

REPORT

OF THE

Indian Road Development Committee

1927-28



X9(D411).2.N27t

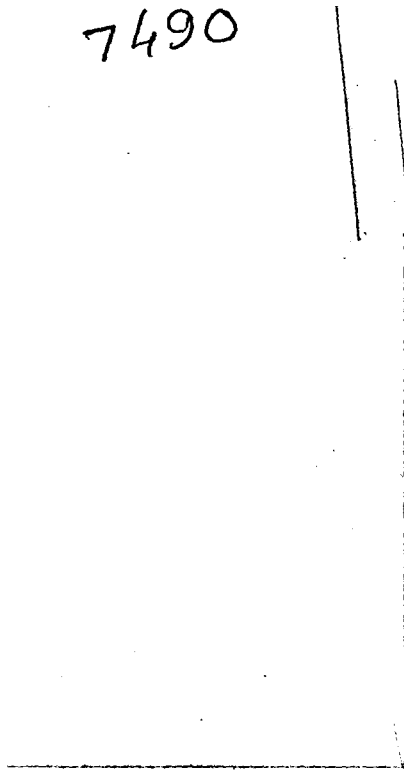
X9(D411).2.N27t
F8
007490

UTTA : GOVERNMENT OF INDIA,
CENTRAL PUBLICATION BRANCH

1928

Price : Rs. 2-14-0 or 5s.

7490



Dhananjayrao Gadgil Library



GIPE PUNE-007490

**SERVANTS OF INDIA SOCIETY'S LIBRARY,
POONA 4.
FOR INTERNAL CIRCULATION**

To be returned on or before the last date stamped below

3 DEC 1986

6 JAN 1987

2 FEB 1987

27 AUG 1990

9 FEB 1992

-6 FEB 1992

-6 MAR 1992

REPORT

OF THE

Indian Road Development Committee

1927-28



CALCUTTA : GOVERNMENT OF INDIA
CENTRAL PUBLICATION BRANCH
1928

Government of India Publications are obtainable from the Government of India Central Publication Branch, 3, Government Place, West, Calcutta, and from the following Agents :

EUROPE :

**OFFICE of the HIGH COMMISSIONER FOR INDIA,
42, GROSVENOR GARDENS, LONDON, S. W. 1.**

And at all Booksellers.

INDIA AND CEYLON :

Provincial Book Depôts:

MADRAS :—Superintendent, Government Press, Mount Road, Madras.
BOMBAY :—Superintendent, Government Book Depôt, Town Hall, Bombay.
SIND :—Library attached to the Office of the Commissioner in Sind, Karachi.
BENGAL :—Bengal Secretariat Book Depôt, Writers' Buildings, Room No. 1, Ground Floor, Calcutta.
UNITED PROVINCES OF AGRA AND OUDH :—Superintendent of Government Press, United Provinces of Agra and Oudh, Allahabad.
PUNJAB :—Superintendent, Government Printing, Punjab, Lahore.
BURMA :—Superintendent, Government Printing, Burma, Rangoon.
CENTRAL PROVINCES AND BHRAR :—Superintendent, Government Printing, Central Provinces, Nagpur.
ASSAM :—Superintendent, Assam Secretariat Press, Shillong.
BIHAR AND ORISSA :—Superintendent, Government Printing, Bihar and Orissa, P. O. Guizarbagh, Patna.
COORG :—Office of the Chief Commissioner of Coorg, Bangalore.
NORTH-WEST FRONTIER PROVINCE :—Manager, Government Printing and Stationery, Peshawar.

Thacker, Spink & Co., Calcutta and Simla.
 W. Newman & Co., Ltd., Calcutta.
 R. Cambay & Co., Calcutta.
 S. K. Lahiri & Co., Calcutta.
 The Indian School Supply Depot, 309, Bow Bazar Street, Calcutta.
 Butcherworth & Co., (India) Ltd., Calcutta.
 Rai M. C. Sarcar Bahadur & Sons, 90-2A., Harrison Road, Calcutta.
 Standard Literature Company, Ltd., Calcutta.
 Association Press, Calcutta.
 Chukerverty, Chatterjee & Co., Ltd., 13, College Square, Calcutta.
 The Book Company, Calcutta.
 James Murray & Co., 12, Government Place, Calcutta. (For Meteorological Publications only.)
 Ray Choudhury & Co., 68/5, Ashutooh Mukerji Road, Calcutta.
 The Oriental Publishing House, 74, Cornwallis Street, Calcutta.
 Scientific Publishing Co., 9, Taitolla Lane, Calcutta.
 Chatterjee & Co., 204, Cornwallis Street, Calcutta.
 B. C. Basak, Esq., Proprietor, Albert Library, Dacca.
 Mitra Brothers, Rajshahl.
 Higginbothams, Madras.
 P. E. Rama Iyer & Co., Madras.
 Rochouse & Sons, Madras.
 G. A. Natesan & Co., Publishers, George Town, Madras.
 Theosophical Publishing House, Adyar, Madras.
 Bright & Co., Trivandrum.
 The Booklover's Resort, Talkad, Trivandrum, South India.
 E. M. Gopalakrishna Kone, Pudumandapam, Madura.
 Vijapur & Co., Vizagapatam.
 Thacker & Co., Ltd., Bombay.
 D. B. Taraporevala, Sons & Co., Bombay.
 Sunder Pandurang, Bombay.
 Ram Chandra Govind & Sons, Kalbadevi Road, Bombay.
 N. M. Tripathi & Co., Booksellers, Princes Street, Kalbadevi Road, Bombay.
 New & Secondhand Bookshop, Kalbadevi Road, Bombay.
 Mrs. Radhabai Atmaram Sagoon, Kalbadevi Road, Bombay.
 A. H. Wheeler & Co., Allahabad, Calcutta and Bombay.
 Proprietor, New Kitabkhana, Poona.
 The Manager, Oriental Book Supplying Agency, 15, Shukrawar, Poona City.
 Rama Krishna Bros., opposite Vishrambag, Poona City.
 S. F. Bookstall, 21 Budhwar, Poona.
 Mangaldas & Sons, Booksellers and Publishers, Bhaga Talao, Surat.

R. B. Umadikar & Co., The Bharat Book Depôt, Dharwar.
 The Standard Bookstall, Karachi, Quetta, Delhi, Murree and Rawalpindi.
 The Karachi Book Depot, Elphinstone Street, Camp, Karachi.
 The English Bookstall, Karachi.
 The Standard Bookstall, Quetta.
 U. P. Malhotra & Co., Quetta.
 J. Ray & Sons, 43, K. & L., Edwardes Road, Rawalpindi and Murree.
 The Standard Book Depôt, Lahore, Nainital, Mussoorie, Dalhousie, Ambala, Cantonment and Delhi.
 N. B. Mathur, Supdt., Nazir Kanun Hind Press, Allahabad.
 The North India Christian Tract and Book Society, 18, Clive Road, Allahabad.
 Ram Dayal Agarwala, 184, Katra, Allahabad.
 The Indian Army Book Depôt, Juhl, Cawnpore.
 Manager, Newal Kishore Press, Lucknow.
 The Upper India Publishing House, Ltd., Literature Palace, Ammuddaula Park, Lucknow.
 Rai Sahib M. Gulab Singh & Sons, Mudd-i-Am Press, Lahore and Allahabad.
 Rama Krishna & Sons, Booksellers, Anarkali, Lahore.
 Puri Brothers, Booksellers and Publishers, Katchen Road, Lahore.
 The Tilak School Bookshop, Lahore.
 The Standard Bookstall, Lahore.
 The Proprietor, Punjab Sanskrit Book Depot, Seidmitha Street, Lahore.
 The Insurance Publicity Co., Ltd., Lahore.
 The Punjab Religious Book Society, Lahore.
 Manager of the Imperial Book Depôt, 63, Chandney Chawk Street, Delhi.
 Fono Book Agency, New Delhi.
 Oxford Book and Stationery Company, Delhi.
 Supdt., American Baptist Mission Press, Rangoon.
 The Modern Publishing House, Ltd., 30, Phayre Street, Rangoon.
 Burma Book Club, Ltd., Rangoon.
 Manager, the "Hitavada," Nagpur.
 Bhisey Brothers, Booksellers and Stationers, Sitabaldi, Nagpur.
 S. C. Talukdar, Proprietor, Students & Co., Cooch Behar.
 The Manager, Ceylon Observer, Colombo.
 The Manager, The Indian Book Shop, Benares City.
 The Srivilliputtur Co-operative Trading Union, Ltd., Srivilliputtur (S. I. R.).
 Raghunath Prasad & Sons, Patna City.
 The Students Emporium, Patna.
 K. L. Mathur & Bros., Guard, Patna City.
 Dandekar Brothers, Indore City.
 Pustakalaya Sahayak Sahakari, Ltd., Baroda.
 The Hyderabad Book Depot, Chaderghat, Hyderabad (Deccan).

X9(D411).2.N275

F8

7490

CONTENTS.

CHAPTER I

INTRODUCTORY.

Paragraph.	Page.
1. Appointment of the Committee and terms of reference	1
2. Procedure of the Committee	2
3. Tour of the sub-committee	2
4. Subsequent proceedings of the Committee	2

CHAPTER II

INDIAN ROADS IN THE PAST.

5. Scope of chapter	3
6. Earliest times	3
7. Mauryan period. Kautilya's Arthashastra	3
8. The Sukraniti	4
9. Chandragupta	5
10. Asoka	5
11. Early travellers	5
12. Pethan and Moghul periods. Ibn Batuta	5
13. The Tarikh-i-Sher Shahi	6
14. The Chadar Gulshan	6
15. European travellers. William Finch	7
16. Tavernier	7
17. Nineteenth century	8

CHAPTER III

INDIAN ROADS TO-DAY.

18. Statistics	10
19. Road mileage according to classes and types	10
20. Road mileage according to area and population	11
21. Road expenditure	11
22. Growth of road expenditure and surfaced mileage	12
23. Administration	13
24. Finance	13
25. Road boards	14
26. Road conditions in India	14
27. Traffic on Indian roads. The bullock cart	14
28. Motor traffic. (a) Passengers	15
29. (b) Goods	15

Paragraph,	Page.
30. Effect of motor traffic on roads	15
31. Defects in the existing road system	16
32. Road maps	17

CHAPTER IV.

THE DESIRABILITY OF DEVELOPING THE ROAD SYSTEM OF INDIA.

33. Marketing of agricultural produce	18
34. Social and political progress	18
35. Roads and railways	19
36. Interdependence of communications	20
37. Conclusion	20

CHAPTER V.

ROAD ADMINISTRATION AND FINANCE IN OTHER COUNTRIES.

38. Comparison with other countries	21
---	----

✓ *Great Britain.*

39. Evolution of the present system	21
40. Classification of roads and contributions by the Ministry	22
41. Road Fund	23

France.

42. Classification of roads	23
43. Service des Ponts et Chaussées	24

✓ *United States of America.*

44. Evolution of the present system	24
45. Federal-aid	25
46. Classification of roads and mileage	26
47. Bureau of Public Roads	26

Canada.

48. Evolution of the present system	27
49. Canadian Highways Act	27

New Zealand.

50. Road administration	28
51. Main Highways Act	28
52. Highway districts	29
53. Subsidies	29
54. Finance	30

Paragraph.	Page.
<i>China.</i>	
55. National good roads movement	30
56. Summary	31

CHAPTER VI.

THE MEANS BY WHICH ROAD DEVELOPMENT IN INDIA COULD MOST SUITABLY BE FINANCED.

✓ 57. Interest of the Government of India in road development	32
58. The constitutional position	32
✓ 59. The finance of road development. (1) From general revenues	32
✓ 60. (2) From additional taxation on motor transport	33
✓ 61. Present taxation on motor transport. (1) Central	34
62. (2) Provincial }	34
63. (3) Local }	35
✓ 64. Taxable capacity of motor transport	36
✓ 65. Proposals for additional taxation on motor transport	37
✓ 66. Duty on motor spirit	37
✓ 67. Reduction in price of petrol	38
✓ 68. Objections to duty on motor spirit. (1) Use of motor spirit for other purposes	39
69. (2) Burden on large towns	39
70. Duty on motor spirit a source of central revenue	40
71. Grants from central revenues for road development. Proposed convention	40
72. Control over expenditure	41
✓ 73. The federal-aid system in the United States	41
74. Principles for expenditure of annual grant. (1) Apportionment among provinces	41
75. Principles recommended	42
76. (2) Approval of projects	43
77. Principles recommended	43
78. Burma	44
✓ 79. Standing Committee for Roads	44
80. Provincial and local taxation	45
✓ 81. Vehicle taxation	45
✓ 82. Methods of assessment	45
✓ 83. Licence fees for vehicles plying for hire	46
84. Loans	46
85. Security for loans	47
✓ 86. Village roads	47

CHAPTER VII.

✓ THE CO-ORDINATION OF ROAD DEVELOPMENT.

87. Central Road Board	48
88. Road Conference	48

Paragraph.	Page.
89. Procedure of the Conference	49
90. Department of Communications	49

CHAPTER VIII.

MISCELLANEOUS.

✓ 91. Contributions by railways	51
✓ 92. Contributions from the Army budget	51
✓ 93. Monopolies of public motor services	51
✓ 94. Tolls	52
✓ 95. Tolls on bridges	52

CHAPTER IX.

SUMMARY OF RECOMMENDATIONS.

96. Summary of recommendations	53
97. Acknowledgments	56

APPENDICES.

I. Resolution of the Government of India appointing the Committee	61
II. Report of the touring sub-committee	63
Supplementary Report on the Punjab	82
III. Statistical Statements :—	
Statement A.—Road mileage according to classes and types in 1926-27	88
Statement B.—Area, population and density of population	92
Statement C.—Distribution of road mileage according to area and population	93
Statement D.—Expenditure on roads in 1926-27	94
Statement E.—Percentages of provincial, local and total revenues spent on roads, and incidence of road expenditure per head of population	98
Statement F.—Provincial and local expenditure on roads from revenue in the year 1913-14 and in the four years 1923-24 to 1926-27	99
Statement G.—Expenditure on road construction and maintenance from revenue in the year 1913-14 and in the four years 1923-24 to 1926-27	100
Statement H.—Surfaced mileage in the year 1913-14 and in the four years 1923-24 to 1926-27	101
Statement J.—Present cost of annual maintenance and construction of roads in different provinces	102
Statement K.—Contributions from provincial revenues to local bodies for expenditure on roads in 1926-27	103
Statement L.—Imports of motor vehicles, parts and accessories, and of tyres and tubes	104

	Page.
Statement M.—Production, consumption and retail price of petrol in India	105
Statement N.—Duty on motor vehicles etc., and on motor spirit	108
IV. Progress made in India with improved forms of road surfaces	107
V. Federal Highway Act of 1921 of the United States of America	147

DIAGRAMS AND MAPS.

1. Sketch map of Konkan and Bombay Deccan showing roads in 1851-52.	}	Facing p. 9.
2. Sketch map of Konkan and Bombay Deccan showing roads in 1927.		
3. Mileage of roads surfaced and unsurfaced and expenditure on maintenance and construction in 1926-27.	}	Facing p. 10.
4. Details of road expenditure in 1926-27.		
5. Percentage of provincial, local and total revenues expended on roads in 1926-27.		
6. Road mileage per 100 square miles of area.		
7. Growth of road expenditure from revenue since 1913-14.		
8. Road map of India (in pocket).		

Note.

The total cost of the Committee, including the cost of printing the report and the evidence, is estimated to be Rs. 1,30,000.

APPENDICES.

CONTENTS.

	Page.
I. Resolution of the Government of India appointing the Committee . . .	61
II. Report of the touring sub-committee	63
Supplementary Report on the Punjab	82
III. Statistical Statements—	
Statement A.—Road mileage according to classes and types in 1926-27	88
Statement B.—Area, population and density of population . . .	92
Statement C.—Distribution of road mileage according to area and population	93
Statement D.—Expenditure on roads in 1926-27	94
Statement E.—Percentages of provincial, local and total revenues spent on roads, and incidence of road expenditure per head of population	98
Statement F.—Provincial and local expenditure on roads from rev- enue in the year 1913-14 and in the four years 1923-24 to 1926-27	99
Statement G.—Expenditure on road construction and maintenance from revenue in the year 1913-14 and in the four years 1923-24 to 1926-27	100
Statement H.—Surfaced mileage in the year 1913-14 and in the four years 1923-24 to 1926-27	101
Statement J.—Present cost of annual maintenance and construction of roads in different provinces	102
Statement K.—Contributions from provincial revenues to local bodies for expenditure on roads in 1926-27	103
Statement L.—Imports of motor vehicles, parts and accessories, and of tyres and tubes.	104
Statement M.—Production, consumption and retail price of petrol in India	105
Statement N.—Duty on motor vehicles, etc., and on motor-spirit . .	106
IV. Progress made in India with improved forms of road surfaces	107
V. Federal Highway Act of 1921 of the United States of America	147

APPENDIX I

Resolution of the Government of India appointing the Committee.

Department of Commerce Resolution No. 489-T. (1), dated New Delhi, the 3rd November 1927.

The following Resolution on the subject of road development was unanimously adopted by the Council of State on the 9th February 1927 :—

“ That this Council recommends to the Governor General in Council, to appoint a Committee, including members of both Houses of the Central Legislature to examine the desirability of developing the road system of India, the means by which such development could be most suitably financed, and to consider the formation of a Central Road Board for the purpose of advising in regard to, and co-ordinating the policy in respect of, road development in India.”

2. In accordance with this Resolution the Governor General in Council after consultation with the local Governments, has decided to appoint a Committee, consisting of members of the two Chambers of the Indian Legislature, with the following terms of reference :—

- (1) To examine the desirability of developing the road system of India and, in particular, the means by which such development could most suitably be financed ; and
 - (2) To consider, with due regard to the distribution of central and provincial functions, whether it is desirable that steps should be taken for the co-ordination of road development and research in road construction, by the formation of a Central Road Board or otherwise.
3. The following gentlemen have agreed to serve on the Committee :—

Chairman :

Mr. M. R. JAYAKAR, Bar-at-Law, M.L.A.

Members :

1. DIWAN CHAMAN LAL, M.L.A.
2. The Hon'ble Sir GEOFFREY CORBETT, K.B.E., C.I.E., I.C.S.
3. The Hon'ble Sir ARTHUR FRÖOM, Kt.
4. KUMAR GANGANAND SINHA, M.L.A.
5. RAJA GHAZANFAR ALI KHAN, M.L.A.
6. Lala LAJPAT RAI, M.L.A.
7. The Hon'ble Mr. MAHMOOD SUHRAWARDY.
8. Mr. MD. ANWARUL AZIM, M.L.A.
9. Mr. MUHAMMAD ISMAIL KHAN, M.L.A.
10. The Hon'ble Dr. U. RAMA RAU.
11. Mr. K. V. RANGASWAMY AYYANGAR, M.L.A.
12. The Hon'ble SARDAR SHIVDEV SINGH UBEROI.
13. Mr. E. F. SYKES, M.L.A.

Mr. H. F. Knight, I.C.S., will act as Secretary and Mr. K. G. Mitchell, A.C.G.I., A.M.I.C.E., A.M.Inst.T., as Technical Adviser to the Committee.

4. The Committee will assemble immediately at New Delhi to decide its procedure. It is desired that the Committee should obtain and consider the views of all local Governments, and should also examine such persons, associations and other bodies as it thinks necessary. Persons who desire to be called as witnesses should apply in writing to the Secretary, care of Department of Commerce, Government of India, New Delhi, giving their full names and addresses, together with a brief memorandum of the points on which they desire to give evidence.

5. The Government of India hope that local Governments and Administrations will afford the Committee all the assistance which it may require and will comply with any request for information which may be addressed to them by it.

APPENDIX II.

Report of the touring sub-committee.

At a meeting of the Road Development Committee held on the 6th November 1927 at New Delhi, the following Sub-Committee to tour the provinces in order to collect information was appointed:

Chairman :

The Hon'ble Sir ARTHUR FROOM, Kt.

Members :

The Hon'ble Mr. MAHMOOD SUHRAWARDY and
KUMAR GANGANAND SINHA, M.L.A.

with Mr. K. G. MITCHELL, *Technical Adviser* and Mr. H. F. KNIGHT, I.C.S., *Secretary*.

It was also decided that other members of the Committee should join the Sub-Committee in their respective provinces when it goes to the headquarters of the local Governments of those provinces. The Sub-Committee was accordingly assisted in their inquiries by Mr. Md. Anwarul Azim, M.L.A., in Calcutta, the Hon'ble Dr. U. Rama Rau and Mr. K. V. Rangaswamy Ayyangar, M.L.A., in Madras, and by Mr. E. F. Sykes, M.L.A., in Bombay.

PART I.

The Sub-Committee's instructions were :—

- “(a) The Sub-Committee should obtain information from local Governments, local bodies and associations interested in road development on the points included in the questionnaire, and secure that the information supplied from each province is as uniform and complete as possible.
- (b) The Sub-Committee, before proceeding on tour, should request local Governments to supply their own officials and local bodies and associations with copies of the questionnaire, and ask them to be prepared to meet the Sub-Committee and furnish the information required.
- (c) The answers to the questionnaire are to be compiled province by province and to be printed and circulated to members of the full Committee as completed.
- (d) The Sub-Committee should not examine representatives of the Railway Department or of Army Headquarters who will be invited to give evidence before the full Committee.”

Our programme was sent to Members of the Committee on the 15th November 1927. We found it impossible in the time available to visit Burma or Karachi, and have had to leave until after Christmas the visit to Lahore concerning which we will submit a separate report.

We visited Allahabad, Shillong, Calcutta, Patna, Nagpur, Madras and Bombay and held informal discussions on road development with

- 14 Honourable Members and Honourable Ministers of local Governments.
- 37 Secretaries, Chief Engineers and other representatives of local Governments.
- 54 representatives of District Boards.
- 51 representatives of Commercial and other Associations.
- 14 private individuals.

Memoranda of all these discussions are being sent to Members. We also inspected improved methods of road construction in Calcutta, Patna and Bombay, and visited the Government Test House, Alipore.

2. We take it that the Road Development Committee do not desire the Sub-Committee to discuss in detail the answers received to the questionnaire as these are all being printed and despatched to Members of the Committee who will wish to form their own opinions thereon. This Report therefore is confined mainly to the information obtained by us as the result of discussions during our tour. There is no need to give the history of roads in India with which the Members are sufficiently acquainted,

but it must be admitted that, compared with many other countries, the Indian road system is undeveloped:

Nine Major Provinces of India.			United States of America.	
Density of Population			31.5	
	Per 100 sq. miles of area.	Per 100,000 of population.	Per 100 sq. miles of area.	Per 100,000 of population.
Mileage of all roads ..	20.18	83.90	80	2,550
Surfaced roads ..	5.38	22.30	12.05	383
Percentage of roads surfaced.	26.5		15.0	

On our tour we found that the backwardness of the Indian road system was universally recognised, and considerable enthusiasm was shown for road development. The recent development of motor passenger transport is appreciated as bringing the facility of rapid travel within reach of millions of the population down to the poorest; while the value of good roads to the cultivator bringing his produce to market is shown by the insistent demand for improved roads and new roads in every province. But, at the same time, the increase of traffic of recent years has led to anxiety as to how roads can be kept up under modern conditions with the money and material available.

PART II.

3. The experience of our tour shows that an improvement in the present unsatisfactory condition of roads in India is eagerly looked for, and we found an almost universal agreement that it is desirable to constitute a Central Road Board with advisory functions to co-ordinate road development, especially on all-India and inter-Provincial roads, to co-ordinate the development of Roads and Railways and to stimulate and co-ordinate research into road-making. It was equally recognised that a corollary to such a Central Board must be Provincial Road Boards or Provincial Communications Boards. Such already exist in the Punjab, the United Provinces, the Central Provinces, Assam, Madras and Bombay. In some quarters the view was expressed that in order to give productive effect to the generally expressed wish for road development in India a Central Board of Communications or a Ministry of Transport should be constituted with executive powers.

We received complaint that when consideration is taken of the import duties on motor cars, on tyres, and spare parts, and of the present petrol excise, motor vehicles are already heavily taxed indirectly and there is a general demand for a reduction in the present import duties or for an equivalent assignment from Central Revenues to road development.

4. It was equally recognised that an immediate improvement of roads is impossible without additional funds and we found very general agreement that the best method of obtaining this would be by means of an increase in the excise and customs duty on petrol, the amount produced by this increase being exclusively devoted to road development. The increase most generally suggested was 2 annas per gallon but there was a certain body of opinion that favoured a 4 annas increase.

The advantages of such a tax appear to be :—

- (i) ease and cheapness of collection;
- (ii) impossibility of evasion; and
- (iii) fairness as proportioning the tax to road use.

It was, however, strongly emphasized before us by almost all

- (i) that the proceeds of such increase in the excise would have to be definitely earmarked for roads, if such a tax is to meet with public approval; and
- (ii) that under modern conditions, the present excise of 4 annas on petrol conflicts with the principle that transport should not be taxed except for the benefit of transport, and that, as soon as finances permit, the present excise should be diverted to road development.

5. As to how funds raised by the Central Government for road development should be spent, or should be allotted among the provinces, we found less agreement. The simplest method of division—i.e., that each province should receive its share of the extra 2 annas excise on petrol according to the amount of petrol consumed in that province—was in favour in Bengal and Bombay. But this was objected to in some other provinces on the following grounds :—

- (i) The heavy consumption of petrol in the cities of Calcutta and Bombay would result in Bengal and Bombay provincial revenues obtaining an excessive share.

- (ii) The object of the Central Road Board would be the development of the roads of India as a whole and assistance to provinces based on the fortuitous position of large cities would be unfair.

It appeared to us that there is force in these objections and we have therefore sought for other methods of distribution, and discussed them with local Governments and others. It was not to be expected that a single formula would satisfy the representatives of every province who naturally wish to do their best for the finances of their province, and therefore favour such distribution as will give it the largest share. But we found universal agreement that a definite formula for fixing the share which any province might get from any Central Road Development Funds is necessary, in order to enable provinces to map out programmes of road development ahead.

We think that division on something on the lines adopted in the United States of America would meet with acceptance. For example, any funds made available from Central taxation might be divided among the provinces as follows:—

- (1) one-fourth of the total should be divided among provinces according to their proportionate area to their total area ;
- (2) one-fourth of the total should be divided among provinces according to their proportionate population to their total population ;
- (3) one-fourth of the total should be divided among the provinces according to the proportion of their total annual expenditure on road maintenance in all the provinces ;
- (4) one-fourth of the total should be divided among the provinces according to their proportionate petrol consumption to the total petrol consumption.

The addition of the shares under each of these factors would give each province's total grant*. We realise, and those whom we met also realised, that there are criticisms applicable to each factor, e.g.,

- (1) Total area would benefit a province with a large desert or forest area where roads may not be needed ;
- (2) Population would be to the disadvantage of a sparsely populated province where roads must needs be long ;
- (3) Expenditure on roads takes no account whether the money is well spent or wasted, and it favours a rich province at the expense of a poor one ;
- (4) Petrol consumption is open to the objection that it unduly favours provinces with large cities.

But, in view of our informal discussions with many persons during our tour, we have formed the opinion that the Committee may find it possible to reach an agreed basis for division accepted by the provinces in this or some similar formula.

*We have not considered the position of the territories directly under the Government of India or of the Indian States in any such petrol excise revenue. We presume that they will receive a share, whether directly or indirectly, from the Government of India, provided they participate in a unified road development policy.

As a basis for discussion we have tentatively worked out the effect of some various formulæ suggested. A 2 annas petrol excise is likely to yield Rs. 60 lakhs, or possibly more in 1927-28, and, as part of this would go to the share of the administered territories and Indian States, we have assumed that Rs. 50 lakhs would be available for distribution among the major provinces. (On 7 months' figures for 1927, Rs. 46½ lakhs would be the share of the provinces, but the latter part of the year is likely to raise this figure—we have therefore assumed Rs. 50 lakhs as available). The figures we give below are merely approximate and may be liable to modification when more accurate information as to provincial expenditure on roads and provincial petrol consumption becomes available.

The figures give the share in lakhs of the provinces from a Central Fund of Rs. 50 lakhs:—

Province.	I.	II.	III.	IV.	V.
Madras	7.5	8.5	8.05	8.12	7.9
Bombay	12.0	9.25	7.12	7.37	8.2
Bengal	10.5	7.5	7.25	7.37	8.2
United Provinces .. .	3.5	4.25	5.75	6.0	5.8
Punjab	3.5	4.75	4.5	4.62	4.5
Burma	7.0	7.25	7.25	6.0	5.7
Bihar & Orissa	2.5	3.25	4.37	4.62	4.2
Central Provinces	2.0	3.25	3.72	3.62	3.2
Assam	1.5	2.0	2.0	2.25	2.3
Total	50.0	50.0	50.01	49.97	50.0

I. This is the share due to each province on a basis of proportionate petrol consumption alone.

II. This combines the two factors of :

- (i) provincial expenditure on road and
- (ii) petrol consumption.

III. This combines the four factors of :

- (i) gross area,
- (ii) population,
- (iii) road expenditure from revenue and
- (iv) petrol consumption.

IV. This combines the four factors of :

- (i) area, taken as whole cultivated area of the province *plus* $\frac{1}{4}$ the uncultivated area, to obviate the effect of areas which require no roads.

- (ii) population,
- (iii) road expenditure and
- (iv) petrol consumption.

V. This combines the same four factors as IV, but to meet the objection that provinces which provide the most petrol revenue should receive consideration for this, the petrol consumption factor is given value double that of each of the other factors.

6. As regards the objects on which such a Central Road Development Fund might be spent, we found an impression in some places that, in the imposition of a central petrol tax, the Central Government would be merely acting as agent for the provinces in collecting a petrol excise to take the place of a provincial motor vehicle tax, and that the proceeds should be handed over to local Governments to spend as they wished.

It appeared to us, however, that this was not contemplated by the terms of reference to the Committee which seems to postulate in the first place a comprehensive development of the roads of India as a whole rather than the immediate augmentation of provincial funds for roads in general, and we think we have indicated this sufficiently to those whom we met and general agreement was reached that the primary objects of expenditure should be the development of roads of all-India or inter-Provincial importance. We recognise however that in framing any classification of roads as of all-India or inter-Provincial importance, special consideration will be necessary in the case of certain provinces where through routes are few or impossible. It should be possible however for the Central Road Board, if and when constituted, to settle this problem of classification. It was impressed upon us however that under no consideration should any part of the share in the Central Fund falling to one province be diverted to any other province.

7. It is clear that the proceeds of the additional proposed 2 annas increase in the petrol excise, which is estimated to produce about Rs. 60 lakhs in 1927-28, will not, when divided among the provinces, allow of large schemes of road development from revenue, and we found an almost universal demand that the proceeds of such an additional 2 annas petrol excise should be made available to provide for interest and sinking fund charges on capital road expenditure incurred out of loan funds by provincial Governments. We see no objection to this; it is universally recognised that expenditure on construction and reconstruction of bridges and culverts and on some of the more permanent items of road-making, such as embankments, can be rightly incurred out of capital, and provided care is taken not to finance short-lived work, such as surfacing, out of loan, the policy is sound. An annual revenue of Rs. 60 lakhs from petrol excise would allow an immediate capital expenditure of about Rs. 9 crores on a 30 year basis borrowing at 5½ per cent. But the objection has been put to us that provincial Governments will hesitate to undertake such fresh capital expenditure unless they can be assured of the recurring income from the petrol excise needed to provide the interest and sinking fund charges on their loans, and it was suggested to us that it would be advisable to earmark this petrol excise by the constitution of a statutory Road Fund, to which it should be annually paid, in order to ensure that funds might be continuously available in the future to assist local Governments.

We suggest that the Committee might consider whether the Legislature would be likely to agree to such a proposal, which not only appears in consonance with road development in other countries but has received the support of every person, official and non-official, who has discussed the matter with us.

If a statutory Road Fund be established, with an agreed formula for division among the provinces, then local Governments could embark on loans for road development with the guarantee of certain annual sums available for interest and sinking fund. Such guaranteed income seems imperative if any substantial progress in road development is to be made in the near future.

8. We report to the Committee that public opinion generally is in favour of the following proposals:—

- (i) The desirability of an Advisory Central Road Board ;
- (ii) The imposition of an extra 2 annas excise on petrol to form a Central Fund, the proceeds to be earmarked for road development ;
- (iii) The division of the proceeds among the provinces on an accepted formula ;
- (iv) The proceeds to be spent primarily on roads of all-India or inter-Provincial importance ;
- (v) Such expenditure to be additional to, and not in place of, any normal provincial expenditure on roads ;
- (vi) The Central Fund should be available to finance interest and sinking fund charges on capital road works constructed out of loan by provincial Governments ;
- (vii) For this purpose the provinces should be assured annual receipt of their shares by the constitution of a permanent Road Fund.

PART III.

9. The terms of reference to the Committee are :—

- (1) To examine the desirability of developing the road system of India and, in particular, the means by which such development could most suitably be financed; and
- (2) To consider, with due regard to the distribution of central and provincial functions, whether it is desirable that steps should be taken for the co-ordination of road development and research in road construction, by the formation of a Central Road Board or otherwise;

and it was clear from these terms of reference that it was impossible to avoid consideration of provincial road problems, nor did those whom we met desire us to do so, and, at the same time, it is equally clear that the provision of roads to reach the mass of the population must be the concern of the provincial Governments and the various local authorities.

We were informed in several provinces that roads in general are deteriorating, and that modern traffic is demanding more expensive forms of road construction, while provincial and local authorities' revenues are not expanding to meet these needs. It was clear that there is general recognition of the need for more and better roads, but that the financial difficulty is in the way.

No panacea to remedy this was suggested to us, but from our discussions we conclude that public opinion is in favour of certain changes in road management. In several provinces there are in existence Road Boards or Communications Boards of an advisory character, and with the assistance of such bodies, it should not be difficult to draw up a classification of roads in each province into, *e.g.*,

- (i) all-India arterial roads,
- (ii) provincial roads, *i.e.*, main roads necessary for internal communication between divisions or districts,
- (iii) district roads, which would primarily serve the needs of a single district, and
- (iv) village roads.

It was put to us that the all-India roads should be maintained by provincial funds with aid from the Central Fund, that provincial roads should be maintained by provincial funds without cost to local authorities, that district roads should be maintained by local authorities with or without aid from provincial funds, and that village roads should be maintained by local authorities only.

10. The reasons given for relieving local authorities from the up-keep of provincial main roads in those cases where such are not maintained by the local Government, were

- (i) that District Boards, with their inelastic revenues and the pressing demands of education and sanitation, cannot afford to keep up their roads to modern standards;
- (ii) that in many cases the District Boards are able only to take account of the needs of their own district, and, where an important provincial main road runs through a district, the District Board tends to maintain only such portion as is of local importance;

- (iii) owing to the varying efficiency and varying finances of various District Boards, the upkeep of through roads varies undesirably from district to district.

This proposal was generally favoured, and the system suggested appears necessary for any comprehensive road development. Some such classification of roads has been found necessary in almost every country.

11. The exact method of 'Provincialisation' of main provincial roads, where such are not already in charge of the Public Works Department, would have to depend on local conditions. Some Presidents of District Boards desired that the local Government should assume entire charge of such roads through the Public Works Department. Others preferred that the local Governments should pay the local bodies the cost of maintenance and leave the work to be done by the District Board staff, with inspection by the Public Works Department officers. We were informed that the latter system was found satisfactory in Berar, and to some extent in Madras, but elsewhere opinion was not so favourable to it. We suggest that maintenance by the Public Works Department or by District Board staff must depend on the individual efficiency of District Boards and that no hard and fast rule is possible, but that the primary object of good roads must be kept in view uninfluenced by other considerations, and that, *prima facie*, divided control is undesirable.

A further proviso which we were asked should be laid down, was that in the event of local authorities being relieved of the cost of 'Provincial' roads, this should not lead to a diminution of the total amount spent on roads by a local authority. It was pointed out to us that the pressing need of education is apt to absorb the available funds of local authorities, and that if more money be provided by the local Government for roads, such must be in addition to, and not in place of, any money previously spent on roads. This appears to us reasonable, and we suggest the Committee might indicate to local Governments the necessity of control in this direction; without such proviso, the release of money previously spent by District Boards on 'Provincial' roads will lead to no improvement in district roads which concern the cultivator most closely. The main object in furthering any road development of India is to ameliorate the economic condition of the agriculturist.

12. The proposal that local Governments should take over the main inter-division and inter-district roads in each province will involve in most cases a further charge on provincial revenues, and we agree that in most provinces revenue is not expanding and that a further increase in general taxation is undesirable.

That roads should be largely supported out of general revenues is an axiom which we do not dispute. The benefits to a country of a system of good roads are almost incalculable: in particular in India with a very large agricultural population, whose livelihood largely depends on their ability to take the produce of their fields to market, good roads are an especial need. This we found recognised everywhere and we wish that funds permitted the provision of a road to every village. We might also draw attention to the Note* on Highway Finance by Mr. J. N. Willys, of which copies have been sent to Members, in which he shows that the good roads in the United States of America are not the result of the country's

*Not printed.

prosperity but the prosperity of the country is largely the result of a forward policy in financing road construction out of general revenues, with the effect that now in America motor vehicle taxation is practically sufficient for the maintenance of roads. We do not, of course, suggest that such a condition of affairs can be attained in India in the near future, but, while holding that much road expenditure should be met from general revenues, we are of opinion that certain classes who particularly benefit from roads—*e.g.*, those who use them whether by bullock cart or motor car or other vehicles—should bear an additional share in road maintenance beyond whatever they may contribute to the upkeep of roads through their payment to general revenues.

13. To deal first with Motor Vehicles. We find there is little uniformity in their taxation, apart from the indirect taxation effected by the import duties on cars, accessories, tyres, and by the petrol excise. The forms of taxation now in force are :—

- (i) *Vehicle registration fee on purchase.*—Rs. 16 to 20, usually not a recurring charge, though in some provinces an annual renewal fee of Rs. 2 or so is in force. This "taxation" is primarily imposed for Police control on motor vehicles, and it has been recognised (see the Taxation Enquiry Committee's report, para. 319) that the charges should be calculated only to cover the cost of administration concerned.
- (ii) *Direct provincial taxation.*—This only exists in the Punjab, where it is calculated on seating capacity. (See Punjab Act IV of 1924.) The U. P. provincial taxation was repealed. Bombay and Bengal had proposed provincial petrol taxation before the Committee was started.
- (iii) *Direct local taxation.*—This, with the exception of one or two Local Boards in the Central Provinces, is only levied by municipalities; and Local Boards, whose roads are largely used by motor vehicles, receive nothing. The rates vary from the high scale of Bombay—Rs. 80 per annum and upwards—to a few rupees a year in smaller municipalities.
- (iv) *Indirect municipal taxation by octroi or terminal tax on petrol, tyres, etc.*—This is probably not a serious item as no complaints were received.
- (v) *Tolls.*—These vary in the provinces; in Madras it was stated to us that the total revenue raised from motor vehicles in the form of road toll was about Rs. 9 lakhs. (We were informed that in Madras the direct local taxation of motor vehicles and the tolls levied on motor vehicles were together equivalent to a tax of Rs. 100 per annum per car.)

With the exception of Madras and Bombay City, it was generally felt that there is room for further taxation of motor vehicles for provincial revenues without hampering the development of transport, and we suggest to the Committee that local Governments be advised to raise some of the money required for roads by means of provincial motor vehicle taxation.

14. We have not thought it within our province to examine closely the varied possible methods of taxation of motor vehicles. The Departmental

Committee on the Taxation and Regulation of Road Vehicles in Great Britain considered the following methods :—

- “(A) The present system (*i.e.*, taxation by horse-power) to be abolished entirely, and a motor spirit duty substituted.
- (B) Taxation to be based on unladen weight, with or without an additional percentage for load, and with a rebate on vehicles fitted with pneumatic tyres.
- (C) Combinations of A and B, or of A and the present system.
- (D) Tax to be based on a combination of horse-power and weight, or upon a combination of horse-power, weight, and nature of tyres.
- (E) A wheel tax varying according to the type of vehicle, combined with a motor spirit duty of 1*d.* per gallon.
- (F) Taxation on an *ad valorem* basis for all vehicles, with a sliding scale according to the age of the vehicle, and a duty of 2*d.* per gallon on imported motor spirit.
- (G) Taxation to be based upon a combination of horse-power tax and a petrol duty, with a reduction in favour of pneumatic tyres. Also an increased tax for trailers.
- (H) Taxation to be based upon a combination of weight and mileage, or a combination of weight, mileage and nature of tyres.
- (I) Vehicles with internal combustion engines to be taxed on the cubic capacity of the engine cylinders, regardless of the purpose to which the vehicle is put; other mechanically-propelled vehicles to be taxed on unladen weight.
- (J) The remaining suggestions were merely for the partial amendment of the present scheme, *e.g.*, heavier taxation of traction engines in view of their noise and the wear and tear caused by them to the roads, etc.”

Provinces may have individual preferences for certain forms of taxation and we have not yet had the opportunity of discussion in the Punjab, which is the only province with a provincial motor vehicle tax in operation.

We would, however, express the opinion that the simpler and the less liable to any evasion tax may be the better. In one city we were informed that out of some Rs. 5 lakhs to Rs. 6 lakhs that should be collected from a corporation motor vehicle tax, only Rs. 2½ lakhs were actually received.

15. The general opinion given to us was that motor vehicle taxation should be provincial and not local with the proviso that local bodies who now draw revenue from motor vehicles would have to be compensated, if provincial were substituted for local motor vehicle taxation. This is in accord with the views of the Taxation Enquiry Committee. In some places, however, the opinion was expressed that the abolition of local motor vehicle taxation would be considered an interference with Local Self-Government and that the power to impose such taxation was of educative value to such bodies.

We admit the force of this contention, but in view of the majority of public opinion in accord with the principle of provincial as against local taxation, the probable financial benefits to local finances from a motor vehicle tax collected provincially, and the convenience of the motor owner,

we suggest to the Committee that it might recommend to local Governments the propriety of provincial motor vehicle taxation with the abolition of local motor vehicle taxation, as an ideal to be aimed at as soon as circumstances permit. The proposal was actually under consideration in Madras before our visit.

16. We further found a body of opinion which favoured the imposition of a petrol excise to take the place of all other taxation on motor vehicles, a proportion of this to compensate local Governments, and local authorities for loss of their motor vehicle taxation. Undoubtedly, such taxation has very great advantages:

- (i) It would cost no more to collect than the present petrol excise.
- (ii) It would be impossible of evasion at least until an alternative motor fuel is available.
- (iii) It would be equitable as proportioning tax paid to the use made of the roads.
- (iv) It would be indirect and not perhaps felt so much as a lump annual motor vehicle tax.

In theory we would endorse it, and with this most of those we met cordially agree.

17. In practice, however, difficulties would arise, *e.g.*, the rate of excise would have to be a flat one throughout all India, as the petrol excise is collected at source in Burma, and this rate would have to be calculated so as to compensate the province with the highest rate of motor vehicle taxation, either provincial or local, for its loss by abolition of such taxation. This would involve in the case of Madras an extra 6 annas excise on petrol, and this rate would probably be higher than other provinces would desire.

Further, an immediate increase of 8 annas per gallon (2 annas for Central Road Fund ; 6 annas for provincial tax) in the price of petrol would undoubtedly be resented by the public even if relieved of other taxation. Also, it is probable that some provinces may wish to retain power to tax motor vehicles on particular lines, *e.g.*, to tax motor buses lightly as being of public service, or to tax them heavily as destroying the roads. We therefore cannot *at present* recommend a unified system of motor vehicle taxation through petrol alone.

18. We have, however, been sufficiently impressed with the great advantages of such a tax to consider seriously the following suggestion made to us, that, in addition to the 2 annas increase in the petrol excise which we have proposed for a Central Fund, a further 2 annas should be added to the excise and distributed solely on the basis of the proportionate consumption of petrol among the provinces, as a form of provincial motor vehicle taxation. What use the provinces should make of any revenue so received would, of course, be a matter for consideration by provincial Governments. In Madras we were informed that it would probably be utilised to reduce the local and municipal taxation on motor vehicles. In some provinces it might suffice to abolish entirely such local taxation and, after providing compensation to local authorities for such abolition, leave a surplus to the local Government. In other provinces where local taxation is light, or justified by local circumstances, it might be utilised for general road purposes. But, in view of the opinions given to us, the

Committee might consider the suggestion to Local Governments that a proposed introduction of a provincial 2 annas petrol excise should have, as its object, the taxation of those motor vehicles which at present escape local taxation entirely or which are inadequately taxed, and that it should not be used to increase the burden on those motor vehicles which pay already adequate taxation. The local taxation of this last might be adjusted so that after the introduction of the proposed 2 annas provincial excise, they should not have to pay in all more than they are now paying.

We do not, of course, suggest that provinces should be compelled to adopt such taxation, but the scheme appears to us to provide a very satisfactory form of provincial motor vehicle taxation, while preserving the local Governments' right either to impose further provincial taxation where desirable or to leave with local bodies the power of motor vehicle taxation for the present. We would suggest, however, that if local Governments leave to local authorities this power, it should be only up to maxima fixed on the conditions of each local authority, and with the proviso that all the proceeds of such taxation should be devoted to roads. Further, as it is so generally admitted that provincial motor vehicle taxation is preferable to local, no further extension of powers to tax motor vehicles should be made to local authorities and that when and if finances permit, local motor vehicle taxation should be entirely abolished and local authorities compensated.

For the present, we admit that varying rates of local motor vehicle taxation may be justified as it is not unreasonable that a car using the good roads in large cities should pay more than one running on bad roads upcountry.

19. We note that any form of taxation by petrol excise will not affect the motor vehicle propelled by steam or electricity. We therefore propose that if the suggestion of either a Central Fund or additional provincial taxation from petrol be adopted, equivalent taxation should be imposed on such motor vehicles as do not use petrol. The number of these will not, as far as we know, be very great and, for simplicity, we suggest that any such countervailing taxation should be provincial and imposed by the provinces and should be sufficient to give such vehicles no advantage over petrol-driven vehicles.

We have not discussed the exact form such taxation should take, but we may in passing suggest that one of the functions of the Central Road Board might well be the co-ordination of statistical and other information regarding motor vehicle taxation in order to attain, as far as possible, uniformity among the provinces, whom it could advise on such questions.

20. As regards road users other than motor vehicles, it was suggested to us that bullock carts do considerable damage to roads, and that all such vehicles, including horse-drawn vehicles, should pay a small annual tax to local authorities, such as District Boards. (In many municipalities they already pay a wheel tax.)

It was pointed out to us, however, that, where tolls exist, bullock carts, etc., contribute to road upkeep. But where tolls are not in force, we agree an annual tax on such vehicles appears fair—possibly with a heavier scale for hired carts than for the cultivator, or even with exemption for the cultivator or for those who contribute to local cess. Owing to the varied systems of land tenure in India, the details of course would have to be left to local Governments, and possibly public opinion is not yet ready for such a tax. We suggest however that the Committee might recommend

such taxation, as we found far more opinion in support of it than we expected.

It was also suggested to us that the narrow iron tyres normally fitted to the bullock cart, and the excessive load per square inch thereby imposed on the surface of the road, were responsible for much of the damage done, and that, therefore, endeavour should be made to enforce a wider width of tyre which should do less damage. It was suggested that tax on bullock carts should differentiate between carts with tyres of a certain minimum width which should escape more lightly than those of the ordinary type. The suggestion is commendable, and we are of opinion that it might be possible to enforce it in municipal areas. But we have doubts whether in the bulk of the country-side such taxation could be either enforced or collected without considerable harassment to the cultivator.

21. We had various other suggestions made to us as to raising additional funds for roads, and of these the following were the most important:—

Tolls.—The general opinion (with which we strongly agree) is that they are undesirable on roads but justifiable on bridges, to go towards the cost of construction. We see no objection to a toll on a new bridge which replaces a ferry, but we suggest that road tolls are a hindrance to transport of every kind and should be abolished as soon as funds allow.

Another suggestion made to us was that provincial Governments or local authorities should be empowered to grant monopoly licences for motor transport, both of passengers and goods, on specified routes under strict conditions of service, etc. On the Pandu Ghat-Shillong road such a monopoly has been granted and brings a revenue of about Rs. 2 lakhs a year. But we received complaints of the high rates charged, and economically such monopolies are generally considered unsound.

It was however urged that such monopolies would produce efficient services, which are impossible under the present cut-throat competition, and that the proceeds of such monopolies would afford great assistance towards road work. We were informed in the Central Provinces that offers had been received by District Boards whereby a private company would construct a road in return for a 5 years' monopoly.

We do not like the idea of monopoly, but admit the method may be justifiable under certain conditions and needs further exploration.

22. It was also suggested to us that local authorities responsible for upkeep of roads should be empowered to issue licences for the plying of public vehicles for hire. Provided the proceeds be spent on roads, this appears justifiable, and it is, we believe, the practice in most countries that the proceeds of such licences go to the local authorities. In the absence of any suitable technical staff with local authorities, it would be necessary however for the Police to retain control over the grant of licences and the running of vehicles, to prevent danger to the public from unsuitable or unsafe motor buses, etc. Provincial Governments should however be able to elaborate a scheme to enable local authorities to draw revenue from such services with due regard to the public safety.

23. It was also suggested to us that District Boards should be allowed to levy a terminal tax on goods imported or exported into the Board's jurisdiction by rail or steamer, in order to raise money for roads. This

appears to us to be a matter of general local taxation and we doubt whether such could be justifiably or successfully earmarked for roads.

This also applies to a suggested surcharge on income tax.

24. It was also suggested to us that Railway Companies should be compelled, or at least permitted, to contribute to the cost of building or maintaining feeder roads which bring traffic to their stations. *Prima facie*, considering the condition of many feeder roads to railway stations in this country, we are of opinion that the suggestion seems reasonable, and we recommend that the Committee might discuss the matter with the representatives of the Railway Board in Delhi.

We have not in our tour considered the question of roads in territories administered by the Government of India or what contribution, if any, the Army Department ought to make towards the cost of roads which are either entirely or partially of strategic value. Such do not appear to fall within the purview of the Sub-Committee.

25. For the purpose of supplementing provincial finances for roads (apart from the contribution from a Central Road Fund as set out in Part II of this Report), we suggest—

- (a) Provincial motor vehicle taxation in the shape of a further 2 annas excise on petrol collected centrally and distributed on the consumption basis to the provinces.
- (b) Provincial motor vehicle taxation to take the place of local motor vehicle taxation and road tolls on motor vehicle, where the 2 annas petrol excise referred to in (a) above may not provide sufficient revenue.
- (c) Further local taxation, which we consider might include
 - (i) taxation of all vehicles other than motor vehicle;
 - (ii) tolls on bridges;
 - (iii) proceeds of licence fees for public service motor vehicles; and
 - (iv) in exceptional cases, grant of monopoly transport concessions.

PART IV.

26. We have not considered at length what should be the composition of the Central Advisory Road Board as that must depend upon the work allotted to it. But as considerable interest was shown in what was likely to be its composition, we have been unable to avoid making reference to the point. But a fairly general suggestion appeared to be that it should consist of :—

- (i) representatives of the Legislature,
- (ii) representatives of the Departments of the Government of India concerned, including the Army Department,
- (iii) a representative of the Railway Board,
- (iv) the Consulting Engineer to the Government of India, and
- (v) a whole-time Road Expert with a permanent Secretary possessing technical knowledge.

It was suggested to us by some that the Central Road Board should be a step in the direction of an eventual Ministry of Transport with large executive powers. We are not in a position to give a definite recommendation on this matter but leave the suggestions for the consideration of the Committee.

PART V.

27. To summarise, we are of opinion, from the information so far received, that the development of the Indian road system can be best attained by the following methods :—

- (i) the formation of an Advisory Central Road Board, and of Road or Communications Boards in each province;
- (ii) some uniform classification of roads on some such lines as all-India roads, provincial roads, district roads and village roads;
- (iii) the formation of a Central Road Fund, which shall primarily contribute to the improvement of all-India roads, and thereby release some provincial funds for other roads;
- (iv) the more important inter-district roads should be provincialised and the remainder, *e.g.*, feeder roads, be classed as district roads and be left to District Boards and Councils;
- (v) further funds for road development should be raised
 - (1) by an additional petrol excise of 2 annas for a Central Road Fund;
 - (2) by a further additional petrol excise of 2 annas for provincial purposes;
 - (3) by provincial motor vehicle taxation involving the abolition of local motor vehicle taxation; and
 - (4) by additional local taxation as suggested,
 with the provisos that—
 - (a) general revenues can be reasonably expected to contribute to roads, and any fresh funds now raised should be spent in addition to the amount already spent on roads,
 - (b) the Central Government should at the first possible opportunity devote at least part of the present four annas petrol excise as additional funds for road development;
- (vi) as the great need of many Indian roads is bridges and re-construction on modern lines, bridging and such re-construction as can be properly considered capital expenditure, should be undertaken from loan funds as early as possible;
- (vii) for this purpose, a statutory Road Fund should be initiated to provide a source to meet interest and sinking fund charges on loans;
- (viii) as the great majority of roads in India are unmetalled, the most urgent object for research is into improved methods of *kachha* road making.

We suggest therefore to the Committee that consideration might be taken of these views in examining the problems presented by the terms of reference.

28. In conclusion, we desire to place on record our appreciation of the help we have received from the local Governments in discussing with the Sub-Committee matters of considerable intricacy at very short notice. We also wish to place on record our appreciation of the time freely given

and of the trouble taken by various public bodies, non-official associations and many private individuals, who appeared before the Sub-Committee and gave us the benefit of their many and interesting views on this important subject.

We are greatly indebted to our Secretary, Mr. H. F. Knight, and to Mr. K. G. Mitchell, our Technical Adviser, for their invaluable help to us on our tour. Under considerable pressure of work, owing to the short time allotted to us in which to tour the provinces, they have displayed the greatest keenness in assisting us in every respect.

We think that this Report indicates the general trend of opinion throughout India so far as we were able to ascertain it.

A. H. FROOM, *Chairman.*

M. SUHRAWARDY.

GANGANAND SINHA.

BOMBAY,

Dated the 23rd December 1927.

SUPPLEMENTARY REPORT ON THE PUNJAB.

The Sub-Committee arrived at Lahore on the morning of January 9th, 1928 and stayed there till the night of January 12th. Kumar Ganganand Sinha had notified that he would be unable to join the Sub-Committee, and did not accompany us to Lahore. On the 9th, the Punjab Government had arranged for the Sub-Committee to view various classes of roads in the vicinity of Lahore and a tour of over a hundred miles was made by road. In the Punjab, roads have been reclassified into "arterial roads", "main roads" and "other roads". Arterial roads are maintained by Government through the agency of the Public Works Department. Main roads are maintained by District Boards with grants from Government of varying percentages calculated on the circumstances of the individual Boards. Other roads comprise the less important district roads and are maintained entirely from District Board Funds. The Sub-Committee traversed sections of all these roads and also of the canal inspection roads which are not open to heavy traffic. From Lahore to Amritsar was an example of—

- (a) how motor passenger traffic can compete with a parallel line of railway. We were informed that the railway passenger traffic between Amritsar and Lahore has fallen by about 50 per cent. in the last year or so owing to the competition of motor bus service;
- (b) the destructive effect of motor bus traffic on road surface.

The Sub-Committee also traversed a line of road recently reclassified as arterial and now under construction as a metalled road with various experimental surfaces. This suggested the necessity of further research into road construction in India. The fact that motor bus services sprang up as the road bed was constructed, and even before it was metalled, is another proof of the tremendous demand for passenger transportation in India and of its value to the agriculturist.

2. The Sub-Committee discussed development of roads with the following officials and non-officials—

The Hon'ble Sardar JOGENDRA SINGH, Minister for Agriculture, Government of the Punjab,

Mr. H. W. EMERSON, C.I.E., C.B.E., I.C.S., Chief Secretary to the Government of the Punjab,

Mr. A. R. ASTBURY, C.I.E., I.S.E., Chief Engineer and Secretary to the Government of the Punjab, P. W. Department (Buildings and Roads Branch),

Mr. S. G. STUBBS, O.B.E., I.S.E., Secretary, Communications Board, Punjab

PIR SAYAD MOHAMMED HUSSAIN, M.L.C.,

The Hon'ble Rai Bahadur LALA RAMSARAN DAS, C.I.E., representing the Punjab Chamber of Commerce,

Mr. R. E. GRANT GOVAN, representing the Punjab Chamber of Commerce,

Mr. OWEN ROBERTS, representing the Northern India Automobile Association and Northern India Chamber of Commerce,

Mr. D. J. HORN, representing the Northern India Chamber of Commerce, and in these discussions had the assistance of the following members of the Road Development Committee—

- (1) Raja GHAZANFAR ALI KHAN, M.L.A.,
- (2) The Hon'ble Sardar SHIVDEV SINGH UBEROI, and
- (3) Diwan CHAMAN LAL, M.L.A.

Mr. W. S. DORMAN, Deputy Chief Engineer, Punjab, was present throughout.

3. Speaking generally, the Sub-Committee's conclusions as given in their Report on their tour in the other provinces of India were confirmed or otherwise as below :

The conclusions summarised in Part II of the Report :—

- (i) We found in the Punjab some doubt at first as to the utility of a Central Road Board. It was feared that it would obtain executive powers and encroach upon provincial autonomy. But it was generally agreed that it would be of use in an advisory capacity for co-ordination and for research and especially as a means of keeping public opinion in touch with the necessity for road development in India.
- (ii) The imposition of an extra two annas excise on petrol to form a central fund was objected to in certain quarters on the ground that petrol is already very expensive in the Punjab, owing to the high cost of freight from the ports and the selling charges of the oil companies. And it was urged that though petrol is produced in the Attock district of the Punjab, yet its price is kept up to the level of that of imported petrol. It was further urged that the Punjab motorist pays heavily in the freight demanded to bring his car up from the port and also in the Punjab provincial taxation. We think however that the imposition of a two annas petrol excise for a central fund would not excite such great opposition as to need the abandonment of the proposal made to us and accepted by all the other provinces.
- (iii) The Punjab Government while prepared to consider other factors for division of the proceeds of such a central fund would urge most strongly that the principle of division should be based on the willingness of a province to help itself in road development by imposing provincial taxation and by spending a reasonable proportion of its revenues on roads ; and it was urged particularly that one of the factors must be the ratio of road expenditure to revenue.
- (iv) That the proceeds should be spent primarily on roads of all-India or inter-Provincial importance was not taken exception to.
- (v) That such expenditure must be additional to, and not in place of, the normal provincial expenditure on roads was emphasised very strongly.
- (vi) The Punjab Government expressed considerable misgivings as to the policy of financing road development from loans inasmuch

as it involves meeting not only the interest and sinking fund charges over a period of years, but the maintenance charges as well, which might develop into a serious burden unless provided beforehand. It was agreed however that bridges might be constructed out of loans. (We consider what work should be constructed out of loans to be a matter which might safely be left to the provincial Government's own discretion.)

(vii) Some doubt was expressed as to the possibility of constituting a permanent Road Fund.

4. *Paragraph 25 of the Report* :—

- (a) There is already fairly heavy provincial motor taxation in force in the Punjab and we did not get any clear indication as to whether the public would favour the imposition of a provincial two annas petrol excise as a substitute for all or part of this. The matter was left to be further considered by those whom we met.
- (b) There are apparently only two road tolls in the province apart from tolls on boat bridges and ferries. The difficulties felt, for example in Madras, as regards local motor vehicle taxation and road tolls do not appear to exist here.
- (c) (i) Taxation of vehicles other than motor cars—Opposition was expressed to the idea of taxing bullock carts.
 - (ii) Tolls on bridges were not objected to.
 - (iii) Proceeds of licence fees for public service motor vehicles—We had no opportunity of discussing this in detail.
 - (iv) Monopoly transport licences—Generally speaking, opposition was expressed to any attempt to restrict motor services in such manner though it was admitted that on one hill road strict control of motor vehicles was in force and imperative.

5. It appeared to us that the most striking feature of our visit to the Punjab was the active interest shown in the province in road development and the benefits which obviously follow in its train. It was urged upon us by all that development of roads was of primary importance to the agriculturist. We were told that where he had access to a good road, he was able to take his produce to a market town and get proper market rates for his produce, which he had formerly to sell at below market rates in his own village to the bania.

6. Again the convenience of travelling by motor bus as compared with travel by rail was stressed and we admit that unpleasant though such competition might be to the Railway Companies, it is in certain areas forming a very useful incentive for the improvement in accommodation for third class passengers and, as it was expressed to us, in the civility with which such passengers are treated by railway employees.

7. We understand that in the Lahore district it costs Rs. 3 to cart 100 c. ft. of road-metal for the first mile of a metalled road and Rs. 4 on an unmetalled road, and for the succeeding miles the rates are Rs. 1-8-0 and Rs. 2 respectively. 100 c. ft. of metal requires about four carts. It might therefore be argued that a metalled road probably saves the cultivator two annas a mile on every trip his cart makes. If account were taken of the

enormous mileage covered by cultivators' carts in moving crops to market, the financial saving to the country by a developed system of roads might perhaps be dimly guessed at.

8. A further point which struck us in the Punjab was the foresight with which the road programme is being planned and the rapidity with which it is being pushed on and it is an example which needs to be followed elsewhere in that the programme is mapped for years ahead and the future maintenance cost of the roads is kept in view all the time. At present the cost of maintaining roads in the Punjab is increasing at the rate of Rs. 10 lakhs a year and should future conditions so demand, the rate of progress would be adjusted according to the money available for maintenance.

9. In conclusion, we would thank the Punjab Government for our very interesting visit to the province and for the information supplied to us. We would also thank those gentlemen, official and non-official, who met us and discussed with us road development.

A. H. FROOM, *Chairman.*

M. SUHRAWARDY.

NEW DELHI,

Dated the 13th January 1928.

APPENDIX III.

Statistical Statements.*

* Statements A to K have been compiled from the answers to the questionnaire given by local Governments and Administrations. In certain instances the figures have been amplified and modified as the result of subsequent correspondence.

STATEMENT A.

Road mileage according to classes and types in 1926-27.

Province.	Provincial.			Local.			Both classes.			Percentage of Provincial to both classes.	Percentage of surfaced to total mileage.	Remarks.
	Surfaced.	Unsurfaced.	Total.	Surfaced.	Unsurfaced.	Total.	Surfaced.	Unsurfaced.	Total.			
	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.			
Madras	3,590	530	4,120	17,850	2,760	20,610	21,440	3,290	24,730	16.6	87.0	
Bombay Presidency	5,940	760	6,700	2,790	8,180	10,970	8,730	8,940	17,670	37.7	47.4	
Sind	60	1,520	1,580	40	10,830	10,870	100	12,350	12,450	14.5	0.8	
Bombay and Sind	6,000	2,280	8,280	2,830	19,010	21,840	8,830	21,290	30,120	27.4	29.3	
Bengal	890	570	1,460	2,510	15,450	17,960	3,400	16,020	19,420	7.5	17.5	
United Provinces	3,170	700	3,870	4,540	26,970	31,510	7,710	27,670	35,380	10.9	21.8	
Punjab	1,870	920	2,790	1,130	19,020	20,150	3,000	19,940	22,940	11.8	12.7	
Burma	2,720	7,210	9,930	480	1,700	2,180	3,200	8,910	12,110	81.8	26.4	
Bihar and Orissa	1,340	240	1,580	2,410	25,340	27,750	3,750	25,580	29,330	5.4	12.8	
Central Provinces	4,370	2,500	6,870	300	1,270	1,570	4,670	3,770	8,440	81.4	55.4	
Assam	400	3,270	3,670	160	5,540	5,700	560	8,810	9,370	37.2	6.0	
Minor Provinces and Administrations.	2,500	2,700	5,200	50	2,050	2,100	2,550	4,750	7,300	..	..	See Statement A-1.
Total	26,850	20,920	47,770	32,260	119,110	151,370	59,110	140,030	199,140	23.8	29.6	

30

Notes on Statement A.

Madras.—3,040 miles of surfaced roads in charge of district boards are here classed as "Provincial". These are trunk roads for which Government assumed financial responsibility in 1920-21. At present however the contribution from provincial revenues is at a flat rate of Rs. 500 per mile per year for maintenance whereas the average actual cost is Rs. 575 per mile per year. Including works of construction, the share of the cost of these roads borne by provincial revenues was, in 1926-27, 75 per cent.

Bengal.—From the Administration Report of the Public Works Department, Buildings and Roads Branch, for the year 1925-26 the total mileage of unmetalled roads is stated to be 34,270. The figures furnished in the reply to the questionnaire are less by some 18,250 miles. This difference is understood to represent roads maintained by union and village boards, complete information regarding which is not readily available.

Burma.—The reply to question A-I (*vis*) of the questionnaire gave the length of metalled roads in 1926-27 as 1,890 miles "Provincial", 330 miles "Local" or 2,220 miles in all. Subsequently the total figure was corrected to 3,200 miles but the classification of the revised figure was not stated. As time did not allow a further reference to the Government of Burma, the new figure has been split up in the same proportion as the old, while the total mileage of both types has been left as first stated.

Bihar and Orissa.—Under "Provincial" are included 67 miles surfaced and 45 miles unsurfaced maintained by the Public Works Department in Feudatory States.

Assam.—The figures given *exclude* 5 miles surfaced and 370 miles unsurfaced of "Central Civil" roads; and also 10 miles surfaced of "Imperial Military" roads.

STATEMENT A-1.

Road mileage according to classes and types in 1926-27.—Minor Provinces and Administrations.

Province.	Provincial.			Local.			Both classes.		
	Surfaced.	Un-surfaced.	Total.	Surfaced.	Un-surfaced.	Total.	Surfaced.	Un-surfaced.	Total.
	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.
North-West Frontier Province ..	1,000	1,600	2,600	23	1,861	1,884	1,023	3,461	4,484
Delhi	140	Not stated.	140	Not stated.	..	..	140	..	140
Baluchistan	(a) 190	(b) 1,070	1,260	..	..	..	190	1,070	1,260
Coorg	250	60	310	..	70	70	250	130	380
Ajmer-Merwara	270	10	280	30	110	140	300	120	420
Central India Agency	(c) 640	..	640	..	..	..	640	..	640
Total ..	2,490	2,740	5,230	53	2,041	2,094	2,543	4,781	7,324
Or, approximately ..	2,500	2,700	5,200	50	2,050	2,100	2,550	4,750	7,300

Notes on Statement A-1.

- (a) 93 miles "Central Civil". 97 miles "Military".
- (b) 924 miles "Central Civil". 143 miles "Military".
- (c) Includes roads maintained in States from Central Civil funds.

The figures regarding Government roads in the North-West Frontier Province have been compiled from the P. W. D. (Buildings and Roads) Administration Report for 1925-26, as the reply to the questionnaire dealt with district board roads only. Military and civil roads are included. The total figures are 1,098 miles metalled and 1,647 miles unmetalled, but these include certain station roads; excluding the latter the round figures given in this statement are a close approximation.

Figures for Delhi Province have been supplied with respect to "Provincial" metalled roads only.

It will be seen that the information available is incomplete. The figures may be taken as being reasonably correct with respect to surfaced roads; they are manifestly incomplete with respect to unsurfaced roads.

STATEMENT B.

Area, population and density of population.

Province.	Area (thousands of square miles).				Percent- age of area cultivat- ed.	Population (millions).			Density of popu- lation. Number of per- sons per square mile..	Remarks.
	Cultivat- ed.	Unculti- vated.	Forest.	Total.		Rural.	Urban.	Total.		
Madras	68.7	53.8	20.5	143.0	48	37.04	5.28	42.32	296	<i>Sub-division of area is only approximate.</i>
Bombay Presidency ..	52.3	10.8	13.9	77.0	68	12.02	3.98	16.00	208	
Sind	14.5	31.5	0.5	46.5	31	2.70	0.60	3.30	71	<i>Ditto.</i>
Bombay and Sind ..	66.8	42.3	14.4	123.5	54	14.72	4.58	19.30	156	<i>Ditto.</i>
Bengal	44.5	25.2	7.2	76.9	58	43.50	3.20	46.70	608	
United Provinces ..	53.6	38.2	14.5	106.3	50	40.57	4.81	45.38	428	<i>Ditto.</i>
Punjab	50.0	44.9	5.0	99.9	50	18.10	2.60	20.70	207	
Burma	33.3	178.4	31.5	243.2	14	11.23	1.98	13.21	54	<i>Excluding Feudatory States.</i>
Bihar and Orissa ..	47.9	23.5	11.8	83.2	58	32.63	1.37	34.00	410	
Central Provinces ..	42.8	30.5	25.6	98.9	43	12.52	1.39	13.91	141	<i>Sub-division of area is only approximate.</i>
Assam	15.0	39.5	7.0	61.5	24	7.73	0.26	7.99	130	
Total	422.6	476.3	137.5	1,036.4	41	218.04	25.47	243.51	235	

STATEMENT C.

Distribution of road mileage according to area and population.

Province.	Mileage per 100 square miles of total area.			Mileage per 100 square miles of cultivated area.			Mileage per 100,000 of population.		
	Surfaced.	Unsurfaced.	Total.	Surfaced.	Unsurfaced.	Total.	Surfaced.	Unsurfaced.	Total.
	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.
Madras	14.15	5.68	19.83	31.25	4.75	36.00	47.90	19.10	67.00
Bombay Presidency ..	11.10	10.74	21.84	16.65	17.05	33.70	53.46	51.73	105.19
Sind	0.22	26.86	27.08	0.70	85.30	86.00	3.09	396.76	399.85
Bombay and Sind ..	7.01	16.81	23.82	13.15	31.90	45.05	44.84	107.61	152.45
Bengal	4.40	20.90	25.30	7.60	36.10	43.70	7.30	34.30	41.60
United Provinces ..	7.30	26.30	33.60	14.30	51.80	66.10	17.00	61.00	78.00
Punjab	3.00	20.00	23.00	6.00	40.00	46.00	14.00	96.10	110.10
Burma	0.92	3.61	4.53	9.60	26.70	36.30	24.20	67.45	91.65
Bihar and Orissa ..	4.40	30.70	35.10	7.85	53.55	61.40	10.80	75.00	85.80
Central Provinces ..	4.68	3.80	8.48	10.90	8.60	19.50	32.60	27.10	60.70
Assam	0.92	14.94	15.86	3.75	58.60	62.35	7.07	171.99	122.06
Total	5.45	13.05	18.50	13.30	32.10	45.40	23.20	55.70	78.90

STATEMENT D.

Expenditure on roads in 1926-27.

Note.—Grants from provincial revenues to local bodies for expenditure on roads are shown as provincial expenditure.

Province.	Provincial.				Local.				Total expenditure from revenue.			Total expenditure including capital.	
	Construction.		Maintenance.	Total.	Construction.		Maintenance.	Total.	Construction.	Maintenance.	Total.		
	Capital.	Revenue.			Capital.	Revenue.							
					Rs. (thousands).								
Madras	7,91	33,47	41,38	2,82	14,96	50,38	68,16	22,87	83,85	1,06,72	1,09,54	
Bombay Presidency	5,09	17,35	43,50	65,94	..	2,25	7,63	9,88	19,80	51,13	70,73	75,82
Sind	2,33	5,96	8,34	..	1,42	6	1,48	3,80	6,02	9,82	9,82	
Bombay and Sind	5,09	19,73	49,46	74,28	..	3,67	7,69	11,36	23,40	57,15	80,55	85,64
Bengal	7,54	22,13	29,67	..	10,84	25,68	36,52	18,38	47,81	66,19	66,19	
United Provinces	25,83	7,14	33,58	66,55	..	6,95	25,42	32,37	14,09	59,00	73,09	98,92
Punjab	28,05	28,09	43,51	99,65	..	7,81	16,65	24,46	35,90	60,16	96,06	1,24,11
Burma	61,60	49,95	1,11,55	..	..	17,38	17,38	61,60	67,33	1,28,93	1,28,93	
Bihar and Orissa	4,90	12,74	17,64	..	11,34	24,13	35,47	16,24	36,87	53,11	53,11	
Central Provinces	20,14	34,66	54,80	..	1,75	2,62	4,37	21,89	37,28	59,17	59,17	
Assam	2,78	17,00	19,78	..	3,98	6,32	10,30	6,76	23,32	30,08	30,08	
Minor Provinces and Administrations	7,60	40,44	48,04	..	6	1,01	1,07	7,66	41,45	49,11	49,11	
Total	58,97	1,67,43	3,36,94	5,63,34	2,82	61,36	1,77,28	2,41,46	2,28,79	5,14,22	7,43,01	8,04,80

Notes on Statement D.

Bombay and Sind.—Grants-in-aid of Rs. 14·16 lakhs in Bombay Presidency, Rs. 4·84 lakhs in Sind, or Rs. 19·00 lakhs in all, were paid to local bodies from provincial revenues, but information is not available as to the distribution of the expenditure of these grants between construction and maintenance. The amounts have been adjusted in this statement by inclusion under "Provincial" and deduction from "Local" in the proportion of the other expenditure distributed between these heads by the Bombay Government.

United Provinces.—The figure of expenditure on construction from provincial revenues includes Rs. 3·4 lakhs interest charges.

Bihar and Orissa.—The expenditure from local funds given in the reply to the questionnaire has since been ascertained to include Rs. 6·03 lakhs grants-in-aid from provincial revenues. This sum has now been included under "Provincial" and excluded from "Local", the adjustment between construction and maintenance having been made proportionately to the figures first reported.

STATEMENT D-1:

Expenditure on roads in 1926-27.—Minor Provinces and Administrations.

NOTE.—No expenditure from capital is reported.

Province.	Provincial.			Local.			Total.		
	Con- struction.	Mainten- ance.	Total.	Con- struction.	Mainten- ance.	Total.	Con- struction.	Mainten- ance.	Total.
North-West Frontier Province ..	6,21	25,76	31,97	2	53	55	6,23	26,29	32,52
Delhi	49	1,88	2,37	Not stated.		..	49	1,88	2,37
Baluchistan	(a) 18	(b) 6,13	6,31	..	..	..	18	6,13	6,31
Coorg .. .. .	..	1,51	1,51	..	10	10	..	1,61	(c) 1,61
Ajmer-Merwara	37	2,12	2,49	4	38	42	41	2,50	2,91
Central India Agency	35	3,04	3,39	..	..	..	35	3,04	(d) 3,39
Total ..	7,60	40,44	48,04	6	1,01	1,07	7,66	41,45	49,11

Notes on Statement D-1.

- (a) "Central Civil".
- (b) Rs. 2,76,000 "Military". Rs. 3,37,000 "Central Civil".
- (c) Figures for construction and maintenance not separated in reply to questionnaire. Expenditure all presumed to be on maintenance.
- (d) "Central Civil".
- (e) Civil expenditure only. Military expenditure not stated.

Delhi.—See note on Statement A-1. No figures have been supplied of expenditure on (a) provincial unmetalled roads and (b) district board roads.

STATEMENT E.

Percentages of provincial, local and total revenues spent on roads, and incidence of road expenditure per head of population.

NOTE.—The expenditure taken is that of 1926-27, the revenue taken is the average of the years 1924-25, 1925-26 and 1926-27.

Province.	Percentage of revenue spent on roads.			Incidence of road expenditure per head of population.		
	Provincial.	Local.	Total.	Provincial.	Local.*	Total.
	Per cent.	Per cent.	Per cent.	Annas.	Annas.	Annas.
Madras	2·5	36·2	5·8	1·6	2·8	4·0
Bombay	4·4	15·6	5·5	5·0	1·2	6·7
Bengal	2·8	35·3	5·7	1·0	1·3	2·3
United Provinces	3·2	16·7	5·0	1·4	1·3	2·6
Punjab	6·5	23·0	7·9	5·5	2·2	7·4
Burma	10·1	29·0	11·0	13·5	2·5	15·6
Bihar and Orissa	3·2	24·4	7·3	0·8	1·7	2·5
Central Provinces	8·9	6·1	8·6	6·3	0·6	6·8
Assam	7·6	61·5	10·9	4·0	2·1	6·0
Total ..	5·0	24·8	7·0	3·0	1·7	4·5

*Calculated on rural population.

STATEMENT F.

Provincial and local expenditure on roads from revenue in the year 1913-14 and in the four years 1923-24 to 1926-27.

Province.	1913-14.			1923-24.			1924-25.			1925-26.			1926-27.			Expenditure index 1926-27. 1913-14=100.		
	Provincial.	Local.	Total.	Provincial.	Local.	Total.	Provincial.	Local.	Total.	Provincial.	Local.	Total.	Provincial.	Local.	Total.	Provincial.	Local.	Total.
								Rs. (lakhs).										
Madras ..	20.0	49.7	69.7	49.1	40.4	89.5	40.1	56.9	97.0	47.6	68.1	115.7	41.4	65.3	106.7	207	131	153
Bombay ..	24.8	14.6	39.4	47.0	22.3	69.3	63.3	21.7	85.0	53.3	27.9	81.2	69.2	11.4	80.6	278	78	216
Bengal ..	11.9	34.6	46.5	27.2	36.0	63.2	27.2	36.2	63.4	36.0	35.9	71.9	49.7	36.5	66.2	248	105	142
United Provinces..	19.1	24.2	43.3	31.4	29.0	60.4	39.6	27.6	67.2	34.5	33.3	67.8	40.7	32.4	73.1	214	133	168
Punjab ..	21.2	14.8	36.0	34.0	20.2	54.2	34.3	18.7	53.0	60.7	20.0	80.7	71.6	24.5	96.1	337	165	266
Burma ..	36.6	19.6	56.2	74.7	17.3	92.0	89.7	13.0	102.7	104.8	20.9	125.7	111.5	17.4	128.9	304	89	229
Bihar and Orissa	13.4	27.3	40.7	13.0	53.3	66.3	11.5	43.6	55.1	10.7	45.4	56.1	17.6	35.5	53.1	131	130	130
Central Provinces	28.3	3.8	32.1	31.3	..	..	37.9	3.1	41.0	43.0	5.0	48.0	54.8	4.4	59.2	193	114	183
Assam ..	41.0	16.2	57.2	17.1	7.4	24.5	16.5	8.3	24.8	17.4	9.3	26.7	19.8	10.3	30.1	48	64	53
Total ..	216.3	204.8	421.1	324.8	..	..	380.1	229.1	589.2	408.0	265.8	673.8	456.3	237.7	694.0	210	116	164

STATEMENT G.

Expenditure on road construction and maintenance from revenue in the year 1913-14 and in the four years 1923-24 to 1926-27.

Province.	1913-14.			1923-24.			1924-25.			1925-26.			1926-27.			Expenditure index 1926-27. 1913-14=100.					
	Construction.	Maintenance.	Total.	Construction.	Maintenance.	Total.	Construction.	Maintenance.	Total.	Construction.	Maintenance.	Total.	Construction.	Maintenance.	Total.	Construction.	Maintenance.	Total.			
Madras ..	19.9	49.8	69.7	15.2	74.3	89.5	Rs. (lakhs).		17.4	79.6	97.0	28.0	87.7	115.7	22.9	83.8	106.7	115	167	153	
Bombay ..	19.6	19.8	39.4	22.2	47.1	69.3	37.7	47.3	85.0	29.5	51.7	81.2	23.4	57.2	80.6	119	288	210			
Bengal ..	17.7	28.8	46.5	15.2	48.0	63.2	15.7	47.7	63.4	21.9	50.0	71.9	18.4	47.8	66.2	104	166	142			
United Provinces	12.9	30.4	43.3	10.4	50.0	60.4	11.5	55.7	67.2	11.0	56.8	67.8	14.1	59.0	73.1	109	194	168			
Punjab ..	12.5	23.5	36.0	11.2	43.0	54.2	7.8	45.2	53.0	24.0	56.7	80.7	35.9	60.2	96.1	287	256	206			
Burma*	14.8	41.4	56.2	31.3	60.7	92.0	47.0	55.7	102.7	55.3	70.4	125.7	61.6	67.3	128.9	415	162	220			
Bihar and Orissa ..	21.5	19.2	40.7	32.5	33.8	66.3	23.1	32.0	55.1	25.0	31.1	56.1	16.2	36.0	53.1	75	192	130			
Central Provinces†	13.4	18.7	32.1	..	..	..	13.2	27.8	41.0	16.0	32.0	48.0	21.9	37.3	59.2	164	200	183			
Assam ..	42.1	15.1	57.2	3.0	21.5	24.5	3.6	21.2	24.8	4.7	22.0	26.7	6.8	23.3	30.1	16	154	53			
Total ..	174.4	246.7	421.1	..	..	..	177.0	412.2	589.2	215.4	458.4	673.8	221.2	472.8	694.0	127	191	164			

* All local fund expenditure assumed to be on maintenance.
Local fund expenditure for 1923-24 not available.

STATEMENT H.

Surfaced mileage in the year 1913-14 and in the four years 1923-24 to 1926-27.

Province.	1913-14.		1923-24.		1924-25.		1925-26.		1926-27.	
	Miles.	Index.	Miles.	Index.	Miles.	Index.	Miles.	Index.	Miles.	Index.
Madras	22,544	100	20,142	89	19,594	87	20,275	90	21,440	93
Bombay	6,628	100	8,584	130	8,655	131	8,720	132	8,830	133
Bengal	2,583	100	3,315	128	3,332	129	3,376	129	3,400	130
United Provinces ..	7,010	100	7,540	107	7,580	108	7,710	110	7,710	110
Punjab	2,615	100	2,650	102	2,932	112	2,945	112	3,000	115
Burma	2,300	100	2,672	116	2,890	126	2,947	128	3,200	139
Bihar and Orissa ..	2,599	100	3,528	136	3,614	139	3,697	142	3,750	144
Central Provinces ..	3,410	100	4,440	130	4,480	131	4,640	136	4,670	137
Assam	386	100	550	142	552	142	554	143	560	145
Total	50,075	100	53,421	106	53,629	107	54,864	109	56,560	113

STATEMENT J:

Present cost of annual maintenance and construction of roads in different provinces.

Province.	Maintenance.				Construction.			
	Surfaced.		Unsurfaced.		Surfaced.		Unsurfaced.	
	Provin- cial.	Local.	Provin- cial.	Local.	Provin- cial.	Local.	Provin- cial.	Local.
			Rs. per mile.					
Madras ..	950	363	66	90	..	..	..	..
Bombay ..	520	..	150	..	..	..	..	..
Bengal ..	2,250	..	370	..	10,000 to 30,000	..	..	..
United Provinces	750	420	200	20	..	..	..	..
Punjab ..	1,870	..	355	..	10,000 to 30,000	..	2,000 to 6,000	..
Burma ..	1,500 to 5,000	..	150 to 750	..	30,000 to 50,000	..	8,000 to 12,000	..
Bihar and Orissa	570		60		9,500		400	
Central Provinces	680		150		15,000 to 20,000	..	..	..
Assam ..	1,800	400 to 700	450 to 600	100	25,000	25,000	12,000 to 15,000	500 to 4,500

STATEMENT K.

Contributions from provincial revenues to local bodies for expenditure on roads in 1926-27.

Province.	For provincial or trunk roads.			For other roads.			Total.	Remarks.
	Con-struction.	Mainten-ance.	Total.	Con-struction.	Mainten-ance.	Total.		
Madras	2,40	13,10	15,50	Rs. (thousands). 2,23	14,79	17,02	32,52	Inspection by Government in case of first class or trunk roads and second class or district roads.
Bombay	1,77	88	*2,65	Separate infor- mation is not available.		19,00	21,65	* A few provincial roads in two districts are maintained by district boards at the cost of provincial revenues.
Bengal .. ..	..	..	..	..	..	..	..	Some provincial roads are maintained by district boards as a charge on provincial revenues. Figures not stated.
United Provinces .. ..	..	..	..	..	..	3,95	3,95	No supervision.
Punjab .. ..	..	..	..	7,60	7,12	14,72	14,72	Supervision of aided works and Class II road maintenance. Special staff.
Burma .. ..	..	..	..	..	..	..	..	A-I. (v) of reply to questionnaire. Grants are made from provincial revenues for district board roads, but figures not stated.
Bihar and Orissa .. ..	..	..	..	..	..	6,03	6,03	Supervision by Superintending Engineers. Not shown in state-ment of expenditure in 1926-27 in reply to questionnaire.
Central Provinces	4,07	8,22	12,29	1,00	..	1,00	13,29	Supervision by Superintending Engineers.
Assam	Details not avail- able.	..	1,76	Details not avail- able.	..	6,53	8,29	There are no district boards in Assam. Some provincial roads are maintained by local boards with annual fixed grants given by Government. In addition to these grants, non-recurring grants are also given by Government to the local boards for improvement of their roads.
Total .. ..	..	..	32,20	..	..	68,25	100,45	

For the nine provinces the total provincial expenditure on roads from revenue was in the year 1926-27, Rs. 456.33 lakhs. Twenty-two per cent of provincial road expenditure from revenues was thus spent through district boards and councils.

STATEMENT L.

Imports of motor vehicles, parts and accessories, and of tyres and tubes.

Year.	Motor cars (including taxi-cabs).			Motor cycles.			Motor omnibuses, motor vans and motor lorries.			Parts and accessories.	Rubber tyres and tubes.
	Number.	Value ex-duty.	Average value.	Number.	Value ex-duty.	Average value.	Number.	Value ex-duty.	Average value.	Value ex-duty.	Value ex-duty.
		Rs. lakhs.	Rs.		Rs. lakhs.	Rs.		Rs. lakhs.	Rs.	Rs. lakhs.	Rs. lakhs.
1913-14 ..	2,880	1.13	3,970	1,463	11	752	76	6	7,510	23	..
1919-20 ..	9,925	2.63	2,646	2,332	17	729	1,229	48	3,934	65	1.14
1920-21 ..	15,432	7.82	5,069	5,179	54	1,043	2,885	2.23	7,052	1.75	1.70
1921-22 ..	2,895	1.74	5,993	734	9	1,226	580	29	5,084	60	1.10
1922-23 ..	4,323	1.38	3,204	866	9	1,039	480	22	4,535	47	1.23
1923-24 ..	7,984	2.05	2,563	1,182	9	761	1,044	25	2,395	42	1.16
1924-25 ..	9,380	2.20	2,344	1,456	10	687	2,162	39	1,791	53	1.10
1925-26 ..	12,757	2.82	2,213	1,629	10	605	4,840*	88	1,822	68	1.65
1926-27 ..	13,197	2.94	2,229	1,803	10	581	6,343†	1.20	1,892	85	1.56
1927-28 ..	15,122	3.54	2,340	2,146	12	557	8,682‡	1.49	1,722	101	2.19

* Of these, 626, average value Rs. 2,407, were complete with bodies, and 4,214, average value Rs. 1,733, were chassis.

† Of these, 998, average value Rs. 2,360, were complete with bodies, and 5,345, average value Rs. 1,804, were chassis.

‡ Of these, 1,270, average value Rs. 2,148, were complete with bodies, and 7,412, average value Rs. 1,649, were chassis.

STATEMENT M.

Production, consumption and retail price of petrol in India.

Year.	Total production in India.	Quantity exported from India.	Quantity consumed in India.	Price per gallon* including excise (at Calcutta).
				Rs. A. P.
		Gallons (thousands).		
1913-14 ..	26,000	21,500	4,500	1 0 0
1919-20 ..	47,268	36,223	11,045	1 12 6†
1920-21 ..	33,226	18,857	14,369	1 8 6
1921-22 ..	38,642	20,156	18,486	1 14 0
1922-23 ..	37,922	19,789	18,133	1 14 0
1923-24 ..	34,045	16,672	17,373	1 11 0
1924-25 ..	43,088	22,059	21,029	{ 1 11 0 to August 1924. 1 8 0 to Decr. 1924. 1 8 6 to March 1925.
1925-26 ..	38,868	8,140	30,728	1 6 6‡
1926-27 ..	40,779	2,219	38,560	{ 1 6 6 to July 1926. 1 5 6 to Novr. 1926. 1 4 6 to March 1927.
1927-28 ..	49,683	3	49,680	{ 1 2 6 to April 1927. 1 1 6

* Bulk price is one anna per gallon less.

† Includes excise duty of annas six per gallon imposed from 16th February 1917.

‡ Excise duty reduced to annas four per gallon from 1st April 1925.

STATEMENT N.

Duty on motor vehicles etc., and on motor spirit.

Year.	Motor cars (including taxi-cabs).		Motor cycles.		Motor omnibuses, vans and lorries.		Parts and accessories.		Rubber tyres and tubes.		Motor spirit.				Total revenue.
	Import duty.	Revenue.	Import duty.	Revenue.	Import duty.	Revenue.	Import duty.*	Revenue.	Import duty. †	Revenue.	Import duty.	Revenue.	Excise duty.	Revenue.	
	Ad.val. p. c.	Rs. lakhs.	Ad.val. p. c.	Rs. lakhs.	Ad.val. p. c.	Rs. lakhs.	Ad. val. p. c.	Rs. lakhs.	Ad. val. p. c.	Rs. lakhs.	Per gallon. As. p.		Per gallon. As. p.	Rs. lakhs.	Rs. lakhs.
1913-14	5	6	5	..	5	2	5	1	5	..	1 6		..	..	9
1919-20	7½	20	7½	1	7½	4	7½	5	7½	9	7 6‡		6 0	41	80
1920-21	7½	56	7½	4	7½	17	7½	13	7½	13	7 6‡		6 0	54	157
1921-22	20	35	20	2	11	3	20 & 11	12	20 & 11	22	7 6‡	Negligible.	6 0	61	135
1922-23	30	42	30	3	15	3	30 & 15	14	30 & 15	37	8 6‡		6 0	65	164
1923-24	30	61	30	3	15	4	30 & 15	13	30 & 15	35	8 6‡		6 0	65	181
1924-25	30	66	30	3	15	6	30 & 15	16	30 & 15	33	8 6‡		6 0	79	203
1925-26	30	85	30	3	15	13	30 & 15	20	30 & 15	50	4 0		4 0	77	248
1926-27	30	88	30	3	15	18	30 & 15	25	30 & 15	41	4 0		4 0	96	271
1927-28	20	71	20	2	15	22	20 & 15	20	15	32	4 0		4 0	124	271

* The higher rates apply to parts and accessories of motor cars and motor cycles.

† The higher rates apply to pneumatic tyres and tubes.

‡ Includes 6 annas excise duty.

Note.—The import duties on lubricating oils in the above years were :—In 1913-14, 5 per cent *ad valorem*. From 1919-20 to 1925-26, 7½ per cent *ad valorem*. From 1926-27, 1s. 4p. per imperial gallon.

APPENDIX IV.

Progress made in India with improved forms of road surfaces.*

Opportunity has been taken to ascertain what has been done in recent years in different parts of India with improved forms of road surface. An enquiry addressed to all provinces has produced the following information.

MADRAS.†

With increased traffic and the introduction of motor bus and lorry services, improved forms of road surfacing became a necessity, as the ordinary water-bound macadam roads get disintegrated very soon and require constant repairs and frequent renewals. The improved forms adopted in the Madras Presidency are :—

- (1) Spraying or surface painting on water-bound macadam road with tar or bitumen.
- (2) Tar or asphalt macadam.
- (3) Tar or asphalt grouting.

Tar spraying.—Of the above, item (1), tar spraying is the one generally adopted as it is easily done. The specifications laid down for surface tarring and tar macadam are the specifications Nos. 1 and 2 of the Roads Department, Ministry of Transport, England. The minimum thickness of metal coat on which surface tarring is done is 3". After the consolidation of metal the road is usually allowed to settle under traffic for a month or so. The surface is then brushed well and tar is applied with a spraying machine. After the initial coat a second coat is applied in 12 months. Subsequent tarring is done in patches when and where there is need, and for purposes of estimate it may be taken to be required once in two years where the traffic is heavy. The cost of surface tarring on a new 3" metal (granite) coat at Madras is Rs. 8,320 per mile of 18 feet roadway as detailed below :—

	Rs.	
3" granite coat at Rs. 6 per 100 sq. ft.	..	5,702
Tarring at Rs. 2-12-0 per 100 sq. ft.	..	2,614
		8,316 or 8,320
The cost of maintenance per mile per annum		
at Rs. 2-12-2 or Rs. 1-6-0 per 100 sq. ft.	..	1,307 or 1,300
		2

Surface painting with bitumen.—Like tar spraying, bituminous surfacing is done on a new metal coat after it has been opened for traffic for some time to allow for any local settling. Bituminous surfacing has come to be adopted only recently and the substance used is spramex. The cost of this form of surface will be about the same as that of tar spraying.

* Compiled by Mr. K. G. Mitchell, Technical Adviser, from notes furnished by various road authorities.

† Note by the Chief Engineer, Public Works Department, Madras

Asphalt grouted macadam.—Where the traffic is exceptionally heavy asphalt grouted macadam (penetration system) is adopted. This consists of:—

- (a) Bottom layer (3" or 4" thick) of stones 2" to 2½" gauge dry rolled, upon which hot asphalt is uniformly applied at the rate of 1.5 to 1.75 gallons per square yard.
- (b) Intermediate layer of stones ¾" to 1" gauge dry rolled, over which a seal coat of asphalt is applied at the rate of 0.5 to 0.75 gallon per yard.
- (c) Fine chippings spread and broomed on the surface and well rolled.
- (d) In addition to the above a thin layer of sand spread over the chippings after they have been rolled in gives better results. This thin layer of sand is also rolled and any surplus removed after two weeks of traffic.

It is anticipated that under heavy traffic conditions this form of road surface will be economical in the long run. With the renewal of the seal coat say once in 3 years, the life of the asphalt grouted macadam is roughly estimated at 12 years.

BOMBAY.

PUBLIC WORKS DEPARTMENT.*

The Chief Engineer states that the asphalt work done on the Bandra-Ghodbander road, described below, has been very successful. He also states that a good deal of surface treatment has been done and is being done in Poona and elsewhere, and that experiments are being started with 'Colas', 'Mexaco' and 'Colfix' but that no results can yet be deduced from these experiments. He also draws attention to the economies effected by the Bombay Municipality by the use of improved road surfaces.

Bandra-Ghodbander Road. Section from Bandra to Andheri.

Previous history.—The Development Department was in charge of the road from 1920 to 1925. To meet the growing needs of traffic, the road was widened from 16' to 30' from Andheri to Santa Cruz and from 16' to 40' from Santa Cruz to Bandra. The surface was improved in 1921-22 by providing 8" of rubble soling and 6" of water-bound macadam. To remove the dust nuisance, tar carpeting was provided for the whole length of the road in 1923-24.

The heavy motor lorry traffic soon broke up the carpeted surface and when the Public Works Department resumed charge of the road in April 1925, the road surface was in a deplorable state and motoring on the road was very difficult and annoying, if not positively dangerous. Serious complaints were received from the public and the problem of repairing the surface was a very pressing one.

* Letter, dated July 4th, 1928, from Mr. D. R. H. Browne, Chief Engineer, Public Works Department, Buildings and Roads Branch, Government of Bombay.

It was first proposed to lay a small length of asphalt macadam in the worst portion. A length of 1,400 ft. was laid in the cold weather following the monsoon of 1925 and was found very satisfactory. The condition of the remaining section, however, had further deteriorated and remedial measures were urgently required. Mr. K. S. Framji, the late Chief Engineer, Roads and Buildings, was therefore requested to visit the road which he did in January 1926, and funds for asphaltting about 2 miles of the road were promised. The work was vigorously pushed on and by May 1926 about 11 furlongs were completed. In the meanwhile, it became apparent that it was not possible to neglect the remaining section of the road and an estimate for repairing it was submitted to Government. Funds were duly received and the whole road was completed in April 1927.

The cost of treating the whole length of $5\frac{1}{2}$ miles from Mahim causeway to Andheri is Rs. 3,45,000.

Petroleum asphalt from the Standard Oil Company has been used throughout the road, with the exception of 2 furlongs $1/1$ and $0/8$. In the former, Mexphalte and Spramex of the Asiatic Company and in the latter natural Trinidad asphalt with suitable flux oil have been used. The working rate with "Socony" and Mexphalte was Rs. 3-1-6 per square yard and that with Trinidad asphalt was Rs. 3-10-6 per square yard.

The surface treated with petroleum asphalt, "Socony" or Mexphalte shewed uniformly good results. The Trinidad asphalt surface, which was laid in February 1927, had to be partly seal-coated soon after the rains.

Central Circle, Bombay Presidency.

Note by the Superintending Engineer, Central Circle, giving a short account of the condition of roads and the progress made to date with improved forms of road surfaces in his Circle.

Most of the roads in this Circle are of long standing and were constructed to meet the traffic conditions which existed in the last century. As fast motor traffic increases and loads become heavier, they are found to be unsuitable for traffic under modern conditions and the result is that the roads deteriorate rapidly, and as the funds provided for their maintenance are insufficient to deal with the extra and more frequent repairs required, their condition is rapidly going from bad to worse. The sub grade for these roads is murum 6" to 9" thick with a coat of metal 3" to 6" thick. The metal is water-bound, the rolling being usually done with an 8 to 10 ton steam roller; though in many lengths the rolling has, owing to inadequate funds, still to be done with the old-fashioned bullock roller. In lengths that have been made or reconstructed recently the sub grade is a 9" to 12" layer of hand-packed rubble soling. The surface is a 6" coat of water-bound macadam. Here too, though the sub grade does not give trouble, the surface does, being found unsuitable to withstand modern fast moving traffic.

Need for a surface that will stand modern traffic conditions has been recognized for some time past. Comparatively little has, however, been done so far in this direction owing to the financial situation. Nearly three miles of road in and around Poona have been treated with asphalt, while the work of asphaltting the road from Ahmednagar to Ahmednagar station and that from Nasik to Nasik Road station is in progress and proposals to asphalt

roads in and around Poona and several important portions of roads in other Divisions in this Circle are under serious consideration of Government.

The asphaltting done up to date in the Poona Division has been by what can be termed '1½" penetration method'. Briefly it is as follows :--

Wet rolling over metal is done in the ordinary way and when the metal is firm and dry, a layer of sand is brushed over the same to fill the interstices between the metal thereby reducing the penetration and quantity of asphalt required. Over this asphalt is poured (9 gallons per 100 sq. ft. approximately or 9/11ths of a gallon per square yard). Sand is then spread over it and the surface again rolled. The overall cost of this per 100 sq. ft. comes to Rs. 17 nearly. This method appears to be the cheapest satisfactory process of asphalt treatment in view of the present financial stringency. For portions of roads requiring preferential treatment what is termed '3" penetration method' is proposed to be adopted. For this method, metal is rolled *dry* to admit of greater penetration and the quantity of asphalt used including that required for the seal coat is 2 gallons per square yard approximately. The overall cost of this method works out for Poona Division to Rs. 28-8-0 per 100 sq. ft. nearly.

BOMBAY IMPROVEMENT TRUST.*

The types of surfaces laid by the Improvement Trust and the areas of each type constructed with the cost thereof are tabulated below :—

Type of surface.	Area laid sq. yds.	Cost.	Average rate.	Remarks.
		Rs. (lakhs).	Rs. A.	
1. 3" sheet asphalt pavement.	2,96,000	20.85	7 0 sq. yd.	Provided for first class roads subject to heavy pneumatic and iron-wheeled traffic.
2. 2½" to 3" asphaltic concrete.	37,000	2.20	5 12 sq. yd.	Provided for second class roads subject to heavy traffic.
3. 3" asphalt penetration with a seal coat.	10,000	.35	3 8 sq. yd.	Do.
4. 1" Mexphalte pavement	1,34,000	3.26	2 8 sq. yd.	Provided for roads with medium traffic.
5. Spramex surfacing ..	60,000 roughly.	.60	1 0 sq. yd.	Provided for roads carrying light traffic and passages.

* Note by Mr. T. R. S. Kynnersley, M. Inst. C.E., Chief Engineer.

The Improvement Trust has not laid any portion with a concrete surface though concrete is adopted for the foundation.

Foundations.—The sub grade is carefully prepared and rolled with a roller of not less than 8 tons finishing with a 15 ton road roller, giving the surface a smooth, compact and uniform appearance.

For all important roads constructed during the last 5 years and treated with asphalt the foundations consist of a 6" thick layer of 1 : 3 : 6 cement concrete with diamond shaped marks in the surface for proper bond with the pavement above, and reinforced when the sub grade is poor. In case of some of the old roads which were already completed as macadam roads with 10" compact rubble packing and 6" consolidated metalling, the asphalt surface has been laid directly on the old surface.

Cost of road foundations.

	Rs.	A.	P.
(a) Cost of 6" thick cement concrete foundation	4	0	0 sq. yd.
(b) Do. with reinforcement	4	8	0 sq. yd.
(c) Cost of macadam road foundation (10" rubble packing and 6" metalling) ..	4	6	0 sq. yd.

The aggregate for cement concrete is a mixture of 1½" and 2½" blue stone metal in equal proportions. The concrete is usually machine mixed and laid on the alternate bay system.

Surface treatments.—These can be divided broadly into two groups, the first three being for heavy traffic roads and the last two for light traffic roads. And selection is made in each group according to the nature and amount of traffic; when the question of funds is the guiding factor preference would have to be given to the cheaper methods according to the money available.

Specification and brief description of construction.

The constituents of an asphaltic surface are stone chips, sand, filler and asphalt cement.

The chips are from blue stone from the Trust quarries having a granular structure, the largest size being ¾".

The sand is Juhu white sand suitably graded with stone dust to give the following ideal grading:—

	For heavy traffic.	For light traffic.
Passing 80 to 100 ..	.. 30 to 35 %	.. 20 to 25 %
40 to 50 ..	.. 40 to 45 %	.. 40 to 45 %
10 to 20 ..	.. 20 to 25 %	.. 30 to 35 %

Filler is required for making the pavement dense, and Portland cement is used for the purpose.

Asphaltic cement is natural asphalt brought to the required consistency by mixing when heated with the necessary quantity of flux oil. The amount

of pure bitumen in the Trinidad asphalt cement of the consistency used by the Trust is about 61 per cent.

Mixing and laying of the asphalt surfaces.

The materials for asphalt pavement have to be mixed in a regular asphalt plant, which has the following important parts:—(1) An engine for working the mixing plant consisting of a drying and heating drum with elevators and a mixing mill, (2) steam heating kettles and (3) boiler for providing steam for working the engine and for heating the kettles.

For fuel for the boiler, oil has been found to be excellent as the chances of over-heating of the materials with the consequent deterioration of the mixture are minimised and a constant pressure can be maintained with little manipulation and attendance.

Laying on road.—The pavements are to be laid in a uniform layer of the required thickness after cleaning the surface of all dust. The rolling has to be very carefully done with power-driven tandem rollers. A thoroughly trained staff is necessary for this work. In case of sheet asphalt, the binder course has to be followed with the surface course the same day to obtain complete adhesion and to avoid dirt, etc., being swept or blown on.

3" sheet asphalt pavement.—This is laid in two courses, the lower one being called the binder course and the upper one being called the wearing surface. The upper course which has to withstand the wear and tear of the traffic and the action of sun and rain is made dense and rich in bitumen, while the lower layer which acts as a stiffener is made of comparatively large sized materials and is not so dense and rich in bitumen.

2½" asphaltic concrete is laid in one course and is a modification of the two-course method based on utility and cost. It is midway between the two courses in consistency.

1" Mexphalte pavement is essentially an asphalt pavement, the only difference being that the bitumen employed is Mexphalte or Asphaltum which is cheaper than asphalt and contains 99% bitumen.

The details of the mixture which has given satisfactory results and is being used in every case at present are tabulated below:—

Materials per box of 600 lbs.

Description.	Ashpaltic cement.	Cement filler.	Sand.	Stone chips.	Penetration of A. C.	Per cent of bitumen.
	lbs.	lbs.	lbs.	lbs.		
Wearing surface course	122	40	438	..	25°	12.4
Binder course ..	45	Nil	120	435	25°	4.6
Asphaltic concrete ..	77	21	262	240	25°	7.8
1" Mexphalte	72	48	480	..	20° to 30° 40° to 50°	12.0

Mexphalte is generally laid on old macadam roads. Prior to laying Mexphalte the road is thoroughly swept and cleaned of all the dust and any irregularities made good by new metal well rolled. Just before laying the mixture on the surface it is painted uniformly with Spramex which is heated over-night and kept ready. The Mexphalte layer is then placed and well rolled as in the case of sheet asphalt pavement.

3" asphalt penetration with a seal coat.—This surfacing is generally provided on macadam roads but can also be provided for road with concrete foundation. The macadam roads are completed with the first layer of 4" consolidated metalling on the 10" rubble foundation and are opened to traffic and allowed to consolidate for at least a year. The surface layer 3" thick with asphalt penetration and a seal coat are then laid as below :—

All the irregularities in the old road surface are made good and the whole surface cleaned of all loose and foreign matter. Over this a 4" loose layer of 2½" metal is laid uniformly and dry rolled with a roller not less than 10 tons, so that the metal is well interlocked but not broken. All irregularities appearing during rolling are remedied simultaneously, and care is taken so that this layer is entirely free of dirt and dust. On this rolled aggregate asphalt cement of the required consistency or Mexphalte of the necessary grade which is heated to a temperature of 320° to 330° is applied uniformly at the rate of 1½ to 1¾ gallons per square yard by means of hand pouring pots with broad nozzle. The heated asphalt in the kettles has to be continuously stirred to avoid separation of the mineral matter in it, with consequent deterioration. The grouted surface when still hot is then covered up with a uniform layer of ¾" chips and the surface well rolled till the pavement is thoroughly compact and interlocked. The surface is then swept clean of all loose material and then the second or the seal coat of the bitumen at the rate of ½ to ¾ gallon is applied and the surface immediately covered with a uniform layer of grit and well rolled, after which the road can be opened to traffic. During the construction of this final layer, the road should be kept free of traffic as far as possible.

Spramex surfacing.—Spramex surfacing is similar in construction to the penetration method except that the bitumen is spramex, which instead of penetrating to 3" to 4" as in the latter case is applied just sufficient to coat the surface. The road has to be fully consolidated before spramexing is done. All the irregularities in the road surface are first made good and the surface cleaned of all dust. The first coat of Spramex is then applied at the rate of ½ to ¾ gallon per square yard and ¼" to ⅝" chips are spread over it uniformly and the surface rolled with a 10 ton roller till the chips are crushed and well interlocked in the interstices of the road bed. The excess material is then removed by means of brushes and a second coat of Spramex at the rate of 1 gallon per 6 square yards is sprayed uniformly and a layer of stone dust and sand is laid and properly rolled in.

BOMBAY PORT TRUST.*

Most of the Bombay Port Trust roads are made of water-bound macadam, a form of construction unsuitable for modern traffic and possessing the additional disadvantages of being dusty and requiring continual watering in the dry weather.

* Note by the Chief Engineer.

Experiments are being made with bituminous surfaces in an endeavour to find a reasonably economical road surface which will stand up to the extremely heavy wear to which all roads in the vicinity of docks are subjected but the experiments have not so far covered a long enough period to enable any definite conclusions to be reached.

The first departure from the practice of the use of either water-bound macadam or setts was in the construction of Manson Road.

As an experiment a portion of this road, about 400 feet long by 45 feet wide, was laid with reinforced concrete in 1923. The concrete foundation was made 6" to 7" thick and of 4 : 2 : 1 mix, the wearing surface was 2" thick and of 1½ : 1 : 1 mix. The aggregate for the foundation was blue stone trap and gravel and that for the surface crushed granite. 'Ironite' was incorporated in a portion of the granolithic surface. The reinforcement was at the bottom of the slab and consisted of ¼" diameter rods spaced at 6" centres transversely and at 12" centres longitudinally.

Work was started in January 1923 and the road was opened for traffic on April 13th, 1923. A census taken shortly after opening showed between 7 A.M. and 6 P.M. in one day 4,918 loaded bullock carts, 703 unloaded bullock carts, 11 loaded lorries and 13 unloaded lorries. The road has been in use now for nearly 5 years and the surface is in very fair condition. The weakest point is at the joints between the slabs. Wear at the joints was noticed not long after the opening of the road but it has not developed as seriously as was then feared would be the case. The expenditure on repairs has been negligible and watering has been dispensed with. After completion the surface was covered with tar and chips, but this soon wore off. A further small length of concrete road was subsequently constructed and opened for traffic on 12th March 1925. The specification was as for Manson Road with the following exceptions: the foundation was 8" thick, blue trap sett stones curved on top and projecting slightly above the road were put in at the joints and the surface was treated with silicate of soda instead of with tar and chips. The transverse rows of blue stone setts can be distinguished. Some of these setts have become worn-down or broken and may have to be replaced in the near future; the surface of the road is in excellent condition and nothing has been spent on repairs or watering. Owing to this road being very narrow the traffic on it is heavy and it was found impossible to keep it properly repaired as a water-bound macadam road.

The cost of this road worked out at Rs. 160 per 100 square feet of which Rs. 10-5-0 were for excavating and preparing the foundations. Owing to the difficulty of obtaining granite in Bombay some quays have been concreted with a surface containing an aggregate of blue stone trap. This appears to be wearing well and if used on concrete roads instead of granite would materially reduce the cost.

From the experience gained hitherto it appears that concrete roads stand the traffic very well if carefully constructed.

The commonest vehicle on the Port Trust roads is the bullock cart. The weight of a cart and driver (without bullocks) is about 10 cwts. The carts

are supposed to carry 16 cwts. but are often loaded to 20 cwts. The width of the steel tyre on each of the two wheels is $2\frac{1}{4}$ " to $2\frac{1}{2}$ ". The wheels are secured to the axles by cotter pins and owing to the large amount of play there is considerable grinding action on the road. The use of large lorries is increasing and these are often loaded well over their designed carrying capacity.

Note on the method of improving an old water-bound macadam road.*

The road referred to runs across the Mazagon Sewree Reclamation, it is about 2,400 feet long by 20 feet wide and it lies for most of its length in a depression, the land reclaimed on either side of it having been finished at a higher level than the road.

The road was built on the top of one of the bunds, which were constructed of murum to retain the clay and mud pumped in by the dredgers employed in the Mazagon Sewree Reclamation Scheme between 1907 and 1914.

One of the main storm water drains was also built on this bund, so it is now directly under the road. The road was constructed with the usual 9" of soling and about 6" of metal, but the surface of the road was not drained and consequently in the monsoon it was often partially submerged, and motor lorries and carts floundered along digging out pot-holes wherever the sub-soil or the surface became softened by the water. The road eventually became badly corrugated and pot-holed.

The traffic on the road has for some time been increasing and is now fairly heavy, probably about 25 lorries laden with 4 or 5 tons of iron, 50 laden bullock carts and 100 motor cars make double journeys over it daily.

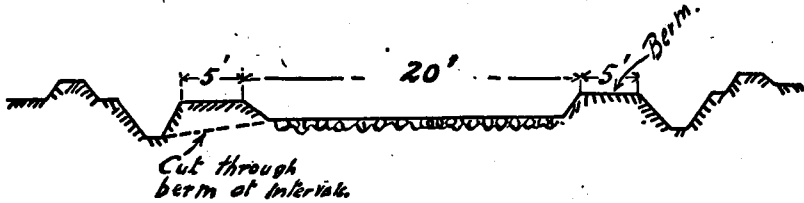
Photo No. 1† shows the condition of the road before it was repaired, and photo No. 2† shows it partly repaired. The depressions were tested by straight edges—everything over 3" below the general surface level was considered to be a pot-hole—these were dug out to a diamond shape thoroughly cleaned and painted with tar, and filled in with tar macadam ($1\frac{1}{2}$ " metal).

After the bad pot-holes had been repaired the corrugated surface of the road was attended to. This was brushed thoroughly clean and painted with tar, *i.e.*, sprayed by hand by means of watering cans of 2 gallons capacity. Tared chipping $\frac{3}{4}$ " gauge were then spread and raked on to the road. The average thickness of chippings was $1\frac{1}{2}$ "; $\frac{1}{8}$ " stone grit was spread on top of these chippings which were then rolled with a 1 ton hand roller. The surface was constantly tested with straight edges to ensure that it was uniform in plane. The carriage-way has been finished with a seal coat of bitumen. Various proprietary emulsified bitumens were used on test lengths, but the greater part is coated with Spramex applied hot.

*Note by Mr. F. G. Carron, M.Inst.C.E., Executive Engineer, Construction.

†Not printed.

Drainage.—The surface drainage of the road has been assured by digging trenches parallel to the road on both sides of it as sketched;



These trenches are graded with a fall of 1 in 180 and discharge into gullies, which are connected to the main storm water drain under the road. Water is drained off the road through cuts in the berm, these cuts being made about 50' apart.

Cost.—The actual cost of draining and repairing the road was Rs. 11-8-0 per 100 sq. ft. which includes the cost of forming the ditches and building gullies and connecting them to the main drain.

Tar to Road Board Specification No. 2 was used for the tar-macadam work.

The chips were mixed with tar in a *concrete* mixer at a depot about $\frac{1}{2}$ a mile from the site and carted to the site as required.

BOMBAY MUNICIPALITY.

Note on the progress made with improved forms of road surfaces in the city of Bombay.

Before 1921-22 the only methods of resurfacing carried out were:—

- (1) Water-bound macadam.
- (2) Tar grouting.
- (3) Surface dressing with 2 paint coats of tar.

These have now been replaced according to traffic requirements by the following:—

- (1) 6" sett pavement on 9" cement concrete foundation.
- (2) 3" sheet asphalt on 6" cement concrete and on existing consolidated water-bound or tarred road.
- (3) 2" asphaltic concrete on existing well consolidated water-bound or tarred road.
- (4) 2½" mixed macadam with ½" mixed seal coat on 6" cement concrete and on existing well consolidated water-bound or tarred road.
- (5) 3" asphalt macadam (penetration method) on 6" cement concrete and on existing well consolidated water-bound or tarred road.
- (6) 6" cement concrete roads.
- (7) Surface dressing with two paint coats of asphalt, chips and grit.
- (8) Surface dressing with two paint coats of emulsified bitumen, chips and grit.

The present cost per square yard and the approximate mileage of the different types both before and after 1921-22 are as follows :—

Type.	Before 1921-22.		After 1921-22.		Remarks.
	Mileage.	Cost per square yard.	Mileage.	Cost per square yard.	
		Rs.		Rs. a. p.	
Water-bound ..	143	2	144	1 2 0	
Tarred roads ..	35	1	..	..
Asphalt macadam ..	..	..	2	3 0 0	
Asphalt surface dressing ..	..	..	*37	1 0 0	*Of these about 5 miles represented $\frac{1}{2}$ " thick sand carpet.
Mixed macadam ..	..	..	2	4 0 0	
Asphaltic concrete ..	..	..	2	4 8 0	
Cement concrete ..	..	..	0.5	5 4 0	
Sheet asphalt ..	..	..	18	6 4 0	
Sett pavement ..	..	..	4.5	5 4 0	
Total ..	178	..	210	..	

The above figures are for wearing surfaces only. The Municipality has laid three roads with concrete wearing surfaces which are now being covered by an asphaltic carpet.

For roads having mainly bullock cart traffic, sett pavement has answered well and where there is mixed traffic we generally provide 6 ft. to 8 ft. margins of sett pavement for carts and the remainder of the width is laid with an asphalt carpet for automobiles. Sheet asphalt has proved very satisfactory under all traffic conditions and asphaltic concrete and mixed macadam for medium traffic.

These methods, however, require a special plant and specially trained staff and are hence suitable for large cities only, which have adopted a continuous programme from year to year. For country roads penetration macadam should be sufficient, as materials locally available can be conveniently used with the help of a small boiler and a few pouring cans.

In this connection the manufacture of cold products, *viz.*, asphalt emulsions has a great promise of simplifying the process of laying, as the stuff can be used straight from the barrel without any heating.

A good surface drainage system and a stable foundation are the essential points of a good road, and no surfacing however costly will be successful unless attention is paid to this.

The initial cost of these methods is considerably more than that of a water-bound road surface, but the advantages derived are :—

- (1) Low annual maintenance.
- (2) Longevity of the pavement.
- (3) Ease of tractive effort.
- (4) Elimination of the dust nuisance.
- (5) Saving in collection of refuse and watering.
- (6) Elimination of nuisance arising from frequent road repairs, etc.
- (7) Sanitary.
- (8) Surface easily scavenged and cleansed.
- (9) Great saving in tyres to motorists.

In the case of roads requiring new foundations the entire cost can be properly met from borrowings, so that only interest, depreciation and maintenance can be charged to revenue, thus lowering appreciably the burden of the tax-payers.

Specifications for the various methods are detailed below.

I.—General directions for surfacing with macadam.

1. The thickness of the surface coating of tar macadam when consolidated by rolling should be from 2 to 3 inches according to traffic requirements. For a greater thickness than 3 inches the material should be applied in two coats.

2. The finished surface should have a cross fall of about 1 in 32.

3. The aggregate of the new surface of tar macadam should be composed of broken stone of approved quality, or selected slag of approved quality, and should contain at least 60 per cent broken to the size of $2\frac{1}{2}$ inches, not more than 30 per cent of from $2\frac{1}{2}$ inches to $1\frac{1}{4}$ inches, and 10 per cent of $\frac{3}{4}$ inch to $\frac{1}{2}$ inch for closing. The last mentioned size should be kept separate and used as top dressing during rolling operations.

4. The stone used must be thoroughly dried before being coated with tar.

5. The quantity of tar used to coat one ton of stone should be approximately from 9 to 12 gallons, varying according to the sizes of the stone, the grade of tar used, the method of mixing and other conditions.

6. The tar macadam, after having been spread and levelled, should be rolled into a smooth surface, but too much rolling should be avoided.

Less rolling is required than in the case of water-bound macadam.

A 10 ton roller is a suitable size for use in most cases, but good results can be obtained by using a 6 ton roller and finishing with a 10 ton roller.

7. Stone chippings, crushed gravel, coarse sand or other approved material (free from dust) not larger than will pass through a $\frac{1}{2}$ inch square mesh, should be used for gritting in quantity not exceeding 1 ton for 300 to 350 superficial yards if grit is used, and 1 ton for 200 to 250 superficial yards if coarse sand is used.

II.—Construction specification.

3" asphalt macadam surface. Finished thickness 3" or as required.

Spreading and compacting coarse aggregate.

(1) Prior to spreading coarse aggregate the prepared base shall be cleaned of all loose and foreign matter. The coarse aggregate which consists of $2\frac{1}{4}$ " metal shall then be spread upon the base in a uniformly loose layer 4" thick. Each load shall be spread outside of the area upon which it is dumped. Every precaution shall be taken to prevent the aggregate from becoming mixed or coated with dirt or other objectionable matter before and after spreading.

(2) The coarse aggregate shall then be dry rolled with a steam road roller weighing not less than 10 tons. The rolling shall start longitudinally at the sides and gutter and proceed towards the centre of the pavement, overlapping on successive trips by at least one-half of the width of the roller. The compacted coarse aggregate shall possess a fairly firm and even surface true to the grades and cross sections shown on the plans and present a texture which will allow of uniform penetration of the asphalt. If any irregularities appear during or after rolling they shall be remedied by loosening the surface and removing or adding coarse aggregate as may be required, after which the area disturbed including the surrounding surface shall be rolled until satisfactorily compacted to a uniform surface. All coarse aggregate which becomes coated or mixed with dirt, dust or foreign substances prior to the application of asphalt shall be removed and replaced with clean aggregate of the same kind and compacted as specified.

First application of asphalt.

(1) Upon the rolled coarse aggregate, hot asphalt shall be uniformly applied at the rate of from one and a half (1.5) to one and three quarters (1.75) gallons per square yard as directed by the Engineer.

Asphalt shall be applied only when the coarse is thoroughly dry for its entire depth, and unless otherwise permitted by the Engineer.

Application of the asphalt shall be made by means of a pressure distributor or with hand pouring pots.

(2) The asphalt shall be heated in kettles to secure uniform heating of the entire contents and shall be brought to a temperature of 300° to 350° F. as directed by the Engineer. A thermometer must be provided to determine the temperature of the asphalt during heating and prior to application.

Hand pouring pots used for applying asphalt shall have a capacity of not less than 3 gallons and shall be equipped with slotted spouts so placed that when the can is emptied by carrying it forward with the end of the spout close to the road surface the width of application shall be not less than 8 inches. Each pot

shall be marked to gauge for accurately measuring the charge of asphalt before it is distributed. The distance to be covered by each charge shall be measured off and the pouring operation conducted so that the rate of application will be uniform as the pot is emptied. The direction of successive pourings shall be reversed. Application shall be made at such angle to the centre line of the road or longitudinally as directed by the Engineer. During pouring the spout of the pot shall be kept within 6 inches of the surface of the road. In distributing slots shall be kept free from obstructions and shall be cleaned as necessary to insure a uniform distributing aperture. A narrow spout pouring pot may be used to apply asphalt necessary to touch up all spots unavoidably missed during the original application.

Filling surface voids with intermediate aggregate.

After the first application of asphalt, and if practicable while still warm, a thin layer of dry intermediate aggregate consisting of $\frac{3}{4}$ " to 1" metal shall be broadcasted over the treated surface in such quantity as to fill the surface voids and just cover the treatment. It shall then be broomed if necessary, to break up all clumps and produce a uniform covering, after which the pavement shall be steam rolled until thoroughly compacted and interlocked.

Suitable precautions shall be taken to prevent the distribution of intermediate aggregate over any portion of the coarse aggregate which has not received the first application of asphalt and in no case shall it be dumped directly upon either the treated or untreated coarse aggregate.

Seal coat.

After the intermediate aggregate has been thoroughly rolled stiff the pavement shall be swept clean of all loose material and treated with a second application of heated asphalt under the same conditions and in the same manner as previously specified, except that the rate of application shall be from one half (0.5) to three quarters (0.75) gallon per square yard as directed by the Engineer.

If hand pouring pots are used, the lines of distribution shall cross those of the first applications at an angle of approximately 90 degrees. After the second application of asphalt and if practicable while it is still warm, dry fine aggregate consisting of $\frac{1}{4}$ " grit shall be broadcasted over the surface and rolled until thoroughly bonded to the road. As required additional fine aggregate shall be spread and broomed over the surface during rolling in sufficient quantity to take up all excess of asphalt.

Upon completion of the pavement, however, only a very light uniform covering of loose aggregate shall be allowed to remain on the road. The finished surface shall be uniform, free from ruts or irregularities in contour and true to the required grade.

Protection of pavement.

During the period between the initial compaction of the coarse aggregate and completion of the seal coat the surface course shall be protected from all traffic other than that absolutely essential to its construction.

III.—Specification for mixed macadam with a mixed seal coat.

The mineral aggregate shall consist of trap rock, other sound stone, or slag, satisfactory to the Engineer consisting of pieces as nearly cubical as possible, not larger than $1\frac{1}{4}$ " in their largest diameter and not smaller than $\frac{1}{2}$ " and from 10% to 15% of clean, sharp sand by weight as determined by the Engineer.

The mineral aggregate shall be mixed in the same manner as specified for sheet asphalt and asphaltic concrete and the proportion of asphaltic cement shall be such that the mixture shall not show excess or deficiency of bitumen.

The mixture shall be hauled to the road and laid and rolled in the same way as specified for asphaltic concrete to a finished thickness of not less than $2\frac{1}{2}$ ".

Mixed seal coat shall consist of fine graded sand of the same quality as specified for sheet asphalt and a quantity of asphaltic cement just sufficient to cover all particles.

The mixture shall be laid as in the case of sheet asphalt but to a thickness of $\frac{1}{2}$ " only. It shall then be rolled and swept over with Portland cement or stone dust.

IV.—Specification for 2" asphaltic concrete.

Asphaltic concrete shall be laid in one layer of 2" thickness.

The mineral aggregate shall consist of crushed trap rock, other sound stone or slag (free from weathered and dirty particles), sand and a finely powdered mineral filler, all of which shall meet the approval of the Engineer.

The sand and filler shall be of the same quality as specified for sheet asphalt.

The stone shall all pass a screen of 2 meshes to the lineal inch and all retained on a 10 mesh screen.

The aggregate and asphaltic cement shall be mixed in the same way as specified for sheet asphalt and the proportions shall be such that the combination shall consist of a standard sheet asphalt surface mixture and an amount of broken stone containing not more than from 8 to 22% of particles passing a 4 mesh and less than 10% of particles passing a 2 mesh screen, showing no excess or deficiency of bitumen.

The mixture shall then be hauled to the street in lorries covered with canvas and shall be laid at a temperature of not under 280°F., by means of rakes to the correct depth and then rolled by Tandem rollers, Portland cement or stone dust being swept over it after it has consolidated.

Statistical information relating to the Bombay Municipality.

Statements and information supplied to the Government of Bombay by the Bombay Municipality showing the financial effects of substitution of asphalt for water-bound road surfaces, and the initial and maintenance costs of various methods of asphaltting. Reproduced by the courtesy of the Chief Engineer and Joint Secretary to the Government of Bombay, Public Works Department.

A.—*Information supplied by the Municipal Commissioner, Bombay, in June 1928 in reply to certain questions regarding roads.*

Information asked for.	Replies.
1. Total number of miles (and square yards) of original water-bound macadam surface under the Bombay Municipality.	143 miles out of a total of 178 miles in 1921-22; area approximately 33,55,000 sq. yards.
2. Total cost of construction of 1 above and per sq. yd.	Cannot be given. Present cost about Rs. 1-8-0 per sq. yd. for 6" metalling.
3. Life of water-bound macadam surface road.	Varies from 6 months to 2 years according to traffic conditions.
4. Total cost of maintenance of water-bound macadam surface (and per sq. yd.) of 1 above.	Rs. 1-2-0 per sq. yd. for 3" resurfacing.
5. Total cost of annual maintenance of water-bound macadam surface (and per sq. yd.) of such portion as was subsequently asphalted, as per 6 below.	Nil so far.
6. Number of miles asphalted out of 1.	11 miles out of a total of 20 miles.
7. Total cost of construction of asphalted roads (and per sq. yd.) of 6.	Rs. 30,51,185 for 20 miles for wearing surface only.

B.—*Initial cost and estimated maintenance costs of various methods of asphaltting.*

Method.	Life.	Initial cost per sq. yard.			Estimated maintenance cost p. a. per square yard.
		Rs.	A.	P.	
2" asphaltic concrete	12	4	8	0	5
2½" mixed macadam with ½" mixed seal coat.	12	4	0	0	6
3" penetration macadam	10	3	0	0	7

C.—Note showing the method followed in fixing the annual cost of repairs and renewals given in statement.

3" sheet asphalt on 4" cement concrete laid over existing rubble packing.

Unit area 10,000 sq. yards	.. ..	(A).
Cost of new surface Rs. 6.5 per sq. yard	.. ..	(B).
Life of surface 15 years	.. ..	(C).
Number of renewals in 30 years	.. .. 1	(N).
Cost of renewal in 30 years	.. .. 10,000 (A) × 6.5 (B) × 1 (N).	
		=Rs. 65,000.
Cost of renewal per annum	.. .. $\frac{65,000}{30}$	=2,167 (D).
Cost of annual repairs at 2 annas per sq. yard	.. ..	Rs. 1,250 (E).
Annual charges for maintenance and renewal	.. ..	2,167 (D) + 1,250 (E).
		Rs. 3,417.
Interest at 6% on Rs. 1,12,500	.. ..	Rs. 6,750.
Sinking Fund at 4% for 30 years on Rs. 1,12,500	.. ..	Rs. 2,006.
Total yearly charges	.. ..	Rs. 12,173.

Same as above but with 8 ft. margins on either side of the road to be sett paved.

Unit area 10,000 sq. yards	.. ..	(A).
Cost of new surface (inclusive of setts) Rs. 6.25 per sq. yard	.. ..	(B).
Life of surface 15 years	.. ..	(C).
Number of renewals in 30 years	.. .. 1	(N).
Cost of renewal in 30 years	.. .. 10,000 (A) × 6.25 (B) × 1 (N).	
		=Rs. 62,500.
Cost of renewal per annum	.. .. $\frac{62,500}{30}$	=Rs. 2,083 (D).
Cost of annual repairs at 2 annas sq. yard	.. ..	Rs. 1,250 (E).
Annual charges for maintenance and renewal	.. ..	Rs. 2,083 (D) + 1,250 (E).
		Rs. 3,333.
Interest at 6% on Rs. 1,10,000	.. ..	Rs. 6,600.
Sinking Fund at 4% for 30 years on Rs. 1,10,000.	.. ..	Rs. 1,962.
Total yearly charges	.. ..	Rs. 11,895.

D.—Statement showing the financial effects of the substitution of asphalt roads for water-bound surfaces.

1 Number.	2 Mode of construction.	3 Unit area in square yards.			7 Capital expenditure per unit area.	8 Estimated life.		10 Details of main-tenance per unit area.			13 Annual charges for maintenance and renewal.	14 Total annual charges for main-tenance per unit area.	15 Cost of water-bound surfacing at Rs. 1.2 per sq. yd.	16 No. of renewals if water-bound surfacing used.	17 Total revenue charge p. a. per unit.	18 Saving p. a. per unit area under revised procedure (col. 17 minus col. 14).	19 Percentage saving on the cost of water-bound surfacing.	
		4 Foundation.	5 Surface.			8 Foundation.	9 Surface.	11 Loan charges.										
			Rs.	Rs.				Rs.	10 Interest at 5%.	11 Sinking Fund 4%.								12 Total.
1	3" sheet asphalt on 4" cement concrete	10,000	4.75	6.50	11.25	1,12,500	30	15	6,750	2,006	8,756	3,417	12,173	12,000	1½	18,060	5,827	32.4%
2	Same as above but width 8' margins on either side sett paved.	10,000	4.75	6.25	11.00	1,10,000	30	15	6,600	1,962	8,562	3,333	11,895	12,000	1½	18,060	6,105	33.9%

NOTE.—The information given is in respect of 3" sheet asphalt on concrete foundations, which has been largely adopted for important roads in Bombay. It should be clearly understood that the figures are for roads subjected to heavy traffic only.

BENGAL.

Little work with improved road surfaces has been done outside the city of Calcutta. The information below has kindly been furnished by the Chief Engineers to the Corporation of Calcutta, the Calcutta Port Commissioners, and the Calcutta Improvement Trust.

CALCUTTA CORPORATION.*

Prior to 1917, Calcutta Corporation made a number of experiments and put down a considerable area of road surface using 'Tar Macadam' laid mainly by the 'Penetration' or pouring method. These road surfaces were a great improvement but still left a great deal to be desired and with the adoption of 'bitumen' as a binder, the use of tar or pitch has been definitely abandoned with satisfactory results.

The system adopted is that generally known as the hot mix asphaltic concrete method, the thickness of the carpet being determined by traffic and other local conditions. Surface painting is also adopted to a considerable extent in the suburban and outlying areas, the bitumen being applied hot.

The following mileages of roads have been paved with asphaltum in Calcutta up to the end of 1927.

3" thick	..	..	..	..	..	1.00
2" thick	..	..	..	..	..	37.58
1" thick	..	..	..	..	..	8.50
$\frac{1}{2}$ " thick	..	..	..	..	..	7.25

There are three asphalt mixing plants situated at a central depot at Palmer's Bridge pumping station, each plant having an output of about 10 tons per hour.

The stone metal used is prismoidal Trap which is machine crushed and screened to gauge at the depot. The materials are heated and screened and mixed in the plant in definite weighed proportions according to the maximum density curve for the particular thickness of road carpet to be laid. The maximum density curve is checked up from time to time.

Bitumen.—The bulk of the bitumen used is a residual bitumen from a petroleum base and is a standardised product manufactured by the large oil concerns such as the Standard Oil Company and the Asiatic Petroleum Company. A penetration of about 30/40 is adopted for the asphaltic concrete carpets while a higher penetration of 100 or over is found more suitable for surface painting. Local materials available and local conditions of climate, traffic, etc., control and indicate the most suitable penetration to adopt.

Recording thermometers are used to keep a check on the heating of the materials.

Transport, etc.—The hot mixture is transported to the road to be surfaced in motor lorries fitted with steel tipping bodies.

The ordinary standardised rolling methods are adopted, cross rolling and diagonal rolling being done wherever possible which unfortunately is not very frequent except in the case of wide roads.

*Note by Mr. J. R. Coats, B.Sc., M. Inst. C.E., M. I. Mech. E., Chief Engineer to the Corporation of Calcutta.

The asphaltum paving is ordinarily laid on the old water-bound macadam road surface which is prepared by cutting and dressing, if required, to receive it.

A concrete foundation has also been used occasionally in the case of newly constructed roads or in cases where the old macadam crust was not thick enough. On the whole good results have been obtained although there have been occasional failures which have been traced to definite causes and noted for future guidance. The main causes have been insufficient thickness of paving to withstand heavy bullock cart traffic and weak foundations.

Experiments have also been carried out with the use of cold emulsions of bitumen and it would appear that there is likely to be a wide field for the use of this class of material but sufficient time has not yet elapsed to give an authoritative opinion.

The working systems adopted in Calcutta Corporation are the evolution of some 12 years' experience of laying bituminous roads in that city and have been carefully organised and modified whenever necessary to give maximum economy combined with efficiency and convenience to traffic.

Analyses of rates for asphaltum work are given in the following statement.

CORPORATION OF CALCUTTA.

Analyses of rates for Asphaltum work for 1926-27.

CORPORATION OF
Analyses of rates for Asphaltum

Particulars.	Asphaltic concrete pavements				
	3 rd Layer.			2 nd Layer.	
	Quantity.	Rate.	Amount.	Quantity.	Rate.
		Rs. A. P.	Rs. A. P.		Rs. A. P.
1. Stone chip No. 1 ..	1,200 c. ft.	} 33 0 0	742 8 0	800 c. ft.	} 33 0 0
2. Stone chip No. 2 ..	1,050 "			700 "	
3. Sand ..	2,160 "	11 6 3	246 0 7	1,440 "	11 6 3
4. Asphaltum ..	260 cwt.	6 3 0	1,608 12 0	173 cwt.	6 3 0
5. Katni cement ..	6 tons.	50 0 0	300 0 0	4 tons.	50 0 0
6. Steam coal ..	6 "	8 12 0	52 8 0	4 "	8 12 0
For 1,000 sq. yards ..	..	..	2,949 12 7	..	..
1. Cost of material per sq. yard ..	..	..	2 15 3	..	..
2. Preparation of bed ..	..	..	0 6 0	..	..
3. Lorry charges ..	..	..	0 5 0	..	..
4. Cost of asphalt mixture, preparation, laying and consolidating with roller complete.	..	..	0 4 3	..	..
5. Tools and plant ..	..	..	0 3 0	..	..
			4 1 6	..	..
			Say 4 0 0	..	..

Particulars.	Asphaltic mastic water-proofing.		
	3 rd layer on single storey roofs.		
	Quantity.	Rate.	Amount.
		Rs. A. P.	Rs. A. P.
1. Stone chip No. 1 ..	Nil.	..	..
2. Stone chip No. 2 ..	Nil.	..	..
3. Sand ..	1,000 c. ft.	11 6 3	113 14 6
4. Asphaltum ..	75.71 cwt.	6 3 0	468 7 4
5. Katni cement ..	2.42 tons.	50 0 0	121 0 0
6. Steam coal ..	2.33 "	8 12 0	20 6 3
For 1,000 sq. yards ..	..	..	723 12 1
1. Cost of material per sq. yard ..	..	..	0 11 7
2. Preparation of bed ..	..	..	0 2 0
3. Lorry charges ..	..	..	0 1 6
4. Cost of asphaltum mixture, preparation, laying and consolidating with roller complete.	..	..	0 4 6
5. Tools and plant ..	..	..	0 0 6
			1 4 1
			say 1 4 0

CALCUTTA.

work for 1926-27.

for road surfaces.

Amount.	1 st Layer.			1 st Layer.		
	Quantity.	Rate.	Amount.	Quantity.	Rate.	Amount.
Rs. A. P.	Nil.	Rs. A. P.	Rs. A. P.	Nil.	Rs. A. P.	Rs. A. P.
495 0 0	667 c.ft.	33 0 0	220 1 9	383 c.ft.	33 0 0	109 14 3
164 0 5	917 "	11 6 3	104 7 3	583 cwt.	11 6 3	66 6 5
1,070 7 0	111-8-0 cwt.	6 3 0	690 8 5	70-07 "	6 3 0	433 8 11
200 0 0	2-60 tons	50 0 0	130 0 0	1-30 tons	50 0 0	65 0 0
35 0 0	3 "	8 12 0	26 4 0	2-23 "	8 12 0	19 8 3
1,964 7 5	..	..	1,171 5 5	..	..	694 5 10
1 15 6	..	..	1 2 9	..	..	0 11 1
0 4 0	..	..	0 2 0	..	..	0 2 0
0 4 0	..	..	0 2 0	..	..	0 1 6
0 3 0	..	..	0 2 0	..	..	0 1 0
0 2 0	..	..	0 1 0	..	..	0 0 6
2 12 6	..	..	1 9 9	..	..	1 1 0
say 2 12 0	..	..	say 1 12 0	..	..	say 1 0 0

Surface treatment with asphaltum.

Painting stone or brick roads.			Seal coating on asphalt pavement roads.		
Quantity.	Rate.	Amount.	Quantity.	Rate.	Amount.
	Rs. A. P.	Rs. A. P.		Rs. A. P.	Rs. A. P.
Nil.	..	..	Nil.	..	..
100 c. ft.	33 0 0	33 0 0	100 c.ft.	11 6 3	11 6 3
100 c. ft.	11 6 3	11 6 3	15 cwt.	6 3 0	92 13 0
52 cwt.	6 3 0	321 12 0	..	..	..
..	..	..	1/2 ton.	8 12 0	4 6 0
1/2 ton.	8 12 0	4 6 0	..	..	108 9 3
..	..	370 8 3	..	..	0 1 9
..	..	0 5 11	..	..	0 2 0
..	..	0 2 0	..	..	0 0 3
..	..	0 0 3	..	..	0 0 6
..	..	0 0 6	..	..	0 0 3
..	..	0 0 3	..	..	0 4 9
..	..	0 8 11	..	..	say 0 5 0
..	..	say 0 10 0	..	..

CALCUTTA IMPROVEMENT TRUST.*

(1) *2" asphaltic concrete on lime concrete foundation.*—This form of construction has proved unsatisfactory, as the lime concrete is too friable to resist the 'creeping' tendency of the asphalt carpet. No roads have been constructed in this way since 1922.

(2) *2" asphaltic concrete on water-bound stone macadam foundation.*—This form of construction is largely used by the Calcutta Corporation and has proved generally satisfactory, provided the foundation is sufficiently consolidated and the asphalt is properly mixed and not overheated. It costs about Rs. 45 per 100 sq. ft. for foundation (thickness 13" including brick soling) and Rs. 40 per 100 sq. ft. for surfacing.

(3) *2" asphaltic concrete on cement concrete foundation.*—Some experimental lengths have given good results. The cost is about Rs. 44 per 100 sq. ft. for foundation (6" thick, 1 : 2 : 4) and Rs. 40 per 100 sq. ft. for surfacing.

(4) *2" asphalt blocks on cement concrete foundation.*—It is proposed to experiment with this method of surfacing in a roadway over a reinforced concrete bridge carrying heavy traffic.

(5) *Water-bound stone macadam foundation with asphalt grouted surface.*—This method of construction is being largely adopted by the Trust for newly made roads with moderately heavy traffic, and for resurfacing existing roads. The grouted layer is from 2" to 2½" thick, and is laid on a cushion of dry sand, which is forced up into the interstices between the stones, thus reducing the quantity of grout required. The cost (total thickness 15" including brick soling and grouted layer) is about Rs. 45 per 100 sq. ft. for foundation (thickness 13" including brick soling) and Rs. 21 per 100 sq. ft. for surface layer.

(6) *Water-bound stone macadam foundation with cement grouted surface.*—Experiments have been made with this system with hopeful results. It appears that the best method of applying the grout is to sandwich it in the form of a stiff paste between two layers of stone so that the roller forces it both up and down. No figures of cost are yet available.

(7) *Water-bound stone macadam with asphalt painted surface.*—This is the usual form of construction for roads carrying medium traffic. The asphalt is applied by hand about 2 months after the road has been opened to traffic, and is kept heavily sanded for several weeks. The cost (surfacing only) is about Rs. 7 per 100 sq. ft.

(8) *Concrete.*—All concrete roads have been laid experimentally by the Improvement Trust and are giving good results. Experience to date shows that contraction joints should be provided at intervals of about 30 ft. and that a good wearing road is obtainable with the following specification :—

<i>Thickness.</i> —Bottom course	..	..	..	..	5"
Top course	..	..	..	..	2"

Coarse aggregate.—

Bottom course, broken trap rock graded from 1½" to ¼".

Top course, broken trap rock graded from ¾" to ¼".

*Note by Mr. M. R. Atkins, B.Sc., M. Inst. C. E., Chief Engineer.

Fine aggregate.—Crushed quartz gravel graded from $\frac{1}{4}$ " downwards.

Cement.—Indian manufacture, developing a tensile strength of 700 lbs. per sq. inch at 7 days.

Concrete proportions.—Bottom course 1 : 2 : 4
Top course 1 : 1 : 2

Foundation.—Layer of broken brick, punned and rolled.

Method of curing.—Ponding with water for 14 days.

Surface treatment on completion.—Silicate of soda, 3 applications at intervals of 24 hours.

Reinforcement does not appear to be essential except when the ground is liable to uneven settlement.

The cost of a concrete road is about Rs. 75 per 100 sq. ft.

CALCUTTA PORT COMMISSIONERS.*

In the Kidderpore Dock area there are three types of roads, namely (1) water-bound macadam, (2) jhama brick khoa and (3) stone sett roads. Without regard to width of road, drainage of subsoil water, traffic conditions, etc., the sections of these roads are generally as follows :—

1. *Water-bound macadam road.*—3" picked jhama brick soling, 6" consolidated, 2" size, hard black trap stone road metal.
2. *Jhama brick khoa road.*—3" picked jhama brick soling, 6" consolidated jhama metal khoa of $2\frac{1}{2}$ " size.
3. *Stone sett road.*—Stone and cement concrete 7" thick, mixture 5 : 3 : 1, aggregate 2" black trap stone. 3" brick soling was laid where soil of formation demanded it. Stone setts $10" \times 5" \times 4\frac{1}{2}"$ size were laid, embedded in $\frac{1}{2}"$ of silver sand, diagonally from the centre line of the road, the line of the setts on one half of the road being at right angles to the line of the setts on the other half of the road.

In most cases in the area no provision has been made for subsoil drainage nor has it been possible to do so. Surface run off has been allowed for in some cases by means of stone slab channels with channel gratings connected to a pipe drain in the centre of the road, and in others by open drains on both or one side of the road.

The methods of construction, maintenance and surface treatment of these roads have been as follows :—

1. *Construction.*—(a) Water-bound macadam.

The ground is excavated to the full width of the road to a depth 9" below the proposed level of the finished road, the formation being dressed to the proposed camber of the road surface, a fall of 1 in 40 usually being allowed. The formation is then brick soled 3" brick on flat with jhama bricks. Stone road metal of 2" size is screened and spread to a thickness of $4\frac{1}{2}"$ and rolled with a 10 ton steam road roller 3 times dry. The metal usually obtained is black trap and 2" metal is found to be a suitable size for the kind of stone and type of road. The pieces of stone should be as nearly cubical as practicable and regular in size

* Note by Mr. J. McGlashan, M. Inst. C. E., Chief Engineer.

to minimise crushing by the roller, irregular size metal is liable to crush more. With a softer stone it would probably be advisable to use $2\frac{1}{4}$ " to $2\frac{1}{2}$ " sizes. After rolling 3 times dry the metal is watered sufficiently to assist in consolidation and to minimise crushing, care being taken to ensure that too much water is not used to avoid softening and weakening the formation earth. Rolling is carried on whilst watering is being done and consolidation is considered to be sufficient when the roller has passed over the metal about 80 times. Complete consolidation is not effected in this layer, to permit a better bond between the two layers. The second layer of 2" stone metal $4\frac{1}{2}$ " thick is then spread and rolled 2 or 3 times dry. Further consolidation is carried out with watering judiciously as in the consolidation of the first layer. Binding material is then spread. As well consolidated metal contains about 25% to 30% of voids, the quantity of binding used is based on this, a little excess material being used to ensure that all interstices are filled but care however being taken to avoid displacement of the metal through a large excess of binding material. The binding material used is composed of stone chips and stone dust obtained from screening the metal, and when this is not obtained in sufficient quantities building rubbish consisting of old mortar, plaster, small pieces of brick, etc., from dismantled buildings is added. This mixture makes a good binder being neither too earthy nor too sharp. In the event of building rubbish not being available a binding mortar consisting of one part soorki, two parts cinders and one part rejected lime mixed in the mortar mill has been used.

After the spreading of the binder, watering is done followed at once by rolling, the wet binding material being well brushed over the surface as the roller passes backwards and forwards till consolidation is complete. In rolling the second layer of metal the roller is passed over from 90 to 100 times.

(b) *Jhama brick khoa road*.—Excavation, dressing formation to the camber and soling is done as for a macadam road. 9" of jhama metal khoa of $2\frac{1}{2}$ " size is spread, rolled 2 or 3 times dry with a 6 ton roller and finally consolidated with careful watering, the screenings from the khoa metal alone or mixed with building rubbish being used as binding material. It is not advisable to use a roller heavier than 6 ton or excessive attrition will take place.

(c) *Stone sett road*.—The approach road to riverside berths from the Neemak Mahal Garden Reach Road junction was constructed in the following manner:—

The formation width of 20' was excavated to a depth of 12" below the proposed level of the finished road surface and dressed to a camber of 1 in 60. Where the formation earth was particularly bad 3" brick soling was laid, allowance being made for this in the excavation at the sites. Cement concrete in the proportion of 5 : 3 : 1, the aggregate being 2" stone metal, was laid to a thickness of 7" over the formation level and finished to the camber of the road being allowed to set under water. Stone setts of black trap rock $10" \times 5" \times 4\frac{1}{2}"$ were laid bedded in $\frac{1}{4}"$ of silver sand and grouted in with cement and sand grout. The setts were laid at an angle of 45° from the centre line of the road in opposite directions. The usual precautions of watering the sett paving, keeping the road closed to traffic till the cement grout had set properly, were observed.

2. *Maintenance of roads*.—Our practice is to repair pot holes as they develop, and to periodically re-coat the road with a thick layer of stone. This

ensures that a proper thickness of metal is maintained and is preferable to patching and repairing as required, under which method it is likely that, although a good surface is maintained, the thickness of the metal may become inadequate.

In re-coating the road surface there is the choice of (1) scarifying and (2) picking up the road. In the case of water-bound macadam roads it has been our practice to pick up to a depth of about $1\frac{1}{2}$ ". The old metal is screened and then mixed with additional new metal of 2" size and the mixture spread to such a depth as will give 6" consolidated metal finally. Usually a layer of 3" is sufficient. Consolidation dry, wet and with binding is then carried out in the same manner as in constructing a new road. The screenings from the old and new metal are used as a binder with as much additional building rubbish as is necessary.

Similarly, in repairing a khoa road the surface is picked to a depth of about 2", the old khoa screened, mixed with the required quantity of new $2\frac{1}{2}$ " khoa and consolidated and bound with binding material composed of the screenings of the old and new khoa.

3. *Surface treatment.*—The rapid development of high speed mechanical traction has enormously increased the wear and tear on our roads. Motor lorry and motor omnibus traffic has been particularly damaging to road surfaces, producing in a short time surface corrugations and pot holes of considerable depth. The impact upon the road surface combined with the uneven distribution of weight in the case of these vehicles increases the amount of damage done.

In the Kidderpore Dock area we have the problem of certain roads subjected to extremely heavy traffic and others which do not have sufficient traffic to keep them properly rolled under existing climatic conditions. The roads subjected to very heavy traffic, notably the swing bridge approaches on Garden Reach Road and Circular Garden Reach Road, rapidly develop pot holes, and require continual attention in making good these weak spots, and have to be re-surfaced every year. Other roads such as roads East and West of No. 1 Dock and Kantapuker Road generally have a disintegrated surface due to insufficient watering in the dry weather, insufficient traffic and washing out of binding material during the monsoon.

With the primary objects of preventing surface disintegration and the lessening of the dust nuisance a programme of surface dressing with various proprietary materials was embarked upon about 15 months ago. The experiments carried out were as follows:—

Six different materials have been used :

- (1) Mexphalte.
- (2) Bitarco.
- (3) Mexaco road oils.
- (4) Ormul.
- (5) Colfix.
- (6) Colas.

There are two methods of application of each material, *i.e.*, grouting and surface dressing. In only two cases has grouting been done, with Mexphalte and with Colas.

Mexphalte and Bitarco have to be heated to a certain temperature and reduced to a liquid state before application. Mexaco road oil is applied cold and is a preparation of bitumen and oils treated under heat. Ormul, Colfix and Colas are emulsions and are applied cold.

Mexphalte and Bitarco applied as a surface dressing have little penetration and result in a skin of material over the macadam. The other four materials applied cold penetrate to a greater extent but do not give an even skin over the surface. In the case of Mexaco road oil it has been found that under traffic conditions the binding materials appear to work to the surface and eventually give a surface coating.

The method of preparation of the road surface for the receiving of the dressing is the same in all cases with the exception that in the case of the emulsions it is not essential that the road surface be perfectly dry, in fact it is in some cases recommended that prior to application of the material the road surface be watered.

Assuming the road to be in a good condition all dust and dirt are removed by brushing, wire brushes being used where necessary. It is essential that cleaning be done thoroughly. Mexphalte and Bitarco are poured in a hot liquid state on to the dry prepared road surface and either brushed or squeezed over to an even thickness depending upon the condition of the surface. Small stone chippings, pea gravel or sand is then lightly spread immediately and rolled in with a light roller. When this has been done the road can be opened to traffic. Mexaco road oil is poured on the surface and brushed to as even a layer as possible, the quantity used depending on the smoothness of the surface. It is left to stand from 48 to 72 hours to enable penetration to take place. Stone chippings or sand is then spread evenly and lightly over the oil and allowed to stand again for about 48 hours. Light rolling may then be done and the road opened to traffic.

Ormul, Colfix and Colas are poured over the prepared surface brushed in a manner similar to that described above, after which stone chippings or sand is immediately spread lightly and rolled in, after which the road can be opened to traffic.

The use of Colfix, Colas and Bitarco is so recent that we are not in a position to give an experienced and considered opinion on the results of using them. Both Mexphalte and Mexaco road oils have been found satisfactory in reducing dust, preventing the disintegration of the road surface during dry weather and during heavy rains, keeping the binding material together and, particularly in the case of Mexphalte, in reducing the development of pot holes and the wear on the macadam.

The rates per hundred sq. ft. for constructing a macadamised road with (a) 9" jhama metal and (b) 9" stone metal are as follows:—

	Rs.	A.	P.
(a) Cutting earth 100 c. ft. at Rs. 6-4-0 per 1,000 ..	0	10	0
Jhama soling 100 sq. ft. at Rs. 6 per 100 ..	6	0	0
Jhama metal 75 c. ft. at Rs. 18 per 100 ..	13	8	0
Consolidating 100 sq. ft. at Rs. 2-8-0 per 100 ..	2	8	0
	<hr/>		
	22	10	0

Say Rs. 24 per 100 sq. ft. including charges for steam road roller.

	Rs.	A.	P.
(b) Cutting earth 100 c. ft. at Rs. 6/4 per 1,000 ..	0	10	0
Jhama soling 100 sq. ft. at Rs. 6 per 100 ..	6	0	0
Stone metal 75 c. ft. at Rs. 25-8-0 per 100 ..	19	2	0
Consolidating 100 sq. ft. at Rs. 2-8-0 per 100 ..	2	8	0
	<hr/>		
	28	4	0

Say Rs. 30 per 100 sq. ft. including charges for steam road roller.

UNITED PROVINCES.*

During the last 3 years improved forms of road surfacing have been carried out on 74½ miles as follows:—

	Miles.
1. Cement concrete	1½
2. Asphalt Macadam T. R. A.	8½
3. Asphaltic Concrete (Mexphalte)	1½
4. Asphaltic Concrete T. R. A.	½
5. Grouting T. R. A.	8½
6. Grouting Mexphalte	8½
7. Grouting Pitch and Tar	½
8. Surface Painting T. R. A.	7½
9. Surface Painting Spramex	24½
10. Surface Painting Asphaltum	½
11. Surface Painting Tar	4½
12. Mexaco treatment	7
	<hr/>
Total	74½

* Note on improved forms of road surface in the United Provinces by the Chief Engineer, Public Works Department, Buildings and Roads Branch, United Provinces.

The following is a very brief description of the work done, cost of the same and conclusions so far arrived at :—

1. *Cement concrete.*—This work consists of a 6" slab; 20' wide of cement concrete thickened at the edges to 9" laid on the alternate bay system. The concrete has been laid in two layers and the mixture in each layer is 1 : 2 : 4, a stronger mixture was at first tried in the top layer but the results did not seem to justify the extra cost. The surface of the concrete was treated with silicate of soda. The cost has worked out at Rs. 5-12-0 per square yard. The concrete has been down for over two years and carries a very heavy load of bullock cart traffic, but up to the present there are no signs of wear on the surface.

In addition to the above work cement concrete has been laid round the corners of the hill road leading to Naini Tal and some of it has been down for 8 years, except for trouble at the joints the surface shows little signs of wear.

The conclusion I have arrived at is that this form of surface is eminently suited for heavy concentrated cart traffic.

2. *Premix.*—The asphalt macadam consists of a 2½" coat, whilst the asphaltic concrete is only 2" thick. The material is mixed and heated in a machine, carried hot to the site and laid. The cost of asphalt macadam with T. R. A. varies from Rs. 4-10-0 to Rs. 4-15-0 per square yard, whilst the cost of asphaltic concrete with Mexphalte is Rs. 4-11-0 and with T. R. A. is Rs. 5-1-0 per square yard.

Most of the work has been down for nearly 2 years and where the traffic is well distributed and moderate, it has been a success, but under concentrated bullock cart traffic there are distinct signs of waviness and even of breaking. The conclusion arrived at is that this form of surface is suitable for moderate and well distributed traffic, but will not stand up to very heavy concentrated bullock cart traffic, as during the hot weather it gets soft and the carts moving in one continuous line form ruts, sections cut through these ruts show that the movement is entirely in the surface coat and not in the foundation. A further disadvantage is that generally before the surface coat can be laid, an under coat of water-bound metal is required which brings the cost in excess of that of cement concrete.

3. *Grouting.*—Consists in laying a 3" coat of stone and pouring bitumen heated to 350° in kettles at the rate of 1.75 gallons per square yard after consolidation of a seal coat of .5 gallon per square yard is given.

The costs work out as follows :—

T. R. A. grout Rs. 3 to Rs. 3-12-0 per square yard.

Mexphalte grout Rs. 2-14-0 to Rs. 3-6-0 per square yard.

Pitch and Tar grout Rs. 3-4-0 per square yard.

The resulting surface under moderate traffic on a 16' road has been a success but on a 24' road under heavy traffic where carts are not diverted from one line, the surface ruts badly being too plastic in the hot weather. The rutting is more noticeable in T. R. A. than in Mexphalte and the latter gives a harder surface. From the excessive bleeding of T. R. A., I am inclined to think that the amount of bitumen poured is excessive and I am trying to overcome this by reducing the quantities of grout and seal to 1.5 and .3 gallons per square yard.

The short length of pitch and tar has not proved a great success as it is breaking up, but a length laid in the Cawnpore municipality seems to be standing better.

In conclusion I consider that grouting is suitable up to 16' width for moderate traffic, but should be avoided in greater widths where heavy bullock cart traffic is likely to be met with.

4. *Painting*.—Consists in pouring hot bitumen or tar over the consolidated water-bound surface at a rate of .5 gallon per square yard. The cost for one coat of bitumen or two coats of tar is about 0-8-0 annas per square yard.

Tar painting on a kankar surface is excellent for light traffic and has been tried with success in Lucknow on the Mall; it gives a dustless surface and prolongs the life of the metal surface below.

T. R. A. has been tried on kankar and stone, it is equally successful under light traffic, but under bullock cart traffic it is apt to peel off owing to the grinding of the cart wheels forming a layer of dust between the paint and the water-bound coat.

Spramex paint has been used extensively on stone and after 9 months is holding well, though there have been cases where it has peeled off the same as T. R. A. Asphaltum tried on stone under light traffic has been down for 3 years with only one repaint after 2 years. The conclusions so far arrived at are that Road Board Tar No. 1 is undoubtedly the best for a kankar road; and that bitumen paint prolongs the life of a stone mile provided the traffic is not excessive, and if it can be prevented from peeling off will, in the course of time, with renewals, form a wearing surface over the water-bound metal.

5. *Mexaco*.—Prepared by Road Oil Company Limited, Calcutta, is a combination of bitumen and oil containing 65% bitumen. It is applied cold and the makers claim that it penetrates the surface and forms an efficient binder to water-bound surfaces. This material has the great advantage that it can be applied cold and does not require any expensive plant. The cost works out at 0-6-0 annas per square yard and one gallon covers $2\frac{1}{2}$ to 3 square yards on the first application.

Several miles have been tried, but the first has only been done 7 months back and it is too early to say whether it will be a success, but it undoubtedly penetrates, binds the metal together and does not peel off like bitumen paint. Under light traffic it gives a good and dustless travelling surface, whilst under heavy traffic it seems to give better results than bitumen paint. In my opinion it is likely to prove a success specially on rough stone roads where the surface binding frequently works loose and blows away. Whether a second coat of Mexaco or bitumen will give the best results remains to be proved; experiments are being tried.

Experiments are being tried with Mexaco on kankar, but so far there does not appear to be much penetration and I am not prepared to say what the result will be like.

PUNJAB.*

The following table shows the progress made to date with improved forms of road surfaces on the arterial roads in this province :—

Nature of surface:	Mileage on 1st January 1927.	Mileage on 31st December 1927.
Stone metal, bitumen sprayed	9.755	9.965
Stone metal, tar sprayed	37.555	47.94
Stone metal, tar and bitumen sprayed	1.00	1.00
Stone metal, bitumen grouted, but left unsealed	2.97	37.645
Stone metal, bitumen grouted and sealed	4.875	16.88
Brick metal, bitumen grouted and sealed	Nil	23.125
Brick metal, bitumen grouted, but left unsealed	Nil	4.25
Whole brick, dipped in bitumen, laid as a pavement and surface sealed	Nil	0.25
Sand carpet	0.60	4.50
Total	56.755	145.555]

I have also made enquiries regarding the work carried out by municipalities and although tar spraying and bitumen painting have been done in a number of places I do not think there is anything of special interest to report.

In 1923-25 a number of experiments were tried on the Grand Trunk Road near Lahore, but unfortunately I have not been able to trace any official report

* Letter from the Deputy Chief Engineer, Public Works Department, Buildings and Roads Branch, Punjab.

on the result of these experiments. The following statement, showing the results so far as they could recently be ascertained, may be of interest :—

Experiment lengths of road surfacings laid in miles 306 and 309 of the Grand Trunk Road in 1923—25.

Number of section.	Locality. Mile/ furlong.	Area. Sq. yds.	Treatment.	Remarks. (January 1928).
1	<u>305</u> 1	694	Tar painting over Pathankot metal in February 1924 and repainted in August 1924.	The traffic over these experimental sections was reckoned as 315 tons per yard width per day. Mr. G. Gilbert, the officer in charge of the work, reports that with the exception of the bitumen penetration in furlong 306/2 all sections wore very badly and that by September 1926 the surfaces were so bad that they had to be coated with 1½-in. of sand carpet.* This carpet has since broken up in a number of places and has had to be repaired. It is now (January 1928) fairly hard, but wavy throughout, and in the hot weather it becomes soft and spreads on to the berms.
2	<u>305</u> 1	525	Tar and bitumen in equal proportions painting over Pathankot metal (August 1924).	
3	<u>305</u> 2	590	Bitumen painting over Pathankot metal in February 1924.	
4	<u>305</u> 2	611	Bitumen painting over a coat of crude oil on Pathankot metal (February 1924).	
5	<u>305</u> 3	400	Tar and bitumen in equal proportions painted over cement-grouted Pathankot metal (September 1924).	
6	<u>305</u> 3	394	Tar painting over cement-grouted Pathankot metal (September 1924).	
7	<u>305</u> 3	346	Jhama-brick ballast† grouted with mastic composed of equal parts by weight of sand and bitumen applied at the rate of 1.54 gallon mastic to the square yard (April 1924).	
8	<u>305</u> 4	144	Pathankot metal† grouted with the same mastic as above but applied at the rate of 1.47 gallons to the square yard (April 1924).	
9	<u>305</u> 4	109	Ditto—mastic applied at the rate of 1.77 gallons to the square yard (April 1924).	
10	<u>305</u> 4	398	Ditto—mastic applied at the rate of 1.39 gallons to the square yard (December 1924).	

* The sand carpet consisted of 49 parts by weight of Pathankot sand, 25 parts of ¼" to ½" stone chips, 16 parts of Portland cement and 10 parts of bitumen (E. Grade Mexphalte in sections 1—11 and 104 Grade Sacony bitumen elsewhere).

† A 3-in. coat broken to 2-in. gauge.

Number of section.	Locality. Mile/furlong.	Area. Sq. yds.	Treatment.	Remarks. (January 1928).
11	$\frac{305}{4-5}$	909	Glutrin and Pathankot metal (December 1923).	This was renewed in March 1926, with water-bound Serai-kala stone tar painted (2 coats) and again painted in May 1927. It is now (January 1928) in very good order. Resurfaced with water-bound Serai-kala stone metal and tar painted in March 1927. Including the sand carpet has broken up completely. The original surface is now very wavy. The sand carpet slides over the concrete and in places has spread 18-in. across the berm. The thickness is only $\frac{1}{2}$ -in. in places, surface very uneven. Surface hard but uneven. The thickness of the carpet varies from $\frac{3}{4}$ " to 2". This also has spread on to the berms. Renewed February 1927.
12	$\frac{305}{5}$	1,311	Glutrin and limestone (January 1924).	
13	$\frac{308}{1}$	176	Serai-kala limestone, water-bound macadam (March 1924).	
14	$\frac{308}{1-2}$	293	Nalagarh stone, water-bound macadam (July 1925).	
15	$\frac{308}{2}$	165	Penetration 1.5 gallons of Socony bitumen per square yard of $4\frac{1}{2}$ in. Pathankot quartzite metal broken to $1\frac{1}{2}$ in. gauge sealed with 0.5 gallon bitumen per square yard and gritted (March 1923).	
16	$\frac{308}{2}$	165	Same as section No. 15 but with a second sealing coat of 0.3 gallon bitumen per square yard (March 1923).	
17	$\frac{308}{2}$	43	Same as Section No. 15 ..	
18	$\frac{308}{2}$	267	6-in. plain cement concrete slab (1 : 2 : 4).	
19	$\frac{308}{2}$	178	6-in. reinforced* concrete slab (1 : 2 : 4).	
20	$\frac{308}{2}$	178	6-in. plain cement concrete slab laid in two courses upper $1\frac{1}{2}$ -in. (1 : 2 : 2 $\frac{1}{2}$) lower course (1 : 2 : 5).	
21	$\frac{308}{3}$	178	3-in. plain cement concrete slab (1 : 2 : 4).	
22	$\frac{308}{3}$	220	2-in. asphalt carpet consisting of 80 parts by weight of Pathankot sand, 10 parts of canal silt and 10 parts of E. Grade Socony bitumen (December 1923).	
23	$\frac{308}{3}$	..	Water-bound macadam (April 1924).

* The reinforcement consisted of $\frac{1}{2}$ -in. diameter rods, 2 ft. 6-in. apart, 2-in. below the surface.

As a result of these experiments it was decided that bitumen-treated roads had a better chance of standing up to bullock cart traffic than concrete roads and consequently recent experiments have been restricted to using various grades of bitumen. The following give particulars of some of the specifications to which we have worked with analysis of cost. It is, however, too soon yet to draw any general deductions from the condition of the surfaces:—

Trinidad Asphalt (unsealed).

Position of work.	Date when laid.	Specification.	Analysis of cost per 100 sq. ft.
Amritsar-Bajjnath Road. Furlongs 3.5 of mile 44 (12 ft. wide).	April 1925	Penetration 1.25 gallons (15-5/8 lb.) of Trinidad asphalt with 25% of flux oil per sq. yd. of 3-in. of Pathankot quartzite broken to 1½ in. gauge, no sealing coat.	Rs. a. p.
			25 c. ft. ballast at 6 4 0 25 per 100 c. ft. 6½ c. ft. bajri at 2 8 0 40 per 100 c. ft. 139 lb. asphalt at 17 6 0 14 per cwt. 35 lb. flux oil at 5 5 0 17 per cwt. Consolidation 1 0 0 Labour and fuel 1 1 0 in heating, mixing and applying.
Actual cost per 100 sq. ft.			33 8 0
Actual cost per sq. yd.			3 0 6

Socony Mastic (unsealed).

Position of work.	Date when laid.	Specification.	Analysis of cost per 100 sq. ft.
Amritsar-Bajjnath Road. Furlongs 6.8 of mile 44 (12 ft. wide).	April 1925	Penetration 1.75 gallons (27 lb.) mastic consisting of equal parts by weight of sand and Socony bitumen on each sq. yd. of 3-in. of Pathankot quartzite broken to 1½ in. gauge, no sealing coat.	Rs. a. p.
			25 c. ft. ballast at 6 4 0 25 per 100 c. ft. 6½ c. ft. bajri at 2 8 0 40 per 100 c. ft. 1½ c. ft. sand at 0 4 0 15 per 100 c. ft. Consolidation 1 0 0 150 lb. bitumen at 15 0 0 Re. 1 per cwt. Labour and fuel 1 1 0 in heating, mixing and applying.
Actual cost per 100 sq. ft.			26 1 0
Actual cost per sq. yd.			2 5 6

Mexphalte sealed with Spramex.

Position of work.	Date when laid.	Specification.	Analysis of cost per 100 sq. ft.														
Grand Trunk Road approaches to Ravi Bridge in miles 3 and 4 (28 ft. and 24 ft. wide).	December 1926 to January 1927.	Penetration 1.5 gallons (15½ lb.) of Mexphalte with a sealing coat of 0.3 gallon (3½ lb.) of Spramex per sq. yd. on 3-in. of Serai-kala stone broken to 2-in. gauge.	<table style="width: 100%; border-collapse: collapse;"> <tr> <td></td> <td style="text-align: right;">Rs. A. P.</td> </tr> <tr> <td>25 c. ft. ballast at Rs. 30 per 100 c. ft.</td> <td style="text-align: right;">7 8 0</td> </tr> <tr> <td>8 c. ft. bajri at Rs. 30 per 100 c. ft.</td> <td style="text-align: right;">2 6 0</td> </tr> <tr> <td>17 gall. (177 lb.) Mexphalte at Rs. 8 per cwt.</td> <td style="text-align: right;">12 10 0</td> </tr> <tr> <td>3.3 gall. (35 lb.) Spramex at Rs. 8 per cwt.</td> <td style="text-align: right;">2 7 0</td> </tr> <tr> <td>Consolidation ..</td> <td style="text-align: right;">1 0 0</td> </tr> <tr> <td>Labour and fuel in heating, mixing and applying.</td> <td style="text-align: right;">2 8 0</td> </tr> </table>		Rs. A. P.	25 c. ft. ballast at Rs. 30 per 100 c. ft.	7 8 0	8 c. ft. bajri at Rs. 30 per 100 c. ft.	2 6 0	17 gall. (177 lb.) Mexphalte at Rs. 8 per cwt.	12 10 0	3.3 gall. (35 lb.) Spramex at Rs. 8 per cwt.	2 7 0	Consolidation ..	1 0 0	Labour and fuel in heating, mixing and applying.	2 8 0
	Rs. A. P.																
25 c. ft. ballast at Rs. 30 per 100 c. ft.	7 8 0																
8 c. ft. bajri at Rs. 30 per 100 c. ft.	2 6 0																
17 gall. (177 lb.) Mexphalte at Rs. 8 per cwt.	12 10 0																
3.3 gall. (35 lb.) Spramex at Rs. 8 per cwt.	2 7 0																
Consolidation ..	1 0 0																
Labour and fuel in heating, mixing and applying.	2 8 0																
Actual cost per 100 sq. ft.			.. 28 7 0														
Actual cost per sq. yd.			.. 2 9 0														

Surface tarring has so far proved most satisfactory and the following analysis of the rates in Lahore may be useful :—

Item.	Rate.	First coat.		Second coat.	
		Quantity.	Cost.	Quantity.	Cost.
	Rs. A. P.		Rs. A. P.		Rs. A. P.
Tar	9 11 0 per cwt.	0.25 cwt.	2 7 0	0.08 cwt.	0 12 6
Grit	40 0 0 per 100 c. ft.	1 c. ft.	0 6 6	1 c. ft.	0 6 6
Sand	8 0 0 ditto.	2 c. ft.	0 2 6	2 c. ft.	0 2 6
Fuel and labour in heating and rolling.	..	..	0 9 0	..	0 4 6
		First coat.		Succeeding coats.	
	Total cost per 100 sq. ft.		3 9 0		1 10 0

BURMA.*

PUBLIC WORKS DEPARTMENT.

The province of Burma has about 100 miles of roads with tarred and bituminous surfaces. There are many of these which have been laid 15 years ago and have stood up to exceedingly heavy traffic. They were made by applying a carpet of oil pitch on the water-bound surface soon after it had been consolidated; this pitch was a waste product in those days, but is now not being made by the oil companies as their existing processes do not produce the same pitch, but another which is not satisfactory.

Such roads which have been made of late have been treated with a mixture of Shalimar pitch and coal tar or Socony road pitch. The cost varies according to the penetration into the metalled surface, dependent on the quality of stone used and the period intervening between the construction of the road and the application of the grouted carpet.

The grouting costs from Rs. 10 to Rs. 16 per 100 sq. ft. which lasts for 2 or 3 years after which a yearly renewal coat costs about Rs. 3 per 100 sq. ft.

The results are found to be eminently satisfactory in that they prevent dust and keep the stones in position until they are worn away by traffic.

Particularly no other kinds of bituminous road construction have been undertaken in this province.

RANGOON CORPORATION.†

Prior to 1910 the roads of Rangoon consisted for the most part of varying widths of metalled surface on a very inadequate foundation composed mainly of laterite and in some cases broken brick. The application of tar, as a dust layer, had been tried, but the quality of the tar obtainable then was not suitable for road work, and the surfaces deteriorated very rapidly with the advent of the rainy season. It was about that time that the writer first considered the use of what is now known as residual bitumen, as a grouting or binding agent for macadam roads, and the Burma Oil Company through their Chief Chemist, Mr. Allen, was approached in order to determine if the residue from the refining stills, which at that time was considered as waste, could be utilised for road work.

Many trials were made with this material and eventually a "pitch" was obtained with which the writer experimented successfully on certain roads, so that it was decided to extend considerably the use of it.

Meanwhile in 1911 the Rangoon Municipality embarked on a programme of road reconstruction, with Val de Travers Asphalte on cement concrete foundations in the business quarters and stone sett paving for the heaviest trafficked roads in the vicinity of the docks and railway. Certain contracts were entered into and resulted in the laying of 2.34 miles of road 50 feet wide between kerbs with asphalte, and 1.14 miles of stone sett paving. The war

* Note by the Chief Engineer, Public Works Department, Burma.

† Note by the Chief Engineer, Rangoon Corporation.

then put an effectual stop to further work of this nature, and in 1919 the roads of Rangoon could be classified as follows :—

Metalled Roads	..	..	..	..	79.04 miles.
Laterite Roads	..	..	..	..	3.43 „
Wood paved Roads	..	..	..	..	0.31 „
Asphalt Roads	..	..	..	..	2.74 „
Kutchia Roads	..	..	..	..	11.42 „
Tarred Roads	..	..	..	..	3.23 „
Bitumen grouted	..	..	..	..	1.00 „
Granite setts	..	..	..	..	1.14 „
					<hr/>
				Total	.. 102.31 „
					<hr/>

Today, 1928, the classification is :—

Metalled Roads	..	..	..	..	30.14 miles.
Laterite Roads	..	..	..	..	7.79 „
Asphalte Roads	..	..	..	..	2.74 „
Kutchia Roads	..	..	..	..	4.66 „
Tarred Roads	..	..	..	..	61.95 „
Bitumen Roads	..	..	..	..	19.90 „
Granite setts	..	..	..	..	2.67 „
Concrete	..	..	..	..	0.17 „
					<hr/>
				Total	.. 130.02 „
					<hr/>

In 1920 the necessity for more or less wholesale reconstruction of the main roads was recognised, and the work of such reconstruction commenced. In Rangoon, particular attention has been directed to the strengthening of the foundations and improving the drainage of surface and subsoil water, and the form of construction which has been most generally adopted, with so far excellent results, has been the provision of new foundations consisting of stone trap, hand packed to a consolidated depth of from 10" to 12" surfaced with road metal consolidated to 4" depth and grouted with a mixture composed of two parts bitumen to one part fine sand or granite dust. This mixture is applied in the following manner. The metal after spreading is steam rolled to the required camber, and the bitumen, after melting and heating to a temperature of about 240° F., has mixed with it in ordinary buckets, a 50% proportion of fine sand or granite dust—preferably the latter if available—which has also been heated to about the same temperature as the bitumen. The

mixture after thorough stirring is applied through hand pouring cans to the metalled surface, the covering area being about .6 square yard per gallon. Stone chips are then spread evenly over the surface, which is finally steam rolled, when the road can be opened to traffic. The grout as applied in this manner has a penetration of about $2\frac{1}{2}$ inches; and after the road has been subjected to traffic conditions for a month or so, a sealing coat of bitumen or road tar may be given. This type of road may well be termed "Bitumastic macadam", and the lasting qualities of it have already been proved in this city, where roads so reconstructed in 1920 are still in excellent condition, and require very little attention for maintenance. The surface is resilient, clean, non-slippery and dust proof.

In addition to the Burma Oil Company, the British Burma Oil Company Limited, as advised by the writer, has succeeded in producing a residual asphalt or bitumen, which is of excellent quality for this class of work.

Asphalt roads.

The roads classified under this head consist of 2" thick paving of Val de Travers Asphalt (powder) laid on a foundation of cement concrete 6" thick. While the success of this kind of road cannot be denied, as they have had a useful life of over 15 years, yet their first cost is high, being Rs. 2 per square ft. for the asphalt alone, and maintenance charges have been heavy owing to the destructive effect on them of bullock and hand cart traffic, the narrow iron tyred wheels of which cause undue wear through biting and twisting action when in motion. Also it is difficult to obtain asphalt powder with the correct proportion of bitumen to suit the varying conditions of this climate, and for economic reasons, this form of road construction has not been proceeded with.

Granite sett paving.

This type of road is very suitable for roads in the vicinity of docks and railway where bullock, hand cart and heavy motor lorry traffic abounds. The construction consists of a foundation of 8" thick cement concrete, reinforced if necessary, and granite stone setts laid thereon with a 1" sand cushion between. The granite setts, which measure approximately $9" \times 5" \times 3"$ and are obtained from India, are laid with joints as close as possible and these joints are flush grouted with a 2:1 fluid cement mortar. This form of pavement requires little or no attention for maintenance, roads which were so paved in the year 1912 are still in excellent condition and the maintenance charges on them have been practically nil.

Tarring.

As will be noted from a comparison of the 1928 classification with that of 1919, there has been a very considerable increase in the mileage of tar painted roads. Until recently it has been customary to use a tar obtainable from India, which conforms in every respect with the Road Board Specification for Tar No. 2, but it has always been realised that even this tar will volatilise and emulsify under the extreme monsoon conditions prevailing in Burma, and for the treatment of city streets it was not effective.

With bitumen becoming more readily available it is now usual to add to the tar 30 % by measure of bitumen which reinforces the former against the effects of damp. The provision of a really water-proof surface is thus obtained, and the use of tar alone is no longer economical.

BIHAR AND ORISSA, CENTRAL PROVINCES AND ASSAM.

In Bihar and Orissa there is little development of this nature to report. In the Central Provinces, *vide* the reply of that Government to question A. 6 of the questionnaire, the need for improved road surfaces has not at present been felt. In Assam again there is little to report.

GENERAL.

Improvement of unsurfaced roads.

The need for the improvement of unmetalled roads is also receiving attention at the present time. When it is remembered that some seventy per cent of the mileage of roads in charge of the Public Works Department and of district boards and councils, is unmetalled, and that in addition there is a large mileage of unmetalled roads in charge of minor local bodies and villagers, the importance of the subject will be realised. The main defects are inadequate drainage and soil unsuitable to carry loads. Attempts are being made in some provinces to deal with the former evil by schemes of remodelling and drainage, in the execution of which graders and other plant are being tested : the results as far as they go are encouraging but experience is at present very limited. Some work has also been done but to a still more limited extent upon the blending of soils to produce "sand-clay" and other improved surfaces.

Suggested policy regarding road research.

The above review of what has been done and what is being done with improved forms of road surface suggests the need of a central clearing house for information. It appeared from the evidence before the Committee and from the discussions of the touring sub-committee that the need for such a clearing house is generally accepted, and further that the Government of India might legitimately apply part of the funds at its disposal to subsidising research initiated by local Governments or by themselves. Some apprehension was however expressed lest central machinery for research be created on grandiose lines and result in heavy expenditure on academic investigations. This apprehension is possibly satisfied in that expenditure in this direction will be largely subject to the advice of the periodical road conference which will be able to appoint a technical sub-committee to consider proposals.

Subject to this advice, it appears probable that funds will be available for meeting the cost, wholly or in part, of experimental work in the field to be carried out by provincial road authorities ; for the provision of additional apparatus at Alipore and in other laboratories ; and for the publication, in periodical literature or special pamphlets, of information likely to be of use to road authorities, on road materials, road plant, road surfaces, and the effect of different classes of traffic, in India and other countries

APPENDIX V.

Federal Highway Act of 1921 of the United States of America.

An Act to amend the Act entitled "An Act to provide that the United States shall aid the States in the construction of rural post roads, and for other purposes," approved July 11, 1916, as amended and supplemented, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the Federal Highway Act. Federal Highway Act.

SEC. 2. That, when used in this Act, unless the context indicates otherwise— Meaning of terms.

The term "Federal Aid Act" means the Act entitled "An Act to provide that the United States shall aid the States in the construction of rural post roads, and for other purposes," approved July 11, 1916, as amended by sections 5 and 6 of an Act entitled "An Act making appropriations for the service of the Post Office Department for the fiscal year ending June 30, 1920, and for other purposes," approved February 28, 1919, and all other Acts amendatory thereof or supplementary thereto. "Federal Aid Act."

The term "highway" includes rights of way, bridges, drainage structures, signs, guard rails, and protective structures in connection with highways, but shall not include any highway or street in a municipality having a population of two thousand five hundred or more as shown by the last available census, except that portion of any such highway or street along which within a distance of one mile the houses average more than two hundred feet apart. "Highway. Limitation."

The term "State highway department" includes any State department, commission, board, or official having adequate powers and suitably equipped and organized to discharge to the satisfaction of the Secretary of Agriculture the duties herein required. "State highway department."

The term "maintenance" means the constant making of needed repairs to preserve a smooth surfaced highway. "Maintenance."

The term "construction" means the supervising, inspecting, actual building, and all expenses incidental to the construction of a highway, except locating, surveying, mapping, and costs of rights of way. "Construction."

The term "reconstruction" means a widening or a rebuilding of the highway or any portion thereof to make it a continuous road, and of sufficient width and strength to care adequately for traffic needs. "Reconstruction."

The term "forest roads" means roads wholly or partly within or adjacent to and serving the national forests. "Forest roads."

The term "State funds" includes for the purposes of this Act funds raised under the authority of the State, or any political or other subdivision thereof, and made available for expenditure under the direct control of the State highway department. "State funds."

SEC. 3. All powers and duties of the Council of National Defense under the Act entitled "An Act making appropriations for the support of the Council of National Defense.

Powers of, in locating highways, etc., transferred to Secretary of Agriculture. National parks, military and naval reservations. Control of highways in, not disturbed.

Army for the fiscal year ending June 30, 1917, and for other purposes," approved August 29, 1916, in relation to highway or highway transport, are hereby transferred to the Secretary of Agriculture, and the Council of National Defense is directed to turn over to the Secretary of Agriculture the equipment, material, supplies, papers, maps, and documents utilized in the exercise of such powers. The powers and duties of agencies dealing with highways in the national parks or in military or naval reservations under the control of the United States Army or Navy, or with highways used principally for military or naval purposes, shall not be taken over by the Secretary of Agriculture, but such highways shall remain under the control and jurisdiction of such agencies.

Indian reservations. Cooperative road construction in.

The Secretary of Agriculture is authorized to cooperate with the State highway departments, and with the Department of the Interior in the construction of public highways within Indian reservations, and to pay the amount assumed therefor from the funds allotted or apportioned under this Act to the State wherein the reservation is located.

Accounting division established.

SEC. 4. That the Secretary of Agriculture shall establish an accounting division which shall devise and install a proper method of keeping the accounts.

Surplus Army road construction materials, etc., transferred.

SEC. 5. That the Secretary of War be, and he is hereby, authorized and directed to transfer to the Secretary of Agriculture, upon his request, all war material, equipment, and supplies now or hereafter declared surplus from stock now on hand and not needed for the purposes of the War Department but suitable for use in the improvement of highways, and that the same shall be distributed among the highway departments of the several States to be used in the construction, reconstruction, and maintenance of highways, such distribution to be upon the same basis as that hereinafter provided for in this Act in the distribution of Federal-aid fund: *Provided*, That the Secretary of Agriculture, in his discretion, may reserve from such distribution not to exceed 10 per centum of such material, equipment, and supplies for use in the construction, reconstruction, and maintenance of national forest roads or other roads constructed, reconstructed, or maintained under his direct supervision.

Distribution for State use.

Proviso. Reservation for national forests, etc.

Interstate highways systems. Preference to projects for connected, etc.

SEC. 6. That in approving projects to receive Federal aid under the provisions of this Act the Secretary of Agriculture shall give preference to such projects as will expedite the completion of an adequate and connected system of highways, interstate in character.

Mileage to be designated by States.

Before any projects are approved in any State, such State, through its State highway department, shall select or designate a system of highways not to exceed 7 per centum of the total highway mileage of such State as shown by the records of the State highway department at the time of the passage of this Act.

Federal aid thereto.

Upon this system all Federal-aid apportionments shall be expended.

Classification of highways.

Highways which may receive Federal aid shall be divided into two classes, one of which shall be known as primary or interstate highways, and shall not

exceed three-sevenths of the total mileage which may receive Federal aid, and the other which shall connect or correlate therewith and be known as secondary or intercounty highways, and shall consist of the remainder of the mileage which may receive Federal aid.

The Secretary of Agriculture shall have authority to approve in whole or in part the systems as designated or to require modifications or revisions thereof: *Provided*, That the States shall submit to the Secretary of Agriculture for his approval any proposed revisions of the designated systems of highways above provided for.

Approval, etc., of systems. *Provido*. Proposed revisions.

Not more than 60 per centum of all Federal aid allotted to any State shall be expended upon the primary or interstate highways until provision has been made for the improvement of the entire system of such highways: *Provided*, That with the approval of any State highway department the Secretary of Agriculture may approve the expenditure of more than 60 per centum of the Federal aid apportioned to such State upon the primary or interstate highways in such State.

Limitation until entire system provided for. *Provido*. Additional to primary highways.

The Secretary of Agriculture may approve projects submitted by the State highway departments prior to the selection, designation, and approval of the system of Federal-aid highways herein provided for if he may reasonably anticipate that such projects will become a part of such system.

Approval of prior project permitted.

Whenever provision has been made by any State for the completion and maintenance of a system of primary or interstate and secondary or intercounty highways equal to 7 per centum of the total mileage of such State, as required by this Act, said State, through its State highway department, by and with the approval of the Secretary of Agriculture, is hereby authorized to add to the mileage of primary or interstate and secondary or intercounty systems as funds become available for the construction and maintenance of such additional mileage.

Additional mileage construction authorized when completion of 7 per cent provide for.

Sec. 7. That before any project shall be approved by the Secretary of Agriculture for any State such State shall make provisions for State funds required each year of such States by this Act for construction, reconstruction, and maintenance of all Federal-aid highways within the State, which funds shall be under the direct control of the State highway department.

State to provide funds for construction before projects may be approved

Sec. 8. That only such durable types of surface and kinds of materials shall be adopted for the construction and reconstruction of any highway which is a part of the primary or interstate and secondary or intercounty systems as will adequately meet the existing and probable future traffic needs and conditions thereon. The Secretary of Agriculture shall approve the types and width of construction and reconstruction and the character of improvement, repair, and maintenance in each case, consideration being given to the type and character which shall be best suited for each locality and to the probable character and extent of the future traffic.

Adequate construction materials, etc., required

Approval of types, etc., by Secretary

Sec. 9. That all highways constructed or reconstructed under the provisions of this Act shall be free from tolls of all kinds.

Freedom from tolls.

Width of roadway, etc.

That all highways in the primary or interstate system constructed after the passage of this Act shall have a right of way of ample width and a wearing surface of an adequate width which shall not be less than eighteen feet, unless, in the opinion of the Secretary of Agriculture, it is rendered impracticable by physical conditions, excessive costs, probable traffic requirements, or legal obstacles.

Apportionment available on certificate from governor of action of State.

SEC. 10. That when any State shall have met the requirements of this Act, the Secretary of the Treasury, upon receipt of certification from the governor of such State to such effect, approved by the Secretary of Agriculture, shall immediately make available to such State, for the purpose set forth in this Act, the sum apportioned to such State as herein provided.

Submission of proposed projects.

SEC. 11. That any State having complied with the provisions of this Act, and desiring to avail itself of the benefits thereof, shall by its State highway department submit to the Secretary of Agriculture project statements setting forth proposed construction or reconstruction of any primary or interstate, or secondary or intercounty highway therein. If the Secretary of Agriculture approve the project, the State highway department shall furnish to him such surveys, plans, specifications, and estimates therefor as he may require; items included for engineering, inspection, and unforeseen contingencies shall not exceed 10 per centum of the total estimated cost of its construction:

Plans, etc., if project approved.

Notification of approval, etc.

That when the Secretary of Agriculture approves such surveys, plans, specifications, and estimates, he shall notify the State highway department and immediately certify the fact to the Secretary of the Treasury. The Secretary of the Treasury shall thereupon set aside the share of the United States payable under this Act on account of such projects, which shall not exceed 50 per centum of the total estimated cost thereof, except that in the case of any State containing unappropriated public lands exceeding 5 per centum of the total area of all lands in the State, the share of the United States payable under this Act on account of such projects shall not exceed 50 per centum of the total estimated cost thereof plus a percentage of such estimated cost equal to one-half of the percentage which the area of the unappropriated public lands in such State bears to the total area of such State: *Provided*, That the limitation of payments not to exceed \$20,000 per mile, under existing law, which the Secretary of Agriculture may make be, and the same is hereby, increased in proportion to the increased percentage of Federal aid authorized by this section: *Provided further*, That these provisions relative to the public-land States shall apply to all unobligated or unmatched funds appropriated by the Federal Aid Act and payment for approved projects upon which actual building construction work had not begun on the 30th day of June, 1921.

Amount to be set aside therefor.

In public land States.

Provisos. Limit increased.

Applicable to unused funds.

Construction, etc., by State highway departments.

Approval by Secretary, etc.

SEC. 12. That the construction and reconstruction of the highways or parts of highways under the provisions of this Act, and all contracts, plans, specifications, and estimates relating thereto, shall be undertaken by the State highway departments subject to the approval of the Secretary of Agriculture. The construction and reconstruction work and labor in each State shall be done in accordance with its laws and under the direct supervision of the State highway department, subject to the inspection and approval of the Secretary of Agriculture and in accordance with the rules and regulations pursuant to this Act.

SEC. 13. That when the Secretary of Agriculture shall find that any project approved by him has been constructed or reconstructed in compliance with said plans and specifications, he shall cause to be paid to the proper authorities of said State the amount set aside for said project.

Payment on completion of project.

That the Secretary of Agriculture may, in his discretion, from time to time, make payments on such construction or reconstruction as the work progresses, but these payments, including previous payments, if any, shall not be more than the United States pro rata part of the value of the labor and materials which have been actually put into such construction or reconstruction in conformity to said plans and specifications. The Secretary of Agriculture and the State highway department of each State may jointly determine at what time and in what amounts payments as work progresses shall be made under this Act.

Advances allowed during construction.

Determination of payments.

Such payments shall be made by the Secretary of the Treasury, on warrants drawn by the Secretary of Agriculture, to such official or officials or depository as may be designated by the State highway department and authorized under the laws of the State to receive public funds of the State.

Method of payments.

SEC. 14. That should any State fail to maintain any highway within its boundaries after construction or reconstruction under the provisions of this Act, the Secretary of Agriculture shall then serve notice upon the State highway department of that fact, and if within ninety days after receipt of such notice said highway has not been placed in proper condition of maintenance, the Secretary of Agriculture shall proceed immediately to have such highway placed in a proper condition of maintenance and charge the cost thereof against the Federal funds allotted to such State, and shall refuse to approve any other project in such State, except as hereinafter provided.

Service of notice to State on failure to maintain highway. Procedure if not attended to.

Other projects to be refused.

Upon the reimbursement by the State of the amount expended by the Federal Government for such maintenance, said amount shall be paid into the Federal highway fund for reapportionment among all the States for the construction of roads under this Act, and the Secretary of Agriculture shall then approve further projects submitted by the State as in this Act provided.

Action if reimbursement by the State.

Whenever it shall become necessary for the Secretary of Agriculture under the provisions of this Act to place any highway in a proper condition of maintenance the Secretary of Agriculture shall contract with some responsible party or parties for doing such work: *Provided, however,* That in case he is not able to secure a satisfactory contract he may purchase, lease, hire, or otherwise obtain all necessary supplies, equipment, and labor, and may operate and maintain such motor and other equipment and facilities as in his judgment are necessary for the proper and efficient performance of his functions.

Authority of Secretary to contract for repairs, etc.

Proviso. Work other than by contract.

SEC. 15. That within two years after this Act takes effect the Secretary of Agriculture shall prepare, publish, and distribute a map showing the highways and forest roads that have been selected and approved as a part of the primary or interstate, and the secondary or intercounty systems, and at least annually thereafter shall publish supplementary maps showing his program and the progress made in selection, construction, and reconstruction.

Map of approved systems, etc., to be prepared. Annual supplements.

SEC. 16. That for the purpose of this Act the consent of the United States is hereby given to any railroad or canal company to convey to the

Conveyance of public rights of way consented to.

highway department of any State any part of its right of way or other property in that State acquired by grant from the United States.

Use of public lands for rights of way or materials.

SEC. 17. That if the Secretary of Agriculture determines that any part of the public lands or reservations of the United States is reasonably necessary for the right of way of any highway or forest road or as a source of materials for the construction or maintenance of any such highway or forest road adjacent to such lands or reservations, the Secretary of Agriculture shall file with the Secretary of the department supervising the administration of such land or reservation a map showing the portion of such lands or reservations which it is desired to appropriate.

Application for.

Transfer to State authorities if not objected to.

If within a period of four months after such filing the said Secretary shall not have certified to the Secretary of Agriculture that the proposed appropriation of such land or material is contrary to the public interest or inconsistent with the purposes for which such land or materials have been reserved, or shall have agreed to the appropriation and transfer under conditions which he deems necessary for the adequate protection and utilization of the reserve, then such land and materials may be appropriated and transferred to the State highway department for such purposes and subject to the conditions so specified.

Reversion when no longer needed.

If at any time the need for any such lands or materials for such purposes shall no longer exist, notice of the fact shall be given by the State highway department to the Secretary of Agriculture, and such lands or materials shall immediately revert to the control of the Secretary of the department from which they had been appropriated.

Rules, etc., to be prescribed.

SEC. 18. That the Secretary of Agriculture shall prescribe and promulgate all needful rules and regulations for the carrying out of the provisions of this Act, including such recommendations to the Congress and the State highway departments as he may deem necessary for preserving and protecting the highways and insuring the safety of traffic thereon.

Annual detailed statements from Secretary.

SEC. 19. That on or before the first Monday in December of each year the Secretary of Agriculture shall make a report to Congress, which shall include a detailed statement of the work done, the status of each project undertaken, the allocation of appropriations, an itemized statement of the expenditures and receipts during the preceding fiscal year under this Act, an itemized statement of the travelling and other expenses, including a list of employees, their duties, salaries, and travelling expenses, if any, and his recommendations, if any, for new legislation amending or supplementing this Act. The Secretary of Agriculture shall also make such special reports as Congress may request.

Special report.

Appropriation for fiscal year 1922.

SEC. 20. That for the purpose of carrying out the provisions of this Act there is hereby appropriated, out of the moneys in the Treasury not otherwise appropriated, \$75,000,000 for the fiscal year ending June 30, 1922, \$25,000,000 of which shall become immediately available, and \$50,000,000 of which shall become available January 1, 1922.

Administration, etc., expenses to be deducted.

SEC. 21. That so much, not to exceed 2½ per centum, of all moneys hereby or hereafter appropriated for expenditure under the provisions of this Act, as the Secretary of Agriculture may deem necessary for administering

the provisions of this Act and for carrying on necessary highway research, and investigational studies independently or in cooperation with the State highway departments and other research agencies, and for publishing the results thereof, shall be deducted for such purposes, available until expended.

Within sixty days after the close of each fiscal year the Secretary of Agriculture shall determine what part, if any, of the sums theretofore deducted for such purposes will not be needed and apportion such part, if any, for the fiscal year then current in the same manner and on the same basis as are other amounts authorized by this Act apportioned among all the States, and shall certify such apportionment to the Secretary of the Treasury and to the State highway departments.

The Secretary of Agriculture, after making the deduction authorized by this section, shall apportion the remainder of the appropriation made for expenditure under the provision of the Act for the fiscal year among the several States in the following manner: One-third in the ratio which the area of each State bears to the total area of all the States; one-third in the ratio which the population of each State bears to the total population of all the States, as shown by the latest available Federal census; one-third in the ratio which the mileage of rural delivery routes and star routes in each State bears to the total mileage of rural delivery and star routes in all the States at the close of the next preceding fiscal year, as shown by certificate of the Postmaster General, which he is directed to make and furnish annually to the Secretary of Agriculture: *Provided*, That no State shall receive less than one-half of 1 per centum of each year's allotment. All moneys herein or hereafter appropriated for expenditure under the provisions of this Act shall be available until the close of the second succeeding fiscal year for which apportionment was made: *Provided further*, That any sums apportioned to any State under the provisions of the Act entitled "An Act to provide that the United States shall aid the States in the construction of rural post roads, and for other purposes," approved July 11, 1916, and all Acts amendatory thereof and supplemental thereto, shall be available for expenditure in that State for the purpose set forth in such Acts until two years after the close of the respective fiscal years for which any such sums become available, and any amount so apportioned remaining unexpended at the end of the period during which it is available for expenditure under the terms of such Acts shall be reapportioned according to the provisions of the Act entitled "An Act to provide that the United States shall aid the States in the construction of rural post roads, and for other purposes," approved July 11, 1916: *And provided further*, That any amount apportioned under the provisions of this Act unexpended at the end of the period during which it is available for expenditure under the terms of this section shall be reapportioned within sixty days thereafter to all the States in the same manner and on the same basis, and certified to the Secretary of the Treasury and the State highway departments in the same way as if it were being apportioned under this Act for the first time.

Sec. 22. That within sixty days after the approval of this Act the Secretary of Agriculture shall certify to the Secretary of the Treasury, and to each of the State highway departments the sum he has estimated to be deducted for administering the provisions of this Act and the sums which he

Apportionment of unexpended balances.

Ratio of apportionment.

To area.

To population.

To rural delivery and star routes mileage.

Provisos. Minimum. Available for succeeding year.

Apportionment under former laws available for two years.

Unexpended balances to be apportioned according to same laws.

Reapportionment of unexpended balances to States.

Certification of amounts apportioned for each

has apportioned to each State for the fiscal year ending June 30, 1922, and on or before January 20 next preceding the commencement of each succeeding fiscal year, and shall make like certificates for each fiscal year.

National forests. Appropriation for roads and trails in, for 1922 and 1923.

SEC. 23. That out of the moneys in the Treasury not otherwise appropriated, there is hereby appropriated for the survey, construction, reconstruction, and maintenance of forest roads and trails, the sum of \$5,000,000 for the fiscal year ending June 30, 1922, available immediately and until expended, and \$10,000,000 for the fiscal year ending June 30, 1923, available until expended.

Amount authorized for roads and trails of primary importance to national forests.

(a) Fifty per centum, but not to exceed \$3,000,000 for any one fiscal year, of the appropriation made or that may hereafter be made for expenditure under the provisions of this section shall be expended under the direct supervision of the Secretary of Agriculture in the survey, construction, reconstruction, and maintenance of roads and trails of primary importance for the protection, administration, and utilization of the national forests, or when necessary, for the use and development of resources upon which communities within or adjacent to the national forests are dependent, and shall be apportioned among the several States, Alaska, and Porto Rico by the Secretary of Agriculture, according to the relative needs of the various national forests, taking into consideration the existing transportation facilities, value of timber, or other resources served, relative fire danger, and comparative difficulties of road and trail construction.

To develop resources of adjacent communities, etc. Apportionment.

Balance for roads of primary importance to adjacent communities, etc. Apportionment.

The balance of such appropriations shall be expended by the Secretary of Agriculture in the survey, construction, reconstruction, and maintenance of forest roads of primary importance to the State, counties, or communities within, adjoining, or adjacent to the national forests, and shall be prorated and apportioned by the Secretary of Agriculture for expenditures in the several States, Alaska, and Porto Rico, according to the area and value of the land owned by the Government within the national forests therein as determined by the Secretary of Agriculture from such information, investigation, sources, and departments as the Secretary of Agriculture may deem most accurate.

Acceptance of State, etc., cooperation.

(b) Cooperation of Territories, States, and civil subdivisions thereof may be accepted but shall not be required by the Secretary of Agriculture.

Construction by States, etc.

(c) The Secretary of Agriculture may enter into contracts with any Territory, State, or civil subdivision thereof for the construction, reconstruction, or maintenance of any forest road or trail or part thereof.

Contracts for construction work.

(d) Construction work on forest roads or trails estimated to cost \$5,000 or more per mile, exclusive of bridges, shall be advertised and let to contract.

Work by the Secretary.

If such estimated cost is less than \$5,000 per mile, or if, after proper advertising, no acceptable bid is received, or the bids are deemed excessive, the work may be done by the Secretary of Agriculture on his own account; and for such purpose the Secretary of Agriculture may purchase, lease, hire, rent, or otherwise obtain all necessary supplies, materials, tools, equipment, and facilities required to perform the work.

Use of appropriations.

The appropriation made in this section or that may hereafter be made for expenditure under the provisions of this section may be expended for the

purpose herein authorized and for the payment of wages, salaries, and other expenses for help employed in connection with such work.

SEC. 24. That in any State where the existing constitution or laws will not permit the State to provide revenues for the construction, reconstruction, or maintenance of highways, the Secretary of Agriculture shall continue to approve projects for said State until three years after the passage of this Act, if he shall find that said State has complied with the provisions of this Act in so far as its existing constitution and laws will permit. Temporary approval of projects when State laws do not allow use of its funds.

SEC. 25. That if any provision of this Act, or the application thereof to any person or circumstances, shall be held invalid, the validity of the remainder of the Act and of the application of such provision to other persons or circumstances shall not be affected thereby. Invalidity of any provision, etc., not to affect remainder of Act.

SEC. 26. That all Acts or parts of Acts in any way inconsistent with the provisions of this Act are hereby repealed, and this Act shall take effect on its passage. Inconsistent laws repealed.

Approved, November 9, 1921.

CHECKED
2003-Q4

7490

Jayakar Committee
Indian Road
Development Committee
1927-28

Name of borrower

Lent on

Received
on

Sarwate 5-2-57

22

**SERVANTS OF INDIA SOCIETY'S LIBRARY
POONA 4.**

1. Books drawn from the library may not be retained for longer than a fortnight.
2. Borrowers will be held strictly responsible for any damage done to books while they are in their possession.