74

Transport- Communications

Monthly Review

Aug 1984 No. 88

TRANSPORT-COMMUNICATIONS

MONTHLY REVIEW

AUGUST 1954—No. 88

INDIAN · ROADS · CONGRESS
TRANSPORT IS CIVILIZATION

INDIAN ROADS CONGRESS, NEW DELHI.

BITUMINOUS WATERPROOFING PRODUCTS OF ALL TYPES

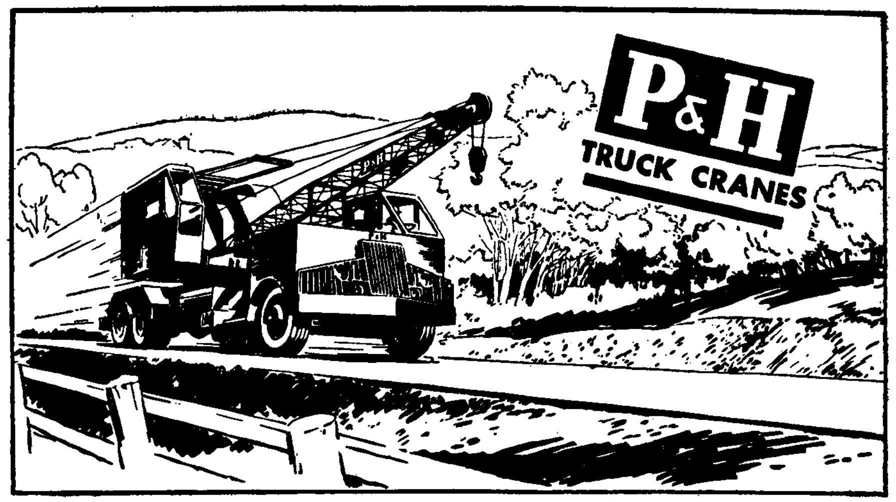
ROAD TARS
•
BITUMINOUS MASTICS
•
ROOFING FELTS
•
BITUMINOUS EMULSIONS
Quick and slow breaking
•
INDUSTRIAL PITCH EMULSIONS
•
EXPANSION JOINTINGS
Precast and Hot-Pour
•
BITUMINOUS
ANTI-CORROSIVE PAINTS
For light and heavy Duty Protection

WATERPROOF CONTRACTS EXECUTED
UNDER GUARANTEE

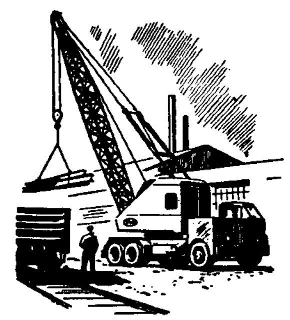
SHALIMAR TAR PRODUCTS (1935) LIMITED

6, LYONS RANGE, CALCUTTA
Branches: Delhi, Bombay, Lucknow, Ambala

STG/19A



FAST TO THE JOB . . . FAST TO FINISH IT



Swift travel enables P&H Truck Cranes to get quickly from one job to another—to handle more of them, miles apart. P&H Truck Cranes are built with two engines—one for travel, another for handling heavy work. Greater stability gives them more lifting capacity around the full 360° of operation than in any other machines of their size. Ask your P&H Distributor for complete information about P&H Truck Cranes.

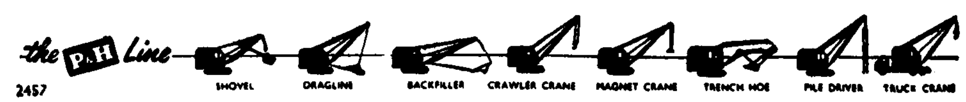
HARNISCHFEGER OVERSEAS CORPORATION, MILWAUKEE 46, WIS., U.S.A.

Cable "Harnosco"
Established in 1884

P & H DISTRIBUTORS

WILLIAM JACKS & COMPANY LIMITED

BOMBAY - CALCUTTA - MADRAS



TRANSPORT-COMMUNICATIONS

MONTHLY REVIEW

AUGUST 1954—No. 88

TABLE OF CONTENTS

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

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

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

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 8 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, Jamnagar House, Shahjahan Road, New Delhi-2.

KORAPUZHA BRIDGE—In mile 7/6-7 of Calicut to Cannanore Road, Malabar District, Madras. Four spans of 100 ft clear each, three spans of 64 ft 10 inches clear each and one span of 60 ft clear.

TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

A REVIEW OF
ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

AUGUST 1954

ROAD DEVELOPMENT IN SAURASHTRA

(Contributed)

HISTORY :

THE Peninsula of Saurashtra on the west-coast of India covers an area of about 22,000 sq. miles and has a population of 41 lakhs. In ancient times the most important route in the Peninsula followed the coast from Ghogha in the South-west to Dwaraka, connecting the centres of pilgimage in the Peninsula to the main land of Gujarat. It may be said that these routes satisfied the needs in those times and were maintained in some measure till the end of Mogul domination. With the decline of the Mogul Empire the Peninsula was thrown in the turmoil of internal war and the system of communication received a setback. The State of internal confusion ended in 1807 when the Kathiawar Peninsula came under the British rule. Till 1865 i.e., for 6 decades no progress was made in road construction. The period between 1865 and 1878 was the beginning of the Road History in Kathiawar Peninsula. All the important trunk roads were constructed during this period. Col. Keating, the British Political Agent at Rajkot constructed a road from Wadhwan to Rajkot in 1865 from the Imperial Funds, and by 1870 roads were constructed connecting Rajkot with Bhavnagar, Navanagar and Jetpur with the co-operation of the various States. The road system thus generally radiated from Rajkot to various important places in the Peninsula.

By 1876, the construction of roads which was first started at the initiative of the British Political Agent at Rajkot, was taken up by the various States.

In the smaller States, road construction had to be carried out under the Local Fund Engineering Department of the Agency. The main defect of these arrangements was absence of proper maintenance due to which roads already constructed began to fall into disrepair.

The Political Agent at Rajkot, therefore, proposed to the Chiefs to subscribe to a permanent road fund under his management to prevent the deterioration of roads constructed at large cost, and in 1874 all first and second Class States agreed to subscribe Rs 64,000/- annually for the construction and maintenance of trunk roads passing through their territory. By 1879 over 322 miles of metalled roads and over 237 miles moorum road were constructed.

Rajkot was connected with Wadhwan, Jodiya, Veraval, Porbandar and Bhavnagar. Roads of local importance, however, were entirely left to the States and so the facilities on local roads varied from State to State. But in the last 3 decades of the 19th century the construction of Railways was making progress as several States embarked upon Railway construction as profitable enterprise. With the advent of Railways the position of Road Transport in Kathiawar Peninsula changed radically and took a change for the worse. The States had invested large amounts of capital in Railway undertakings and came to regard roads as a rival transport system adversely affecting railway revenues.

Consequently, road construction and construction of bridges etc. suffered with the result that there was no co-ordination of the needs of different areas and industries in the State. The internal rivalries between various States added to the neglect. Consequently the road system that existed at the time of integration of the various States and Estates of Kathiawar Peninsula, numbering about 222 was fragmentary. The roads that existed were not planned for catering to the needs of a developing community or to meet the demands of expanding industry and trade. In fact there was considerable wasteful expenditure in constructing the roads which had but little use except to serve as approaches to hill stations, summer resorts or hunting grounds for the ruling Princes.

Position at the Time of Integration

At the time of integration, the total road milage was 3035. The break-up according to the types and class of roads was as under :—

		Miles	
1.	**State Highways.**		
	(a) Concrete roads		1
	(b) Asphalt roads		26
	(c) Water-Bound Macadam Roads		415
			442
2.	**District Roads**		
	(a) Asphalt roads	55	
	(b) Water-Bound Macadam roads	795	
	(c) Moorum roads	305	
	(d) Earth roads	225	1380
3.	**Other roads**		
	(a) Asphalt roads	3	
	(b) Water-Bound Macadam roads	580	
	(c) Moorum roads	410	
	(d) Earth roads	220	1213
	Total		3035

It will be seen from these figures that out of 3035 miles of roads, 1160 miles were of lower types, i.e., fair weather roads or improvised cart tracks. Even most of the Water-Bound macadam roads were without cross drainage works and functioned during fair weather only.

Requirement of Roads: The total milage of 3035 miles works out to about 14 miles of roads per hundred square miles of country. Incidence of roads in some of the other States are as under :

Name of the State		Milage of roads both surfaced & unsurfaced per 100 square miles of area
Madras	...	32
Bombay	...	29
West Bengal	...	40
Uttar Pradesh	...	31
Bihar	...	48
Assam	...	29
Saurashtra	...	14

From the above, it will be seen that Saurashtra is poorly served by roads than other States.

Saurashtra being agricultural area, about 2/3 of the population is in villages. During the monsoon these thousands of villages are literally cut off from one another and from towns, which makes medical aid etc. practically impossible. These thousands of people require to be provided with means of contact with outside world to bring up awakening, raised standard of life and spread of education etc. Roads are the **sine qua non** of any plan which aims at the economic development of the country.

Missing Links

The existing road system is not connected and co-ordinated. At present there are no direct road connections between several important trade centres. Also, after the integration the areas of the different principalities have been re-grouped to form the Collectorates, Deputy Collectorates, Talukas and Mahals. It is necessary that District headquarters have direct road links with sub-divisional headquarters and that Taluka and Mahal headquarters are joined with District and sub-district headquarter.

For example in Madhya Saurashtra District, Morvi which is an important Deputy Collectorate is not connected by a direct link with Rajkot which is the headquarters of the district. There is no road from Morvi to Malia which is the Mahal headquarter under Morvi Deputy Collectorate.

Coming to the question of inter-district connections, . there are no direct road connections between Junagadh and Bhavnagar or Bhavnagar and Surendranagar or Jamnagar and Junagadh.

So far as inter-state connections are concerned, Saurashtra is not connected by a road with the rest of India. There is no road connection with Ahmedabad. It is, therefore, necessary to provide important missing links to make the existing road system a connected one and to connect it with road system of rest of India. The mileage of missing links required is about 700.

Bridges

Many of the river crossings in the existing road system are unbridged. The result is that even some of the trunk roads go out of commission during the monsoon. This is a serious handicap to traffic. Even on the State Highways like Rajkot-Jamnagar road, River Dondi near Padadhari, river Bavani near Dhrol, river Und near Wankia and river Kankavati near Phala were without bridges. The traffic on this road is at a standstill during the 4 months of monsoon. Similarly on Rajkot-Bhavnagar road which is another State Highway, River Bhadar near Atkot, river Sindari near Sanosara, and river Malasari near Vartej etc. cause stoppage of traffic during monsoon.

It is therefore necessary to provide bridges and causeways to make at least the principal roads all-weather.

Important Village and Other Roads

Practically no attention was paid to the provision of roads in rural areas by the former States (except Gondal State) even though these were essential to open out rural areas and for the needs of development. Kalawad-Rajkot, Gondal-Babre, Than-Sara-Dhrangadara, Sanosara-Garia-dhas-Jesar, Ashrana-Doongar roads and such others are the examples. In Saurashtra about 700 villages have a population of 1000 and above, 1250 villages have a population of 500 and above and the remaining 2400 and odd villages have a population of less than 500. If the target were to connect villages having a population of 1000 and over to the main road system or with each other and the nearest marketing centre or with railways, about 1250 miles of new roads will have to be constructed. If villages with population 500 and above were to be provided with road communication, the milage necessary would be 2750.

Modernising and improving State Highways and other Roads

Practically no systematic attention was paid to the maintenance of roads and many of the States (pre-merger) had no adequate organisation to look after them. As a result, even arterial roads are mostly in a worn out condition for want of renewals over a period of years.

There are many unmetalled stretches on the main roads. To bring them to standard, substantial improvements and replacements are necessary. On many of them, minor cross drainage works are also to be provided. For example, on Rajkot-Bhavnagar road which is a State Highway there are several miles with only a moorum surface and cross-drainage works at several places are missing. An important road from Jodia to Amran is completely without cross-drainage works. Thus quite a large milage of the existing metalled roads require restoration. Roads joining important towns, which are unmetalled require to be upgraded. On State Highways, due to considerable increase of fast moving traffic and heavy goods trucks, the Water-Bound Macadam surface is not found adequate. Road stone gets loose and corrugations are developed making travelling uncomfortable. Life of a Water-bound Macadam surface is only 3 to 4 years. With the traffic at present obtaining on these roads, it has therefore been found very difficult to maintain this surface in condition. The cost of maintaining one mile of metal road will be more than Rs 1500 per mile per year. An asphalt road requires seal coat every 4th or 5th year and its life is only 12 years. The maintenance cost of the asphalt road is also about Rs 2000 per mile per year considering the cost of seal coat. The life of a cement concrete road is 30 years and it requires not more than Rs 250 per mile per year for maintenance.

Thus, it has been found that the provision of cement surface becomes economical in the long run even without considering the benefits that would accrue to the vehicle operators. Moreover almost all materials to be used will be indigenous.

Comprehensive Road Plan

A comprehensive road scheme for Saurashtra which provides road communication to all villages would require about 8800 miles of roads including existing ones and it is roughly estimated to cost over Rs 20 crores. A scheme to provide roads for villages with a population of 500 and above requires 6500 miles of roads and it would roughly cost Rs 15 crores, including improving and restoring existing road system. It is felt that the latter is the minimum requirement. This would give an incidence of 29.5 miles of roads per 100 square miles of area.

First Stage Plan

The above is the target to be achieved but in view of the fact that the State has been formed only recently and taking into consideration the available financial resources a First Stage Plan has been worked out to make the fragmentary road system connected by providing important missing links and causeways and bridges. It also provides for the improvement of some of the important existing roads and modernising the State Highways and construction of new roads to connect villages with population of 1000 and above.

The cost of First Stage Plan is as under :

	Miles	Rs in Lakhs
(1) Providing missing links	700	252.00
(2) Providing missing bridges & causeways on existing main road system	Nos. 44	90.75
(3) Providing important village & other roads	1250	157.00
(4) Modernising & Improving State Highways	320	263.00
(5) Improvement of other roads	—	68.50
	Total	831.25

Work Done Since Integration till 1951 i.e., 3 Years of Pre-plan Period

The total expenditure on road development since integration to the end of 1950-51 was Rs 77.17 lakhs including Rs 26 lakhs spent on earthwork for roads during the 1948-49 scarcity for giving relief. Considering this the milage of roads at the beginning of the plan period was as under :

	Miles
Concrete roads	1
Asphalt roads	95
Metalled roads	1785
Moorum roads	721
Earth roads	697
	3200

Construction of about 103 miles of new roads was begun and 123 miles of roads on which earthwork was done during scarcity were converted into moorum roads. 48 miles of existing roads were improved and 26 miles were provided with ashpalt surface. Four new major bridges were practically completed and two were improved.

The First Five-Year Plan from 1951-52 to 1955-56.

The First Five-Year Plan of Saurashtra Government envisages an expenditure of Rs 20·36 crores on the various development schemes out of which Rs 3 crores (14 per cent) are allocated for road development. From this amount only a part of the above mentioned First Stage Plan could be undertaken and the item-wise distribution is as under:

	Miles	Rs in lakhs
(1) Improvement to existing Roads: Upgrading: providing cross drainage works:	64 114	29·71
(2) Modernising State Highways Improving & providing cement concrete surface etc.:	108	84·50
(3) Construction of Causeways & bridges:	38 Nos.	73·50
(4) Construction of Missing links (which will initially remain as moorum roads)	313	54·29
(5) Construction of village & other roads (earthwork & moorum topping)	458	58·00
		300·00

The year-wise expenditure proposed on different schemes during the Five years of the plan was as under:

Scheme	1951–52	1952–53	1953–54	1954–55	1955–56	Total for 5 years
	Rupees in lakhs					
(1) Improvements to existing roads	2.04	8.52	6.50	6.50	6.15	29.71
(2) Modernising State Highways	16.50	26.37	21.63	10.00	10.00	84.50
(3) Causeways & bridges	7.02	13.05	17.34	18.00	18.09	73.50
(4) Construction of Missing links	6.99	24.30	8.50	8.50	6.00	54.29
(5) Construction of village & other roads	2.43	11.65	17.42	16.50	9.00	58.00
TOTAL :	34.98	83.89	71.39	59.50	50.24	300.00

Progress of the plan in the First two years

Programme for expenditure on various schemes and targets to be achieved as per plan and the actual expenditure and targets actually achieved in 1951-1952 and 1952-1953 is shown in Appendix I. It also shows the expenditure planned and budgeted during 1953-54 with targets aimed and expected to be achieved. The details of progress shown in the table is given below:

(a) Improvements to Existing Roads

The work of upgrading 4 miles and improving another 8 miles was started in 1951-52. At the end of 1952-53 the work on 10 miles is completed and it is in progress on another 28 miles.

(b) Modernising State Highways

Since starting the work in 1951-52, 37 miles have been completed by the end of 1952-53 and four miles are in progress.

(c) Causeways & Bridges

In 1951-52, two bridges are completed and four were started. At the end of 1952-53 four bridges are completed and 8 are in progress.

(d) Missing links

Due to scarcity conditions in 1951-52, 122 miles were started, and during 1952-53 another 111 miles were started. According to the plan 126 miles out of 233 already started are to be metalled and 107 miles are to remain as moorum roads. The stage at which the work on these miles progressed at the end of 1952-53 is as under:

Metalled with C.D. works Miles	Moorum with C. D. works Miles.	Moorum without C. D. works Miles	Only earthwork with C. D. works Miles	Only earthwork without C. D. Works Miles
26.75	43.50	53.30	13.50	96.25

(e) Village & other roads

Due to scarcity conditions 242 miles were started in 1951-52 and additional 70 miles were started in 1952-53. Out of these, earthwork on 242 miles is completed. The progress of the expenditure is short of the plan at the end of 1952-53 due to withholding starting of new works because of financial consideration due to scarcity conditions in 1951-52 and 1952-53.

It is expected that by 1953-54 the leeway will be made up.

Acceleration of the plan

An additional amount of Rs 150.25 lakhs is proposed to be spent on the road development scheme during the planned period.

The following additional works are proposed:

Scheme	Additional funds proposed Rs in lakhs	Additional targets.
( ) Improvement to existing Roads	15.00	Improvement to 711 miles of roads will be taken up out of which improvement to 85 miles will be completed.
(b) Modernising State Highway	50.00	Additional 58 miles of State Highways will be modernised.
(c) Causeways & bridges	17.25	17 additional bridges will be started.
(d) Construction of Missing links	40.00	In the original plan, roads were to be kept as moorum roads, 225 miles of these roads will be provided with metal surface.
(e) Construction of village & other roads	28.00	415 additional miles of roads will be provided. Earthwork for these roads has been partially completed during scarcity and they will be provided minor C. D. works and moorum surface.
	TOTAL:	150.25 lakhs.

Considering the additional amount proposed above, the expenditure and targets of the accelerated First Five Year Plan would be as under:

Scheme	Planned Expenditure Rs in lakhs	Planned targets miles	Additional Expenditure Rs in lakhs	Additional targets
(a) Improvements to existing roads	29.71	83 improvements 114 miles to be provided with culverts	15.00	85 miles improvement (171 miles will be started out of which 85 miles will be completed)
(b) Modernising State Highways	84.50	108 miles	50.00	58 miles
(c) Causeways & bridges	73.50	38 Nos.	17.25	17 new bridges & causeways will be started, out of which 7 will be completed.
(d) Construction of Missing links	54.29	331 miles	40.00	225 miles which were to remain as moorum surfaced will be provided with metalled surface
(e) Construction of village & other roads	58.00	476 miles	28.00	415 miles-earthwork on these roads has been partially done during scarcity.
TOTAL:	300.00		150.25	

National Highways

The Saurashtra Govt. agreed to participate in the National Highway scheme in 1950. The Central Govt. proposed to construct a National Highway from Kandla Port to Ahmedabad via the Northern Boundary of the State. On representations being made to the Central Govt. the alignment as finally fixed runs from Mithapur on Saurashtra Bombay border to Limbdi - Sayla - Dolia - Bamanbore - Wankaner - Morvi and on to Rann of Kutch. Work started on this N. H. as under are :-

(1) Earthwork of road from Mithapore to Limbdi

(2) Earthwork of road from Limbdi to Sayla

(3) Earthwork of road from Sayla - Dolia

(4) Bamanbore - Wankaner

This highway is termed as N. H. 8-A and the liability for maintenance & repairs and new constructions has been taken over by Government of India from 1-4-51. From 1st April, 1953 Bamanbore-Rajkot - Porbandar road has also been declared a National Highway and assigned No. 8-B On both these National Highways 8-A and 8-B works as detailed In Appendix II have been proposed.

APPENDIX I

ROAD SCHEMES	1951-52 Expenditure Planned	Expenditure Actual	Targets Planned	Targets Actual	1952-53 Expenditure Planned	Expenditure Actual	Targets Planned	Targets Expected
Improvements to existing roads	2.04	0.61	Miles 12	Completed 4. In progress 8.	8.52	2.86	Miles 16 Cumulative 28	Cumulative completed 10. In Progress 28.
Modernising State Highways.	16.50	10.15	20	,,	26.37	31.33	32	Complete 37. Progress 4.
Causeways & Bridges.	7.02	5.51	5	Complete 2. Progress 4.	13.05	11.18	6	Complete 4. Progress 8.
Construction of missing links	6.99	5.89	35	In Progress 122.	24.30	17.76	75	Completed 88. In Progress 145.
Construction of village and other roads.	2.43	2.21	55	In Progress 242.	11.65	5.87	121	Completed 70. In progress 172.
	34.98	24.37			83.89	69.00		

ROAD SCHEMES	1953-54 Expenditure Planned Budget	Expenditure Revised	Targets Planned	Targets Expected	Total at the end of 1953-54 Expenditure Planned	Expenditure Expected	Targets Planned	Targets Expected
Improvements to existing roads	6.50	13.34	Miles 12 Cumulative 40.	Cumulative Complete 28 Progress 25.	17.06	16.81	40	Complete 28. Progress 25.
Modernising State Highways.	21.63	22.63	26	Complete 14 Progress 37.	64.50	64.11	69	Complete 62. Progress 37.
Causeways & Highways.	17.34	22.41	8	Complete 3 Progress 23.	37.41	39.10	19	Complete 9. Progress 23.
Construction of missing links	8.50	24.71	75	Completed 145 In Progress 64.	39.79	48.36	185	Completed 233. Progress 64.
Construction of village & other roads.	17.42	17.01	100	Completed 100. In progress 212.	31.50	25.09	276	Completed 170. In progress 212.
	71.39	100.10			190.26	193.47		

Appendix II

STATEMENT SHOWING PROPOSED WORKS ON NATIONAL HIGHWAYS

Sr. No.	Name of work.	Estimated cost.	Phasing. 1954-55	Phasing. 1955-56
1	2	3	4	5
(1)	Constructing Wankaner-Morvi Section of National Highway 8-A.	4,01,000	1,50,000	2,51,000
(2)	Constructing a bridge over River Minsar on Porbandar Kutiyana Section of N. H. 8-B.	6,24,000	2,26,000	4,00,000
(3)	Constructing a bridge over river at Daduka on Varjangjalia Kutiyana Section of N. H. 8-B.	2,99,600	2,00,000	99,000
(4)	Surfacing Varjangjalia-Kutiyana Section of N. H. 8B.			
	Section I.	1,17,401	1,17,401	—
	Section II.	1,03,760	1,03,760	—
(5)	Improving curve in mile 7 of Gondal-Jetpur Section of N. H. 8-B.	28,296	28,296	—
(6)	Providing 1½" premixed asphalt carpet after reconditioning on Gondal-Jetpur Section of Bamanbore Porbandar Road. N. H. 8-B.	5,86,100	5,86,100	—
(7)	Providing 1½" premixed asphalt carpet etc. to Jetpur-Upleta Section Bamanbore-Porbandar Road. N. H. 8-B.	9,38,000	5,00,000	4,38,000
(8)	Providing 1½" premixed asphalt carpet etc., to Porbandar-Kutiayana Section of Bamanbore-Porbandar road-N. H. 8-B.	9,38,000/-	5,00,000	4.38,000/-
(9)	Providing 1½" premixed carpet after reconditioning on Bamanbore-Kuvadva Section of Bamanbore-Porbandar road, N. H. 8-B.	4,69,000	3,00,000	1,69,000
(10)	Restoring & reconditioning and providing 1½" premixed carpet on Dolia-Bamanbore section of Ahmedabad-Kandala Road. N. H. 8-A.	9,00,000	6,00,000	3,00,000
(11)	Bridge over river Bhadar at Jetpur on Bamanbore-Porbandar road. N. H. 8-B.	10,00,000	3,00,000	7,00,000
(12)	Kandla-Ahmedabad N. H.8-A. Section Bombay-Saurashtra border to Limbdi.			
	(a) Rubble soling & metalling.	8,75,000	3,75,000	5,00,000
	(b) Minor cross drainage works.	4,25,000	4.25,000	—
(13)	Kandla-Ahmedabad N. H. 8-A. Section Limbdi to Sayla.			
	(a) Rubble soling & metalling.	5,00,000	3,00,000	2,00,000
	(b) Minor C. D. Works.	3,50,000	3,50,000	—
(14)	Kandla-Ahmedabad N. H. 8-A Section Sayala to Dolia.			
	(a) Rubble soling & metalling.	2,25,000	2,25,000	—
	(b) Minor C. D. Works.	1,25,000	1,25,000	—
(15)	Kandla-Ahmedabad N. H. 8-A. Section Bamanbore-Wankaner.			
	(a) Rubble soling & metalling from Bamanbore to Garida & restoring the surface on the rest of the road from Bamanbore to Wankaner.	2,75,000/-	1,75,000	1,00,000
	(b) Minor C. D. works on 6·3 miles from Bamanbore to Garida.	50,000	50,000	—

THE DESIGN OF CONCRETE MIXES ON THE BASIS OF FLEXURAL STRENGTH

DESIGNING concrete mixes on the basis of flexural strength does not differ essentially in procedure from the method for designing mixes to satisfy a specification involving compressive strength. There are, however, two operations in designing the mix which may give results different from those obtained by the method involving compressive strength. There are : (1) the estimation of the required average flexural strength to correspond with the specified minimum strength ; and (2) the estimation of the water-cement ratio needed to give the required average flexural strength.

An investigation is at present in progress at the Road Research Laboratory, U. K., to provide data on the water-cement ratio required to provide the necessary average modules of rupture. In the results so far obtained the general tendency is for the flexural strength to increase with the angularity of the coarse aggregate if the water-cement ratio remains constant. The data obtained in these tests have been used to design mixes of " Very low " workability having (1) an average compressive strength of 5,500 lb per sq. in. at 28 days, and (2) an average modulus of rupture of 550 lb per sq. in. at 28 days. Table I gives the mix proportions. For the required compressive strength the water-cement ratios ranged from 0.61 to 0.66 ; a value of 0.64 would probably be acceptable for any of the aggregates. For the required modulus of rupture the water-cement ratios ranged from 0.57 to 0.75-a range of nearly four times as great and too large to be ignored. On the basis of compressive strength the rounded gravel requires the least quantity of cement, whilst on the basis of flexural strength the leanest mix was obtained with the crushed rock.

If the mix containing irregular gravel is one that has shown satisfactory performance, for, say, road work, it may well be desired to produce a concrete of comparable quality in another district where the material locally available is a crushed rock. If, with the crushed rock, the mix is designed on the basis of flexural strength, which would be quite logical for road work, the results given in the last column of Table I show that some 14 per cent less cement would be required than if the mix were designed on the basis of compressive strength.

It will be seen from the foregoing remarks that the principle of mix design is essentially the same when flexural strength is substituted for compressive strength, but where it can appropriately be employed the use of flexural strength for designing mixes may lead to appreciable economies in cement. Because of this it is felt that more attention should be given to the flexural strength of concrete and that, for road and airfield work in particular, concrete mixes should be designed on the basis of the required flexural strength.

TABLE I

Cement contents of concrete required by compressive and flexural strength methods of design.

		Mixes with rounded gravel aggregate	Mixes with irregular gravel aggregate	Mixes with crushed rock aggregate
	Water-cement ratio by weight	0.61	0.66	0.64
	Aggregate cement ratio by weight	10.4	9.4	8.7
Mixes giving average compressive strength of 5,000 lb per sq. in. at 28 days	Relative cement content per unit volume of concrete	93	100	107
	Water-cement ratio by weight	0.57	0.66	0.75
	Aggregate cement ratio by weight	9.9	9.4	10.1
	Relative cement content per unit volume of concrete	98	100	93

(Extracted from a Paper by P. J. F. Wright, contributed at the Symposium on ' Mix Design and Quality Control of Concrete', London, 11-13 May, 1954.)

ROADS ARE A SERVICE

Roads are a Service for all forms of development whether agriculture, trade or industry.

WOMEN AND CARS

WITH both the paint conceals the years, but the lines give them away.

PRESTRESSING OF CONCRETE FOR ROAD PAVING STUDIED BY BRITISH RESEARCH BOARD

(Extracted from 'HIGHWAY RESEARCH ABSTRACTS' JANUARY, 1954)

AMONG the many research activities of the British Road Research Board, described in its recently published annual report for the year 1952, are investigations into various phases of concrete road construction, including improvement of riding quality, allowance for air entrainment, prestressing, determination of quality by testing in place, value of dowel bars, and equipment for resealing joints.

Investigations have shown that two of the main causes of the surface irregularity of machine-laid concrete roads are uneven spreading of the concrete on the formation and poor alignment of the forms and uneven settlement under the loads imposed by the finishing machine.

Various compounds have been developed in recent years which, when added to concrete during mixing, produce numerous minute bubbles of air in the mix. The presence of this air improves the workability of the concrete, greatly improves its resistance to attack by frost, reduces any tendency for fresh concrete to bleed, and reduces water absorption of the set concrete. On the other hand, the entrained air causes a reduction in strength of concrete of any particular composition.

Work on the development of prestressed roads has been continued both in the field and in the laboratory. In the field, the movements of slabs have been measured on prestressed concrete roads at Crawley, New Town and in Hampshire. In addition, the methods of construction and behaviour of other prestressed concrete roads are being observed. The amount of prestress in a concrete road slab will depend upon the freedom with which the slab can contract under the effect of the prestressing forces. Some resistance to free movements is imposed by the subgrade and it is necessary to know what this resistance is in order to determine how residual stress remains in the concrete. Measurements of the movement have therefore been made.

Safety precautions to be taken in the design and construction of prestressed concrete roads have been recommended. These include stronger, well-compacted concrete and transverse reinforcement near the anchorages, protection for the operators from flying wedges, distant-reading devices for observing the amount of extension applied to the tendons, and goggles to protect the eyes against flying fragments of concrete.

So far, attention has been directed to the problem of distribution of stress, the more difficult problem of variation of stress with time being deferred until later.

No gauges are yet available for measuring internal stresses in concrete and all work has been done with gauges that measure strain, the appropriate stresses being inferred by using the measured value of the modulus of elasticity.

Concrete in situ falls into two categories: (1) cases where the concrete is "known," test specimens made from the mixes being available for determining the compressive strength or modulus of rupture and for obtaining the relation between wave velocity and these quantities, and (2) cases where the concrete is "unknown."

It is the custom to use the compressive strength of the concrete as a criterion of quality, and methods of designing concrete mixes are invariably based on this

property. In road and runway work, however, the tensile strength of the concrete is of greater importance than the compressive strength, since failure is usually associated with cracking of the concrete. Because it is difficult to measure the tensile strength of concrete directly, it is the custom to determine the modulus of rupture on a beam tested in flexure.

The rate of application of the load had a marked effect on the observed strength, higher rates of loading resulting in higher modulus of rupture. This effect has a bearing on the effective strength of road slabs, which are subjected to various types of stress. A flexural stress which is imposed slowly, such as that due to thermal warping, will be relatively more important than a similar stress imposed very rapidly as in the case of stresses due to traffic.

The performance of a dowel-bar joint in a concrete pavement is considered by examining the behaviour of a single dowel-bar under laboratory tests and then applying the results obtained to an actual joint between slabs. Data on the size and spacing of dowel-bars necessary to provide adequate strengthening of the slab at its weakest parts, namely corners and edges, are tabulated in the paper for various conditions. These tables relate the diameter, spacing and length of dowels to the wheel load, modulus of subgrade reaction of the base and the thickness of the concrete slab.

Resealing the joints of a concrete road is an essential maintenance operation. Existing methods of doing the work by hand are so wasteful of manpower that the work is often neglected and the roads deteriorate in consequence. Road trials have shown that the work may be greatly speeded up by the use of machines for the following operations: (1) a rotary pick for cleaning out the accumulated debris wedged in old joints, (2) a rotary wire-brush for removing loose dust, (3) a pressure-sprayer for applying a tack-coat, and (4) a machine for pouring hot sealing compound. Five men using these machines can reseal 10,000 ft of joint in a normal working day.

DEFINITIONS OF HIGHWAY ENGINEERING TERMS

Curve Compound

A curve consisting of two or more arcs of different radii curving in the same direction and having a common tangent at the point or points of junction.

Curve Reverse

A curve consisting of two arcs of the same or different radii curving in opposite directions and having a common tangent at the point of junction.

REINFORCED CONCRETE ARCH BRIDGE IN BRAZIL

(Extracted from "Concrete & Constructional Engineering", June 1954)

A BRIDGE (Fig. 1) across the Rio das Antas in the south of Brazil, which is believed to be the second largest reinforced concrete arch in the world, has recently been completed. The arch has a span of 180 metres (610 ft); the longest arch in the world is Sando bridge in Sweden, which has a span of 866 ft. The river is subject to very rapid rises following rain. One set of wooden falsework was swept away by flood, and was replaced up to deck level by latti steel pillars supporting lattice girders on which was erected the wooden falsework for the arch ribs and the shuttering for the deck. The steel work was designed so that it could be dismantled and used for another bridge on a nearby site.

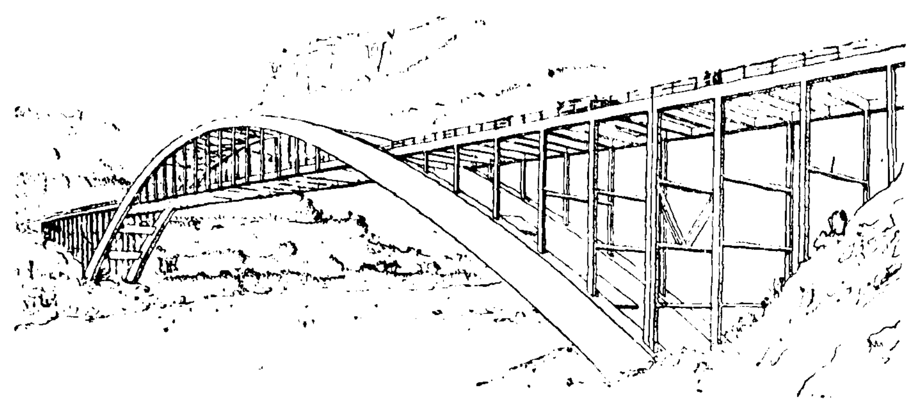


Fig. 1.—Arch of 610 ft span

Specification NB-6 for road bridges and the loading for Class I roads and NB-2 for the calculation and construction of reinforced concrete bridges (see Appendix I) were used in the design. The principal traffic is heavy lorries carrying timber from pine forests in the neighbourhood. The two arch ribs are hollow in cross section, varying from 5 m. (16.4 ft) in depth at the springings to 3 m. (9.84 ft) at the crown. Their width is constant at 1.5 m. (4.93 ft), and their centres are 8.7 m. (28.5 ft) apart. A span of 180 m. (610 ft) and a rise of 28 m. (92 ft) above the springings give a rise-to-span ratio of 1 to 6.4. The ribs are of catenary shape and carry a dead load (their own weight and that of the deck and supporting members) of 4.2 tons per foot at the crown and 6.95 tons per foot at the springings. The supporting posts are 23.6 in. square and the horizontal bracing between the arch ribs is of K shape above the deck and in the form of a slab below the deck. Contraction joints are provided at the middle of the length of the deck and above the springings, where the supporting columns are duplicated and separated by 1.18 in. The ribs were designed for a temperature variation of 5 deg. C. from the normal, the bridge being at a latitude of about 30 deg. south. Shrinkage of the concrete was assumed to be equivalent to a fall in temperature of 15 deg. C.; the coefficient of reinforced concrete in Brazilian specifications is 10^{-5} per degree C. The viaducts at each end of the bridge consist of a series of in-situ frames. The total length of the bridge and viaducts is 915 ft. The Viaducts have slender members to produce structural stability with a pleasing appearance.

The calculations for the viaduct frames were compared with experiments on celluloid models at the Instituto Tecnologia at Porto Alegre. After construction, strains in the pillars were measured with Huggenberger gauges while the trestle was subjected to a lateral load. Agreement among the different methods

was reported to be good; none of these, however, revealed an interesting vibration problem which occurred when the viaducts and their decks were completed. By standing and twisting one's body on the deck of the viaduct at the contraction joint one could easily cause oscillations of as much as $\frac{3}{4}$ in.; this was rectified by the provision of inverted V-shaped members.

A crack occurred in one of the edge-beams supporting the deck of the viaduct. Opinions differed on whether the slight settlement of the foundation which caused this was due to occasional layers of soft decomposed rock in the excavation, or to the use of dynamite in excavating the foundations for the arch ribs; the latter opinion seemed to have more support.

Although the local aggregate was not as cubical as was desired it was used because it was available. The concrete had strengths of 3880 lb. per square inch at twenty-eight days, and 640 lb. of cement were used per cubic yard. The cost was 16,147,000 cruzeiros, which is equal to £107,500.

APPENDIX 1

Brazilian Code NB-6 of 1950 specifies the live loads to be considered in the calculation of three classes of road bridges. The loads are composed of road rollers, lorries, and miscellaneous traffic. Details of the vehicles are given in Tables 1 and II.

TABLE I - ROAD ROLLERS.

	Type A	Type B	Type C
Total weight (tons) ...	6.88	15.72	23.60
Weight (tons) of front roller ...	4.92	6.98	0.84
Weight (tons) of each rear wheel ...	0.98	4.42	6.88
Width of front roller (ft.)...	3.28	3.28	3.28
Width of each rear wheel (in.) ...	3.94	15.75	19.68
Distance between front and rear axles (ft.) ...	9.84	9.84	9.84
Distance between centres of rear wheels (in.) ...	62.99	62.99	62.99

TABLE II - LORRIES

	Type A	Type B	Type C
Total weight (tons)	5.92	8.85	11.81
Weight on each front wheel (lb.)	1655	3310	4410
Weight on each rear wheel (lb.)	4970	6620	8820
Width of each front wheel (in.)	3.15	4.72	4.72
Width of each rear wheel (in.)	7.08	9.45	9.45
Distance between front and rear axles (ft.)	9.84	9.84	9.84
Distance between centres of rear wheels (in.)	26.99	26.99	26.99

The live load due to miscellaneous traffic is to be calculated as a uniformly-distributed load whose intensity is given as a function of the parameter g_0. Arches or main beams are calculated as follows:-

	kg. per sq.m.	lb. per sq. ft.
(a) With less than 25 m. (82 ft) of theoretical span	g_0	g_0
(b) With span l between 25 m. and 125 m. (82 ft and 410 ft.)	$[g_0-(l-25)]$	$[4.88g_0 \left(\frac{l}{3\ 28}-25\right)]$ 0205
(c) With more than 125 m. (410 ft) of theoretical span	$g_0 - 100$	$[4.^{88}g_0 =100-/0.205]$
(d) For the calculation of the other members	g_0	g_0

It is permitted to ignore fractions of 10 kg. per square metre (2 lb. per square foot).

Miscellaneous traffic is assumed to be distributed on the footpaths and the part of road not occupied by vehicles. For this purpose the area occupied by a vehicle (roller or lorry) is assumed to be a rectangle 8.2 ft. wide and 19.69 ft long with the centre over the longitudinal axis of the vehicle midway between the front and rear axles.

In calculating arches or main beams it is permissible to ignore the effect of the redistribution of loads caused by the secondary beams. In the case of arches or main beams of 98.43 ft or more span it is permissible to substitute concentrated loads of vehicles (roller or lorry) of equal load but uniformly distributed over a rectangle 8.2 ft. wide by 19.69 ft long.

Class 3.—The loads for Class 3 bridges consist of $g_0 = 82$ lb. per square foot for miscellaneous traffic a roller of type A, and as many lorries of type A as there are line of traffic, less one, all pointing in the direction of the traffic, and in the most unfavourable position for the calculation of each member, with the exceptions that there must not be more than one vehicle in each traffic line, nor must there be less than 8.2 ft. between the longitudinal axes of two vehicles. The calculations must also allow for one roller of type B in the most unfavourable position for the member under consideration but pointing in the direction of the traffic.

Class 2.—The loads comprise $g_0 = 92.5$ lb. per square foot for miscellaneous traffic, a roller of type B, and as many lorries of type B as there are traffic lines, less one, placed as described for Class 3 bridges. The calculations must allow for a roller of type C placed as for Class 3 bridges.

Class 1—The loads comprise $g_0 = 102.5$ lb. per square foot for miscellaneous traffic, a roller of type C, and as many lorries of type C as there are traffic lines, less one, and placed as described for Class 3 bridges.

Brazilian Code NB—2 of 1950 specifies the vertical impact factor for road bridges as follows. Elements of the roadway (slabs, cross beams, longitudinal beams. struts, ties,) 1.3.

Straight main beams: Spans up to 65.7 ft., 1.3; Spans greater than 230 ft., 1.0. Arches: Spans up to 164 ft., 1.2; Spans greater than 230 ft., 1.0.

For intermediate spans the coefficients of impact may be obtained by linear interpolation.

Vertical impact is not considered in the cases of (a) the transformation of loads for the calculation of earth pressures; (b) Bearings, solid pillars, and foundations; (c) Footpaths.

ELECTRIC APPLIANCES IN THE 16TH CENTURY

When he came to the question in his history examination, "Who was Anne Boleyn?" a certain student wrote as his answer, "an electric-iron." Asked by his teacher why he had put down such a silly answer, he replied :

"I can show you where it says so in my history book. 'Henry the Eighth, tired of his first wife, pressed his suit with Anne Boleyn.'"

HERE AND THERE

1. HOW GREAT THINGS ARE ACHIEVED

● TO-DAY it may be argued that great advances, such as those men made, can no longer be expected through the works of individual men of high talent; that development has become so complex a business that only through the work of teams and the direction of committees can the ground be surveyed and useful work be begun. There is, of course, a grain of truth in that submission. But how far it misrepresents the whole of the truth. For no team, no committee ever produced or could produce anything creative and advanced unless there was amongst its members some individual with creative powers. The bringing together of a group of ordinary men can lead to nothing more than an integration of ordinary ideas. Fertile ideas are individual things. They make their appearance in individual minds. Nor do we believe they come from sudden and unexpected flashes of insight "out of thin air." They arrive as the consequence of hard study of the fundamentals of a problem and hard thinking about them thereafter; combined with an unwillingness to accept as gospel the opinions of other men, however high their reputations, without personally subjecting them to critical analysis. Outstanding men in engineering, if not also in other fields, have proved to possess a surprising ability, even in the face of initial antagonism, of inspiring others with their own faith and their own determination; and they have attracted around themselves groups of men who have proved only less talented than themselves.

Ideas come to many men. It is not only the great who have them. It is, indeed, not fecundity in ideas alone that makes great men. Other qualities of mind are also wanted.

So vast, in fact, has become the estate of human knowledge that its boundaries can be reached only through long and intensive study of specialised fields. Advances, therefore, upon any wider front must be made by teams of specialists rather than by individuals. But, fundamentally, there has been no change. Fecundity in conception, determination against discouragement, faith, energy and firmness of purpose are individual, not collective qualities. No team, however otherwise well chosen, can make great advances unless it has amongst its number at least one greater man to inspire creativeness amongst the rest to fire enthusiasm and to select by some touch of genius, as such men do, which among many conflicting paths will lead most directly and most simply to the desired end.

2. BRIDGE ACROSS THE YANGTSE

● A BRIDGE more than twice as long as the Sydney harbour bridge is to be built across the Yangtse river in China within the next five years, the New China News Agency said yesterday.

Mao Yi Sheng, President of the Society of Civil Engineers wrote in the English language magazine China that the bridge will have a span of 3,762 feet. The span of Sydney harbour bridge is 1,650 ft.

It will be of the continuous truss type.

(*Extracted from "Hindusthan Times" 7-7-54.*)

3. ROAD VERSUS RAIL IN GERMANY

● THE FIRST TWO BILLS of a series intended to embody a new policy for German transport have been approved by the Federal Cabinet. They will impose stiff additional taxation on long-distance road transport to raise funds to improve the German road system.

Some of this money will go to the improvement of ordinary roads, and a substantial amount will be spent on extensions to the Autobahn system. It is planned to set up a public corporation which will build about 370 miles of new Autobahn in six or seven years at a cost of about £ 100 million. The federal railways' recommendations to restrict the competition of road haulage have been largely accepted by the Government. It is proposed to prohibit the carriage of certain goods by road over distances of more than (approximately) 32 miles.

(Extracted from ' World Highway Report' INTERNATIONAL ROAD FEDERATION '.)

4. WHY AMERICA IS ABLE TO BUILD A LARGE MILEAGE OF ROADS

● Mr. GREER, who is in London as the guest of the British Road Federation and the International Road Federation, was presenting a paper on " The Development of a Modern Highway System " at the Royal Empire Society.

He said, reason for the vast road programme which America had been able to carry out was that **the U. S. Government had " given guidance and inspiration without the accompanying factor of domination or usurpation of the rights of the various states "**, said Mr. Greer.

In Texas, Road funds were derived totally from the road user, based on the theory of " pay as you ride ". **Out of the fuel tax of four cents per gallon, three cents went to developing and maintaining the highway system.** The remaining one cent went to the State schools. Funds derived from the sale of the licence or identification plates all went to the support of the road system.

A road system must contain three distinct types of roads; namely, the main trunk highways or the system for the carrying of long-distance traffic. The second is the middle distance type of traffic movement which we ordinarily think of as the state or internal system and last, but not least by any means, is the short haul or local type of road development, which is so highly important to the development of the rural areas as well as the local economy.

A programme must be balanced between these three distinct entities. Regardless of pressures, a balance must be maintained, since each of these highway types is dependent upon the other for the complete circulation of the motor vehicle population. It is true that, in the development of these three distinct systems of roads, care must be exercised to provide a standard of design commensurate with the traffic that is anticipated on the particular road to be built.

(Extracted from " HIGHWAYS AND BRIDGES, June 23rd, 1954 ".).

5. SHORT CUT TUNNEL THROUGH MONT BLANC

● THE ITALIAN GOVERNMENT has ratified the agreement drawn up with France to build a road tunnel under Mont Blanc, which, at 15,782 feet, is the highest mountain in Europe. It will be open to traffic all the year round, providing a link with Switzerland as well as between France and Italy.

The tunnel will be seven-and-a-half miles long and 19½ feet wide. Money for it will be put up by private enterprise. A French company will provide £5,000,000 and a further £3,000,000 will come from an Italian company.

The scheme will cut more than 100 miles off the road journey between Paris and Turin.

(Extracted from the Statesman, 22nd July 1954)

6. CONTRIBUTION TO THE CENTRAL ROAD FUND IN PAKISTAN DOUBLED

● A CENTRAL ROAD FUND was created in 1949 out of two and half annas excise and customs duty on petrol.

With effect from 1953-54, to make more funds available for the construction of roads the rate of subvention has been doubled from Rs 0-2-6 to Rs 0-5-0. The fund is administered by the Central Government. Eighty five per cent is distributed among the Provinces and States in proportion to their area, population, petrol consumption and expenditure on road maintenance. The balance is to be spent on research and administration.

(Extracted from Highways, Bridges and Engineering Works - June 30th, 1954.)

7. RAISED CONCRETE DIVIDING STRIPS SAFER THAN CENTRE GRASS STRIP

● A CONCRETE SEPARATOR, 4 ft wide and 8 in. high, will divide traffic lanes on the projected 133-mile north-eastern extension of the Pennsylvania Turnpike.

It has been favoured over the 10-ft wide grass centre strip used for the existing turnpike " partly as a safety feature and partly because it is a cheaper type of construction," according to a turnpike commission engineer.

The 10-ft grass strip was held responsible for many cross-lane head-on collisions in a safty survey conducted last year, and the turnpike commission since has been experimenting with various types of median barriers.

(Extracted from " Engineering News-Record, April 29, 1954.")

8. BRITISH HIGHWAY BRIDGE LOADINGS

● DURING the second half of the 19th century, the introduction of traction engines brought with it the need to consider heavy loads in highway bridge design. Their increasing weight in the early part of the 20th century initiated various recommendations for design loading, culminating, after the 1914–1918 war in the Ministry of Transport Train and the British Standard Train, both representing closely the heaviest loads travelling on highways.

The former train was subsequently replaced by an equivalent-loading curve, which simulated its effects but was simpler to use.

There has been since then a steady increase in the weight and number of ordinary heavy vehicles, and of vehicles carrying heavy indivisible loads. Gross loads of 100 tons are now commonplace and must be considered in the design of normal bridges. whilst exceptionally heavy loads of 150 tons and more must be carried on selected routes.

An equivalent-loading curve continues to be the simplest tool for the designer. The Ministry of Transport and Civil Aviation, in close collaboration with the British Standards Institution Committee, has revised the equivalent-loading curve to take into consideration these changes and to make allowance for a vehicle of approximately 100 tons weight. Provision is made for reduced intensities of normal loading.

It has been recognised that all lanes of a bridge need not be considered as fully loaded. Decreases in loading for increasing lengths of lane have been re-examined and have led to substantial reductions for loaded lengths greater than 100 ft; the loading is now stated in terms of lanes instead of unit widths to permit (except for slabs) variation in width of lane without variation in total live load, making possible, in most cases, a reduction of about 10 per cent. Per load per lane over the range from 20 ft to 75 ft For loaded lengths of less then 20 ft, an increase in loading is necessary to offset the high local intensities due to one bogie of the 100-ton vehicle. Since it occurs infrequently, a general limit of 30 per cent overstress has been accepted.

An abnormal train of four axles, each with four wheels, has been stipulated as a " check " loading for bridges required to carry exceptionally heavy loads. Although given in terms of unit loads to permit variation, 45 units (180 tons gross) will generally be required in Britain when this loading is specified. This train is based on regulations governing the construction and use of vehicles to carry abnormal indivisible loads. In its use, overstress of 25 per cent is permitted because of its infrequency of occurrence.

(Extracted from "The British Constructional Engineer" June, 1954.)

9. CAPACITY OF DIFFERENT TYPES OF TRAFFIC LANES.

● THE HIGHEST HOURLY TRAFFIC volumes that a highway will accommodate safely at reasonable speeds is termed the practical capacity. The following are some of the practical capacities of different types of facilities having 12-foot traffic lanes, excellent alignment, adequate shoulders, and no intersections at grade with major cross movements:

Type of highway	Capacity-in passenger cars per hour
Two-lane rural	900 total
Three-lane rural	1500 total
Multi-lane rural	1000 for each lane in the direction of heavier travel
Multi-lane urban expressway	1500 for each lane in the direction of heavier travel

When present, the average commercial vehicle with dual rear tires can be considered, for purposes of estimating capacity, as two passenger cars in level terrain and as four passenger cars in rolling terrain.

(Extracted from New Frontiers for Highways, July, 1952.)

CURRENT LITERATURE

ABSTRACTS

U. D. C. — 625.8.042 Calcium Chloride in Concrete, BIBLIOGRAPHY 13-HIGHWAY RESEARCH BOARD.

THE pamphlet presents an annotated bibliography, arranged in chronological order, relating to the effect of calcium chloride on the properties of cement and concrete.

The effect of integral calcium chloride on hydrating cement is to increase its early and mature strength. Generally, with 2 per cent calcium chloride, setting time of cement is reduced from one-third to one-half. The total heat of hydration is not significantly increased, but the rate of heat liberation is markedly increased.

Where adequate water supply is not available, calcium chloride used either integrally in the concrete or applied to the surface in conjunction with wet burlap coverings, furnished an efficient curing method. When applied at the surface the deliquescent properties of the material bring about absorption of moisture from the concrete and air which furnishes an evaporation resistant moisture film. Also, the use of calcium chloride increases the surface hardness of the concrete.

If the general results of field studies are often not entirely in agreement as to the efficiency of calcium chloride for curing concrete, it is due to the difficulty of proper control of various conditions during construction.

Data reported from studies indicate that the integral use of calcium chloride causes more rapid rate of liberation of the heat of hydration of the cement while maintaining the concrete temperatures more nearly normal and thus promoting development of the strength of the concrete during the early critical period and thereby furnishing materially greater resistance of the concrete to the detrimental effect of low temperatures. The usual winter care including the application of heat to the material and insulating coverings is recommended. But it is stated that the protection period may be markedly reduced when calcium chloride is incorporated in the concrete, resulting in significant economy.

It has been established that calcium chloride incorporated in concrete does not contribute to corrosion of steel in the concrete.

The strength contributing value of cement is dependent upon di-calcium and tri-calcium silicate compounds in particular. The optimum amount of calcium chloride recommended for use in cement is probably limited to an amount that can chemically combine with the aluminates without free calcium chloride remaining in uncombined state. The consensus of opinion is that the initial diluted solution of calcium chloride in contact with cement causes a decrease in the pH value of the solution, enabling the earlier formation of the super-saturated solution necessary to cause precipitation of silicated products, the principal strength contributing elements of hydrated cement. This does not in any way change the normal chemical reaction except to act catalytically.

Calcium chloride may be incorporated in concrete in solution or in the dry form. The latter method is the more convenient and amenable to accurate control.

The highly deliquesent properties of the calcium chloride ensure a uniform solution with the mixing water in concrete. The calcium chloride may be measured either by weight or volume since the material has a uniform gradation. Its use by either method is simple and practical for satisfactory field control.

UDC-625-721.5 DRIVER PERFORMANCEON HORIZONTAL CURVES By the Highway Transport Research Branch Bureau of Public Roads.

(Reported by ASRIEL TARAGIN HIGHWAY ENGINEER)

SOME important observations were derived from this study of free-moving passenger-car speeds on horizontal curves of two-lane rural highways. Drivers do not slacken speed after entering a curve, presumably making their adjustments on the approaches. Speeds in the shorter-radius inside lanes are no less than in the outside lanes, despite the fact that sight distances average 20 per cent shorter. Operating speed and the degree of curvature are linearly related: while drivers do not move at the high speeds permissible by the design on easy curves, they often exceed the design speed on sharp curves.

Superelevation apparently has no effect on vehicle speeds, and the utilized coefficient of side friction is relatively small when the superelevation is high. However, there is a close relation between "Unit superelevation"—the rise per foot of width per degree of curvature–and safe driving speed. Few vehicles exceed a safe speed on horizontal curves designed with a unit superelevation of more than 0.005 foot per foot of pavement per degree of curvature.

Where the minimum sight distance is 400 feet or more, drivers travel at speeds from which a stop can be made within the available sight distance, but where the sight distance is below 400 feet drivers travel at speeds from which a stop can be made within the available sight distance only when the perception and reaction times are ignored. Speeds are considerably lower on horizontal curves than on vertical curves with the same minimum sight distances.

It is evident that if roads are to be built safely for the accommodation of actual driver behaviour – and this seems logical—the design of horizontal curves on two-lane rural highways should take into account unit superelevation, and should provide a minimum sight distance of at least 400 feet, allowing for reasonable perception, reaction, and braking time. That an adequate margin of safety is needed is evidenced from the implication in the study results that driver speeds are more controlled by the obvious danger of running off the road, when negotiating a horizontal curve, than by the possible hazard of an unseen object where sight distance is limited on either horizontal or vertical curves. The physical stress of centrifugal force can actually be felt, while the sight distance hazard can only imagined.

—o—

PERMISSIBLE WIDTH OF GOODS VEHICLES RAISED TO 8 FEET IN THE U. K.

The Minister of Transport, U. K., announced that the permissible width of goods vehicles weighing over 4 tons when unladen will be increased from 7 ft 6 in. to 8 ft.

SELECTED RECENT LITERATURE IN ENGINEERING JOURNALS

IV. SOIL ENGINEERING AND DRAINAGE.

1. **A Table for Calculating the Set of Piles**; J. K. NESBIT - *Concrete and Constructional Engineering*, March, 54, pp. 97-99.

2. **Influence of Duration of Tests at Constant Rate of Strain on Measured "drained" Strength**; R. E. GIBSON and D. J. HENKEL - *Geotechnique*, March, 54 - pp. 6-15.

3. **Some Investigations on Granular Soils with Particular Reference to the Compressed - Air Sand Sampler**; T. K. NIXON - *Geotechnique*, March, 54 - pp. 16-31.

4. **Some Tests on Bored Piles in London Clay**; H. Q. GOLDER and M. W. LEONARD, *Geotechnique*, March, 54 - pp. 32-41.

5. **Estimating the True Consolidation Behaviour of Clay from Laboratory Test Results**; JOHN H. SCHMERTMANN, *Proceedings, American Society of Civil Engineers, Separate No. 311*, October 53.

6. **Specifications for Heavy Grading Remedy Foundation Problems with New Highway Design and Method**; E. L. BLOMQUIST, *Western Construction*, February 54, - pp. 57-58.

7. **Load Transfer in Underpinning**; L. E. HUNTER—*Contractors Record and Public Works Engineer*, March 54 - pp. 19–20.

8. **Fifty Years of Investigation of Foundation Soil**; Dr. KARL TENZAGHI—*Part I, Schweizerische Bauzeitung* April 3, 54 - pp. 181-185 (in German PART II, *Schweizerische Bauzeitung* April 10, 54 - pp. 202-207 (in German).

9. **Road Foundation Problems in Glasgow - Filtering Water Away from Clay**; *Highways and Bridges and Engineering Works*, March 31, 54 - pp. 6 and 8.

10. **Design and Construction of Earth Dams and Embankments in America**; S. RODIN—PART (7), *Civil Engineering and Public Works Review*, March 54, pp. 281–283.

11. **Strength Characteristics of Compacted Clays**; *Highways and Bridges and Engineering Works*, April 28, 54-p. 6.

12. **Settlement Check Platforms for Roadway Embankments**; *Highways and Bridges and Engineering Works*, April 28, 54–p. 6.

13. **The Structure of Inorganic Soil**; T. WILLLAM LAMBE, SEPARATE No. 315, *Proceedings of the American Society of Civil Engineers*, October 1953.

14. **Trafficability of Soil as Related to Mobility of Vehicles**; R. C. STEWART and S. J. WEIRS—*Separate No. 328, Proceedings of the American Society of Civil Engineers*, November 53.

15. **Estimating the True Consolidation Behaviour of Clay from Laboratory Test Results**; JOHN H. SCHMERTMANN, *Separate No. 311, Proceedings American Society of Civil Engineers* October 53.

16. **Membrane under Filter Bed Solves Drainage Problem**; H. H. BROWN—*Western Construction*; March 54, p. 59.

17. **Well Points Save the Day on Los Angeles River Job**; DON FIX, *Western Construction*; March 54 p. 53–54.

18. **Tiled Bulkheads**; DIE BAUTECHNIK, April 54, pp. 120–122 (in German).

19. **Comparative Investigation on the Bearing Capacity of R. C. and Steel Piles**; GERNARD MENZE—*Beton and Stahllbetinbau*, April 54-pp. 79-88. (in German).

20. **A Concept of Slope Design of Earth Dam Embankment**, *C. Y. LI—Separate No. 327, Proceedings of the American Society of Civil Engineers*, November 53.

21. **Application of Soil Mechanics in Swiss Highway Construction**; ROB RUCKLI—*Strasse and Verkehr*, August 53-pp. 305-314 (in German).

22. **Geotechnical Analysis of the Bearing Capacity of Road Subgrades**; R. PELTIER—*Strasse und Verkehr*, August 53-pp. 315-323.

23. **Pile Foundations for Buildings**; JOHN W. DUNHAM—*Separate No. 385-Proceedings of the American Society of Civil Engineers*, January 54.

24. **Fill Utilization for Building Foundations**; GORDON B. DALRYMPLE—*Separate No. 417, Proceedings of the American Society of Civil Engineers*; January 54.

25. **Guildhall Provision of New Foundation to the North Wall by Underpinning and Other Means**; BURNARD GEEN—*Paper No. 5958—Proceedings of the Institution of Engineers, Part I, Vol. 3*, March 54, No. 2-pp. 201—217.

26. **Application of Soil Mechanics in Swiss Highway Construction**; Dr. ROB-RUCKLI—*Strasse und Verkehr*, August 53—pp. 305-314 (in German).

27. **Geotechnical Analysis of the Bearing Capacity of Road Subgrade**; R. PELTIER—*Strasse und Verkehr*, August 53—pp. 315-323.

28. **Some Recent Foundation Research and its Application to Design**; (DISCUSSION), *Structural Engineer*, May 54, p. 156-157.

29. **Successful Stabilisation of a Retaining Wall, British Railways (N. E. Region) Project**; *Highways and Bridges and Engineering Works*, May 5, 54, p. 8.

30. **Draining Downtown Street Corner-without Storm Sewers**; J. L. MORRIS, *Roads and Streets*, May 54, p. 134-135.

31. **Inclined Driven Short Anchoring Piles**; W. SCHERICK, *Die Bautechnik*, May 54, pp. 155-166 (in German).

32. **Noteworthy Deeply Pier Foundation**; *Die Bautechnik*, May 54, pp. 166-168 (in German).

33. **Exact Method of Calculation of the Rapture of an Earthen Mass by Cylindrical Slopping**; M. CAQUOT, *Annales Des Ponts et Chaussees*, May-June 54, pp. 345-354 (in French).

34. **Foundations on Black Cotton Soil**; *Indian Concrete Journal*, May 54, p. 175-176.

35. **Rectangular Footings Assymmetrically Loaded**; HAQ TOON YAN, *Indian Concrete Journal*, May 54, pp. 177-182.

36. **Soil Survey for the North-South Motorway in Lancashire**; *The Surveyor*, June 54, pp. 471-472.

37. **Sub-Soil Freezing at Fleetwood**; *The Surveyor*, June 5, 54, p. 472-473.

38. **Site Exploration for Maritime and River Works**; MICHAEL JOHN TOMLINSON—Maritime Paper No. 25, *Proceedings of the Institution of Civil Engineers, Part II, Vol. 3*, June 54, No. 2, pp. 225-272.

39. **Vibrations and Soil Settlement-Shaking Machine Simulates Compression Loading in Investigation of Sandy Foundation Soil**; *Engineering News Record*, May 27, 54, p. 38.

40. **Geotechnical Properties of Norwegian Marine Clays**; LAURITS BJERRUM, *Geotechnique*, June 54, pp. 49-69.

41. **A Stress-Strain Theory for Cohesionless Soil with Applications to Earth Pressures at Rest and Moving Walls**; P. W. ROWE, *Geotechnique*, June 54, pp. 70-88.

42. **Bloom-Base Allowance in the Design of Pile Caps**; H. T. YAN, *Civil Engineering and Public Works Review, Part I.*

Part II, Do Do June 54, pp. 622-623.

PUBLICATIONS ADDED TO THE ROADS WING LIBRARY DURING JUNE, 1954

The Manager of Publications, Delhi.

1. **Report by the Railway Board on Indian Railways for 1952-53. Vol. I (PRB. 21-1-53 (N).**
2. **-do- Vol. II-Statistics.**
3. **Census of India 1951-Vol. VI-Part IV-Calcutta Industrial Region Tables. P. C. C. 59 by A. Mitra (2 copies)**
4. **Census of India Paper No. I, 1953–Languages-1951 Census P. C. C. 89** (2 copies)
5. **Rules of procedure and conduct of business in the House of the People (3rd edition)** (3 copies)
6. **Census of India-1951 Vol. 2, Uttar Pradesh, Part I-A-Report P. C. C. 100. by Rajeshwari Prashad.**
7. **Census of India, 1951 Vol. XII, Assam. Manipur and Tripura, Part I-A, Report P. C. C 106, by B. R. Vaghaiwalla.**

Government Central Press, Madhya Bharat, Gwalior.

8. **Census of India. 1951, Vol. XV, Madhya Bhart and Bhopal. Part I-A, Report P. C. C. 107. by Rang Lal.** (2 copies)
9. **Census of India 1951 Volume XV-Madhya Bharat & Bhopal, Part-1-B-Subsidiary Tables. P. C. C. 108 by Rang Lal.** (2 copies)
10. **Census of India 1951, Vol. XV, Madhya Bharat and Bhopal, Part II-A Tables. General Population tables house-hold and age (sample) tables and social and cultural tables, P. C. C. 109 by Rang Lal** (2 copies)
11. **Census of India 1951, Vol. XV, Madhya Bharat and Bhopal, Part II-B, Economic Tables. P. C. C. 100 by Rang Lal** (2 copies)
12. **The Mechanics of Engineering Soils (2nd ed.) by P. Leonard Capper and W. Fisher Cassie,** (E & F. N. Spon Ltd., 22, Henrietta Street, London, WC2).
13. **Report of the Proceedings of the 9th International Road Congress, Lisbon, 1951.** (2 copies)

(Science Industries, Para 195)

Association of the Principals of the Technical Institution in India, c/o. Delhi Polytechnic, Delhi.

14. **Reports on Technical education 1953-54, from Central, zone and Northern zone.**
15. **Report of the Council of the Association of principals of Technical Institutions (India) for the year ended 31st March, 1954.**
16. Symposia on role of the A. P. T. I (1), in the present educational set-up **of the Country.**

University of Roorkee, Roorkee.

17. **Housing in rural areas (cyclostyled) by O. P. Jain and S. C. Goyal.**
18. **Use of indigenous materials for low cost housing for rural areas** (cyclostyled) by S. C. Goyal.
19. **Housing in rural areas - General specifications.**
20. **Money making ideas for construction men; a book of selected and job tested engineering and construction practices and ideas that will save time, Money and effort and engineering and construction men.** (Engineering News-record, 330, West Street, New York, 36, N.Y.)
21. **Library of Production "Know How".** (McGraw Hill Digest, 300, West 42nd Street, New York, 36, N.Y.)
22. **The effect of additions of bitumen on Concrete** (Photostat copy) by R. Grun and K. Obenauer.
23. **Concrete mix design; a practical method for the production of quality Concrete for available materials-Melbourne technical College Research bulletin No. 2,** L. Boyd Mucan (Melbourne Technical College Press, Melbourne, 1953.)

BUDGETS AND ADMINISTRATION REPORTS

GOVERNMENT OF MADRAS BUDGET FOR 1954-55

	Rs in lakhs		
	(Composite Madras State)	Residuary (Madras State)	
	Accounts 1952-53	Revised Estimate 1953-54 (Second 6 months)	Budget Estimate, 1954-55
Civil Works Revenue			
Rents	10.98	2.93	4.17
Receipts from Workshops	0.89	0.21	0.35
Recoveries of expenditure	58.28	23.84	35.21
Transfer from Central Road Fund	53.93	22.49	18.28
Ferry Receipts—Highways Deptt.	3.98	1.86	2.91
Tolls on Roads	—	0.04	0.18
Miscellaneous	17.29	7.61	9.38
Deduct—Refunds	-1.97	-0.14	-0.21
Total	143.38	58.84	70.27
Receipts from Roads			
Receipts under the Indian Motor vehicles Act.	32.24	12.85	30.42
Receipts under the Madras Motor Vehicles Taxation Act, 1931	352.18	132.05	251.06
Receipts under Motor Vehicles (Taxation of Passengers and Goods) Act, 1952	11.05	27.00	59.54
Other Receipts	33.39	0.01	0.03
Deduct-Refunds	-2.91	-0.89	-1.05
Receipts under Motor Vehicles Act Total	425.95	171.02	340.00
Sales Tax on Motor Spirit	169.85	65.00	125.00
Receipts from Roads-Total	595.80	236.02	465.00

Civil Works—Expenditure

	Rs in lakhs		
	(Composite Madras State)	Residuary (Madras State)	
	Accounts 1952-53	Revised Estimate 1953-54 (Second 6 months)	Budget Estimate 1954-55
Original Works			
Buildings	31.14	11.12	23.71
Communications	54.05	17.94	13.35
Miscellaneous	1.42	0.12	0.01
Lump Sum Deduction for Probable saving	—	—	-3.07
Repairs			
Buildings	42.14	14.34	21.94
Miscellaneous	1.00	0.59	0.97
Maintenance of Communications	387.85	45.47	150.82
Maintenance of Avenues	7.04	2.13	4.25
Development Schemes Under Five Year Plan			
Buildings—P. W. D.	3.20	2.71	2.04
Communications-Highways Department	81.81	23.68	30.98
Other Development Schemes—P. W. D.	6.71	0.89	1.37
Suspense { P. W. D.	12.79	3.10	-1.02
Suspense { Highways Department	-6.05	35.45	10.07
Lump addition for Re-grant of Lapses	—	—	0.10
P. W. D. { Establishment	20.45	6.04	21.39
P. W. D. { Tools and Plant	1.46	0.29	0.48
Highways Department { Establishment	50.40	14.24	30.41
Highways Department { Tools and Plant	80.62	22.54	38.28
Grants-in-Aid	158.43	28.75	30.26
Total	934.46	229.40	376.34
Capital Outlay on Civil Works outside the Revenue Account			
Original Works Buildings	47.25	19.71	33.69
Development Schemes Buildings	45.58	28.68	47.42
Establishment (Five Year Plan and Other Development Schemes)	8.14	3.72	5.57
Deduction for probable savings	—	—	-3.66
Lump addition for regrant of lapses	—	—	0.20
Tools and Plant	0.49	0.22	0.32
Total	104.75*	52.33	83.54

* Includes Rs 0.75 lakh on account of expenditure incurred solely in Andhra Area and Rs 2.54 lakhs on account of supervision charges.

A BRIEF REVIEW OF MADRAS BUDGET FOR 1954-55

(with special reference to Civil Works)

TOTAL revenue receipts of the Government of Madras for 1954-55 are estimated at Rs 45 crores and revenue expenditure at a little over Rs 50 crores. This is the first budget of the residuary State of Madras after the separation of Andhra in October, 1953. Hence Budget estimates for the current your cannot be directly compared with the Accounts for 1952-53 as the latter related to the Composite State, or the Revised Estimates for 1953-54 which covered only the latter half of the year for the residuary State.

Revenue expenditure on Civil Works for 1954-55 is estimated at about Rs 376 lakhs which forms 8.4 % of the total state revenue. This does not take into account the capital outlay to be met from outside the revenue account which is about Rs 83.5 lakhs. Revenue expenditure on the Highways Department alone (Original Works, Repairs and Schemes under the Five-Year Plan) amounts to nearly Rs 200 lakhs which is 4.4% of the total revenue.

SAVING TIME BY CUTTING CORNERS

Many motorists try to save a little time by cutting corners. They may save time at the moment, but they may also find that they are taking a short cut to a shorter life.

(Extracted from California Highways and Public Works, March - April 1954.)

LIST OF APPROVED WORKS ON NATIONAL HIGHWAYS

S. No.	Job No.	Name of works	Amount (Rs in Lakhs)
		ANDHRA	
1.	922 AH 5	Formation of the Northern approach road to Pennar bridge (length 2 furlongs)—N. H. No. 5	0.24
		BOMBAY	
2.	915 BM 8	Providing cross drainage works in the new lengths of the Baroda Vasad Section of the Bombay—Ahmedabad Road—N. H. No. 8	1.05
3.	921 BM 8	Construction of cross drainage works on the Prantij-Himmatnagar Section of the Bombay-Ahmedabad-Delhi Road. N. H. No. 8.	5.34
		HYDERABAD	
4.	914 HD 9	Reconstructing the R. C. C. culvert across Huthi Nalla in mile 133/6 of Hyderabad-Sholapur Road, N. H. No. 9	0.15
		MADHYA PRADESH	
5.	918 CP 7	Construction of National Highway No. 7 from Dhoki to Hyderabad border—miles 11/6 to 16/0.	2.27
6.	919 CP 7	Construction of a bridge over the Wana River on National Highway No. 7 in Madhya Pradesh	9.89
		MADRAS	
7.	920 MD 7	Forming a diversion road from M 303/4 to 304/3 of National Highway No. 7 in Madurai Distt.	1.23
		ORISSA	
8.	916 RS 6	Improvement to the Ghati portion of N. H. No. 6 from 22nd mile to 28th mile-Baripada Bamanghaty Road (6 miles).	1.88
		SAURASHTRA	
9.	917 SR 8-A	Providing rubble soling and metalling to section from Saurashtra limit to Limbdi of N. H. No. 8-A.	9.43

MILLARS'
MACHINERY

Concrete Mixers—Tilting and non-Tilting Types.
Asphalt Mixers—for Hot and Cold Mix.
Roller Pan Mixers—for Mortar.
Diaphragm Suction Pumps for effective lift up to 25 ft.
Self-Priming Pumps for handling Seepage at lowest possible cost.
Tower Hoists for speedy construction.
Wellpoint Pumping Equipment for dewatering—the only successful method of combating running sand.

TIMBER
HARDWOODS - SOFTWOODS - PLYWOODS

MILLAR'S TIMBER & TRADING CO., LTD.
(INCORPORATED IN ENGLAND)
VICTORIA HOUSE, VICTORIA ROAD, BOMBAY-27.

Telephone: **41077** *Telegrams:* **JARRAH**

Branches and Agents throughout the World.

THE HINDUSTAN CONSTRUCTION CO. LTD.
CIVIL ENGINEERING CONTRACTORS.

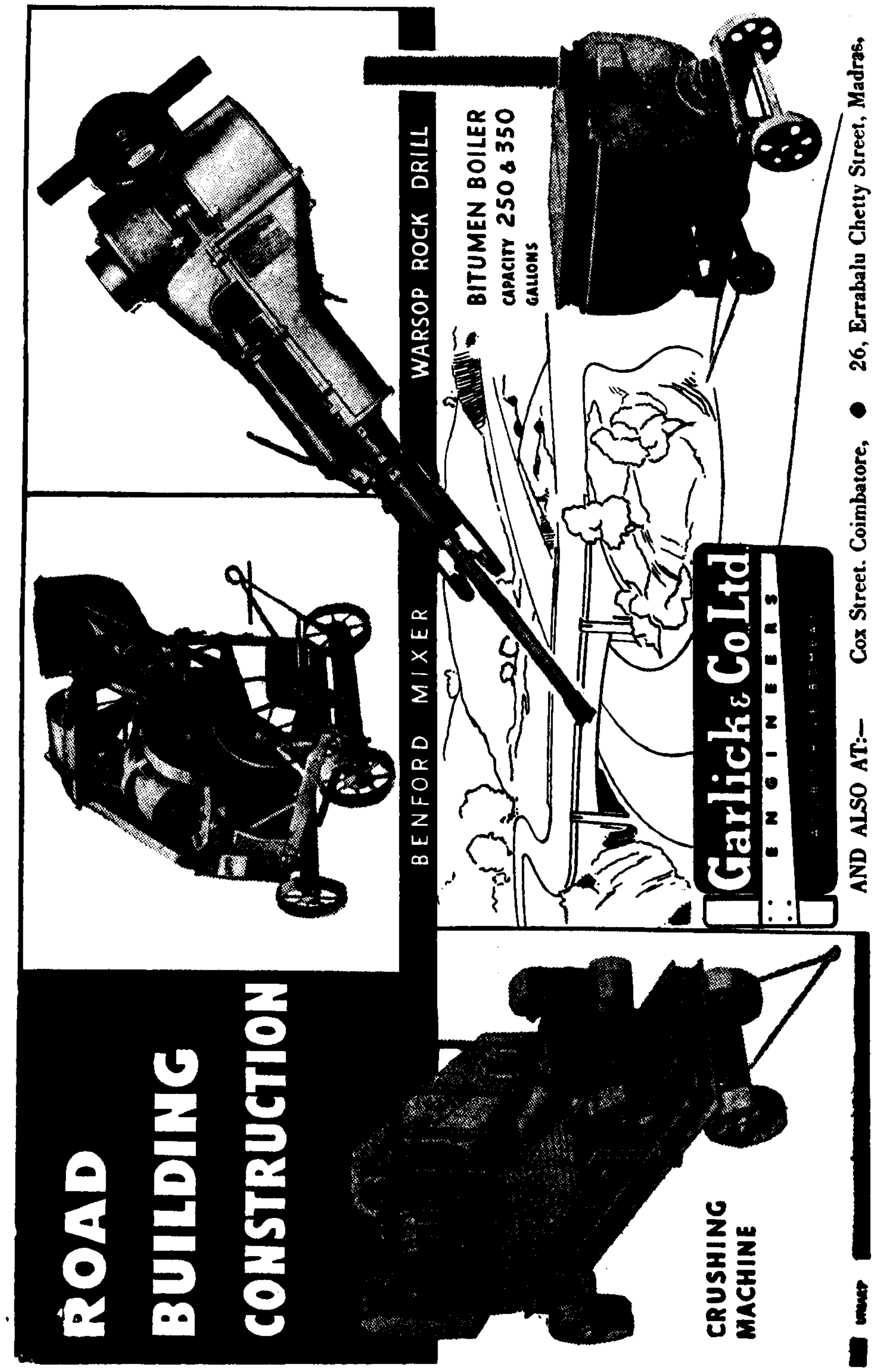
Can undertake constructional works of any magnitude.

Specially:
Railway & Hydro TUNNELS - DAMS for Hydro Electric, Irrigation and Water Supply Schemes - Road and Railway Bridges - Buildings - Docks - Jetties.

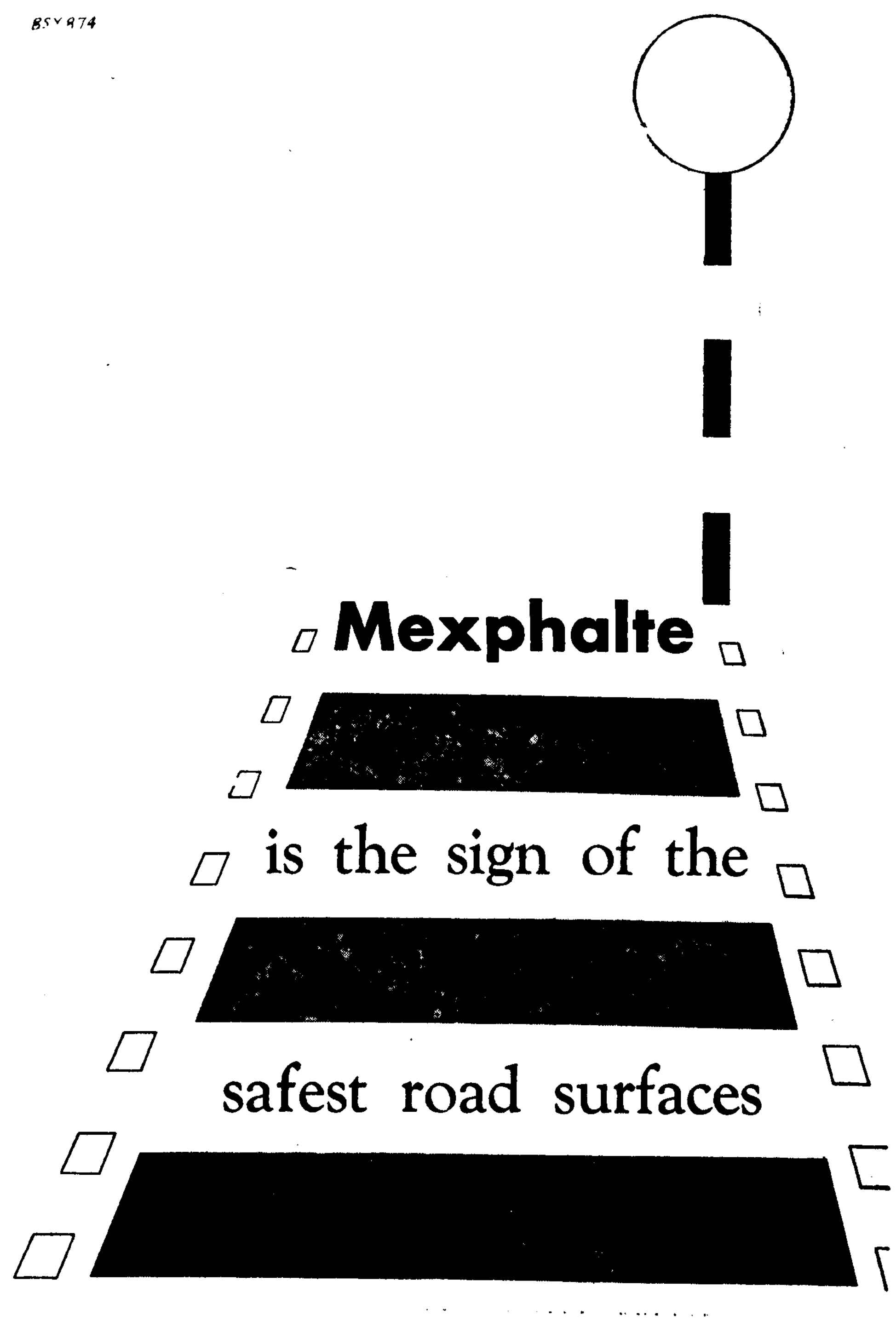
ALSO.
Precast & Hindustan ZEISSL PILING - GUNITING - Core DRILLING - GROUTING - Sewage and Water Purification Works.

Head Office:
Construction House,
Ballard Estate,
Bombay.

Telephone: 26036—Five lines. **Telegrams: HINCON**




... Gentlemen.
... for sheer brilliance of finish...
.. delightful to behold...
..for positive durability...
...for interior or exterior use ..
...in industry or the home...
... there is no doubt about it that...
..the answer is ... the Synthetic Enamel of impeccable taste...
SHALIMAR SUPERLAC
SYNTHETIC ENAMEL
We apologize for the back or "Chairman's-eye-view" of the speaker!
SHALIMAR PAINT, COLOUR & VARNISH COMPANY, LIMITED
CALCUTTA • BOMBAY • MADRAS • NEW DELHI • KANPUR


Mexphalte
is the sign of the
safest road surfaces

D4//m 2, N48 N54-88

…ed num… …ples …

publications of the Indian Roads Congress

are available for sale.

	Publications.	Price inclusive of postage, etc. Rs	A.	P.
1.	Volume IX—Part 4—October 1945	3	0	0
2.	Volume IX—Bound—Madras 1945	10	0	0
3.	Volume X—Part 4—August 1946	3	0	0
4.	Volume XI—Part 4—May 1947	3	0	0
5.	Volume XI—Bound—(Parts 3 & 4) 1947	6	0	0
6.	Volume XII—Part 2—January 1948	3	0	0
7.	Volume XII—Part 3—April 1948	3	0	0
8.	Volume XII—Part 4—March 1948	3	0	0
9.	Volume XII—Part 5—September 1948	3	0	0
10.	Volume XII—Bound—1947-48	12	0	0
11.	Volume XIII—Part 1—December 1948	3	0	0
12.	Volume XIII—Part 2—January 1949	3	0	0
13.	Volume XIII—Part 3—January 1949	3	0	0
14.	Volume XIII—Bound—1948-49	11	0	0
15.	Volume XIV—Part 1—September 1949	3	0	0
16.	Volume XIV—Part 2—December 1949	3	0	0
17.	Volume XIV—Part 3—December 1949	3	0	0
18.	Volume XIV—Part 4—July 1950	3	0	0
19.	Volume XIV—Bound—1949-50	8	0	0
20.	Volume XV—Part 1—August 1950	3	0	0
21.	Volume XV—Part 2—November 1950	3	0	0
22.	Volume XV—Part 3—January 1951	3	0	0
23.	Volume XV—Part 4—August 1951	3	0	0
24.	Volume XV—Bound—1950-51	9	0	0
25.	Volume XVI—Part 2—March 1952	3	0	0
26.	Volume XVI—Part 3—April 1952	3	0	0
27.	Volume XVI—Part 4—October 1952	3	0	0
28.	Volume XVI—Bound—1951-52	8	0	0
29.	Volume XVII—Part 1—December 1952	3	0	0
30.	Volume XVII—Part 2—January 1953	3	0	0
31.	Volume XVII—Part 3—January 1953	3	0	0
32.	Volume XVII—Part 4—December 1953	3	0	0
33.	Volume XVIII—Part 1—December 1953	3	0	0
34.	Volume XVIII—Part 2—December 1953	3	0	0
35.	Volume XVIII—Part 3—January 1954	3	0	0
36.	Road Research Bulletin No. 1	5	0	0
37.	I. R. C. Standard Specifications and Code of Practice for Road Bridges in India (1937)	1	8	0
38.	Proceedings of the Chief Engineers' Conference at Nagpur on the Post-war Road Development in India	2	8	0
39.	Type Designs for Highway Milestones	0	8	0 plus packing and postage
40.	Route Marker Signs for National Highways	0	8	0 plus packing and postage
41.	Dimensions and Weights of Road-Design Vehicles ...	0	8	0 plus packing and postage
42.	Recommended Practice for the Location and Layout of roadside Fuel Filling stations.	0	8	0 plus packing and postage

Copies can be had from the Secretary,

INDIAN ROADS CONGRESS,

JAMNAGAR HOUSE, SHAHJAHAN ROAD,

NEW DELHI-2.

Printed by K. S. Krishnan at The Progressive Printers, 17, Coral Merchant Street, Madras-1, & Edited and Published by J. Subrahmanyam, Hony. Secretary, Indian Roads Congress, Jamnagar House, Shahjahan Road, New Delhi-2.—800.

Date of delivery from the