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## NOTE ON ROAD RESEARCH IN INDIA

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### REFERENCES

## A. INTRODUCTION

1. On an average, transport accounts for about a quarter of the total financial provision of national development plans of independent African countries and more than 80 per cent of this is allocated for the construction, improvement and maintenance of roads.
2. Expenditure on roads could be brought down if, through intensified research and the effective application of research findings, the costs of surfacing and foundations were reduced. Such research could also lead to further economies through the maximum use of low-cost local material as substitute for imported road building materials.
3. In this connexion attention is drawn to the following item of the work programme approved by the Commission at its VIIIth session which reads partly:

## "62. Description:

It is intended to undertake studies of the adequacy of existing facilities for road research in the region, and of the extent and problems of application of research results to road construction and design. The object of these studies will be to devise proposals and projects, where necessary, for strengthening road research and its utilization. This project ... will, it is expected, be greatly strengthened by the proposed establishment of an all-Africa road congress, the possibilities of which are now under examination..."

4. Throughout 1967 the secretariat of the Economic Commission for Africa was exploring the possibility of a study tour to a developing country outside Africa which offers a range of experience pertinent to these matters.
5. At the initiation of the secretariat, therefore, and in collaboration with the office of Technical Co-operation (OTC) and the Indian Government, ECA arranged a small team of African road engineers to visit India from 29 October to 21 November 1968 to attend a national seminar on roads and bridges and the 31st session of the Indian Roads Congress, followed by a short road development study tour to Madras State and New Delhi.
6. The secretariat had hoped to send a total of 9 road engineers, 2 from each of the 4 ECA sub-regions and one as conducting officer from ECA. The response from the countries invited was, however, disappointing and only 5 engineers, one from ECA and 4 from the following countries, actually took part: Chad, Congo (Brazzaville), Ethiopia and Sierra Leone.
7. The African participants first attended the National Seminar on the Design and Construction of Roads and Bridges, organized by the Indian Union Ministry of Transport and Shipping (Roads Wing), which was held at Bombay from 29 October to 2 November 1968.

8. The Seminar, the first of its kind in India, surveyed the progress achieved in the design and construction of roads and bridges throughout India during the last 20 years and also discussed the problems of future development in these fields.

9. Following the Seminar, the 31st session of the Indian Roads Congress was also held at Bombay from 2 to 9 November 1968. The Congress, which is the premier institution of highway engineers, was attended by about 600 engineers from all over India and a few from abroad and discussed a number of interesting papers relating to highways, bridges and traffic engineering. The Congress had organized technical exhibition where a number of firms and government departments took part, which was open to the public during the 31st session.

10. The African road engineers then went on a Road Development Study Tour and their first stop was at Madras where they inspected selected roads of particular interest and also visited the Indian Institute of Technology, the Highways Research Station, Chitram and Company (manufacturers of wide range of cranes) and the Ashok Leyland Limited (manufacturers of trucks).

11. In New Delhi the team visited the Central Road Research Institute, the secretariat of the Indian Roads Congress, the Union Ministry of Transport and Shipping (Roads Wing) and the Transport and Communications Division of the Planning Commission.

#### B. CENTRAL ROAD RESEARCH INSTITUTE

12. The Central Road Research Institute (New Delhi), which started research work in 1950, has as its governing body the Council of Scientific and Industrial Research and is thus attached to the Ministry of Education.

13. The main objectives of the Institute include the following:

- (a) To acquire up-to-date information on road research from all over the world and to apply the results in India after suitable modifications;
- (b) To improve the existing techniques of road construction and maintenance and provide suitable specifications in conformity with the requirements of the country with special reference to the nature of the local materials available;
- (c) To investigate the properties of local soils and locally available inferior aggregates, with a view to evolving cheap types of rural roads;

- (d) To study the characteristics of various binders, like cement, bitumens, tars, etc., and their rational use in road construction with locally available aggregates;
- (e) To tackle the problems of road safety in relation to the geometrics of highway layout and the psychology of road users so as to make roads safer for all types of traffic;
- (f) To train road technologists; and
- (g) To assist the highway departments in the country in the solution of important highway problems.

14. The Institute is well-provided with a wide range of specialized research and testing staff and equipment needed for work relating to various sections of highway engineering, such as soil engineering, concrete and bitumen technology and traffic engineering, etc.

15. The work of the Institute is so organized as to include, among other research problems, the following:

- (a) Research connected with the fixing of standards and specifications for roads and runways;
- (b) Collaborative research with engineering universities and research organizations of States and industrial concerns;
- (c) Technical advice and assistance to outside organizations; and
- (d) Dissemination of results of research by pamphlets, symposia, refresher courses, research publications, the training of practising road engineers and that of the teaching staff from universities.

16. A scheme for exchange of personnel between the Government Highway Departments and the Institute has been put into operation and the staff of the Institute also delivers lectures and helps in the conduct of examinations at the post-graduate level in the universities.

17. The items of work of significant importance, which have made a direct impact on the practices of road construction or on the economics of road construction, so far carried out in the Central Road Research Institute, include the following:

- (a) Creep strength of clays and its implication in bridge and embankment construction;
- (b) Surkhi (burnt clay) as a puzzolanic;

- (c) Parking study;
- (d) Use of scientifically processed soil, in place of stone or brick in the lowest layer of a road;
- (e) Stabilization of soil with locally available inferior aggregates for use in low cost road construction;
- (f) Stabilization of black cotton soil subgrades;
- (g) Utilization of inferior local aggregates (Moorum, laterite, Kankar, etc.) in road construction;
- (h) All India study of subgrade moisture;
- (i) Embankments on marshy grounds;
- (j) Brick sandwiched concrete pavements;
- (k) Expansion joint fillers from coconut pith;
- (l) Processing low-temperature tar as a road binder;
- (m) Anti-stripping agents;
- (n) Design and construction of heavy duty factory and township roads;
- (o) Origin - destination study for the Master Plan of Delhi; and
- (p) Traffic and transport studies for greater Calcutta development plan.

18. Furthermore, the projection of scientific activities of the Central Road Research Institute has been so programmed as to contribute positively to national industrial development, with particular emphasis on road industry.

19. The Institute plays a significant role by rendering technical advice on all difficult road design and construction problems to various concerned organizations, like State Public Works Department, Central Public Works Department, Directorate General Border Roads, Ministry of Transport and Shipping (Roads Wing), Traffic and Police authorities from different States, Municipal Corporations, private industries and several other government departments.

20. In regard to application of the results of research, the persistent efforts of the Institute to get special funds allocated to facilitate research development work in the Public Works Departments have borne fruit in as much as, at the instance of the Planning Commission, the State and Central Public Works Departments have been persuaded to spend one per cent of their road budgets on the introduction of new techniques on road projects already provided in the plan.

21. In line with this, a high level technical committee, called the Central Assessment Committee, has been appointed by the Government of India on the advice of the Indian Roads Congress to select suitable new techniques for development.

22. The Institute gives refresher courses periodically for the senior and junior highway engineers and occasionally foreign scholars are also trained.

23. The 1st International Refresher Course for Junior Highway Engineers from ECAFE Region countries is to be held at the Central Road Research Institute. The syllabus for this course includes advanced soil mechanics and soil stabilization, flexible pavements, rigid pavements, bridges, general highway matters, traffic engineering and highway safety, economics and planning of transportation with special emphasis to highways, study tour, dissertation and field demonstrations.

24. The Institute regularly participates in the annual sessions of the Indian Roads Congress to join in discussions on important technical and research papers contributed by the Institute's staff and by other highway research engineers in India.

25. The Institute is also represented on several Indian (e.g., the Indian Standards Institution) and International scientific bodies allied to its line of work.

26. Many research publications and bulletins designed to promote rapid utilization of research results by the road industry have been published.

27. The Institute regularly publishes results of research, in the form of Road Research Papers, Road Research Notes and Road Research Monographs. Technical Annual Reports are also issued.

28. The Institute has an abstracting service to cover all the published works, pertaining to Highway Engineering and Research, in scientific journals of various Asian and African countries. Issues of the "CRRI Road Abstracts" are supplied by the Institute to interested individuals and organizations on request.

#### C. HIGHWAYS RESEARCH STATION (MADRAS)

29. The scheme for the establishment of a research station in Madras financed from the Central Road Fund's allocation to the Madras state was considered by the Board of Communications in 1951 and accepted by the Government and recommended to the Government of India for sanctioning the scheme for execution under Central Road Fund's allocations to the Madras state and to meet half the cost of annual recurring expenditure from the Central Funds.

30. The Highways Research Station was established with a building of its own in 1957.

31. The central object underlying all the station's research is the devising of ways by which highways transportation may be made more safe, expeditious, economic and comfortable.

32. During the past eleven years the Highways Research Station has undertaken many such works not only within State Highways Department but also for private agencies and other States.

33. The activities of the Highways Research Station can be broadly classified under the following headings:

- (a) Soils - Classification and testing of soils to provide foundation and pavement designs;
- (b) Concrete - design of concrete mixes and control of the quality;
- (c) Bitumen - routine test of materials used and designs;
- (d) Structures - bridges and miscellaneous road elements, testing and analysis thereon, study of pavement performance, etc.;
- (e) Traffic - road location, layout of junction and designs of intersections, traffic flow, road safety and surface characteristics;
- (f) Library service - consideration of new specifications and interpretation and revision of specifications to meet new conditions as they arise.

34. These activities are divided under four main sections each forming a laboratory:

- (a) Soils;
- (b) Bitumen and aggregate;
- (c) Concrete and structures;
- (d) Traffic and safety.

35. The activities of the soils section, in addition to the publication of articles and research notes prepared in the soil laboratory, may be broadly classified under the following groups:

- (a) General testing of soils;

- (b) Design of road pavement;
  - (i) Design of low cost roads;
  - (ii) Design of pavement thickness.
- (c) Investigation of road failures;
- (d) Foundation investigations for bridges and buildings;
- (e) Research schemes.

36. The general activities in the bitumen section of the bitumen and aggregate laboratory may be classified as follows:

- (a) General testing of bituminous materials;
- (b) Design of bituminous mixtures for pavements;
- (c) Investigation of bituminous pavements failures;
- (d) Study of additives for improving the adhesive characteristics of binder with aggregate;
- (e) Study on the comparative merits of fillers on asphaltic concrete works;
- (f) A comparative study of various adhesion tests to evaluate a reliable method of test;
- (g) Use of rubber in bituminous pavements.

37. The activities in the aggregate section of the bitumen and aggregate laboratory may be broadly classified under the following headings:

- (a) General testing of aggregate samples;
- (b) Maintaining a record of test values of aggregates of Madras State;
- (c) Testing of aggregates for their suitability in black top works;
- (d) Study on the possibility of using sea sand;
- (e) Use of low-grade aggregate in bases for black top surfacings;
- (f) Study on polishing characteristics of stones;
- (g) Miscellaneous works.



38. The activities in the concrete section of the concrete and structures laboratory may be broadly classified as follows:

- (a) Routine tests;
- (b) Study on the influence of admixtures in concrete and mortars;
- (c) Design of concrete mix for works;
- (d) Quality control;
- (e) Research schemes.

39. The general activities in the structures section of the concrete and structures laboratory may be grouped as follows:

- (a) Use of pre-stressed slabs and blocks in strengthening of culverts and small span bridges;
- (b) Strengthening of RCC slab decking of bridges and culverts for modern loadings;
- (c) Use of twisted steel in RC works;
- (d) Study of cutstone slabs.

40. The activities of the traffic and safety laboratory may be broadly classified under the following headings:

- (a) Traffic surveys;
- (b) Speed and delay studies;
- (c) Study and development of pavements marking materials;
- (d) Accident investigations;
- (e) Design of intersections;
- (f) Traffic management.

41. The Highways Research Station has a workshop for the fabrication of certain small spare parts and this reduces the cost of these by approximately 25 per cent. It also manufactures simple machines of local interest such as three-wheel trolly, concrete mixers and asphalt spreaders.

D. THE INDIAN ROADS CONGRESS

42. The Indian Roads Congress, constituted in 1934, is the premier institution for highway engineers. It provides a forum for regular pooling of experience and ideas on all matters affecting the construction and maintenance of roads in India, recommends standard specifications for roads and bridges for the whole of India, studies road research done in the country, and provides a platform for the expression of professional opinion on matters relating to road engineering, including such questions as those of organization and administration.

43. At the inaugural meeting in 1934 there were only 73 engineers from all over India, but today the Indian Roads Congress has about 2,500 members representing engineers of all ranks from Central and State Governments, research institutes, military engineering services, Border Roads Organization and commercial interests.

44. Before the Indian Roads Congress was formed in 1934, there were no generally accepted road standards or bridge codes of any kind; there was no forum for discussion of road engineering problems; there was no organized method for correlating experimental and testing works carried out in the various States and no method of disseminating the results of these experiments and tests; there was no co-ordinated study of road problems in India and no means by which the Central and State Governments could obtain the collective opinion of road engineers in the country. But now the Indian Roads Congress has largely filled these gaps.

45. Among other duties, the Indian Roads Congress acts as a technical institution obtaining agreement on road and road engineering standards for the whole of India and the Congress has issued the Codes of Practice on different types of bridges.

46. The Congress also studies highway research done in the country and advises the subjects on which research should be carried out at each place and keeps an eye on the results of research and on their application and implementation.

47. The Congress has a permanent secretariat in New Delhi, but its technical activities are mainly carried out through its 19 committees and 25 sub-committees consisting of experts in each subject. A brief indication of the functions of some of these is given below:

- (a) Bituminous Pavements Committee - drafting standards on bituminous pavements;
- (b) Bridges Committee - drafting standard specifications and Codes of Practice for road bridges in India and preparing type designs for the superstructure for various span lengths;

- (c) Community Projects Road Maintenance Committee - this committee, after collecting information on the practices prevalent in regard to the construction and maintenance of these roads in different States and after careful consideration and study of the various aspects of the problem, has finalized the recommended practice for the maintenance of roads constructed under the community projects and national extension service schemes;
- (d) Research Organization Committee - this committee ~~serves~~ as a liaison body to co-ordinate the road research activities both in directing them along specified channels and in disseminating and implementing the results on a practical scale;
- (e) Road Transport Development Committee - studies road and road transport problems and makes recommendations to the governments for increasing the road transport capacity;
- (f) Road Transport Operation Cost Committee - studies the cost of operation of motor vehicles on different classes of roads and the economy resulting from road improvements;
- (g) Specifications and Standards Committee - drafting standards on various items of road work (layout of roads, design of pavements, etc.) and specifications for flexible pavements, etc.
- (h) Test Track Committee - proposes tests and examines results of tests carried out at the Road Test Track, Calcutta.
- (i) Other Committees - other committees deal with the following subjects:
  - (i) Cement concrete road surfacing;
  - (ii) Dimensions and weights of road design vehicles;
  - (iii) Education of the highway engineer;
  - (iv) Manufacture in India of road-making machinery and mechanization of road making operations;
  - (v) Provincialization of local bodies engineering services;
  - (vi) Prevention of ribbon development;
  - (vii) Soil research;
  - (viii) Stabilized soils roads;
  - (ix) Traffic engineering.

48. During the annual session of the Congress, panel discussion on important subjects are also arranged and so far the subjects discussed are the following:

- (a) Surface dressing;
- (b) The use of soil in all-weather cheap road construction;
- (c) Roads in water-logged areas;
- (d) The use of low-grade aggregate in road construction;
- (e) Strengthening of thin cement concrete pavements;
- (f) Maintenance of roads;
- (g) Maintenance of earth roads;
- (h) Road drainage practices.

49. The Indian Roads Congress issues two publications:

- (a) The "Journal" which is a quarterly publication and contains papers on standards, specifications, roads and layout, bridges, etc.; and
- (b) The "Transport-Communications Quarterly Review" which contains original articles and abstracts from technical journals for the benefit of keeping highway engineers abreast with the latest advances in the science of road engineering.

50. The Congress has arranged with the Central Road Research Institute to publish research papers and notes of the Institute in the journals of the Congress and the Road Research bulletins.

51. The following is a list of the subjects on which 272 papers along with the discussions thereon have been published in the journals of the Indian Roads Congress:

- (a) Roads in general;
- (b) Road surveys, design, layout and construction;
- (c) Soil and earthwork, soil science as adapted to road foundation, banks and earth surface, soil stabilization, etc.;
- (d) Water-bound macadam roads, and other low-cost roads such as Murum, brick and other forms of trackways;

- (e) Tar and bitumen surfacing, carpets, etc.;
- (f) Concrete;
- (g) Miscellaneous materials and process, aggregate tests, sizes, etc.;
- (h) Bridges, retaining walls and other structures;
- (i) Traffic statistics, regulation and control of traffic, economics of road and road transport;
- (j) Road maintenance and road usages;
- (k) Standardization of design, loadings, impact, specifications;
- (l) Research and experiments;
- (m) Administration and finance;
- (n) Plant, machinery and apparatus.

52. There is no doubt that a study of papers on these subjects and the discussions thereon is of incalculable benefit to the road engineers of India.

53. The Indian Roads Congress possesses a library which is at the disposal of the members and books are supplied on loan.

54. About 60 per cent of the income of the society comes from contributions from the Central and State Governments. Other sources of income include annual membership fees and revenue collected from sale of publications and advertisement fees.

55. The affairs of the Indian Roads Congress are controlled by a Governing Body, known as the Council, representative of all interests.

56. The secretariat of the Indian Congress, which consists of about 25 persons, is responsible for the co-ordination of the activities of the various committees and sub-committees, the selection of technical papers, the publishing of technical and research papers, and the supervision of the overall activities of the Indian Roads Congress.

#### E. ROAD PLANNING

57. The Transport and Communications Division in the Planning Commission is responsible for the planning and co-ordination of the various modes of transport including roads.

58. In India roads are divided into five categories: national highways, State highways, major district roads, other district roads and village roads.

59. National highways fall directly within the sphere of responsibility of the Central Government, i.e., the Union Ministry of Transport and Shipping (Roads Wing), which meets the entire expenditure required for their construction, improvement and maintenance. The Central Government also assists the State Governments in the construction of selected roads of inter-State and economic importance.

60. The State highways and the other minor roads fall within the field of responsibility of State Governments and local authorities.

61. Although the Central Government is responsible for the administration and finance of national highways, the construction and maintenance of these roads have been undertaken by the Public Works Departments in the States acting as agencies of the Centre since the Central Government does not have a road construction organization of its own.

62. Resources for road development are provided under the Five-Year Plans and for maintenance under the normal budget.

63. The road development plans for the national highways, prepared by the Central Government, and those for the State highways and other roads, prepared by the State Governments, are submitted to the Transport and Communication Division of the Planning Commission. These plans are studied and recommended for approval by a Working Group which is headed by the Director of Road Development and also includes a representative from the Central Road Research Institute.

64. The road development programme, be it for the national highways or for the State highways and other roads, is aimed at, in order of priority: (i) completion of carry-over works from the preceeding Five-Year Plan; (ii) completion of missing road links and bridges; (iii) roads leading to areas where minerals and industries are being developed; (iv) up-grading sub-standard roads; and (v) construction of new roads.

65. India attaches so much importance to the development of rural roads that about 25 per cent of the planned total expenditure on roads is earmarked for the construction and improvement of rural roads.

66. In 1929, the Government of India established the Central Road Fund. Proceeds collected from the duty levied on petrol is credited to the Fund and utilized for road development. Eighty per cent of the proceeds are allocated to State Governments on the basis of actual petrol consumption within their territories and from the balance, which is retained at the Centre as the Central Road Fund (ordinary) reserve, grants are made for expenditure on experimental and research schemes and for the construction of specified roads and bridges.

67. The Indian Roads Congress, in co-operation with the Roads Wing of the Ministry of Transport and the Central Road Research Institute, has been undertaking the function of co-ordinating the research work of the various laboratories. However, it has been recommended that a highway research board, similar to the Highway Research Board of USA, should be set up so that more definite arrangements can be made for the conduct of research, for the co-ordination of the results of research work done in the country and for giving wider publicity to the results achieved.

68. Towards the end of the Second Plan, chief engineers from the Central Government and the States met and formulated a new twenty-year road development plan for the period 1961-81.

69. Factors such as area, population, regional levels of development and development needs and possibilities were taken into consideration in working out specific proposals and it is planned that in a developed agricultural area no village should remain more than 6.5 km (4 miles) from a metalled road or more than 2.5 km ( $1\frac{1}{2}$  miles) from any type of road.

70. The Plan envisages that by 1981 the average length of road would be 32 kilometres per 100 square kilometres of area compared to 16 km for every 100 sq. km at the end of the Second Plan. (In developing Africa, i.e., excluding the Republic of South Africa, Rhodesia and the dependent territories, the density of all-weather roads is about 1.0 km for every 100 sq. km of area i.e., one-sixteenth of the present geographic density in India).

71. The scheme of priorities proposed under the Plan include provision of missing bridges, improvement of road surface to at least one-lane black-topped specifications for national and State highways, in the vicinity of large towns widening of main roads to two-lanes or more and provision of two-lane on major arterial routes.

72. The cost of completing the programme was estimated at Rs.5,200 crores (about US\$6,933 million), of which Rs.630 crores (about US\$840 million) were for village roads.

73. Although the plan outlined by the chief engineers has remained a broad guide for more detailed planning in the States and its priorities have been generally kept in view, specific commitments have been made by the Central and State Governments only in terms of five-year and annual plans of development.

#### F. MANPOWER AND TRAINING

74. For the training of high-level manpower India has five Institutes of Technology located at Bombay, Madras, New Delhi, Kanpur and Karakpur, which receive aid from Russia, Germany (FRG), the United Kingdom, the United States of America and UNESCO respectively.

75. These Institutes teach many technical disciplines, but as far as highway engineering is concerned the civil engineering department in addition to its regular techniques, occupies itself in research work (soils, concrete, asphalt, etc.) with an Indian outlook.

76. As mentioned earlier, the Central Road Research Institute also gives refresher courses periodically for the senior and junior highway engineers.

77. It may be worth adding here that it was reported in a Bombay newspaper that in 1968 there were about 50,000 trained engineers without employment.

78. In brief, India has all the skilled and unskilled manpower required for the construction, improvement and maintenance of the road systems in the country.

#### G. SUMMARY AND RECOMMENDATIONS

79. The Central Road Research Institute, which serves as a national laboratory, plays an important role by rendering technical advice on all difficult road design and construction problems to various concerned organizations, like Central and State Public Works Departments, other Government Departments, private industries, etc.

80. Besides the Central Road Research Institute there are road research stations in some States as in Madras, Uttar Pradesh, Punjab and West Bengal.

81. The Indian Roads Congress, in co-operation with the Roads Wing of the Ministry of Transport and the Central Road Research Institute, undertakes the function of co-ordinating the research work of the various laboratories and advises the subjects on which research should be carried out on each place and keeps an eye on the results of research on their application.

82. Both the Central and State road plans provide funds specifically for road research and the earmarking, by the States, of at least 1 per cent of their Central Road Fund allocations for road research is now considered to be insufficient.

83. In Africa it is well known that there are a number of well-equipped road laboratories, but it is believed that the great majority, if not probably all of them are engaged not in research but in the testing and control of road construction specifications.

84. There seems to be therefore, an immediate need for finding ways and means, through actual inspection and examination of the various road laboratories and research centres in the independent African countries, for equipping, augmenting and operating existing research centres with the ultimate aim of reducing the overall costs of road construction and maintenance, of adopting last techniques in highway construction and maintenance and developing of regional or sub-regional research and research training institutes.

85. An African Roads Congress of highway engineers should be established as early as possible on a Pan-African basis.



86. An African highway conference, sponsored by the Imperial Highway Authority of Ethiopia and the International Road Federation in co-operation with the United Nations Economic Commission for Africa and the Organization of African Unity, will be held in Addis Ababa, October 20-25, 1969. It is hoped that many African road engineers will attend since this conference is expected to provide the forum for deciding on the proposed establishment of African Roads Congress.

87. It is hoped arrangements will be made to send a small team of African road engineers, who are directly concerned with road research, to go to India to study the research work and the organizational set up of the Central Road Research Institute and of one or two State Research Stations.

88. The team should also visit the Transport and Communications Division of the Planning Commission to acquaint itself on how the planning of transport in general and roads in particular is co-ordinated in India.

89. The visit to India could be so arranged as to enable the African engineers to attend the annual session of the Indian Roads Congress before starting on their road development study tour or it could be arranged alternatively at a time when the Central Road Research Institute gives a refresher course for highway engineers.

90. Ways and means of arranging a refresher course for African road engineers should be found. The syllabus for such a course would include general highway matters, advanced soil mechanics and soil stabilization, flexible and rigid pavements, bridges, traffic engineering and highway safety, economics and planning of transportation with special emphasis to highways, etc.

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