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MONTHLY REVIEW

AUGUST 1957—No. 124

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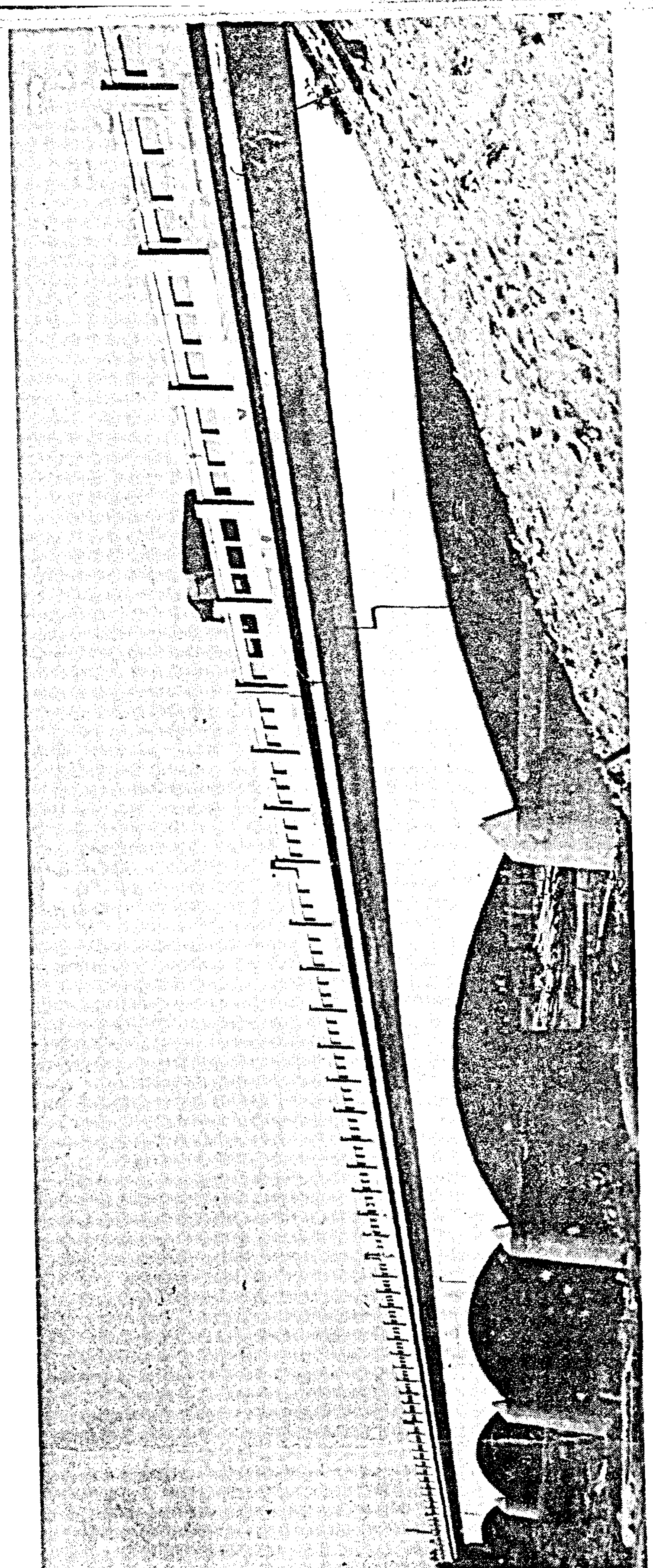


LITTLE GANDAK BRIDGE

TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

A REVIEW OF

ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

AUGUST 1957

REVISION OF THE NAGPUR PLAN

THE recommendations of the Conference of Chief Engineers at Nagpur in 1943 laid down a rational basis for road planning and development on an All-India Scale. They gave due recognition to the existing trend of development of roads in the country. Thus roads were divided into four classes according to their importance and functions they were intended to perform. This provided the first step in the evolution of an integrated road scheme on an All-India basis. Further, it was made clear that all classes of roads are to be regarded as of importance for national welfare; one class is not to progress at the expense of another; development is to be balanced between the classes and to proceed in a **planned sequence.** The significance of these recommendations hardly need over-emphasising; they have proved their worth through the years since the Nagpur Plan was framed and should be a constant guide for the future so that road development may be smooth and continuous.

The Nagpur Plan envisaged, for the Indian Union, construction and improvement of 20,750 miles of National Highways, 53,950 miles of State Highways and 256,300 miles of District and Village Roads over a period of 20 years. The total mileage contemplated was 331,000 or, according to surface, 123,000 miles of surfaced roads and 208,000 miles of unsurfaced roads. At the beginning of the first Five-Year Plan there was a surfaced milage of 97,546 and an unsurfaced milage of 150,963 or a total of 248,509 miles. At the end of the First Five-Year Plan, i.e., on 31st March 1956, the total milage of roads in the country rose to 316,668, consisting of 121,617 miles surfaced, and 195,051 miles unsurfaced. The total figure at the end of the First Five-Year Plan given above includes 6,120 miles of surfaced roads and 38,139 miles of unsurfaced roads constructed under the Community Development Projects and the National Extension Schemes. Further, under the Second Five-Year Plan, it is estimated that about 22,000 miles of metalled roads and about 40,000 miles of unmetalled roads will be added. Thus the targets of the Nagpur Plan would be exceeded as far as total road mileage in the country as a whole is concerned. The position as regards bridging is probably not as satisfactory, as a number of road bridges would still remain to be constructed to complete the road system.

However, as already stated before, the Nagpur Plan was drawn in 1943. Since then vast changes, political, social, and economic have taken place. There has been mass awakening in the country and a desire for better standard of living. This has resulted in greater efforts in the utilization of natural resources in the way of undertaking huge hydro-electric schemes for irrigation and power, construction of several new towns and cities, better living conditions in the villages, development of industries—both large and small, etc. Transport plays a vital part in this all-round development and, on account of limitations of both rail and water transport, development of road communications requires a very considered and careful review to serve the expanding needs adequately. What is immediately required is an All-India Plan on a loan basis to meet the country's present and future needs; thereafter detailed road development plans for each State or region would also have to be prepared taking all the above factors into consideration.

As an outcome of the Nagpur Conference, 13,800 miles of roads in the Indian Union were selected to be classed as National Highways. These constitute the frame-work within which the road system of the country is being developed. Since April 1947, the construction and maintenance of these highways became a direct responsibility of the Centre. It has become a statutory responsibility since August 1956. It is to be seen whether this milage is adequate today or additions to it are required. The needs of strategic roads will also have to be considered.

For assessing the needs of National & State highways and Major District Roads in each area, the formula recommended by the Nagpur Conference took into account several factors like agricultural areas, non-agricultural areas, large villages, towns and markets, proposed agricultural and industrial development for the next 20 years, the length of rail communications existing in the area, etc. For Minor District and Village Roads, gradation of population of villages from 500 onwards was duly considered. The grid or net-work of roads envisaged under the Nagpur Plan consists of a square with 10 miles sides in agricultural areas and 40 miles sides in non-agricultural areas. This meant that in highly developed agricultural areas no village will be more than 5 miles from a main road and the average distance will be less than 2 miles in most cases. Similarly in non-agricultural areas no village will be more than 20 miles from a main road and the average distance will be 6 or 7 miles.

Shri Varma in his Presidential Address at the Shillong session attempted to assess the requirements of total road milage with a view to bring all the villages within a distance of 3 miles of a metalled road in developed areas, 9 miles in semi-developed or forest areas, and 20 miles in undeveloped areas. The total requirement of metalled roads worked out to 3,20,000 miles and the cost of such a road system Rs. 4,000 crores. He estimated that, at the present rate of progress, it would require 75 years to achieve this target. What is more staggering is that, even then, we would have a road system at the rate of 0.5 miles per square mile of area against the figure of 1.99 of Great Britain and 2.4 of France. The magnitude of the problem and the need for a well-considered realistic plan capable of execution may well be imagined.

Addition of new milage is no doubt necessary but, side by side, improvement of existing roads and reconstruction or strengthening of weak bridges to carry the present traffic should also receive attention with adequate allowance for the needs of industrial areas.

The Chief Engineers who met at Nagpur in 1943 were seized with great enthusiasm when they met in that historic place to pool experience and to attempt a combined approach to the problem of evolving a road plan for the whole of India. It would be in the fitness of things if they were to make another historic event and put their heads together in order to review and revise the Plan under the present day needs of the country.

WINNING ROAD SLOGAN

Results of a competition organised by the Roads Campaign Council among the 180,000 members of Townswomen's Guilds throughout Britain to find a slogan emphasising the need for better roads in Britain have now been announced. The winning slogan: "Build better roads faster, or drive to disaster," was submitted by a Glasgow woman. The Council expects to use the slogan on posters in the coming months.

From:—" Modern Transport, May 11, 1957."

BRIDGING INDIA'S RIVERS

" LITTLE GANDAK BRIDGE "

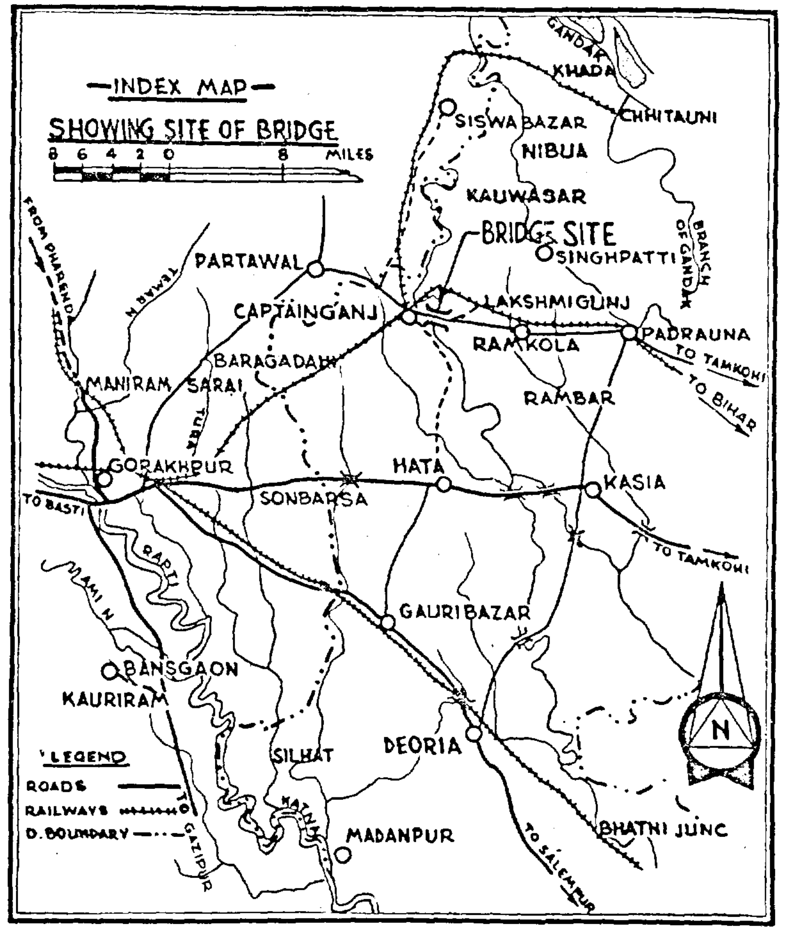
By

SHRI M. S. BISHT *

I. General.

DEORIA District of the State of Uttar Pradesh is very deficient in communications especially its northern part. In this area there is a good number of sugar mills and the construction of a road from Tamkohi to Captainganj was a long felt need of the area so as to improve its economy. The construction of this road was sanctioned by the Government under Phase I in 1946. This road crosses Little Gandak river in mile 3 and an all-weather bridge was proposed to be constructed along with the road. (Index map)

Work on the bridge was started in 1949 but had to be stopped in 1950 as all available funds of the State were diverted to the schemes of 'Grow More Food'. The construction of the Bridge was,



* Chief Engineer, P.W.D., B & R., Uttar Pradesh.

however, again resumed in 1954 and it was opened to traffic in January 1956.

2. Design.

Little Gandak is a tributory of the mighty Gandak and assumes big proportions in rains and so a fairly big bridge was considered necessary.

The bridge has a clear linear waterway of 442 feet consisting of two main spans of balanced cantilever type each of 146 feet with 3 suspended spans of 50 feet each. The main spans have a central span of 98 feet with 24 feet cantilever on each side. The entire superstructure is reinforced cement concrete (Fig. 1)

There are four piers, and these as well as the abutments rest on wells which are of brick masonry reinforced both vertically and horizontally by R. C. C. pillars and bands. The abutments are of R C.C. while the piers are of brick masonry. The bridge has been designed for I. R. C. Class A loading. The roadway is 22 feet with no footpaths.

3. Dimensions and particulars of the bridge.

(a) Wells:—The twin wells both under the abutments and the piers have an inner diameter of 7′—6″ each and an external diameter of 13′—6″ at top and 17′—6″ at bottom thus giving a batter of 1 in 17.5 on the outside. Along the lateral direction the length is 23′—6″ at the top and 27′—6″ at bottom. There are six reinforcing vertical pillars of R.C.C. each 1′—6″ × 1′—6″ and horizontal bands 6″ thick at 8′—7″ intervals (Fig. 2).

The brick masonry of the wells has been done in cement sand mortar in the proportion of 1 part cement and 4 parts of sand. The curbs are of reinforced cement concrete 6′—5″ thick.

The total depth of wells is 35′—0″ and the whole depth is plugged, the bottom five feet with cement concrete in the proportion of 1 part cement, 3 parts sand and 6 parts brick ballast. At top, just below the cap, cement concrete has again been provided for a depth of one foot. In between sand has been filled in.

The wells are capped with a reinforced cement concrete slab 2 feet thick.

(b) **Abutments** :—Both the abutments are 22′—8½″ high including thickness of the capping slab. Each abutment consists of 2 R C. C. columns each 3′ × 4′ spaced 16 feet centre to centre with a 9″ thick R.C.C. capping slab at the top and stiffened with two R.C.C. tie beams of hexagonal shape (Fig. 3).

A R. C. C. dirt wall on the exterior edge and two walls on the sides have been provided to stop the dust and earth entering into bearings. The wall on the exterior edge is 7′—2″ high and 10″ wide and on the sides these are 4′—0″ high and 6″ wide.

(c) **Piers** :—Each pier is 17′—2¼″ high including the thickness of pier cap. The piers are 24′—6″ long and 6′—6″ wide at bottom and 22′—6″ long and 4′—6″ wide at top. They are of brick masonry laid in cement sand mortar in the proportion of 1 : 4. Within the piers two R.C.C. pillars 1′—6″ spaced 15′—3″ c/c have also been provided under the bearings. The edges of the piers both on upstream and downstream have been inclined to form a cut water. The piers have been finished with a capping slab at top 2′—6″ thick with a camouflage block at each end (Fig. 4).

(d) **Bearings** :—Each pier has two bearings one for each main beam. These bearings have a capacity of 270 tons. Alternative piers have Roller and Rocker bearings. As the rocker bearings are of smaller height they have been placed over R C.C. pedestals 3′—0″ × 4′—0″ × 1′—½″.

Each abutment and articulation joint has a 80-ton bearing capacity arrangement below each of the main beams. These are alternately roller and rocker type with the abutments having roller type.

(e) **Superstructure** :—The two main beams have a depth of 10′—9″ at piers and 6′ at centre. The depth at the end of the cantilever is 7′—3″. The width of the beam is 18″ with splays on the interior side. Near piers and at articulation joints the width has been increased to 2′—3″. The cross beams for the beam

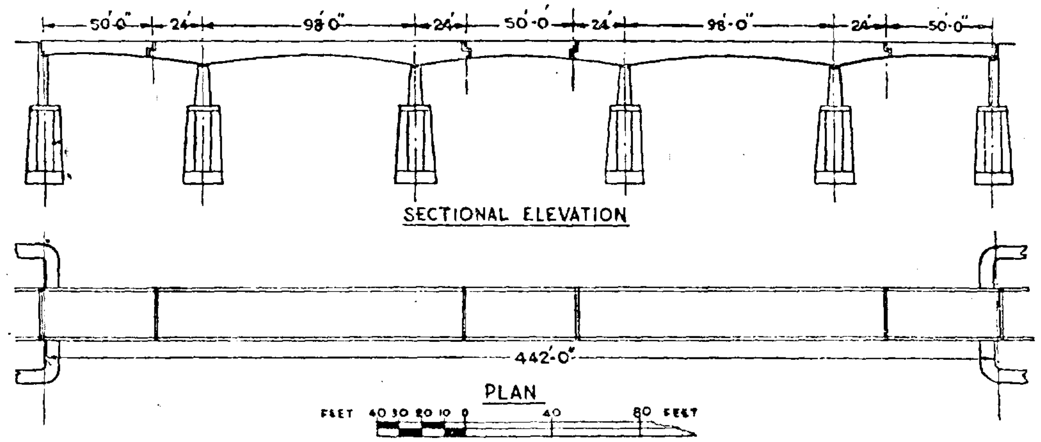


Fig. 1

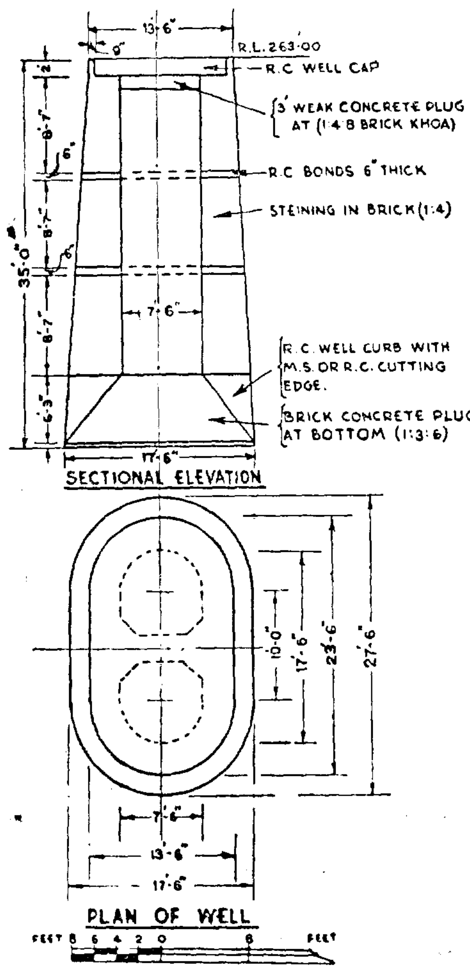


Fig. 2

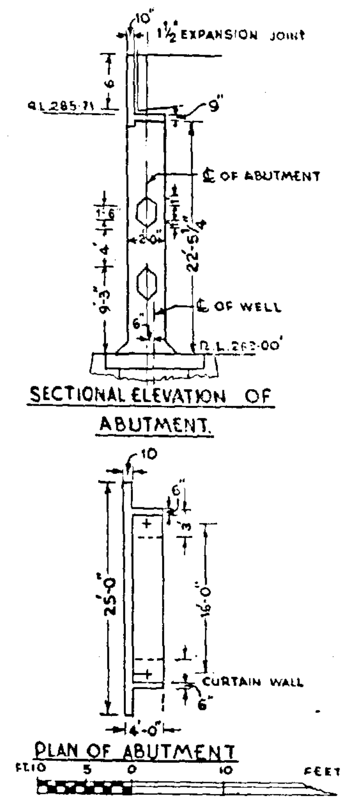


Fig. 3

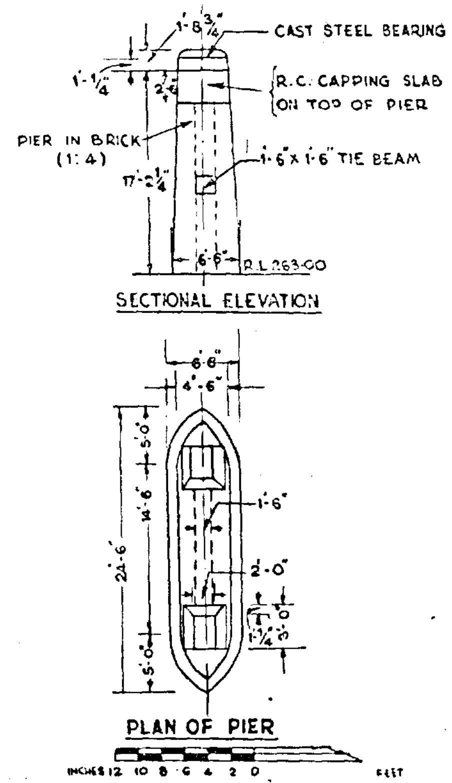


Fig. 4

portion are 2′ wide and 4′ deep with 2′ × 2′ stiffeners at bottom to form a frame. There are in all 5 cross beams in the beam portion. For the cantilever portion these beams are 4′–1″ × 1′–0″ with a stiffener 3′ - 2½″ × 1′ - 0″ at bottom at a point 16′ away from the pier. Thus there are two cross beams only.

The suspended spans consist of 2 main beams with a depth of 6′ on the abutment and 7′ – 3½″ at articulation joints. These beams are 18″ wide and have been splayed to 2′ – 3″ at ends. There are four cross beams one each at articulation joint and abutment and two at intermediate points. The size of the intermediate beams is 4′ × 1′. At the articulation joint the size is 2½′ × 1′ with a stiffener 4′ – 1″ and at the abutment the size of the cross beam is 6′ × 1′ – 6″.

The bottom of the beams everywhere has been curved to give a good appearance.

The deck slab is 7¼″ thick finished with plain cement concrete wearing coat. The road width is 22′ clear. The parapets are of post and panel type made of R. C. C.

4. Centering and Shuttering

For the centering the wooden ballies which are available in plenty locally were used. The diameter of the ballies varied from 6″ to 9″ and they rested over sleepers to distribute the load. At the top of the verticals R.S. Joists as runners were used which with suitable packing pieces and wedges formed the base for beam bottom. For the spans where water was running, ballies were sunk to about 20′ depth and used as piles.

Shuttering consisted of steel panels of different sizes which were used to form sides of main beams, cross beams, stiffeners and bottom of deck slabs. The haunches at the top of beam were made with wooden pieces.

5. Materials used

(a) **Bricks** :—Local available first class bricks were used throughout for brick work and brick ballast.

(b) Coarse aggregate for concrete-Pakur Stone from Santhal Pargana in Bihar was used.

c) Fine aggregate for concrete—Sone river sand from Bihar and Banda sand from U.P. mixed in equal quantities were used. The fineness modulus of the mixed sand was about 2.65.

(d) Fresh Japla cement was used.

(e) **Steel** :—Only tested steel has been used.

(f) **Water** :—Water for concreting has been taken from a well on the bank of the river. The water from the well was pumped into a pucca tank where it was stored for 24 to 48 hours before use in concreting.

6. Quantities

The following quantities of concrete, steel and cement were used in the superstructure.

S. No.	Item	Main beams, cross beams, etc. of 2 main spans	Decking of 2 main spans	Main beams, cross beams, etc. of 3 suspended spans	Decking of 3 suspended spans	Railing kerbs, wearing coat etc.	Total
1.	Concrete	8400 cu. ft.	6000 cu. ft.	3500 cu. ft.	3000 cu. ft.	3000 cu. ft.	23900 cu. ft. say 24000 cu. ft.
2.	Steel	80 tons	15 tons	19 tons	8.5 tons	5.6 tons	128.1 tons. say 130 tons.
3.	Cement	...	...	...	...	...	250 tons.

The percentage of steel as a whole was about 2.5 per cent by volume. The main beams have a reinforcement of about 4.44 per cent by volume.

7. Tools and plant

(a) **Concrete mixers** :—Two mixers were in use, and a spare one was always at site as a stand-by.

(b) **Vibrators**:—There were four mechanical vibrators having a vibrating needle of 2¼″ diameter and 20″ length with flexible shafts. Since clear gap in between main reinforcement bars was only 1½″ a rod of 1″ diameter, was fixed with clamps to the vibrator needle.

(c) **Pump** :—One pump was used to pump water for curing, concreting and other purposes.

(d) **Generators** :—There were two generators, but only one was used. The other was kept as a stand-by.

(e) **Pile driving monkey** :—A monkey 14″ high and 10½″ diameter weighing about 300 lbs was used for driving ballie piles.

8. Tests and Strengths.

Working compressive stress in concrete was assumed as 750 lbs per square inch and an over all strength of 3000 lbs per square inch at 28 days. Cubes and cylinders were got made at site and tested for this strength in the P.W.D. Research Laboratory at Lucknow.

Steel stress was assumed at 16000 lbs per sq. inch and, therefore, only tested steel was used.

Pakur stone was also tested in the P.W.D. Research Station Lucknow and was found suitable.

Banda sand has over 4 per cent silt and also appreciable organic impurities. It was, therefore, thoroughly washed before use.

River water which was used in concreting was a little alkaline, but this was not considered harmful as cement itself is very alkaline. Care was, however, taken not to take water from the places where there was lot of vegetation and other decayed material.

The usual field tests for slump, bulking-silt contents of fine aggregate, fineness modulus were made from time to time.

Costs.

The total cost of the bridge including the approaches is Rs 6.70 lakhs approximately. The cost of the bridge alone is Rs 6.20 lakhs approximately which gives a rate of Rs 1,400/- per linear foot, or Rs 64/- per sq. foot of the roadway.

DEFINITIONS OF HIGHWAY ENGINEERING TERMS

GRADIENT INCLINE GRADE
(a) The rate of rise or fall with respect to the horizontal along the length of a road (or other work) expressed as a ratio or as a percentage.
(b) The length of a road or other work which is not level.

GRADIENT AVERAGE
The net rise or fall of the road surface level in a longitudinal direction in any section divided by the longitudinal length of that section measured in the same units and expressed either as a fraction or a percentage.

NOTES ON ENGLISH ROADS

Impressions of a New Zealand Engineer

UNLIKE those in New Zealand, the English roads have been developed over centuries. They have the advantage of strength while being hampered and restricted where improvement to alignment and gradient is concerned.

Administration by County Councils

Except for those borough and city streets controlled by urban authorities, the whole of the roading system of England is controlled and maintained by county councils. The roads fall into the following classes:

Trunk roads	100 per cent Government funds
1st class	75 per cent Government funds
2nd class	60 per cent Government funds
3rd class	50 per cent Government funds
Unclassified	County funds

The chief of the engineering department is known as the county surveyor. Under him are district surveyors, deputy county surveyors and assistants. The district surveyors do most of the travelling and are generally in charge of their district. One deputy county surveyor informed me that he spent most of his time writing letters to the county clerk.

A.A. and R.A.C.

The Automobile Association and the Royal Automobile Club perform quite an important function in England. They attend to the signposting. They have motor-cycle patrols and operate a road side telephone system.

The signposting uses a very efficient system of route numbers. Names of streets or roads are not used, but names of towns are. The main routes radiate from London. Between the routes the roads are numbered with a number which incorporates the main route number. The road number is preceded by a letter A or B according to the standard of road.

Loading on Roads

Except on a few bridges, and these were very rare, no load restriction at all was observed in England. Four-axle lorries towing tractors, both with enormous loads, were very common; and in the Midlands on some of the roads lorry traffic would form 50 per cent of the vehicles. I was told of one machine part weighing 180 tons which was transported 200 miles for shipping to America.

Nowhere did I see evidence that this loading was harmful to the road. The controlling factor appeared to be the ability of the tyres to carry the load.

The roads obviously are built with this loading in view. Metal depth and sealing was rarely less than 18 in.

With these observations in mind, one cannot help forming the opinion that the adoption of 6 in. metal depth in New Zealand is far too low and that a much greater load-carrying capacity should be aimed at. As the years go by, the demand for heavier and heavier loads must take place.

Formation

Very little formation work as we in New Zealand know it has been carried out in England for many years. Most of the work appears to be repeated improvement to surfaces. Except on the main roads, very little attention is given to visibility, particularly at intersections. The writer observed several cases of particularly blind intersections where the county council had gone to considerable expense to instal a system of mirrors to assist the motorists where the entire

blockage to view could be removed with a power shovel in two days.

Gradients in some places are as steep as 1 in $4\frac{1}{2}$, but this is fairly rare and not on the main roads.

For the traffic carried, roads are narrow by New Zealand standards. A two-way road is strictly a two-way road with no provision for parking, or stopping. This is taken care of by specially constructed stopping places, or "lay-by's" as they are called or by simply driving the vehicle on to the footpath.

Roads are so constructed with a raised grass verge or a concrete kerb that it is difficult to drive off the edge of the road.

A feature of the English roads which particularly appealed was the absence of watertables and side drains leading to them.

Metal Course

The section of the metal roadway varied with the road and with the district, but the outstanding feature everywhere was permanence and strength.

The procedure observed in the few places where the roads were being laid or widened was as follows: First a power shovel would excavate to the required depth; usually not less than 18 in. Then quarry spawls were placed to form a base. This was followed by a course of about 3 in. crusher run metal and by other courses of fine metal until the required metal level was reached.

Traffic compaction is not relied on at all. Compaction is carried out by heavy road rollers, which are used in great numbers in England.

Power graders are not used in England or the Continent. There are extremely few unsealed roads, and these would have fences right along the metal edge so that they could not operate as a grader in any case. Scarifying is done by tyres attached to the back of the rollers.

The adoption of feather-edge metalling is unheard of. The full depth of metal is placed for the full width of traffickable road. This is bounded on both sides either by a concrete kerb formed by casting in place or by laying precast concrete blocks, or by a specially placed grass verge about 4 in. higher than the road surface. The function of this border is to keep the water and traffic from fretting the edge of the surface away.

Throughout England most of the trunk roads have concrete edges. They extend from London to Edinburgh. In fact most of the activity on the roads was concerned with the placing of additional concrete edging.

Except in south-east England, the supply of raw metal provides no problem, there being adequate supplies of rock and many large and efficient quarries. In the London district considerable quantities of pit gravel are used, but chips are also shipped from Cornwall.

Bituminous and Tar Surfaces

Surface Sealing

When it comes to the laying of sealed surfaces, England is right to the fore. Their methods and equipment are most modern, and the resultant roads are excellent.

With the numerous gasworks and the oil refineries in England the producers of tar and bitumen are able to supply to the user both these products hot at very short notice. Both organizations have the use of insulated road tankers and railway wagons which will hold the temperature for up to 4 or 5 days. Some of these tankers can also be heated if necessary. In many cases the producers of the bitumen or tar do the actual spraying themselves.

Gang sprayers are used generally. Considerable research into these machines has been carried out by the Road Research Laboratory, which is part of the Department of Scientific and Industrial Research. They have produced a sprayer in which the pump is driven by the truck motor. It delivers bitumen at a constant rate per square yard of surface, irrespective of the road speed of the truck.

Chip spreaders have also been subject to research. The latest product can be controlled for width of spread as well as for depth of spread. This is mounted similarly to our fantail spreaders.

Very efficient heating tanks for holding the bituminous materials are in use. These are made in Glasgow by Edmister Brown & Co. Ltd. They are automatic, electric, and can be set to hold the material at any required temperature.

The use of wet fix by its addition to bitumen is found to be too expensive, but other procedures are adopted. To give improved adhesion in some cases chips are precoated in a mixer with road tar oil, diesel and creosote, and then stacked and allowed to dry. Another procedure is to spray the agent as a fine mist on the surface of the bitumèn before the chips are spread.

The actual sweeping, spraying, chipping and rolling follow the normal procedure adopted in New Zealand and do not require elaboration here. This type of sealing is used only as maintenance and for the laying of unimportant roads. The bulk of the surfaces laid today are bituminous macadam or tar macadam carpet coats, which will be dealt with next.

Bituminous Macadam and Tar Macadam

The laying of these surfaces is covered by Bituminous Macadam, B.S.S. 1621: 1950, and Tar Macadam and Tar Carpet, B.S.S. 802: 1945, so this article will deal with the equipment, the production of the material and very briefly with the actual laying of the surface.

Production of the Plant Mix Material

The mixing is usually carried out at the crusher plant where the chips are produced. Chips are drawn off from their respective bins on to a conveyor belt which feeds either a rotary drier or an elevating drier. The dried chips are weighed off into the mixers and the requisite bitumen or tar added. The mix is usually delivered direct to the trucks which are passed over a weighbridge on leaving the works.

The crushing and mixing plant owned and operated by the Larnac C. C. was built at a cost of 500,000 Pounds. It has a capacity of 600 tons of plant mix a day with an average production of about 400 tons of plant mix, besides various grades of road metal. The chips are graded from ¼ in. to ¾ in. generally with a definite absence of fines. The bitumen or tar content is generally a minimum of 5 per cent by weight of the mix.

The price of the mix ex works averages about 30 sh. a ton, the dried chips being priced at 10 sh. a ton. These figures seem very low compared with the price of plant mix in New Zealand, but they explain how it is possible to use the material to the extent it is in England.

Laying of Bituminous Macadam or Tar Macadam

The mix is used either for resurfacing sealed surfaces or for laying new surfaces. In cases of small areas and isolated patches it is tipped out of the truck and spread by shovels and raked to a uniform surface. The surface is then thoroughly rolled with a 10 or 12 ton roller the tyres of which are kept wet by dripping water. Usually the spreading is done with Barber-Green spreaders; with these when an adequate fleet of trucks is available, a considerable area can be covered in a day.

No tar coat was observed to be used when spreading on a sealed surface or a metal surface. The depth of carpet laid varied with the type of road and the money available. In recoating an existing bituminous macadam road carpet may be as thin as 1 in. while in laying a new surface several carpets may be laid until the bituminous surface may have a total depth of 4 in. Each layer would be roller-compacted as it is placed and the lower layer would contain larger chips than the upper layers.

Owing to the absence of fines in the mix it is very open in texture and the carpet laid does not appear waterproof. Traffic and rolling tighten the surface up sufficiently and this is usually all that is done.

I am told that there have been cases where water has caused damage through penetrating the crust. Patches appear fatty through the bitumen being washed off the lower chips and thus forming a

surplus near the surface. As a result of this, as a precaution, sometimes, the laying of the carpet is followed by a very light spray of about 1/20 gallon to 1 sq. yard; the sprayed surface is then blotted with fines.

Maintenance of Bituminous Macadam Surfaces

The resulting surface produced by the Barber-Green is smooth, non-skid and durable. Normal maintenance reseals can be carried out on it; or after a number of years, should it become out of shape the bituminous macadam can be planned off to a level surface. Quite an elaborate machine has been developed for this work.

The surface is levelled out and is ready to receive a fresh coat; the surplus material produced by the planing action can be used again.

It is readily appreciated that, with a strong metal course, and the bituminous macadam carpet surface combined with the planning possibilities, the surface of the English roads has reached a very high standard.

Comparison with other Countries

Throughout Europe one finds a great contrast in the roads and the methods adopted.

In Southern Ireland and portions of France, bitumen is being hand-pumped from the sprayer and hand-sprayed. Chips are spread from small horse-drawn carts or from small heaps placed at intervals along the road—methods which were adopted in New Zealand 30 years ago.

Germany and Belgium have some very fine concrete roads. The autobahn leading from the Black Forest to the Rhine Valley is worthy of particular mention. It provides for six lanes of traffic; three in each direction. There are no intersections. Cross traffic crosses either over or under the autobahn. All towns are by-passed. One approaches and leaves the autobahn by a system of approach roads. Excellent parking and stopping places are provided on both sides throughout the length of the road.

There appears to be no speed limit. Vehicles all travel at their maximum cruising speed.

Most lorries in Germany are diesel-powered, and it is very rare for one to operate without a trailer. One lorry and trailer had a measured load of metal of 36 cu. yd. Such loads formed an uninterrupted flow throughout the length of the autobahn.

Although certain roads on the Continent are exceptionally good, taken over all, the English roads are definitely the best.

The Australian roading system has a much greater proportion of unsealed roads in the country and the smaller country town is very poorly off for footpaths, kerbs and channels.

The conclusion is that good roads can be built where the population is sufficiently dense to provide adequate funds to meet the roading demands.

Being a young country, with only 2½ million population, New Zealand has achieved much, but it is felt that New Zealand roads should be constructed with greater consideration for the demands for heavier loads.

From "Engineering", New Zealand, March 15, 1957.

THE THREE R's

The three R's are important all through life. At 20 it's Romance, at 45 it's Rent (and Rates) and at 65 it's Rheumatism.

RATING ACTUAL CONDITIONS OF COUNTY ROADS

By

HOWARD G. MINIER

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(The description of Washtenaw County's sufficiency-rating system and its results is abstracted from a Paper presented at the annual Michigan Highway Conference, which was held in Grand Rapids in 1955—Editor.)

One of the requirements of the highway act passed by the 1951 session of the Michigan legislature affecting counties is an annual report to the state highway commissioner on the mileage and condition of all highways and structures under the jurisdiction of the county road commissions. The certification of the mileage of primary and local roads, though a tedious and time-consuming job, has become a routine procedure. However, reporting the condition of these miles of primary and local roads had been more or less an unsubstantiated report of what actually existed in Washtenaw County prior to an adequacy survey.

From meetings such as the Michigan Highway Conference, from published articles in magazines and from conversations with highway officials and engineers in other states, we found that a method of rating highways on the basis of actual conditions was in use. The formal rating of a road system is not new, of course. Road-rating methods have been adopted in one form or another by at least 22 states. Counties, however, have only made limited use of sufficiency-rating studies.

The objectives of an adequacy-rating study are the following:

1. To aid in assigning priorities for reconstruction by evaluation of the relative adequacy of each highway section according to certain prescribed standards.

2. To minimize or eliminate the element of personal judgment in the assignment of ratings.

3. To evaluate a road section's ability to carry traffic quickly, safely and economically.

4. To hold to a minimum political and area pressure in highway planning and construction.

5. To keep officials advised on the current status of their highway system.

6. To measure the progress in eliminating deficiencies when ratings are made at regular intervals.

To compare one road with another. In 1953 and 1954 a road-adequacy survey was made of all the roads on the Washtenaw County road system, using design standards and a rating system tailored to our county by our engineering department. The survey was made to find the number of miles of roads that were adequate; that is those that could carry safely the traffic volume of today and meet present-day standards for secondary road design requirements. We had obtained sufficient data by the use of traffic meters to determine the annual average daily traffic for each road.

The first step in our rating study was to divide the road system into four groups according to the average daily traffic. The second step consisted of establishing design standards for each traffic group, using the U. S. Bureau of Public Roads and the Michigan State Highway Department Standards, modified to fit our particular county traffic needs.

Other rating systems were studied and a set of forms was developed to obtain

the necessary field data. Several bugs had to be eliminated in the report form before one was found that would supply all the necessary information for a complete field inventory of the road systems.

The next procedure was to make the actual field inventory, which was completed by the townships. This required that the roads be divided into sections. The location of the section under study was reported as it related to the township and the road name. A definite terminus was selected, such as the county line, an important road junction or a change in road structure. In general we tried to start in the south and west corner of each township.

From the field data the actual physical characteristics of each road section were

a road-adequacy survey, we assigned numerical values to the various components of a road.

The three principle components and their numerical values were:

1. Condition 35 points.
2. Safety 30 points.
3. Service 35 points.

These were further subdivided, defined and weighted into a smaller elements to assist in making the field inventory as uniform as possible.

The rating of the condition of a road section was determined by its structural adequacy and an estimate of its remaining life. Structural adequacy was broken

Desirable Design Standards, Based on Average Daily Traffic.

Average Daily	Group 1	Group 2	Group 3	Group 4
Traffic	0–100	101–500	501–1000	1001–4000
Design speed	30 m.p.h.	40 m.p.h.	50 m.p.h.	60 m.p.h.
Maximum curvature	18 deg.	10 deg.	6 deg.	4 deg.
Lane width	9 ft	10 ft	11 ft	12 ft
Shoulder width	3 ft	4 ft	6 ft	8 ft
Stopping distance	200 ft	275 ft	350 ft	475 ft
Passing distance	500 ft	900 ft	1400 ft	2100 ft
Maximum grade	10 per cent	6 per cent	6 per cent	6 per cent
Right-of-way width	66 ft.	66 ft.	80 ft.	120 ft.

determined. The field information was analyzed in our office and a number rating assigned to each component of the total inventory of the road.

In order to better understand the number rating, a comparison can be made to a written examination that all of us have taken in school at one time or another in our lives. A grade of 100 was perfect and a grade of zero meant that you know absolutely nothing about the subject. Following the same procedure the examination would have a minimum passing or acceptable grade, and each question would have a certain numerical value. Applying the same principle to

down into pavement condition and sub-base and drainage, with pavements assigned a value of 10 per cent of the 35 per cent, and sub-base and drainage 12 per cent. Remaining life of the pavement was assigned a numerical value of 13 per cent.

To determine the rating for safety, shoulder width was given a value of 8 per cent of the 30 per cent of total pavement-lane width 7 per cent: stopping sight distance 10 per cent and consistency of profile and alignment 5 per cent. The service of a road section was determined by assigning alignment a value of 12 per cent of the 35 per cent total, passing opportunity 8 per cent, rideability 10 per cent and pavement width 5 per cent.

Tables were set up to help determine such things as the remaining life of bituminous-mix surfaces and gravel surfaces. For example, if a section of road had been surfaced with bituminous material within the last year it was given a remaining-life rating of 13. If a section had been given a bituminous surface within the past 10 years it was assigned a remaining-life rating of 11. If a road section was surfaced with gravel during the past 5 years four times it was assigned a remaining-life rating of 8.

In the service component, the rating for alignment was based on the number of substandard curves. Passing opportunity was figured on the basis of the number of passing sight-distance restrictions, usually on a percentage basis. Rideability takes into account the roughness of the road surface settlement or heaves in the subgrade, irregularities of cross-section or superelevation and so on, any of which contributes to driver fatigue.

If a road scored 100 points it was considered perfect. On the other extremity a score of zero indicated that no road existed at all. We called the sum of the ratings applied to the individual elements for a section of road the basic rating. We found that two adjustments were necessary in this basic rating in order to give due weight to traffic and lack of paved surfacing.

The eastern half of our county is industrial and carries heavier traffic than the western half, which is rural. We had obtained the average daily traffic for both local and primary highways for both the eastern and western sections of the county. Three charts or curves for this adjustment were constructed according to a method devised by the Bureau of Public Roads. The effect of the use of such a chart is to raise or lower the basic rating of a road section. This is dependent on whether the average daily traffic carried by a specific road section is above or below the average. The average daily traffic volume for Washtenaw County, including primary and local roads, is, for all practical purposes, 250 vehicles. We found through the use of the traffic adjustment chart that the higher the traffic the greater the deduction for the adjusted rating and the lower the traffic the higher the addition for the adjusted rating.

For example, two road sections may end up with the same basic rating. One carries an average daily traffic of 5,000 vehicles per day and the other an average daily traffic of 100 vehicles per day. From the curves on the chart the adjustment for 100 vehicles per day is a plus 3 and for the 5,000 vehicles per day is a minus 15.

The second adjustment we made was related to gravel surfaces. In our survey, the type of surfacing had no effect in obtaining the basic rating on a section of road. However, we felt that an adjustment in the rating should be made for gravel surfaces. We agreed that there was no need for adjustment up to an average daily traffic of 100 vehicles. To make this adjustment, we constructed a straight-line variation chart for gravel-surfaced roads from zero at average daily traffic of 100 to a deduction of 10 points for an average daily traffic of 200. Whatever its final rating, we believe a gravel road carrying more than 200 vehicles per day is inadequate.

The final adjusted rating of a section of road is its adequacy number, which is obtained as the sum of the basic rating, the traffic adjustment and the gravel-surface adjustment.

The next and most important step was to determine what was a passing number. After careful consideration and random sampling in all sections of the county we selected a number of 60 for our local roads and a number of 65 for our primary roads.

In other words, if a section of a local road had an adequacy number of 60 or more, it was considered adequate. If the adequacy number was less than 60 it was considered inadequate. By the same method, the break-off point for primary roads was 65.

Survey results in Washtenaw County disclosed that 37 per cent of our primary

(Continued on page 26)

THE STRENGTH OF MASONRY ARCH BRIDGES*

THE object of this series of tests was to extend the work already done by the Building Research Station and reported in Research Paper No. 16, National Building Studies by testing a variety of bridges under a greater range of loads, using the criteria of deflection and spread indicated in that Paper.

Since only a small proportion of the large number of bridges for which assessments are required could be tested, the aim was to develop a rational method of assessment based on the elastic behaviour of an ideal arch, with allowances, where necessary, for other factors.

The maximum load used in the previous tests was a 36 ton bogie or a maximum single axle of 27 tons. The maximum loads in the tests described were 90 tons bogie and 45 tons axle, the axles being spaced 4 ft 7 in. apart.

The B. R. S. criteria for bridges up to 45 ft span under a single 20 ton axle were, increase in span 0.015 in. and crown deflection 0.05 in. If the increase in span or the deflection under a single 20 ton axle did not exceed these values, the bridge could carry a 40 ton bogie safely, if not it might be defective and therefore suspect.

It was clear that with the much better distribution provided by the twin-axle loading of the test vehicle in these tests an amendment to the rule was justified, and it was agreed to assume that a bridge could safely be considered to carry that bogie load which produces those movements. In fact, although the increase in span criterion was not exceeded it was possible to apply load sufficient to induce deflection movements considerably in excess of the suggested values. In the eight cases quoted no apparent damage was done to the bridge and recovery was apparently satisfactory although not quite complete, and the arches were, therefore, proved to an amount of from 1.2 to 2.0 times the load for critical deflection.

Further objects of the tests were to obtain answers to the following questions:

(1) What dispersion of load through the fill covering the arch ring can be assumed?

(2) What allowance can be made for transverse strength of the bridge and the possibility of there being slab action?

(3) To what extent can it be assumed that masonry arches behave elastically?

(4) What is the effect of abutment movement?

(5) What allowance can be made for the strength contribution of the fill, the parapet, and the spandrel walls?

(6) To what extent can mortar joints be assumed to carry tension?

Test Procedure

Thirteen bridges were tested. So far as possible the bridges selected were in sound condition, free from obvious defects, with the joints well mortared, and included both brick and stone structures. The test vehicle, by the movement of a heavy concrete slab backwards and forwards, provided bogie loads ranging from 20 tons to 90 tons at 6 ton intervals, so that it was possible to measure the deformation of the structure under progressively increasing loads and so study to what extent the behaviour of the bridge was systematic.

In other tests single measurements of deformation were taken under the effects of a passing commercial abnormal load carrying vehicle.

*Masonry Arch Bridges: A Study, by C. S. Chettoe, B. Sc. (Eng.), M.I.C.E and W. Henderson, M.B.E., B. Sc., A.M.I.C.E., presented at the Institution of Civil Engineers Structural and Building Division Meeting on Tuesday, 21st May 1957.

In almost every case the time available for testing was severely limited, being rarely in excess of 8 hours. Deflection was measured on the axis at the crown and quarter points and, in some cases, at 1/8, 1/4, 3/8, crown, 5/8, 3/4 and 7/8 points or a selection of these. Other deflectometers were placed along the crown, generally half-way between the centre-line and the elevation so as to give a transverse profile. The deflectometers used were capable of reading to 0.0001 in., with a range of 1/2 in.

Measurements of increase of span were made at the centre-line of the bridge and half-way between this and the elevations. Rotation at the abutments was not measured.

Details are given in the Paper of the measurements taken and the deflection curves show a consistent behaviour under increasing load. After the first application of load and its removal, some residual deflection or hysteresis was observed in every case, and this continued in varying amounts throughout the test. These residual deflections were in most cases comparatively small. Abutment movements of greater or less degree took place in every structure, the shortening of the span with the load over the abutment being as often as not more noteworthy than the lengthening of the span with the load at the crown.

Thoroughout the tests no damage appeared to be done to any of the structures tested, nor was there, at any stage, visual evidence of the opening of voussoir joints.

Conclusions

The results obtained are discussed in detail in the Paper and the conclusions reached are summarised as follows :

(1) It is reasonable to assume a dispersal angle of 45 deg. to the vertical through the road surface and sound filling material. Dispersal it is considered, could be taken down to the level of the arch extrados, or even in many cases to the axis. The angle of dispersion should be reduced in poor fill and might reasonably be increased for exceptionally good filling.

(2) The tests indicate that the arches behaved elastically. In some cases the slope of the crown deflection curve increased at a point approximating to, or above, the Building Research Station's criterion of 0.05 in. This increase in slope is taken to indicate a probable reduction in effective section of the vaults due to inadequate tensile strength of the mortar joints.

(3) Residual deflections occur, but in normal cases, with arches in good condition where fill and backing are sound, it is thought that they are not a cause for concern.

(4) Abutment movement generally takes place. Its causes are complex but it can result in either lengthening or shortening of the span under the passage of live load. In relation to the original span of the arch, the shortening measured in some of the bridges tested may be simply the reversal of a lengthening under dead load. It may, therefore, be wise to look on the total range of movement as being an indication of the true total span increase, although it may not necessarily be so.

It is not considered that changes in span are likely to be cumulative in sound arches having adequate backing and sound filling. The amount of movement to be expected might be estimated by comparison with these and B.R.S. test results. In order to allow for the unpredictable nature of this movement, a value of, say, 0.02 in. to 0.04 in. might be assumed for single-span arches of moderate span, having good backing, although there are cases where it might be ignored. For bridges with weak backing a considerable increase in abutment movement and reduction in strength is to be expected.

(5) No direct evidence of composite action with the filling was adduced from the tests. Such action, it seems reasonable to assume, must always tend to occur. With soft fills as clay, the effect may well be negligible but with tightly packed stone filling or grouted fill it may be considerable. Such evidence as the tests produced was, however, negative.

(6) The spandrels may well contribute to the strength of the vault, but there was no direct evidence that they could be assumed to do so. Separation of the

(Continued on page 19)

THE EFFECT OF SALTS ON SOILS IN RELATION TO THEIR SUITABILITY FOR BRICK MAKING

THE use of burnt bricks as a building material dates from a very early period. The qualities to be sought in bricks for building purposes are generally soundness, strength and hardness. Success in attaining the desired aim depends chiefly on the proper selection of brick earth as well as on drying and proper burning. In addition to these factors, presence of salts in the earth also subtantially affects the strength of burnt bricks.

In order to elucidate all these points, a comprehensive experimental study had been carried out in the B. & R. Research Laboratory, Karnal with a wide range of soils prevalent in the Punjab.

Some definite conclusions arrived at regarding the selection of suitable soils for brick burning and the effect of salts on their strengths are given below :—

(1) Silty loam or silty-clay loam soils with a plasticity index ranging from 12.0—26.0 and sand content varying from 5—30 per cent produce hard and sound bricks.

(2) The adverse effect of deleterious salts like sodium sulphate when present in a soil can be completely eliminated by proper burning.

(3) Sandy soils having low plasticity index and a high sand content can also be used for burning good bricks with the addition of a small proportion (say 2.5 per cent) of common salt at the time of moulding. It was, however, noticed that by increasing the sand content and correspondingly reducing the plasticity index beyond a certain limit, it will not be possible to get bricks of higher compressive strengths.

(Extracted from a report by Shri L. R. Chadda and Shri V. S. Aggarwal).

(Continued from page 18)

spandrels from the vault in many cases, and other indications from visual inspections, lead to the conclusion that any contribution in this respect cannot be relied on.

(7) From visual examination and probing of the joints of many bridges it is clear that mortar can range from a hard and tough material intimately keyed to the masonry and capable of withstanding considerable tension to something very little more cohesive than damp sand. Even where pointing is good, this may conceal a weak mortar behind it.

(8) Skew bridges, provided the length of abutments squarely opposite each other is sufficient—approximately equal to or not much less than the effective width of the arch—can reasonably be dealt with as square spans.

(9) The loads placed on all the single-span arches tested with the special test vehicle were particularly severe, the maximum bogie load generally being either 84 or 90 tons applied on two axles 4 ft 7 in. centres, each axle having four wheels with solid tyres. The overall length of each axle between outer edges of tyres was 7 ft 9 in. Increasing loads were placed on each arch and allowed to stand at the crown for periods of from 5 to 10 min. No apparent damage was caused to these bridges.

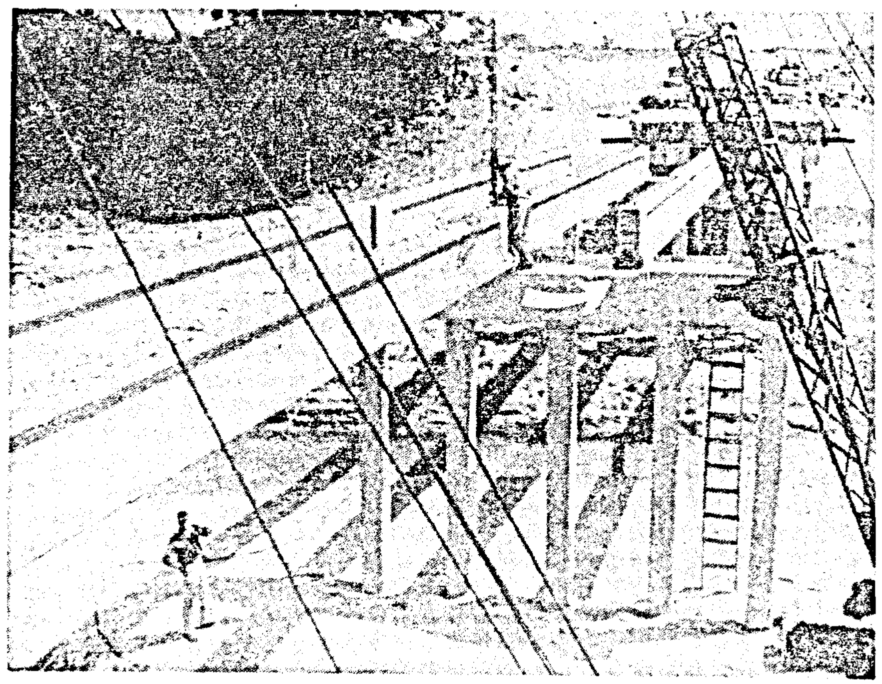
(From "The Surveyor & Municipal & County Engineer"—May 25, 1957.)

HERE AND THERE

1. RUBBER SEATS FOR PRESTRESSED BEAMS

A neoprene plate has been developed by the Texas Highway Department Bridge division to be used as a bearing material for precast, prestressed concrete beams. The neoprene plate was used for the first time in seating 53 ft long prestressed beams for a bridge near Victoria, Texas.

Portland cement, asphaltic fibreboard, steel rockers and lubricated metal sliding plates have been used in attempting to find a satisfactory and economical seating material. Each has some objectionable feature, either poor functioning or lack of economy. Some metal bearings used with beams in bridge work cost almost as much as the beams they support.



Prestressed Beams for bridge near Victoria, are seated on Rubber Bearings

The problem of seating precast members is most serious where heavy loads cause high bearing stresses and relatively large rotations at the bearings. In prestressed design, in particular, where span lengths are longer than with reinforced concrete, a positive and dependable bearing is necessary.

An acceptable beam bearing must (1) provide a smooth and uniform transfer of load from the beam to the substructure; (2) permit beam rotation at the bearing due to deflection of the beam under load

and (3) allow lateral and longitudinal movement of the beam due to thermal forces. In addition, the bearing must be economical, dependable and durable, and should be easily maintained or maintenance free.

Neoprene Rubber bearing plates

The neoprene bearing plate used in Texas is made of a highgrade synthetic rubber, highly resistant to oil, sunlight and weather. Made in a wide range of hardness, it has an extremely long life. Tests show that a durometer hardness of about 70 is the most desirable.

Texas designs allow a dead-load bearing stress of 300 psi. Combined dead-load, live-load and impact bearing stress should not exceed about 800 psi.

Plate dimensions

To permit beam rotation and longitudinal movement, the neoprene plates are held to a width of 6 to 8 in. in the direction of the beam axis and are at least the full width of the bottom flange of the beam in the other direction.

Thickness of the plate must be increased as the span of the beam increases. An increase of 0.10 in. in plate thickness for each 10 ft of span is considered adequate. However, one inch is the maximum thickness that should be used in a single plate, since the rubber tends to "bulb out" on the sides when used in thick pieces. Where thicker bearings are indicated, a series of plates should be built up with a restraining material between. Since the neoprene plate tends to adhere to the concrete surface, the plate is not expected to creep or move from its initial position. The beam under thermal movement will flex the neoprene rather than slide on it. This small amount of working will help keep the rubber alive.

No rigid connection between superstructure and substructure is permitted, because the neoprene bearings will compress under live loading. A ½ in. thick plate loaded to 250 psi. will compress about 1/16 in.

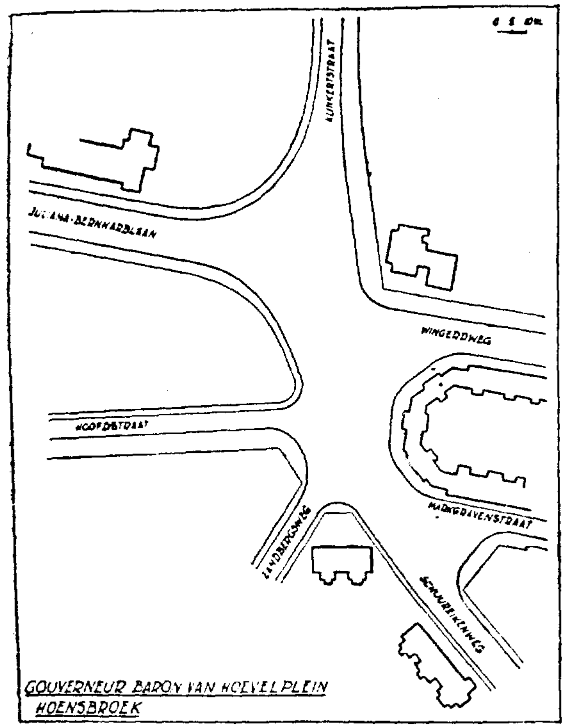
(From 'Engineering News-Record', May 16, 1957.)

2. INTERSECTION IMPROVEMENT

The illustrations on next page show the centre of the village of Hoensbrook, Holland, "before" and "after" improvements had been adopted.

The main route through the village has been divided into two carriageways by means of a median strip, with gaps for left-turn movements. Side-roads now enter the main road at right angles, thereby improving the drivers' field of vision. In addition, some side roads now have channelising islands at the approach to the intersection.

BEFORE



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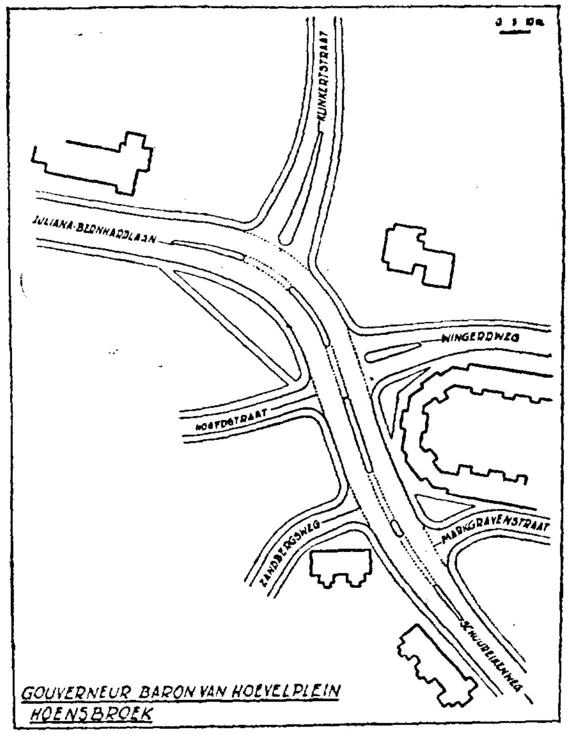


The effect of these improvements has been to channelise traffic and thereby reduce the number of possible conflict points between the various traffic streams. Furthermore, the conflict points remaining have been separated and clearly defined.

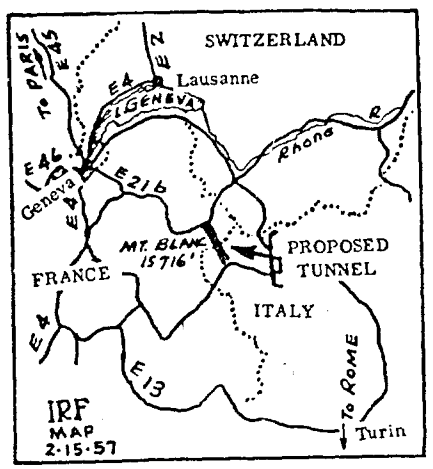
(From 'International Road Safety and Traffic Review,' Spring, 1957, No. 2).

3. MONT BLANC TUNNEL GETS RATIFICATION

THE 7-mile highway tunnel planned for construction beneath Mont Blanc in Switzerland will be constructed jointly by Italy and France. The French Parliament recently ratified their part of the work. Italy ratified a treaty on the subject in 1954, and the French body has voted to prove joining in the venture.

The undertaking has been proclaimed as "a victory and a tremendous step forward in international co-operation."

The tunnel will provide a direct all-season route between Rome and Paris, and reduce driving distance between the two capitals by more than 90 miles. Presently, the excellent highways linking the two cities are blocked by snow for several months of the year. The tunnel will cost an estimated 25 million dollars (U. S.). The Switzerland state of Geneva and the city will contribute part of the sum, the remainder to be borne by France and Italy.

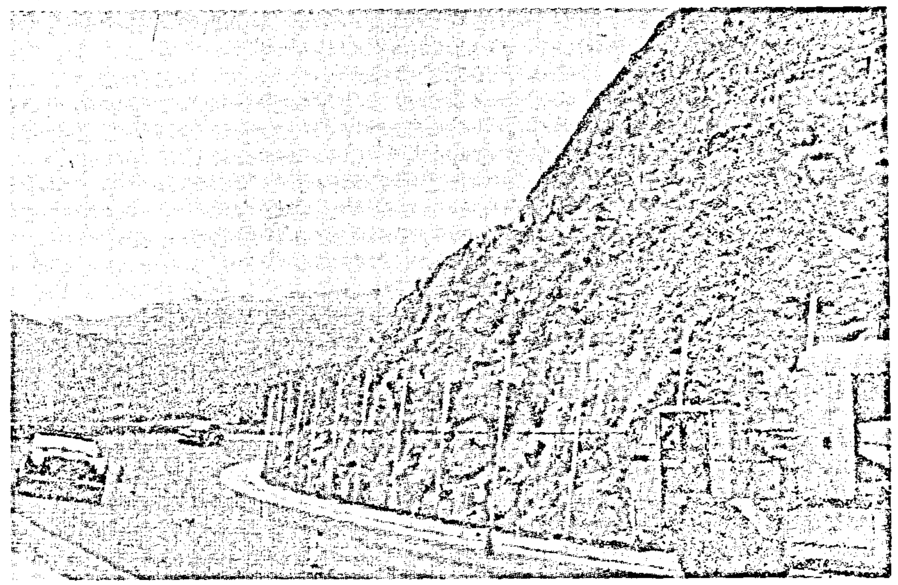


Location of the new tunnel seemed to be assured by recent French Parliament action in France.

The International Road Federation of Washington, D. C., describes the tunnel as an 11,900-meter long bore which will range in altitude from 3,950 ft to 4,250 ft. The roadway will be 7 meters wide with an additional width every 50 meters for emergency stops and larger areas for stops every 500 meters, alternating on the right and left sides. Ventilation will be designed to support a movement of 210 vehicles per hour through the tunnel. Construction should be completed within three years.

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

4. WIRE MESH FENCES PROTECT DRIVERS



TUMBLING rocks in the past two years have hit several cars travelling Hawaii's Nuuanu Pali highway between Honolulu and Windward Oahu. The Territorial Highway Department now has erected wire mesh fences to help protect against the danger. Though several steel auto tops have been punctured in the past slides no one, fortunately, has been seriously hurt.

(From 'Engineering News-Record', April 18, 1957).

5. GHANA ROAD IMPROVEMENTS

IN Ghana (formerly the Gold Coast) from 1951 to 1955 nearly 60 million pounds was spent on the improvement of communications, on water and electricity and on social services. The 1951 ten year plan has virtually been completed in six years.

During recent years the improvement of communications has been one of the most spectacular achievements in Ghana. Over 1,000 miles of all-weather roads have been built since 1946 and some 500 miles of secondary roads. In Ashanti and in the Northern Territories in particular, results of the new roads built have been far-reaching.

The importance of road transport, as a factor in general development, is shown by the fact that the number of road vehicles has more than trebled in the last

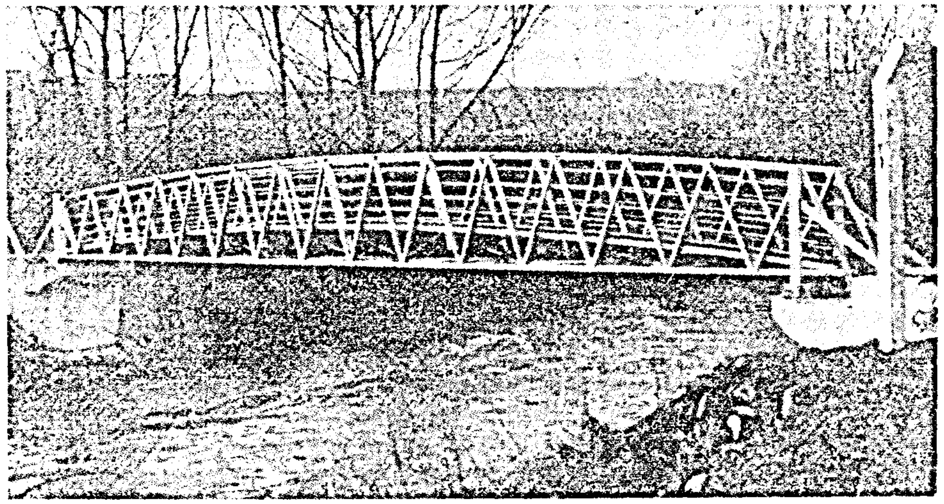
10 years and now exceeds 30,000 of which some 50 per cent are commercial vehicles. Four-fifths of the commercial vehicles are owned by businesses using them on own account and the balance are carriers for hire.

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

6. ALL-WELDED FOOTBRIDGE OF ALUMINIUM CONSTRUCTION

AN aluminium alloy bridge recently constructed across the River Ebbw at Rogerstone, Monmouthshire, is one of the first of its kind to be of all-welded construction. The bridge, connects two parishes of Bassaleg and Rogerstone and will maintain a right of way that has been in existence for many years.

The bottom chord girders are 4 in. x 3 in. x ¼ in. extruded section. Lattice members are of 3½ in. x 1¾ in. lipped channel section, and bracing members of 1¾ in. equal bulbed angle. The material used in the construction was aluminium alloy Noral B. 51 S. (B. S. 1476 : H.E. 30), fully heat-treated.



The footbridge spanning the River Ebbw at Rogerstone, Monmouthshire. The bridge is one of the first to be of all-Welded aluminium construction.

It is of through-type W-latticed girder construction with the top chord of each girder serving as a handrail. The top chord is curved to a radius of 226 ft, the depth of girders being 4 ft 6 in. at the ends and 6 ft 3 in. at mid span. The 4 ft 6 in. wide footway is similarly curved to give a 4 ft 6 in. handrail height throughout.

The complete structure weighed 2,100 lb without the bituminous floor covering. The bridge is carried on pin joints at the concrete supports, a link being provided at one end for thermal expansion.

The bridge was strengthened laterally with wind bracings which run diagonally and obliquely from the bottom chord girder to the joint intersection areas at road level.

The road troughing was attached by rivets to an angle section which was welded to the lattice members throughout the length of the bridge.

The whole job was welded completely by the Argonaut process using type N. 6 wire of 1/16 in diameter. Four-and-a-half coils of N. 6 wire, and 700 cu.ft. of argon was consumed during the welding operation.

(From 'The Surveyor and Municipal and County Engineer', May 11, 1957.)

CURRENT LITERATURE

ABSTRACTS

EFFECT ON SOIL COMPACTION OF TIRE PRESSURE AND NUMBER OF COVERAGES OF RUBBER-TIRED ROLLERS AND FOOT-CONTACT PRESSURE OF SHEEPS FOOT ROLLERS - Waterways Experiment Station, Vicksburg, Mississippi.

THIS report presents the results of a field and laboratory study of the effects of tire pressure and number of coverages of rubber-tired rollers and foot-contact pressure of sheeps foot rollers on the compaction and stress-strain characteristics of a lean-clay soil. Test fills were constructed using a rubber-tired roller, with tire pressures ranging from 50 to 150 psi and compacted by 4 to 16 coverages, and a sheeps foot roller with 14-sq in. feet loaded to produce nominal foot-contact pressure of 125 and 375 psi. Laboratory and field-compacted samples of the clay were subjected to water content, density, CBR, and triaxial shear tests.

It was found that increasing the number of coverages or tire pressure of a rubber-tired roller, within the limits used in this study, results in higher maximum densities at lower optimum water contents. Increase in density results in (a) increase in strength where the soil water content is dry of the optimum for the highest compaction effort used, and (b) decrease in strength where the soil water content is wet of optimum. Increasing the foot pressure of the sheeps foot roller used had little effect on the degree of compaction or strength obtained in the test soil.

TOLL ROADS IN THE U. S. A.—H. J. H. Starks, B. Sc, Ph. D., D.I.C., F. Inst. P.* The Engineer, February, 22 and March, 1, 1957.

A striking feature of the road developments in the United States of America in the past ten years has been the growth of toll roads. Some aspects of the planning, financing, operation and safety of the toll roads in the eastern States of America are described in this article which is based on information collected by the author during a visit to the United States in 1954—55. The modern toll road is a divided highway with restricted access, having no intersections, sharp curves or steep hills; there are no traffic lights, turning vehicles, pedestrians or cyclists. Like other major highways in America, toll roads are built to the highest engineering standards: the cost of their construction and operation is financed by tolls levied on those who use them. In this respect, toll roads provide one solution of the most pressing problem facing many countries today—the problem of financing new roads. The article gives a brief description of the planning, design, construction and cost of a typical toll road. Data on the usage of toll roads and the problems of traffic diversion and generation are discussed. Information is given on the types of accident occurring on toll roads and on the accident studies which have led to the adoption of various safety measures; in some cases these have greatly reduced the accident rate in spite of a considerable growth in traffic. The number of accidents and the number of personal injuries sustained per million vehicle miles are generally much lower on toll roads than on other main roads. The author's impressions of driving on toll roads under different weather and traffic conditions are also given.

DESIGN AND LAYOUT OF STATE ROAD nr. 4A, (Amsterdam)—Burgerveen—Ypenburg—(Rotterdam).

The main route from Amsterdom (The Hague-Delft) to Rotterdam at present is formed by the state road nr. 4

* Road Research Laboratory, Department of Scientific and Industrial Research.

(Amsterdam-Burgerveen-The Hague) and nr. 13 (The Hague - Ypenburg) - Delft - Rotterdam. When these roads had been completed the necessity was felt to make a by-pass for through-traffic east of the Hague. The present route through the Hague takes a lot of time.

A description is given of the choice of the route, the junctions, intersections and roundabouts.

The quality of the subsoil of the new road is in general very bad and changes continually. Extensive soil-mechanic investigations had to be made. From the results of these investigations it was evident, soil improvements would have to be applied on a large scale. A brief description is given of the soil-mechanic investigations, the results, the settlement and equilibrium calculation of the embankment, the excavating, dredging, sandsucker and pumping plants.

Furthermore the building of the embankment, the compaction and drainage of the sand and the choice of the pavement are discussed and a description is given of some interesting technical projects, viaducts of prestressed concrete, the "polders" in the road, bridges and the aqueduct.

(Continued from page 16)

roads, 68 per cent of our local roads and 30 per cent of our sub-division streets were adequate. This method of evaluation gave us the relative condition of our highways as compared to acceptable standards.

We have used the study for the following purposes :—

1. As an aid in planning local-road improvement programs with the various townships in which they participate financially.

2. As a help in developing the economic study of highway needs for President Eisenhower's program.

3. As a guide in the development of Washtenaw County's part in the Michigan highway needs study now in progress.

4. As this year's annual condition report of our roads that we send to the state highway commissioner.

We have found that having each road rated by number has proved very helpful in comparing one road with another. It takes the guesswork out of the statement that a road is "good" or that a road is "bad."

We realise that our rating system has its limitations and should be used with common sense. We all know that our highway deficiencies cannot be eliminated at once even if we had enough money to do it. By using the rating system as a guide to establish priorities of improvement, we think that the driving public will receive the most for its road dollar.

The promise of a rating system is to break down highway engineering into simple elements that are understandable, to the ordinary citizen. It has assisted us in planning improvements with our limited finances on a sound basis. By the use of an adequacy rating as one of the tools in highway managemant we believe that we are better able to plan and prepare for the future highway needs of our County.

(From :—"Better Roads" April 1955.)

LAMP POST

An erection that never collided with anything except in self defence.

SELECTED RECENT LITERATURE IN ENGINEERING JOURNALS

X. BRIDGES AND OTHER STRUCTURES

1. **Easy Computation of Comparative and Principal Stresses**; PAUL SAMHEL, *Die Bautechnik, Volume 33, No. 10*, October 1956, pp. 357-358 (in German).

2. **Viaduct Sets Welded-Girder Record**; EDWARD J. RAMER, *Engineering News Record, Volume 157, No. 18*, November 1, 1956, pp. 43-46.

3. **Auditorium Framed with Prestressed Roof Girders**; ERIC C. MILKIE, *Journal of the American Concrete Institute, Volume 28, No. 4*, October 1956, pp. 363-374.

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5. **Ventilation System Changes Cascade Tunnel Operation**; *Engineering News Record, Volume 157, No. 19*, November 8, 1956, p. 52.

6. **A Matrix Method for Multiframe Beams (Deflection and Sway)**; H. TH. WOERNLE, *Der Stahlbau, Volume 25, No. 6*, June 1956, pp. 140-145 (in German).

7. **New Method of Design of Statically Undeterminate Frames**; DR OTTO BRAUN, *Der Stahlbau, Volume 25, No. 10*, October 1956, pp. 236-245. (in German)

8. **Contribution to the Design of Skew Girder Decking**; JENS J. STARKE, *Der Stahlbau, Volume 25, No. 10*, October 1956, pp. 251-253 (in German).

9. **Some Expedients in Structural Analysis**: B. S. S. RAO, *Indian Concrete Journal; Volume 30, No. 11*, November 1956, pp. 364-369.

10. **Abridgement of the Iteration Method According to Kani**; ERNST ZELLERER and HANNS THIEL, *Die Bautechnik, Volume 33, No. 6*, August 1956, pp. 288-289 (in German).

11. **The Stanchion Problem in Frame Structures Designed According to Ultimate Carrying Capacity**; MICHEL REX HORNE, *The Journal of the Institution of Engineers, Australia, Volume 28, No. 10-11*, October-November, 1956, pp. 253-274.

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18. **Practical Applications of the Theory of Elasticity**: R. GUILLOT, *Travaux, Volume 40, No. 266*, December 1956, pp. 658-662 (in French).

19. **Stress Analysis of Three-pinned Arch-ribbed Domes**; LYGMANT STANISLAW MAKOWSKI and MADHUKAR NARAYAN GOGATE, *Paper No. 6116, Proceedings of The Institution of Civil Engineers, Part III, Volume 5*, December 1956, No. 3, pp. 824-844.
20. **The Solution of Redundant Frameworks by Successive Reduction of the Gaps in Cut Members**; WILIAM WRIGHT, *Proceedings of the Institution of Civil Engineers, Part III, Volume 5*, December 1956, No. 3, pp. 845-850.
21. **Determining the Tension in Ropes, Continuous Record Obtained with Instrument Devised By B. I. S. R. A.**; H. N. WILKINSON, *Engineering, Volume 182, No. 4736*, December 14, 1956, pp. 753-755.
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30. **Testing Structural Members Variable Load-application Points**; *Engineering, Volume 182, No. 4738*, December 28, 1956, p. 817.
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12. **National Register of Scientific & Technical Personnel in India**, Vol. I, Part I 'Engineer' August 1949.

    Vol. II-Medical Personnel, Part I, March 1950.

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    Vol. II, "Medical Personnel" Part II, April 1951.

    Vol. I-'Engineers' Part III, December 1951.

    Council of Scientific and Industrial Research, **New Delhi.**

CORRECTION

Kiul bridge near Jamui whose photograph was published on page 2 of July 1957 issue of Transport-Communications Monthly Review lies on Sikandra - Jamui - Kharagpur - Bariarpur - Ghorghat Road and **not** on Patna - Ranchi N. H.

BUDGETS AND ADMINISTRATION REPORTS

GOVERNMENT OF RAJASTHAN CIVIL WORKS BUDGET 1957-58

The following extracts relating to Civil works have been taken from the Government of Rajasthan Budget for the year 1957-58.

Revenue (Civil Works)

Heads	Budget Estimates (1957-58) (in lakhs)
Rents	18.00
Ferry Receipts	0.05
Tools on roads	0.21
Transfer from Central Road Fund	16.50
Grants from the Government of India for the Development of State Roads of economic or inter State Importance	35.82
Other Miscellaneous Receipts	5.00
Deduct-Refunds	-0.09
Total	75.49

Expenditure (Civil Works)

Buildings	
Original Works	0.55
Repairs	26.02
Communications	
Original Works	52.32
Repairs	75.00
Miscellaneous	
Original Works	——
Repairs	3.00
Suspense	4.00
Add. Prorata charges Establishment	7.29
Tools and Plant	2.68
Add-New items	0.06
Grand Total	170.92

Capital account of Civil Works outside the revenue account

Items	Budget Estimates 1957-58.
Original Works	
Buildings	189.24
Communication	182.70
Grants-in-aid	10.00
Tools and Plant	
New items of expenditure	28.05
Deduct-Receipts and recoveries on Capital Account	-91.63
Amount transferred from Grants to Municipal Boards	-3.20
Add-prorata charges	
Establishment	17.99
Tools and Plant	6.11
Total	339.26
Receipt from Roads	
Receipts under the Provincial Motor Vehicles Taxation Act	62.14
Other receipts	0.15
Deduct-Refunds	-0.29
Total	62.00

GOVERNMENT OF RAJASTHAN (Civil Works Budget) 1957-58.

(A brief review)

THE estimated revenue and Expenditure figures for the year 1957-58 are Rs 2938.33 lakhs and Rs 3218.94 lakhs respectively, deficit on Revenue Account Rs 280.61 lakhs.

Revenue expenditure on Civil Works in 1957-58 is estimated at Rs 170.92 lakhs, which forms 5.8 per cent of the total revenue for the year. The estimated expenditure on communication (original works and repairs) alone is, however, 4.3 per cent of the total revenue for 1957-58.

The total outlay on Civil Works outside the revenue account for the year 1957-58 is Rs 339.26 lakhs, out of which Rs 182.70 lakhs are proposed to be spent on communications alone.

LIST OF APPROVED WORKS ON NATIONAL HIGHWAYS

S.No.	Job No.	Name of work	Amount Rs Lakhs
		ANDHRA	
1.	1751 AH 5	Construction of a bridge across Nall Vagu and improving S curve in mile 178/7 of Madras-Calcutta Road—National Highway No. 5.	0.98
		ASSAM	
2.	1752 AS 37	Permanent restoration of damages to miles 220 to 223 and 230 of National Highway No. 37 caused by floods of 1955.	3.65
		BOMBAY	
3.	1754 BM 50	Construction of a by-pass road near the college of Military Engineering, Kirkee, on the Poona-Nasik Road, National Highway No. 50.	4.89
4.		Two works each costing less than two lakhs.	1.83
		DELHI	
5.	1753 DLH	Acquisition of land on Eastern side of approach road from G.T. (Meerut) road to the site of the new proposed bridge over River Jamuna in Delhi.	6.52
6.	1755 DLH	Raising Upper Bela Road to the standard of National Highway—Construction of drains.	0.75
		KERALA	
7.	1757 KR 47	Improvement to National Highway No. 47 —Quilon Alleppey road miles 15/0 to 18/0—Protective works	0.39
		ORISSA	
8		Three works each costing less than 2 lakhs	0.84
		WEST BENGAL	
9.		Two works each costing less than 2 lakhs	1.75

Transport-Communications Monthly Review August 1957

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46.	Road Research Bulletin No. 1		
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