

# TRANSPORT- COMMUNICATIONS

MONTHLY REVIEW

JULY 1960—No. 159

86



INDIAN ROADS CONGRESS, NEW DELHI

# SOME SELECTED PUBLICATIONS OF THE INDIAN ROADS CONGRESS

available for sale:

| Name of publication                                                                                            | Price (including postage, etc.) |           | Rs                       | pP |
|----------------------------------------------------------------------------------------------------------------|---------------------------------|-----------|--------------------------|----|
| 1. Vol. XII (Bound)                                                                                            | ...                             | 1947-1948 | 12                       | 00 |
| 2. Vol. XIII-3                                                                                                 | January                         | 1949      | 3                        | 00 |
| 3. Vol. XIII -parts 1 & 2 (Bound)                                                                              | ...                             | 1948-1949 | 5                        | 50 |
| 4. Vol. XIV (Bound)                                                                                            | ...                             | 1949-1950 | 8                        | 00 |
| 5. Vol. XV (Bound)                                                                                             | ...                             | 1950-1951 | 9                        | 00 |
| 6. Vol. XVI (Bound)                                                                                            | ...                             | 1951-1952 | 8                        | 00 |
| 7. Vol. XVII (Bound)                                                                                           | ...                             | 1952-1953 | 9                        | 00 |
| 8. Vol. XVIII-3                                                                                                | January                         | 1954      | 3                        | 00 |
| 9. Vol. XVIII-4                                                                                                | March                           | 1955      | 3                        | 00 |
| 10. Vol. XIX (Bound)                                                                                           | ...                             | 1954-1955 | 10                       | 00 |
| 11. Vol. XX (Bound)                                                                                            | ...                             | 1955-1956 | 9                        | 00 |
| 12. Vol. XXI-1                                                                                                 | February                        | 1957      | 3                        | 00 |
| 13. Vol. XXI-2                                                                                                 | March                           | 1957      | 3                        | 00 |
| 14. Vol. XXI-3                                                                                                 | April                           | 1957      | 3                        | 00 |
| 15. Vol. XXI-4                                                                                                 | December                        | 1957      | 3                        | 00 |
| 16. Vol. XXI (Bound)                                                                                           | ...                             | 1956-1957 | 10                       | 00 |
| 17. Vol. XXII-1                                                                                                | November                        | 1957      | 3                        | 00 |
| 18. Vol. XXII-2                                                                                                | December                        | 1957      | 3                        | 00 |
| 19. Vol. XXII-3                                                                                                | December                        | 1957      | 3                        | 00 |
| 20. Vol. XXII-4                                                                                                | November                        | 1958      | 3                        | 00 |
| 21. Vol. XXII (Bound)                                                                                          | ...                             | 1957-58   | 13                       | 00 |
| 22. Vol. XXIII                                                                                                 | November                        | 1958      | 3                        | 00 |
| 23. Vol. XXIII-2                                                                                               | December                        | 1958      | 3                        | 00 |
| 24. Vol. XXIII-4                                                                                               | October                         | 1959      | 3                        | 00 |
| 25. Vol. XXIV-1                                                                                                | October                         | 1959      | 3                        | 30 |
| 26. Vol. XXIV-2                                                                                                | November                        | 1959      | 3                        | 00 |
| 27. Vol. XXIV-3                                                                                                | December                        | 1959      | 3                        | 00 |
| 28. Vol. XXIV-4                                                                                                | January                         | 1960      | 3                        | 00 |
| 29. Road Research Bulletin No. 1                                                                               | ...                             | ...       | 5                        | 00 |
| 30. Road Research Bulletin No. 2                                                                               | ...                             | ...       | 5                        | 00 |
| 31. Road Research Bulletin No. 3                                                                               | ...                             | ...       | 5                        | 00 |
| 32. Road Research Bulletin No. 4                                                                               | ...                             | ...       | 5                        | 00 |
| 33. Road Research Bulletin No. 5                                                                               | ...                             | ...       | 5                        | 00 |
| 34. Road Research Bulletin No. 6                                                                               | ...                             | ...       | 5                        | 00 |
| 35. Proceedings of the Chief Engineers' Conference at Nagpur on the Post-war Road Development in India         | ...                             | ...       | 2                        | 62 |
| 36. Recommended Practice for Numbering Bridges and Culverts                                                    | ... Re                          | 0 50      | Plus Packing and Postage |    |
| 37. Dimensions and Weights of Road-Design Vehicles                                                             | ... Re                          | 0 50      |                          |    |
| 38. Recommended Practice for Location and Layout of Roadside Motor-Fuel Filling Stations                       | ... Re                          | 0 50      |                          |    |
| 39. Type Designs for Furlong & Boundary Stones                                                                 | ... Re                          | 0 50      |                          |    |
| 40. Type Designs for Highway Milestones                                                                        | ... Re                          | 0 50      |                          |    |
| 41. Route-Marker Signs for National Highways                                                                   | ... Re                          | 0 50      | Including postage        |    |
| 42. Standard Specifications and Code of Practice for Road Bridges, Section I—General Features of Design (1956) | ... Re                          | 0 75      |                          |    |
| 43. Standard Specifications & Code of Practice for Road Bridges, Section II (1958)—Loads & Stresses            | ... Re                          | 2 50      |                          |    |
| 44. I.R.C. Paper No. 167—"Design of Small Bridges and Culverts" by Goverdhan Lal.                              | ... Re                          | 2 00      |                          |    |
| 45. Bridging India's Rivers                                                                                    | ... Re                          | 7 00      |                          |    |

**Concession:** Most of the publications are available to Members of Indian Roads Congress on concession. Details on application.

Copies can be had from the Secretary,  
**INDIAN ROADS CONGRESS,**  
JAMNAGAR HOUSE, MANSINGH ROAD,  
NEW DELHI-2.



## **HUBER-WARCO** **MOTOR GRADER**



**BLACKWOOD HODGE**

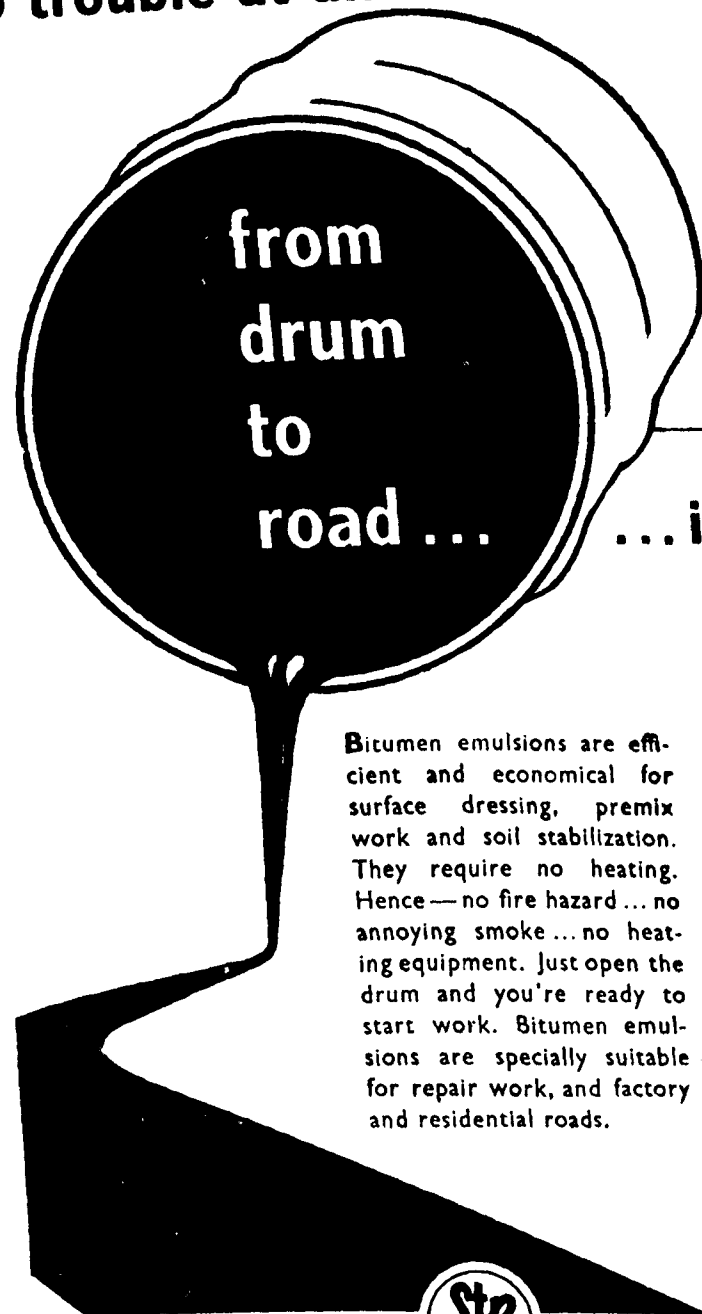
BLACKWOOD HODGE (INDIA) PRIVATE LTD.



ASSOCIATED COMPANIES BRANCHES WORKS AND AGENCIES THROUGHOUT THE WORLD

Please mention this journal when replying to advertisements.

no trouble at all ...



from  
drum  
to  
road ...

**Stp**  
**BITUMEN  
EMULSION**

... in one easy  
application

Bitumen emulsions are efficient and economical for surface dressing, premix work and soil stabilization. They require no heating. Hence—no fire hazard ... no annoying smoke ... no heating equipment. Just open the drum and you're ready to start work. Bitumen emulsions are specially suitable for repair work, and factory and residential roads.

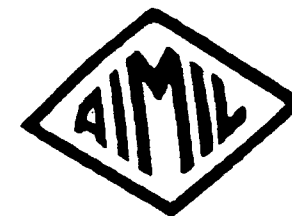


**SHALIMAR TAR PRODUCTS (1935) LIMITED**  
CALCUTTA • DELHI • BOMBAY • LUCKNOW • CHANDIGARH

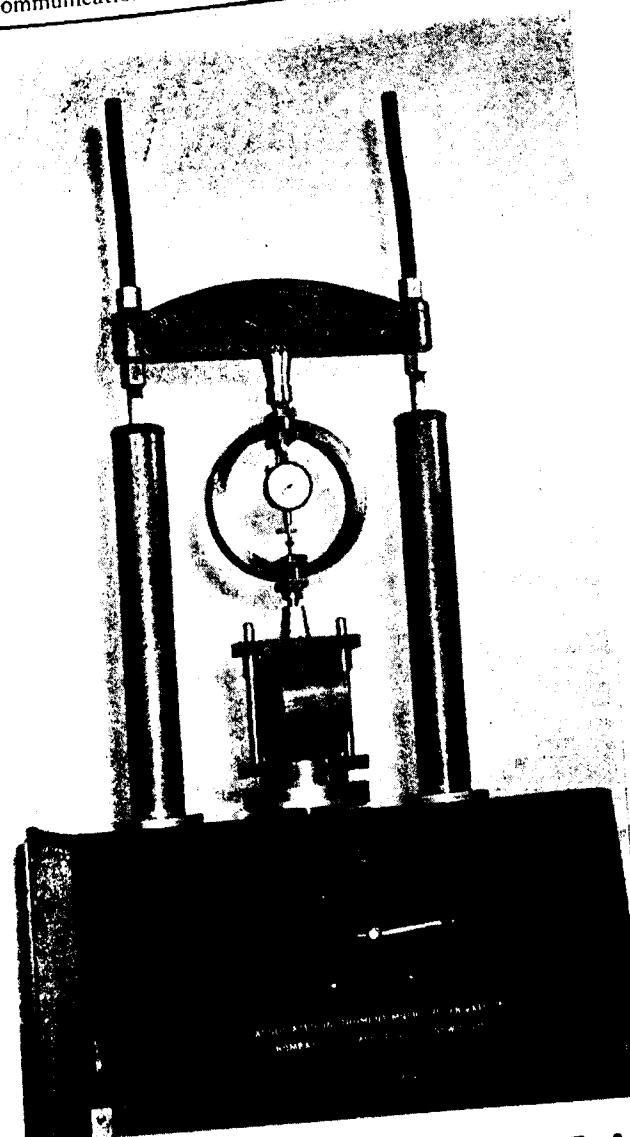
Agents: The Bombay Co. Private Ltd., Madras I • R.C. Abrol & Co. (Private) Ltd., New Delhi I

Please mention this journal when replying to advertisements.

ANOTHER



FIRST



### MARSHAL STABILITY TEST APPARATUS

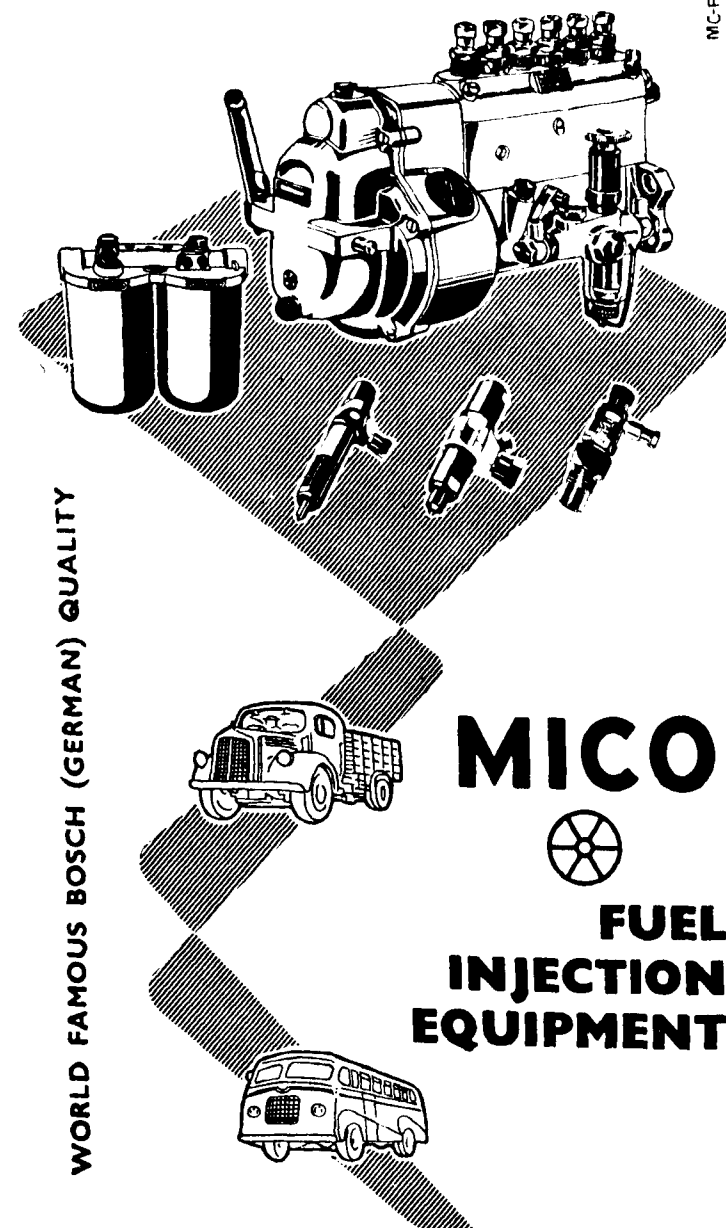
Electrically driven to give a speed of 5 cms. per minute. Manufactured strictly in accordance with A.S.T.M.D—1559. This is used for measuring resistance to plastic flow of cylindrical specimen of bituminous paving mixture.

MANUFACTURED BY:  
**ASSOCIATED INSTRUMENT MANUFACTURERS  
(INDIA) PRIVATE LTD.**

We are the only licensed manufacturers of such specialised Scientific Instruments under the Industries (Development and Regulation) Act, 1951.  
INDIA HOUSE, FORT STREET, B-5, GILLANDER HOUSE, SUNLIGHT INSURANCE BUILDINGS,  
P. O. Box 119, P. O. Box 2136, 26-27, ASAF ALI ROAD,  
BOMBAY. CALCUTTA. NEW DELHI.

Please mention this journal when replying to advertisements.

## The Choice of Leading Diesel Fleet Owners



**MOTOR INDUSTRIES CO., LTD., BANGALORE**

Sales Houses at:  
 BOMBAY-2 : 41, Queen's Road  
 CALCUTTA-16 : 77-B, Park Street  
 MADRAS-2 : 1/155, Mount Road  
 NEW DELHI-1 : Ghaziabad Engg. Co., Ltd. 44, Janpath

Please mention this journal when replying to advertisements.

# TRANSPORT- COMMUNICATIONS

MONTHLY REVIEW

JULY 1960—No. 159

## LIST OF CONTENTS

|                                                          | Page |
|----------------------------------------------------------|------|
| <b>GENERAL</b>                                           |      |
| Highways and the National Economy                        | 3    |
| Highway Construction in the Sahara                       | 8    |
| Bridging India's Rivers—The Kurubarapalli Bridge         | 12   |
| <b>TECHNICAL</b>                                         |      |
| Standards of Design of Rural Roads                       | 20   |
| Car Parking—The Problem and some Solutions               | 23   |
| <b>HERE AND THERE</b>                                    |      |
| 1. Road Transport saves Money                            | 29   |
| 2. Australian Cheap Road Technique                       | 29   |
| 3. Refresher and Special Courses—Roorkee                 | 30   |
| 4. New Life for Old Concrete                             | 31   |
| 5. Fourteen Lane Highway                                 | 32   |
| 6. Flexible Concrete developed by Soviet Scientist       | 33   |
| 7. Contraction joints in Concrete Roads                  | 33   |
| <b>CURRENT LITERATURE</b>                                |      |
| Abstracts                                                | 35   |
| List of Insdoc Translations available in the CRR Library | 36   |
| <b>BUDGETS AND ADMINISTRATION REPORTS</b>                |      |
| List of Approved Works on National Highways              | 39   |
| ALSO: Definitions of Highway Engineering Terms           |      |

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

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

**Subscriptions.** Annual subscription including postage is Rs Fourteen. Single copy including postage is Re one and twenty-five paise.

To members of the Indian Roads Congress, Engineering Personnel below the rank of an

S. D. O. and Engineering students, a special reduced subscription rate of Rs eight per annum is offered. Students are required to apply through the Principal of their College.

**Advertisements.** Advertising rates per insertion

|                    | Full Page | Half Page |
|--------------------|-----------|-----------|
| Inside front cover | Rs 100/-  | —         |
| Inside back cover  | 100/-     | —         |
| Outside back cover | 120/-     | —         |
| Ordinary position  | 75/-      | 45/-      |

Detailed rate card can be had on application to the Secretary, Indian Roads Congress, Jammagar House, Mansingh Road, New Delhi-2.

## THE KURUBARAPALLI BRIDGE



Showing the old arch bridge. Note that the end span on the Bangalore side has been closed and protected by revetment.



Showing a view of the new bridge from the downstream side

Detailed article at pages 12-19.

## TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

A REVIEW OF  
ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

JULY 1960

86

### HIGHWAYS AND THE NATIONAL ECONOMY<sup>1</sup>

By

ELLIS L. ARMSTRONG

Commissioner, Bureau of Public Roads U.S. Department of Commerce, Washington, D. C.

#### Highways and Human Progress

THE long history of road building has produced many famous names and many famous materials. The massive stone blocks that distinguished the Roman roads were lasting symbols of a great empire. John McAdam and Thomas Telford left an imperishable impact on the civilization of their time. Down through the ages roadbuilders have been history makers, their records written in stone.

Transportation, the movement of people and goods, has always played a tremendously important part in human progress. Transportation has moulded kingdoms, and roads have fostered freedom in many countries.

Today in America, highway transportation has taken the centre of the stage, for it affects not only commerce, agriculture, industry, and defence, but the daily lives of every man, woman, and child in this great country of ours. And now, as always,

stone-crushed rock is a basic material. To carry out the new long range highway program we are going to need aggregates in almost unbelievable quantities. In the years ahead we will require mountains of crushed stone, sand, gravel, slag and other "road metals," just as we will require vast quantities of asphalt, tar, oil, and cement to bind these basic materials into our countrywide highway network, now some 3.5 million miles in extent.

The Federal-Aid Highway Act of 1956, and subsequent legislation, opened up vast amounts to a new era for highway users and roadbuilders alike. But I think we can get a clearer view of this, future and what it implies if we look back for a moment.

#### Highway Growth

In 1890 we had some 2 million miles of rural roads in this country, but only about 100,000 miles had all-weather surfaces. Farmers living back from the railroad, battling dust or mud, began to demand

<sup>1</sup>Presented at the 43rd Annual Convention of the National Crushed Stone Association, Conrad Hilton, Chicago, Illinois, February 22-24, 1960.

better roads. They were joined by several million "Wheelmen" who demanded easier going for their bicycles. Principal road-building tools were the pick and shovel and the slip scraper.

Ten years later some 8,000 automobiles were scaring horses in our cities and on country roads, but few people dreamed that an era was coming to its end.

By 1916 annual motor vehicle production exceeded 1 million for the first time, and the federal government entered the roadbuilding field on a nationwide scale. Federal-aid legislation since that initial step in 1916 has authorized increasing amounts of money and has broadened the basic concept of our highway needs and how to meet them, but the generic Act fostered a co-operative state-federal approach which underlines and strengthens the federal-aid highway program even today.

Few partnerships have been more worthwhile or more necessary. By 1921 there were about 10.5 million motor vehicles registered in this country and our total road and street mileage was just under 2.9 million—about 3 vehicles per mile. Here and there a few streets and main roads were crowded and there was even some talk about reaching a "Saturation point" for cars. But we still felt that the real problem was how to provide more hard surfaced rural roads, to get the farmers out of the mud.

In 1930 our road mileage exceeded the 3 million mark, but cars, trucks, and buses totalled 26.5 million—that figures out to almost 9 motor vehicles per mile of roadway. More important, these vehicles were bigger and faster, and serious congestion was developing on many key routes near big cities and industrial areas. Traffic had begun to choke our city streets and accidents cast a grim and darkening shadow over the whole country.

By 1941 the national figure was about 11 vehicles per mile, with every indication that this ratio would climb much higher. At the same time earlier trouble signs had multiplied. Costly, dangerous patterns of congestion were widespread and bumper-to-bumper traffic on city streets was threatening the very existence of downtown areas.

The traffic toll in dead and wounded matched our casualties of World War II.

That war demonstrated the vital defence role of our main highways, and during the decade that followed it became clear that in order to equate the motor vehicle with our way of life, we needed a bold new approach. A plan that would not only assure us an interstate system of super-highways, but would also greatly increase the traffic bearing capacity of many presently overburdened routes.

### Long Range Highway Program

That is the purpose of the Federal-Aid Highway Act of 1956. To provide a long range program for a 41,000-mile network of interstate highways, built to standards which will handle the types and volumes of traffic predicted for the system in 1975; and to so improve the federal-aid primary and secondary systems and their urban extensions that these essential routes will measure up to the Nation's immense capacities in other respects.

Today the federal-aid highway plan is 815,000 miles in extent, including the interstate system. That is about one-fourth of the Nation's total mileage. Yet these same traffic arteries now carry over 63 per cent of all motor vehicle traffic and in 10 years we expect the figure to reach nearly 70 per cent. These routes, rural, urban and suburban, include the "Main Streets" of America. Obviously these vital routes hold the key to our highway future.

### Motor Vehicle Traffic and Gross National Product

And let me remind you that there is a direct and well established relationship between the volume of motor vehicle traffic and the gross national product the total annual production of goods and services. They move together. In 1958 for example, we had 1.5 miles of highway travel for every dollar of gross national product. Highway dollars are dynamic dollars and that is why safer, swifter, more efficient highways mean better, more prosperous, living for all Americans.

Here in this great country of ours, from 1956 to 1971, we expect highway travel to

increase nearly 70 per cent, from 623 billion vehicle miles to more than a trillion.

This is the prospect that our highway program is geared to. The 1956 Act authorized nearly 25 billion dollars of federal funds for improvements to the interstate system over a period of 13 fiscal years, 1957-69. The matching basis for these funds is 90 per cent federal, 10 per cent state.

The 1956 Act and later legislation also sharply increased the regular authorization for primary and secondary roads. Thus over the 5 years 1957-1961, this ABC federal aid alone will be 4.4 billion dollars to be matched on a 50-50 basis by the states. It is a reasonable assumption that these "Regular" ABC authorizations will be continued at about the present level for at least another 10 years.

### Impact of Highway Program on Aggregate Industries

It would be hard to exaggerate the overall impact of such a huge construction program. Whether we are thinking in terms of labour and materials, engineers and machines, or the many, many kinds of development that go hand in hand with highway improvement, the long term prospect is hard to grasp.

Just for the moment let us focus on your own industry, crushed stone, and other aggregates.

According to our estimates, about 114,000 tons of aggregates—crushed stone, gravel, slag, and sand—are used for every million dollars' worth of construction in the federal-aid highway program. Of this figure, 49,000 tons are purchased by contractors, the remaining 65,000 tons being produced by the contractors themselves. The federal-aid construction program and similar state highway work in 1960 will total about 4.25 billion dollars to be expended directly on construction operations. This means that federal-state construction this year will require the purchase of some 210 million tons of aggregates.

But this is not the whole construction picture. Local road and street construction will involve an expenditure of about 1.33 billion dollars this year. Applying our factor for generally similar federal-aid secondary work (48,000 tons per one million

dollar of construction), this local road construction should call for the purchase of 65 million tons. Thus the total highway construction market for purchased aggregates this year is a respectable 275 million tons.

### Availability of Aggregates

In recent years questions have arisen about the nation wide availability of aggregates for construction and the bureau through its field offices has asked the state highway departments whether the known supply of aggregates is ample to take care of anticipated highway needs for at least the next 15 years.

Very briefly, the replies indicate that the supply is not considered adequate in Colorado, Mississippi, or Oklahoma; a few states have indicated localized shortages of partial deficiencies, such as a lack of crushed rock, gravel, or fine aggregates.

Quite naturally most of the states have kept track of their known sources of supply and also have looked for new sources of material in the vicinity of proposed new construction.

The bureau has co-operated with several states in comprehensive surveys of existing and potential aggregate sources and similar "prospecting" is under consideration in several others.

Needless to say, none of this "Prospecting" is done with the idea of competing with existing sources where supplies are adequate at reasonable costs. Rather the purpose is to assure an adequate overall supply of material for highway needs.

### Distribution of Highway Construction work

Highway construction like many other industries which are largely local, has a healthy share of small and medium size contractors among some 6,000 who are operating in this field.

Thus during the first 6 months of 1959 more than 4,000 federal-aid highway contracts were awarded, involving a total cost of around 1.4 billion dollars. These contracts had an average cost of about 350,000 dollars and they ranged from less

than 25,000 dollars up to about 10 million dollars. Thirty per cent of the low bids received by the state highway departments were for amounts under 50,000 dollars. Put another way, contracts under 1 million dollars accounted for 44 per cent of the total contract cost involved but represented 90 per cent of the total number of contracts offered to bid.

So no matter how you reckon it, the highway program provides a wide and equitable distribution of work throughout the country. It is distinctly a grass roots approach.

As a matter of fact Section 116(d) of the 1956 Act itself declares that it is in the national interest to encourage and develop the actual and potential capacity of small business and to utilize this important segment of our economy to the fullest practical extent in construction of the federal-aid highway systems, including the "interstate system".

Highway maintenance is also an important item. Nationwide annual cost of maintaining our 3.5 million miles of roads and streets is about 2.4 billion dollars. Certainly crushed stone and other aggregates figure importantly in this total.

### Impact of New Highways on National Economy

Now let us turn once more to the impact of highways on our national economy. As I suggested earlier, we can approach this broad subject from several angles. Suppose we look first at the direct effects.

During the course of the program we will require close to 50 million tons of steel and almost 1.5 billion barrels of cement. More than 9 billion board feet of lumber and timber piling will be used.

This list could be extended to include a much wider range of products such as paints, aluminum, highway signs, and explosives.

There is a long range multi-billion dollar market ahead for the manufacturers of earth moving and other road building machinery.

These are solid, down-to-earth estimates, but they are mainly on the surface. We will have to dig much deeper to uncover the real magnitude, the full promise of the new highway program.

Let's begin with agriculture and farm life. Today more than 4.5 million cars and nearly 3 million trucks give our farm families year round access to a nationwide network of rural roads and these in turn connect with countless communities, towns, and cities, with markets and sources of supply. Beyond a doubt this transport system has contributed greatly to the steadily increasing productivity which features American agriculture from coast to coast.

These and other highway benefits are reflected in rural land values. U.S. Department of Agriculture reports indicate that farms served by gravel roads sell from 3 to 11 per cent more than similar property located on dirt roads; while for paved roads the figure goes up to 32 per cent. Other studies have indicated that the price differentials may run from 38 to 78 per cent in favour of better roads.

The multiple role of highway transport in business and industry is obvious—so obvious that some of us may take it for granted. Express routes around big cities, like Massachusetts Route 128, which skirts Boston, have sparked the growth of industrial parks, residential areas, and shopping centres. Expressways and Thruways have given much greater mobility and wider job opportunities to most of the labour force.

The famous New York Thruway has attracted some 650 million dollars worth of industrial, commercial, and residential development along its 538 mile route—and the story is not ended. These great traffic corridors bring development in depth, by contrast to the ribbon pattern of growth that was so common when 2 lane or 4 lane pavements without access control were pushed out into the countryside.

Today there is an area close to California's East Shore Freeway which covers only 9 per cent of the total industrial acreage in Alameda County and yet has attracted well over 40 per cent of the dollars invested in new industries in that county.

Looking to the Southwest, "Before and after" studies of the Gulf Freeway and the Dallas Expressway afford striking examples of the effect such highways have on adjacent land values—increases of 500 to 700 per cent were recorded.

Here in Chicago, the Edens Expressway and other magnificent traffic corridors with

their skillfully planned interchanges are telling a thrilling story.

### New Highways and Traffic Safety

Beyond the economic dividends that the new highway program promises, beyond the improved urban and city betterments that are implicit in sound highway planning, lies perhaps the most important factor of all—increased traffic safety.

Last year traffic accidents took close to 38,000 lives. In towns and cities, on the open road and even on dead end streets, this perpetual panorama of sudden death never ceased from coast to coast. But even that ghastly backdrop does not tell the whole traffic accident story. Last year about 1.4 million men, women, and children were injured, many were left hopelessly crippled and more than 100,000 suffered permanent physical impairment.

Moneywise, the annual drain from traffic accidents is more than 5.6 billion dollars. Some of us pay more than others but this cost is not restricted to so-called "victims" of traffic accidents—it shows us as a charge against our way of life.

When it comes to the cost of congestion and traffic delays, the estimated price tag varies. For instance the Automobile Manufacturers Association has estimated that when the interstate system is completed highway users will save 500 million dollars a year in vehicle operating costs, plus another 825 million dollars in time losses by commercial vehicles, and 725 million dollars in reduced losses from accidents.

Fortunately, we now know that modern design standards including controlled access, can drastically reduce highway accidents.

Last year on most of our toll expressways the death rate per 100 million vehicle miles of travel was about a third of the national rate on rural roads. And some of the newer facilities like the New York Thruway and the Edens Expressway are cutting the toll far below the national rate.

When it is completed we expect the interstate system to save at least 4,000 lives a year.

And let us not forget that as the regular ABC program of federal aid goes forward safety will be prominently featured in the

design and construction of these vital arteries.

### Current Progress of Federal-Aid Program

I imagine most of you are quite familiar with progress on some phase of the federal-aid program, because you have had a direct hand in it. Suppose I give you a quick overall run down—in terms of money, pavement, and structures.

Construction is going forward on 4,500 miles of the national system of interstate and defence highways at an estimated cost of 2.82 billion dollars. Since July 1, 1956, construction contracts have been completed on 5,900 miles of the system at a cost of 2.42 billion dollars. Included in the program were about 4,600 bridges under way and 4,700 completed. Moreover, an additional 2.21 billion dollars has been authorized or spent for preliminary engineering work and right-of-way acquisition in the period since July 1, 1956.

And the continuing programs of federal aid for the primary and secondary systems and their urban extensions also set new records. Work is under way on 19,000 miles, including 4,300 bridges, at an estimated cost of 2.29 billion dollars. Since July 1, 1956, ABC construction contracts have been completed on 95,700 miles and 15,800 bridges, at a cost of 5.75 billion dollars. These ABC program figures include the work being accomplished with the special 400 million dollars. Provided by the Federal-Aid Highway Act of 1958.

This is a splendid record, one, which clearly demonstrates that the highway fraternity, officials and engineers, contractors and suppliers, and the many groups and individuals that play a part in this vast undertaking, can do the job and keep it on schedule.

But I do want to remind you of another task, another obligation, that is never ending. I mean of course the day-in, day-out public understanding job in behalf of adequate standards, adequate financing to keep all phases of construction on schedule, and equally important, to maintain a balanced program fitted to the needs of a great and growing Nation.

(From: "Crushed Stone Journal", March, 1960).

## HIGHWAY CONSTRUCTION IN THE SAHARA

THE problem of road construction in the Sahara is dominated by two basic factors: the type of transportation required and the climate. Briefly reviewed in their general lines, the type of transportation required until about 1955 was no more than that necessary to serve a widely scattered population, distributed over nearly 1,930,000 square miles (5,000,000 km<sup>2</sup>) or more than 10 times the area of France, and to provide administrative contact with the centres of population at the oases.

For these purposes, a simple road net was perfectly sufficient and had been developed into a system with a total length of about 6,200 miles (10,000 km) of which about 300 miles (500 km) had been surfaced. The remainder simply were more or less improved trails that were kept in serviceable condition as well as possible.

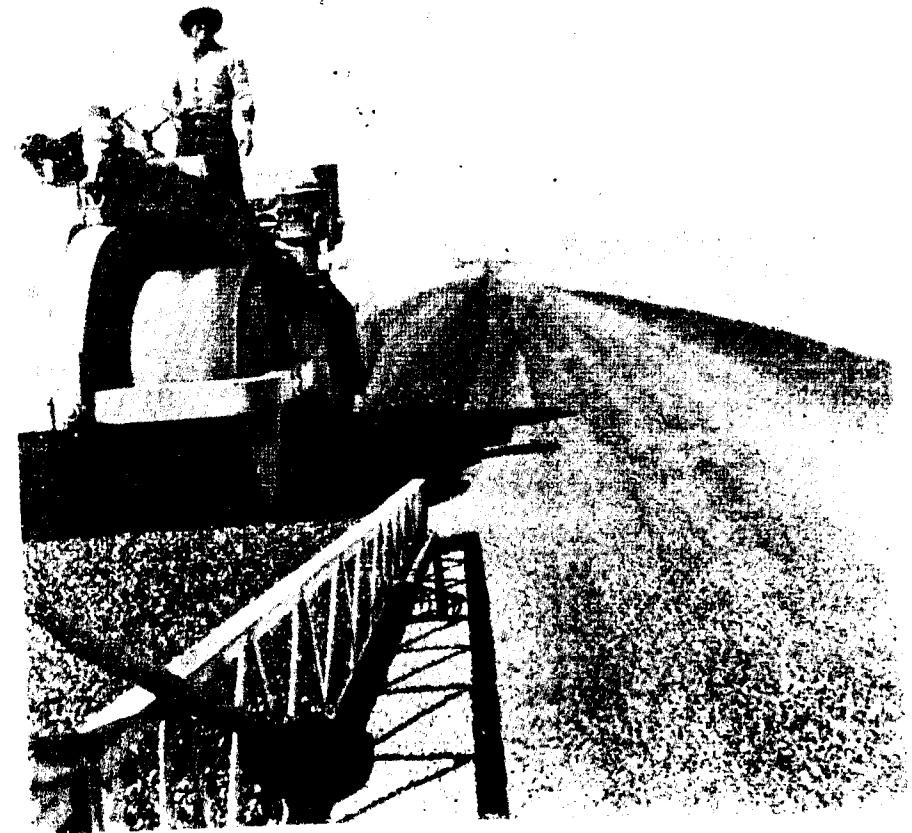
The problem of constructing roads in the Sahara, capable of sustaining heavy truck traffic, began to make itself felt in 1954 and became acute in 1956. At that time, prospection had disclosed the existence of the natural gas pockets and oil fields of Hassi-messaoud and of Edjele. As the crow flies, the former is located some 430 miles (700 km) south of Algiers and the latter is at a distance of more than 740 miles (1,200 km) from the Mediterranean Coast. Other mineral resources have since been discovered in the Southwest. Quick and efficient development of all this sub-soil wealth brought about the need for a different type and special kind of transportation.

This involved first of all the temporary requirements arising out of the prospection for petroleum deposits, the sinking of test wells and the delivery of supplies to construction sites at the oil fields, along the pipelines under construction and along the necessary new roads. Aside from these temporary needs, provision had also to be made for permanent construction to enable exploitation and development of the newly discovered wealth.

Contrary to Black Africa, transportation in the Sahara must utilize heavy and extra-heavy vehicles. At the end of their run, the trucks must be able to travel on unimproved trails or to proceed simply cross-country. In order to do so, they have to be equipped with very powerful engines, very large-surface tires and very wide wheel bases. The only way of amortizing the high cost of such vehicles lies in their ability to carry very large loads so that today the trucks rolling in the Sahara are among the largest and heaviest in the world and are designed for wheel loads greatly in excess of those permitted on normal highways.

The climate of the Sahara also necessitated considerable adjustment of standard road construction methods to the particular requirements of the area. Only about one-twentieth of this area has annual rainfall of more than 6 inches (150 mm) and one-ninth has only 3/4 inches (20 mm). Summer temperatures rise to above 120°F (50°C). The soil consequently contains only minute amounts of moisture and totally lacks cohesion. Trucks moving over the trails laid out cross-country tear up the soil, the totally dry soil cannot recombine of its own accord and the wind carries off the fine elements which could provide sufficient cohesion in the presence of water. The only way of utilizing such trails constructed over unimproved natural soil would have been to constantly bring in and place materials suitable for providing a coherent surface.

However, the amount of traffic which would justify this procedure, does not exist because the estimated annual traffic of only 50,000 tons would involve maintenance costs higher than those for a surfaced highway or 30 vehicles per day. These considerations eliminated the principle of progressively improving a system of temporary simple roads which would have been difficult to use effectively and prohibitive from the point of view of maintenance costs.



Construction of the road from Ghardaia to Ouargla in the Sahara

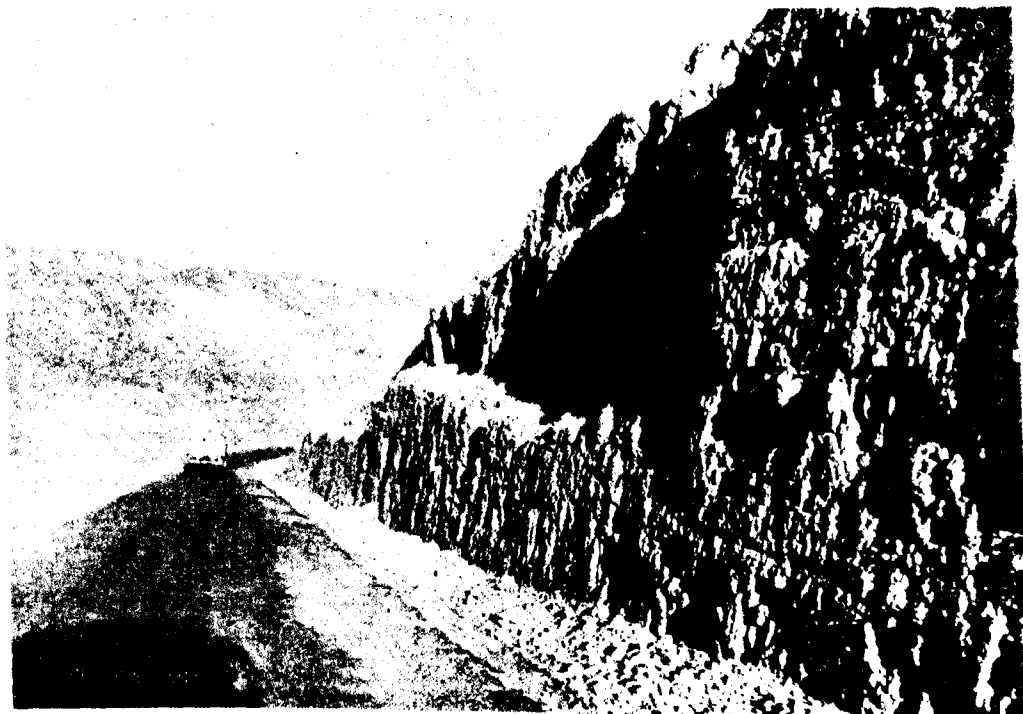
It was therefore decided to begin immediately with the construction of surfaced roads. At the same time, the basic principle adopted elsewhere in Africa and consisting in the utilization of local materials is even more strongly indicated in the Sahara. The soil materials found in the Sahara vary greatly but are satisfactory for base course construction.

These materials are sands containing more or less clay or gypsum and even pure gypsum. We also find sands intermixed with gravel and with pebbles distributed over the surface of the ground. In general, these materials are "fines" which would be coherent if they were slightly moist which is not the case. Fortunately, their chemical character occasionally aids the engineers to a certain extent. It was noted that the presence of gypsum and limestone improved

their cohesive qualities sufficiently to make them "set" like cement mortar when they were moistened and compacted.

The lack of water in the Sahara, from the point of view of the road builder, is both an advantage and a disadvantage. An advantage because the greater part of the damage to which roadways are subject is due to the water which has penetrated them. A disadvantage also because it is very difficult, if not impossible, to build roads without having water available during their construction.

The placing of the base-course materials requires appreciable quantities of water as indicated by the figure of about 130,000 US gallons (500 m<sup>3</sup>) necessary per day and per construction site. At the present rate of construction, these figures are almost 10



Start of the trail from El Golea to in Salah

times as large as the needs of a simple caravan. The quantities necessary for the construction of roads were made available by drilling wells to depths from 330 to 4,000 feet (100 to 1,200 m) but this resulted inevitably in very high costs which represent from 3 per cent to 10 per cent of total expenditures simply for making the necessary water available.

One of the basic factors for economical construction of roads in the Sahara is the necessity for planning on large-scale and high-output construction sites. This is the only way for amortizing the high cost of transporting materials and operating the establishments of the contractor and requires a large amount of work and full use of the equipment.

As a general rule, it is assumed that a given construction method must be capable of being applied over sections from 30 to 60 miles (50 to 100 km) long of the same road. In this respect, there is the particularly striking example of Gassitoul section of the road to Edjele. Over this stretch, the builders encountered various types of materials of which the most abun-

dant were relatively coherent. However, their physical characteristics were quite different in the various borrow-pits opened along the road. It would have been necessary to correct these characteristics by the addition of other materials procured elsewhere and in proportions varying from one pit to the next.

In order to avoid constant changes of method at the same site which would have interfered with efficient performance, an entirely different process was adopted which had the advantage of being applicable to all the different types of sands without any changes. The process consists in incorporating into the soil materials a chemical compound, sodium lignosulphite, in very small proportions which confers the necessary cohesion and stability on these sands. Here is an outstanding example of how the selection of a very simple process can overcome serious difficulties in achieving efficient output and efficient utilization of equipment at a given site.

Sodium lignosulphite, by-product of paper-pulp manufacture, has long been in use (particularly in Sweden) although the

manner of incorporating it in the base-course materials in the Sahara is new. The highway engineers in the Sahara also employed other products manufactured solely for the purpose of road construction and discovered relatively recently. Several of them are due to the work of French chemists and possess the property, when intermixed with the soil, to protect it against the absorption of water as well as to retain the water which it contains. In practice, they make the soil actually "waterproof". It is highly interesting to see samples of soil, treated with these products, retain their cohesion when immersed in water, while, the untreated sample immediately disintegrates.

The recommended technique therefore consists in mixing these products with the soil and well-defined quantity of water, to place and compact the soil, and to protect later by a surface layer because it does not possess adequate strength at the surface to resist the action of vehicle wheels. A start has been made in the Sahara toward the utilization of these products but it is too early to say that their use has already become current although the low cost of the process may lead eventually to its general use.

Standard methods of stabilizing soils with cement or asphalt require proportions of 3 per cent to 10 per cent in general whereas these new chemical products are sufficient in minute quantities. Their price is high but becomes economical when we consider the small quantities needed and the consequent savings in transportation costs, especially where great distances are involved. In the Sahara, for instance, it is entirely feasible to ship these new stabilizing products by plane.

An important point should be noted in connection with all these modern techniques of road construction, by soils stabilized through mechanical cohesion or the admixture of gypsum or chemical compounds, that are considerably advanced in relation to standard macadam construction. In order to avoid difficulties during or after construction, it is absolutely necessary to work in close co-operation with fully qualified engineers and laboratories. Such

co-operation should start during the initial design stage of the project by a central laboratory which will aid in determining the most economical type of surfacing on the basis of existing field conditions and locally available materials, and should continue during construction by means of site laboratories which will be charged both with locating deposits of suitable materials and inspecting the quality of their installation.

Construction projects in the Sahara generally consist of sections from 60 to 180 miles (100 to 300 km) in length. For such sections, the contractors usually establish one base camp where heavy maintenance and even large repairs to equipment can be effected and where the necessary warehouses and other construction installations are located. These base camps are in radio contact with the head offices of the contractor at Algiers or on the Mediterranean Coast. For the project itself, the contractors install mobile camps for the workers and equipment operators that are moved forward at intervals of about every 12 miles (20 km).

The present schedule to be completed by the end of 1960 comprises the construction of about 1,100 miles (1,800 km). Of that total, about 620 miles (1,000 km) have been built during the last five years and the rate of completion now is about 250 miles (400 km) per year. The cost of construction of these roads is evidently relatively high and amounts to about 13 to 20 million francs <sup>(1)</sup> per km (6/10 mile). The necessary capital investment runs into many ten thousand million francs <sup>(2)</sup> but is fully justified because it will provide for the production of 40 to 50 million tons of oil by 1965.

As far as we know, the Sahara is the first example of the construction of stable roads in the desert and so merits a special report, both because French engineers have been able to devise here a new and advanced technique of road construction and because this technique has been here tested and developed to the point where it can be applied by other countries under similar circumstances.

(From "French Economic And Technical Bulletin No. 2, 1960")

(1) 130,000 N. F. to 200,000 N. F.

(2) 100,000,000 N. F.

## BRIDGING INDIA'S RIVERS

## KURUBARAPALLI BRIDGE\*

## Introduction

THE Markanda Nadi crosses the Benaras Cape Comorin road-National Highway No. 7. (Krishnagiri Bangalore Section) near Kurubarapalli in Salem District, Madras

State at Mile 167/8, Fig 1, there was already an arch bridge which could not stand the heavy unprecedented floods in October 1956. Although this bridge was strengthened to carry the traffic temporarily, the

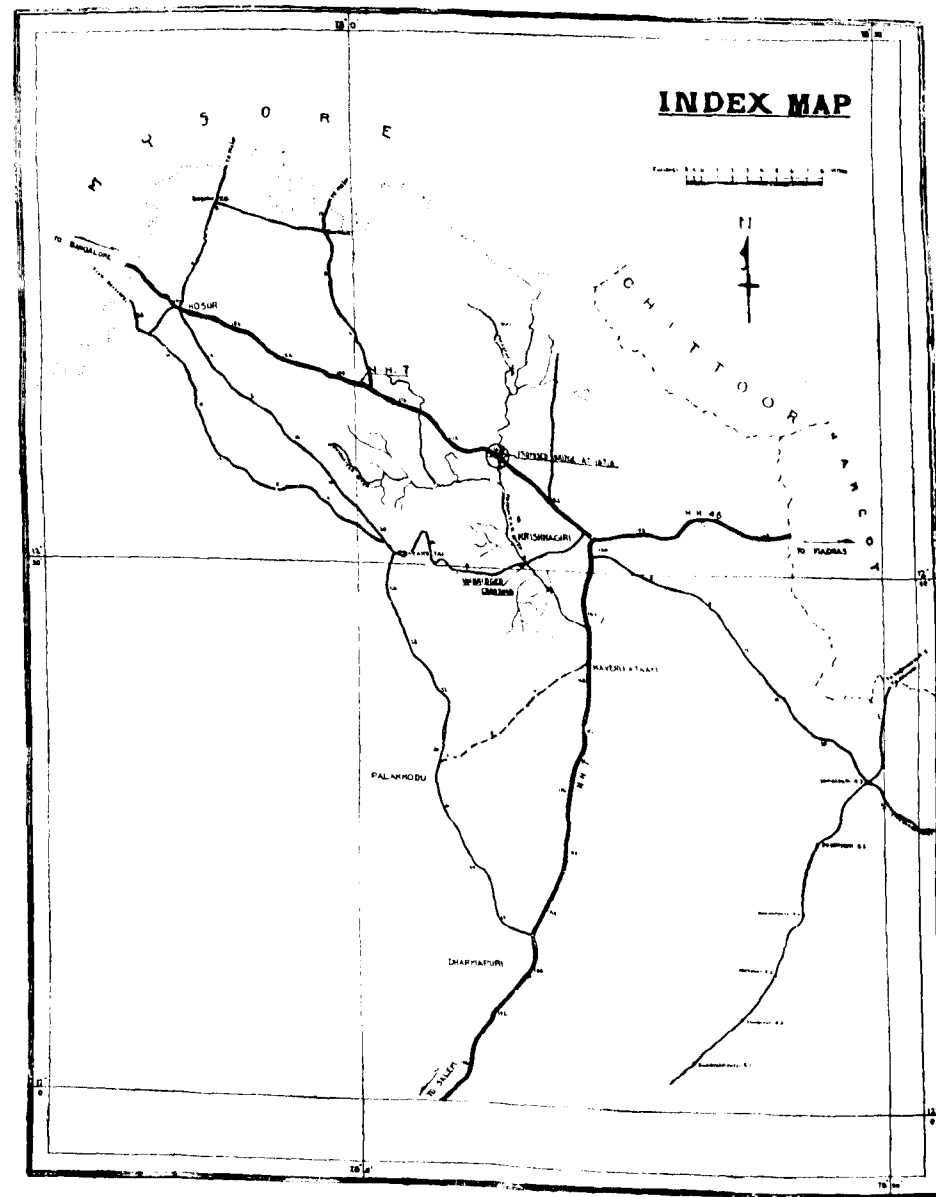


Fig. 1

\* By courtesy of the Chief Engineer (Highways), Madras.

construction of a new bridge at a site 175 ft upstream of the existing arch bridge, with larger ventway was taken up. This gives a fairly straight alignment with only two curves one on the Madras side and another on the Bangalore side, Fig. 2.

## Hydraulic Particulars

On the 16th October 1956 when the existing arch bridge collapsed, considerable damage was caused to the anicut across the river at Marasamudram about two and a half miles upstream. Detailed investigation was conducted by the Public Works Department, Madras for the restoration and extension of the damaged anicut. The maximum discharge on the 16th October, 1956 was assessed as 53,000 cusecs as against the original assessment of 34,300 cusecs. The value of 'C' adopted in the Ryves formula in the original calculation was 600. But in the present case this was

actually found to be 934 on the 16th October, 1956.

There is a free catchment of 7 square miles between the anicut and the bridge. The terrain is also close to the hill slope. Assuming a value of  $C = 934$ , as observed in the Ryves formula, the discharge due to the free catchment area is 3,720 cusecs. Hence the total expected discharge at the bridge site is 56,720 cusecs.

With a linear waterway of 360 ft, an afflux of 0.354 ft is created and the velocity developed under the vents will be 10.9 ft per second. The natural velocity of the river was found to be between 10.47 to 11.02 ft per second. This high velocity seems reasonable in view of the rocky bed. Under the above circumstances, the velocity of 10.9 ft per second developed under the bridge is reasonable. The spans of the collapsed bridge are 48 ft each. Since the terrain is hilly, it is likely that some drift wood may come down the river. It was, therefore, considered desirable to adopt longer spans in spite of a slight increased cost. Hence 6 spans of 60 ft clear were provided. A free board of 4 ft was provided over the M.F.L.

## General Features of Design

The new bridge consists of 6 spans of 60 ft clear. The superstructure is of reinforced concrete beam and slab type designed for I.R.C. class 'AA' loading. The clear roadway between kerbs is 24 ft. The working stresses adopted for concrete is 750 lb per sq. in. and for steel is 18,000 lb per sq. in.

## Foundations

Hard rock was met with at a depth of 5 to 15 ft from bed level. Hence open foundation was adopted. All the foundations except the wings on Bangalore side abutment rest on hard rock. The wings on the Bangalore side rest on soft rock. A vertical joint from the foundation level was provided between the Bangalore side abutment and wings. The rocky bed was suitably benched wherever necessary. Dowel bars 1 in. diameter taken 2 ft 6 in. into bed rock and 3 ft into masonry, fixed in



Photo. 1.

Showing the reinforcement in position for the Bed Block in the Bangalore side Abutment.

cement mortar 1 : 2, were also provided to prevent the lateral movements of the structure and for anchoring the foundation to rock.

### Piers and Abutments

Piers and abutments were constructed in mass vibrated cement concrete 1:3:6 mix with  $1\frac{1}{2}$  in. hard granite broken stone. The abutments are 6 ft wide at 91.75 and 12 ft wide at 70.50 with a front batter of 1 in 12. The piers are 6 ft wide at top with a side

batter of 1 in 24 on either face. Circular cutwaters for the piers and abutments were provided. The wings are gradually splayed out from 24 ft to the full formation width of 38 ft. Necessary weep holes with proper stone packing were provided in the abutments and in the downstream wings for drainage of the back fill. The abutments and piers were provided with reinforced concrete continuous bed blocks 1 ft 6 in. thick extending 3 in. beyond the face of the piers and abutments at top, Fig. 3 and Photos 1 to 3.



Photo 2.  
Showing the finished  
piers

Photo 3.  
Showing the centering  
and the reinforcement for  
the main and cross beams  
with side shutters for the  
main beams fixed in  
position



### Superstructure

The decking consists of 3 flanged Tee Beams, Photo 4, with ribs 12 in. wide and 61 in. deep spaced at 9 ft centres freely supported over piers and abutment. The Tee Beam flanges are 12 in. deep and 24 in. wide. The thickness of the deck slab is 9 in. The thickness of the cantilever slab extending outside the Tee ribs at the outer face of the Tee rib is 15 in. and at the farther end 6 in. The main beams are connected by cross beams spaced at 12 ft centres at ends and 13 ft centres in the middle portion. The end cross beams are 12 in. thick and the middle cross beams are 10 in. thick and are 16 in. above the bottom of the Tee beam flanges. The clear roadway over the bridge is 24 ft. The kerbs are 15 in. wide and 12 in. deep. The decking is of vibrated reinforced cement concrete 1:2:4 mix with  $\frac{3}{4}$  in. hard granite broken stone, Figs. 4 and 5.

Sliding plate bearings were provided, under the Tee beam flanges, at the free end and fixed plate bearings were provided for the fixed ends.

The wearing coat is of vibrated cement concrete 1:1 $\frac{1}{2}$ :3 mix with 65 per cent of 1 in. 25 per cent of  $\frac{1}{2}$  in. and 10 per cent of  $\frac{1}{4}$  in. I.R.C. size hard granite broken stone. The wearing coat is of 3 in. uniform thickness. A transverse camber of  $\frac{1}{8}$  in. per ft was given at the top of the bed block so that the deck slab and wearing coat might be of uniform thickness.

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

The roadway over the bridge is drained by means of 3 in. diameter drainage spouts fixed in the kerb at 33 ft intervals.

Precast barrel shaped R.C.C. hand rails fixed in reinforced cement concrete posts cast-in-situ were provided. The parapets

over the wing walls are of cement concrete 1 : 3 : 6 mix with  $1\frac{1}{2}$  in. size hard granite broken stone.

### Approaches

Reinforced cement concrete approach slabs (1 : 2 : 4 mix) 24 ft 6 in. wide and 12 ft long and 6 in. thick resting over the back wall of the abutments were provided to eliminate the live load surcharge. The approach slabs were laid over a layer of lean cement concrete (1 : 4 : 8 mix) 6 in. thick.

The length of the approach road on the Madras side is 610 ft and on the Bangalore side is 1200 ft. The approaches on either side are fairly straight and join the existing road on the Madras side with a curve with a radius of 900 ft and on the Bangalore side with a radius of 1000 ft. The approach on the Madras side was kept level for 50 ft and then joined to the existing road with a gradient of 1 in 84. The approach on the Bangalore side was kept level for 100 ft and then taken in a gradient of 1 in 50 for a distance of 600 ft and level thereafter joining the existing road. The formation width of the approaches are 38 ft with side slopes varying from 1 vertical to 1 in 4 horizontal.

The metal crust consists of 22 ft wide and 6 in. thick metalling laid over 23 ft wide and 6 in. thick hard granite metal (6 in. boulders) soling. The bottom 3 in. thick metalling was done with 2 in. metal and the top 2 in. thick metalling with  $1\frac{1}{2}$  in. metal. The metal width was gradually increased from 22 ft to the full width between wings in a distance of 20 ft. Gravelling the berm on either side for a width of 5 ft and 6 in. thickness was also done. Surface dressing with precoated chips 22 ft wide suitably widened on either side of the bridge approach was laid over the Water Bound Macadam surface.

Rough stone dry packed revetment 1 ft thick over a gravel backing of 6 in. was provided to protect the slopes of the approaches. The side slope of the revetment is 1 : 1. Suitable inspection steps were also provided in the revetment, Photo 5.

Photo 4.  
Showing the T-beam deck  
after the removal of the  
scaffolding centering &  
shuttering

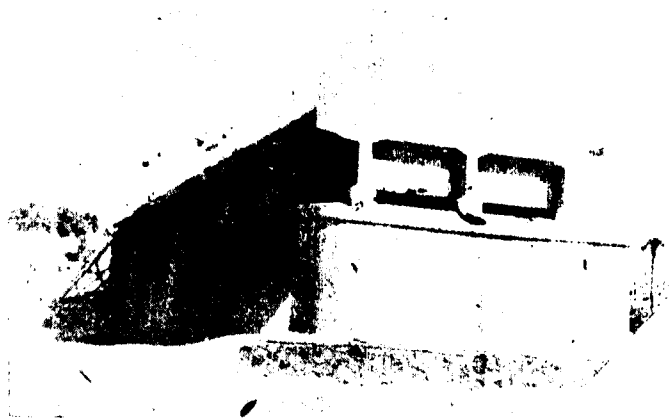


Photo 5.  
Showing the wings,  
parapet wall, revetment  
and inspection steps on  
the Bangalore side.

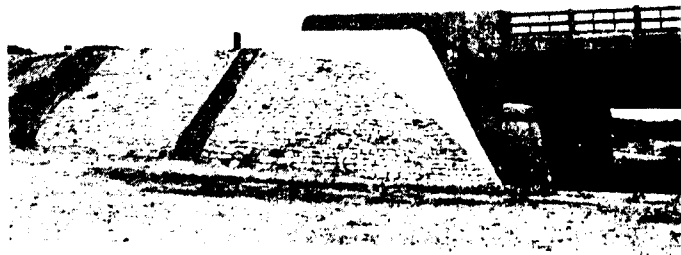
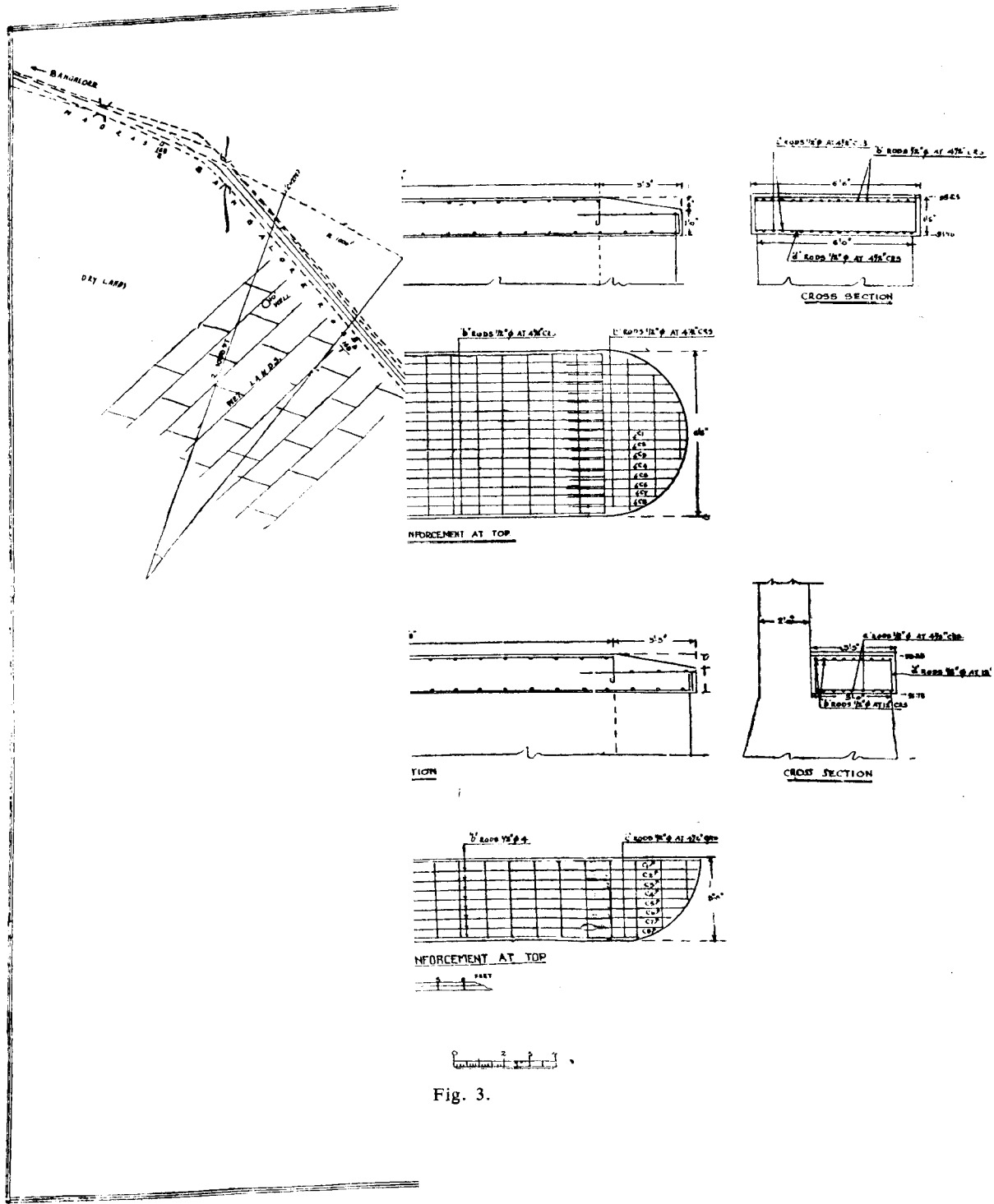
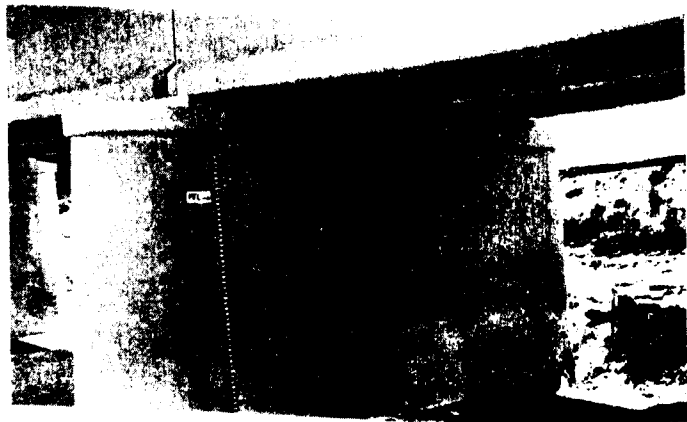


Photo 6.  
Showing the Enamel Flood  
Gauge fixed on the  
upstream end of pier



### Miscellaneous

Precast cement concrete guide stone, with nominal reinforcement was provided on the approaches. A flood gauge, Photo 6, was fixed on the 5th pier on the upstream side to note the flood level in the river. Necessary cautionary signs indicating the curve on the approaches and also information sign giving the name of the river were also provided.

### Materials used :

|                          |              |
|--------------------------|--------------|
| Cement                   | ... 560 tons |
| Mild steel reinforcement | ... 133 tons |

### Cost

Break up of the cost of the bridge is given below :—

|                       | Rupees to the nearest thousand. |
|-----------------------|---------------------------------|
| (a) Foundation        | ... 23,000                      |
| (b) Piers & Abutments | ... 89,000                      |

July 1960

|                    |              |
|--------------------|--------------|
| (c) Superstructure | ... 2,07,000 |
| (d) Approaches     | ... 1,37,000 |
| Total Cost         | ... 4,56,000 |

### Analysed Costs

|                                                                                                                                                                                   | Rupees    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| (a) Per running foot of bridge                                                                                                                                                    | ... 1,169 |
| (b) Per square foot of carriageway excluding kerbs                                                                                                                                | ... 48.71 |
| (c) Per square foot of entire elevation area enclosed between the line connecting the lowest part of the foundation and a line connecting the upper most points of superstructure | ... 31.14 |
| (d) Per cubic foot of bridge from bottom of foundations to top of roadway...                                                                                                      | 1.45      |

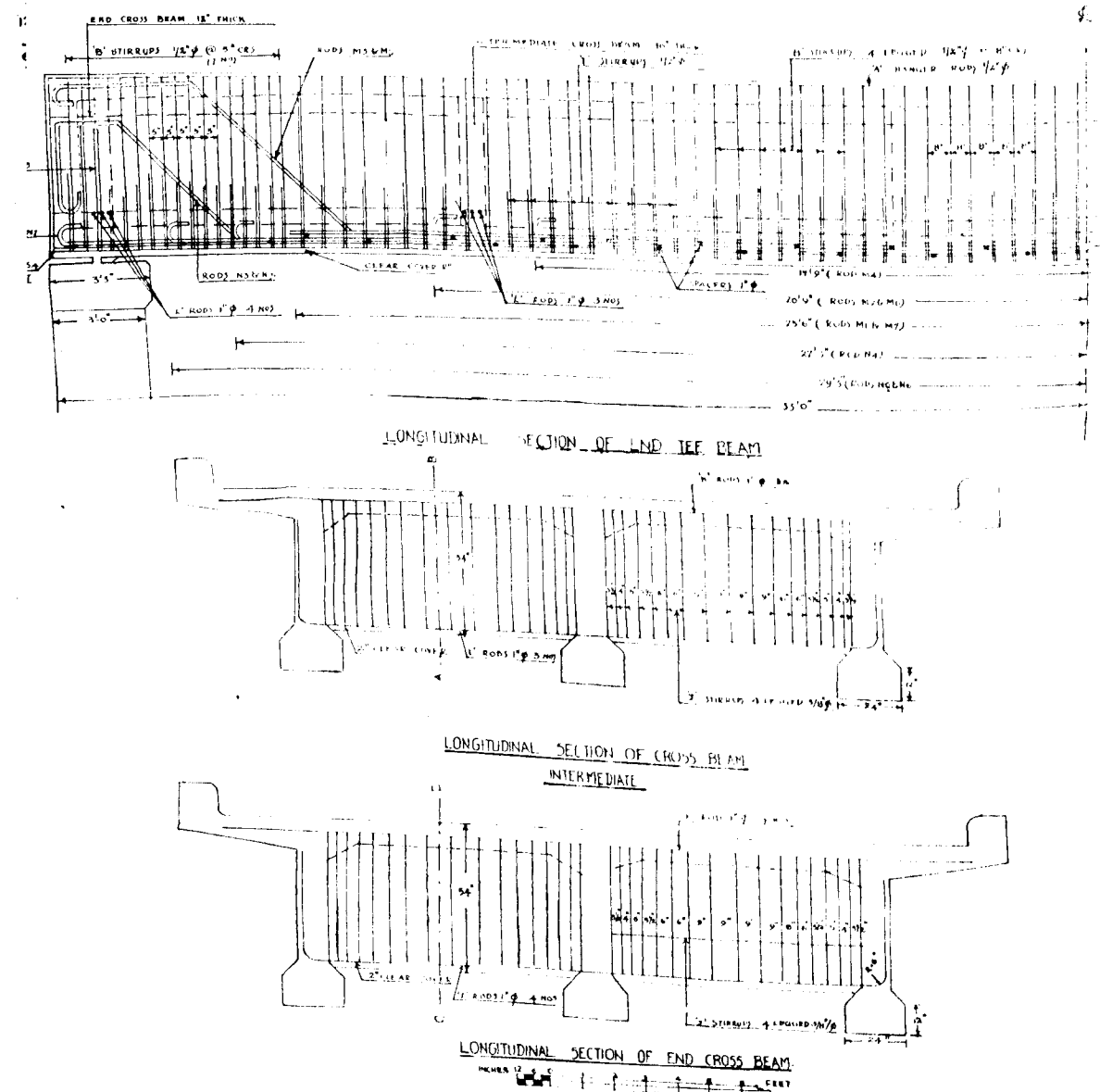


Fig. 5.

## STANDARDS OF DESIGN OF RURAL ROADS

By

J. T. DUFF, MSc, A.M.I.C.E., A.M.I.E.E.

Senior Engineer, Ministry of Transport, Traffic Engineering Branch.\*

**GUIDANCE** on the design of rural roads was first given by the Ministry of Transport in Memorandum No. 336 (Roads) issued in August 1930. Revisions have been made from time to time since then but with the increasing influence of traffic engineering in recent years the need has arisen for a complete revision of the standards of design. This revision is now being undertaken by the Ministry in conjunction with the Road Research Laboratory and the County Surveyors' Association.

Guidance in official memoranda must perforce be limited in most cases to the laying down of maximum or minimum values or sometimes a range of values for various features. No indication is generally given for the considerations which led to the adoption of these values. A knowledge of these considerations is an important aspect of traffic engineering enabling the engineer to use the guidance given intelligently to produce a good design.

The features of design which are mainly affected by traffic considerations are:

- (a) Cross-section  
traffic lanes  
central reserves  
verges, hard shoulders, lay-bys  
footpaths  
cycle tracks  
cross-fall
- (b) horizontal alignment  
curves and superelevation  
visibility
- (c) Vertical alignment  
gradients  
visibility
- (d) intersections.

This talk will not deal with the traffic design of intersections.

The basic aims in the traffic design of roads are:

- (a) Improvement of traffic flow
- (b) increased safety
- (c) enhanced amenity.

The need to improve the existing road system was well illustrated by Drs. Glanville and Smeed in their paper to the Conference on the Highway Needs of Gt. Britain. They showed that about 8 per cent of the road mileage is curved with a radius of 500 ft or less. There are about 2.6 bends and 0.3 double bends per mile of road. Nineteen per cent of the mileage has a gradient of 1 in 20 or steeper. On the other hand about 25 per cent of the vehicle mileage travelled is carried on the busiest 1 per cent of the road system and 60 per cent on the busiest 10 per cent so that improvement of a small proportion of the 190,000 miles of road could achieve a considerable improvement in traffic flow.

### Factors affecting design

The factors which affect traffic design include:

#### (i) The volume of Traffic

The design has to cater for peak flows but it is uneconomic to design for absolute peaks which occur only on a few hours throughout the year. The American concept of designing on the 30th highest hourly flow (i.e. the flow which is only exceeded in 29 hours during the year) has theoretical attractions and has been widely accepted in Europe. It is difficult to use in practice however because manual counts and O. and D. surveys can only be made to cover relatively short periods. In this country therefore design is based on the concept of a 'busy day' which is the traffic averaged

over seven consecutive days (6 a.m.-10 p.m.) in August. This can generally be measured directly and would frequently give very similar results to the American method.

#### (ii) Composition of Traffic

Slow moving and large vehicles affect the carrying capacity of a road. For design purposes, therefore, the volumes are measured in 'passenger car units' which are calculated by using the following weighting factors:—

|                                                     |     |     |
|-----------------------------------------------------|-----|-----|
| Motor cycles                                        | ... | 1.0 |
| Cars                                                | ... | 1.0 |
| Light goods (less than 33 cwts.)                    | ... | 1.0 |
| Medium and heavy goods (more than 30 cwts. unladen) | ... | 3.0 |
| Buses and coaches                                   | ... | 3.0 |
| Pedal cycles                                        | ... | 0.5 |

#### (iii) Speed

The design speed of a road is the speed used for correlating the design features to give a uniform standard of comfort and safety in driving along it. For new roads the following design speeds are proposed:

|                                                                         |     |           |
|-------------------------------------------------------------------------|-----|-----------|
| Dual carriageways (including motorways).                                | ... | 70 m.p.h. |
| 33 ft carriageways and Trunk and Class I roads with 24 ft carriageways. | ... | 60 m.p.h. |
| Other classified roads with two-lane single carriageways                | ... | 50 m.p.h. |

For improvements to short lengths of existing roads the speed below which 95 per cent of drivers travel on adjacent unimproved lengths can be used (provided such lengths are already to a reasonable standard). The 95 percentile speed is approximately 1.32 times the average speed on most roads.

#### (iv) Vehicle performance

Standards of braking, acceleration, etc., govern the design of acceleration and deceleration lanes, visibility distances. The design features must be chosen to include the majority of vehicles and drivers bearing in mind that drivers are generally unwilling to use the maximum performance of which their vehicles are capable.

#### (v) The human element

Reaction time is the factor which most directly influences road design. The average reaction is about  $\frac{3}{4}$  sec. but some 3 per cent of drivers have reaction times as long as 2 secs.

### Traffic surveys

Since the volume, composition and speed of traffic play such an important part in the design of rural roads a considerable amount of effort has to be devoted to the measurement of these factors prior to design. In order to allocate traffic to a new road it is necessary to know the origins and destinations of vehicles and their journey times on existing routes.

Traffic censuses may be carried out by manual recording or by means of automatic counts. The latter, however, do not differentiate the various types of vehicles, so that some manual counting is necessary to determine the flow in passenger car units. A number of different methods are available for finding origins and destinations but the direct interview of drivers (generally employing some sampling technique) has been mostly favoured in this country. The speeds and journey times can also be measured in a variety of ways.

The design of new or improved roads is based on estimates of the traffic which the roads will have to carry in the future. This estimate is made up of:

- (i) the traffic likely to be diverted from existing roads.
- (ii) new traffic generated as a result of industrial or residential development or because the road provides facilities for travel which did not exist previously.
- (iii) an allowance for future growth.

Traffic on the Trunk and Class I roads in August has been growing in recent years at 5 per cent per annum (measured in passenger car units) and this is the rate generally used in the absence of local variations. The aim is to provide a layout having sufficient reserve capacity to make the investment worth while rather than to provide for growth over an arbitrarily fixed period of years. This will sometimes require an economic analysis.

\* Given to the Institution of Civil Engineers, Traffic Engineering Study Group on 10-12-59.

### Cross-section

(a) The capacity of a road for rural design purposes is usually chosen to permit reasonable freedom to travel at constant speeds and to overtake when necessary. The saturation capacity based on minimum headways at low speeds plays very little part in rural design. The design capacity is of necessity an arbitrary figure achieving a compromise between freedom of movement and the cost of providing too lavish a layout. Criteria which are used to determine this compromise are:

- (i) the mean speed of traffic which falls as the volume of traffic increases;
- (ii) the mean difference in speed between successive vehicles which is constant at low volumes but decreases to zero as the flow increases;
- (iii) the total number of overtakings rises to a maximum at a level of flow intermediate between light and saturation levels.

The design capacities recommended by the Ministry of Transport are:

|               |        |                                |
|---------------|--------|--------------------------------|
| Two-lane      | 6,000  | passenger cars per 16 hr. day. |
| Three-lane    | 11,000 | passenger cars per 16 hr. day. |
| Dual two-lane | 25,000 | passenger cars per 16 hr. day. |

Lane width affects the speed of vehicles, the capacity of the road and the accident record. Modern practice is to have traffic lanes of 12 ft or more. The recommended widths for trunk and important classified roads in this country are:

|                   |                                  |
|-------------------|----------------------------------|
| Two-lane roads    | 12 ft (=24 ft overall).          |
| Three-lane roads  | 11 ft (=33 ft overall).          |
| Dual carriageways | 12 ft (=2 x 24 ft or 2 x 36 ft). |

(b) The central reserve on a dual carriageway serves to separate opposing streams of traffic and if properly planted, helps to reduce headlight dazzle at night. Breaks in the central reserve on all-purpose roads should be restricted, as far as possible, to important road junctions. The fol-

lowing minimum widths are recommended for new roads in rural areas:

|                                                                                                               |              |
|---------------------------------------------------------------------------------------------------------------|--------------|
| Normal site conditions                                                                                        | ... .. 15 ft |
| Sites where geographical, agricultural or other conditions prevent the necessary overall width being obtained | ... .. 10 ft |

There is evidence, particularly on motorways, that widths considerably in excess of these minimum figures are always advantageous.

(c) The verges on trunk and important classified roads (all-purpose) should have a minimum width of 12 ft of which at least 4 ft adjacent to the carriageway should be kept clear of all obstructions. Obstructions reduce the capacity as well as create dangers.

(d) The provision of cycle tracks in rural areas is generally considered only where the number of cyclists exceeds 1,000 per 16-hour day or where there is a heavy flow over a short period.

### Horizontal alignment

(a) The motion of a vehicle on a curve of radius  $r$  can be described by the simple relationship:

$$K + \tan A = V^2/gr$$

where  $K$  is the friction,  $\tan A$  the superelevation, and  $V$  the speed of the vehicle in ft/sec. For a curve of given radius it is possible to choose  $A$  and  $V$  so that no friction is necessary. On roads carrying traffic travelling in a wide range of speeds the amount of superelevation must be compromised. Too little on a road on which there is insufficient resistance to skidding could result in the faster cars not being able to steer round the curve. Too much superelevation may make the steering difficult for slow moving heavy vehicles and may, in extreme cases, result in the shifting of loads.

For design purposes curves should be laid out with the largest possible radius. In limiting cases they should be designed by choice of radius and superlevation so that  $\frac{.067V^2}{r} + \tan A$  does not exceed 0.15 where  $V$

(Continued on page 34)

## CAR PARKING—THE PROBLEM AND SOME SOLUTIONS

By

C. H. GLOVER, B.A., (A.M.)

*A shortened version of the paper given to the Annual General Meeting of the South East of England Branch on 5th March 1959.*

THE vehicle in motion and the vehicle parked are interlinked constituents of traffic and during the course of a day's motoring one vehicle may assume both roles. It is artificial therefore to try to consider one while ignoring the other, and so, although this paper is limited to a consideration of the parked vehicle only, it is necessary to keep the relationship of this aspect to the whole traffic picture in view.

What then constitutes the problem of car parking? What are the disadvantages arising from the present pattern of car-parking in town centres, with cars parked indiscriminately at the kerbside wherever they can find space?

### Parking in Central London

The magnitude of the problem can be shown by quoting data obtained by the Road Research Laboratory from studies of parking in Central London<sup>1</sup>. The 'Inner London' area includes nearly seven square miles between Hyde Park and the Tower, and between the River Thames and Euston and Pentonville Roads. At any time during ordinary business hours it contains a number of parked vehicles which increased from approximately 25,000 in 1951 to nearly 43,000 in 1955. Within this area the density per square mile of these parked vehicles now varies between about 12,000 in parts of the West End and 4,000 in some of the bombed areas of the city. In the most heavily parked streets of the West End there were in 1955 between 300 and 400 parked vehicles per mile of street while even in the main thoroughfares, where 'no parking' regulations are in force, some 50 parked vehicles were counted per mile of street.

The predominance of parked vehicles in Central London is shown by the fact that they form over 80 per cent of the total vehicles in the area during business hours.

For a better understanding of the problem posed by this mass of parked cars it is necessary to know more than the actual numbers involved. An important factor is the length of time for which these cars remain parked. In Inner London it was found in 1956<sup>2</sup> that almost 35 per cent of the total cars parked stayed for less than half an hour, 18 per cent stayed between 30 minutes and one hour, another 18 per cent between one and two hours, 13 per cent two to four hours, 7 per cent four to six hours, 9 per cent six to ten hours and just under 1 per cent over ten hours (a total of 1,46,000 cars were parked during the day). The number of cars parked at any given time increased steadily from 8.30 a.m. until 11 a.m. and then remained almost constant until 1.30 p.m., when the peak half-hour began with nearly 40,000 cars parked. There was a corresponding afternoon period of little change before a decline in numbers began about 3.30 p.m.

These figures show the parking problem of Central London in outline. At peak hours the district is saturated with parked cars and although the bulk of them remain only for a short time, many are parked throughout the day. For any accurate study of the problem presented by these parked cars, however, their actual numbers would need to be related to the width of the carriageway of the street in question, and its status as a traffic route, i.e., the volume of traffic that moves, or tries to move along it.

The most detailed measurements of the obstruction of parked vehicles have been made on city streets of about 30 ft width. When the number of parked vehicles was less than about 100 per mile of street, observations showed that the reduction in traffic speed was about half a mile per hour for every 10 additional standing vehicles, whether the parking was on both sides of

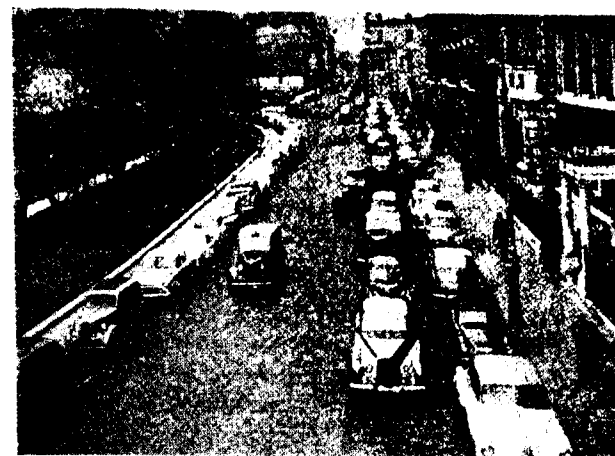
the street or was substantially unilateral. In the average busy street the effect on traffic speed of variations of parking during the day is similar to that caused by variation in the number of pedestrians crossing the road and by variations in the amount of traffic on the street.

In certain circumstances single parked vehicles can have a disproportionately large obstructive effect. Near a signal controlled intersection a standing vehicle at a distance of 5 yards or less from the stop line was found to reduce the maximum rate at which vehicles discharged during the green time by over 30 per cent and a single standing vehicle was found to reduce the speed of the traffic on its own side of the road by as much as 3 miles per hour.

The obstruction caused by unbroken lines of kerb parked vehicles has not, so far, been

amount equal to the width of a kerbside standing vehicle.

The waste of time and fuel involved in finding a vacant parking space during business hours in the West End is illustrated by the fact that, in recent tests it took an



average of 3 minutes to drive from a chosen destination to the nearest vacant street parking space, while a further 4.1 minutes were wasted in walking to (and from) the destination from the parked vehicle. In a recent investigation, social survey obtained a figure of just under 6 minutes for the average walking time in nine areas of Inner London. The former figures were obtained with a driver familiar with the West End—They would have been worse for a stranger. The total cost of this kind of waste must be considerable.

studied in such detail as that of open parking but in a recent study of a few unilateral waiting streets in the West End it was found that the removal of the line of parked vehicles produced traffic speed improvements averaging 27 per cent which is greater than the increase to be expected from a widening of a reduced street width by an

In an investigation into parking difficulties, Social Survey<sup>3</sup> found that while only 30 per cent of the people they interviewed said they had difficulty in finding a parking place, a further 20 per cent of the same people, when later asked if parking was satisfactory, said 'No, because there was no room to park'.

The effect of standing vehicles on road safety can be seen from the 1947-48 report of the London and Home Counties Traffic Advisory Committee, which stated that in the first 4 months after the introduction of no waiting regulations in Central London in May 1947, the number of personal injuries sustained in road accidents decreased by 31.5 per cent during no-waiting hours in the restricted streets, whereas they increased by 8 per cent in the Metropolitan Police District as a whole. It is understood also that in the year following the introduction of no-waiting regulations in Glasgow accidents decreased by about 30 per cent.

**How parking is generated:** The city centre is an aggregation of different uses of land, but in the main these fall under three headings: where people work, where they shop and where they seek entertainment and recreation. Generally, in the centres large towns of residential uses are a minority. This separation of home and work and home and shops, or cinema, or sports ground, forces people to travel, and since about one person in thirteen in Great Britain now owns a car it is to be expected that many cars will be used for this travelling. Equally obviously since the decision to travel by car is a personal one, there will be considerable variation in the numbers so travelling according to multiplicity of factors, which only a knowledge of personal habits and attitudes of different sections of the population can resolve. A number of attempts have been made to relate car-ownership and car-use to income, to distance travelled, and to reason for the journey. In the investigation carried out by the Social Survey for the Road Research Laboratory a sample of about 10,000 people was interviewed in Central London; the sample was made up of 2,700 people travelling to work, 4,500 going shopping and 2,250 travellers and visitors to offices and factories. Just over 3,000 of these interviewed owned cars; of these slightly less than half used them to travel in Central London. It was found that approximately 16 per cent of people whose incomes were stated to be less than 500 pounds per annum, owned cars, whereas 42 per cent of people earning between 500 pounds and 1,000 pounds owned them, as did 75 per cent of those earning over 1,000 pounds, 48 per cent of staff-car owners travelled to work in their cars,

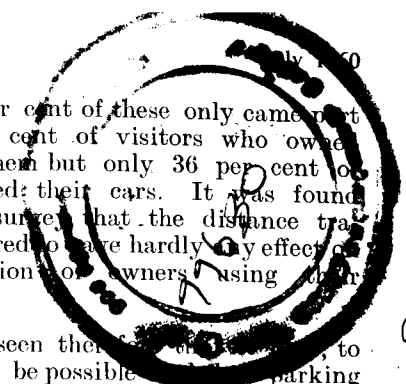
though 10 per cent of these only came part way; 50 per cent of visitors who owned cars used them but only 36 per cent of shoppers used their cars. It was found during this survey that the distance travelled appeared to have hardly any effect on the proportion of owners using their cars.

It can be seen therefore that, to some extent, be possible to estimate parking demand, and the probable extent of any parking problem, from a knowledge of people's income and the purpose of their trip, but as yet there is no very substantial basis of evidence from which to work. Moreover a number of more intangible factors affect the result, e.g., the extent to which the conditions awaiting the would be parker act as a deterrent or a stimulant to his using his car for a journey into town.

An alternative approach to analysing the driver is to consider the use of land that attracts him to the town centre. It is apparent from observation that different uses of land attract varying numbers of parked vehicles. Attempts have been made therefore to estimate the vehicle generating power of different uses, relating the vehicles to some common denominator such as floor area, or numbers of employees. The difficulty here is that, although a predominant factor, the use of land is only one of a number of variables that affect the numbers of vehicles parked and therefore there is a wide range in the results obtained for the same uses.

Nevertheless some useful indications of demands for parking created by different uses of land are being obtained and are being applied in the standards of car-parking accommodation in new buildings.

This power of generation must be considered in relation to the type of parking generated—whether it be mainly all-day parking by employees, short-term parking by visitors or whether it consists largely of commercial vehicles. Surveys made at office buildings in Central London have shown that 50 per cent of visitors to buildings stayed less than 20 minutes and that, while the average duration of parking for employees is approximately nine hours, and for shoppers 2½ hours, visitors average only ¾ hour. The difficulty with visitors' cars and with commercial



99630

D411m2, N48  
N60-159

delivery vehicles is that it is desirable to park them immediately at their destination: the longer-term parker can, however, be accommodated at some distance. Short-term and long-term parkers do present very different demands for parking accommodation: obviously the shorter the duration the greater the desire of the parker to park near his destination.

So far reference has been made to the problem of parking in town centres but there is a rapidly worsening problem in residential areas, particularly in the older suburbs of mainly terrace houses. While a car owner may not be a car user in the town centre, he is always one at his home and this problem will obviously increase in proportion to the general increase in car ownership without the checks imposed by congestion and obstruction in the town centre. Indeed it seems likely that as car ownership increases the number of car owners without garages or garage space will rise sharply. The newer residential areas are not without their problems despite the present trend towards one car space per house. Already in some post-war council estates the ratio of cars to houses is as high as 1 to 3 with 200 to 300 garageless cars on the streets or verges each night.

**Some solutions to the problem:** The car parking problem is made up of a variety of individual problems. This variety is matched by the range of solutions that have been offered to solve these problems, a range that spans the possibilities from complete banning of the motor vehicle to absolute provision for it.

**Banning the vehicle:** Banning is often advocated by those who feel that to make adequate provision for the vehicle within the city centre would ruin either their existing townscape or their exchequer and probably both. Then there is also the safety as well as the aesthetic and economic points of view the argument in this case being that the town centre should be given over to the pedestrian and the possibility of accidents thereby removed.

Against this point of view is the argument that a town centre lives by and thrives upon the trade and custom brought by traffic that will go elsewhere if banished to a distance. The argument

here is by no means settled but it seems that a compromise is being reached. There are practical difficulties in the way of complete banishment. Vehicles must have access to service the buildings, and very often the ban on the private car is coupled with the idea of cross-centre bus services from inner-ring road car parks. These then are already breaches into the inner area and remove some force from the arguments of the proponents of the idea. Fire-engines, ambulances, doctors and invalids would also have to be treated as special cases. On the face of it, it seems that modern life and the modern town centre is too dependent on the motor vehicle to dispense with it entirely. Since in many ways the motor vehicle has been an agent of the town's growth to its present size and complexity, banning the vehicle may seem to be like trying to maintain the structure by removing some of its supports.

Nevertheless the introduction of smaller traffic-free precincts has many advantages, particularly in the provision of pedestrian malls where the shopper can move safely and freely but in the knowledge that his car is within a few minutes' walking distance: the number of examples of this solution is increasing.

**Discouraging the vehicle:** Much less positive in approach than the solution of banning the car is one which may be called that of discouragement. There is a widely held belief that traffic congestion and lack of parking space act as an automatic control on the desire of car owners to travel to and park in a city. The belief is that there is a certain level at which congestion and frustration become intolerable and that this factor will limit the numbers to park and so regulate supply and demand. The continuation of this argument is of course that any measures to relieve the present situation will only result in the numbers of cars and parkers increasing until the old degree of frustration is reached at a new level. Therefore it would simply be a waste to attempt to relieve the present situation. This argument, however, ignores the advantages to the new car travellers.

**Regulation of parking:** A much larger and more common solution is that of limitation and regulation. While there is

argument as to the correctness of excluding vehicles entirely from an area, there seems to be much more general agreement that it is desirable that parked cars should be removed from the streets of a city. If this is not to involve banning, then obviously alternative off-street accommodation must be provided. As an interim measure while this is being achieved, regulations and devices are employed to limit both the areas and the length of time in which cars may park. It may not be entirely desirable that all streets should be cleared of parked vehicles. Land in central areas is expensive and it is possible for some lightly-trafficked side streets or squares to be used for car-parking. The police and highway authorities have for long had powers to prevent parked cars from obstructing the flow to traffic and have used these powers, and regulations have been made to keep the main thoroughfares clear of parked private cars that have been displaced on to side streets. In most of these streets the main problem is the long-term parker, who by his presence from early morning until evening frustrates an ever increasing number of would be short-term parkers. Devices have therefore been introduced to regulate parking in the interests of the short-term parker in these central zones, and in 1956 with the passing of the Road Traffic Act it became legal in this country to institute a charge for parking on the public highway. This innovation was made to enable the installation of parking meters in part of London. These devices were first introduced in Oklahoma City in 1935 and have since spread all round the world, and most recently into Mayfair. The meter has not been without its opponents as was evident during the debate in Parliament<sup>4</sup> on the introduction of meters into Mayfair. Nevertheless they seem to be popular with local authorities, who are currently asking for over 2,000 more to be added to the 625 already in use.

Nor is there a lack of alternatives. The Paris 'disc' scheme was commended during the debates on the meters in Mayfair. The argument against it was that it would bring in no revenue except from fines. However, according to one source<sup>5</sup>, revenue from these fines was about 36,000 Pound a month. According to a recent account<sup>6</sup> the total savings during a year of operation of the disc scheme was 903 million francs as against enforcement expenses of 242 million francs.

This calculation took into account the additional numbers of vehicles offered parking space and the savings in time and fuel effected by reducing the amount of cruising in search of a space. It is too soon to have any comparable figures for the London parking meters, but in the first nine months of their operation both the revenue received and the operating costs have been higher than was expected. There has been an increase in the speed of traffic through the area concerned and a reduction in the level of parking.

It is reported that local shop-keepers are appreciative of increased trade due to increased turn-over of vehicles, and indeed one firm at least proclaims the advantages of the meters in their advertising.

The older system of limitation of parking time by regulation was criticised both for its failure to bring in revenue from parkers using the kerb space and also that it lacked force unless the area was rigorously patrolled. The meter certainly overcomes the first of these contentions, but is still demanding in man-power for adequate enforcement and to prevent 'meter-feeding'.

**Providing off-street space for the parked vehicle:** For the long-term parker and as a long-term solution to the problem there remains the provision of off-street parking. This can take the form of paved open space providing a single 'layer' of parked vehicles or, more elaborately and expensively, of multi-storey parking garages to accommodate larger numbers of vehicles on a given ground area. It is not proposed here to discuss the subject of parking garages except to say that there now seem to be many excellent designs, both mechanical and non-mechanical, and that the major problems remaining seem to be firstly the delivery or collection of the vehicles they house with the minimum of delay at times of peak demand, and secondly the provision of the necessary financing for such costly erections. It must be borne in mind also that large parking garages create their own problems of traffic flow and that therefore their siting and size must be carefully considered in relation to existing street capacities.

**American experience:** Off-street parking of cars in towns is now a thriving

industry in the U.S.A., and is mostly run by private enterprise. During 1958 the construction of new off-street parking facilities came to a total value of 400 million dollars, almost the same amount as was invested in the previous year. The total investment in off-street parking at the end of 1958 was approaching five billion dollars. An increasing number of cities reported an adequate supply of off-street parking, although the long-term parker was relatively poorly catered for in central areas. Considerable enforcement was still required to ensure proper turn-over at parking meters, and increasing pressure is being applied to prevent 'meter-feeding', by repeated fining of offenders. The parking industry is introducing increasing numbers of automatic devices, such as ticket-issuing machines and gate controls, to reduce the number of employees required particularly in 'fringe-area' parking lots. In the smaller cities corporations of businessmen are increasingly joining together to provide parking space both directly, and indirectly through the establishment of a local parking business, and there has been widespread introduction of schemes whereby shoppers can obtain free parking by purchasing goods from a shop participating in parking schemes. Publicity techniques have also been used to ensure that any spaces available for parking are made known to as wide an audience as possible. It has been noticeable that financing of

parking structures has become easier, and it is sometimes suggested that returns from renting parking spaces can be comparable with, if not better than, those from renting office space on the same site in a central area.

#### Acknowledgement

This paper is published by permission of the Director of Road Research.

#### References :

1. ROAD RESEARCH BOARD. Road Research 1957 (and other years). *Department of Scientific and Industrial Research*. London, 1950 (H.M.S.O.).
2. MINISTRY OF TRANSPORT AND CIVIL AVIATION. *Parking Survey of Inner London*. Interim Report, September 1956 London 1956 (H.M.S.O.).
3. CENTRAL OFFICE OF INFORMATION. *Social Survey*. Report No. 245. July 1956. London, 1956.
4. Parliamentary Report in *The Times* 26th February, 1st May and 6th May, 1958.
5. Hansard No. 423, p. 980 *et seq.*
6. BOURLON, P. Extract from talk given to House of Commons. All Party Group on Roads. *Contractors Rec.*, 1959, 70 (7), 14.

(From "Journal of the Town Planning Institute", November, 1959)

#### DEFINITIONS OF HIGHWAY ENGINEERING TERMS

- SPECIFIC AREA :** The surface area per unit weight usually expressed in sq. centimeters per gram, of all the particles in a material.
- SPECIFIC GRAVITY :** The ratio of the weight of any given volume of a substance to the weight of an equal volume of pure water, the temperature of both the substance and the water being specified.

## HERE AND THERE

### 1. ROAD TRANSPORT SAVES MONEY

● GIVING further details of the advantages of road transport, Mr. Turner said : Changing to the road has saved us money on the short hauls, roughly speaking on all those below 300 miles, which represent about 80 per cent of our despatches from our distribution centres. From our Bombay factory to Poona by road, for instance, is Rs 6.50 per ton of *Dalda* cheaper than by rail : it is Rs 3.25 cheaper to take a ton of *Sunlight* from our Delhi depot to Ludhiana

by road than by rail. And we are endlessly looking for economies in packaging. Once upon a time, for instance, all our soap was moved in wood boxes. Now 70 per cent goes in cardboard containers, which are a quarter cheaper. If all this still had to go in wood boxes it would cost us an extra Rs 24 lakhs; you can see what that would do to your dividend.

(From "The Automobile Magazine of India, April, 1960").

### 2. AUSTRALIAN CHEAP ROAD TECHNIQUE

● THE Australian triumph in the construction of permanent "Kutecha" roads with only sand and soil as materials has evinced considerable interest abroad especially in poor countries like India. The commercial feasibility of building roads on the above lines is enormous compared to the expenses conventional asphalt or cement roads incur. Road Transport in India can look up to the prospect of more roads all round provided the metallic elements of their cost structure is nullified by the promising Australian formula.

This idea took seed in Western Australia and for a long time the States Main Roads Department, in whose charge lay the country roads over 975,920 square miles, had been doing applied research on it.

It all started in 1926. Mr. J. Digby Leach, who is at present the Commissioner of Main Roads, applied his mind to the study of corrugations in dirt (non-metalled) roads. He advanced a theory that the power emanating from internal combustion engines of vehicles shivers the pavement into sectors of maximum and minimum vibration. This causes the corrugations, in the depths of which, when the shake-up is more, the pavement materials get fortified ever so slightly.

The method evolved from this theory is founded on the concept that the power shaping the corrugations could be utilised to strengthen the road materials.

The technique consists in mixing soil and sand and rotating them with a vibrating roller. The road gets consolidated by the waves transmitted by the motor traffic. And a shower of rain hardens the road even as water hardens cement concrete.

The implementation of this process in four areas of West Australia amply testifies its workability.

The northernmost area is 400 miles from the Great Northern highway between Port Hedland and Broome. On an average, annually, it has 25 rainy days. This works out to 15 inches an year.

The track was notorious for kicking up dust arising from the silt of the plains during the dry season while during the wet period, on the other end of the scale, it used to get bogged down like a marsh.

A new site was located for portions of the road by the edge of sand dunes in the coast and the soil in the plains where the silt was convenient for blending.

The remainder of 130 miles was deliberately built on the east side to circumvent the

mangrove swamps swept by tides. The road was sliced through thick acacia growth of this area, the loose red sands of which had a stability of their own obviating the carting of silt clay to a considerable extent.

Traffic is infrequent in this sand-soil road, and heavy oil exploration vehicles compose the bulk of the transport. As a portion of the distance is innocent of road building elements, huge clay pits are ploughed into which a power grader pours the estimated amount of course river sand to make the proper blend. This compound is later carried to the location of the road, dressed to its correct breadth and depth, is strengthened by water and rolled to harden.

For the branch from Perth to Geraldton the Main Roads Department discovered a process of automatic consolidation by mixing strong, smooth grains of soil to sand. The finest performances are given by loose sand clay with a low elasticity ratio to act as consolidator.

Broadly, a proportion of one section of soil to three of sand is blended. Field experiments have proved that the ratio of consolidating elements is quite elastic, varying, in volume from 20 to 40.

The fourth section of the sand-soil roads lies in the Experance area in the south coast of West Australia. The elements making for road building were confined to sand, smooth sand-soil and laterite gravel here and there in small quantities. The laboratories fixed on the right blendings of earth and sand through research work.

The introduction of consolidating elements for standardising or lowering the flexibility is necessary for most of the gravel, limestones and sandstones for the pavement. The utilisation of raw materials from the local region has got round the costs difficulties that cement or bitumen treatment involves not only for making pavements but also for roads with bigger traffic capacity.

(From "State Transport Review, Bombay," April, 1960).

3. REFRESHER AND SPECIAL COURSES—ROORKEE

● "THE University of Roorkee will be running Post-graduate Refresher and Special Courses as per programme given below. Detailed particulars can be had from the Director, Refresher Courses, University of Roorkee, Roorkee, U.P.

| S. No. | Particulars of Courses                                                       |                      |
|--------|------------------------------------------------------------------------------|----------------------|
| 1.     | Three months' Refresher Course in Civil Engineering comprising of :—         |                      |
|        | Part I—Canals, Tubewells and Soil Mechanics.                                 | 1- 9-60 to 15-10-60  |
|        | Part II—Concrete Technology & Structures, Hydrology, Flood Control and Dams. | 3-10-60 to 30-11-60  |
| 2.     | Three months' Refresher Course in Mechanical Engineering comprising of :—    |                      |
|        | Part I—Production Engineering & Workshop Technique.                          | 15-11-60 to 9- 1-61  |
|        | Part II—Heavy Earth-moving & Allied Machines, Tubewells, Towers and Gates.   | 21-12-60 to 15- 2-61 |
| 3.     | Three months' Refresher Course in Civil Engineering comprising of :—         |                      |
|        | Part I—Foundation Engineering, Concrete Technology and Concrete Structures.  | 15- 4-61 to 7- 6-61  |
|        | Part II—Buildings, Highways and Bridges.                                     | 21- 5-61 to 14- 7-61 |

| S. No. | Particulars of Courses                                                                  |                                     |
|--------|-----------------------------------------------------------------------------------------|-------------------------------------|
| 4.     | Three months' Refresher Course in Electrical Engineering comprising of :—               |                                     |
|        | Part I—Transmission and Transformation.                                                 | 1- 8-61 to 30- 9-61                 |
|        | Part II—Generation.                                                                     | 10- 9-61 to 31-10-61                |
| 5.     | Three months' Special Course in Public Health Engineering for serving engineers.        | 1st September to 30th November 1960 |
| 6.     | Three months' Special Course in Public Health Engineering for Engineering Subordinates. | do.                                 |
| 7.     | Three months' Special Course in Public Health Engineering for Serving Engineers.        | 1st March to 31st May, 1961         |
| 8.     | Three months' Special Course in Public Health Engineering for Engineering Subordinates. | 1st March to 31st May, 1961         |

Short Term Specialist Courses

|     |                                                              |                                       |
|-----|--------------------------------------------------------------|---------------------------------------|
| 9.  | " Heat Treatment of Metals "                                 | 1st September to 30th September, 1960 |
| 10. | " Design of Highways Bridges.—Balanced Cantilevers Bridges." | 1st November to 30th November, 1960   |
| 11. | " Prestressed Concrete."                                     | 1-12-60 to 31-12-60                   |
| 12. | " Design and Performance of Overhead Transmission Lines."    | 16- 1-61 to 11- 2-61                  |
| 13. | " Mechanical Design of Transmission Towers "                 | 13- 2-61 to 28- 2-61                  |
| 14. | " Foundation Engineering "                                   | 15- 4-61 to 14- 5-61                  |
| 15. | " Earth Dams "                                               | 17- 4-61 to 13- 5-61                  |
| 16. | " Engineering Mathematics "                                  | 15- 5-61 to 17- 6-61                  |
| 17. | " System Protection "                                        | 1- 6-61 to 28- 6-61                   |
| 18. | " Foundry Engineering "                                      | 1- 7-61 to 22- 7-61                   |
| 19. | " Engineering Geology "                                      | 1- 8-61 to 31- 8-61                   |

4. NEW LIFE FOR OLD CONCRETE

● MEANS of restoring deteriorated concrete were among the subjects discussed at a recent convention of the American Concrete Institute.

It was stressed that a good concrete repair must be thoroughly bonded to the older concrete, be sufficiently impermeable to prevent moisture from reaching the underlying material, be free from setting cracks which would allow moisture to pass, be resistant to freezing where this is likely to occur, and match the surrounding surfa-

ces. Unsound concrete should, of course, be removed completely before the work starts.

Repairs can be made with concrete of conventional type, or by several other means. "Prepakt" concrete, now widely used in the USA, is applied both to concrete and masonry repair work, and has also gained favour for certain types of new work where proper placement of conventional concrete is difficult or impossible. "Prepakt" is essentially a concrete of gap grading in which the coarse aggregate is

first placed in the formwork and a sanded grout is then pumped into the voids of the aggregate mass. Bond strength between new "Prepakt" and old conventional concrete, is much greater than that between old and new conventional concrete, and "Prepakt" excels in low drying shrinkage, which is only about 1/6 that of hydraulically applied mortar and less than half that of the conventional material. This low drying shrinkage, which is considered to be due to point-to-point contact of the pieces of coarse aggregate, also promotes greater crack resistance. Laboratory tests and observations of field structures over a period of years have shown that prepakt concrete, of suitable materials and applied by good workmen, resists weathering action caused by freezing and thawing better than conventional concretes. Later age strength of prepakt concrete is also considerably greater. In the repair of many old masonry and concrete structures by the prepakt method, neat cement grouting is also carried out, to improve stability and to reduce leakage.

Other materials play their part also in the repair of concrete. One of these is epoxy resin, of low viscosity. The bond strength of properly formulated adhesives is greater than that of concrete: tests have demonstrated that rupture always occurs in the concrete, not in the adhesive. Adhesives and binders for highway use are formulated

of epoxy resin, a plasticiser and a curing agent. A certain amount of finely ground inert filler, such as talc or silica can be added, depending on the viscosity at the actual time of mixing.

For the repair of highways, quick hardening is desirable, though this complicates the handling of the mixture, since rapid hardening formations have a short "Pot" life; in other words they harden in the mixing vessel if they are not used quickly. Consequently, small batches have to be mixed and applied promptly. In patching spalled highway areas in California, the binder used contains no filler, and has a pot life of about 20 min. at 70 deg. F. Under favourable conditions, traffic has been restored in 3 to 5 hours.

It is considered economical to use epoxy concrete in fairly large volumes on structures where traffic is very heavy. But if the repairs are substantial, and traffic conditions permit, it is more economical to use Portland cement concrete bound to the original work with a coating of epoxy adhesive. When epoxy adhesive is used, the same basic conditions apply as in any other kind of concrete repair work. The old surface must be scrupulously cleaned, preferably by sandblasting. The concrete may be damp, but it must be free from surface moisture.

(From "The Engineering", 29 April 1960.)

## 5. FOURTEEN LANE HIGHWAY

● CHICAGO is beating the world record in the matter of road construction. By 1964, it will have a five-mile long super highway with no less than 14 traffic lanes. It will be a unique highway in many respects. There will be seven lanes in each direction, four lanes will make up the inner Expressway and three lanes will be used as an outer 'Collector' Expressway. The major advantage of the separate 'Collector' and Inner Expressways is to reduce the dislocation of traffic caused by drivers changing speed and lanes while leaving and

entering Expressway. At the distance of every half a mile, there will be ramps between the cross street and the collector lane; at a distance of every mile-and-a-half, there will be connections between inner and outer Expressways. The road is estimated to cost 110 million dollars and ninety percent of this will be met by the Federal Government because the Expressway will be a part of a gigantic inter-state road system.

(From "State Transport Review, May 1960.")

## 6. FLEXIBLE CONCRETE DEVELOPED BY SOVIET SCIENTIST

● A SOVIET scientist has developed a flexible concrete said to be almost as strong as cast iron. According to a Tass news agency report, the concrete can be welded by softening the surfaces to be joined chemically and joining them under high

pressure. Because of the scientist's research, this new concrete's production methods are very much like those of metals.

(From "Highways and Bridges and Engineering Works," April 20, 1960).

## 7. CONTRACTION JOINTS IN CONCRETE ROADS—AMERICAN ENGINEERS USE ECONOMICAL METHOD

● INTRODUCED in the U.S.A. about a year ago, a new method of forming contraction joints in concrete surfacing, is now being widely used in that country.

The method involves the insertion of a hollow metal strip directly into the fresh concrete, after pouring and finishing, which not only eliminates handforming or sawing of joints, but also forms a connecting bond over the necessary plane of weakness in a slab of concrete. The theory behind this idea is that the hollow metal insert which actually makes a joint of only two or three inches deep, causes the concrete to crack below the insert down to the base course during contraction of the slab, thus creating a true joint. The joint, when completed, besides having distinct design features, also results in substantial savings in installation costs.

### 3m. Feet of These Joints Now Used

After a year of laboratory tests and experience on over 40 installations, the technique has won engineering approval and established itself as advance in paving technology. Highway engineers and air field pavement designers in a dozen American states have approved its use. The inventor, William Middlestadt, of Baltimore, Maryland, reports that more than three million feet of pavement joints have been formed by this method during that short period.

The insert, called "Unitube" is a hollow strip of light weight galvanized steel, usually  $\frac{3}{8}$  inch wide across the top, with  $2\frac{1}{4}$  inch sides which taper together at the

bottom to permit easy insertion into the wet concrete. Each of these side flanges turns outward and upward at the bottom to form a claw for imbedding each side of the flexible metal insert to the slab so that it spreads and closes with contraction and expansion of the slab.

The folded metal strips are produced in 2 inch and 3 inch depths, but to meet various specifications can be pre-cut to desired lengths. Ten-foot lengths which interlock end-to-end, are installed to form the longitudinal joint. Transverse joints are placed from the side forms to the centerline where they butt against the longitudinal joints.

### Placing By Two-Man Crew

A two-man crew works from a specially designed rig. "The Planter," which rides the forms behind the contractor's paving train. This machine provides guides for accurate placement of the Unitube and a vibrating "T-Bar" device is used to form a groove in the fresh concrete and then push the Unitube to the proper depth. The  $\frac{3}{8}$ -inch-wide flat top is left flush with the finished surface.

After the concrete is cured, a one man operated mechanical vibrating machine called a "Crimper" is run along each joint, folding the top of the metal tube inward and downward to produce a joint  $\frac{1}{2}$ -inch deep to hold the sealing compound. Sealing is accomplished by normal methods, except that less material is required to provide a water-tight joint with the permanent Unitube in place, and the operation moves faster.

Various advantages are claimed for the Unitube method over hand-forming or sawing. Joints are costly to saw in some areas, where aggregates are hard, and construction men dislike the critical timing problem inherent in sawed joints. The raveling which occurs from too early cutting or the uncontrolled cracking from too long a delay are eliminated with the new method. Contractors using the Unitube for the first time like the idea of being able to form joints at the same time as they perform the paving job and to crimp and seal at their convenience later.

### Design Advantage

The major design advantage to engineers familiar with the troublesome history of joints is that the folded metal insert creates a joint depression of the right size. Recent research in America has established the fact that sealing compound in a groove that is wider and shallower than the traditional

deep, narrow cut suffers far less internal strain when the opposing slabs contract, and is thus less likely to fall and lose its bond to the concrete.

Maintenance engineers have been impressed by the fact that the new insert forms a barrier to prevent migration of sealer to the sub-base during hot weather so eliminating much periodic resealing.

In addition to the American highway departments which have authorized its use, the U.S. Navy, Army Corps of Engineers, and Air Force have approved its application on several major airfield paving projects, and the Middlestadt Corporation says that production facilities are being expanded to meet a demand for one million dollar worth of the metal inserts this year. The company also manufactures the equipment needed for installation.

(From "Highways and Bridges and Engineering Works, April 20th 1960").

(Continued from page 22)

is the design speed in m.p.h. the super-elevation should normally be 1 in  $37r/V^2$  but not steeper than 1 in  $14\frac{1}{2}$ .

The minimum radii recommended for curves are

| Design speed | Normal minimum | Absolute with 1 in $14\frac{1}{2}$ super |
|--------------|----------------|------------------------------------------|
| 70 m.p.h.    | 2,800 ft       | 1,500 ft                                 |
| 60 m.p.h.    | 2,100 ft       | 1,000 ft                                 |
| 50 m.p.h.    | 1,450 ft       | 750 ft                                   |
| 40 m.p.h.    | 900 ft         | 500 ft                                   |

(b) Ability to see ahead is of the utmost importance for the safe and efficient use of a road. The first requirement is for sufficient visibility for a driver travelling at the design speed to stop before hitting an obstruction in the same lane. This is known as the **minimum stopping visibility distance**.

On dual carriageways this is all that is required but on single carriageways it is necessary to provide sufficient visibility, over as much of the road as possible, for a driver to complete an overtaking manoeuvre. This is known as the **minimum overtaking visibility distance**.

The standards for stopping distances are based on a reaction time of 2 secs. and a deceleration of 0.3 g. The standards for overtaking distances are based on a speed difference of 10 m.p.h. with the overtaking vehicle travelling at the design speed and taking 8 secs. to complete the overtaking manoeuvre.

(c) A gradient of 1 in 25 is now generally considered the maximum for a new road except in very difficult country.

(From "The Surrey and Municipal and County Engineer", 19 December, 1959)

## CURRENT LITERATURE

### ABSTRACTS

**SOIL STABILIZATION WITH ASPHALT, PORTLAND CEMENT, LIME AND CHEMICALS, BULLETIN NO. 241 of the Highway Research Board, National Research Council, 2101 Constitution, Washington, D.C.**

THIS 126-page bulletin contains six papers dealing with stabilization of poor soils and presented at the 38th Annual Meeting of the Highway Research Board, as follows:

"Soil-Organic Cationic Chemical-Lignin Stabilization," by J. M. Hoover, D. T. Davidson, J. J. Plunkett and E. J. Monoriti.

"Water in Cutback Asphalt Stabilization of soil," by R. K. Katti, D. T. Davidson and J. B. Sheeler.

"Chemical Treatments for Surface-Hardening of Soil-Cement and Soil-Lime Fly ash," by R. L. Handy, J. L. Jordan, L. E. Manfre and D. T. Davidson.

"Improvement of Soil-Cement with Alkali Metal Compounds," by T. W. Lambe, A. S. Michaels and Z. C. Mohl. This paper includes a discussion by L. T. Norling and R. G. Packard, and a closure by the authors.

"Fine-Grained Soil Stabilization with Phosphoric Acid and Secondary Additives," by A. S. Michaels and F. W. Tausch, Jr.

"Use of Calcium Chloride for Soil Base Stabilization in Maryland," by J. Eldridge Wood.

**BRIDGES BEARING PADS, FOUNDATIONS, SCOUR AND WATERWAYS, BULLETIN NO. 242 of the Highway Research Board, National Research Council 2101 Constitution, Washington, D.C.**

THIS 77-page bulletin contains six research papers presented at the 38th Annual Meeting of the Highway Research Board, January 1959.

The first four papers were sponsored by the Committee on Bridges, as follows:

"Elastomeric Bridge Bearings," by R. L. Pare and E. P. Keimer, and "Report on Tests of Neoprene Pads Under Repeated Shear Loads," by A. M. Ozell and J. F. Diniz, describe research on elastomeric (rubber-like) materials which show considerable promise of being particularly suitable for seating precast bridge girders.

"Tests of Steel Tubular Piles Driven near Saigon River, Vietnam," by D. Allan Firmage, and "A Rational Method for Determining Safe Foundation Pressures and Embankment Stability," by S. Lifshitz, present two rather widely different engineering approaches to the problem of safe foundation design, possibly accounted for by differences in geology of the construction locations.

The other two papers, sponsored by the Committee on Surface Drainage of Highways, are: "The Use of Backwater in Designing Bridge Waterways," by Joseph N. Bradely, and "Laboratory Observation of Scour at Bridge Abutments," by H. K. Liu and M. M. Skinner. They provide new information which may guide engineers in shaping and positioning bridge waterways and in designing adequate protection against damaging erosion.

**HIGHWAY BRIDGES, PAINTING AND DECK CONSTRUCTION BULLETIN NO. 243 of the Highway Research Board, National Research Council, 2101 Constitution, Washington, D.C.**

THIS 27-page bulletin contains two papers presented at the 38th Annual Meeting of the Highway Research Board which are of special interest to bridge and maintenance engineers.

"Highway Bridge Painting," by John D. Keane, presents a check list of things to avoid in painting highway bridges and some important considerations in painting bridges.

"Smooth Riding Bridge Decks," by Nomer Gray, presents some of the distinctions made in the construction of concrete bridge decks and the construction of concrete pavement on grade.

# LIST OF "INSDOC TRANSLATIONS" AVAILABLE IN THE CENTRAL ROAD RESEARCH INSTITUTE LIBRARY, NEW DELHI.

(Contd. from previous issue)

- HUMM (W.).**  
Waymouth particle interference: Contribution to the mathematical treatment of mixtures of particle sizes.  
Insdoc Trans. No. 815.  
Trans. from German from "Schweizer Archiv for Angewandte Wissenschaft und Technik 1941, 7, 109-112". 3448
- HUMMELL (A.).**  
On the shrinkage of cement-bound masses, its measurement & effects.  
Insdoc Trans. No. 1737.  
Trans. from German from "Tragung-berichte Der Zement industrie. 1954, (10), 25-49". 5697
- KATHREIN (G.).**  
General Principles for a predetermination of the compressive strength of concrete.  
Insdoc Trans. No. 814.  
Trans. from German from "Tonind-Ztg. 1934, 8 (85), 1035-1036". 3445
- KIRCHHOFF (F.).**  
Black concrete spreader for highway and city road construction.  
Insdoc Trans. No. 1463.  
Trans. from German from "Strasse und autobahn 1950, 1 (5), 13-17". 4617
- KOZLOVSKY (B.K.).**  
New standards for planning motor roads for general use.  
Insdoc Trans. No. 2368.  
Trans. from "Avtom Dorgi, 18 (1955), 27-30" from Russian. 7614
- KRAH (R.).**  
New type of Pegging of transverse joints in concrete road surfaces.  
Insdoc Trans. No. 1446.  
Trans. from German from "Strasse und Tiefbau 1950, 4, 286-7". 5143
- KRAL (A.).**  
Influence of the Petrographic properties of the aggregates on the strength hardness of concrete.  
Insdoc Trans. No. 813.  
Trans. from German from "Int. Ass. Testing Materials London, Congress, April 19-24, 1937, 346-348". 3446
- KROPP (J.).**  
Formation of joints in concrete road surfaces.  
Insdoc Trans. No. 1451.  
Trans. from German from "Strasse und Autobahn, 1950, 1 (9), 9-11". 5168
- KUBIK (F.).**  
Influence of the silicic acid content on the soundness of hardened portland cement kept in air.  
Insdoc Trans. No. 720.  
Trans. from German from "Tonindustrie-Zeitung 1926, 50 (180, 299)". 3344
- KUHL (H.).**  
50 years of cement chemistry in theory and practice.  
Insdoc Trans. No. 1315.  
Trans. from German from "Zement kalk-Gips 1951, 1 (231-6)". 5010
- KULLBERG (G.).**  
Road Machine of the state road institute.  
Insdoc Trans. No. 1604.  
Trans. from Swedish from Original "Statens Viginstitut, Meddeland No. 69. 6572
- KULLBERG (G.).**  
Special apparatus for traffic studies.  
Insdoc Trans. No. 1543.  
Trans. from Swedish from "Svenska Vagforeningens Tidskrift 1955, 9, 345-50". 5676
- KURAOKA (Eojiro).**  
On spectroscopic analysis of silicates.  
Insdoc Trans. No. 1566.  
Trans. from Japanese from "Reports of the Govt. Ind. Res. Inst. Tokyo, 279-96". 5486
- LANDGREBE (H.).**  
Corrugations on water bound road surfaces.  
Insdoc Trans. No. 1447.  
Trans. from German from "Strasse und Tiefbau, 1950, 4, 181-4". 5169
- LEROUX (M.).**  
Aging of road tars.  
Insdoc Trans. No. 666.  
Trans. from French from "Revue Generale des Routes et des Aerodromes 1953, (262), 23-35". 3321
- LETTERS (K.).**  
Investigations on tar and bitumen and their miscibility, with the help of thin films on water-surfaces.  
Insdoc Trans. No. 871.  
Trans. from German from, "Bit. Teere Asph. Pech 1952, 3 (10), 258-261 & 1952, 3 (11), 284-88". 3768

- LINCKENHEYL (G.).**  
Surface coatings.  
Insdoc Trans. No. 1987.  
Trans. from French from "Revue Generale des Routes et des Aerodromes 1950, 20, 21-32, 36-46, 51-59". 6934
- LUFTSHITZ (H.).**  
When can additives like gneiss and crushed granite sand have a damaging effect.  
Insdoc Trans. No. 874.  
Trans. from German from "Zement 1933, 22, 136-8". 3812
- MALLISON (H.).**  
Investigation of tar gravel.  
Insdoc Trans. No. 16 6.  
Trans. from German from "Strassen und Tiefbau (1954), 8, 96-99". 5585
- MALLISON (H.).**  
Roughness and smoothness.  
Insdoc Trans. No. 1341.  
Trans. from German from "Strasse und Autobahn 1952, 3 (9), 283-4". 5007
- MANOUVRIER (F.).**  
Comparative tests on road concretes.  
Insdoc Trans. No. 3133.  
Trans. from French from "Annales des Travaux Publics de Belgique 1946, 102 (6), 721-44". 10489
- MATTHIAS (K. H.).**  
New hot spraying method for the construction of bituminous (tar) roads.  
Insdoc Trans. No. 1164.  
Trans. from German from "Strasse und Autobahn 1950, 1 (2), 26-28". 4690
- MAURICE (DUMAS)**  
Introduction of probabilities in the domain of the strength of materials.  
Insdoc Trans. No. 2758.  
Trans. from French from "Annales des ponts et chaussées 1947, 117, 693-8". 9617
- MEYER (Eric V.)**  
Repair and maintenance of concrete roads.  
Insdoc Trans. No. 1509.  
Trans. from "Beton Teknik. Copenhagen 1952, 18, 1, 1-20. 5428
- MOLL (P.).**  
On testing of fine gravel regarding its strength.  
Insdoc Trans. No. 1313.  
Trans. from "German from Strasse und Autobahn 1951, 2, 18-20, 56-58". 5013
- MUSSGNUM (G.).**  
Sintering of raw meal.  
Insdoc Trans. No. 827.  
Trans. from "German from Zement-Kalk-Gips 1953, 6 (2), 46-53". 3524
- NEUMAME (E.).**  
Relations between traffic stresses and composition of bituminous surfaces.  
Insdoc Trans. No. 1964.  
Trans. from "German from Strasse und Tiefbau 1948, 2, 292-98". 6710
- NICOL (M.A.).**  
Action of water on three anhydrous and crystallised silicates of calcium.  
Insdoc Trans. No. 1395.  
Trans. from French from "Bulletin de la ociete Chimique de France 1952, 19, 418-21". 5130
- NIKOLITSA (G.).**  
Stresses and joints in concrete road surfaces  
Insdoc Trans. No. 1408.  
Trans. from "Beton und Stahlbetonbau 1950 45, 276-9". 5130
- OBERTO (D. H. T.)**  
Investigation regarding relation between the skid resistance of a road surface & grain-size.  
Insdoc Trans. No. 1734.  
Trans. from Dutch from "Wegen 1955, 29, 289-97". 7578
- OINOUE (CHIKAO).**  
On the setting of concrete in water and compressed air.  
Insdoc Trans. No. 1119.  
Trans. from Japanese from "Jl. Soc. of Civil Engineering Japan, 1931, 9, 1159-1180, (40 pages)". 4834
- PAOLI (R.).**  
How to estimate the surface quality of roadways.  
Insdoc Trans. No. 1431.  
Trans. from French from "Annales des pont et Chaussées 1952, 122, 247-69". 5046
- PARFAIT (F.).**  
Principles of Organisation of connecting roads.  
Insdoc Trans. No. 1736.  
Trans. from French. 5986
- PELTIER (R.).**  
Estimation of the resistance of the foundation soils of soft road surface.  
Insdoc Trans. No. 1668.  
Trans. from French from "Revue Generale des Routes et des Aerodromes (1955), 25, 59-74". 5657
- PERICHON.**  
Equipment for the making of road surface coatings.  
Insdoc Trans. No. 1294.  
Trans. from French from "Revue Gen. des. Routes et de Aerodrome 1949, 19, 32-38". 4906

PINCON (A.).  
Comparative study of the granulometry of cement concretes; bitumen concretes and clay concretes.  
Insdoc Trans. No. 3110.  
Trans. from French from "Travaux 1951, 298-303".  
9619

POGANY (A.).  
Estimation of abrasion resistance of concrete from the abrasion resistance of mortar and additional materials.  
Insdoc Trans. No. 1647.  
Trans. from German from "Zement 1935, 24, 522-24".  
5583

POHLMANN (R.).  
Material testing by the visible sound process.  
Insdoc Trans. No. 817.  
Trans. from German from "Die Technik 1948, 3, 465-70".  
3520

POUYOL (J.).  
Application of loaded plate method to the study of surfaces.  
Insdoc Trans. No. 1965.  
Trans. from French from "VI-A 1950, 11, 83-87".  
6599

PRETTRE (M.).  
Studies on silica and alumina Gels.  
Insdoc Trans. No. 1409.  
Trans. from French from "Bulletin de L'Ass. Francias dosh Techniciens du Pe-trole 1952, (91), 23-41.  
5045

PROT (M.).  
Statistical tests on mortars and concretes.  
Insdoc Trans. No. 2760.  
Trans. from French from "Annales de L'Institute Technique du Batiment et des Travaux Publics. 1949, No. 81".  
10554

QUARANTA (F.).  
Determination of the bearing capacity of soils and road foundations by means of loading tests.  
Insdoc Trans. No. 2477.  
Trans. from French from "La Technique Routiere 1956, 2, 9-17".  
8711

RADCZEWSKI (O. E.).  
Electronoptical investigation of transforma-tion reactions of clay minerals.  
Insdoc Trans. No. 893.  
Trans. from German from "Tonindustrie Zeitung 1953, 77 (17-18), 291-6".  
3868

RIO (A.).  
"Some observations on the constitution and properties of ferrico, pozzuolanic and ferrico-pozzuolanic cements".  
Insdoc Trans. No. 855.  
Trans. from Italian from "L'Industria Italiana del cemento 1950, 20 (97/8) 167-72".  
3631

RIO (A.): CERRONE (M.) & GRANDS (R. DEL)  
"Research on the influence of asphaltenes on the technological properties of bitumen".  
Insdoc Trans. No. Nil.  
Trans. from Italian from "II International Congress asphalte Rome 1954".  
7007

RISSEL (E.).  
Experiences with concrete containing plastic additives.  
Insdoc Trans. No. 1532.  
Trans. from German from "Zement-Kalk-Gips 1955, 10, 355-361".  
5126

RISSEL (E.).  
Repairing old concrete by the use of artificial Materials.  
Insdoc Trans. No. 1531.  
Trans. from German from "Zement-Kalk-Gips 1953, 4, 101-105".  
5048

RISTER (L.).  
Prevention and removal of salt-efflorescence on superstructures.  
Insdoc Trans. No. 1738.  
Trans. from German from "Allgemeine Bauzeitung 1954, 9 (420), 1014".  
5696

LIST OF APPROVED WORKS ON NATIONAL HIGHWAYS

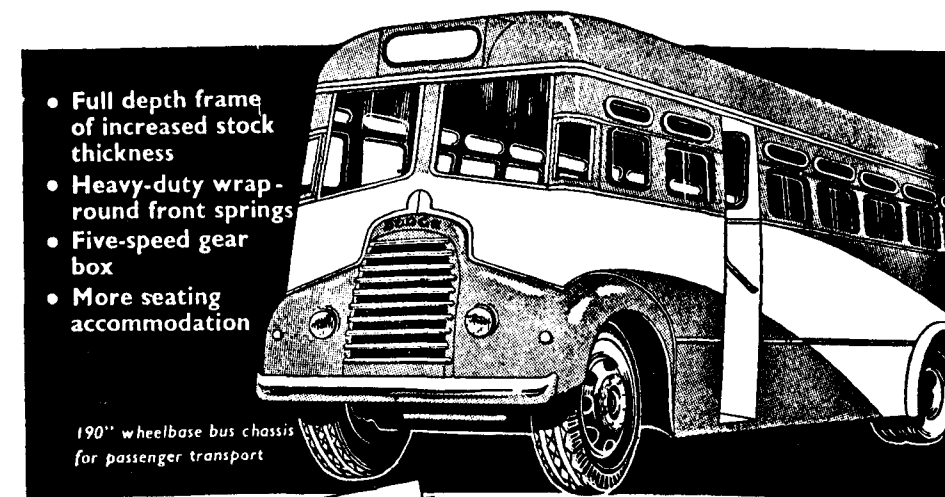
| S. No.          | Job No.    | Name of the work                                                                                                                                                           | Amount<br>(Rs in lakhs) |
|-----------------|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| ANDHRA PRADESH  |            |                                                                                                                                                                            |                         |
| 1.              |            | Four works each costing less than 2 lakhs.                                                                                                                                 | 1.23                    |
| ASSAM           |            |                                                                                                                                                                            |                         |
| 2.              | 2275-AS-38 | Reconstruction of bridge No. 334/3 (Namdang) and Makum-Ledo-Lekhapani-Road on N.H. No. 38.                                                                                 | 3.52                    |
| BOMBAY          |            |                                                                                                                                                                            |                         |
| 3.              | 2273-BM-7  | Construction of 23 culverts on Karanji Pohra Road Section of N.H. No. 7 in Yeotmal Distt.                                                                                  | 2.30                    |
| 4.              | 2274-BM-8A | Providing C.D. Works from Saurashtra border to Limbdi Section of N.H. No. 8A.                                                                                              | 2.72                    |
| 5.              | 2276-BM-4  | Constructing the approaches to railway overbridge in place of the existing railway level crossing in mile 82 of Bombay - Poona Road, N. H. No. 4.                          | 2.15                    |
| 6.              | 2277-BM-6  | Additional land acquisition to 150 ft and widening formation width to 38 ft in miles 38/4 to 65/3 of Dhulia-Edlabad-Nagpur Road Section of N.H. No. 6, in Wardha District. | 4.68                    |
| 7.              | 2278-BM-8A | Construction of bridge across Harbad river in Mithapur in mile 43/4 of Bagoka-Deopur Section of N.H. No. 8A.                                                               | 4.93                    |
| 8.              |            | Four works each costing less than 2 lakhs.                                                                                                                                 | 4.11                    |
| DELHI           |            |                                                                                                                                                                            |                         |
| 9.              | 2280-DLH-2 | Improvement to Delhi-Mathura Road between miles 5/2 to 11/6-SH (Flattening and turfing of slopes and other improvements).                                                  | 0.67                    |
| JAMMU & KASHMIR |            |                                                                                                                                                                            |                         |
| 10.             | 2268-JK-1A | Restoration of flood damages to guide bunds to Tawi bridge on J. S. Road N. J. 1A.                                                                                         | 2.90                    |
| 11.             | 2269-JK-1A | Construction of 6x40 ft span under-strutted bridge in mile 39 over Sheri Nallah N.H. No. 1A.                                                                               | 4.35                    |
| 12.             | 2270-JK-1A | Construction of 60 ft span of R.C.C. Arch Bridge at Buniyar in mile 49 of Srinagar-Uri Road, N.H. No. 1A.                                                                  | 2.41                    |

| S. No.                | Job No.    | Name of work                                                                                                                                             | Amounts<br>(Rs in lakhs) |
|-----------------------|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| 13.                   | 2271-JK-1A | Reconstruction of Chandanwari Bridge in mile 54 on Srinagar-Uri Section of N.H. No. 1A.                                                                  | 2.30                     |
| <b>MADHYA PRADESH</b> |            |                                                                                                                                                          |                          |
| 14.                   | 2261-MP-3  | Protection work to the bank of Narmada river near Khalghat Dak-Bungalow in mile No. 53 of Agra-Bombay Road N.H. No. 3.                                   | 0.38                     |
| <b>MADRAS</b>         |            |                                                                                                                                                          |                          |
| 15.                   | 2264-MD-5  | Electrification of Travellers Bungalow at Gummidipundi, Acharpakham and Karungali on N.H. in Madras.                                                     | 0.06                     |
| 16.                   | 2279-MD-7  | Widening the formation to 38 ft (including land acquisition) in mile 290/0 to 295/3 of N. H. No. 7 near Madurai.                                         | 3.51                     |
| <b>PUNJAB</b>         |            |                                                                                                                                                          |                          |
| 17.                   | 2282-PB-1  | Providing 4½ in. thick stone metal wearing coat and 3/4 in. thick premix carpet on Karnal-Bye-pass (Portion of G.T. Road-N.H. No. 1) in Karnal District. | 3.16                     |
| <b>UTTAR PRADESH</b>  |            |                                                                                                                                                          |                          |
| 18.                   |            | Two works each costing less than 2 lakhs.                                                                                                                | 1.45                     |



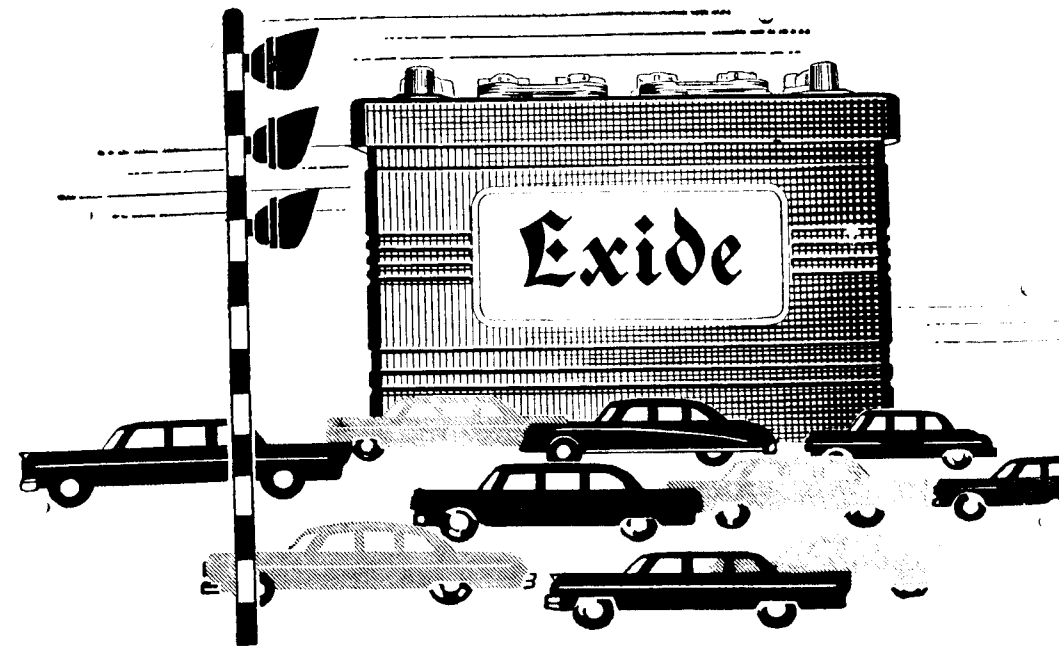
## DODGE

### DIESELS

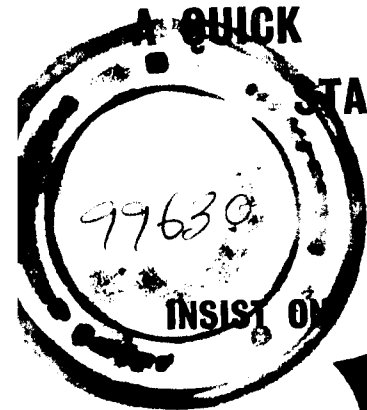


Progressively manufactured by  
**THE PREMIER**  
**AUTOMOBILES LTD.**  
 BOMBAY

Contact your  
 nearest dealer.



**ALWAYS  
"OFF" TO  
A QUICK  
START**



No matter how frequently you use the self-starter, your Silver Exide will always bear the load. Special long-lived Porvic Separators of microporous plastic, offer sustained insulation to the battery plates. And the Exide plates of hard-wearing CB 95 alloy, being fully protected, have a really long and useful service life.

Remember, only Silver Exide offers you all these features plus a Hard Rubber Container that is TOUGH, SHOCK RESISTANT and LEAK-PROOF.

*Silver*  
**Exide**

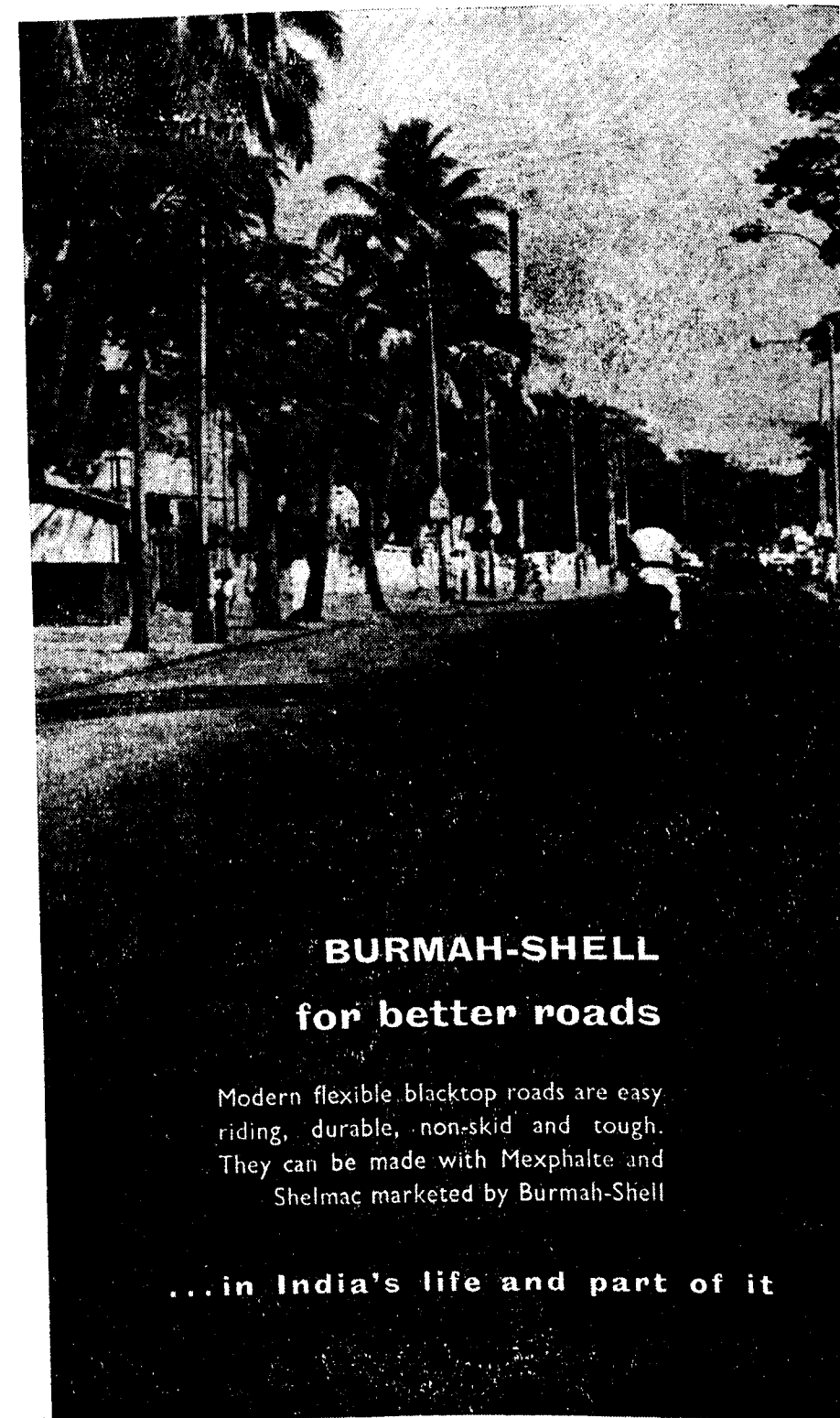
*Still keeps going when the rest have stopped.*

†BSC-32 D411 m 2, N4.8 CHLORIDE & EXIDE BATTERIES (EASTERN) PRIVATE LTD.

Please mention this journal when replying to advertisements.

N60-159

vi



## BURMAH-SHELL for better roads

Modern flexible blacktop roads are easy riding, durable, non-skid and tough. They can be made with Mexphalte and Shelmac marketed by Burmah-Shell

...in India's life and part of it

VINCENT ROAD, Bombay, 3" Asphaltic Concrete in two courses laid in 1950 using Bitumen supplied by Burmah-Shell.

Please mention this journal when replying to advertisements.



**it's so much  
easier with a -**

How arduous it would be to break a heap of stones  
by hand! And how long it would take!

Hand broken metal no doubt is cubical, but the  
modern, perfected Baxter-Marshall "Knapping  
Motion" Stone Breaker not only produces equally  
good cubical samples, but also yields increased  
output at lower labour cost.



## **Marshall, Sons & Co. (India) Ltd.**

33/1, Netaji Subhas Road, Calcutta.

Marshall's Building, Ballard Road, Bombay I.

Marshall House, Hanuman Road, New Delhi.

Marshall's Building, 2nd Line Beach, Madras.



**Marshall Sons... In step with Mechanisation**

Printed by K. S. Krishnan at The Progressive Printers, 17, Coral Merchant Street, Madras-1  
& Edited and Published by A. J. D'Costa, Hony. Secretary, Indian Roads Congress, Jamnagar  
House, Mansingh Road, New Delhi-2-950.