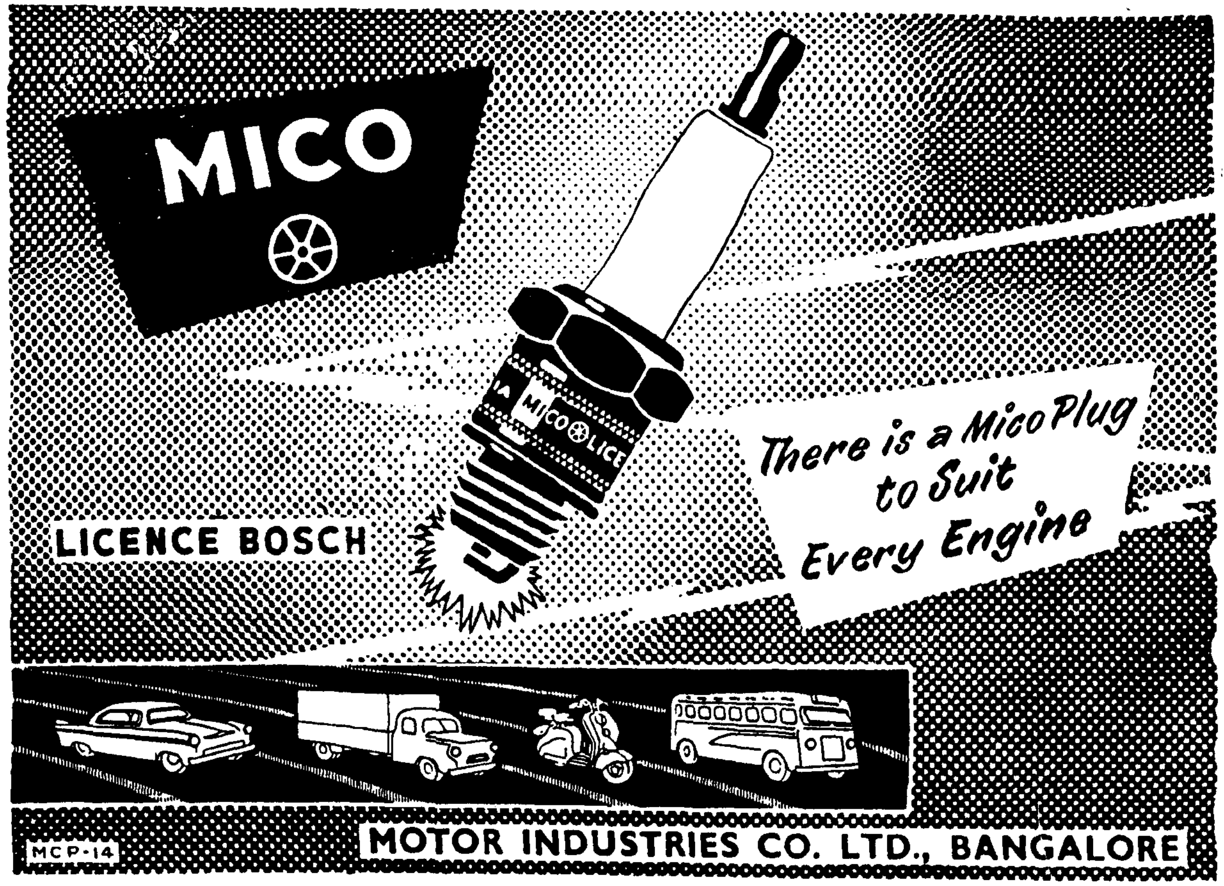
TRANSPORT-COMMUNICATIONS

MONTHLY REVIEW

DECEMBER 1959—No. 152

INDIAN ROADS CONGRESS, NEW DELHI.



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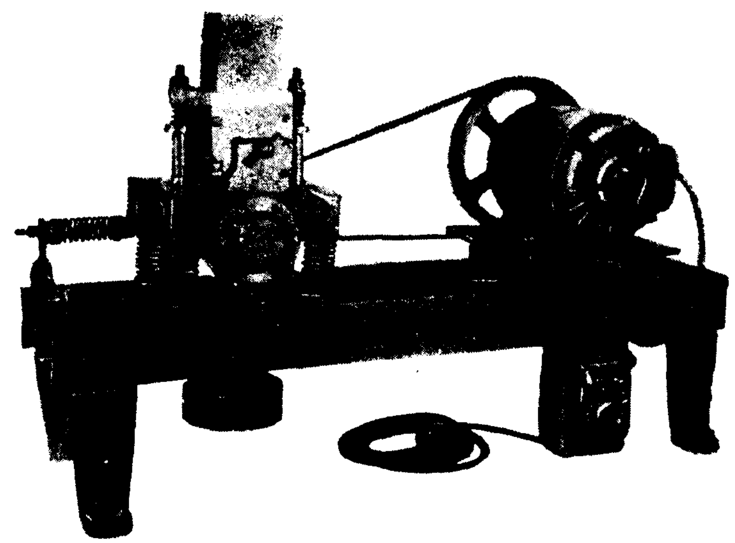

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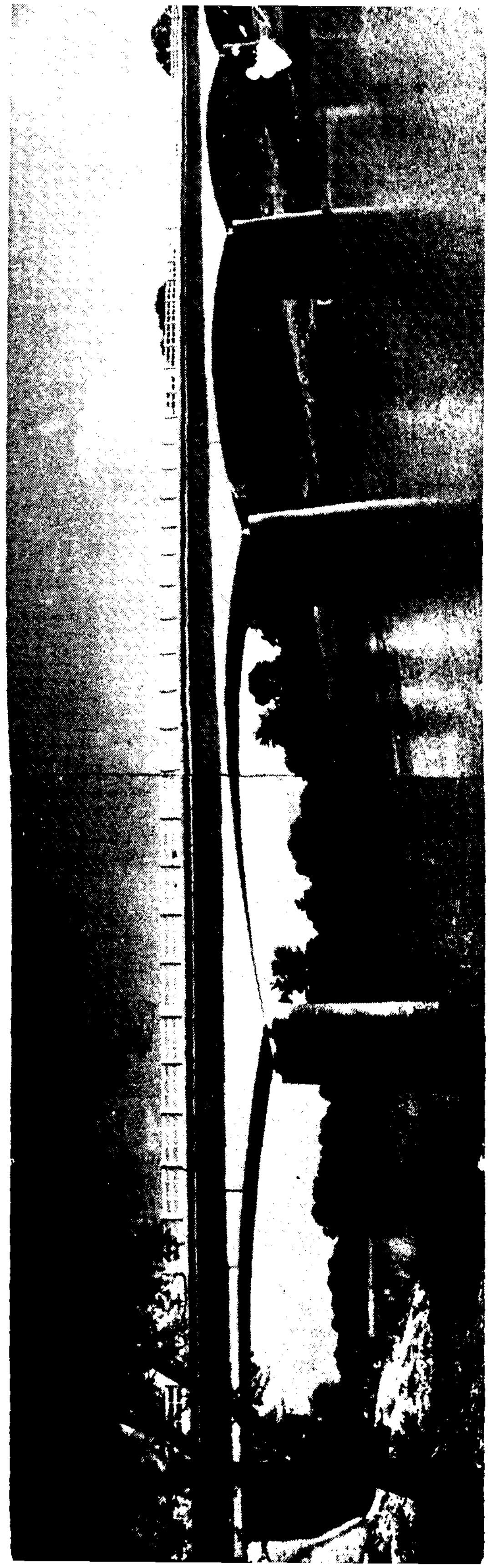

BRIDGE OVER RIVER GOMTI

Location : At Naipura Ghat in Barabanki District (U.P.)
Type of bridge : R.C.C. Balanced Cantilever
Spans : 3 spans of 98 ft each and 2 end spans of 74 ft each
Loading : I.R.C. Class A
Clear roadway : 22 ft. no footpaths
Railing : R.C.C. post and panel type
Bearings : Alternate rocker & roller bearings
Cost : Rs 8.13 lakhs

TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

A REVIEW OF
ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

DECEMBER 1959

THE SILVER JUBILEE SESSION OF THE INDIAN ROADS CONGRESS

BANGALORE—JANUARY-FEBRUARY, 1960

THE Indian Roads Congress will be completing 25 years of life in December 1959. At the invitation of the Government of Mysore, the Silver Jubilee of the Congress will be celebrated at its next Session to be held at Bangalore from the 28th January to the 4th February, 1960. Ten Papers, brief summaries of which are given below, will be discussed during the Session. A General Report on road research work done in India during 1958-59 will come up for discussion on the 31st January. There will also be a panel discussion on "The use of soft aggregates for road constructions". Many technical Committees of the Indian Roads Congress will meet during the Session. It is expected that about 400 delegates from all parts of India and abroad will attend the Session. An Engineering Exhibition in which the Ministry of Transport & Communications, Government of India, State P.W.Ds., E-in-C., A.H.Q., and engineering firms will participate, will also be arranged on this occasion.

Dr. P. Subbarayan, Minister of Transport & Communications, Govt. of India, will inaugurate the Session on the 29th January. Shri U. J. Bhatt, Chief Engineer, P.W.D., B & R., Bombay State, who is President of the Congress for this year, will deliver the Presidential Address.

SUMMARIES OF PAPERS

1. **Paper No. 213—"Some Studies in Soil Mechanics as applied to Roads in West Bengal"—S.N. Gupta & P.L. De**

The Paper describes some applications of soil mechanics in the construction and maintenance of roads. The general properties of soil survey and sampling are described. Examples of application of scientific studies of soil in different stages of road construction, viz., construction of embankments and cuttings, design of the pavement thickness, improvement of subgrades and different methods of soil stabilization as adopted in West Bengal, are given. Investigation of road failures and their suggested remedies are also dealt with in the Paper.

2. **Paper No. 214—"Design and Construction of Training Works Over River Ghogra at Ayodhya"—N.C. Bhargava**

The Paper describes the construction of river training works over river ghogra at Ayodhya. These bunds are part of the scheme of bridging this river in mile 84 of Lucknow-Gorakhpur road, also known as O.T. Road, National Highway No. 28. The bridge will have a waterway of about 3,110 ft. While the guide bunds had been completed this year, the construction of the main bridge is scheduled to be taken in hand very shortly.

Details of design, construction, difficulties met with and organisational problems have been dealt with in this Paper.

3. Paper No. 215—" Investigation into Causes of Cracks in certain Concrete Pavements "—Brig. S.K. Bose

The behaviour of two concrete runway pavements subjected to increasing wheel loads and tyre pressures were observed and recorded in this Paper. In one case, the observations were carried out over a period of approximately 10 years. The behaviour of the old runway pavement over a period of eight yeas is first discussed with reference to field data. Calculations of stresses due to wheel loads and temperature stresses are given. The old pavement was then overlaid with a new layer of concrete pavement after replacing the damaged slabs. The behaviour of the concrete everlay over a period of two years is recorded.

In the second case, the observations were made over a shorter period. One interesting feature in this case, however, was that an experimental stretch of the runway was overlaid with a bituminous pavement.

The behaviour of both the bituminous and concrete overlays at Hakimpet is also recorded.

4. Paper No. 216—" Flood Discharge Estimation for Small Catchments "—B. Balwant Rao

The Paper describes a method of estimating flood discharge from small catchments in Andhra Pradesh by making use of the data available from rain gauges. The rain gauge data has been analysed and from that the hourly intensity of rainfall that could be expected by an analogy of the rainfall characteristics collected from the two automatic recording rain gauge stations at Begumpet and Visakhapatnam has been attempted.

The Paper also describes the use of hourly intensity to get the flood discharge.

Illustrative examples to show the application of the above data to actual problems met with in Andhra Pradesh have been included.

A map of Andhra Pradesh with zones of equal hourly intensity has been prepared to select suitable values for evaluating flood discharge in different localities.

5. Paper No. 217—" Design and Construction of Prestressed Concrete Bridges across Kunwary River "—Y.K. Patil & C.V. Kand

The River Kunwary flows through the northern districts of Madhya Pradesh (Bhind and Morina). The river crosses the Morina-Ambagh-Mehgan road near Dimni and Budhara while it crosses the Bhind Etawah road at Didi. The former is an important feeder road connecting two National Highways, viz., Agra-Bombay road and Gwalior-Etawah road (proposed National Highway). At these three crossings high level prestressed concrete bridges are being constructed. Bridges at Didi and Dimni have a maximum span of 132 ft centre to centre with the R.C.C. deck slab supported on four main girders while at Budhara there are three main prestressed girders having a maximum span of 27 ft centre to centre. The girders are cast in situ and post tensioned by Freyssinet's method. The supporting piers are of R.C.C. shell-type and rest upon well foundations. The Paper deals with the hydraulic investigations, design and construction of these bridges.

6. Paper No. 218—" Crystal Pattern Formula for Integrated Highway Planning in India "—K. C. Mittal

The Paper presents an approach to the problem of integrated highway planning, based on a pattern of roads designated as " Crystal Pattern " with special reference to Uttar Pradesh.

The fundamental requirements of highway planning in respect of accessibility to a road and road milage on area basis are considered and the application of these principles in the evolution of the Crystal Pattern Formula of road planning is described.

The merits of this pattern are discussed in detail and the targets of different classes of roads obtained by its application are given.

The preparation of a Master Plan of roads for any area by the application of the method described in the Paper is also explained.

7. Paper No. 219—" Design and Laying of a Bituminous Carpet of a National Highway "—S. R. Mehra, C G Swaminathan & V. R. Vaish

The Paper deals with the various aspects of laying of an asphalt carpet commencing from the stage of design to the actual execution of the work.

Based on the CBR tests, the thickness of the road structure for the Delhi-Mathura Road to carry the present intensity of traffic was arrived at. Then a survey of the local quarries and crushers was made. Based on the analysis of the materials available and keeping an eye on the cost, a design for the asphalt mixture was arrived at after conducting a series of tests in the laboratory. The continuous mixing plant which was used for the construction was also calibrated so as to give the required mixture and the various phases in the plant control and operation are discussed. The laying of the mixture was done by a mechanical paver and finisher. Tests before and after laying of the mixture were also carried out periodically. The role of a field control laboratory, details of mechanized construction and the cost structure are all dealt with in the Paper.

8. Paper No. 220—" Road Transport Operation Cost on Various Types and Conditions of Surfaces "—Dr. M. K. Ganguli

At the instance of the Government of India, the Indian Roads Congress appointed a Committee to study (i) the cost of operation of motor vehicles on different classes of roads and (ii) the economy resulting from road improvements. As recommended by the Committee, controlled experiments were carried out by Bombay and Uttar Pradesh State Transport undertakings according to design and specifications supplied by the Committee. This Paper gives the details of the actual experiments and their results. The results indicate in detail that there is substantial reduction in the cost of operation of motor vehicles with the improvement of road surfaces. Experience of other countries is also reviewed in this Paper.

9. Paper No. 221—" Origin and Destination Study of Traffic in Greater Delhi-1957 "— T. S. Khanna & T. R. Sehgal

Origin and destination of vehicles provide necessary data required for planning, design and location of routes to best serve the demand of the traffic flow. This Paper describes the results of an origin-destination survey of Delhi undertaken jointly by the Central Road Research Institute and the Town Planning Organization of the Ministry of Health.

For purposes of this survey, the urban territory of Delhi has been divided into 48 zones, based on natural and artificial boundaries and roads serving particular areas. Survey stations selected on the loop lines, indicating inner and outer cordon lines, are 31 in number. On these survey stations vehicles were stopped on sampling basis and interviewed by the roadside, asking them their points of origin and destination, purpose, income and frequency of trips.

The data thus collected has been mechanically analysed These basic tables have been submitted to rigorous analysis through tables and maps. Origin and destination of each trip has been established separately for motor vehicles, animal driven vehicles, and cyclists. Correlation has been studied between (i) mode of conveyance and occupation, (ii) purpose of the trip and mode of conveyance, (iii) mode of conveyance and income group, and (iv) distance covered and mode of conveyance.

The utility of this information in relieving congestion on road, has been discussed in detail.

10. Paper No. 222—" Regional Concept for Highway Planning—The Web and Lattice Pattern "—D.G. Bhagat.

The Paper stresses the need for adequate and balanced planning of the road system both for urban and rural areas.

It develops the concept of regional units for purposes of planning of the highway network. It proceeds to describe the road fabric which would be suitable for the trend of development in the country. The web and lattice pattern is recommended for agricultural and developed areas.

An illustrative highway plan is also described showing its applicability for a particular district.

BRIDGING INDIA'S RIVERS

PERANDAPALLI BRIDGE

(By courtesy of the Chief Engineer, Highways, Madras)

Introduction

THE Ponnair river crosses the Banaras-Cape Comorin road—National Highway No. 7 (Krishnagiri-Bangalore section) near Perandapalli in Salem District, Madras State, at mile 187/4, Fig. 1.

An arch bridge exists at this crossing. This bridge consists of one central span of 45 ft and two end spans of 40 ft each on either side. All the three arches are elliptical in shape. The piers and abutments are of brick in lime mortar. The arch rings are also of brick in lime mortar. The clear roadway between 9 in. thick masonry parapets is 13 ft-6 in.

The existing arch bridge, Photo 1, situated on a National Highway having very heavy traffic is a bottleneck owing to its narrow roadway. The entrance to the bridge on the Krishnagiri side is also on a curve. The bridge has a longitudinal camber-hump, putting fast traffic to a lot of inconvenience. Cracks have also developed at the crown of the arch. In addition, the existing bridge is not safe for the present I.R.C. Class "AA" loading. Hence the construction of a new bridge on the downstream side of the existing bridge was taken up.

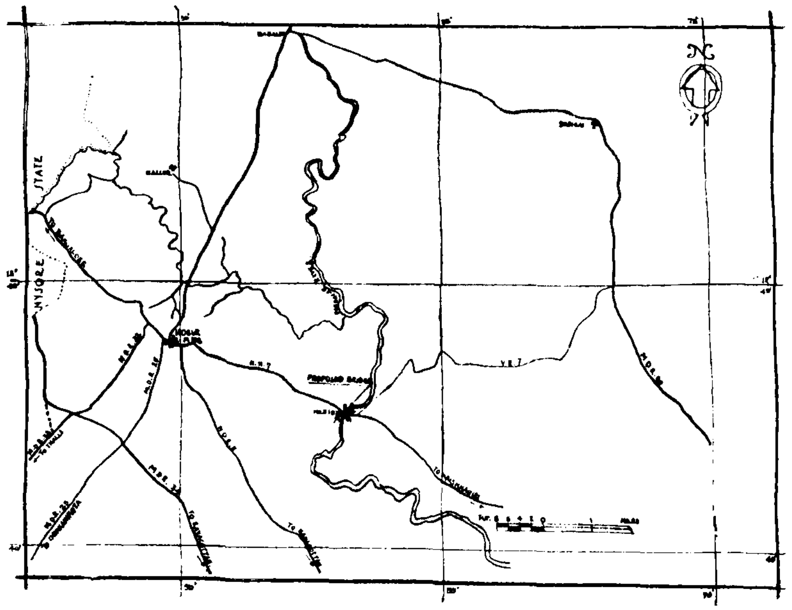

Fig. 1
Key Map

Site

The new bridge, Photo 2, is constructed at a site, Fig. 2, about 60 ft downstream of the existing bridge. The width of the river at this site is less than that at an upstream crossing. The approach on the Bangalore side is straightened up and that on the Krishnagiri side is taken on a smooth curve.

Photo 1. **Existing gold arch bridge**

(8)

Hydraulic Particulars

The maximum discharge at the proposed crossing by Kutter's formula works

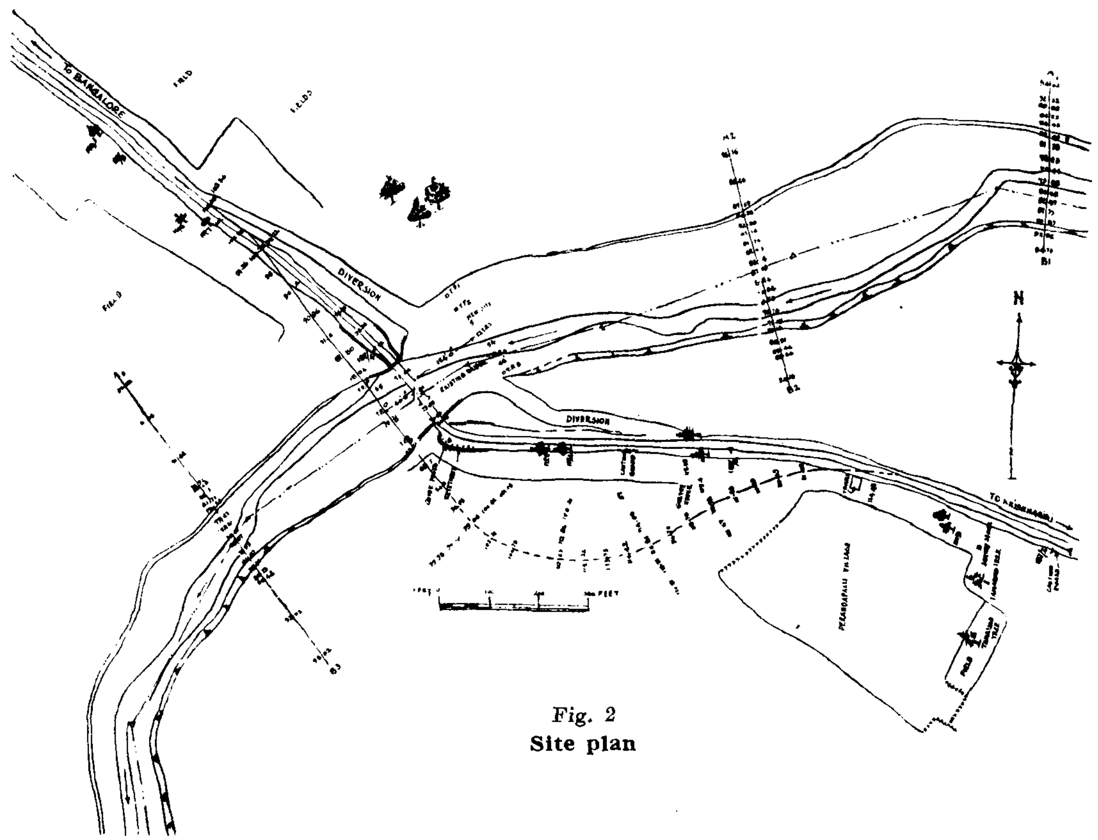

Fig. 2
Site plan

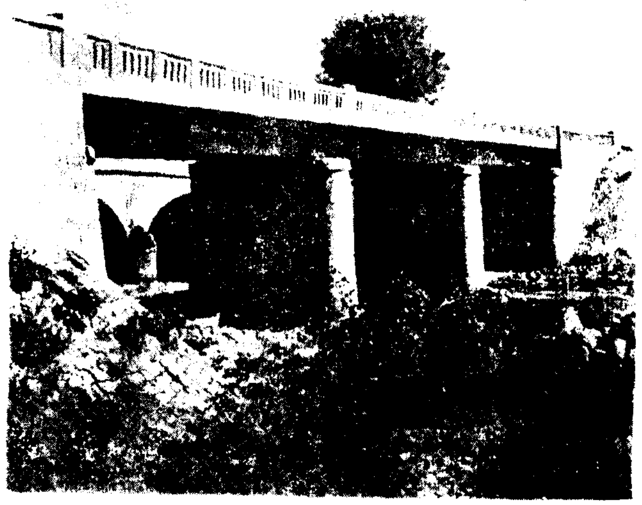

Photo 2. **The new bridge**

out to 24,203 cusecs The discharge computed by Ryves' formula comes to 44,960 cusecs. The large variation in discharge is due to the catchment area being studded with a number of tanks. Hence it was considered not necessary to provide waterway for the higher discharge. The existing arch bridge with a linear waterway of 125 ft has been discharging the floods effectively all these years. Based on this, a linear waterway of 135 ft was considered sufficient for the new bridge. This would be sufficient to discharge 29,973 cusecs, i.e., two third of the discharge arrived at by Ryves' formula. Hence three spans of 45 ft clear are provided.

The foundations are taken down to hard rock and anchored by providing $1\frac{1}{4}$ in. diameter dowel bars taken 3 ft into rock strata and 3 ft 6 in. into the masonry so that no sliding effect will be developed due to the possible restriction of waterway and the resultant increase in the velocity.

A free board of 4 ft is provided over the M.F.L. (95.00). The bottom of the deck is kept at 99.00.

General Features of Design

The new bridge consists of 3 spans of 45 ft clear each. The superstructure is of beam and slab type designed for I.R.C. Class "AA" loading. The beams rest on reinforced bed block over mass concrete masonry. The working stresses adopted for concrete are 750 lb per sq. in. and for steel 18,000 lb per sq. in. All the mild steel reinforcement joints over one in. in diameter are welded. Welded rods are also got tested periodically.

Foundations

Rock is met with at shallow depths of 3 to 5 ft. The Krishnagiri side abutment and all piers are founded on rock. Under Bangalore side abutment also, the boring particulars revealed hard rock at level of 70.75. But during actual execution it was found that only huge boulders mixed with loose earth were present at this level. Consequently boulder after boulder inlaid with layers of earth, had to be removed with the hope of meeting with hard rock. But only a uniform layer of well moorum was struck at level of 66.00. Below this level a trial pit 3 ft by 3 ft upto 63.00 was put up and the soil between 63.00 to 66.00 was also found to be uniform well moorum. A load test, Photo 3, to ascertain the bearing capacity of the soil at level of 66.00 was conducted and was found to be satisfactory. Hence the

Photo 3. **Plate Bearing Test Assembly in position**

Photo 4. **Concreting in the foundation of Bangalore side pier with dowel bars fixed in foundation rock**

foundations of the Bangalore side abutment and wings were stopped on well moorum between levels of 66.13 to 66.68.

Where the piers and abutments are founded on rock, the foundation rock is suitably benched before laying the levelling course of cement concrete 1:3:6 mix.

Photo 5. **22 feet clear roadway over new bridge**

Dowel bars, Photo 4, $1\frac{1}{4}$ in. diameter taken 3 ft inside bed rock and 3 ft 6 in. in the bottom of the footing are provided to prevent the lateral movement of the structure and for anchoring the foundation to rock. In the case of Bangalore side abutment and wings, the dowel bars were fixed in concrete in holes dug 3 ft into moorum soil.

Piers and Abutments

Piers and abutments were constructed in mass concrete 1:3:6 with $1\frac{1}{2}$ in. hard granite broken stone and with 20 per cent hard granite plums not exceeding 3 in. in size. A batter of 1 in 12 for the abutments and 1 in 18 for the piers was provided on the faces. Circular cutwaters for the piers and abutments were provided. Curved wings were adopted so as to make suitable connection with the formation width of 38 ft.

The abutments and piers were provided with reinforced cement concrete continuous bed block 1 ft-6 in. thick extending 3 in. beyond the face of the piers and abutments at top.

Superstructure

The decking consists of 2 T-beams with ribs 21 in. wide and 50 in. deep spaced at 14 ft centres, freely supported over piers and abutments, Fig. 3. The thickness of the deck slab is 8 in. The thickness of the cantilever slab extending

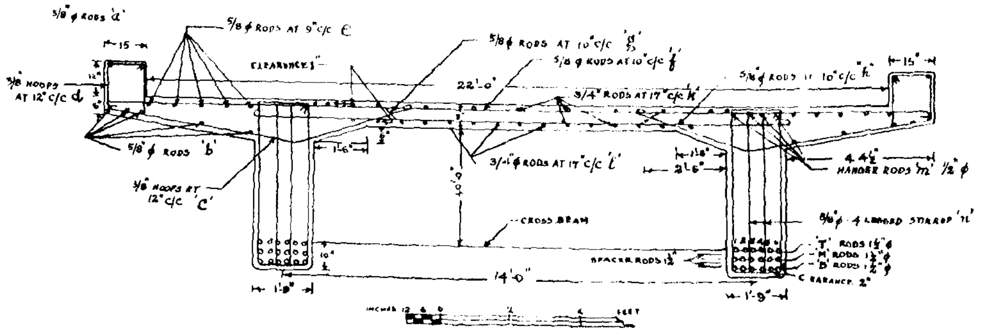

Fig. 3
Cross section of deck

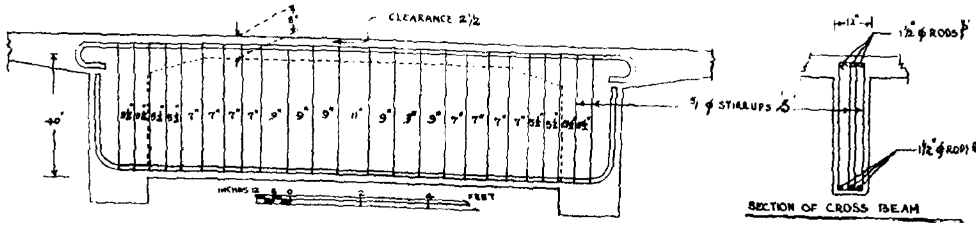

Fig. 4
Longitudinal section of cross beam

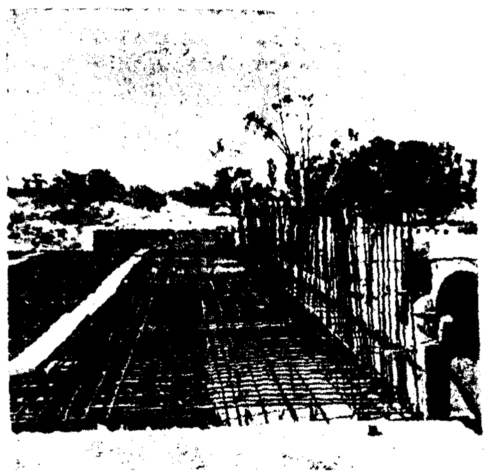

Photo 6. **Reinforcement for the decking on Madras side with vertical bars for posts of handrails in position**

outside the T-ribs at the outer face of the T-rib is 14 in. and that at the farther end is 6 in. The main beams are connected by cross beams at 9 ft—4-4/5 in. centres. The cross beams are 12 in. thick and the bottom of the cross beam is 10 in. above the bottom of the T-ribs, Fig. 4. The clear roadway over the bridge is 22 ft, Photo 5. The kerbs are 15 in. wide and 12 in. deep.

The decking, Photo 6, is of vibrated reinforced cement concrete $1:2:4$ with $\frac{3}{4}$ in. (B.S.S.) hard granite broken stone.

Sliding plate bearings are provided under the T-beams at the free ends and grout pads are provided for the fixed ends. Suitable holes were left in the bed block concrete for providing grout pads. The sliding plate bearings and the grout pads were provided only at the time of laying concrete for T-beams, Photo 7.

The wearing coat is of vibrated cement concrete $1:1\frac{1}{2}:3$ with 66-2/3 per cent of 1 in. size metal and 33-1/3 per cent of $\frac{1}{2}$ in. size metal. The average thickness of the wearing coat is 3 in., 2-5/16 in. towards kerb and 3-11/16 in. at centre.

The superstructure in each span is completely separated from the adjacent span. A clear gap of 1 in. is continued right through the superstructure filled with a resilient joint filler. This is held by a bulb shaped 1/16 in. thick and 10 in wide copper sheet (with 4 in. × $1\frac{1}{2}$ in. slots at 8 in. centre to centre cut on either side) fixed to the superstructure.

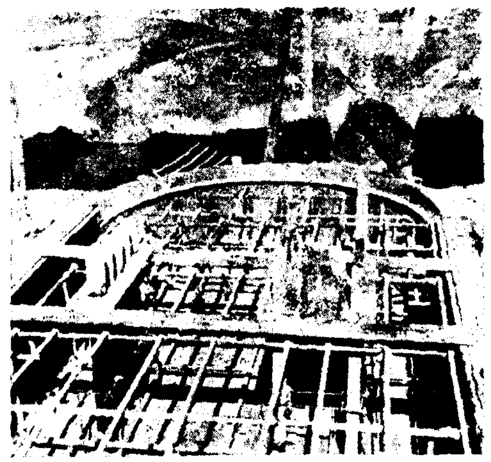

Photo 7. **Reinforcement and formwork for bed block over pier. Arrangement to leave holes for fixing the fixed end bearing is also fitted to the formwork**

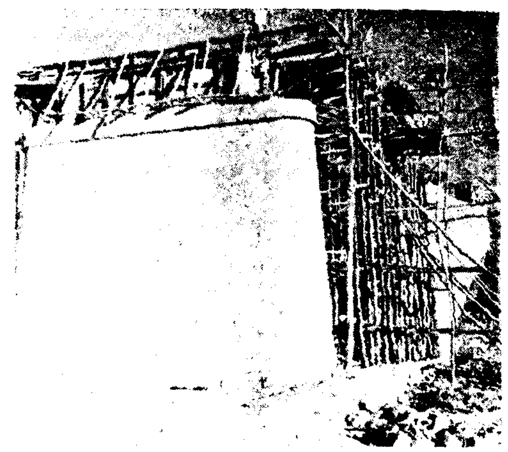

Photo 8. **Scaffolding and formwork for the deck on Madras side end view**

The roadway over the bridge is drained by means of 3 in. diameter drainage spouts fixed in the kerb at 16 ft-4 in. intervals. Wearing surface is suitably sloped towards these outlets. No gratings are provided at the entrance of the spouts.

The parapets and pilasters are of cement concrete $1:3:6$ mix with $1\frac{1}{2}$ in. B.S.S. size hard granite broken stone. The top 6 in. thickness of the parapet and pilasters is finished with cement concrete $1:2:4$ with $\frac{3}{4}$ in. B.S.S. size hard granite stone.

Reinforced cement concrete panel type hand rails are provided.

Approaches

Reinforced cement concrete $(1:2:4)$ approach slabs 6 in. thick are provided on either side for a length of 10 ft between wings to relieve the live load surcharge on the abutments.

Approaches to the bridge are kept level and straight for a distance of 50 ft on both the sides. Beyond this, a gradient, of 1 in 30 is provided so as to meet the existing road. The formation width of the approaches is 38 ft with a side slope of 1 vertical to $1\frac{1}{2}$ horizontal.

Rough stone dry packed revetment 1 ft thick over a gravel backing of 6 in. is provided to protect the slopes of the approaches at the sides of the wings. Beyond the ends of the bridge, the revetment is extended to a distance of 22 ft. Suitable inspection steps are also provided in the revetment.

The metalled width is 22 ft upto a distance of 50 ft from the end of the wings and it is then reduced to 12 ft width in a further distance of 50 ft.

The road crust consists of 5 in. thick metalling laid over 8 in. thick gravel soling. The bottom layer of 3 in. thick metalling is done with 2 in. size hard granite metal and the top layer of 2 in. thick metalling with $1\frac{1}{2}$ in. size hard granite metal. After one rainy season the water-bound macadam surface was renewed to 2 in. thickness with $1\frac{1}{2}$ in. metal. Over this, surface dressing with precoated chips was laid.

Precast cement concrete guide stones are provided on the approaches.

Quantity of cement used	432 tons
Quantity of steel used	53 tons

(*Continued on page 22*)

THE ELEVENTH INTERNATIONAL ROAD CONGRESS

MODERN LOCATION OF HIGHWAYS

THE first question discussed at the XIth International Road Congress included a section devoted to the aesthetic layout of roads. In the report presented by the Federal Republic of Germany, Oberregierungs-baurat Lorenz presented the following information on this subject.

Aesthetic Points of View

Aesthetic qualities of alignment had to be taken into account for the construction of the autobahnen (motorways), because they offer often a wide field of vision The following basic principles have evolved :

1. Horizontal curves should be sufficiently long, to avoid the appearance of a kink.
2. Short sag vertical curves between long straight grades should not be used, to avoid likewise the appearance of a kink.
3. Short sag vertical curves between long curved grades should not be used, to avoid the appearance of a pocket.
4. Horizontal bridges between grades should not be used, to avoid the appearance of a board having been laid over the valley.
5. The broken-back arrangement of curves (flat back, or short tangent between two curves in the same direction) should be avoided. This broken-back alignment is not pleasing in appearance.
6. A flowing line that conforms generally to the natural contours is preferable to one with long tangents that slashes through the terrain.
7. In the case of a wide carriageway and especially in terrain with a wide field of vision, a smooth grade line with gradual changes, consistent with the type or class of highway and the character of terrain, should be preferred to a line with numerous breaks and short lengths of grade.

These principles have led to the theory of flowing three-dimensional alignment. This theory has been developed from aesthetic points of view, but problems of riding dynamics and driver psychology soon corroborated this theory of thinking in three dimensions when designing a highway. The three-dimensional alignment of a highway takes into account the many changes of direction due to terrain, planting, other traffic routes and water courses. These changes of direction should be visible already from a far distance and they should merge on into another without the impression of forced alignment. This applies to horizontal alignment as well as to profile and to the combination of both in the three-dimensional reality. This theory of flowing three-dimensional alignment led to the following basic principles :

8. In addition to tangents and circular horizontal curves, transition curves are introduced as a third geometric design element of equal importance. These transition curves are not limited to the minimum length as required by riding dynamics, but they are used in any length consistent with flowing alignment. The transition curves must in any case be so designed as to provide a natural easy-to-follow path for drivers, such that the centrifugal force increases and decreases gradually as a vehicle enters and leaves a circular curve. The minimum curvature is 3 deg. More than 30 deg. can rarely be obtained in practice.

9. Transition curves should be used in the following three cases :

(a) transition from a tangent to a curve,

(b) transition from a sharp circular arc to a flat circular arc curved in the same direction and vice versa,

(c) transition from one curvature to the opposite one.

10. To effect transition, the following elements can be used : the "Euler" spiral, which in mathematical terminology is the clothoid (preferred in the Federal Republic of Germany and in many other countries), the cubic parabola and the lemniscate.

11. In addition to the above elements, the following procedures have proved to be useful for obtaining a flowing alignment :

(a) free-hand drawing of the alignment for preliminary design,

(b) the Spline method for final design (an elastic rod is used as a rule), and

(c) the Winkelbildverfahren for control and improving the alignment.

12. the flowing alignment is generally composed of curves and reverse curves. Tangents are only used in exceptional cases.

13. The bridges merge into the flowing alignment.

14. The consistency of the alignment requires that sharp curves at the ends of long tangents and sudden changes from easy to sharply curving alignment be avoided.

15. The vertical alignment should preferably be composed of crest vertical curves and sag vertical curves following each other continuously. Constant upgrades and constant downgrades can also not be objected to from a technical point of view, but for aesthetic reasons, however, the three-dimensional alignment should always be kept in mind (vide 18).

16. There are many possibilities for the three-dimensional alignment, and some of them have not yet been investigated. The following is a safe guide : the change point of the horizontal reverse curves shall be at approximately the same point as the change point between crest and sag. Thus, the sag or the crest have the same length as the respective horizontal curve. From an aesthetic point of view there would also be no objection if a horizontal change point coincides with a low point of a sag vertical curve or a high point of a crest vertical curve, but surface run-off would be impaired by this.

17. In former times, the following elements were used : tangent, horizontal curve, crest, sag and constant grade. The opinion at that time was that these elements can be used at random ; but the alignments resulting from such random use were unsatisfactory from an aesthetic point of view. The three-dimensional alignment uses the following elements : curved sag, curved crest, curved constant grade. The use of these elements requires learning to think in three dimensions, but this will avoid aesthetically deficient alignment.

18. The following can be added to the principles as outlined under 16 and 17 above : if the horizontal aligment has less change points than the profile, undulating curves will result. If the profile has less change points than the horizontal alignment, s-shaped sags, crests or constant grades will result. The values of the elements both in horizontal alignment and profile must be adjusted one to another.

19. The control of the aesthetic quality of the alignment is made during or after the design, but before construction, by the following methods :

(a) Calculated or constructed perspectives. The perspective picture of the carriageway including the bridges and slopes can, for the purpose of representation of the fitting of the highway into the landscape, be inserted into a photographic or stereo photographic picture of the landscape. The photographic picture of the landscape may also be replaced by a landscape drawing made on the scale of the perspective.

(b) Gradient models are used to provide an overall picture of the three-dimensional alignment.

If these 19 principles are observed, the highway will definitely be satisfactory from an aesthetic point of view. These principles do, however, not preclude the use of other ideas for alignment.

(From "Roads and Road Construction", October, 1959).

STUDY OF SIEVE-SIZE EFFECT ON ATTERBERG LIMITS OF SOILS

By

K. R. SAXENA J. SATYA PRABHU *

1. Introduction

THE Atterberg tests on soils are conducted usually on soil fraction passing No. 36 sieve (B.S.S.) or 40 mesh (U.S.). The present study is made to ascertain how far the Atterberg limits obtained for soils by conducting tests on 40 mesh sieved material are justifiable and representative of the plasticity characteristics of these soils which, in nature, exist in an unsieved state. The study is also made to assess whether different sieves for the two principal groups of soils, namely, the cohesive and non-cohesive, are to be used to find out the exact plasticity characteristics of soils. Present studies are made taking into consideration the main groups of the soils according to P.R.A. system of classification (U.S.A.).

2. Investigations

Twenty-six soil samples belonging to different groups were selected and their Atterberg limits were determin d taking 36 mesh (B.S.S.) pass soil fraction as well as 10 and 22 mesh (B.S.S.) pass soil fraction. On 42 soil samples belonging to A-7 group of P.R.A. classification system, the Atterberg limit tests were conducted on soil fractions passing 36 mesh (B.S.S.) and 200 mesh. Besides this, the textural and P.R.A. classifications of all these soils were investigated and recorded for a coherent study.

3. Test Results

The identification and Atterberg test results of the soils are given in Tables 1 and 2.

4. Discussion of Test Results

4.1. In the soils selected for conducting the Atterberg tests, the two principal groups, namely, the coarser and the granular soils belonging to A-2 group and the plastic and clayey soils belonging to A-7 group, are mainly studied. The soils selected, therefore, belong to cohesive and non-cohesive groups, as a comparative study conducted on these two principal groups of soils will be very valuable for further investigations.

4.2. In case of non-cohesive granular soils it is seen that the values of liquid limit and plastic limit decrease with the increase of coarser fractions. In soils of A-2-6 group where the clay content present is less than 5 per cent, 10 mesh (B.S.S.) passed soil fraction has not given any Atterberg limit values. Thus it shows that the coarser fraction has an effect in decreasing the plasticity characteristics of soils and, in the light of this, taking "soil fines" for conducting Atterberg limit tests for non-cohesive granular soils may not be very appropriate. Usually soil fines are taken for determining the Atterberg limits of a soil. Soil fines contain sand ranging from medium to very fine type, besides silt and clay. If the percentages of sand, silt and clay in soil fines are estimated, they will be very different from the percentages of sand, silt and clay inherently present in an unsieved soil. Apart from it if clay, that contributes to soil plasticity alone, is taken in soil fines, its percentage will be higher than that of clay present in the virgin soil. Consequently, high and unreal values of liquid limit and plastic limit are obtained in the case of non-cohesive granular soils when their liquid limit and plastic limit are determined on the 'soil fines' fraction of soils. But if 10 mesh pass soil fraction is used it can very nearly be a true specimen of coarse grained type of soil. Even for shear tests, 10 mesh or 4 mesh pass material is

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samples

.imit per cent		Plastic Limit per cent			Plasticity Index			Remarks
assing 2 mesh	Passing 36 mesh	Passing 10 mesh	Passing 22 mesh	Passing 36 mesh	Passing 10 mesh	Passing 22 mesh	Passing 36 mesh	
35.5	40.0	—	21.05	24.2	—	14.45	15.80	
34.10	38.0	—	21.10	21.70	—	14.0	16.30	
23.0	29.0	10.6	11.6	14.3	7.9	11.4	14.70	
66.0	72.0	41.9	41.4	42.70	21.9	24.6	29.30	
54.0	71.80	26.10	30.0	42.60	18.90	26.0	29.0	
59.0	64.5	18.20	21.60	20.2	31.3	37.4	44.3	
50.0	54.50	18.40	21.75	20.10	22.60	29.25	32.40	
47.5	55.8	18.40	28.15	27.15	11.60	19.35	28.30	
54.5	52.0	25.55	32.80	26.80	18.70	21.70	25.20	
50.0	53.80	22.95	30.50	25.50	12.55	19.50	28.40	
21.75	24.5	13.75	13.75	25.60	8.25	8.0	8.90	
36.0	37.5	14.9	18.4	22.0	11.60	17.60	15.50	
34.3	39.5	13.94	16.90	20.10	14.06	17.5	19.40	
54.0	56.0	26.50	30.35	31.6	17.0	23.65	24.40	
18.5	54.0	25.5	28.5	30.2	18.0	20.0	23.8	
4.20	57.0	30.20	31.20	31.26	22.0	22.0	25.74	
75.5	82.20	28.75	31.70	31.70	41.25	43.8	50.50	
1.5	83.0	50.45	47.90	51.50	32.05	33.60	31.50	
8.20	38.10	16.20	26.00	26.00	9.60	12.20	11.20	
33.50	34.50	19.30	23.35	20.45	7.70	10.15	14.05	
7.90	42.00	20.0	22.90	26.10	11.50	15.0	15.90	
Nil	32.25	Nil	Nil	25.55	Nil	Nil	8.50	
9.70	38.00	Nil	21.70	25.55	Nil	8.0	12.45	
Nil	22.50	Nil	Nil	19.50	Nil	Nil	3.00	
Nil	22.50	Nil	Nil	17.40	Nil	Nil	5.10	
5.50	45.50	20.70	27.85	29.0	13.80	17.65	16.50	

Sl. No.	Gravel per cent	Plastic Limit per cent		Plasticity index		Remarks.
		Passing 36 mesh	Passing 200 mesh	Passing 36 mesh	Passing 200 mesh	
1.	5.0	20.90	26.15	31.10	45.35	
2.	7.0	30.95	46.90	38.05	59.60	
3.	4.0	32.70	44.60	33.0	51.0	
4.	6.0	34.50	42.50	33.50	47.50	
5.	6.0	30.10	40.40	29.90	30.10	
6.	6.0	28:50	26.80	22.0	26.70	
7.	–	22.95	35.40	31.05	29.10	
8.	4.0	36.0	44.0	22.0	24.0	
9.	6.0	28.0	38.60	17.50	25.40	
10.	3.0	25.45	42.50	27.55	27.50	
11.	–	37.30	36.50	27.70	33.50	
12.	–	21.50	29.90	13.0	19.60	
13.	2.0	36.0	38.25	42.0	67.25	
14.	3.0	20.40	30.95	11.60	20.05	
15.	4.0	25.0	38.60	16.0	31.40	
16.	–	18.35	29.85	7.65	14.15	
17.	–	20.06	29.30	10.44	23.20	
18.	–	26.20	40.0	17.30	16.09	
19.	–	31.0	39.30	16.60	20.70	
20.	–	23.16	36.30	11.34	16.20	
21.	–	31.20	46.36	27.80	27.64	
22.	–	39.0	42.50	27.50	26.50	
23.	17.50	43.0	53.40	18.00	31.00	
24.	–	29.90	49.90	36.10	40.10	
25.	–	21.70	44.20	25.80	36.00	
26.	–	30.60	47.20	29.40	36.80	
27.	1.0	33.00	53.90	32.50	38.60	
28.	2.0	33.00	53.90	32.50	38.60	
29.	2.0	35.70	54.40	37.0	40.60	
30.	6.0	19.80	41.30	25.20	33.70	
31.	5.0	51.0	47.0	43.0	56.90	
32.	5.0	38.10	43.45	24.40	31.53	
33.	4.0	23.0	37.0	15.0	28.0	
34.	3.0	32.50	43.40	20.0	30.60	
35.	5.0	28.35	36.80	18.65	26.20	
36.	9.0	41.40	50.20	22.50	32.80	
37.	–	18.95	39.50	40.05	55.0	
38.	–	21.50	35.30	18.0	30.20	
39.	—	35.10	47.0	18.40	25.00	
40.	–	46.0	38.80	30.0	50.20	
41.	–	36.30	49.50	21.70	24.00	
42.	10.0	22.60	26.0	21.0	52.50	

used, and for constructional purposes not less than 10 mesh pass material is ever used. Thus it may be apt to determine the Atterberg limit tests on 10 mesh passed material for coarse grained soils as, after all, plasticity is a mechanical property dependent on the size and shape of the soil grains.

4.3. Soils which belonged to A-2-6 group and which contained only 4 per cent of clay or less, did not give any values of liquid limit or plastic limit when 10 or 22 mesh passed material was used for determining Atterberg limit values. From this it appeared that the presence of 4 per cent of clay at least is needed for coarse grained soils to exhibit plasticity characteristics.

4.4. In the case of cohesive soils also the liquid limit and plastic limit values decrease with the increase in coarser fractions (in this case the soil-size increase being due to aggregation of soil particles of small size.) From Table 2 it is clear that if finer meshes than 36 mesh (B.S.S.) are used, higher values of liquid limit and plastic limit are obtained for these soils than that got for 36 mesh sieved soil fraction. In the clayey or fine-grained soils, the primary soil particles exist in a finely divided state, as such, the 36 mesh pass soil fraction, which is not a true representative of the soil, gives lower values of liquid limit when compared to 200 mesh pass material. The values of liquid limit and plastic limit obtained by finer sieves can be more representative of the plasticity characteristics of clayey or finely grained plastic soils, and can thus be useful to an Engineer while selecting cohesive soils for constructional purposes, keeping in view their swelling characteristics.

4.5. Reference to Table 1 shows that for soils belonging to A-4 group of the P.R.A. classification system of U.S.A., the increase in coarser fractions has not produced any appreciable influence on the Atterberg limit test values. This shows that the plasticity characteristics of silty soils are not affected by increase in coarser fractions. It is only silt in silty soils that imparts plasticity to them.

5. Conclusions

5.1. In the case of coarse grained soils, the Atterberg limits obtaining by conducting tests on 10 Mesh B.S.S. passed material may be more representative of the plastic behaviour of coarse grained soils.

5.2. In the case of cohesive soils, the Atterberg limits obtained by conducting tests on material passing finer mesh than 36 may be more representative of cohesive soils. 200 mesh sieved soil may be used with advantage in cohesive soils for determining Atterberg constants.

5.3. A minimum of 4 to 5 per cent of clay is needed for soils of coarse grained type to exhibit any plasticity characteristics, when material passing 10 mesh is taken.

5.4. The plasticity characteristics of silty soils seem to be not affected by the increase of coarser fractions. It is not the size of the silt particles but the quantity of it that contributes to plasticity in silty soils.

5.5. Further studies, that are being made, will be useful in arriving at definite conclusions with regard to different sieves that are to be used for different types of soils.

Acknowledgment

We acknowledge with gratitude the valuable guidance given by Late Shri J.S. Narasimham, Research Officer, Soil Mechanics Laboratory, for the fundamental approach to the subject. We are grateful to the Director of Laboratory, Sri R. K. V. Narasimham, for having permitted us to work on the problem and to send the Paper for publication.

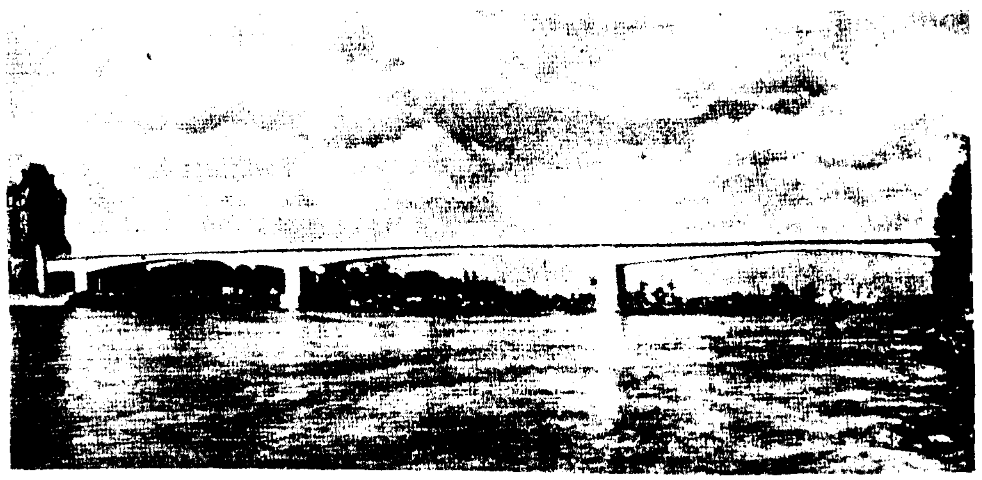
No one but the Mint can make money without advertising.

—*W. E. Gladstone.*

NEW BRIDGE DESIGNS ON WEST GERMAN MOTORWAYS

PRESTRESSED CONCRETE CANTILEVERED STRUCTURE OVER RHINE AT WORMS

THE new Nibelungen bridge over the Rhine at worms was one of the many prestressed concrete bridges seen by the British Road Federation party touring West German highway schemes. The Nibelungen bridge was the first to be built in concrete over the navigable part of the Rhine. It replaces a steel arch bridge which was destroyed during the last war. The cantilever method was used for erection and the prestressing is by the Dywidag system.



The Nibelungen bridge over the Rhine at Worms, a prestressed concrete structure constructed on the cantilever principle

The bridge has three spans of 101, 114 and 104 m. respectively. It has a width of 13.5 m. between railings.

The bridge piers rise from caissons—which are the same as were used for the old bridge—and girders cantilever out symmetrically from the piers. The superstructure, therefore, is rigidly connected to the piers. The cross-section is essentially two box girders varying in depth from 6.5 m. at the springing to 2.5 m. at the crown, with a transversely prestressed deck slab spanning between them ; the deck slab is of variable depth. The movement joint between the cantilevers has a vertical connection to ensure continuity. A vertically prestressed roller bearing is provided to transmit the shearing forces but offers no resistance to longitudinal movement.

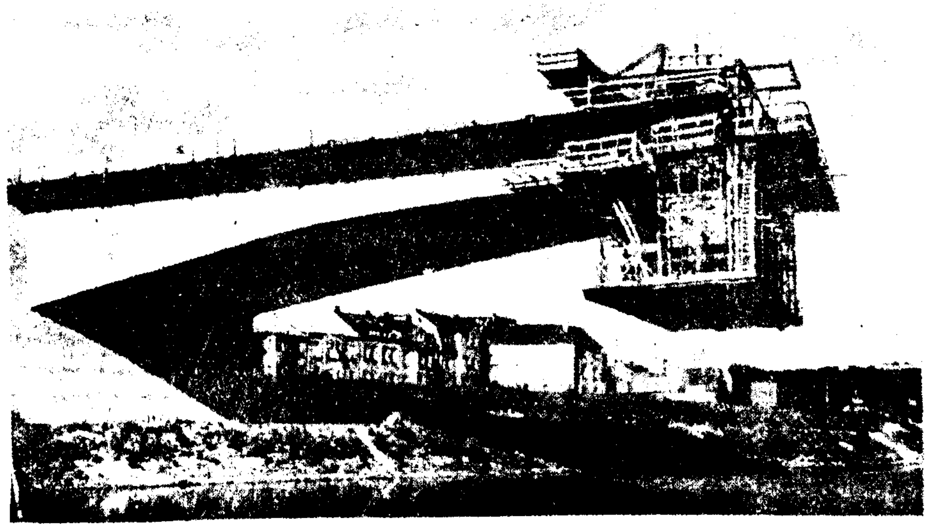
The authority responsible for the bridge was the Rheinland—Pfalz county.

Bridge over the Rhine linking Koblenz and Pfaffendorf

Competitive designs and tenders for the re-building of the original bridge, destroyed in 1945, were submitted in April, 1950. A design embodying a girder-type bridge of steel construction was selected as being most suitable from the viewpoint of harmonising with the landscape. The bridge has a three-span continuous superstructure (span lengths approximately 103 m., 105 m. and 103 m. respectively) consisting of two steel box girders, 4.11 m. deep, 2.05 m wide and spaced 14.70 m. centre-to-centre. Overall width of superstructure 20.78 m. including 12 m. wide carriageway, 1.6 m. wide cycle tracks, and 2.6 m. wide cantilevered footways. The deck consists of a continuous reinforced concrete slab, which is covered by an aluminium membrane and a 5 cm. thick asphalt road surfacing. The bridge was opened to traffic in July, 1953.

Bridge over the Moselle at Koblenz

The bridge over the Moselle at Koblenz was destroyed at the end of the war and has been replaced by a prestressed concrete bridge. There are three over-water spans, one of 335 ft, one of 374 ft and a central span of 404 ft.



Construction in progress on the Koblenz bridge over the Moselle

The bridge was designed on similar lines to the bridge over the Rhine at Worms. Prestressed hollow box beams are cantilevered from two central piers and from two land piers and carry a transversely prestressed deck. The Dywidag system of prestressing was used.

From the two river piers construction was carried out in both directions symmetrically, to eliminate bending in the piers; at the end abutments effective counterbalancing was provided by beam overhangs. The concrete was placed in situ in 10-ft lengths, the form-work for each section being erected from carriages working along the already cast and stressed stubs. The prestressing bars were in 20 ft lengths. At the end of each 10-ft section a number of the bars were stopped off and tensioned, stressing the new section back against the preceding one, while additional lengths of bar were coupled on to the remainder as required, preparatory to casting the next block. Placing the bars and casting a 10-ft length of concrete took three days, and after a further three days prestressing was carried out.

The Wuppertal autobahn

There are, in all, 16 bridges on the new length of the Wuppertal autobahn. They have a total length of about 1,550 m. In the Schwelm Valley the subsoil is extremely unsuitable for bridge construction. The limestone contains open seams and is riddled with cavities which are likely to collapse suddenly. This factor has influenced the construction of the foundations for the Schwelm and Langerfeld bridges, two of the four most important bridges on the motorway; these four bridges are described below.

Schwelm bridge

The Schwelm bridge carried the Federal motorway over a road, the Wuppertal-Hagen section of the railway, the River Schwelme and the Jesinghauser Strasse, which is connected to the motorway access point Wuppertal-East-Schwelm. Work on the foundations started in the autumn of 1958. The construction time required for completing the bridge is 20 months in all.

The design of the bridge was dictated by the need to keep visibility clear for the working of the railway. It is a continuous, three-span structure, 207 m. long in all; span lengths are 60 m., 87 m. and 60 m. As it takes the acceleration and deceleration lane of the access point the bridge is 31 m. wide.

The superstructure consists of two separate halves. Each half consists of two concrete box sections which are connected by the deck slab and by diaphragms. The structure is prestressed longitudinally and transversely. The exposed concrete surfaces are to be formed with wrought timber shuttering. The underside view of the superstructure is dominated by the four box girders. The two rows of supports, each with four slender rocker-type supports of elliptical section, also have exposed concrete surfaces.

As in the case of the Langerfeld bridge, the limestone formation has made construction of the foundations difficult. For the Cologne abutment reinforced concrete caissons, 4 m. by 10 m. on plan and extending down to as much as 15 m. depth and resting on the sound limestone, are to be installed. Caissons of 4 m. dia. will be installed under the intermediate supports. The Kamen abutment will be founded on the limestone rock of the valley side.

Langerfeld bridge

The bridge carries the Federal motorway over the Langerfeld valley, crossing the Schwelmer Strasse (B7) and the 'Inder Fleute' municipal road. It was designed to harmonise with the built-up character of the Wuppertal Langerfeld industrial region and is a continuous, eight span structure, with an overall length of 315 m. It lies in a curve of the motorway, with a radius of 600 m.

The superstructure consists of two separate concrete box sections with cantilevered slabs on both sides. It is longitudinally prestressed and is partially prestressed in the transverc direction.

The exposed concrete surfaces will be formed by smooth shuttering panels and will be enlivened by 'Dummy' joints. The piers will have exposed concrete surfaces.

The geological formation of the subsoil makes the construction of the foundations for the piers and abutments a very difficult task. Reinforced concrete caissons of 4 m. dia. (or 6 m. in the case of the central pier) and with walls 40 cm. thick, resting on the sound limestone stratum, were installed. They extend down as far as 20 m. and were filled with rammed concrete.

Work on the two abutments began in March 1958. Experience gained in installing the caissons for the abutment foundations was to be subsequently utilised in the very difficult task of constructing the foundations for the intermediate piers. Work on these latter foundations was started in September 1958, so that it will be possible to complete the construction of the superstructure of the bridge in 1959.

Wuppertal bridge

The bridge carries the Federal motorway over the Wupper Valley, containing Federal highway B 51, the River Wupper, and the Wuppertal-Radevormwald section of the railway and also Oehder Strasse.

The bridge is located in a sag curve (concave transition between gradients). It is continuous over seven spans, with an overall length of 418 m. (maximum span, 73 m.). The concrete piers vary in height from 14 m. to 28 m. and are faced with stone; maximum height above the river bed is 35 m. The trapezoidal steel box girder acts compositely with the longitudinally and transversely prestressed deck slab, which is cantilevered out a distance of 4 m. on either side.

The welded steel structural components are assembled on site to form 12 m. long box girder segments. All site joints are riveted. Erection starts from the Cologne abutment, using auxiliary supports in the first span; in the further spans, the cantilevered method of erection is employed, with the aid of one auxiliary support at the centre of each span. The deck slab—which is vacuum-treated—is concreted in separate bays, the full width of the bridge.

Longitudinal prestress is carried out during erection (the steel box girder is raised by amounts of upto 1.80 m. and the composite steel-and-concrete superstructure subsequently lowered), using 25-ton or 50-ton tendons (Freyssinet system). Transverse prestress is produced by means of 50 ton tendons.

The trapezoidal section and the large lateral cantilevers have not hitherto been employed on so big a scale.

Blombachtal bridge

The Blombachtal bridge carries the Class I provincial road No. 419 over the Blombach Valley, containing the dual carriageway, motorway and the Oberbarmen-Remscheid-Lennep section of the railway. Road No. 419 will have the character of a feeder road from Wuppertal-Elberfeld to the Wuppertal-South access point. Construction work on the bridge started in May 1957; completion date August 1959.

The bridge is a fixed-end reinforced concrete arch with the deck supported on columns standing on the arch, which has a span of 150 m. and a rise of 27 m. The maximum height above the valley floor is about 50 m. In cross section the arch is a box-section 11.50 m. in width and having a depth which increases from 2.30 m. at the crown to 3.60 m. at the springings, while the wall thickness correspondingly increases from 0.40 m. to 0.60 m. The box-section member is stiffened by longitudinal and transverse diaphragms.

The deck structure is formed by a five-webbed box-section with a 3.25 m. wide cantilevered deck slab on each side. The carriageway is 8.50 m. wide; future widening to 13.80 m. is possible. The overall width of the superstructure is 15.30 m. The overall length of the bridge from carriageway abutment to carriageway abutment, is 327.90 m.

The subsoil consists of rock containing open seams; it was injected with cement grout under the arch abutments.

Cologne and Rhine bridges

The position of Cologne and its division by the Rhine mean that this city has the most heavily trafficked of the Rhine bridges. In addition, the volume of traffic in the city, which has a population of 764,000, has increased by more than 6 times during the past 10 years, and the narrow street system in the central area has almost reached the limit of its capacity.

To relieve the traffic congestion, two urban express roads are already under construction in the city. These are the re-routed Federal Highway B 55, which crosses the Rhine by way of the new Severins bridge, and the Innere Kanalstrasse.

Federal Highway B 55 and Severins bridge scheme

Previously the B 55 passed right through the central area of Cologne and through the inner suburb of Deutz on the right bank of the Rhine. There were eight heavily trafficked junctions, with traffic volumes at some points greater than 50,000 vehicles per day. The capacity of the road had long been exceeded.

The new B 55 crosses the Rhine by way of a new bridge and conveys traffic from the direction of Aix-la-Chapelle and Belgium to the Ruhr-Frankfurt motorway and onwards to the east, by-passing the town centre. In built-up areas the new B 55 is provided with three traffic lanes in each direction. In the non-built-up areas on the right bank of the river, it has, for the most part, two lanes in each direction.

The section of the B 55 on the left bank of the Rhine, from the Aachener Strasse to the approach ramp to the new bridge, will be provided with a 'green wave' co-ordinated control system, which enables vehicles to travel the whole length of the road as far as the bridge without having to stop. The junctions of the B 55 and the projected north south road, which will be a new main road through the town centre, will be constructed as multi-level inter-sections. So, too, will be the accesses to and from the existing riverside road (Rheinuferstrasse).

On the right bank of the Rhine, the B 55 has been carefully routed to take traffic away from the Cologne-Deutz town centre. The entire length of the B 55 as far as the suburb of Kalk will be free of crossings on the level. Connections to the industrial area along the Siegburger Strasse and to the feeder road to the Frankfurt motorway are provided.

The new Severins bridge, by which the B 55 crosses the Rhine, is now being built. The cost of the bridge scheme, excluding the cost of land, is 42 milion DM. [£1 = 12 DM.] The new bridge is a six-span steel bridge, with an overall length of some 700 m. and an unusual aspect of its design is the use of an asymmetric suspension carried by a single tower standing on a river pier. The bridge thus gives the minimum of obstruction to shipping, preserves the view down the river and forms a 'counterpoint' to the Cathedral.

On the left bank of the Rhine, the approach viaduct to the Severins bridge has an overall length of 167.10 m. The 28 m. wide deck of the viaduct is constructed in prestressed concrete. Main longitudinal beams are spaced at 16.60 m. intervals and are carried on vertical piers. Transverse secondary beams are placed at 2.50 m. intervals. These secondary beams support a slab which is transversely prestressed.

The viaduct leading to the bridge on the right bank of the Rhine is constructed in two sections: the 'entry' ramp is 172.00 m long and the 'exit' ramp 250.00 m. long. Each ramp is supported on vertical piers; those carrying the entry ramp are positioned slightly off centre. Near the bridge abutment, the two separate ramps are connected by means of a concrete slab.

On both sides of the bridge, footways and cycle tracks at the entry and exit points of the bridge are free from grade intersections with motorway traffic.

From the Gotenring, part of the right bank approach, there is a 60 m. long three-span concrete ramp to the Siegburger Strasse. The deck of this ramp is partially prestressed in both the longitudinal and transverse directions on the Dyckerhoff-Widman system.

(From "the Surveyor & Municipal & County Engineer, Vol. CXVIII, Number 3518, Saturday, 7 November, 1959".)

(Continued from page 11)

Costs

Analysis of the Costs of the Bridge

	Rs to the nearest thousand
Foundations	20,000
Piers, Abutments	68,000
Superstructure	85,000
Approaches	23,000
	1,96,000

Analysed Costs

		Rs
(a)	Per running foot of bridge	1,333.33
(b)	Per square ft of carriage-way excluding kerbs	60.61
(c)	Per square ft of entire elevation area enclosed between the line connecting the lowest part of the foundation and a line connecting the uppermost points of superstructure	34.96
(d)	Per cubic foot of bridge from bottom of foundation to top of roadway	1.59

IMPROVEMENTS TO FACILITATE MOVEMENT OF TURNING TRAFFIC AT INTERSECTIONS*

DRIVERS of vehicles desiring to make a turn from a through road at an intersection have to reduce speed to undertake the movement. Similarly, drivers turning into a through road require to accelerate until their speed matches that of the through traffic. These turning movements tend to interfere with the movement of through traffic and in some cases to create unsafe conditions. The use of an auxiliary lane, or a speed change lane, at intersections of this nature is designed to facilitate the movement of turning traffic and improve the flow of traffic generally.

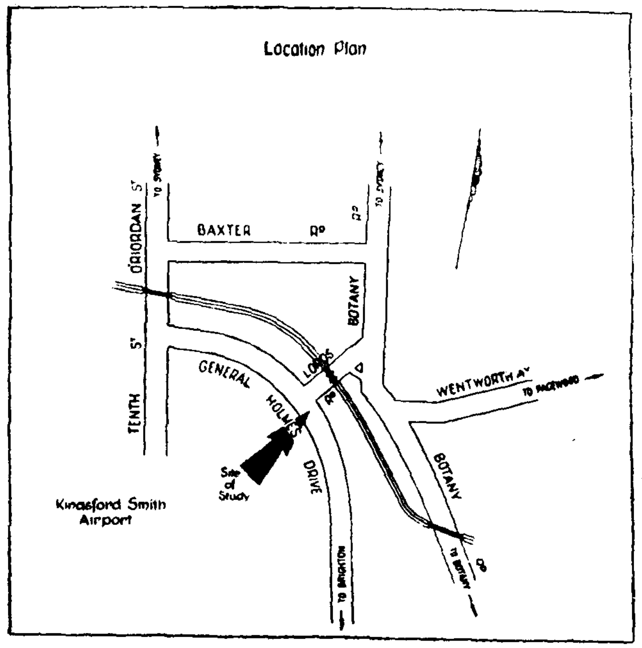


Fig. 1

The study of the use of speed change lanes is included in the programme of coordinated research on traffic problems being undertaken by the Traffic Engineering Committee set up by the Conference of State Road Authorities of Australia. As a first contribution to this study, the Department of Main Roads, New South Wales, recently investigated the question of improving conditions at a right-turn lane at a suburban intersection.

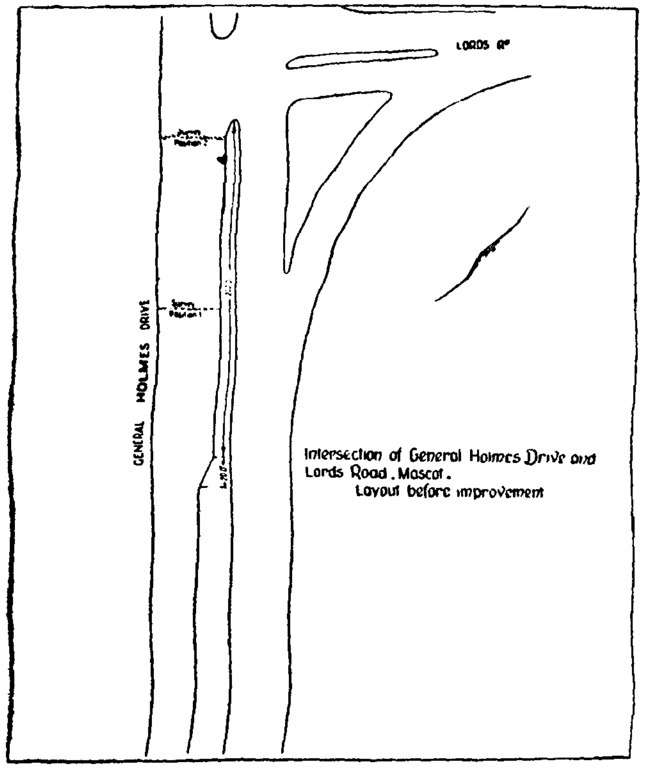


Fig. 2

The site chosen was the junction of General Holmes Drive and Lords Road, Mascot (Fig. 1). General Holmes Drive is a divided four-lane highway and a right-turn lane had been constructed in the kerbed median for traffic turning, right, into Lords Road. This lane was 200 ft long and 10 ft wide with a 20 ft lead-in taper at the beginning of the lane (See Fig. 2). There were no lane lines or pavement markings to encourage the use of the extra lane and it was seen that most of the vehicles making the

* Reprinted from "Main Roads" June, 1959.

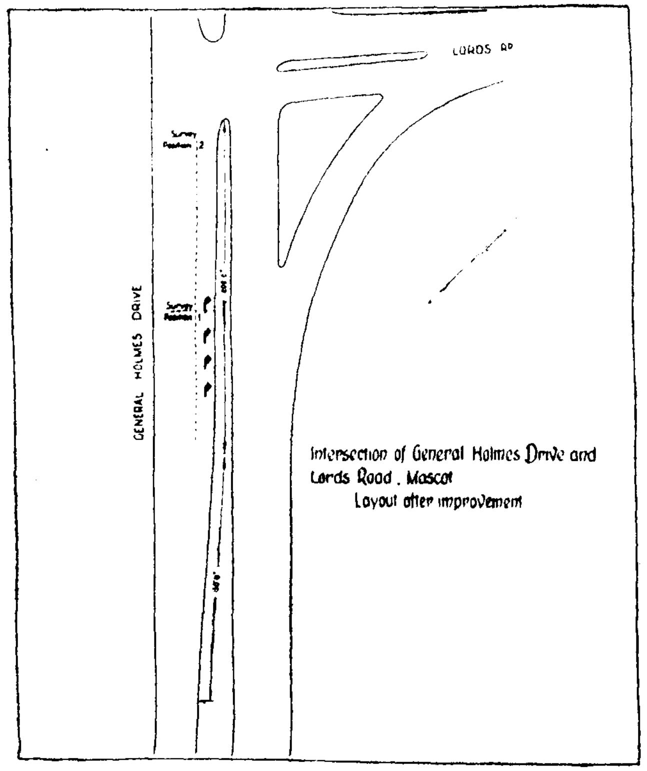


Fig. 3

turn remained on, or partly on, the through lane on which they had approached the junction.

It was considered that greater use of the turning lane might be expected if :

(i) the lead-in taper at the beginning of the lane were lengthened to 150 ft ;

(ii) a lane line were marked to separate the turn-lane from the through lanes; and

(iii) arrows painted to indicate that this lane was to be used by right turning vehicles.

These improvements, which are illustrated in Fig. 3, were carried out, but prior to doing the work, measurements were made to determine the position on the pavement of vehicles turning right.

A further placement study was carried out after the improvements had been completed and the results of the studies are shown in Fig. 1 and in the table below.

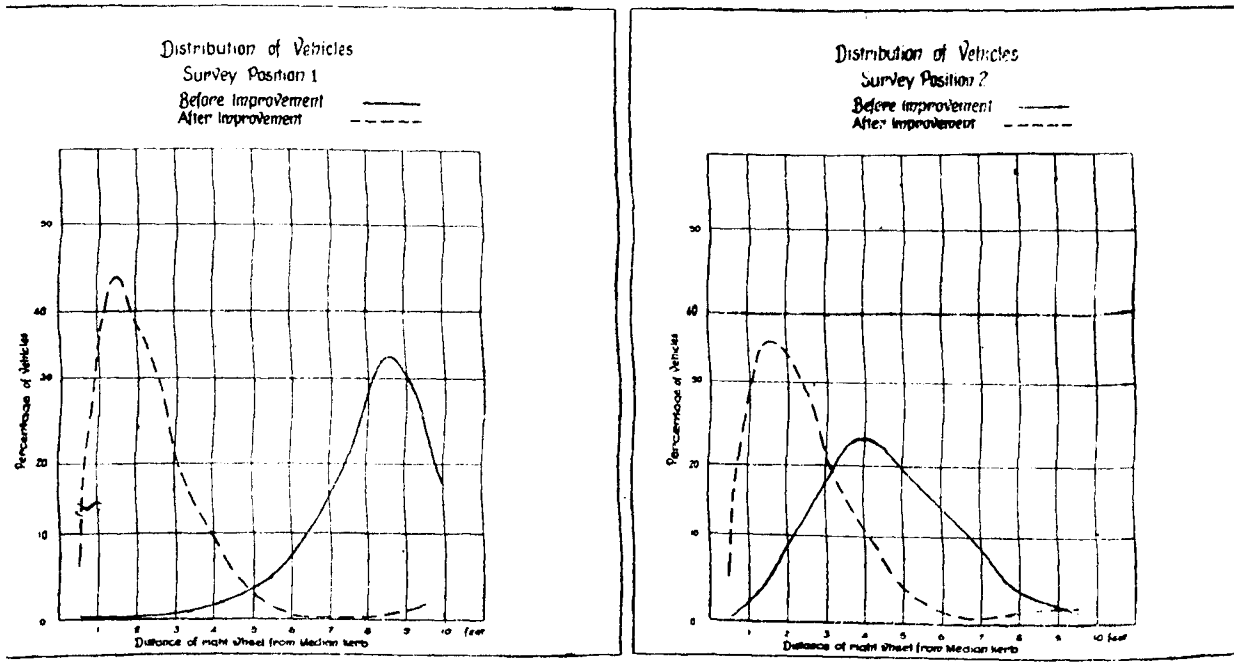


Fig. 4

TABLE

Per cent of vehicles with right wheel at distance shown from the median

Position 1			Position 2		
Distance (feet)	Before (per cent)	After (per cent)	Distance (feet)	Before (per cent)	After (per cent)
0– 1	—	7.1	0– 1	0.4	5.6
1– 2	0.7	43.3	1– 2	4.9	35.6
2– 3	1.3	24.0	2– 3	12.6	28.0
3– 4	0.7	18.0	3– 4	23.3	15.7
4– 5	2.7	2.7	4– 5	22.0	6.6
5– 6	8.0	1.1	5– 6	17.0	2.5
6– 7	8.7	—	6– 7	8.1	0.5
7– 8	21.3	1.6	7– 8	7.2	1.0
8– 9	32.6	—	8– 9	3.1	2.0
9–10	24.0	2.2	9–10	1.4	2.5

The "Before" and "After" studies show that turning traffic is now travelling much closer to the median and not encroaching on the through traffic lanes.

For example, at survey position 1, before the alterations 91 per cent of turning vehicles were encroaching to some extent on the through lanes, whereas following the improvements, only 4 per cent of the vehicles encroached on the through lanes. The conclusion drawn from this study is that appropriate treatment of deceleration lanes by the provision of adequate lead-in taper and pavement marking has a significant beneficial effect on vehicle placement.

(*From "Roads and Road Construction Oct. 1959"*).

HERE AND THERE

1. THE ECONOMICS OF ROAD TRANSPORT

● QUITE apart from the relatively narrow subject of transport costs, the value of a good road system to the industrial and agricultural efficiency of a country is paramount. It may make certain types of production, certain factories or certain crops possible which were impossible before the roads were built—or the old one improved, and this applies just as much to so-called developed countries as to those which are labelled under-developed. Better roads may increase the total prosperity of a country in a way which cannot be calculated solely by a comparison of transport costs, or even by before and after comparisons of the value of land adjacent to roads which are built or improved. These views sum up the challenging statement made in Rio de Janeiro by Mr. Christopher T. Brunner at the Permanent Association of Road Congresses. Mr. Brunner is Vice-Chairman of the British Road Federation and is one of the foremost authorities on the economics of road transport and a tireless crusader for better roads. Dealing with the subject of the financing of road works and their economic justification he expressed the view, held by many, that personal transport is not yet truly accepted by many of the world's governments as a normal part of the life of a community. Although it may be the governments' business to provide for the movement of goods they feel that it is not specially their concern to serve people travelling in their own vehicles. Traffic congestion has become a universal problem and certainly neglect of the personal side aggravates the difficulties already exprienced in the more rapid conveyance of goods.

(*From "The British Trade Journal and Export World", October 1959*).

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2. ROAD TRANSPORT PRODUCTIVITY TEAM

● INDIA has embarked on an ambitious programme of economic development in order to provide its teeming millions with a better standard of life. Transport is vital for this development since every commodity produced requires it at various stages. India's goal is to double its national income in about 15 years and consequently road transport is required on a much bigger scale than ever before.

India's road traffic consists of about 10 million animal-drawn vehicles, 130,000 goods trucks, 45,000 buses and about 300,000 other motor vehicles. While animal-drawn traffic, the bulk of which is used by farmers in the non-agricultural season, is bound to continue under the prevailing economic conditions in India, the picture of the future rural India generally envisaged is one in which motor transport will penetrate to the remotest villages and place at the disposal of the villager modern means of transport and readier communication with the outside world. Constructive development of road transport is necessary for this purpose.

With the growth of economic activity, the demand for long-distance motor transport is also growing and the regulations which discouraged inter-State road services in the past have now been revised. An Inter-State Transport Commission has also been created whose function

is to develop and regulate trans-border operation of motor transport.

In May 1958 the Government of India appointed a Road Transport Reorganization Committee under the Chairmanship of Shri M.R. Masani, M.P., in order to recommend a model administrative set-up for motor transport which would ensure the healthy growth of transport by road. Among the recommendations of the Committee are that truck trailer combinations should be encouraged, that motor transport taxation should be rationalised, that operators should be induced to form themselves into viable units, that credit facilities should be increased, that the procedure for the grant of permits should be simplified, that permits should be valid for fairly large areas and that inter-State permits should be issued more liberally. The object of many of the recommendations is to make road transport more efficient and more economical.

The decision of the National Productivity Council of India to send a Road Transport Productivity Team to study methods of operation in W. Germany, U.K., and U.S.A. and the fine gesture by the Technical Co-operation Mission of the U S. Goverment in agreeing to meet the expenses of this tour show the importance attached the world over to road transport. The Team consists of twelve members representing a cross-section of India's road transport industry. It is headed by Shri D.S. Rathor, I.A.S., Transport Commissioner of U.P. and includes an experienced officer of the Goverment of India, Shri A.S. Bhatnagar, Under-Secretary, Ministry of Transport and Communications. The other members are Shri Durga Dass, Shri P.N. Sahni, Shri Manmohan Singh, Shri R E. Wates, Shri Kundan Lal, Shri P.V.S. Mani, Shri T K. Seshadri, Shri R.S. Gupta, Shri D. Bommiah and Shri C.S. Nair, Secretary, Indian Roads and Transport Development Association.

Productivity is the finding of ways and means of minimising wastage and increasing output per man-hour with the existing tools without additional capital investment. To achieve this, a rational approach to the available resources of men, machines, materials, capital, etc., has to be developed. India has much to learn from advanced Western countries in this sphere. It is for this purpose that Productivity Teams, assisted by the democratic Western nations, much more industrially advanced, are undertaking these tours, to study the methods of productivity adopted by those countries, with a view to improving productivity in our country.

The terms of reference tentatively drawn up for the Road Transport Productivity Team include the following subjects of study:

1. Methods of operation of road transport enterprises including management structure, economics of size, maintenance, and daily utilisation of vehicles, timetables, rates, booking arrangements, co-ordination with other carriers, amenities provided, etc.
2. Organization of the industry.
3. Working conditions and wage structures.
4. Methods of financing the industry.
5. Operation of truck-trailers and piggie backs.

In addition the Team will also undertake a general survey of regulatory measures, the development of transport on "own" account and prevailing systems and burden of taxation.

(*From "IRTDA News Letter", 31st October 1959*).

He who has a thousand friends
Has never a one to spare
And he who has one enemy
Will meet him everywhere.

—*R. L. Stevenson.*

3. APPLYING LATEST KNOWLEDGE TO BRIDGE DESIGN

(Khosla Committee Report Submitted)

● THE HIGH LEVEL Committee of Engineers on Bridges, appointed by the Ministry of Railways in 1957, has submitted its report to the Railway Minister, Shri Jagjivan Ram.

Headed by Dr. A. N. Khosla, Vice Chancellor of the Roorkee University, the committee included amongst its members senior engineers from the Ministries of Railways, Defence, Transport and Communications, Central Water and Power Commission, and the Meteorological Department. A number of other eminent retired engineers were also co-opted.

The Committee was asked to review the methods of design of bridges in the light of the latest knowledge and experience, and to lay down the standards which should generally guide the future design of new construction of bridges in India.

As a result of deliberations for nearly two and a half years, the recommendations of the committee have been incorporated in a report to the Railway Minister which will now be considered by the Ministry of Railways.

(From "Indian Railways," November 1959.)

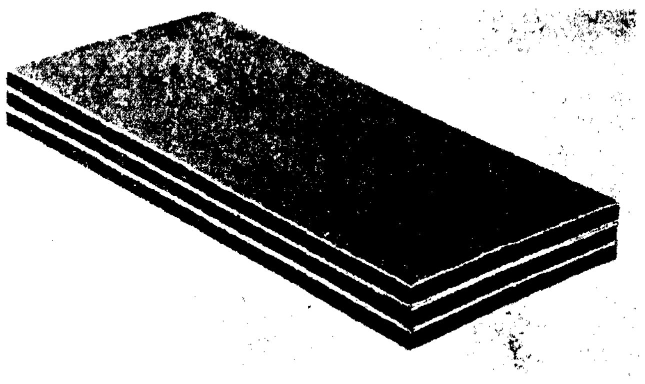
4. P. S. C. EQUIPMENT INTRODUCE NEW BRIDGE BEARING PADS

● THE PROBLEMS of taking up movements in bridges and long-spanned framed buildings are old ones. Roller rocker bearings need maintenance, are affected by the extremes of climatic conditions and are not easily replaced. P. S. C.

Equipment Limited of Uxbridge have just introduced a new bearing pad made of natural rubber, reinforced with steel, which they claim will solve all these problems.

The rubber is firmly bonded between two thin sheets of steel, to form a sandwich. The necessary thicknesses are obtained by building up these sandwiches, one on top of another.

There is no movement between steel and rubber, nor between steel and steel, so that all movement, including shear and rotation, is taken up by the rubber itself. They are made in any size, but without the considerable expense of mould charges;



New "Freyssi" rubber/steel bonded bearing pad.

the size and shape necessary for the individual structure are calculated from data supplied on a simple form.

Freyssi pads are calculated to last for many years, probably for the life of the structure, but if they have to be replaced the operation is simple. They will stand extremes of temperature in hot and cold climates and, when used as "rockers", offer considerable resistance to additional horizontal loads such as those caused by heavy vehicles braking suddenly on a bridge.

The principle has been successfully tried out abroad with neoprene, but the great improvements recently in the compounding of natural rubber have made it far superior for the purpose.

The cost of pads for spans up to about 120 ft is less than that of steel bearings, but it may be rather more for longer spans.

(From "Highways and Bridges and Engineering works," Oct. 14, 1959.)

5. LONDON'S MAJOR TRAFFIC ROUTES

● THE URGENT improvement to the whole of London's major highway system is recommended by the London and Home Counties Traffic Advisory Committee in a report "London Traffic, 1958" published by H.M.S.O. last week. The capacity of the internal routes must be matched to the capacity of the major arteries coming into London. A thorough traffic review of key intersections should be made.

Other points in the report are:

Roads must be kept clear for moving traffic, making comprehensive schemes of parking control in central London essential. These must be accompanied by public off-street parking facilities and facilities for loading and unloading off main thoroughfares.

Conflict between vehicles and pedestrians in busy town and city centres can be a frequent source of congestion. Foot-bridges, pedestrian subways, and guard rails should be used more frequently.

Better discipline on the part of drivers and pedestrians alike and a stricter adherence to traffic regulations.

If these objects are to be attained, an adequate number of traffic engineering staff must be trained.

(From "Highways & Bridges and Engineering Works," October 21 1959).

6. 'IF AND WHEN ROADS IMPROVE'

● "I STRONGLY advise you to enjoy the convenience of a car while you can. It won't be long before it will be quicker to go on foot," said the Duke of Edinburgh at the Annual Dinner of the Society of Motor Manufacturers and Traders.

The Duke observed that more people in Britain were owning better cars but there was less room to drive them either for enjoyment or advantage.

He said that driving could be a pleasure under reasonable conditions. "There must be several people here who can remember the days when that was possible, even on a Bank holiday. We all very much hope that it will be possible again, if and when roads begin to improve."

He had heard that visitors to the motor show were advised to leave their cars at home. He thought that a delightful touch of irony.

Mr. J. M. A. Smith, president of the society, forecast that universal car ownership was not more than 20 years away. He said: "You cannot sweep back the growing tide of car ownership."

(From "Highways & Bridges and Engineering Works," October 1959.)

CURRENT LITERATURE

ABSTRACTS

HIGHWAY BRIDGE FOUNDATION PRACTICE IN QUEENSLAND; I. G. Cameron, The Journal of the Institution of Engineers, Australia, Vol. 31, No. 7-8, July-Aug., 1959.

THE Paper deals with the design and construction of foundations for short and medium span highway bridges. The structural and economic considerations which enter into the choice of foundation type are discussed. Queensland streams differ from those in most other parts of the world in the great heights attained by the streams during flood. Flood heights of 80-90 ft above normal water level have been recorded in a number of streams, and 40-50 ft flood rises are common-place. Queensland streams also carry large quantities of debris which can cause severe transverse loading on the bridge. It is therefore essential to design the majority of bridges as submersible structures. Design criteria and procedures for this type of structure are described. Methods used by the queensland Main Roads Department in the construction of bridge foundations are also described in some detail.

LANDSLIDE OCCURRENCE AND ANALYSIS: BULLETIN 216 HIGHWAY RESEARCH BOARD of the National Academy of Sciences—National Research Council 2101 Constitution, Washington, D. C.

THIS 43-page bulletin includes three papers presented at the 37th Annual Meeting of the Highway Research Board, as follows:

"Regional Concept of Landslide Occurrence," by Robert F. Baker and Robert Chieruzzi, covers the initial phases of a basic study of landslides, under the long-range objective of developing or refining quantitative methods of analyzing the degree or stability of natural slopes.

"An Appraisal of Measures for Improvement of Slope Stability," by R. G. Hennes, S. E. Hawkins, and E. L. McCoy, presents several graphs enabling the engineer to estimate the amount of drainage required to achieve a desired factor of safety of an earth slope, and safety factor improvement by benching or reducing the slopes of excavations.

"Computer Solution of Swedish Slip Circle Analysis for Embankment Foundation Stability," by Roger V. LeClerc and Robert J. Hansen, describes a method developed by the Washington State Department of Highways to investigate a given range of slopes, automatically advancing to the next flatter slope if the safety factor is found to be less than the predetermined value, and to investigate a range of slopes in individual analyses for each slope.

CONCRETE PAVEMENT DESIGN RESEARCH, 1958: BULLETIN 217 HIGHWAY RESEARCH BOARD of the National Academy of Sciences—National Research Council 2101 Constitution, Washington, D.C.

THIS 49-page bulletin contains two papers presented at the 37th Annual Meeting of the Highway Research Board.

The first, entitled "Fifteen-Year Report on Experimental Concrete Pavement Project in Oregon," by G. S. Paxson, deals with a portion of the Northeast Portland Secondary Highway paved in 1941, with facilities for measuring performance of expansion and contraction joints at various spacings, with and without load transfer devices.

The second, entitled, "Performance of Doweled Joints Under Repetitive Loading," by Leslie W. Teller and Harry D. Cashell, describes a device and procedure for load-transfer tests of full-sized joints under shear and flexure, and results of a series of tests to determine the effects of several variable factors.

SKID PREVENTION RESEARCH—1959: BULLETIN 219 HIGHWAY RESEARCH BOARD of the National Academy of Sciences—National Research Council 2101 Constitution, Washington, D.C.

THIS 73-page bulletin comprises the final reports of several committees to the First International Skid Prevention Conference, held at the University of Virginia in September 1958, together with other pertinent papers in the skid prevention field presented at the 38th Annual Meeting of the Highway Research Board. The following are included:

"Resume of First International Skid Prevention Conference," by Tilton E. Shelburne.

"Accidents and the Human Element in Skidding." Final Report of Subcommittee B.

"Relationship of Vehicle Dynamics to Skidding." Final Report of Subcommittee.

"Relationship of Tire Design and Composition to Skidding." Final Report of Subcommittee.

"Relationship of Road Surface Properties to Skidding." Final Report of Subcommittee D.

"Comparison of Several Methods of Measuring Road Surface friction," by Jack H. Dillard and Terrence M. Allen.

"Review of Laboratory and Field Methods of Measuring Road Surface Friction." Final Report of Subcommittee E.

"A Laboratory Investigation of Pavement Slipperiness," by J. W. Shupe and W. H. Goetz.

ICE MELTING PROPERTIES OF CHLORIDE SALT MIXTURES: BULLETIN 220 HIGHWAY RESEARCH BOARD of the National Academy of Sciences—National Research Council, 2101 Constitution, Washington, D C.

THIS 24-page bulletin contains two papers given at the 38th Annual Meeting of the Highway Research Board on this question of major importance to maintenance personnel, especially in states of the snow and ice belt.

The first paper, by M. S. Kersten, L. E. Pederson, and A. J. Toddie, Jr., discusses the results of "A Laboratory Study of Ice Removal by Various Chloride Salt Mixtures." Included was a wheel test to approximate field conditions of melting application of chloride mixtures.

The second paper, by William E. Dickinson, describes field tests to determine the "Ice-Melting Properties and Storage Characteristics of Chemical Mixtures for Winter Maintenance."

RECENT ADDITIONS TO THE LIBRARY OF THE INDIAN ROADS CONGRESS

1. **Proceedings of the Highway Research Board — Thirty-Seventh Annual Meeting, 1958**; Vol. 37, Highway Research Board, 2101, Constitution Avenue, Washington D.C.

2. **"Conditions of Contract (International) for Works of Civil Engineering Construction"; (1st Edition—August 1957)**, Federation Internationale Des Ingenieurs Conseils, Langstrasse, 64, Zurich, (Switzerland).

3. **"Traffic Engineering" (1955)**; Theodore M. Matson, Wilbur S. Smith and Frederick W. Hurd, McGraw-Hill Book Co. Inc., New York.

Highway Research Board, 2101 Constitution Avenue, Washington 25 D.C.

4. **"Urban Research in Highway Planning" HRB Bulletin No. 190 (1958)**;

5. **"Highway Needs Studies" HRB Bulletion No. 194 (1958)**;

6. **"Photogrammetry and Aerial Surveys — A Symposium" HRB Bulletin No. 157 (1957)**;

British Standards Institution, British Standards House, 2 Park Street, London W. 1.

7. **BS 1121 : Part 39 : 1959—"Methods for the Analysis of Iron & Steel"—Part 39 : Nitrogen in Steel**;

8. **BS 1125 : 1959—"W. C. Flushing Cisterns (including Flush Pipes)."**

9. **BS 1305 : 1959—"Batch Type Concrete Mixers"**;

10. **BS Code of Practice — CP 202 (1959) General Series "Tile Flooring and Slab Flooring"**;

11. **BS Code of Practice—CP 2003 (1959) "Earthwork"**;

12. **"The Problems in Engineering Structures" (1958)**; R. J. Ashley and A. H. Chilver, Edward Arnold (Publishers) Ltd., London.

13. **"An Outline of Photogrammetry" (1959)**; K. Schwidefsky, Sir Issac Pitman & Sons, Ltd., London.

14. **Magazine of Concrete Research No. 26, Vol. 9, August 1957**, Cement and Concrete Association, 52-Grosvenor Gardens, London SW 1.

15. **Proceedings of the Third Congress of the Federation International dela Precontrainte, Berlin 1958, Vol. III**; Cement and Concrete Association, 52 Grosvenor Gardens, London SW 1.

FRIEND

For herein does a friend differ from a flatterer; the flatterer speaks to give pleasure, but the friend refrains from nothing, even that which gives pain.

LIST OF APPROVED WORKS ON NATIONAL HIGHWAYS

S. No.	Job No.	Name of work	Amount (Rs in lakhs)
		ASSAM	
1.	2137 AS 37	Remetalling and surfacing certain portions of Assam Trunk Road East, N.H. No. 37 in between miles 197 and 207 in Jorhat East diversion.	6.77
2.	2142 AS 37	Remetalling and surfacing certain portions of miles 146 to 151 of Assam Trunk Road East, N. H. Route No. 37 in Devgaon Sub-Division.	4.57
		BIHAR	
3.		Three works each costing less than 2 lakhs.	3.68
		BOMBAY	
4.	2139 BM 8-A	Providing ¾ in. premix asphalt carpet on Lumbdi-Sayala-Dolia (miles 64/4 to 91/1) Section of National Highway No. 8 A.	7.48
5.	2140 BM 6	Black topping miles 213/5 to 237/2 (Except length effected by geometrical improvements) of Surat-Dhulia-Edlabad-Nagpur Road, National Highway No. 6.	4.93
6.		Two works each costing less than 2 lakhs.	1.76
		HIMACHAL PRADESH	
7.	2147 HP 22	Purchase of spare parts of Air Compressors and pneumatic boring hammers required for the construction of Hindustan-Tibet Road, National Highway No. 22.	0.25
		JAMMU AND KASHMIR	
8.	2143 JK 1-A	Constructing an experimental avalanche deflector in the Eastern valley at North Portal of Jawahar Tunnel.	0.26
		ORISSA	
9.	2138 RS 6	Widening and black-topping the portion of N.H. No. 6 betwen Bargarh and Lohaseha-ty on Madhya Pradesh border miles 113/4 to 138/0.	5.60

S. No.	Job No.	Name of work	Amount (Rs in lakhs)
10.	2149 RS 5	Construction of a high level bridge over the river Brahmani on National Highway No. 5 near Dharmasala.	42.49
		PUNJAB	
11.	2141 PB 1	Providing road over-bridge over G. T. Road near Ludhiana on National Highway No. 1.	2.52
		WEST BENGAL	
12.	2136 BG 2	Improvement of G. T. Road, N. H. No. 2 (widening and resectioning) between miles 53 and 104 (84th 2nd qr. to 88th 1st qr. and 88th to 94th 2nd qr.)	7 61
13.	2135 BG 34	Construction of culverts in the diversion of N.H. No. 34 at Krishnagar in the Nadia District.	0.61

DEFINITIONS OF HIGHWAY ENGINEERING TERMS

WATER GRADIENT: The surface below which, except for relatively small quantities of dissolved or entrapped air, water fills the voids in soil or rock.

[Its level can be found by measuring the elevation to which water rises in a well sunk below the surface at any location. Water table will vary with the season and the soil.

Where the water-table rises above the ground-level a body of stagnant water exists.]

WATER TABLE: Same as Water Gradient.

Transport-Communications Monthly Review December 1959

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