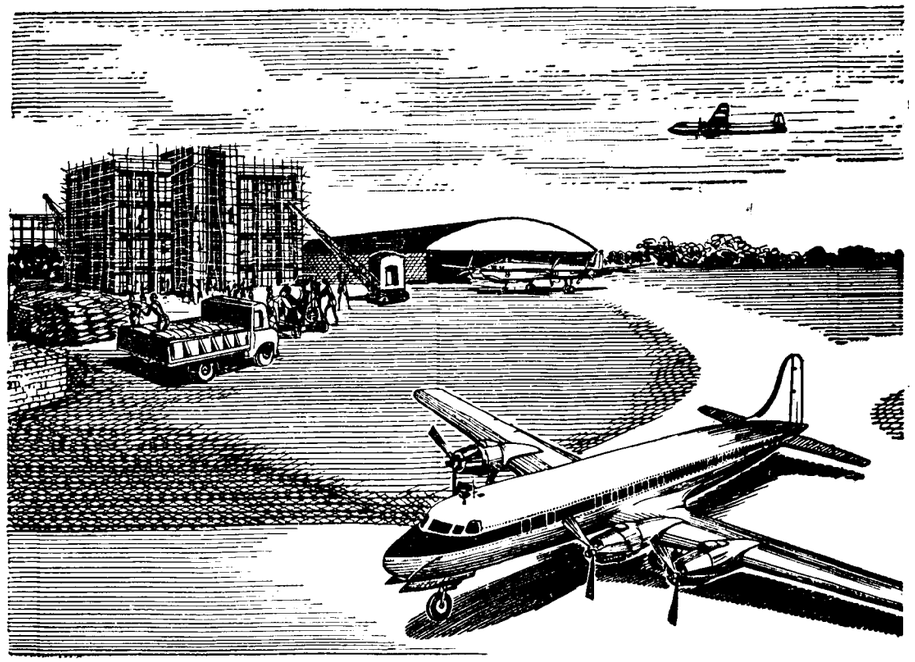
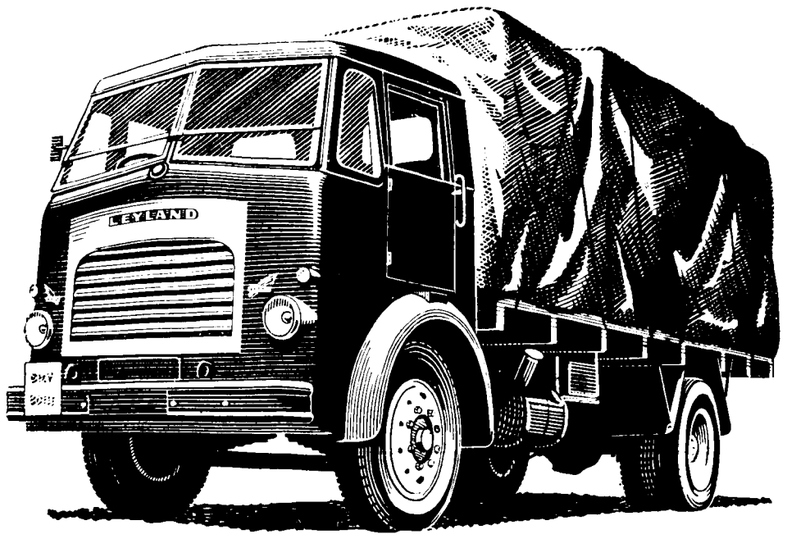
TRANSPORT-COMMUNICATIONS

MONTHLY REVIEW

JULY 1956—No. 111

INDIAN ROADS CONGRESS, NEW DELHI.





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

This Review is sponsored by the Roads Wing of the Ministry of Transport, but the Government of India accept no responsibility for any views or opinions expressed.

Subscriptions. Annual subscription including postage is **Rs** Fourteen. Single copy including postage is Rs one and annas four.

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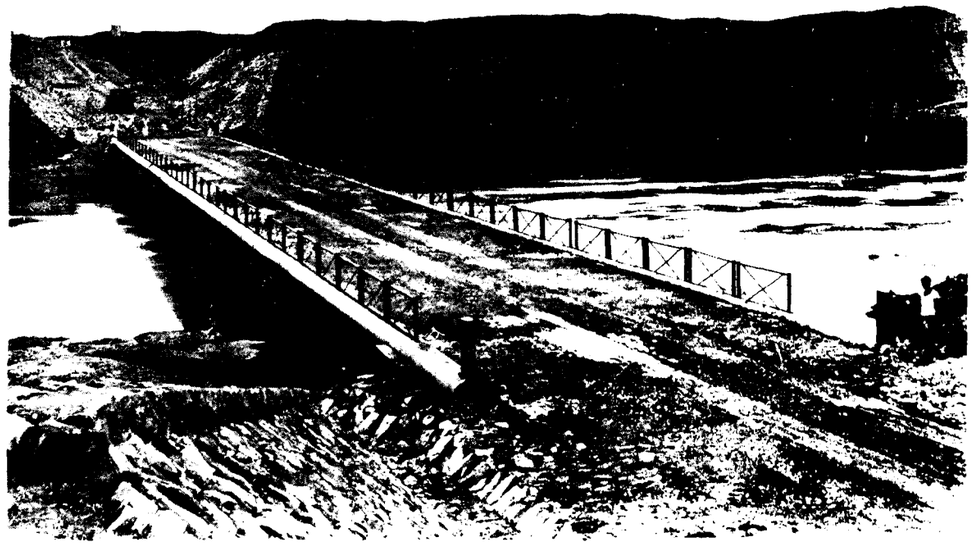
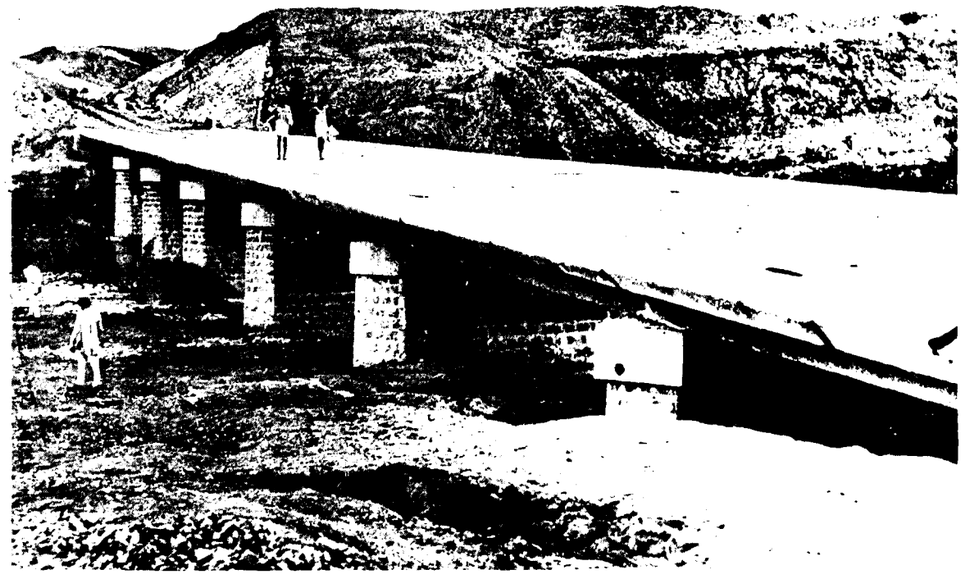


The Barna Bridge



The Barna Bridge—without collapsable parapets

TRANSPORT-COMMUNICATIONS
MONTHLY REVIEW

A REVIEW OF
ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

JULY 1956

BRIDGING INDIA'S RIVERS

THE BARNA BRIDGE, BHOPAL

The Site

THE river Barna, a tributary to the Narbada, rises in the hilly tract of Tehsil Goharganj, crosses the Bhopal-Bareli road at mile 35, runs parallel to the road in hills and emerges into the plain area near Bari through a gorge. Thereafter it runs parallel to the road for about 12 miles and crosses the road and joins the Narbada about 9 miles below the crossing. There was no bridge at either of the crossings with the result that the entire fertile valley of Narbada to the east remained cut off from the west for five months in the year.

Several sites between Bari and the confluence of the river with the Narbada were examined and the site in mile 69 was selected as the best, Fig. 1.

Hydraulic Data and Waterway

The catchment area of the river at the site of the bridge is 353 sq. miles. The discharge calculated from Dicken's Formula with the coefficient of 1,000. comes to 93,165 cusecs. The active channel in summer is only about 40 ft but in high floods water spreads up to half a mile from the right bank and about two furlongs from the left bank. The bridge was, therefore, designed as a submersible bridge.

General Features of Design

The bridge consists of 7 spans of 39 ft each centre to centre. The superstructure is of beam and slab type designed for two lanes of I. R. C. Class A loading or one lane of I. R. C. Class AA loading, whichever gave higher stress. The beams rest on piers of coursed rubble masonry on well foundations. The working stresses adopted for concrete and steel are 950 lb per sq. in. and 18,000 lb per sq. in. respectively. Wind pressure is taken as 20 lb per sq. ft. The bridge is designed for a maximum intensity of pressure of 3·2 tons per sq. ft. on the soil.

Foundations

Trial bores taken at the site of the bridge revealed sandy soil to a depth of about 9 ft overlying a layer of hard yellow clay of 2 ft depth. Below the hard yellow clay layer, clay mixed with gravel for 39 ft in depth overlying a 10 ft layer of clay mixed with fine sand was found. The design provided for two wells of 6 ft 6 in. diameter on the inside and 10 ft diameter on the outside with a well cap 2 ft thick to receive the piers and abutments. This was subsequently changed, at the request of the contractors, to one well with 15 ft and 18 ft diameter on the inside and on the outside respectively with a 2 ft thick R. C. (1 : 2 : 4) cantile-

vered well cap. The depth to which the wells were sunk was determined taking into consideration the scour depth according to Lacey's Formula.

Well Kerb

The wells were provided with steel cutting edges and R. C. C. kerbs. The cutting edges were formed of mild steel flat 8 in. by $\frac{1}{2}$ in. welded to 4 in. by 4 in. by $\frac{1}{2}$ in. angle, bent to correct curvature (Fig. 2).

Formwork for the kerb was made of timber. The mix of the concrete was 1 : 2 : 4 and was compacted by vibration with immersion vibrators.

Steining

The steining of the wells was of 1 : 3 : 6 cement concrete reinforced by 5/8 in. diameter verticals, threaded to kerb angles and $\frac{1}{2}$ in. diameter horizontal bars at 2 ft centers (Fig. 2). The concrete was compacted by vibration.

The steining was raised in 8 ft stages in two lifts of 4 ft height. Steel shuttering was used. Bolts, which were subsequently cut away, were left in the concrete for supporting the upper lift of shuttering.

Sinking The bed of the river, except at piers 2 and 3 from the left bank, remains dry for 8 months. The well kerbs were laid on the ground at 1 ft above the water level for all piers except No. 2 and 3 where temporary islands were formed and kerbs laid. Steining 8 ft high was cast before starting the sinking.

Sinking to a depth of about 2 ft below water level was done by manual labour. For further sinking, $1\frac{1}{2}$ cu. yard grabs and Scotch Derricks were used.

Sinking was comparatively easy and fast in sandy soil, but as the yellow clay was approached, sinking became difficult. Dewatering was done, the bed was loosened by pickaxes and the clay was lifted by grabs. On several occasions a rail chisel had to be used to break up conglomerate under the cutting edge.

Maximum kentledge for sinking was 100 tons made up of sand bags loaded on loading platforms of girders.

During sinking, all the wells except those of piers 2 and 4, got slightly tilted. The tilt was corrected by loading the higher side, propping the lower side and putting blocks under the cutting edge on the lower side.

Wells, sunk to the designed level, were tested for prescribed loading before plugging. The load applied was made up of sand bags. Maximum sinking after loading was found to be $\frac{1}{4}$ in. which was considered satisfactory.

After the removal of the test load, water from the well was pumped out, the bottom of the well was cleaned and plugged with concrete 1 : 2 : 4 for a depth of 3 feet. Concrete was lowered by buckets utilizing the winch which was used for dredging. Where dewatering was not possible, dry mixture 1 : 2 : 4 was placed by means of plugging buckets under water. After two days sand filling was done under water. The top 1 ft was plugged with concrete 1 : 3 : 6 (Fig. 2).

Piers and Abutments

Piers are constructed in coursed rubble masonry in cement mortar 1 : 3 and are 4 ft wide at bed block level and 5 ft $\frac{1}{2}$ in. wide at capping slab level with a batter of 1 in 24 on both sides. They were provided with R.C.C. cap 2 ft thick on top.

The abutments are 6 in. thicker than the piers. Short R.C.C. wings were cantilevered from the top of abutment slab.

Superstructure

The Superstructure consists of three trough shaped R.C. beams 24 in. deep connected at the supports by 6 ft wide diaphragms with a 12-in. thick R. C. slab on top, Fig. 3 page 6.

The centering for the troughs and the slab was made of 3/16 in. thick M. S. plates properly stiffened. Steel girders were used to support the centering. On one side the steel girders were inserted in holes left in the masonry of the piers below the pier cap, and the other ends were supported on a cross girder. This cross girder was supported on wooden trestles resting on bed blocks of cement concrete 5 ft by 6 ft 6 in. by 4 in. thick. These bed blocks were tested at site by

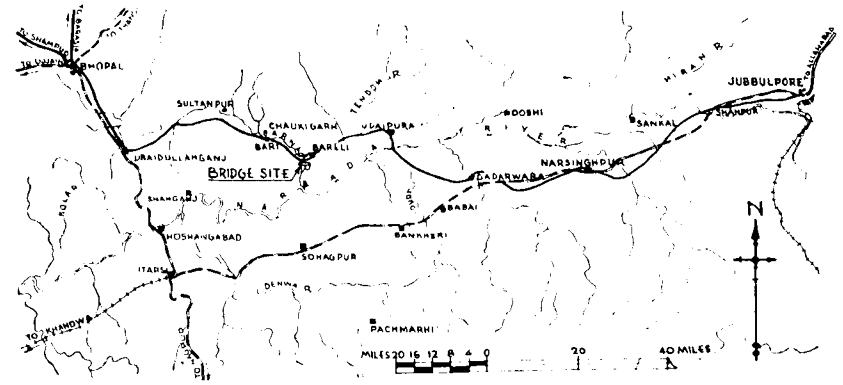


Fig. 1. Key map showing the site of the bridge

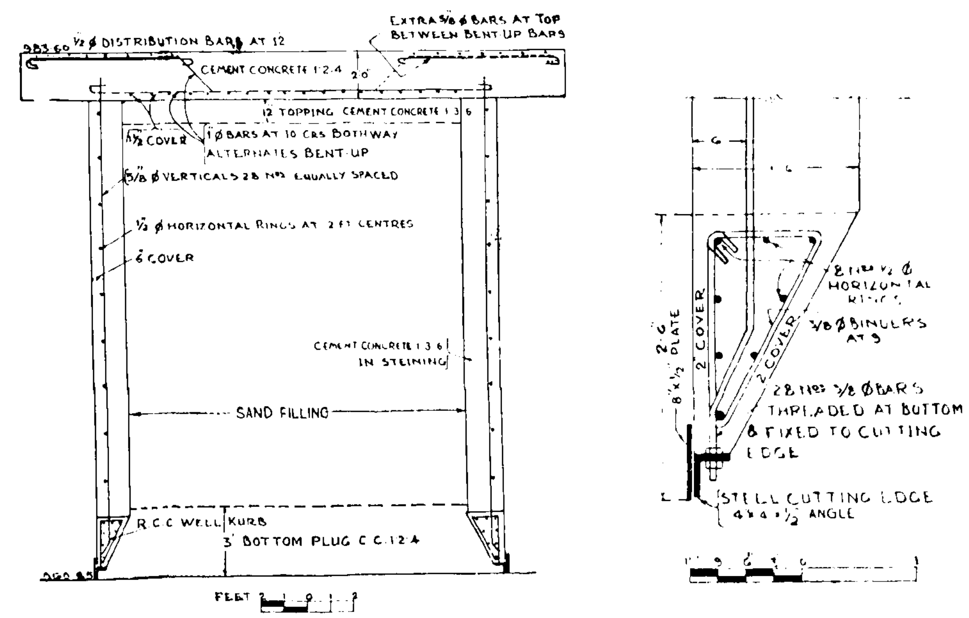


Fig. 2. Details of Wells

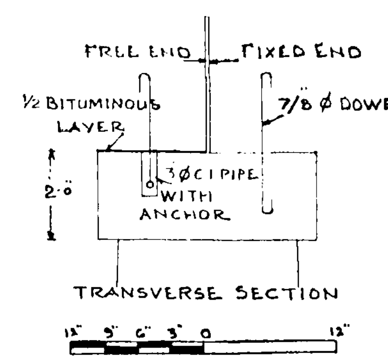
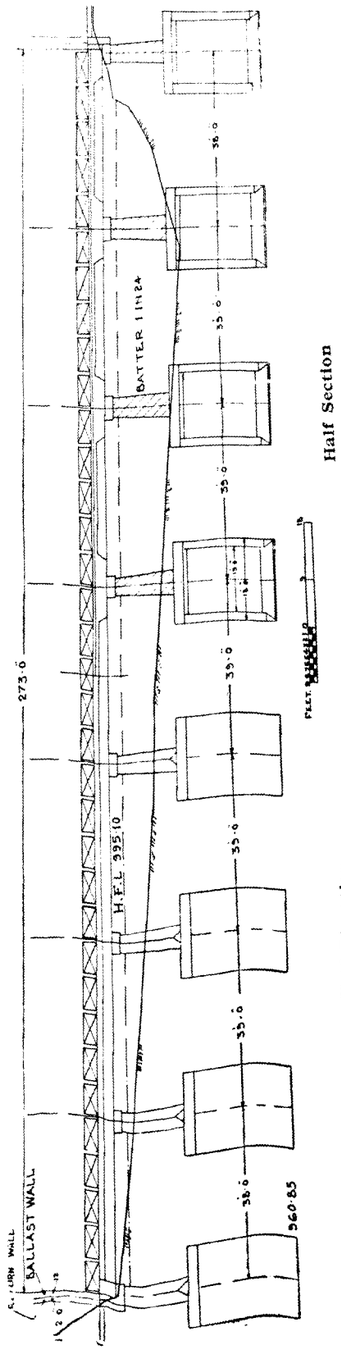


Fig. 4. Details of expansion arrangements



Half Section

Half Elevation

Fig. 3. Details of Superstructure

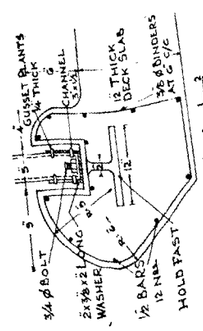
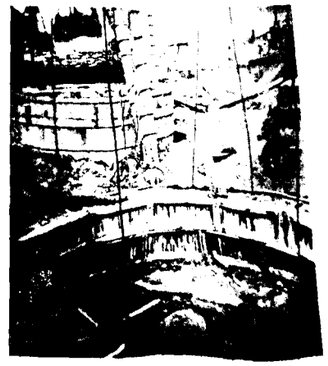
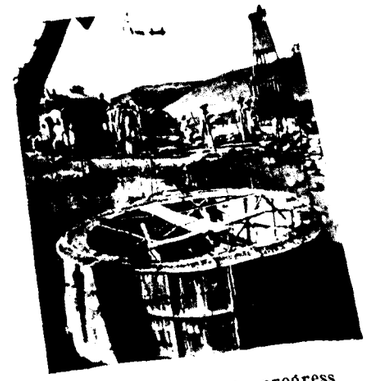


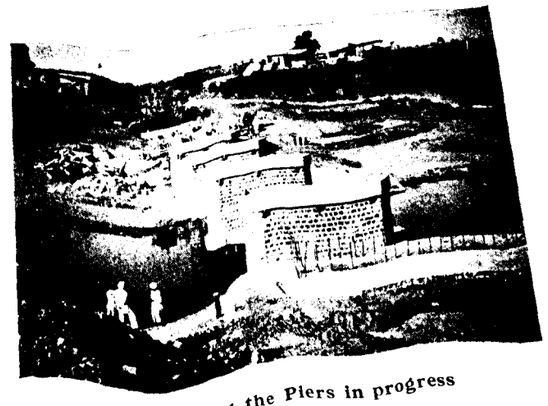
Fig. 5. Details of Kerb



Centering of well showing kerb portion

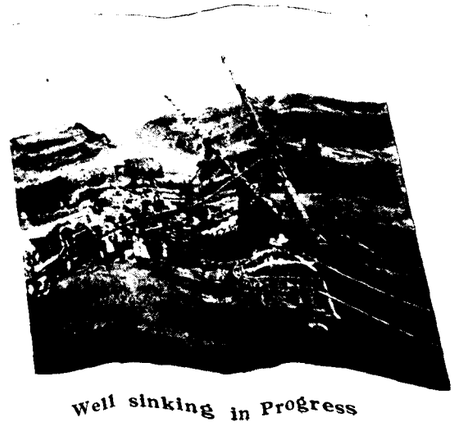


Well sinking in progress



Masonry of the Piers in progress

Well sinking in Progress



Well sinking in Progress

loading them with sand bags on platforms for the calculated weights borne by each.

Wedges were used to bring the Centering to designed levels.

The concrete (1 : 2 : 4 nominal mix) was machine mixed and vibrated by rod vibrator. A 50–50 mixture of Narbada sand of fineness modulus 2.6, containing coarse angular grains and Barna coarse sand was used after laboratory analysis. Graded Coarse hard sand stone aggregate of $\frac{3}{4}$ in. size from a hill 12 miles away was used. The beams were first concreted. On the following day, the surface of the concrete was scraped, neat cement was applied and the slab was laid. Cubes of the concrete were tested for compression.

The main reinforcement of the beams was welded. Welding was economical. Random samples of the welds were tested in laboratory for tension. They gave good results, none of them breaking at welds.

Also by employing welding it was possible to provide sufficient space for the concrete round the reinforcements. It would have been difficult to concrete the deck satisfactorily if reinforcements were to be provided with the necessary overlaps specially when bars were available in lengths of 18 ft only.

One end of the slab was firmly anchored to the pier cap by means of bars and the other end was kept free. The space between the slab and the pier cap for free end was filled with sanded bitumen. Joints between two slabs were filled with pre-moulded bitumen, Fig. 4—page 5.

$1\frac{1}{2}$-inch diameter G. I. Pipes were embedded in the slab, the top being at the top of wearing coat and at 5 ft longitudinally and 5 ft cross-wise, to prevent airlock in the troughs when water just reaches the bottom of the beams.

The wearing coat is 1 : 2 : 4 cement concrete, $3\frac{1}{2}$ in. at centre and $2\frac{1}{2}$ in. at sides. This was laid when all the slabs were completed. Joints in the wearing coat were provided with angle iron and pre-moulded bitumen.

Details of the kerb are shown in Fig. 5 —page 6. Drain holes were kept in the kerb. Standard collapsible iron railings 3 ft high were provided.

Approaches

R.C.C. approach slab, 10 ft long and 12 in. thick, was laid at each end of the bridge.

Approaches to the bridge are taken in a gradient of 1 in 25, with 40 ft length from the bridge at level. The left approach is straight while the right approach is aligned in a horizontal curve with a radius of 800 ft.

Testing the Bridge.

The bridge was tested for Class AA loading (application of static load of 77 tons at the centre of the span and recording deflections) before opening it to traffic. The deflections were well within limits.

Costs

Analysis of the costs of the bridge is given below.

	Rupees to the nearest thousand
Foundations	2,06,000
Piers } Abutments }	42,000
Superstructure	1,52,000
Testing of bridge	5,000
Total Cost	4,05,000

Analysed Costs

		Rs
(a)	Per running ft of bridge	1,462
(b)	Per sq. ft. of carriageway, excluding footpaths	60
(c)	Per sq. 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.	35
(d)	Per cu. ft. of bridge from bottom of foundation to top of roadway.	1/4/-

ROADS IN LEBANON

THE Lebanon, a country of 10,500 square kilometers (4049 sq miles), with a population of a million and a half, is situated on the eastern coast of the Mediterranean on the borders of the Orient and the West, and has absorbed the culture and civilisation of both worlds. Owing to its geographical position and its topography, it can be regarded as an outstanding example of a country where the development and improvement of a road network are vital to its economy.

The coast road, north of Tripoli.

The high mountain ranges, traversed by deep gorges, form a powerful natural barrier between the eastern neighbouring countries, which have relatively flat terrain, and the Mediterranean, where there is only a straight, narrow coastal strip. These tortuous mountains surround one of the few large ports of the Levant-Beyrouth the prosperity of which entirely depends on the size and quality of its land communications. At present Beyrouth is served by roads which have to carry a traffic flow corresponding to the trade and activities of the port, where in 1952 goods unloaded were 1,120,554 tons

Roads for Essential Transport

For goods transport, speedy and economical communications are essential and these can only be ensured by means of roads, since waterways are non-existent and the only railway line over the mountains is narrow gauge (1.05 m. or 3.444 ft) railway which winds with difficulty through excessively steep gradients. Over a distance of 47 km. or 29.187 miles this railway passes from sea level (15 m or 49.2 ft) at Beyrouth, to 1,487 m. or 4877 ft at the summit of Dahrel-Baidar, and descends steeply again to 1,005 m. or 3296 ft in the Bekaa plain. The gradients range from a minimum of 5 per cent to a maximum of 7 per cent and it was found necessary to adopt rack and pinion gear in order that the trains could make the climb. This route serves the sole purpose of helping to promote tourist traffic.

At the end of World War II, a Five Year Plan for major road works was

drawn up: the greater part of this programme has now been completed, but still falls short of present economic requirements and the rise in motorised traffic.

The number of motor vehicles has risen from 14,421 on 1st January, 1951 to 22,933 on 31st October, 1954, an increase of 60 per cent in less than four years. Over the same period, budgetary allocations for road works were as follows:

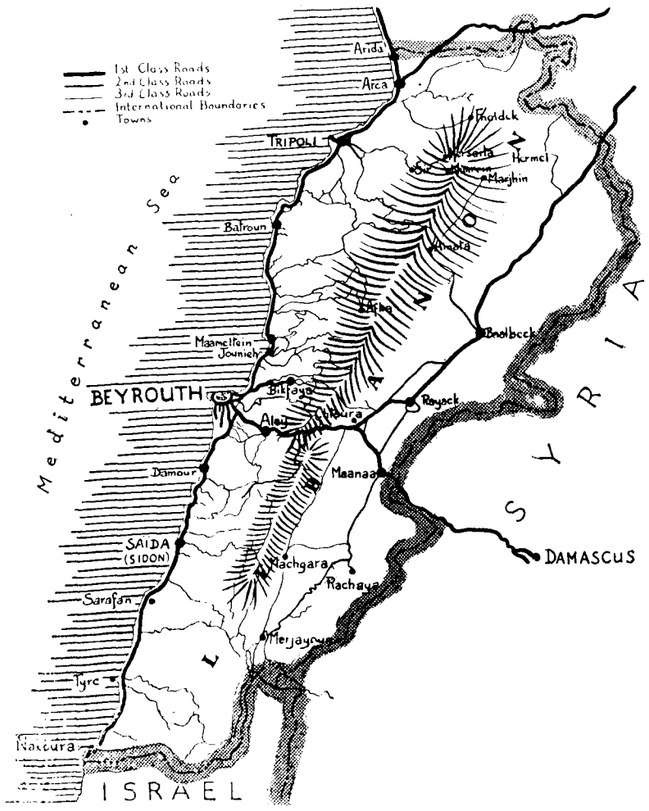
		Rs
1951	LL. 9,000,000	(13330000)
1952	6,166,000	(8931100)
1953	6,440,000	(9331000)
1954	8,640,000	(12663500)

Classification of roads is in two categories: National roads - routes of international importance-and Regional roads.

The total length of National roads is 560 km. or 347.76 miles, made up of the following: Coast road; Beyrouth-Damascus road; Saida-Merjayoud road; Chtaura-Baalbeck road; and Chtaura-Mechgara road.

Regional and Tourist Routes

The Lebanon caters for tourists on a large scale, with its summer and winter sports resorts, and a number of roads have been built for this purpose. Owing to the mountainous character of the country, however, they can only serve a limited area and towns only 6 km. or 3.73 miles apart, as the crow flies, are often linked by roads 40 km. or 24.84 miles in length, as, for example, Reyfoun and Bikfaya.



(*From 'Road International' An International Road Federation Publication.*)

THE ROAD IN THE LANDSCAPE

Road Functions

THE primary purpose of roads and highways is to provide a system of efficient traffic channels. Nevertheless, there are other important functions also to be served by the roads. These various functions need not be incompatible. Indeed, their integration—under good design which takes them all into account—is mutually beneficial. Roads, in harmony with the local features and treated as part of a fine landscape, contribute to the safety and efficiency of motoring, by overcoming boredom and fatigue, which are among the factors leading to negligence and accidents.

Utility and Amenity

The use and beauty of the roads should be inter-related, inseparable functions. Whatever the travellers' reasons for being on the road, he should benefit from its beauty. Roads designed to fulfil the important function of giving pleasure in addition to their other purposes are a logical part of man's effort to control and improve his environment.

General Aims of Treatment

The landscape of the road should be considered as an integral part of the country-side from two points of view—that of the traveller who sees the road in perspective, and the countryside from the road, usually at speed, and that of the observer viewing the road from surrounding land or from the air. There is no real conflict, however, between these apparently opposite viewpoints. The same broad principles meet both requirements, though both should receive consideration in the siting, construction and planting of the roads.

Road Safety

The treatment which makes for road safety through psychological factors also makes the road a less conspicuous feature when seen from a distance. The driver's interest is to be kept alert since monotony and repetition make for drowsiness leading to accidents: and for the distant observer, the road should be seen not as an intrusion cutting the landscape in half but as an interesting line occasionally visible, yet merging, for the most part, easily and naturally into its surroundings. Careful blending of the road to its surroundings makes for less monotony of alignment, and the strong contrasts which can be given by the planting and boundary treatment help to hold the driver's interest and to break the line of the road seen from afar.

Regard for Existing Features

In cases where the siting of a new road disregards existing features and underlying ground form, planting of the road verges in the attempt to conceal the scar often merely has the effect of emphasising the ugly line. The attempt fails for the same reason that unrelated decoration or ornament applied to the surface of any badly designed structure fails in its objective. Superficial adornment masks but does not conceal underlying form: and although plant masses in themselves contribute three-dimensional form, this is insignificant in relation to the land forms over which the road passes, and small compared with the length of its reaches or vistas.

Long straight cuttings or banks should be avoided. Where appropriate, planting should be widely variable so as to form irregular pockets while connecting smoothly and sympathetically. Generous drifts of top soil for the establishment of vegetation should be provided on cuttings and embankments.

Speed and Efficiency

German engineers when making the later autobahn roads found it advisable to avoid "long straights" in order to reduce accidents which had been numerous on the earliar autobahns. Easy horizontal curves, well related to vertical

curves following the indications of the topography, give a better appearance particularly in undulating country such as ours.

"The Fitted Highway"

Extremely high maximum speeds should not become an overriding criterion in the construction. Nor is it desirable that economy of cost should be an overriding factor. Yet, if extremes be avoided, it can be said that economy of construction, safety, good landscape appearance and reasonable speed are by no means incompatible. The "fitted highway" construction takes human factors into account, and being adapted to the configuration of the district through which it passes, follows the indications of the contours closely. The fitted highway, gently winding in response to existing forms, may be slightly longer between two given points than the inflexible autobahn, but the former is less costly both in construction and maintenance than the speedway.

Details of Alignment

The siting of new roads should not affect the economic use of the land more than is absolutely necessary. From an agricultural point of view, roads should preferably be sited on poor land: there may be cases where considerable divergence in order to avoid rich farmland, though making a road longer, would prevent dislocation of agriculture and avoid a considerable amount of compensation. The line of demarcation between different types of land use may often indicate the best position for a road. For example, the line between forest and farmland, or between valley farm and hill pasture, may be pleasingly emphasised by the road. Where a road divides a field or a farm into two parts, some realignment of farm boundaries might be possible by which a farmer or owner could be offered additional land on the same side as the bulk of his land in exchange for an area separated from it by the road. When the general position of a river, stream, or railway indicates the best general line for a road to follow, the different character of the curves, arising, from their different nature and function, provide interesting variation and opportunities for good planting. Near towns, the highway or by-pass may become the line of demarcation between urban development on one hand, and open country or green belt on the other, defining clearly the limits of the town.

Detail Siting

The detail siting of the roads should be planned in relation to existing land forms and other existing features such as trees and hedges, having regard not only to speed of traffic, but also to the structural relationship between the road and its surroundings, without which no road becomes an integral part of the landscape.

Parallelism

A narrow strip of central reservation between two parallel carriageways entails greater relative maintenance cost and is unpleasing visually because it increases the number of parallel lines. Many such lines, running interminably in a wide ribbon of equal width always create an unpleasing landscape feature, the more so in undulating countryside. Mere planting of the central and outer strips does not improve the appearance while the lines remain parallel.

Economy of Separate Alignment

In the case of wide roads, separate alignment of the dual carriageways, with considerable variations of width of the central reservation, permits closer "fitting" of the highway to the contours, besides reducing parallel lines. When the fall of the ground is across the general direction of the road, separate alignment is economical in construction, since the two roads need not be on the same level, and much of the fall can be absorbed in the central green space, to the great advantage of the landscape. Existing trees and hedges which might have to be sacrificed for the sake of parallel alignment can often be saved if the two roads are separated, and the new planting can be more varied and interesting. Headlight glare can thus be avoided or overcome without the rigid ribbon of central planting which disfigures so many of the new roads it is intended to adorn.

Variations in Treatment

Wherever possible, the ground taken in for new roads should be of irregular shape, so that the boundaries are not exactly parallel with the line of the road. An equal width of planting all along the roads is in any case undesirable, variety being of far greater value. Relatively narrow spaces beside the road may be all that is needed in some cases, and could be compensated for by greater width for important planting at another point for the sake of contrast. It is recognised that the requirements of the farms on either side may necessitate parallel boundaries in some cases, but opportunities for breaking the parallel frequently occur nevertheless, and in some cases, irregular shapes taken in to the road verge may contribute to better angles on the adjacent fields, so helping the farm work in those fields. Every such opportunity should be taken.

Contrast between the Close Screen and Open View

Emphasis of the boundary, particularly where it is parallel to the road, should be avoided except, for instance, where the road runs across flat land with a clearly defined rectangular pattern of fields and hedgerows. Continuous lengths of banks, hedges, or the line of cuttings and embankments, where the level of the road differs sharply from the adjoining contours, tend to mark the parallel unduly. Banks and hedges usually interfere with the view of the country from the road, but may serve to screen the road from local inhabitants. Used sparingly for the latter purpose, or where the view from the road is poor and insignificant, they may give interesting variety, contrasting well with more open stretches bounded only by open or sunk fences. In some cases an open view on one side may contrast pleasingly with a close screen on the other, or for short lengths both sides may be screened as a change from open treatment. The same principle of variety applies to hedges centrally placed between dual carriageways.

Cuttings and Embankments

Cuttings and steep embankments which may sometimes be necessary, even in the case of the fitted highway should be so modelled that the junction of the old and new contours on either side do not run parallel to the road. The line should be as little marked as possible, finishing if feasible with a curve rather than an angle. Planting then serves to soften its appearance.

Prevention of Erosion

Cuttings and embankments should be clothed with vegetation if only to prevent erosion, though such planting may also serve to link the road to its surroundings. The growth of plants in such positions depends on the gradient of the slope in relation to the type of rock or soil of which it is composed. A porous or quickly drying material will not support plant life at a very steep angle, whereas a soil retentive of moisture may be able to do so. The objective where possible should be to have a gradient on which top soil can be retained, so that planting can be carried out where necessary.

Retention of Topsoil

Topsoil from the surface to be excavated for new roads, and from all areas where levels are to be altered, should be stripped and kept separate from subsoil, for re-use where required on new levels or for roadside planting.

Public Utility Services

It is undesirable that public utility services, if permitted, be placed so as to interfere with the planting of new roads.

(From the pamphlet "The Landscape Treatment of Roads" issued by the Council for the preservation of Rural England.)

RURAL ROADS IN THE U.S.A.

There are 3,012,520 miles of rural roads in the United States. Sixty per cent of these roads are paved—the rest are dirt.

WELDING WITH SPECIAL REFERENCE TO BRIDGE GIRDERS

by

V. VENKATARAMAYYA

WELDING is a very wide term, as it includes various processes of joining metal parts. The physical and metallurgical reactions that take place during welding are complex but to the engineer, its application and its advantages over other methods are of more absorbing interest. There has been very rapid and phenomenal progress in the field of welding in the last two decades and welding has proved itself a versatile tool both for repairing and fabricating many kinds of components and structures. In this brief talk* I propose to deal only with its application to Railway structures and the rail joints.

On the Railways gas welding, metal arc welding, resistance welding including Flash-butt and Thermit welding are employed, as each of these processes has its special advantages in its particular field. Gas welding is used mostly for repairing and building up of parts including special castings and railway crossings. Metal arc welding is used more extensively for fabricating steel work. All types of structures including bridge girders and railway carriages are fabricated by arc welding. Worn-out railway crossings and switch rails are also built up by arc welding. Steel sheets and plates required for railway carriages are joined together by resistance seam welding. Flash-butt welding and Thermit welding are used mostly for joining the rail ends and thereby producing long continuous rails.

On the Indian Railways metal arc welding was introduced as early as 1936 for strengthening bridge girders. Additional plates were welded to plate girder flanges or rolled steel joists to augment the strength. A number of girders were strengthened in this manner and given longer lease of life. A few plate girder spans were fabricated completely by welding in 1940. Since then a number of plate girders have been fabricated by welding and also in the case of three major bridges, the main members of 150 ft truss spans have been built up by welding, the members being finally connected to the gussets by field riveting. Many rigid frame portal structures including foot overbridges have been built up by welding on the Railways. The entire steel work of about 1200 tons in the roadway and railway floor systems of Ganga Bridge at Mokameh will be fabricated by welding.

The main advantages of welding of structural steel work are the saving in the weight of steel, quicker production and less elaborate equipment. The connections are also neater and there are fewer pockets where rain water could collect and start corrosion. In the case of rigid frames and other indeterminate structures, the monolithic action at the joints and connections is better ensured by welding, since the joints are easily strengthened and made rigid by welding. There is not only no loss of section due to holes as compared to riveting but when the structures are designed as monolithic rigid frames, they require less material and are more economical. Welding yields best returns when the structures are designed as rigid structures and not when it merely replaces riveting as a fastening.

The main drawbacks and difficulties of welded fabrication have been the distortions, stress concentrations, embrittlement of parent material and inspection. These factors are not of much consequence in the case of structures subjected to static loading but they are of utmost importance in the case of structures such as Railway Bridge Girders which are subjected to repeated dynamic loading. The

The talk was given at the Central India Centre of the Institution of Engineers (India).

fatigue strength of a structure is materially affected by the presence of stress concentrations, distortions, embrittlement of parent metal and slight defects in welds such as porosity or slag inclusions. Distortions can be prevented to a large extent by careful procedure and sequence of welding but cannot altogether be avoided. In Germany where welding has practically replaced riveting in the structural fabricating shops, much attention is given to the sequence of welding. In important cases, a small length of prototype structure is built up initially to decide the best sequence of welding for minimum distortion. The order of placing of each small length of weld is noted carefully and the order is changed as required in order to reduce the distortions to the minimum. The order or sequence which was finally found to be the best on the prototype is adopted on the actual structure.

Our experience with the welding of bridge girders has not been entirely satisfactory. In order to save in the extent of welding, stiffeners were fitted on one side of the web of plate girders. It was found that welding or stiffeners on one side caused serious distortion of the web and we are now fitting stiffeners on both sides alternately in the staggered position to reduce the observed distortions. To our knowledge, bridge girders have been fabricated in other countries with stiffeners on one side of the web but our fabricators have not been able to control the distortion. Some of the welded plate girders were also found to have negative camber, due to less attention having been given to the sequence of welding. In some cases X-Ray examination revealed lack of penetration of fillet welds.

With welding it is very important that the minimum size of weld required should be used and excessive welding does not add to the safety. Extra weld only increases the distortions and stress concentrations. It is also essential to ensure that parts being welded are not permanently restrained during welding, to avoid high residual stresses.

Stress concentrations reduce the fatigue strength appreciably. Abrupt change of sections should be avoided, particularly in the case of welded bridge girders which are subjected to fatigue loading. It cannot be over-emphasised that welded design should not be a mere copy of a riveted design. The welded design should ensure that the stress lines flow uniformly without clustering or concentrating at certain points if fatigue fractures are to be avoided.

Inspection of finished welds has been a difficult problem. There is no simple reliable means of testing the welds. Radiographic examination or supersonic examination will show the internal defects but their application requires extensive experience. The interpretation of the radiographs and the question as to what defects as revealed by the radiographs could be permitted has been somewhat baffling. The Inspection Directorate of the Director General of Supply and Disposals have obtained a portable X-Ray equipment for examination of welds and it is operated by the Alipore Test House. In the last few years a number of welds have been X-Rayed and considerable experience has been gained in the interpretation of radiographs.

Radiographic examination will not by itself ensure sound welding throughout the job, since it is not practicable to test all the welds. Only careful planning, adequate training of welders, proper sequence and control of welding positions can produce satisfactory welding. Suitable fixtures and jig work which will enable the welds to be made from a convenient position of the welder will also help in producing good quality work. It is to be hoped that our fabricators with their experience in welding will inspire confidence in welded structures and before long welding will entirely replace riveting in shops.

(With the kind permission of the Institution of Engineers India).

SITE INVESTIGATION

SITE investigation is a necessary preliminary to any engineering project, the object being to obtain information about the nature and properties of the various types of soil in the region likely to be affected by the proposed work. The scale of the investigation obviously depends on the magnitude and importance of the project. While as a general rule it may be said that money expended on site investigation is money well spent, the question of economics must not be overlooked.

In deciding upon the depth to which the investigation should be carried, detailed information from geological survey organizations, which exist in most countries, is very useful. The chief point is to estimate the depth of soil which will be appreciably affected by the applied loads, and this depends upon the extent of the loaded area. According to the concept of the bulb of pressure, at a depth of 1½ times the breadth of the foundation the increase of pressure is approximately one-fifth of the contact pressure of the soil immediately under the base of the structure. For road construction, since the loads are applied on comparatively small areas, it is generally only necessary to go down a few feet below the formation.

For shallow investigations the excavation of test pits is the most satisfactory method; the soil can be examined visually and samples are easily taken for testing. For depths more than a few feet timbering is usually necessary and groundwater may be encountered; hence the use of bore holes becomes more economical. In soft soils the hand-operated post-hole auger can be used for depths up to 20 ft. For greater depths well-boring apparatus is required. Samples of loose material brought up from the bore-holes at various depths are used for identification and classification, and in cohesive soil undisturbed samples are taken by forcing in a thin-walled tube with a detachable cutting edge. The tube with its contents is withdrawn from the hole, the cutting nose and driving cap are replaced by solid caps, and the sample is extruded from the ready for conveyance to the laboratory. When required for testing, the soil sample is extruded from the tube by means of a screw jack, and specimens are cut from it for the various tests required.

For shear strength tests in the unconfined and triaxial compression apparatus smaller sampling tubes, 6 in. long by 1½ in. internal diameter, are used from which the test specimens, 3 in. long, are cut. Even though the walls are made as thin as possible for adequate strength, the volume of soil displaced is quite appreciable. This fact, as well as the friction produced during driving and the subsequent ejection of the sample, means that the soil cannot be entirely undisturbed. By using well-designed sampling tubes with clean and well-greased surfaces and with careful handling the disturbance can be reduced to a minimum, and except for certain types of "sensitive" clay, the normal method of sampling appears to be satisfactory. The provision of undisturbed samples of sandy soil, with little or no cohesion, presents considerable difficulty, but some ingenious devices have been made which extract samples with a minimum of disturbance to the soil structure.

Penetration tests are sometimes used to assess the variation in soil properties with depth. A penetration test does not give a direct measure of soil properties such as shear strength or compressibility, for the penetration resistance is probably a function of both. By correlation with direct tests, however, comparative data can be obtained. An example of a static penetration test is the Dutch deep sounding apparatus. This consists of a cone at the end of a rod which is guided in a steel tube. The tube is

(*Continued on page 22*)

HERE AND THERE

1. FINANCIAL AID FOR ROAD RESEARCH SCHEMES

● WITH a view to promote, guide, and co-ordinate road research in India, the Council of Scientific & Industrial Research have constituted a committee, "Road Research Committee". The functions of the Road Research Committee are:

i) To advise the Council of Scientific & Industrial Research on road research problems.

ii) To initiate and foster road research in India and recommend the financial grants when necessary.

iii) To help co-ordinate road research under various auspices in the country.

iv) To make a survey of the present knowledge on the subject, take stock of the research work done in the country on it and formulate planned programme of research for the advancement of knowledge or the application of such knowledge to problems of national or industrial importance to India.

v) To watch the progress of work of the specific schemes which might be taken directly under the auspices of the Committee. The Council is willing to give financial assistance for various research projects.

Investigators in the engineering departments in the States or the Central Government, engineering colleges, research laboratories are eligible to take advantage of the financial assistance. Applications in prescribed form are to be sent to the Secretary, Road Research Committee, Central Road Research Institute, Okhla, Delhi. The schemes will be considered by the Road Research Committee, who will recommend to the Council of Scientific & Industrial Research for sanction of the grants. Application forms can be obtained from the Secretary, Road Research Committee.

2. MERITS OF PUBLIC WORKS

● IN assessing the merits of a public work or the relative merits of various public works, the basic criterion is the 'usefulness' or 'community value' of each project. The measurement of usefulness is a difficult matter and, unless an adequate investigation of all aspects of the projects is made, a pronouncement on their usefulness is apt to be arbitrary. It is essential that the objective or objectives of the projects also be clearly and concisely defined.

In order to assess the 'desirability' of a project and have a basis for determining its 'community value,' certain fundamental criteria can be applied. Thus to be 'desirable' a project should be technically sound, economically justifiable, and socially desirable and acceptable.

These criteria will enable a general comparison to be made not only between public works of the same kind but also between different kinds of public works, and will provide the basis for determining the desirable priority of projects.

To assess fulfilment of these requirements involves a careful analysis and weighing of the results of all investigations made in relation to the project and its problems.

(*From 'The Surveyor and Municipal and County Engineer,' 11th February, 1956.*)

3. LOSS OF BUSINESS DUE TO ROAD REPAIRS—COURT RULING

● A State highway department, acting through a private contractor, may construct highway and close streets with city's permission. This ruling was given by the Court of Civil Appeals of Texas in the U.S.A. Any inconvenience or damage that adjoining or abutting property owners may suffer from these temporary obstructions must be endured without legal relief, unless lacking authority the contractor interferes with highway, or he prolongs the work unduly.

A merchant sued contractor and city for damages occasioned by loss of business stemming from unreasonable delay in completing a street-paving job in front of his store. The roadbuilding firm was constructing a two-mile section when a nearby river rose to record-breaking heights. Under the circumstances, testified the State Highway Department, there was no unreasonable delay in the contractor's work. Higher tribunal, concurring in this view, reversed District Court's decision against the contractor.

(*From "Roads and Streets," January, 1956*).

4. 3750-MILE HIGHWAY IN SOUTH EASTERN EUROPE

● AN ambitious plan to complete a 3,750 mile highway to encircle southern Europe was recently discussed by representatives of the four countries to participate - Greece, Italy, Turkey and Yugoslavia.

The discussions were held under auspices of the United Naations Economic Commission for Europe at Geneva. The completed highway would greatly enhance the tourist potential of the region, which is rich in historic and cultural interest, while contributing to the development of international trade.

Three major gaps in the highway circle are at the Greek-Turkish frontier; between Belgrade and the Greek border, and between Patras and Brindisi.

(*From "World Construction," April, 1956*).

5. CURING OF CONCRETE BY ELECTRICITY

● ELECTRO-CURING of concrete will reduce appreciably dislocation of traffic while concreting of roads is in progress, according to the Indian Institute of Science, Bangalore.

Instead of roads being blocked for weeks together it would be sufficient to hold up the traffic only for 24 hours if this method was adopted. The process will not be very costly.

Experiments conducted at the Institute have revealed that passing alternate current for 24 hours through freshly placed concrete gives it as much strength as is normally obtained by curing concrete under water for seven days. Concrete after electro-curing can be further cured under water or by mere exposure to air.

(*From 'Hindustan Times,' New Delhi, 12—3—1956*).

6. NEW KIND OF BRICK

Indian Engineers' Approval

● AN engineer in the University of Louisiana has found a way of making a new kind of brick—with a mixture of dirt, asphalt and rice hulls. He said farmers in rice-growing areas that have the raw material at hand could make their own bricks easily and build their own homes.

His formula: Mix the ashes of burned rice hulls, emulsified with asphalt and plain dirt, add water, stir, and pour into forms. When the material is dried, the best bricks are to hand.

The Louisiana Civil Defence Director, who tested the bricks during atomic fall-out experiments said that the bricks held up very well.

(*From "The Statesman," dated April 23, 1956.*)

7. ROTARIES

● IF ROTARIES are small, they cause a build-up of traffic and breed as much impotence as do traffic light signals; in addition they create the unfortunate situation that vehicles meet one another almost at right angles on the rotary. The essence of a good rotary is easy weaving. Generally speaking, a large rotary is preferable to a traffic light control on the open road, even if the distance traversed is increased, as it enables traffic to keep moving.

The Specifications and Standards Committee of the Indian Roads Congress have laid down desirable standards for rotaries under Indian conditions. These have been published as Paper No. 178 in the Journal of the Indian Roads Congress, Volume XIX-Part 3, June, 1955.

8. CARPETS WITH AGGREGATE OF $\frac{3}{8}$-IN. MAXIMUM SIZE

● THE most popular type of bitumen-macadam or tarmacadam carpet has aggregate of $\frac{3}{4}$-in. size. In the experiment with granite carpets in Aylestone Road, Leicester the carpets containing $\frac{3}{8}$-in. aggregate are now, after four years, in a good condition over as wide a range of compositions and are marked by a pleasing and uniform surface texture.

In the experimental gravel-tar carpets laid in 1952, the carpets made with $\frac{3}{8}$-in. gravel are in better condition and are considerably more uniform in surface texture than those with $\frac{3}{4}$-in. gravel.

The use of a smaller aggregate should frequently lead to a saving of material; it may be laid more thinly, and a more uniform surface is usually obtained which might be expected to give a greater durability. The finer texture given by the smaller aggregate is particularly attractive for use on roads in residential areas.

(*From 'Road Research Report, 1953,' Road Research Laboratory, England*).

9. RUBBER LEVEL CROSSING

● AKRON, Ohio, the rubber centre of the world, now has the first rubber railroad crossing in the world.

Engineers predict that the rubber installation will eliminate one of the major irritations of motorists and will prove a boon to railroads through greatly reduced maintenance expense.

(*The Highway Magazine, Highway Research Abstracts, April, 1955*).

10. PLASTIC OVERCOATS FOR TRAFFIC SIGNS

● A new technique of covering the posts of traffic signs with a protective plastic sleeving, which, it is stated, is unaffected by weather and any oil, acid, or alkali splashed on by passing vehicles, has been developed. Excluding air and water from the post down to below ground level, where corrosion is most likely, says the report, tests have shown that the sleeving—which can be fitted to installed traffic signs—will keep the posts new in condition and appearance without attention for an almost indefinite period. The risk of colour change or hair-cracking has been obviated, it is added.

(*From 'The Surveyor and Municipal and County Engineer,' 5th May, 1956.*)

CURRENT LITERATURE

ABSTRACTS

FACTORS INFLUENCING TRAVEL PATTERNS. BULLETIN 119 OF THE HIGHWAY RESEARCH BOARD WASHINGTON, D. C.

THIS bulletin contains five papers presented at the Thirty-Fourth Annual Meeting of the Highway Research Board, held in Washington, D. C. in January 1955.

The Paper, "Trends in Traffic Diversion on Edens Expressway", by W. J. Mortimer, is based on data collected in a road interview survey made in 1950, before the Edens Expressway had been opened to traffic, and a similar follow up survey made in 1954.

The Paper, "Objective and Subjective Correlates of Expressway Use", by E. W. Campbell and R. S. McCargar, discusses a method for assigning traffic to a proposed expressway network in the Detroit Metropolitan Area.

The Paper, "Induced Traffic on Chesapeake Bay Bridge", by E. W. Bunting, analyses, the origin and destination data collected annually at both the bridge and the ferry, which it replaced.

The Paper, "Intra-city Traffic Movements", by F. H. Wynn, presents an analysis of data from 20 post-war origin and destination surveys, sponsored to discover the characteristics of urban travel that are common to all communities.

The Paper, "Evaluation of Intercity-Travel Desire", by Willa Mylroie, discusses the development, use, and limitations of a mathematical formula for measuring the relative desire and travel between cities in the State of Washington.

STATISTICAL ANALYSIS OF HIGHWAY ACCIDENTS. BULLETIN 117 OF THE HIGHWAY RESEARCH BOARD WASHINGTON, D. C.

THIS bulletin contains two papers. The first, "Accidents Versus Width of Paved Shoulders on California Two-Lane Tangents-1951 and 1952", by D. M. Belmont, is based on the statistical analysis of 771 injury accidents which occurred in 1,122 road sections each 1 mile in length. The roads were in rural areas, with 55 m.p.h. nominal speed limits, and with no substantial roadside development. The roads had paved or treated shoulders, bordered with not more than one foot of untreated or soft shoulders, as an average for the section. It was found that the accident rate tended to increase with shoulder width, except at traffic volumes below about 2,000 vehicles per day when the trend may be reversed.

The second paper, "Application of Statistical Quality Control Techniques to the Analysis of Highway-Accident Data", is by M. Norden, Orlansky, and H. Jacobs. This Paper reviews current techniques for the study of accidents and points out their advantages and disadvantages. The Authors then present the development of statistical control techniques, together with the results of a pilot application of these techniques to an actual highway situation.

DRIVER BEHAVIOUR AS AFFECTED BY OBJECTS ON HIGHWAY SHOULDERS, Public Roads, June, 1955.

SHOULDERS along a highway are needed for several reasons. They add to the comfort of the drivers and in crease safety. Wide shoulders provide a storage space outside the traffic lanes for disabled vehicles and for short-time parking of vehicles as may be desired by

drivers. They also serve as a space to avoid an accident in case of emergency.

It is generally believed that vehicles standing along the travelled way of a highway either by choice of the drivers or due to mechanical failure influence the behaviour of vehicles on the highway.

In this study vehicle speeds and placements were recorded on two-lane highways carrying light to moderate traffic and a four-lane divided highway carrying volumes as high as 3,400 vehicles per hour in one direction.

The study of four-lane operations was conducted on the section of a road which had two 12-foot lanes in each direction of portland cement concrete with shoulders 10 feet wide. A 30-foot grass median separates the vehicles travelling in the opposing directions. The posted speed limit at this location is 50 miles per hour for passenger cars and 45 miles per hour for trucks.

The speeds and transverse positions of vehicles were first recorded at all locations under normal conditions, that is, with the shoulders clear of any object. Similar data were then recorded with the objects placed on the shoulder at various distances from the pavement edge. The objects placed on the shoulder included a passenger car, a highway maintenance truck, and a barricade. Studies were conducted with each of these objects placed at the pavement edge, 3 feet from the edge, and 6 feet from the edge. Data were recorded during a period of 3 hours for each condition at each location. Driver behaviour data were thus obtained for nine different conditions in addition to the normal condition at each study location. The data for normal conditions were used as a base to determine the effect on driver behaviour of each of the several objects placed on the shoulder. These data cannot be used, however, to compare driver behaviour on various surface widths, because design elements and traffic conditions were not the same at the different locations included in this study.

From this study it may be concluded that:

1. Vehicle speeds were not affected significantly by objects on the shoulder during light to moderate traffic volumes.

2. Objects parked on one shoulder affected the lateral position of only those vehicles travelling in the lane adjacent to the occupied shoulder. The effect was greatest when the object on the shoulder was at the pavement edge, and diminished rapidly with an increase in the distance of the object from the edge of the pavement.

3. The narrower the pavement, the greater was the shift of traffic away from the object on the shoulder. On a two-lane highway with a 16-foot surface, the shift was 3.3 feet, and on one with a 24-foot surface the shift was 1.8 feet.

4. A car, truck, or barricade on the shoulder had about the same effect on the lateral positions of vehicles on two-lane highways. On the four-lane highway a truck had about the same effect as a car, but a barricade caused a lateral movement about one-half as great as that caused by a car or truck.

EFFECTS OF CHLORINATION AND MICRO-ORGANISMS AND CONSTITUENTS OF ASPHALTS--BULLETIN 118, HIGHWAY RESEARCH BOARD, WASHINGTON, D. C.

THIS bulletin contains three Papers presented at the Thirty-Fourth Annual Meeting of the Highway Research Board in January, 1956.

1. "Effect of Chlorination on Oxidizability of Road Asphalts", describes some of the physical and chemical effects of direct chlorination on road building asphalts. Laboratory experiments indicate that the oxidizability of the asphalt may be materially reduced by treatment with chlorine.

2. "Constitution and Characteristics of Paving Asphalts", contains results of analysis with asphalts of various composition and derivation, and defines and correlates the constitution and fundamental character of asphalts in a manner significant to their use in highway pavements.

3. "Action of Micro organisms on Petroleum-Asphalt Fractions", discusses a new conception of asphalt oxidation in old bituminous surfaces. Tables are included for petroleum engineers interested in the analysis of asphalts.

THE STRAIN GAUGE PRIMER by C. C. Perry and H. R. Lissner, McGraw-Hill Book Company, New York, 1955.

STRAIN is a fundamental engineering phenomenon. This book deals with the measurement of this fundamental engineering phenomenon by the use of strain gauges. Chapter I gives history of the growth and development of the strain measurement. Chapter II deals with the bonded wire resistance strain gauge, its manufacture, and operating characteristics. Chapter III gives detailed instructions for the proper bonding of strain gauges under conditions which are generally met with. Also, the use of strain gauges for measuring loads, forces, pressures, etc., is dealt with in detail.

(*Continued from page 16*)

forced into the soil by means of a jack, carrying with it the cone; then the cone is pushed down ahead of the tube. The resistance of the soil to penetrate by the cone alone and that of the tube and cone together are measured, and thus the point bearing resistance and the frictional resistance can be separated. In this way the bearing capacity of piles driven to various depths can be estimated. This method is used extensively in Holland and Belgium, where conditions are particularly suitable. In other forms of penetration test the dynamic resistance is measured, for example, the number of blows of a specified magnitude required to cause a certain penetration. The results of such penetration tests must obviously be applied empirically.

(*From an article "An Elementary Introduction to Soil Mechanics" by P.L. Capper. Engineering, September 9, 1955*).

WHAT IS IT THAT GOES TO CREATE A WORK OF ART?

Our unconscious being is that within us which is most fixed and most permanent; in everything emanating from it there is something constant invariable that is found in all that comes from the same creator. This it is that constitutes his style, the expression of his responsibility. Style and the power to move the minds of others are the reflections of the creative emotion, in whatever way it expresses itself. Whatever be the inherent value and the particular nature of the ideal pursued, whether the result be a work of art will depend only on the human and moral factors placed at the service of this ideal.

FREYSSINET

SELECTED RECENT LITERATURE IN ENGINEERING JOURNALS

1. GENERAL

1. **Photogrammetric Surveying;** *Indian Builder, Vol. 3, No. 2,* February 1955, pp. 3-7 & 35.

2. **Studies in Engineering Hydrology (Symposium);** *The Journal of the Institution of Engineers, Australia, Vol. 26, No. 1071,* October-November 1954, pp. 217-260.

   (a) **The Estimation of Maximum Possible Precipitation;** N. B. LOVETT, p. 217.

   (b) **The Derivation of Infiltration Indices under Australian Conditions;** E. M. LAURENSON, p 225.

   (c) **An Automatic Integrator for the Calculation of Excess Rainfall;** J. R. LEARNMONTH, p. 230.

   (d) **Development of Unit Hydrographs under Australian Conditions;** P.H. FEKETE, p. 234.

   (e) **The Derivation and Synthesis of the Unit Hydrograph When Rainfall Records are Inadequate;** T. D. EALIN, p. 239.

   (f) **Some Recent Advances in Hydrologic Physics;** J. R. PHILIP, p. 255.

   (g) **Discussion and Communications;** L. B. LOVETT, p. 260.

3. **The Modern Road in the Landscape;** H. B. BAKKER, *Wegen, Vol. 29, No. 1,* January 1955, pp. 15-17 (in Dutch).

4. **The Functions and Place of a Materials Engineer in Highway Engineering;** E. W. W. RICHARDS and F. N. SPARKES, *The Journal of the Institution of Highway Engineers, Vol. III, No. 5,* January 1955, pp. 9-30.

5. **The Brussel-Ostend Autobahn;** HANS SCHAR, *Strasse und Verker, Vol. 41, No. 1,* January 1955, pp. 11-12 (in German).

6. **The Belgium Road Pavements;** E. BRUTTIN, *Strasse und Verkehr, Vol. 41, No.1,* January 1955, pp. 13-14 (in German).

7. **On the Equipment and Location of American Through Roads;** Part II, Dr. WEHNER, *Strasse und Autobahn, Vol. 5, No. 12,* December 1954, pp. 408-411 (in German).

8. **The Construction of the North Road in Flensburg District (Germany);** ERICH KLOSS, *Strasse und Autobahn, Vol. 5, No. 12,* December 54, pp. 393-399 (in German).

9. **The Lateral Stability of Shingle Beaches;** J. W. HOYLE and G. T. KING, *The Journal of the Institution of Municipal Engineers, Vol. 81, No. 8,* February 1955, pp. 357-368.

10. **Recent Developments in Main Drainage;** JOHN T. CALVERT, *The Journal of the Institution of Municipal Engineers, Vol. 81, No. 8,* February 1955, pp. 369-375.

11. **How to use Calcium Chloride for ice Control on Highways;** *Roads and Engineering Construction,* January 1955, pp. 87, 88, 90, 92 & 96.

12. **Contribution on the Defence of Coasts, General Problems;** DREYFOUS-DACAS, *Annales des Ponts et Chausses, Vol. 125, No. 1,* January-February 1955, pp. 17-45 (in French).

13. **The Storm Water Drainage Channel of the "LeCady" Torrent at Vernot-Les-Bains**; JACQUES ROUX, *Annales des Ponts et Chausses, Vol. 125, No. 1,* January-February 1955, pp. 47-66 (in French).

14. **The Casablanca-Rabat Highway**; P. MATHIS, *Travaux, Vol. 39, No. 238,* February 1955, pp. 53-64 (in French).

15. **A Survey of Road Development in Recent Years**; DOUGLAS M. CLARKE, *Transport and Communications Review, United Nations, Vol. VII, No. 4,* October-December 1954, pp. 21-31.

16. **Organising Research for the Small Firm, Using Technical College Facilities**; *Engineering, Vol. 179, 4645,* February 4, 1955, p. 132.

17. **Problems of Maintenance of Port Structures**; D. BARTINGS, *New Zealand Engineering, Vol. 10, No. 1,* January 1955, pp. 22-25.

18. **Organization for Metropolitan Traffic and Transportation Planning**; CHARLES A. BLESSING, *Proceedings American Society of Civil Engineers, Vol. 81, Separate 602,* January 1955.

19. **The Planning and Installation of a Laboratory, Providing a Wide Range of Engineering Services**; *Engineering, Vol. 179, No. 4646,* February 11, 1955, pp. 173-174.

20. **Growth Retarders for Roadside Verges — The Use of Maleic Hydrazide**; *Roads and Road Construction, Vol. 33, No. 386,* February 1955, pp. 34-37.

21. **Salt Treatment of Snow-Covered Roads**; THOMAS VICKERS, *The Surveyor, Vol. CXIV, No. 3286,* February 26, 1955, pp. 189-190.

22. **15 Years Rural Freeway Construction**; WALTER HODEL, *Traffic Engineering, Vol. 25, No. 4,* January 1955, pp. 143-149.

23. **Chemicals for Ice and Snow Removal**; *Better Roads, Vol. 24, No. 12,* December 1954, p. 34.

24. **Economic Considerations Relating to Priority of Public Works**; W. D. CHAPMAN, *The Journal of the Institution of Engineers, Australia, Vol. 26, No. 12,* December 1954, pp. 293-296.

25. **Providing Transport in Underdeveloped Regions—Relation of Demands to Resources**; E. R. HONDELINK, *Modern Transport, Vol. LXXIII, No. 1876,* March 12, 1955, pp. 3 & 30.

26. **Some Considerations of Airfield Pavement Design**; GAMES ASTON SKINNER and FREDERICK ROYAL MARTIN, *Proceedings of the Institution of Civil Engineers, Airport Paper 26, Part II, Vol. 41,* February 1955, No. 1, pp. 55-118.

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28. **Camber in Bridge Stringers Due to Vertical Curve**; HAROLD KINBALL, *Civil Engineering.*

29. **German Standard—Painting of Steelwork—Standard—Draft—DIN 55928**; *Der Bauingenieur, Vol. 30, No. 12,* December 1955, pp. 449-451 (in German).

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14. **The Meeting Beams of Headlights, Effects of Deterioration & Misaim, Reprinted from Trans. Illum. Eng, Soc. London, Vol. XVIII, No. 8. 1953, pp. 207-220,** A. J. Hariss, Road Research Laboratory, Harmondsworth, Middlesex, U. K.

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17. **The Technique of Surface-Dressing with Tar,** A. R. Lee & G. H. Fuidge, British Road Tar Association, 9 Harby St., London, W. 1.

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35. **Appraisal of Several Methods of Testing Asphaltic Concrete, Bulletin No. 126, June 1952,** Fred J. Benson, Texas Engineering Experiment Station, College Station, Texas (U. S. A.)

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BUDGETS AND ADMINISTRATION REPORTS

GOVERNMENT OF BOMBAY BUDGET FOR 1956–57

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

Revenue (Civil Works)

Heads	(In lakhs of rupees)		
	Accounts 1954–55	Revised Estimate 1955–56	Budget Estimate 1956–57
Rents	12.61	13.50	13.00
Ferry receipts	1.27	1.09	1.25
Tools on roads	0.02	—	—
Receipts from self supporting workshop	1.00	0.64	0.70
Recoveries of expenditure	1.21	0.79	1.14
Miscellaneous	35.75	30.00	30.00
Transfer from Central Road Fund	174.06	159.98	—
Deduct-refunds	–0.22	–0.27	–0.15
Development schemes			
i. Rents from properties	26.93	25.36	26.56
ii. Sale of Electricity	1.04	0.88	1.00
iii. Miscellaneous receipts	0.85	0.70	0.73
iv. Deduct—refunds	–0.01	–0.01	–0.02
Total	254.51	232.66	74.21

Expenditure (Civil Works)

Buildings			
Original Works	70.84	100.99	35.78
Repairs	45.50	48.06	53.73
Communications			
Original Works	337.58	414.72	476.51
Repairs	40.86	44.10	102.49
National Highways-Repairs Miscellaneous	39.17	40.00	45.00
Original Works	1.23	4.56	—
Repairs-Miscellaneous	0.41	—	—
Establishment	149.01	163.73	165.00
Tools and plant	25.78	33.94	34.79
Grants-in-aid	24.61	20.61	2.11
Suspense	13.96	22.09	341.94
Charges in England	—	—	0.07
Deduct-Recoveries adjusted in the accounts in reduction of Expenditure	–366.46	–421.81	–1019.51
Development Schemes			
Original Works	4.51	4.79	0.22
Repairs	10.75	10.94	12.07
Establishment-Ordinary	2.34	1.96	1.54
Special	3.45	3.73	3.71
Tools and plant	0.29	0.31	0.24
Grant-in-aid	0.25	0.25	0.25
Second Five-Year Plan (Buildings).	—	—	0.20
Total	404.08	492.97	256.14

Heads	(In lakhs of Rupees) Accounts 1954–55	Revised estimate 1955–56	Budget estimate 1956–57
Capital account of Civil Works outside the Revenue Account			
Original Works			
Buildings	130.16	134.05	348.04
Communications	32.00	91.59	72.81
Establishment charges	26.02	28.18	52.57
Tools and plant charges	3.25	4.51	8.42
Charges in England (Establishment)	0.02	0.02	0.04
Recoveries adjusted in the accounts—reduction of expenditure	–0.65	–41.41	–104.28
Development Schemes			
Works	0.35	4.34	7.45
Establishment-Ordinary	0.06	0.54	0.93
Special	0.06	0.05	0.06
Tools and plant	0.01	0.09	0.15
Deduct-Receipts of a Capital Nature	–2.91	–1.72	–2.00
Second Five-Year Plan Schemes			
Buildings	—	—	154.20
Establishment charges	—	—	19.26
Tools and Plant charges	—	—	3.08
Charges in England	—	—	0.01
Deduct-Expenditure met from grant from Government of India	—	—	–19.89
Total	188.37	220.24	540.85
Receipts from Roads			
Receipts under the Indian Motor Vehicles Act	25.03	15.31	15.77
Receipt under the State Motor Vehicles Taxation Act	247.40	270.00	260.00
Fees and other receipts (Indian Motor Vehicles Act)	1.27	0.80	0.34
Receipts from Motor Spirit sales tax	175.97	176.00	175.00
Deduct-Refunds	–13.35	–17.92	–11.20
Total	436.32	444.19	439.91

GOVERNMENT OF BOMBAY BUDGET FOR 1956–57

(A brief review with reference to Civil Works)

TOTAL revenue receipts of the Government of Bombay for the year 1956–57 are estimated at Rs 7810.08 lakhs and revenue expenditure at Rs 7786.65 lakhs bearing a surplus of Rs 23.43 lakhs. Revised estimate for 1955–56 and actuals for 1954–55 show surpluses of Rs 82.96 lakhs and Rs 793.40 lakhs respectively.

Revenue expenditure on Civil Works is estimated at Rs 256.14 lakhs as against Rs 492.97 lakhs in 1955–56 (Revised estimate) and Rs 404.08 lakhs in 1954–55 (Account). This works out to about 3.8 per cent of the state revenue for 1956–57; 6.2 per cent for 1955–56 (Revised estimate) and 5.1 per cent for 1954–55 (Accounts).

Expenditure on communications alone (Original works and repairs only) is estimated at Rs 579.00 lakhs for 1956–57 which forms 7.4 per cent of the estimated total revenue while the corresponding percentages for 1955–56 and 1954–55 come to 5.8 per cent and 4.8 per cent respectively.

Expenditure on Civil Works outside the revenue account is estimated at Rs 540.85 lakhs for 1956–57 as against 220.24 lakhs for 1955–56 and Rs 188.37 lakhs for 1954–55. The increase in expenditure under this head in the current season is due to increase in expenditure on Buildings (Original works) and Schemes under Second Five-Year Plan.

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36. **Retention of Cover Stone by Asphalt Surface Treatments, Bulletin No. 133, Sept. 1953,** Fred J. Benson & Bob M. Gallaway, Texas Engineering Experiment College Station, Texas (U. S. A.)

37. **Space Frames and Curved Girders, Engineering. Report No. 18, 1953-54.** James Michals, The Iowa State College, Ames, Iowa.

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40. **Experimental Investigation of Stresses in Gusset Plates, Bulletin No. 16, May 1952,** Engineering Experiment Station, The University of Tennessee, Knoxville, U. S. A.

DEFINITIONS OF HIGHWAY ENGINEERING TERMS

CONTROLLED ACCESS: An approach from a highway to abutting property, the siting of which is subject to certain restrictions.

LIST OF APPROVED WORKS ON NATIONAL HIGHWAYS

S. No.	Job No.	Name of work	Amount (Rs in lakhs)
		ANDHRA	
1.	1604 AH 7	Constructing a bridge across K. C. Canal on the diversion of N. H. 7 at Kurnool.	2.38
2.		Two works each costing less than 2 lakhs.	2.17
		BIHAR	
3.		Three works each costing less than 2 lakhs.	2.66
		BOMBAY	
4.	1609 BM 6	Survey of a high level bridge across Girna River in mile No. 189/1 on the Surat—Edlabad — Nagpur Road, N. H. No. 6 (Replacement of a causeway in mile No. 190).	0.06
		DELHI	
5.	1603 DLH 2	Construction of culverts on the portion of byepass connecting N. H. No. 1 with N. H. No. 2 in Delhi State from Railway siding to Delhi Mathura Road.	1.49
		HIMACHAL PRADESH	
6.	1607 HP 22	Widening 6 ft track to 24 ft wide motorable road from Gaura towards Wangtoo part of H. T. Road, N. H. No. 22, miles 109/0 to 111/0.	5.11
		PUNJAB	
7.	1613 PB 1A	Widening N. H. No. 1A Section Malikpur to junction with Amritsar-Pathankot Road, Mile 70/2—70/7.	0.18
		TRAVANCORE-COCHIN	
8.	1605 TC 47	Improving miles 31/0 to 34/0 of Quilon-Alleppey Section of N. H. No. 47.	4.06
		UTTAR PRADESH	
9.	1601 UP 24	Construction of a bridge over the Ganga river at Garhmukteshwar on N.H. No. 24.	77.97
10.	1602 UP 28	Construction of river training works for the proposed bridge over the Sarju (The Ghogra) at Ayodhya on N. H. No. 28.	54.13
11.	1611 UP 2	Extension of Waterway to the Karmanasha bridge in mile 394 of G. T. Road N. H. No. 2	0.66