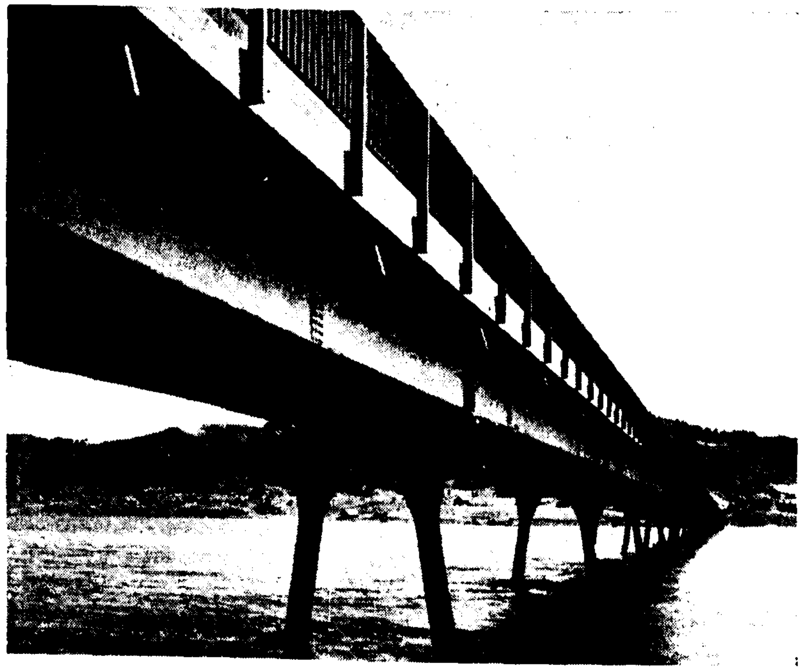
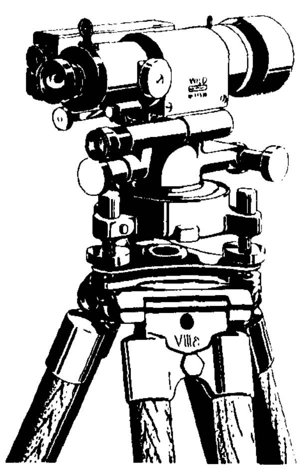
TRANSPORT-COMMUNICATIONS

MONTHLY REVIEW

SEPTEMBER 1958—No. 137

INDIAN ROADS CONGRESS, NEW DELHI.





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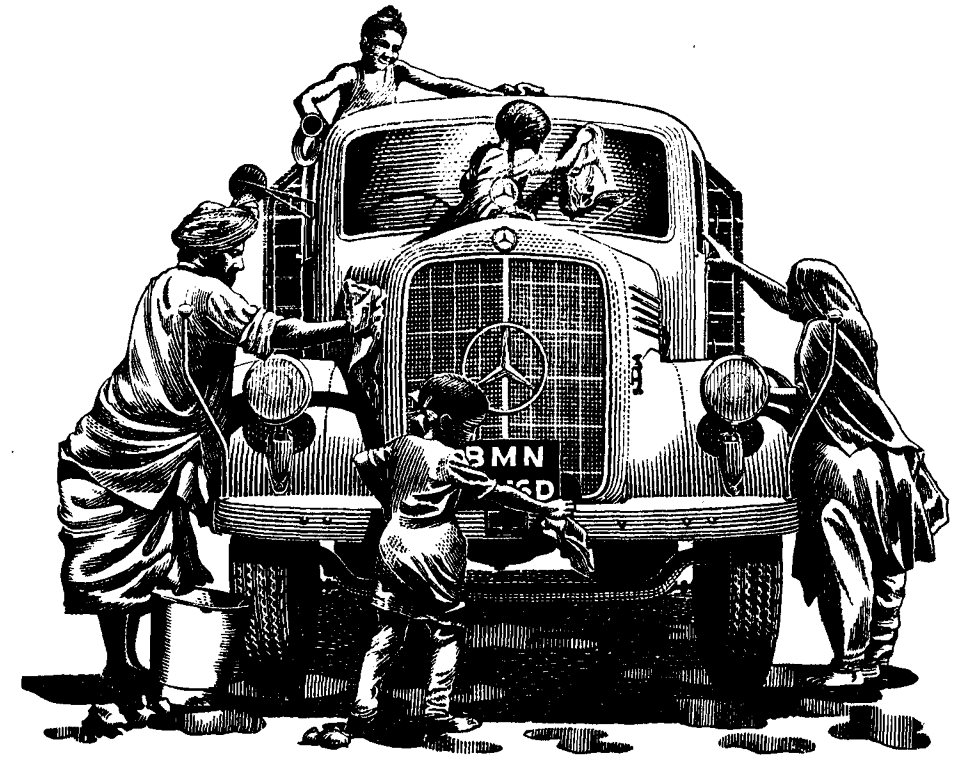

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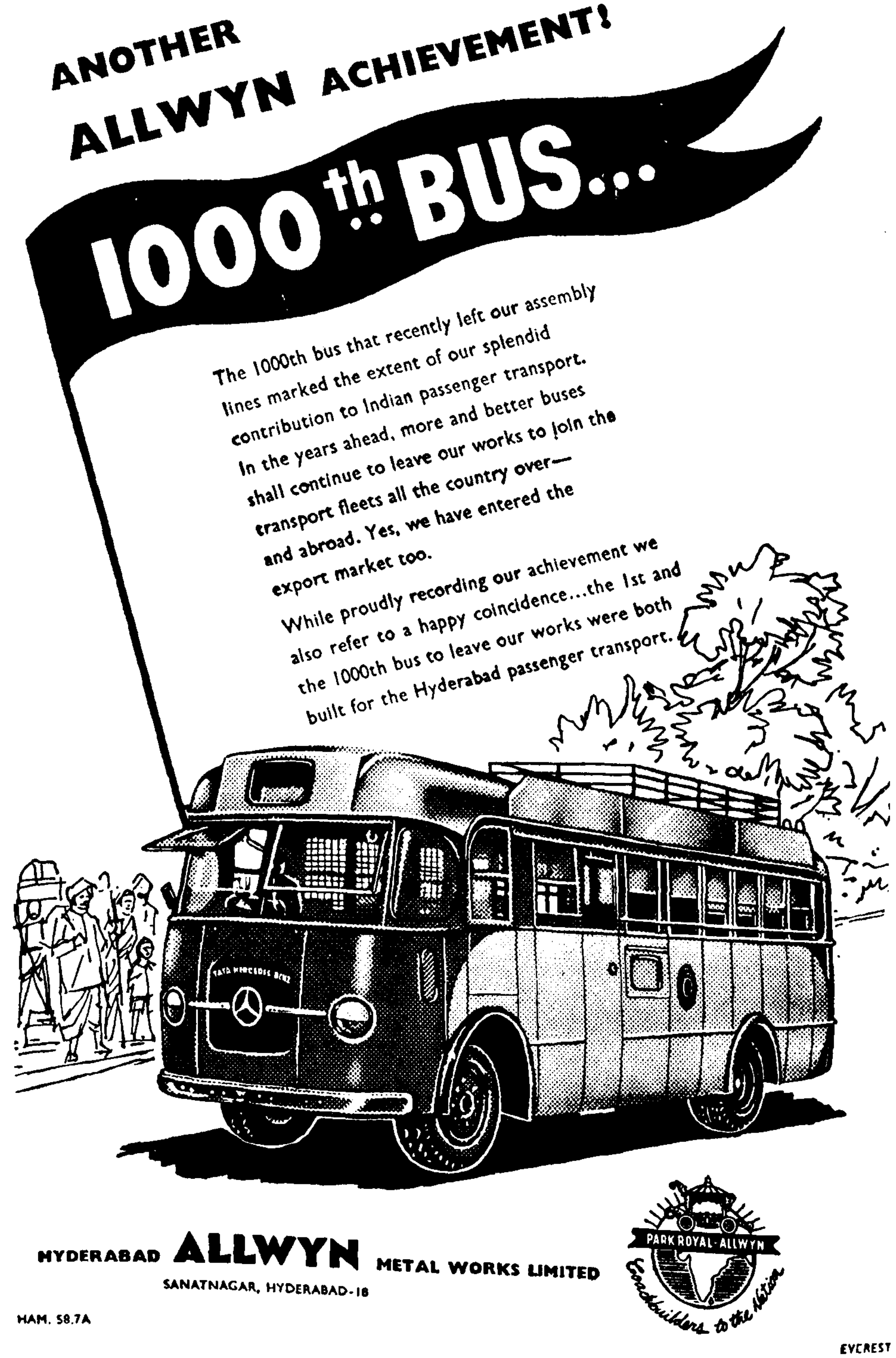
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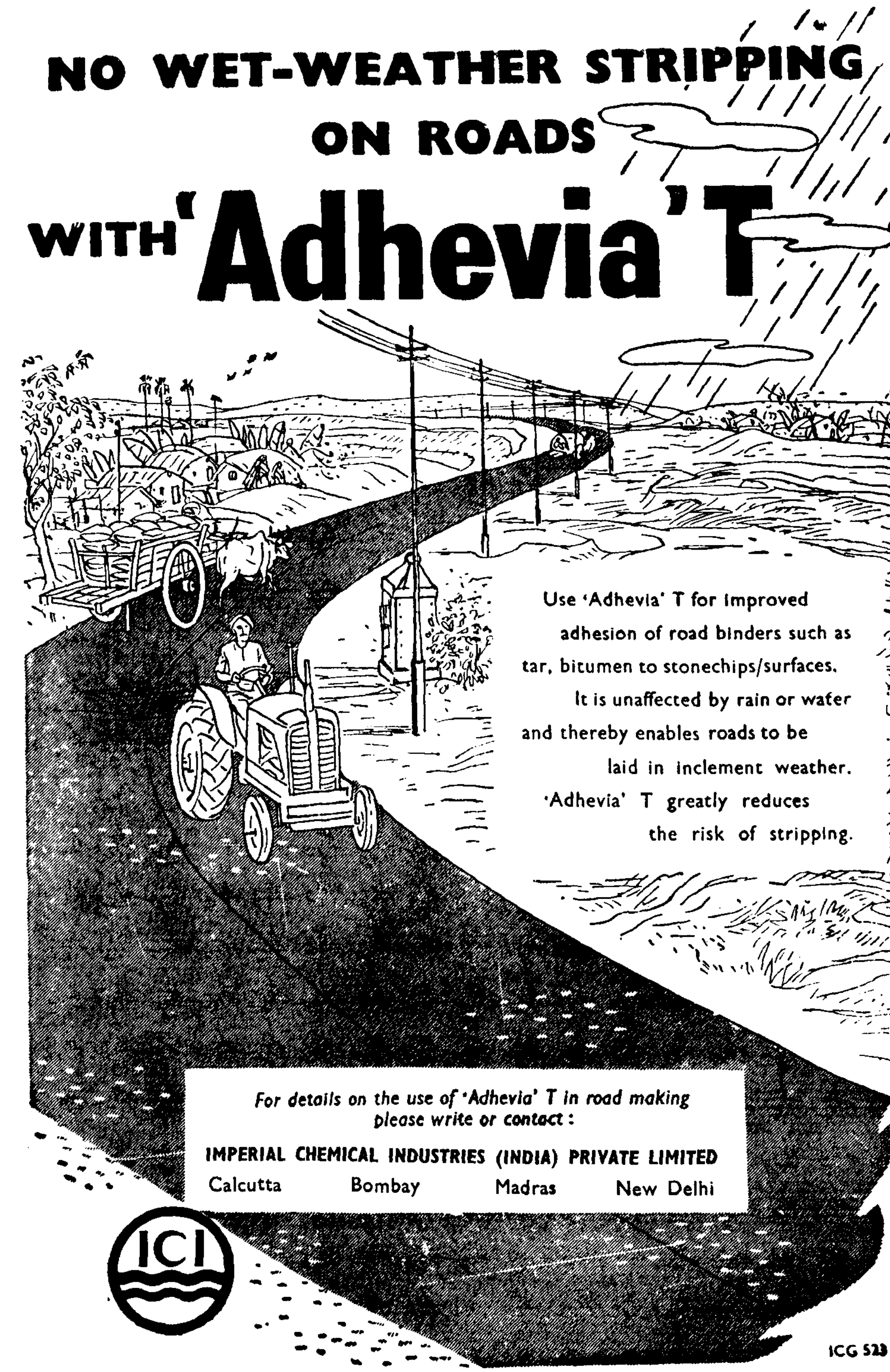
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TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

SEPTEMBER 1958—No. 137

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VIADUCT AT THE BORDER OF RHINE AT UNKELSTEIN, NEAR REMAGEN.

TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

A REVIEW OF
ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

SEPTEMBER 1958

UNSPECTACULAR JOB

ROADS are generally viewed with indifference in our country. If they are in good condition, we go ungrudgingly over them; if they are in bad condition, we still go joggingly along, perhaps only cursing the P.W.D. a little but forgetting all about it at the end of the journey. Roads are nobody's direct concern, yet the concern of the entire nation in them is evident from the fact that the cost of transport and thereby the economy of the country is influenced by the condition of roads. Road Maintenance, though a very unspectacular part of an engineer's job, is therefore a matter of vital importance to the country.

It has been roughly estimated that the loss to motor transport on account of bad roads is of the order of Rs 38 crores per year. The Road Operation Cost Committee of the Indian Roads Congress is seized with this problem. The tentative conclusions arrived at by this Committee after actual observations in different parts of the country go to show how the condition of roads influences the transport costs. For example, it is seen that improvement in the surface of bad roads reduces the fuel cost per mile from 22.6 pies to 16.7 pies, which means a saving to the extent of 26 per cent. As regards saving in the wear and tear of vehicles, the average life of tyres on a good road is about 50,000 miles, while on other roads it may be less than 24,000 miles. Experiments also show that there is sufficient reduction in the cost per vehicle mile in respect of spare parts due to the type and condition of road. From a bad to a good road, reduction is from 5.32 to 1.89 pies per vehicle mile.

Road maintenance sounds a tame affair, but it is really a struggle against so many unruly forces with limited resources. Increase in traffic on our roads has been phenomenal during the last decade or so. The number of motor vehicles in India has increased from 1,21,282 in 1943 to about 4,18,067 in 1955 and is bound to increase tremendously in the near future. Some stretches of roads have already been widened to two traffic lanes to cope with this increase, with simultaneous correction of geometric standards, wherever necessary. The weights of laden vechicles have also increased particularly on the main roads. It is felt that the traffic intensity on parts of the Grand Trunk Road (north), for example, may be anything of the order of 6,000 tons per day. Floods cause considerable damage to roads every year, principally in low lying stretches, due to rise in water table and capillary action. The existing road crusts are therefore found insufficient to meet the increasing demands of traffic and the ravages of natural elements and progressive improvements have had to be carried out both in the type of surface and subsequent renewals. All this is reflected in increased maintenance costs.

The existing practice as regards costing is to group maintenance costs under different component items; firstly, there is ordinary repairs consisting of patch work, dressing of berms, arboriculture, repairs to road structures like bridges, culverts, retaining walls, parapets, drains, etc. This work is done through the agency of gangs employed on permanent basis. This is an old practice prevailing in our Public Works Departments dealing with roads and has been found to work satisfactorily for our conditions. It requires limited equipment and may be said to secure satisfactory quality of work with least supervision. Secondly, there is the renewal coat or surfacing for which collection of metal and consolidation are necessary. Surface dressing is the method commonly employed for this, but the use of thin premix carpets is increasingly coming into use as it secures a smoother riding surface. The necessity for proper planning in respect of this item is evident as materials have to be collected well in advance of the execution of the work. If the handicap imposed by an annual budget could be overcome by working on, say a 3-year programme, greater efficiency could be secured as a result of better planning and control. Thirdly, there are miscellaneous recurring charges on account of providing ferry services, pontoon bridges, seasonal construction in river beds, etc. The work on ferries and pontoon bridges is mostly done through the agency of contractors. Lastly, there are the special repairs necessitated by floods and other natural agencies which have already been referred to. A lot of expenditure is incurred on these repairs every year and so it is desirable first to bring the sections which are vulnerable to damages to a tolerable standard before undertaking costly improvements of their surfaces.

Comparison of performance between direct labour and contract work cannot be done strictly in our case as each system is used according to its suitability under certain conditions. Neither do we have the specialist gang organisation which is a common practice in more advanced countries. This implies greater mechanization of maintenance operations which is a question requiring detailed examination for our conditions with a view to see if it is possible to cut maintenance costs and hours of labour, and also to secure better quality of riding surface demanded by modern traffic. In an interesting Paper* presented to the Institution of Municipal Engineers, London, Mr. Reginald A. Kidd outlines the aims of the scheme of road maintenance adopted in the County of Nottinghamshire. It seeks to establish the allocation of the maximum possible amount in annual estimates to defined works and the minimum reasonable to general maintenance; the progressive attainment of uniformity of the carriageway throughout each major route in the county; and allocation of available funds year by year in terms of the maximum possible area of carriageway. Briefly, the keynote of the policy is the widest distribution of monies throughout the mileage, great emphasis on the maximum possible output of work for maximum economy and efficiency, and uniformity of carriageway characteristics for the benefit of the travelling public in appearance, comfort and safety. The Nottinghamshire scheme necessarily involves treatment of complete areas of the surface by machine methods which we may not be able to do without in the years to come side by side with manual labour.

* Road Maintenance, Technique, Policy and Processes in Nottinghamshire by Reginald A. Kidd — Journal of the Institution of Municipal Engineers, July, 1958.

CRISIS IN TRANSPORT

By

B. V. VAGH

Executive Vice President,

The Indian Roads and Transport Development Association.

Requirements of Transport

1. Various estimates have been put forward regarding the long-distance transport requirements of the 2nd Plan. Of them it should be sufficient to deal with three which have been based on data which can be verified. In the order in which they were framed they are as follows:

(i) The Railway Estimate referred in the Plan.

(ii) The writer's estimate put forward after the Plan was published (Goods Transport in the 2nd Five Year Plan).

(iii) An estimate framed by the Road Transport Development Committee of the Indian Roads Congress last year.

2. The railway estimate which was based on the increase in production of coal, steel and raw materials for steel plants, cement, and a 5 per cent increase per annum in miscellaneous traffic came to about 181 million tons of long-distance traffic in the year 1960–61. However, since it was framed at the beginning of the Plan there have been a few additions like increase in food production, imports of Burma rice, imports of steel and cement and a revision of certain targets, totalling some 26 million tons (page 22, item iv, Goods Transport in the 2nd Five-Year Plan by the writer). About half of this, say 14 million tons may require long distance traffic. Taking them into account the railway figure should work out to about 181 + 14 = 195 million tons by 1960-61.

3. The writer's estimate was based on the increase in the over-all production of all commodities as mentioned in the Plan divided into two categories: (i) items listed in tons, and (ii) items listed in numbers, units, horse-power, etc. The Transport capacity required by the former will be more or less proportionate to their tonnage, that of the latter cannot be correctly estimated but in the light of past experience seems to work out to about 10 per cent of that of items listed in tons. An estimate of the transport requirments of the 1st Plan framed on this basis, which was suggested by the writer in 1954 (P 11, Goods Transport and the Plan) worked out to about 1.35 times the 1950/51 capacity i.e. 124 million tons of railway traffic (1.35 × 92) while the actual came at the end of the 1st Plan to 120 million tons made up of 115 million tons carried and 5 million tons left over. The basis was thus borne out by results. On the same basis the transport requirements of the 2nd Plan work out to about $2\frac{1}{4}$ times the capacity in 1950–51 (P. 4, Goods Transport in the 2nd Five-Year Plan) i e. $2\frac{1}{4} \times 92$ million tons (50/51 railway traffic) = 207 million tons of rail traffic, excluding water transport in the year 1960/61.

4. The estimate of the Indian Roads Congress was also based on the overall production of commodities and an allowance for items not listed in tons as in the writer's estimate but it separated agricultural production required for local consumption which travels over short distances and is carried mostly by bullock-carts. Excluding the estimated capacity of water transport this estimate came to about 210 million tons in the year 1960/61.

5. Thus, these three estimates of the probable requirements of long-distance traffic of the Plan, other than water trans-

INCREASE IN MAXIMUM LADEN WEIGHT LIMITS SUGGESTED BY THE I. R. T. D. A. ON THE I. R. C. SPECIFICATION FOR VEHICLES

NOTE:-

1. ALL DISTANCES BETWEEN AXLES SHOWN IN THE DRAWING ARE MINIMUM
2. UP TO THE LOADING SHOWN IN THE DRAWING ANY AXLE-SPACING ABOVE THE DISTANCES SHOWN IS SAFE
3. UPTO THE AXLE-SPACING SHOWN IN THE DRAWING ANY LOAD UP TO THAT SHOWN IS SAFE
4. FOR A KNOWN AXLE-SPACING THE MAXIMUM PERMISSIBLE LOAD CAN BE CALCULATED FROM THE

FORMULA $W = 1025 (L+24) - 3L^2$

WHERE W = GROSS LOAD IN Lbs.

L = DISTANCE IN FT. CORRECT TO THE NEAREST FOOT BETWEEN THE EXTREME FRONT & REAR AXLES.

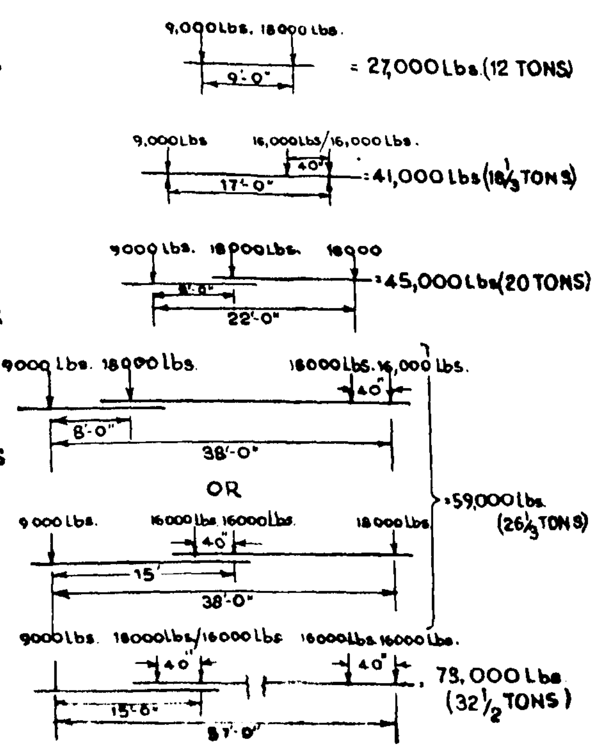
ANY LOAD BELOW THE MAXIMUM SO OBTAINED IS SAFE.

5. MAXIMUM PERMISSIBLE REAR AXLE-LOAD 18,000 Lbs. FOR SINGLE AXLE & 32,000 Lbs. FOR A DOUBLE AXLE IN BOTH CASES WITH DUAL TYRES.

6	MAXIMUM WIDTH OF VEHICLE	8'-0"
7.	MAXIMUM LENGTH, SINGLE UNIT, WITH TWO AXLES	35'-0"
8.	" " " " " MORE THAN TWO AXLES.	40'-0"
9.	MAXIMUM LENGTH, SEMI-TRAILER COMBINATION	50'-0"
10.	MAXIMUM LENGTH, TRUCK/TRACTOR AND TRAILER COMBINATION	60'-0"
11.	MAXIMUM HEIGHT OF LOADED TRUCK	12'-6"
12.	MAXIMUM HEIGHT OF DOUBLE-DECKED VEHICLE	15'-6"

N. B. ALL REAR AXLES WITH DUAL TYRES

1. 2-AXLE TRUCK — 2 AXLES
2. 3-AXLE TRUCK — 3 AXLES
3. 2-AXLE TRUCK, ARTICULATED WITH A SEMI-TRAILER ON ONE AXLE — 3 AXLES
4. 2-AXLE TRUCK, ARTICULATED WITH A SEMI-TRAILER ON TWO AXLES — 4 AXLES
OR
3-AXLE TRUCK, ARTICULATED WITH A SEMI-TRAILER ON ONE AXLE — 4 AXLES
5. 3 AXLE TRUCK, ARTICULATED WITH A SEMI-TRAILER ON TWO AXLES — 5 AXLES



port capacity, work out as follows:

(i) The original railway estimate with additional items of production and imports decided upon since it was framed: 195 million tons.

(ii) The writer's estimate based on overall production of all commodities: 207 million tons.

(iii) The Indian Roads Congress estimate based on overall production but separating items travelling over short distances: 210 million tons.

Nos. (ii) and (iii) tally closely. No. (i) is about 12 to 15 million tons less probably because it was based on an ad-hoc allowance of 5 per cent increase per annum in miscellaneous traffic and also because provision for the revised cement target was not made in it (Foot note P. 464, 2nd Plan). Hence, the probable requirements of long-distance goods traffic seem to be around 205 million tons but may be taken at 200 million tons per annum by 1960/61 for estimating purposes.

Provision

6. Out of a capacity of about 200 million tons other than that of water transport thus estimated to be required in 1960/61 a capacity of about 120 million tons was available in 1955/56. Therefore, the requirements of the 2nd Plan work out to about 80 million tons of long-distance goods traffic in 1960/61. Out of this the railways have provided for about 40 million tons (161 million tons in 60/61 minus 120 million tons in 55/56). There is no provision yet for long-distance road traffic. Whatever little inter-State road traffic has developed recently is on short distance and on temporary permits and is in no sense a regular feature of our long-distance traffic planning. Therefore, our provision for long-distance traffic is just half of that required and the Planning Commission has decided not to allot more funds to the railways.

Road Transport

7. This is where road transport comes into the picture. Since 1939 road transport has been confined to zones and regions and not allowed to expand. The picture has now changed. Restrictions on road transport have been removed as a result of the amendment of the Motor Vehicles Act, credit facilities for the puchase of trucks have been made available as a result of amendment of the State Bank Act, there is a greater awareness of the potentialities of road transport as a result of the reports of the Traffic Commission and the Estimates Committee, the last Transport Commissioners' Conference has recommended a liberalisation of the licensing system, an Inter-State Transport Commission has been appointed and a moratorium has been announced for the nationalization of goods transport up to the end of the 3rd Plan. True, a number of things still remain to be done, viz., the introduction of truck-trailers, a centralised taxation system, relief from the present high level of taxation and, full integration of inter-State traffic but still the improvement is substantial and sufficient to warrant a change in the country's policy for the development of long-distance traffic.

Road System

8. There is appreciable improvement in the condition of our roads also. Long-distance traffic will travel principally by our national highways of which we have 13,800 miles. All this mileage barring about 600 will have a modern surface by 1960/61 and about 2,000 miles will have two lane carriageways by that date. There is no through communication on this entire system yet as 56 major bridges and some small bridges have still to be provided but there should be no great difficulty in utilizing the system for about 8 months in a year if diversions are provided at places where the rivers run dry during the dry weather and ferries are provided where they do not and the water is deep. Both the Transport Development Committee of the Indian Roads Congrees and the Technical Sub-Committee of the Transport Advisory Council have recommended these measures.

Traffic Capacity

9. No information is available about the traffic these roads carry at present but it is bound to be small since inter-State

permits are not issued freely. Here, it may be useful to have some idea in broad outline of the traffic capacity of our metalled roads. In 1955/56 we had 1.76 lakhs of trucks of all types and 2.42 lakhs of other motor vehicles, which on the mileage of 1.22 lakhs of metalled roads in the country out of a total of 3.17 lakhs give an average of about 1.5 trucks and about 2 other motor vehicles per mile. At the end of 1956 there were 16.82 lakhs of trucks of all types and 52.35 lakhs of other motor vehicles in the U.K., which on the mileage of 1.89 lakhs of roads in that country give an average of about 9 trucks and 27.7 other motor vehicles per mile. *Therefore, as compared to the U.K. our metalled roads carry about one-sixth of the trucks and about one-thirteenth of the other motor vehicles in that country.* Our road system is being developed on the lines of systems in countries like the U.K. Therefore, on the basis of the above data and making all possible allowances for deficiencies in our road system there seems to be a *prima facie* case for suggesting that our metalled roads should carry at least half the traffic in that country i.e. about 3 times our present number of trucks and 6 times our present number of other vehicles per mile. Talking only of trucks this comes to $5\frac{1}{4}$ lakhs against the present number of 1.76 lakhs i.e. about $3\frac{1}{2}$ lakh more trucks. Against this the number of additional trucks required for the full implementation of the Plan, including passenger, feeder and long-distance traffic but excluding vehicles required for replacement, as estimated by the Indian Roads Congress is about 1.78 lakhs, i.e. just about half. Actually, the number of our other vehicles being only one-sixth of that our roads can carry in addition to the extra trucks on the basis suggested above there is room on our roads for far more than $3\frac{1}{2}$ lakhs of extra trucks.

Outlay

10. Out of about 1.78 lakhs of trucks required for the 2nd Plan as per the I.R.C. estimate about 75,000 trucks will be capable of carrying eventually about 40 million tons per annum of long-distance traffic by our national highways. This will be sufficient for the full implementation of the Plan. The outlay required to develop this traffic will be two-fold, (i) that for providing diversions and ferries, and (ii) that for providing 75,000 trucks. Fortunately, the problem about the former has been solved by the recent announcement of the Finance Minister to allocate to national highway about Rs 12 crores from the surplus of the State Trading Corporation on account of cement and it is suggested that this amount should be earmarked for this work. In regard to trucks, excluding import duty their cost will be about Rs 75 crores, all in foreign exchange. This is where the main difficulty will arise and the country has to devise ways and means to minimise this expenditure without impairing the transport capacity.

Ways and Means

11. There are two ways of doing this: (i) by putting on the roads from 15,000 to 20,000 trailers and (ii) by raising the permissible laden weights of commercial vehicles. Trailers are being produced in the country capable of carrying upto 90 per cent of the pay load of a truck. This means that 15 to 20,000 trailers will do work of about 15,000 trucks, which fact will reduce the foreign exchange from about Rs 75 to 60 crores. Trailers are of indigenous manufacture and do not require any imported materials except in their braking system. In regard to the laden weight of vehicles if this is raised from 18,000 to 27,000 lbs per truck an additional capacity of 50 per cent will be available on the same number of trucks. In actual practice it may not be more than about 25 per cent since a large number of trucks of a capacity of 27,000 lbs are not likely to be available. Yet even this reduction will account for a further reduction of about 25 per cent in the foreign exchange. The implications of the two proposals are thus profound from the point of view of national economy.

The Employment of trailers is now a well-known feature of road transportation throughout the world. Its advantages are two: (1) It reduces the initial cost of a vehicle per unit of the pay-load since a trailer costs only about 30 per cent of the cost of a truck, and (2) it reduces the cost of operation by making it possible for a truck to carry heavier loads per trip within the carrying capacity of roads. A

diagram showing the manner in which this can be done based on the I. R. C. specifications of vehicles is given on page 6.

Role of the I. R. C.

12. It is here that the Indian Roads Congress can play a decisive role by giving a lead to the Road Engineers in the country to rise to the occasion by revising old ideas and permitting higher laden weights, truck-trailer combinations and establishing through communication where bridges may be either missing or weak by providing diversions and ferries.

13. In addition, speed limits may be imposed in the case of weak bridges where diversions cannot be provided. It is not intended to suggest that all this should be done without due regard to safety or conservatism. By the end of the 2nd Five Year Plan the country's investment in roads will be of the order of about Rs 720 crores and the only return the country is having on this colossal amount is about $1\frac{1}{2}$ vehicle per mile of both metalled and unmetalled roads including the truck-equivalent of bullock-carts: If we cannot increase this number to the extent required on account of financial difficulty let us at least increase the carrying capacity of our vehicles by allowing greater laden weights and permitting trailers.

14. In this connection the following observation of the Tariff Commission may be noted:

"Two such measures deserve special mention, viz., an increase in the limit of permissible laden weights of vehicles, and the use of trailers."

"We recommend that a fresh examination should be undertaken by all State Governments to see how far the restrictions on permissible laden weights could be relaxed, and the use of trailers with goods vehicles allowed."

They used to say that aeroplanes for the individual would eventually be as cheap as cars, but now they're working to make cars as expensive as aeroplanes.

H. B. Fox.

DEFINITIONS OF HIGHWAY ENGINEERING TERMS

BASE LINE: A straight line in the field the horizontal length of which is accurately obtained and from which, by triangulation, the position of other points may be determined or from which a survey may be expanded.

BEARING: The angular deviation of a survey line at any point in the line from a known direction through that point. Generally, the known direction is taken as the true north and south line through the point.

MAGNETIC BEARING: The angular direction of a survey line from a point with reference to the magnetic north-and-south line through that point at the date of observation.

TRANSPORT OF GOODS BY ROAD

IT has been said that today is an age of realism, and, that being generally accepted, more realism might well be brought into the realm of highway construction. It appears that too much emphasis is often placed on the cost of building new roads or improving existing ones. The cost of not having good roads is hard to measure.

Though the costs of a bad roading system are clouded, they are nevertheless very real: vehicle repair costs may be increased by 50 per cent for loose or bad surfaces or by as much as 100 per cent for very bad ones; tyre wear may be doubled and still further increased by bad alignment and steep grades.

Great strides have been made in road improvements over the last thirty years, sealed roads have increased from 934 to 11,171 miles, yet the need for better roads is greater today than ever before. We can sell our products overseas only if our costs are reasonable and transport costs form an important part of the cost of production.

Statistics of the work done by road transport are difficult to obtain anywhere. In New Zealand the network of the State railways system embraces practically every line of importance and facilitates the employment of elaborate accounting machines for the computation of statistics. A very different picture obtains in the road transport industry. Approximately 80 per cent of the businesses licensed under the Transport Act, 1949 are operated by firms, including owner-drivers, each with no more than three vehicles.

Although accurate statistics are almost impossible to obtain estimates can be given:

Calendar Year	Estimated Total Operating Cost (million pounds)	Estimated Net Freight (Ton-mile millions)
1931	10	180
1939	17	430
1950	50	840
1957	86	1375

A considerable proportion of this tonnage involves the cartage at some stage of production of goods for export.

Present State of Efficiency in New Zealand

The word "efficiency" is capable of being interpreted in various ways. Certainly the term is a wide embracing one. It can be said quite definitely that over the years there has been a substantial increase in the efficiency of road transport. The 1958 model heavy truck is incomparably superior to its ancestor of the thirties. The roads over which the trucks run have been greatly improved. The techniques of management and of loading and unloading goods are constantly being improved. All this adds up to convincing progress. We are in an age of transition in so far as transport is concerned. Rail transport is being supplanted by road and air transport and in what might be termed the contest of the three for supremacy, the victory goes in the long run to the form of transport able to give the best service to the public.

The main aim of any freight transportation system should be the most efficient possible movement of goods and services at the lowest possible cost. The term cost here is to be interpreted in the broadest possible sense—the expenditure of labour, capital and commodities. Efficiency is governed by several factors.

(a) Speed

There are some rare circumstances in which speed is undesirable, or at least is not essential. Fast transport leading to an accumulation of goods at a destination where there are insufficient storage facilities may be a very great disadvantage. This could be the case, say, in the transport of New Zealand meat or dairy produce to markets in the East such as Japan, India, the Philippines, or Indonesia, where there is a very great lack of refrigerated storage. But, in general, speed is vital to the efficiency of any transport service, and this applies particularly to New Zealand where its importance is highlighted by the rapid expansion of the air freighting of perishable products such as fruit. Road transport, nevertheless, plays a vitally important part in the transport of perishable commodities.

The speed of road transport in New Zealand for heavy trucks is 30 miles per hour. This limit severely hampers the operating efficiency, but it probably is a factor in the relatively low injury accident rate that these vehicles have. The dramatic and economic recovery of Western Germany in the last ten years is due in no small measure to the efficiency of her internal transport system; heavy trucks are not subjected to any speed limit, but the overall accident rate in West Germany is deplorably high.

Faster transport reduces the cost of the goods being transported. It helps in reducing the capital charges that production has to bear. It means that manufacturers or sellers can operate with lower stocks of raw materials or goods knowing they can be replenished promptly. When goods are in the process of being transported they are useless for any other purpose.

From the point of view of operation of transport, increased operating speeds mean a fuller utilization of transport capital equipment. While this fact is probably of greatest significance in railway transport it is a matter of importance to the average road operator. A decrease in the average journey time means that it is possible to do the same amount of work with a smaller vehicle fleet, in other words, with less capital equipment.

The limit on the speeds of heavy trucks is, therefore, an important factor in reducing the efficiency of road transport in New Zealand and places it at a disadvantage with rail and air transport.

(b) Capacity

As in the case of passenger transport, the carriage of freight in all forms of transport is subject to marked seasonal fluctuations. Any transportation system must be able to handle with reasonable expedition the peak demands for its service. Necessarily this leads to excess capacity, particularly during the winter months when demand for transport falls off sharply. The aim of the competent operator is to organize his business so that his capacity is fully used, but, although this is a fine theoretical aim, it is seldom attainable in actual practice. An operator in New Zealand who has an average annual payload of 3 tons finds that he is confronted with work necessitating possibly a six ton payload in the stock season while in the winter he finds it difficult to get a ton. The statistician would say that he should have a truck of 3 tons capacity. The operator in such circumstances in actual practice, if he has only one vehicle, uses one probably of 5 tons.

The influence of seasonal demand in creating unused capacity is by no means confined to road transport. It is obvious in many industries, but there is another interesting factor peculiarly applicable to New Zealand road transport—the legal limits on axle weights, or what is more generally known as "road classification". About 71 per cent of all Main and State Highways were classified Class Two as at March 31, 1957. In the case of a two-axled vehicle, this limits the gross weight to 12 tons with a maximum of 6½ tons on any one axle. In the case of a multi-axled vehicle, the gross load is 23 tons with 6½ tons maximum on spaced axles, or 5 tons on tandem axles. These restrictions severely limit the efficiency of road transport. It is difficult to give statistics showing the exact effect of road classification on transport costs and charges because other factors are involved. In some districts, such as Hawke's Bay for example, the more markedly seasonal nature of the work gives a lower effective rate of truck hours than in, say, South Auckland where extensive cream and bobby calf cartage contracts and cartage of fertilizer give more even loadings. The types of commodities carried also vary widely between the different areas. Nevertheless, one specific quotation from a rates schedule suffices to show the effect of road classification. In the schedule of cartage rates for the North Auckland area issued on January 21, 1958, which covers cartage on roads in Classes Three and Four, provision is made for the rates to be reduced by $7\frac{1}{2}$ per cent when certain classes of goods are carried over roads classified "Two".

A similar provision applies in the Waikato rate schedule. It is estimated that just over 3,000,000 pounds annually is received for the cartage of goods by licensed transport operators in the Waikato area. If all the roads were upgraded to Class Two, the annual cartage bill for the Waikato area would be immediately reduced by approximately 200,000 pounds with the prospect of a further reduction as soon as the carriers had been able to change their trucks to the larger types customarily used on Class Two roads.

Legal restrictions on backloading or on types of goods carried also tend to hamper the efficiency of road transport.

Although not falling strictly within the category of capacity, it is convenient to mention here the 30 mile restriction in some cases upon road transport. If there is an available route for the carriage of goods which includes at least 30 miles of open Government railway, goods must be carried by road only so far as it is necessary to permit of their carriage by railway unless the total distance of carriage by road and railway would be greater by more than one third than the shortest distance available or unless they are carried on a route or routes or between terminal points as expressly authorised in the licence. Exemptions from this restriction apply to certain commodities and the distance is extended to 50 miles in the case of livestock and certain perishable products.

The "30 mile restriction", or more appropriately the "30 and 50 mile restriction", is probably the most severe limitation on the efficiency of road transport. In practical application it means that road transport is confined to trips of little more than an hour's continuous running. In America in the last two decades the sphere of operation of the motor truck has been substantially extended with resultant benefits to the economy. The economy of the U.S.A. would be severely affected if long-distance motor transport were to be subjected to any restriction comparable in severity to the 30 mile restriction. According to a recent bulletin of the U. S. Department of Agriculture, improvements in highways and equipment have made it possible for truckers to offer rates that are competitive with rail rates. Motor transport is offering faster deliveries than the rail service and giving door to door service with fewer handlings. In the cost-conscious American business world, motor transport is now well-established in the long-distance field. No comparable development, or anything even approaching it, is in sight in New Zealand.

(c) Use of Trailers

Criticism can fairly be made of the reluctance of the transport operators in New Zealand to increase capacity and decrease cost by the use of trailers. On the Continent, trailers are used extensively in many countries. The following figures show possible results from the use of trailers.

The costs of operating a truck with a payload capacity of 5 tons compared with the costs of operating a truck and trailer with a combined payload of 10 tons have been estimated to be as follows:

	Truck only	Truck and Trailer
Running Costs	pence per mile	pence per mile
Petrol—Truck only 8 mi/gal		
Trailer and Truck 6 mi/gal	4.88	6.50
Oil—6 per cent of petrol	0.29	0.39
Tyres—Truck only—16,650 mile life of 7 tyres	3.75	3.75
Trailer only—27,500 mile of 4 tyres		1.53
Repairs—Truck only	3.74	3.74
Trailer only—10 per cent of truck		0.37
Depreciation—Truck 2/3 of net price 100,000 miles	1.81	1.81
Trailer 2/3 of net price 150,000 miles		0.56
Total running costs	14.47 pence	18.65 pence

	Truck only	Truck and Trailer
	pound per mile	pound per mile
Standing Charges		
Licence fees and 3rd party	14	24
Insurance	34	50
Heavy traffic fees	78	142
Depreciation—Truck 1/3 of net price 6 years	64	64
Trailer 1/3 of net price 9 years		19
Wages of driver		
52 weeks @ 40 hours		
Truck	649	
Truck and trailer		677
Interest @ $4\frac{1}{2}$ per cent	63	95
Overhead charges	100	100
Total standing charges	1,002 pounds	1,171 pounds

Applying these costs on the following assumptions:

(a) The truck does 1,600 hours' effective work in a year.

(b) The truck and trailer combination does 1,600 hours' effective work in a year.

(c) The truck travels at an average of 25 m.p.h. over a 25 mile haul (one way).

(d) The truck and trailer travels at an average of 20 m.p.h. over a 25 mile haul (one way).

(e) It takes 10 minutes to load and unload one ton and both the truck and the truck and trailer carry full loads.

On this basis the following tonnages would be carried in a year:

Payload carried	5 tons	10 tons
Time to load and unload	50 min	100 min
Time to travel return trip	120 min	150 min
Total time for round trip	170 min	250 min
Total effective hours per annum	1,600 hrs	1,600 hrs
Trips per annum	565 trips	384 trips
Tonnage carried	2,825 tons	3,840 tons

The cost per ton-mile would be:

Truck

565 trips at 50 miles a trip @ 14.47 pence	= 1,703 pounds
Standing charges per annum	1,002 pounds
Total cost	2,705 pounds

Tonnage carried		2,825 tons
Average haul		25 miles
Ton-miles	$= 2{,}825 \times 25$	= 70,625
Truck cost per ton-mile		= 9.19 pence

Truck and Trailer

384 trips at 50 miles a trip @ 18.65 pence	= 1,492 pounds
Standing charges per annum	1,171 pounds
Total cost	2,663 pounds

Tonnage carried		3,840 tons
Average haul		25 miles
Ton-miles	$= 3{,}840 \times 25$	= 96,000
Truck and trailer cost per ton-mile		= 6.66

Thus, in this example, not only is a greater quantity of goods carried (38.0 per cent more) by the truck and trailer in the same time, but the cost per ton-mile for truck-trailer haulage is only 72.5 per cent of the cost for the truck cartage.

Put another way, 100 trucks and trailers could do the same work as 136 trucks and, what is more, do it cheaper.

136 trucks at 70,625 ton-miles	= 960,500 ton-miles
136 trucks at 2,705 pounds operating costs	= 367,880 pounds
Cost per ton-mile	= 9.19 pence
100 truck-trailers at 96,000 ton-miles	= 9,600,000 ton-miles
100 truck-trailers at 2,663 pounds operating costs	= 266,300 pounds
Cost per ton-mile	= 6.66 pence

Future Trends

It is debatable whether or not road transport can look forward to any progressive relaxation of the present legal restrictions upon its sphere of operations. Some slight relief from the 30 mile restriction has been allowed during the past two years, but this relief, particularly in regard to livestock cartage, has had a marked effect on railway revenue.

In a similar manner, the march of time will bring with it further substantial improvements in our highways. The National Roads Board since its inception in 1954 has already achieved a great deal in rapidly extending the length of sealed roads and strengthening road crusts. We have a long way to go before we have all our main and state highways in Class one; the class Two goal is closer.

The use of light weight alloys may be expected to accelerate from now onwards. These are already effecting marked increases in payload ratio—i.e., payload to gross weight of vehicle.

Further savings in weight will come from the wider use of air suspension instead of conventional springing. Development in this sphere is rapid.

Within the next few years the large sums spent on the gas turbine powered truck should produce concrete results in the form of commercial vehicles. Chevrolet have a gas turbine truck, the Turbo Titan, in an advanced stage of development. Advantages will be better in climbing rates on grades (important for New Zealand) because more of its base power is used on grades, simplified transmission, probably low maintenance requirements, air cooling, no oil consumption. A disadvantage at the moment is the high fuel consumption, but this is being overcome.

"Piggyback" operations might have some application in New Zealand. "Piggyback" means the hauling of a truck-trailer to a railway station where the trailer is loaded on a "flatcar", something like our "U" or "UB" class wagons. The trailer is picked up by a truck or tractor at the destination and taken to warehouse, factory or store. This is proving highly successful in the United States and Canada. Recently a new light weight low cost "Piggyback" rail wagon has been developed in U. S. A. for this work.

The use of pallets is extending rapidly in U. S. A. and Europe. In what are sometimes called "fishyback" operations, pallets are loaded from truck and trailers to hold of ship direct.

"Lift on" refrigerated containers are now being used in Australia for cartage of perishable foodstuffs. These are light-weight portable containers with about 500 cu. ft. of space, or 5½ to 6 tons weight of load, gross weight about 10 tons each with own diesel plant capable of operating unattended for about a week.

Within the next two decades the atomic powered vehicles will be a reality. This almost certainly will revolutionize road transport. There is a tendency to say that it is a long way off; it is often not realized that the development of inventions proceeds with unexpected rapidity. Probably the atomic motor vehicle is much closer than we realise.

It is possible that trailers will be used much more extensively. The "road train" may well become common on New Zealand highways.

Loading and handling methods are constantly being improved. To quote a good example: Automatic coal trucks are now coming into use in Great Britain. Coal is carried by truck in 8 ton loads and bagging is done at customer's gate. Three 1-cwt bags can be loaded in 60 seconds measured accurately and recorded on a truck meter. Another example is the "Daybrook" power-gate which greatly facilitates loading—it is really an electrically-operated adjustable tail board which can be locked in any desired position. In horizontal position it can be used to extend the capacity of the truck while in operation. Economy of time in loading and unloading is important. The automatic coal truck saves 2 hours on each 8 tons of coal in loading and unloading.

Urban traffic congestion is a continual problem in overseas countries and already it is becoming apparent in New Zealand. It is understood that the Ministry of Transport in Great Britain is considering "double-decked" roads for areas in which the widening of existing roads would involve heavy expenditure for demolition and compensation. Upper roads would have two carriageways of 20 ft width raised on a single pier with cantilever support, but would not extend to the whole width of the road beneath in order to allow a reasonable amount of day-light for nearby premises and road below. The access would be by rams with clover-leaf entrance and exit. The upper roads would be for fast goods traffic as well as cars.

(From "New Zealand Engineering," July 15, 1958.)

MARKSMANSHIP

One of the greatest marksmen of the FBI was passing through a small town, and everywhere he saw evidences of the most amazing shooting. On trees, on walls and on fences there were numberless bull's-eyes with the bullet hole in the absolute center.

He asked to meet the person responsible for this remarkable feat. The man turned out to be the village idiot.

"This is the most wonderful marksmanship I have ever seen," said the FBI man. "How in the world do you do it?"

"Easy as pie," replied the village idiot. "I shoot first and draw the circle afterwards"

TRAFFIC FLOW AT ROUNDABOUTS

A REVIEW OF THEORY AND PRACTICE

By

B. G. MANTON, B.SC. (ENG.), D.I.C., A.M.I.C.E., M. INST. H.E.,

(Continued from previous issue)

American Experience

Some illuminating figures relating to the merging of traffic from one stream into another are given in a recent report on the observed capacities of Californian freeways with their associated entry ramps. Conditions at these points are not so very different to the merging from lane to lane which occurs on a roundabout, except that speeds on a freeway are likely to be higher than those usual with gyratory traffic, and, in some cases, the weaving lengths are longer.

It is stated in this report[12] that a combined total of about 150 vehicles in 5 minutes (1,800 vehicles per hour) can merge from a ramp into one lane of a freeway at a speed of 30 miles per hour. Furthermore, " when the speed of ramp vehicles drops below 25 miles per hour in the merging area, congestion with stoppages usually occurs."

It is reported, however, that the highest whole-hour merging volume was not less than 1,956 vehicles. This consisted of 1,309 vehicles on the ramp merging with 647 on the freeway, the weaving length being 405 feet.

Design Methods

There are certain guiding principles in roundabout design about which there is usually little argument. The outer kerb line at the entrance, for example, should have a radius of at least 40 feet to permit large vehicles turning left, without weaving, to keep within the nearside lane. The extension of this curve becomes the exit from the roundabout and the radius should be increased to 150 feet, or thereabouts, if space permits, so that emerging traffic may get clear without delay. It will sometimes be difficult in built-up surroundings to provide a radius of this size without encroachment on property and the engineer, as so often happens, must make the best of a bad job.

There is more difference of opinion when we come to consider the carriageway width round the central island. The City Engineer of Manchester[13] has stated that more than three lanes " must create either dangerous traffic conditions or substantially reduce the free flow movement of traffic." A roundabout has been designed for a new road in that city with 36-feet carriageways for circulating traffic and a weaving length, in each segment, of 220 feet. The traffic capacity of this roundabout is estimated by the City Engineer to be 2,600 vehicles per hour per segment, or 866 vehicles per hour per 12-foot lane. This agrees tolerably well with Col. Green's[3] estimate of 5,300 vehicles per hour for a roundabout with 40-foot carriageways, equivalent to 2,650 vehicles per hour per segment.

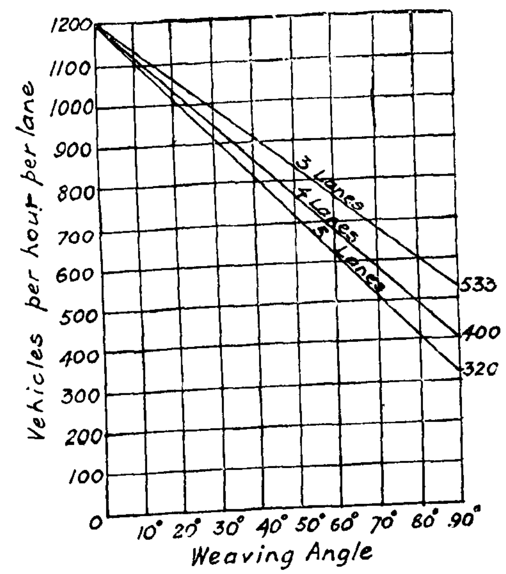
Both the Surrey and Middlesex County Councils are proposing to construct roundabouts in which a width of 40-feet has been adopted for the circulating roads, and it is an interesting fact that five, and sometimes six, weaving lanes can function without difficulty to drivers, or undue hazard, at Hyde Park Corner. This area, indeed, is remarkably free from accidents.

An extremely simple method of computing roundabout capacities is given in the Ministry of Transport publication " Design and Lay-out of Roads in Built-up Areas ", Appendix 5. This is based on graphs devised by Clayton,[14] who

made the legitimate assumptions that the capacity depends upon the width of the circulating carriageway and the weaving length, or weaving angle. If the latter is zero, the capacity per lane is equal to that on a long uninterrupted length of one-way street, estimated by Clayton as 1,200 vehicles per hour. If the weaving angle is 90 degrees the capacity is considered to be that of a signal controlled junction with a flow of 1,200 vehicles per lane per hour on each of four approaches. With 8 lanes at entry the junction will take a maximum flow computed by Clayton to be 3,200 vehicles per hour, a figure which has been confirmed by the writer, and other observers, from actual counts.

With symmetrical traffic distribution throughout the circulating road, each segment of the roundabout will carry one-half of the total flow i.e. 1,600 vehicles per hour and this is equivalent to 533,400, and 320 vehicles per hour per lane respectively, for widths of three, four and five lanes.

On the assumption that capacity is inversely proportional to weaving angle, straight line graphs are drawn through the above value for a 90 degree weave, converging at 1,200 vehicles per hour per lane for a weaving angle of zero, as shown in Fig. below.



It is pointed out that these graphs give maximum capacities and it is suggested that 75 per cent should be taken as normal working capacities.

More recently, Wardrop[15] has derived a capacity formula based on practical tests carried out by the Road Research Laboratory. This takes into account the following factors: weaving width (w), entry width (e), weaving length (l), proportion of vehicles weaving (p), proportion of medium and heavy vehicles, including buses (h).

The maximum flow of vehicles per hour through a weaving section is given by the formula:

$$Q = \frac{4.9\ (w + e)\ (41 - 3\ w)\ (3 - p)}{1\ (0.56\ -\ h)}.$$

It is pointed out, however that the application of this formula should be restricted to cases in which the variables fall within the following limits:

w between 20 and 60 feet.
e/w between 0.4 and 1.0.
w/l between 0.12 and 0.4.
p between 0.4 and 1.0.
h between 0 and 0.25.

When applied to actual examples the results given by Wardrop's formula are not widely different from those derived from Clayton's graphs, although the formula usually gives rather higher values for maximum capacities.

Typical examples

Several existing roundabouts have been studied both to ascertain whether there is any correlation between these two methods of estimating capacity and also to compare the derived results with actual traffic flows. A directional traffic survey at peak periods at a busy roundabout requires a team of six, or more observers, although the writer has sometimes found it possible to obtain directional counts single-handed at off-peak periods when flows are not heavy.

If a convenient elevated point overlooking the site were available there would seem to be possibilities in photographic methods, not necessarily with continuous recording, but with separate exposures at fairly close intervals.

The traffic figures given in the following examples are derived from actual counts and the dimensions involved are taken from plans, some of which have been kindly supplied by highway authorities, to whom acknowledgments are made later.

The weaving segments of each roundabout have been considered individually and the "working capacity" is regarded as the volume at which the roundabout is well loaded, but not to such an extent that jamming is causing queues to build-up on the approaches, although occasional checks of short duration may occur to a few vehicles. "Maximum volume" is the highest recorded number of vehicles which have negotiated the roundabout in one hour and the heavy flow, in this case, may have been accompanied by definite, though intermittent, jamming on one or more segments.

Roundabout No. 1

Segment	Theoretical Maximum Capacity in v.p.h. Based on Clayton's graphs (1)	Theoretical Maximum Capacity in v.p.h. Based on Wardrop's formula (2)	Capacity in v.p.h. given by 75% of Col. 1	Actual Traffic Flows in v.p.h. Working volume	Actual Traffic Flows in v.p.h. Maximum volume
N. E.	1935	2133	1451	1642	not recorded
S. E.	1920	2217	1440	1257	
S. W.	1860	2185	1395	1215	
N. W.	2040	2133	1530	1592	

Roundabout No. 2

Segment	(1)	(2)	Capacity in v.p.h. given by 75% of Col. 1	Working volume	Maximum volume
N. W.	3000	3160	2250	1464	1720
N. E.	1920	2492	1440	1470	1727
S. E.	2940	2932	2205	1508	1772
S. W.	2280	2440	1710	1423	1672

It will be noticed that in the case of roundabout No. 1 reasonably good working was obtained with volumes approaching, and, on two segments, exceeding 75 per cent of the maximum volumes obtained from the Ministry of Transport (or Clayton's) graphs. In the case of roundabout No. 2, however, the obliquity of the interesting roads resulted in there being two segments of adequate weaving length and two which are much too short. In addition, the centre island had rounded corners of too small a radius to suit large vehicles, thus the full width of the carriageway could not be used to the best advantage when these vehicles were making a turn. In addition, the overloading of the north-eastern segment prevented full use being made of the higher capacities on the north-western and south-eastern segments where excellent weaving lengths and angles were provided.

The moral is that theoretical estimates of capacity are based on the assumption that there shall be no flagrant disregard of the accepted rules of good design.

(To be continued)

(From: "Highway and Bridges and Engineering Works," May 7, 1958.)

LEAN-MIX CONCRETE BASES

By

L. S. Blake

LEAN-MIX is a concrete of low workability, suitable for compaction by rolling, and containing considerably less cement than is used in conventional concrete roads. The aggregate used in lean-mix complies generally with the requirements for concrete aggregates although not necessarily to the same high standard. Lean-mixes with aggregate/cement ratios of about 20 may be similar to soil-cement, but if the aggregate has been prepared in any way, then the material made from it should be regarded as lean-mix. Soil-cement is made from material which has not been prepared except, possibly, by the removal of stones larger than 3 in. in size.

The use of lean-mix as a road base material was encouraged by the Ministry of Health who in conjunction with the Institution of Municipal Engineers published a specification for its use on housing estates in 1944. At that time there was a need to conserve the use of cement, but although this need no longer remains, the use of lean-mix bases has continued to an increasing extent. The proposed extensive use of lean-mix on the London-Birmingham Motorway and its application to several other major road schemes, for example, the Gatwick Airport diversion (A. 23), bear testimony to its economy and performance. Lean-mix has been used extensively for housing estate roads and also by the Air Ministry on airfields. It is employed on the Continent in several countries for motorway construction. Lean-mix is also very suitable for use in confined spaces, in urban streets and for the alignment of roads.

The advantages of a lean-mix base are that: it can be laid rapidly by plant in common use by local authorities and contractors; only a small labour force is required; it requires a minimum of site supervision and control testing; it can be safely used by construction traffic about three days after laying; it will not deform because of subsequent compaction by traffic and therefore, the final surfacing can be applied about three days after laying and can be used by traffic the following day—lean concrete has been laid and surfaced on the same day and opened to traffic the following day; when compacted, it will not suffer damage due to exposure to rain, nor will it allow surface water to penetrate into the subgrade if for any reason it is impractical to apply a surface immediately.

There is considerable practical experience in the use of lean-mix, especially in Crawley[1,2], Surrey[3], Leicester, [4,5], Bracknell, North Wales, and on a large number of airfields. In this paper an attempt is made to summarise existing knowledge on design and construction.

Mix Design

Designing a lean-mix is a simple process, because some of the variables that must be considered when designing mixes for other purposes are fixed by practical considerations. The moisture content is determined by the need to obtain full compaction by rolling and because of this, in practice, the compressive strength of lean-mix is largely dependent upon cement content.

Aggregate and aggregate grading. Gravels and crushed stone aggregates have been used, but with lean-mix the standards for cleanliness and hardness normally applied to concrete can be lowered. The most common maximum size of aggregate is $1\frac{1}{2}$ in. and although there is no objection to using 2 in. aggregate it may prove difficult to obtain the required surface regularity if the maximum size is increased above this value.

Both natural sands and crushed rock fines have been used successfully—the proportion of sand should be between 35 and 40 per cent. With less than 35 per cent of sand the tendency for segregation is increased and it may not be possible to achieve a sealed surface on completion of compaction—though an open texture surface may not be detrimental if, as is usual, the lean-mix base is covered with sufficient thickness of bituminous surfacing. The use of sand proportions much in excess of 40 per cent may result in surface undulations forming during rolling.

Water content. Field compaction experiments made by the Cement and Concrete Association have shown that the relation between moisture content of the mix and the dry density obtainable by means of a given amount of compaction by rolling is similar to that found by Proctor for soils. There is an optimum moisture content for compaction above or below which reduced dry densities are obtained. The optimum moisture content is approximately the same for all richnesses of mix and is about 5½ per cent by weight of dry materials. Mixes varying in richness from 6 : 1 to 24 : 1 have been compacted successfully using this moisture content. In practice, the moisture content should be the highest that is consistent with obtaining a smooth surface by rolling.

Cement content. The compressive strength of lean-mix is a function of its water/cement ratio and the density to which it is compacted. Because the water content is the same for all mixes, the cement content decides the compressive strength and all the other elastic properties of the mix since they, in turn, are related to compressive strength. The maximum dry density which can be obtained by a given amount of compaction is also influenced by the cement content of the mix.

Most of the earlier lean-mix bases were laid using mixes with aggregate/cement ratios of about 14, but recently engineers have tended to favour mixes with ratios of about 20. In North Wales, where granite aggregate is used, mixes of 24 : 1 have been in common use for several years. The latest Ministry of Transport specification allows the use of aggregate/cement ratios of between 15 and 20 for gravel aggregates and of between 18 and 24 for granite aggregates.

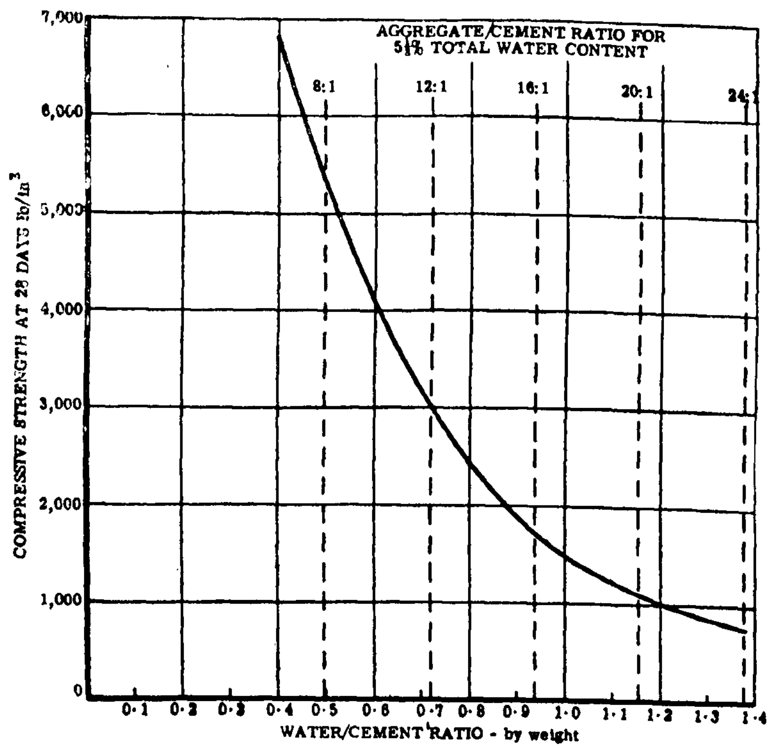


Fig. 1. **Relation between compressive strength and water/cement ratio assuming full compaction.**

Although mixes as lean as 40 : 1 may have sufficient stability in a base, variations due to incomplete mixing would result in some portions of a mix containing no cement at all. For this reason, it is inadvisable to use mixes leaner than about 24 : 1.

Consideration of the properties of lean-mixes leads to the conclusion that bases laid using mixes richer than 15 : 1 may be regarded as 'rigid' while those using mixes as lean as 20 : 1 or 24 : 1 tend towards the 'flexible' type. The 'rigid' bases have much better load-spreading characteristics but cracks may occur in them that are sufficiently wide to cause cracks in bituminous surfacings thinner than 4 in. or 5 in.; the use of reinforcement together with appropriately spaced joints might control these cracks and allow the use of thinner surfacings, but this may not be the most economical way of overcoming the problem. It is considered that the use of leaner mixes might reduce the possibility of these wide cracks forming and provide a more economical road base.

Fig. 1 gives a relation between compressive strength and water/cement ratio assuming full compaction; superimposed on the figure is the relation between aggregate/cement ratio and compressive strength for mixes with a total water content of 5½ per cent by weight of dry materials. It will be seen that richer mixes (aggregate/cement ratio lower than 15) can be expected to have average compressive strengths in excess of 2,000 lb/in.^{2} at 28 days. An analysis of test results on sites shows that higher coefficients of variation may be expected with lean-mixes than with rich mixes but some of this greater variation may be due to the difficulty in making lean-mix cubes and, consequently, to the variation in density of the cubes.

Work is at present in progress at the Cement and Concrete Association's research laboratories on some of the fundamental mechanical and elastic properties of lean-mix and, although the work is far from being complete, Table 1 gives some of the results which may be expected under site conditions.

Table 1

Properties of Typical Lean-Mixes Suitable for Rolling

Property of mix		Aggregate/cement ratio of mix by weight: 15	24
Average 28-day compressive strength	(lb/in)^2	2,000	1,000
Average 28-day flexural strength	(lb/in)^2	300	200
Maximum dry density to which the material is likely to be compacted on the site	(lb/ft)^3	135	130
Modulus of elasticity	(lb/in)^2	$3-5\times10^6$	$2-4\times10^6$
Co-efficient of thermal expansion	(per deg. F)	$4-8\times10^6$	

Note: All the above figures are approximate and apply to gravel aggregates. A water content of 5½ per cent by weight of dry materials has been assumed for both mixes.

Pavement Thickness Design

Standard methods of designing 'rigid' and 'flexible' pavement thicknesses are given respectively in the Road Research Laboratory's Road Notes 19 (6) and 20 (7), although the latter does not deal with heavy and very heavy traffic intensities.

Most engineers consider that lean-mix should be designed as a 'flexible' base but, because of its superior load-spreading characteristics, its thickness can be reduced from that given by the C. B. R. method in Road Note 20; reductions of 25 to 33 per cent have often been used. Thus, if the C. B. R. method of design gives a base thickness of 15 in., 10 in. or 12 in. will do if lean-mix is used. The base thickness should not, however, be reduced below 6 in. This approach is reasonable from theoretical considerations, and it has worked well in practice: the good load-spreading characteristics of lean-mix are due to its high elastic modulus, which does not decrease greatly with decreasing cement content over the range used in practice.

Full-scale experiments by the Road Research Laboratory are at present in progress which will provide more complete information on designing pavements to be made using lean-mix and may lead to greater economy. In some circumstances it may be more economical to lay a granular sub-base beneath the lean-mix for example: on clay sub-grades. Generally, however, a sub-base is not necessary. Lean-mix can be laid in one or more layers to provide any total thickness required.

Joints

Most lean-mix road bases have been laid without joints, apart from inevitable construction joints, but some engineers incorporate expansion joints at 200 ft to 400 ft intervals if the concrete is laid in cold weather.

Longitudinal joints should be avoided if possible as these form a weakness in the base; it is therefore preferable to lay the road in full width.

Construction joints at the end of the day's work should be vertical butt joints. They may be formed by using heavy baulks of timber to roll against or by 'feathering-off' and then cutting back to a vertical face: the latter method is preferred in practice but it is essential to cut a vertical face otherwise heaving may occur when the lean concrete expands.

Construction Methods

Batching and Mixing: Although it is preferable to batch the materials by weight, volume batching can be accepted if it is well controlled. Continuous and batch type concrete mixers have been used with equal success. Because of the potentially fast rate of construction, it is desirable to use mixing plant with capacities above 25 yd.[3] per hour even on the smallest job, and therefore on such work it is convenient to use ready-mixed concrete. The use of ready-mixed concrete is of particular advantage on confined sites.

Spreading. The lean-mix can be spread by hand but for the larger job a variety of spreading plant is available. Dozers and graders are frequently used for spreading but bituminous surfacing spreaders and stone spreaders are also popular. One disadvantage of the bituminous surfacing and stone spreaders is that they are limited in the thickness they can lay. The thickness of material which can be compacted satisfactorily in one layer depends upon compaction plant used, but, wherever possible, it is advisable to compact in one layer. If the base is laid in more than one layer, no layer should be thinner than 4 in.

To produce a given thickness of compacted base the lean-mix should be spread with a surcharge of about 25 per cent; for example, to achieve an 8 in. base the material should be laid to approximately 10 in.

As with all other materials, the regularity of the surface of the base depends a great deal upon the uniformity of spreading but, with normal care, a tolerance of 3/8 in. measured on a 10 ft straight edge can be achieved. Forms are sometimes used to assist in maintaining levels, but many authorities prefer to lay the kerbs or kerb bedding before starting base construction; alternatively, the lean-mix

base should be widened by 18 in. outside each edge of the carriageway, the extra widths being used as kerb bedding.

Compaction. Rollers of 8 to 10 ton are capable of compacting 8 in. thick lean-mix bases and small vibrating rollers will also give good compaction on this thickness. Thicknesses up to 14 in. can be compacted by means of heavy vibrating rollers or plate vibrators, although with the latter there are difficulties in producing the required surface tolerance. Tandem rollers are often preferred for obtaining good surface finishes. Small vibrating rollers are almost always used on small jobs, and they are also used frequently on large jobs: in addition to producing good compaction they are easily manoeuvrable.

Graders are often used during the compaction operations to maintain levels, but they are not necessary if bituminous surfacing spreaders are employed. To assist in obtaining the required regularity of surface, a light roller (50 cwt) should be used before finally compacting with heavier rollers; if a vibrating roller is used, the first one or two passes should be without vibration.

Curing: Lean-mix requires curing and the most convenient method of doing this is by spraying a bitumen emulsion or cut-back tar or bitumen membrane at the rate of one gal. for every 6 to 10 yd.[2]

Surfacing. The surfacing can be laid three days after the base is completed. (Lean-mix bases have been laid and surfaced in one day and opened to traffic the following day.) That the final surfacing can be laid on lean-mix bases so soon after their completion is of considerable practical advantage. With most other types of base the delay is longer.

Concluding Remarks

The growing use of lean-mix bases is due to their economy and the practical advantages enumerated in the introduction to this paper. Road constructors welcome its use because lean-mix is a reliable material, simple to lay and requiring no special plant. It is popular with road-engineers because it requires a minimum of site control to ensure satisfactory work.

Mix design and control is a simple process because many of the variables are fixed by practical considerations and there is now a good measure of agreement amongst engineers that the mix should be designed as lean as practicable, aggregate/cement ratios of about 20 being preferred. Although a precise method of designing the thickness of lean-mix bases is not available, experience has shown that the C.B.R. method of designing granular bases is entirely safe to use and that, because of the good load-spreading properties of the material, lean concrete bases can be made 25 to 33 per cent thinner than granular bases of equivalent performance.

Construction methods are simple and capable of giving high outputs with a comparatively small labour force. An added attraction of the lean-mix base is that it can be used safely by construction traffic and will not suffer, or allow the sub-grade beneath it to suffer, from exposure to rain during construction.

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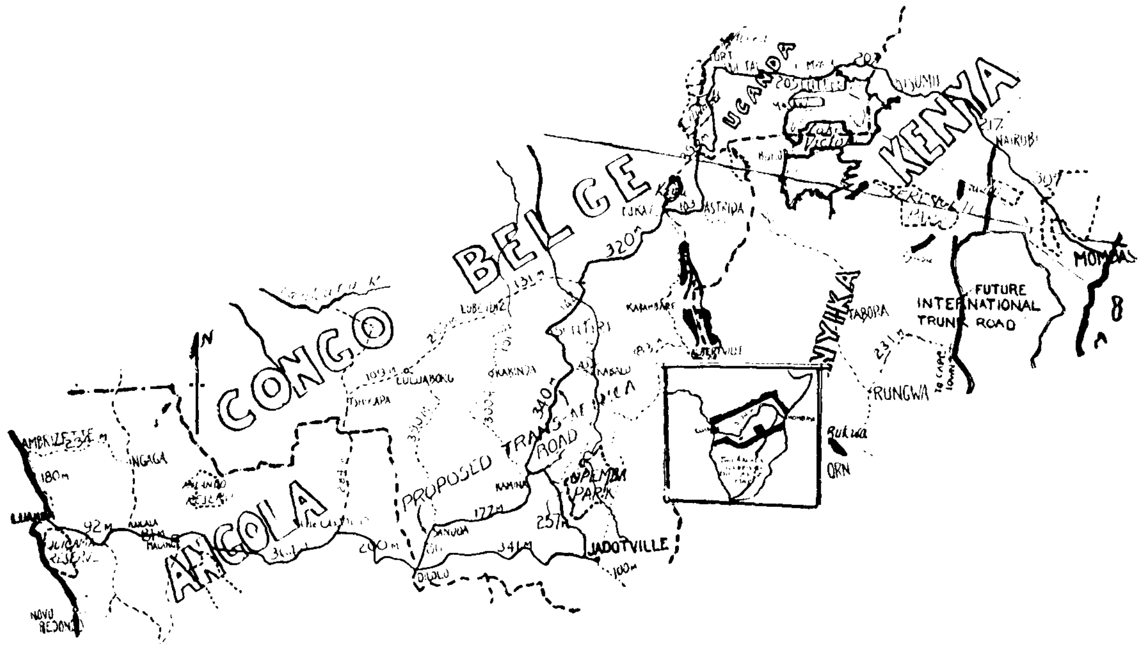
(From "The Surveyor and Municipal & County Engineer", 10th May, 1958.)

HERE AND THERE

1. TRANS-AFRICAN ROAD—FROM OCEAN TO OCEAN ACROSS AFRICA



JUST a century has passed since David Livingstone, explorer, completed his journey on foot, between Mombasa and Luanda. Livingstone took two years to cover the three-thousand mile stretch, and lost whatever he had of youth and health in the process. Later—much later—a German Army Officer, Paul Graetz, made the attempt in a motor car in 1907. He took off from Dar-es-Salaam, roughly following Livingstone's track until the vicinity of Jadotville, when he became discouraged, turned south, and finally hit the Atlantic Ocean at Swakopmund, having traversed the Caprivi Strip on the way.

Even to-day, any one seeking to travel by road from Mombasa to Luanda would have quite an adventurous trip before him. The thousand-odd miles from Mombasa to the Luanda border might be relatively comfortable. There has been much recent development, right up to the Ruwenzori mountains, and accommodation and service could be found readily enough. In a reliable vehicle, that stage could be covered comfortably in four days, despite the long stretches of untarred road in Kenya. The next thousand miles through the Congo would probably take a week and be accompanied by such possibilities as bogging down, smashing the vehicle and encountering ill-disposed big game. The farther south one went, however, the better would the Conditions become, and probably the last congo stretch, from Kamina to Dilolo, could be easily negotiated. Entering Angola, on the last lap, however, could bring the traveller to a final week of hard work.

The development of this route into a commercial highway, linked to the projected Cape Town—Nairobi Trunk Road, is now exercising the attention of a number of organisations, not the least of which is the International Road Federation. In the near future, an issue of the

well-known quarterly paper, Road International, is to be devoted to the trans-African routes.

The foregoing map, showing approximately the best route that could be followed to-day by a well-equipped motorist, indicates that a crow-flight journey of some 1,750 miles involves a road trip of 3,194 route miles. The experienced African traveller will be reminded, by this, of the veteran British surveyor Colonel Moss. When replying to an official query as to why he had chosen a circuitous four-hundred-mile route between Kampala and Lake Edward, when, as the crow flies, the distance is but 205 miles, he officially replied: "I am not a—crow".

Well, no known road vehicle is endowed with corvine properties either, and so any route serving Equatorial Africa is bound to be a meandering one, especially since the productive areas that it will serve for the next decade lie far apart, separated by difficult terrain.

(*From: "African Roads and Transport," May/June, 1958*).

2. TESTING ROADS BY CONTROLLED VEHICLE LOADS

THE Highway Research Board of the National Academy of Sciences—National Research Council announced recently the award of contracts for furnishing semi-trailers to be used on the AASHO Road Test at Ottawa, Illinois. The test, sponsored by the American Association of State Highway Officials and administered by the Highway Research Board, is being conducted to determine the effect of vehicular loads on pavements and bridges of varied design.

Procurement of the test vehicles is being handled by the Bureau of Public Roads of the U. S. Department of Commerce, acting as agent for the Academy-Council. The award supplements the purchase of the trucks and tractors to be used in combination with the semi-trailers and completes procurement of seventy test vehicles ranging from light pick-up trucks to heavy truck-tractor semi-trailers.

The test vehicles will be operated in a total of ten separate test lanes constructed in a series of test loops with sections representing various standards of road and bridge construction. They will apply controlled loads ranging from 2,000 to 30,000 lb for single axles and from 24,000 to 48,000 lb for tandem axles continuously for a period of two years during which each vehicle will be operated 235,000 miles.

The start of controlled load traffic on the test road, on which construction is now nearing completion, is scheduled for late summer.

(*From: "Highways and Bridges and Engineering Works", June 18, 1958*).

3. UNLOADING BAYS IN L.C.C. AREA

NEW PARKING accommodation standards are announced by the town planning committee of the London County Council. Plans for large shops and stores in central areas will have to include provision for car parking facilities in the ratio of one car for every 2,500 sq. ft. of gross floor space. In district and local shopping centres, however, public car parks would be used. Small shops will not normally be expected to provide their own parking facilities. For commercial buildings, special requirements governing the loading and unloading of lorries are laid down. These provide for one lorry space of 500 sq. ft. for every 5,000 sq. ft. of gross floor space, with a minimum requirement of one space, and a maximum requirement of 75 per cent of the site area. To permit maximum freedom of internal design, this single standard covers loading, unloading and waiting space, and no additional loading or unloading space is required. All these standards will be reviewed within the next three years "in the light of experience" and developers may in exceptional circumstances secure relief from the full requirements.

(From: "Modern Transport", June 21, 1958).

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4. RECORDING ROAD PROFILES

● A SPECIALLY-DESIGNED 22-wheel motor-vehicle recently began a survey of the surfaces and profiles of 9,300 miles of highway in the State of Michigan. The work is being carried out, through the University of Michigan, under a 45,000 dollar grant from the Michigan Trucking Association, the American Trucking Associations, and the Automobile Manufacturers Association. The vehicle is provided with 16 small wheels at the front and rear, and these, together with recording wheels in the centre, are used to record the profile of every mile of road, the total surface irregularities per mile, and the difference in elevation between the wheel tracks. Michigan is the second state in the United States to develop such a vehicle. California has a similar one.

The instruments on the vehicle are situated in a second cab, which is directly behind and above the driver's compartment, and the two are linked by an "intercom". At the rear of the vehicle are situated the crew's quarters. Moving from 4 to 5 m.p.h., the vehicle can detect road irregularities as small as 1/32 in. Data are recorded on graphs, which will be used to show the effect of variations in soil conditions, drainage, and construction, as modified by local weather conditions. A camera mounted at the rear of the vehicle photographs each road slab to enable progressive changes, if any, in the crack patterns to be detected. The vehicle also has an arrangement of targets and mirrors to help the driver to remain parallel with the kerb.

(From: "Engineering", July 25, 1958).

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5. MORE ACCENT ON URBAN ROAD IMPROVEMENTS URGED BY R.I.A.

● THE benefits of quicker travelling on motorways and improved trunk roads will disappear if transport encounters serious traffic difficulties when it enters town or urban areas en route to its destination, said Mr. Wallace E. Riche, Chairman of the Roads Improvement Association, speaking at the 71st Annual General Meeting held in London last week.

The road improvement programme now in progress will provide about 100 miles of new trunk roads during the next two to three years. Approximately three-quarters will be motorways—roads reserved exclusively for motor vehicles—and the balance dual carriageways to existing roads, by-passes, new bridges, fly-overs at congested junctions and the like.

These works, however, are less than a tenth of the minimum necessary for the free and safe flow of traffic in normal times and to achieve this, similar improvements and extensions must go forward at an increasing pace for several years ahead.

(From: "Highways and Bridges and Engineering Works", June 11, 1958).

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6. HIGHWAY ENGINEERS AND THEIR TRAINING

● THE definition of roads and highways as a responsibility of the administration has persisted since the earliest times. Probably it first arose pertinently in China, where, about A.D. 700, roads for imperial mounted couriers were maintained at the State expense. The levying of rates for their maintenance has increased ever since, and it is fair to say that in the last 1,250 years, such publicly built and maintained roads have seldom measured up to the traffic using them—the fiscus has always lagged behind his ratepayers. Since roads have, since the earliest times, proved to be of considerable economic, social, political, military and industrial importance, it is natural that they have always enjoyed a good deal of public interest, and up to recent times in this country they have even been the subject of political skulduggery. But now-a-days the technological skill needed to determine correct road locations, and to design roads, is such that only properly trained men can do such jobs.

Problems connected with roads and road traffic to-day demand a high degree of mathematical and statistical skill, financial expertness and legal ability. Even psychologists have to co-operate and Press and Public relations are not the least important aspect of road engineering. The essential engineering tasks themselves have become complicated, too. The road engineer must be at once topographer and geologist, soil physicist and hydraulic engineer, geometer and structural designer, chemist and statistician. Huge demands are made upon his professional ability, not to mention his penchant for getting on with other people, in many walks of life—his histrionic talents, his diplomacy and his far-sightedness.

(From: "African Roads and Transport", May/June, 1958.)

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7. BRIDGE FOR MOTORWAY—ROAD TO BE EXCAVATED

● A New bridge to carry a double-track railway and a 15 ft wide road over a new motorway is to be built by the London Midland Region of British Railways at Carnforth Brow, Lancashire. Work will begin this month. Situated a mile east of Carnforth, the bridge is to be constructed for the Ministry of Transport to carry the Carnforth-Wennington line over the Lancaster by-pass section of the North-South Motorway.

The new bridge, which will have a 73 ft square span across the roadway, has been designed with a steel superstructure consisting of three main girders of welded construction. The centres of the main girders are at 28 ft 6 in. for the railway and at 17 ft for the accompanying road. Cross girders under the railway are broad flange beams made up into welded compounds, and those under the road bridge are rolled steel joists. The deck of the bridge will be of continuous reinforced concrete slabs cast in situ.

The bridge will cross the proposed motorway at an angle of about 60 deg. so that although the square span across the motorway is 73 ft, the bridge girders rest on bearings 85 ft apart. The bearings at one end are of the rocker type. The substructure will comprise vertical abutments and battered wing walls of conventional design constructed of concrete with brick facing.

Method of Erection

The bridge will be erected prior to the construction of the motorway, the final job being the excavation of the earth between the abutments down to motorway level. Initially the tracks will be supported on temporary way beams to enable the abutments and wing walls of the new bridge to be constructed in trenches lined with steel sheet piling. The girder work will be assembled alongside the railway on rolling-in-runways. The completed and waterproofed bridge unit will then be rolled into position and jacked down on its bearings. This will be done during a week-end so as to minimise interference with train services. The motorway will then be excavated beneath the bridge.

The bridge has been designed under the direction of Mr. J. Taylor Thompson, Chief Civil Engineer, London Midland Region. The steel-work contractor is Booth and Sons (Bolton), Limited, and the general contractor Sir Lindsay Parkinson and Co., Limited.

(*From : " Modern Transport ", June 7, 1958.*)

PERSONAL AND MISCELLANEOUS

SHRI M. P. NAGARSHETH, Divisional Engineer (Consultant), Ministry of Transport & Communications (Roads Wing), has been promoted as Deputy Bridges Officer with effect from the 14th July 1958.

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SHRI M. B. LAL, Planning Officer, Ministry of Transport & Communications, Roads Wing, retired from service on the 10th September, 1958.

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SHRI O. SIVASANKARA MUDALIYAR has assumed charge as Deputy Chief Engineer (Highways), Madras with effect from the 12th September 1958.

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SHRI E. A. NADIRSHAH has been appointed as a delegate to the Canadian Sectional meeting of the World Power Conference and the Executive Council for the World Power Conference and the Sixth International Congress on Large Dams at New York. He has already left for U.S.A. and is expected to return to India by the 10th of November 1958.

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The 19th Annual General Meeting of the Delhi Branch of IRTDA was held at Chelmsford Club on the 17th September 1958. SHRI S. K. PATIL, Union Minister for Transport and Communications was the chief guest. SHRI C. V. NAZARETH of the Concrete Association of India is Chairman of the Branch for the current year.

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The Executive Council of the Central Road Research Institute met at Okhla on the 5th September 1958.

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The Study Week on Highway Safety under the auspices of the ECAFE will now be organised in Bombay sometime in July-August 1959 instead of December 1958.

CURRENT LITERATURE

Abstracts

ALLOCATING HIGHWAY COST RESPONSIBILITY ; Bulletin 175, Highway Research Correlation Service, Highway Research Board of the National Academy of Sciences-National Research Council, 2101, Constitution, Washington, D.C.

THIS bulletin contains reports on studies in 5 states presented at the 36th Annual Meeting of the HRB as follows :

" Washington State Highway Cost Allocation Study ", by R. G. Hennes and Willa W. Mylroie, presents a discussion of objectives, procedures, methodology and some of the findings of a 3-year study of highway cost allocation conducted by the Washington State Council for Highway Research through the agency of the University of Washington and the Washington State Legislative Joint Fact-Finding Committee on Highways, Streets, and Bridges.

" Comparative Highway Cost Allocation ; Incremental and other Methods ", by William E. Koenker, developed from a highway cost allocation study in North Dakota, compares the tax assignments to various vehicle type and weight groups which would be made under the ton-mile, the cost function, and the incremental methods of highway taxation ".

" Comparison of Incremental and Ton-Mile Allocation Methods ", by William L. Hall and Ralph D. Johnson, discusses a Montana highway cost allocation study in which a comparative analysis of motor-vehicle tax responsibility was determined by the incremental and ton-mile allocation methods.

" Results of the Kentucky Highway Finance Study ", by James W. Martin, Charles R. Lockyer, and Eugene C. Holshouser, discusses the methods employed and the comparative results obtained in a Kentucky highway cost allocation study. The role of credit financing is also discussed.

" The 1956 Rhode Island Highway Finance Study," by Judson E. Brown and Wayne C. Allinson, discusses the approach used in a "general fund" state to select the method of financing for the proposed long-range state highway program. The question of providing additional assistance to local communities for highway purposes is also discussed.

FLEXIBLE PAVEMENT STUDIES AND GEORGIA DESIGN PRACTICE; Bulletin 177, Highway Research Correlation Service, Highway Research Board of the National Academy of Sciences-National Research Council, 2101, Constitution, Washington, D. C.

This bulletin contains three papers on flexible pavement design as presented at the 36th Annual Meeting of the Highway Research Board.

The first, by Stuart Williams and Allan Lee, describes the pavements studied, the test procedure used, and the results to date on a co-operative program of load-deflection tests of several high-type flexible pavements in Maryland.

The second, by W. F. Abercrombie, describes the basic factors considered and the manner in which they are incorporated into flexible pavement design by the State Highway Department of Georgia.

The third, by Donald M. Burmister, evaluates the pavement system (subgrade, sub-base, pavement) for the AASHO Road Test by layered system methods as developed by the author.

VEHICLE PERFORMANCE AS AFFECTED BY PAVEMENT EDGE LINES AND TRAFFIC SIGNALS; Bulletin 178, Highway Research Correlation Service, Highway Research Board of the National Academy of Sciences-National Research Council, 2101, Constitution, Washington, D. C.

THIS Bulletin contains two papers presented at the 36th Annual Meeting of the Highway Research Board as, follows :

"Platoon Movement of Traffic from an Isolated Signalised Intersection", by Brian J. Lewis. The Paper discusses an investigation of the extent to which motor vehicles remain bunched together when travelling freely down a semi-expressway type of facility after having been formed into platoons by an isolated signalized intersection. A definite pattern of vehicle performance prevails, and a method is suggested for co-ordinating the timing of a second traffic signal to afford less delay to the traffic stream than if allowed to operate in some entirely random manner.

"Pavement Edge Lines on 24-Foot Surfaces in Louisiana", by L. L. Thomas, Jr. It is concluded that the psychological effect on a majority of vehicle drivers is the only benefit from pavement edge lines, and that the tendency of vehicles to move towards the centre of edge-stripped pavements does not appear sufficient to create any abnormal hazard on a 24-ft surface; however, this may not be applicable to narrower pavements.

PRESTRESSED CONCRETE PAVEMENT RESEARCH; Bulletin No. 179, Highway Research Board of the National Academy of Sciences-National Research Council, 2101, Washington, D.C.

THIS bulletin contains three papers presented at the HRB 36th Annual Meeting, as follows:

"Review of French and British Procedures in the Design of Prestressed Pavements", by Phillip Melville, deals with current design practices in those countries. Two-Directional prestressing is most often used, with the amount gradually lowered in recent projects to near 200 psi. Comparison is drawn between the European methods and those used in the United States.

"Theoretical and Practical Aspects of Prestressed Concrete for Highway Pavements", by Thomas Cholnoky, describes the design and testing of experimental prestressed concrete slabs at the Patuxent River Naval Air Station.

"Model Studies of Prestressed Rigid Pavements for Airfields", by Paul F. Carlton and Ruth M. Behrmann, describes studies carried on as part of the Rigid Pavement Investigational Program conducted by the Ohio River Division Laboratories.

AIR PHOTO AND SOIL MAPPING METHODS; APPRAISAL AND APPLICATION: Bulletin No. 180, Highway Research Board of the National Academy of Sciences-National Research Council, 2101, Constitution, Washington, D. C.

THIS bulletin contains two papers on appraisal and application of air photo and soil mapping methods presented at the 36th Annual Meeting of the Highway Research Board, together with a listing of the current USGS activities in geologic mapping throughout the United States and its territories.

Included in the USGS activities listing are tables of available geologic map indexes, projects of the Geologic Division, projects of the Ground Water Branch of the Water Resources Division, and the names and locations of the several State Geologists.

The first paper, by J. D. Mollard and H. E. Dishaw, summarizes data covering ten years of mapping granular construction materials from aerial photographs.

The second paper, by Frank K. Evans, describes the use of soil maps in the operation and planning of the highway facilities of Ingham County, Michigan.

SELECTED RECENT LITERATURE IN ENGINEERING JOURNALS

I. GENERAL

1. **The Sampling of Road Traffic**: JOHN C. TANNER, *Applied Statistics, Vol. VI, No. 3*, November 1957, pp. 1283-1286.

2. **Motorways and Traffic Engineering in Belgium**; *The Surveyor, Vol. CXVI, No. 3425*, December 14, 1957, pp. 1283-1286.

3. **Notes on the German and Italian Autobahns**; M. CAMBOURNAC, *Revue Generale des Routes et des Aerodromes, Vol. 27. No. 310*, November 1957, pp. 65-79 (in French).

4. **Current Practices in Highways for Alleviation of Frost Damage**; J. A. KNIGHT, *Roads and Engineering Construction*, October 1957, pp. 148-156.

5. **A Look at How to Blast Concrete**, *Engineering News Record, Vol. 159; No. 19*, November 7, 1957, pp. 104-105.

6. **The Education of Engineers**; *Concrete and Constructional Engineering, Vol. LII, No. 11*, November 1957, pp. 391-393.

7. **Notes on the Use of Resistance Strain Gauges**: P.H.R. LANE, *The Engineer, Vol. 204, No. 5315*, pp. 812-815.

8. **State Highway Network**: P. SOULTER, *Schweizerische Bauzeitung, Vol. 75, No. 49*, December 7, 1957, pp. 769-777 (in German).

9. **Betterment Levy**; C. S. PARTHASARTHY, *Journal of the Institution of Engineers (India), Vol. 38, No. 4, Part 2*, pp. 327-352.

10. **Economics of Indian Road Construction**; K. F. ANTIA and S. VENKATARAMIAH, *Journal of the Institution of Engineers (India), Vol. 38, Part 1*, pp. 297-305.

11. **The Slipperiness of Road Pavements - Description of Research Apparation**; J. DAUBE, *La Technique Routiere, Vol. 2, No. 3*, September 1957, pp. 117-121 (in French).

12. **The Application of Radio - Active Techniques to Road Problems**; J. HUET, *La Technique Routiere, Vol. 2, No. 3*, September 1957, pp. 122-133.

13. **Car Parking Standards**; *Roads and Road Construction, Vol. 35, No. 416*, August 1957, p. 252.

14. **Revolutionary Road Building Project in Holland**; *Roads and Road Construction, Vol. 35, No. 416*, August 1957, p. 258.

15. **Education and Training for Highway Engineering Employees**; ROBLEY WINFREY, *Traffic Quarterly, Vol. XI, No. 4*, October 1957, pp. 557-572.

16. **Old Roads**; MAXWELL N. HALSEY, *Traffic Quarterly, Vol. XI, No. 4*, October 1957, pp. 580 595.

17. **Technical Training Conducted at Three Levels in Wisension**; R. F. MILHANPT, *Better Roads, Vol. 27, No. 9*, September 1957, pp. 30-31.

18. **Engineering-Aid Training is Training for Advancement**; GENE HUNTLEY, *Better Roads, Vol. 27, No. 9*, September 1957, pp. 31-32.

19. **Engineering-Aid Training is Emphasized in South Carolina**; JASSE A. RUTLEDGE, *Better Roads, Vol. 27, No. 9*, September 1957, p. 32 & 48.

20. **Road - Rating System is Big Help in Many Ways**; DANIEUL H. KUENZTO, *Better Roads, Vol. 27, No. 9*, September 1957, pp. 27-29, 48 and 50.

21. **Report on Investigation of Scour at Bridges Caused by Floods of 1955**; LYLE K MOULTON AND BERNARD E. BUTLER, *Highway Research Abstracts, Vol. 27, No. 8*, September 1957, pp. 14-31.

22. **Financial Management in Construction**; W. C. Bloom, *Civil Engineering, Vol 27, No 10*, October 1957, pp. 58-59.

23. **Motorway Progress in Austria**; C. Francis Armstrong, *Roads and Road Construction, Vol. 35, No 418*, October 1957, pp. 300-304.

24. **Roads in Victoria**; *Roads and Road Construction, Vol. 35, No 418*, October 1957, and *Vol 35, No. 417*, October 1957, pp. 311-315.

25. **Holland-Germany Motorway**; J. F. Springer, *Contractors Record and Public Works Engineer, Vol 9, No. 2*, May 1957, pp. 29-32.

26. **Anchorage of the Roof of Tunnels against Falling**; P. Volumard and A. Bastide, *Travaux, Vol. 41, No. 276*, October 1957, pp. 520-522 (in French).

27. **Everybody's Business-Local Authorities and Local Press**; Frank Staniforth, *The Journal of the Institution of Municipal Engineers, Vol. 84, No. 5*, November 1957, pp. 176-182.

28. **Planning Our National Park Roads and Our National Parkways**; Dadley C. Bayliss, *Traffic Quarterly, Vol. XI, No. 3*, July 1957, pp. 417-440.

29. **Technology and Society**; *The Engineer, Vol. 204, No. 5309*, October 25, 1957, pp. 592-595.

30. **Car Parking: Theory and Practice**; Wilfred Burns, *The Surveyor, Vol. CXVI, No. 3408*, August 17, 1957, pp. 863-866.

31. **Limited Life Design: A Survey of the Problem**; J. A. Pope, B. K. Foster, and N. T. Bloomer, *Engineering, Vol. 184, No. 4773*, August 30, 1957, pp. 275-278.

32. **Construction to the Protective Works against Avalanches**; M. Laboudigue, Introduction by G. Pezet, *Revue Generales, des Routes et des Aerodromes, Vol 27, No. 301*, February 1957, pp. 75-84 (in French).

33. **Meeting Industrial Traffic Demands at Billingham**; *The Surveyor, Vol. CXVI, No. 3414*, September 28, 1957, pp. 1013-1014.

34. **New Highway Laws Enacted**; *Better Roads, Vol 27, No 8*, August 1957, pp. 25 27 and 62-63.

35. **Testing the Reliability of Complicated Machines-Improved Mathematical Model for Photo type Trials**; C. Morris, *Engineering, Vol. 184, No. 4766*, July 12, 1957, pp. 41-44.

36. **Can Britain's Highway Procedure be Streamlined? - A Plea for Modern Thoughts at Legislative Level**; Col. S. M Lovell, *The Journal of the Institution of Highway Engineers, Vol. IV, No. 4*, October 1957, pp. 15-23.

37. **Rail Electrification and Highway Embankments-Co-operation Between Railways and Local Authorities**; *The Surveyor, Vol. CXVI, No. 3418*, October 26, 1957, p. 11-16.

38. **The National Method for Estimating Flood Peaks**; *Irish Constructions to the Technique*, Jame C. J. Dooge, *Engineering Vol. 184, No. 47774*, September 6, 1957, pp. 311-313.

39. **How to Step up Your Design and Drafting Efficiency**; *Engineering News Record, Vol. 159, No 11*, September 12, 1957, pp. 38-39.

RECENT ADDITIONS TO THE LIBRARY OF THE INDIAN ROADS CONGRESS

1. **Symposium on Role of Models in the Evolution of Hydraulic Structures and Movement of Sediment 1952 Publication No. 53**; Central Board of Irrigation and Power, New Delhi.

2. **Symposium on Determination of Costs and Benefits of River Valley Projects 1953, Publication No. 54**; Central Board of Irrigation & Power, New Delhi.

3. **The Application of Electrical Analogy of the Design of Hydraulic Structures, Publication No. 55; Dr. V. I. Vaidhia, July 1954**, Central Board of Irrigation & Power, New Delhi.

4. **River Behaviour, Control and Training (Synopsis)**; July 1954, Central Board of Irrigation & Power, New Delhi.

5. **New Projects for Irrigation and Power in India-1954 Popular Series Fourth and Revised Edition Leaflet No. 3**; Central Board of Irrigation and Power, New Delhi.

6. **B.S. 1198, 1199 & 1200: 1955, Building Sands from Natural Sources**; British Standards Institution, British Standards House, 2, Park Street, London W. 1.

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BUDGETS AND ADMINISTRATION REPORTS

MADRAS STATE BUDGET FOR 1958-59

The following extracts relating to Civil Budget Works have been taken from the Madras State Budget for the year 1958-59.

Revenue

Heads	Actuals 1956-57	Revised Estimate 1957-58	Budget Estimate 1958-59
	In lakhs of Rupees		
Rents	8.25	7.71	4.58
Receipts from workshops	0.57	1.12	1.00
Recoveries of expenditure	71.36	31.90	29.04
Grants from Government of India for the development of State Roads of economic or inter-State Importance	24.00	12.54	20.17
Ferry-receipts-Highways Deptt	1.71	0.20	0.20
Tolls on roads	...	0.38	0.88
Subventions from the Union Government for Development scheme	*	*	17.50
Miscellaneous (including Receipts in England)	26.90	16.58	13.83
Deduct-refunds	-4.06	-0.88	-0.88
Total	128.73	69.55	86.32
Expenditure			
Buildings			
Original works	15.49	29.26	41.00
Repairs	38.16	37.61	35.53
Communications			
Original works	-7.32	18.83	25.72
Repairs	221.51	207.84	222.73
Miscellaneous			
Original works	9.31	0.01	0.01
Repairs	1.03	1.94	1.89
Development schemes	52.61	...	...
Suspense	0.19	8.96	2.62
Lump sum deduction for probable savings	...	-3.29	-2.04
Lump addition for regrant of lapses	...	0.10	0.10
Add recoveries	319.42	330.02	225.06
Establishment	79.92	95.69	88.48
Tools and Plant	41.27	29.81	29.67
Charges in England	0.01	0.01	...
Total	771.60	756.79	670.77

* Included under Miscellaneous

Capital Outlay on Civil Works Outside the Revenue Account

Heads	Actuals 1956-57	Revised Estimate 1957-58	Budget Estimate 1958-59
	(Rupees in lakhs)		
Buildings	60.51	193.96	259.29
Communications	2.26	56.13	57.35
Miscellaneous	2.63	3.32	13.03
Establishments	0.11	0.25	...
Tools and Plant	39.94	13.80	6.84
Grants-in-aid	40.88	47.56	38.53
Development Schemes	40.00	...	...
Lump sum deduction for probable savings	...	-28.56	-33.18
Lump sum addition for regrant of lapses	...	0.20	0.20
Add-recoveries	...	15.08	31.73
Total	186.33	301.74	373.79
Revenue from Roads			
Receipts under the Indian Motor Vehicles Act	33.94	25.15	20.19
Receipts under the Madras Motor Vehicles Taxation Act	339.05	349.14	355.61
Receipts under the Motor Vehicles (Taxation of Passengers and Goods) Act, 1952	65.13	72.40	75.85
Other receipts	2.02	0.02	0.02
Receipts under the Madras Sales of Motor Spirit Taxation Act, 1939.	107.87	110.06	110.06
Deduct-refunds	-2.41	-1.71	-1.65
Total	545.60	555.06	560.06

MADRAS STATE BUDGET FOR 1958-59

(A brief review with reference to Civil Works)

THE estimated revenue receipts of the State for the year 1958-59 is Rs 6,390.28 lakhs. The expenditure on revenue account is estimated at Rs 6,375.53 lakhs resulting in a surplus of Rs 14.75 lakhs. The revised estimate for 1957-58 showed a revenue of Rs 6,041.07 lakhs and expenditure of Rs 6,036.24 lakhs on revenue account with a consequent surplus of Rs 4.83 lakhs.

Expenditure on civil works during 1958-59 is estimated at Rs 670.77 lakhs, which form 10.5% of the total State revenue. The corresponding ratio of previous year was 12.5%. Out of the total revenue expenditure on civil works, communications, (original works and repairs) account for 3.8% of estimated revenue for 1958-59, while it was 3.8% for 1957-58 (revised estimate). The provision for capital expenditure on civil works outside the revenue account is estimated at Rs 373.79 lakhs for 1958-59, while the revised estimate for the same for 1957-58 is Rs 301.74 lakhs.

LIST OF APPROVED WORKS ON NATIONAL HIGHWAYS

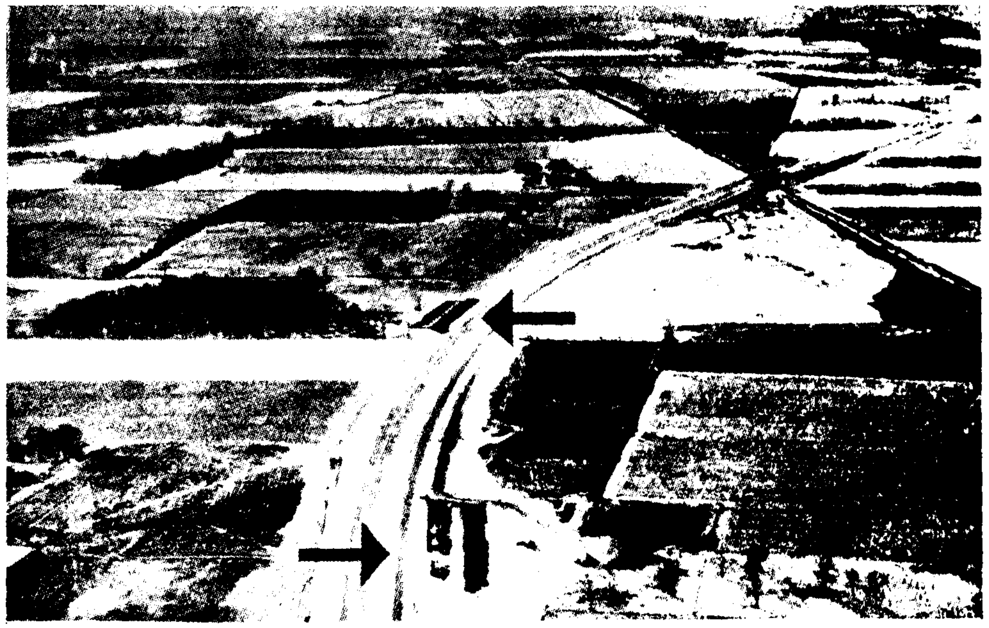
Sr.No.	Job No.	Name of Work	Amount (Rs in Lakhs)
		BOMBAY	
1.	1911 BM 8 A	Surface dressing in mile 9/2 to 18/5 of the Kandla-Chirai Section of the Kandla Ahmedabad National Highway No. 8-A.	2.96
		JAMMU & KASHMIR	
2.	1916 JK 1 A	Construction of bridge over Maghar Khad on Pathankot Jammu Road.	4.73
		ORISSA	
3.	1913 RS 5	Improvement to National Highway No. 5 miles 745/3 to 755/5 (Dual Carriageway) between Cuttack and Bhubaneswar.	3.28
		RAJASTHAN	
4.	1914 RJ 8	Construction of a bridge across Khajuri River at mile 19/27 of Bichiwara-Ratanpur Section of National Highway No. 8.	1.25
		UTTAR PRADESH	
5.	1912 UP 24	Widening miles 11-19 of Lucknow-Bareilly Road National Highway No. 24 in Lucknow District.	5.50
		WEST BENGAL	
6.	1910 BG 34	Construction of approach road to the bridge over the river Bhagirathi on National Highway No. 34 near Berhampore.	13.77

side parks. However, location of parks will also be governed by other factors besides spacing, such as, adequate and pure water supply; existing topography of ground which would hold grading operations to a minimum and would also make possible the construction of approaches on easy grades; a location having natural drainage and not subject to floods; having sufficient trees, desirable but not essential; locations with historical significance; locations having scenic value or providing lookouts over unusual scenery; high volumes of traffic at certain portions of the route; and value of land to be acquired.

Sites adjacent to interchanges are not recommended due to so many other features, such as route markers and directional signs, distracting the driver's attention away from the roadside park.

There is a common consensus amongst authorities that roadside parks should not be located near municipalities, but there is a wide difference of opinion as to the minimum distance they should be located away from the municipality. This varies between 2 and 10 miles. The committee recommended a minimum distance of 3 miles be maintained.

The committee recommended that a minimum area of 3 acres be provided for a park site. At the present time, it is not legal for the state to award concessions for gasoline stations and restaurants. Up to this time, no long stretches or limited access highways have been built, resulting in practically no public demand for such facilities. The committee feels that after such stretches have been built, the public will demand that such facilities be provided. However, the committee is of the opinion that roadside parks should be kept apart from gasoline stations and restaurants. It has been found where such facilities are combined they have not proved too successful, as the intended use by the travelling public for one facility is not compatible with the intended use for the other. Most vehicles will park around the restaurant and filling station, requiring extra large parking areas to be constructed at this point. The park area adjacent to these establishments is subjected to heavy usage, making it very difficult to maintain vegetation, whereas the balance of the park area receives very little use.



FIRST roadside rests to be constructed on the new Interstate System in the United States are located on U. S. 25 east of Piqua, Ohio: Arrows point to the two parks, one for each travel direction

The committee recommends that on four, or more lane divided limited access highways, that roadside parks be constructed in pairs. If it is not found to be feasible to construct these directly across from each other, the park on the right hand side of the road travelling in either direction should be located ahead of the park on the left hand side. This will reduce the number of median crossings by drivers attempting to pull into the first roadside park encountered. On two-lane limited access highways with right of way being provided for future additional two lanes divided, the committee recommends that the park adjacent to the first two lanes be constructed, and that the right of way be concurrently acquired for the park on the other side. On two-lane limited access, the committee recommends that a park be provided on one side only. Rights of way for parks should be purchased at the same time that the road right of way is acquired.

Construction of a single roadside park in the median in place of constructing a pair of parks was considered but thought inadvisable. It would induce traffic to turn into and off the high-speed lanes, induce other hazardous traffic movements and introduce problems in alignment. This plan would be unquestionably cheaper but it was thought that safety in this case was more important than lower initial construction costs and more economical maintenance.

(From: "Highway Magazine", May/June, 1958.)

ARITHMETIC

He: *"Women can't keep secrets."*

She: *"Yes, they can. I've kept my age a secret since the day I became 25."*

He: *"But one day you'll let it out".*

She: *"No, I won't. If I can keep a secret for nine years, I can go on keeping it."*

TRAFFIC FLOW AT ROUNDABOUTS—A *REVIEW OF THEORY AND PRACTICE*

By

B. G. MANTON, B.SC. (ENG.), D.I.C., A.M.I.C.E., M.INST. H.E.

(*Continued from previous issue*)

THEORETICAL analyses of the weaving which occurs at roundabouts have been given by Watson and Royal-Dawson.

Watson deals separately with cars and larger vehicles. In the latter case he assumes a vehicle length of 25 feet and considers two such traffic units separated laterally by what is called a "gauging distance" of 20 feet and travelling, initially, at 10 miles per hour on converging paths, as shown in Fig. 1. It is then assumed that vehicle A maintains this speed and vehicle B is slowed at the rate of 1 mile per hour per second. After 6 seconds A will have travelled 88 feet and

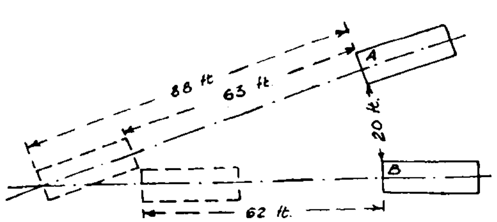


Fig. 1

B, now moving at 4 miles per hour, will have travelled 62 feet. If the length of vehicle A is deducted from the distance travelled it is apparent that the front of B and the rear of A will be practically in contact at this instant of time. However, A, running at 10 miles per hour will draw away from B and latter will obtain more and more clearance. After 1 second it will be nearly 10 feet and after 2 seconds nearly 20 feet. B can thus begin to accelerate back to its original speed.

It is deduced from this that large vehicles could weave if evenly spaced at 6 second intervals under the given conditions of speed, deceleration rate, and angle of convergence. This would be equivalent to a flow of 600 vehicles per hour in each lane, or a total of 4,200 vehicles per hour through one intersection.

The assumed conditions are somewhat artificial and Watson suggests that 85 per cent of the theoretical flow should be taken as a practical figure.

For traffic streams composed entirely of cars, Watson states that "there should be a 4 seconds interval between successive vehicles in each converging stream if they are to intersect safely and without holding over an accumulation. This means that two streams of 900 vehicles per hour can intersect under favourable conditions." The same method as before is used in arriving at this figure, but the approach speeds are assumed to be 12 miles per hour and the speed after deceleration 6 miles per hour, the rate being 1½ miles per hour per second.

The practical weaving capacities for one intersection point are stated to be 1,500 vehicles per hour for 100 per cent small vehicles and 1,200 vehicles per hour if the traffic flow includes 25 per cent of large vehicles, equivalent to 750 and 600 vehicles per hour per lane respectively.

Royal-Dawson approaches the question in rather a different way. He assumes that the "maximum practical capacity" of a traffic lane, 10 feet wide, is 1,000 vehicles per hour, but considers that on a roundabout the number for estimating purposes should be restricted to 800. It is interesting to note that Royal-Dawson suggested this figure as far back as 1936.

Twenty years later the Road Research Laboratory conducted an experimental investigation of roundabout capacities at Northolt airfield and among the conclusions resulting therefrom Wardrop has reported that "*High flows of the order of 800 mixed motor vehicles per hour per 10 feet of weaving width, can be accommodated in a weaving section of normal dimensions under ideal conditions (daylight, good weather, no pedal cycles, etc.)*"

Royal-Dawson next assumes that 800 vehicles will travel through the roundabout at a uniform speed and with uniform spacing and calculates the headways measured from the front of one vehicle to the front of the preceding vehicle, at different speeds.

This distance is readily found, of course from the formula $H = \dfrac{5280 \,.\, V}{N}$ where N is the flow in vehicles per hour, V is the speed in miles per hour and H is the headway in feet.

Thus, at 15 miles per hour the headway is 99 ft, at 10 miles per hour 66 feet, and at 5 miles per hour 33 feet.

The weaving of vehicles 20 feet long and 6 feet wide, with a converging angle of 45 degrees, is now considered and it can be shown that weaving is possible at 10 miles per hour whereas at 5 miles per hour it is not.

If we imagine a vehicle of the stated dimensions crossing a 10-feet lane, as shown in fig. 2, at A, it will be apparent that the distance travelled in clearing this lane is approximately 20 feet plus the length of the vehicle, or about 40 feet in all. At 10 miles per hour the time taken to travel this distance is nearly 3 seconds. A second weaving vehicle, B, approaching the lane, will have to travel 26 feet before the lane is again obstructed and it will therefore be clear for nearly 2 seconds. The occupied length of the lane during weaving is about 18 feet and this could be cleared in slightly over 1 second at a speed of 10 miles per hour. Hence a vehicle travelling along the lane at this speed could get through if correctly positioned relative to the weaving flow. There would, however, be little to spare either in time or space.

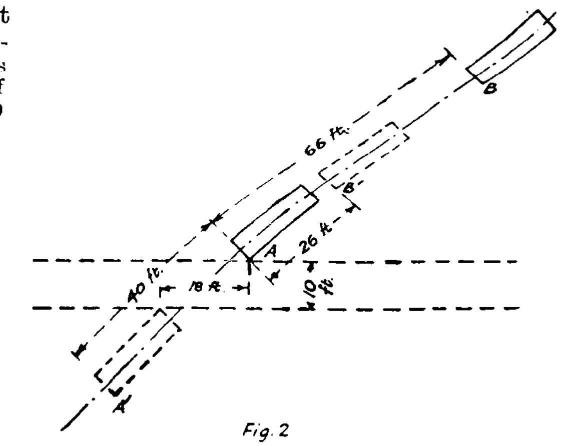


Fig. 2

If both streams are moving at 15 miles per hour with a headway of 99 feet the land will be occupied by vehicle A for slightly less than 2 seconds and there will then be an interval of nearly 3 seconds during which the lane is clear, giving ample time for a correctly placed vehicle travelling along the lane to get through. At 5 miles per hour, however, with a headway of only 33 feet, the lane is never completely clear of the weaving vehicles.

In this connection, Rao and Barber correlated headway and speed from studies of traffic flow carried out by post-graduate students of Imperial College, London. There is evidence from these investigations that the linear headway/speed curve, derived from what may best be described as "normal" driving practice, is a straight line within the range 5 to 45 miles per hour, as shown in Fig. 3.

The time headway/speed curve shows a rapid diminution as speed increases, tending towards a fairly constant value at speeds over 30 miles per hour.

This elementary arithmetical analysis emphasises the fact that there is a minimum traffic speed below which a roundabout will not function satisfactorily. Both Watson and Royal-Dawson show that adequate gaps must be left between vehicles if smooth working is to be achieved, but this requisite is often ignored by many drivers who adopt the pernicious practice of following the vehicle in front practically bumper to bumper at low speeds.

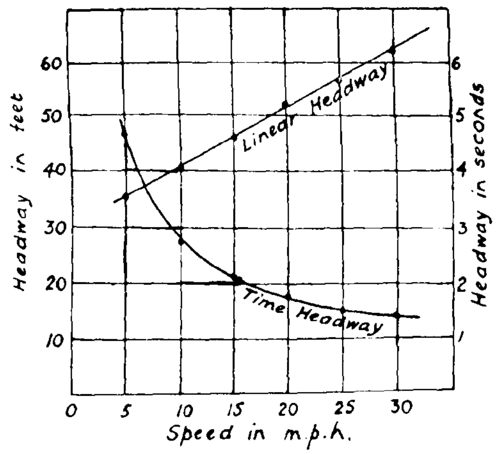


Fig. 3.

Watson's analysis also points to the fact that roundabouts would function more efficiently if there were a mandatory ruling that drivers must give way to traffic approaching them from the offside, this direction of approach being clearly visible from the driving position, unlike converging streams from the nearside which are so often hidden from view.

SPEED AND CAPACITY

Royal-Dawson has not extended his simple analysis to weaving angles other than 45 degrees and it is rather instructive to do so. If, for example the weaving angle is 15 degrees the distance traversed in crossing the lane is 82 feet and the length of lane occupied during the crossing is 62 feet. With a traffic speed of 15 miles per hour the lane will be partially or totally blocked during nearly 4 seconds and will be free for nearly 1 second, but this gives insufficient time for a vehicle travelling along the lane to get through. At 20 miles per hour, however, the headway would be 132 feet and weaving would be just possible, while at 25 miles an hour and a headway of 165 feet weaving becomes quite easy.

These figures, as they stand, indicate that the flatter the weaving angle, the faster can vehicles converge with safety, and Watson points out that the smaller the weaving angle the faster can vehicles converge with safety.

Both the analytical methods of Watson and Royal-Dawson are, of course, based on artificial assumptions. No traffic flows, unless under some form of control, obey the disciplined and meticulous arrangements as to speed and headway which have been assumed. Nevertheless the results, when compared with the Road Research Laboratory's practical investigations, indicate that the theoretical capacities can be obtained under certain circumstances, but requires a reduction factor to cover the idiosyncrasies of individual drivers which may include almost every undesirable characteristic from an aggressive contempt for other people's rights down to sheer stupidity. This factor must also take into account such imbecilities as the location of zebra crossings close to the exits of the circulating carriageways.

The findings of these two pioneers of traffic engineering also emphasise the necessity of designing roundabouts on sufficiently spacious lines to enable circulating traffic to move at speeds within the region of 15 to 25 miles per hour.

Some 300 vehicles were timed by the writer when negotiating a three-quarter turn, or 270 degrees, on a roundabout with a circular island 250 feet in diameter. The average radius at which traffic circulated was 133 feet and 87 per cent of the vehicles travelled round this arc at speeds between 17 and 25 miles per hour when given a reasonable clear run. The corresponding centrifugal ratios are within the range 0.15 and 0.30 and it appears that the radius of the turning circle may be related to the speed in accordance with the formula $V^2/gr = 0.25$, frequently used in curve design.

(to be continued)

(From "Highways and Bridges and Engineering Works," April 30, 1958.)

THE VELSEN TUNNEL

A New Link between north and south Holland

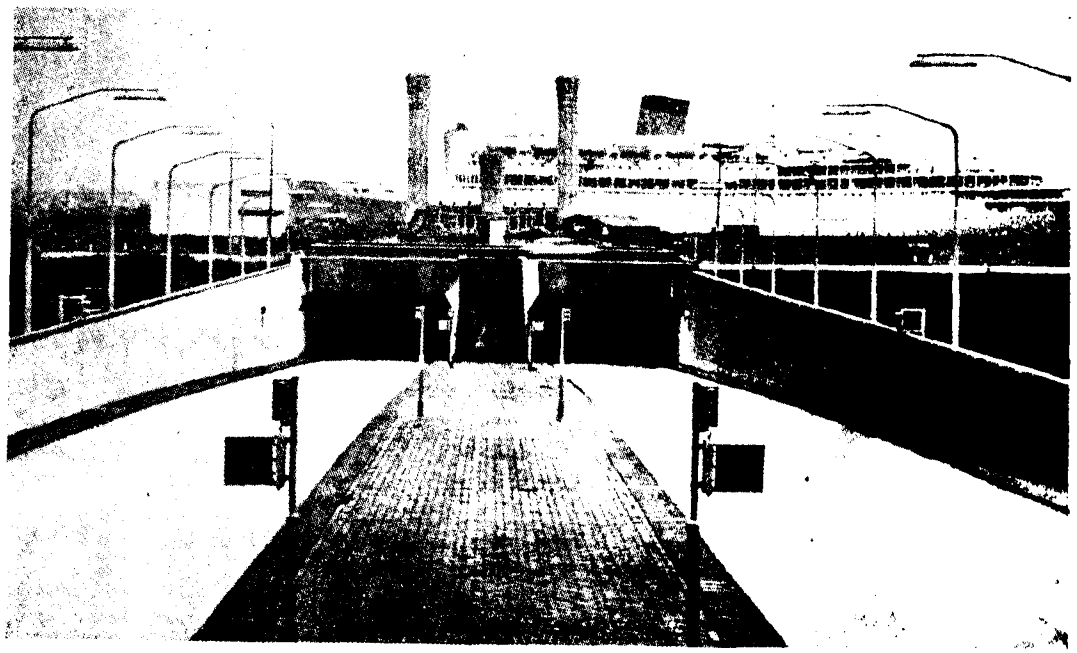
QUEEN Juliana of the Netherlands opened the Velsen Tunnel to traffic on Saturday, September 28th, 1957. This tunnel runs under the North Sea Canal, the important shipping artery which connects Amsterdam, Holland's second port, with the North Sea at Ijmuiden. It consists, in fact, of two collateral concrete tunnels, one for motor and one for railway traffic. The railway tunnel replaces the railway swing bridge which was an obstacle to navigation. The road tunnel, for motor traffic only, forms a much-needed link between north and south Holland, supplementing the ferry which had become inadequate for the greatly increased industrial traffic. Work on the tunnel, begun in 1941, was discontinued in 1942 and not started again until 1952. At a total cost of 13 million pounds, this scheme represents a major civil engineering feat, involving the excavation of over three million cubic yards of soil and the placing of approximately 445,000 cubic yards of concrete.

The lengths of the railway and road tunnels, including approaches, are respectively 3,530 yd. and 1,800 yd.: the road tunnel has two carriageways in separate compartments, with powerful ventilation plants installed on both sides of the canal. These facts give some measure of the task involved. The method of construction chosen was that of open excavation, an unusual procedure for deep tunnels but less expensive than the more usual shield method. Here open excavation was possible because the greater part of the site is in open ground and the geological formation down to 52 ft, below New Amsterdam Level is chiefly fine sand mixed with silt, and therefore easily workable.

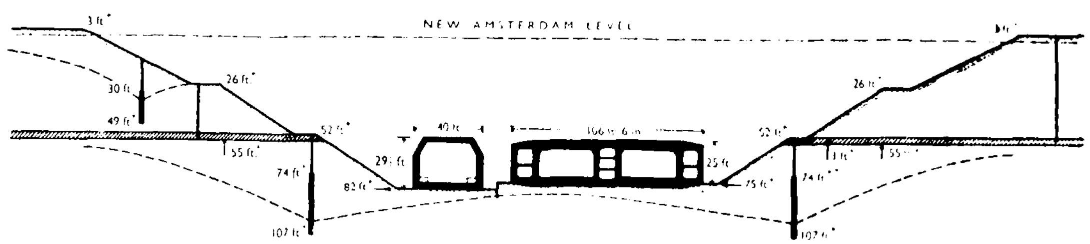
Considerable difficulties did, however, arise in excavation. The gradient of the road tunnel is 1 : 28.5, that for the rail tunnel is 1 : 60, but they both had to be the same depth of 76 ft below New Amsterdam Level at their lowest level, in order to allow for the deepening of the North Sea Canal to 51 ft and for sufficient soil cover still to be left over the tunnels. A complicating factor in achieving this depth was the existence of a 3 ft layer of clay at 52 ft, which separates the salt water above it from the fresh water below. As this fresh water supplies the surrounding area, it was essential that the clay seal should not be permanently destroyed, nor the salt water allowed to contaminate the fresh water during construction. Special precautions were therefore taken over pumping operations. This was done by creating three stages of well points, instead of only one, and by pumping in three stages so that there would be no danger of water bursting through the clay layer owing to too much pressure. Steel sheet piling was also used to penetrate the clay and seal off the ground water from the fresh water during excavation. The clay removed in the excavation was carefully replaced above the tunnels on completion of the work.

The North Sea Canal was widened between 1930 and 1940 except for that portion to the east of Velsen where the tunnel was to be built, and the construction of the tunnel was linked with the widening of this last section of the canal as it was essential that the canal be kept open for shipping at all times, construction took place in four stages. First, an excavation was made to the south, extending across the peninsula left when the rest of the canal was widened. This part of the tunnel was completed, and earthed over. The next stage consisted of widening the southern part of the canal, so that shipping could be diverted into it. Earthed embankments were then made in the northern half of the canal, and the second half of the tunnel constructed between them. Finally these embankments were removed by dredging and the whole canal was opened to shipping.

The 840 yd-long covered part of the motor tunnel is 106 ft 6 in. wide exter-



Entrance to the motor tunnel: in the background, the towers of one of the ventilation buildings, and a ship in the North Sea Canal

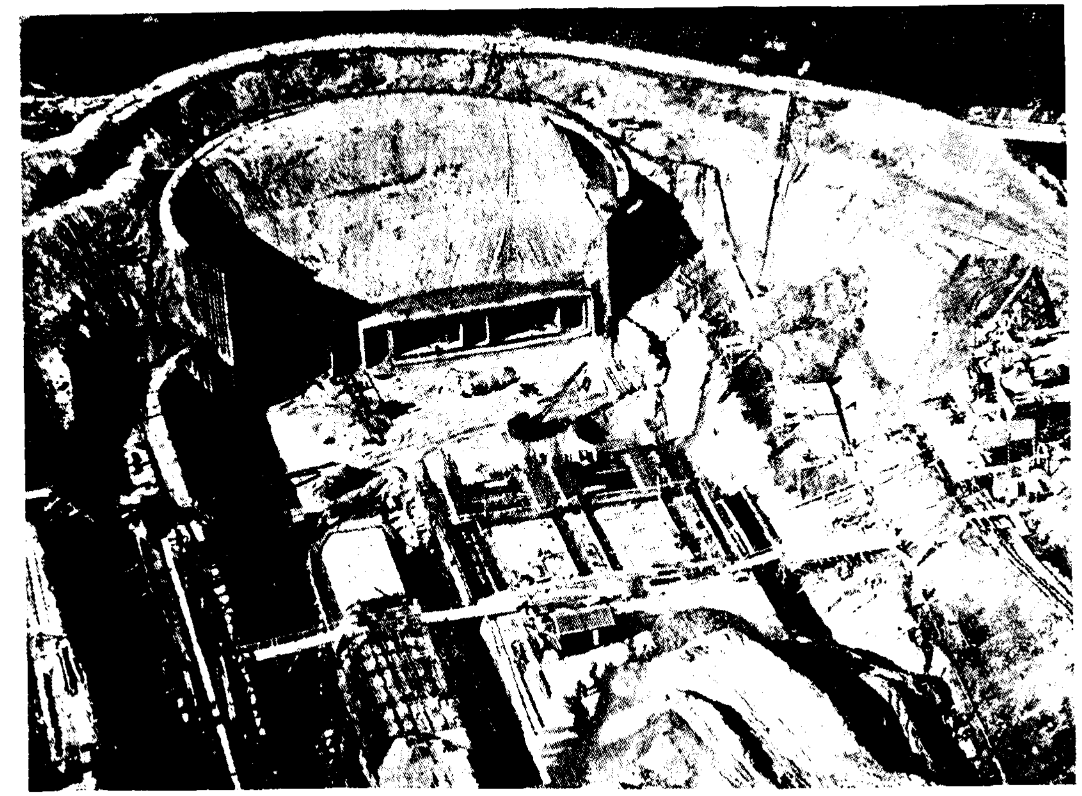


Cross-section of the excavation, of the railway tunnel and of the motor tunnel with its twin compartments.

nally by 25 ft high. Its two internal compartments are 31 ft wide by 13 ft 9 in. high with a road width of 23 ft. Each road has a footpath on either side, which helps to dispel the unpleasant sensation of being too close to the wall when driving and there is also a 6 in.-wide, open channel between each pavement and the wall to facilitate cleaning.

Several unusual ideas have been incorporated in the design to solve the problems of ventilation, noise and lighting. In order to keep the tunnel as shallow as possible, thereby reducing excavation costs, a transverse ventilation system is used. The inlet ducts are placed in the middle of the tunnel body, with an upper and a lower channel for each roadway. The outlet ducts are to the right of the carriageways, where most of the exhaust gases concentrate. They are all connected to the roads by branch ducts. The northern and southern halves of the tunnel each have their own ventilation plant, situated at a quarter and at three-quarters of the length of the covered part of the tunnel.

Noise and the claustrophobic conditions tend to heighten the nervous tension of drivers in a tunnel. In Velsen noise has been reduced by inclining the tunnel walls slightly outwards so that the sound goes up, and by installing small perpendicular screens in the roof every 30 ft, to



The start of the tunnel sections in the building pit of the southern excavation

prevent sound transmission. Noise reduction and good lighting have in one respect gone hand in hand. It was found that more uniform lighting of the carriageway would be achieved with a dark roof than a light one and this made possible the provision of a sound-absorbent lining which would not have stood up to the cleaning required with a light roof. The side walls are painted a soft yellow-green, a colour which has almost as good light-reflecting properties as white, but is much easier on the eyes. The combination of this colour with the black roof is also supposed to offset feelings of claustrophobia.

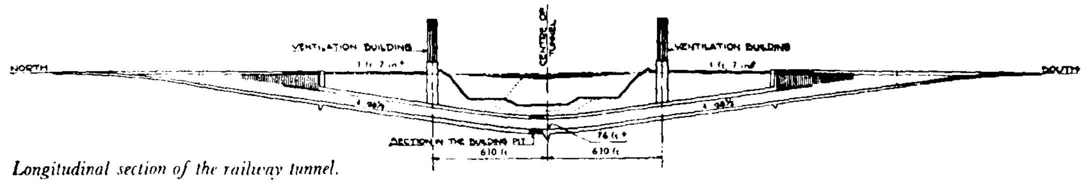
The covered part of the tunnel is lit with fluorescent tubes, fitted in pairs in recesses hollowed out in the roof at 15 ft intervals. These light fittings are placed so that their centre lines are just outside the centre lines of the traffic lanes, in order to influence drivers to keep well out to the right in the nearside lane and well out to the left when overtaking.

The north-south aspect of the tunnel has meant a particular problem in lessening the abruptness of the change from daylight to artificial light. Perhaps the most novel feature of the tunnel design is the way in which this has been done. The tunnel walls run on for about 150 yds. of the 480 yd.-long open approaches. As the height of these walls is greater than the clearance required over the carriageways, a lattice of precast, prestressed concrete elements has been constructed to act as an awning and make the transition in lighting gradual. The units serve also to strut the walls and are prestressed together from the side of the tunnel on the Dywidag system, using 26 mm. diameter bar. Each unit is about 11 ft deep and 6 in. wide and is inclined at 60 degrees to the line of the roadway. They are spaced approximately 6 ft 6 in. apart and give grid openings of about 6 ft 6 in. by 3 ft 3 in., measured across and along the axis of the roadway respectively. Black in colour at the tunnel entrance, they merge gradually through shades of grey into white at the open end of the approach.

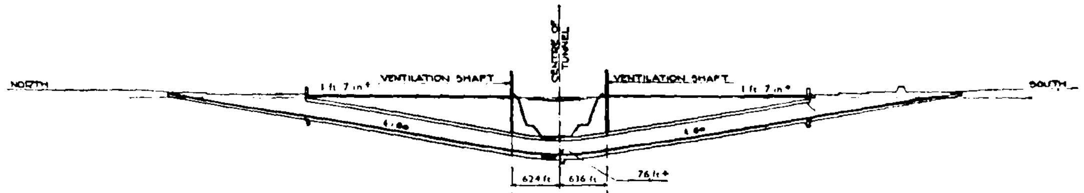
The covered portion of the railway tunnel is a mile and a quarter long, and is 40 ft wide by 23 ft high externally. It has an internal area of 30 ft by 18 ft, and accommodates a double-track electric railway with inspection paths, 3 ft 6 in. in width, on either side. In contrast to the road tunnel, it presented no particular difficulties in the lay-out of services. It is not artificially ventilated, as, with electrification, the air currents set up by the trains, aided by two vertical shafts placed at one-third and two-thirds of the tunnel length, are considered adequate ventilation.

from the central weigh-batching and mixing plant to the building site in 'Henschel' trucks, and then either placed by four pumps, each a capacity of 20 cu. yd. an hour, or taken to the forms by conveyor belt. Swedish 'Vibro' poker vibrators were used to compact the concrete. The 30 mm. diameter reinforcing bars were welded together into one long bar by a special welding machine and then cut to the required length.

Each tunnel was constructed in 60 ft sections and the bottom half was placed first. The upper parts were cast in a single operation, and the largest amount of concrete placed at one time was in the construction of each of these upper sections.



Longitudinal section of the railway tunnel.



Longitudinal section of the motor tunnel.

Movable steel forms, developed from the 'Blaw-Knox' system, were used in building the tunnels. They were made up of panels 40 in. by 19½ in., joined together by special units. When the concrete had set the vertical walls of the inner formwork were pulled inwards, lowered and moved on; the outer formwork was then also moved on.

The tunnels took over 100,000 tons of cement and 35,400 tons of reinforcing steel in their construction. The cement and aggregates were all transported to the site by ship; the cement was unloaded by a 'Fuller' cement pump, with a capacity of 25-30 tons an hour, and the aggregates by bucket-crane with a capacity of 160 tons an hour.

The concrete was mixed in two 1 cu. m. capacity mixers which together produced 78 cu. yd. an hour; it was transported

Nearly 2,600 cu. yd. of concrete was necessary for this operation, which took place about once a month, and went on continuously throughout the 24 hours.

Both tunnels are surrounded by a watertight protective covering of asphaltic bitumen in which two layers of wool felt and asbestos felt are incorporated. Additional insulation is provided at the joints between the tunnel sections by layers of copper foil. The asphaltic bitumen has a further covering layer of 5 in. of reinforced concrete.

The Directie Sluizen en Stuwen (locks and dams directorate) of the Rijkswaterstaat was responsible for the design of the Velsen tunnel and also for supervising its construction. The main contractor was N. V. Amsterdamsche Ballast Maatschappij.

(From: "Concrete Quarterly", January-March, 1958).

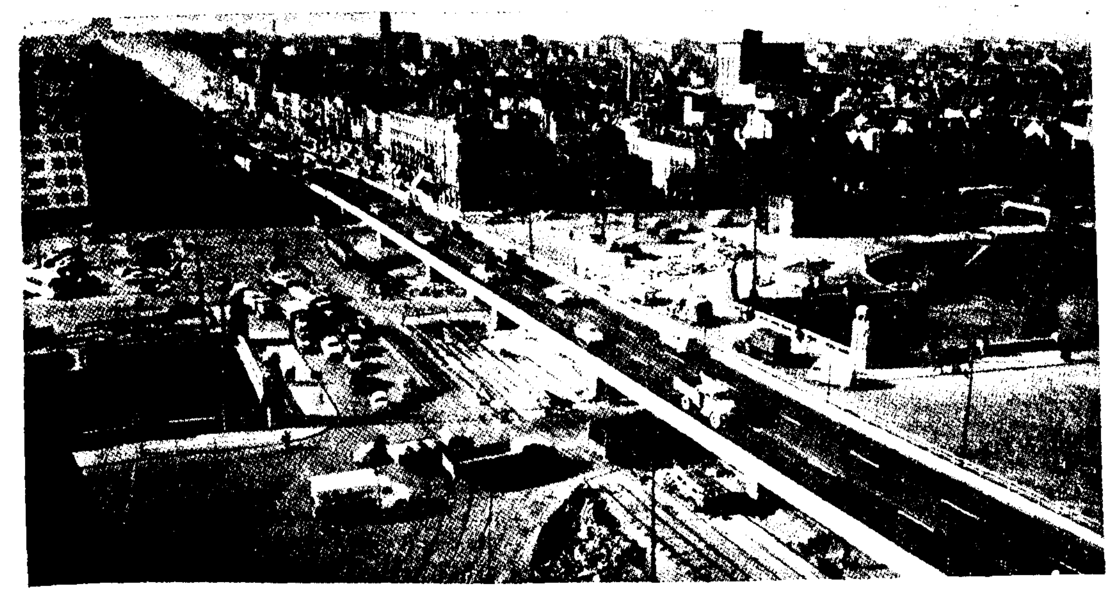
HERE AND THERE

1. BRUSSELS FAIR SPOTLIGHTS

Belgian Road Advance

● VISITORS from throughout the world will throng to Brussels during the 1958 summer months. The magnet is the World's Fair being staged at Heysel Park. The 450 acre spectacle located near Lacken Royal Palace will have five main sections Belgium, Belgian Congo, Foreign, International and Folklore. A feature of the Belgian section is the daring Atomium Structure—some 360 ft high, symbolizing the theme of the fair.

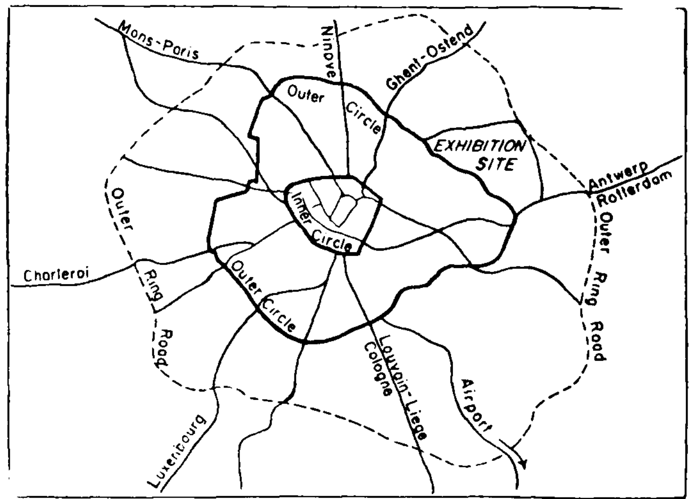
As with all West-European countries since the war, Belgium has seen a tremendous growth of motor vehicle ownership and traffic movement. Over 115,000 motor vehicles from outside Brussels daily enter the city, joining the 125,000 vehicles locally registered. To relieve growing congestion and provide for the future, three rings of express roads are planned in and around the metropolitan city. The outer circle, some 4.5 miles outward from the centre is now partly constructed. It will include wide boulevards built to modern design standards.



Viaduct at Place Saincteletle, one of the express facilities completed in Brussels' Postwar program. (United Press Photo.)

Important tunnels, viaducts and over-crossings for the other belt routes also have been completed. The Charleroi Canal, for example, is crossed with a prestressed concrete viaduct 2,400 ft long.

Or, the engineer or contractor visiting Brussels might wish to inspect the two-level cross-overs, constructed at Place de



Sketch of the inner, middle and outer belt of express highways planned for Brussels and environs: Considerable construction to modern design standards has been completed: more is planned to keep up with traffic growth.

la Justice and the Boulevard St. Lazare to relieve a jam created by the wide route built previously over the North-South Railway junction tunnel. The novel framing here embodies Preflex beams (wide-flange steel beams with tension areas encased in concrete during deflection).

Other construction examples are pictured here, courtesy of G. N. Balbachevsky, Editor of Acier-Stahl-Steel.

(From: "World Construction", May, 1958.)

2. RADIO FOR MAINTAINING SASKATCHEWAN ROADS

● A new two-way radio communication system has been installed by Saskatchewan's highway department, designed to increase the operating efficiency of the maintenance branch of this Canadian organization.

The service is expected to maintain fast direct contact between head office and the district personnel. The latter in turn will be able to speak with the operators of units functioning within the district area. The new system involves three base stations. Receiving sets have been installed in 15 units such as snow plows, roving patrols and cars driven by supervisory personnel.

If the results obtained warrant doing so, the system will be extended to ten base stations, serving the entire provincial highway system. At such time there will be from 100 to 125 vehicles or equipment units equipped with two-way radios. Branches of the department of highways other than maintenance will also have the facilities of this communication system placed at their disposal.

Similar two-way communication systems are being operated by highway departments in Ontario and British Columbia, as well as in various American states. They have demonstrated considerable savings in time and costs, and have increased the efficiency of road maintenance activities, particularly under winter conditions.

(From "World Construction," May, 1958).

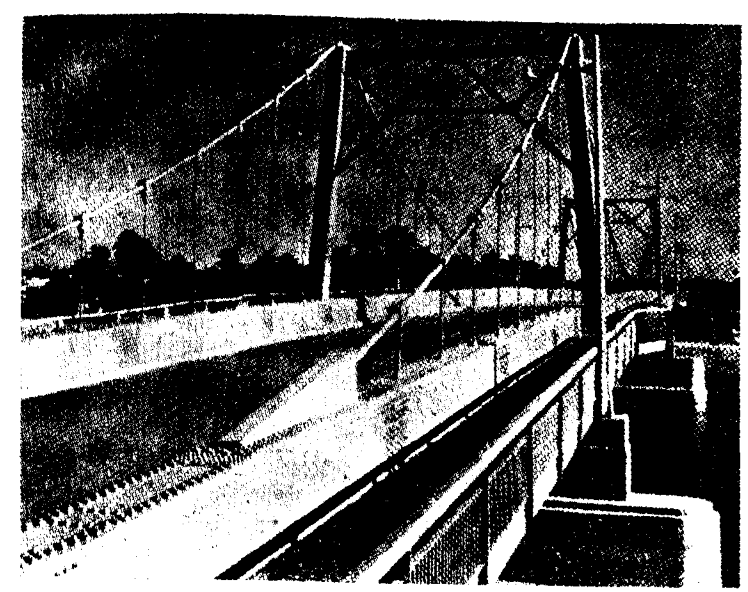
3. SUSPENSION BRIDGE FOR IRAQ

Important Highway Link Over Euphrates

● THE first modern suspension bridge in Iraq was opened recently at Samawa, a developing township on the banks of the Euphrates about half-way between Baghdad and Basrah. The bridge carries the highway on the western route between the capital and the port and provides an important link in the new trunk road programme of the Iraq Development Board. The contract for the construction of embankment approach roads, piled abutments and river piers and the entire superstructure, including 800 tons of steelwork, was awarded to Sir William Arrol and Co., Ltd. and Posford, Pavry and Partners of London were appointed by the Iraq Development Board as consulting engineers for design and construction.

The new suspension bridge is of the self-anchoring type. There is a clear span between abutment bearings of about 527 ft. The supporting towers positioned at the "quarter points" give a clear navigational opening of about 245 ft, and the clear head-room under the bridge at maximum recorded flood level is 16½ ft. The carriageway, suitable for two lanes of traffic, is 26 ft wide, and two footways, each 6 ft wide, are cantilevered out from the main girders.

These main girders are box form 85 in. deep by 29 in. wide with ½ in. thick web and flange plates connected to 8 by 6 by ¾ in. corner angles. The steel box section towers are splayed to enable the main girders to pass inside the legs while carrying the cables immediately over the vertical centre lines of the girders and they are hinged at their bases over the piers so as to be free to take any inclination dictated by the cables. The main girders are carried on fixed trunnion bearings at the south abutment, on trunnion links at the north abutment and at the lower cross girders of the towers, and the whole of the expansion is allowed for at the north abutment with a flat plate type expansion joint. All the steelwork is high tensile steel.



The new bridge carries two-lane traffic 527 ft over the river.

The suspension cables each contain 270 galvanised high tensile steel wires 0.276 in. diameter gathered together into a hexagonal cross-section. For protection, the completed cables were given a sealing coat of barium chromate paste and then tightly bound with 10 gauge soft iron wire, which was subsequently painted along with the remainder of the structure. From the last hanger the wires splay out to their anchorages and this portion was given protection by pouring hot bitumen around them completely to encase them. The cable hangers are formed from $1\frac{1}{8}$ in. diameter steel bars fixed to the girders by trunnions to obviate any tendency for the hangers to be subjected to bending due to relative movement between the girder and cable. Provision for carrying services is made under the footways and access manholes are built into the pavement construction, but the lighting cables for the sodium lighting on the bridge are carried in the handrails.

(From: "Highways and Bridges and Engineering Works", June 25, 1958).

4. DEADLY MEDICINE

● THE frightful danger of alcohol to drivers was stressed in an article published in the current issue of the British Medical Journal. The authors are three members of the Department of Psychology of Manchester University who urged a stringent tightening up of the regulations concerning the taking of alcoholic drinks and driving. They consider that any drink, however slight, is dangerous and advise that measures taken to reduce traffic accidents "must forbid the taking of alcohol for some specified period before driving".

These conclusions are based upon the results of tests carried out on a group of Manchester bus drivers. The tests consisted of giving various quantities of whisky, and they then had to estimate how successful they would be in driving a bus through gaps of different widths. Having made the estimate, they drove the bus through particular gaps. The results showed that as they consumed more whisky they were prepared to drive through a narrower gap, and that they needed a wider gap before they could drive the bus through it without touching the posts on either side. Correlating their findings with the concentration of alcohol in the blood, it was found that the trustworthiness of a man's judgment of his driving skill was impaired even after a small amount of alcohol producing a blood alcohol level lower—than 0.5 mg. per millilitre—a level considered to be safe by the United States National Safety Council. The menace to public safety, they say, "comes particularly from those who after a slight amount of alcohol, feel they are sober, or believe they are driving more cautiously".

(From: "Engineering", June 27, 1958.)

5. LIGHTWEIGHT PORTABLE SEISMOGRAPH

● A NEW portable seismograph which forms a radical departure from the conventional instrument which has been a basic tool in sub-surface investigations for more than 20 years, has been announced by Hunting Technical and Exploration Services Ltd. This firm is associated with Ronka Geophysical Instruments Ltd., Canadian distributors of the manufacturer, Geophysical Specialities Co. of Minneapolis. The new equipment, made possible by advances in electronics during the last few years, is said to solve problems as accurately as the older equipment and at a fraction of the cost. The heavy initial and operating costs of the former equipment often discouraged its use. Other difficulties included the size and weight of even the smallest of the conventional units; the necessity for using dynamite (dynamite is only necessary now for depths of 50 ft or more, and for water crossings); the awkwardness of photographic recording with the need for

a portable dark-room; and the difficulty of keeping a complete unit and crew on stand-by ready for immediate action.

The new seismograph is not designed to replace the conventional equipment but rather to solve a group of problems which are relatively simple geologically but exceedingly important economically.

The seismograph works on the principle that sound waves generated by a sledgehammer or detonating cap will follow sub-surface paths which depend upon the nature of and depths to the formation. The equipment measures accurately the time taken for the waves to travel from the sound source through the sub-surface layers and back to a detector on the surface.

The equipment consists of a console approximately a foot and a half by half a foot by nine inches, cables and a miniature geophone. With the sledge-hammer it weighs less than 20 lb. It can be operated by two men and because of portability and lack of wet batteries, motors, etc. is ideally suited to poorly accessible areas so common in engineering and mining applications.

The basic requirement for the use of the Model MD is that the speed of the sound waves be substantially greater in the bedrock than in the overlying material. Comparing velocities it has been found that lower velocities are associated with loose, poorly consolidated materials and the higher velocities with harder rocks and well-consolidated materials. Typical overlying materials through which depths to bedrock can be determined include alluvium, glacial till, tundra, soil and weathered rock. The bedrock may be granites or other crystallines, but can equally well be limestone, hardpan, compact tills or other well consolidated materials.

A water table can be mapped also, if it occurs in a porous and poorly compacted formation.

The location of bridge foundations is an engineering use of the seismograph.

For dam site location it is often possible by use of the seismograph, to reject proposed sites with relatively little work by showing the absence of solid rock suitable for foundations.

(From: "Highways and Bridges and Engineering Works," June 11, 1958.)

6. JAPAN EXPRESSWAY

● STEPS have been started by the Japanese Construction Ministry to build the Project Nagoya-Kobe expressway by 1960. Total construction cost for the 4-lane super-highway is (U. S.) 220. 3 million dollars.

When completed, according to the International Road Federation, the road will be 115.5 miles long and have a design speed of 75 mph. The Ministry is seeing financing from three sources, a 78 million dollars World Bank loan, a central government appropriations and a public bond issue.

(From: "World Construction," May, 1958).

7. TRAVEL STAGGERING DISCUSSED IN NEW YORK

● NEW YORK City administration authorities, in conjunction with the New York city Transit Authority and the City Planning Commission, are investigating staggered hours to relieve peak-hour travel to and from the metropolis. The transit authority has already tried, without significant success, to get mid-town businesses to stagger employees' hours. The city fathers are endeavouring to ascertain which businesses could advance or retard their starting and finishing times by upto 30 min.

(From: "Modern Transport," June 28, 1958).

NOT MAN SLAUGHTER?

I was a competent driver, sure,
Self assured, with intentions pure.
My thoughts may have been of home,
Or pleasures, to which all are prone.

Then something happened, quick as a flash,
I could not stop, he came in a dash.
A sickening thud, I screeched to a halt,
My heartbeat quickened, was this my fault?

He lay there still, a bundle of rags,
A boy about five, my hopes then sagged.
A careless moment, a speed too fast,
Had cut off a life, his hopes now passed.

Life dear to him, troubles not known,
Was ne'er to know honor or renown.
A mother's love will guide no more,
The footsteps of her boy's decor.

Of blame, police made it quite clear:
No charge was placed, no more to fear.
The speed I used to greet my wife,
I never thought would take a life.

Take this tip and reduce your speed,
'Twill be your gain if you take heed.
No price is on those seconds saved,
But life, most dear, can't be repaid.

Grant me a steady hand and watchful eye,
That none shall be hurt when I pass by.
Suffer those who share the road with me,
Golden Rule Safety as taught by Thee.

Teach me to use my car for others' need,
Nor miss through love of speed.
The beauty of Thy world: that thus I may,
With care and Safety, serve Thy way.

Elmer Wolf,
Formerly Mayor,
Cuyahoga Falls, Ohio.

(From: "The American City," May, 1958.)

CURRENT LITERATURE

ABSTRACTS

NATURAL BUILDING STONES-FIVE STANDARDS ISSUED; Indian Standards Institution, New Delhi.

WHILE it is recognized that certain differences would continue to exist in the practices followed in different parts of the country on account of the variation in a natural material like stone, it is felt that the laying down of some uniform requirements for dimensions and workmanship of natural building stones would assist the building stones industry in contributing largely to the rationalization of the building industry as a whole.

In 1957 the Indian Standards Institution published an Indian Standards IS: 1121–1957 covering methods for Determination of Compressive, Transverse and Shear Strengths of Natural Building Stones. Recently, the Institution has published the following Standards dealing with natural building stones:

1. IS: 1122–1957, Methods for Determination of Specific Gravity and Porosity of Natural Building Stones.
2. IS: 1124–1957, Method of Test for Water Absorption of Natural Building Stones.
3. IS: 1125–1957, Method of Test for Weathering of Natural Building Stones.
4. IS: 1126–1957, Method of Test for Durability of Natural Building Stones.
5. IS: 1127, Specification for Dimensions and Workmanship of Natural Building Stones.

These form a part of a series of standards being prepared by the Institution to cover important characteristics of natural building stones providing guidance regarding their use.

IS: 1122-1957 lays down the procedure for determining true specific gravity, apparent specific gravity and porosity of natural building stones. IS: 1124-1957 lays down the procedures for testing water absorption of natural building stones. IS: 1125-1957 lays down the procedure for testing natural building stones for effects of weather. IS: 1126-1957 lays down the procedure for testing the durability of natural building stones.

IS: 1127-1957 lays down the requirements for dimensions and workmanship for natural building stones. Dimensions recommended are based on 10 cm module in accordance with the principles of modular co-ordination for dimensional standardization in building industry. This specification has been prepared after an extensive survey of building stones industry in India. Considerable data, through a questionnaire, were received with regard to types of stones, their quality, dimensions and workmanship. It showed appreciable variation in the practices followed in the country from one part to another.

ANALYSES OF SOIL FOUNDATION STUDIES; Bulletin 173, Highway Research Correlation Service, Highway Research Board of the National Academy of Sciences, National Research Council, 2101, Constitution, Washington, D. C.

THE expanded highway programme emphasizing the system of inter-state highways will doubtless call for higher, more massive embankments than heretofore. Some of the embankments, particularly in coastal areas, will of necessity be constructed over soft foundation soils that present special problems in design and construction.

Cognizant of these possibilities, two HRB Committees (Stress Distribution in Earth Masses, and Survey and Treatment of Marsh Deposits) sponsored the five papers presented in this Bulletin. These five papers concern the following facets of the over-all problem of design and construction over soft foundation soils.

1. Magnitude and time-rate of settlement due to compression strains.

2. Forces developed in piling due to negative skin friction as consolidation takes place in a soil layer through which a pile penetrates in passing to a firm, less compressible stratum.

3. Four methods used in constructing embankments over marsh deposits. These include the control of rate of placement and use of berms; the removal of soft compressible material; the displacement of weak soil by the embankment; and the installation of vertical sand drains.

4. Review of the use of vertical sand drains over a period when design changed from an empirical approach to one based on theoretical concepts.

5. Simplified explanation of the theory and related computations for estimating fill subsidence on soft foundations.

A TENTATIVE METHOD FOR THE DETERMINATION OF THE ORIGINAL WATER CEMENT RATIO OF HARDENED CONCRETE; A. W. Brown, Journal of Applied Chemistry, Vol. 7, Pt. 10, pp. 565-572, October 1957, Society of Chemical Industry, Belgrave Sq., London, S. W. 1.

THE strength of concrete is greatly influenced by the water-cement ratio used in mixing the concrete before placing. In the examination of samples of hardened concrete, a knowledge of the original water-cement ratio is, therefore, most desirable. This cannot be found only by chemical analysis because normally much of the original water has evaporated leaving voids within the concrete as a continuous capillary porosity.

The method described involves the determination of the capillary porosity on a dried sample of concrete by refilling it with an organic liquid and measuring it as an increase of weight and calculating the equivalent amount of water. The cement and combined water contents of the sample are determined by analysis. From these figures, making an allowance for any carbonation which has taken place, the original water-cement ratio can be calculated.

Experiments have been carried out which show that errors which might arise due to air-entrainment, accidental or deliberate, are negligible if the procedure outlined is followed. Possible effects of porous and calcareous aggregates are discussed.

STUDIES IN COMPOSITE DESIGN OF STEEL BEAM AND CONCRETE BRIDGE DECKS: Bulletin No. 174, Highway Research Correlation Service, Highway Research Board of the National Academy of Sciences-National Research Council, 2101, Constitution, Washington, D. C.

THE two papers in this bulletin were presented at the 36th Annual Meeting of the Highway Research Board.

The first, by I. M. Viest, R. S. Fountain, and C. P. Siess, outlines the background and development of the new "AASHO Specifications for Composite Steel and Concrete Bridges". It is intended as an aid in familiarizing design engineers with the specifications and as a record for future specification writers.

The second paper, by Bruno Thurlimann, describes testing of a composite beam structure using different types of shear connectors. On the basis of the results tentative design recommendations are made regarding use of steel shear connectors.

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1. **Gravel Base Roads in Northern Rhodesia, Design, Construction and Maintenance**: G. Rawlings Pape, *The Surveyor, Vol. CXVI, No. 3393*, May 4, 1957, pp. 489-492.

2. **Datum Selection in the Drawing Office—Functional Requirements, Interchangeability and Production Methods**: L. P. Wakefield, *The Engineer, Vol. 203, No. 5284*, May 3, 1957, pp. 675-677.

3. **Snow**; E. W. H. Wallis, *The Journal of the Institution of Highway Engineers, Vol. IV, No. 2*, April 1957, pp. 17-39.

4. **Heavy Haulage by Road Transport**; E. G. Milne, *The Journal of the Institution of Highway Engineers, Vol. IV, No. 3*, April, 1957, pp. 50-65.

5. **The Impact of Laboratory Engineering on Road Making**; G. R. Forrester, *The Journal of the Institution of Highway Engineers, Vol. IV, No. 2*, April, 1957, pp. 66-79.

6. **The "Bicycle" Problem and Cycle Paths**; Victor Bourgeois, *Revue Generale des Routes et des Aerodromes, Vol. 27, No. 303*, April, 1957, pp. 75-85 (In French).

7. **Landscape Study of the Southern Autoroute of Lille**; Jean P. Bernard, *Revue Generale des Routes et des Aerodromes, Vol. 27, No. 303*, April, 1957, pp. 57-72 (In French).

8. **Eight-Tenths Mile of City Express way for 95 Million Dollars**; *Engineering News Record, Vol. 158, No. 20*, May 16, 1957, pp. 48-52.

9. **New 97-Mile Motorway for the Midlands and North West**; *Highways and Bridges and Engineering Works, Vol. XXIV, No. 1187*, April 24, 1957, pp. 1 & 3.

10. **A Road Reconstruction Scheme in the Highlands—Notes on its Preparation**: F. Davidson and A. I. Herbert, *The Journal of the Institution of Municipal Engineers, Vol. 83, No. 11*, May 1957, pp. 370-374 *and Roads and Road Construction, Vol. 35, No. 414*, June 1957, pp. 168-170.

11. **New Cloverleaf Autobahn Junction at Frankfort**; Fritz Kind, *The Surveyor, Vol. CXVI, No. 3395*, May 18, 1957, pp. 540-541.

12. **Future Developments in Level Crossing Protection — Continental Practice Reviewed in Transport Ministry Report**; *The Surveyor, Vol. CXVI, No. 3394*, May 11, 1957, pp. 509-510.

13. **The Skid-Wheel—A New Method of Moving Heavy Loads on Soft Ground**; E. R. Stables, *Engineering, Vol. 183, No. 4754*, April 19, 1957, pp. 494-497.

14. **Landscaping: Full Partner in Turnpike Designs**; *Engineering News Record, Vol. 158, No. 24*, June 13, 1957, pp. 62-64.

15. **Country Bus Garage Design, L.T.E. Standard for New Towns**: *Modern Transport, Vol. LXXVII, No. 994*, June 15, 1954, p. 10.

16. **Improved Method of Particle Size Analysis**: T. H. Hughes, *The Engineer, Vol. 203, No. 5289*, June 7, 1957, pp. 860-864.

17. **Keeping a Needs Study up-to-date**; *Better Roads, Vol. 27, No. 6*, June 1957, pp. 37, 38, 60 & 62.

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19. **The Luider Lee Reclamation**; *The Engineer, Vol. 203, No. 5292*, June 28, 1957, pp. 997-999 part I.

20. **Management is Hampered by Bad Technical Writing Training, and Qualifications are needed**; I. M. SLADE AND B. C. BROOKES, *Engineering, Vol. 184, No. 4769*, August 2, 1957, pp. 137-138.

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28. **Synthetic Storm Pattern for Drainage Design**; C. J. KEIFER AND H. H. CHU, *Proceedings of the American Society of Civil Engineers, Hydraulics Division, Vol. 83, No. HY 4*, August, 1957, Paper No. 1332, pages 1-25.

29. **Dutch Motor Road**; *The Engineer, Vol. 204, No. 5307*, October 11, 1957, pp. 540-541.

30. **Predicting the Registration of Proleum-Fueled Motor Vehicles**; ALLEN KEITH GILBERT, *Traffic Engineering, Vol. 27*, April 1957, pp. 320-321.

31. **Civic Design**; PROF. R. J. GARDNER MEDWIN, *The Journal of the Institution of Municipal Engineers, Vol. 83, No. 12*, June 1957, pp. 385-389.

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33. **The Design of Alignments for Mountain Roads and Improvement Works**; W. B. JEPSON, *Civil Engineering, and Public Works Review, Vol. 52, No. 611*, May 1957, pp. 542-546.

34. **The Luider Lee Reclamation**; *The Engineer, Vol. 204, No. 6565*, July 12, 1957, pp. 63-66.

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39. **Road Construction—Concrete and Flexible Methods Compared**; W. E. I. ARMSTRONG, *The Journal of the Institution of Municipal Engineers, Vol. 84, No. 6*, December, 1957, pp. 201-206.

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1. **"Make Way Ahead" (The Case for A National Authority)**: British Road Federation Ltd., 4-A, Bloomsbury Square, London W. C. I.

2. **New Zealand Ministry of Works Statement including the Departmental Annual Report of the Commissioner of Works & The Divisional Reports of the Engineer-in-Chief, Govt. Architect, Director of Housing Construction and Chief Mech. Engineer also including the Annual Report of the Soil Conservation and Rivers Control Council, 1955**; Hon. W. S. Goosman, Ministry of Works, P. O. Box 8013, Govt. Building, Wellington, New Zealand.

3. **Country Roads Board Forty-First Annual Report for year ended 30th June, 1954**: Country Roads Board of Victoria Exhibition Building, Carlton N. 3, Australia.

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7. **Surveying—Theory and Practice, 1954**: P. A. Krishnaswami, The Author, 33, Velacheri Road, Selaiyur, Tambaram, Chingleput Distt., (Madras State.)

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BUDGETS AND ADMINISTRATION REPORTS

GOVERNMENT OF KERALA, CIVIL WORKS BUDGET 1958-59

The following extracts relating to Civil Works have been taken from the Government of Kerala Budget for the year 1958-59.

Revenue (Civil Works)

Head	Revised Estimate 1957-58	Budget Estimate 1958-59
	In lakhs of Rupees	
Rents	3.25	3.50
Receipts from workshops	0.02	0.02
Recoveries of expenditure	1.30	1.50
Grants-in-aid from Government of India towards construction of roads of economic or inter-state importance	22.00	19.00
Miscellaneous		
(i) Sale of avenue trees	2.00	2.00
(ii) Special Tolls	0.40	0.45
(iii) Aid from Government of India under the village Road Development co-operative scheme	0.45	0.73
(iv) Other items	23.00	23.00
Deduct-refunds	-0.30	-0.30
Total	52.12	49.90

Expenditure (Civil Works)

Original Works		
Buildings	21.65	8.18
Communications	57.39	70.26
Miscellaneous	1.00	—
Repairs	104.00	104.78
Establishment	51.39	54.43
Tools and Plant	19.00	20.00
Grants-in-aid	3.00	3.00
Suspense	130.00	100.00
Total	387.43	360.65

Heads	Revised Estimate 1957-58	Budget Estimate 1958-59
	In lakhs of Rupees	
Capital Account of Civil Works outside the Revenue Account		
Original Works		
Buildings	164.13	141.46
Communications	87.00	89.88
Miscellaneous	37.00	36.25
Establishment	21.00	25.00
Tools and Plant	1.00	2.00
Total	310.13	294.59
Revenue from Roads		
Receipts under the Indian Motor Vehicles Act	7.00	6.00
Receipts under the State Motor Vehicles Taxation Act	125.37	153.00
Receipts under Non-motor Vehicles Act	5.00	5.00
Taxes on Motor spirit	47.63	47.00
Other receipts	0.08	0.10
Deduct - refunds	-0.45	-0.30
Total	184.63	210.80

GOVERNMENT OF KERALA CIVIL WORKS BUDGET

(A brief review)

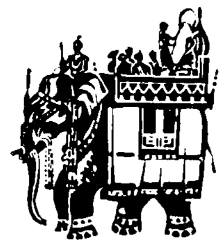
THE budget estimate of the Government of Kerala for the year 1958-59 indicates revenue receipts of Rs 3362.44 lakhs against revenue expenditure of Rs 3417.27 lakhs leading to a deficit of Rs 54.83 lakhs. The revised estimate for 1957-58 placed revenue receipts at Rs 2967.88 lakhs and expenditure at Rs 2987.57 lakhs with a deficit of Rs 1969 lakhs.

The expenditure on civil works for 1958-59 is estimated at Rs 360.65 lakhs which works out to 10.7 per cent of the total state revenue. It was Rs 387.43 lakhs in 1957-58 (Revised estimate) which amounted to 13.1 per cent of the State revenue in the corresponding year.

Apart from the revenue expenditure a sum of Rs 294.59 lakhs has been provided for civil works on account of capital expenditure outside the revenue account for the year 1958-59 as against Rs 310.13 lakhs for 1957-58 (Revised estimate). Rs 89.88 lakhs have been provided for communications under this head for the year 1958-59.

LIST OF APPROVED WORKS ON NATIONAL HIGHWAYS

Sr.No.	Job No.	Name of Work	Amount (Rs in Lakhs)
		ANDHRA PRADESH	
1.	1902 AH 7	Removing hump and eliminating work in mile 48/2-4 of Kurnool Gooty Section of National Highway No. 7.	0.25
2.	1904 AH 5	Upgrading the Section from Tadepalligudem to Peravali miles 4/2 to 19/4 of Tadepalligudem to Khandavalli Road on diversion of National Highway No. 5 in West Godavari Distict.	6.44
		BOMBAY	
3.		Two works each costing less than 2 lakhs.	0.90
		DELHI	
4.	1905 DLH 1	L/O planting of hedge on central strip of the bye-pass connecting National Highway No. 1 with National Highway No. 2 from Rajghat to Mathura Road.	0.25
		JAMMU & KASHMIR	
5.	1901 JK 1-A	Construction of buildings near the North & South portals of the Jawahar Tunnel at Banihal for boring, the bulldozers and their personnel.	0.70
		KERALA	
6.	1906 KR 47	Improvements to National Highway No. 47 in Kerala State—Trivandrum-Quilon Road miles 22/0 to 25/0.	3.70
		PUNJAB	
7.	1909 PB 2	Constructing bye-pass at Hodel on Delhi Mathura Road (Second phase) providing additional Road crust and premix carpet.	1.58
		UTTAR PRADESH	
8.	1908 UP 24	Widening of miles 242-239 of National Highway No. 24, Lucknow-Bareilly Road (mile 64-67).	3.73



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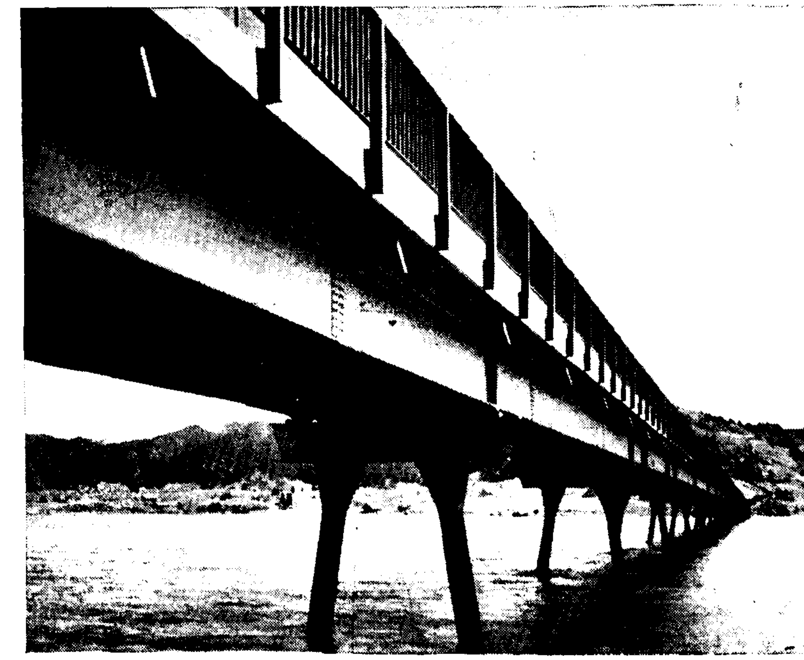

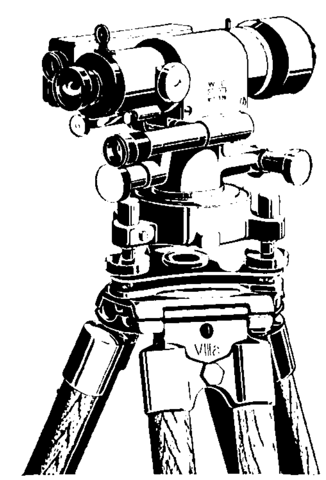

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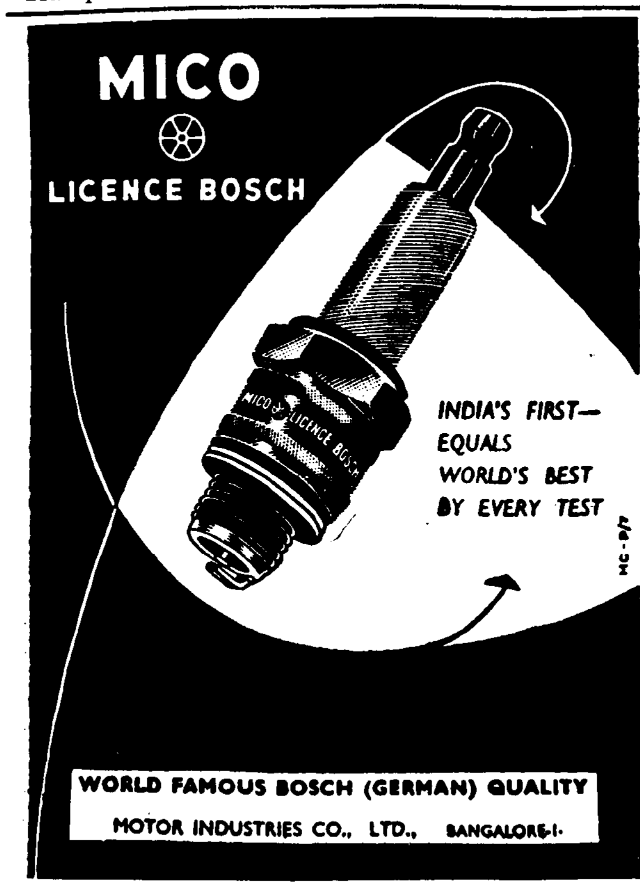
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