lead.

Pneumatic spades will be used to attack the face from the sixteen open cells formed

Left: Front view of shield showing shaped cutting edge and some of the adjustable working platforms. Right: Rear view of shield, with some of the high pressure rams on the left and one of the hydraulic erectors.

by the cross members of each of the shields. After disposing of an initial stratum of gravel they will cut into the chalk throwing the debris on to conveyors which will take it to the back of each of the shields. Here it will be pulverised and mixed with water. The resulting slurry will be pumped through pipes up to the surface, where it will be deposited to form the earthworks that will serve to hold back river flood water from the cuttings down which the approach roads will run to the tunnel mouths.

As the main tunnel goes forward the pilot tunnel will be absorbed and its lining dismantled and sent to the surface. Since up and down movements of the shield and its changes of direction are to very fine limits the work of the tunnel makers calls for a combination of precision and heavy engineering skills. Shield tunneling is slow work. There is a limit to the amount of labour that can be brought to bear at the working face. An advance of five to six feet a day will be regarded as good. It is estimated that 3,000,000 cu. ft. of chalk and gravel will have to be removed.

Ground Treatment

In the preparatory work before driving the tunnel, advantage has been taken of the latest technique in the pre-treatment of difficult ground. Use is being made of the French "Soletanche" system of grouting where the tunnel is to pass through the gravel stratum. The principle of the method is that the voids in the gravel are sealed by the injection, in successive stages, of composite grouts designed to penetrate deposits of differing permeability. The main material employed is Bentonite, a processed clay capable of penetrating soils in which the grain size is too small to admit a cement grout. The larger voids are filled first with a clay cement grout followed by a clay-chemical grout to penetrate the finer materials. The aim is to produce, in effect, a box in which compressed air entering the gravel exposed at the tunnel face will be contained between two walls of treated gravel and a ceiling and floor formed by the overlying silt and chalk respectively.

Work on the Purfleet side will be started shortly. Tunneling landwards from the shaft bottom towards the projected approach cuttings, will probably not be started until the main tunnel under the river is driven. A third shield will then be brought into use on the Dartford side for the landward tunneling, but a series of parallel pilot tunnels will be used to form the full bore on the Purfleet side.

Tunnel Data

Total estimated cost.........£ 11,000,000 (approx).

Amount of present contract.........£ 6,000,000.

Length of tunnel.................4,700 ft.

Length of open cutting at entrances......1,500 ft.

Overall length.................4 miles (subject to Parliamentary approval to extend Northern approaches to A. 13).

Lowest point below high water......100 ft.

Number of vehicles expected to use tunnel...... over 2,000,000 a year.

Internal diameter of main tunnel lining......... 28 ft 2 in.

(the deck will carry a two-lane roadway).

Flanges of lining segments.........14 ins. deep.

Total weight of cast iron for main tunnel lining.......................34,000 tons.

Number of bolts required for lining......260,000.

Weight of lead for caulking lining......160 tons.

Diameter of pilot tunnel completed in 1938...... ....12 feet.

Capacity of compressors for maintaining pressure during work.......... ....42,000 cu. ft. per minute (total installed capacity including standby plant).

Weight of shields...........300 tons.

Pressure exerted by shield rams.........6,000 lbs. per sq. in.

(thrust equals 5,000 tons).

Capacity of ventilation plant......600,000 cu. ft. per minute.

Roads which will feed the tunnel

London—Roachester Road A. 2.

London—Trilbury Road A. 126.

Barking—Southend Road A. 13.

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

DEFINITIONS OF HIGHWAY ENGINEERING TERMS

REFERENCE MARK : A mark, signal, or object, distant from observation station. Also the angular direction of a mark from the observation station from which the relative directions of other marks, signals, or objects may be measured.

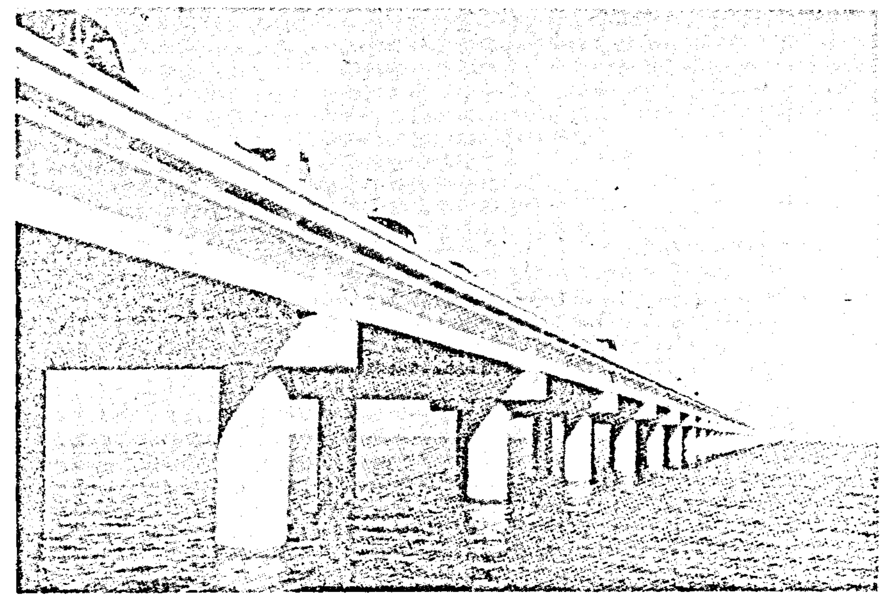
TURNING POINT : The intersection of any two consecutive straight survey lines forming part of a closed or open traverse.

PRESTRESSED CONCRETE IN WORLD'S LONGEST HIGHWAY BRIDGE

A 24-MILE-LONG highway bridge across Lake Pontechartrain has recently been completed and is claimed as one of the world's longest overwater bridges. In spite of the exceptional length of the bridge it has been completed in four months under the allotted time of 24 months, an engineering feat made possible by the use of reinforced and prestressed concrete units made at a giant casting yard adjacent to the site.

Essentially the bridge is composed of three pre-cast concrete units. Firstly, the pre-cast concrete piles which were stressed before driving, and secondly a reinforced concrete beam which capped pairs of piles and thirdly, the pre-cast concrete deck beams which were stressed before being placed in position.

The prestressed concrete cylinder piles are cylindrical in section with an outside diameter of 54 in. and a 4 in. wall thickness and on the average the pile length was 88 ft.

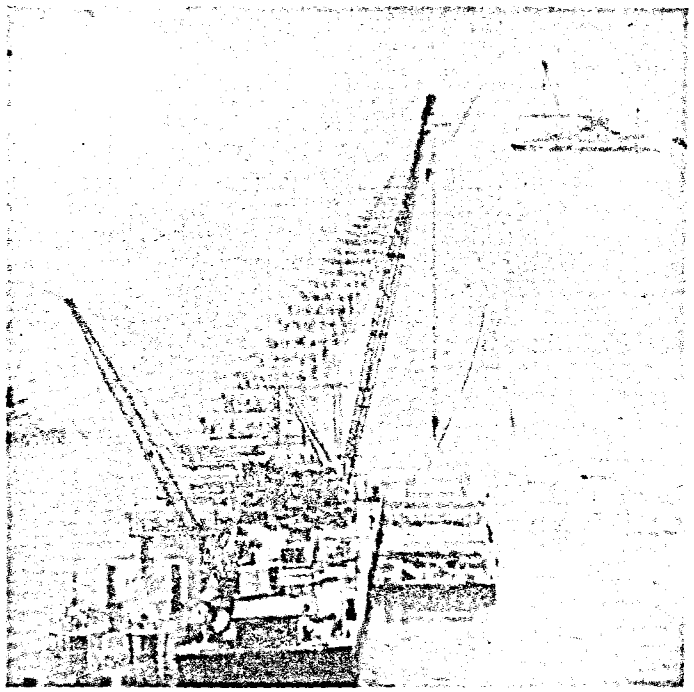


The completed bridge in Service

Economically the structure has been made possible because it shortens the length of highway to New Orleans by 29 miles, a saving worth the average toll of one dollar per passenger vehicle. By the levying of these tolls it is hoped soon to repay the bonds which have financed the construction of this 46 million dollar bridge.

To make possible the construction of a bridge of this length at all the structural units in it had to be capable of mass production and to this end both pre-casting and prestressing was employed.

The piles were centrifugally spun in steel forms, the concrete being specified to have a 28-day strength of 5,000 lbs per sq. in. To insert the stressing wires twelve holes were left in the wall of the cylinders which as cast had a length of 16 ft. Normal spiral reinforcement welded to longitudinal bars was also incorporated to allow the cylinders to resist handling stresses. To form a pile the 16 ft sections were joined end to end in the casting yard, a thermoplastic seal applied



Pile caps being placed on the already driven prestressed piles

at the joints, the wires inserted and stressed to 150,000 lbs per sq. in.

Core holes were then grouted up at an applied pressure of approximately a 100 lbs per sq. in.

Deck spans for the bridge were monolithic and were cast in specially constructed metal forms. Each unit had a width of 33 ft and a length of 56 ft. The width of 33 ft accommodated a 28 ft wide carriage-way, the remaining space on each side provided an anchorage for the aluminium guard rails and an emergency walkway.

When the deck slabs were cast enough steel forms were assembled in the casting yard to cast a total of 24 spans and then each span was cast in one non-stop pour. The stressing wires were then put in tension and the slab steam cured. On completion of this operation the tension on the wires was released and the ends cut free. Next operation was the lifting of one complete span unit, with a weight of 185 tons, by gantry crane after which they were placed on barges for towing to the site.

A considerable amount of high tensile steel wire and cable was used in the construction of the bridge, a total of 11,350 miles or 3,200 tons of 0.192 in. diameter stressing wire was employed and 4,150 miles or 3,500 tons of $\frac{3}{8}$ in. diameter wire was necessary for the completion of the deck spans.

One of the most important factors in the rapid completion of the bridge was the casting yard which was established near Mandeville at the north end of the bridge. Construction of the yard took only three months and in this short time 190,000 cu. yds. of dirt was dredged and a greater quantity of fill, 240,000 cu. yds. placed. To provide a foundation in the bad ground 8,300 wood piles were driven and 19,000 cu. yds. of concrete placed on them followed by 15,500 sq. yds. of concrete paving.

Whilst mass production was applied in the casting yard to provide the components at the required rate it was also necessary to erect the concrete sections at an equal speed. The

(Continued on page 36)

INDIAN NATIONAL GROUP OF THE INTERNATIONAL ASSOCIATION FOR BRIDGE AND STRUCTURAL ENGINEERING

THERE is an "International Association for Bridge and Structural Engineering" (with headquarters at Zurich, Switzerland). The object of the Association is to promote international co-operation among scientists, engineers and manufacturers, and to facilitate interchange of knowledge, particularly in regard to bridge and structural engineering. The Association has been doing very useful work by arranging discussions and publishing papers, promoting research, etc.

It was considered desirable to form a National Group of the Association in India so that practicing engineers in this country could derive maximum advantage of the facilities available through the activities of this Association. The formation of a National Group at the present time would be particularly useful in view of the vast field for the execution of numerous and extensive bridge and structural engineering projects which are planned in the national five year plans in the Central and State Government sectors and also in the private enterprise section.

The idea of organizing such a National Group was well received by the Engineering profession in India. The matter was also discussed by the Council of the Indian Roads Congress and by the Chief Engineers who favoured the idea of forming the Indian National Group of the IABSE.

Accordingly, a Committee consisting of representatives of the Government of India, Ministry of Transport & Communications, Railway Board, Engineer-in-Chief, Army Headquarters, C.W. & P.C., C.P.W.D., Business interests was constituted to draft the constitution of the Indian National Group of the IABSE. The constitution prepared by the committee was considered by the general body of persons interested in the Indian National Group at their meeting held on the 15th May 1957. A copy of the constitution adopted at that meeting is given below.

Membership is open to qualified individuals, Government Departments and organizations connected with or interested in Bridge and Structural Engineering. The details of the qualifications prescribed for Membership and Associate membership will be found in article 4 of the constitution. Those who are interested in the membership of the Indian National Group of the IABSE may kindly fill up the application form and send it to the Secretary, Indian Roads Congress, who is also the Secretary of the Indian National Group of the International Association for Bridge and Structural Engineering.

INDIAN NATIONAL GROUP OF THE INTERNATIONAL ASSOCIATION FOR BRIDGE AND STRUCTURAL ENGINEERING

CONSTITUTION

I. Name & Objects

Article 1. *Name.*

The name of the Society is the Indian National Group of the International Association for Bridge and Structural Engineering.

The short title shall be IABSE (ING).

Article 2. *Objects.*

The aim of the Society is to promote co-operation among scientists, engineers and manufacturers, and to foster the exchange of knowledge, ideas and results of research work in the sphere of bridge and structural engineering in general, whether it be in steel, reinforced concrete or any other material.

For this purpose, the Society may adopt necessary means e.g., publish or arrange to publish Papers or Periodicals. It may also accept subscriptions, subsidies, etc., grant pay, prizes and honoraria for the work done in furtherance of the objects of the Society; hold periodical meetings to discuss technical questions and to promote such other activities as may be incidental or conducive to the attainment of the objects of the Society.

II. Membership

Article 3. *Membership.*

There shall be two classes of members:

(a) Members, and

(b) Associate members.

Article 4. *Qualifications for Membership.*

(a) *Members.*

The minimum qualification for a Member shall be any one of the following:

(i) Corporate Membership of the Institution of Engineers (India).

(ii) The possession of a degree or diploma recognised by the Institution of Engineers (India) for exemption from the examination for Associate Membership;

(iii) Ordinary Membership of the Indian Roads Congress;

(iv) A Science Graduate carrying out research on any aspect which has or would have a bearing on Bridge and Structural Engineering.

(b) *Associate Members.*

Government Departments, Local Authorities, Scientific Institutions, Port Authorities, Firms and Technical Associations connected with or interested in Bridge & Structural Engineering will be eligible for Associate Membership.

Article 5.

Every Member and Associate Member of the National Group will remain a member of the International Association for Bridge and Structural Engineering as long as the member is on the rolls of the National Group.

Article 6.

Application for membership in the form annexed, and supported by one member of the National Group, will be addressed to the Secretary of the Group. The Executive Committee has the power to accept or reject any application.

III. Entrance Fee and Subscriptions

Article 7. *Entrance Fee.*

An entrance fee shall be payable by Members & Associate Members on election on the following scale:

Members ...	Rs 15/-
Associate Members.	Rs 300/-

Article 8.

Subscription for a Member and an associate member shall be Rs 15/- and Rs 100/- respectively per calendar year, payable before the 31st of January of the year to which it relates. Names of members who have not paid subscriptions till the 31st of December of the year to which they relate shall be removed from the rolls of the Group. For re-admission, a fee of Rs 15/- and Rs 300/- shall be charged from Members and Associate members respectively.

Life membership may be obtained by one initial payment of 20 times the annual subscription.

Membership of the Society can only be terminated at the end of a calendar year, at least 8 months

notice being given to the secretariat beforehand.

IV. Management

Article 9. *Managing Committee.*

The Management of the Society shall be in the hands of a Managing Committee consisting of the following Members and Associate Members of the Group:

a. A representative each of the Union Ministries of Transport & Communications, Defence, Iron & Steel, Railways and Natural Resources and Scientific Research.

b. A representative each of the Central P. W. D., Engineer-in-Chief, Army Headquarters, Central Water & Power Commission, Indian Standards Institution, Institution of Engineers (India), Indian Roads Congress, and the National Buildings Organization.

c. A representative each of State Public Works Departments.

d. A representative of non-Government Associate members.

e. Three representatives of Members.

f. Three representatives of Bridge & Structural Engineering Firms.

g. Three representatives of Technical Associations sponsored by connected industries.

h. Three representatives of Scientists connected with any aspect of research on Bridges & Structures.

i. One representative of Associates of Principles of Technical Institutes.

Article 10.

The meetings of the Society shall be held as and when considered necessary by the Executive Committee but at least one meeting shall be held every year.

Article 11.

The Managing Committee shall meet annually to elect a Chairman and Treasurer from amongst the Members and Associate members of the National Group, and 4 members of the Executive Committee from the members of the Managing Committee. They shall also receive the report of the Executive Committee at this Annual meeting.

Article 12.

The Secretary of the Indian Roads Congress shall act as the Secretary of the Society for the time being.

Article 13. *Executive Committee*

The day to day management of the Society shall be carried out by an Executive Committee consisting of the Chairman, the Treasurer, the Secretary and four members. The Executive Committee shall meet at least twice a year and the quorum shall be three.

Article 14.

The term of office of the Managing Committee, the Office Bearers and members of the Executive Committee shall generally be a year. But they will continue to hold office till the next election.

Article 15.

During the interval between two annual meetings, the Executive Committee shall have all the powers of the Society except to amend rules. All the decisions of the Executive Committee shall be placed before the Managing Committee.

Article 16.

Amendments to the rules shall be carried out only by a 75 per cent majority of the members present either at a meeting of the Managing Committee or by postal ballot. At least a month's notice shall be given for such a meeting. In case of a postal ballot, one month's time from the date of posting shall be given for the receipt of replies.

Article 17.

The quorum at the meetings of the National Group will be 15 and for the Managing Committee 25 per cent of the strength of the Committee.

V. General

Article 18.

The Managing Committee, as defined in article 9, shall determine the seat of the Society which, for the present, shall be at the same place as the office of the Indian Roads Congress.

Article 19.

In the last month of each calender year, the National Group will send to the International Association for Bridge & Structural Engineering at Zurich an up to date list of Members and Associate members with their addresses and professional affiliations. Any amendment to the constitution of the National Group shall also be sent to the Secretary of the International Association at Zurich.

Article 20.

Members or Associate members of of the Society may submit to the Secretary of the National Group each year before the end of June, statements of their activities, if any, in the field of bridge and structural engineering along with brief abstracts of their publications, if any, during the previous calender year. The scope of this statement is left to the discretion of each member.

Article 21.

The Managing Committee shall prepare a summary of all the statements received, with a view to give a comprehensive picture of the activities in bridge and structural engineering in India during the previous calendar year.

Article 22.

Before the 1st of October each year, the Chairman of the National Group shall send to the Secretary of the Executive Committee of the International Society, 100 copies of the Annual Report of the National Group ; one copy of the Report shall be forwarded at the same time to each Member and two copies to each Associate member.

Article 23.

A complete set of the International Report, whenever received from the International Society, shall be published by the National Group if it is in a language other than English. One copy of the Report will be sent to each Member and two copies to each Associate Member.

Arrangements for the translation of Papers published by the Association at Zurich written in languages other than English will be made by the National Group.

INDIAN NATIONAL GROUP OF THE INTERNATIONAL ASSOCIATION FOR BRIDGE AND STRUCTURAL ENGINEERING

Application for membership

The undersigned*
The undersigned public authority*
association*
firm*
organization*
desires to join the National Group of the International Association for Bridge and Structural Engineering as Member/Associate member and declares his* its* agreement with the statutes of Association.

†We shall be represented by ____________________

Place...Date.................................

Name and Designation..

Profession...

Address...

Signature

*Cross out the words not applicable.
†Applicable to Associate members.

Particulars

Date of birth...

Academic qualifications...

Brief details of professional career with dates ....

Research experience and Papers, if any ....

Membership of other Scientific or Technical Institutions ....

Interests - steel work or reinforced concrete, etc. ....

Special requirements ....

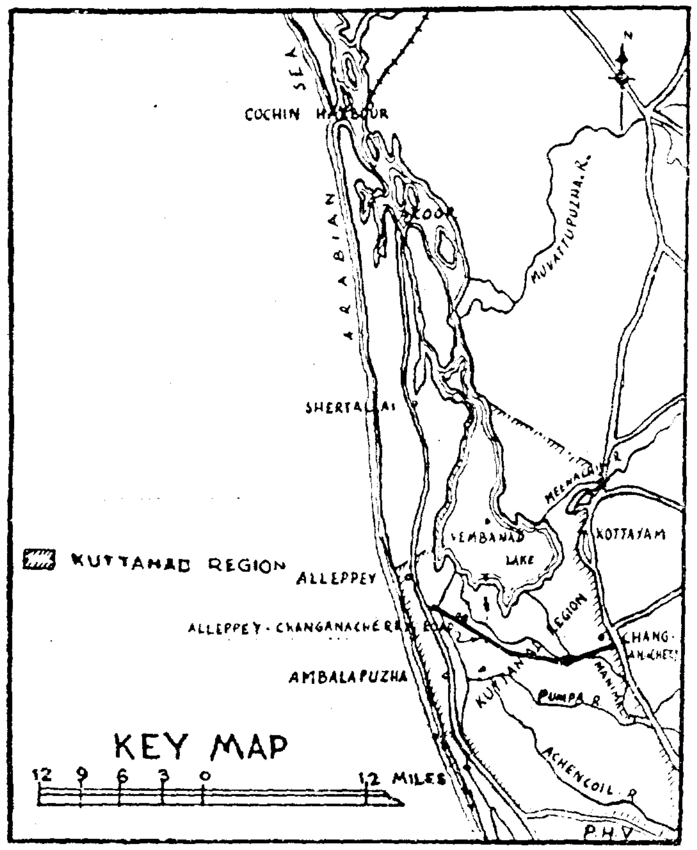
From my personal knowledge of the applicant and in consideration of his qualifications as stated above, I recommend him as being in every respect a fit and proper person to be admitted to the National Group. } Applicable in case of Members only.

Signature of Supporting member. (Roll No.)

SOME EXPERIENCES IN THE CONSTRUCTION OF R. C. C. BRIDGES IN THE PEATY CLAYEY SOIL OF KUTTANAD IN KERALA STATE

By
P. H. VAIDYANATHAN*

KUTTANAD is a region comprising about 400 sq. miles of mostly flat water-logged area of recent geological origin. Three of the main rivers of the State namely Manimala, Pampa and Achencoil flowing through this territory join the Vembanad lake at its southern tip (see *key map*). The normal ground surface here is about 2 to 6 ft below mean sea level. The soil is clayey except at the western fringes where it is sandy. Even though the top surface contains a large percentage of silt, the soil below is soft impervious clay. Several borings done over the area for deep bore-wells indicate uniformity in regard to stratification and the soil for about 300 to 400 ft in depth alternates between clays of various grades admixtured with sand, decayed timber, and other vegetable matter in layers. Thus excavation for foundations is very difficult under water. The tested load bearing capacity of soil is only 0.2 to 0.25 ton per sq. ft.



* Executive Engineer, Kuttanad Development Scheme, Alleppey, Kerala State.

Under the first Five Year Plan of the State when the development of the Kuttanad area was taken up, the construction of a road link between Alleppey on the western side and Changanacherry on the eastern side, a distance of about $14\frac{1}{2}$ miles, was started at an estimated cost of Rs 35,90,800. This road passes right through the heart of Kuttanad and has to cross several canals with average widths ranging from 25 to 70 ft. Kuttanad being water-logged the only means of communication that existed hitherto is water transport and a large number of interlinking criss-cross canals have been made along the boundaries of paddy fields. Fourteen such canals have to be crossed in addition to 3 major river crossings of widths varying from 300 to 700 ft along this road. The road when completed is intended to be a provincial highway and, as such, bridges have been designed for I. R. C. class 'A' loading. The canals and river courses having served as the principal means of communication and on account of low bearing pressure of soil, no heavy structure such as bridges had so far been attempted or constructed in the locality. The few bridges that have already been constructed are all in timber and are meant only for pedestrian traffic. The difficulties that were encountered during the planning and execution of bridges along this road are briefly dealt with below. The road work was taken up in 1951 and completed in 1956.

BRIDGES AND THEIR DESIGNS

Twelve bridges have been constructed. These are indicated in the tabular statement, page 23. The construction of the road was commenced from the Changanacherry end for a length of $7\frac{5}{8}$ miles i.e., up to Konnankara in the first instance. The remaining length of the road was taken up nearly 2 years after the completion of the above portion.

Details of Foundations

Except at the two canal crossings, one at the Alleppey end and the other at the Changanacherry end, the foundation soil in all the canals was clay reducing in stiffness from top layers down to about 35 to 40 ft below. This naturally indicated the adoption of a design which would reduce the load coming on the foundations to a minimum and, as far as possible, avoid side thrusts being brought to bear on the foundations. As in the case of all bridge structures, the general principle that the proportionate cost of the foundations should not be more than 50 per cent of the total cost of the bridge was adopted in these cases also. Under the conditions experienced in this region there was no possibility of taking the foundations to any unyielding stratum at an economic depth. Pile foundation with reliance on skin friction demands 80 to 90 ft of penetration in the type of clayey soil encountered. It was, therefore, decided that the foundations for the bridges of 30 ft to 75 ft spans should be on wells sunk up to about 30 ft below bed level, the load being essentially calculated to be borne on the bearing area of the wells by sealing the bottom with concrete. The skin friction that might be developed on the sides of the wells was not taken into account in determining the safe load on the structure.

Details of Substructure & Superstructure

It was proposed to construct double cantilever type bridges for the four main crossings at Chantha Thodu, Puthen Thodu, Mampazhakari Thodu, and Konnankara Thodu with well foundations for the piers. Each of the 3 wells adopted as foundation of the pier is of 10 ft outside dia. with $2\frac{1}{2}$ ft thick rubble masonry steining reinforced with 8 Nos. 7/8 in. dia. rods placed vertically at about 2 ft centre to centre and with intermediate cement concrete rings 6 in. thick, acting as breaking courses (Fig. 1).

The construction of the bridge across Chantha Thodu was started first, this being the first important canal crossing from Changanacherry end. This bridge is intended to pass regular passenger boat traffic under it. The decking has a clear head room of about 10 ft above M. F. L. viz., plus 105 (plus 100 being assumed as M.S.L.). The central line of the canal at this site is at an angle of 45 degree with the central line of the road i.e., the skew angle of the bridge is 45 degree.

The wells were sunk to an average depth of 30 ft below bed level. During sinking of the wells, fine sand for a depth of about 3 ft was found at about 12 ft below bed level. For the next 6 ft the sand became coarser so that at about 28 ft below bed level, very coarse sand mixed with small boulders was obtained. Hence it was decided to stop the wells at this stage. Since heavy springs were encountered, plugging the bottom of the wells in dry condition was not possible. A colcrete machine was, therefore, used to inject cement grout 1 : 2 proportion into a layer of granite metal of sizes 3 in. to 6 in. well packed for a thickness of about 5 ft average inside the well, the water level remaining the same both inside and outside. All the 6 wells for the two piers were similarly plugged. The wells were then filled up with sand. Two layers of 1 : 3 : 6 cement concrete plugs, one at about the middle of the well another at the top of thickness of 1 ft and 2 ft respectively were provided to act as braking courses. The well cap was moulded on top as usual for all the wells together.

Before casting the well cap, one of the wells was test loaded to 120 tons i. e., about 50 per cent more than the design load. Test loading was done by means of sand bags placed over the wells and allowing the static load to remain for 14 days. No settlement was noticed, indicating thereby that the sand foundation was quite reliable and unyielding. No further tests were conducted on the other wells as it was considered unnecessary in view of uniformity of nature of soil obtained.

SUBSIDENCE OF APPROACH EMBANKMENT AND REMEDIAL MEASURES

The superstructure was also completed in due course as per design without encountering any undue difficulties. But when the approach embankment was being formed, unexpected difficulties began to crop up. The design contemplated the approach embankment to remain stable independently, without affecting the bridge proper, as shown in Fig. 1. However, as the work was nearing completion there was an unexpected breach of the coffer dams due to floods and in the sweep of the flood-flow erosion took place in the incomplete portion of the toe of the embankment and there was subsidence of the rubble pitching which tended to load heavily on the outside of the two masonry piers. As the floods subsided, examination showed that the two piers had suffered damage, apparently due to the collapse of the embankment pitching on to the piers and the consequent side thrust exerted on them. Hair line cracks over the entire length of the pier at about 6 ft above the well cap were seen to have developed. As a result of this damage, it was decided that the design originally adopted for the approach embankment should be revised in such a way that the loads transmitted from the earth fill should directly reach the foundation instead of causing, even remotely, any side-thrust on the piers.

A dry rubble retaining wall design as shown in Fig. 2 to retain the earth fill of the approach embankment was therefore adopted to meet the situation. It took almost a year for the completion of the work as per revised design, when once again the coffer dams breached before the completion of the bed protection below the bridge due to heavy floods. Heavy scours occurred and a portion of the retaining wall tumbled down. The cracks originally developed on the piers once again opened up further and remained in that condition. After the floods had subsided the matter was again examined in detail. The distance between the centre line of the piers at top, at the middle and at bed level was measured and it was found that there had been a certain movement of the wells towards each other reducing the span to the extent of $2\frac{1}{2}$ in. On analysis of this phenomenon it was clear that it was a case of the retaining walls with their approach earth exerting a lateral thrust on the wells and thereby forcing them to move closer to each other and the foundation medium in which these wells were founded had developed only very little passive pressure to resist this movement. This was indeed very surprising and least expected. Owing to the continuity of the foundation material with the intervening gap of 2 ft between the wells, any side thrust exerted by the embankment structures should have been dissipated or transmitted without affecting the wells which are founded deeper. Actually, the wells had rotated in the vertical plane to a slight extent with their base as centre. Due to the partial fixity of the top of the piers with the deck beams, and the partial fixity of the bottom of the wells which were founded

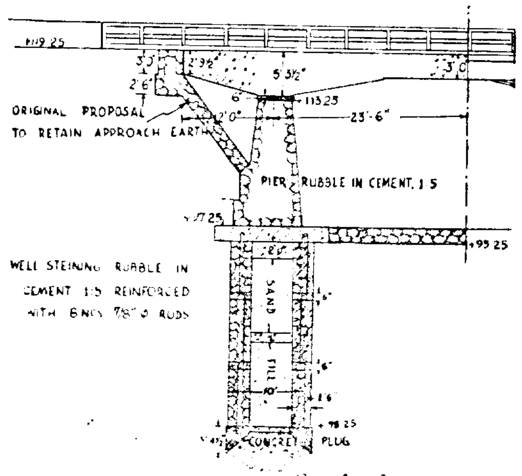


Fig. 1

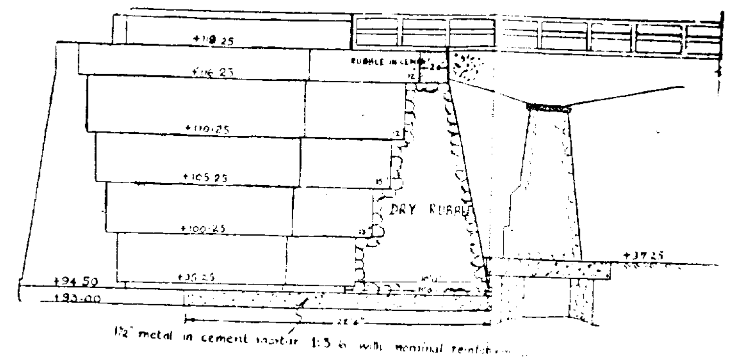


Fig. 2

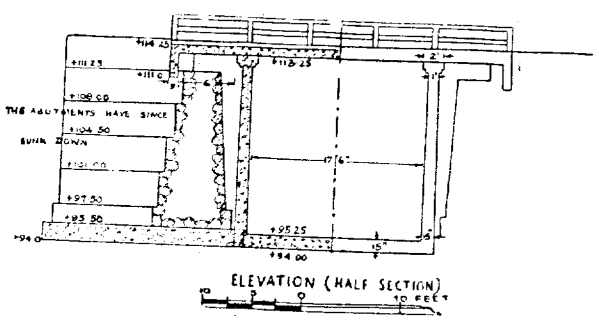
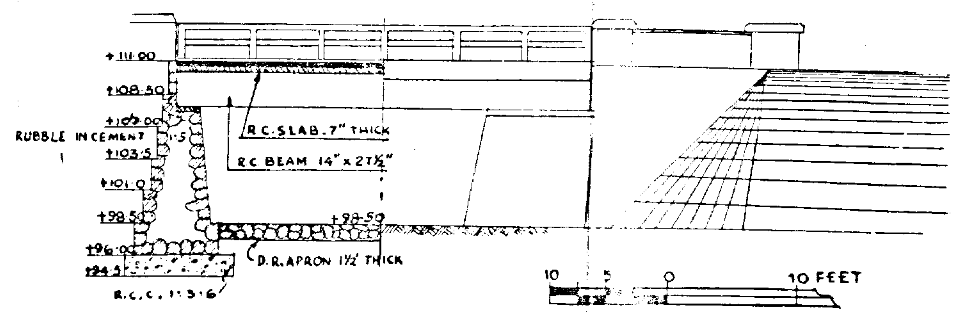
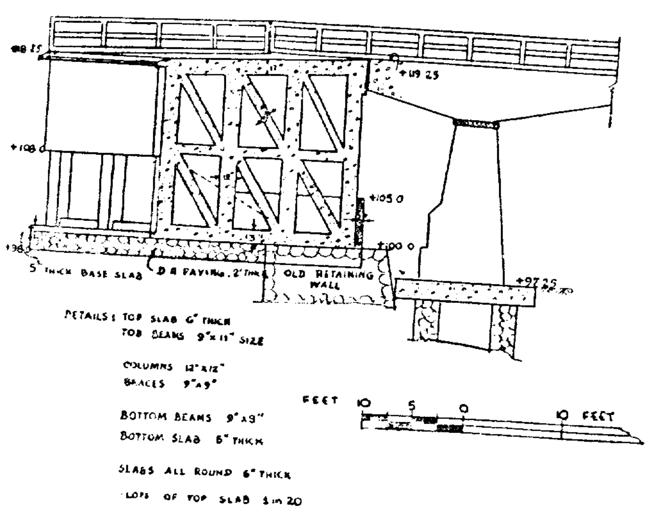


Fig. 3



BRIDGE ACROSS RAMANKARY THODU

Fig. 4



BRIDGE ACROSS PUNNAKUNNAT

Fig. 5

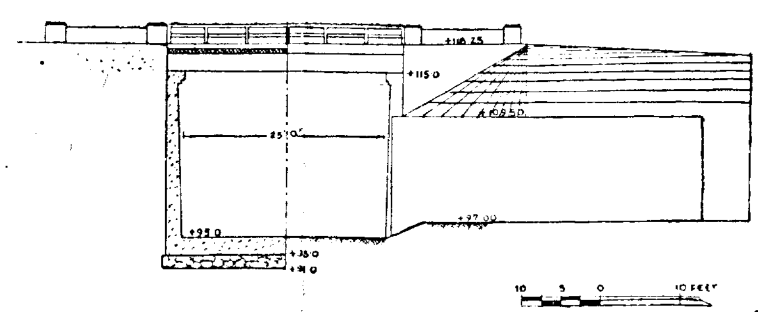


Fig. 6

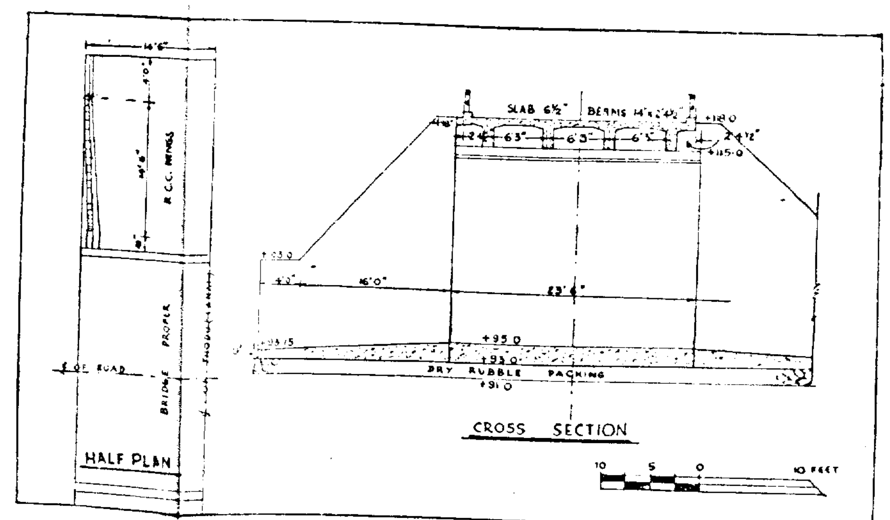


Fig. 7

on sand for some depth, as mentioned earlier, the pier masonry yielded to tension developed on the inside face, due to the bodily movement of its base resting over the wells.

This is how the phenomenon could be finally explained.

A second alternative design for retaining the approach earthwork was, therefore, made. This design eliminated all possibility of transmitting the embankment stresses on to the wells. The design consisted of a series of RCC vertical columns 12 in. x 12 in. standing over a sort of raft foundation with slab and beams over it. The approach earth was retained against the structure as shown in fig. 3. The whole structure rested over a 2 ft thick dry rubble paving. In order to avoid any possible slippage occuring between the base slab and the dry rubble paving, the structure was filled up to a certain height with earth, thereby increasing the dead weight of the structure. The pressure developed at the bottom of the structure was not more than that which existed at the place by natural earth cover previously. By such a design any tendency for movement by rotation of the wells would be eliminated.

With the experience gained from the bridge construction at Chantha Thodu, it was decided to have RCC piers instead of masonry ones, for the remaining 3 bridges of this type. But unlike the Chantha Thodu bridge, the soil encountered at the 3 other bridge sites was clay for the full depth to which the wells were sunk. The peculiarity of the clay was that while sinking the wells it required addition of water from outside to soften the thick clay to facilitate scooping it out for lowering the steining on RCC well curbs. But when once the surface was exposed and work-men trampled over the material, it became so soft that it was a treacherously poor foundation. It was, therefore, decided that the plugging of the well should be done at such a position where the clay immediately below the kerb was not disturbed appreciably. The wells having been sunk to about 25 ft to 30 ft in depth had about 3 to 4 ft of slushy clay above the kerb level. No attempt was made to remove it, because any such removal would have lowered the wells further and made the foundation unsatisfactory. Random rubble in sizes $1\frac{1}{2}$ to 2 cu. ft. was dumped inside with sand admixture and thoroughly packed and rammed to form a dry surface and the plugging was done for about 3 to 4 ft thickness over the rubble surface with cement concrete 1 : 3 : 6. In order to provide sufficient grip with the steining masonry, $\frac{3}{4}$ in. to 1 in. dia. rods were inserted in the well steining and embeded in the plug concrete, thereby avoiding any possibility of the plug slipping up later on.

Having completed 3 such wells for a pier, the well cap was cast in RCC 2 ft thick, made monolithic with the wells after filling the hollow space with dry sand. The foundation having thus been made ready, a test load of 50 per cent in excess of the design load was applied on the well caps with sand bags and the day to day settlement was observed and recorded. Details regarding the amount of load applied and the total settlement observed on the various bridges are given in the tabulated statement, page 23.

As anticipated some initial sinkage occured soon after loads were applied, but after nearly $1\frac{1}{2}$ months with the load in the static condition, the sinkage noted was trifling and the test loads were therefore removed. There had been no unequal settlement due to the loading as verified from the levels of the well cap and hence further work of the superstructure was proceeded with. The bridges have since been completed and observations of settlement are being continued which indicate only a very slow rate of time settlement.

Box Type Design

For all the remaining minor bridges i.e., of spans up to 30 ft it was decided to adopt the beam and slab type of design as shown in fig. 4. Accordingly, the bridge across Ramankary Thodu was constructed and completed according to this design. The foundation soil here was sand mixed with clay and no appreciable settlement was observed. But in the case of the Punnakunnathusserry bridge of the same design, owing to the loose dry foundation soil, a raft foundation of 30 ft x 20 ft R. C. C. slab below the abutments was adopted to reduce the pressure on the foundation and thus the sinkage. But when the abutments were constructed over it, up to a height of 16 ft, it showed signs of settlement. Hence test loading was done over the abutments with 45 tons each. As a result of this test loading the western abutment sank by about 3¼ ft and the eastern one by about 2¼ ft. Moreover both the abutments tilted towards the canal side falling out of plumb. Because of the settlement and tilting of the abutments it was thought inadvisable to proceed with the work further and hence fresh design had to be made. An R. C. C. box type design as shown in fig. 5 was adopted so as to reduce the load/sq. ft. on the foundation soil to the minimum possible and the bridge has since been completed according to this design. This design was found to be successful in reducing the sinkage.

Having encountered such unexpected difficulties in the first 8 miles of the road from Changanacherry end, it was decided that in the extension of the road beyond and up to Alleppey, a design should be adopted which would not require taking the foundation deeper than 5 ft from the bed level. A raft foundation was the only answer to this. In this design the load coming on to the foundation soil was so fixed that it would not be stressed to anything beyond the load it already sustained before execution. This should naturally limit the extent of unfavourable sinkage. A box type design more or less as adopted at Punnakunnathuserry was decided upon as shown in fig. 6 for the bridges of this portion of the road.

Five canals had to be crossed along the remaining length of the road and it was decided to have 25 ft clear span R.C.C. box type bridges, as mentioned, at all the crossings. Here again the approach embankment required special treatment. It was originally proposed to have dry rubble toe walls and retaining walls for protecting the approach earth work. But while constructing one such wall to about 8 ft height at one of the bridge sites, it was noticed that the whole mass of dry rubble wall moved away into the canal portion. This apparently was due to the poor frictional resistance offered by the clay at the base of the dry rubble foundation. So two alternative designs were considered, one similar to the column structure adopted for the first 4 bridges in the earlier portion; and the other a half box type (as shown in fig. 7) R.C.C. structure both up stream and down stream of the main structure to act as wings, independent of the main bridge. Of these, the second design was adopted and work taken up accordingly and completed.

Observation of settlement do not show any unequal settlement. The settlement measured is also very little and is diminishing progressively with time.

Subsequently the construction of another parallel road about 5 to 6 miles south of this Alleppey-Changanacherry road has been taken up. This road also passes through waterlogged areas with more or less the same soil conditions. Bridges along this road have been designed to be of the box type construction with the wings monolithic with the abutments. One such bridge of a very small span has already been completed and is standing alright. Preparations for the constuction of other bridges are under way.

As already stated, the clayey soil became unworkable when mixed with water and trampled over, so dry rubble paving to a thickness of about 2 ft was provided under the foundation slab so as to give a working platform over which the concreting operation could be carried out. Pumping out of water had to be done in all the localities. Though the work was carried out even through the rainy season, it was not very difficult to keep the site free of water during the working hours, because the surrounding clay soil was impervious. The sites had of course to be protected with suitable ring bunds.

CONCLUSION

In the construction of bridges in the type of soil met with in Kuttanad, the main problem is in respect of stabilising the high embankments for providing navigational head room for the bridges. The methods adopted in the construction of R.C.C. box type bridges in the second half of the Alleppey-Changanacherry road viz., Konnankara to Alleppey, can be recommended for use in other similar conditions. By adopting a box type design, the main difficulty due to poor soil conditions viz., sinkage of heavy structures has been partially overcome. The sinkage noticed is only uniform and it is hoped that a state of equilibrium will be reached when there may not be any further sinkage. This has to be verified by more observations in due course.

Statement showing particulars of bridges and other details.

(wherever levels are noted +100.00 is reckoned as M. S. L.)

Name of Bridge	Type	Span	Foundation details	Piers	Skew angle of bridge	Test loading details
1. Bridge across Chanthathodu	Double cantilever type	Central span 47′ with 12′-6″ cantilever spans	Wells – 3 Nos. under each pier – 10′ outside dia. 2½′ thick rubble masonry steining—sunk to an average depth of 28′ below bed level.	Rubble masonry	45°	Northern well of eastern pier test loaded with 120 tons of sand bags—no sinkage observed.
2. do. Puthen thodu	do.	do.	do. do. but wells sunk to an average of 25′ below bed level.	Reinforced cement concrete	76°	Each well cap test loaded with 450 tons of sand bags. Sinkage observed were as follows: Eastern well cap — 1.75′ Western .. — 1.50′
3. do. Mampazhakari	do.	do.	do. do. well sunk to an average of 32′ (western wells) and 22′ (eastern wells) below bed level.	do.	60°	Western well cap test loaded with 450 tons of sand bags sinkage observed — 0.88′ Eastern wells test loaded individually as follows:— *Loading* *Well* *Sinkage* 144½ T. South 1.06′ 133½ T. Central 0.07′ 144½ T. North 1.07′
4. do. Ramankary thodu	Beam & slab type	25′ clear	...	...	80°	...
5. do. Punnakunnathusserrythodu	R. C. C. box type (Revised Design)	17′-6″ clear	...	...	Square bridge.	Each abutments test loaded with 457 tons. Eastern one sank by 2¼′ and western one by 3¼′.
6. do. Konnankara thodu	Double cantilever type	Central span 52′-0″ with 13′-0″ cantilever spans	Wells 3 Nos. under each pier sunk to an average of 27′-6″ below bed level.	R. C. C.	65°	Well caps test loaded each with 450 tons of sand bags sinkage observed western well cap — 2.12′ eastern ,, — 1.8′
7. do. Thuramughomthodu	R. C. C. box type	25′-0″	...	...	Square	...
8. do. Mathresherril	,,	,,	...	...	do.	...
9. do. Pongayil eastthodu	,,	,,	...	...	do.	...
10. do, Pongayil westthodu	,,	,,	...	...	71°	...
11. do. Bhoothapandam kayal	,,	,,	...	...	Square	...
12. do. Ambalapuzha canal	Beam & slab type	,,	...	...	do.	...

EXPERIMENTS ON PERMEABILITY OF SOILS*

EXPERIMENTS on the property of soil which permits moisture to pass through it is called permeability. The soils which do not allow the fluid to pass through it are called impervious. This property of soils plays an important part in beds of reservoirs, or in cases of mud roofs of houses where it is desirable that least quantity of moisture should penetrate through.

To get an idea of permeability, four different soils which are generally met with in the alluvial deposits of the Punjab were selected for the study, viz., sandy loam, silty loam, silty clay loam and loam, to determine their degree of permeability at different densities all the four soils mentioned above were compacted to increasing densities by changing the moisture of compaction.

The blocks thus obtained were fitted into cylinders and a six inch column of water was allowed to stand over them. The amount of water which percolated through was measured and recorded as permeability in cubic feet per sq. ft. area per foot depth of soil in 24 hours. The results showed that permeability decreases as the density increases. The effect of density is much more marked in silty clay loam and silty loam soils than in loam or sandy loam soils.

It was further seen that whatever be the density, none of the soils can be made impervious except silty clay loam of a density of 1.95 or above. The reasons for the impermeability of wet clayey soil are well established and need not be repeated here.

Since it is the clayey nature of the soil which has been responsible for the low permeability, it was considered worth while to find out the lowest plasticity index or, in other words, the lowest clay content which would make the compacted soil impervious to water. With this object in view the plasticity index of silty clay loam soil was brought down to 15, 13 and 11 by the addition of sand. When all the three soils thus prepared were compacted to 1.95 density it was observed that the soil with a plasticity index of 15 and a sand content of 28 per cent alone was impervious. It will, therefore, mean that a plasticity index of at least 15 is required to cut out permeability.

The results could have practical bearing in as much as a silty clay loam soil can be used successfully, wherever locally available, for cutting out seepage through beds of reservoirs, provided a dry bulk density of 1.95 or above can be attained.

But a silty clay loam soil, though it can be made impervious to water, will not be very successful in actual practice, on account of the fact that clayey soils get soft when wet and lose stability gradually by continued contact with free water. It, therefore, becomes essential that a soil before it can be successfully used as an impervious crust, besides being impervious, should also be resistant to softening action of water. It has been found that a small quantity of cement in a compacted cement soil mass adds considerably to the resistance of soil to softening action of water.

It has also been observed that it is not very convenient to attain a density of the order of 1.95. Therefore, permeability tests under a head of 6 in. of water were carried out by compacting soils to a density of above 1.8 with increasing percentages of cement. The results showed that the effect of cement is much more marked in case of silty clay loam, and silty loam soils than in the case of loam and sandy loam soils. The use of cement will, however, depend on consideration of costs.

Further experiments were carried out by painting the cement soil blocks with cold penetration bituminous material and finding out the permeability. For the tests, sandy loam soil having good permeability was selected and compacted to densities varying from 1.5 to 1.8. The finished surface was painted with cold penetration bituminous material primer

* (Extracted from a Report by Messrs S. R. Mehra and L. R. Chadda on Experimental work at the Building and Road Research Laboratory, Karnal PUNJAB.)

No. 2 at 20 lb per 100 sq. ft. It was observed that when these painted blocks were subjected to the permeability test, they were found to be totally impervious. Such treatment may be of use in lining small channels.

Selection of Soils for Roofs

Selection of a proper soil for mud roofs is an important factor in building construction.

With a view to determine a suitable specification of soils for covering first and second class mud roofs, the experiments on permeability were further continued with different types of soil commonly found in the Punjab.

As already pointed out permeability not only varies from soil to soil but also depends upon the density. Silty or silty clay loam soils with P. I. greater than 10.0 show fairly high resistance to flow of water and may, therefore, be considered more suitable for covering mud roofs. But, the use of silty clay loam soils with P. I. greater than 12.5 on account of high shrinkage as well as involving higher cost of digging and pulverisation may not prove very successful and also economical in field practice.

So, for finalising suitable specifications of soils to be recommended for roofing purposes, the study of behaviour of each type of soil under field conditions was considered highly essential.

In the semifield trials, all the five soils selected for the study were compacted individually on 4 ft × 4 ft roof sections constructed with 2 in. tiles laid in 1 : 4 cement : sand mortar on wooden battens and covered with ¾ in. 1:4 cement : sand plaster. The earth was rammed to 1.4 to 1.6 density in 5 in. thick layer and finished with a gobri leep after drying (no mud plaster).

In the beginning these experimental roofs were put under 1 in. deep water continuously for 72 hours and later on subjected to 50 Nos alternate wetting and drying cycles. Each weathering cycle consisted of 12 hours wetting under 1 in. deep water at night and then 12 hours drying in the sun. The results obtained with each type of soil under weathering cycles are summarised below:

Soil No. 1 (Sandy loam)—The roof was compacted to 1.6 density using optimum moisture (12 per cent) and later on finished with a gobri leeping. On drying it was kept under 1 in. deep water but it started leaking after 4 hours. Lower densities were not tried.

Soil No. 2 (loam)—Experimental roof prepared with this soil compacted to 1.6 density at 12 per cent moisture also started leaking at many points after 5 hours remaining under 1 in. deep water. Due to early leakage it was not subjected to weathering cycles.

Soil No. 3 (Silty loam)—Experimental roof was compacted with this soil to 1.6 density at 11 per cent moisture and finished with a gobri leep and then subjected to weathering tests. This roof, besides standing under water for 72 hours, withstood the effect of 50 Nos wetting and drying cycles without showing any leakage.

The same soil was tried for 1.43 density and subjected to similar weathering tests. Although no leakage took place, but the surface was found to be soft after the end of 50 cycles.

Soil No. 4 (Silty loam)—Experimental roofs prepared with this soil using 12 per cent moisture and compacted to 1.6, 1.5, 1.4 density respectively also gave quite satisfactory results.

With this soil too, roofs besides remaining under water for 72 hours continously, withstood the effect of 50 wetting and drying cycles without showing any leakage. However, with 1.4 density the surface of the roof was found to be soft at few points at the end of 50 wetting and drying cycles.

Soil No. 5 (Silty clay loam)— Experimental roofs prepared with this soil at 1.6 density using 13 per cent moisture for compaction and finished with a gobri leep started leaking at a number of points after remaining under water for 18 hours. With 1.4 density, similar results were obtained.

Conclusion

It is clearly indicated in the above study that silty loam soils with P. I. 10–12.5 and sand content 10 to 20 per cent are quite suitable for covering mud roofs when rammed within a range of 1.4 to 1.6 density, which is easily attainable by the ordinary methods of compaction in use for such work.

HERE AND THERE

1. THOMAS H. MACDONALD

QUIETLY, as he had lived, Thomas H. Macdonald died in Texas, Sunday, April 7, 1957.

Born in July 23, 1881, Leadville, Colo., he graduated from Iowa State College, B.C.E. in 1904.

Became State Highway Engineer, Iowa, (1907-1919) and rose to be Chief and later Commissioner, U. S. Bureau of Public Roads (1919-1953).

Career

Sponsored organization Highway and Highway Transport Education Committee later the Highway Research Board—1920.

Sponsored organization Advisory Board on Highway Research, 1920. This organization later became the present Highway Research Board.

Chairman, Joint Board of Interstate Highways, 1924. Sponsored organization Pan American Highway Congress, 1924.

Participated in organization of tours of Latin engineers, journalists and engineers to United States throughout the 1930s.

Sponsored membership by United States in Permanent Association of International Road Congresses, 1926.

Sponsored meeting of that body in United States in 1930 when representatives of all countries met in Washington, later toured the United States.

Served as chairman and member of official U.S. delegations to meetings of Permanent Association in Italy and Germany prior to World War II.

Served in same capacity on official delegations to South and Central America.

Sponsored creation of official U. S. Inter-regional Highway Commission, 1941.

Served as member official commission on Alaska Highway. Later was charged with responsibility of building that road.

Accompanied members of Congress on official delegations as member in Central American surveys of Inter-American Highway problems.

Throughout his term of office, served as member of Executive Committee, American Association of State Highway Officials and took active part in all of its deliberations on part of the federal government.

Directed participation of the Bureau of Public Roads in expenditure of Federal funds in aiding governments of Philippines, Turkey, Ethiopia, Liberia.

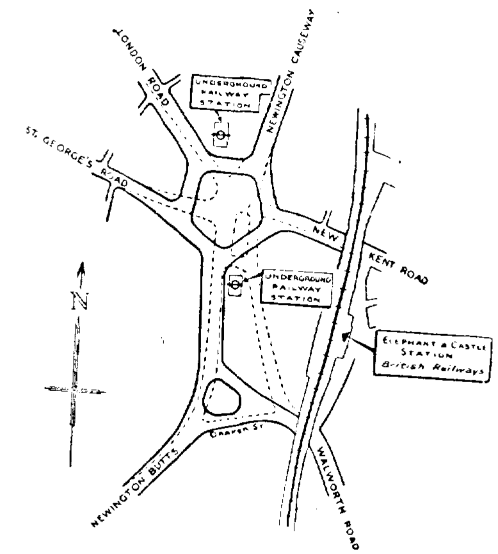
Sponsored first President's Highway Safety Conference 1945.

(From : "*American Highways, April, 1957*").

[*Along with Major General Fleming, Thomas Macdonald visited the Roads Wing of the Ministry of Transport in 1946. His death is a loss not only to his country but to the whole world—Ed.*]

2. ELEPHANT AND CASTLE ROAD SYSTEM IMPROVEMENT

THE MINISTER of Transport and Civil Aviation, has made a grant to the London County Council towards the cost of improving the complex road system at the Elephant and Castle. Road work is expected to start on the scheme shortly. The grant amounts to 401,250



pounds and represents 75 per cent of the estimated cost of 535,000 pounds for the first stage. A further grant will be made later towards the second stage of the scheme, which is estimated to cost 955,000 pounds and which it is hoped will follow immediately on the completion of the first stage.

The first stage of the scheme is the diversion of Walworth Road into a new triangular roundabout at the junction of Draper Street and Newington Butts, with pedestrian subways under each of the approach roads. The second stage is the construction of a five-sided roundabout at the main Elephant and Castle intersection, with pedestrian subways under each of the approach roads. Newington Butts will be widened to provide two carriage-ways, each 40 ft wide linking the two round-abouts.

The intersection at the Elephant and Castle of six important roads, where traffic converges from seven of the Thames bridges, makes it one of the busiest and most vital traffic centres in London. Nearly 40,000 vehicles use it each day. The existing Junction is controlled by police traffic signals.

(*From "The Surveyor, and Municipal and County Engineer", June 22, 1957.*)

3. ROAD PLANS OF GERMANY

AT present the road network in Federal Germany is as follows:

	miles
Motorways	1,360
Federal roads	15,310
Main provincial roads	33,375
Secondary roads	30,810
Non-classified roads	75,000

Motorways

Under the long-term road construction and improvement plan to be undertaken by the Government it is proposed to build a further 1,244 miles of motorways: 376 miles will be built in the first phase, 396 miles in the second phase and 472 in the third.

In 1956, 81 miles of motorways were built out of the 376 miles envisaged for the first phase.

Federal roads

Out of a total length of 15,310 miles, 5,037 miles of the Federal roads carry heavy traffic and are planned for improvement. In particular roads through nearly 700 German towns totalling some 310 miles need rebuilding and work to bring them up to the standard laid down is needed also on some 1,970 miles of by-passes. New Federal roads covering some 655 miles are to be built.

Motor Vehicle Increases

On an average the number of motor vehicles has during recent years doubled every four years and it is estimated that by 1967 there will be 7 million privately owned motor vehicles, and the total number of vehicles on the roads will reach some 10 million.

Road Revenues

In Western Germany for the fiscal year 1953-54 road revenues totalled 2,590 million marks (220 million pounds). Road expenditure in the same period amounted to 1,796 million marks (153 million pounds).

(From "British Road Federation Bulletin", June 1957.)

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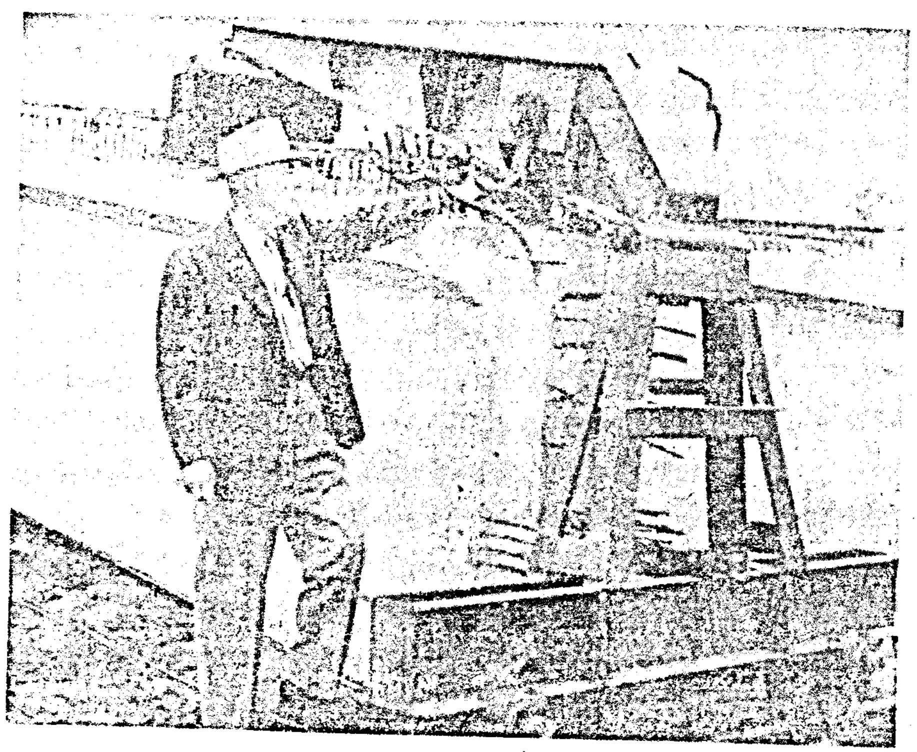
4. LEVER ON RAILS LIFTS 71-TON BEAMS

A PRESTRESSED concrete fabricator has developed a novel method for lifting and moving heavy beams from the casting bed to a storage site without cranes. He uses a lever set on rails and a small jack supported on the beam to be lifted.

Precast Concrete, Inc., Lakeland, Fla., was to produce 34 beams, each 100 ft long and 11 ft high. The 71 ton weight of the beams was beyond the capacity of the yard crane to handle, and to rent two mobile cranes would be too expensive.

The casting schedule called for one beam to be produced each day and four beams to be released and moved from the bed to storage the same day.

To solve the lifting and moving problem, Roy N. Hill of Lakeland Engineering Associates, Inc., designed a hoist consisting of a lever on wheels activated



by a small jack placed on top of the beam to be lifted and under the end of the level. The fulcrum of the lever is atop an A—frame that rolls on a rail. Threaded clevises pinned to the lever a short distance away from its fulcrum are attached to lifting bolts cast vertically into each end of the beam.

As the jack opens, it raises the lever. Because of the mechanical advantage due to the application of the jacking force at a much greater distance from the fulcrum than the lifting force, the beam is raised, even though the jack bears on the beam.

The A-Frame at each beam end, after the beam is lifted, is pulled to the storage area.

(From "Engineering News Record," May 16, 1957).

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5. WIRE IN PRESTRESSED CONCRETE

ONE of the projects in the metallurgy department of the National Physical Laboratory, Teddington, Middlesex, has been the study of the effect of fire on hard drawn steel wires in prestressed concrete beams. Under servere heat the wires deform plastically and loss of prestress occurs, leading to collapse. At failure the surface of the beam may exceed 1,000 degree Centigrade, although the wire may only reach 400 degree Centigrade. It has been confirmed by tests that this temperature is reached within 2 to 4 hours of the commencement of the fire. It is also found that considerable losses in strength occur by the time the wire temperature reaches 150 degree Centigrade. From the results of the research it would appear desirable that the undersides of prestressed concrete beams should be thermally insulated, and that some method of reloading the wires should be developed.

(From "Engineering", June 7, 1957).

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6. CANADIAN SUPERROAD PLANNED

A six-lane modern expressway is to be constructed cutting through Canada's capital city of Ottawa. This highway to be known as the Queensway is estimated to cost 31 million dollars and will be fully access controlled.

Financing is to be shared by the Canadian Federal Government (Federal District Commission and Trans-Canada Highway) together with the Province of Ontario and the city.

The expressway will comprise 10 miles within the city and 22.8 miles extending outside. The central portion will be six lanes and the remainder four lanes, divided. A total of 34 under passes and over passes will be required.

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

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construction. The subject has been dealt with under the following sub-headings: in so far as the policy of the Highways Department has been, is being and may be affected in the future.

(a) Soil testing to provide pavement designs for new roads, and to check on the amount by which the existing pavement may be deficient in thickness.

(b) Soil testing to assist in the design of bridge and building foundations, landslides and drainage problems.

(c) The production of suitable specifications and their amendment in order to ensure that competitive tenders may be obtained from suppliers.

(d) Design of concrete mixes and routine control of the concrete produced.

(e) Routine checks that the delivered materials comply with the relevant specifications. Where this is not the case, a course of action is suggested to the Assistant County Surveyor responsible.

(f) Keeping abreast of the latest work of the Road Research Laboratory and other research department in order to maintain continually the highest level of design and control efficiency.

(g) Introducing specifications for new materials when it is considered desirable.

(h) Assisting manufacturers to comply with specifications, generally by the amendment of their plant, when so requested by them.

(i) Correlation between specifications and road performance.

THE VIBRATION OF SIMPLE SPAN HIGHWAY BRIDGES, John M. Biggs. Herbert S. Suer and Jacobus M. Louw—Journal of the Structural Division—Proceedings of the American Society of Civil Engineers (Proc. Paper 1186.)

The purpose of the investigation reported herein is to develop an analytical method by which the magnitude and character of highway bridge vibration due to the passage of heavy vehicles can be predicted. A method of analysis based upon certain simplifying assumptions is presented. The accuracy of the method and the validity of the assumptions are investigated by comparison with laboratory tests on model bridges. Tests of actual structures are used to prove the applicability of the method to field conditions. These tests also serve to indicate the field conditions which should be assumed for design purposes. Theoretical results obtained by both analog and digital computers are presented to show the effects of the various parameters involved. Finally, the problem is reduced to its simplest form and charts are provided which can be used to predict maximum dynamic deflections. The investigation is limited to simple-span girder and stringer bridges loaded by single two-axle vehicles.

TOLL HIGHWAYS: THEIR ECONOMICS AND CONSTRUCTION, Horace D. Morgan, Vernon F. Bartlett, Hubert S. Smith and Edward W. Richards—Proceedings, Institution of Civil Engineers (Great George St., Westminster, London, S.W.1), Vol. 5, Pt. 3, No. 3, pp. 575-624, December 1956.

THE purpose of this Paper is to demonstrate the possibility of building some of the badly needed long-span road bridges and tunnels in Great Britain as financially self-liquidating projects. The methods of forecasting the diverted and generated traffic to be anticipated on a new crossing are described, and a typical example is given in detail showing how a long-span highway bridge could be financed without resort to public funds, and would pay for itself in a short term of years by means of tolls charged on traffic using it. Thereafter it could be freed. Particulars of the operation and excellent financial position of the Mersey tunnel are described.

Numerous examples are also given of toll bridges and tunnels in America and elsewhere, and particulars of some badly needed facilities, such as the proposed Severn, Forth, and Humber bridges, and the Tyne and Darford tunnels in Great Britain.

The road section of the Paper describes the principles on which the systems of toll roads must be established to be successful, the constitution of the

(Continued on page 36)

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4. **Physical Incompatibility of Matrix and Aggregate in Concrete**; G. M. Smith, *Journal of the American Concrete Institute, Volume 27, No. 7*, March 1956, pp. 791-798.

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6. **The Oxton By-pass Extension**; R. A. Kidd, *Road Paper No. 50, Proceedings of the Institution of Civil Engineers, Part II, Volume 5*, June 1956, No. 2, pp. 200-240.

7. **Non-destructive Methods for Testing Concrete**; R. Jones, *Contractors Record and Public Works Review, Volume 8, No. 2*, June 1956, pp. 44-49.

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13. **The Riding Quality of Machine-finished Concrete Roads in Denmark and Netherlands**; G. B. Taylor, *The Surveyor. Volume CXV, No. 3363*, October 6, 1956, pp. 774-776.

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(*Continued from page 32*)

turnpike authority, and its investigations into traffic engineering and revenue, the relation of the full-road system and the turnpikes, and the basis of both in a national highway program. An account is given of some of the major American turnpikes, with an analysis of their uses and sources of revenue.

(*Continued from page 10*)

piles were barged out into the Lake handled and driven by two large barge-mounted cranes. Some difficulty was experienced in driving these piles and considerable jetting was required to sink them through the dense sandy-clay bottom of Lake Pontechartrain. With the piles driven in pairs a reinforced concrete pile-cap weighing 20 tons and also pre-cast in the casting yard was hoisted into place and secured in position by cast-in-place concrete. Next the deck span was barged out and hoisted into position by a derrick-boat. Completion of the bridge was made by adding the aluminium guard rails and the lighting system.

In the bridge are 240,000 cu. yds. of concrete in the decking and pile bents, 18,000 tons of reinforcing steel and 3,000 tons of structural steel work.

Now in operation the bridge will carry a total of 1,300,000 vehicles of all classes in the first year and produce a revenue of 1.9 million dollars. In the twentieth year this is expected to reach 3 millon dollars.

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

CHARACTER

Among the certitudes which I have acquired during a half-century of construction and research, there is one which is abundantly certain, it is that virtues of character-courage, probity and love for the task accepted—are infinitely more necessary to the engineer than those of intelligence, which is never more than a tool in the hands of a moral being.

E. Freyssinet

THE DOCTOR'S CAR

"*The doctor's car had a flat tyre,*" *said the garage mechanic.* "*I 've put it right.*"

"*Call it flatulency of the perimeter,*" *said the manager,* "*and charge him three guineas.*"

UNWISE

"*The driver of today is driving the car of tomorrow on the roads of yesterday.*"

BUDGETS AND ADMINISTRATION REPORTS

MADHYA PRADESH STATE BUDGET FOR 1957-58

The following extracts relating to Civil Works have been taken from the Madhya Pradesh Budget for the year 1957-58.

Revenue (Civil Works)

Heads	In lakhs of rupees	
	Revised* Estimate 1956-57	Budget Estimate 1957-58
Rents	6.85	12.93
Ferry receipts	1.96	5.16
Tolls on Roads	.34	.81
Receipts of works shop	.48	1.70
Recoveries of expenditure	.15	.34
Contribution from the Government of India for development of State Roads of economic and Inter-State importance	12.00	20.00
Other items	2.36	8.25
Deduct-Refunds	-.08	-0.18
Total	24.06	49.01

Expenditure (Civil Works)

Original Works		
Buildings	33.77	60.37
Communications	23.88	41.66
Miscellaneous	0.34	1.50
Repairs	115.50	223.26
Grant-in-aid	0.58	1.44
Suspense	5.48	19.10
Reserve (Through the agency of Local Bodies)	—	15.00
Repairs	0.91	2.20
Deduct—Transfer from C.R.F.	-11.95	-30.69
Development Schemes		
Original Works		
Buildings	—	15.36
Communications (Roads)	—	27.36
Establishment	—	1.39
Tools and Plant	—	3.09
Total	168.51	381.04

* The revised estimate is based on preliminary account figures for five months (for the period from 1st November 1956 to 31st March 1957).

(Continued)

Capital outlay on Civil Works outside the Revenue Account

Heads	(In lakhs of rupees) Revised Estimate 1956-57	Budget Estimate 1957-58
Original Works		
Buildings	164.49	395.75
Communications	100.23	—
Miscellaneous	0.37	4.80
Grand-in-aid	18.35	15.75
Deduct-recoveries	-2.39	-17.49
Development schemes		
I. **Works executed by P.W.D.**		
Original Works		
Buildings	--	188.08
Communications	—	207.72
II. **Works through the Agency of Department**		
Original Works		
Buildings	—	6.53
Communications	—	8.27
Miscellaneous	—	6.85
Establishment	—	23.03
Tools and Plant	—	33.66
Grants-in-aid	—	1.50
Total	281.05	874.45
Revenue from roads		
Receipts under the Indian Motor Vehicles Act	4.04	7.00
Receipt under the State Motor Vehicles Taxation Act	27.14	82.00
Other Receipts	0.16	0.47
Deduct-Refunds	-0.13	-0.30
Total	31.21	89.17

GOVERNMENT OF MADHYA PRADESH 1957-58

THE total revenue for the year 1957-58 is estimated at Rs 5088.54 lakhs and expenditure charged to revenue at Rs 5436.94 lakhs resulting in a deficit of Rs 348.40 lakhs. Revised estimates for 1956-57 (for the period from 1st Nov. 1956 to 31st March 1957) indicated a deficit of Rs 243.37 lakhs. Revenue being Rs 1641.62 lakhs and expenditure Rs 1884.99 lakhs.

Revenue expenditure on Civil Works for 1957-58 is estimated at Rs 381.04 lakhs which is 7.5 per cent of the total state revenue.

The expenditure on capital account outside the revenue for the current year is Rs 874.45 lakhs. Communications and buildings form the main items of expenditure.

LIST OF APPROVED WORKS ON NATIONAL HIGHWAYS

S. No.	Job No.	Name of Work	Amount Rs lakhs
		ANDHRA	
1.	1767 AH 7	Constructing a diversion between miles 95/4 and 100/2 of Hyderabad Kurnool Road in Mahboobnagar District, National Highway No. 7	2.97
2.	1770 AH 7	Acquisition of land for extension of Hyderbad Nagpur Road (National Highway No. 7) at Bowaipali village in Andhra Pradesh.	0.05
3.	1773 AH 7	Construction of diversion from mile 100/7 to 126/1 on National Highway No. 7 in Raichur District.	16.99
4.	TA 89 AH 5	Construction of a bridge across Samalkote canal near Vemagiri at mile 7-8 of Rajahmundry Kalinada Road N. H. No. 5	2.78
		BIHAR	
5.	1769 BR 31	Purchase of machinery for the construction of Southern approach road to the rail-cum-road bridge at Mokameh on N. H. No. 31.	8.68
6.		Three works each costing less than two lakhs.	3.67
		BOMBAY	
7.	1775 BM 8	Land acquisition for the construction of National Highway No. 8 outside Nadiad town.	2.51
8.	TA 88 BM 4	Constructing the approaches to a Railway over-bridge in place of the existing railway level crossing in mile 82 of the Bombay-Poona Road, National Highway No. 4.	2.15
9.		Five works each costing less than two lakhs	2.72

S.No.	Job No.	Name of work	Amount Rs Lakhs
		DELHI	
10.		Two works each costing less than two lakhs.	0.33
		ORISSA	
11.	1761 RS 42	Reconstruction of bridge No. 121 at mile 149/3 of Cuttack-Sambalpur Road N. H. No. 42.	0.18
		PUNJAB	
12.	1772 PB 1	Providing additional waterway on G. T. Road (N. H. No. 1) in Ludhiana District—Construction of 5 ft span culverts in miles 194/0, 194/2 194/5, 195/2 and 195/5.	0.19

How India may use Photogrammetric and Electronic Data—Processing Devices by Olin W. Mintzer (Published in May 1957 issue of the Review.)

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(2) Special representatives of the International Business Machines Corporation and in particular to Mr. Rustin Blaylock.

(3) Staff of the computing Laboratory, Case Institute of Technology, and in particular to Mr. FrederickWay.

CORRECTION

In the August 1957 issue of T.C.M.R. on *page 4, line 2* from top in the article on Revision of Nagpur Plan read 'broad basis' for 'loan basis'.

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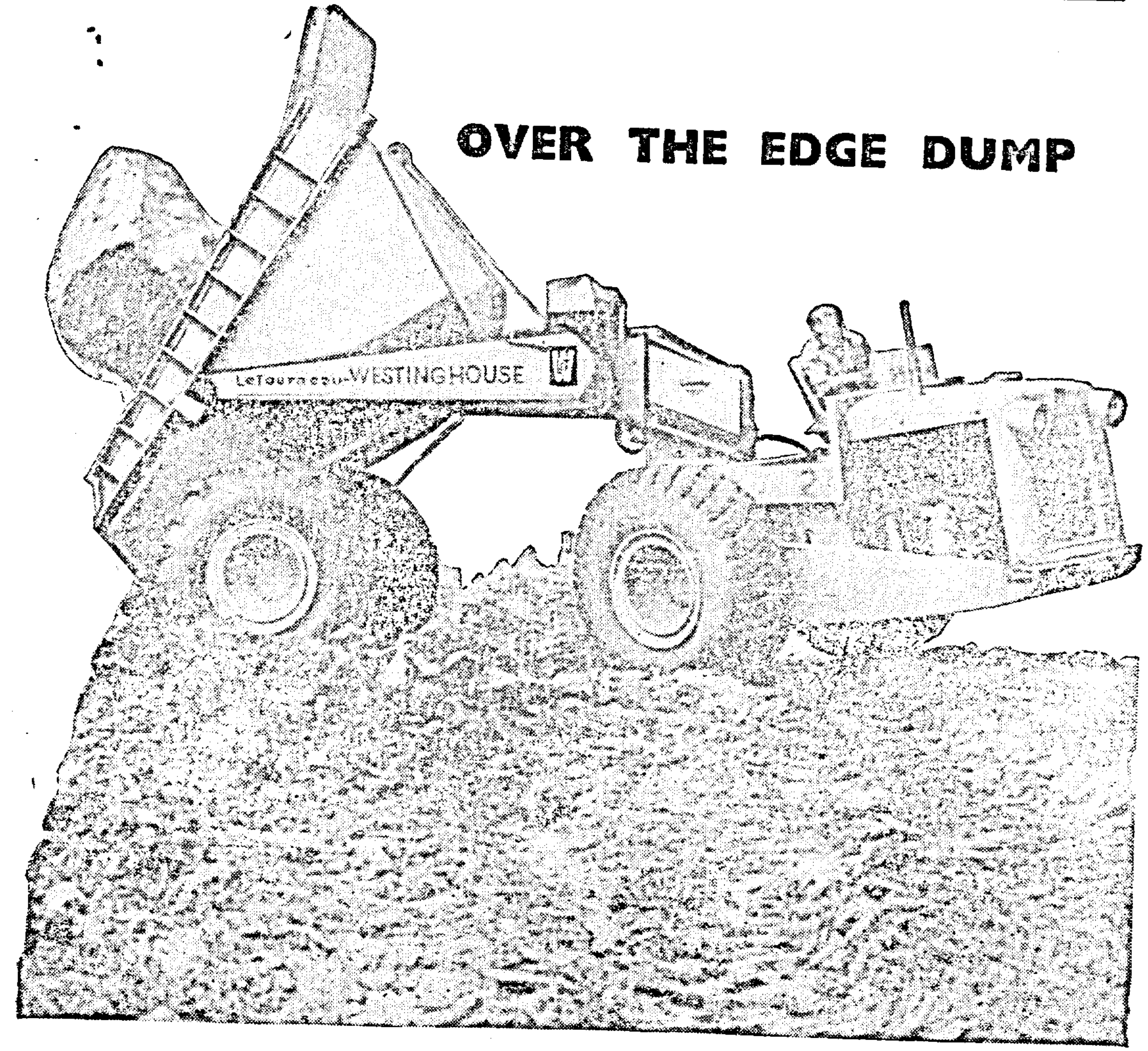

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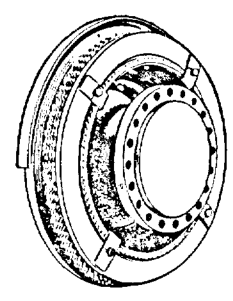

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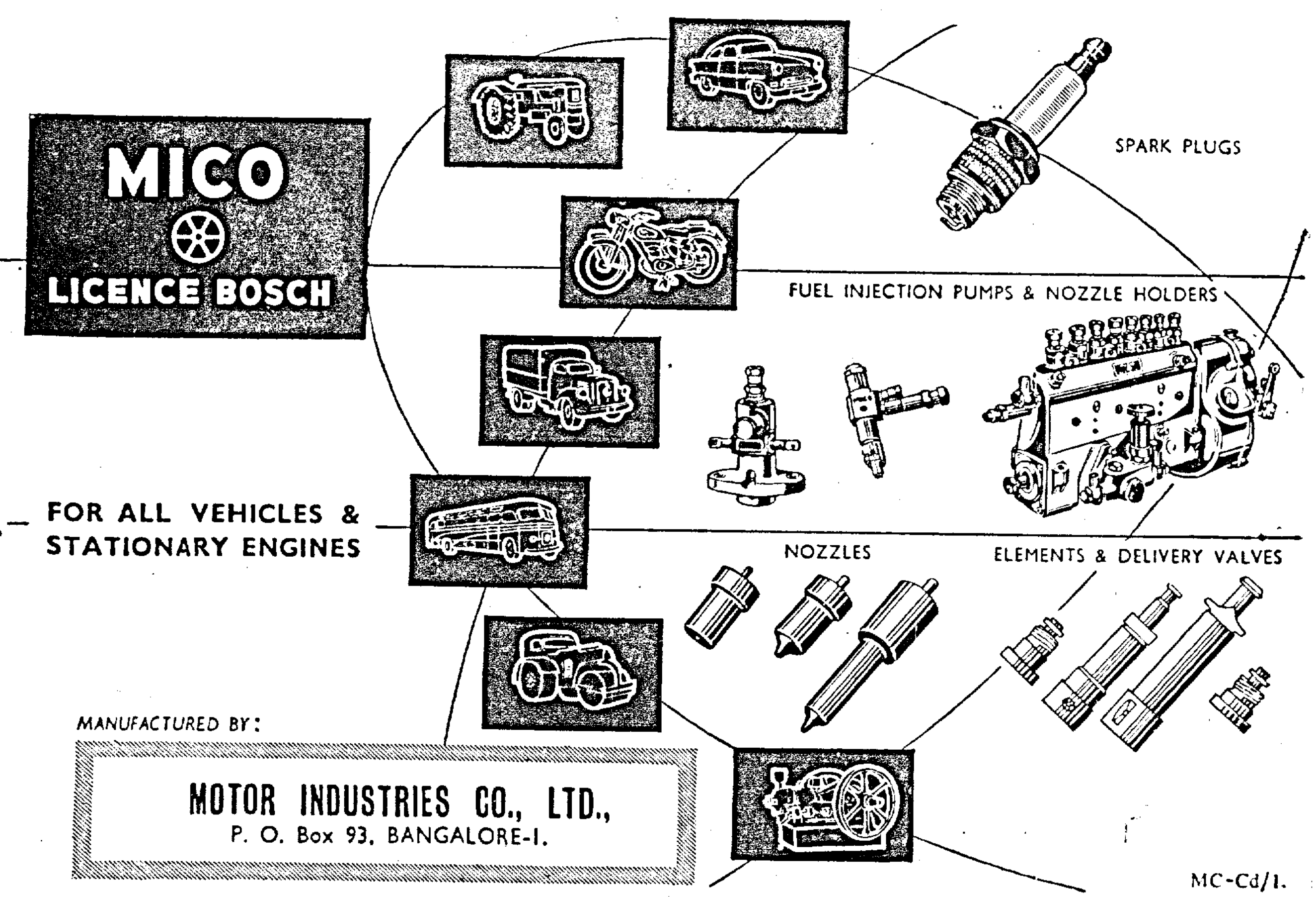
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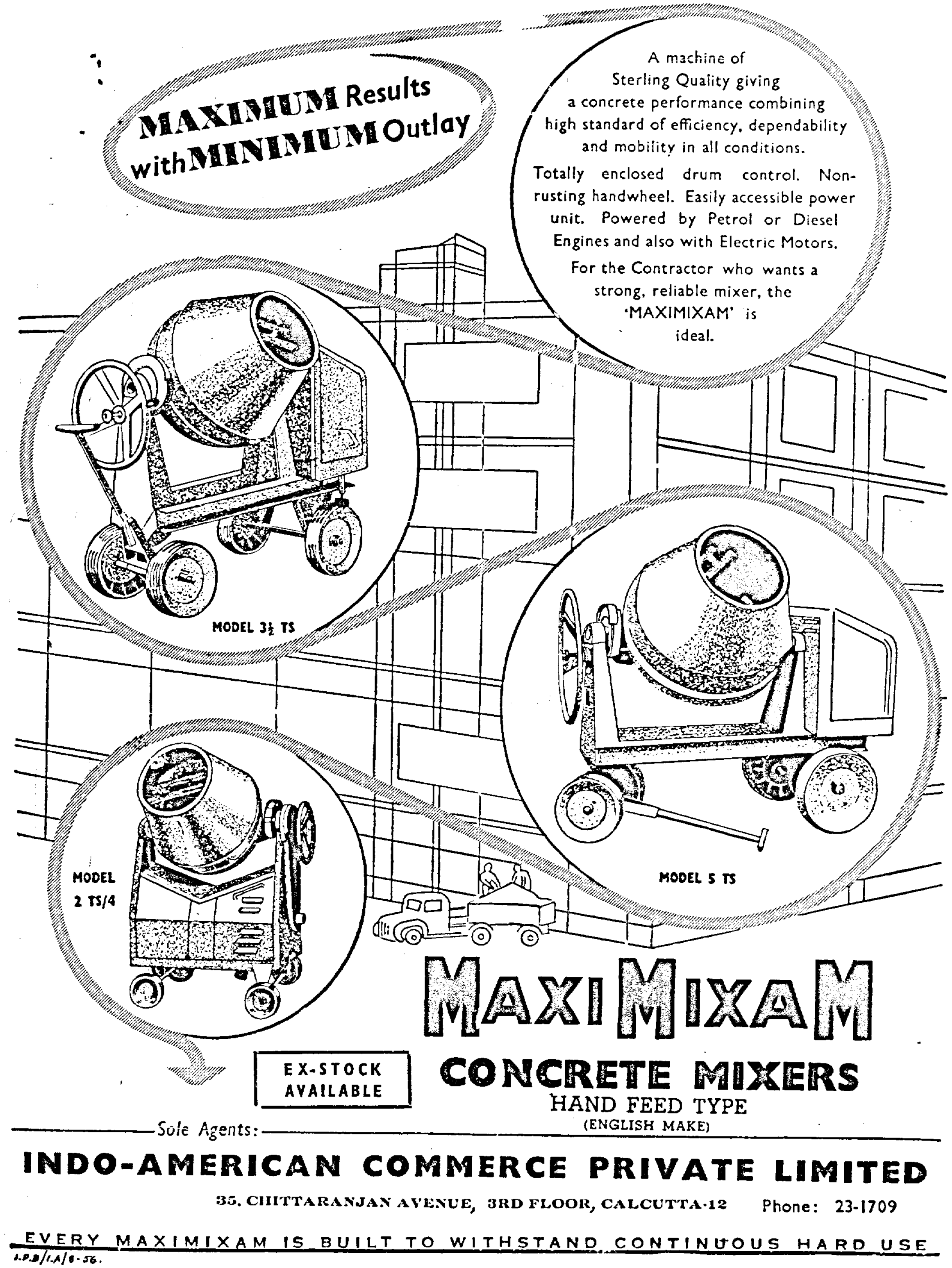
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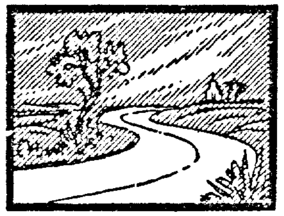

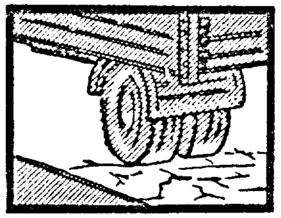

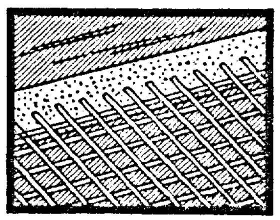

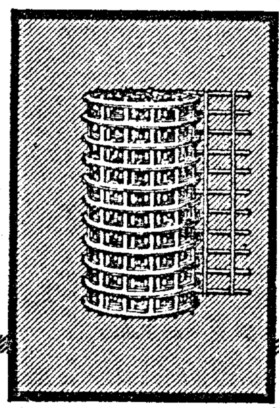

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