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TRANSPORT
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MONTHLY REVIEW
DECEMBER - 1958 - NO. 140

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TRANSPORT-COMMUNICATIONS

MONTHLY REVIEW

DECEMBER 1958—No. 140

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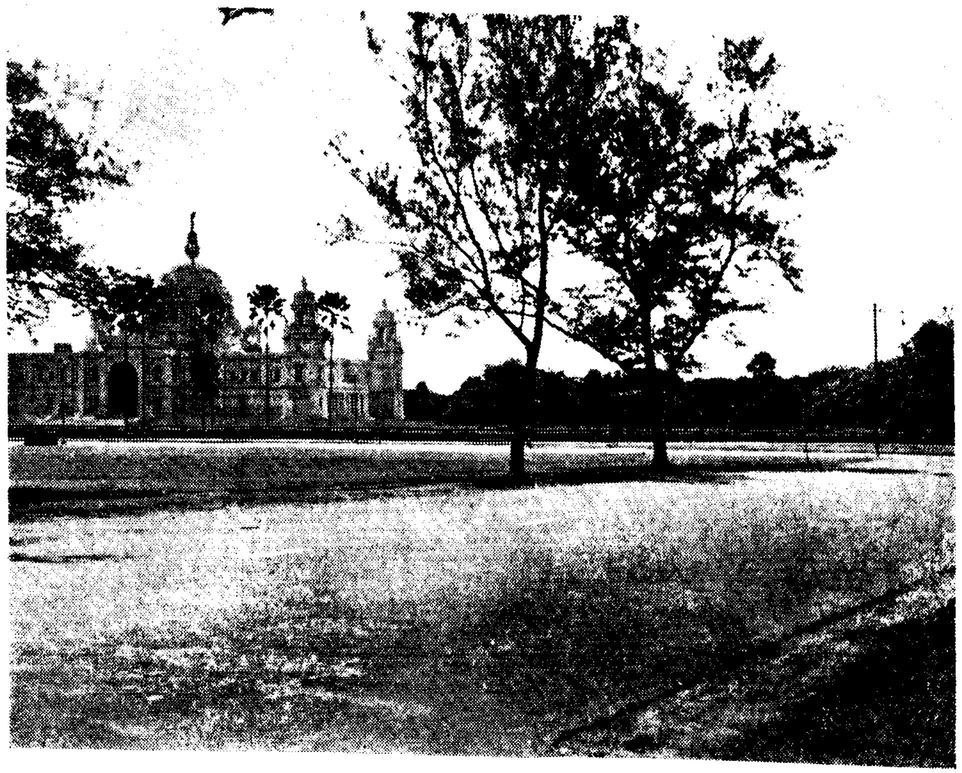
INDIAN ROADS CONGRESS, NEW DELHI.



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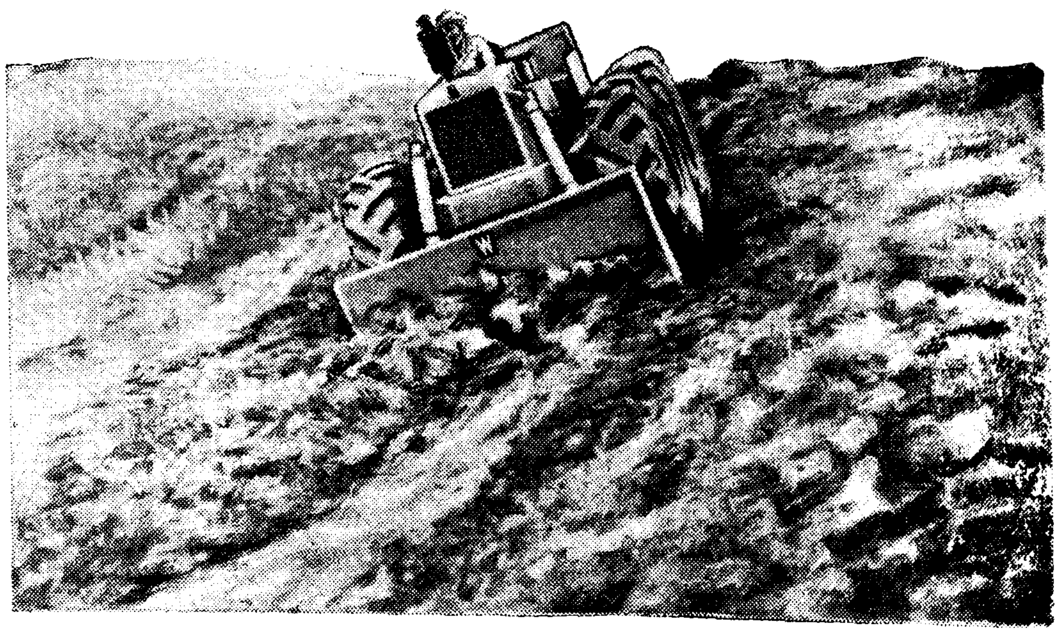

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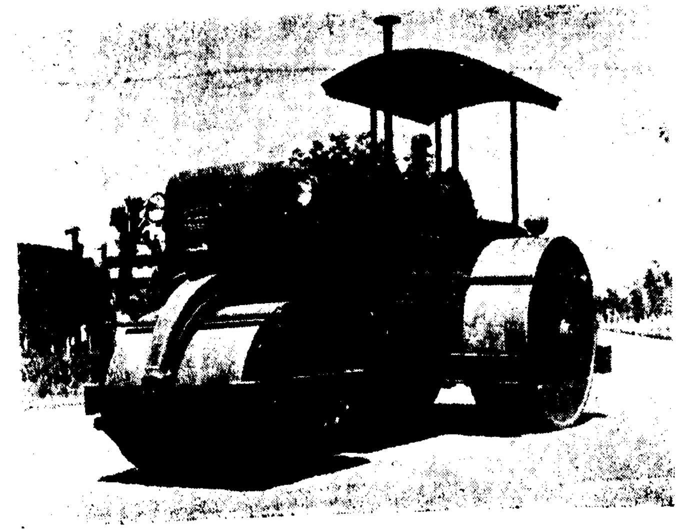

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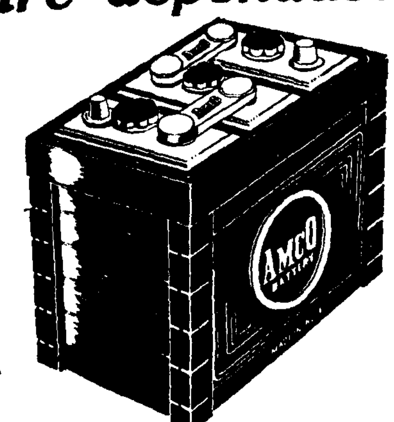

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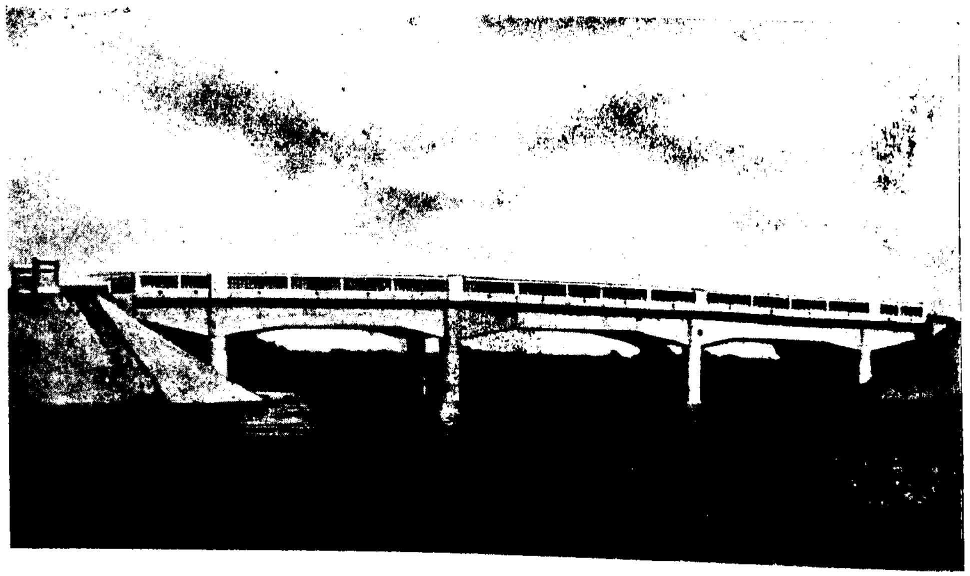

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INDIAN ROADS CONGRESS

TWENTY-THIRD SESSION

Hyderabad—January 1959

The Indian Roads Congress will hold the Twenty-third Annual Session at Hyderabad from the 6th to the 13th January 1959. More than three hundred Highway Engineers from all over India are expected to attend.

The following Papers will come up for discussion :

Paper No.	Subject	Author
	Volume XXIII-1	
206	" Construction of an R.C. Cantilever Hollow Girder Bridge over Betwa River at Jhararghat "	P. N. Srivastava
207	" Adequacy Assessment of Highways "	D. G. Bhagat
	Volume XXIII-2	
208	" Traffic Survey In and Around Calcutta "	S. K. Laha, A. K. Das Gupta, & S. Chatterjee
209	" An Investigation of a Concrete Pavement Failure "	Dr. Bh. Subbaraju & Y. C. Gokhale
	Volume XXIII-3	
210	" Brick Pavement in Highway Construction "	D. C. Chaturvedi & J. C. Tayal
211	" Investigation of Failures of a Bituminous Road "	C. G. Swaminathan & S. Arumuga Swami
212	" Landslide Investigation and Treatment in Assam "	G. C. Sharma

Besides Papers, panel discussion on " Roads in Waterlogged Areas " will be taken up.

A general Report prepared from the reports of research work received from the Central Road Research Institute and the State Road Research Laboratories for the year 1957–58 will also be discussed during the Session.

Visits to engineering works of interest in and around Hyderabad will be arranged for the delegates.

A technical engineering exhibition in which various engineering firms, and Government Departments are expected to participate will be arranged at the time of the Session.

TRANSPORT-COMMUNICATIONS

MONTHLY REVIEW

DECEMBER 1958—No. 140

TABLE OF CONTENTS

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

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

A PERSPECTIVE VIEW OF THE INTERSECTION OF FOUR FREEWAYS IN LOS ANGELES. (Please See Page 32)

TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

A REVIEW OF
ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

DECEMBER 1958

STEADY GROWTH

THE annual session of the Indian Roads Congress near at hand is an occasion to review some aspects of the trend of work and activities of the Society. Among these, the pride of place undoubtedly goes to the Papers presented for discussion at the general sessions. Since the inception of the Society in 1934, the Papers continue to be discussed with unabated interest and enthusiasm and the Proceedings now record a significant number of over 200 Papers discussed so far, many of which are recognised to be of outstanding merit. These along with the discussions thereon constitute a permanent record of the Society's accomplishments though, let us emphasize, this is only a means to an end and not an end in itself.

Every year about six or seven contributions are added to the pool of road problems so far discussed. Considering that the membership of the Society has now grown to over 17,000, this number seems indeed a meagre one and one would, therefore, wish for a much greater number of Papers to be published throughout the year, so that there may be a greater scope for discussion of problems and greater opportunity for diffusion of knowledge and experience of interesting features of jobs performed and investigations and research carried out, by which those who follow may benefit by what has gone ahead. If anyone is obsessed with an idea of fear or nervousness to brave the storm of discussion, we would assure him that there is probably no greater sense of achievement for a member of any profession than that of having contributed his share to the sum total of professional knowledge and experience, by which not only his interests will be advanced but also the larger ones of the profession. We would, therefore, urge members—both old and young—to contribute more Papers even at a little sacrifice of time and effort all of which we are sure would be well directed towards a worthy cause.

Besides Papers by individual members, there is the work of the Committees, the number of which has now grown to nearly 20, which work on different subjects pertaining to several aspects of roads and bridges. Some of them deal with purely technical aspects of road and bridge designs, soil science, road transport and operation, traffic engineering, mechanisation, road research, etc., while others deal with general matters pertaining to administration, education, organization, finance, etc., in relation to roads. Although it is said in a lighter vein that in difficult situations we do not commit but committe ourselves, yet, by its very nature, the work of the committees is a slow process as the problems dealt with are both difficult and complex and the proposed solutions have to reconcile what are often conflicting shades of expert opinion and judgement. However, the final recommendations which emerge are the result of collective effort towards the evolution of carefully considered and technically sound proposals.

In this connection, particular mention may be made of the work of standardisation of road and bridge subjects, a duty assigned to the Indian Roads Congress by the Nagpur Conference of Chief Engineers. For the evolution of any standard, the very quintessence of expert knowledge and mature experience, irrespective of the quarter from which it comes, has to be distilled so that the product is sound and suitable for widest possible application in the country. A prerequisite to standardisation is availability and utilization of largest amount of information regarding existing practices, and for that reason it seems appropriate that the Indian Roads Congress should duly process and frame the standards on different aspects concerning the use of roads and bridges as it is doing at present.

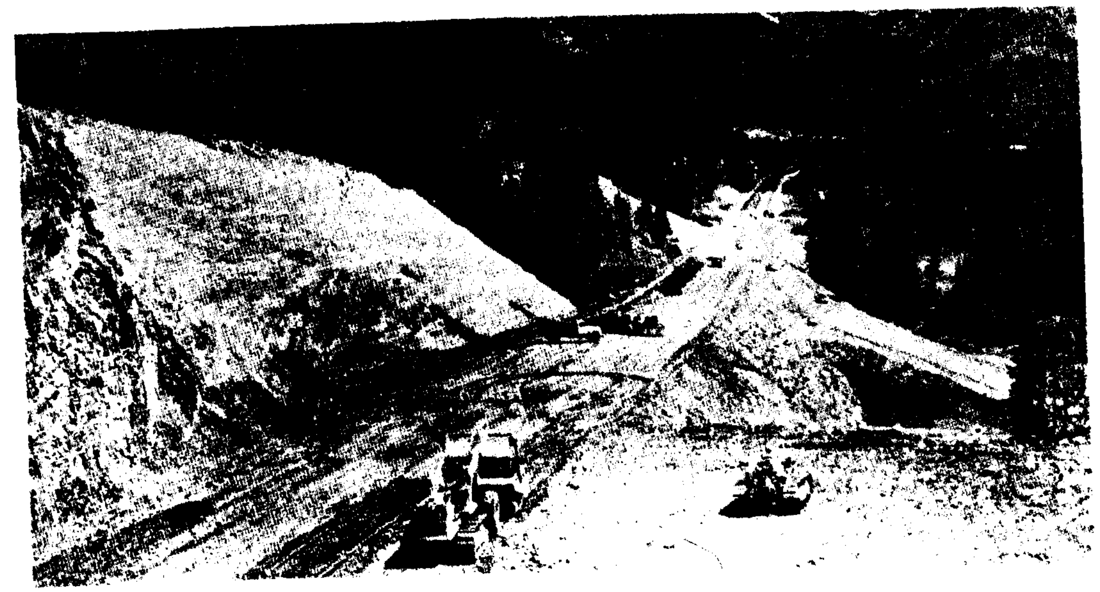
Another aspect which is assuming progressively greater importance for us is road research. Fortunately, we now have several full fledged road research institutions in the country engaged in research work on different aspects of roads, their construction and usage. However, the fruits of research have to be carried to the field and the problems of the field brought to the laboratory. This coordination between the two is indispensable and is best achieved through the instrumentality of the Indian Roads Congress. Since the last two sessions, a report on road research work carried out in different parts of the country is discuss edby the general body where both research and field workers freely participate. There can be probably no better opportunity for this healthy communion than the auspices of the Indian Roads Congress.

The problem of road development in a vast and varied country like India is a complicated one calling for a mean between the conflicting requirements of improvement in quality of roads and provision of extensive road mileage throughout the country. The transport needs of the future will press in both these directions. Towards the former goal the need is for improvement in the strength and durability of pavements consistent with traffic, improvement in the geometric standards of roads, and strengthening of existing bridges where required for carrying increased loads of the future. Towards the latter goal, the idea of low-cost roads in its truest sense should provide a clue for a satisfactory solution. In any case, the approach to these matters by free and frank discussion of the problems, by evolution of well considered standards and codes of practice for economical and practical execution, and with guidance of research and field experimentation, seems to be the right one.

HIGHWAY DEVELOPMENT IN CANADA

WITHOUT efficient patterns of communication and transportation the nation of Canada would not exist today as one of the leading middle powers of the world. The earliest exploration of the country was made possible by the presence of a vast inland system of waterways. Settlement and colonization followed the lines laid down by the Great Lakes and the rivers that flowed into them.

without the assistance of the federal government. Until 4 years ago, federal policy in the field of motor transportation was non-existent In 1954, the privy council ruled that the federal government had exclusive jurisdiction over interprovincial and international transportation. Without a national transportation-development policy motor transportation has grown rapidly, creating an imbalance between the four methods of transportation in Canada.



Construction of the Trans-Canada Highway through Banff-Yoho National Park in the Rocky Mountains

In the 19th Century railways became the chosen instrument of colonisation, pushing settlement into the Canadian west. Today man has devised another means of transportation—the motor vehicle. The Cinderella of the transportation story, motor transportation has within the past 10 years threatened the supremacy of both its predecessors.

Unlike the waterways, the railways and the airlines, Canadian motor transportation has developed almost entirely

The lack of a national transportation policy also has helped to create several anomalies within the highway industry itself. One of these is the absence of a nation-wide assessment of the social and economic functions that roads and streets are fulfilling in Canada today.

The most recent Dominion Bureau of Statistics report estimates rural mileage at 453,000 miles. Included in this total estimate, however, and in the estimates of Saskatchewan and Alberta, which have the first and second largest rural-road mileages, respectively, of all Canadian provinces, are an unknown number of miles of unimproved or unused highway allowance. Surfaced road mileage is much higher, in proportion to the total, in Ontario than in any other Canadian province.

A second anomaly in the Canadian motor transportation picture is the absence of a national highway connecting the 10 provinces. In a country noted for the design and production of one of the most intricate jet engines ever developed, the failure to construct a national highway cannot be attributed to a lack of engineering ability.

Nor has the project lacked support from the Canadian people. The passage of the Trans-Canada Highway Act in 1949 was preceded by 40 years of lobbying on the part of road and motor associations, trucking organizations and other groups from all sections of Canada. At the root of the delay was the Canadian system of divided political jurisdiction over highways and a lack of precedent for federal entry into a field previously considered the exclusive domain of the provincial governments.

Once begun, the Trans-Canada Highway has had a checkered career. The location of the route in order to give the maximum benefit to the nation as a whole has meant that in some provinces it must pass through areas not urgently in need of a highway of this type. These provinces, already straining their budgets to imrove the more heavily travelled roads, have not always been able to give the Trans-Canada route priority.

To speed up construction in these "gap" areas the federal government 2 years ago increased its contributions. Ninety per cent of the construction costs in areas not to exceed 10 per cent of the total provincial mileage is now borne by the federal government. The cost of the remaining mileage is shared equally by the provincial and federal governments as in the original act.

The most serious of the "gaps" not yet closed are in northern Ontario and the Fraser Canyon of British Columbia, where the terrain is particularly rugged. Saskatchewan, is, as yet, the only province to have completed the section of the highway within its borders.

No super-highway cutting a giant swath through the Canadian wilderness, the Trans-Canada has been termed "merely adequate" for current needs for highway experts. Its maximum width of 24 ft may be increased only at provincial expense where traffic warrants it.

Most of the nation's Main Street will be surfaced with asphalt—a 3-in. wearing surface of hot-mix asphaltic material, laid over a minimum of 6 in. of granular base course. Merely adequate as they may be, even these standards are difficult for some of the provinces to achieve. A wide disparity in the technical skills of road construction between the 10 Canadian provinces has further hindered the progress of the Trans-Canada Highway.

Although standards differ, the provinces are generally agreed on the construction needs they must fill within the next decade. These include the provision of a greater mileage of paved highways designed to withstand heavier loads, improved geometric design and the replacement of inadequate bridges. The mechanisation of the road-construction industry in Canada during recent decades has largely paralleled that in the United States.

Striking differences in the industries of the two countries do, however, exist. Factors brought about by Canadian geology and climate pose problems that are encountered infrequently or not at all below the 49th parallel.

There is, for example, no region in Canada free from the problem of snow clearance. Within the past decade advances in snow and ice-removal techniques have made winter travel very nearly as reliable as during any other time of the year. The cost of maintaining the large fleets of snow plows, blowers, sand and chemical stockpiles necessary to accomplish this feat, however, is large.

Because these are essentially Canadian problems their solution rests primarily

with Canadian research agencies. Before the Second World War the lack of research facilities in Canada forced road agencies to turn to the United States where research was already a highly developed, coordinated national activity. Canada retained a larger membership in the U.S. Highway Research Board than of any except the larger States.

The pace of Canadian research, however, has quickened. During the current year an estimated 1,000,000 dollars will be spent by Canadian agencies on the

The Talbot Highway, joining Quebec city and the Saguenay region of Quebec province. This development highway is built through some of the most rugged terrain in eastern Canada and leads to the pulp and paper towns of the Lake St. John area and aluminum city of Arvida.

advancement of knowledge in the highway field. The total, representing one-tenth of 1 per cent of the national government outlay on highways and streets in the current year, still is proportionately smaller than in the United States, but it is increasing rapidly each year.

Closely related to research activities is the technique of long-range planning of future highway and street requirements, which is becoming increasingly popular with Canadian provincial and municipal governments. Experts in the highway field have predicted that within the next 25 years a larger population, earning larger annual incomes, will push motor-vehicle registrations to more than double the present level.

In anticipation of these demands upon their services two provincial governments have established planning branches within their highway departments. The leader in this field is Ontario, which is already entering the second year of a 20-year program of highway and street development to cost an estimated 3,000,000,000 dollars. The province of Saskatchewan will shortly embark on a long-range program.

Although other Canadian provinces have been slower to adopt long-range planning techniques, large municipalities, which can expect the lion's share of future traffic congestion, are attempting to plot the course of urban growth and to prepare for it.

Traffic surveys have been conducted and urban re-development planned in centers such as Montreal, Toronto, Hamilton and Ottawa. The municipality of metropolital Toronto contemplates the expenditure of 160,000,000 dollars during the next 10 years on streets within its 13-member municipalities. The only Canadian city to have incorporated a subway into its transportation scheme, Toronto now plans a second underground rapid-transit facility.

In the heavily populated southern regions of Canada future development is likely to proceed on much the same lines as in the United States, although at a slower rate.

The imminent expansion of the Canadian North, however, will require the establishment of new planning criteria. Economically feasible exploration and exploitation will hinge upon the balanced development of all the transportation services, waterways, airlines, railways and highways.

In the north the role of highways will change. Low-cost, low-standards roads will be required to accommodate the quickly changing patterns of exploration and settlement. The planning and construction of these northern roads can be expected to differ greatly from anything yet encountered in either the United States or Canada.

Another future development of national significance will be the publication of a Canadian Manual of Uniform Traffic control devices. Although traffic signs, signals and pavement markings have been standardized in the United States for nearly a quarter of a century, no similar uniformity exists at the present time in Canada.

The preparation, publication and distribution of a Manual of Uniform Traffic Control Devices for Canada is one of several projects currently being undertaken by the Canadian Good Roads Association. Formed in 1814 and recently reorganized to permit greater emphasis on the advancement of technical information in the highway field, the C.G.R.A. combines in one organization the functions of the American Association of State Highway Officials, the Highway Research Board, the American Road Builders Association, the National Highway User's Conference and the Automotive Safety Foundation.

Like these organizations, the C.G.R.A., as well as most of the Canadian people, are watching with interest the progress of the Neuburger bill in congress, which would make 125,000,000 dollars in United States funds available for the paving of the Alaska Highway.

(From: "Better Roads", September, 1958).

GRAMMAR

The youngster did very well in school except that he couldn't get his past participles straight. He had just finished saying, "I have wrote", and the teacher explained that he was wrong again. "You sit down and write 'I have written' a hundred times," she told him.

The one hundred lines were left on the teacher's desk with this note: "I have wrote, 'have written' one hundred times as you said, and now I have went home".

SOME SPECIAL ASPECTS OF URBAN MOTORWAYS WITH PARTICULAR REFERENCE TO THE STRETFORD-ECCLES MOTORWAY BY-PASS*

By

James Drake, B.Sc., M.I.C.E., M.I.Mun.E.,

County Surveyor and Bridgemaster, Lancashire County Council

IT is only recently that new road schemes of any magnitude have been authorised in Great Britain and consequently any Paper contributed by a British Author must, of necessity, deal with planning and design, rather than with actual experience of operating conditions.

The first urban motorway to start in Great Britain is the Stretford-Eccles Motorway By-pass. It is the Author's intention to discuss a number of aspects of this scheme, from a traffic engineering viewpoint.

Such aspects may not have any individual novel features, but the grouping together of those considerations which have been encountered in practice whilst carrying out one major project, will serve to give perspective to the subject, and provide a basis for comparison or guidance—particularly in Great Britain, where the road programme is just beginning to get underway.

In a recent Paper,† the Author gave his opinion that priority should be given to the National Motorway System and that construction of urban motorways would be very sensitive to the levels of expenditure which can be expected. Assuming a sufficiently high level of expenditure then it is felt that schemes which are to receive approval should measure up to certain standards of value, determined after consideration of cost, traffic volumes and conditions, safety or other special features.

The Author would, however, like to point out that so far as the present example is concerned, a project for the construction of new roads to alleviate conditions at Barton Bridge, was first contemplated in 1925. With a scheme of such standing, it is not surprising that the conditions—high lighted by enormous queues which have formed at Barton Bridge—have tended to speak for themselves.

However, irrespective of this, there is no doubt that any urban motorway schemes carried out in the future will require full traffic engineering investigations in their initial stages.

Description of the Stretford-Eccles Motorway By-pass

The existing road facilities for traffic by-passing Manchester on the Western side and travelling to the heavily industrialised Trafford Park Estate, have been inadequate for many years and with the general increase in the volume of traffic, conditions have deteriorated to such an extent that it has now become imperative to provide a by-pass road which can carry the existing and anticipated heavy volume of traffic with speed and safety. A plan of the area, showing the motorway, is given in Fig. 1.

At present, long distance North/South traffic is compelled to use either A. 575 through Worsley, Eccles and Stretford or to pass through either Salford and

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* A paper presented at the Fourth International Study Week, Copenhagen, September 16-21, 1958.

† Paper No. 2—Institution of Civil Engineers Conference on the Highway Needs of Great Britain, November, 1957.

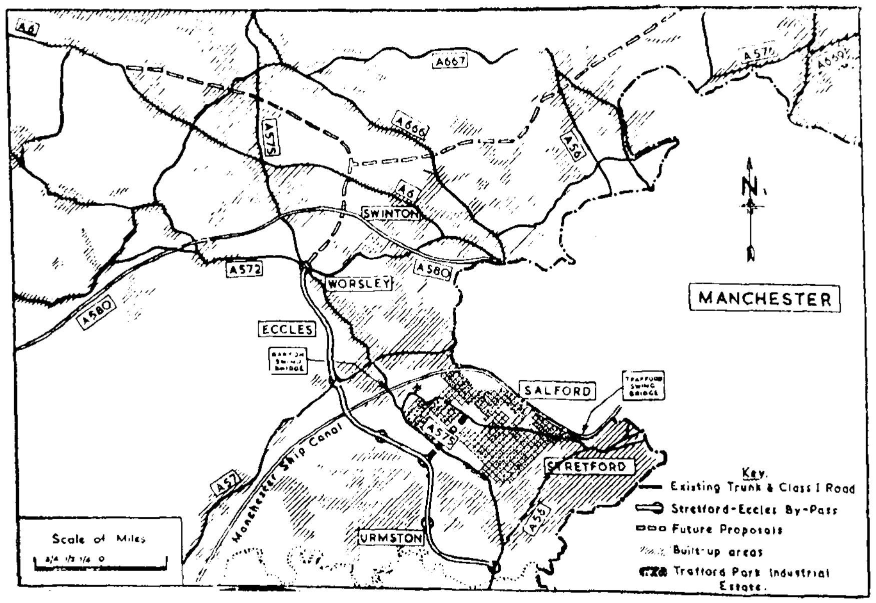


Fig. 1

Manchester itself. In addition, traffic to and from the Trafford Park industrial estate relies on the same road. All traffic passing over the Manchester Ship Canal does so by Barton Bridge which has a carriageway width of only 17 ft 6 in. (5.35 m.) and which is frequently closed to allow ships to pass along the Ship Canal. Workers travelling daily from the north side of the Canal to Trafford Park are particularly affected by the closing of the bridge.

The A. 575 route is mainly narrow, badly aligned, frequently intersected by other major roads and is heavily built up. It has a narrow carriageway, reducing to 16 ft (4.9 m.) over one section. These conditions combine to make the road congested, dangerous and completely unsuitable for the weight of traffic using it.

The Traffic Problem in Detail

Traffic Flow: Basic information regarding traffic conditions can be obtained from straightforward traffic counts on the network of roads in the area. The relation of these volumes to road width and other conditions such as parking, cross-traffic, etc., gives a measure of the overloading. When these findings are examined in the light of quantitative and qualitative observations of traffic behaviour, including pilot counts of origin and destination movements and volumes turning at important junctions, it becomes possible to make an assessment of the amount of traffic likely to use the new route.

Fig. 2 gives details of 16-hour counts of motor vehicles on the main roads in the area. This information is based on the standard census particulars prepared for the Ministry of Transport and Civil Aviation and gives the average daily figures taken over a period of seven consecutive days. Counts of traffic flow at junctions and supplementary censuses have been carried out where necessary to cover any weak points in the network, or to supply information considered to be particularly relevant to the problem. The volumes in fig. 2 have been corrected to 1956 levels of traffic by applying appropriate increases based on a national traffic growth of $7\frac{1}{2}$ per cent per annum.

In considering the capacity of a road, account has to be taken of this annual growth. The standard increase at present in use in Great Britain for ultimate traffic is 75 per cent over 1954 figures, although this is now generally considered to be too low.

Thus considering point "A" on the diagram, the prevailing carriageway width on the road is 20 ft (6.1 m.), although portions are as little as 16 ft (4.9 m.). The capacity of such a road is taken as about 3,000 motor vehicles per day (4,500 private car units). This indicates that the road is already overloaded by 160 per cent and that the ultimate overload will be 300 per cent.

considerable mixed traffic, not evident from the motor vehicle counts, e g., the southern entrance to Trafford Park is used by over 2,000 cyclists going to work in the morning.

The foregoing presents a picture of bad traffic conditions such as should justify new roads. However to secure priority in the road programme, it has been

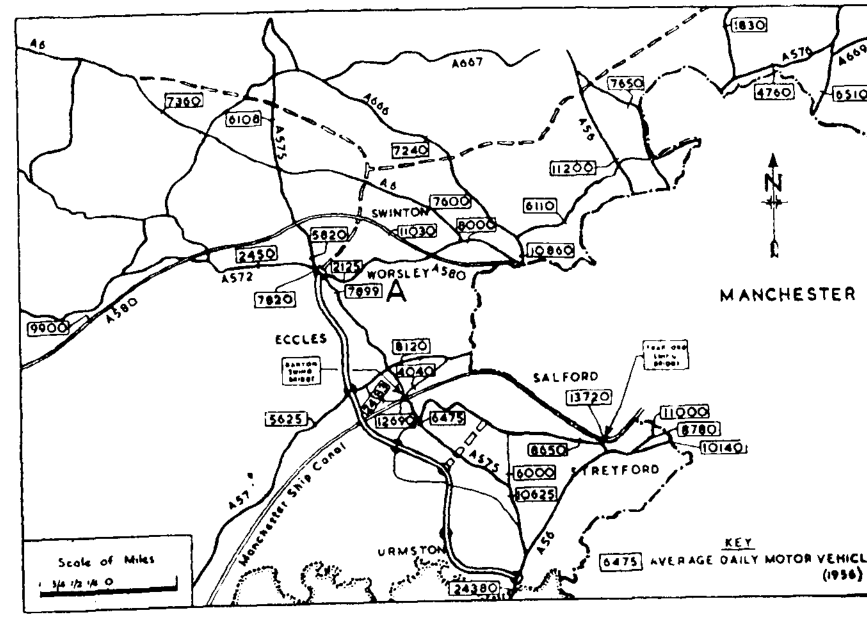


Fig. 2

Although consideration of the daily traffic flows reveals major deficiencies, a further complication is introduced by the peak volumes associated with the commencement and finish of work in the Trafford Park industrial estate. At these times virtually the whole working population from the factories takes to the road, by car, bus, cycle or on foot. There are at present four exits from the estate, and all are already adversely affected by heavy traffic flows on the routes to which the estate gives egress. Consequently the congestion is very severe.

Although there is a tendency for the use of cycles in Great Britain to decrease, they are still very popular for travelling to and from work. This is particularly so in the area of Eccles, Urmston and Stretford, which is comparatively flat. The roads in this vicinity do, in fact, carry

necessary for conditions to be worse than bad. In the case of the Stretford-Eccles by-pass the additional factor is provided by the Barton Swing Bridge.

This bridge is swung to permit the passage of ships along the Manchester Ship Canal. Some indication of the frequency of the closures can be seen from the fact that during September, 1956, the bridge was swung 609 times, the road being closed to traffic an average of 23 times on each week day, the total time closed being 2 hours 55 minutes per week day, i.e., nearly 8 minutes per closure. The gross delay is greater than this as the traffic queues in turn generate their own congestion, particularly as clearance only occurs over the 17 ft 7 in. (5.35 m.) wide bridge. Fig. 1 shows the two swing bridges which provide virtually the sole crossing facilities over the Manchester

Ship Canal, which separates North from South over the whole Western portion of the map.

Another aspect of the problem is the traffic congestion in the centre of Manchester. Although the existing A. 575 route serves as a by-pass to the city, it is not sufficiently attractive to divert much traffic. However, improvements along the Stretford-Eccles by-pass combined with extensions at either end would serve to bring about an improvement in Manchester.

Accidents: The accident position on the roads under investigation, is typical of that for an urban area. During the last four years 214 injury accidents have occurred on the five-and-a-quarter mile length of the route A. 575 between its junction with A. 56 in the South and the Northern terminal of the motorway by-pass. This is equivalent to an accident rate of 5.0 accidents per million vehicle miles.

The accidents included 4 fatal and 43 serious accidents so that such types therefore represent 20 per cent of the whole. This low proportion reflects the congested nature of the roads.

It is hoped that rates of 0.4 accidents per million vehicle miles will be achieved on the motorway and that not more than 50 per cent will be fatal or serious. This indicates an appreciable increase in safety for the distance travelled.

The extra volume of traffic attracted to this route will tend to reduce the apparent accident saving. It is likely, however, that much of the traffic will be attracted from other roads of high accident intensity but the benefits are so widespread that they will be difficult to measure.

Journey Times: A notable feature of journey times on this route is the variation which can occur, according to whether the swing bridge is open to traffic, or closed. Whilst the 5½ mil[illegible] km.) can be covered in just over [illegible] quarter of an hour, at an average speed of about 20 m.p.h. (32 km./h.), when the bridge is closed the journey is considerably longer and may take 30 minutes.

Observations taken over a number of years so that the bridge is closed to road traffic for about 8 or 9 minutes each time it is swung. Allowing for variations each side of the mean and for the time required for the traffic queues to free themselves, it is seen that the journey time will often be more than doubled. On some occasions the bridge swings a second time before the traffic is cleared, so that even worse times are possible.

This feature makes it impossible to plan bus services properly, goods vehicles, flow erratically and to be sure of timing business appointments, a 15-minute safety margin is necessary. Although the details are measurable and can be averaged out, it is considered that the factor of unreliability increases the delay cost considerably more than the average. This appears to be an important factor, which the author has yet to see evaluated or even taken account of, although it must occur to some degree in all situations where congestion is experienced.

The Solution Adopted

In 1949 the road plan for Lancashire, prepared by the county council, accepted the line for the motorway, as shown in the 1945 Manchester regional plan, for a by-pass at the western side of the city but indicated that the road should be of motorway construction.

The line of this new motorway is shown in Fig. 1. Extensions are proposed ultimately in a North-Easterly direction, round the North of Manchester into Yorkshire and also to link with the Preston-Lancaster-Glasgow trunk road A. 6. Extensions are also envisaged running south into Cheshire to form the Altrincham by-pass and along the south side of Manchester to link up with A. 6, and the remainder of the proposed outer ring road.

The present scheme allows for a bridge over the Manchester Ship Canal, which is to be crossed at high level, with viaduct approaches making a total length of half-a-mile (800 meters).

It is evident that a motorway constructed as proposed, will have the following effects:

1. Provide a route for traffic from the North and West to the South and Midlands:

Potential motorway traffic

Proportion already uses A. 575: 20-30 per cent range from 7,899 vehicles per day.

Likely that through traffic from the A. 580, A. 6, A. 666 group will be attracted: 5-10 per cent range from 11,030, 8,000, 7,240 (see Fig. 3).

2. Communications in the Trafford Park will be improved, particularly when the new connecting link is constructed (shown by broad dashes in Fig. 2).

This affects both normal daily flows and workers' peaks.

Potential Motorway Traffic

Proportion already uses A. 575 north of Canal: 25-35 per cent range from 7,899.

Considerable increase, particularly south of Canal with the construction of the Trafford Park Link: 40-50 per cent range from 10,625.

So far as peak flows, in Trafford Park are concerned, free flow will be possible at the north-western entrance, whilst the southern entrance will be freed from the substantial volume of through traffic. The link into the estate will have the effect of doubling the number of accesses from the South and West, and each will be able to operate more efficiently than the two existing ones.

In other words, the Park traffic problems will be solved in the South and West.

3. The extension of the by-pass in a northerly direction to complete the Western outer ring road will provide a better route for traffic which at present goes through Manchester along A. 56.

Potential Motorway Traffic

5-10 per cent range from 24,380.

4. The by-pass and its accesses opens up communications for the section of the Manchester conurbation, covering the Worsley, Eccles, Urmston areas.

5. The construction of the new route will, by added convenience and saving of time, generate and attract further volumes of traffic. The route will provide the only continuously clear through across the Ship Canal for a distance of 15 miles. Such conditions are very favourable for generation of traffic and it is considered that a 20 per cent increase over the "direct" flow allocation is conservative.

When account is taken of the amount of traffic arising from the above sources it is likely that 20,000 vehicles per day will ultimately be passing over the Canal bridge. This figure allows for a traffic growth of 75 per cent over 1954.

Other Aspects of Planning and Traffic Engineering

Planning: It has been mentioned previously that the Barton Bridge Project is of long standing and consequently it has always been to the fore when planning proposals for the area have been considered. Particularly was this the case when the line of the route was decided about 10 years ago. Since that time it has been possible to protect the route from development. Old property has not been rebuilt, whilst new construction is kept well clear of the line.

The result is that today, the new route can be built with comparatively little demolition work, yet it serves considerable areas of development, much of which has taken place recently.

Public Inquiry: In Great Britain the legislation connected with the construction of the new road is formidable, principally in its aspects designed to prote[illegible] interests of the individual. This legislation provides powers for the Ministry of Transport and Civil Aviation to call a Public Inquiry when the objections warrant it.

Such inquiries have been held in connection with the Stretford-Eccles by-pass and it was found necessary to introduce considerations of traffic engineering into the prepared case. Such arguments have included facts and calculations designed to show the necessity for the route. Although these details were presented at the inquiry, it transpired that the objectors did not challenge the justification to the route, but confine their opposition to questions of necessity particular junctions and to the road line. In the latter case it was possible to show that other lines could only be obtained by a sacrifice in the standards of alignments, for which the minimum radius has been maintained at 2,000 ft (610 m.).

The siting of junctions required more involved calculations. The principal objection to be resisted was to the effect that the northern motorway connection be omitted and the road be extended to A. 580 (see Fig. 1).

It was possible to show that although the extension to A. 580 forms part of the ultimate proposals for the Manchester Outer Ring Road, the construction is not an economic proposition, until a further source of traffic is tapped. If the motorway were extended to A. 580, no other significant traffic sources would become available as the motorway would virtually form a "T" head with the east-west route, which already has branches (A. 572 and A. 575) towards the south. An appreciable volume of new traffic would only be attracted if the motorway were extended northwards to A. 56.

The extension of the motorway and the omission of the junction at A. 572 would appreciably increase the travelling distance for a large proportion of the traffic. Calculations were made of journey times and of the corresponding volumes of traffic affected to demonstrate the reduced value of the objectors' proposal.

Phasing: The phasing of a programme of motorway construction is an important feature, calling for traffic engineering investigations. Economic difficulties often require a route to be constructed in sections and it is seen from the previous example that the selection of terminal points, designed to produce efficiency at each stage, becomes a matter of judgment and investigation.

In this connection it is important that a "Road plan" be prepared so that integration of individual schemes into the overall pattern can be fully considered.

Design

The motorway will have no cross traffic, no steep gradients and no sharp curves, horizontal and vertical lines having been coordinated to give a smooth curving ribbon effect. The carriageways will be separated by a central verge and special hardened shoulders will be provided along the near edge of each, for emergency uses. Lay-bys will be provided for parking purposes. In addition to the terminals, there will be four other connections to the motorway, giving an average spacing between each of 1.2 miles (1.9 km.).

In general, the road width is 94 ft (28.7 m.), with dual carriageways each 24 ft (7.3 m.) wide. A contrasting marginal strip 1 ft (0.3 m.) wide, flanks each side of the carriageways. The outer verges are 14 ft 6 in. (4.4 m.) wide including the 8 ft (2.4 m.) hard shoulder. The central reserve is 13 ft (4.0 m.).

Over the bridge, the deck width is 73 ft (22.3 m.), consisting of two 24 ft (7.3 m.) carriageways with 1 ft (0.3 m.) margins, 9 ft (2.7 m.) central reserve and 6 ft (1.8 m.) side verges. The minimum radius is 2,000 ft (610 m.) and the maximum gradient 1 in 23.

Economy Aspect

As this urban motorway is the first in Great Britain it is believed that a useful purpose is served by assessing an approximate figure for the economic benefits arising from the motorway and relating these to the expenditure involved. Details of the calculations are given in Appendix 1.

It should be understood, however, that the figures have been prepared solely for the purpose of this Paper, and were not required to secure approval to this

scheme. The case for the scheme was based on a qualitative examination of conditions reinforced by such quantitative measurements of traffic flow, delays, accidents, as have already been described.

It may well be that in future a high degree of quantitative analysis may be necessary to judge between competing schemes, but some standard procedure and empiricism will probably need to be evolved.

APPENDIX 1

Investigation of Economic Returns.*

Estimated average Volume of traffic on the motorway by 1965 = 16,000 vehicles per day

Of this volume, about one-fifth is generated traffic which it is proposed to ignore in this investigation.

Thus, net volume of traffic on the motorway
Traffic remaining on existing A. 575 route = 18,000 vehicles per day

Vehicles have also been diverted from other routes, but these are not very widespread and it is not possible to calculate the relief on these routes = 5,000 vehicles per day

Existing Route:

Present journey time	17.0 minutes per vehicle
Nominal allowance for Bridge unreliability	1.0 minutes per vehicle
Congestion due to increased traffic by 1965	5.0 minutes per vehicle
Total...	23.0 minutes per vehicle

Motorway:

Estimated average speed ...	40 m.p.h. (64 km./h.)
Length ...	5.95 miles (9.5 kms.)
Journey Time ...	9.00 minutes

Time spent each year under urban conditions if motorway is not constructed $= 18{,}000 \times \frac{23}{60} \times 365 = 2{,}500\ 000$ vehicle-hours.

Time spent each year running under urban conditions when motorway is constructed $= 5{,}000 \times \frac{18}{60} \times 365 = 546{,}000$ vehicle-hours.

Saving of running under urban conditions = 1,954,000 vehicle-hours.

* "The Basic requirements for the Roads of Great Britain," by W. H. Glanville and R. J. Smeed, Institution of Civil Engineers Conference, 1957.

Time spent each year running under motorway conditions $= 13{,}000 \times \frac{9}{60} \times 365 = 711{,}000$ vehicle-hours

Taking the values derived in the above-mentioned Paper of 5 shillings for the value of a vehicle-hour on rural roads and 10 shillings for urban roads, then the total saving amounts to 800,000 pounds.

This sum represents 15 per cent of the total estimated cost of the Motorway, which is 5¼ million pounds.

The above calculations neglect the value of the accident saving and of the cost of running over the extra third mile (5.40 m.) required due to the increased length of the motorway. The former is greater but the monetary values are small compared with the other savings and the result is not materially affected by neglecting their difference. It should also be mentioned that the figures of 5 shillings and 10 shillings mentioned above are approximations which tend to under-estimate the gains from road improvement since they make no allowance for non-working time saved nor for additional comfort and convenience.

(*From : " Roads and Road Construction ", October, 1958.*)

DEFINITIONS OF HIGHWAY ENGINEERING TERMS

CATCH-WATER DRAIN: A drain excavated on the upper slope of a hill road to intercept and collect water flowing towards the road, and to lead it to a point where no damage will result to the road.

CATCHMENT AREA:
(1) The area drained by a water course at any section.
(2) Area from which the rainfall flows into
(a) a drainage line at any specified section or
(b) a reservoir.

FOUNDATIONS FOR ROADS AND STRUCTURES *

IT is not entirely fortuitous that in 1958 one may see roads and other structures, built over a period of many years, continuing to play the part which their designer originally created for them. That the proportion of failures in such structures is very small is to a large extent due to the satisfactory design and construction of their foundations. Such foundations must be designed to meet technical standards which have been evolved over many years and also to satisfy important economic factors. Indeed, technical knowledge is now so advanced that the designer must appreciate the economics of the position in view of the present high costs of labour before allowing expensive modern methods to influence his thinking. In order to consider this criterion for a satisfactory design one must appreciate the methods which enable such structures to be founded. In the following review, these will be discussed from a general point of view, since most foundation design is of a well-known nature.

It would not be out of place at this stage to define the function of a foundation. A foundation may be described as a buffer between a dead or live load and the earth's crust. It is clearly the vital part of a structure, although in most instances its position requires it to be below ground level and therefore out of sight. Nevertheless, its importance is such that nowadays when a contractor occupies a site it is generally quite a time before there is any evidence of construction above ground level.

In the following assessment, the methods employed in obtaining satisfactory foundations in both roads and various structures will be discussed and for each case the theoretical and constructional approach will be suggested. The vastness of civil engineering makes it impossible for the examples to be comprehensive, but it is to be hoped that those cases discussed will afford an indication of what the designer and contractor should aim for.

Preliminary Site Investigation

It is now generally accepted that preliminary site investigation is an essential part of all construction work, and money so spent will prove to be well invested. In new road construction, boreholes to determine subsoil conditions should be put down to levels several feet below the existing level in the case of embankments and below the formation level in the case of cuttings. The spacing of boreholes on the line of the road is a matter of local determination and should be of the order of 200 ft. Where a new embankment is of appreciable height it is wise to put down boreholes to about twice the embankment height below the final level. This will ensure that any settlement due to soft organic strata being compressed may be predicted and may indicate that the road alignment would be better altered to obviate this.

In addition to boreholes, the soil type, grading, density, shear strength, California Bearing Ratio and other bearing properties should be determined. These will be referred to later and with this knowledge the designer will be able to prescribe the correct method of construction.

For structures other than roads, the intensity of loading at foundation level is somewhat higher and therefore a more detailed investigation will be necessary. Boreholes should be put down to determine the stratum which will give the required bearing capacities, and undisturbed samples of cohesive strata should be obtained in order to measure shear strengths. The grouping of boreholes in such an investigation will usually eliminate any risk of missing an existing weakness in the sub-strata.

* The winning thesis in the Richard Pickering Prize Competition, 1957-58, on the subject 'The Methods employed in obtaining Satisfactory Foundations for Roads and Structures'.

Road Design

1. **Preformation Level:** It is very rare for a road to be constructed without some form of excavation or filling and it is advisable to take special care in the design of cuttings and embankments in order to maintain overall stability. In cohesive soils the possibility of a rotational failure should be investigated. With reference to Fig. 1, the factor of safety for the embankment slope stability should be at least 1.5 and the embankment slope designed accordingly. Embankments should generally be composed of non-cohesive materials which will not produce failure in this way.

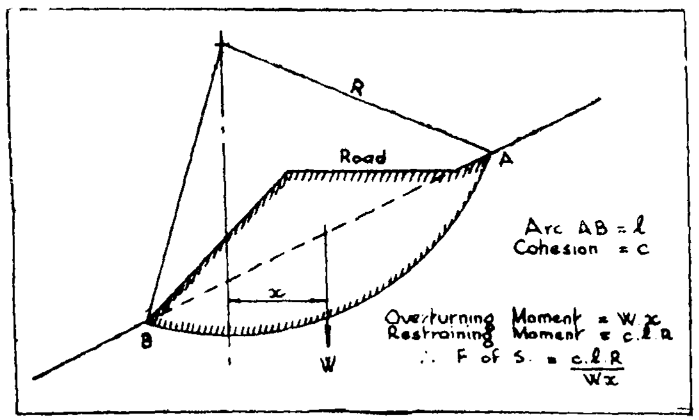


Fig. 1. **Overall Stability.**

2. **Pavement Foundation:** It is well known that road pavements may be classified as either flexible or rigid, the former being composed of compacted layers of broken stone and the latter of concrete in some form. The design of pavement thickness is not an exact process and it must be realised that experience is the overruling factor which shows the designer if the results are sensible. The problem is to determine what thickness of paving is required for a given type of loading and perhaps the most well-known and widely-used method for flexible pavements is the C.B.R. method.

The California Bearing Ratio method measures the relative bearing values of different layers of material below the surface level in terms of a standard layer of broken stone. The apparatus consists of a tube containing the material under investigation and a plunger which is allowed to penetrate the material at a given rate. The results are plotted as a graph of load and penetration and the C.B.R. value determined from the position of the curves.

Fig. 2 shows how the C.B.R. values may be used to design a pavement. The bearing value for the different layers has been previously determined and by using the design graph obtained from a long

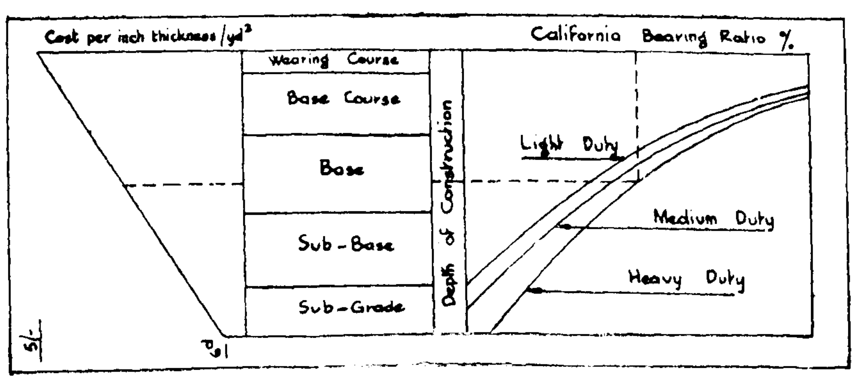


Fig. 2. **Design.**

series of experiments the road foundation may be designed. The figure also shows the approximate relative costs of the various materials in a road and one may quickly arrive at an economical section especially if cheap local materials are available. It should be remembered that the C.B.R. method gives a conservative design and the actual thickness of paving constructed may be only about 80 per cent of the design thickness.

Rigid pavements in themselves are foundations since the slab, usually of concrete, is supported directly by the sub-grade. The methods of design are less empirical than for flexible pavements and it may be mentioned that the formulae of Westergaard and Boussinesq enable the pavement thickness to be determined. This theoretical approach is necessary in airfield runway design where heavy wheel-loads constitute the traffic and the pavement must be capable of reducing the stresses at subgrade level to bearable limits while maintaining its own stability.

Road Construction

1. **Materials Available.** The basic material for road foundations is natural or broken stone and the method of use depends on the type of pavement required. For flexible pavements, Fig. 3 shows the materials which may be used. It is important that the grading of materials will give a dense layer on compaction and very often blending of materials will be necessary to achieve this grading.

For rigid pavements or cement stabilised base layers the aggregate or naturally occurring subsoil is bound together with cement which is mixed-in in concrete mixers or pulvimixers respectively. Lean-mix concrete of about 1 : 14 is a common foundation layer and the method of laying is illustrated in Fig. 6. Stabilised base layers formed in situ (soil cement) may be used if the soil type is satisfactory. Preconstruction tests should be made to determine if the cement will hydrate and cubes taken to find the cement proportion to give a seven-day compression test result of 150 lb per sq. in. Soil cement construction can achieve considerable economy over more conventional methods.

2. **Methods of Construction:** It is of great importance to obtain a high degree of compaction of materials for road foundations. Fig. 4 shows the relation between dry density and moisture content of a material and dry densities of 95 per cent of the optimum value should be aimed at. This objective clearly demands close supervision of construction and compaction in layers, but with

Wearing Course	Coated Macadam or Asphalt
Base Course	
Base	Soil Cement Macadam Lean Concrete
Sub-Base	Soil Cement Gravel, Slag
Sub-Grade	Natural Soil

Fig. 3. **Materials.**

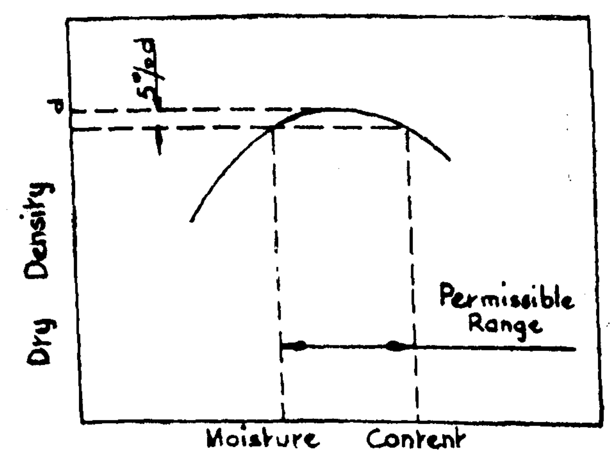


Fig. 4. **Compaction.**

Reference should be made to the relevant British Standards to determine the quality of material required. It is modern plant available it is easily possible. For subgrade materials, sheepsfoot and pneumatic-tyred rollers and vibrating compactors may be used. Fig. 5 illustrates these types, the sheepsfoot being most satisfactory for compacting dry cohesive materials, while the pneumatic-tyred and vibrating rollers for cohesionless materials.

maxim where road improvements are concerned to interfere with existing sound construction as little as possible as a well-compacted paving is a very good start to a foundation. For cement stabilised materials or weak concrete founda-

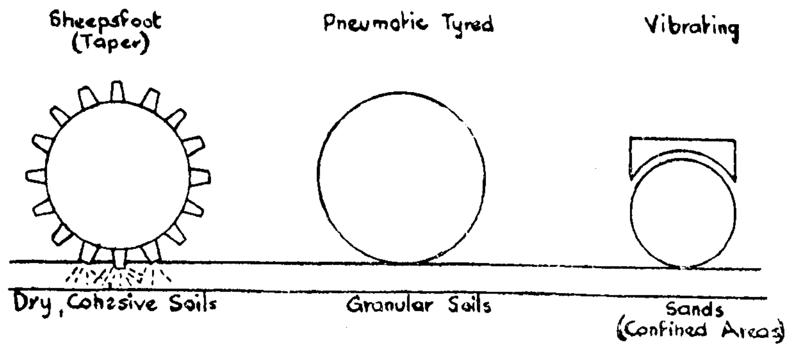


Fig. 5. **Types of roller**

Macadam layers may be laid by means of tracked machines which compact the stone in predetermined thicknesses, although after-rolling is usually necessary. It is most important that for rigid pavements the formation to receive the paving is as smooth as possible. This

tions, considerable economy and speed of construction may be achieved by the use of a sequence of plant as shown in Fig. 6. It is important that in concrete foundations the whole layer is well vibrated in order that the full depth will be effective in transmitting surface loads. (See

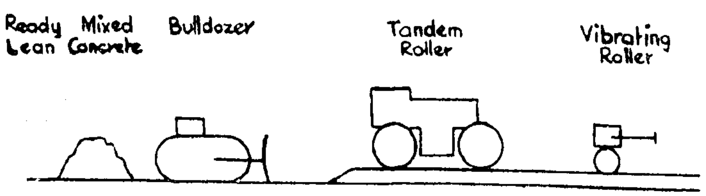


Fig. 6. **Mechanisation for lean concrete foundations**

precaution will greatly reduce friction forces which may cause local failure and may be achieved by rolling the subgrade and using water-proof paper. It is a good

Fig. 7). The vibration ensures that the bottom of the layer achieves the same

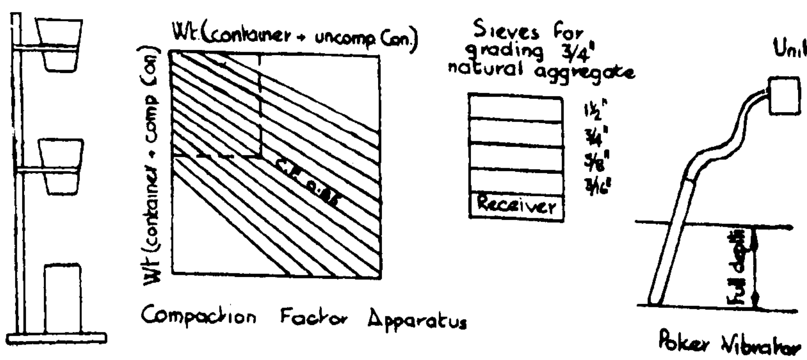


Fig. 7. **Control of concrete.**

(Continued on page 33)

NEW FORMS IN CONCRETE BRIDGES

IN prestressed concrete continuous beams, the designer has the facility of being able to transform a prestressing cable profile in such a way that while the stresses in a beam remain unchanged, the reactions at the supports can be varied. This process, known as linear transformation of a cable profile, has been extended by Professor D. Vandepitte to its logical conclusion to produce a concrete bridge analogous to the steel suspension bridge. This idea has been applied by Professor Vandepitte to a number of bridges; the bridge at Merelbeke across the Ring-canal in Belgium is an example of this form of construction. The bridge is, in Professor Vandepitte's opinion, not a good example of this form of construc-

forced concrete box abutments which are filled with sand and connected to the end of the bridge by a hinge of the Mesnager type at one end and by eye bars at the other to allow horizontal movement.

The stiffening beams are 5 ft 5 in. deep and the transverse section of the bridge is as shown in the diagram. The suspenders for the cable are bent rods bearing on cable bands and are anchored to the transverse diaphragms of the bridge as also shown in the diagram. The cable itself is composed of 510 galvanised high tensile steel wires of 0.2 in. diameter which are all parallel. The two main cables are in fact parts of one endless cable which is looped round two end blocks in the bridge

Merelbeke Bridge

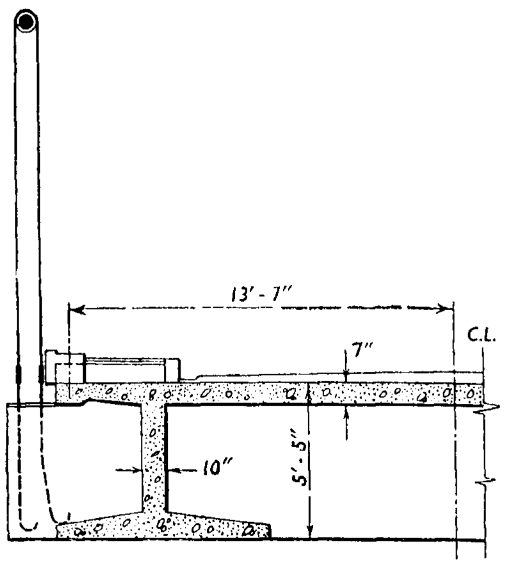
tion since it represents virtually the lower limit to the range of spans for which it is suitable. However, it will serve as an illustration.

The elevation of the bridge is shown in the illustration. The centre span only is suspended since the side spans are relatively short compared with it. The two main stiffening beams are continuous over the intermediate supports, giving three spans of 59 ft, 183 ft and 59 ft. The action of the cables at the ends of the bridge is counteracted by the large rein-

deck; at each block the main cable is split into three separate cables and the wires in each cable are arranged in a steel channel placed round the end block.

Prestressing of the entire structure was effected by pushing up the four columns simultaneously by hydraulic jacks, there being two jacks per column. The rise of the cables governed the amount of prestress applied to the bridge and in this case was 14½ in. Since the frame consisting of the columns and their bracing was independent of the actual bridge deck the elevation of the roadway above the piers was not changed by the prestressing operation.

On completion of the stressing operation, cast steel hinges were placed under the columns and packed into position so that the jacks could be removed. Downward reactions at the intermediate supports are taken directly by the piers, while any upward reactions are transmitted by three tie rods to the foundations.



Transverse section of Merelbeke Bridge

This form of construction opens new fields in multi-span bridge design, particularly when the spans are of the order of 300 ft or more. Professor Vandepitte believes it possible, both economically and technically, to build prestressed concrete bridges of spans up to 1,000 ft in this way.

The other form of construction which is notable is that put forward by Dr. Ing. R. Morandi for the Maracaibo Bridge in Venezuela. This bridge joins the opposite banks of the Maracaibo Lagoon and has a total length of about $5\frac{1}{2}$ miles. The entire structure is to be in prestressed concrete with 10 spans of 490 ft and one span of 1,300 ft and a clearance under the bridge of a minimum of 150 ft. It is in the design of the large central span and the two adjacent spans that the new approach is evident. A short description of the design will make this clear.

At the ends of the three-span central section the design incorporates two X-shaped supports; the outer, upper arms of these supports supply the bearings for the adjacent spans. The other arms serve three functions:

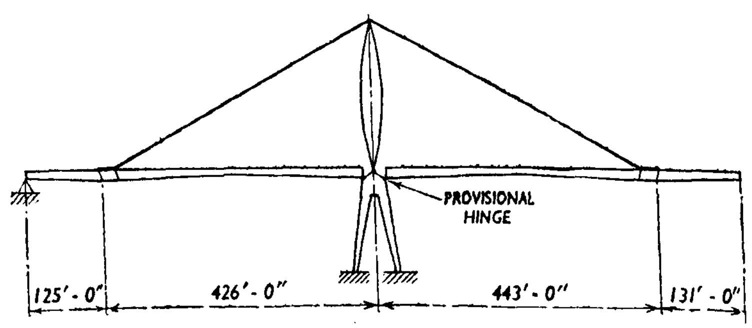
(a) To contain the tension ties for the adjacent span.

(b) To contain the tension ties for the end span in the central section.

(c) To support the end span of the central section.

In this way the ends of the three-span central section are capable of sustaining both the upward and downward reactions caused by the passage of loads across the central section.

The two intermediate supports for the three-span beam are also of special form; they are shown in the diagram. The end spans are supported on the X-shaped supports and the central piers and also by sloping ties from the top of an extension



Arrangement at pier of central section of Maracaibo Bridge

210 ft high on the intermediate piers. The central span consists of two sections supported by the ties from the towers and a suspended span.

The method of construction is for the two sections supported by the ties to be constructed on falsework with hinges at the junction with the intermediate supports. By tensioning the high tensile steel ties to the design value, the beams will be supported and also partially prestressed by the horizontal component of the force in the tie. The simply supported beam will be launched between the two systems in equilibrium at each of the intermediate supports. At this stage the aerial ties will be sheathed in concrete but allowing free movement of the steel. The ties will then be further tensioned to compress the sheath and the cables grouted. Finally, the provisional hinges will be locked.

The purpose of the concrete sheathed cables is to reduce the vertical variations of the elastic supports which depend on the movement in the concrete sheath rather than the steel cables. This ensures that the behaviour of the horizontal elements is completely different from that in a normal suspension bridge.

(From "Developments in the Design and Construction of Concrete Bridges", by P. G. Bowie and R. E. Rowe, The Engineer, Oct. 24, 1958.)

PURE LOGIC

"If ever I don't know what to do when I'm driving," said she, "I just imagine it's my husband driving, and I know at once what to tell him to do."

CURIOSITY

An old lady at the Zoo kept on looking at a rhino and then asked the Keeper: "What is the sex of this rhino?" The Keeper replied: "The sex of the rhino, Ma'am, is a matter of concern to other rhinos only."

ROAD SURFACE-WATER DRAINAGE

By

MR. A. R. MOLLISON, B.Sc., A.M. INST. H.E.

A badly drained road is an inconvenience to road users, and in certain cases can be a source of danger. The system should be so designed that it adequately deals with storm conditions but, of course, that it is no more expensive than it has to be.

General Considerations

The surface of the road must be given sufficient cross fall or camber to allow the water to shed reasonably quickly to the channels. The minimum crossfall found practicable is about 1 in 40 for bituminous macadam surfaces, 1 in 50 for asphalt and 1 in 60 for concrete. The crossfall to be adopted also depends on the method of laying the material, i.e., whether hand laid or machine laid, and the skill of the operators.

The latter considerations determine to an even greater degree the minimum longitudinal gradient of the channel. It is not advisable to make this less than 1 in 200 unless a specially formed channel, say in concrete, is used. When flat stretches are unavoidable a channel in precast concrete units or cast in situ concrete is a considerale advantage as it can be laid accurately to gradients at flat as 1 in 250.

It almost goes without saying that valley curves require to be drained at the lowest point. It should be noted that low points may occur at places other than in valley curves. For instance, if the carriageway is fairly flat and super-elevation is applied, then the raising of the outer channel may produce a low point. One other point should be noted with regard to valley curves. If a vertical curve of large radius is used then there will be a certain length of the road which is more or less flat. The difficulty will be experienced with summit curves as well as valleys. A suggested method of dealing with this is described under the section headed "Flat Stretches."

There are certain places, e.g., at road junctions, where special treatment is required and is usually necessary to prevent channel flow from streaming over the carriageway. The arrangement of camber, crossfall or gullies, etc., will depend on the layout.

Spacing of Gullies

The spacing of gullies is affected by several considerations, most of which cannot be easily determined and practically all of which vary. It is not easy, then, to determine any definite rule, but the following calculations are made in an attempt to derive a theoretical basis for design.

Model tests or other experiments in a laboratory would probably help in substantiating or correcting the results.

The basic factors to be considered are:

(a) The area of surface to be drained;
(b) The permeability of the surface;
(c) The intensity of rainfall;
(d) The quantity of water that can be discharged through the gully;
(e) The limiting flow in the channel.

(a) Area of Surface

The method adopted in deriving a formula will be to determine the area of surface (A) which can be drained by one gully for the given set of conditions. The spacing of the gullies is then found from:

$$A = L \times W \text{ ....(1)}$$

Where L is the required spacing and W is the width being drained.

(b) Permeability of Surface

The permeability of the surface will depend upon the type of material used. Concrete and asphalt will probably allow no water to permeate, unless at joints or cracks. Coated stone surfacing materials, however will have a certain permeability (see "Porosity of Graded Carpets" by J. D. Pocock and R. W. Bell—Surveyor, 9th June, 1956). In view of the fact the surfacing will be renewed relatively frequently compared with the life of a road it will be advisable to design for the worst case, that is for nil permeability even though it is known that this will not be the case at time of construction.

(c) Intensity of Rainfall

The intensity of rainfall will be taken as 1 in. per hour. This represents quite rare storm conditions but it should be remembered that the drainage system is intended to prevent flooding and must have a reasonable factor of safety against such occurring.

(d) Discharge through Gully

The quantity of water that the gully can take will depend on two limiting factors—the amount flowing in the pipe connection to the sewer, and the amount flowing through the surface grill or side entrance.

It is assumed that the connection to the sewer is a 6 in. fireclay pipe and calculations are based on the pipe running half full. The pipe is then an open channel, and the Chezy formula is used. The gradient of the pipe is variable and the problem is to relate area of surface drained to gradient of pipe connection.

$$\text{Chezy formula } V = C\sqrt{mi}$$

$$m = \text{hydraulic mean depth.}$$

$$= \frac{r}{2} = 0.125 \text{ ft.}$$

$$\text{Bazin value of } C = \frac{157.6}{1 + \frac{N}{\sqrt{m}}}$$

$$= \frac{157.6}{1 + \frac{0.20}{\sqrt{0.125}}} \quad \text{(assumed value of } N = 0.20)$$

$$= 100 \text{ (approx.)}$$

$$V = 100\sqrt{mi}$$

$$= 100 \times 0.353\sqrt{i}$$

$$= 35.3\sqrt{i} \text{ ft/sec.}$$

$$Q = aV = \frac{\pi r^2 V}{2}$$

$$= \frac{\pi (0.25)^2}{2} \times 35.3\sqrt{i} \text{ cusecs.}$$

$$= 3.46\sqrt{i} \text{ cusecs.}$$

But the volume of water delivered from the surface to make up this flow is the area (A) × intensity of rainfall (ft/sec.)

$$\text{Area} \times \text{Intensity} = 3.46\sqrt{i}$$

$$\text{Area} \times \frac{1}{12 \times 3600} = 3.46\sqrt{i}$$

$$\text{Area} = 14.95 \times 10^4 \sqrt{i} \text{ sq. ft.}$$

At a gradient of 1 in 100 this gives a drained area of 14,950 sq. ft. and at 1 in 50 and area of 21,200 sq. ft. At steep gradients turbulent flow will occur in the pipe, however, the high values suggest that the gully connection is hardly likely to be the deciding factor.

Normal gully entrances can allow large quantities of water to flow through them. Surface grills have openi[illegible] 50 sq. in. or more and side [illegible] also have [illegible] large orifice. As the [illegible] of a 6 in. diameter pip[illegible] 28 sq. in. it is not likely that the gully [illegible]nce will be a deciding factor.

(e) Channel flo[illegible]

The limiting flow in the channel [illegible] dictated by the necessity to preven[illegible] excessive spread of water across the carriageway. Water spreading over the surface cuts down the effective width of the road and is also a nuisance to pedestrians. At steep gradients the flow may also tend to by-pass the gully entrance.

Calculations are based on a maximum width of channel flow of 30 in., which is not assumed excessive for an intensity of 1 in. of rainfall per hour, The channel section is an important factor and calculation for a flow section as shown in Fig. 1 is as follows :—

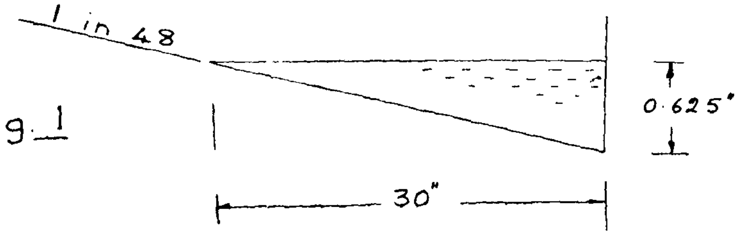


Fig. 1

Hydraulic mean depth $m = \frac{30 \times 0.625}{2 \times 144}$

$\times \frac{12}{30.625} = 0.0255$

Chezy formula $V = C\sqrt{mi}$

Bazin value of $C = \frac{157.6}{1 + \frac{N}{\sqrt{m}}}$

$= \frac{157.6}{1 + \frac{0.30}{\sqrt{0.0255}}}$

Assuming $N = 0.30$

$= 54.7$

$V = C\sqrt{mi} = 54.7\sqrt{0.0255\sqrt{i}}$

$= 8.74\sqrt{i}$ ft/sec.

$Q = \frac{30 \times 0.625}{2 \times 144} \times 8.74\sqrt{i}$

$= 0.568\sqrt{i}$ cusecs.

Area $\times$ Intensity $= 0.568\sqrt{i}$

Area $\times \frac{1}{12 \times 3600} = 0.568\sqrt{i}$

Area $= 2.45 \times 10^4 \sqrt{i}$ sq. ft.

The area of road surface which can be drained by a channel into one gully can be obtained from this equation for any particular gradient of the channel.

Graph No. 1 has been plotted from calculated values. At gradients over 1 in 100 the line of the graph was altered from the dotted line (calculated) to the full line (assumed). This alteration was considered necessary to cater for turbulent flow which will occur at steep gradients and for the possibility of channel flow by-passing the gully entrance.

Graph No. 2 has been prepared in the same way as described above, in this instance for a carriageway crossfall of 1 in 30. It will be observed that the values of A are correspondingly much higher than where the crossfall is 1 in 48.

The graphs show that the flow in the channel is a more deciding factor than the discharge through the gully.

Flat stretches

When the longitudinal gradient of the carriageway is flatter than 1 in 200 special measures must be taken to ensure that drainage is maintained. A common procedure is to form the channel between gullies as shown in Fig. 2.

It will be observed that the crossfall of the carriageway varies—from a maximum at the gully (G) to a minimum at the summit (S) of the channel. In this way the channel can be laid to the minimum fall even although the centre line is at a flatter gradient.

The resultant undulations on the carriageway are not excessive and do not give unpleasant effects for vehicle speeds up to 30 m.p.h. The method is suitable for roads subject to speed restriction but may be undesirable on those carrying faster traffic. In the latter case, however, a raised kerb may not be required and drainage to the verge or to French drains can be employed.

The channel section for the method shown in Fig. 2 can be determined by drawing, or levels, etc., can be calculated

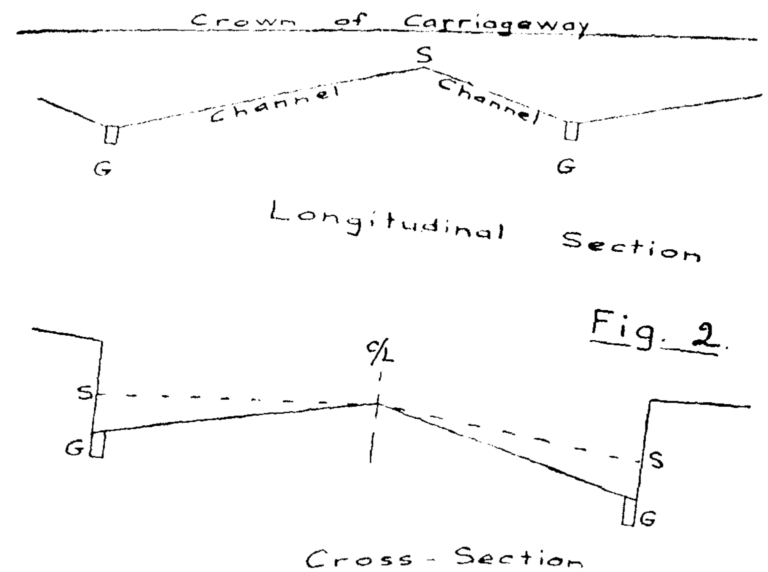
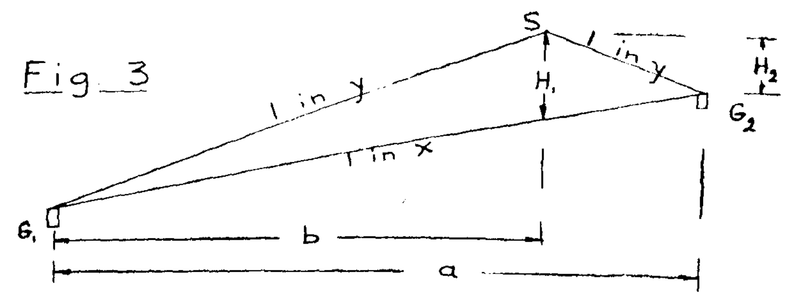


Fig. 2.

Fig 3



using the following formulae which refer to Fig. 3.

$$H_2 = \frac{a\,(x-y)}{2xy} \quad \ldots\ldots (2)$$

$$H_1 = \frac{a\,(x^2-y^2)}{2x^2\,y} \quad \ldots\ldots (3)$$

$$G_1S = b = \frac{a\,(x+y)}{2x} \quad \ldots\ldots (4)$$

Example

A 30-ft carriageway has 7 ft 6 in. footpaths on either side and is to be laid to a longitudinal gradient of 1 in 600. The minimum gradient of the channel is 1 in 200. What is the spacing of the gullies (a) on the straight where the carriageway is cambered and (b) on the curve where the carriageway is superelevated to 1 in 30?

(a) The crossfall will be taken as 1 in 48 minimum and 1 in 30 maximum.

Over 15 ft 1 in 30 gives a rise of 6 in. at the crown.

Over 15 ft 1 in 48 gives a rise of 3¾ in. at the crown.

Difference $= 2\frac{1}{4}$ in. $= H_1$ in equation ...... (3)

$$H_1 = \frac{a\,(x^2-y^2)}{2x^2\,y} \quad \ldots\ldots (3)$$

$$\frac{2.25}{12} = \frac{a\,(600^2-200^2)}{2 \times 600^2 \times 200}$$

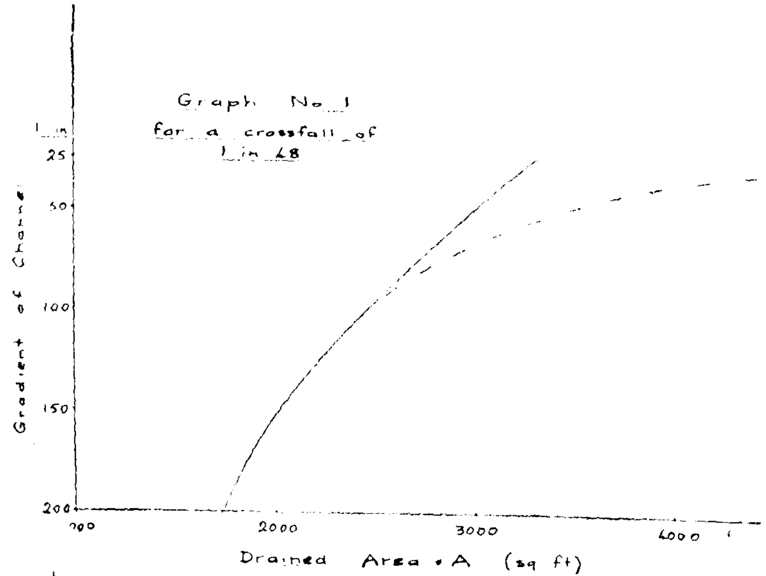
$a = 84$ ft.

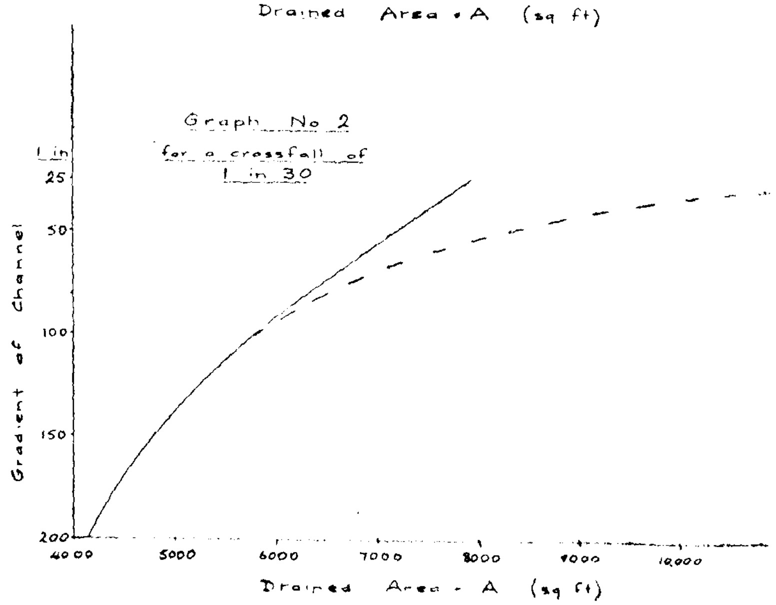
But $A = L \times W$......(1) and in this instance W = half the carriageway width + width of one footpath.

$A = 84\,(15+7.5)$

$= 1890$ sq. ft.

From Graph No. 2, maximum area A at a grade of 1 in 200 is 4150 sq. ft. The spacing of 84 ft is permissible.





(b) When the carriageway is superelevated all drainage will be to one channel, and

$$W = 30 + 7.5 + 7.5 = 45 \text{ ft}$$

Taking the value of area A from Graph No. 2 as before then

$$4150 = L \times 45 \text{.....................} (1)$$

$$L = 92 \text{ ft} = \text{required spacing}$$

We now have the case where the spacing is fixed by channel flow and the carriageway must be graded to suit.

$$H_2 = \frac{a\,(x-y)}{2xy} \quad \text{......} (2)$$

$$= \frac{92\,(600-200)}{2 \times 600 \times 200}$$

$$= 0.1518 \text{ ft or } 1.8 \text{ in.}$$

Normally one channel should be 12 in. above the other to give a superelevation crossfall of 1 in 30. To cater for the provision of summits in the channel the fall will vary between 12.9 and 11.1 in. in 30 ft, that is the crossfall will be between 1 in 28 and 1 in 32.5.

(*From "The Journal of the Institution of Highway Engineers", October, 1958*).

HERE AND THERE

1. TRAFFIC STUDY WEEK—JULY, 1959

● A TRAFFIC Study Week is being organized at Bombay in July, 1959 under the auspices of the ECAFE. The exact dates and programme will be announced shortly. In the meantime, members are requested to contribute Papers on the following subjects for discussion at the proposed Traffic Study Week:

I. Accident studies

(a) Traffic accident statistics: accident report forms, reporting procedure and filling of reports;

(b) Analysis of causes of accidents: study of traffic accidents according to type of collision, type of vehicle, road conditions, driver's age, traffic violations, and other factors;

(c) Elimination of 'black spots': experiments with various methods and 'before-and-after' studies assesssing results.

II. Traffic operations

(a) Regulation of movement: systems of speed limits and speed zoning in rural and urban areas;

(b) Studies and field measurements of intersection and road capacities under mixed traffic conditions in rural and urban areas;

(c) Geometrics of roads and their effect on traffic flow and accidents.

III. Road user behaviour and methods for improving the same.

IV. Future trends and traffic prediction for planning urban and rural roads.

2. **Procedure**: Members who intend to contribute Papers are requested to intimate the fact direct to Shri D. D. Suri, Deputy Secretary, Govt. of India Ministry of Transport, and Communications, Department of Transport, Transport Wing, North Block, New Delhi and to send a short synopsis of their proposed Paper to him as early as possible.

3. On receipt of acceptance of the subjectmatter of the Paper, the Member concerned should send his contribution to the said officer, complete in all respects and with original drawings, photographs, etc., as and when ready. At least *three* copies of the typescript matter should be sent, typed (double space) on one side of good stout paper of foolscap size.

4. The complete Paper, if intended to be read at the proposed Traffic Study Week should be submitted *before the end of February, 1959.*

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2. POST-GRADUATE REFRESHER COURSE, ROORKEE-APRIL/JULY 1959

● THE UNIVERSITY of Roorkee will be running the next Post-graduate Refresher Course in Civil Engineering on Concrete—Plain, Reinforced and Prestressed—Foundation Engineering, Buildings and Highways from 15th of April to 14th of July, 1959. The course will be open to serving Engineers only. Detailed particulars may be had from the Director, Refresher Courses, University of Roorkee.

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3. JAPAN: 2000 MILLION POUNDS ROADWORKS

● IN 1954, the Japanese Government began a five-year Road improvement plan and so far has spent 241 million pounds on highways. By the end of the fourth year—March 1958 vehicles had increased 10 per cent for each year the plan operated and freight tonnage transported by road reached 617 million tons in 1956, an increase of 16 per cent over the previous year. Road development was stepped up under a new ten-year plan which increased the expenditures for highways each year at the same rate that the Japanese gross national product is increasing 6.5 per cent annually.

Japan expects to spend more than 2000 million pounds on highways in the next ten years. Local authorities will provide about one-fifth of the total. The rest will come from government funds to be provided by a new law setting up another five-year plan starting this year. If the law is passed as it now reads, it will provide for all primary national highway projects to be completed in about seven years as well as 40 per cent of the ten-year programme for local and provincial roads.

(*From "British Road Federation Bulletin", October, 1958*).

4. NEW ORLEANS 30 MILLION POUNDS BRIDGE

● THE longest cantilever bridge in the United States and the third longest in the world is nearing completion in New Orleans. It is 2.3 miles long.

It spans the Mississippi River at the edge of the main business district to connect the city proper with heavy industrialised sections on the west bank of the river.

Costing 30 million pounds it is the key structure in an urban expressway development programme whose overall cost will be in excess of 49 million pounds.

(*From "British Road Federation Bulletin", October, 1958.*)

5. AUTOMATIC PARKING LOT OPENED IN MEMPHIS

● ON July 22, 1958, the City of Memphis opened to public use a 468-car parking lot between dawntown Memphis and the Mississippi River, which forms the western city limit. Entirely new to Memphians and most others who come to Memphis from surrounding states are the coin-operated electric parking gates which control and collect for use of the lot.

Access to the parking lot is by way of Riverside Drive, a roadway which parallels both the Central Business District and the river. Entrance to the lot is free and is gained by the front wheels of an automobile passing over an opening detector to raise the "in" gate. Only after the rear wheels pass over a closing detector does the "in" gate lower to its original position.

The "out" gate can be raised by a patron of the lot only by depositing 25 cents in any combination of coins other than one including pennies. Again,

two impulses are required to lower the gate, with the second being applied by passage of the rear wheels over the closing detector. The gate lowers in less than two seconds, thus preventing two cars existing on one quarter

The 25 cents parking charge is effective for all or any portion of the period from 4 p.m. to 2 a.m. the following day. The lot is cleared from 2 a.m. to 4 a.m. for the purpose of cleaning and to prevent long term storage.

Public acceptance and use has been most encouraging, an average of 412 cars using the lot daily including Saturdays but excluding Sundays in the first 27 days following its opening, according to W. P. Huntzicker, Memphis Traffic Engineer.

There are three entrances and as many exits, with entrance being prevented when the lot capacity has been reached. After the 468th car enters, the "Lot Full" sign is automatically illuminated at each entrance, and the "in" gate will not raise until at least one car has left making room for another. The gates are inter-connected with the counter-mechanism located at the centre gate.

(*From "Traffic Engineering," October 1958*).

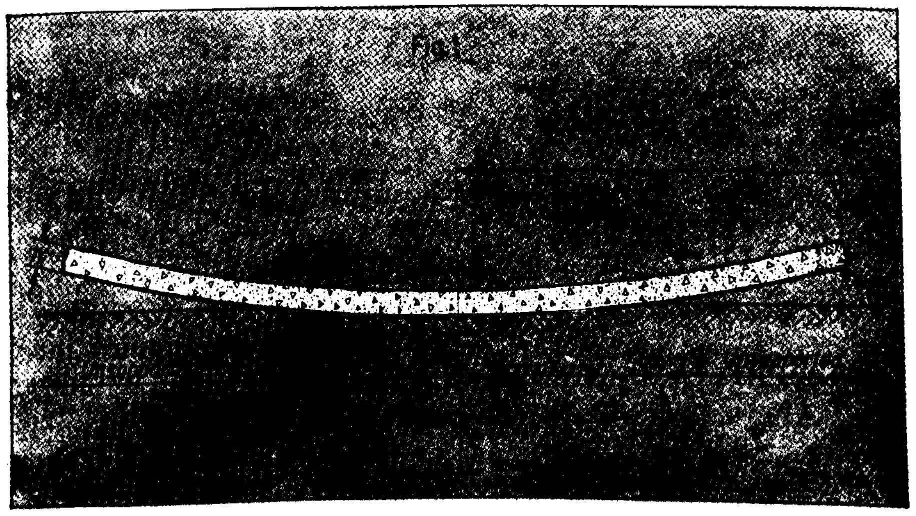
6. WARPING IN CONCRETE SLABS IS STUDIED

● TWO Purdue University researchers—Prof. Gerald A. Leonards and Prof. M. E. Harr—have derived formulas for the stresses and deflections in warped slabs. The formulas allow for the condition when the slab is only partially supported by its base.

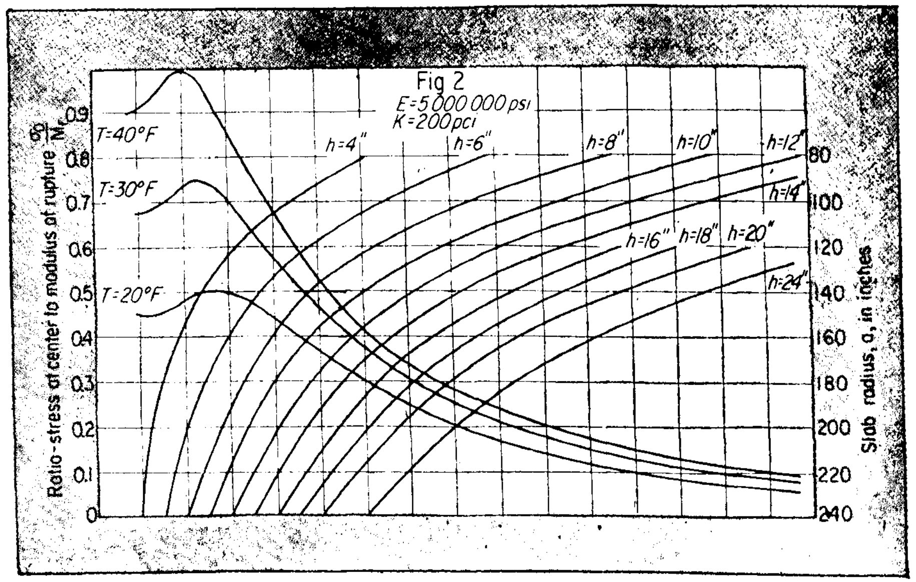
The researchers first set up and solved, for a free edge boundary condition, differential equations that considered a circular slab with partial support. Next they determined deflections, stresses and degree of support for a variety of combinations of slab size and weight, thickness, moduli of elasticity and subgrade reaction and temperature and moisture gradients.

Then the researchers plotted nomographs from these data. Solutions are also available for a variety of superimposed loading conditions.

The importance of considering the curling effect in pavement design has become



SECTION OF CIRCULAR SLAB was basis for the study. Temperature and moisture gradients were assumed to increase linearly across the section.



NOMOGRAPHS give the ratio of maximum normal stress of modulus of rupture for combinations of temperature, slab thickness and radius of warping.

evident. Serious cracking continues to develop in modern, well-constructed concrete slabs: in some instances cracks develop in newly-laid pavement even before the road is opened to traffic.

Whenever top and bottom surfaces of a concrete slab are at different temperatures or have different moisture contents, the slab will show this curling effect. The degree of warping depends on the moisture and temperature gradients. But prior to the work at Purdue, engineers have assumed full support of the slab by the base course or they have corrected for warping effects by semi-empirical modifications of existing formulas.

For the special case in which the slab does remain in full contact with its support, the Purdue equations reduce to those developed by H .M. Westergaard. The deflections computed from the Purdue equations show good correlation both with early studies made by W. K. Hatt on the effect of moisture on concrete and with recent tests by the Portland Cement Association on the effects of temperature gradients.

(*From "Engineering News-Record", October 16, 1958*).

7. MODEL HELPS ENGINEERS CHECK COMPLEX INTERCHANGE DESIGN

● THE intersection of four freeways in Los Angeles will be so complex that California highway engineers built a 17,000 dollars model to double check their designs. Superimposed on the existing Santa Ana Freeway just east of downtown Los Angeles will be the starting points of the new Golden State, Olympic and Pomona Freeways. The interchange will require 32 new bridges in addition to

existing Santa Ana Freeway structures. Construction is expected to start early in 1959 with cost estimated at 20 million dollars. At one point, a section cut through the model would show 27 different traffic lanes.

(*From "Engineering News-Record", October 16, 1958*).

8. DESIGN OF ROAD OVERBRIDGES

● IN the case of road overbridges, the construction depth will have to be kept to the minimum in order to reduce the height of the approaches and to achieve overall economy. With ordinary precast R. C. girders with cast-in-situ deck, the depth is rather excessive and the girders are also very heavy for handling. If the girders are cast-in-situ, the depth could be reduced and for short spans, it may even be possible to adopt only a flat slab. Generally, either a rigid frame arch or prestressed concrete construction or composite steel and concrete construction with proper sheer connectors at the junction of steel and concrete will be found to be economical and suitable, the choice being dependent on the length of span and local conditions.

As many of the road crossings are on skew and since the span lengths and local conditions vary, standardization of any particular span length may not serve much useful purpose.

(*From "Indian Railway Technical Bulletin", Number 130, August 1958*).

(*Continued from page 20*)

ultimate compressive strength as the top layer.

Road Maintenance

Having discussed at some length the design and construction which contribute towards a satisfactory foundation, it is necessary to consider related measures which must be taken to maintain this condition. Perhaps the greatest cause of foundation failure is due to the ingress of water into base materials. The effect of water is to seriously reduce the bearing capacity of a material and also to cause settlement under loading. A differential settlement of one inch in a foundation may be sufficient to cause failure. Clearly, then, the road surface must be sealed and adequate drainage provided to prevent such trouble occurring. The usual way of doing this is by a system of surface water drains in a built-up road or an open ditch at each side of a country road. The natural water level will then be kept below the foundation layers and stability ensured.

(*From "The Journal of the Institution of Municipal Engineers", October 1958*).

CURRENT LITERATURE

ABSTRACTS

SPECIFICATION FOR SAND FOR PLASTER; Press Note No. 205. Indian Standards Institution. 29th August 1958.

SAND is an important constituent of building mortar. For satisfactory performance, the fine aggregate used in the mortar should be clean, free from impurities and should have a particle size grading suited for the purpose for which the mortar is to be used, that is, whether in masonry work or plaster work, and whether for undercoat or finishing coat of plaster. Particle size grading of sand is particularly important for plaster work: as a delicate balance is to be struck between workability on one side, for which coarse fractions need be avoided, and strength and freedom from drying shrinkage on the other side, for which fine fractions need be minimized.

With a view to prescribe the requirements of quality, grading, sampling and testing of naturally occurring sand and crushed stone sands, used for internal wall and ceiling plastering, and external plastering and renderings, using mixes of lime, cement, composite lime-cement or gypsum (with or without admixtures) and sand, the Indian Standards Institution has drafted an Indian Standard Specification for Sand for Plaster Doc: BDC 8 (36/1). The specification mainly relates to sand used for making mortar for plaster work. Particle size gradings for sand for internal and external plaster work have been separately given.

REPORT OF THE CENTRAL ROAD RESEARCH INSTITUTE, NEW DELHI, FOR THE YEAR 1957-58; Council of Scientific & Industrial Research.

THIS report deals briefly with the work carried out at the Central Road Research Institute during the year 1957-58. The progress of work done in the Institute is set forth under the following main heads:—

(1) Soils.

(2) Flexible pavements (Bituminous materials).

(3) Rigid pavements (Concrete materials.

(4) Roads.

(5) Traffic engineering, economics and statistics.

Full-scale field investigations were carried out in order to subject the various specifications derived on the basis of laboratory studies to tests of repeated checks in the field. Investigations of actual road failures, foundation analysis of many structures, etc., were also undertaken with the objective of suggesting possible remedies in the shape of improved construction and maintenance techniques.

The report contains as an appendix a list of publications, interim reports and Papers of the Central Road Research Institute issued up to 31-9-1958.

A SYMPOSIUM ON "PRESTRESSED CONCRETE AS APPLIED TO BUILDINGS"; Central Building Research Institute, Roorkee, Indian Construction News, Vol. 7, No. 8, August 1958.

THIS issue contains proceedings of the symposium on prestressed concrete as applied to buildings, held at the Central Building Research Institute, Roorkee, during February 1958. It contains various Papers dealing with details of prestressing technique, as to how it should be applied to buildings with a view to

(*Continued on page 37*)

SELECTED RECENT LITERATURE IN ENGINEERING JOURNALS

X. BRIDGES AND OTHER STRUCTURES

1. **Load Factors for Prestressed Concrete Bridges**; T. Y. Lin, *Proceedings of American Society of Civil Engineers, Journal of the Structural Division, Vol. 83, No. ST 4*, July 1957, Paper No. 1315, pp. 1-18.

2. **Synopsis of First Progress Report of Committee on Factors of Safety**; Oliver G. Julian, *Proceedings of the American Society of Civil Engineers, Journal of the Structural Division, Vol. 83, No. ST 4*, July 1957, Paper No. 1316, pp. 1-22.

3. **Vibration Susceptibilities of Various Highway Bridge Types**; Le Roy T. Oehler, *Proceedings of the American Society of Civil Engineers, Journal of the Structural Division*, Paper No. 1318, pp. 1-41.

4. **Application and Development of A.A.S.H.O. Specifications to Bridge Design**; Eric L. Erickson and Neil Van Einam, *Volume 83, No. ST 4*, July 1957, Paper No. 1320, pp. 1-38.

5. **Anchorage Slip Wrecks Suspension Bridge**; *Engineering News Record Vol. 159, No. 17*, October 24, 1957, p. 26.

6. **Prestressing on Ciprus Christi's Bridge**; *Engineering News Record, Vol. 159, No. 11*, September 12, 1957, pp. 51-56.

7. **Analysis of Continuous Beams by Fourier Series**; Seng-Lip Lee, *Proceedings of the American Society of Civil Engineers, Journal of the Engineering Mechanics Division, Vol. 83, No. EM 4*, October 1957, Paper No. 1391, pp. 1-13.

8. **Graphical Solution of Equations of Vibrations**; Wen Hsing Li, *Proceedings of the American Society of Civil Engineers, Journal of the Engineering Mechanics Division, Vol. 83, No. EM 4*, Paper No. 1412, pp. 1-11.

9. **Traffic Structure of Roads**; *Schweizerische Bauzeitung, Vol. 75, No. 22*, June 1957, pp. 334-337 (in German).

10. **The Design of Neath and Briton Ferry Viaducts**; R. P. Mears and E. E. Pool, *Proceedings of the Institution of Civil Engineers, Vol. 7, Session 1956-57*, July 1957, Road Paper No. 54, pp. 465-498.

11. **An Investigation into the Stress Distribution in Pile Caps with some Notes on Design**; N. B. Hobbs and P. Stein, *Proceedings of the Institution of Civil Engineers, Vol. 7, Session 1956-57*, July 1957, Paper No. 6179, pp. 599-628.

12. **Long-Span Prestressed Concrete Bridges Constructed by Freyssinet System**; Yves Guyon, *Reply of the Author to Discussion, Proceedings of the Institution of Civil Engineers, Vol. 7, Session 1956-57*, June 1957, pp. 425-432.

13. **A Method of Determining an Approximate Value of the Critical Loads at which Lateral Buckling Occurs in Rigidly Jointed Trusses**; N. W. Murrary, *Proceedings of the Institution of Civil Engineers, Vol. 7, Session 1956-57*, June 1957, Paper No. 6209, pp. 387-403.

14. **Tests on Clifton Suspension Bridge Cross-Girder**; Malcolm Holmes, *Proceedings of the Institution of Civil Engineers, Vol. 7, Session 1956-57*, June 1957, pp. 404-408.

15. **The Ultimate Strength of Reinforced Concrete Beams in Shear**; Royston Jones, Contribution by Kamal N. Ghali, A. J. Ashdown, and D. M. Crtilos, *Magazine of Concrete Research, Vol. 9, No. 25*, March 1957, pp. 32-41.

16. **Proposed Manual of Standard Practice for Detailing Reinforced Concrete Structures**; ACI Committee 315, *Journal of the American Concrete Institute., Vol. 28, No. 7*, January 1957, pp. 617-624.

17. **Rigid Frame Failures;** B. G. ANDERSON, *Journal of the American Concrete Institute, Vol. 28, No. 7,* January 1957, pp. 625-668.

18. **Application of Steel Strap Reinforcement to Girders of Rigid Frames, Special A.M.C. Warehouses;** R. R. LUNOE and G. A. WALLIO, *Journal of the American Concrete Institute, Vol. 28, No. 7,* January 1957, pp. 669-678.

19. **Shear Strength of Reinforcemet Concrete Frame Members without Web Reinforcement;** J. MORROW and J. M. VIEST, *Journal of the American Concrete Institute, Vol. 28, No. 9,* March 1957, pp. 883-889.

20. **Design of Floating Slab Foundation;** N. B. GREEN, *Journal of the American Concrete Institute, Vol. 28, No. 9,* March 1957, pp. 889-898.

21. **Elastic Design of Prestressed Sections in Flexure by Charts or Tables;** W. W. LAWILSKI, *Journal of the American Concrete Institute, Vol. 28, No. 10,* April 1957, pp. 961-988.

22. **Analysis of Continuous Arches in Flexible Piers;** W. E. RILEY, *Journal of the American Concrete Institute, Vol. 28, No. 10,* April 1957, pp. 999-1012.

23. **Tables for Circularly Curved Horizontal Beams with Symmetrical Uniform Loads;** M. SCHUTZ and M. CHEDRAUL, *Journal of the American Concrete Institute, Vol. 28, No. 11,* May 1957, pp. 1033-1040.

24. **An Idea for Long-Span Prestressed Concrete Bridges;** E. V. WALSUM, *Journal of the American Concrete Institute, Vol. 28, No. 11,* May 1957, pp. 1057-1065.

25. **Diagonal Tension Strengh of Reinforced Concrete T. Beams with Varying Shear Span;** A. F. AL-ALUSI, *Journal of the American Concrete Institute, Vol. 28, No. 11,* May 1957, pp. 1067-1077.

26. **Under-Reinforced Concrete Beams under Long-Term Loads;** H. A. SAVYOR and J. E. STEPHENS, *Journal of the American Concrete Institute, Vol. 29, No. 1,* July 1957, pp. 21-29.

27. **General Method for Analysis of Flat Slab and Flates;** J. F. BROTCHIE, *Journal of the American Concrete Institute, Vol. 29, No. 1,* July 1957, pp. 31-50.

28. **A Prestressed Concrete Bridge;** P. SOUTTER, *Civil Engineering and Public Works Review, Vol. 52, No. 613,* July 1957, pp. 780-783.

29. **An Unusual Method of Concrete Bridge Reconstruction;** *Civil Engineering and Public Works Review, Vol. 52, No. 613,* July 1957, p. 785.

30. **Fatigue Test on Lee-McCall Prestressed Concrete Beams;** *Civil Engineering and Public Works Review, Vol. 52, No. 613,* July 1957, pp. 786-787.

31. **Bond and Crack Formation in Reinforced Concrete—A Review of Last Months International Symposium in Stockholm;** *The Surveyor, Vol. CXVI, No. 3403,* July 20, 1957, pp. 771-773.

32. **Some Notes on the Ultimate Bending Strength of Prestressed Continuous Beams;** JEAN MUTLER, *Travaux, Vol. 41, No. 272,* June 1957, pp. 315-331 (in French).

33. **Reconstruction of the Sarrclouis Bridge;** THIERRI JEAN, BLOCK and MITCHELL BRISAC, *Travaux, Vol. 41, No. 272,* June 1957, pp. 332-336 (in French).

34. **Design of Cylindrical Reservoirs of Uniform Thickness of Sides;** R. MUZET, *Travaux, Vol. 41, No. 272,* June 1957, pp. 344-354 (in French).

35. **Tied Arches Made of Concrete Block Span 100 Ft;** *Engineering News Record, Vol. 159, No. 23,* December 5, 1957, pp. 26-27.

36. **The Gottstattstrasse Swing Bridge in Biel;** A. HEER, *Schweizerische Bauzeitung, Vol. 75, No. 19,* May 11, 1957, pp. 292-295 (in German).

(Continued from page 34)

economy in construction. The Papers have been grouped under the following:

Theme 1 - Materials and methods.

Theme 2 - Prestressed concrete roofs.

Theme 3 - Research on prestressed concrete as applied to buildings.

Theme 4 - Economics of prestressed concrete as applied to buildings.

The proceedings of this symposium are useful and interesting as a source of reference and they will enable a larger section of the people to know the actual techniques of this method of construction in its various aspects.

MERDEKA BRIDGE, SINGAPORE: INVESTIGATION, DESIGN, AND CONSTRUCTION; Reginald John Hollis-Bee, M.I.C.E., Proceedings of the Institution of Civil Engineers, October 1958.

THIS Paper describes the reasons for the construction of a bridge over the Kallang Basin and its associated trafficways. It gives details of the site investigations, and of the design, construction, and testing of the Bridge.

Preliminary reconnaissance revealed that the site was in a swamp and foundations were extremely poor, so long reinforced concrete piles would be necessary. The design was controlled in varying degrees by the requirements of navigation in the Kallang River and by the limitation of foundation strength.

The loading specified was that of the Ministry of Transport Loading Curve with a check for abnormal vehicles. The design adopted was a bridge of twenty-five 80-ft spans.

A bund was constructed along the centre-line and the bridge was built "in the dry".

To produce a light (in weight) and economical design, hollow piers and precast post-tensioned main beams with a post-tensioned transversely prestressed deck system were adopted. Precast A frames with cast-in-situ sheathing walls gave light and economical piers.

Preparing and driving long piles necessitated the devising of joints both for the concrete columns as well as for the driving tubes.

The main beams were precast on special bases at each end of the bridge site and after curing and post-tensioning were transported along the filling and lifted on to the piers.

A beam test to destruction and a test to determine the lateral distribution of loads on a finished span are described.

The testing and concrete control is explained and results are quoted.

The bridge was officially opened on 17th August, 1956, and named the Merdeka Bridge.

HEREDITY

A PROUD father was talking of the intelligence of his son. "You know, dear," he told his wife, "I think he must have got his brains from me."

"He certainly must have done," retorted the wife. "I've still got mine."

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1. **"Abatement of Highway Noise and Fumes"**; Bulletin No. 110, Pub. No. 363 (1955), Highway Research Board, 2101, Constitution Ave., Washington D.C.

2. **"Proceedings of the Fortieth Annual Highway Conference Held at Grand Rapids, Michigan"**; March 15, 16, 17, 1955, University of Ann Arbor, Michigan, (U.S.A.)

3. **Fertilizer Research, Part I—Iowa State College Engineering Report, No. 25 (1955-56)**; G. L. Bridger & Associates, Vol. LIV, September 7, 1955, No. 15, Iowa State College, Anes, Iowa (U.S.A.).

4. **Ministry of Transport & Civil Aviation Report on the Administration of the Road Fund for the Year 1954-55**; Her Majesty's Stationery Office, London S.E.-1.

5. **Deptt. of Main Roads New South Wales 30th Annual Report—Year ended 30th June 1955**; Deptt. of Main Roads, New South Wales, 309, Castlereagh Street, Sydney (Australia).

6. **Highways & Local Govt. Deptt. South Australia Thirty-Eighth Annual Report 1954-55**; The Secretary to the Commissioner, Highways & Local Govt. Deptt., Richards Building, Currie Street, Adelaide (S. Australia).

7. **Country Roads Board Forty-First Annual Report for Year ended 30th June 1954**; The Secretary, Country Roads Board, Exhibition Building, Carlton No. 3, Victoria (Australia).

8. **Irrigation Research Institute Uttar Pradesh Annual Research Report, 1954 (Technical Memorandum No. 25)**; The Director, Irrigation Research Institute, Roorkee (U.P.).

9. **"Structural Effects of Heavy-Duty Trailer on Concrete Pavement—A Supplemental Investigation to Road Test One—MD"—Highway Research Board Special Report No. 14, Pub. No. 283 (1953)**; Highway Research Board, 2101, Constitution Ave., Washington D.C.

10. **"An Experimental Investigation of Sub-harmonic Oscillations in a Nonlinear System", No. 97, 1956 (Transactions)**; K. Goransson & L. Hansson, The Royal Institute of Technology, Stockholm (Sweden).

11. **"The Neutron-Proton System with a Central Exponential Potential II, No. 98, 1956 (Transactions)**; P.O. Brundell & B. Enander, The Royal Institute of Technology, Stockholm (Sweden).

12. **"Uber Die Genauigkeit Der Luftphotogrammetrie"—No. 99, 1956 (Transactions)**; B. Hallert, The Royal Institute of Technology, Stockholm (Sweden).

13. **"Loading Characteristics of Air Blasts From Detonating Charges", No. 100, 1956 (Transactions)**; Sune A. Granstrom, The Royal Institute of Technology, Stockholm (Sweden).

14. **"Einfache Theorie Der Gaszirkulation in Sorptions—Kalteapparaten Nach V. Platen und Munterz"—No. 101, 1956 (Transactions)**; Matts Backstrom, The Royal Institute of Technology, Stockholm (Sweden).

15. **"Torsion, Bending and Lateral Buckling of I-Beams", No. 102, 1956 (Transactions); Bulletin No. 22 from the Division of Building Statics and Structural Engineering**; Henrik Nylander, The Royal Institute of Technology, Stockholm (Sweden).

(Continued on page 41)

BUDGETS AND ADMINISTRATION REPORTS

MADHYA PRADESH STATE BUDGET, 1958-59

The following extracts relating to civil works have been taken from the Madhya Pradesh Budget for the year 1958-59:—

Revenue (civil works)

Heads	Actuals 1-11-56 to 31-3-57	Revised Estimate 1957-58	Budget Estimate 1958-59
	(In lakhs of Rupees)		
Rents	4.57	12.00	13.00
Ferry Receipts	2.29	5.48	5.43
Tolls on roads	0.37	0.97	1.00
Receipts from workshop	0.35	1.17	1.10
Recoveries of Expenditure	0.27	0.60	0.52
Transfer from Central Road Fund	0.19	—	—
Contribution from Govt. of India for the Development of State Roads of economic or Inter-State Importance	10.52	—	—
Miscellaneous—Other items	9.59	8.25	8.25
Deduct—Refunds	-0.62	-0.32	-0.23
Total	27.53	28.15	29.07

Heads	Actuals 1-11-56 to 31-3-57	Revised Estimate 1957-58	Budget Estimate 1958-59
Expenditure			
Buildings			
Original works	28.25	72.35	55.06
Repair	*	57.75	57.75
Communications			
Original works	17.65	61.91	72.12
Repair	*	191.25	191.25
Miscellaneous			
Original works	6.00	1.35	1.16
Repair	*	1.00	1.00
Grant-in-aid	0.34	1.26	1.00
Suspense	-10.96	20.00	20.00
Reserve	—	—	15.00
Through the agency of local bodies (Repairs)	—	2.20	2.20
Deduct—Recoveries			
(a) Transfer from Central Road Fund.	-1.39	-20.08	-18.99
(b) Contribution from Government of India for development of State Roads of economic or Inter-State Importance	—	-25.33	-37.06
(c) 60% of Central Government's share for the scheme for Technical Training (Labour)	—	-0.69	-5.10
Total	175.28 ≠	362.97	355.39

≠ Includes Rs 135.39 as expenditure on repairs for which break up not available.

Capital account of civil works beside the revenue account

Heads	Actuals 1-11-56 to 31-3-57	Revised Estimate 1957-58	Budget Estimate 1958-59
	(In lakhs of Rupees)		
Original works—Buildings	219.79	445.64	315.15
Communications	106.79	216.47	130.01
Miscellaneous	2.57	10.14	1.86
Grant-in-aid	7.33	15.00	0.75
Deduct—Recoveries subvention from Central Road Fund	-0.44	-0.41	-0.42
Receipt and recoveries on capital account	-0.05	-6.84	-17.14
Write back of Grants-in-aid to revenue account	—	—	-1.00
Government of India's share of expenditure on account of centrally-sponsored schemes of Medical Department	—	—	-14.25
Subsidy from Government of India under slum clearance scheme	—	—	-2.00
Total	335.99	680.00	412.96
Revenue from Roads			
Receipts under the Indian Motor Vehicles Act	2.19	8.20	8.41
Receipts under the State Motor Vehicles Act	27.61	81.93	91.75
Tax on sales of motor spirit and lubricants	18.71	58.00	60.00
Other receipts	1.53	0.23	0.26
Deduct—Refunds	-0.14	-0.22	-0.26
Total	49.90	148.14	160.16

BRIEF NOTE

The Budget estimate of revenue receipts for the year 1958-59 is Rs 5616.79 lakhs and the expenditure on revenue account is estimated at Rs 5506.76 lakhs, which show a surplus of Rs 110.03 lakhs. The revised estimate for 1957-58 showed a revenue of Rs 5088.54 lakhs and an expenditure on revenue account of Rs 5436.94 lakhs with a consequent deficit of Rs 348.40 lakhs. In 1956-57 actual revenue and expenditure amounted to Rs 1980.06 lakhs and Rs 2078.31 lakhs respectively (for the five months from 1st November 1956 to 31st March 1957), leaving a deficit of Rs 98.25 lakhs.

Expenditure on civil works during 1958-59 is estimated at Rs 355.39 lakhs which form 6.3 per cent of the total state revenue. The corresponding ratios for the previous year was 7.1 per cent. Out of the total revenue expenditure on civil works, communications (original works and repairs only) account for 4.7 per cent of the estimated revenue for 1958-59 while the percentage for the same for 1957-58 (revised estimate) was 5.0 per cent.

Expenditure on civil works outside the revenue account for the year 1958-59 is estimated at Rs 412.96 lakhs, revised estimate for the year 1957-58 is Rs 680.00 lakhs. Expenditure on communications and buildings form the main items of expenditure.

LIST OF APPROVED WORKS ON NATIONAL HIGHWAYS

Sr. No.	Job No.	Name of work	Amount (Rs in lakhs)
		HIMACHAL PRADESH	
1.	1930 HP 22	Construction of Store Godown and a Chowkidar Quarter at Rampur on Hindustan-Tibet Road, National Highway No. 22.	0.14
		JAMMU & KASHMIR	
2.		Two works each costing less than 2 lakhs.	0.90
		RAJASTHAN	
3.	1928 RJ 8	Construction of minor bridges on Bichiwara-Ratanpur Section between miles 16 to 22 of National Highway No. 8.	0.76
4.	1931 RJ 8	Construction of cross drainage works on Bichiwara - Ratanpur Road, National Highway No. 8.	3.77

(Continued from page 38)

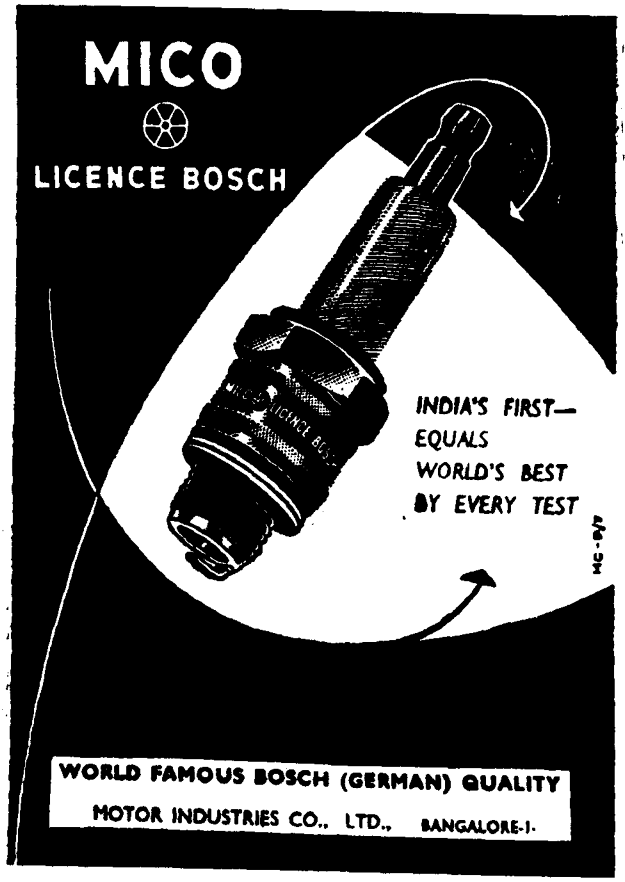
16. **"Grading of Fine Crushed Rock", Engineering Note No. 43 (1953);** Country Roads Board, Exhibition Building, Carlton No. 3, Victoria (Australia).

17. **"Formation & Grading—Use of Top Soil", Engineering Note No. 44 (1953);** Country Roads Board, Exhibition Building, Carlton No. 3, Victoria (Australia).

18. **"Maintenance—Patching" — Note No. 45 (1954);** Country Roads Board, Exhibition Building, Carlton No. 3, Victoria (Australia).

19. **"Preparation of Sealed Pavements before Resealing", Engineering Note No. 46 (1954);** Country Roads Board, Exhibition Buildings, Carlton No. 3, Victoria (Australia).

20. **"The Use of Explosives in Road Work", Engineering Note No. 47 (1954);** Country Roads Board, Exhibition Building, Carlton No. 3, Victoria (Australia).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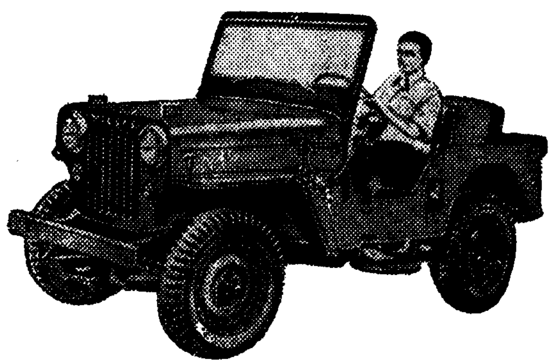

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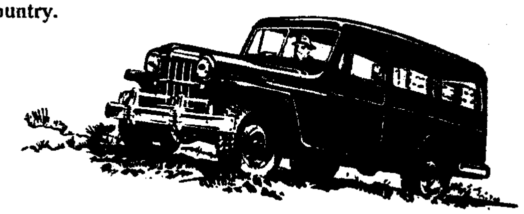

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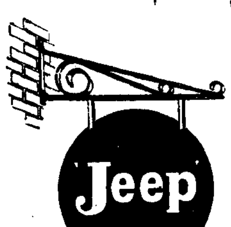

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