TRANSPORT-COMMUNICATIONS

MONTHLY REVIEW

DECEMBER 1956—No. 116

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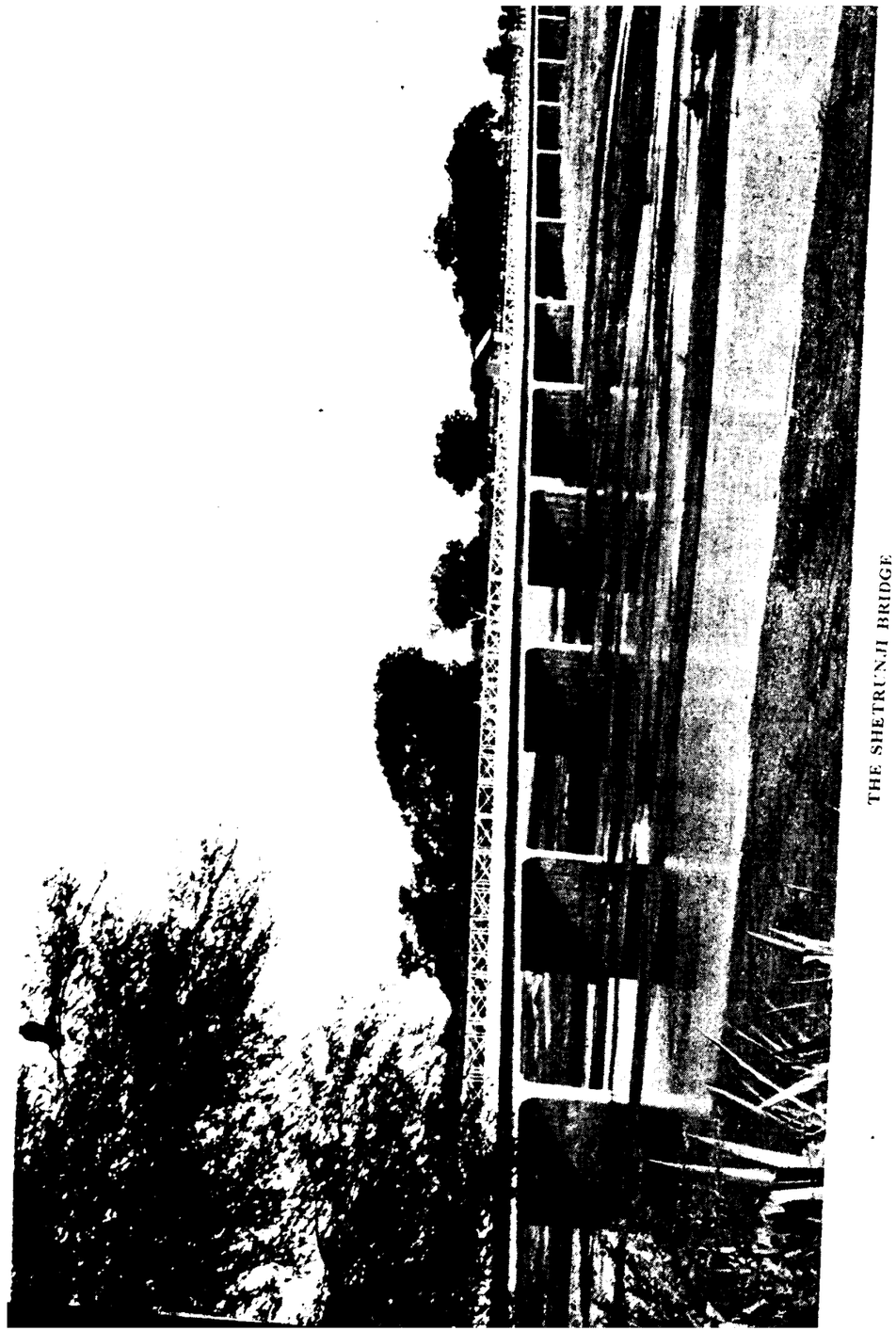


THE SHETRUNJI BRIDGE

TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

A REVIEW OF
ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

DECEMBER 1956

BRIDGING INDIA'S RIVERS

THE SHETRUNJI BRIDGE

THE Amreli-Kundla road connecting Amreli, a district headquarter and an important trade centre in the Bombay State, with Kundla, a business centre and Mahuva, a port on the southern coast of Kathiawar, is crossed by Shetrunji river in mile 5/4. Before the construction of the bridge, in the rainy season the road was closed to traffic for a number of days. Because of the importance of the link as a channel for trade provision for bridging the river was made in the first Five-Year Plan and the work completed in 1956. Fig. 1 is a key map showing the location of the bridge.

Hydraulic Data

The catchment area of the river at the site of the bridge is 800 sq. miles. The area is fan-shaped and the maximum discharge calculated by the Inglis' formula worked out to 2,70,000 cusecs. The maximum flood level for this discharge was 368.54. This maximum discharge was expected to occur once in four years. Therefore, to reduce the cost of construction, a submersible

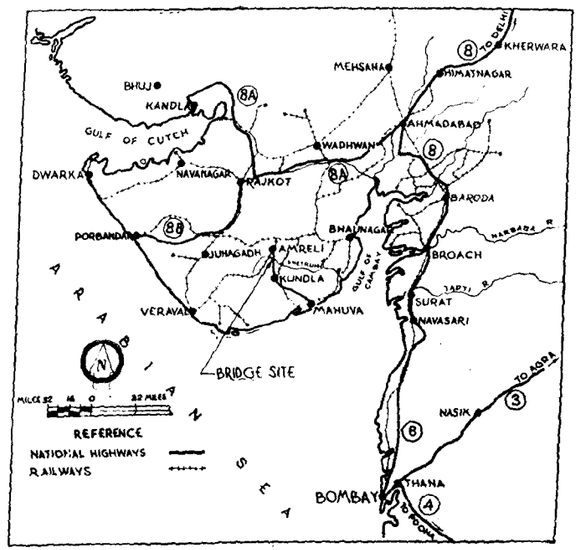


Fig. 1.

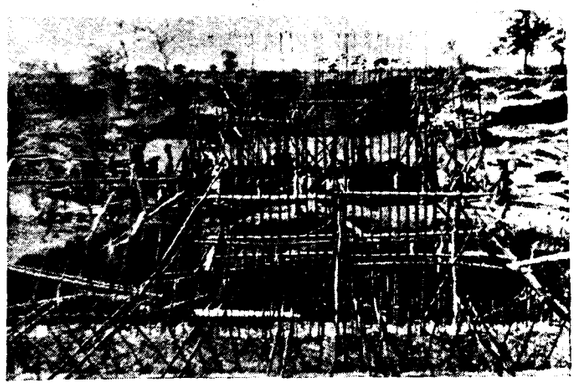


Photo 1.
Centering & Reinforcement of pier.

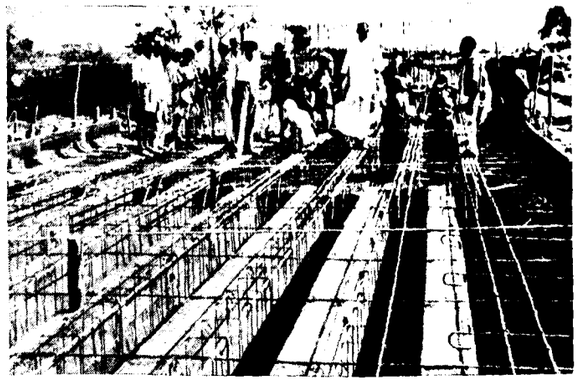


Photo 2.
Reinforcement for the Decking.

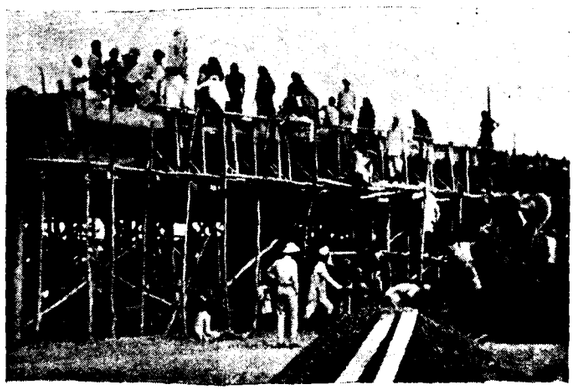
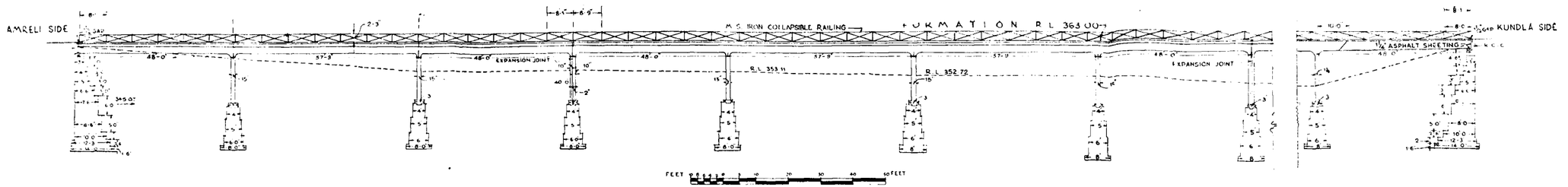
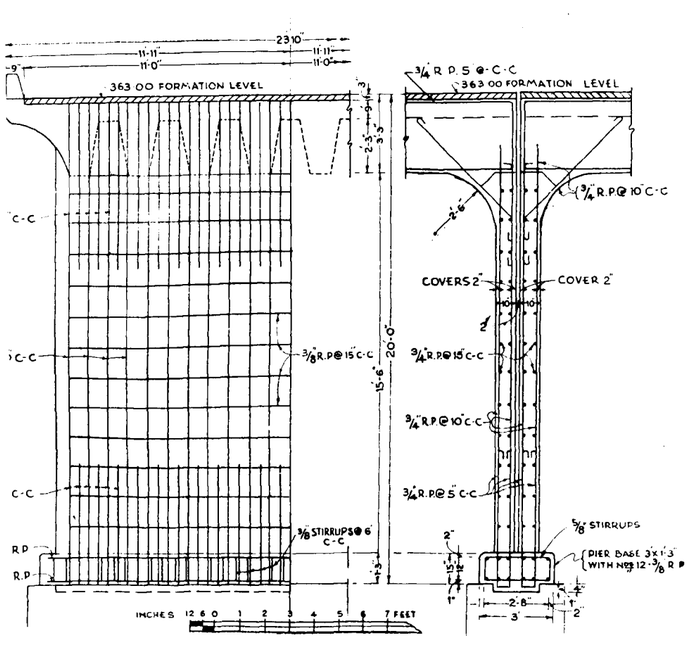


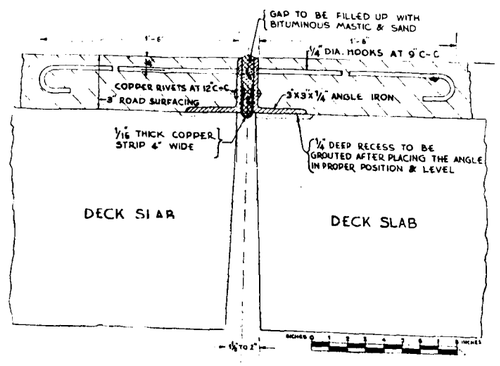
Photo 3.
Concreting the Deck.



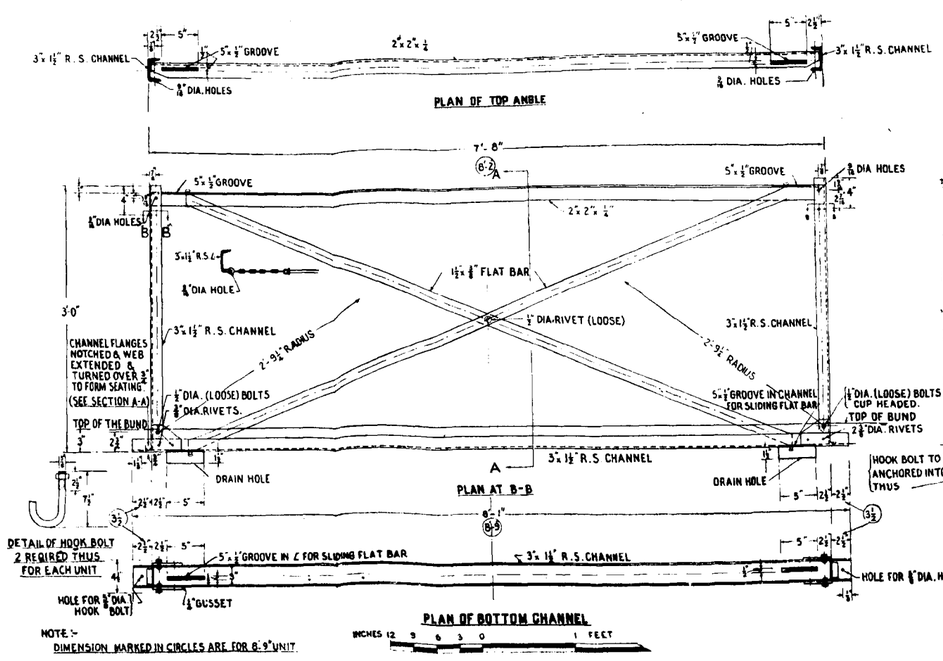
Longitudinal Section
Fig. 2.



Cross Section through Double Pier
Fig. 3.



Details of Expansion Joint
Fig. 4.



Details of Collapsible Railings
Fig. 5.

bridge with a road level at 363.00, i.e nearly 6 ft below the highest expected flood level, was considered suitable. With the road level at 363.00 it was expected that interruptions to traffic would be a few.

The site of the bridge was just upstream of the existing crossing.

Foundations

Good foundations were available at depths varying from 19 to 28 ft below the river bed and, therefore, open foundations were adopted. The foundations up to reduced level of 345.00 consisted of R.C.C. with a top width of 4 ft spread out to a width of 8 ft at the reduced level of 330.00.

Superstructure

The bridge, which is designed for I.R.C. Class A loading, consists of 14 spans and is of R.C.C. frame type. There are four units of frames, the two units at the centre have each four spans of 48 ft, 57 ft 9 in., 57 ft 9 in., and 48 ft. The end units have three spans each of 48 ft, 57 ft 9 in., 48 ft centre to centre of piers, Fig 2. Thus the total length of the bridge is 730 ft 6 inches. The frame consists of R.C.C. deck slab 3 ft thick and R.C.C. piers, Fig 3. To reduce dead weight, this slab had been troughed as shown in the cross-section, Fig 3. The slab was cast monolithic with the wall type R.C.C. piers which are 15 in. thick. The piers at the ends of each unit are 10 in. thick and an expansion gap of 2 in. is provided between the units, Fig. 3. Between the deck slab and the abutments, asphalt sheeting $1\frac{1}{4}$ in. thick was provided. The edges of the deck slab have been curved as shown in the cross section to minimise resistance to the flow of water.

The roadway over the bridge is 22 ft wide and a wearing surface of cement concrete 3 in. thick is provided for the roadway. The details of the expansion joint in the wearing coat are shown in Fig. 4. Collapsible mild steel railings, details in Fig. 5 are installed.

Costs

Total cost of the bridge is Rs 7,81,700 and the break-up is given below:

Pier foundations	...	Rs	2,35,000
Pier base and superstructure	...	Rs	71,500
End abutments	...	Rs	42,851
Deck slabs	...	Rs	2,92,200
Road surfacing and expansion joints including finishing of the surface	...	Rs	13,149
M. S. Collapsible railings	...	Rs	24,800
Approaches	...	Rs	44,300
Miscellaneous, such as shed, pitching, work-charged establishment, contingencies etc.	...	Rs	57,900
		Rs	7,81,700

The overall cost per running foot of bridge works out to about Rs. 1,070 and the cost per sq. ft of carriageway works out to about Rs 49.

DEFINITIONS OF HIGHWAY ENGINEERING TERMS

ROCKER BEARING: A bearing or a support which permits slight angular movement in the supported ends of a bridge superstructure.

ROLLER BEARING: A bearing assembly, consisting mainly of rollers with suitably designed top and bottom plates, which permits of slight longitudinal movements in the supported ends of a bridge superstructure.

THE NATIONAL HIGHWAYS BILL IN RAJYA SABHA*

The National Highways Bill discussed by the Lok Sabha and the Rajya Sabha was assented to by the President on 11-9-56 and is now on the Statute. The concluding portion of the discussions in the Rajya Sabha is given below.

Shri T. J. M. Wilson (Andhra) said that in view of the very useful role that road transport played in supplementing rail transport, the provision of Rs 55 crores in the second Five-Year Plan for the development of National Highways was small. Also, the target of 13,800 miles of National Highways for a country of the size of India was very inadequate. He believed that the Ministry of Transport was aware of the necessity to have a balanced and integrated system of road transport and would take more powers not only to maintain and develop National Highways but also to improve and build better and more balanced District and State roads.

There was a variety of rates for tolls obtaining in the different parts of the country and Shri Wilson hoped that the Union Government would take steps to systematise the basis of tolls. On roads where traffic was very heavy and mixed, i.e. when bullock carts and motor vehicles used the same road, there occured serious accidents. He, therefore, suggested that the Government might segregate the cart traffic.

National Highway No. 9, connecting Poona-Sholapur-Hyderabad- Vijayawada, should be extended to Masulipatam. It was a very important port, to which a large portion of goods from Andhra and Hyderabad found an outlet. The distance was only 40 miles.

Shri Maheswar Naik (Orissa) said that areas rich in minerals or those capable of being developed agriculturally remained under-developed because of lack of easy communications. Shri Naik brought to the notice of the House the bad condition of National Highway No. 6 in the Mayurbhanj district of Orissa, and said that in spite of the development that had taken place in the first Plan period, there were about 20 miles of this important highway which had not yet been constructed. Also, there were a number of unbridged rivers on the route. The Baripada-Balasur section of N. H. 5 was also in a state of disrepair. It was not easily negotiable during the rains. The four big rivers in Orissa crossing N. H. 5 were not yet bridged. Consideration should be given to making the existing railway bridges across these rivers as road-cum-rail bridges.

The area of the country enclosed by National Highways No. 2, 7, 6 and 33 was very extensive and rich in mineral resources. In order to develop the area, a National Highway starting near Sambalpur on N. H. 6 and connecting National Highways Nos. 7 and 2 in the north was necessary. The area was also not well served by rail communications.

Shri V. C. Keshwa Rao (Andhra) was of opinion that third class roads maintained by District Boards should be improved. Even though improvement of these roads did not come under the head National Highways, the Union Government might consider giving grants for their development.

In the Andhra State there were two parallel National Highways, one on the east coast, and the other on the western side. Travel from east to west was not possible unless by making a detour of 2 to 3 hundred miles by railway. Therefore, he suggested that the Government should consider declaring a highway connecting Kotapatnam, Kurnool, Belgaum, and Kolhapur as a National Highway. Such a highway connecting the three parallel National Highways would afford facilities for the Rayalaseema area. There was also the need to connect Nagarjunasagar with Hyderabad. Therefore, a highway connecting Hyderabad with Nagarajunasagar and N. H. 5, somewhere near Nellore, might also be considered for declaration as a National Highway.

Visakhapatnam was a sea resort and a sea port. But National Highway No. 5 was about 10 miles from the town. The roads round about the town, which are important from the tourist point of view, might be maintained from Central funds.

Trees which would yield some income to the Government should be planted on both sides of National Highways.

Shri Jaswant Singh (Rajasthan) said that Rajasthan had many places of historical importance and lack of proper facilities for travel acted as a deterrent to many foreign visitors seeing these. Therefore, in addition to the N. H. 8 connecting Bombay and Delhi via Rajasthan, a highway connecting Delhi, Jodhpur, Bikaner and Jaisalmere and along the Pakistan border was very necessary. This highway would serve not only the strategic needs of the country but also the area irrigated by the canals under the Bhakra Dam. The region was not served well by railways. Therefore, roads were the only means of moving the products in the irrigated area and crossing the desert for strategic purposes. Also, there were many dacoities taking place in the area and those who committed them easily escaped into Pakistan. Therefore, from the point of view of law and order also, such a highway was very necessary. The Rajasthan Government was doing the utmost they could for improving the roads in their territory. Shri Jaswant Singh urged that a highway connecting Delhi, Jodhpur, Bikaner and Jaisalmere up to Hanumangarh should be declared as a National Highway. It would be an asset not only to Rajasthan but to the country as a whole.

Shri Vijay Singh (Rajasthan) supported the suggestion, made by Shri Jaswant Singh, that a highway connecting Bikaner and Delhi should be declared as a National Highway. He referred to the suggestion of Dr. Barlingay that sections of roads should also be made fit for the purpose of emergency landing of aircrafts, and said that as far as Rajasthan was concerned, the suggestion was not acceptable as afforestation was very important to the area. He urged that wherever National Highways were constructed, afforestation should also be done.

Shri O. V. Alagesan, the Deputy Minister for Railways and Transport, replying to the debate, referred to the philosophy and principles of planning of the road system enunciated by Dr. Barlingay and said that the engineers who evolved the Nagpur Plan did take into consideration what Dr. Barlingay had suggested. The Star and Grid formula evolved by the Nagpur planners was the concrete form of the philosophy that he had enunciated. A 'star' represented various towns and cities from which roads radiated to market centres. But geometrically these stars could not be connected by cobwebs. Therefore, between the centres of population the road system took the shape of a 'grid'. It might be said that the stars are places of important towns along the National Highway system.

All the ideological planning referred to could be done only if a start were made with a clean slate. But the geography and the development that had already taken place had to be taken into consideration, and the present system of National Highways was selected after giving consideration to the principles enumerated as far as practicable. If we looked at the map of the United States of America, wherein their roads called Inter-State Highways which were analogous to the National Highways of India, were figured, the ideal geometric pattern was not there. That was because of the limitations placed by geography and other considerations.

A plea was made for drawing up a master plan. A special officer who would go thoroughly into the question of road development in one or two States was being appointed shortly, and a questionnaire had already been issued to the various States. This questionnaire was meant to collect ideas from the States. The data collected would be analysed and then a balanced plan would be drawn up. This plan was expected to be ready by the time the third Plan was to begin.

Many members had pleaded for the inclusion of more roads in the National Highway system. With the limited finance that had been allotted to National Highways in the second Five-Year Plan,

* Concluded from page 12 of November 1956 issue of T. C. M. R.

i.e. Rs 55 crores, it was not possible to add more milage to the system. However, by the end of second Plan period the entire National Highway system would be asphalted to a width of one lane carriageway. In addition, 2,000 miles of the National Highways would have two lane asphalted carriageways. Thirty bridges across rivers crossing the National Highway system had already been completed: 60 more would be completed and 55 would be in progress by the end of second Plan period. The Government was prepared to extend the National Highway system but that would have to wait for the third Plan.

Shri Bisht wanted a National Highway to pass through Himalayan region. The construction of mountain roads was not easy and required lot of funds. Sufficient aid had been given for the construction of the road to Badrinath and the work was in full swing. Taking into consideration the need of the Himalayan region, the road from Pathankot to Jammu and Srinagar and up to the border at Uri had been declared a National Highway after the first Plan. The construction of a low level tunnel across the Pir Panjal range was also undertaken. This was a very important work. There were other roads also in the border region which had been taken up and fully financed by the Centre. But due to the inherent difficulty of construction in the mountainous country the work was rather slow.

A point was made that the customs and excise duty on petrol had increased, whereas contribution to the Road Fund had remained stationary at 2½ annas. The Taxation Enquiry Commission had recommended that further contribution of 4½ annas, which should go into an All India Rural Communications Fund, should be made. Even though this was the natural way of developing a satisfactory system of rural communications free from financial vicissitude, the proposal did not find favour with the Planning Commission and the Finance Ministry.

The idea of a Road Board was mentioned. The Roads Wing of the Ministry of Transport was doing all that was necessary in that connection in a very able and efficient manner. During the war years, some sort of a Road Board functioned in this country but it did not produce praiseworthy results.

Use of railway bridges for road traffic was mentioned. On examination it was found that that was not a convenient way. In many cases it was easier and took less time to construct a road bridge instead of remodelling the existing railway bridge. Also, railway traffic was increasing at a rapid rate and provision of road traffic along the railway line would hinder and come in the way of rail traffic. So, decking of railway bridges for purposes of road traffic was not a very desirable means by which road traffic could be moved.

The bits of roads falling within municipal areas had been excluded from National Highway system because they passed through heavily congested areas and really retarded the easy flow of traffic. A circular was addressed to all the State Governments that the Centre would be prepared to maintain municipal links under certain conditions until it was possible to make by-passes outside the municipalities or by-passes within the municipal limits with parallel service roads. As soon as replies were received from all the States, it would be possible to take a decision on maintaining the portions of National Highways passing through municipal areas with a population of 20,000 or more as a temporary measure.

After a clause by clause detailed discussion the Bill was passed.

ROADS IN NATAL

Historical

THE first settlement by Europeans in Natal, a province of the Union of South Africa, took place in the year 1820. The English speaking immigrants settled round Durban whereas the Dutch settlers went a little inland and settled round the provincial capital.

Means of communication by road in the early days was the bullock cart. Therefore, the early roads consisted of tracks worn by these vehicles, which were not passable during the rainy season. With the advent of the motor car, roads were gradually improved. The bridges constructed during the early days were for a single lane of traffic and were mostly of steel. Some of the earliest pin-jointed and wrought iron structures are still in use in the country.

There are nearly 10,000 miles of roads in Natal. Of these, 600 miles are classified as National roads. These 600 miles are administered at the national level by the Ministry of Transport. Responsibility for the design, construction and maintenance is delegated to the provinces. Finance for these national roads is derived from taxation on petrol. The other roads, which are called provincial roads, are financed from provincial revenues and are administered by the Provincial Council.

Organization

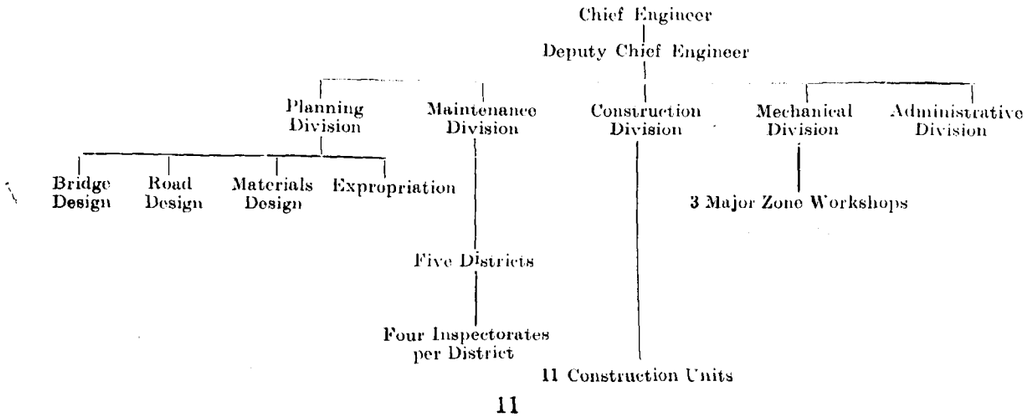
The organization at the national level consists of a chief engineer, a deputy chief engineer and the following five divisions at the headquarters :

(1) planning
(2) maintenance
(3) construction
(4) mechanical, and
(5) administrative

Planning

An Organisation Chart of the department is given below:

The planning division consists of a Road Design, Expropriation, Materials, and Bridge sections. The Road Design section, on the starting of a scheme, is responsible for making traffic surveys. Preliminary alignments are chosen and reconnaissance is carried out. In recent years aerial surveys have been used for selecting alignments. When the final alignment is chosen to conform to the code of geometric standards laid down, longitudinal sections to horizontal scale of 100 ft = 1 in. and a vertical scale of 10 ft = 1 in. are prepared.



When the plans have been finalized, an expropriation staff led by an engineer acquires necessary land. Simultaneously with the work of acquiring land, a soil survey along the alignment is carried out. The department has a fully equipped materials laboratory capable of carrying out all soil tests. American methods of design for the pavement such as Group Index and the C. B. R. methods are generally employed. A special longitudinal section of the road wherein data regarding the soils and other materials relevant to the construction are marked is prepared. Soils which are specially unsuitable for use in embankments are marked as such.

Construction

The road construction is carried out partly by contract and partly by the department. Roughly about 2/5th of the construction is by contract and 3/5th by the department. There are eleven construction units, each under the charge of an engineer. A senior engineer of this division visits each unit once in three weeks. Each of the construction units has a full complement of earth moving machinery consisting of scrapers, graders, flat and pneumatic rollers, trucks, compressors, water carts, etc., and its outturn is expected to be nearly 90 lakh cu. ft of earthwork in one year. The plant of one unit is looked after by five mechanics under one chief mechanic. These machanics attend to the repairs in the field and only in case of an extensive breakdown the plant is returned to a workshop for repairs.

Machinery

The Mechanical Division has three large workshops in the central, northern and southern regions of the country, where major repairs to the plant of all the construction divisions are carried out. This Division is also in charge of operation and maintenance of about 180 vehicles used by the engineers and road inspectors throughout the country.

Maintenance

The Maintenance Division deals with the upkeep of existing roads and bridges. It consists of five districts, each of which is in charge of a district engineer. Each of these districts is divided into Inspectorates and a Road Inspector is in charge of each of these Inspectorates.

Bridges

The Bridges Section consists of nine engineers including a Chief Bridge Engineer and is responsible for the preparation of designs. Ordinarily, the output is 40 new designs of bridges per year.

Most of the bridges in the country occur in isolated places far away from towns and, therefore, the department aims at making the design as simple as possible. Also, well established firms are generally reluctant to tender for small works in isolated locations because of the heavy overhead charges. In very big works where big firms are expected to tender, simplicity of design is not very material.

South African Rivers

South African rivers are very violent in their behaviour. In the dry season it is said that a man who falls into the river, brushes the dust from his clothes and climbs out. In the wet season, however, a trickling stream of three inches depth may change within the hour to a raging torrent thirty feet deep. This flood may carry with it debris of all kinds from the catchment area and it is awe inspiring to hear large boulders, feet in diameter, rumbling down the rocky river beds.

Coastal Bridges

As rivers approach the coast they become wider and more meandering. Most of the big rivers end in a lagoon, fronted on the seaward side by enormous sand dunes thrown up by the sea. During the dry season, these dunes may completely close the river mouth, the small flow of water finding its escape by percolation through the sand. With the advent of the rainy season these dunes break down under the impact of river floods, and the location of the mouth may vary from year to year according to the position at which the dunes collapse.

Flood Calculations

Flood estimates are made using five different methods: **Talbot's formula**;

(Continued on page 29)

A REVIEW OF PAPERS PRESENTED AT THE FIFTH CONGRESS OF THE INTERNATIONAL ASSOCIATION OF BRIDGE & STRUCTURAL ENGINEERING, LISBON*

Special Problems of Reinforced and Prestressed Concrete

FIFTEEN papers were included in this section with a general report by Prof. E. Torroja, and many of them in widely differing manners were related to the question of durability in its widest sense. R. Peltier and J. R. Robinson have continued their work on the corrosion theory explained at the Cambridge Congress in 1952, and the first results confirm the existence of the lime-migration phenomenon and support the theory that it is principally the lime which protects the reinforcement from corrosion. But other factors such as steel stress, thickness of cover and width and degree of cracking are also important and are discussed by other authors. The reporter shows that generally a crack of one-tenth of a millimeter in width is not a means of entry of corrosive agents, and, except in special circumstances, cracks of up to a fourth or a third of millimeter are acceptable, but all these figures are empirical. Larger cracks may also be allowed if the overload is only of temporary duration.

Dr. P. Abeles examines the behaviour of cracked prestressed concrete beams and the closing and healing of different kinds of cracks. He also deals with visible and microscopic cracks under static and fatigue loading in the presence of pretensioned steel; crack in prestressed beams subjected to impact and flexural and shear cracking. In relation to the maximum permissible width of crack to avoid corrosion Dr. Abeles suggests 0.2 millimeter.

There is a tendency to use deformed bars of high-quality steel as reinforcement to provide improved bond, an increased number of cracks and to reduce their size. Contributions appear from France, Great Britain and Germany on this theme to show similar trends in each country. M. Lazard suggests that these special steels may be used so long as wider cracks are not obtained. Using 65 per cent of the ordinary steel cross section he shows similar cracking phenomena for the high tensile steel as compared with mild steel reinforced beams, the results agreeing closely with those of H. E. Lewis. Close to the ultimate load the steels with the higher yield points give better service, with an increase in the number of cracks, which continue to be narrow, rather than a development in the size of the existing ones. Deflections are increased and particularly for thin slabs some limitation of span to depth ratio is necessary: 28 is suggested by H. E. Lewis.

Y. Saillard describes the tests he has carried out with deformed and twisted bars in an attempt to establish the ideal cross-section to provide an increase of bond. Comparative tests on beams reinforced with three types of steel were reported. Prof. Rusch has also described tests carried out in Germany with beams reinforced with plain and deformed bars and compared them with the results of tensile tests. The distribution of cracks in the two cases corresponds closely and he suggests tensile tests as a rapid means of estimating the amount of cracking for different depths of deformation in the bars. His results are of very great interest in that he includes the influence of cover, the position of the reinforcement, the quality of the concrete as well as types of bars.

* Continued from Page 23 of November 1956 issue of T. C. M. R.

A new type of reinforcement is suggested by Prof. E. Friedrich which he calls a double bar, where the transference of tension from the steel to the concrete is by a series of transverse connecting bars. This allows a considerable increase of the cracking load (load at which cracks are 0.2 mm. in width), and the use of higher steel stresses up to 4,500 kg. per sq cm., and the elimination of hooks.

Prof. Freudenthal discusses the concept of safety of prestressed concrete in terms of service and failure capacity, considering the effects of creep of concrete and of the fatigue sensitivity of the steel at the high levels of prestress. The importance of the non-linearity with respect to stress of the creep-rate of concrete is emphasised together with the reduction, with increasing prestress, of the safe range of repeated load amplitudes.

The problem of excessive deformation and its relation to cracking is considered by F. Szepe. Taking a width of crack of 0.15 mm. as harmless, an approximate but safe calculation shows that the maximum permissible tensile stress in a beam is proportional to the amount of reinforcement and inversely proportional to the diameter of the bars. Structures so designed have been satisfactorily tested and the conclusions lead to the suitability of high tensile steels, the reduction of structural dimensions and the general economy of reinforced concrete bridge construction.

The extensive paper presented by N. Boutron and M. Bertrand describing maintenance work carried out on reinforced concrete structures on the French Railways is of very great interest, especially their injection methods using cement, bituminous solutions, rubber solutions and aqueous latex emulsions.

The contribution by V. Guyon deals with elastic deformation of continuous prestressed beams and slabs after cracking, and concludes that the assumption of plastic strains must be rejected in order to explain the high values of tensile stresses obtained in tests. Prof. E. Rausch deals with torsion reinforcement in reinforced concrete structures, and suggests the use of longitudinal and transverse reinforcement and methods of calculation. Bond efficiency and the behaviour of end anchorages in prestressed concrete structures are discussed by R. Buhrer, in relation to the section, arrangement and type of surface of the cables and ducts and of the grout and concrete. A. Rohnisch discusses the frost sensitivity of compressed mortar in prestressed concrete, describing work carried out to determine suitable methods of test. M. Prof describes a machine for performing accelerated corrosion tests suitable for cement, mortar, concrete, stone and metals.

The two main points in the discussion were the use of high tensile steels as reinforcement and the problems with crack formation and the maximum permissible width of crack. Although agreement has not been reached the discussion of this mass of technical data from many countries has undoubtedly resolved many differences.

Practice of reinforced and prestressed concrete

Seven papers had been presented in this section in the preliminary publication on which Prof. G. Wasthund reported, but many further papers on this rather wide subject had been submitted for the Final Report and brief contributions were made by the authors. Since the subject covered both site and factory work in reinforced and prestressed concrete, it was not easy to present a logical sequence.

B. Goschy had made a theoretical study of the redistribution of stresses in a composite system of reinforced concrete due to the difference in shrinkage between the parts, and the redistribution due to the differences in creep characteristics. A method of calculation was proposed based on the results of elastic and plastic analyses which had been confirmed by tests. The redistribution of stresses is of greatest importance under working load conditions as the ultimate loads are not appreciably affected. E. Cordosa dealt with the secondary stresses in reinforced concrete arches due to formwork deformation and shrinkage of concrete, and methods adopted to reduce their effect.

Details of measured losses of prestress in Freyssinet cables in two bridges at Gothenburg were given by A. Bergfelt, for friction, creep shrinkage and temperature. Measurement of permanent set is being continued.

Dr. S. C. C. Bate of the Building Research Station had presented a paper which studied the variation in cracking moments and failing moments of small prefabricated prestressed concrete beams. Significant correlations were established between the strength of the concrete and the bending moment at failure, and from these the effect of variations in the strength of the concrete on the variations in performance was obtained. Dr. J. M. Plowman dealt with the problems encountered in the manufacture of precast units for post-tensioned bridge members of high strength with the aid of vibration, and suggests three remedies. Firstly, to ensure that adequate power for vibration is applied to obtain an acceleration at any point in a casting greater than 3g; secondly, to continue vibration for 120 per cent of the time at which the emission of bubbles from the surface ceases and, thirdly, to design the mix for vibration using the graphs he provides.

G. Enskog described the design and construction of high reinforced concrete bridge piers in North Sweden using sliding forms, and J. Courbon gave details of two new types of prestressing cable and their application to bridge construction.

In the discussion, Dr. U. Finstervalder gave details of progress and experience with his overhand erection system for large bridges at Coblenz, Karlstadt, Ulm and Cologne, and the latest developments in the Dywidag prestressing system. Dr. P. Abeles discussed the condition of partially prestressed concrete structures after several years use, and P. Cot described the prestressed concrete runway at Orby. Training in concrete practice in Great Britain was described by A. W. Hill and F. S. Snow with particular reference to the courses arranged by the Reinforced Concrete Association in conjunction with the City and Guilds of London Institute.

(From "The Surveyor and Municipal and county Engineers" 28 July 1956).

CORRECT INTERPRETATION

You Will Remember: *You have either forgotten or never knew.*

Kindly Expedite Reply: *For heaven's sake do try and find the confounded papers.*

Estimate: *A shot in the dark.*

THE RUSH HOUR?

"What do they mean by the rush hour, Dad?" "That's when you see all the traffic standing still."

BITUMEN AND BITUMINOUS PAVEMENTS IN HIGHWAY ENGINEERING *

By
SUJAN SINGH

BITUMEN

BITUMEN has been in use since ages. People who inhabited the valleys of the Euphrates, the Tigris and the Indus have used bitumen as far back as 3,200 to 3,000 B.C. In India, the earliest known use of the substance was at Mohanjo Daro in Sind (now in Pakistan), where a layer of bitumen was used to make a storage tank watertight. It again came into prominence when fast moving traffic came into being.

What is bitumen? The latest Indian Standards Institution deflnition of bitumen is as follows :

> " A non-crystalline solid or viscous material having adhesive properties, derived from petroleum, either by natural or refinery processes, and substantially soluble in carbon disulphide.

Bitumens are black or brown in colour. They may occur naturally, but are usually end-products from distillation of, or extracts from, selected petroleum oils."

There is generally confusion between the words bitumen and asphalt. Whenever bitumen is mixed with aggregate or any foreign matter, it is termed Asphalt. Bitumen is used on roads, but once aggregate is mixed, it is called asphalt road. According to the Indian Standards Glossary of terms I. S. 334-1953, Asphalt is—

> " A natural or artificial mixture in which Bitumen is associated with inert mineral matter. The word " Asphalt " should always be qualified by indication of its origin or nature."

Bitumen is classified as under :

1. Natural, and
2. Refined.

1. Natural Bitumen is found in the form of lakes and rocks. There are several asphalt lakes in the world, important among them being in Trindad and Bermuda. In these lakes, the crude has been under atmospheric evaporation for ages and got converted into Bitumen. The bitumen is mixed with foreign matter which has been blowing into these lakes since their formation. The bitumen formed by these lakes is, therefore, called " Lake Asphalt ".

Asphalt rocks are found in France and Switzerland and they are mostly limestone rocks with about 4 to 8 per cent bitumen. As the composition of rock and lake asphalt cannot be conveniently altered, their uses are limited.

2. Refined bitumen is derived from petroleum and is obtained by distillation. It is usually an end-product, but its consistency is controlled and different grades are produced. This type of bitumen is commonly used for bituminous pavements.

Types of Bitumen

There are mainly two types of refined bitumen :—

1. Steam refined, and
2. Air blown.

Steam refined bitumen is produced in different grades and these grades are known as straight. They are designated by their penetration, such as bitumen 10/20 pen., 30/40 pen., etc. Straight grades are normally available from 10/20 pen. to 200 pen. @

Air blown bitumen has a high melting point and low ductility. It is mostly used for industrial purposes.

Important Tests

In order to determine physical and chemical properties of bitumen, several tests

* Lecture delivered at Boorke University as part of a refresher course in civil engineering.

@ IS-73-1950—Asphaltic Bitumen and Fluxed Native Asphalt for Road-Making Purposes

are carried out, such as for determining

Penetration
Softening Point
Ductility
Loss on Heating
Drop in Penetration after Heating
Flast point
Solubility in Carbon Disulphide
Specific Gravity

Of these three important tests are helpful in selecting suitable grade for a particular job. These are :

Penetration Test—Penetration is the consistency of bitumen which is determined by an apparatus called Penetrometer. In this apparatus a standard needle loaded with 100 gm weight is allowed to penetrate into bitumen for 5 seconds. The temperature of bitumen during test is kept at 25 deg. C. The distance the needle penetrates into bitumen is measured in tenths of a millimetre and the figure is called penetration.

Softening Point Test—Softening point is the temperature at which bitumen reaches a certain degree of softness. A sample of bitumen is placed in a standard brass ring and cooled. A standard sized steel ball is placed on the bitumen and the ring is suspended in water bath and temperature of the water is raised at the rate of 9 deg. F. per minute. The temperature at which the bitumen softens sufficiently to allow the ball to pass through the ring and touch the bottom of the bath, which is kept at 1 in. below the ring, is called the softening point. This test is known as the Ring & Ball Test.

Ductility Test–Ductility is the distance in centimetres which a standard briquette of bitumen at a temperature of 25 deg. C. can be drawn out without breaking when the ends are pulled apart at the rate of 5 centimetres per minute. Ductility is a measure of the resilience of the bitumen tested.

Bitumen Cutbacks

It is not possible to apply straight bitumen under all conditions, because the viscosity at which they are workable could only be attained at certain temperatures, which are sometime quite high.

The cutbacks are normally straight grades blended with a suitable solvent. The Indian Standards Institution definition of a cutback is :

> " Bitumen, the viscosity of which has been reduced by a volatile diluent."

There are several types of cutbacks, but those commonly used are rapid curing (RC) ; medium curing (MC) ; and slow curing (SC) cutbacks. Indian Standards Institution have issued specifications, Indian Standard 217-1951, for six grades of each of the types mentioned above. These are designated RC-O, RC-1, RC-2, RC-3, RC-4, and RC-5, MC-O, MC-1, MC-2, MC-3, MC-4 and MC-5, SC-O, SC-1, SC-2, SC-3, SC-4 and SC-5.

Special cutbacks for priming coat work and other jobs are available.

Bitumen Emulsion

While some of the grades of cutbacks can be applied cold (at atmospheric temperature), they cannot be used on wet surfaces. Bitumen Emulsion has the advantage that it can be used in wet conditions. Bitumen Emulsion is defined as under :

> " A liquid product in which a substantial amount of bitumen is suspended in a finely divided condition in an aqueous medium and stabilized by means of one or more suitable materials."

Bitumen Emulsion consists of bitumen, water and emulsifier. Minute particles of bitumen are suspended in aqueous phase by agitation, which is done through a mill or a mixer. In order to retain the dispersion, suitable emulsifiers are added which prevent the emulsion from precipitating. Emulsifiers generally used are soap solution or Bentonite. There are two grades of emulsion namely :-

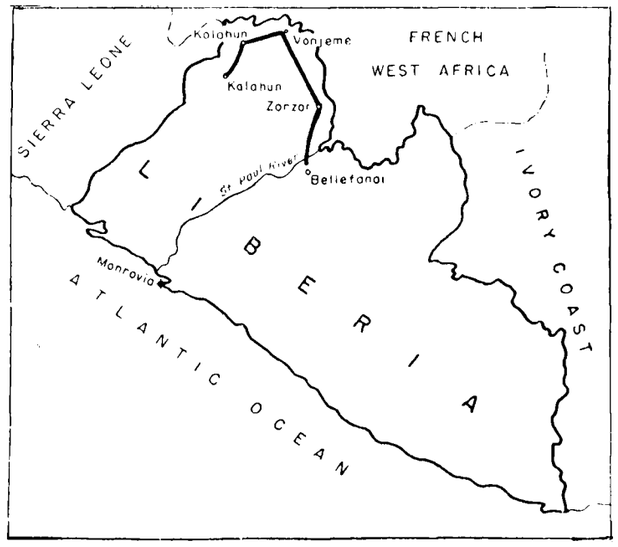
semi-stable and
stable.

Semi-stable emulsion is used for surface-dressing while stable emulsion is meant for premix work. Emulsion should be used soon after manufacture, but not later than six months from the date of manufacture. If stored for more than six months, it should be examined and used only if in a sound condition. Emulsions should in no case be stored where temperatures go below freezing point. Due to freezing and thawing of the water phase, the emulsion will break.

HERE AND THERE

1. HIGHWAYS IN LIBERIA TO HELP IN STABILIZATION OF FOOD PRICES

● CONSTRUCTION work on a 150-mile new highway near the French West African border of Liberia will start shortly. This road will open for development large areas which are now tropical jungle. It will provide access to mineral resources and timber, and in addition will help stabilize food prices within the country. Present transportation difficulties result in widely varying prices of food; for example, rice grown inland costs three times its price at the coastal town of Monrovia, only about 150 miles away.



This project is part of a highway program designed to improve transportation between inland and coastal towns and among interior developments. It is financed with the aid of a loan of 12 million dollars from the U.S. Export-Import Bank, and is under the direction of the Liberian Secretary of Public Works and Utilities. Locally available materials will be used in the Construction of the road.

2. OCRATED CONCRETE

● OCRATED concrete is made by treating ordinary concrete with silicon tetrafluoride gas (SiF_4). It is important that the concrete is dry before the treatment, because the gas reacts immediately with water and is decomposed.

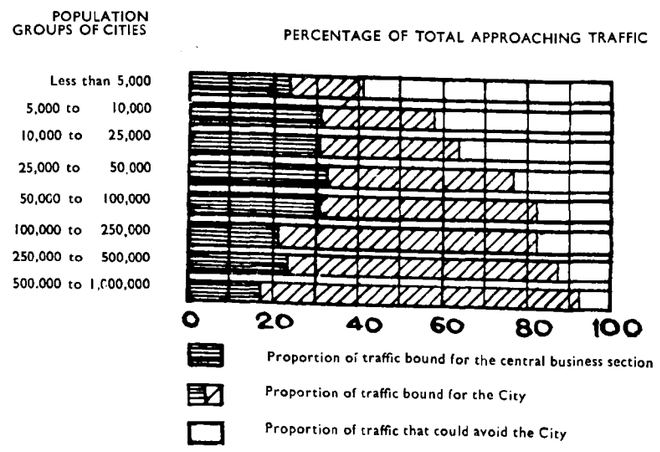
The gas reacts with the free lime, $Ca(OH)_2$, present in the concrete, and the calcium fluoride which is formed is very resistant to acid attacks. Also the calcium monosilicates, formed during the hardening of the concrete, react with the SiF_4 gas and are transformed into more resistant compounds. The advantage of using ocrated concrete where acid attack is expected is, therefore, obvious.

Laboratory tests which have been made show that ocrated concrete is about four times more resistant against attacks from 10 per cent hydrochloric acid, compared with ordinary concrete.

(*From "The Indian Concrete Journal" October 1956*)

3. TRAFFIC BY-PASSING TOWNS

● AT one time it was thought that congestion in towns was largely caused by through traffic, and the building of by-passes was considered to be the solution. Subsequently, surveys of where traffic wished to go revealed that the larger the town the smaller the proportion of traffic approaching it which could be by-passed. Results of investigations in the U.S.A. are shown in the figure below which shows not

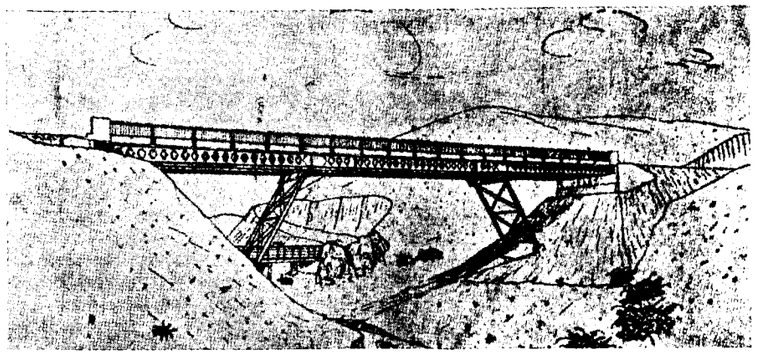


only the proportion of traffic wishing to go into towns of various sizes, but also the proportion which wishes to go into the central area of the town. For large towns, as will be seen, only 10 per cent is by-passable, and in all cases between 20 and 30 per cent of the approaching traffic wishes to get right into the business centre of the town. J. Barnett of the U. S. Bureau of Public Roads, has stated: 'Adequate traffic data and the judgment of competent highway engineers inevitably lead to the conclusion that to serve traffic best, arterial routes should be located so that the through routes outside the city are connected with the central business district...In the larger cities the procedure consists of the construction of a close-in circumferential route from which arterial roads to the outskirts of the city and beyond radiate in several directions....In large metropolitan areas another characteristic part of the pattern is the outer circumferential route and sometimes an intermediate circumferential route.'

(*From 'The Surveyor and Municipal and County Engineer,' 22, September 1956*).

4. RAKING PIERS FOR A BRIDGE OVER A GORGE

● IN New Zealand a 3-span bridge with sloping supports that carry the structure at its third points has been designed. These raking piers are founded on rock near the bank, thus eliminate the construction of very high piers in the bed of the stream.



Steel girders with large hexagonal openings in their webs serve as continuous stringers for the structure. The concrete deck rests on these stringers. The figure given below shows an artist's impression of this bridge when it will be complete.

(*From "Engineering News-Record", September 27, 1956.*)

5. THE NEED FOR PRECISE LANGUAGE FOR HIGHWAY CONSTRUCTION WARNING SIGNS.

● IN Texas, U. S. A., a certain highway was being converted into two strips of one-way lane each separated by an open space. A warning sign reading "Construction—Drive Carefully" was put up at the junction of an intersecting street with the highway. A motorist using the highway at night entered the area of construction presumably under the mistaken notion that it was safely open to travel. He drove into an unbarricaded open pit with fatal result. His widow sued the contractor for damages alleging negligence. The Lower Court gave judgment in favour of the contractor. But the Supreme Court opined that "There was no sign warning the public not to use the new highway. On the contrary, there was a sign which advised the public 'Drive Carefully'."

The moral of the case is that the highway warning signs should be clearly understandable and should be properly placed as not to confuse the public.

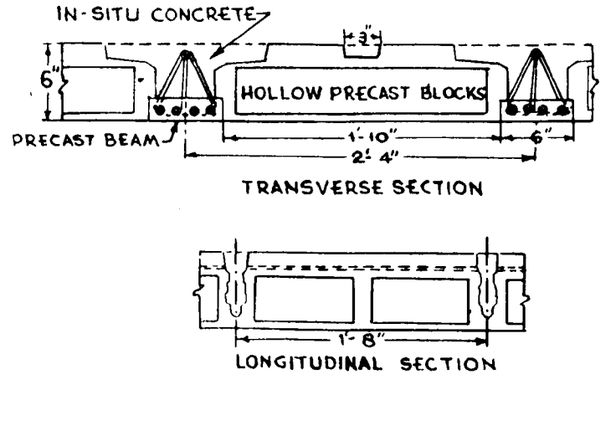
(*Adapted from Court Decisions, "Roads and Streets", September 1956.*

6. A NEW TYPE OF FLOOR

● A NEW type of floor requiring no shuttering or props and all the parts of which can be lifted by hand, comprises partly precast and partly in-situ concrete inverted tee-beams between which span light-weight hollow concrete blocks. A precast slab 6 in. wide and 2 in. deep forms the soffit of the beam and contains four 5/8-in. diameter longitudinal bars. Stirrups protrude from the top of this slab and support an upper $\frac{3}{8}$-in. diameter longitudinal bar. A continuous $\frac{3}{8}$-in. diameter bar is welded to the top and bottom bars to form diagonal reinforcement to resist shearing forces.

The hollow blocks are made with foamed-slag aggregate. They have two cavities, and the sides are rebated to fit on the precast parts of the beams. Along the centre of the top of the blocks and extending the full length is a groove 3 in. wide by 1 in. deep in which electrical conductors may be placed. The blocks are 6 in., 7 in., or 8 in. deep by 1 ft 8 in. long by 1 ft 6 in. or 1 ft 10 in. wide. A stronger floor may be made by placing two or more beams side by side between the blocks. When the beams and blocks have been laid, the cavities between are filled with concrete.

Tests have been made at the Building Research Station U. K. on floors 6 in. thick with spans of 7 ft 9 in., 11 ft 9 in., and 16 ft 3 in.; the compressive strength of the in-situ concrete at the time of the test was 2,770 lb, 2,850 lb, and 2,620 lb per sq. inch respectively. The floors failed when subjected to the equivalent of uniformly-distributed loads of 1,310 lb, 620 lb and 330 lb per sq. ft respectively.



It is stated that floor thickness of 6 in. are suitable for a span of 16 ft, 7 in. for 18 ft, and 8 in. for 20 ft. The system, which is patented, has been developed by Messrs. William Sindall Ltd., of Cambridge.

(*From 'Concrete & Constructional Engineering', September, 1956.*)

CURRENT LITERATURE

ABSTRACTS

STRUCTURAL DESIGN CONSIDERATIONS FOR PAVEMENT JOINTS. Report by Committee 325. Journal of the American Concrete Institute, July 1956.

THE structural design of joints for concrete pavements for roads and runways is dealt with in detail. The function and classification of joints are given. Joints have been classified as under :

(1) Expansion joints,
(2) Contraction Joints,
(3) Hinge or Warping joints,
(4) Construction joints, and
(5) Longitudinal joints.

Recommended design details for the various transverse and longitudinal joints for highways and airports are given along with diagrams. Determination of size and spacing of dowels for transferring load at joints is dealt with in detail, and mathematical calculations for determining the size and spacing of these are included.

THE WIND RESISTANCE OF LATTICE GIRDER BRIDGES by E. Ower. The Institution of Civil Engineers and The Institution of Structural Engineers ; 1948.

THIS Paper, which is in two parts, contains an account of the aerodynamic experiment on wind resistance of lattice girder bridges in the first part. Scope and description of the experiment, results of tests, the effects of shielding and solidity, and the effect of trains on the bridge, are discussed. In Part II, the results of experiments are correlated to published data of similar kind from other sources. A degree of generalisation is shown to be possible which, in the opinion of the Author, should enable wind resistance of bridges to be calculated with sufficient accuracy for purposes of structural design.

AN INTRODUCTION TO ENGINEERING ECONOMICS. The Institution of Civil Engineers, England.

EVALUATING the ultimate costs of alternative engineering projects is dealt with. The mechanism of evaluation taking into account the initial cost, life of the facility, depreciation, maintenance, running cost and overhead charges, are discussed.

Nine worked out examples, including one in which the economics of alternate routes of a railway is worked out, are given. Tables giving compound interest, sinking fund for loan redemption and depreciation reserve, and present value for rates interest of from 1¼ per cent to 5 per cent are included. An appendix gives the mathematical derivations of the formulae.

JOINT SPACING IN CONCRETE PAVEMENTS : Research Report 17-B : Highway Research Board Washington, D. C.

THE publication contains reports on six experimental concrete pavement projects covering a 10-year period of study, describes the condition of the pavements and presents data collected. Research Report 3B, "Investigational Concrete Pavements, Progress Reports of Cooperative Research Projects on Joint Spacing," an earlier publication, described the condition of the experiments up to 1945. A comparative study of the data is also included. The projects were constructed in cooperation with the Bureau of Public Roads in six states for the purpose of studying joint spacing in plain and reinforced concrete pavements.

The experimental features common to the six state projects consist of a series of plain and reinforced concrete sections in which the joint spacing is varied. The

(*Continued on page 25*)

SELECTED RECENT LITERATURE IN ENGINEERING JOURNALS

VII. CONCRETE.

1. **Concrete Road Building in the Netherlands and Motor Traffic Highways in Particular** ; J. C. N. RINGELING, *Cement, Vol. 7, No. 9-10*, October 55, pp. 228-234 (in Dutch).

2. **Concrete Road Building in the Netherlands and Motor Traffic Highways in Particular** ; J. C. N. RINGELING, *Cement, Vol.7, No. 11-12*, December 55, pp. 288-297 (in Dutch).

3. **Treatment of Concrete with SiF Gas**, A. A. VANDER VLIST *Cement, Vol. 7, No 9-10*, October 55, pp. 241-244 (in Dutch).

4. **Extension of the Use of Blast Furnace Granulated Slag in Cement** ; M. M. MARY, *Annales de l' (Institut Technique du Batiment et des Travaux Public) No. 97*, January 56, pp. 38-48 (in French).

5. **Continental Concrete Roads** ; D. R. SHARP, *The Surveyor, Vol. CXV, No. 3333*, January 21, 1956, pp. 62-67.

   Also—Contractor's Record and Municipal Engineering, Vol. LXVII, No. 4, January 25, 1956, pp. 15-21.

6. **Lessons of the Oxton Concrete By-Pass Experiment** ; R. D. KIDD's Paper, *Highways and Bridges and Engineering Works, Vol, XXIII, No. 1123*, January 25, 1956, pp. 1, 3 & 4.

7. **A Vibration Method for Measuring the Thickness of Concrete Road Slabs in Situ** ; R. JONES, *Magazine of Concrete Research, Vol. 7, No. 20*, July 1955, pp. 97-102.

8. **Variation of Concrete Strength Due to Delay in Placing** ; K. RAY, J. K. KARMARKER and S. K. DATTA, *Indian Concrete Journal, Vol. 30, No. 2*, February 1956, p. 42.

9. **Soil-Cement for Cold Storage Construction** ; L. R. CHADDA and B. P. KAPUR, *Indian Concrete Journal, Vol. 30, No. 2*, February 1956, pp. 43-45.

10. **Making Trial Mixtures of Concrete by Adding Aggregates to Grout** ; *Indian Concrete Journal, Vol. 30, No. 2*, February 1956, p. 45.

11. **New Possibilities of Rapid Hardening of Cements, Mortars and Concrete**—M. DARIEZ and R. LEZY, *Travaux, Vol. 40, No. 255*, January 1956, pp. 30-32 (in French).

12. **Contribution to the Study of Effects of Temperature Variations on Concrete Roads** ; PIERE MARIE, *Revue General des Routes et des Aerodromes, Vol. 25, No. 287*, December 1955, pp. 63-78 (in French).

13. **Problems Connected with the Stiffness of Road Slabs** ; A. J. P. VAN DER BURGH, *Cement, Vol. 7, No. 1-2*, February 55, pp. 5-7 (in Dutch).

14. **Treatment of Cement and Concrete with Sillicones** ; J. C. M. VANDER BRINK, *Cement, Vol. 7, No. 1-2*, February 55, pp. 8-9 (in Dutch).

15. **Diatomite As Additive to Concrete** ; P. C. A. VAN BUNREN, *Cement, Vol. 7, No. 1-2*, February 55, p. 27 (in Dutch).

16. **Protection of Underground Concrete Work** ; J. DORLEYN, *Cement, Vol. 7, No. 1-2*, February 55, pp. 30-32 (in Dutch).

17. **Additions to Special Concrete at Low Temperatures** ; P. W. D. SCHANOO, *Cement, Vol. 7, No. 9-10*, October 55, pp. 235-236 (in Dutch).

18. **Desertation Regarding Steam Hardening of Concrete** ; PROF. O. GRAF, *Cement, Vol. 7, No. 9-10*, October 55, pp. 249-250 (in Dutch).

19. **Defining Concrete Mixes—Recommended Data for inclusion in Reports**: *Engineering, Vol. 181, No. 4697*, February 3, 1956, p. 125.

20. **Calculation of Pressure of Concrete on Forms**: R.SCHJODT, *Proceedings, American Society of Civil Engineers, Vol. 81, Separate No. 680*, May 1955.

21. **Experiments on Concrete under Combined Bending and Torsion**: N. S. J. GERASSAM, *Proceedings of the Institution of Civil Engineers, Part I General, Vol. 5*, March 1956, No. 2, pp. 159-166.

22. **Design and Construction of Heavy Duty Airfield Pavements at Edwards AirForce Base**; ROBERT J. SHULTZ and ROBERT B. FATHERSON, *Journal of the American Concrete Institute, Vol. 27, No. 5*, January 1956, pp. 525-536.

23. **Investigation of the Properties of Concrete by Non-Destructive Method (Sonic Apparatus)**; D. C. CHATURVEDI, G. C. GUPTA and H. D. SRIVASTAVA, *Journal of the Institution of Engineers (India), Vol. 36, No. 8, Part 1*, April 1956, pp. 1645-1655.

24. **A Method of Determining Tensile Strength of Cement Mortar**; IQBAL ALI, A. B. LINGAM, and K. RAMCHANDER, *The Indian Concrete Journal, Vol. 30, No. 4*, April 1956, pp. 106-108.

25. **Effect of Carbon Dioxide on Fresh Concrete**; J. A. KANER and R. L. FREEMAN, *Journal of American Concrete Institute, Vol. 27, No. 4*, December 1955, pp. 447-454.

26. **Concrete Mix Design for Vibration**; *Highways and Bridges and Engineering Works, Vol. XXIII, No. 1131*, March 21, 1956, pp. 6 & 8.

27. **A Rapid Field Method for Design of Concrete Mixes**; C. A. BAKER, *The Journal of the Institution of Engineers, Australia, Vol. 20, No. 4-5*, April-May 1956, pp. 119-126.

28. **Design of Pavements in Prestressed Concrete**; PIERRE D. COT, and E. BECKER, *Revue Generale des Routes et des Aerodromes, No. 292*, May 1956, pp. 53-72 (in French).

29. **The Control and Testing of Concrete Quality**; S. ROSENAK, *Indian Concrete Journal, Vol. 30, No. 6*, June 1956, pp. 177-179 & 183.

30. **Concrete Roads, Road Construction for smaller Works**: *Indian Concrete Journal, Vol. 30, No. 6, Part 4*, June 1956, pp. 203-208.

31. **Paya Lebar Airport, Singapore—Preliminary Investigations and Site Survey Work for Runway 8,000 ft by 200 ft**; *The Surveyor, Vol. CXV, No. 3342, 12*, May 1956, pp. 237-238.

32. **The Sealing of Joints in Aerodrome Pavements and Concrete Roads**; JEAN MORSON, *Revue Generale des Routes et des Aerodromes, No, 291*, April 1956, pp. 61-64 (French).

33. **The Uniformity of Mixes Intended for Construction of Concrete Roads**; E. VAN VOLSAM and R. RUTRON, *Revue Generale, des Routes et des Aerodromes. No. 290*, March 56, pp. 59-66. No. 291, April 56, pp. 65-84 (in French).

34. **Use of Large Tendons in Pretensioned Concrete**; NEILS THORSEN, *Journal of the American Concrete Institute, Vol. 27, No. 6*, February 1956, pp. 649-659.

35. **Rational Design of Concrete--Encased Stanchions — Full-scale Tests Suggest Savings in Steel**; OSCAR FABER, *Engineering, Vol. 180, No. 4691*, December 23, 1955, pp. 855-857.

36. **A General Method of Analysis of Rigid Frames**; PANAGIOTIS D. MOLIOTIS, *Proceedings, American Society of Civil Engineers, Vol. 81, Paper No. 811*, October 1955.

LIST OF PUBLICATIONS ADDED TO THE ROADS WING LIBRARY DURING OCTOBER 1956

1. **The Ninth Year of Freedom** (Published by the All India Congress Committee, Jantar Mantar Road, New Delhi).

2. **Preliminary Publication**—International Association of Bridge & Structural Engineers, Fifth Congress, Lisbon.

3. **Handbook of Graphic Presentation** by Calvin F. Schmid (The Ronald Press Company, New York).

4. **Consistency of Remoulded Soil** by S. P. Baidye (Soil Mechanics Laboratory, Damodar Valley Corporation).

5. **Colorado Manual on Uniform Traffic Control Devices for [illegible] Highways** (Adopted [illegible] of Highways [illegible] Research Division, Denver 22, Colorado, U. S. A.

(*Continued from page 22*)

plain concrete sections have transverse contraction joints at relatively close spacing (15 to 25 ft) and expansion joints at 120, 400, 800 and 5,280 ft. The reinforced sections have expansion joints at 120-ft spacing with one intermediate contraction joint. In general, load transfer devices were used in all expansion joints, but were used in only part of the contraction joints of a given project.

PRESTRESSED CONTINUOUS BEAMS AND FRAMES by P. B. Morice and H. E. Lewis Proceedings of the American Society of Civil Engineers, Journal of the Structural-division, September 1956.

THE paper describes methods of design for continuous prestressed concrete [illegible] particular those of [illegible] uniform sections [illegible] methods for determining suitable [illegible] profiles are discussed and it is shown that certain displacements of these profiles are possible without affecting the stress conditions. In the case of frames consideration is given to the effects of varying direct forces on section design. The methods of allowing for transom shortening due to prestress are discussed.

A comparison is made between simply supported and continuous beam construction, it being shown that the use of continuity becomes advantageous only when large dead loads occur.

It is also shown that the adoption of alternating long and short spans, as has sometimes been suggested, does not lead to economy. (Author's Summary).

A SAW

Of all the saws I ever saw, I never saw a saw saw as this saw saws.

BUDGETS AND ADMINISTRATION REPORTS

GOVERNMENT OF BIHAR CIVIL WORKS BUDGET FOR 1956-57

The following extracts relating to Civil Works have been taken from the Government of Bihar Budget for the year 1956-57.

Revenue (Civil works)

Heads	(In lakhs of rupees) Actuals 1954–55	Revised estimate 1955–56	Budget estimate 1956–57
Rents	11.46	7.44	9.36
Recoveries of expenditure	.35	.32	.21
Recoveries on account of Distt. Engineers lent to Local Bodies.	—	1.46	1.41
Leave Salary contribution on account of Distt. Engineers recoverable from Local Bodies.	1.02	—	—
Miscellaneous	15.04	4.34	4.19
Tolls on Roads	1.02	1.25	1.25
Ferry Receipts	.60	1.00	1.00
Transfer from Central Road Fund	22.56	28.91	28.21
Deduct—Refunds	-.27	-.19	-.08
Total	51.78	44.53	45.55
Expenditure (Civil Works)			
Original Works	155.25	174.09	124.65
Repairs	80.15	73.08	152.11
Grants-in-aid	27.78	80.24	42.31
Suspense	-43.12	22.01	2.09
Lump addition for regrant of lapses	—	.25	.25
Establishment	30.89	37.13	41.94
Tools and Plants	5.87	6.34	5.93
Charges in England	.14	—	—
First Five Year plan			
Lump provision on account of tools and plant	3.05	13.85	—
State Highways and Buildings	187.80	436.90*	10.00
Repairs	40.98	64.37	—
Second Five Year Plan			
Lump provision on account of new roads	—	—	50.50

* Inclusive of lump provision on account of Buildings, Roads and Bridges.

Heads	(In lakhs of rupees) Actuals 1954–55	Revised estimate 1955–56	Budget estimate 1956–57
Lump provision for State's share for inter-state roads under improvement	—	—	5.00
Lump provision on account of tools and plant	—	—	12.00
Grants-in-aid	—	—	47.00
State Highways and Buildings @ Expansion Schemes	—	—	166.87
State Highways and Buildings New	—	—	424.82
Establishment (New Scheme)	—	—	2.49
Total	488.79	908.26	1087.96
Details of recovery			
Amount charged to other Departments	—	—	-3.00
Amount Recoverable from the Government of India, as Departmental Charges on National Highways works	—	—	-3.00
Revenue from Roads			
Receipts under the Motor Vehicles Act	4.33	4.05	4.05
Passenger and Goods Transport Tax	24.21	23.58	23.97
Sales Tax on motor spirit	47.11	45.00	45.00
Total	75.65	72.63	73.02

GOVT. OF BIHAR CIVIL WORKS BUDGET 1956-57

(A Brief review)

THE total revenue receipts of Bihar for the year 1956–57 are estimated at Rs 4399.72 lakhs and revenue expenditure at Rs 6487.93 lakhs with a consequent deficit of Rs 2088.21 lakhs. The revised estimates for 1955-56 indicate a deficit of Rs 2017.83 lakhs with a revenue amounting to Rs 4006.65 lakhs and expenditure to Rs 6024.48 lakhs. In the year 1954-55 (accounts) revenue amounted to Rs 3599.90 lakhs and expenditure met from revenue to Rs 4212.94 lakhs leading to a deficit of Rs 613.04 lakhs.

Revenue expenditure on civil works for 1956-57 is estimated at Rs 1087.96 lakhs which forms 25 % of the total State revenue in the year. The corresponding percentage figures for the two preceding years 1955-56 (Revised Estimate) and 1954-55 (accounts) are 23 % and 14 % respectively.

@ Exclusive of lump provision on account of new roads and Inter-State roads.

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LIST OF APPROVED WORKS ON NATIONAL HIGHWAYS

S. No.	Job No.	Name of work	Amount (Rs in Lakhs)
		ANDHRA	
1.	1654 AH 5	Formation of a byepass at Tanuku on National Highway No. 5 in West Godavari Distt.	5.03
2.		Two works each costing less than 2 lakhs	1.61
		ASSAM	
3.	24 AS 37	Permanent restoration of flood damages to miles 220 to 223 and 230 of National Highway No. 37 caused by flood of 1955 in Sibsagar Sub-division.	3.65
4.	32 AS 31	Providing seal coat to certain miles of Jogighopa-Baxirhat section (miles 109 to 186) of National Highway No. 31.	0.29
		BOMBAY	
5.	29 BM 4	Providing cycle tracks on both sides of Harris Bridge in mile No. 108 of Bombay-Poona Road, National Highway No. 4.	1.91
6.	30 BM 4	Widening the approaches on either side of Harris Bridge miles 107/8 to 108/1 of Bombay-Poona Road, National Highway No. 4 to provide cycle tracks.	0.73
		JAMMU AND KASHMIR	
7.	1658 JK 1A	Construction of an addition spur No. 5A between spurs Nos. 5 & 6 in river Basantar on Pathankot–Jammu Road National Highway No. 1A.	0.20
		PUNJAB	
8.	25 PB 22	Improving surface of Ambala-Kalka Road, National Highway No. 22, miles 4-5.	0.69
		SAURASHTRA	
9.	27 SR 8B	Providing 1½" premixed asphalt carpet to Kutiana-Upleta Section of N. H. No. 8B.	10.74

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S. No.	Job No.	Name of Work	Amount (Rs in Lakhs)
		TRAVANCORE-COCHIN	
10.	1655 TC 47	Reconstruction of the Manali bridge in Travancore-Cochin on National Highway No. 47.	1.93
11.		Two works each costing less than 2 lakhs	1.38
		UTTAR PRADESH	
12.	1660 UP 2	Construction of an over-bridge to replace the level crossing near Kosi-Kalan Railway Station of Delhi-Agra Section of National Highway No. 2.	1.78
13.	26 UP 25	Construction of a byepass on Lucknow-Jhansi road, National Highway No 25.	5.23
14.	28 UP 28	Construction of a bridge across the Rapti river near Gorakhpur on National Highway No. 28.	41.43
15.	31 UP 2	Construction of diversion (Barari Byepass) in miles 775-776 of Bombay-Delhi Road National Highway No. 2 in Mathura Distt.	0.84
		WEST BENGAL	
16.	1699 BG 9	Construction of culverts in sub-section Alampur to mile 3/5 of Joypur Beel Alampur Section of N. H. No. 6 in the district of Howrah.	0.77

(*Continued from page 12*)

an empirical method in which constants are chosen to suit the shape and area of the catchment, vegetation, slope and mean rainfall; a rational method, in which run-off is calculated from a modification of the Bransby-Williams formula derived from Irrigation Department research over many years; a flood level method, in which the highest known flood is used to deduce the flow and finally a comparison of the river concerned with a representative series of rivers throughout the Union for which flow records have been maintained through many years. The weighted mean of these results is used to determine the size of opening to be used.

10-Year Road Programme 1949–59.

After the second World war, in 1949 a 10-year road building programme was launched. This programme contemplated the construction of 600 miles of high-speed national roads. Under this programme, every year nearly 90 miles of new high standard black-topped roads and 360 miles of gravelled roads, whose alignments have been improved, are being constructed By 1954, 85 per cent of the vehicle-miles travelled in the country were on black-topped roads.

(*Adapted from "The Journal of the Institution of Highway Engineers", July 1956*).