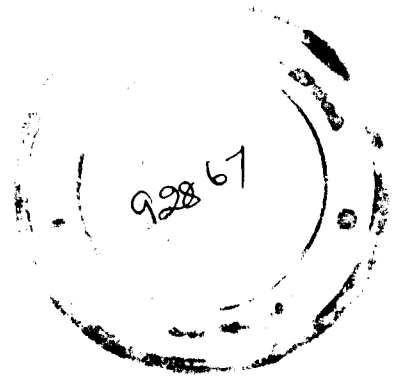
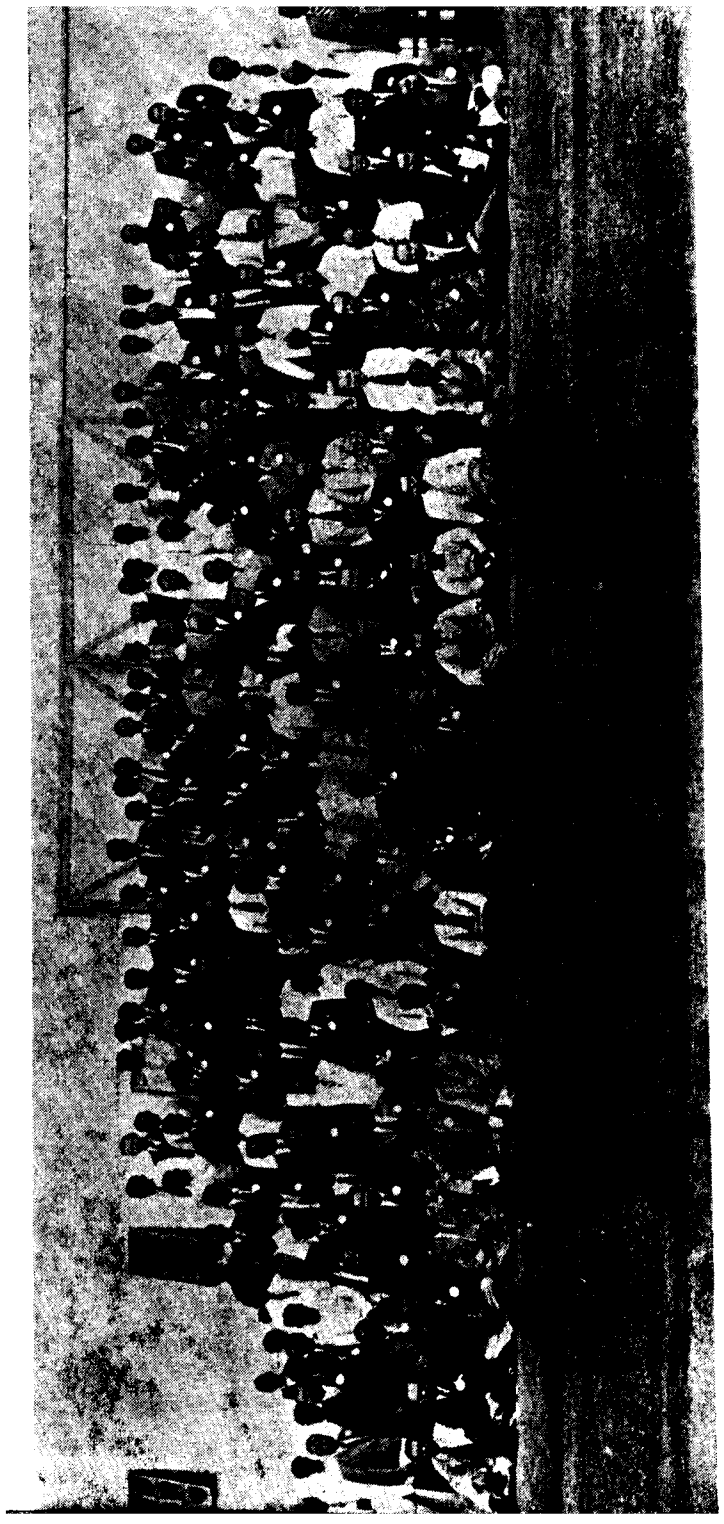
LIST OF MEMBERS OF THE COUNCIL FOR 1953—54

1. F. P. Antia.
2. M. L. Bahl.
3. C. M. Bennett.
4. U. J. Bhatt.
5. M. S. Bisht.
6. Brig. K. N. Dube.
7. P. V. Divatia.
8. G. N. Dutt.
9. C. J. Fielder.
10. K. S. Gangadhara.
11. W. A. Griffiths.
12. S. Gupta.
13. R. N. Joshi.
14. K. K. Kartha.
15. G. H. Khan.
16. Kishori Lal.
17. U. N. Mahida.
18. G. M. McKelvie.
19. M. Meeran.
20. C. P. Misra.
21. T. Mitra.
22. A. C. Mukerjee.
23. E. A. Nadirshah.
24. S. C. Nayak.
25. D. P. Nayar.
26. Raghbir Singh.
27. D. V. Rao.
28. Romesh Chandra.
29. Sujan Singh.
30. K. V. Thadani.





INDIAN ROADS CONGRESS, EIGHTEENTH SESSION, BHUBANESWAR, FEBRUARY, 1954.

Shri R. K. Batra, I.S.E., President, 1953—54.

Shri R. K. Batra, was born at Maghiana (West Punjab) on the 8th August 1898 and received his early education there, attaining a brilliant record in Government College, Lahore. He was educated at the Thomason Engineering College, Roorkee, from 1919 to 1922 and passed his C.E. with honours in the year 1922. He was appointed to the Indian Service of Engineers in June 1924.

He soon rose to the rank of an Executive Engineer in April 1929 and was promoted to the rank of an S.E. in March 1943. He was appointed as C.E., Madhya Pradesh in October 1949. He is still serving the country as the Chief Engineer, Government of Madhya Pradesh, Roads and Buildings and Irrigation, Nagpur, having been re-employed on retirement in November 1953.

He was elected as a member of the Indian Roads Congress in the year 1946 and became the President of the Society for the year 1953-54.

INDIAN ROADS CONGRESS

NOTICES AND ANNOUNCEMENTS

CONTRIBUTION OF PAPERS FOR THE NINETEENTH SESSION OF THE INDIAN ROADS CONGRESS

The next General Session of the Indian Roads Congress is likely to be held sometime in June 1955. The exact date, place, and programme of the Session will be communicated to Members in due course.

2. Procedure: Members who intend to contribute Papers on any subject connected with Highway Engineering are requested to intimate the fact to the Secretary, Indian Roads Congress, and to send a short synopsis of their proposed Papers as early as possible.

On receipt of acceptance of the subject matter of the Paper, the Member concerned should send his contribution to the Secretary, Indian Roads Congress, complete in all respects and with original drawings, photographs, etc., as and when ready. At least three copies of the typescript matter should be sent, typed (double space) on one side of good stout paper of foolscap size.

3. The complete Paper, if intended to be read at the nineteenth Session, should preferably be submitted within next two months.

From past experience it is observed that most of the Members send in their contributions at the last moment, when the Congress Office is busy on work connected with the Session. As it takes a long time to get Papers printed in the Journal and as it is desirable that Members should have time to study Papers well in advance of the date of the Session, it is hoped, that Members will make an effort to send their contributions as and when ready.

Members may please note that Papers received late in the year are likely to be carried over to the next year.

4. The younger engineers are particularly requested to contribute Papers which, if required, will be suitably edited by the Indian Roads Congress Office before publication.

5. MEDALS: The following Medals are available for award:

(*i*) The Mitchell Medal:

For exceptionally good Papers contributed to the Indian Roads Congress in any year. This has been instituted to perpetuate Sir Kenneth Mitchell's connection with the Congress.

(*ii*) The Indian Roads Congress Medal:

For Papers considered by the Council of the Indian Roads Congress to be of a decidedly more than average merit.

6. The Council have reserved the right to award more than one Medal in any year or to withold the award of a Medal in any year without assigning any reason. All Members are eligible for the award of the Medals.

7. Rules and Regulations for the contribution of Technical Papers and the Award of Medals are published on pages 8 to 13 of Volume XVIII–1 of the Journal of the Indian Roads Congress, December 1953.

II. NEW ADMISSIONS

LIST OF MEMBERS OF THE INDIAN ROADS CONGRESS ENROLLED FROM 11—12—1953 TO 30—9—1954

Serial No.	*Roll No.*	*Name*	*Address*
1386	1783	Ram Nath Saxena.	Consulting Engineer to M/s. Gopal Swarup & Sons, P. O. Mahendru, **Patna-6** (Bihar).
1387	1784	Umeshwar Prasad Verma.	Sectional Officer, Bihar P.W.D., **P. O. Sindri Institute**, District Manbhum (Bihar).
1388	1785	Zain S. Shah.	M/s. Burmah Shell, Burmah Shell House, Connaught Circus, **New Delhi.**
1389	1786	A. K. Datta.	Sales Engineer, M/s. Greaves Cotton & Co., Ltd., 4, Mission Row Extension, **Calcutta-1.**
1390	1787	G. C. Gupta.	Assistant Research Engineer, Research Institute, P.W.D., **Lucknow** (U.P.).
1391	1788	K. S. Narayana Rao.	Junior Engineer (H), **Rampachodavaram**, Via Rajahmundry, (S. Railway).
1392	1789	D. K. Sahgal.	Executive Engineer, P. W. D., B. & R., Amritsar Provincial Division, 430, Hide Market, **Amritsar.**
1393	1790	V. C. Goyal.	Assistant Engineer, P.W.D., B. & R., **Karanprayag**, District Garhwal (U.P.).
1394	1791	S. M. Hussain.	District Engineer, District Board, **Muzaffarpur** (Bihar).
1395	1792	P. G. Nambiar.	Divisional Engineer (Highways), Coleroon Bridge Division, **Sirkali** (Madras State).
1396	1793	P. R. M. Patnaik.	Executive Engineer, Bhubaneswar Division, P.W.D., **Bhubaneswar** (Orissa).
1397	1794	P. T. Govindarajulu.	Assistant Engineer, 104, Shenoy Nagar, **Madras-10.**
1398	1795	K. B. Subbaya.	Instructor, Highways Engineering, College of Engineering, Guindy, **Madras-25.**

Serial No.	Roll No.	Name	Address
1399	1796	R. Nagarajan.	Senior Scientific Assistant, Central Road Research Institute, Okhla, New Delhi.
1400	1797	S. K. Chakravarty.	Assistant Engineer (Roads), Bongaon Sub-Division, Anderson House, Alipore, Calcutta-27.
1401	1798	Mani Dharray N. Patni.	Executive Engineer, B. & R., Bikaner (Rajasthan).
1402	1799	G. Papa Rao.	Assistant Engineer, P. W. D., Phulbani (Orissa).
1403	1800	G. Alexander.	Associate Professor in Civil Engineering, Annamalai University, Annamalainagar. (South India).
1404	1801	G. S. Rao.	Assistant Executive Engineer, C.P.W.D., Hijli, Kharagpur.
1405	1802	K. L. Mazumdar.	Superintending Engineer (South), Shillong (Assam).
1406	1803	M. V. Rajwade.	Executive Engineer, P. W. D., Bilaspur (Madhya Pradesh).
1407	1804	G. N. Senapathy.	Executive Engineer, P. W. D., Ganjam Division, Ganjam (Orissa).
1408	1805	G. Patnaik.	Assistant Engineer, P. W. D., Bhanjanagar, Ganjam (Orissa).
1409	1806	B. N. Bhaduri.	Executive Engineer (Roads), P-82, Lake Road, Calcutta-29.
1410	1807	S. V. Shevade.	Technical Assistant to the Superintending Engineer, P. W. D. Udaipur (Rajasthan).
1411	1808	Vishrampuri.	Assistant Engineer, B. & R., P.W.D., Jaipur (Rajasthan).
1412	1809	M. V. Ittycheria.	Supervisor, P. W. D., Achamma Lodge, Kunnukuzhy, Trivandrum (T. C. State).
1413	1810	R. Guha.	S. D. O. (W. & B.), Cooch-Behar (West Bengal).
1414	1811	A. P. Mitra.	Executive Engineer, W. & B. Department, 15/2/L, Ballygunge Station Road, Ballygunge Post, Calcutta-19.

Serial No.	Roll No.	Name	Address
1415	1812	B. C. Chattopadhya.	Assistant Engineer, Development (Roads), 26/3, Hindusthan Park, Calcutta-29.
1416	1813	H. P. Mirchandani.	Executive Engineer, P. W. D., Balaghat (Madhya Pradesh).
1417	1814	A. T. Nalawade.	Assistant to Chief Engineer, P. W. D. & Irrigation, Gwalior (M. B.).
1418	1815	B. R. Das Gupta.	Assistant Engineer, W. & B. Department, 52-C, Mirzapur Street, Calcutta-9.
1419	1816	S. Samajdar.	Assistant Engineer, W. & B. Department, 112, Ballygunge Gardens, Calcutta.
1420	1817	C. K. Sarkar.	Assistant Engineer, W. & B. Department, 28/B, Ripon Lane, P. O. Park Street, Calcutta-16.
1421	1818	Brig. S. K. Bose.	Deputy Chief Engineer, Southern Command, H. Q. Southern Command, Poona.
1422	1819	M. L. Shukla.	Assistant Engineer, Bridge and Planning Division, P. W. D., B. & R., Lucknow (U. P.).
1423	1820	T. S. Vedagiri.	Assistant Executive Engineer, Central P. W. D., New Delhi.
1424	1821	Shiekh Abdul Salam.	Assistant Engineer, R. & B., Zaindar Mohala, 2nd Bridge, Srinagar, Kashmir.
1425	1822	B. B. Pattanayak.	Executive Engineer, Mayurbhunj Division, P. O. Baripada, District Mayurbhunj (Orissa).
1426	1823	K. M. Das.	Assistant Engineer, Chief Engineer's Office, Bhubaneswar (Orissa).
1427	1824	B. V. Rajanna.	Junior Engineer, Highways, Sompeta, District Srikakulam (Andhra State).
1428	1825	Hari Hara Das.	Consulting Engineer, Bijoy Bhaudar Building, Berhampur (Orissa).

Serial No.	Roll No.	Name	Address
1429	1826	A. P. Nand.	Assistant Engineer, Capital Construction Sub-Division, No. III, P. O. Bhubaneswar (Orissa).
1430	1827	R. P. Verma.	S. D. O., P. W. D., Chandwa, District Palamau (Bihar).
1431	1828	H. Damodaran.	Junior Engineer (H), Trichy West, Tiruchirapalli (S. I.), (Madras State).
1432	1829	Gurmukh Singh.	Assistant Engineer, P. W. D., B/R, Ratangarh (Rajasthan).
1433	1830	A. A. Menon.	Sub Divisional Officer, I/C. Depot Area, Pulgaon Camp P.O., (Madhya Pradesh).
1434	1831	Indra Prakash Gupta.	District Engineer, P.W.D., B & R., Etah. (U. P.).
1435	1832	Des Raj Varma.	Assistant Engineer, Designs, Punjab P. W. D., Buildings & Roads Branch, Simla-2.
1436	1833	S. G. Vichare.	Deputy Engineer, P. W. D., Sihor, (Saurashtra).
1437	1834	M. M. Bukhshi.	Assistant Engineer, District Board, Dumka (Bihar).
1438	1835	N. Veerappan.	Junior Engineer, Highways, Hosur. (Madras State).
1439	1836	M. L. Sabberwal.	Acting Executive Engineer, P.W.D., Bharatpur. (Rajasthan).
1440	1837	P. B. Fondekar.	Assistant Engineer, Concrete Association of India, 82-84, Queensway, P. O. Box 45, New Delhi-1.
1441	1838	Harbans Singh.	Assistant Engineer, P.W.D., B/R, Palwal, District Gurgaon. (Punjab).
1442	1839	Panchanan Bandopadhyaya.	Assistant Engineer, District Board, Manbhum P. O. Dhanbad (L. B.) (Bihar).
1443	1840	V. N. Parikh.	Deputy Engineer, P.W.D., Dandia Bazar, Baroda.
1444	1841	B. K. Jain.	Lecturer in Civil Engineering, 11, Pologround, Roorkee. (U.P.).

Serial No.	Roll No.	Name	Address
1445	1842	Trilochan Singh Bajaj.	Sub Divisional Officer, Subarnarekha Sub-Division, C.P.W.D., Jainsola, P. O. Baharagora, Distt. Singhbhum. (Bihar).
1446	1843	Y. R. Mahendroo.	Sub Divisional Officer, Kangra Provincial Sub Division, Dharmsala, Distt. Kangra. (Punjab).
1447	1844	Bhabadeb Sarma.	Temporary Engineer, Sub Divisional Officer, M.B. Road Sub Division No. 1, P. O. Mawphlang, Distt. J. & K. Hills (Assam)
1448	1845	P. R. Kumar.	College of Military Engineering, Kirkee, Poona-3.
1449	1846	Ram Krishna.	Overseer, P.W.D., B/R, 191, Civil Lines, Jhansi. (U.P.)
1450	1847	S. P. Goyal.	Assistant Engineer, P.W.D., B/R., Agra.
1451	1848	D. V. Rao.	Assistant Engineer, P. W. D., Lower Canal Sub Division, Balaghat. (M.P.)
1452	1849	H. C. Malhotra.	Executive Engineer, P.W.D., B. & R., Branch, Gurgaon Provincial Division, Gurgaon.
1453	1850	V. V. R. Shankar.	Municipal Engineer, Adoni, Distt. Kurnool.

ASSOCIATE MEMBERS

1	50	Central Road Research Institute.	Delhi-Mathura Road, P.O. OKHLA, Delhi.
2	51	M/s. British Insulated Callenders' Cables Ltd.	Esplanade House, Waudby Road, P.O. Box 111, Fort, Bombay-1.
3	52	M/s. Armstrong Smith Ltd.	Gresham Assurance House, Sir Phirozshah Mehta Road, Post Box No. 185, Bombay-1.

III. DEATHS

THE COUNCIL HAVE RECEIVED WITH REGRET INTIMATIONS OF THE FOLLOWING DEATHS:

Serial No.	*Roll No.*	*Name*	*Address*
1	1149	Brinda Roy.	Executive Engineer, Chotanagpur Waterways Division, Ranchi, P.O. Hinoo (Bihar).
2	476	S. B. Tyabji (L.M.)	Spanish Villa, Perry Cross Road, Bandra, Bombay-20.
3	90	Mohd. Abu Turab.	Superintending Engineer (Retd.), A/8-No. 220 Lane, Opp. Raj Mahal Talkies, Lingampalli, Hyderabad-Deccan.
4	1279	L. U. Prosad.	Executive Engineer, Construction Division IV, P.O. Durgapore, District Burdwan (West Bengal).
5	61	J. C. Sahney.	Executive Engineer, P.W.D., B. & R. Branch, 95, Gwalior Road, Agra.
6	685	C. N. Thirupuvanam.	Divisional Engineer (Highways), C/o. C. Narayanaswamy Mudaliar & Sons, Neeligodown Street, Vellore, South India.

PROCEEDINGS OF THE EIGHTEENTH SESSION OF THE INDIAN ROADS CONGRESS

Vol. XVIII - Part 4 BHUBANESWAR February 1954

PRESIDENTIAL ADDRESS

The Eighteenth Session of the Indian Roads Congress was held at Bhubaneswar from the 4th to the 11th February 1954, and was formally opened by Shri Naba Krushna Chowdhury, Chief Minister, Orissa State, at 11-00 a. m. on the 5th February 1954. The proceedings opened with an Address by Shri R. K. Batra, the President, the full text of which is given below:

It is my proud privilege to welcome you, Sir, on behalf of the Indian Roads Congress and to voice our feelings of gratitude for the honour you have done us, in coming into our midst today, to

Shri R. K. Batra, President delivered the Presidential Address.

bless and open this Eighteenth General Session of our Society. I also extend our hearty welcome to our lay guests, who as representatives of the public and trustees of the common man's interests have graced this occasion with their presence in evidence of their interest in our activities. We want to take you into our confidence and cultivate your goodwill and support in our endeavour to add to and improve upon the road map of India. We need the sympathetic and helpful understanding of all road users in respect of the magnitude of our problems and the odds against us. To

members and delegates, I offer my cordial greetings on this happy occasion of our annual re-union to discuss and compare notes of our past year's work and experience.

We also express our grateful thanks to the Orissa Government for the courtesy extended to us in inviting the Congress to their new Capital at Bhubaneswar. We are meeting here for the first time in the 20 years' history of our Institution. Bhubaneswar has historical, cultural, and religious associations going back to the early centuries. The town as you see it today, is recent construction and has been planned and laid out according to a Master Plan based on what is described as "neighbourhood units" and there will be plenty of opportunities for all as they go round the place to observe and study the utilities and amenities of such an arrangement. Unfortunately, due to financial stringency, only the first phase of the programme has been taken up in hand so far. Quite apart from the attractive and novel features of this town, there are many ancient and beautiful temples scattered all round among which is the famous Lingaraj temple. These temples are noted for their distinctive architecture which is unique and striking in its pattern and are well worth a visit. The famous age-old temple of Puri frequented by pilgrims from all over India, is very near from here and those who are interested will be enabled to go and worship at this sacred shrine. The temple at Konarak dedicated to the Sun God, though in ruins, is a marvel in architecture and you will be interested to see it. The caves of Khandagiri and Udaigiri are another attraction in the neighbourhood.

We should also express our indebtedness to the Orissa State Officers for the excellent arrangements made both for holding the sessions here and for our boarding and lodging arrangements in spite of the various handicaps under which they must have laboured.

Orissa is still a young State created within the last three decades by welding together the most remote and outlying districts of the other contiguous old States and with a number of the Princely States added on after the attainment of Independence. No wonder, therefore, if it has to work against the backlog of progress in its still unopened areas and a chronic and deficit economy. Its heroic struggle to come up and rise to its due stature on par with other States is worthy of our admiration. We wish the State the best of luck and success in its efforts. May the Grace of Lord Jagannath of Puri in conjunction with the bounty of nature activated by the construction of Hirakud Dam leaven in quick time the economy of the State and contribute to its ever-increasing prosperity.

The past Presidents of this Congress have, in their successive Addresses at the annual sessions, fully traced the history of its birth and achievements during the last two decades, and I need not traverse the same ground or enlarge upon it much further. The very fact, that the membership of this Congress has swelled from the 73 first fathers of this Association, who appeared on the scene in 1934, to a family of 1,315 in number within two decades is a measure of its vitality, popularity and usefulness. Most of the road Engineers of the country, both in Government service and outside, are there either as members or as associate members.

Our primary objective and function is to see to the advancement of the technique of road construction so as to make for better strength and more enduring life of our structures and towards the utilization of local materials to best advantage and for maximum service thereby reducing costs to the minimum possible. Towards this end, we are engaged in the creation and maintenance of a central pool of ideas by drawing upon past experience and up-to-date knowledge on the subject and are acting as clearing house for such of the ideas as have been proved in practice not only in this country but also in other parts of the world which have similar problems. It is a threshing ground for all the plentiful and varied lore on the subject, where the chaff is winnowed out and the hard core of grain is isolated. The officers working in the Roads Wing of the Ministry of Transport, which is mothering and nursing this Institution, pass on the results of their studies both on the theoretical and practical aspects. The field knowledge comes in through the many Papers, and notes and comments on them contributed by the engineers working in the States and from the estimates of major projects. All such grist is passed through the mills of the technical staff and the subcommittees working on behalf of the Roads Congress and the matter is churned, sifted, and presented finally to the Members in the form of condensed specifications and standards and codes of practice. The comprehensive Bridge Code prepared under its auspices is an outstanding document and is today the Bible of the Bridge Engineer. Prior to the advent of this body, we had to rely solely on the British Standards Specifications which did not take into account our local conditions and material resources. Hence, on this score alone, the Indian Roads Congress fills up the void which has long existed in the technical armoury of our highway departments. Besides this, we are enabled to compare the various approaches to and the methods adopted towards the solution of the several road problems met with in the different parts of this country. Similar Societies of advanced foreign countries exchange their literature with ours.

The Roads Congress has recently started a new service of publishing extracts and excerpts from the technical journals in the Transport-Communications Monthly Review for the benefit of the executive staff who, owing to their wholetime preoccupation with the organization and accomplishment of their day-to-day work, are not able to keep abreast of the latest advances in the science of road engineering, which is growing fast by rapid strides. They simply do not have the time and energy to read systematically and discursively. So whatever is worthwhile as throwing more light on the different facets of road engineering is purveyed to them in concentrated essence for easy assimilation and guidance or as a pointer to the proper quarry for further information.

By encouraging the Members to contribute Papers or original articles based on their independent studies of particular subjects or experience on specific works and by bringing them up for discussion at the annual sessions, the Congress is providing a platform for crystallizing the various amorphous ideas which the different Members would have at one time or other imbibed in the course of their work. Engineers are generally silent workers, always in communion with nature for extracting its secrets, and if they talk at all about their work, they do so more in the language of sketches and drawings and terse specifications, not often intelligible to the lay public. It is, however, necessary for engineers in these democratic days to carry conviction to the public and to this end to be able to explain to them, in layman's language, the pros and cons of their projects. These faculties could be developed more and more by constant exercise and attempt at marshalling our facts, arranging them in their logical sequence, and indicating the inferences therefrom.

Annual prizes, medals, or honoraria are being awarded by the Congress for Papers of special merit. The aim and ambition of the Congress in this direction is to keep beaming the searchlights of the Congress over the whole of our fraternity and its area of operation and kindle every spark of talent therein and rouse it into flame so as to illumine the several yet hazy, twilight and dark corners in the field of our science. With this objective in view, the venue of the session is being changed from year to year so as to enable all States, all men, and all problems to be canvassed and covered in its sweep.

In fulfilment of its educational objective the Congress is maintaining an up-to-date library and it lends books to members who are constantly kept informed of the list of new books added from time to time. It has a small museum not sufficiently large yet for want of accommodation. There is an Education Sub-

committee which is working on the proper syllabus and curriculam of Highway Engineering studies.

Of late, along with our annual sessions, we have been organizing technical and film exhibitions of road practice, machinery, tools, etc., for the benefit of engineers. As a matter of fact, these exhibitions have been drawing a considerable number of visitors from among the public as well.

Road construction and maintenance till the other day, even within the memory of the senior Engineers, was largely craftsmanship based on intuition and empiricism. But motor vehicles with their high speeds and heavy loads have brought in their train a multitude of complex problems, for the solution of which we have to adopt a scientific and rationalised approach. Soil, which was being classified by appearance and feel, has now to be classified by the qualitative and quantitative content and behaviour of its several ingredients. The potentialities of using stabilized soil for the construction of the base courses of road pavements, where stone and other hard materials do not exist within economical leads, are enormous and impressive advances have already been made in devising specifications for the proper use of local soils. From the simple water-bound macadam and stone-sett pavements of pre-motor era, we have since advanced to pavements of concrete and bitumen mixtures, and from masonry arches we have passed on to Reinforced and Prestressed concrete. The strength and performance of the different materials going into these new types of construction have to be investigated for different conditions and proper specifications and processes have to be evolved by conducting large-scale laboratory experiments. Hence the construction of road research laboratories has become an imperative necessity. The institution of the Test Tracks at Alipore, Calcutta, and at Okhla near Delhi, and the building up of Road Research Laboratories both by the Central Government and the States owe their inspiration to the impetus and fillip given by the Congress during the last several years.

The Roads Congress has also got subcommittees to advise on road machinery, tools and plant, and on the problems of transport as a whole. It has another Subcommittee commending to the State Governments the advantages of constituting specialized highway departments working directly under their wings. Now to those who are still lagging behind in giving full effect to this suggestion, we wish to point out the considerable achievement of Madras, West Bengal and Bombay, which have so far followed our lead. The question of forming an All-India Service of Engineers, on the analogy of I. A. S. and I. P., has also been mooted and is worthy of serious consideration.

The Highway Chief Engineers of States having met at the instance of the Roads Congress in the year 1943 drew up the well known Nagpur Plan suggesting an *ad hoc* 10-year road development programme for the country as a whole so as to provide an integrated and closely knit grid of roads, and presented it to the several Governments. Though for various reasons this programme has had a chequered career in its implementation during the last ten years, it is satisfactory to note that our efforts have at last borne fruit in that a fairly large provision has been made in the Five-Year Plan under this head as a result of the general appreciation of the need for roads. Though it may not be as large as it should have been in view of the prevailing backwardness in the matter of adequate communications in this vast spread-out country, we have to accept it gracefully as it is said that no more could be provided on account of the competing demands on available finances.

In this connection, I can do no better than quote the recent pronouncement of our Prime Minister whose instinctive flair for striking the right emphasis is indisputable.

> "I have come to the conclusion that one thing to which we must give topmost priority is roads—roads of all kinds, not only very up-to-date bitumenized or cement roads, but roads of any kind, to open out vast areas of this country which are closed up today and which you cannot reach unless you walk or ride...I give roads first priority."

Any tardiness in this direction will be to the peril of the Welfare State. This is also the considered opinion of the Roads Congress and the Nagpur Report is specific on this issue of balanced development.

Whatever is the use of exhorting people to move out to the villages without creating conditions which would attract them. Young men who have been having their education in urban surroundings fight shy of leaving the towns for want of even the minimum amenities in the countryside. Today there is such a well-defined watershed separating the sophisticated urban and the simple rural communities who live two different standards of life both materially and culturally. There is a big lag between the two standards and it is necessary to help develop an intermediate standard incorporating the best features of each. The ocean of buoyant life is all to one side of the ridge and the tides and waves of technical, cultural, and social progress lap up only to levels of the urban areas and break thereafter. It is necessary to cut channels through the ridge for inducing direct and open flow through this barrier by equalising the levels as far as

possible between the village and town life. Again, the common man who lives largely in the village as the producer of the basic wealth of the country and the elementary necessities in food and raw materials can no longer be ignored. He has been till recently approaching the Government with applications in a supplicant mood for his release from the land-locked interior. But the last war and its repercussions which precipitated a new era in the affairs of men and changed all fundamental values accepted hitherto, have exalted this common man to his rightful place in the democratic way of life. He insists to be brought on to the broad stage of life to establish direct contacts with the virile modern civilisation. Social justice has to be done to him and he should be relieved from his joyless, drab, monotonous and uneventful existence. It should also be the concern of the Government not to let him languish and waste his energy in the desultory and factious life now ruling in the villages.

It is necessary to build new village roads first before our other economic plans could be put on wheels. Unless we criss-cross the whole country with village roads of at least minimum specifications, village communities will be a drag on our progress and will not be in a position to contribute their mite to the building up of the country's economy. At least those villages should be linked up first which lie within a few miles on either side of the existing roads. A low type village road at small cost at first stage development can be provided to give the villager access en to the main roads which lead to towns and markets. With the construction of these links, the several amenities of life under different categories can be brought within his easy reach. Such roads will also help in the dispersal of ancillary and of even main industries towards the countryside where labourers could live a cheaper, healthier, and more spacious and effective life, and thus reduce the cost of production and increase the output. They would further facilitate the exploitation of the unexplored resources lying in the interior. In short, the effect will be to create such a congenial environment to rural existence as to tempt men of the stamp of Lloyd George who, after retiring from the Prime Ministership of England, found the growing and marketing of potatoes from rural England a sufficiently profitable and exhilirating occupation in his later life. Good transport facilities in the interior would help towards the desirable exodus ef educated people, young and old, to the countryside where they can live useful lives far from the madding crowd and enliven the countryside with their gifts and experience.

It is a welcome trend that the Community Project and National Extension Service Administrations are intensely seized of this issue in their programmes and are concentrating on

village road construction by enlisting public co-operation. The Government of India, have also offered token grants to State Governments for encouraging construction of village roads on co-operative basis by the villagers offering free labour, gifts of land, money or idling transport. Such a procedure while reducing the incidence of cost to the Government to the minimum is also the best way of enhancing the dignity of labour and practically demonstrating the equality of man and man. The energies of local scout and other youth organizations could be harnessed purposefully to creative work instead of being limited to or frittered away on spectacular ceremonial. We shall thus be working with the community and not merely for it and there seems to be no better way of converting the prevailing frustration into enthusiasm and the insurgent masses into a resurgent and self-respecting community with faith and confidence in itself.

The Government in the past had been acting on our recommendation without definitely committing themselves to any firm policy. But today, by the pressure of public opinion or may be as a result of the persistent labours of the Roads Congress and other road promotion associations like the I. R. T. D. A., it is extremely gratifying to see on the horizon the dawn of a new road era and the prospects of a sure and steady advance towards the fulfilment of our dreams. The recent statement of the Hon'ble Minister for Transport at the Silver Jubilee meeting of the I. R. T. D. A. is a charter for road development and indicates a go-ahead policy. Let me quote the relevant portions of his statement made on behalf of himself as well as of the Government.

"Policy. Our policy is to encourage the development of an integrated system of transport in which..... road transport will play an appropriate and useful role in its own sphere of effective service. Government's plans are further based on a full recognition of the fact that road transportation facilities still lag behind the actual requirements for proper economic progress. There is less than one-fifth mile of road per sq. mile in India against 2 miles in the U. K. and one mile in the U. S. A. On a population basis, India has only 6 furlongs of road per 1,000 persons against 3.6 miles in the U.K. and 12 miles in the U.S.A..... Governments in India are quite conscious of the large leeway still to be made and the community projects do include the construction of rural roads as an important part of their programmes. I may say that I am personally very keen on the development of proper roads connecting different villages to the main roads. A small amount of Rs 20 lakhs has been provided in the current year's budget for this purpose,

but I shall be glad to provide more if there is an increase in villageroad building on a voluntary basis".

The overall money provision for capital road construction and improvements under the Five-Year Plan is of the order of Rs 145 crores inclusive of Rs 25 crores from the Central Road Fund and Rs 10 crores recently added under the head of relieving unemployment for constructing inter-State roads or roads of economic importance to rural areas. Physically, the plan covers the construction of about a hundred large bridges and construction or improvement of 24,000 miles of roads in the several States of the Union. Some of the largest bridges over the Ganges, Sone, Godavari, Kistna, Torsa, Damodar, Rupnarain, Cossye, to mention only some of them, find place therein. Add to this, the provision made under Community Projects and National Extension Service Administrations for more than 20,000 miles of new village roads and the expenditure likely to be incurred on road improvement and construction by Municipalities and other administrations like those of Forest and River Valley projects. Now with the steady progress of these schemes by easy rises and treads, we shall have arrived by the middle of 1956 at the first landing on the stairs of progress from which we can easier aspire further.

Now we can take it that the Government is fully convinced of the deficiency in our road system and the urgency of making up the same. If more money has not been provided, it is due to want of resources and not for want of will on the part of the Government as we have been assured. Let us, therefore, for the time being reconcile ourselves to this position; for, it may also not be possible to get more work done in a satisfactory manner under the limitations of the present organizations and within the remaining two years of the 5-year period. We may look forward to provision on a larger scale under the next Five-Year Plan. Meanwhile, we can settle down to hard practical and technical work in the execution of all the projects to strict schedule and with the utmost economy. Towards such a consummation, on a solemn occasion like this, let us dedicate ourselves heart, soul and body to play our part in accelerating the progress of the country.

There next remains the important issue of the creation of a non-lapsing fund for road development which has been for long the prime plank in the platform of the Roads Congress. The latest advance registered in the progress of this idea is that the Planning Commission has accepted it in principle and in spirit by enunciating the proposition that road development "should be steady, balanced, and continuous and that for this purpose a certain continuity in the supply of funds is essential if wasteful

expenditure is to be avoided and programmes are to be pursued without interruption." In implementation of this idea they have fixed the money provision for development works over a 5-year period and have further permitted works to be taken up (in the Central sector at least) of 100 per cent more value so as to provide for continuity and overflow into the successor plan. Such elasticity conceded towards the natural extension of the programme into future years is a guarantee for the smooth flow of the requisite funds required not only for this Plan, but also for the subsequent ones. We hope, on realization of the advantages of this policy during the present 5-year period, the same will be continued and we would have ultimately a separate non-lapsing fund constituted by statute before long. The States also, meanwhile, must be taking steps towards the constitution of their own non-lapsing funds for road development from motor vehicle user taxes and by credit of the due share of road cesses under the approach made to them separately in terms of the Motor Vehicles Taxation Enquiry Committee's findings.

Let me next proceed to an appraisal of the existing road system and its deficiencies. From a study of the road map one can see that the required quantum of arterial road milage (of National and State Highways) is fairly existing as it is, except in the Part C and some of the Part B States, and except for missing links in various reaches and missing bridges particularly over big rivers. These roads are the responsibility of the Centre and the State Governments and have been built up over years to tolerable standards. We have however to provide the missing links and bridges and to improve the roads for the quality and efficiency of service demanded by the higher stresses and strains of modern traffic. The main deficiency lies in the want of Feeder roads to and from the villages.

How to go about remedying the defects in both these systems in an economical manner in relation to the poor resources of this country and in what sequence, we should consider. We may suppress the likely temptation of importing costly ideas and methods and the dazzling standards of American Highways as there is a vast difference between the developed hinterland of American prosperity and our stagnant backland which has still to be explored for throwing up the wealth which only could sustain a higher grade and more commodious road system. The stream of arterial travel characteristic of America stems from their advanced mechanization and the prevailing high standards of life there. Our standards should be modulated to lesser scale and hitched to nearer stars. We have to resort to stage construction and stagger improvement so as to spread our moneys over as large an area as possible, and not until definite traffic load

trends, offering the prospect of a continuity, are established, should any big commitment on expansion be made.

The main desideratum which reduces the all weather utility of our road system is the bridging of the many perennial rivers and creeks on the lengthy coastline of the Peninsula and of the several major and minor rivers in the plains. Construction of bridges and culverts over smaller channels, therefore, should be an early charge on available resources. Another frequent sight along the roads which could not have escaped the most casual road traveller is the Notice Board warning about the weak and narrow bridge ahead and enjoining speed or load limit. There are heaps of such obsolescent and derelict structures which have outlived their normal life or are too narrow and unreliable for the heavy loads and their impacts. Considerable reconstruction and replacement is called for and they have to be tackled one by one giving priority to those which are demonstrably unsound and have visibly deteriorated.

There is next the width of roadway and its geometric alignment—factors pertinent to the safety of modern high speed travel. In this ancient land of intense settlement over centuries and roads laid afterwards of slow evolution, and for slow traffic, individuals and communities lived and cultivated haphazard and hence roads through them have had to be narrow and winding. These now need widening and straightening to cater to fast traffic. Again, even where wise men in the past, in exercise of their elementary instincts, laid wide roads with broad margins, pushful and avaricious owners of properties by the roadside have gradually encroached and closed in upon the traffic width so that in and around inhabited areas we have what is called Ribbon Development, which detracts seriously from the traffic capacity of such roads. These grabbings have to be reclaimed by stern and sustained executive action. Curves, both horizontal and vertical, have to be eased and superelevated and amplified by acquiring at corners for increasing sight distances, the worst bottlenecks and death traps being taken up first.

There is again the question of bye-passing along through routes that pass through bazars of intermediate towns, where the local urban traffic resists and holds up through traffic. Where the volume of the latter is sizeable, ring roads on the outer periphery of the towns with limited access service roads or in the alternative, accommodation or distribution routes within the town will have to be provided.

Yet another aspect of road development is its aesthetics and avenue perspectives. New avenues have to be planted and reared

while the existing ones have to be protected against the vandalism practised by the villagers. There is also the need to maintain all the rest houses along the main roads in efficient condition so as to afford reasonable comfort to tourists and travellers.

Road interests adversely affected or insufficiently conserved due to laxity and want of vigilance hitherto have to be safeguarded in future by enacting a statutory Highway Law which will regulate access to roadside land and prescribe the limits of building, set back and control lines.

Segregation of traffic according to the different speeds of vehicles has to be kept in view in the design of pavements for heavy mixed traffic.

Railway over-bridges and subways and improved level crossings are also required on a large-scale but may perhaps be deferred to the next stage of development.

Road Maintenance.—Physicallly, roads are a piece of the social, industrial, and agricultural equipment of the country which must be maintained. The State, as the owner of these roads, is no more free than an industrialist is—not to maintain his tools and plant. If we do not maintain the roads adequately, certain unpleasant consequences follow and we actually waste money. Though our arterial roads can be said to be maintained at present to some standard, it is not adequate. The maintenance of secondary roads, i.e., the minor district and village roads, is very poor and almost in name only although such roads are of great importance in the day-to-day life of the masses as coming close to the skin of the large number of villagers living thereon. Not having the means to maintain them in the way they like highway authorities have been compelled to resort to makeshift methods of patchwork, often with the result that the repaired surface is at least as dangerous as the one it replaces. Water-bound macadam which has been the mainstay of our road surfaces can no longer survive under present conditions of traffic. It has ceased to be an economical proposition except where traffic is light and pneumatic tyre borne and stone is available in plenty just by the roadside and even then it is sisyphian labour and terribly wasteful of human effort as having to be repeated on a cycle of too frequent renewals. The only answer is to go in for rigid or flexible pavements of concrete or black top of high grade specifications related to the traffic intensities on the main arteries. Concrete roads cost Rs 75,000 and high specification black top Rs 40,000 on the average per mile and unless capital construction at these high costs is undertaken, the maintenance of these roads will be an unmitigated headache to the engineer and

their unsatisfactory condition will continue to give room for complaint by the public. Hence, until we have a plentitude of funds to construct surfaces suited to the traffic in each case we may not be able to show satisfactory results. Smooth and dustless surfaces yield handsome dividends in the shape of better health of the people living alongside it, of conservation of the energy of man, animal, and machine, and of considerable national savings in spare parts and replacements of motor vehicles most of which are at present imported from outside. It has been roughly estimated that the loss to motor transport on account of bad roads is of the order of Rs 38 crores per annum. This aspect has come to the forefront of late and a Committee of the Roads Congress recently constituted at the instance of the Transport Advisory Council is now engaged in studies of the comparative costs of operation of motor vehicles on different types of pavements and of the economy in transport costs resulting from improvement of road surfaces.

The maintenance of the secondary roads for all-weather traffic is a much more difficult problem so long as bullock-cart again remains the principal means of rural transport. Low cost roads with stabilized soil surfaces are not the solution in spite of the lighter traffic on them as they are incapable of standing up to the cutting action on the iron tyres of the cart. The only possible way of keeping up these roads in traffickable condition for the greater part of the year is for the villagers to take up this work themselves to be done at frequent intervals by reforming the surface after each rainfall and just before the moisture in the roads dries up and by the addition of locally available stabilizing materials of gravel, sand, or clay, as may be required. It is on account of the difficulty of maintaining these roads that quite often the construction of new village roads is sought to be postponed until such time as money could be found for initially providing a stable crust capable of standing up to the needs of the particular traffic.

It must be quite relevant on this occasion to make a brief mention of the highlights of the road development programme of Orissa State in particular. Quite a number of missing links on the Calcutta-Madras and Calcutta-Bombay National Highways are being forged at present and the construction of many of these stretches is already complete. Bridges over the Kathjuri and Kuakhai rivers and the Taldanga Canal on the former route and over the Mahanadi on the latter have already been constructed and are in use, while bridges across the Subernarekha, Brahmini and Baitarni are in course of construction. In this context it may be pointed out that the first three bridges are of daring design and of types attempted only recently in this country.

Now, I wish to refer to a question which has been agitating the minds of many senior engineers in Government service for a considerable time. In connection with our country's developments in the several sectors, a great responsibility rests upon their shoulders. To come up to the nation's expectations, they have got to work willingly, courageously and unflinchingly. You must have however noticed from speeches made by senior engineers all over India during the last few years that there is a sense of frustration among them. India needs good engineers very badly and she cannot advance unless a conscious effort is made to diagnose and remove the causes which are frustrating them. There is a dignity in the profession which must be fostered. If the engineer has to deliver the goods on a hundred fronts to-day, he must have the proper environment to do so. It is not correct to smother him with censure all round. It is generally overlooked that the engineer has to play an important part in the life of the community not only as a technician but also as a planner and administrator. One of the major causes of his despondency, I venture to say, is that many of his plans are often spoiled because they have to pass through hands which lack the training and experience required for a proper appreciation of them. I am convinced that the nation is not getting the best out of her engineers in the present arrangement, which has come to stay due to the innate reticence of engineers. May I in this connection remind them of what Dr. John Matthai, the then Minister-in-charge of Transport, said in 1948 in a message to the Indian Roads Congress.

> "Too often Engineers appear to play the role of big silent men. I have always felt that, with their education and their experience as men of affairs, they should achieve much more, if they would emerge from their shell."

Ladies and Gentlemen, your over-worked patience must be at the end of its tether, so let me close after doing a little introspection and loud thinking on the human side. It is necessary as all progress is conditioned by the nature of the human agency working at it. My exhortation to you, the young assistant engineer is that you should develop initiative and pride of profession as well as possession in your works. You should quickly, after emerging from college, learn all about the practical side of your work lest you be outwitted by the engineering trade with whom you have to deal all the time and without whose co-operation you cannot show results. Maintain an attitude of humility and sense of humour and proportion and be not dismayed by criticism. Where it is unbiassed and correct, own up and benefit therefrom. If it is ill-informed, the opportunity afforded to clear yourself will enhance your reputation. Work up by the hard way and

do not buckle under stresses. Whatever be your station at the time in the official hierarchy, shed your lustre on the job and do not consider the job as your ornament. Guard against getting cynical as a cynic is an enemy of himself and of society. Train yourself to take responsibility for whatever you do. Your future will then be assured as Society and the State are bound to look after your interests. You have very big opportunities in the offing for bringing out your best and advancing your knowledge in the many-sided works coming under the Five-Year Plan, especially in the construction of bridges over the major rivers. Let economy be your watchword. Be on the scent for new quarries and newer and better techniques. Be loyal to the Congress and reduce the gap between its well thought out specification and your actual working standards.

To the senior engineers my appeal is that you should take a keen and lively personal interest in guiding your assistants on the right path, not only by putting up warning signs at all the likely pitfalls by the way but also by giving helpful and positive advice and direction. Train him to be a worthy successor to you in due time. You are fortunate that your early career was cast in the good old pre-war days when engineers worked under easier conditions. The lot of today's entrant into service is certainly more difficult and he needs sympathetic handling.

To you, our guests, let me address myself finally. Pray, be gentle in future while you swear at a road for, from what has just been explained, it must be apparent to you by now why roads are often bad and that good roads mean high costs. A road like a billiard table has to be paid for. All the economies we try, do not carry us far. In this connection it is pointed out, paradoxical as it may seem, that you are all paying even now without being conscious of it, extras in the shape of your vehicle and health repair bills arising out of the jolts and dust nuisance on bad and rough roads. I request you therefore to throw in your weight on the side of getting more funds for road maintenance. There is no use indulging in cavilment of the engineer-in-charge. These engineers are of your choice. They were trained by selection, trained in examination and tested and stamped by the Public Service Commission, and must therefore be the best men the country could yield. You have no go except to manage with them. So, if they are good, encourage them to be better. If they are lame, give them crutches and set them on feet; and if they are bad, diagnose the disease and nurse them to health and vigour by going to the root causes. Then only can progress be registered. I now request you, Sir, to inaugurate this Session.

INAUGURAL ADDRESS

In declaring the Session open, Shri Naba Krushna Chowdhury said :

Mr. President, Ladies and Gentlemen,

It is a matter of great happiness for us in Orissa to have had this opportunity of providing our new Capital as the venue for the 18th Annual Session of the Indian Roads Congress and of welcoming in our midst eminent Engineers from all parts of the country. I extend to you all a most cordial welcome on behalf of myself and the Government and people of Orissa. I have no doubt that in these surroundings where the relics of the glorious ancient past mingle with a growing modern township, you will find a congenial atmosphere for your serious deliberations. I understand that the present session includes visits to Hirakud, Konarak and Puri—places which will give you an idea of the present achievement as also the achievements of by-gone days.

Shri Naba Krushna Chowdhury inaugurated the Session on 5-2-54.

We have all listened to your very interesting and may I venture to say, Mr. President, highly instructive address. To me, it is very gratifying indeed to note that you attach great importance to the building of village roads and adopting economical methods. I have been particularly delighted to hear you impressing upon our Engineers the desirability of making a practical approach to the problems before them by taking into account local conditions and not being dogmatically wedded to the superior American or European standards. This is a very sound and timely advice.

It would be presumptuous of me to speak before this distinguished gathering of Road Engineers of such commonplace things as the importance of easy communications for a

programme of all round development. It is true that in the first Five Year Plan, it has not been possible to accord the development of road communications as high a priority as it deserves because the primary problem of food had unavoidably to receive our immediate attention. We are now happily turning the corner so far as the food problem is concerned and I have every hope that development of communications will hereafter receive its due place in our plans of development. The Indian Roads Congress will deliberate on many technical problems regarding the development of road science. You will, no doubt, apply all the resources of your technical knowledge and experience to devise economical, as opposed to cheap specifications which are the crying need of the hour. With the establishment of a Central Road Research Institute, new opportunities have been provided to the Road Engineers to develop their science and technique.

With the dawn of Independence, the expectations of the people have naturally gone very high. Both quick and lasting results are expected. We have a great leeway to make up in our national reconstruction. While we are all desirous that this process of national reconstruction should be completed as early as possible, there are many limiting factors particularly that of financial resources ; and we have to exercise the utmost economy. Fortunately for us economy is not merely a dire necessity but by its very nature, engenders all the virtues that foster progress or growth of a nation. It is the tight hand of economy which builds and indicates strength. Our own history and the history of other great nations teaches us that extravagance is a sign of decadence. Closely allied to this question of economy is the larger and more important question of integrity. In the context of the changed condition in our country with the advent of Independence, this concept of integrity has acquired a new force. In every sphere of activity for the development and reconstruction of the country we have to be moved by the patriotic urge, to dedicate ourselves to the service of the country, work for its advancement and for the betterment of the conditions of the masses. Integrity, about which we used to talk in the past, as a virtue, has now become a necessary concomitant of this patriotism. It has to come now from within and not as a result of checks and controls from above. Amongst our Engineers and other technical personnel particularly, it should be the twin forces of patriotism and pride of profession that should give rise to this virtue in the rank and file.

I may be permitted the liberty of drawing your attention to an unfortunate tendency noticeable generally amongst educated young men in our country. This is the growing disinclination on their part to work with their hands. Manual

labour is looked down upon. It is considered dignified to live on the labour of others. This is a serious matter because the country needs more and more workers in the field. Unless, therefore, this tendency is counteracted, most of our dreams of a great and glorious future may be shattered. This is really a relic of our feudal caste-ridden past and our faulty and deficient educational system. I am certain the Roads Congress would give this matter the serious consideration it deserves. Engineers with their excellent training, both at home and abroad, should set a healthy example to the rest of the educated community. It will be a tragedy if instead of doing that they succumb to the prevailing vice and go after Whitecollar positions. You have not only to build big bridges and broad highways, great dams and aqueducts, but you will also have to take a leading part in clearing the debris of feudalism and building the solid edifice of a democratic society by bridging the gulf that separates the workers and peasants from the class of Babus and gentlemen who hate to soil their hands.

With the growing tempo of development work in our country, we are requiring increasing numbers of qualified Engineers. We are, in fact, experiencing a very great shortage of Engineers in many spheres and at all levels. In view of this, it is felt that our Engineers should not be overburdened with administrative responsibilities and work in spheres which do not call for play of their technical skill and knowledge. I would request the Roads Congress to give their earnest consideration to this matter also.

Before I conclude, I would like to pay my warm tributes to the Engineers of our country who, in the post-Independence period, have taken up execution of gigantic projects requiring the highest skill, experience and professional ability. The Hirakud Project in this State, with which I am intimately concerned and of which I have first-hand knowledge, is being entirely executed by our own Engineers at all stages. The Project, when completed, will be a matter of pride to the whole nation. It would be an achievement of which our Engineers could be justly pround. Even in the construction of smaller projects, roads, bridges, etc., the Engineers are distinguishing themselves and have won admiration here and abroad. I am confident that what our Engineers achieve in future will be even more worthy of admiration and wider recognition.

I need hardly say how much interested I am in the deliberations of your Congress and how sincerely I wish them all success. I again thank you for asking me to inaugurate this, the 18th Annual Session of the INDIAN ROADS CONGRESS and I have great pleasure in doing so.

PRESIDENT'S CONCLUDING REMARKS

I thank you, Sir, on behalf of the Indian Roads Congress for your kind welcome and for the help and encouragement you have given us by your presence here today.

We appreciate what you have justly said that educated young men should not be afraid of manual labour.

And now, Sir, may I request you to present the "Indian Roads Congress Medal" to Shri K. K. Nambiar and Shri K. Namasivayam, Authors of Paper on "The Investigation, Design and Construction of the Cauvery Bridge at Pugalur".

Message from Shri Jawahar Lal Nehru, Prime Minister, India

The Prime Minister sends his good wishes for the 18th Session of the Indian Roads Congress.

Message from Shri O. V. Alagesan, Deputy Minister for Transport & Railways, Government of India

I have great pleasure in sending my best wishes for the success of this Eighteenth Session of the Indian Roads Congress.

Of all transport facilities, road communication comes nearest to man. It functions from his front gate and from portal to portal.

We are today right in the middle of the execution of the current Five-Year Plan and have got into our stride. Road development forms a part of the plan. Although the public purse is not too large vis-a-vis the many urgent needs of the country, yet enough has been provided for a very good beginning. Now it is up to our engineers to use their ingenuity and skill to produce maximum results out of these funds. Here is at once a serious challenge to and a glorious opportunity for them.

May your deliberations be directed purposefully towards this end.

Message from His Excellency Shri K. Santhanam, Lieutenant Governor of Vindhya Pradesh

I have been following the proceedings of the Congress for the past many years. It has come to be a valuable institution for the sifting of principles and practices of road making in India and the establishment of traditions which in due course will result in raising the standards of work in this field.

As I shall not be able to attend in person, I would request you to convey my greetings and good wishes to the Conference.

Messages of good wishes for the successful Session have also been received from :

His Excellency the Governor of Orissa.

Shri Lal Bahadur Shastri,
Minister for Transport & Railways, India.

Sardar Swaran Singh,
Minister for Works, Housing and Supply, India.

Shri C. Deshmukh,
Minister for Finance, India.

Shri K. C. Reddy,
Minister for Production, India.

Dr. P. S. Deshmukh,
Minister for Agriculture, India.

Shri G. V. Mavalankar,
Speaker of the House of People, India.

Shri M. C. Shah,
Deputy Minister for Finance, India.

The following institutions have also sent their good wishes :

The Institution of Engineers, Australia.
The American Association of State Highway Officials.
The Highway Research Board, U. S. A.
Queensland Main Roads Department, Australia.
Department of Main Roads, New South Wales, Australia.
Bureau of Public Roads of the U. S. A.

INDIAN ROADS CONGRESS
EIGHTEENTH SESSION-BHUBANESWAR

Bhubaneswar, the picturesque new capital of Orissa, was the scene of the Eighteenth Session of the Indian Roads Congress which met between the 4th and 11th of February last. The delegates who were able to spare some time for visiting the innumerable temples scattered round about Bhubaneswar must be carrying with them the haunting memory of these beautiful shrines which exhibit a unique architectural style. The finest specimens are the Lingaraj, and Rajarani, and the Mukteswar temples. The Lingaraj, is Bhubaneswar's main shrine and is one of the best archaeological monuments in India. It stands in a courtyard 520 ft by 465 ft and towers up to a height of 127 ft from the ground.

The Session was inaugurated by Shri Naba Krushna Chowdhury, Chief Minister, Orissa, on the 5th February 1954. About 200 delegates from all parts of India attended the session. This was the first meeting of the Congress in Orissa.

Shri R. K. Batra, Chief Engineer, Roads and Buildings, Madhya Pradesh, delivered the Presidential Address. The special point made out in his Address (published in full in this issue) was the creation of a non-lapsing fund for road development in order to ensure that road development is steady, balanced and continuous.

The President assigned first priority to the construction of village roads and, next, to bridges and culverts on rivers and waterways along main roads. He also urged the need of replacing on a programme, the weak or obsolescent and derelict structures which have outlived there normal life or are too narrow and unreliable for the heavy loads and their impact.

Other points touched upon by the President in his speech were the provision of adequate width of roadway and suitable horizontal and vertical curves—factors pertinent to the safety of modern high speed travel. He also referred to other aspects of road development such as aesthetics and avenue perspective, segregation of traffic, railway over-bridges and sub-ways and improved level crossings.

The President advised the younger engineers to develop intiative and pride and profession, maintain an attitude of humility, sense of humour and proportion and be not discouraged by criticism.

To senior engineers, he appealed to take a keen and lively personal interest in guiding their assistants with helpful and positive advice and direction.

The Chief Minister in his inaugural address said that while every one desired the process of national reconstruction to be completed with the least possible delay, there were many limiting

Shri K. K. Nambiar, receiving the I. R. C. Medal.

factors, particularly financial stringency and they had to exercise the utmost economy. He further referred to the shortage of suitable technical personnel for the execution of projects. He paid high tributes to engineers and advised young men not to be afraid of doing manual labour themselves.

The Indian Roads Congress Medal was awarded to Shri K. K. Nambiar and Shri K. Namasivayam for their Paper "The In-

vestigation, Design and Construction of the Cauvery Bridge at Pugalur."

Messages of goodwill were received from the Prime Minister, the Hon'ble the Speaker of the House of People, His Excellency the Governor af Orissa, His Excellency the Lieutenant Governor of Vindhya Pradesh, and several Ministers of the Centre and the States and professional institutions abroad.

There were five Papers and one Road Research Note open for discussion. About sixty speakers, took part in the discussions.

The panel discussions on "Practices prevalent in India regarding the construction of Cement Concrete Roads" which had not been completed at the last session were continued at this Session and completed. The discussions after suitable editing will be published by the Indian Roads Congress.

There was the usual round of Committees and Council meetings.

The Specifications and Standards Committee discussed the Standards to be adopted for Road-Rail Level Crossings. The Research Organization Division considered the reports of the

The newly elected President, Shri H. P. Mathrani, Consulting Engineer (Road Development), Government of India addressing the 43rd Council on 9-2-54.

research work done in various research laboratories. The Test Track Division considered the report of the work done at the Road Test Track, Calcutta. Other Subcommittees which met during the Session were the Papers Subcommittee, the Education Subcommittee, the Road Transport Subcommittee, the Subcommittee

dealing with the question of the Provincialization of Local Bodies Engineering Services. The Education Subcommittee discussed the draft syllabus for Refresher Courses for engineers already employed and draft model syllabus for Highway Engineering in Civil Engineering Degree Course.

Demonstration of the actual working of Motor-Grader and Asphaltic Concrete Mixer were also arranged for the benefit of delegates.

The delegates were accommodated in the M. L. A.'s Hostels and Quarters—all in one place, and this helped the delegates to come into close contact with each other throughout their stay at Bhubaneswar during the Session. In the evenings, all delegates assembled in the meeting hall to see interesting technical films on the use of latest road making machinery.

The Technical Exhibition was opened by Shri Bhairab Chandra Mahanti, Deputy Minister for Works, Orissa. The coloured and flood lights of the exhibition gave a festive appearance and the public, too, visited the exhibition in large numbers. The details of the exhibition are given at pages 509–511.

On the 9th, the delegates visited the old Sun-god Temple of Konarak which is nearly forty miles from Bhubaneswar. On the 10th, the delegates paid a visit to the famous Jagannath Temple at Puri. The last day was devoted to the inspection of Kathjuri, Kuakhai and Taldanga Canal bridges and the layout of the new capital at Bhubaneswar.

TECHNICAL EXHIBITION

Eighteenth Session, Bhubaneswar, February, 1954

A technical exhibition was organised on the grounds opposite to the Legislative Assembly Building.

The exhibition was opened on the 5th February 1954 by Shri Bhairab Chandra Mahanti, Deputy Minister for Works, Orissa, who went round all the stalls and showed keen interest in the exhibits.

Shri Bhairab Chandra Mahanti, Deputy Minister for Works, Govt. of Orissa, declaring the exhibition open.

Speaking on the occasion, the Minister said that it is only the engineers who could bring prosperity to the country by developing her resources. He laid particular emphasis on the development of the scientific aspects of Engineering. He also appreciated very much the idea of organising exhibitions of the latest types of road making machinery for the education of the public about what is being done to develop the road communications in the country.

The exhibition remained open throughout the Session and attracted interested visitors from among the lay public of Bhubaneswar. The exhibits included models and photographs of bridges, explanatory charts and sections of roads and machinery, materials and processes used for the construction of modern roads.

The following organisations took part in the exhibition :

1. Government of India, Ministry of Transport, Roads Wing.

   Statistical and graphical presentation of data regarding road development, vehicles, etc. Charts showing progress of work under the Five Year Plan, Sample copies of periodicals received in the library of the Ministry of Transport, Roads Wing. A model of a Traffic Rotary was also displayed. This showed how traffic accidents could be avoided at crossings.

2. Buildings and Roads Research Laboratary, Karnal, Punjab.

3. Highways Deptt. Research Laboratory, Madras.

4. Government of Orissa—(i) Building & Roads Branch.
   (ii) Public Relations Deptt.

5. Government of West Bengal, Road Development Deptt., showing one of the exhibits was a relief map of West Bengal.

6. Firms :

(1)	M/s. B. R. Herman Mohattas.	Displayed Charts, Catalogues, Models and Photos. In some cases machinery used in construction were exhibited.
(2)	,, Burmah Shell.	
(3)	,, Concrete Association of India.	
(4)	,, Dunlop Rubber Co. Ltd.	
(5)	,, Greaves Cotton & Co. Ltd.	
(6)	,, Heatly Gresham & Co. Ltd.	
(7)	,, National Foundary Rolling Mills.	
(8)	,, Standard Vacuum Oil Co. Ltd.	
(9)	,, Shalimar Tar Products, Ltd.	
(10)	,, Tractors (India) Ltd.	
(11)	,, William Jacks & Co.	

One of the Stalls in the Technical Exhibition.

A demonstration of the use of a motor grader in road construction was given on the 7th February 1954 by Messrs. Tractors (India) Limited.

Messrs. Willam Jacks arranged for demonstration of their Mixall and showed how the machine could be used in constructing a bituminous carpet.

—

Minutes of the 42nd Council Meeting of the INDIAN ROADS CONGRESS Held at Bhubaneswar on the 4th February, 1954.

Present

R. K. Batra - President

C. M. Bennett	H. P. Mathrani
B. Chaudhury	E. A. Nadirshah
C. J. Fielder	K. K. Nambiar
Goverdhan Lal	S. C. Nayak
W. A. Griffiths	L. R. Patel
S. Gupta	K. Ramaswamy
R. N. Joshi	Sujan Singh
U. N. Mahida	

J. Subrahmanyam—Secretary

The following co-opted and invited Members also attended

E. Zipkes, Dr.	K. F. Antia
A. K. Sen	H. Sunder Rao

B. N. Shenoy

1. Confirmation of the Minutes of the 41st Council Meeting.

The Minutes of the 41st Council Meeting held at Madras on the 12th February 1953 as published at pages 561 to 564 of Volume XVII-part 4 of the Journal of the Indian Roads Congress were confirmed.

2. Approval of the Minutes of the Executive Committee Meetings.

The minutes of the meetings of the Executive Committee held at New Delhi on the 24th October 1953 and the 21st January 1954 were approved.

3. Audit Report for the year 1952-53.

The Report of the auditors for the year 1952-53 was recorded. The Council approved of the creation of a reserve of Rs 10,000 to cover bad debts and of the fund being maintained at this figure.

4. Draft Report of the Council to the General Body of Members for the period 1st January 1953 to the 31st December 1953.

The draft report was approved.

5. Budget

The budget estimate for 1953-54 was approved.

6. Change in the Secretaryship of the Indian Roads Congress.

The Council noted that on the transfer of Shri J. M. Trehan as Engineer Liaison Officer at Madras, the President, under the provisions of rule 11-a of the Memorandum of Association, etc., had appointed Shri J. Subrahmanyam, Divisional Engineer (Consultant), Ministry of Transport, Government of India as Secretary with effect from the 1st April 1953.

The Council appreciated the work done by Shri J. M. Trehan during the tenure of his office and passed the following resolution:

> "The Council of the Indian Roads Congress places on record their appreciation of the excellent work done by Shri J. M. Trehan as Secretary, Indian Roads Congress".

7. Amendment to Rules and Regulations.

The Council agreed to amend Rules 9-d, 11-b, and 20 by substituting the words "Consulting Engineer to the Government of India (Road Development)" *for* "Consulting Engineer to the Government of India (Roads)".

8. Standards of the Indian Roads Congress.

The Council expressed the view that it was necessary to take steps to ensure application of the Indian Roads Congress Standards throughout the country. Accordingly they decided that the Government of India should be requested to address all State Governments and impress upon them the need for conscious effort in this behalf. The Council passed the following resolution:

> "The Council decided that the Government of India should be requested to circulate the following four standards to all State Governments".
>
> (1) Dimensions and Weights of Road-Design Vehicles;
>
> (2) Recommended Practice for Location and Layout of the Roadside Motor-Fuel Filling Stations;
>
> (3) Type Designs for Highway Milestones; and
>
> (4) Type Designs for Route-marker Signs.

9. Appreciation of the services rendered by Shri G. M. McKelvie.

The Council greatly appreciated the services rendered by Shri G. M. McKelvie to the Indian Roads Congress and unanimously passed the following resolution:

> "The Council of the Indian Roads Congress places on record their great appreciation of the services rendered by Shri G. M. McKelvie to the cause of Road development in general and the Indian Roads Congress in particular. With his retirement from the service of the Government of India in May 1953, the Indian Roads Congress lost the

(iv) The Indian Roads Congress thank Shri Lal Bahadur Shastri, Minister for Railways and Transport, Govt. of India, for his good wishes for the success of the Session.

(v) The Indian Roads Congress thank His Excellency the Governor of Orissa for his good wishes.

(vi) The Indian Roads Congress thank Shri O. V. Alagesan, Deputy Minister for Transport and Railways, Government of India, for his inspiring message to the members of the Indian Roads Congress.

(vii) The Indian Roads Congress thank His Excellency Shri K. Santhanam, Lieutenant Governor of Vindhya Pradesh, for his very inspiring message and good wishes to the members of the Indian Roads Congress.

(viii) The Indian Roads Congress thank Shri Bhairab Chandra Mahanti, Deputy Minister for Works, Orissa for kindly declaring open the technical exhibition organized by the Indian Roads Congress on the occasion of the Session and for his Address on that occasion.

(ix) The Indian Roads Congress thank Institutions and other well wishers who have sent messages of goodwill and encouragement.

(x) The Indian Roads Congress thank Shri C. M. Bennett, Chief Engineer, Shri B. S. Jootla, Deputy Chief Engineer, Shri S. Mumtaz Ali, (Local Organizing Secretary, Indian Roads Congress), officers and other staff of the Public Works Department, Orissa, for the efficient arrangements made by them for the Session and for the convenience of the delegates.

(xi) The Indian Roads Congress thank the firms and Governments who participated in the technical exhibition organized at this Session and offered technical films to be screened.

(xii) The Indian Roads Congress thank the Railway Board for providing additional accommodation on trains for the delegates attending the Session of the Indian Roads Congress.

7. Scrutineers for the Election of Council Members.

Messrs. C. J. Fielder, C. M. Bennett, Goverdhan Lal and K. K. Nambiar, were appointed scrutineers for the election to the Council under rule 9-i of the Rules and Regulations of the Indian Roads Congress.

8. Elections. The following were elected as Members of the Council.

9-f. (i) Representatives of Associate Members other than Public servants.

F. P. Antia	O. C. K. Krishnan
C. J. Fielder	E. A. Nadirshah
R. N. Joshi	L. R. Patel

g. Representative of District Board Engineers.

S. N. Sinha

h. Representative of Municipal, Improvement Trusts and Cantonmnt Engineers.

M. Meeran

i. Representative elected by the General Body.

S. N. Gupta	C. P. Misra
E. V. S. Iyer	S. C. Nayak

9. Under rule 9-a, b, c and d the following were nominated by their respective administrations as Members of the Council:

9-a Name of participating Administration	Name of representative
Andhra	J. M. Frederick
Assam	B. Chaudhury
Bihar	M. L. Bahl
Bombay	U. N. Mahida
Madhya Pradesh	R. K. Batra
Madras	K. K. Nambiar
Orissa	C. M. Bennett
Punjab	D. P. Nayar
Uttar Pradesh	M. S. Bisht
West Bengal	T. Mitra

	Hyderabad (Deccan)	D. V. Rao
	Jammu & Kashmir	D. N. Gupta
	Madhya Bharat	P. V. Divatia
	PEPSU	Raghbir Singh
	Rajasthan	Kishore Lal
	Saurashtra	U. J. Bhatt
	Travancore-Cochin	K. K. Kartha
9-b	Engineer-in-Chief, Army Headquarters	Brig. K. N. Dubey
9-c	Central P.W.D.	M. S. Mathur
9-d	Consulting Engineer (Road Development)	H. P. Mathrani
10.	Past Presidents:	
9-e		
	R. K. Batra	
	T. Mitra	
	G. M. McKelvie	

Annexure I

LIST OF MEMBERS WHO ATTENDED THE EIGHTEENTH SESSION OF THE INDIAN ROADS CONGRESS HELD AT BHUBANESWAR IN FEBRUARY, 1954.

S. No.	Name of State etc.	No. of delegates who attended the I.R.C. Session.
	ABSTRACT	
1.	**Government of India:**	
	(a) Ministry of Transport, Roads Wing ...	22
	(b) Engineer-in-Chief's Branch ...	3
	(c) Central P.W.D. ...	3
2.	Council of Scientific and Industrial Research	7
3.	Andhra ...	8
4.	Assam ...	3
5.	Bihar ...	17
6.	Bombay ...	16
7.	Madhya Pradesh ...	6
8.	Madras ...	15
9.	Orissa ...	28
10.	Punjab ...	3
11.	Uttar Pradesh ...	13
12.	West Bengal ...	31
13.	Hyderabad-Deccan ...	2
14.	Jammu & Kashmir ...	4
15.	Madhya Bharat ...	3
16.	Mysore ...	1
17.	Rajasthan ...	5
18.	Sikkim ...	1
19.	Saurashtra ...	2
20.	Travancore-Cochin ...	3
21.	Tripura ...	1
22.	Delhi ...	3
23.	Kutch ...	1
	Total ...	201

LIST OF MEMBERS WHO ATTENDED THE EIGHTEENTH SESSION OF THE INDIAN ROADS CONGRESS HELD AT BHUBANESWAR IN FEBRUARY, 1954.

S. No.	Roll No.	Name.
		1. GOVERNMENT OF INDIA.
		(a) Ministry of Transport (Roads Wing)
1.	322	Bazaz, S.L.
2.	1446	Bhalla, R.S.
3.	783	Bhargava, T.N.
4.	758	D'Costa, A. J.
5.	879	Goverdhan Lal.
6.	1387	Grover, D. T.
7.	1078	Gurusahani, R. L.
8.	785	Hardayal.
9.	1288	Mathrani, H. P.
10.	1310	Mitra, N. B.
11.	1702	Mukerjee, A.
12.	1274	Murthi, B. S. N.
13.	950	Nagarsheth, M. P.
14.	890	Patel, B. P.
15.	724	Rajagopalan, S. K.
16.	752	Ramaswamy, N. S.
17.	Invitee	Ranganathan, K.
18.	1532	Sehra, P. T.
19.	1515	Sen, N.
20.	723	Subrahmanyam, J.
21.	389	Sunder Rao, H.
22.	637	Surya, N. S.
		(b) Engineer-in-Chief's Branch
23.	1818	Bose, Col. S. K.
24.	16	Chaubal, Lt.-Col. V. S.
25.	Invitee	Deb, A. K.
		(c) Central P.W.D.
26.	737	Dewan, N. G.
27.	1801	Rao, G. S.
28.	1820	Vedagiri, T. S.

S. No.	Roll No.	Name.
		2. COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH
29.	Invitee	Puri, B. D.
30.	1191	Shaukat Rai.
		Central Road Research Institute, Okhla
31.	1625	Gonsalves, G. F. D.
32.	1796	Nagarajan, R.
33.	1345	Swaminathan C. P.
34.	847	Uppal, Dr. H. L.
35.	1535	Zipkes, Dr. E.
		3. ANDHRA.
36.	1263	Abdul Rahman.
37.	813	Prabhala, R.
38.	1824	Rajanna, B. V.
39.	757	Ramamohan Rao, R.
40.	230	Ramamurty, K.
41.	1013	Rao, B. K. V.
42.	472	Seshagiri Rao, N.
43.	1523	Venkatachalam, B.
		4. ASSAM.
44.	1247	Barua, H.
45.	941	Chaudhury, B.
46.	1802	Mazumdar, K. L.
		5. BIHAR.
47.	1637	Amanullah, N.
48.	399	Bahl, M. L.
49.	1634	Chakravarti, A. C.
50.	623	Dubey, J. P.
51.	1286	Ghosh, T.
52.	471	Gupta, S.
53.	1778	Jaiswal, S. N.
54.	1691	Jha, B.
55.	1259	Lall, Y. K.
56.	434	Misra, C. P.
57.	1250	Nand Kishore Prasad.
58.	1291	Nilkanth Sinha.
59.	1776	Prinja, K. C.
60.	1266	Roy, P. K.
61.	754	Sinha, S. K.
62.	871	Sinha, S. N.
63.	856	Sircar, S. K.

S. No.	Roll No.	Name.
		6. BOMBAY.
64.	1241	Antia, K. F.
65.	1522	Apte, M. P.
66.	1336	Daftary, N. D.
67.	1739	Desai, I. C.
68.	1129	Iyengar, C. L. N.
69.	1474	Jagus, P. J.
70.	1430	Joshi, R. N.
71.	217	Krishnan, O. C. K.
72.	636	Macha, T. K.
73.	553	Mahida, U. N.
74.	23	Nadirshah, E. A.
75.	1609	Nagarkar, G. P.
76.	163	Rege, D. Y.
77.	1595	Shinde, Y. A.
78.	1148	Shivdasani, P. D.
79.	792	Shukla, G. D.
		7. MADHYA PRADESH.
80.	1547	Agrawala, G. D.
81.	978	Batra, R. K.
82.	1379	Gurbaxani, T. C.
83.	972	Malhotra, C. L.
84.	1813	Mirchandani, H. P.
85.	1803	Rajwade, M. V.
		8. MADRAS.
86.	1800	Alexander, G.
87.	994	Chandrasekharan, E. C.
88.	1284	Golikere, P. R.
89.	1794	Govindarajulu, P. T.
90.	80	Griffiths, W. A.
91.	671	Meeran, M.
92.	268	Nambiar, K. K.
93.	1792	Nambiar, P. G.
94.	997	Naraynaswami Iyer, T. S.
95.	660	Nayak, S. C.
96.	1775	Selvam, T. T.
97.	1785	Shah, Z. S.
98.	219	Sirajuddin, P.
99.	1795	Subbayya, K. B.
100.	514	Srouty, M. S.

S. No.	Roll No.	Name.
		9. ORISSA.
101.	204	Bennett, C. M.
102.	1747	Bhanja, M. M.
103.	1825	Dass, H. H.
104.	1823	Dass, K. M.
105.	1746	Dass, N. P.
106.	285	Das, P. C.
107.	886	Gupta, G.
108.	292	Iyer, E. V. S.
109.	304	Jootla, B. S.
110.	1115	Kashyap, M. G.
111.	303	Mahapatra, M.
112.	728	Misra, B.
113.	1306	Misra, D. S.
114.	1272	Mishra, U. N.
115.	625	Mohanty, A. B.
116.	1722	Mumtaz Ali, S.
117.	661	Nanda, G.
118.	690	Padhi, R. N.
119.	564	Padhi, S. R.
120.	1799	Papa Rao, G.
121.	513	Parija, K. C.
122.	1822	Patanayak, B. B.
123.	1805	Patnaik, G.
124.	1793	Patnaik, P. R. M.
125.	1327	Rao, A. R.
126.	112	Roy, G. P.
127.	536	Sahu, B. N.
128.	1127	Sinha, S. N.
		10. PUNJAB.
129.	68	Balwant Singh.
130.	1402	Bhasin, P. C.
131.	427	Nayyar, S. L.
		11. UTTAR PRADESH.
132.	1181	Bansal, K. L.
133.	205	Bisht, M. S.
134.	1543	Gahlowt, R. S.
135.	1790	Goyal, V. C.
136.	1787	Gupta, G. C.

S. No.	Roll No.	Name.
137.	1176	Mahabir Prasad.
138.	264	Parmara, D. S.
139.	1255	Sahni, K. S.
140.	1521	Shukla, C. N.
141.	1819	Shukla, M. L.
142.	1273	Sinha, P. S.
143.	45	Srivastava, M. P.
144.	958	Srivastava, P. N.
		12. WEST BENGAL.
145.	1421	Basu, K. N.
146.	1806	Bhaduri, B. N.
147.	15	Bhattacharyya, B.B. (Associate member)
148.	1628	Bose, A. K.
149.	1777	Bose, D. K.
150.	1649	Chakravarti, S. C.
151.	1797	Chakaravarthy, S. K.
152.	1812	Chattopadhya, B. C.
153.	45	Chaterjee, D.
154.	1815	Das Gupta, B. R.
155.	1786	Datta, A. K.
156.	1393	Dutt, A. C.
157.	41	De, K. C.
158.	530	Dutt, P. R.
159.	231	Fielder, C. J.
160.	1810	Guha, R.
161.	936	Gupta, S. N.
162.	Invitee	Mackay, S.
163.	512	Marik, T. P.
164.	1811	Mitra, A. P.
165.	488	Nagarkar, D. B.
166.	21	Patel, L. R.
167.	1544	Ray, S. N.
168.	1294	Roy Chowdhury, D. P.
169.	766	Roy, R. C.
170.	1417	Saha, N.
171.	1816	Samajdar, S.
172.	1817	Sarkar, C. K.
173.	1735	Sen, A. K.
174.	727	Sen, B. R.
175.	863	Sen Gupta, P. N.

S. No.	Roll No.	Name.
		13. HYDERABAD-DECCAN.
176.	29	Narasimham, J. S.
177.	407	Ramaswamy, K.
		14. JAMMU & KASHMIR.
178.	1607	Dogra, N. N.
179.	1552	Narboo, S.
180.	1583	Wanchoo, S.
181.	1821	Sheikh Abdul Salam.
		15. MADHYA BHARAT.
182.	1575	Ghatpande, G. S.
183.	1814	Nalawade, A. T.
184.	578	Yadav, H. J.
		16. MYSORE.
185.	1668	Manchigiah, M. H.
		17. RAJASTHAN.
186.	1661	Bhatnagar, V. R.
187.	1798	Patni, M. N.
188.	1598	Satyanarain Singh.
189.	1807	Shevade, S. V.
190.	1808	Vishram Puri.
		18. SIKKIM.
191.	707	Jali, F. C.
		19. SAURASHTRA.
192.	34	Mehta, J. T.
193.	1313	Patel, N. C.
		20. TRAVANCORE-COCHIN.
194.	1599	Gopalakrishna Iyer, V. V.
195.	1809	Ittycheria, M. V.
196.	1654	Kartha, K. K.

S. No.	Roll No.	Name.
		21. TRIPURA.
197.	307	Sen, A. K.
		22. DELHI.
198.	40	Shahni, T. C.
199.	39	Shenoy, B. N.
200.	1432	Sujan singh.
		23. KUTCH.
201.	1471	Vora, P. K.

Annexure II

BALANCE SHEET AS AT 30TH SEPTEMBER, 1953.

(Excluding Transport-Communications Monthly Review)

LIABILITIES		Rs A. P.	Rs A. P.
SUNDRY LIABILITIES			
Creditors for Expenses	...	4,564 2 0	
Subscriptions received in Advance from :			
Ordinary Members :			
1953–54 480 0 0			
1954–55 70 0 0			
Associate Members :			
1953–54 55 0 0	...	605 0 0	5,169 2 0
MITCHELL MEDAL FUND			
(Invested as per contra)	...		2,012 1 0
BUILDING, MUSEUM & TECHNICAL FUND			
Balance as per last Balance Sheet	...	126,003 14 9	
Add : Amount of life Membership Fee-Reserve	...	893 0 0	126,896 14 9
PROVIDENT FUND			
Deposits including interest earned	...		16,175 14 2
AMOUNT HELD IN SUSPENSE ACCOUNT	...		138 0 0
T. C. M. R. ACCOUNT	...		4,346 2 0
INCOME & EXPENDITURE ACCOUNT			
Balance as per last Balance Sheet	...	115,289 9 7	
Add : Unclaimed Balance unadjusted	...	2,000 0 0	
		117,289 9 7	
Add : Balance being Excess of Income over Expenditure as per annexed Income & Expenditure Account	...	812 8 3	118,102 1 10
Total	...		2,72,840 3 9

(Sd.) J. SUBRAHMANYAM.
Secretary.

We have audited the Balance Sheet of the INDIAN ROADS CONGRESS (excluding Transport-Communications Monthly Review) as at 30th day of September, 1953, above set forth, and have obtained all the information and explanations we have required.

In our opinion, the above Balance Sheet set forth gives a true and correct view of the state of the affairs of the Congress according to the best of our information and explanations given to us and as shown by books.

(Sd.) J. C. CHANDIOK,
B.A., A.C.A. (England & Wales), F.C.A.,
for Walker, Chandiok & Co.,
Chartered Accountants.

Kashmere Gate,
Delhi.
Dated, this 29th day of December, 1953.

ASSETS			Rs A. P.	Rs A. P.
EQUIPMENT				
Balance as per last Balance Sheet		...	5,837 3 6	
Additions during the year		...	1,259 14 0	
			7,097 1 6	
Less : Depreciation		...	701 11 3	6,395 6 3
LIBRARY BOOKS				
Balance as per last Balance Sheet		...	1,585 12 6	
Additions during the year		...	219 15 0	
			1,805 11 6	
Less : Written off	7 6 0	...		
Depreciation	179 13 6	...	187 3 6	1,618 8 0
DRAWING MATERIALS				
Balance as per last Balance Sheet		...	26 5 0	
Less : Depreciation		...	1 9 0	24 12 0
STOCK-IN-HAND				
(Certified as to quantities & values by the Secretary)				
Journals		...	33,755 6 0	
Paper		...	2,619 0 9	36,374 6 9
SUNDRY DEBTORS				
Subscription in arrears from :				
Ordinary Members		...	9,706 0 0	
Associate Members		...	500 0 0	
Outstandings on Journal		...	221 3 0	
Subsidies Receiveable (of which Rs 6,000 are considered bad & doubtful)		...	50,000 0 0	
Advertisement Charges (of which Rs 988-4-0 were considered bad & doubtful)		...	1,028 4 0	
Session Expenses Receiveable		...	264 0 0	
Transport Charges (of which Rs 50 are considered bad & doubtful)		...	505 0 0	
Delegation Fees		...	4,590 4 0	66,866 11 0
Central Road Research Institute		...	52 0 0	1,799 4 0
ADVANCES		...		5,543 12 9
INTEREST ACCRUED ON INVESTMENTS		...		
INVESTMENTS				
Rs 6,000/- 5 years Post Office Certificates		...	6,000 0 0	
Rs 40,000/- 12 years National Savings Certificates		...	40,000 0 0	
Rs 50,000/- Treasury Receipts (T. S. D. C.).		...	50,000 0 0	
Rs 21,300/- 3% Loan 1963-65		...	20,271 10 0	116,271 10 0
PROVIDENT FUND				
12 Years National Savings Certificates		...	11,200 0 0	
Interest accrued thereon to 31-12-1952		...	150 0 0	
Balance with Imperial Bank of India		...	2,697 14 2	
Loans Advanced		...	2,128 0 0	16,175 14 2
MITCHELL MEDAL FUND				
Rs 1,600/- 3% Loan 1963-65		...	1,652 14 11	
Interest accrued thereon		...	16 0 0	
Balance with Imperial Bank of India		...	343 2 1	2,012 1 0
CASH & OTHER BALANCES				
With Imperial Bank of India		...	19,728 5 10	
Postage Stamps in hand		...	29 8 0	19,757 13 10
Total		...		272,840 3 9

INDIAN ROADS CONGRESS

INCOME AND EXPENDITURE FOR THE YEAR ENDED 30TH SEPTEMBER, 1953.

(Excluding Transport-Communications Monthly Review)

EXPENDITURE	Rs A. P.	Rs A. P.	INCOME	Rs A. P.	Rs A. P.
To Opening Stock of Journal as on 1st October, 1952	35,327 4 0		By Subscription :		
,, Cost of Paper	10,938 5 6		Ordinary Members ...	23,730 0 0	
,, Cost of Printing ...	11,060 4 9		Associate Members ...	3,000 0 0	
	57,325 14 3		Members restored ...	160 0 0	
			Life Members ...	100 0 0	26,990 0 0
Less : Closing Stock of Journal as on 30th September, 1953 ...	33,755 6 0	23,570 8 3			
,, Establishment		30,659 6 0	,, Entrance Fees :		
,, Local & other Allowances ...		14,648 11 0	Ordinary Members ...	1,900 0 0	
,, Honorarium to Secretary ...		1,200 0 0	Associate Members ...	120 0 0	2,020 0 0
,, Bank Charges ...		171 8 0			
,, Provident Fund Contribution ...		2,026 6 0			
,, Audit Fee ...		450 0 0			
,, Postage & Telegrams ...		2,958 12 9	,, Sale of Publications ...	3,953 6 6	
,, General Printing & Stationery ...		1,585 8 3			
,, Uniform to Class IV Servants ...		250 10 9	,, Advertisement ...	6,892 14 0	10,846 4 6
,, Miscellaneous Expenses ...		1,355 8 3			
,, Publicity Account ...		600 0 0	,, Subsidies ...		48,000 0 0
,, 17th Session Expenses ...		10,451 10 9			
,, Subscriptions to other Societies ...		403 8 0	,, Interest on Government Securities etc. ...		4,063 10 0
,, Library Books written off ...		7 6 0			
,, Bad Debts written off ...		9,208 2 6	,, Miscellaneous Income ...		18 6 0
,, Depreciation written off ...		883 1 9			
,, Balance being Excess of Income over Expenditure carried to Balance Sheet ...		812 8 3	,, Receipts on account of :		
			Delegation Fees ...	7,320 0 0	
			Transport Charges etc. ...	1,985 0 0	9,305 0 0
Total		1,01,243 4 6	Total		1,01,243 4 6

Kashmere Gate,
Delhi.
Dated, this 29th day of December 1953.

(Sd.) J. SUBRAHMANYAM,
Secretary.

In terms of our report appended to the Balance Sheet.
(Sd.) J. C. CHANDIOK,
B.A., A.C.A. (England & Wales), F.C.A.,
for Walker, Chandiok & Co., Chartered Accountants.

INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDED 30TH SEPTEMBER, 1953.

EXPENDITURE		Rs A. P.	Rs A. P.	INCOME		Rs A. P.
To opening Stock as on 1st October, 1952	...	567 10 11		By Sales & Subscriptions of the Journal	...	1,855 0 0
,, Purchase of Paper	...	4,586 12 9		,, Advertisements	...	12,546 13 0
,, Printing Charges	...	6,492 7 0		*Note*:—Subscriptions received for unexpired period have not been adjusted in the accounts.		
		11,646 14 8				
Less: Closing Stock as on 30th September, 1953	...	1,300 2 9	10,346 11 11			
,, Postage	...		1,414 6 9			
,, Miscellaneous Expenses	...		33 12 0			
,, Bank Charges	...		24 14 0			
,, Bad Debts written off	...		164 2 6			
,, Balance being Excess of Income over Expenditure carried to Balance Sheet	...		2,417 13 10			
Total	...		14,401 13 0	Total	...	14,401 13 0

BALANCE SHEET AS AT 30TH SEPTEMBER, 1953.

LIABILITIES		Rs A. P.	Rs A. P.	ASSETS		Rs A. P.	Rs A. P
SUNDRY CREDITORS				**BOOK DEBTS**			
For Expenses	...	152 14 3		For Advertisement considered good	...	2,200 14 0	
Advances received	...	1,755 0 0	1,907 14 3	For Advertisement considered Bad and Doubtful	...	1,062 1 0	3,262 15 0
SUBSCRIPTIONS BILLED AS PER CONTRA	...		126 0 0	**SUBSCRIPTIONS RECEIVEABLE**			
SURPLUS ACCOUNT				Bills sent per V. P. P.	...		126 0 0
Balance as per last Balance Sheet	...	4,589 2 11		**DUE FROM GENERAL ACCOUNT**	...		4,346 2 0
Add: Balance being Excess of Income over Expenditure as per annexed Income & Expenditure Account	...	2,417 13 10	7,007 0 9	**STOCK IN HAND** (Certified as to quantities & values by the Secretary)	...		1,300 2 9
				STAMPS IN HAND	...		5 11 3
Total	...		9,040 15 0	Total	...		9,040 15 0

Kashmere Gate,
Delhi.
Dated, this 29th day of December 1953.

(Sd.) J. SUBRAHMANYAM,
Secretary.

Audited and found correct.
(Sd.) J. C. Chandiok,
B.A., A.C.A. (England & Wales), F.C.A.,
For Walker, Chandiok & Co., Chartered Accountants.

Annexure III

INDIAN ROADS CONGRESS

REPORT OF THE COUNCIL TO THE GENERAL BODY OF MEMBERS FOR THE PERIOD 1ST JANUARY TO THE 31ST DECEMBER 1953.

[The Report covers the period from the 1st January to the 31st December 1953, though a few matters referred to in it are carried beyond the latter date for convenience and completeness of record.]

1. GENERAL

The Seventeenth Session of the Indian Roads Congress was held at Madras in February 1953 when 226 members and five invitees attended the Session. The four Papers published in the Journal of the Indian Roads Congress Volume XVII-parts 1 to 3 were read and discussed. Three Committees and seven Subcommittees were reconstituted to deal with various engineering and administrative problems. The Soil Research Subcommittee which had been divided into two Divisions at the last Session was reconverted into one subcommittee. The Bituminous Treatment of Wet Aggregates Subcommittee and the Highway Layout Subcommittee were abolished. The residual functions of the former Committee were entrusted to the Flexible Pavements Division and the work of the latter to the Geometric Design Division of the Specifications and Standards Committe.

The Executive Committe held two meetings at New Delhi on the 24th October 1953 and the 21st January 1954.

2. ADMINISTRATION

Shri R. K. Batra, Chief Engineer, Madhya Pradesh, was elected President of the Indian Roads Congress at the Madras Session. Shri H. P. Mathrani, Consulting Engineer (Road Development) and Joint Secretary to the Government of India, Ministry of Transport, continued as Honorary Treasurer. Shri Goverdhanlal, Deputy Consulting Engineer to the Government of India (Roads) continued as Honorary Deputy Treasurer.

Shri J. M. Trehan continued as Honorary Secretary till the 31st March 1953, when he was transferred as Engineer Liaison Officer, Madras. In his place, Shri J. Subrahmanyam, Divisional Engineer (Consultant), Ministry of Transport, was appointed

as Honorary Secretary with effect from the 1st April 1953. Shri A. Mukerjee continued to work as Honorary Assistant Secretary.

Shri P. A. Krishnaswamy who had been appointed as Technical Secretary with effect from the 2nd December 1952 resigned for reasons of health. The resignation was accepted and he was relieved on the 15th June 1953. In the vacancy thus caused Shri B. N. Shenoy (a retired Planning Officer in the Ministry of Transport, Roads Wing) was appointed as the Technical Secretary with effect from the 30th July, 1953.

3. OFFICE

The office continued to function in New Delhi. It disposed off 6,796 receipts and issued 15,589 letters during the period under report.

The staff worked satisfactorily.

4. MEMBERSHIP

(1) There were 77 new admissions during the year to the Society and 138 removals from the rolls. The removals were the results of resignations (29), deaths (9) and non-payment of arrears of subscription (100). The members, from whom it became impossible to recover the arrears of subscription in spite of a prolonged effort, had retired from service, left India or otherwise failed to respond. The number of members on the rolls on the 30th September 1953 was 1,255 (1,227 Ordinary and 28 Associate).

(2) **Life Membership** :—During the Congress year from the 1st October 1952 to the 30th September 1953, 10 Members enrolled themselves as Life Members bringing the total number of such members to 121. This number is, however, included in the total number of ordinary members. The fees received from them have been transferred to a separate reserve after deducting Rs 10 per member for initial expenses.

5. DEATHS

It is with deep regret that the Council record the deaths of the following Members :

Anand Kumar	D. N. Mallick
K. G. Bhate	A. G. Mitra
A. N. Ganguli	U. S. Ramasundaram
K. Venkatachallam	

6. BUDGET

The budget for the year 1953-54 and the 'Actuals' for 1952-53 were approved by the Executive Committee at their meeting held on the 24th October 1953. The estimate have been placed before the Council at its 42nd meeting. The 'Actuals' for 1952-53 show an excess of income over expenditure of Rs 4,000 against an estimated deficit of Rs 11,602. This improvement in the budgetary position resulted from economy in expenditure. Also some of the publications which had been expected to be printed during 1952-53 were not published.

The total contribution received from the States during the year ending the 30th September 1953 was Rs 41,000. The outstanding from the Central and the State Governments on the 30th September 1953 amounted to Rs 50,000. The States concerned are being urged to expedite payment of the outstanding contributions. It is expected that the outstanding contributions will be realized during the current year. Sums, amounting to Rs 13,000 were received after September 1953. Further intimations sanctioning contributions amounting to Rs 16,000 have also been received but their payment is still awaited.

The arrears of subscriptions at the beginning of the Congress year 1952-53 were Rs 13,717-12-0, due from 276 members. The names of 138 members who had retired from service, had died or otherwise failed to respond were removed from the rolls. Consequently a sum of Rs 6,017-12-0 standing as arrears against these members was written off by the Executive Committee during the year 1952-53.

A sum of Rs 2,350 was realised from 62 Members.

After adding the arrears for 1952-53, the total of arrears on the 1st October 1953 stood at Rs 10,206 due from 192 Members. Action has been taken regarding this and some further names have been removed from the rolls by the Executive Committee at its meeting in October 1953. Details of the action that is being taken will be reported in the next annual report.

7. AUDIT

At the Seventeenth Session at Madras it was decided to appoint Messrs. Walker, Chandiok & Co., Chartered Accountants and Auditors, Delhi to audit the accounts of the Congress for 1952-53. The report was examined by the Executive Committee on the 21st January. It was also placed before the Council at their 42nd meeting on the 4th February 1954.

8. PUBLICATIONS

There was a steady demand for the publications of the Indian Roads Congress during the year under report.

In addition to other publications, bound Volume XVI was made available for sale. Circulars were issued to all State Governments, other administrations, and engineering firms bringing to their notice that bound Volume XVI was available. Announcements regarding the publications were also made in the Journal and the Transport-Communications Monthly Review. As a result these publications received sufficient publicity and had a brisk sale.

A booklet, "Bridging India's Rivers", has been published by the Indian Roads Congress. It is a collection of the articles that appeared in the Transport-Communications Monthly Review during 1952.

The booklet contains useful imformation, both for the interested public and engineers. Salient features of design, interesting problems during the construction, broad analyses of costs and the utility of these bridges have been sketched in the articles.

It is proposed to distribute copies to important persons and also Indian missions abroad. This will keep them informed of the progress made by India in bridging her rivers.

The balance of the publications as on the 31st December 1952 was as under:

Name of Proceedings	*Volume*	*Balance*
I.R.C. Proceedings	1 to VII-part 1, & VIII	sold out
Do.	VII-part 2	46
Do.	IX-part 4	122
Do.	IX (bound)	160
Do.	X-part 1	sold out
Do.	X-part 4	253
Do.	X (Bound)	sold out
Do.	XI-part 4	182
Do.	XI-parts 1 & 2 (Bound)	sold out
Do.	XI-part 3 & 4 (Bound)	115
Do.	XII-part 1	sold out
Do.	XII-part 2	411
Do.	XII-part 3	428
Do.	XII-part 4	509
Do.	XII-part 5	439

Name of Proceedings	*Volume*	*Balance*
Do.	XII-parts 1 to 3 (Bound)	435
Do.	XII-parts 4 & 5 (Bound)	245
Do.	XIII-part 1	298
Do.	XIII-part 2	373
Do.	XIII-part 3	732
Do.	XIII-part 4	Sold out
Do.	XIII-parts 1 & 2 (Bound)	594
Do.	XIII-parts 3 & 4 (Bound)	174
Do.	XIV-part 1	296
Do.	XIV-part 2	390
Do.	XIV-part 3	325
Do.	XIV-part 4	425
Do.	XIV (Bound)	538
Do.	XV-part 1	781
Do.	XV-part 2	341
Do.	XV-part 3	390
Do.	XV-part 4	422
Do.	XV (Bound)	588
Do.	XVI-part 1	Sold out
Do.	XVI-part 2	128
Do.	XVI-part 3	173
Do.	XVI-part 4	179
Do.	XVI (Bound)	940
Do.	XVII-part 1	106
Do.	XVII-part 2	205
Do.	XVII-part 3	128
Road Research Bulletin No. 1		202
Bridge Code (1937)		95
Nagpur Report		248
Lecture of Prof. Madhava		Sold out
Paper "Water-Bound Macadam"		36

It is noticed that the demand for the last Part of each Journal is smaller than for the other Parts. This is so because the last Part of each Volume does not contain any Papers. The discussions on Papers are printed in the last Part of each Volume and they are as important as the Papers as they bring out fresh points of view. It is hoped that with this explanation, the demand for these issues will improve.

Members who do not possess a complete set of the Journals of the Society are advised to complete them before the volumes in hand are sold out.

On a reciprocal basis, copies of the publications continued to be supplied to several technical institutions in India, the United States of America, the United Kingdom, Australia and Germany.

Copies were also sent to the offices of the United Nations Organization in the Far East. Recently some more important Institutions have been addressed for the exchange of their literature with our Journal. A list of the important periodicals which are being received in the I. R. C. Library is given at pp. 548–549.

The "Transport-Communications Monthly Review" has received much attention from engineers and laymen alike. It contains important and interesting articles on Highway Engineering and Road Transport. From the month of February 1953, an abstract service has been started. Further a list of selected literature on roads and allied subjects is being published from September 1953. In order to increase the usefulness of the Journal to the younger members of the profession a series of articles, in the form of questions and answers have been started.

The members of the Indian Roads Congress, subordinate engineering staff, and engineering students can obtain this publication at a concessional rate of Rs 8 per annum against the ordinary rate of Rs 14 per annum.

Complimentary copies of the Review are being issued to State Governors, Rajpramukhas, Chief Commissioners, Ministers at the Centre and in the States, and the Chief Engineers concerned with roads, and other important persons. Also complimentary copies of the issue for March 1953 were given to the Members of the Indian Roads Congress.

The Council request Members and other readers of the Review to take a hand in making the Review more useful by sending articles and other suitable contributions for publication.

9. INFORMATION

Enquiries from Members as well as non-Members on problems relating to Highway Engineering and allied subjects were attended to. Some of the subjects on which information was sought are given below:

(1) Specifications for laying cement concrete pavements.
(2) Vertical curves.
(3) Glossary of Highway Engineering terms.
(4) Restriction of loads on certain types of roads.
(5) Specification for stone metal for concrete.
(6) R. C. C. pipes.
(7) Landscape planning of roads.
(8) Surface dressing specifications.

(9) Standards fixing slow down signals.
(10) Formation of cross ruts in roads.
(11) Suspension rope foot bridges.
(12) Boiler & sprayer equipments.
(13) Road surfacing materials.
(14) Road milage statistics in India and of foreign countries.
(15) Cement concreting of municipal roads under which water mains are laid.
(16) Standard for type designs of highway milestones.
(17) Road signs and standards for furlong posts.
(18) Maintaining a record of test values of stone metal available in the various States.
(19) R. C. C. slab bridges for I. R. C. Loadings.
(20) Road traffic signs.
(21) Tables and graphs giving sizes of piers and abutments.
(22) Haulage by trucks and tractor-trailers.
(23) Testing of concrete structures (building and bridges).
(24) I. R. C. Standard Specifications and Code of Practice for Road Bridges.
(25) Cement concrete trackways.
(26) Specifications for steel & R. C. C. bridges.
(27) Simple methods of calculating the safe bearing capacity of soils for the foundations of causeways and submersible bridges.
(28) Prevention of road accidents.
(29) Soil cement construction in India.

10. LIBRARY

A large number of technical journals of various institutions in India and abroad were received in exchange for the Indian Roads Congress publications. Some new books and Standards of the British and the Indian Standards Institutions were added to the Library of the Congress. Members can borrow books from the libraries of the Congress and the Consulting Engineer (Road Development) by writing to the Secretary, Indian Roads Congress. The rules regarding the loan of books are published in Volume XVIII-part 1 of the Journal for the Congress.

Lists of additions to the library are published monthly in the "Transport-Communications Monthly Review". Members are requested to see the lists and make free use of the library books. Fifty books were issued on loan during the year under report. This is a small number considering that the Society has a

membership of 1,300. It is urged that members should make more use of these libraries.

11. MEDALS AND PRIZES

The Executive Committee in their meeting during the Madras Session noted that the following Papers had been commended by the Papers Subcommittee.

Paper No. 158 "Construction of Shillong-Silchar Road" by S. C. Pal & R. C. Das.

Paper No. 160 "The Design of Road Beds" by G. Sriranga-chary.

The General Body at their meeting held at Madras on the 11th February 1953 reviewed their decision taken at the Jaipur Session in February 1946 and accepted the recommendations of the Executive Committee and the Council that in future Members of the Council should also be eligible for the award of prizes and medals for Papers contributed by them.

12. COLLECTION OF PARTICULARS OF BRIDGES

The Indian Roads Congress have been collecting particulars of bridges of lengths above 100 ft for publication in the form of a book. The information collected is under compilation in collaboration with the Roads Wing of the Ministry of Transport. As soon as compilation is complete, the question of its publication will be taken up.

13. MEMBERSHIP OF SOCIETIES AND INSTITUTIONS

(1) The Indian Roads Congress is a member of the Indian National Society of Soil Mechanics and Foundation Engineering. Shri S. R. Mehra, Principal, Punjab College of Engineering, Chandigarh, represented the Indian Roads Congress on the National Committee of the Society during the year.

(2) The Congress is a Sustaining Member of the Indian Standards Institution and maintains a close liaison with the activities of the Institution through representatives nominated to serve on their Councils and Committees dealing with subjects which have a bearing on roads.

Shri H. P. Sinha continued to represent the Indian Roads Congress on the Engineering Division Council of the Indian Standards Institution.

The following continued to represent as the principal and alternative representatives of the Indian Roads Congress on the Building Division Council of the Indian Standards Institntion.

Principal Representative	...	Shri S. B. Joshi
Alternative ,,	...	Shri H. P. Sinha

The other representatives of the Congress on the various Sectional Committees of that Institution are:

EDC: 2–Cement	...	Shri E. P. Nicolaides
EDC: 20–Drawings	...	Shri H. P. Sinha
CDC: 7–Bitumen & Tar Products		Shri K. K. Nambiar Shri Brijmohan Lal
BDC: 1–Terminology Notation & Drawings Sectional Committee		Shri H. Sunder Rao (Principal representative) Shri J. Subrahmanyam (Alternative representative).
BDC: 7-Structural Steel Sectional Committee	...	Shri D. S. Desai (Principal representative) Shri M. P. Nagarsheth (Alternative representive)
BDC: 14-Bridges Sectional Committee	...	Shri J. Chambers (Principal representative) Shri D. S. Desai (Alternative representative)

The following are the principal and alternative representatives of the Indian Roads Congress on the Road Tar Subcommittee of the Indian Standards Institution.

Principal representative	...	Shri R. N. Chatterjee
Alternative representative	...	Shri G. C. Khanna

(3) It was decided that the Indian Roads Congress should join the Prestressed Concrete Group set up under the auspices of the Institution of Engineers (India). Shri K. K. Nambiar was nominated to represent the Indian Roads Congress on that Group.

(4) The Indian Roads Congress is also represented on the Road Research Committee set up by the Council of Scientific and Industrial Research. Shri H. Sunder Rao was nominated to represent the Indian Roads Congress on that Committee.

14. REPRESENTATION ON THE BOARD OF ENGINEERING RESEARCH

The Prime Minister in his capacity as President of the Council of Scientific and Industrial Research set up this Board to co-ordinate research in various branches of engineering. The President of the Indian Roads Congress is a member of the Board.

TECHNICAL ACTIVITIES

15. SPECIFICATIONS AND STANDARDS COMMITTEE

The Committee held meetings on the 7th February and the 26th October 1953. The following subjects were discussed.

(1) Questionnaire on surface dressing.
(2) Specifications for road stone and chippings.
(3) Standards for "Dimensions and Weights of Road-Design Vehicles"
(4) Recommended Practice for the location and layout of road side Fuel-filling stations.
(5) Set-out tables for horizontal curves.
(6) Glossary of Highway Engineering terms.
(7) Standard form for recording traffic census.

The questionnaire referred to at item (1) above was approved by the Committee for circulation to the Chief Engineers and manufacturers of tar and asphaltic binders for eliciting replies. The information on the current specifications for surface dressing and the performance of surface dressed roads in different parts of the country is being collected. When that has been done the Committee will draw up a note on "Recommended Practice for Surface Dressing."

The specifications for road stone and chippings referred to at item (2) above were discussed by the Committee but final decisions have not been arrived at so far.

Items (3) and (4) have been finalized by the Committee. These were circulated to the members of the Council and the Committee and their approval to publish them as the finalized standards of the Indian Roads Congress was obtained. The standards have been published in Volume XVIII-parts 2 & 3 of the Journal of the Indian Roads Congress.

In addition to items (3) and (4), two more standards mentioned below have been published in Volume XVIII-parts 1 and 2 of the Journal, viz.,

(i) Type Designs for Highway Milestones: Vol. XVIII-1.
(ii) Route Marker Signs for National Highways; Vol. XVIII-2.

Item (5). The design tables for horizontal curves along with set-out tables for spirals have been approved by the Committee and their inclusion in a booklet on horizontal road curves is under consideration.

Item (6). Glossary of Highway Engineering Terms, has been published in draft form in Vol. XVIII—part 3 of the Journal.

Item (7). The Committee have also approved a form for recording traffic census. It will be shortly circulated to the various administrations and published in the Journal of the Society.

The following subjects have been under study:

(i) Design of Road Intersections.
(ii) Road-Rail level crossings.
(iii) Testing Road stones.

The Committee recommends that the Council should request the Ministry of Transport of the Government of India to circulate the Indian Roads Congress Standards to the State Administrations and urge them to enforce the standards.

16. BRIDGES COMMITTEE

The Sections of the Bridge Code dealing with the following subjects have been under study:

(i) Prestressed concrete.
(ii) Steel structures.
(iii) Masonry structures.
(iv) Reinforced cement concrete.

17. TECHNICAL SUBCOMMITTEE

(1) Test Track Division.

The Division of the Subcommittee held a meeting during the Session at Madras in February 1953. The progress of work done at the Road Test Track, Calcutta, was discussed. The present (1952-53) series of tests are being carried out to determine, under adverse conditions, the comparative performance of the soil stabilized base courses of different thicknesses.

It is expected that these tests will be completed shortly and the subcommittee proposes to discuss the future programme of tests at their meeting during the coming Session.

According to the recommendations of the subcommittee made at their meeting on the 2nd January 1952, the Governnent of Uttar Pradesh were requested *not* to carry out repairs to the experimental lengths near Agra but to allow them to deteriorate to the point of destruction, so that definite conclusions could be derived from the experiments. The progress report for the period ending the 30th September, 1952, received from the Executive Engineer showed that it would soon be necessary to repaint the surfaces. A meeting of the local Committee of the Test Track Division was called on the 31st January 1953 at Agra in order to appraise finally the behaviour of binders used. The Committee reported that the sections where Delhi stone had been used the road surfaces were still in a satisfactory condition, while the surfaces where Bharatkup stone had been used were breaking up. The Committee agreed that repairs of the latter could be put in hand by the Executive Engineer when he thought necessary, under intimation to the Indian Roads Congress. These stretches were repainted on 12-6-1953.

Tests on surface dressing laid out on the Delhi-Mathura Road near the Central Road Research Institute, Okhla (Delhi) are in progress.

The manuscript of Road Research Bulletin No. 2 containing reports of work done at the Road Test Track at Calcutta from 1942-1945 was made ready for sending to the Press. The Chief Engineer (Highways), Madras kindly agreed to go through the Bulletin before it was sent to the Press.

(2) Research Organization Division.

The Division of the Subcommittee held meeting at Delhi on the 16th December 1952 and the 27th October 1953.

They made certain suggestions about the use of stabilized soil in the construction of village roads. The Convenor of the subcommittee, who is also the Technical Adviser to the Community Projects Schemes, was requested to keep the suggestions in view.

The subcommittee decided to request all road research organizations to send half-yearly reports of their work on subjects research on which was in progress. On conclusion of the research on any of those subjects they should contribute Papers for

publication through the Indian Roads Congress. The matter was placed before the Chief Engineers' meeting held at Madras on the 12th February, 1953. They agreed to help the Indian Roads Congress in the co-ordination of road research in India by ensuring that Papers and Reports on road research should be sent to the Indian Roads Congress before they were sent to any other Institution for publication.

At the meeting on the 27th October 1953, the subcommittee discussed the following reports :

(1) Paper on : "The use of linseed Oil-cake as Stabilizer in Earth Road Construction" by Messrs. Manohar Lal and B. L. Dhawan.

(2) Abstract of Reports on the work done from July 1951 to June 1952, at the Roads and Buildings Laboratory, Karnal (Punjab).

(3) Annual Report for the year 1951-52 of the Uttar Pradesh, P. W. D. (B. & R. Branch), Research Station, Lucknow.

18. SOIL RESEARCH SUBCOMMITTEE

The subcommittee held two meetings one at Madras in February 1953 and the other at Delhi on the 28th October 1953.

On the request of the Indian Roads Congress, the Govt. of India had agreed to provide funds for carrying out experiments on surface dressing with tar on stabilized roads with and without tack coat in the Punjab and Madras. The subcommittee considered that, wherever possible, both Bitumen and Tar should be used, for the purposes of comparison and that the Madras light-chipping carpet specifications may be taken as equivalent to two-coat surface dressing. These views were communicated to the Government of India.

At the Madras meeting the subcommittee stressed the economic importance of stabilized soil construction and desired that the Consulting Engineer to the Government of India (Road Development) might be approached to encourage research and full-scale experiments in stabilized soil. These recommendations were considered by the Executive Committee, at their meeting held at New Delhi on the 24th October 1953. As decided by them, the Government of India were requested to urge the Chief Engineers of all States to encourage the use of stabilized soil for

base courses in the construction of roads where conditions permitted.

The subcommittee wished that work done on 'soils' in various States should be made known to them. Reports on soil research will be placed before them.

At the meeting held on the 28th October 1953, the subcommittee considered the proposal for a special test track for research on the use of soil for village road construction and recommended that inexpensive low speed test tracks should be set up in each state for testing different specifications for soil stabilized road construction. Preferably these should be on diversion of roads.

Further, the subcommittee considered the details of machinery required for road work with stabilized soil. Shri G. Srirangachary was requested to send a note on the subject as it was understood that soil stabilization work with full-scale equipment had been carried out in Madras. He was requested to include information about the work done in the Punjab in co-operation with Shri R. N. Dogra.

The subcommittee also discussed:

(1) A note: "A System of Classification of Soils for Highway Construction in India".

(2) Report of the Uttar Pradesh, B. & R. Research Station, Lucknow, for the year 1951–52.

(3) Report of the Roads and Buildings Laboratory, Karnal, for the period July 1951 to June 1952.

19. EDUCATION SUBCOMMITTEE

The subcommittee held a meeting during the Madras Session in February 1953.

They discussed a draft syllabus for Highway Engineering in the degree courses. The Syllabus has been circulated to the Members of the Subcommittee.

Refresher courses for engineers and engineering subordinates working in Highway Department were also discussed. Details of the course conducted at the College of Engineering, Kirkee, as also of a course of lectures given at the Road Research Laboratory, Harmondsworth, England have been obtained and passed on to the Education Subcommittee.

20. PROVINCIALIZATION OF LOCAL BODIES ENGINEERNIG SERVICES SUBCOMMITTEE

The subcommittee held a meeting during the Madras Session in February 1953 and recommended that for efficient and planned development and construction of Local Board works and their proper maintenance, the Council of the Indian Roads Congress should impress upon State Governments the necessity of their District Board Engineering Organizations being taken over immediately and merged with the State's Building and Road Department, the services of the staff being provincialized under the the direction and control of the State Chief Engineer concerned.

The recommendations were accepted by the Organization Committee and the Executive Committee at their joint sitting held at Madras during the Session and then by the Council at their meeting held on the 12th February 1953. The Council passed a resolution that the Government of India should be requested to advise the State Governments to adopt, as early as possible, the policy advocated in the resolution. The resolution has been communicated to the Government of India. The results are awaited.

21. MANUFACTURE OF ROAD MAKING MACHINERY AND MECHANIZATION SUBCOMMITTEE

The subcommittee held a meeting during the Session at Madras in February 1953. They considered the supply and demand position of various essential items of road machinery in India. The discussions brought out that the position regarding tar boilers was satisfactory and importing them was not necessary to any significant extent.

It was mentioned at the meeting that much trouble had been experienced in importing spares for machinery, without which it was not possible to get satisfactory work out of the machines in use. The Consulting Engineer (Road Development) promised to assist when reference was made to him.

22. ROAD TRANSPORT SUBCOMMITTEE

The subcommittee in their meeting held at Madras during the Session in February 1953 again stressed the need for an Indian Road Transport Congress.

A committee was formed to draft a resolution asking the Government of India to constitute an Indian Road Transport Congress and also to draft a memorandum outlining the urgency and reasons in support of the resolution. The resolution and the memorandum when received from the subcommittee will be placed before the Executive Committee for consideration before forwarding them to the Government of India.

23. OPERATION COSTS COMMITTEE

At the instance of the Government of India, the Indian Roads Congress appointed a committee of experts to study (i) the cost of operation of motor vehicles on different classes of roads ; and (ii) the economy of accruing in that cost as a result of road improvement. The report of the committee has to reach the Government of India before the next meeting of the Transport Advisory Council. The Committee held its first meeting at Delhi on the 25th September 1953. They discusssed a questionnaire for the circulation and collection of data for study. It is expected that the data will be collected during 1954 and it will be possible for the committee to prepare their report early in 1955. They, however, propose to submit an interim report at the next meeting of the Transport Advisory Council.

MISCELLANEOUS

24. PAPERS FOR THE 18th SESSION

Fourteen Papers were received. Six were accepted for publication, two were rejected, two returned to the Authors with suggestions for revision, and four are under consideration for the next Session.

25. RESEARCH PROBLEMS

The Executive Committee, at their meeting on the 29th September 1950, considered that, as students in engineering colleges were not likely to be familiar with road problems requiring research, the Indian Roads Congress should compile a list and circulate it to engineering colleges.

A list of research problems suggested by the Members of Council and the Convenors of Committees and Subcommittees was compiled and was passed on to the Research Organization Division for scrutiny. It will be placed before the Executive Committee in due course.

26. TEST VALUES OF ROAD STONES

In order to complete the collection of test values of various types of stone metal available in different parts of the country, the Government of India, Ministry of Transport circulated a standard form to all State P. W. Ds., explaining that whenever any test of stone metals was done, the test data should be recorded in the offices of the concerned Executive Engineer or Superintending Engineer and a copy supplied to the State Chief Engineer, as well as one copy to the Consulting Engineer (Road Development). As a result of this circular, information from many State P. W. Ds. was received. Replies from the remaining States are awaited. After this information from all States has been received, compilation will be taken up for publication.

LIST OF JOURNALS

1. American Foundryman.
2. American Highways.
3. Annual Reports of the Institution of Engineers (India), Bombay Centre.
4. Automobile Roads.
5. Better Roads.
6. Bitumen Teere Asphate Peche and Verwandte Stoffe (in German).
7. British Road Federation (Bulletin).
8. Bulletin Technique De la Suisse Romande (in French).
9. Bulletin of the Institution of Engineers (India).
10. Central Board of Irrigation & Power Abstracts.
11. Commonwealth Today.
12. Concrete Quarterly.
13. Cement (Holland).
14. Engineering News of India.
15. Highways & Bridges & Engineering Works.
16. Highway Current Literature.
17. Highway Research Abstracts.
18. Indian Journal of Power & River Valley Developments.
19. Irrigation & Power (Journal of Central Board of Irrigation & Power).
20. Indian Railways.
21. Indian Standards Institution Bulletin.
22. Indian Construction News.
23. Journal of Scientific & Industrial Research.
24. Journal of the Institution of Engineers (Australia).
25. Journal of the Institution of Engineers (India).
26. Journal of the Institution of Military Engineers.
27. Journal of the Institution of Municipal Engineers (U.K.).
28. Journal of the Institution of Transport.
29. Journal of the Indian Institute of Science.
30. Link Belt Speeder News.
31. Magazine of Concrete Research.
32. Main Roads.
33. Monthly News Letter of I.R.T.D.A.
34. Motor Transport.
35. Municipal Gazette.
36. Proceedings of the Institution of Civil Engineers, London.
37. Power Engineer.
38. Public Roads.
39. Quarterly Technical Bulletin, (Ministry of Railways.)
40. Road Abstracts.
41. Road Builders' News.
42. Road International.
43. Roads & Road Construction.
44. Science and Engineering.
45. Shovel News.
46. State Transport Review, Bombay.
47. Strassen - und - Tiefbau (In German).
48. Structural Engineer Journal.
49. Strasse und Verkehr (In German).
50. Surveyor & Municipal and County Engineer.
51. The Highway Magazine.
52. The Indian Concrete Journal.
53. The Indian & Eastern Engineer.
54. U. N. E. S. C. O. Bulletin for Libraries.
55. World Construction.
56. Western India Automobile Magazine.

Minutes of the 43rd Council Meeting of the INDIAN ROADS CONGRESS held at Bhubaneswar on the 9th February 1954.

The meeting began with Shri R. K. Batra in the Chair.

Present:

M. L. Bahl
C. M. Bennet
V. R. Bhatnagar
M. S. Bisht
S. K. Bose, Col.
Goverdhan Lal
S. N. Gupta
E. V. S. Iyer
R. N. Joshi
K. K. Kartha
O. C. K. Krishnan
U. N. Mahida
K. L. Mazumdar
H. P. Mathrani
M. Meeran
C. P. Misra
E. A. Nadirshah
K. K. Nambiar
S. C. Nayak
K. Ramaswamy
S. N. Sinha
H. J. Yadav
J. Subrahmanyam-Secretary.

The following co-opted Members attended.

K. F. Antia
T. P. Marik
S. L. Nayak
R. C. Roy
Sujan Singh
P. N. Wanchoo.
E. Zipkes, Dr.

The following attended by invitation

R. S. Bhalla
B. S. Jootla
S. Mumtaz Ali
H. Sunder Rao
B. N. Shenoy

1. Co-options and Invitations.

The Council approved the action taken by the Executive Committee in co-opting and inviting certain members to attend the Council meeting.

2. Confirmation of the Minutes of the 42nd Council Meeting.

The Minutes of the 42nd Council Meeting held at Bhubaneswar on the 4th February 1954 were confirmed.

3. Office Bearers.

The following were elected to hold Office till the next General Session.

President	H. P. Mathrani.
Vice-Presidents	C. M. Bennett.
	U. N. Mahida.
	F. P. Antia.
Honorary-Secretary.	J. Subrahmanyam.

At this stage the newly elected President, Shri H. P. Mathrani, took the chair.

4. Venue of the next General Session.

The Council recorded their thanks to the Governments of Madhya Pradesh and Jammu and Kashmir for extending invitations to the Indian Roads Congress to hold their next Session at Nagpur and Srinagar respectively.

The Executive Committee was authorized to fix the venue and dates of the next Session.

5. Committee and Subcommittees.

The Convenors of Committees and Subcommittees were appointed as under:

(1)	Specifications & Standards Committee	Goverdhan Lal.
(2)	Bridges Committee	H. P. Mathrani.
(3)	Technical Subcommittees:	
	(i) Test Track Division	T. Mitra.
	(ii) Research Organisation Division	H. P. Sinha.
(4)	Road Transport Subcommittee	U. N. Mahida.
(5)	Soil Research Subcommittee	E. Zipkes.
(6)	Education Subcommittee	E. A. Nadirshah.
(7)	Provincialization of Local Bodies Engineering Services Subcommittee	B. N. Roy.
(8)	Papers Subcommittee	H.P. Mathrani.
(9)	Manufacture of Road Making Machinery and Mechanization Subcommittee	R. S. Bhalla.
(10)	Organisation Committee	H. P. Mathrani.
(11)	Committee to Study the cost of operation on various types of road surfaces	H. P. Mathrani.

6. Miscellaneous.

(1) The members of the Council decided that in addition to the resolution of appreciation passed at the 42nd meeting, a suitable present may be sent to Shri G. M. McKelvie. Members of the Council were requested to contribute towards the cost of the present.

(2) It was agreed that the panel discussions on "Cement Concrete Road Surfacing" may be printed in the Journal. A subcommittee consisting of the following members, with powers to co-opt, was appointed to examine the material and draft a note.

E. A. Nadirshah	Convenor
K. K. Nambiar U. N. Mahida Goverdhan Lal	Members

(3) The question whether the Refresher Courses for subordinates should also be worked out was considered. The Council decided that it was not necessary for the Indian Roads Congress to work out details of Refresher Courses for subordinates for the present.

(4) The Council noted that Professor S. Mackey had kindly offered to conduct Refresher Courses in Soil Mechanics at Kharagpur.

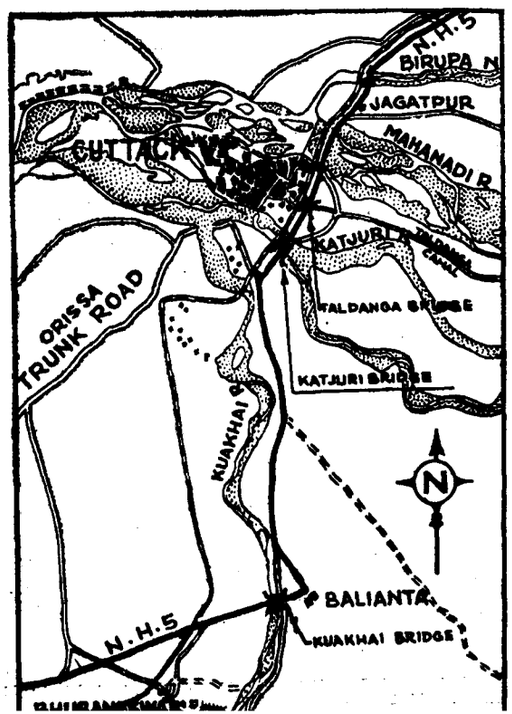
Inspection Tour Notes

INDIAN ROADS CONGRESS—EIGHTEENTH SESSION 1954

KATJURI AND KUAKHAI BRIDGES

The Mahanadi emerges into the plains through the gorge at Naraj and bifurcates itself into two branches, the Mahanadi and the Katjuri.

Cuttack, the old capital of Orissa, is enclosed by these two rivers, the Katjuri flowing to the south of the town and the Mahanadi to the north. The Katjuri again bifurcates itself opposite to Cuttack and throws off the Kuakhai. During the monsoon, Cuttack was not, therefore, accessible except by ferry



or by rail. The road bridges over the Katjuri and Kuakhai have recently been constructed, providing a road connection to the south and the new capital at Bhubaneswar. Proposals for road bridges over the Mahanadi, the Birupa another branch of the Mahanadi to the north of Cuttack are under consideration.

KATJURI BRIDGE

This bridge was completed in 1951. It is located about 800 ft below the railway bridge and 2,828 ft long between faces of abutments, consisting of 17 spans of 160 ft each centre to centre of piers, with two end cantilever spans of 54 ft each. The 160 ft spans are of balanced cantilever type with a suspended span of 80 ft and cantilevers of 40 ft each.

The piers whose height from the well caps to the bearing seat is 32.5 ft rest over foundations consisting of twin wells. The over-all size of the well is 30 ft by 15 ft 6 inches. The thickness of the steining is 3 ft and the dredge holes are 9 ft 6 inches in diameter. The piers and abutments are made of 1 : 3 : 6 cement concrete lightly reinforced. The wells have been sunk to 80 to 110 ft below bed level.

The bridge is designed for the Indian Roads Congress Class AA loading. The hydraulic data are given below :

Observed H. F. L.	R. L. 79.00
Estimated discharge	577,000 cusecs
Estimated mean velocity in the unobstructed channel	5 ft per second
Estimated scour level at piers in the main stream	R. L. 6.5
Estimated scour level at other points	Twice the difference between H. F. L. and dry season bed level.

The superstructure consists of three reinforced concrete girders spaced at 11 ft centres over which is the deck slab of 9 in. thickness, covered by 1 : 2 : 4 cement concrete wearing coat of 3 inches. The road width is 24 ft and footpaths 6 ft wide are provided on either side of the carriageway. The depths of the girders are 18 ft at the support and 8 ft at the centre and the webs are 9 in. thick.

Roller and rocker bearings are provided and sliding plate bearings under the free ends of the suspended spans. Each roller and rocker bearing is designed for a load of 400 tons.

The total cost of the bridge was Rs 45,89,000, consisting of Rs 20,36,000 for the foundations, Rs 3,13,000 for the piers and abutments, Rs 1,30,000 for the bearings and Rs 17,60,000 for the superstructure. The cost per running foot of bridge works out to Rs 1,623.

KUAKHAI BRIDGE

The construction of this bridge was taken up at the same time as that of the Katjuri Bridge and it is generally of a similar type to the former. The total length of the bridge is 1,696 ft consisting of 15 spans of 106 ft each and end spans of 53 ft each. The main spans are designed as balanced cantilever structure with suspended spans in alternate spans.

The roadway is 24 ft wide with 6 ft footpaths on either side. The roadway is carried by three girders at 11 ft centre to centre and 13 ft 5 in. at the supports and 6 ft at the centre. The centre girder has been made 2 in. higher than the end ones throughout its length so as to produce a cross slope for drainage, keeping the thickness of deck slab and wearing course uniform over its section. The girders are of web and flange type construction with a web thickness of 9 inches. The thickness of the flange varies from 7 in. at the centre of the span to 15 in. at the support.

The piers are of lightly reinforced (1 : 3 : 6) concrete and the abutments are designed as retaining walls of the counterfort type for earth pressure and traffic loads but not loads from the bridge.

Foundations.—The foundation for each of the piers consists of two separate circular cement concrete wells of 13 ft 6 in. diameter with a 2 ft 6 in. thick steining, and a 3 ft thick vibrated R. C. well cap on the top. The wells were sunk to a depth from 40 to 60 feet below bed level.

Roller bearings, each having four rollers of 4 in. diameter, have been provided at the free ends of the supported spans, and rocker bearings at the fixed ends. The bearings have been designed for a load of 240 tons.

The sliding bearing at the free ends under each of the three girders of the suspended spans consists of two $\frac{1}{2}$ in. mild steel plates, each 2 ft 6 in. by 2 ft $4\frac{1}{2}$ in. in size, with a $\frac{1}{4}$ in. thick copper plate in between. At the fixed end each girder has four

vertical dowels, each 12 in. long and 1 in. diameter, embedded half in the cantilever and half in the suspended span.

Provision for expansion in the roadway has been made at the free ends of the suspended spans. Two angles, 2 in. by 2 in. by ¼ in., have been embedded in the wearing coat with their tops 3/8 in. below the road surface, so that when a 3/8 in. thick iron plate is placed on the angles the top of the plate is in level with the road surface. On one side the plate is welded to one of the angle irons whereas the other side slides freely over the other angle iron. The clearance of 3/8 in. provided between the free end of the plate and the concrete of the wearing surface is filled with bituminous expansion material.

The total cost of the bridge was Rs 23,21,000. Of this Rs 8,12,000 was for the foundation, Rs 13,04,000 for the piers and abutments, and Rs 9,69,000 for the superstructure. The cost per running foot of the bridge works out to Rs 1,768.

TALDANGA CANAL BRIDGE

After crossing the Kuakhai and the Katjuri rivers N. H. 5 crosses the Taldanga Canal, near Cuttack. The two main piers of the bridge over this canal have reinforced concrete foundations of 1 : 3 : 6 mass concrete. The superstructure consists of solid slab with overhanging cantilevers. Three bearings have been provided on each pier. The cantilever arm is of 47 ft length on either side of the piers.

In order to permit navigation under it, the bridge has been constructed with sufficient clearance.

NEW CAPITAL, BHUBANESWAR

Orissa was formed into a new province in 1936 and Cuttack, the premier town in Orissa, was chosen as the temporary administrative headquarter. The need for a separate town for the capital of the province was keenly felt from the beginning as Cuttack was very congested and there was hardly any scope for extension. After a long and controversial discussion regarding the suitability of different places for the New Capital, Bhubaneswar was finally selected on the basis of a Greater Cuttack Scheme. The Greater Cuttack Scheme envisages the linking up of Bhubaneswar, the administrative centre, with Cuttack, the commercial centre, and Chowdar, the industrial centre of the State.

Bhubaneswar is situated at a distance of 30 miles from the sea, its climate is temperate and the southern breeze is cool in summer. It is well linked with other places by roads, rail and air. It is the centre of Oriya culture and architecture and was the seat of ancient kingdoms. Vast area of suitable land belonging to Government is available for buildings and the cost of acquisition of the land is practically 'nil'. There is scope of expansion of the capital in all directions. Water-supply is easy as the Kuakhai river flows at a distance of four miles from the capital.

The principles on which the Master Plan was based are given below (i) That the schools be located in such a way that the children can escape traffic hazards and do not have to walk more than a mile. (ii) The shopping places should be such that they may not be more than ¾th of a mile from any residence. (iii) Persons shall not have to walk more than a mile to reach their work. On the above basis the whole area is divided into units, the main roads running from the boundaries between units.

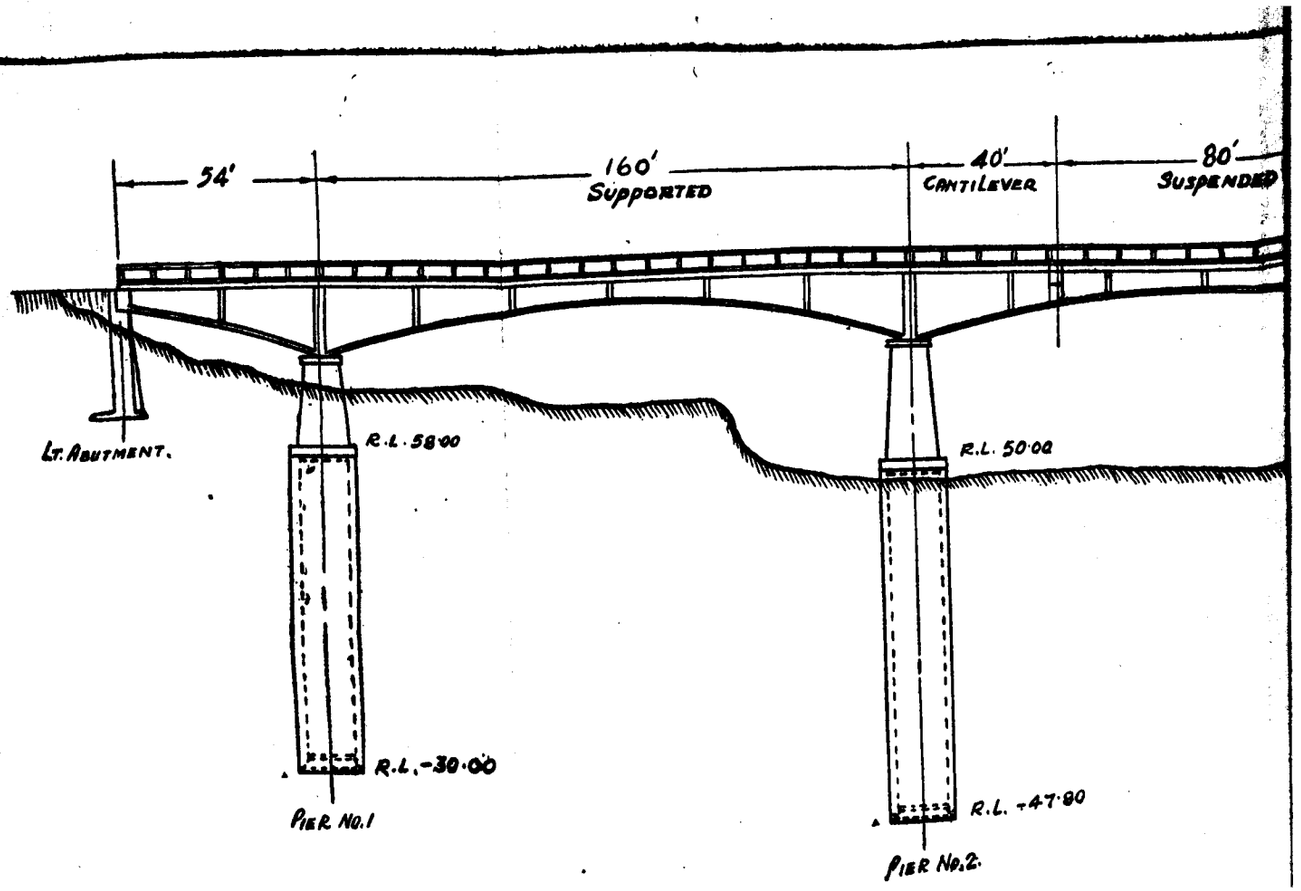
The split-up of the cost of the project is as under :

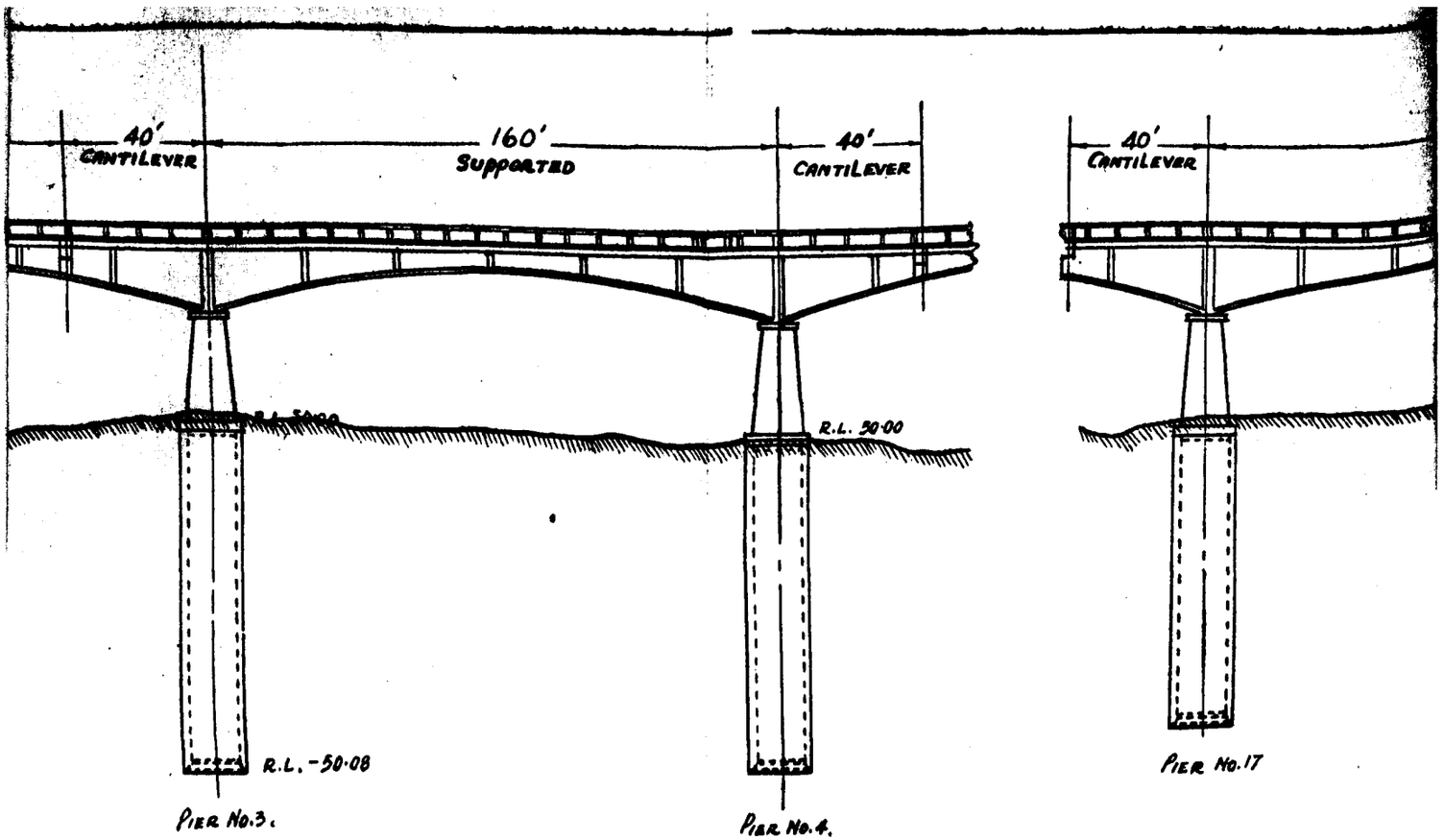
		Rs Lakhs.
1.	Land acquisition expenses	3.60
2.	Survey expenses	0.74
3.	Jungle clearing	7.00
4.	Road construction	30.88
5.	Different kinds of buildings	535.24
6.	Electrification	15.00
7.	Water-supply	26.00
8.	Temporary water-supply	0.50
9.	Drainage and sanitation	25.00
10.	Arboriculture	2.00
11.	Purchase of machinery and T. & P.	10.00
12.	Medical and Public Health	2.58
13.	Establishment	12.37

The permanent water-supply system for New Capital is designed for a population of 50,000 persons having a daily

consumption of 40 gallons per capita per day. The source of supply is river Kuakhai which flows four miles north-east of the capital.

The power supply is from a thermal station located near Cuttack 26 miles from Bhubaneswar.


54'
160'
SUPPORTED
40'
CANTILEVER
80'
SUSPENDED
LT. ABUTMENT.
R.L. 58·00
R.L. 50·00
R.L. -30·00
PIER NO.1
R.L. -47·80
PIER NO.2.



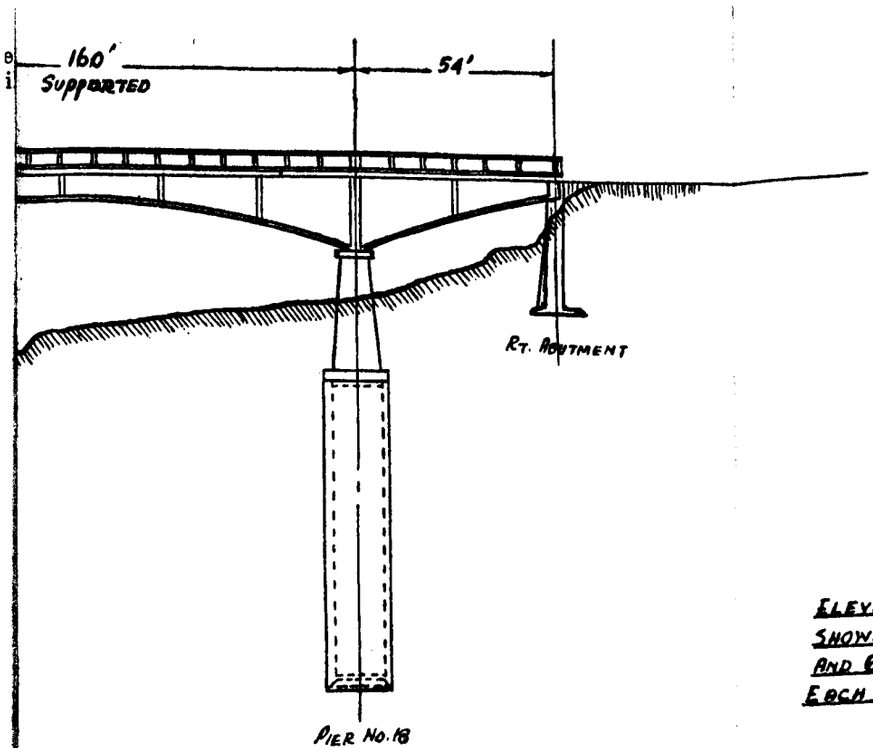
SCALE

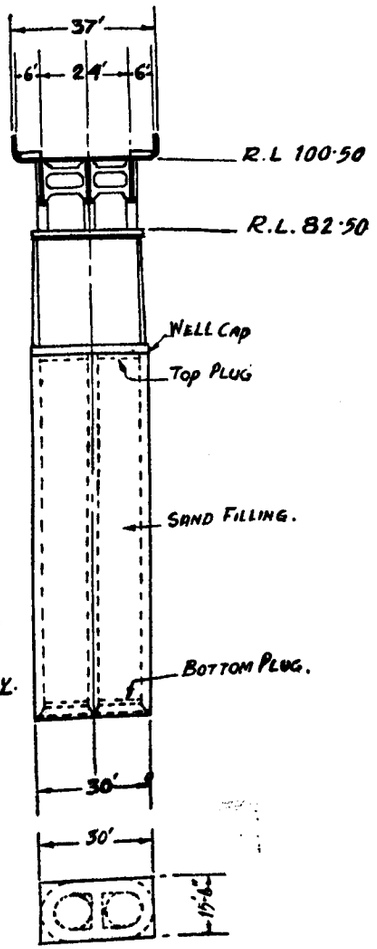
FEET 50 25 0 50 100

LONGITUDINAL ELEVATION.

KATHJURI BRIDGE ON N.H. No.5 NEAR CUTTACK

LENGTH:- 2828 FT.





TRANSVERSE ELEVATION OF PIER SHOWING 24' ROADWAY AND 6' FOOT PATH ON EACH SIDE OF ROADWAY.

PLAN OF TWIN WELLS AND CAP OVER THEM.

PANEL DISCUSSION

CEMENT CONCRETE ROAD SURFACING

With a view to obtain and exchange information and experience on cement concrete road construction a Panel discussion of the following questions was held on the 7th and 8th February 1954.

The first four questions had been discussed at the earlier Sessions. Discussion on remaining questions was concluded at this Session*.

Questions for the Panel Discussion

CEMENT CONCRETE ROAD SURFACING

1. When do you adopt a cement-concrete surface in preference to other types of surfaces?

2. What types of base courses do you provide under cement-concrete surfacing when the subgrade is:

   (a) rock;
   (b) gravel;
   (c) sand;
   (d) sandy clay;
   (e) clay;
   (f) silt or black cotton soil.

3. What methods of compaction do you specify for

   (a) subgrade;
   (b) sub-base; and

   what tests do you prescribe to show that compaction is complete?

4. Do you insulate the cement-concrete slab from the base course or do you bond it with the base course?

   What are the conditions in which either of the method is prescribed as suitable?

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* Please see proceedings of the 43rd Council meeting—Para. 6 (2) at page 552 of this issue.

5. What materials have been used as insulating material and with what results ?

6. What are the thicknesses of concrete slab and base course prescribed for roads carrying normal traffic and heavy traffic on various classes of subgrade ?

7. To what extent do you reduce the thickness of the main slab by the provision of a base course ? Is each designed independently of the other ? What is the minimum thickness of cement-concrete slab used and with what results ?

8. Have you used the thickened edge section and if so, what is the section used and with what results ?

9. What is the least acute angle that you have permitted in slabs at intersections ? Have any breakages of such corners been noticed and under what conditions ?

10. What is the maximum width of slab constructed without using a longitudinal joint ?

11. What is the least and the greatest spacing of transverse expansion joints ? Does this vary with slab thickness ?

12. What kinds of joints, and what spacing between these joints have been adopted by you and how have they behaved ?

13. Have you noticed any deformations or displacement of slabs which are directly attributable to presence or absence of joints ? If so, what is the range of movement ? What steps do you take to rectify such defects ?

14. What mixes do you prescribe for the concrete for road slabs ?

15. Do you grade the coarse aggregate or use the material as naturally graded and received from the quarry ?

16. What is the maximum and minimum slump or water used per bag ?

17. Do you use mechanical equipment for the finishing of the surface ?

18. What methods of maintenance of concrete surfaces have been adopted and at what average cost ?

19. Have you done any cement macadam work or rolled concrete and if so, what has been your experience with it ?

INTERNATIONAL ASSOCIATION OF ROAD CONGRESSES

Tenth Session 1955

The Tenth Session of the International Association of Road Congresses will be held at Istanbul, Turkey, in September 1955. The last Session of the Association was held at Lisbon in September, 1952.

The Congress will be held in two Sections : the first Section will deal with the construction and maintenance of roads and the second Section with Traffic on Roads, Administration and Finance.

The following questions will be considered during the first Section :

FIRST QUESTION

Surfacing of Roads & Runways

A. Concrete Roads and Runways

In particular : new methods of construction, increase in size of slabs, joints, dowels, prestressed concrete, air-entrained and plasticised concrete.

B. Surfacings made with plastic binders

In particular : new methods of construction, sealing preparations ; use of dopes, standardization of stripping tests.

C. (1) Non-skid properties : Measuring of these properties and their standardization, Determination of limiting coefficients.

(2) Frost and Icing : How these conditions occur—Remedies, palliatives—Protection.

(3) Modernisation or mechanical equipment and its use in construction and maintenance.

SECOND QUESTION

Soils

A. Bearing Capacity

Bearing capacity of the subgrade and carriageway foundations in relation to soil composition and water content. Improvement and standardization of tests.

B. Stabilization of Soils

In particular: Improvement of soils used. Prevention of erosion—Drainage—Laterite soils—Expansive soils.

THIRD QUESTION

Low-Cost Roads

A. Lightly trafficked roads in rural areas

Construction—Maintenance—Possible limitations of load and user—Mechanized equipment for construction and maintenance—Gradual improvement of standards.

B. Roads in under-developed areas

In particular; Road characteristics; cross section, profile, road and carriageway widths—Headroom below bridges, width and bearing capacity of bridges; Drainage, water-flow from catchment areas, standardization of small culverts and bridges—Statistical results.

The Congress will discuss the following questions in their Second Section:

FOURTH QUESTION

The Road in relation to Traffic

A. Traffic-Circulation

In particular: Censuses, traffic surveys (types and number of vehicles, distance and routes travelled)—Estimating increases in traffic—Attraction of traffic to new routes.

B. Road Characteristics in relation to traffic

In particular: Layout—Carriageway capacity—Lane capacity—Distribution on the carriageway—Segregation of streams—Designs of junctions and intersections.

C. Road equipment (outside built-up areas)

(1) Traffic control devices (use of carriageway markings, signs, control of, and provision for parking, waiting and stopping).

(2) Ancillary services—Installation for use of road users,

D. Accidents, Road safety

In particular: Accident statistics and investigation—How, from these studies conclusions can be drawn as to methods of design, construction and traffic regulation so as to avoid repetition of accidents and lessen their gravity.

FIFTH QUESTION

Allocation of Funds and Economic justification of roadworks

A. Methods of Financing Works

In particular: Allocation of special taxes—Tolls—Application to International routes.

B. Economic justification of road works
(Rentability generally)

In particular: Statistical survey—Modernization and Improvement; their final influences on maintenance charges and vehicle operation costs—Economies resulting from reduction in accidents.

SIXTH QUESTION

Urban Roads and Traffic in cities, with particular reference to car parks and parking—layout and equipment of road intersections—traffic control signals—water-proofing and drainage of carriageways—tramways in built up areas will be considered by the joint meetings of Sections I & II

Discussion on Paper No. 165*

"A New Method of Applying Kentledge By Hydraulic Jacks For Sinking Foundation Wells"

By

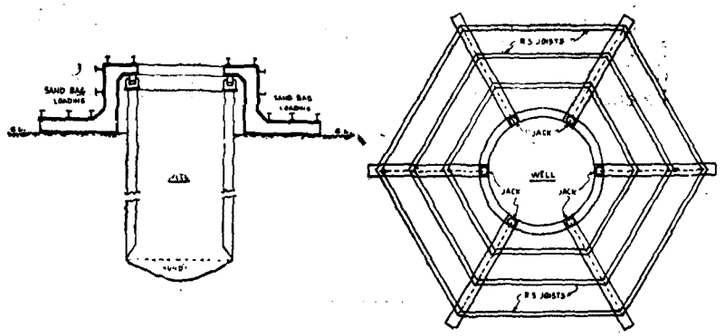
G. P. NAGARKAR AND M. P. APTE

Friday, February 5, 1954

Shri K. K. Nambiar (Chairman) called upon the Authors to introduce the Paper.

Shri G. P. Nagarkar, introducing the Paper, mentioned that while he was working at Ahmedabad as a Professor of Applied Mechanics in the Engineering College, he had a chance to visit the construction work. It so happened that he suggested to Shri Apte the general idea and Shri Apte had worked out the details successfully and developed the method.

For facilitating grabbing operations it was desirable to increase the clear space of 7 ft between the main girders by adopting an arrangement as shown in the figure below. By this arrangement it was possible to increase the number of jacks.



Shri M. P. Apte, the joint Author, said that on account of scarcity of materials, competition and increasing costs, there was a tendency to reduce the thickness of the well steining.

* Published in the Journal of the Indian Roads Congress, Vol. XVIII—1, December 1953, pages 23 to 39.

Moreover, it was very difficult to work the rail cutters under the well curb, when a well with thick steining had to be sunk into a hard clayey strata. Therefore the application of the kentledge with speed and economy was a major problem for the bridge engineer. What was described in the Paper was an attempt to solve the difficulty.

The method described could be used in the rivers with standing water by substituting the buried anchorages with floating pontoons.

Shri K. F. Antia was of opinion that the method adopted was not suitable where there was standing water. Even if pontoons were used for the anchorages they had to be ballasted before jacking could be done.

There was a large amount of information on foundations in the technical bulletins of the Railway Board. An ingenious method of sinking wells was described in the Technical Bulletin No. 1931. In a certain bridge wells could not be sunk in spite of heavy kentledge. Holes were scooped out on the outside of the well curb along the periphery and tins of lubricating oil were emptied. The oil worked up reducing the frictional resistance. Where an inch or two of sinking was possible, about 12 inches was the out-turn.

Shri Antia was of opinion that pile foundations could be adopted with advantage in alluvial rivers where there was no likelihood of obstruction from large boulders. A railway bridge with cast-in-situ pile foundations was completed near Bombay where the heaviest loaded pile carried as much as 40 tons.

Shri Antia desired information on —

1. details of the design of the mix and the strength at 7 days of the concrete used for the steining of the well; and
2. the considerations leading to the choice of two separate wells in preference to the twin octagonal wells used in old designs.

He supported the suggestion that experiments should be conducted to find out the extra load that anchors could carry due to the shear resistance in addition to the weight of the soil.

Shri E. C. Chandrasekharan stressed the need for a scientific study of the foundation problems using the principles of Soil Mechanics.

The bearing capacity of the foundation layer of hard clay was assumed as 5 tons per sq. ft. The value was, probably, based on the usual values assigned to different groups of soils classified arbitrarily by visual identification or perhaps by intuitive judgment and experience. He felt that it was necessary to replace the conventional methods by a scientific study.

Study of Plate II of the Paper showed that it was proper to allow for scour depth to the bottom of the layer of coarse sand. The feasibility of founding the bridge on the layer of "clay with kankar" was worth investigation. Even if the foundation had to rest on hard clay, the need for taking the wells 10 to 15 ft into the layer was not apparent. Suitable soil sampling and testing enabled the engineer to arrive at proper decision on the foundation levels.

While soil tests served as powerful aids in solving foundation problems, field observations were necessary. For example, evaluation of the skin friction was necessary in determining the load bearing capacity of foundations. It was not possible to determine its value even approximately by means of laboratory tests. He enquired if any observations were made in this regard and how far such observations compared with the average value of 4 cwt. per sq. ft. assumed for the skin friction in para. 3.3 of the Paper.

Shri E. A. Nadirshah said that masonry wells had substantial self-weight and so comparatively smaller kentledge was required to sink them. The need for substantial amount of kentledge arose because of the small thickness of R. C. wells which ranged from 9 to 12 inches.

The value of 4 cwt. per sq. ft. assumed for the skin friction was on the high side and it was necessary to indicate if this value was the maximum. While in the conventional method of applying kentledge it was possible to transfer the load to the well at a number of points by suitable arrangement, there was concentration of stresses at the jacks when the new method was adopted. Increased percentage of reinforcement was, therefore, necessary to transfer the stresses over the whole of the well steining.

In rivers where there was shallow standing water of one or two feet, excavation of pits for burying the anchorages was difficult. In such cases use of flat bottomed barges loaded with stone or sand etc., was an alternative.

In wells of larger diameter or those requiring higher loading, use of a greater number of jacks was indicated. Shri Nadirshah wanted the Authors to indicate the best arrangement in such cases so that the resultant reaction of the jacks coincided with the axis of the well ensuring maximum working space for the grab.

Shri R. N. Joshi said that during the course of sinking a well, a stage when it did not sink by its own weight was reached. Methods such as blasting and making a **kundi** were dangerous because accidents could happen. In his view, the best method of sinking wells was by the application of kentledge. The working space available limited the kentledge of the conventional type that could be put on a well. Normally it was convenient to load a well of 12 ft diameter with 50 tons. But waste of time and expenditure were involved.

Engineers had been advocating increased thickness of steining to increase the dead weight because of the fact that a method such as the one described by the Authors was not known. The adoption of increased thickness had some disadvantages in addition to increased cost. With thick steining, the **kundi** or the central pit was too far away from the cutting edge to exert any effective cutting action since grabbing could be done only in the centre. Also, while sinking in sand when a sandblow occured, hollows were likely to be created in the bottom portion of the well, leaving the lower portion of the well hanging on the upper portion which was gripped by the skin friction. In such cases, wells with thicker steining were likely to give way and he knew of such instances.

He cited the instance of the bridge across George's River, New South Wales, Australia, where the thickness of the R. C. C. well steining was 7 in. for a diameter of 6 ft and 9 in. for a diameter of 8 to 10 ft for depths of 60 to 80 feet.

He said that he attached great value to the method described by the Authors because of its ease of application and the fact that pumping, which might induce heavy blows or blasting or increased thickness of steining could be avoided.

Shri B. N. Shenoy desired to have information on the following:

(1) The reasons for not adopting a well of smaller diameter when the load on the wells was only 385 tons whereas the load carrying capacity of the well now adopted was 500 tons.

(2) The basis on which the value of 4 cwt. per sq. ft. was arrived at for the skin friction.

(3) The sub-soil water level and the spring conditions to enable one to provide for the effects of buoyancy.

Shri Shenoy pointed out that Plate II of the Paper showed hard clay below the sandy strata while in para. 2.4 it was mentioned that soil was " alluvial ".

He suggested that the jacks might be mounted on a circular channel or angle-iron sleeve fitted to the top of the steining and connected to each other.

Shri H. P. Mathrani referred to Shri Antia's remark that pile foundations were preferable to wells and said that while properly designed piles were suitable, wells were much stronger against lateral forces. Piles also could be designed to withstand the lateral forces.

Wells were designed relying solely on the bearing capacity of the soil on which the well rested and neglecting skin friction. When piles were adopted their bottom level should be kept sufficiently below the level at which wells might have been founded to allow for friction and grip.

Shri S. C. Nayak was of opinion that the rate of Rs 2 per 100 cu. ft. of excavation in sandy soil for the anchorage pits assumed in the cost analysis was on the low side. The rate might be anything up to Rs 10 per cu. ft. Also, taking out the anchorages, arranging the R. S. Joists and bullies would cost something. Taking account of all the above factors might upset the cost analysis made by the Authors.

Shri J. S. Narasimham referred to para. 2.4 of the Paper where 5 tons per sq. ft. was assumed for the bearing capacity of the soil and remarked that highway engineers in India were not fully acquainted with the correct terminology of the different types of soils as used in soil mechanics. In the absence of undisturbed samples, attempts ought to be made to ascertain at least the penetration resistance of the foundation soil. This was obtained by driving the boring tube with a monkey weight of 1,414 lb falling over a height of 18 inches. From the number of blows to drive the tube through the different soils it was possible to predict the safe bearing capacity.

When sand strata extended to 30 or 40 ft below the bed, was it justified in cutting the foundations deeper than the sand? What was the maximum depth of scour against which provision was necessary when data about density, size of the sand grains, and shear strength at various depths were available?

In Shri Narasimham's opinion injection of cement or clay slurry into the sandy layer increased the stability of foundations when carried for sufficient distance on the upstream and downstream side and was well worth trial.

Shri D. P. Roy Chowdhury enquired if the well steining had been designed for combination of earth pressure on one side and the direct load applied through the jacks to provide for the contingency viz., a pocket of soil other than sand being met with and wanted to know the percentage of reinforcement used.

Shri D. N. Khurana* was of opinion that 5 cwt. per sq. ft. of skin friction should be assumed for the design of the structural steel work of the jack arrangement.

The Author had assumed the resistance by the buried anchorage to be equal to the weight of the soil overlaying the buried anchorage at 100 lb per cu. ft. plus the weight of the steel. The resistance based on this assumption worked to 150 tons. But it was not correct to assume that the load due to the fill acted vertically. Study of such loadings made at the Iowa State College showed that the load per running foot (Wt) is given by the formula :

$$Wt = Ct \times W \times (Bt)^2$$

Where Wt = Vertical external load on anchorage in pounds per foot run.

Ct = A coefficient depending on the nature of the soil and equal to 0.6 in this case.

W = Unit weight of fill material in pounds per cubic foot.

Bt = Width of the pit at top of anchor in feet.

Calculations by applying this formula showed that the total resistance is 131 tons which was 12.6 per cent less than what the Authors had assumed.

Shri Fateh Chand did not favour the neglecting of skin friction. The safe load of 5 tons per square foot assumed in the design was, in his opinion, on the high side.

He felt that the method described was useful where the necessary equipment was available; but District Boards who generally do not stock such equipment constructed bridges with

* This and subsequent comments were received in writing.

well foundations occasionally. Purchasing the necessary equipment for a single work would push up the costs.

The conventional method of applying kentledge by sand bags on the other hand, required no elaborate gadgets.

Also the costs of sinking could be reduced if a height of sinking more than 4 ft 6 in. adopted by the Authors, were employed.

Tilts could be controlled by loading the higher side with more sand bags.

Shri M. P. Apte, Joint Author, in reply, to the difficulties of fixing the anchorage in water raised by **Shri Antia, Shri Nadirshah** and **Shri Nambiar**, said that water round the well did not present any difficulty. It was not necessary to bury the anchorages. The bullies shown in Plate III of the Paper could be placed on the ground and loaded. If the water round the wells were shallow the joists could be placed in the water above the bed level and the anchorage would be equally effective so long as sufficient load to allow for buoyancy, was placed. If the depth of the water was substantial, the anchoring could be done by employing pontoons, as mentioned in his introductory remarks. Two pontoons loaded with the required kentledge could be connected to the 24 in. by 7½ in. R. S. beams which were used in the arrangement described in the Paper. The pontoons and the girders could be floated near the well and then the kentledge applied with jacks. If the connection between the main joists and the pontoons was adjustable the method could be used in tidal streams also.

Shri Nayak had mentioned that the rate for excavation of sand assumed in the cost analysis was low. The cost of kentledge by jacks worked out to be lower than the cost of the kentledge by the ordinary method even if the rates given by Shri Nayak were assumed. If the excavation in sand was very expensive, it could altogether be dropped and the anchorage could be provided above the ground level as mentioned before. Moreover the bigger the kentledge required the cheaper would be the arrangement of applying the kentledge by hydraulic jacks.

Both **Shri Roy Chowdhury** and **Shri Fatehchand** had asked whether the thicker well steining would not have been more economical than applying the kentledge externally. As shown in appendix No. II of the Paper a kentledge of 200 tons costed about Rs 500 while increasing the weight of the well by 200 tons required concrete of about 3,100 cu. ft. which costed about Rs 6,000.

Replying to **Shri Khurana** and **Shri Antia** regarding the strength of the anchorages used, Shri Apte said that it was safe to assume the strength of the anchorage as equal to the weight of the soil filled over the anchorage. In the Author's opinion, at the time of the failure of the anchorage, the pull would be equal to the weight of the soil filled over the anchorage plus the resistance to shear along the vertical planes along which there was failure. In sandy soils this shear resistance was due to the internal friction of the particles while in clay soils the resistance was due to cohesion.

Replying to the point about concentration of stresses raised by **Shri Nadirshah, Shri Antia** and **Shri Shenoy**, the Author said that if the area of the bed plates and the packings were such that the safe strength of the concrete developed at the time of applying the kentledge was not exceeded, there would be no damage to the well steining. If the kentledge was big necessitating the use of a large number of jacks, it might be necessary to provide a continuous ring of bed plate designed to transfer the load uniformly.

Referring to the querries of **Shri Chandrasekharan**, and **Shri Nadirshah**, the Author said that the value of 4 cwt. per sq. ft. of surface area for the skin friction was based on the experience of well sinking work in similar conditions in other bridges in the same region. The assumed figure tallied fairly with the maximum kentledge applied on the work. On page 26 of the Paper it was stated that a maximum kentledge of 180 tons had to be applied. This was for a height of 40 feet and hence the surface area of frictional resistance was about 1,400 sq. ft. Thus due to the external kentledge, the friction worked out to nearly 290 lb per sq. ft. Adding to this the weight of the steining, say about 132 lb per sq. ft., the frictional resistance worked to very nearly 4 cwt. per sq. ft. The least kentledge required for some of the wells was about 60 to 80 tons. The estimation of the maximum kentledge required will have to be made by the engineer in each case before putting the anchorages.

Replying to Shri Nadirshah regarding the anchorage when a large number of jacks had to be used, the Author said that in his introductory remarks, Shri Nagarkar had already given a solution. A number of jacks could be placed over the well steining above the jacks Z-type frames. The vertical leg of this frame would be about six feet and the top and bottom horizontal arms about 1 ft 6 in. and 10 ft in length respectively. All these frames could be connected by R. S. Joists on all the sides of the well. This arrangement had not been tried but he felt that with suitable modifications it would work well.

Replying to **Shri Fatehchand**, the Author said that the reasons for the adoption of the height of 4 ft 6 in. steining at a time were already given on page 25 of the Paper. He was not sure if a height greater than this would be convenient for the working of sinking machinery or economical.

Disagreeing with Shri Fatehchand that bridges with well foundations were constructed only rarely he said that arranging for R. S. Joists was not difficult.

Answering **Shri Nambiar**, the Author said that applying sufficient and quick kentledge was a golden rule for preventing "blowing in" unless one edge of the well was touching rock, big boulder or some such obstacle. By the application of sufficient kentledge the well must sink down immediately and the blowing in from the sides would be prevented. When blowing in took place, the soil near and below the well curb became loose and so kentledge became more and more effective. Normally blowing in took place due to the hydrostatic pressure difference between the inside and outside of the well. The water level inside the well should be kept high by pumping water into the well, as due to grabbing there was a natural tendency for the water level inside the well to go down.

Replying to **Shri Antia**, the Author pointed out that both the pile foundations and the well foundations had their own advantages and disadvantages. Under Indian conditions well sinking would continue to be used for many years to come. Where scouring was anticipated, it was difficult to make piles stronger against lateral forces while the wells were naturally much stronger to resist these forces. If the bearing capacity of the ground was taken account of in the design, wells could be founded at much higher level than the piles and were therefore cheaper.

Lubricating the well with oils if it had worked economically was an ingenious idea.

He felt that two separate circular wells were much easier to sink than the twin octagonal wells. They required lesser kentledge and could be sunk truly and quickly without much difficulty.

Replying to **Shri Narasimham**, **Shri Chandrasekharan** and **Shri Fatehchand**, the Author said that strata met with was, as shown in Plate II of the Paper, hard clay with black sand and kankar. Moreover it was at a depth of forty feet below the ground level. Before plugging the wells, 10 per cent of the wells were tested and the bearing capacity of 5 tons per sq. ft. was found to be safe. Actually the well sinking was stopped five feet above the estimated level as the strata was found to be suitable.

Shri Narasimham and **Shri Shenoy** wanted to know why the friction of wells was neglected in designing the foundations. Usually wells were founded a few feet below the scouring level and they could not be treated as piles. It was customary everywhere to neglect the skin friction in the case of wells and it was on the safer side. In the present case, for example, the frictional resistance varied from 60 to 180 tons and to determine how much of this was offered by the ground below the scour level was difficult. Also the minimum diameter of the well was governed by the dimensions of the dredger which had to be used and it was not possible to reduce further the diameter of the well.

The cross section of the river given in the Plate II was as actually revealed during the progress of well sinking work.

The sub-soil water level was about R. L. 50 in the summer season.

Replying to **Shri Roy Chowdhury**, Shri Apte said that twelve $\frac{3}{4}$-inch diameter bands were used in the well steining, which was designed to withstand all forces specified in the Indian Roads Congress Bridge Code.

Replying to **Shri Narasimham** regarding the injection of clay into sand to prevent scouring effects, the Author said that laboratory experiments must be supported by field experiments and observations for a number of years before it could be adopted by engineers.

In conclusion, thanking the various speakers, Shri M. P. Apte, said that the constructive comments made during the discussion have encouraged him to make further experiments.

Shri K. K. Nambiar (Chairman) winding up the discussion, referred to the point about the use of piles instead of well foundations, and remarked that considering the conditions prevailing in the country, the nature of the rivers that had to be bridged and the numerous works in the Five-Year Plan, well sinking would be adopted for many more years.

The new method, in his opinion, had its own limitations. It was difficult to adopt it where wells had to be sunk in standing water. On the other hand, the method was quite useful for removing cants and tilts. Concentration of stresses occurred at points where hydraulic jacks were applied and some method to

distribute the stresses over a larger area of steining was necessary.

Questioning the accuracy of calculations for the resistance of the anchorages, the Chairman cited the case of testing the beams of the Palar Bridge* where a similar method of loading by jacks was adopted. Even though the weight of the anchorages used there was calculated as 100 tons it was found that they took loads in excess of 160 tons. In addition to the weight the shear resistance of the soil came into play. The Authors were on the safe side in taking 100 tons as the weight of the anchorages.

He thanked the Authors for their interesting Paper.

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*Paper No. 164 published in the Journal of the Indian Roads Congress, Vol. XVII-3, January 1953.

Discussion on Paper No. 166*

"Location of Roads in Hilly and Mountainous Country"

By

B. CHAUDHURY

Friday, February 5, 1954

Shri H. P. Mathrani (Chairman) introduced the Author and said that the main object of a road was to provide the means for economical transport. All roads, particularly hill roads, should be so aligned and constructed that the cost of transport was reduced to the minimum. Maintenance, too, should be economical.

The Author, had mentioned the gradients adopted. But there might be deviations from these standards. Where traffic was very light, as in the case of jeepable roads, these might have to be lowered. The efficiency of the internal combustion engine fell with the increase in altitude, roughly at a rate of 4 per cent for every 1,000 feet. So for hill roads in general higher standards should be adopted.

Shri Mathrani stressed the need for curves having radii as large as possible. Further, he pointed out that sharp curves at steep gradients should be avoided. Concluding he said that the standards described in the Paper were applicable to the special conditions obtaining in Assam.

The Author, **Shri B. Chaudhury**, introducing the Paper said that after the partition of the country the Assam P. W. D. was faced with the difficult problem of constructing long lengths of hill roads in parts of the State. People living in those areas had no proper means of communications. Consequently they had lost their markets and also their supplies were cut off. A heavy programme had to be pushed through at a time when there was dearth of personnel experienced in the construction of hill roads. Instructions therefore, had to be written for their guidance. These were modified from time to time. The Paper, was a compilation of those instructions suitably amplified.

The Author made the following changes in the Paper :

(1) Page 44, Table – The words "Approximate Percentage" to be substituted for the words "Per cent" occurring in column 4.

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*Published at pages 41 to 57 of Vol. XVIII-1 of I. R. C. Journal, December, 1953.

(2) Page 46, first line below sketch – read XY = 1600 for = 1600.

(3) In line 4 of para. 2 on page 52, substitute the words " man-day " for the words " coolie-day ".

(4) In line 2 of the penultimate para. on page 52, insert the word " junior " before the word " technical " occurring at the end of the line.

(5) Page 53, para. 10.1 – Read " One Assistant Engineer " instead of " On Assistant Engineer ".

(6) Page 54, penultimate para. line 1 – Read 1000 ft for 100 ft.

Shri K. K. Nambiar said that the data furnished in the Paper regarding the personnel to be employed, tools and plant required for the investigation and the approximate cost, etc., was very valuable to engineers who might have to take up such works in future.

In para. 1.4 the Author had rightly enunciated the principle that the alignment of a road should be such as to enable vehicles to travel with ease and safety and that the expenditure of motive power and wear and tear of the vehicle should be reduced to the minimum. At the same time it should also be ensured that the cost of construction and the maintenance of a road was as low as possible. In trying to reduce the cost of construction it was false economy to lower the standards of alignment and design of the road. Poor alignment resulted in increased cost of vehicle operation, because the cost of transportation included both the cost of construction and maintenance of the road and the cost of operating vehicles.

In paras. 3.2 and 3.3, the Author had suggested gradients for adoption on hill roads. These standards could not be of universal application as the design of grades depended upon the merits of each case, e.g., the nature and volume of traffic to be expected, the terrain and the rainfall of the area, etc. For example, it was well known that a safe and convenient " Coasting Grade " for passenger vehicles was 5 to 6 per cent or 1/20 to 1/17. If the slopes were steeper, change of gears was necessary for ascending the slopes and brakes had to be constantly applied to keep the speed within limits during descending. A grade steeper than 6 per cent was disadvantageous to descending vehicles in all respects except for considerations of fuel consumption. Therefore, 6 per cent or 1 in 16 should be the maximum gradient that should be allowed. If the surface proposed to be provided was cement concrete and

if steel-tyred bullock carts in large numbers were expected, a grade steeper than 1/20 should be ruled out as the iron-shod hooves of bullocks slipped on such steep gradients. If the need to cater for all types of vehicles was considered, 5 per cent or 1/20 should be the limiting grade. This gradient allowed for the climbing up of all normal passenger vehicles in top gear and the climbing down without application of brakes. Ability to maintain a constant speed without change of gear avoided traffic jams and increased the capacity of the highway. Continuing, Shri Nambiar said that trucks found difficulty in negotiating grades exceeding 3 per cent and gear shifting was essential on steeper grades Thus the type and volume of traffic must necessarily have a bearing on the standards of grades to be adopted.

Another factor to be borne in mind in the case of roads constructed at very high altitudes was that vehicles designed for use in low altitudes tended to lose power at high altitudes necessitating a further reduction in grades for ascending slopes.

In para. 3.5, the Author had indicated the radii of curves to be adopted on hill roads. In this connection a distinction should be made between " blind curves " and " open curves ". " Blind curves " were " outside curves " round the hill or spur and " open curves " meant " inside curves " heading a gully or a ravine. The California practice was to have a minimum of 200 ft radius for " blind curves " and 100 ft for " open curves". Sudden variations in curvature were likely to mislead traffic and lead to vehicles getting out of control. This should, therefore, be avoided.

Shri Nambiar pointed out that no mention had been made in the Paper regarding combination of curvature and grade. A good alignment should aim at a balance between grade and curvature. The following principles had to be borne in mind:

(1) Curvature at the bottom of a steep grade should be avoided.

(2) Combination of vertical summit curves and sharp horizontal curves was dangerous particularly for night driving.

Where deviation was to be made it was often found better to sacrifice grade for improved alignment.

Another well-known principle in deciding upon a grade line was to provide an economical balance between cutting and filling.

The suggestion of the Author on page 52 regarding inspection of the alignment on completion of the preliminary survey by a

senior officer, namely the Superintending Engineer or the Chief Engineer, was a very sound one. Shri Nambiar had had two or three instances where a special staff consisting of a sub-division was employed to survey some ghat roads and after the entire survey was completed and the project estimates drawn up, the estimates were found defective and were returned with suggestions for re-location. If the alignment had been inspected by a senior officer on completion of the preliminary survey itself, such duplication of work and waste of money could have been avoided.

Concluding Shri Nambiar said that it was desirable to make a final inspection of the project after the final plans were completed and the project was ready for being put on tenders. [illegible] an inspection was obligatory in some of the States of the U.S.A. and was commonly referred to as P. S. and E. Inspection (Plans, Specifications and Estimates Inspection).

Shri B. N. Bhadhuri remarked that infructuous rise and fall of the alignment was, in many cases, unavoidable. Where a deep gorge was met, there was no choice but to lose height and rise again. For example the proposed alignment of the alternative route to Kalimpong from the east of Tista, rose from about 400 to 3,000 ft with a gradient of 1 in 20. It had to cross river Ryang at about 1,600 ft. The loss of height could not be avoided. Again, in this section a long length of 7 miles of the alignment had to follow the same contour round a steep hill about 3,000 ft high. As an alternative it was proposed to construct a tunnel about 3,000 ft long. It had the great advantage of reducing the length and curvature. In the old Kalimpong road the ruling gradient of 1 in 12 had to be maintained by introducing a loop and increasing the length at one place.

Shri Bhadhuri suggested that for speedy construction, a 10-ft wide road should be built first and all culverts should be completed. Side drains and retaining walls, too, should be completed to avoid heavy slips. Further, the report of the engineer should be accompanied by that of a Geologist.

Referring to para. 7.1 relating to the study of contour maps for hilly areas, Shri Bhadhuri pointed out that one inch to a mile maps were not suitable. They should be enlarged to a scale of 4 inches to a mile. For the Kalimpong road he got the maps enlarged to 4 in. to a mile by the Survey of India.

The strength of the party proposed in para. 8.2 of the Paper was too inadequate. For steep slopes and dense forests more labourers and technical men were wanted for quicker and better results. Help from the forest guards and labourers was essential.

Reconnaissance and preliminary survey should be combined. The most essential work was to cut out a foot track at least 2 ft wide near the alignment for the safe and speedy movement of the party. The cost of this should be included in the estimate for surveying. The party should be provided with binoculars and levels. The estimate should provide for sufficient porters and tents as well as first-aid boxes. If provision for all these were made the estimate for surveying would cost about Rs 2,000 per mile, including the cost of 2 ft wide track.

Shri N. D. Daftary said that the information regarding progress of field work that could be expected and the likely costs of survey, etc., were very interesting. He pointed out that no mention was made in the standards for superelevation at page 43 of the Paper. In Bombay State, for the Bombay-Poona Road, the maximum superelevation provided at any curve was limited to 1 in 10. This was necessary because superelevation greater than 1 in 10 was considered to be uncomfortable and unsafe for bullock carts because of the steep gradients. The maximum gradient, was restricted to 1 in 12 for short lengths not exceeding 300 ft, as stated in the Table at page 43 of the Paper. He wanted to know whether that was compensated for at curves and for superelevation.

For horizontal curves, he suggested a minimum radius of 80 ft for roads with very heavy traffic.

Regarding the equipment for reconnaissance and survey, Shri Daftary suggested inclusion of a pair of binoculars and a camera. Provision for jungle cutting was also necessary under reconnaissance and preliminary survey.

Shri B. Chaudhury, the Author, replying to **Shri Nambiar** said that as stated in para. 3.2 of the Paper and also by Shri Mathrani, the gradients suggested for hill roads were for first class or important roads. For unimportant roads, the gradients could be steeper. In the area concerned traffic was very light and recommendations given were considered adequate for minor roads. The curves could, however, be eased and widened later on as traffic demanded.

Referring to **Shri Bhadhuri's** comments that infructuous rise and fall could not be avoided while crossing a river or a steep hill the Author stated that diversions or detours in such cases were unavoidable and depended on the nature of the terrain. Regarding the introduction of loops at certain places, it had been stated in para. 7.2 of the Paper that such loops or zig-zags could be introduced when no other alternatives were available. It was

not found necessary in Assam to construct side drains where only 10 to 11 ft wide formation was under construction, because it was possible to let out storm water at convenient points without any damage to the formation even under the high rainfall conditions obtaining in Assam. However, where the soil was sandy, it was difficult to avoid expenditure on side drains.

One inch to a mile maps were consulted because maps to a bigger scale were not available. Before starting reconnaissance the construction of a pathway might not be necessary if cart tracks or footpaths connecting villages already existed.

Referring to Shri Bhadhuri's suggestion that reconnaissance and preliminary survey should be taken up at one and the same time, the Author considered that it was not necessary as that might result in wasteful expenditure on preliminary survey in case the alignment was found unsuitable at a later stage. The Author agreed that amenities like a radio set, conveyance, etc., should be provided for the survey staff, if possible.

With regard to **Shri Daftary's** comment about the standards of superelevation, the Author pointed out that these had been omitted deliberately as the Paper dealt with the survey and location only and not with the construction of hill roads. I. R. C. Paper No. 119 by the Standards and Specifications Committee permitted a maximum superelevation of 1 in 15.

The Author subscribed to Shri Daftary's view that the gradient of 1 in 12 was high. But for reasons already stated, this could not be helped. A minimum radius of 80 ft was no doubt better, but meant extra cost for construction.

A pair of binoculars and a camera were an asset to the survey party and should be included.

Shri H. P. Mathrani (Chairman) winding up the discussion, thanked the Author for his Paper.

Discussion on Paper No. 167*

"The Design of Small Bridges and Culverts"

By

GOVERDHANLAL

Saturday, February 6, 1954

Shri U. N. Mahida (Chairman) called upon Shri Goverdhanlal to introduce his Paper.

Shri Goverdhanlal, in introducing his Paper, said that he had felt a need for a Paper of the kind while dealing with estimates for minor bridges. A note on the subject was first drawn up and the Paper is an enlargement of that note.

Large mistakes are generally made in the run-off calculations from catchments. So the Paper recommends rational methods for calculating discharge in preference to empirical formulae. Data for the varied conditions prevailing in India are not readily available. Young engineers, in his opinion, should study available rainfall data with a view to establishing a simple relation between rainfall and discharge under various conditions in India.

Shri K. K. Nambiar said that the Paper was very interesting and useful specially to young engineers. It dealt mostly with hydraulic features such as the design of waterways. Except for the two Plates 4 and 5 which gave details of arches and R.C.C. slabs, no mention of superstructure design was made. Details about the selection and economics of different types of culverts would have added to the usefulness of the Paper.

Referring to page 188 of the Paper, where it had been stated that heading up at the inlet and the velocity through the vents increased till discharge through the vents was equal to that of the stream, Shri Nambiar said that increased heading called for increased height of embankment and increased cost in protecting the bank from erosion. In such cases, the saving in cost of pipes would have to be viewed against the additional expenditure of embankment and revetments.

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*Published in the Journal of the Indian Roads Congress, Vol. XVIII-2, December, 1953, pages 123 to 214.

The base width of the wall to retain haunch filling, as shown in the tabular column in Plate 4, was on the underside. For a span of 40 ft, the base width of face wall was given as 2 ft for stone masonry and 2 ft 3 in. for brickwork. If a section were taken at the pier for a 40 ft span which had a rise of 10 ft, it would be found that the roadway was 13 ft above the base of the face wall. Therefore, the base of the face wall should have sufficient width to retain 13 ft of earth filling and a surcharge equivalent to the liveload on the bridge. Insufficient thickness caused longitudinal cracks. He had occasion to observe such longitudinal cracks due to insufficient section of the base wall in many laterite or brick masonry arches in the South Canara District of Madras State. Also, cracks occurred due to the vibration of the arches under traffic. The arch ring under the face wall was not as resilient as the central barrel of the arch and would not vibrate in resonance with it because the masonry face walls at the ends acted somewhat monolithically with the arch rings and made that portion of the arch stiff.

The remedy adopted was to tie up the face walls by mild steel tie-rods running right through from one face to the other. Several laterite arch bridges strengthened in that manner could be seen functioning satisfactorily even today.

In thick R. C. C. slabs it was necessary to put some reinforcement at the top to take care of warping stresses. Plate 5 showed that the top was left without any reinforcement.

Shri K. F. Antia said that in the Railways different values for the coefficient in the Dickens formula have been evolved, taking into account the shape, the size and the slope of the catchment, and they had fairly good results. For instance, different values were used for the fan catchment and the gully catchment, and so on. There was yet another formula, that of Gordon Acorn, which the Author had not mentioned and which had been used by the Railways. It was applicable to hilly country and was originally used in Khyber Railway. Its latest application was on the Badmi-Barkhera section of the Central Railway.

Shri Antia wished to know if the rational formula given in Article 4 had given satisfactory results in practice. He suggested that Article 8 "Alluvial Streams—Lacey's Equations" be put before Article 7 "Fixing Design Discharge". Limitations regarding application of Lacey's and of the rational formulae would have been helpful.

It had been mentioned that discharges should be worked out by all the three methods but the limit of area beyond which the application of all the methods did not yield satisfactory results had not been indicated.

For this purpose classification of drainage structures was necessary. Structures with spans of 100 ft and over might be classed as major bridges. Structures with spans from 20 to 100 ft were minor bridges and those having spans under 20 ft were culverts. The Railways had only two classess of bridges: major bridges were those with single spans of 60 ft or multiple spans of 40 ft and above.

In Article 9 mention had been made of the linear waterway of bridges. These remarks applied to alluvial rivers but paragraph 9.5 mentioned streams not wholly alluvial. The co-relation between discharge and linear waterway of "not wholly alluvial" streams should be indicated.

It should be clearly indicated that the formulae for scour depth should be used as guides and not rigidly applied. Citing the examples of River Narbada and a tributary to River Tapti, Shri Antia said that his experience was that no rigid rules were applicable for finding the depth of scour.

There were cases, for example in extreme west Gujerat, where the land was as flat as a billiard table and streams flowed without any defined waterway. In such cases, it was almost an impossibility to know where the water was going to flow. Experience and judgment were the only guides in such cases.

On the Assam rail link, which was completed very recently, pipe culverts of 8 ft diameter were installed. There was one danger in pipe culverts, particularly corrugated iron pipes, if they were not properly installed. They had a tendency to distort and become elliptical and also to sag in the middle of the culvert length. The sagging resulted in the filling of the lower curved portion of the culvert with bed material and reduced waterway was the result.

Shri Antia suggested to the Roads Wing to consider the Paper as the nucleus of a Constructional Manual as such a manual would be of great help to young engineers.

Shri P. R. Golikere referred to para. 3.3 of the Paper which gave values ranging from 450 to 673 for the coefficient C in the Ryve's formula. Those values were suitable for the rivers and streams in the South Eastern and Central regions. But they were too low for the catchments in the area between the Western Ghats and the Arabian Sea. His experience of the South Konkan on

the West Coast and South Orissa on the East Coast was that values of C ranging from 1,000 to 1,500 were necessary. In limited area within 100 miles of the Western Ghats, a value as high as 2,000 was required. In the absence of such a recourse, the figures of discharge fell too short of those calculated by Kutter's formula. He suggested that the country be divided into suitable zones, and a set of 3 values prescribed for each zone instead of 3 values common to the whole of the country. Such a zonal division had been made by the I.R.C. Bridge Code in the case of wind pressure.

In the example given in para. 13.8 of the Paper, the regime depth had been worked out as 12.1 ft and the maximum scour depths as 41, 31 and 24 ft respectively for the three linear waterways given in the example. A silt factor of 1.2 had been adopted in the calculations. Supposing that within these depths soils having different silt factors were met with, Shri Golikere wanted to know how the Author proposed to modify the results having regard to the depths of these strata having varying silt factors. Medium clay or hard clay was more difficult to scour than sand, though clay had a smaller silt factor due to much finer particles.

In para. 14.1, three rules had been given specifying a minimum depth of foundations below the maximum scour line, subject to a minimum of 6 ft for arched bridges and 4 ft for other types of bridges where the bed is erodible. Taking the case of bridge built across a straight reach of river and having an adequate width flooring (i.e. width from recognised formula or from the thumb rule of 1.5 L on the downstream side and 0.75 L on the upstream side of the ventway, L being the difference in level between the M.F.L. and the floor surface), the normal scour depth D would obviously be the depth of scour expected to occur immediately upstream or downstream of the flooring. In such a case, he was of opinion that it was sufficient if a minimum depth of foundation, as calculated by Rankine's or other recognised formulae, was provided below the floor level and not below the maximum scour line.

Shri Golikere recommended the following addition to para. 15.4 :

" Where there is great disparity in the leads for the *principal* materials of construction and especially when cement and steel have to be transported over long distances, the adoption of this thumb rule is not recommended but the economical span based on the equation in para. 15.2 should be worked out. This applies to big as well as small bridges."

In Madras State, the practice was to provide a total linear waterway one-ninth more than that computed for five values of discharge, velocity and height of ventway. Thus, if the discharge was 10,000 cusecs, V = 10 ft per sec., L = 12 ft.

$$\text{Linear waterway to be provided} = \frac{10{,}000}{10 \times 12 \times 0.9} \text{ ft}$$

Similar practice might be current in other States also. Referring to the equation $\Sigma s = \Sigma l + \Sigma t$ in para. 15.9, he wanted the Author to clarify in what respect the equation was an improvement over the above.

Reading Table 16.1 and Plate 5 of the Paper, it is seen that the width of the backing wall worked out to be inadequate, for example the length of the bearing for a 10 ft span $= 0.5 + 0.04 \times 10 = 11$ inches. So the width of the wall over the backing abutment comes only to 4 inches. This 4-in. wide backing wall would have to be R. C. and even then its ability to withstand direct heavy wheel load, impact and tractive forces would have to be investigated. It might even be cheaper to increase the top width of the abutment and provide a masonry or plain concrete backing wall.

Two separate tables, one for brick masonry and another for stone masonry, were desirable in place of Table 16.1 on page 168 of the Paper.

The following should be added to para. 16.2 :

" When the wings and abutment are founded (a) on different kinds of soil or (b) at different levels on the same but yielding kind of soil (i.e., other than rock), small gaps should be left between the abutments and wings right from the bottom of foundations up to the bottom of parapets to obviate the ill-effects of any possible unequal settlement. This gap should be packed with ruberoid or other suitable material. "

The Author had rightly stressed the necessity of affording protection to prevent the retrogression of the bed. The lowering of bed levels in the vicinity of three bridges on the Madras-Calcutta National Highway and at two railway bridges about half a mile upstream of the road bridges has taken place in the course of the three-quarters of a century that had elapsed after the construction of the bridges. In the railway bridges the sill was about a foot proud of the bed levels immediately downstream. One of the three road bridges had collapsed in December 1952. The bed level 15 to 20 ft downstream of it had been found to be 2 ft lower than the bottom level of the foundations. For the case of the two standing road bridges, the bed

level 30 to 40 ft downstream was a foot or so lower than the bottom of foundations.

Shri G. Gupta wanted to know whether the formula $\frac{i}{I} = \frac{T+c}{t+c}$ was applicable under Indian monsoons and whether any actual experiments had been done by means of automatic recorders.

Shri Gupta felt that in order to determine I_ρ, information available in the rain gauge registers of the Meteorological Department might not be adequate since the raingauges were read at 24 hour intervals only.

Shri M. P. Apte referred to the section of the abutment given at page 167 and said that there would be heavy concentration of stresses at the rentrant angle in the section of the abutment shown in Fig. 16.1 of the paper.

Referring to the relation between the intensity and spread of storm, given at pages 137 and 138, Shri Apte suggested the collection of local information. Reliance on the figures given by Fig. 4.10 would not be correct when applied to places in close proximity, when there was much difference in the intensity of rain. For instance, at Bhandardara the rainfall was nearly 300 inches per year while at a place named Rajuri, which is only about 6 miles away, the rainfall was hardly 20 or 25 inches. For such areas it was not correct to rely on the figures given in Fig 4.10, and the formula given should be used as a general guidance only.

On page 159, the maximum scour depth was given as 1.5 times the normal depth. Shri Apte thought that the scour depth for alluvial soils was only 1.27 times the normal depth. Also when scour was taking place the silt factor of the river was changing and it was not clear how far the calculations would hold good with the changing silt factor. Shri Apte felt that more information on the subject would have increased the value of the Paper.

The Author has recommended that site of the bridge should be such that it should be on a straight reach of the stream. In some cases it was possible that skew currents could develop during floods even though the flow was normal. It was necessary to specify the extra forces for which the design should be made. Also, in certain cases there was likelihood of skew currents even on straight reaches. So it was advisable to take a few cross-sections of the river upstream and downstream of the proposed site and then determine the direction of the current in the river.

Shri R. Nagarajan said that the design of the retaining wall both as an abutment and as a face-wall for live load was very complicated when the depth of the wall considered was small. The equivalent surcharges suggested by the Bridge Code for small retaining walls was many times greater than the height of the wall itself. The application of Spangler and Boussineq's equation for finding the pressure due to live loads gave very high values of earth pressure.

Research studies with pressure cells should be made to find out the pressure due to live loads on a retaining wall at various depths. These studies might include the effect of layered systems on the pressure distribution on retaining walls at various depths.

Shri H. P. Mathrani proposed that the Council might set up a small committee to study the Paper and publish a manual on the subject for the guidance of young engineers.

In para 11.7 it was assumed that the slope of the section under consideration was the same as that of the Lacey's section. He did not think that the above assumption was generally correct. Ordinarily the gradient in the locality had to be considered. The river Indus near Sukkur passed through a small gorge near Lansdowne bridge where the gradients were four to five times steeper than those a mile or two below.

When the question of silt and how the canals behaved with suspended material were not known, Kennedy was the first to evolve his formula from observations in the canals of the Punjab. Subsequently, Lacey worked out formula from a larger amount of data on canals and rivers all over the world. For canals and rivers in Sind, Shri Mathrani found that Lacey's formulae did not apply under certain conditions. It was found that V depended neither on the hydraulic mean depth nor the mean depth. While carrying silt in suspension, work was being done against gravity. Therefore, water was doing work in lifting up the silt and the amount of work done varied with the weight of the material lifted and the mean height through which it was lifted. So, for the present, he would advise that Lacey's formulae be followed for all equations, and not Kennedy's for some and Lacey's for some others as was done by the Author.

In para 20.3 of the Paper the Author had suggested that in spill zone of streams additional culverts be put in to relieve the pressure. Shri Mathrani would advise that as far as possible the culverts should not be put in because it was not possible to determine the share of discharge that passed through those culverts. It was best to widen the main bridge a little as to divert the whole flow through the main river. But where the

culverts were unavoidable, great care should be taken in designing them.

One of the engineers had raised the point about the varying silt factors in the river beds and how they should be dealt with. Actually, the formula of Lacey was based on the assumption that silt factor of the material the river carried was the incoherent material which formed the river section itself. At the same time if one came across very much friable material in the bed or a very much harder material than the silt itself, the conditions did not alter. Shri Mathrani did not think any formula had been evolved yet.

Shri B. N. Shenoy said that in most cases structures might not exist within reasonable distance of the site of the proposed bridge. One therefore had to evaluate the discharges using the methods described in articles 4 and 5 of the Paper. There would always be a difference between the values obtained by the two methods except in the case of streams having hard inerodible beds with no sand or silt. This could obtain only in hill streams. In plains, the beds of streams would generally be liable to scour during high floods. So unless the discharge was worked out, using the cross-section when there was scour it would not tally with the discharge worked out from the catchment. Normally during investigation and surveys, the cross-section taken was that of the dry weather stream and so discharge based on such a cross-section should be less than the actual discharge. This aspect had to be taken into account while attempting to reconcile the figures of discharges worked out according to the articles 5 and 6 respectively.

It was not always possible to locate the drainage structures in the middle of a straight reach. Winding and meandering courses should be trained for some distances above and below the site so as to streamline the flow.

Shri J. T. Mehta said that the section of the abutment given in Article 16 of the Paper was inadequate. Calculations using Spangler's equations and 30 lb per cu. ft. fluid pressure according to the Indian Roads Congress Code of Practice for bridges resulted in the resultant going out of the middle third.

Shri R. N. Joshi pointed out some printing errors and said that the run-off from a catchment depended on the condition of the catchment. For example, run-off due to light rain immediately following a heavy rain was more than that when the catchment was dry. Shri Joshi was of opinion that the formula $Q = A.\ Io.\ \tau$ was not applicable to large catchments. The mention of unit hydrographs, in his opinion, would have enhanced the value of the Paper.

Discussion on Paper No. 168*

"Stabilization of Certain Clayey Soils in India by Heat Treatment"

By

Col. S. K. BOSE

Saturday, February 6, 1954

Dr. E. Zipkes (Chairman) calling upon Col. Bose to introduce his Paper remarked that it dealt with methods of stabilization of black cotton soils near Poona. The emphasis was on heat treatment in order to change the heavy clay character of the soil to a sandy one and stabilizing it by the addition of natural clay soil and other stabilisers.

Col. S. K. Bose, in introducing the Paper, said that the object of the investigation reported in the Paper was to find a method of building roads quickly and economically in clayey soils where conventional methods of road construction were expensive and time consuming. Such a method depended upon making maximum use of the local material, viz., the stabilization of soil locally available using local materials to the maximum extent. A glance at the soil map of India revealed that more than half the country was covered either with black-cotton or alluvial soil both of which were difficult to stabilize. Although the title of the Paper referred to stabilization by heat treatment of certain clayey soils, heat treatment was studied only when it was found that other methods were not suitable or not economical. Investigations which did not yield successful results, e.g., stabilization with various chemicals, had been given in summarized form in the Paper. The data regarding these which covered several pages could be obtained from the Author by those interested.

Mixing various proportions of local coarse sand with black cotton soil was tried. The mechanical analysis of mixed material and its index properties are included in Table 2. It was found that at least three parts of sand to one part of soil was required. This was not economical.

Soil stabilization oil was mixed with black cotton soil in proportions varying from 1 to 4 per cent and in certain cases mixing lime with it. The samples were then compacted at optimum moisture content and immersed in water for 48 hours and

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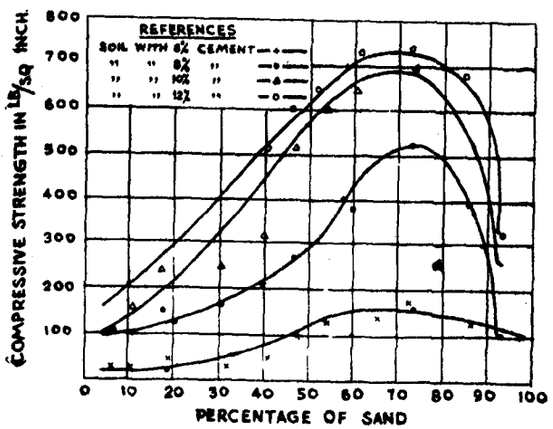
* Published at pages 215-245 of Vol. XVIII-2 of the Journal of the Indian Roads Congress, December 1953.

tested for shear. The shear test results had not been included because of their very low magnitude. These ten samples mixed with the oil and compacted at OMC were subjected to compression tests, which showed that addition of oil invariably reduced the compressive strength. The ten soil samples (Table 2) without shell stabilization oil when compacted at OMC gave higher values than when stabilization oil was added to the soil-sand mixes. All the samples mixed with the shell stabilization oil disintegrated within 12 hours when immersed in water.

Then cement stabilization was tried and it was found that the addition of 30 per cent cement to black cotton soil yielded poor results, the compressive strength being only 192 lb per sq. inch. Hence, a combination of cement and sand containing various proportions of cement ranging from 6 to 12 per cent was tried.

The Figure below shows a small correction obtained with further tests on 12 per cent cement mix. It was observed that when 70 per cent coarse sand was mixed with 30 per cent soil, the best



results were obtained for most percentages of cement. Mere addition of 70 per cent sand without cement was uneconomical. Assuming that 350 lb per sq. inch was the minimum strength for soil stabilization work, it was found that at least 8 per cent cement with 45 per cent of sand or 10 per cent of cement with 35 per cent sand was necessary. This again was uneconomical where sand had to be brought from long distances. When tested for durability with 12 cycles of alternate wetting and

drying, the loss in weight in each of the samples was never less than 14 per cent, which was much more than the permissible value. Hence the effect of lime on the soil was studied. With the addition of 8 to 10 per cent lime, very good results were obtained and in proportion exceeding 4 per cent the dispersion of silt and clay became difficult with coagulation of particles and the results were not consistent. An important thing noticed was the effect of lime in changing the index properties of the mix as apparent from Fig. 6 of the Paper (p. 226).

A combination of lime and cement was then tried and the results were given in Table 5 (p. 228). An addition of 10 per cent lime and 10 per cent cement to the soil gave satisfactory results but this was also not economical.

Heat treatment was then studied. The soil was heated in electrical muffle furnace uniformly and a very important change in physical properties in the neighbourhood of 500 deg. C. was noticed. An examination of Table 6 (pp. 229, 230) of the Paper would reveal that clay was turned almost to the consistency of sand. The heat treated soil, however, showed little reactivity with cement. To increase its reactivity with cement, clay was introduced by adding natural soil to the heat treated product. It was found that there was an optimum moisture content beyond which the addition of clay reduced the compression strength. Various proportions of lime were added to the heat-treated soils. But the effect of lime was not noticeable to the same extent as was found with the natural soil. This was natural as there was considerable reduction in clay content. Also in the case of Road Tar No. 3 it was found that by addition of an optimum clay content to the heat-treated soil a better compressive strength was obtained. The results were given in Tables 7, 8 and 9 of the Paper. The addition of clay to heat-treated soil up to the optimum content increased the strength three times with 10 per cent cement, or with 6 per cent tar. These results were then applied to alluvial soil and the results shown in various Tables of the Paper.

The experiments reported in the Paper showed that a method of stabilization that was good for one type of soil should not be applied indiscriminately to another. The results obtained by heat treatment of alluvial soil were not as satisfactory as those obtained with the black cotton soil. A method of heat treatment had been given in the Appendix merely for the sake of information, and once the method of stabilization by the heat treatment described in the Paper was accepted for black cotton soil, a suitable mechanical device for the treatment in the field could always be devised.

Corrigendum to the Paper

Page 220—Table 1
(b) Plastic limit read 32.4 instead of 34.2.

Page 221—Last line
Instead of " maximum shrinkage "
read " minimum shrinkage ".

Page 222—Table 2(b). Remarks on samples 8, 9 and 10
Instead of "Samples 8, 9 & 10 showed very little change from Sample No. 7 ".
read " Samples 8, 9 and 10 are non-plastic."

Page 224—Line 7
Instead of " as soil sample No. 10 "
read " as soil samples Nos. 1 to 10 "

Page 232—Last but 8 line
Omit the words " of moisture content "

Page 234—Para 18
Instead of " Fine sand 4.2 "
read " Fine sand 24.0 "
add " Coarse sand 4.2 "

Page 237—Line 3
Omit the words—" Kaolinite group than to "
Line 8
Substitute the word " Kaolinite " in place of " Montomorillonite "

Shri S. N. Gupta referred to the Author's definition of black cotton soil in para. 7, page 220, as a heavy textured clayey soil derived from Deccan trap, and desired to know whether the black cotton soil of West Bengal which was not always black came under this definition.

There was variations in the black cotton soil. So, in his opinion, it was desirable to collect nation-wide data and evolve a standard definition or classification of black cotton soils.

The study made by the Author had immense research value and should be pursued even though it had little or no value in practical application in its present form. Though heat treatment

of soil in a road bed had not been accepted as an economic method of soil stabilization, the study had served to confirm our knowledge on the subject, viz.:

(1) Fine grained soils, e.g., clay or black cotton soil was unsuitable for stabilization by bitumen or cement nor was the method economical owing to the large surface area required to be coated in the process and the difficulty involved in mixing.

(2) For stabilization of black cotton soil it was necessary to first upgrade the classification of the soil by the addition of granular materials and then, if necessary, to further stabilize with cement or bitumen.

It was, therefore, customary to select higher type soils for stabilization by means of cement or bitumen. It was satisfactory if black cotton or other clayey soils were stabilized by addition of granular materials and made suitable for a base within economic limits.

He stated that regarding the method of heat treatment it was said in para. 25, sub-para. 3, page 241, that compaction should be completed before burning whereas in the next sub-para, on the same page, it was stated that the previously consolidated formation should be broken into colds before burning, which appeared to contradict the first statement.

Dr. H. L. Uppal referred to page 222, last para., and stated that in his opinion, apart from the long haulage of sand for stabilization, it was the process of mixing sand with black cotton soil which made it uneconomical because of the very clayey and gelatinous nature of the soil. Unfortunately, the soil selected by the Author for treatment with sand was not as clayey as most of the black cotton soils. If the soil given in Table 1 was judged by the Group Index method, which gave the rating of soils in terms of their clayeyness and coarse fraction, it had a Group Index of about 25, whereas the Group Index of black cotton soil of India varied between 20 and 50.

Referring to page 223, para. 10 (b), he wanted to know whether the increase in the index values was due to proper grading of the final mixture as a result of addition of sand. If the grading of sand used had been given it would have been useful.

It had been mentioned at page 224, top para., that the effect of cement was tried on soil mixtures given in Table 2. But from Fig. 5 it appeared to be a different soil with much higher plasticity index.

It was necessary to mention the basis on which the compressive strength of 250 lb per sq. inch was considered satisfactory. The Road Research Laboratory, Harmondsworth, where the stabilization of a clayey soil had been carried out with cement and lime, had raised the required compressive strength for a road base from 250 to 400 lb.

Also, in the U. K. study 2 per cent lime was considered to be optimum for certain reasons, mostly due to capillarity and saturation, and it was shown that the increase in compressive strength when 2 per cent lime and 15 per cent cement was added was 1½ times than if 15 per cent cement alone was used. He desired to know how the optimum percentage of lime had been fixed by the Author.

The compressive strength was a function of dry bulk density. It was, therefore, essential that while determining the compressive strength, the dry bulk density should also be determined. The lack of information about the dry bulk density did not permit the reader to form a correct idea of the variations of compressive strength given in Table 3, page 225.

Drawing the attention of the Author to the method of estimation of exchangeable Ca and other cations given in Soil Science, Vol. 42—1936, Dr. Uppal desired to know the details of the method used in determining the exchangeable basis as given in para. 13, page 225.

Mentioning that the temperature in the different areas of the muffle varied so much even when the temperature recorded was the same, because of the heating elements being closer to one sample than the other, Dr. Uppal desired information on the type of muffle, the procedure of heating, the time taken before the muffle attained the desired temperature, and the quantity and depth of loose soil.

The effect of heat on black cotton soil had been worked out very much in detail, showing the physical, mechanical, and the chemical changes brought about by various temperatures in "Physics and chemistry of soils" by Puri.

Shri B. P. Patel referred to Appendix mentioning that heat treatment process was used in Australia. During his visit to Australia it was ascertained that this process was tried and found unsuccessful for the following reasons :

(1) Burning of the soil in situ by Irvine machine was found very costly.

(2) The machine was capable of burning the soil only to a depth of 3 to 4 inches of top layer and this was not sufficient.

As such, this machine was not now used in Australia.

Experience in Australia showed that the heating of soil in situ by machine would be successful only if some improvement in the design of machine was made to reduce the cost of operation and increase depth of burning.

Shri E. C. Chandrasekharan opined that the study was a systematic laboratory investigation on a selected highly plastic soil of the black cotton type and two alluvial soils on their susceptibility to stabilization by different methods.

The Author had not mentioned the criteria for judging the efficacy or suitability of each of the different methods of stabilization ; also, the actual method of mixing and testing, and the shortcomings and advantages of the different methods, especially in respect of cost, were not brought out in sufficient detail.

Reporting the results of tests conducted in the Soil Research Laboratory of the Madras Highways Department, he said that in a typical black cotton soil obtained from the deltaic regions of River Krishna, Andhra State, showed that the plasticity index could be reduced from 50 to 10 by adding about 4 parts of a locally available fine sand and one part of the black cotton soil, the best combination of sand and the clay being 6 : 1, the cost of sand in this case being nearly Rs 30 per 100 cubic feet. The bearing power with a North Dakota Cone penetrometer on a test block for the 4:1 combination after soaking was only 180 lb per sq. inch. Addition of 2 per cent lime, costing Rs 2 per cu. ft., resulted in an increase of the bearing power to 400 lb per sq. inch and reduction of plasticity index to 7. It was significant to note that addition of an extra quantity of 6 per cent sand for the best sand-clay combination would cost an amount equal to that of adding lime, whereas addition of lime facilitated easy mixing. Recommendations were, therefore, made to add 2 per cent lime to the 4 : 1 sand-soil combination. The speaker believed that in black cotton soil areas where sand was relatively cheap, combinations of sand and lime would be quite workable.

The higher shearing strength of the saturated black cotton soil with S.S.S. oil and sand, over that without sand had been taken by the Author as an improvement in the waterproofing of the soils, caused by the addition of sand. While it was possible that the mixture of black cotton clay and sand might have shown a lesser moisture absorption than the black cotton soil alone for

obvious reasons, the higher strength of the former, in his opinion, was probably due to the presence of the cohesionless sand and increase in mechanical bond rather than to any improvement in the waterproofing characteristics brought about by an addition of sand. However, an admixture of sand facilitated obtaining a uniform mix of the black cotton soil with the oil, which was a primary consideration in stabilizing such soils.

Development of chemical stabilizers was undertaken during the Second World War with the primary object of obtaining a stabilizer that enable speedier construction, for example, elimination of the period of curing of 7 days required for soil-cement etc., and use of minimum amount of stabilizer involving least delay and difficulties in transportation. Cost considerations forbade the use of chemical stabilizers for peacetime operations.

He agreed with the Author that, of the chemical stabilizers used, Aniline-Furfural was the best. From his work and association with the proponent of this stabilizer, Dr. Winterkorn, he stated that by adopting a proper procedure with Aniline-Furfural combination, excellent results could be obtained both for cohesive and cohesionless soils. Aniline-Furfural in the proportion 2 : 1 was a quick acting and fast setting resin that yielded good results with as little as 2 to 3 per cent of the stabilizer. The reaction was so fast that the material set in the course of a few hours. Retarders as coal tar, pitch or bitumen, could be added to suit constructional convenience. The stabilizer combined the cementing advantages of Portland cement and the waterproofing effect of bituminous materials, resulting in what may be called a semi-rigid, semi-flexible system. Besides combining with the organic substances as rubber with inherent bactericidal and fungicidal properties, when added to bituminous materials in small quantities, it improved their adhesive properties. It also permitted the use of conventional road making machinery. Thus as a stabilizer for both cohesionless sand and cohesive clay the Aniline-Furfural combination, when suitably applied and processed, had shown excellent results both in the laboratory and in the field. The only consideration that came in the way of its use in peacetime operations was its high cost of nearly annas 12 per pound. In the light of his suggestions, he wanted the Author to describe the method adopted in admixing this stabilizer, their proportions and the nature of reactions noticed etc.

From the testing works conducted in Madras on soils of medium plasticity, he believed that there was a wide scope for developing suitable combinations of cement and lime as stabilizers for cohesive soils. No mention was made in the Paper on the minimum value of compressive strength required of the stabilized soil-cement or soil-cement-lime. 450 lb per sq. inch was desirable. Current practice in the U. K. was to specify a minimum laboratory strength of 250 lb per sq. inch on samples of height: diameter ratio of 2 : 1 for secondary roads. For the development of a large network of low cost feeder roads in this country it was appropriate to have the 250 lb per sq. inch figure as a tentative minimum.

Table 5 showed that higher compressive strength values are obtained for combinations of the black cotton soil with 10 per cent lime plus 3 per cent cement, and 10 per cent lime plus 6 per cent cement, than for 10 per cent cement plus 3 per cent lime and 10 per cent cement plus 6 per cent lime. Thus a higher percentage of cement than lime did not seem to yield as good results as the reverse of it since lime is cheaper than cement. A suitable combination of lime and cement might prove a successful and economical method for stabilizing highly plastic soils.

In explaining the increase in strength due to addition of natural black cotton soil in a mixture of cement and heated black cotton soil and cement, the Author had taken the relationship between shearing resistance, cohesion and angle of internal friction given by Coulomb. Coulomb's equation was applicable to a natural soil mass, the cohesion of the fine particles of which was a function of the amount and thickness of water films on the surface of the fine fractions. In his opinion it could hardly be extended to a system where an external cementing medium, such as Portland cement (of about 10 per cent), had been used. Data giving the volume changes in all types of soil stabilization would have enabled a study of the compressive strength void relationship.

Continuing, he said that compressive strength determination on dry soil bitumen samples may show rather high values while those soaked under water may show the other extreme. It appeared that the stability tests like Hveem's or Marshall's stability or Cone Penetration would be advantageous for testing such systems, but the results could not be directly compared with the results obtained from soil-cement or similar systems.

Close examination of the basic dehydration curves given in the Paper, Fig. 2, page 219, and those obtained in the present investigation, Fig. 3, page 221, and Figs. 7 and 8, page 236, revealed that a reasonable and a reliable comparison was not convincing. The Montmorillonite and Kaolinite clay groups could be better distinguished by a comparison of values of their base exchange capacity.

The Montmorillonite groups had low base exchange capacity while the Kaolinite group had higher capacity. The observations made on the decrease in the compressive strength of heated Kankinara and Panagarh soils with 5 per cent cement from the values obtained for non-heated soils was probably due to the fact that the heated soils had become friable and hence more sandy in texture, with the non-heated soils, the clay fractions were comparatively free to swell and just filled the voids, indicating the importance of volume relationships.

Field experiments on the following were essential:

(i) Use of lime with or without other materials as sand, cement, etc.

(ii) Heat treatment.

Shri P. N. Srivastava referred to page 242 where it was mentioned that it was necessary to seal the surface with bitumen to minimise wear, and desired to know the effect of heat on the exposed surface and whether there was any likelihood of cracks developing on the surface.

Referriug to various types of stabilization of clay, he stated that in Lucknow laboratory experiments to stabilize soil with linseed oil cakes were in progress and results were encouraging.

Shri S. Mackey observed that black cotton soils might be classified as expansive clay soils that gave a more lucid description from a engineering standpoint. In his experience with black cotton soils from the Haifa area, it was found that a load of 2 tons per sq. ft. was required to prevent undisturbed samples of soil from expanding in a consolidometer when subjected to contact with water under an increasing range of pressures from zero upwards.

He felt that it would be interesting to extend the classification of these soils carried out by the Central Road Research Institute* to include their consolidation properties. If a road subgrade was liable to large expansive forces or volume changes, a 6-in. road pavement was very likely to fail irrespective of whether it was of flexible construction or of rigid concrete construction. Hence it was of paramount importance to highway engineer to know something about such properties before engaging on any major road project involving black cotton soils.

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* Journal of the Indian Roads Congress, Vol. XVIII-2, December 1953.

Since most of the Indian black cotton soils were alkaline in character, they did not lend themselves to stabilization by resinous materials as it was generally accepted that resinous substances were susceptible to attack in alkaline soils.

Shri M. P. Apte said that suggestions as to how the heat treatment method used in Australia could be adopted in India would have added value to the Paper.

The rates and cost analysis of the method used in Australia, given on page 243, showed that about 45 tons of coal would be required for heating one mile length of 10 ft width and about 8 to 10 per cent of cement would also have to be mixed for stabilizing the base. As against this solution, alternative stabilization methods involved only adding 10 per cent lime and 10 per cent cement or 8 per cent cement and about 42 to 45 per cent of sand. Comparative cost analysis for different methods of stabilization would have been valualbe.

In the Deccan area treatment by lime would be cheaper since the cost of coal was about Rs 45 per ton and lime Rs 40 per 100 cu. ft. Also, where the lead of sand was less than 50 to 60 miles, adding sand worked out cheaper than heating by coal or equivalent quantity of firewood.

Referring to page 229, lines 7-8-9, he said that even if heat treatment was adopted, 10 to 8 per cent cement had to be used and as the question of cost of transport of cement did not affect the rate analysis of the two methods he felt that heat treatment might not prove cheap.

Shri J. S. Narasimham pointed out that the colour was not the criterion to indicate the characteristics of the soil as some soils 'brown' in colour were more plastic than the black variety. A terminology for correctly describing such soils was necessary from the engineer's point of view. Experiments in Hyderabad State with soils containing more than 90 per cent clay had indicated that when the soil was subjected to pre-soaking for a period of 24 hours, the compaction characteristics viz., optimum moisture and optimum density changed. Higher Proctor Densities and lower optimum moisture contents were observed with pre-soaking than without pre-soaking.

In para. 12, the Author had mentioned that the cement was added to mixes of soil and sand. He wanted to know whether the properties of the sand with particular reference to its affinity to the clay ineral were investigated.

The Author had mentioned, at page 230 in Table 6, that at 500 deg. C. 60.8 per cent soil was converted into coarse sand consistency. Tests of this sand to determine whether the addition of moisture would change the grain size into clay fraction again were important.

He enquired whether the minimum quantity of tar required to coat the black cotton soil in its natural state, given in para. 17 at page 233, namely 10 per cent, was determined by tests or by visual inspection.

Although treatment of black cotton soils was economically prohibitive, from a research point of view the Paper had brought out new information on the subject.

Shri K. F. Antia said that the Author had developed a new method which was of sufficient importance to warrant undertaking a pilot scheme, where detailed specifications could be worked out and costs could be determined.

He also suggested that the cement content required to be mixed to the heat-treated soil with 25 per cent natural soil for attaining a compressive strength of 250 lb. per sq. inch for secondary roads and 400 lb per sq. inch for main roads might be ascertained.

Shri E. A. Nadirshah* observed that none of the soils whose characteristics were given in Table 2, page 222, were suitable for mechanical stabilization judged by the usual standards, viz., liquid limit not exceeding 25 and plasticity index not exceeding 6.

Also, bituminous stabilization was suitable for cohesionless soils whose moisture content were low and as the hygroscopic moisture content of black cotton soil was fairly high during most of the year, the addition of further fluids in the form of bituminous materials would only cause a loss in strength as the test results had shown.

Referring to the test results in para. 16, page 231, he pointed out that the strength of specimens which were not cured was extremely low which was contrary to the general finding that at early ages the air cured or dried specimens usually showed higher strengths than moist cured ones.

Referring to para. 20, Table 10, he stated that the classification of the soils tested according to USPRA classification system,

* Comments received in writing.

which had been approved by the working committee of the Indian Roads Congress for adoption for Indian soils, would assist in judging the soil in respect of its suitability for stabilization. For example, the Panagarh and Kankinara soils, whose properties are given in Table 10, page 235, belonged to the A-6(7) and A 7-5(3) groups of the P.R.A. and would require 8 to 14 per cent of cement for a satisfactory stabilization.

The liquid limit, plastic limit, sand content, clay content, etc., should have been expressed to the nearest whole number in accordance with standard practice abroad.

Also, it was desirable to conduct the experiments by changing cement content in increments of 2 per cent. Increments of 5 per cent adopted were much too large. Referring to Table 12, page 238, where only 5, 10 and 15 per cent of cement had been tried, he observed that a cement content of 8 per cent for the Panagarh soil and 12 per cent for the Kankinara soil would have been adequate for satisfactory stabilization.

Col. S. K. Bose (Author) in reply to **Shri Gupta's** remarks said that he had used the term black cotton soil with some hesitation because of the widely varying nature of such soils. The soils of Bengal were not black cotton soils but silty soils. Also, compaction of soils before heat-treating would give improved results. The Australian method was based on compacting the formation with smooth roller, and the heating machine had a mechanical digger to break up the compacted surface for ease of burning.

In reply to **Shri Patel's** remarks that the Australian method of heating the soil was economical, the Author said that the Australian method of heat treatment was not akin to method suggested in this Paper. Heating alone did not solve the problem of stabilizing as the product obtained by heating was an inert material which had very little reactivity with cement, but the addition of clay to the heated product made stabilization easier. The Australian method did not envisage adding optimum quantities of natural soil to burnt soil. So the economics of the present process could not be judged from Australian experience. By adding an optimum clay content to the burnt soil as much as three times the compressive strength was obtained when stabilized either with cement or tar alone.

In reply to **Dr. Uppal**, the Author confirmed that the stabilization with shell soil stabilization oil was not satisfactory. In the two series of tests with shell soil stabilization oil conducted, various mixes were tested for 48 hours. Shear tests were also carried out. The results were very poor, values never exceeding

0.1 ton per sq. foot. Every time shell soil stabilization oil was added, it was found to reduce the compressive strength. Referring to the base-exchange process, the results given in the Paper were from the analysis made by Dr. J. K. Basu who had carried out these tests for years.

Referring to Dr. Uppal's remark about the optimum percentage of lime in the U.K. study, the Author said that addition of lime of more than 2 per cent to soil gave much better results. In all cases lime was added before cement to coagulate clay and thus leaving for cement lesser superficial area to coat.

For heat treatment a muffle furance was used and the soil sample was placed over the asbestos sheet of ½ in. thickness. It was found to give the soil complete heat treatment within one hour, even though a shorter duration such as 15 minutes had been found suitable by other workers.

In the Author's opinion, the criterion for stabilization was not only the crushing strength of 250 lb per sq. inch but also conformity with the requirements under American standardized durability tests consisting of 12 cycles of alternate heating and cooling. He stated that the percentage of loss in no case of these experiments was less than 14 per cent which was much more than the value specified for durability tests. He further stated that the soil samples used in the test by him for determining crushing strength were of 2 in. diameter and 2¼ in. length.

Shri Chandrasekharan had mentioned that the cost of the method would enable one to judge the usefulness of the process described. But the Paper described only a laboratory study and this discussion of costs in rupees could not be made. But a comparison of the quantities requiring transport and the amount of non-indigenous materials could be made. Lime-cement combinations were likely to give the better results than with cement alone but lime alone could not serve the purpose.

In reply to **Shri Srivastava**, the Author stated that although on the result of heat treatment the soil became sandy in appearance, the material would not permit granular stabilization as the result of combustion was inert with little reactivity with cement. He had no opportunity of studying the Australian method firsthand and could not comment on the details of the method.

In reply to **Prof. Mackay's** suggestion that black cotton soil should be termed 'expansive soil', the Author said that the term 'black cotton soil' had been used in a general way. Work on swelling pressures and soils had been done at C.M.E., Poona.

Shri Apte had stated that the cost analysis had not been worked out. The Author replied that coal would not be necessary for the treatment and actually in the Australian method wood had been used for burning.

In reply to **Shri Narasimham**, the Author remarked that the method of investigation given in this Paper could be tried on black cotton soil of 90 per cent clay content. The soaking of samples in a suitable dispersing agent for 24 hours for the accurate determination of clay and silt was not carried out in his experiments. Also, the soil after treatment was not tested to find out if it behaved as clay when water was added. His observation of resulting product as sand was based only on particle size and not on any other physical characteristic.

Referring to **Shri Antia's** remark that a pilot scheme should be initiated based on the obvervations made in the experimental study, the Author felt that well equipped laboratories, such as the Central Road Research Laboratory, New Delhi, should take up the investigation and carry it up further to determine an effective way of utilizing the laboratory process in the field.

In reply to written comments of **Shri Nadirshah**, the Author reported that for a good stable soil, liquid limit should be between 14 and 25 and the plasticity index between 4 to 8 under average rainfall conditions. An exception to these values could only be made when the stabilized course is protected from rain by waterproofing courses. Black cotton soil was unsuitable for mechanical stabilization without adequate protection from rain.

Referring to crushing strength in para. 16, viz., 22 lb per sq. inch for soil samples without curing, he reported that these samples were neither air-cured nor dried before testing. Four samples were prepared by mixing heat-treated soil with 10 per cent cement at optimum moisture content and were tested immediately for crushing. The results of crushing strength were 22.1, 22.1, 22.1 and 25.8 pounds per sq. inch respectively. (The last result was neglected).

Regarding adoption of U. S. P. R. A. classification, he stated that the study had been based purely on the identification of clay minerals in the various soil-types because such identification was necessary to understand the lattice structure of the clay minerals and also the base exchange capacity with lime or with a combination of lime and cement.

The investigations on Panagarh and Kankinara soils were not completely reported in this Paper. The results shown in the

Paper were more in the nature of showing the limitations in the application of results obtained in black cotton soil to other soil types, vide para. 21 of the Paper.

Dr. Zipkes (Chairman) observed that it was not possible to include aspects relating to economics or design of field equipment in a research Paper. A research Paper was meant to give the fundamentals of a new idea or process and indicated future trends.

From the discussion it was seen that the inclusion of details of tests, etc., conducted by the Author was necessary for a proper evaluation of the results presented, even though it would have added to the length of the Paper. Just as it was very easy to guess the colour of the wall paper when once the door of a room was opened, so also the results of a successful research looked very simple whereas lot of hard work and patience were involved in obtaining them. He thanked the Author for his Paper.

Discussion on Paper No. 169*

" Roadside Development In Madras State "

By

K. RAMASWAMY REDDY and P. G. NAMBIAR

Sunday, February 7, 1954.

Shri C. M. Bennett (Chairman) called upon Shri P. G. Nambiar (Joint Author) to introduce the Paper.

Shri P. G. Nambiar introducing the Paper for discussion stated that the Paper embodied the principles adopted by the Highways Department of Madras in the matter of roadside development. The expression ' Roadside development ', connoted the application of landscape architecture to roads so as to make them more attractive and less tiresome to the road users. It also implied measures such as the provision of adequate surface drainage, intended to make the roads more enduring against the forces of nature such as erosion, storms, even though miles and miles of avenues existed on our roads since ancient times, the possibilities of planting trees in groups or arranging them in an informal pattern had yet to be largely explored. Landscaping of roads might not have been attempted as an end in itself but road engineers in the past had been conscious of the pleasing effect that a road could produce when harmonised with the landscape and hence had taken care to preserve scenic effects whenever possible.

For convenience of treatment the subject matter of the Paper was discussed under the following five headings :

1. roadland width and the landscape ;
2. the highway alignment and the landscape :
3. the highway cross-section and the landscape :
4. roadside planting : and
5. roadside drainage.

Integration of ideas about adequate geometric standards and principles of landscaping was bound to result in economy in the long run on account of substantial reduction in the annual maintenance cost of cut and fill slopes, shoulders, ditches, etc. With respect to roadside planting, however, initial investment

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commensurate with the magnitude of the planting scheme was unavoidable but the need of roadside trees was recognised on all hands and there was ample return from the investment by way of sale of lease, rights, etc.

Successful roadside planting, even in favourable conditions of soil and climate, depended on careful planning in every detail, strict adherence to a calendar of duties, vigilance and care in execution and adequate maintenance.

Shri Nambiar drew attention to some of the more significant printing errors given below :

			For	Read
Page 321	Para 3	Line 7	Stagging	Staggering
Page 327	Para 8.1	Line 7	of	or
Page 327	Para 8.4	Line 2 from bottom	posts	pots
Page 336	Para 13.6	Line 3	stake	stage
Page 337	Fig. 18	Line 2	weed	wood
Page 351	S. No. 7	Col. 3	fiscu	ficus
Page 353	S. No. 22	Col. 4	maru	ma
Page 354	S. No. 37	Col. 3	fornia	feronia

Shri B. N. Shenoy said that not much literature on the subject was available, at least under the auspices of the Indian Roads Congress. The Paper, therefore, was very useful as it gave information about how to grow avenue trees, what types of trees to grow in particular soils and climates, and the shade and fruit bearing characteristics of different species. The Paper could be treated as a Manual for avenue plantation.

Shri Shenoy added that it must have been the experience of many, as it had been his, that it was necessary to vary the types of trees according to the nature of the soil, etc., and considerations of fruit bearing and fuel value alone should not be allowed to prevail. Whereas a banyan cutting thrived in almost any soil without much looking after high cost was involved in tending more valuable trees till they grew to a height as made it impossible for cattle and goats to nibble at them. To secure this, efficient fencing was necessary apart from maintenance by watering, weeding, etc. Thirty years back, the cost of a single satisfactory wall fence along was about Rs 2 but now, with the prevailing wages, the cost of fencing one plant might be Rs 8 to 10.

Very good effects can be achieved by landscaping, particularly on hill roads where pleasant perspectives can be developed by taking advantage of all the observation spots and selection of shapely or tall majestic species of trees.

On page 312, para. 4.1, it was mentioned that edge bunds should not be put up in any circumstances as a measure of erosion control. Shri Shenoy's experience with roads passing through friable soil in a particular deltaic district had shown that the construction of edge bunds enabled localization of drainage outlets at about 40 ft apart. An edge bund or a dowel bank as it is referred to by the Irrigation Department, about $1\frac{1}{2}$ ft wide and 8 inches high enabled the traffic to use the full formation width of the road between outlet to outlet. Through these outlets, water could flow down the slopes along slant channels paved with turf or stone or brick in the case of high embankments. By this method, he was able to keep hundreds of miles of road formation in functioning condition during the rains.

The flat side slopes recommended in Fig. 1, page 313 were suitable for embankments within 2 ft in height. For heights greater than 2 ft, such flat slopes might not always be possible on considerations of cost of land and earth-work, nor were they essential in this country where speeds of vehicles were still comparatively slow. In any case, the curved shoulder of the embankment given in Fig. 2, para. 4.3, commencing right from the edge of the carriageway and sloping away at the heavy camber of $\frac{3}{4}$ in. to 1 in. per foot would engender a feeling of insecurity and force traffic to the central strip of the road resulting in the full formation width of the road not being used for crossing and overtaking traffic.

Shri S. C. Nayak said that the Paper was based on the actual experience of the senior Author, Shri K. Ramasamy Reddy, specially while he worked as Divisional Engineer (H), South Arcot District. He had developed a love for plants. Unlike the usual run of Papers presented to the Congress, as one read the Paper it evoked the higher instincts of man. The Authors deserved appreciation for their excellent Paper which was based not so much on book learning as on their personal experience.

The two points which had attracted his attention while inspecting the roads in question were: (1) the rounded side slopes of roads in embankment, and (2) pot irrigation. The steep side slopes baulked the driver while the rounded ones infused a sense of safety. This could not be explained in words but had to be experienced while at the wheel. The rounded slopes also did away with scour, especially when covered with grass or turf.

Usually the ill-paid avenue staff neglected their duties with regard to regular watering, especially when water was to be carried on head loads from a distance. Without regular watering plants will not thrive in dry weather. The system of pot irrigation did away with the need for daily watering as the base of the plant was kept cool by percolation of water from the mud pots. This arrangement retained moisture without wastage of water by evaporation. Shri Nayak added that keeping one of the pots half filled with manure in layers intermixed with local earth. Ensured good growth of the plant as manure was let into the roots in its very essence.

Referring to Shri Shenoy's observations regarding edge bunds, Shri Nayak admitted that they served to localise scour but added that they endangered the embankment seriously. The turfed 'chutes' needed attention as paved drains were often found undermined and broken up. If Shri Shenoy were now to take a ride past Tindivanam he would see for himself the improvement and feel the sense of safety created after the edge bunds and steep slopes were replaced by rounded banks.

As for the cost of mud walling, Shri Nayak said that now-a-days they had a guard of willow or wattle costing Rs ½ to 1/8 as against Rs 2 for mud walling, referred to by Shri Shenoy, in pre-war days.

It would have enhanced the value of the Paper, if the Authors had given the average cost of rearing up a plant until it could be left free from the depradations of the goat.

Suggestions as to how the vandalism could be effectively checked in order to save the existing trees during days of scarcity of firewood would have been invaluable.

A list of fruit bearing avenues which could earn for the State would have been made the Paper complete. For example, in districts of Salem, North Arcot and South Arcot in Madras, the annual income from the tamarind trees exceeded Rs 1,00,000 (figure given from memory) in each district.

Shri R. Nagarajan said that the engineers' job was complete only after landscaping the roadside to harmonise with the surroundings. There was always a conflict between utility and appearance. In the correct balancing of the above two factors lay the success of the highway engineer.

It was equally important that road structures like bridges should be architecturally well designed to suit the surroundings and to improve the landscape of the place. Reinforced concrete

was handy for such structures as the material could be moulded to any desired shape or form. Good design of roundabouts at junctions in buil-up areas improved the appearance of the road-side when planted with short shrubs. Provision of parking places, where a pleasing natural view of the locality could be had along at least main roads covering long distances should also be made to reduce monotony.

Shri Nagarajan agreed with the Authors (para. 6.3 clause 4) that the avenue tree should be deep rooted as shallow, spreading roots damage the road structure. Experience of British engineers had also borne out this fact as could be seen from one of the publications of the Road Research Laboratory, Harmondsworth, England entitled "The Investigation on Road Foundation Failure in Great Britain". It was recorded there that during the few years of continuous drought in England, even well-designed and constructed concrete pavements had given way due to the above cause. He also agreed with the Authors (para. 6.1, clause 2) that it was always advantageous to choose a type which required the least amount of water except in cases where water was freely available without appreciable expense.

Shri J. S. Narasimham said that the Paper on 'Roadside Development' had focussed the attention of Highway Engineers to a field which had not been given much prominence in the past. It had not been developed in India in a scientific manner as in the U. S. A. Apart from financial considerations, another reason which could be offered to explain this deficiency was that the subject of landscape architecture was comparatively new and so far had not been introduced in the syllabus for Civil Engineering as had been done in the U. S. A.

The utility of a highway was enhanced not merely by the construction of cement concrete or black-top roads but by a full appreciation of landscape beauty and its preservation. The highway engineers had changed the contours of the landscape with a view to get easy grades by having deep cuts in utter disregard of landscape beauty. The cuts and the borrow pits thus created had, however, been left there in a manner showing little appreciation of the beauty of nature. It was here that landscape architects should advise the highway engineers.

Shri Narasimham made the following remarks:

(a) Tall trees planted on either side of the road at vertical curves gave an indication to the motorists, during night, of the direction in which the highway passed over the ridge, thus contributing to safety.

(b) **Fast growing trees** should be planted at safe distances from the paved surfaces. Here again the landscape architect and the highway engineer had to work in close collaboration.

(c) The Authors had not made any mention about the use of bill boards along the roads. The present tendency in Western countries was to discourage bill boards and advertisements along the roadside as they distract the attention of the motorists particularly during night time resulting in accidents. Their case should, therefore, be considered only if they constitute a source of substantial income to the Department.

Shri C. N. Shukhla disagreed with the Authors' recommendation for rounding off the slope at top off bank (para. 4.3 Fig. 2). In his opinion this would cause a car to go of the bank when an obstacle was to be avoided. Also, the effective travelling width of the road was reduced and vehicles crossing each other had to slow down considerably for safety.

Shri Mahabir Prasad offered the following comments and suggestions :

(a) In para. 1.5 it would be better if one more item under roadside development in addition to the five items given were added as follows :

(6) Roadside fixed benches under shady trees and wider embankments for parking cars.

(b) In para. 2.1 the Authors had stated that hand width should be 100 ft or more. The Authors were requested to throw some more light as to how this 100 ft width was proposed to be utilised. It would be better if a typical cross-section were given. The Authors might also give an idea of the cost per mile on landscaping and tree plantation.

(c) No precautions had been suggested by the Authors for the protection of the landscape from cattle.

(d) Was it advisable to increase road land width by 100 or 50 ft where the land was good and cultivable merely for landscaping.

(e) In para. 4.3 (Fig. 2) a slope of 3/4 in. to 1 in. per foot was shown in the shoulder. The fall of 8 to 10 in. in a 10 ft berm which formed part of the travelling surface

was excessive and hence dangerous to traffic. Also, the excessive slope would cause the berms to be cut more frequently during rains.

(f) In para. 4.2 (Fig. 1) the Authors had shown a side slope of 3 : 1 for unobstructed line of sight. In the figure the 10 ft berms beyond the metalled edge of the road were not shown. If these were shown then even a 3 : 1 slope would not be sufficient.

(g) In para. 4.8 the Authors had stated that turfing was suitable for prevention of erosion or cutting of high embankments. In Uttar Pradesh 'sarpat' grass had proved very effective for this purpose. In such places it was also necessary to provide drains along the slopes of embankments at a suitable intervals say 50 or 10e ft depending upon the run-off and gradient of th0 road.

Shri S. N. Gupta said that there should be some picnic spots by the side of highways. These would add to their beauty and popularity. There should be benches here and there and the whole arrangement should fit in well with group plantation as proposed by the Authors.

The avenue trees might obstruct the smooth running of the equipment (particularly earthmoving equipment) which should be allowed to move freely. Shri Gupta liked to know whether the Authors had taken this point into consideration.

Shri Gupta desired to know the average amount spent or proposed to be spent by the Madras State for roadside development of different categories of roads.

Shri M. S. Srouty observed that it would not only be costly but there was hardly enough land width to provide the flat side slopes suggested by the Authors for embankments on existing roads. He, therefore, presumed that the recommendations applied to new roads.

Plantation of banyan trees was to be deprecated because, in Shri Srouty's experience, roots of banyan trees were known to cause damage to buildings as far away as 130 ft.

Shri M. Meeran said that trees had been ruined by vandalism of the public by cutting their bark as well as branches for use as fuel. The need for some sort of legislation to protect roadside trees was, therefore, evident.

In connection with the maintenance of overhead services, viz., electric wires, telegraph and telephone wires, branches of roadside trees in cities were being cut making them un-balanced and liable to uprooting during storms.

Shri Meeran agreed with the speakers who had pointed out that fast growing trees should be avoided as they caused damage to the pavements.

Referring to willow-tree guards he observed that these were no doubt inexpensive but from his own experience he could say that their use had not been a success; because they were easily removed by the neighbouring people at night for use as fuel.

He endorsed the suggestion of previous speakers that there should be picnic spots along highways. This was not a novel idea and such picnic spots existed along ancient highways.

Shri E. A. Nadirshah * hoped the contents of the Paper would be given due thought by road engineers in this country. So far a road had been considered solely as a means of communication and its aesthetic and architectural value was neglected.

In other countries, in the design of a road, thorough consideration was given to landscape architecture and specialists in this line were consulted. Some of the hints given by the Authors in para. 2.1 should prove very useful in this respect.

The location of electric transmission line towers and the presence of ugly borrow pits on the sides were a common eye sore on some of the highways. He hoped proper steps would be taken to avoid these in future.

Referring to para. 4.7, he suggested that the varieties of grass to be planted on the sides should be those that were not liked by sheep and cattle.

Planting a tree alongside a road was considered an act of charity in olden days. If similar practice was encouraged and systematized, ample funds could be made available for roadside arboriculture.

Shri P. G. Nambiar (Joint Author) in replying to the discussion agreed with **Shri Shenoy** that the present day cost of raising avenue trees was much higher than the cost some year-ago. Therefore, it was all the more necessary that everythine possible should be done to minimise casualties and promotg

* This communication was received in writing.

economy by careful planning and execution of every planting project as emphasized in the Paper.

Edge bunds had some disadvantages. For instance, water can spill over only at the chutes which may be spaced at intervals of 30–50 ft. If the road is level or on a gentle grade, water was liable to stagnate at depressions in the shoulders which got softened and became a source of danger to traffic. Also, the chutes often required protection against erosion by paving. Water eventually found its way under this paving and completely undermined it by eroding the embankment material, thus defeating the very purpose of the edge bund. With a rounded edge and gentle side slopes drainage water spills over at all points and there was little danger of erosion. The rounding did not endanger traffic; on the other hand, it enhanced safety by ensuring a gentle transition for the vehicles which were forced to leave the shoulders. It was for these reasons that the Authors had suggested the curved top.

Referring to **Shri Nayak's** point regarding yield from fruit bearing avenue trees, the Author stated that avenue trees like tamarind and other fruit bearing trees yielded a good return as soon as they reach the fruit bearing stage, and the investment of initial cost required for raising them was repaid in a short time.

Shri Nagarajan's suggestion to provide parking places was a good one. Wherever possible, these could be associated with scenic vistas to make them more enjoyable to the tourists.

In reply to **Shri Narasimham**, the Author stated that at vertical curves so long as the road was straight and there was sufficient sight distance, the situation was safe. But when a vertical curve was combined with a horizontal curve, the planting of tall trees was a very useful device to indicate the direction of the road.

Irrespective of the available width many principles of roadside development could be applied, though not all. If the standards of road land width for N.H., P.H., etc. recommended by the Indian Roads Congress were followed, it would be quite ample for the purpose.

In reply to **Shri Prasad's** point regarding flat side slopes, the Author believed that the driver gets a feeling of spaciousness and safety if he is able to have a clear view of the side slopes and particularly of the junction of the side slopes with the ground. That was the idea sought to be conveyed in Fig. 1 and it was desirable to provide slopes which satisfied that condition.

Protection of trees against vandalism, referred to by various speakers, was an administrative matter and co-operation of departments such as revenue and police as well as the public was necessary to combat it. The situation was rather serious in certain parts of Madras and the Government of Madras had been considering stringent measures to put down vandalism. A committee probably had also been appointed to go into the whole question.

Regarding **Shri Gupta's** point about mechanisation of road work, no aspect of roadside development would interfere with the use of machinery. In fact some features like easy side slopes, rounding of top and bottom of side slopes could be accomplished easily by means of graders, etc. It was also possible to save standing trees in the road margin during grading operations.

The Author agreed with **Shri Srouty** that banyan trees were not suitable for the avenue. This point had been clearly brought out in para. 7, Appendix II.

In reply to **Shri Meeran**, the Author stated that trees in city areas were a problem in themselves. Varieties which spread out their branches or grew very tall aggravate the problem. A possible partial solution would be to plant varieties which do not grow very tall and have a compact silhouette.

For city streets, instead of willow guards which were easily stolen away, R. C. tree guards would be more economical and tidy.

In reply to **Shri Nadirshah** the Author stated that the Paper was perhaps the first one on the subject of Roadside Development to be read before the Indian Roads Congress. In other countries, notably the U.S.A., almost every State Highway Department had its own clear-cut policy in the matter of roadside development and Manuals on the subject and specially trained staff were available. The Indian Roads Congress could take a lead and disseminate information and lay down standards, suitable to Indian conditions.

Regarding para. 4.7, as suggested by Shri Nadirshah, it was eminently desirable to have the ground cover consisting of varieties of grass etc. which were not relished by cattle, provided this condition did not lead to the choice of thorny varieties which may be a nuisance to road users.

Shri C. M. Bennett (Chairman) admitted that the subject of roadside development was not given the attention it deserved

in this country. In the U. K. in a small way and in the U. S. A. in a big way it was being pursued in detail with great interest. The fundamental reason for its neglect was probably lack of funds. Landscape development costs money and whatever little funds available went for improvement of road surfaces.

The Chairman thanked the Authors for their very interesting Paper and to the various speakers who had taken part in the discussion.

INDIAN ROADS CONGRESS

Classified List of Papers, etc., in the Proceedings I to XVIII

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III. Soil and Earthworks, Soil Science as adapted to Road foundation, Banks and Earth Surfaces, Soil Stabilization, etc.

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12	A Method of Soil Stabilization for Low Cost Roads.	S. R. Mehra	X Parts 3 & 4	110	379 to 427-3 & 790 to 795-4	110
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23	Design of Road Beds.	G. Sriranga-chary	XVI Parts 2 & 4	160	301 to 353-3 & 556 to 563-4	160
24	Compaction of Some Alluvial Soils of India.	Central Road Research Institute Okhla, Delhi	XVII-2	—	291 to 344	—
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4	Gravel Roads.	N. N. Ayyangar	II	23(b)	199-203& 227-233	26
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10	Low Cost Roads for the East.	Col. F. L. D. Wooltorton	XII Parts 3 & 5	125	283 to 327 -3 & 412 to 424-5	125
11	Low Cost Roads in India and Use of Soil Science for their improvement.	G. Sriranga-chary	XIII Parts 1 & 4	135	59 to 146-1 & 112 to 132-4	135

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21	Behaviour of Brick Metal in Tar Carpets.	K. C. De	XV Parts 3 & 4	154	393 to 414 -3 & 651 to 658-4	154
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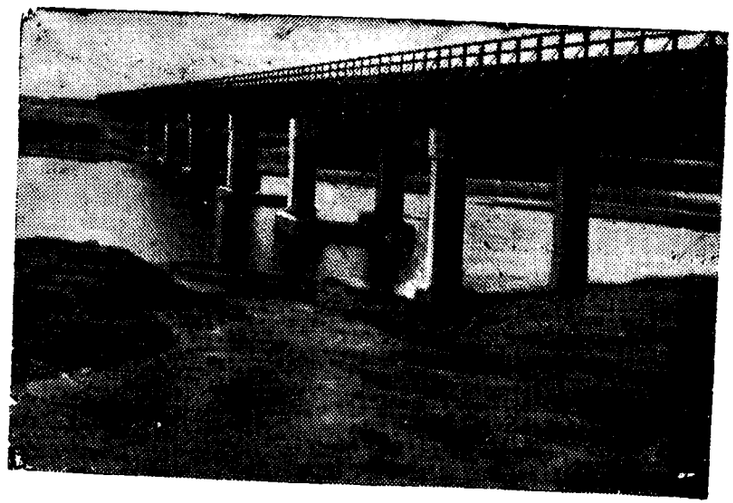

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