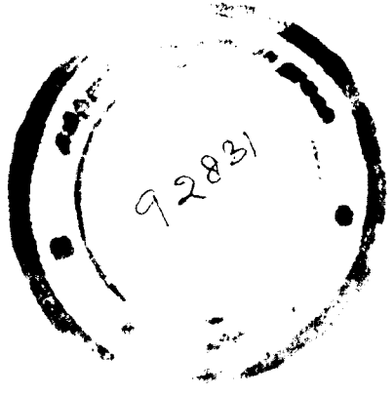
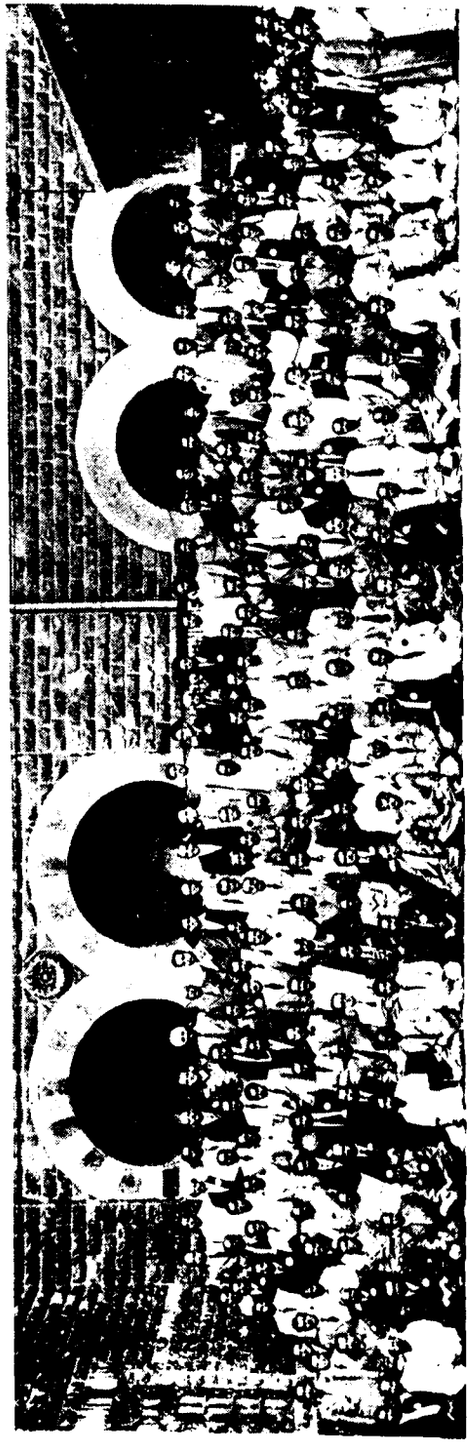
The Indian Roads Congress as a body does not hold itself responsible for statements made, or for opinions expressed, in the Papers or discussions in its Proceedings.





Indian Roads Congress—Fourteenth Session, Bombay, January 1950.

(The President, Shri Brijmohan Lal, is not in the photograph.)

SHRI BRIJMOHAN LAL, I. S. E., President, 1949—50.

Shri Brijmohan Lal was born at Meerut in 1898 and received his early education there, attaining a brilliant record in the Meerut College. As an under-graduate, he joined the Civil Engineering Class of Thomason Civil Engineering College in 1918 and obtained a Higher Certificate as an Assistant Engineer in 1921. He was appointed to the Indian Service of Engineers in 1922 in the Punjab P. W. D., Buildings and Roads Branch. He soon rose to the rank of an Executive Engineer in 1928 and, in that capacity, he was responsible for a large number of works on roads, bridges, and buildings. He became a Superintending Engineer in 1943 and in addition, was appointed Secretary, Communications Board, Punjab in 1944. He was elected Member of the Institution of Engineers (India) in 1944.

His services were appreciated by the Government in 1945 by the award of the title of Rai Bahadur. On the partition of the Punjab, he was appointed Chief Engineer, P. W. D., Buildings and Roads Branch, East Punjab, on the 15th August 1947, in which capacity he is still serving the country.

INDIAN ROADS CONGRESS

NOTICES AND ANNOUNCEMENTS

Contribution of Papers for the Fifteenth Session of the Indian Roads Congress.

The next General Session of the Indian Roads Congress is likely to be held sometime in January–February 1951. The exact date, place and programme of the Session will be communicated to Members in due course.

2. 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. **The complete Paper, if intended to be read at the next Session, should preferably be submitted within the next three months, but not later than September 1950.**

3. 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 in their contributions **within the next four months.** 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 before publication.

5. 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 withhold the award of a Medal in any year without assigning any reason.

7. **ESSAYS:** Members are informed that the Council of the Indian Roads Congress, at their 34th meeting held at Bombay on the occasion of the 14th Session, have decided to discontinue the Prize Essay Competition.

8. Rules and Regulations for the Contribution of Technical Papers and the Award of Medals are published on pages 9 to 14 of Volume XIV-1 of the Journal of the Indian Roads Congress—September 1949.

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II. NEW ADMISSIONS

LIST OF THE MEMBERS OF THE INDIAN ROADS CONGRESS ENROLLED FROM 1-11-49 to 28-2-50

Serial No.	Roll No.	Name.	Address.
1294	1438	M. S. Thirumale Iyengar	Chief Engineer, Highways, 15, Victoria Crescent Road, Egmore, Madras.
1295	1439	O. H. Koenigsberger	Director of Housing, Ministry of Health, Room No. 73, North Block, Central Secretariat, New Delhi.
1296	1440	S. S. Swaminathan	Superintending Engineer, (Civil), C. P. Electricity Department, Lele Bungalow, Dharampeth, Nagpur.
1297	1441	G. C. Jain	District Engineer, P.W.D. B'R, Saharanpur.
1298	1442	K. C. Pandya	Director, C/o, The Allied Construction Co. Ltd., 24-B, Hamam Street, Fort, Bombay.
1299	1443	M. M. Bose	Executive Engineer, Central Division, P.W.D. Patna.
1300	1444	U. B. Sreepada Rao	Supervisor (Highways), Civil Bazar, Bellary.
1301	1445	J. B. Nanda	Divisional Engineer, P.W.D., Udhampur. J. & K. State.
1302	1446	R. S. Bhalla	Deputy Matorials & Plant Officer, Ministry of Transport, Roads Organisation, Jamnagar House, New Delhi.
1303	1447	J. K. Roy	Assistant Engineer (Roads), Loco Building Works Projects, Sarkar Villa, P.O. Mahijam. (Santhal Parganas).
1304	1448	E. Krishnan	Section Officer, (Highways), Bharatha Puzha Bridge, Kuttippuram (S.I.)
1305	1449	J. P. Singh	Superintending Engineer, B & R Branch, Patiala.
1306	1450	K. V. Joglekar	Deputy Secretary to Govt. of Bombay, P.W.D. Secretariat, Fort, Bombay.
1307	1451	S. K. Subramaniam	Managing Director, Gannon Dunkerley & Co. (Madras) Ltd. 14, Boag Road, Madras-17.
1308	1452	P. Sharma	S.D.O., P.W.D. Dibrugarh P.O. (Assam).
1309	1453	S. K. Karandikar	Superintending Engineer, Central Circle, Poona-1.
1310	1454	M. V. Rajwade	Executive Engineer, P.W.D. Raipur. (C. P. & Berar).

Serial No.	Roll No.	Name.	Address.
1311	1455	P. C. Chopra	Chief Engineer, Vindhya Pradesh, Rewa.
1312	1456	S. N. Banerjee	Assistant Engineer, Works & Buildings Deptt., Siliguri Sub Division, P.O. Siliguri, District Darjeeling (West Bengal).
1313	1457	H. K. Gandotra	Divisional Engineer, Kashmir R & B Division, Gugji Bagh, Srinagar.
1314	1458	S. G. Lakhani	Assistant Brick & Sand Supply Officer, C/o Office of the Assistant Housing Commissioner (West), Bombay.
1315	1459	S. K. Mitra	Assistant Engineer (W & B), Jalpaiguri, (West Bengal).
1316	1460	K. Narasimha Rao	Municipal Engineer, Kakinada.
1317	1461	Phiroz Bomanji	Deputy Commander, Royal Indian Engineers, C/o CRIE, 133 Works, No. 56 Army P. O. New Delhi.
1318	1462	D. N. Ghosh	Assistant Engineer, (W & B) P.O. Khatra District Bankura. B.N.Rly. (West Bengal).
1319	1463	K. D. Bhagwagar	Engineer Roads, Bombay Municipality, 53 Minoo Mansion, Victoria Gardens Road, Bombay-27.
1320	1464	M. N. Mewada	Executive Engineer, P.W.D. Presidency Division, Bombay.
1321	1465	K. Subba Rao	Executive Engineer, Shimoga, (Mysore).
1322	1466	N. K. Desai	Deputy Engineer, Dadabhai Road, P.W.D. Office, Andheri, Bombay.
1323	1467	S. A. Sharma	Executive Engineer, Satpura Division, P.W.D. Chhindwara (C.P.)
1324	1468	T. H. Dhanokar	Deputy Engineer, "A" Sub-Division, P.W.D. Secretariat, Fort, Bombay.
1325	1469	V. Lakshmi Narayan	Assistant Engineer, Tunga Project, Shimoga. Mysore State.
1326	1470	V. Ramiah	Assistant Engineer, No. 3 Buildings Sub Division, Bangalore. Mysore State.
1327	1471	P. K. Vora	Assistant State Engineer, P.W. D. Nagar Chakla, Bhuj. (Kutch).
1328	1472	A. R. Mastoor	Deputy Engineer, P.W.D. Jawhar Sub Division, Jawhar. District Thana.
1329	1473	V. J. Masarwala	Deputy Engineer, C/o Superintending Engineer, B.C., P.W.D Bombay.

Serial No.	Roll No.	Name.	Address.
1330	1474	P. J. Jagus	Assistant Engineer, Concrete Association of India, 1-2 Queen's Road, Bombay-1.
1331	1475	B. T. Unwalla	Assistant Engineer, Concrete Association of India, 1-2 Queen's Road, Bombay-1.
1332	1476	C. J. Pinto	Deputy Engineer, P.W.D. 1996 Convent Street, Poona-1.
1333	1477	M. N. Dalal (L.M.)	Principal & President, Indian Roads & Transport Development Association, 3, Cuffe Parade, Bombay.
1334	1478	G. S. Thosar	Assistant Engineer, Maintenance (Roads), Plot 14, Sir Balachandra Road, Dadar, Bombay.
1335	1479	S. P. Narke	District Engineer, District-Local Board, Dharwar.
1336	1480	S. R. Gadhoke	Superintending Engineer, United States of Rajasthan, Jodhur.
1337	1481	R. D. Bakori	Executive Engineer, P.W.D. Office, Bandra-Bombay, 20.
1338	1482	I. K. Modi	Deputy Engineer, P.W.D. Room No. 111 Housina Colony, Scheme No. 6, Road, No. 4, Sion, Bombay.
1339	1488	M. D. Deodhar	Deputy Engineer, P.W.D, Bungalow No. 60, Ranade Road Extension. (B.B.C.I.) Dadar, Bombay.
1340	1484	K. S. Deshpande	Deputy Engineer, P. W. D. 1, Lady North Coto Orphanage, Chaupaty Road, Babulnath, Bombay No. 7.
1341	1485	M. M. Desai	Municipal Engineer, Baroda City Municipality, Khadia Pole, Baroda.
1342	1486	K. Rajagopalan	Assistant Engineer, Ernakulam, The United States of Travancore & Cochin.
1343	1487	P. K. Daruwala	Executive Engineer, Housing Suburban West Division, Andheri (Bombay).
1344	1488	G. B. Sompura	563, Manekvadi, Bhavnagar, (Saurashtra).
1345	1489	T. Huch Veeriah	Executive Engineer, P. W. D., Building Division, Mysore.
1346	1490	K. V. Raja Rathnam	Assistant Engineer, P. W. D. Building Division, Mysore.
1347	1491	O. H. Patel	Deputy Engineer, Gujarat Irrigation Circle, Baroda.

Serial No.	Roll No.	Name.	Address.
1348	1492	M. M. Patel	Assistant Engineer, Municipal Office, Danapith, Ahmedabad.
1349	1493	M. P. Karkare	In charge of Roads in Baroda Municipality, Sidhanath Ganeshwadi, Baroda.
1350	1494	E. J. Unrigar	Assistant Engineer, C/o. Messrs. Tata Power Co., Ltd., Bombay House, Bruce Street, Fort, Bombay.
1351	1495	V. V. Bedekar	Divisional Engineer, Local Government, Aurangabad, (Hyderabad State).
1352	1496	K. P. Chattopadhyay	Assistant Engineer. W & B, Haringhata Works Sub-Division, P. O. Barajagul. District Nadia, (West Bengal).
1353	1497	D. V. Deshpande	Assistant Engineer, Development, Poona City Municipality, Poona-2.
1354	1498	M. N. Guha	Assistant Engineer, W & B Deptt. Kurseong Dist., Darjeeling, (West Bengal).
1355	1499	Syed A. B. Inamul-Hoque	Temporary Engineer, Office of the Executive Engineer, L. A. Division, P. W. D. Gauhati. (Assam).
1356	1500	R. B. Sen	Technical Assistant to Superintending Engineer, Road Planning Circle, Anderson House, Alipore, Calcutta.
1357	1501	Norman Henry Taylor	Development Engineer, C/o Rocondo Ltd., Ewart House, Bruce Street, Bombay.
1358	1502	N. C. Bulsara	Superintending Engineer, North Gujarat Circle, P. W. D. Bungalow No. 14, Cantonment, Ahmedabad.
1359	1503	H. D. Ganguli	Assistant Engineer, (W & B), 47, Ballygunge Gardens, P. O. Calcutta 19.
1360	1504	D. B. Kankanwadi	Executive Engineer, Irrigation Projects Division (South) P. W. D. Dharwar.

ASSOCIATE MEMBERS.

1	40	T. C. Shahani	Roads Engineer, Standard Vacuum Oil Co., P. O. Box No. 255, New Delhi.
2	41	K. C. De	Roads Engineer, C/o Bengal Chemical & Pharmaceutical Works Ltd., 94, Chittaranjan Avenue, Calcutta—12.

III. DEATH.

The Council have received with regret intimation of the following death :—

1	576	P. M. Chowdhury	District Engineer, P. W. D., Goona, (Gwalior).

IV. ADDRESSES OF MEMBERS WANTED.

Communications addressed to the following members have been returned unclaimed by the Post Office. Members able to give information regarding the present address of any of those concerned are requested to forward particulars to Secretary, I. R. C.

Serial No.	Roll No.	Name of Member.	Last known Address.
1	453	Basu, N.	152, Ind. Rly. Maint Co., C/o 6, A. B. P. O.
2	779	Banerjee, Shishir Kumar.	Assistant Engineer, Waterways Sub-Division, Patna.
3	575	Dixit, M.K.	C/o Lashkar Municipal Committee, Lashkar, Gwalior.
4	1145	Dhruva, R.C.	Executive Engineer, (Housing). Gaurd Room, Pochkhanwala Road, Worli, Bombay No. 18.
5	1225	Gulzar Singh, S.	Assistant Engineer, Designs, P. W. D. Building and Roads Branch, Simla-E.
6	894	Hanly, P.J.	15/1, Chowringhee Square, Calcutta.
7	229	Hodgson, E.S.	Overdeans Court, Diffen Hall near Farham Surrey, (England).
8	566	Jadhav, M.K.	Chief Engineer & State Architect, Ketkibag Bungalow, Camp Road, Baroda.
9	931	Khalique, M.V.	Ministry of Transport (Roads), New Delhi.
10	173	Kidar Nath.	32, Kaonli Road, Dehra-Dun, U. P.
11	24	Korni, M.A.	114, Regent Estate, Tolly Gunj, Calcutta.
12	998	Mathew, K. George.	Supervisor, P. W. D., Trivandrum.
13	830	Mathur, J.K.	Assistant Engineer, Jodhpur Railway, Jodhpur.
14	206	Mufti, M.I.D.	Inspector of Works and Stores, Central Command, Meerut.
15	183	Nawab Ahsan Yar Jung Bahadur (L.M.).	Afsar Manzil, Jublee Hill, Hyderabad-Deccan.
16	417	Parang, Hari Ram (L.M.).	Retired Executive Engineer, Lal Chowk, Qila Gujar Singh, Lahore.
17	955	Parmeshri Dass	Assistant Engineer, P. W. D., Azamgarh, U. P.
18	693	Rajaratnam, K.M. Mudaliar.	District Board Engineer, Kistna Dist. (Madras Presy.).
19	956	Rizvi, S.H.	Executive Engineer, P. W. D., Provincial Division, Jhansi, U. P.
20	844	Salukhe, V. B.	Guest House, Dewas Junior.
21	720	Shaw, M. (L.M.).	Executive Engineer, Central P. W. D., Indore.
22	1089	Uttam Singh. (L.M.).	Chief Engineer, Jaipur State, Jaipur.

LIST OF COMMITTEES AND SUBCOMMITTEES

1. *SPECIFICATIONS AND STANDARDS COMMITTEE:*

G. M. McKelvie — *Convenor*
K. S. Raghavachary — *Member-Secretary*

(i) *Geometric Design Division:*

T. Mitra — Brijmohan Lal
N. V. Modak — K. K. Nambiar

(ii) *Structural Design Division:*

(a) *Rigid Pavements:*

A. C. Mukerjee or nominee
M. S. Thirumula Iyengar or nominee
One representative of E-in-C
C. V. Nazareth

(b) *Flexible Pavements:*

Brig. Partap Narain — S. R. Mehra
C. J. Fielder — G. Srirangachary
V. N. Rangaswami

(iii) *Specifications and Costing Division:*

(For items other than (i) & (ii)
H. Sunder Rao
One representative of E-in-C (Surveyor of works)
N. V. S. Murti
H. P. Sinha or nominee of C. P. W. D.

2. *BRIDGES COMMITTEE:*

H. P. Mathrani — *Convenor*
S. L. Bazaz — *Member-Secretary*

(i) *Location, Layout and Hydraulics Division:*

Brig. Partap Narain — G. R. Nangea
A. Nageswara Ayyar — J. Chambers
Kanwar Sain — A representative of C.B.I.

(ii) *Substructure and Superstructure Division:*

K. F. Antia — S. B. Joshi
D. S. Desai — E. P. Nicolaides
K. G. Bhate — P. S Subramaniam
S. K. Ghosh — M. V. Joglekar
V. Venkataramyya

3. *TECHNICAL SUBCOMMITTEE:*

(i) *Test Track Division:*

Chief Engineer (W. Bengal) —*Convenor*

C. J. Fielder — Satya Nand
K. S. Raghavachary — G. Srirangachary
S. N. Gupta — S. N. Chakravarti

(ii) *Research Organization Division:*

K. S. Raghavachary — *Convenor*

A representative of Engineer-in-Chief's Branch
Chief Engineer, Works & Buildings, West Bengal
Chief Engineer, Buildings & Roads, Uttar Pradesh
Chief Engineer (Highways), Madras
Chief Engineer, Buildings & Roads, Punjab.

4. *ROAD TRANSPORT SUBCOMMITEE:*

F. P. Antia — *Convenor*

K. M. Kantawala — E. A. Nadirshah
V. N. Rangaswami — R. N. Dogra

5. *BULLOCK-CART SUBCOMMITTEE:*

B. V. Vagh — *Convenor*

S. B. Joshi — J. A. Taraporevala
E. A. Nadirshah

6. *SOIL RESEARCH SUBCOMMITTEE:*

S. R. Mehra — *Convenor*

One representative of E in-C. — One representative from Central Board of Irrigation
U. J. Bhatt — K. S. Raghavachary
C. J. Fielder — G. Srirangachary
V. N. Rangaswami — H. L. Uppal

7. *EDUCATION SUBCOMMITTEE:*

V. N. Rangaswami— *Convenor*

N. V. Modak — K S. Raghavachary
E. A. Nadirshah — J. A. Taraporevala

8. *BITUMINOUS TREATMENT OF WET AGGREGATES SUBCOMMITTEE:*

W. A. Griffiths — *Convenor*

M. L. Bahl — D. C. Dutta
R. N. Dogra — Laxman Sarup
T. Mitra

the Hon'ble the Minister of State for Transport and Railways, Government of India and other distinguished Members [Messages reproduced on pages 421 and 422.]

Sir, the city of Bombay where we have met today, has a place of its own in the annals of the country's progress and the achievement of our independence. Directly one thinks of the Province of Bombay, many illustrious names come to one's mind, Naroji, Tilak, Ranade, Bhandarkar, Gokhale. and above all, Mahatma Gandhi, the architect of our freedom and the Father of our Nation. We cannot think of a better setting for the contemplation of the many difficult problems that encompass us today, in whose proper solution lies the future and destiny of our land and our race.

Vast, momentous, and revolutionary changes have taken place in this land of ours since we met here last. What our most sanguine hopes were not able to forecast has actually become a reality. And we stand today pivoted on the wings of destiny and untrammelled by the mental shackles that had damped our hopes and clogged our growth. We are absolutely free to mould our destiny as we will and have luckily got amongst us two pilots who will steer us clear of the shoals and quick sands that must inevitably lie in the way in a period of transition. You must have already divined that I am about to mention the names of Pandit Jawahar Lal Nehru and Sardar Vallabh Bhai Patel.

The accession of the States to the Union is a momentous event in Indian History. No fewer than one hundred and sixty seven small and big states, including the major State of Baroda, have merged into the Province of Bombay, enlarging its area and population by 39,712 square miles and 85 lakhs persons respectively, and converting it into one of the largest administrative areas of the Indian Union.

The problem of problems before us today is that of improving the lot of the common man and it is here that the engineer with his bold imagination and audacious spirit of adventure must undoubtedly come in to assist in the process of nation building. The Province of Bombay can very proudly lay claim to have completed many and bold engineering projects. The Wilson and Lloyd Dams and the Back Bay Scheme are among the monuments that will long stand time's tyrannous claims. The Marine Drive, arising out of the last mentioned project, represents a fine piece of the road builder's art and may well be the envy of the East. I am, therefore, very happy that we have met today in a most appropriate spot for chalking out our plans for the development of our road communications which are among the inevitable passports to agricultural efficiency, rural plenty, and industrial prosperity.

ROADS IN INDIA

The history of road construction in India extends well back into hoary antiquity. Our recently unearthed cities of Mohenjodaro and Harrapa reveal that even in that Chalcolithic age, some five thousand years or more ago, we were quite adepts in the art. We find in post-Vedic literature demonstrable signs of proficiency in road making and efficiency in their maintenance, for it is inconceivable that the horse chariots mentioned so frequently rolled on uneven ground or unlevelled paths. In fact, the very existence of these means of communications postulates a fair degree of advance in road-making. The epic of Ramayna affords further proof of the construction of roads in as much as Bharata, when he resolved to meet his banished brother Rama, ordered the making of a proper road through the forest areas so that he and his retinue could travel smoothly.

क्रियतां शिल्पिभिः पन्थाः समानि विषमाणिच ॥

वाल्मीकी रामायण, अयोध्याकाण्ड ॥ श्लो ॥ ३ ॥

The extent to which the science of road building later developed will be clear from the following extract from the ARTHA-SHASTRA, the well known treatise on Mauryan polity by Kautilya, written more than three centuries before Christ:—

> " Chariot roads, royal roads, and roads leading to DRONA-MUKHA, STHANIYA, country parts, and pasture grounds shall be four dandas (twenty-four feet) in width. Roads leading to SAYONIYA, Military Stations, burial or cremation grounds, and to villages shall be eight dandas (forty-eight feet) in width. Roads to gardens, groves, and forests shall be four dandas. Roads leading to elephant-infested forests shall be two dandas. Roads for chariots shall be five Arantis (7½ feet) and roads for minor quadrupeds and men shall be two Arantis (3 feet)."

In his days, the principal RAJAPATHA or Royal Road was that which passed through Patliputra or Patna. This road continued right upto the North Western Frontier Province. After the main routes had been laid out, trees were planted, wells were dug, and hostelries for travellers built at regular intervals. Distance pillars were noticed by MAGASTHANES (300 B. C). Imperial and Provincial officers looked after the upkeep of these roads. The labour for maintenance was provided by the towns and villages lying along the roads. The SHUKRANITI (10—14 century A D.) gives details of the roads of the period. Roads were built with convex surfaces "like the back of a tortoise." They had drains on both sides.

Road development continued under the Mogul Rulers. Special attention was paid by Sher Shah to the Grand Trunk Road from Agra to the Frontier. Though very few masonry bridges were built in that period, the technique of building boat bridges reached a high level of proficiency as even elephants could not only cross but, even at times, engage in combats on such bridges, a form of sport in which Jehangir is reported to have indulged.

On the occupation of the country by the British, road development began on a large scale, but roads were mostly constructed from the strategic and administrative points of view, little attention being paid to their civic or economic aspects. One of the most important projects undertaken at a cost of rupees fifty lakhs was the construction of the re-aligned Grand Trunk Road in 1848 from Lahore to Peshawar, a distance of 264 miles with 103 major bridges.

This development of roads had hardly begun when the Railways came upon the scene in the middle of the 19th century and for economic reasons the roads running parallel to them were given less attention while stress was laid on the development of feeder roads. The culmination of this lack of Central interest in the main roads was reached in the Government of India Act of 1919 which transferred "roads" to the provinces, the Central Government ceasing to concern itself with road development except for roads of military importance and certain arterial roads in Indian States. The Provincial Administrations in their turn in some provinces placed the greater part of their road milage in the charge of local bodies, taking direct responsibility for the maintenance and construction of only a strictly limited milage of main roads.

At about the time this devolution took place, however, there was a revolution in transport in India. The World War (I) had ended and surplus military vehicles were cheaply available for civilian use in large numbers. Motor transport developed and the roads began to deteriorate rapidly. Public opinion was roused and, in November 1927, the Government of India appointed the Jayakar Committee to advise on a road policy. This Committee recommended early in 1928 that the Central Government should assist the provinces in the development of roads and suggested the levy of an additional tax of two annas per gallon of petrol over and above the general revenue tax of six annas imposed on this fuel. The income from this additional tax of two annas was to be earmarked for road development. The present gross tax on petrol is now 15 annas out of which only 2½ annas, *i.e.*, 1/6th is made available for roads. The proceeds from this tax form the Central Road Fund.

The Committee also recommended the setting up of (1) a separate Road Department in the Central Government, (2) a Transport Advisory Committee consisting of representatives from the Central Government and the provinces, and (3) a Central Organisation for information and research. A Central Road Organisation was set up in 1930 and a Transport Advisory Council in 1935. On the recommendation of the Jayakar Committee also, a road conference first met in 1931 to discuss various technical matters.

THE INDIAN ROADS CONGRESS

When, however, in 1934, the Central Legislature adopted a resolution providing for the continuation of the Road Fund without any specified limit, the Central Government immediately convened an inaugural meeting of the Indian Roads Congress. Thus was this Congress founded and constituted to provide a forum for the regular pooling of experience and ideas of all matters affecting the construction and maintenance of roads, to recommend standard specifications, and to provide a platform for the expression of professional opinion on matters relating to Road Engineering, including such questions as those of organization and administration.

Beginning with a modest membership of 74 in 1934, the Congress has now no less than 1,250 members, representing Engineers of all ranks from Central, Provincial and State Governments, Military Engineering Services and Commercial interests.

Since 1934, the Congress has held 13 sessions in different parts of the country spreading from Roorkee in the North, Calcutta in the East, Jaipur in the West, and Trivandrum in the far South. The number of delegates has risen from 73 at Delhi in 1934 to 237 last year at Ranchi. No fewer than 141 technical Papers have been discussed, some of which attained a very high standard of merit, Besides discussion of technical Papers, works of engineering interest in each locality have been inspected during these meetings.

Since 1945, technical exhibitions containing models of road works and bridges, and displaying technical literature, engineering machinery, etc, have been organized at each session and have attracted keen interest, not only among Members of the Congress but also among outside visitors. Popular lectures are now also being arranged on topics of common interest and technical films bearing on Engineering subjects are being exhibited. In fact, our desire is to make each annual session as educative as possible, more particularly for the benefit of younger members of the profession. So far, 34 Council meetings have also been held to discuss road

problems. A large number of Committees and Subcommittees are always in being to deal with technical subjects.

The most outstanding contribution of the Indian Roads Congress to the science of Road Engineering in India is "The Standard Specifications and Code of Practice for Road Bridges in India," which has been accorded general acceptance throughout India. Previous to the drafting of this Code and its predecessor, there were no generally accepted bridge specifications of any kind in our country and for the design of each particular bridge, the Road Engineer had to start from scratch, assuming his own Highway loadings and making his own specifications for materials. The Bridge Code has yet to be finalized, (it exists in draft form at present) but it has already resulted in greatly improved designs and far reaching economies We shall be discussing, in Committee, Section III of the Code this Session. The final Code may take another three or four years before it is completed to cover all fields of bridge engineering but in the meantime we are making good use of the preliminary drafts.

Other technical Committees of the Congress have been carrying on admirable work in the matter of laying down standards for roads, studying the economics of highway types, defining the widths of pavements required for various intensities of traffic, fixing standards of road curves, horizontal and vertical, laying down roadrail level crossings, determination of maximum dimensions, weights, and speeds of motor vehicles in India as related to road standards, and laying down standards for road layouts, building-lines, control-lines and land widths. All these matters, Sir, are of great importance in the construction of new roads and the improvement of old ones and the deliberations of these committees will go a long way in making road travel cheaper, speedier, and safer in times to come.

For the economic construction and maintenance of roads, it is necessary to have some means of testing the traffic bearing capacity and life of the various types of road crusts under the traffic and other conditions prevailing in this country. For this purpose a Road Test Track was constructed at Calcutta in 1935 and a series of tests on the performance of various kinds of stones, surfaces, and road making materials have been carried out under the guidance of a subcommittee appointed by this Congress. These experiments have established certain principles which are sure to lead to considerable economy in design. The valuable results obtained have been published in the form of a Road Research Bulletin.

In view of the fact that the prewar number of bullock carts in India was 87 lakhs against 1.7 lakhs of motor vehicles, the former must continue to play a very important part in the transport system of India. It follows, therefore, that measures should be taken to improve the bullock cart wheel with a view to minimising the

damage it caused to roads. The Indian Roads Congress has, for a long time, been studying this question through one of its Subcommittees which was appointed first in 1943 and is now on the point of submitting its final report.

Soil mechanics should play a vital part in the construction and maintenance of roads. This aspect of road Engineering has been largely ignored in the past but now a new science is being developed in this matter. As long ago as 1937, at the instance of the Indian Roads Congress, the investigation of certain problems connected with the Punjab soils was started in the Punjab Irrigation Research Institute at Lahore. A Soil Research Subcommittee was appointed in 1938 to advice on soil research generally. Pioneer work in this direction was, however, being done by the Punjab P. W. D. in the private laboratory of an officer as a result of which, the Government of India, on the recommendation of the Soil Research Subcommittee, agreed to give Rs. one lakh for experimental work over 25 miles of road in the Punjab in 1944.

A regular Soil Laboratory was then established at Lahore along with three Mobile Field Laboratories mounted on trailers. A second length of 32 miles of stabilized soil road was constructed in 1946. A scheme for training selected officers and subordinates from various Branches was also begun in 1946 and 10 officers, 28 overseers, and two Research Assistants sent from all over India, were trained. Unfortunately, due to partition, the good work that was being carried on at Lahore was interrupted in August, 1947. The East Punjab P. W. D., however, showed remarkable energy and initiative in setting up a Soil Research Laboratory at Karnal soon after the partition. Besides continuing research on soils for construction of roads, experiments were undertaken to design suitable soil mixtures for constructing walls for buildings and rendering them waterproof.

These experiments proved so successful that 4,000 two-roomed houses have been built in the East Punjab in 1948 with stabilized soil walls without using any bricks in the superstructure. Had these specifications not been evolved, these houses could not have been built. This project of building 4,000 houses with stabilized soil walls is thought to be the largest of its kind in the world.

The Government of the East Punjab have now drawn up a fresh scheme of training engineer officers of our Provincial Governments and States at the Soil Research Laboratory at Karnal. With the help of officers previously trained at Lahore, the Governments of the Uttar Pradesh, Hyderabad, and Madras have also set up Soil Research Laboratories and other Provincial Governments intend to follow suit. The Soil Research Subcommittee has thus

done outstanding work towards the solution of the age-old problem of the cheap all-weather roads in India and in creating a general consciousness among the road Engineers of our country with regard to immense possibilities of the use of soil in economical highway and building construction.

The Indian Roads Congress has also been alive to the necessity for improving the technical education of Road Engineers in India. A Subcommittee appointed to study this problem at the Council meeting in March 1944 in Bombay came to the conclusion that instead of having a highway engineering course as a specialized subject in the civil engineering colleges, general civil engineering courses should ordinarily include some basic training in highway engineering though not in an intensified form, and specialized training to young engineers should be imparted by the various administrations employing them.

Regular studies should be secured by attaching engineers to various Research Institutions when these were set up and after the Central Road Research Institute was established. Regular lectures should be organized on highway engineering as a training ground for post-graduate students.

On the recommendation of this committee, the Government of India agreed to send abroad engineers in Government service for advanced study of current engineering practice and modern trends in countries with highly developed engineering faculties. Three delegations of road engineers have already been to the United States of America; the first delegation also visited the United Kingdom. The members of these delegations have created a very good impression of the capabilities of Indian engineers in the States they visited. The exhaustive studies in Road Engineering made by these delegates will, I am sure, be of great benefit in the planning, design, and construction not only of roads, but also of other engineering works.

On the recommendation of the Indian Roads Congress, the Government of India had agreed to set up, under the Council of Scientific and Industrial Research, a Road Research Planning and Advisory Committee. This Committee is considering plans to set up an Institute at Delhi at an early date. The requirements of the Institute in regard to staff, buildings, and laboratory equipment etc., have been worked out and steps are being taken to acquire land for the purpose. An Assistant Director to attend to the initial work required to establish the Road Research Institute was appointed in 1947.

Efforts are being made to recruit a scientist having vast experience of road research in foreign countries to work as

Director of the Institute, but no appointment has yet been made. This Congress regrets to note the very slow pace at which the setting up of this Institute is proceeding. It is hoped that the Council of Scientific and Industrial Research will expedite the setting up of this organization and that the present financial stringency will not come in its way.

Among the many other activities of the Congress, mention may be made of the work done on the bituminous treatment of wet aggregates, the study of achitectural treatment of highway layouts, and the steps taken to encourage the manufacture of road-making machinery in India. I should also mention that this Congressis publishing a magazine, the "TRANSPORT-COMMUNICATIONS MONTHLY REVIEW" containing original articles and abstracts from technical journals, which are informative anpof general interest both to officials and non-officials interested in roads and road transport.

THE NAGPUR PLAN

At the last Bombay Session in 1939, Sir Kenneth Mitchell, who was then our President, envisaged that after the war, large war arrears of road construction would have to be made good. He had roughly estimated that 50,000 miles of pucca metalled roads would be required. A few years later, when war clouds were lifting, while presiding over the Gwalior Session in 1943, he stressed the need for formulating a road plan for the whole of India.

Soon afterwards, at the suggestion of this Congress, the Government of India convened, in December 1943 at Nagpur, a conference of the Chief Engineers of Provinces and larger States to consider ways and means of planning comprehensively for the future road development of India. This conference, consisting of most of the experienced Highway Engineers of India, after serious deliberations, formulated a road plan now commonly known as the Nagpur Plan. This plan anticipated the needs of India for the first twenty years after the war, but hoped for completion of the programme of development in ten years.

It classified the roads into four categories—National Highways, Provincial Highways, District Roads, and Village Roads, and recommended the improvement and construction of roads making for a total milage of 1,47,000 miles of hard crust roads and 2,53,000 miles of earth roads as against the existing milage of 79,000 and 1,63,000 respectively. The total cost was estimated to be Rs. 450 crores (costs computed at 50 per cent above prewar figures) for the whole programme. This total cost also included construction of new bridges for Rs. 45 crores.

The Government of India and the Provincial Governments readily accepted this plan in principle and the people of the country hailed it with great satisfaction and began to look forward to speedy amelioration of road communications. In a message of good wishes to a session of the Council meeting of the Congress held in Lucknow on the 14th September 1944, Sir Edward Benthal, Transport Member of the Government of India, stated that "all authorities appear to be unanimous as regards the general priority which the development of communications should have in the scheme of post-war planning."

Highway Engineers zealously got busy to complete the projects and the detailed plans, and by the time the war ended in 1945, they were ready with their blue prints to start work, just at the word "go." Some road works were authorized to be undertaken in 1946–47 as anti-slump measures and more particularly to provide work for demobilized soldiers. Work on the proper post-war programme was, however, to begin from April, 1947.

Soon after, came the partition of India into two Dominions which dislocated all transport and the various organizations concerned with the procurement of road materials. Works for which funds had been provided in the budget for 1947–48 could not be proceeded with according to programme inspite of the best efforts of the Highway Engineers. By the middle of the year 1948, the difficulties of transport by rail and road and procurement of materials had eased a little and the Engineering personnel had settled down to work but in the month of September a bomb-shell fell on their zeal. The Government of India intimated to the Provincial Governments of the great impending financial stringency and asked them to slow down the pace of their development work in all spheres.

At the Centre, large cuts were indicated in the funds for construction, improvement, and repairs of National Highways. As has always happened in the past, the heaviest blow of the axe of retrenchment fell on the funds for civil works in each province and more specially on works of road communications. All post-war development works in the provinces were being carried out on the basis of obtaining equal grants from the Centre, but the latter were reduced to very low figures for the years 1948–49 and 1949–50 and have been reduced almost to nothing for future years.

My predecessor at Ranchi referred to the disappointment of Highway Engineers at this reduction of allotments, but had hoped that this would be a passing phase. The disappointment has, however, now turned into a sense of frustration. Most of the road

works in the provinces have either been suspended altogether or their rate of progress miserably slowed down. No new road works are being taken up at all.

Gentlemen, as you are aware, road projects take time to get going. The stages of surveying, designing, and estimating require much effort but, once works are started they gain momentum which, if interrupted, throws everything out of gear. Our road schemes have recently suffered a terrible setback which will not only affect the development of communications in the country but also retard its economic progress.

Let us, at this stage, examine the target of our road programme and the up-to-date achievements. I have said the Nagpur target was to build and improve 68,000 miles of hard crust road and 90,000 miles of earth road. In this period of three years commencing from April 1947, we have not completed one hundredth part of our target and our expenditure has been in proportion, allowing for present date costs of labour and materials. The disappointment that this slow progress of work on the road plan has caused in the country may be judged from the following extract from a speech delivered at Bombay on the 6th October 1949 by Mr. Manackji N. Dalal, President of the Indian Roads and Transport Development Association—a non-official body which has, for the last twenty-three years, been advocating the cause of roads :—

> "To have a paper plan like the Nagpur Plan does not serve our requirements. It is only by the translation of the plan into actual roads that the country can benefit. The present five-year plan is mostly confined to bridging, construction of small missing links in the road system, and generally arresting in parts the deterioration of roads caused by previous neglect combined with wartime increase of military traffic. Additions proposed to the existing milage at present are insignificant. It is in the remaining parts of the Nagpur Plan that the actual expansion of the road system is to materialize.
>
> Every time road development has been contemplated, unexpected difficulties have cropped up in the financing of the Plan. Finance is the rock on which previous road programmes have foundered and it has already affected nearly a third of the five-year target. It is essential, if history is not to repeat itself, that financing of roads should be placed on a firm and satisfactory basis."

ROAD FINANCE

It has been constantly stressed by this Congress that development of road communications should have priority among the socia

services because it is not humanly possible without roads to bring to the villagers who make up 85 per cent of our population the benefits that should follow the activities of our education and health services. Nor can we hope to give the cultivator a real incentive to produce more unless he can carry his produce cheaply to the markets. The industrialist also cannot develop his industries if his main market, the villages, are shut off from the producing centres by the lack of roads.

If we are to improve our standard of living to the extent that would enable us to attain a position in the world commensurate with our size and population, provision of facilities for the free movement of the villager is the first necessity; only then will he extend his mental as well as his economic horizon.

Sir, we are not oblivious of the great economic crisis through which we are now passing. Our greatest problem is the shortage of food, a good portion of which we have to import. Our Government has set the target of self-sufficiency in this respect by 1951 and all our energies and resources are at present devoted to the "Grow More Food" campaign,

But, again to quote Mr. Dalal, "The good earth can yield food and industrial raw materials wherever means of access to the land and facilities for movement of men and materials are in existence, but **no economic activity is possible if such facilities are absent.** The primary means of transport is, everywhere, the road and it is only when every acre of fallow and uncultivated land in the country has a road to serve it that we shall be able to induce our cultivators to put it under the plough."

I can only plead that to make the 'Grow More Food' campaign a real success, it must be coupled with a "**Build More All-Weather Roads**" campaign. I would suggest that good planning would provide that an appreciable share of the large funds that are now being allotted for 'Grow More Food' should be deflected towards development of road communications in food producing areas.

The problem of financing road development has been solved in other countries and it is not beyond solution in India. The Chief Engineers, when they evolved the Nagpur Plan, gave much thought to how their road development programme was to be financed. They claimed they had not planned a 'Utopia' but a rational and feasible plan based on what should be spent on roads if India was to be provided with reasonable transport facilities and the capacity of the country to pay for those facilities.

They claimed that roads in India would ultimately pay for themselves just as roads in the U. K., the U. S. A. and many other

countries have paid for themselves. During the year 1948–49, the revenue from the various kinds of taxation on motor vehicles alone was as follows:—

		Lacs.
Provincial motor vehicle tax	...	Rs. 341
Provincial motor vehicle fees	...	78
Customs revenue from motor spirit	...	967
Excise revenue from motor spirit	...	133
Import tax on motor vehicles and spare parts	...	806
Provincial Sale Tax on motor spirit	...	269
Excise duty on motor tyres and tubes	...	199
Total	...	2,793

Say Rs. 28 crores

The total number of motor vehicles of all sorts on the roads in March, 1949 were only 266,429. Thus the incidence of taxation per motor vehicle comes to about a thousand rupees per year, probably the highest in the world.

Taking the capital invested in the existing 65,000 miles of metalled roads and 114,000 miles of unmetalled roads at Rs. 20,000 and Rs. 5,000 per mile respectively, including all bridges, the total capital cost of the roads would be about Rs. 185 crores and, treating the roads in the same way as the railways have been treated, the contribution which road transport should make to general revenues would be 4 per cent of Rs. 185 crores or Rs. 7·5 crores This would leave 28 minus 7·5 or 20·5 crores minus, say one crore (covered by fees) for collection and administration or say 19·5 crores for expenditure on roads from the funds obtained by the taxation of the motor vehicle user alone.

This does not take into account the receipts due from the other users of road, *viz.*, bullock carts, bicycles, and horse vehicles, etc., who hardly pay any direct taxes.

That there are, in addition, indirect receipts is shown by the well-known pilot survey conducted in 1943 by the Indian Roads and Transport Development Association which proved how the construction of new roads would so assist in reducing transport costs, in increasing agricultural output, and changing over cultivation to money crops, including fruits and vegetables, that for every Rs. 100 spent annually on road construction and maintenance, the community would benefit by an increased annual income of Rs. 277.

Against all these receipts, direct and indirect, what are the Centre and the Provinces spending on roads? This year the

Centre, who take by far the greater portion of the receipts, are spending only about Rs. 6 crores. The Provinces and the Centre combined are spending about 3 per cent of their total revenues on roads as against about 9 per cent in most of the Commonwealth countries and the U. S. A.

Why does our National Government lag behind the governments of other countries in this matter? Do we need roads less in India than do the Commonwealth countries? Or are our Governments not convinced that roads will bring prosperity to the cultivators, to our industries, and to our country as a whole, prosperity which our leaders so much desire?

WAYS AND MEANS

It has been suggested by a business association in the press that one method of financing the construction of roads and bridges would be to encourage private companies to undertake their development by granting of monopolies and concessions for running transport on the roads constructed by them. It was long ago said that one of the primary duties of a Government was to provide communications and it would not reflect well on any Government that left this duty to be undertaken by others. However, the suggestion indicates that some business people are quite convinced that roads will more than pay for themselves if developed properly.

Would it not be possible to treat our roads as Government treats the railways and expect them to pay only 4 per cent on the capital invested in them (excluding the strategic roads) towards general revenues? If this were done there would be sufficient funds with the existing taxation to maintain the roads properly and provide for their development if only on a small scale.

As I have stated earlier, users of roads other than owners of motor vehicles hardly pay any taxes. It is but appropriate that all of them should take their share of the burden of the expenditure on construction and maintenance of roads. It would be difficult to realise any direct tax from rural owners of bullock carts and those who benefit from the use of roads as means of access to their houses and lands but it would be quite easy to levy a cess on all land revenue and earmark it exclusively for the construction of all-weather village roads.

The total annual land revenue in the Indian Dominion excluding the States is 25 crores. If a road cess of two annas per rupee were levied, it would give us about three crores annually. The total cost of village roads under the Nagpur Plan is about 50 crores. It should be possible to construct these village roads out of the road cess in a period of about 15 to 20 years.

In due course much revenue could be obtained from betterment in land value arising from the construction of roads. At present, in this province of Bombay, road-side values of land have increased in some places ten to twelve-fold since before the war. This increase in values, largely arising from the expenditure of public monies, is going at present into private pockets.

In pursuance of one of the recommendations of the Nagpur Conference, the Government of India appointed, in December 1945, the Road Lands Enquiry Committee, one of the terms of reference of which was to examine the possibility of diverting to the public the betterment values of land arising from the public improvement of roads. This Committee recommended the levying of betterment charges on the value of land so appreciated at rates varying from 50 per cent to 75 per cent of the increased values. No decision has yet been taken in this matter by Government as the Draft Highway Bill in which provision has been made for this levy has not been enacted. In my opinion the levying of betterment rates on road side lands is an essential requirement, especially in built-up areas. The receipts from this levy should be earmarked for expenditure on roads.

There are plenty of ways in which road development and therefore the development of the country could be financed if there were only the desire and the will to foster this development. Other countries have found ways and means to finance their roads and this Congress would urge our National Government to take its proper place in the world in this as it is doing in other respects.

Gentlemen, I have ventured to put forward a few suggestions to bring the Nagpur Plan into the sphere of realities. Its total cost at present rates would be about 700 crores of rupees. If the plan is completed in 20 years instead of the ten originally hoped for, about 35 crores of rupees would be required per year. Adding maintenance costs of existing roads at about Rs. 10 crores per year, a sum of Rs. 45 crores would be needed annually. It should not be difficult to find funds to attain this objective by the adoption of some of the suggestions outlined above and by taking loans funded on the ever growing road revenues, if there is only the will to do so.

THE ROAD BOARD

This brings me, Sir, to our oft-repeated demand for an independent Road Board. We believe that without the creation of such a Board, it would be impossible to push any road plan to completion. The Chief Engineers when formulating the Nagpur Plan were acutely aware of the need for drive and co-ordination if planning were to be effective and organized and their unanimous

view was that some whole-time impartial and independent authority was required to proceed with the work of co-ordinating planning and, above all, be responsible for effective progress of the plan.

A powerful and independent Road Board should be able to smooth out the present difficulties between the Provinces and Centre and, in conjunction with other authorities including the Railway Board, it should be able to co-ordinate for the best use of the country, communications by land, water, and air. This Board could also effectively deal with the problem of financing the road plan and advise the Centre and Provinces on business lines. Our Government have been gracious in accepting most of the recommendations made at the Nagpur Conference, but the formation of the kind of Board we advised is still pending.

On behalf of this Congress I would again urge the Union and State Governments to create this Road Board. We feel that without the formation of such a Board, it will be difficult to make tangible progress in road development. Had this Board been constituted earlier and adequate funds earmarked for the roads placed at its disposal, we would not have been reduced to the present state of inactivity and frustration nor would there have been the present lack of incentives to the cultivators to grow more food. A very large percentage of food prices, as indeed of the prices of all articles, is covered by expensive transport.

NON-LAPSING FUNDS

Our demand for the non-lapsing funds has been repeated from this platform year after year. The present fluctuations in grants with every budget and the uncertainty regarding the provision for the coming year prevent us from planning our road construction as it should be planned. Our Road Fund is non-lapsing. thanks to the foresight of the Jayakar Committee, and the tangible results obtained from this Fund are something of which we can be proud. But the Road Fund does not represent 10 per cent of the expenditure on roads and for the other 90 per cent we must live from hand to mouth, never being in a position to organize our works properly.

In the United States, a firm budget allotment is given for roads two years in advance and the money thus allotted does not lapse for another three years. The engineers get sufficient time to prepare proper detailed estimates, assign priority to works and arrange for men, materials, and machinery. Thus funds, which are provided in 1949 for works to be undertaken in 1951, do not lapse till 1954. Considering the actual duration of most of the works from a year to three years, the engineers actually get about five years to spend their allotments.

The system prevalent here on the other hand is most wasteful when funds for a work in progress during one year are not allotted next year and the materials collected have to lie unused until 'the financial god' chooses to favour a particular work. Our Governments in India have financial difficulties, but may these not be in part at least, due to the fact that our Finance Departments are not moving with the times in the modern world but trying to apply procedures of administration of the Country's finances long discarded in the advanced countries?

Our critics may say that we engineers should stick to our task of building roads and leave the question of finances to those who understand finance. Yet it was not till engineers in other countries busied themselves with the question of financing their works that it was possible for real progress in engineering to be made. At this Session we are reading Papers on engineering works in progress but if we are starved of funds much of the value of these Papers will be lost.

FRONTIER ROADS

I would now refer, Sir, to the problem of roads in our frontier provinces of East Punjab, West Bengal, and Assam. These provinces have been partitioned and, as they are adjacent to Pakistan, complicated problems have arisen regarding roads on their borders. The East Punjab has been particularly affected on account of the Kashmir operations. Its existing roads have had to bear the brunt of heavy military traffic which, because of careful maintenance, they have so far done without appreciable deterioration even although they had carried not long previously unprecedented traffic consisting of caravans of refugees, traffic of an intensity which could never have been anticipated by the designers.

Very meagre funds are, however, being allotted for National Highway improvement in the Punjab and the time is approaching when these roads, however carefully maintained, will not stand up to the military and other traffic coming on them unless their specification is improved.

I would, therefore, strongly urge that funds for completing our border roads should be found either from the defence budget or from that of the National Highways so that the province is not found wanting in facilities of communications for military transport should a necessity arise. Moreover, Gentlemen, as the East Punjab is a province of slender resources, it is not in a position to undertake any portion of the Post-War Road Development Programme from its own revenues.

The problem of road communications in West Bengal is altogether peculiar. The border roads of the partitioned province, designed to feed the then existing railway and inland navigation transport systems, come up to the newly created Pakistan boundary and stop there as far as India is concerned. Every such road has thus become a *cul-de-sac*. Many roads in this border region have part of their lengths running in Pakistan territory. A certain bridge essential for communications in West Bengal is now situated in Pakistan.

This province, which was already suffering from a scarcity of good communications, has now practically lost what little it had. A Technical Committee was appointed by the Government of India for the investigation and solution of this problem and in partial acceptance of the recommendations of this Committee, the Central Government has sanctioned a sum of Rs. 40 lakhs for some of these roads. This amount will be augmented by the province from its provincial resources but the main problem still awaits solution.

The border road problems of Assam are complicated by the existence of vast tribal areas in that Province which borders not only on Pakistan but also on Burma and China. There are thus many border road problems of this province awaiting solution.

ROAD TRANSPORT

The principle of Nationalization of Transport in India has now been accepted in most of the provinces. It is also accepted that there should be complete co-ordination between the agency responsible for the selection and running of motor vehicles and the one entrusted with the task of construction and maintenance of the track on which the vehicles will run, so that among other things, the improvement in types of motor vehicles used should be in complete harmony with the development of roads and bridges.

This complete co-ordination is, however, only possible if the administration of the two is under one authority, in much the same way as the running of railway trains and the maintenance of the railway track is controlled by the same agency. It would then be possible to utilise the earnings from the Nationalization of Transport towards construction of roads in rural areas and the State would then, to a very large extent, be relieved of the heavy responsibility for road development in non-urban areas, which, under present financial conditions, appears a most formidable task.

It is already one of the recommendations of the Nagpur Conference that a Highway Department should be formed in each province for giving whole-time attention to the planning and

construction of roads and it is but appropriate that the transport problems, which are technically closely allied to those of roads, should be dealt with by the Highway Department. I hold that Highway Engineers can deal with Transport problems in a more efficient manner than non-technical staff.

Moreover, it is essential that the head of the Highway Department should also be a Secretary to the Government so that he may be closely associated with the Minister and be able to advise on the formulation of policies at first hand instead of through a third party.

A NEW ERA

Gentlemen, we stand now on the threshold of a new era. Ten days hence our country will be declared a free Republic and it is for us to prove ourselves its worthy citizens. A high responsibility will devolve on us, Highway Engineers, to lead the country to prosperity through the development of road communications on a planned, scientific basis, exercising the utmost economy and keeping always in view our slender financial resoures—all this without lowering the technical standards required to make the roads fit for the traffic they are intended to carry. We also must devote much more attention to the development of rural roads than we have done in the past.

We have to develop a more scientific outlook and lay greater emphasis on research as in this way alone will we be able to improve our methods of road construction and maintenance as required by the conditions of our traffic, our soil, our climate, and alas, our finances. We shall need all our skill, honesty of purpose, and conscientious hard work, for the service of our country. This surely is an unprecedented opportunity which has luckily come our way. May we prove ourselves worthy.

Sir, I am afraid I have over-taxed your patience with this rather long discourse. Please bear with me a minute or two longer while I summarize the main points I have touched on. First of all I have laid emphasis on the urgent need for completing the Nagpur Plan, and of finding funds for this Plan by reserving a larger share for roads than at present of the proceeds of all taxes on the motor vehicle user. I have suggested several ways of obtaining revenue for roads, by levying a road cess on land revenue, by realizing betterment values from road side lands, and by ploughing back into the roads some of the profits made by State-owned transport.

It has also been suggested by me that the 'Grow More Food' campaign should be coupled with a 'Build More All-weather Roads' campaign and that a portion of the funds reserved for

'Grow More Food' should be diverted towards building roads in rural areas. I have emphasized that the early formation of a Road Board is a necessity and have pleaded for the institution of non-lapsing funds.

I have also referred to the necessity of road research and the importance of the development of rural roads, and finally I have recommended that the Highway Chief Engineers should be Secretaries to Government in all the Provinces and that the Transport Department should also be placed under them. These, Sir, are the general views of the Indian Roads Congress, a body I am proud to represent.

I thank all of you for gracing this occasion with your presence and listening to my address and I would now request you, Sir, the Hon'ble Premier, to inaugurate this, the 14th Session of the Indian Roads Congress.

INAUGURAL ADDRESS

In declaring the Session open the Hon'ble Shri B. G. KHER said:

Mr. President and Gentlemen,

It gives me immense pleasure to be in the midst of Road Engineers from all over India when I rise to inaugurate this, the Fourteenth Session of the Indian Roads Congress. I consider this a great privilege, as it gives me an opportunity to meet a body of experts who have taken upon themselves the task of devising ways and means for the development of road communications in the Country on scientific lines. I am aware that the Indian Roads Congress by their advice, practical work and technical guidance are doing a great service to the country.

I am glad that the Congress accepted the invitation of the Bombay Government to hold this session here and I extend to you on their behalf a hearty welcome to this premier City of India. Bombay is the birth-place of many important events in the annals of this Country and I am sure that the active and electrified atmosphere of this place will be a source of healthy inspiration to the Congress.

After independence, the formidable task of developing our Country has fallen on the shoulders of our Countrymen. Government is eager to have an all round development in the various phases of the Country's life so that better standards of life are obtained and self-sufficiency is created in this vast Continent of ours. The successful achievement of this multifarious development mainly depends upon the hard work, active co-operation, sincerity of effort and technical skill on the part of every one concerned. Your President has rightly pointed out that in every field of development, an engineer has to play a prominent part.

The primary needs of mankind are food, shelter, clothing and communications. It should be the first aim of any free country to make these easily, freely and cheaply available to one and all. As this body of yours is mainly concerned with the item of communications I shall enumerate their vital necessity to this country. As regards communications, I envisage a great necessity for fourfold development, viz., (i) Roads (ii) Railways (iii) Waterways and (iv) Airways. Roads amongst these require the foremost attention of the Country.

On India's national emblem there is a wheel. I am sure you as Road Engineers must be considering this wheel as inseparable from ideals of speed and facilities of movement. Both these demand good roads. It is well known to every one that 90 per cent

of our population lives in villages. These villages in most cases have not got decent access to towns and cities where they can sell their produce and buy their daily needs. During the monsoon, many of them get entirely cut off and it becomes immensely difficult to provide them with necessities of life and medical relief in case of epidemics. These villages become islands of isolation, where necessary articles cannot be conveyed. It has been rightly said "Out of all inventions, those which bridge distances have done most for civilization". In the chain of civilization, production, distribution and exchange, communications provide an essential link. They fulfil in the economy of the nation, the same function as arteries and veins in the human body. If the resources of a country are unknown and undeveloped, if the abundance of nature in one area is often accompanied by the visitation of famine in another, if societies are isolated, educational facilities limited, health services, elementary education, trade and commerce restricted, it is mainly because proper lines of communications are not in existence. Progress has no meaning if the necessities and amenities of good life are denied to the poorest villager. I would request your special attention to the development of rural roads and their proper linking with the major system of roads.

The second point of vital importance which I want to place before you is the urgent need of evolving cheap and economical methods of road construction. We have to construct a huge mileage of new roads. You are aware that our financial position is not so sound. We have therefore a problem before us to construct maximum mileage of roads at minimum cost. I specially appeal to you that as experts in road engineering you must evolve new formulae for economical and cheaper construction in different regions according to the availability of local materials and to suit local conditions of traffic. I have no doubt that the Indian Roads Congress is paying special attention to this problem and would successfully tackle it.

The third point which I would like to stress is the development of the roadside arboriculture. There is a considerable necessity of planting as many trees as possible in this country and you will agree with me that roadside berms are ideally suitable for avenues of shady and fruit bearing trees.

The Bombay Province has accepted the recommendation of the Nagpur Conference and I understand it is proposed to provide—

Major Roads	...	13,265 miles
Minor Roads	...	17,618 ,,

Against this mileage, the Bombay Government has already programmed to undertake during first five years the construction of 270 road works covering 45 major bridges and 1,803 miles of roads. Several important works have also been started under the Provincial Road Fund and Central Road Fund. I must say that much more remains to be done but financial limitation cannot permit that at present. We have already got the Board of Communications in this Province and the advice of that body has been found to be of great value.

I think I should not take any more of your time, but before I close I must thank you, Mr. President, and delegates, who have taken the trouble of coming to this Congress at great personal inconvenience and crave your indulgence for the shortcomings that you must be experiencing in the arrangements made here for you. I earnestly wish that you enjoy your stay in Bombay.

It is with much pleasnre that I declare the Fourteenth Session of the Indian Roads Congress open and wish it a grand success.

President's Concluding Remarks.

I thank you, Sir, on behalf of the Indian Roads Congress for your kind welcome and for your wise words of encouragement and advice. I assure you, Sir, that the Congress, as a body, will make every effort, as it has been doing in the past, to develop rural communications by evolving economic specifications. The General Body of Members are, I am certain, keenly aware of the need for economy in every sphere of their professional activities.

Sir, you have expressed the need for developing arboriculture along our roads. The plantation of avenues of trees has always been a part of our road construction and maintenance and we are not likely to forget this amenity which affords shade to travellers and beautifies the countryside and will, ultimately, provide some of our much needed fuel.

On our part, Sir, we hope that even in the present time of acute shortage of funds, the Governments in India will not forget the value of roads as a means of improving the economic development of the country.

Now I must ask you, Sir, to present the Mitchell Medal and the Indian Roads Congress Medal to two of our Members for Papers they have written—

The Mitchell Medal, to Shri G. Srirangachary, for his Paper No. 135 on "Low Cost Roads in India and the use of Soil Science for their improvement,"

The Indian Roads Congress Medal to Dr. R. K. N. Iyengar for his Paper No. 120 on "Well Foundations of the Kalabagh Bridge over the Indus";

I have also pleasure in announcing that Shri D. G. Bhagat and Shri Jagdish Bahadur, the Authors of Paper No. 141 on "Fundamentals of Highway Needs and Highway Peanning", have been considered worthy of honourable mention.

MESSAGE FROM

The Hon'ble Shri K. Santhanam, Minister of State for Transport and Railways, Government of India.

This year I feel a greater hesitation in sending my message to the Indian Roads Congress than I did last year. It is not easy for a layman to advise experts on their job, nor do I think it useful to utter conventional claptrap.

The Indian Roads Congress meets this year under the shadow of the severe campaign of economy which has been necessitated for the restoration of the health of the national economy and finance. I humbly suggest that the main problem to be considered by the Congress is how to ensure that the beneficent work of road building can proceed in spite of this campaign.

During my recent tour of Rajasthan, I realised more than ever that without more roads, especially roads linking the villages with the towns and the main roads, no progress is possible in any other economic sphere. I would like the Engineers gathered from all parts of India to consider whether it would not be worth while to stop for a year or two further expansion of metal roads and concentrate national activity in the building of rural communications I would also like them to consider whether in this effort they may not try some unconventional methods such as making a deal with the village population so that the latter may provide labour free of charge while the Highways Department provide the technical and mechanical assistance.

I am coming to feel more and more that the insistence on adherence to the conventional methods would not permit expansion at a rate which will have a demonstrable effect on the people. The rising tide of popular impatience at the slow pace of economic transformation is among the greatest dangers which the new Indian Republic will have to face. If Road Engineers can manage to build at least 10,000 miles of village roads in the next few years with the means available, they will be rendering an invaluable service in the cause of orderly and peaceful political evolution of India.

Message From His Excellency Shri Jamshed Vesugar, Ambassador of India to the Republic of Argentina.

The Fourteenth Annual Session of the Indian Roads Congress is being held appropriately in Bombay, the most modern city in India, and the one most rapidly expanding in population, com-

merce, industry and ideas. Geographical limitations have hampered the growth that the dynamic spirit of Bombay demands, but geography can be conquered by communications; and I hope road engineers will in the very near future provide unimpeded access to India's gateway.

The year 1950 is a momentous year in the history of India, more momentous than the year of Vikramaditya or the year of Lord Buddha. India has attained a great freedom, and is now on the threshold of attainment of other freedoms—freedom from hunger, freedom from ignorance, freedom from want. In a land of almost a million villages, the key to these freedoms is free communication. Only when the road and the motor bus reaches every village, when every hut has two bicycles, will the people be able to shed the shackles of the village. To the road makers and path makers of India—I say—dedicate yourselves to widening the horizons of the villages of India.

Message from Sir Kenneth Mitchell.

May your Fourteenth Session be outstandingly successful, and please remember me to my many old friends.

Message from Shri Jivraj N. Mehta.

I wish every success to the Congress.

Message from Shri G. A. D. Cochrane.

My best wishes for successful Session. One of the roads to prosperity is better roads and more of them.

Message from Shri P. M. Otway.

You have my best wishes for a very successful and enlightening Congress.

Message from Shri I. A. T. Shannon.

Best wishes for a very successful Fourteenth Congress.

Message from Shri C. G. Kale.

I wish the Congress a successful Session in Bombay.

Minutes of the 34th Council Meeting of the INDIAN ROADS CONGRESS held at Bombay on the 14th January, 1950.

Present:

Brijmohan Lal—President.

F.P. Antia	S.B. Joshi
M.L. Bahl	K.M. Kantawala
H.S. Batliwala	G.M. McKelvie
R.K. Batra	T. Mitra
Bhagwat Prasad	N.V.S. Murti
M.N. Bhuyan	E.A. Nadirshah
M.S. Bisht	Partap Narain, Brigadier
S.N. Chakravarti	B.S. Puri
C.J. Fielder	Romesh Chandra
S.K. Ghosh	B.N. Shenoy
W.A. Griffiths	C.P. Subbiah

H. Sundar Rao—Secretary

The following co-opted Members also attended:

K.G. Bhate — S.R. Mehra
H.P. Mathrani — K.S. Raghavachary
V.N. Rangaswami

The following attended by invitation:

N.V. Modak — N.C. Patel
B.V. Vagh

1. Confirmation of the Minutes of the 33rd Council Meeting.

The Minutes of the 33rd Council meeting held at Ranchi on the 7th February 1949 as published at pages 68 to 75 of Volume XIII-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 Executive Committee Meetings held at New Delhi on the 20th May, 1st August and the 26th December 1949 were approved.

3. (i) Audit Report for the year 1948-49.

The report of the Auditors on the accounts for the year 1948-49, was recorded.

(ii) **Draft Report of the Council to the General Body of Members for the period 1st January to the 31st December 1949.**

The draft report was approved.

4. Discontinuance of the Prize Essay Competition.

The Council accepted the recommendation of the Executive Committee to discontinue the Prize Essay Competition.

5. Budget.

The budget estimate for 1949–50 was approved. The Council noted the response received from some of the Provincial Governments to the appeal issued for increased contributions. They considered it very desirable that Provincial Governments should agree to contribute to the Indian Roads Congress on the basis of two hundredth part of their share from the Central Road Fund.

6. Amendments to the Memorandum of Association, Rules, Regulations and Bye-laws.

The draft revised Memorandum of Association, Rules, Regulations and Byelaws were considered and approved with a few modifications. The approved Memorandum of Association, Rules, Regulations and Byelaws are given in Appendix. The Treasurer was authorized to finalize the Accounting Procedure as deemed necessary.*

The Council issued revised instructions regarding interpretation of the expression "qualified engineers" occuring in rule 5-b of the Memorandum of Association, Rules, Regulations and Byelaws and noted the accepted convention relating to the preparation of the draft presidential address each year.

*Byelaws will be printed separately at a later date when the accounting procedure has been finalized.

APPENDIX.

I. MEMORANDUM OF ASSOCIATION

OF THE

INDIAN ROADS CONGRESS

1. **Name** — The name of the Society shall be "The Indian Roads Congress".

2. **Objects** — The objects of the Society shall be:—

a. to promote and encourage the science and practice of the building and maintenance of roads:

b. to provide a channel for the expression of the collective opinion of its members on matters affecting roads;

c. to promote the use of standard specifications and to propose specifications;

d. to advise regarding education, experiment, and research connected with roads;

e. to hold periodical meetings to discuss technical questions regarding roads;

f. to suggest legislation for the development and improvement of roads;

g. to suggest improved methods of administration, planning, design, construction, operation, use and maintenance of roads;

h. to establish, furnish, and maintain libraries and museums for furthering the science of road making;

i. to publish, or arrange for the publication of proceedings, journals, periodicals, and other literature, for the promotion of the objects of the Society;

j. to accept subscriptions, subsidies, donations, endowments, and gifts in furtherance of the objects of the Society;

k. to invest and deal with the funds of the Society or entrusted to the Society, to acquire and hold any movable or immovable property, and to borrow or raise money for the furtherance of the objects of the Society and to sell, lease, exchange, or otherwise deal with the same;

l. to grant pay, prizes, honoraria, or scholarships (including travelling scholarships) for meritorious work in furtherance of the objects of the Society;

m. to do all such other lawful things as may be incidental or conducive to the attainment of the above objects.

3. **Income and property** — The income and property of the Society, whensoever and howsoever derived, shall be applied solely towards the promotion of the objects of the Society as herein set forth and no portion thereof shall be paid or transferred or distributed, directly or indirectly, by way of dividend, bonus, interest, or otherwise howsoever, by way of profit to the members of the Society; Provided that this shall not prevent the payment in good faith of remuneration to any officer or servant of the Society or other persons in return for services rendered.

4. **Governing Body** — The Governing body of the Society shall be the Council as constituted by the Rules and Regulations of the Society.

II. RULES AND REGULATIONS

MEMBERSHIP

5. The Society shall consist of :—

a. **Patron and Vice-Patrons:**

Such persons as accept the invitation of the Council to be a **Patron or Vice-Patrons** of the Society from time to time: provided that there shall never be more than one patron and six vice-patrons at any one time.

b. **Ordinary Members** :

Such qualified engineers* who are or have been connected with Roads†, and such other persons being scientists of eminence in, or being engaged in a responsible capacity in, the sciences allied to road construction and maintenance, as may be elected ordinary members of the Society by the Council.

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* The expression "qualified Engineers" shall for the purposes of this Rule be deemed to include :—

(i) Corporate Members of the Institution of Engineers (India).

(ii) Persons holding such qualifications as are acceptable by the Institution of Engineers (India) for election to Corporate Membership.

(iii) Any person who shall, in the opinion of the Council, by reason of academic qualification or long practice in engineering or otherwise be sufficiently qualified in engineering to bring him within the said expression.

† The expression "connected with Roads" shall, for the purpose of this Rule, be deemed to include, being or having been :—

(i) connected with the construction and maintenance of roads, or

(ii) engaged (whether in public employ or in business or otherwise) in connection with roads or materials used in connection with roads or the use of roads or in writing about the same or otherwise connected with roads to an extent, in the opinion of the Council, sufficient to bring a person within the said expression.

c **Associate Members:**

(i) Such persons, who, while not eligible to be ordinary members, are or have been, in the opinion of the Council, engaged in the administration of roads or road transport or so engaged in business connected with the construction and maintenance of roads or with the manufacture or sale of material used in connection with the making or repairing of roads or of road transport vehicles, or the operation thereof, as may be elected associate members of the Society by the Council; and

(ii) Such Institutions, Government Departments, Public Bodies, or Firms who have been, in the opinion of the Council, engaged in the administration of roads or road transport or so engaged in business or work connected with the construction and maintenance of roads or with the manufacture or sale of material used in connection with the making or repairing of road transport vehicles, or the operation thereof, as may be elected associate members of the Society by the Council. Each such body shall be represented at any time by only one nominee approved by the Council.

d. **Honorary Members:**

Such persons who on account of their being in the opinion of the Council sufficiently distinguished or interested in roads as may be elected honorary members of the Society by the Council. Honorary members shall at no time exceed 25 in number.

6. **Entrance fee:** An entrance fee shall be payable by members on election on the following scale :—

		Rs.
Patron, Vice-Patrons and Honorary Members.	...	Nil.
Ordinary Members.	...	25
Associate Members.	...	120

7. **Subscription:**

a. A yearly subscription shall be payable by members on the following scale :—

		Rs.
Patron, Vice-Patrons and Honorary Members.	...	Nil.
Ordinary Members.	...	25
Associate Members.	...	120

Provided that a rebate of Rs 5 in case of ordinary members and Rs. 20

in the case of associate members may be claimed if the subscriptions are paid within three months of the due date.

b. Ordinary members whose subscriptions are not in arrears may compound their future annual subscriptions by a single payment depending upon their age at the time in accordance with the age table below. Age shall be reckoned as that on the birthday nearest first October of the year of commuting annual subscriptions.

Associate members of at least 5 years standing elected under Rule 5-c(i) on attaining the age of 55 years may, on their retirement from their profession, be permitted by the Council to compound for life by a single payment, according to the table for ordinary members.

Age Table for Compounding for Life Membership.

Age	Compounding Fee	Age	Compounding Fee	Age	Compounding Fee
25	397	36	307	47	180
26	391	37	296	48	167
27	383	38	287	49	153
28	376	39	276	50	139
29	368	40	264	51	124
30	360	41	253	52	109
31	352	42	243	53	93
32	343	43	231	54	77
33	335	44	219	55	60
34	325	45	207	56 and over	40
35	316	46	193		

c. A year shall, for the purposes of this Rule, be from the first day of October until the last day of September following. Subscription shall be due on election and thereafter on the first day of October of every year following that while a person continues to be a member of the

8. **Cessation of Membership:**

a. Any member who has not paid his subscription due within two years of the due date shall automatically cease to be a member.

b. The Council shall have power to cancel the membership of any member of the Society who shall be deemed to have been guilty of any conduct prejudicial to the Society or rendering him unfit to remain a member thereof; Provided that at least two-thirds of the members of the Council present in person shall be in favour of such action and; Provided further that before any decision is taken, the member in question shall be afforded an opportunity to state his case in person or writing.

c. A member may resign from his membership of the Society by notice in writing to the Secretary to that effect provided he is not in arrears with his subscriptions for more than one month and that no such resignation shall be valid until the member resigning receives an acceptance of his re-ignation in writing from the Secretary.

GOVERNING BODY

9. The Society shall be controlled by and the management of its affairs shall be entrusted to a Council constituted as follows:—

a. A representative of each participating * unit of administration, to be nominated by the Government of the administration concerned from among the ordinary members of the Society.

b. A representative to be nominated by the Engineer-in-Chief, Army Headquarters, India, from among the ordinary or associate members of the Society.

c. A representative of the Central Public Works Department of the Government of India to be nominated by the Chief Engineer of that Department from among the ordinary members of the Society.

d. The Consulting Engineer to the Government of India (Roads) for the time being.

* Participating units of administration are those listed in Parts A and B of the First Schedule of the Constitution of India who participate in the activities of of Indian Roads Congress by guaranteeing to send a specified number of senior delegates to the General Session (or if no delegates are sent, to pay the delegation fees for those delegates) and, in addition, subscribe to the funds of the Society.

e. Past Presidents of the Society, for a period of three years after they vacate their presidentship.

f. (i) Six ordinary or associate members of the Society or representatives of associate members elected under Rule 5 c (i) and (ii) (not being public servants) to be elected annually at the time of the Annual General Meeting by a Board consisting of all such members present at the meeting.

(ii) One ordinary or associate member or a representative of associate members elected under Rule 5.c (ii) but being a public servant to be elected annually at the time of the Annual General Meeting by a Board consisting of all such members present at the meeting.

Provided that in the event of any dispute as to the composition of the Board the dispute shall be referred to the President of the Society for decision and his decision shall be final; and Provided further that in the event of the votes of the said Board being equal in respect of one or more candidates, a fresh election shall be held in respect of such candidate or candidates, and if upon such fresh election there are still equal votes in respect of any candidate or candidates, the decision shall be taken by drawing lots.

g. One ordinary or associate member of the Society to be elected annually at the time of Annual General Meeting by a board of district board engineers and district board assistant engineers who are members of the Society, but are not under the administrative control of the Chief Engineer of the territory in which they are serving, and are present at the meeting.

h. One ordinary or associate member of the Society to be elected annually at the time of the Annual General Meeting by a board of municipal, improvement trust and cantonment engineers who are members of the Society and are present at the meeting.

i. Four ordinary or associate members of the Society or representatives of associate members elected under Rule 5.c who shall all have been members of the Society for at least five years to be elected by the Annual General Meeting; Provided that members elected from any one territory shall not exceed two.

PRESIDENT AND VICE-PRESIDENTS

10. The Council shall at its first meeting after each Annual General Meeting elect a President and not more than three Vice-Presidents of the Society from among its own members, who shall hold office and continue to be members of the Council till a new Council has been elected. The President shall have power to fill any vacancies in the office of the Vice-Presidents that may occur between two General Meetings.

SECRETARY AND TREASURER

11. a. The Council shall appoint a Secretary on such terms as it deems fit. The President shall have power to make changes in the personnel of this office whenever such changes are necessary.

b. The Consulting Engineer to the Government of India (Roads) for the time being shall be ex-officio Treasurer of the Society.

12. The Council shall hold office until the newly elected Council referred to in Rule 9 takes charge

13. The Council shall have power :—

a. to fill any vacancies on the Council that may occur between two General Meetings of members elected under Rule 9-f, g, h & i, and

b. to add to its number by co-opting not more than ten members of the Society; such co-opted members shall also have voting powers except for the purposes of Rule 24.

c. to invite any member, ordinary or associate, or any other person, to a particular meeting: such persons shall have no voting powers.

14 Any nominated member of the Council as aforesaid may nominate, by written notice to the Secretary, a member of the Society to represent and vote for him as a member of the Council.

15. The President, or in his absence a Vice-President to be nominated by the President, shall preside at all meetings of the Council; otherwise, the meeting shall elect one of the Vice-Presidents present as a Chairman. The Chairman shall have a casting vote.

16. If at any time the President for the time being is absent from India, or is unable to perform the duties of his office, he shall nominate a Vice-President to act for him. In the event of the President failing to nominate one of the Vice-Presidents as aforesaid, the Vice-Presidents shall elect one of themselves to perform the office of the President.

17. The Council shall meet when possible at least once a year as defined in rule 7–c at such time or times as the President may direct and one of such meetings shall be at the time of the General Session of the Society; and on the requisition of at least ten members, the President shall call a meeting of the Council provided that instead of actually meeting, the President may direct that the Secretary refer the matter specified in the requisition for decision by post as hereinafter provided. At meetings of the Council twenty shall form a quorum.

18. The Secretary shall, on the orders of the President, refer any matter for the decision of the Council by sending to each member of the Council by Registered Post with acknowledgement due, a Memorandum setting forth the question or questions to be decided and specifying a date not less than thirty days from the date of posting of the Memorandum by which the votes of members of the Council shall reach him. Upon receipt of not less than twenty votes by the date specified, the Secretary shall record the decision of the Council as decided by the majority of the votes received by the said date and communicate such decision to the members of the Council. If less than twenty votes are received by the said date it shall be presumed that no decision has been made. In the event of the votes received by the Secretary as aforesaid being equal, the President shall have a casting-vote.

EXECUTIVE COMMITTEE

19. The President, the Vice-Presidents, the Treasurer and the Secretary shall form the Executive Committee with powers, subject to the approval of the Council, to direct and manage the affairs of the Society, to keep the activities of the Society under review, and to report to the Council from time to time. The Executive Committee shall have power to co-opt not more than two members with power to vote. Three shall form a quorum, one of them being either the President or a Vice-President. The President or, in his absence, a Vice-President shall preside. If, in the absence of the President, more than one Vice-President is present the members attending the meeting shall elect one of the Vice-Presidents as a Chairman. The President or Chairman shall have and exercise, in addition to his vote, a casting-vote in the case of an equality of votes.

COMMITTEES

20. The Council shall appoint the convenors of all committees and subcommittees except as otherwise provided in this rule. The Executive Committee or the President under authorization from the Executive Committee shall appoint the other members of such committees or subcommittees in consultation with the respective

convenors as far as possible. The Executive Committee or the President under authorization from the Executive Committee shall have the power to appoint such special committees including their convenors as may be deemed necessary from time to time. The number of members in each subcommittee or a division of a committee shall not be less than three and will not ordinarily be more than five The Consulting Engineer to the Government of India (Roads), shall be ex-officio member of all such committees or subcommittees in addition to the personnel appointed under this rule. Any committee or subcommittee constituted under this rule shall have power to co-opt not more than two members.

MEETINGS OF THE SOCIETY

21. There shall ordinarily be a General Session of the Society once a year at such time and place as the Council shall decide. At this Session there shall be a General Meeting for the purpose of disposing of the following business:—

a. To receive the report of the Council and the audited accounts for the previous year, or years ending 30th September;

b. To elect under Rule 9, members of the Society to serve on the Council until the next General Meeting as aforesaid;

c. To appoint Auditors; and

d. To transact such other authorized business as the President shall allow.

At such General Session, the Council may arrange for Papers to be read on subjects of professional and technical interest and for discussion thereon and for works to be visited.

22. The President shall preside at all General Meetings of the Society or shall nominate a Vice-President or in their absence nominate some other member of Council to preside in his place. In the absence of the President and of the Chairman nominated by the President at any meeting, the members present shall elect a Chairman. The Chairman shall have a casting-vote.

23. Fifty members present in person shall form a quorum of the General Meeting

ALTERATION AND INTERPRETATION OF RULES

24. These Rules and Regulations shall not be altered, extended, or abridged without the approval of at least two-thirds of those

present in person at a meeting of the Council and at least 30 days' notice shall have been given of such meeting and of any proposal to alter, extend, or abridge these rules and regulations.

25. In the event of any differences of opinion arising as to the interpretation of the Rules and Regulations, the decision of the Council shall be final and binding.

FRAMING AND ALTERATION OF THE BYE-LAWS

26 The Council shall have power to make, add to, abridge, and amend such Bye-laws as may appear to the Council to be necessary for the conduct of the Business of the Society, and as shall be consistent with the Memorandum and Rules and Regulations of the Society.

Minutes of the Business Meeting of the

INDIAN ROADS CONGRESS

held at Bombay on the 17th January, 1950

The Fourteenth Annual General Business Meeting of members was held at Bombay on Tuesday, the 17th January 1950, at 2.30 P. M. In all 221 Members and two invitees (names and particulars in Annexure I) attended the Session.

2. Confirmation of the Minutes of the last Business Meeting.

The minutes of the last Business Meeting held at Ranchi on the 7th February 1949 as printed on pages 36 to 67 of the Journal of the Indian Roads Congress, Volume XIII-4, July 1949, were approved.

3. (i) Audit Report.

The Audit Report for the period 1st October 1948 to the 30th September 1949 (Annexure II) was recorded.

(ii) It was decided to appoint M/s. A. F. Ferguson & Co., Chartered Accountants and Auditors, New Delhi, to audit the accounts of the Indian Roads Congress for 1949-50.

4. Report of the Council to the General Body of Members.

The Report of the Council (Annexure III) was taken as read and approved.

5. Resolutions of Thanks.

The following resolutions were passed with acclamation:

(a) The Indian Roads Congress express their thanks to the Government of Bombay for their kind invitation to hold the Fourteenth General Session at Bombay and for the very efficient arrangements made.

(b) The Congress express their thanks to the Hon'ble Shri B. G. Kher, Premier of Bombay for his encouraging and instructive Address to the Fourteenth Session and for his permission to print the Address in the Journal of the Indian Roads Congress.

(c) The Congress express their thanks to the Hon'ble Shri K. Santhanam, Minister of State for Railways and Transport, Government of India for kindly declaring open the technical exhibition organized

by the Congress and also for his inspiring message to the Members of the Congress attending the Session.

(d) The Indian Roads Congress express their thanks to the Hon'ble Dr. Jivraj N. Mehta, Minister for Public Works, Bombay for his good wishes for the success of the Session.

(e) The Indian Roads Congress express their appreciation and thanks to Shri N. P. Gurjar, Chief Engineer, Bombay, Shri K. M. Kantawala, Assistant Housing Commissioner, (Local Organizing Secretary, Indian Roads Congress), Shri N. C. Patel, Deputy Secretary, P. W. D., Bombay and other staff of the Bombay P. W. D., for the very efficient arrangements made by them for the convenience of the delegates of the Congress.

(f) The Indian Roads Congress thank their Past Presidents, Vice-Presidents and other old members and well-wishers who sent messages of good will and encouragement for the Session.

(g) The Indian Roads Congress thank the G. I. P. Railway authorities for arranging a special train for members of the Congress participating in the inspection tour to Nasik.

6. Scrutineers for the Election of Council Members.

Messrs. Basil Gray, H. P. Mathrani, A. Nageswara Iyer, V. N. Rangaswami, and Romesh Chandra were appointed scrutineers for the election of Council Members under rule 9–i of the Memorandum of Association, Rules, Regulations, and Byelaws of the Indian Roads Congress.

7. The following announcements were made from the Chair with regard to the elections :—

(1) "Only those Members of the Congress who are not in arrears of their subscription are entitled to vote. Voting slips will be given to those Members who wear their badges, or can give their Roll numbers, or can otherwise be identified as not being in arrears."

(2) "As Institutions, Government Departments, Public Bodies, and Firms have only been made eligible for associate membership of the Indian Roads Congress under revised rule 5–c(ii) at the 34th Council meeting held at Bombay on the 14th January 1950 and as there are no such members at present, the seat under rule 9–f (ii) will remain vacant in the meantime."

8. Elections.

The following were elected as Council Members under Rule 9–f (i), g, h and i :—

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

Dr. F. P. Antia	E. A. Nadirshah
C. J. Fielder	L. R. Patel
S. B. Joshi	V. N. Rangaswami

g. **Representative of District Boards.**

Hari Shankar Sharma.

h. **Representative of Municipal, Improvement Trust and Cantonment Engineers.**

K. Narasimha Rao.

i. **Representatives elected by the General Body.**

K. G. Bhate	D. B. Nagerkar
C. P. Misra	K K. Nambiar

The following were nominated by their respective administrations Council Members under Rule 9-a, b, c & d :

9–a. Name of participating administration.	Name of representative.
Bihar ...	M. L. Bahl
Madhya Pradhesh (C. P. & Berar) ...	R. K. Batra.
Orissa ...	C. M. Bennett.
West Bengal ...	S. N. Chakravarti.
Assam ...	Romesh Chandra.
Uttar Pradesh (United Provinces) ...	A. C. Mukerjee.
Bombay ...	N. P. Gurjar.
Madras ...	M. S. Thirumale Iyengar
Punjab ...	P. L. Verma.
b. Engineer-in-Chief's Branch	Brig. Partap Narain.
c. Central P. W. D.	B. S. Puri.
d. Consulting Engineer (Roads)	G. M. McKelvie

9e. Past Presidents of the Society.

(1) C. G. Kale
(2) S. N. Chakravarti
(2) Brijmohan Lal

9. The following members were co-opted to the Council for the 35th Council meeting :—

K. F. Antia
H. S. Batliwala
W. A. Griffiths
K. M. Kantawala
H. P. Mathrani
S. R. Mehra
T. Mitra
N. V. Modak
B. N. Shenoy
B. V. Vagh

The following members were invited to attend the 35th Council meeting :—

S. L. Bazaz
U. J. Bhatt
N. K. Bhonsle
P. C. Chopra
S. R. Ghadoke
A. N. Iyer
Vepa Krishnamurti
E. S. Nair
K. S. Raghavachary
J. P. Singh
K. Subba Rao

10. A letter received from Shri Fateh Chand regretting his inability to attend the Fourteenth Session was read out.

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Annexure I.

LIST OF MEMBERS WHO ATTENDED THE FOURTEENTH ANNUAL SESSION OF THE INDIAN ROADS CONGRESS HELD AT BOMBAY IN JANUARY 1950.

S. No.	Name of Province or State.	No. of delegates who attended the I.R.C. Session at Bombay.
	ABSTRACT.	
1.	**GOVERNMENT OF INDIA:**	
	(a) Roads Organization ...	15
	(b) Ministry of Railways. ...	1
	(c) Engineer-in-Chief's Branch. ...	2
	(d) M. E. S. ...	3
	(e) Central P. W. D. ...	5
	(f) Council of Scientific and Industrial Research ...	2
	(g) CENTRAL BOARD OF IRRIGATION. ...	1
2.	**DELHI.** ...	9
3.	**MADRAS.** ...	21
4.	**BOMBAY.** ...	81
5.	**WEST BENGAL.** ...	21
6.	**PUNJAB.** ...	5
7.	**UTTAR PRADESH.** ...	9
8.	**MADHYA PRADESH.** ...	4
9.	**ORISSA.** ...	1
10.	**ASSAM.** ...	1
11.	**BIHAR.** ...	12
12.	**HYDERABAD (DECCAN).** ...	7
13.	**MYSORE.** ...	7
14.	**UNITED STATES OF TRAVANCORE & COCHIN.**	2
15.	**P. E. P. S. U.** ...	2
16.	**SAURASHTRA.** ...	3
17.	**VINDHYA PRADESH.** ...	1
18.	**MADHYA BHARAT.** ...	4
19.	**RAJASTHAN.** ...	2
20.	**KUTCH.** ...	1
21.	**CEYLON.** ...	1
	TOTAL: ...	**223**

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LIST OF MEMBERS WHO ATTENDED THE FOURTEENTH SESSION OF THE INDIAN ROADS CONGRESS HELD AT BOMBAY IN JANUARY 1950.

S. No.	Roll No.		Name.
		1. GOVERNMENT OF INDIA.	
		(a) Roads Organisation.	
1.	–	...	Anantapadmanabhan, C. S. (Invited).
2.	76	...	Ayyar, A Nageswara.
3.	322	...	Bazaz, S. L.
4.	783	...	Bhargava, T. N.
5.	1078	...	Gursahani, R. L.
6.	785	...	Hardayal.
7.	1288	...	Mathrani, H. P.
8.	54	...	McKelvie, G. M.
9.	960	...	Nagarsheth, M. P.
10.	790	...	Oza, M. G.
11.	–	...	Parulekar, V. M. (Invited).
12.	87	...	Raghavachary, K. S.
13.	723	...	Subramaniam, J.
14.	389	...	Sunder Rao, H.
15.	918	...	Trehan, J. M.
		(b) Ministry of Railways.	
16	1241	...	Antia, K. F.
		(c) Engineer-in-Chief's Branch.	
17.	16	...	Pratap Narain.
18.	1323	...	Tawadey, V. B.
		(d) M. E. S.	
19.	1399	...	Benjamin, G.
20.	1461	...	Bomanji, P.
21.	1404	...	Satyanarayana, D.
		(e) C. P. W. D.	
22.	145	...	Chopra, A. N.
23.	1233	...	Gupta, S. N.
24.	418	...	Mathur, M. S.
25.	310	...	Puri, B. S.
26.	953	...	Shri Krishna.

S. No.	Roll No.		Name.
		(f) Council of Scientific and Industrial Research.	
27.	1170	...	Dinesh Mohan.
28.	833	...	Iyengar, R. K. N.
		(g) Central Board of Irrigation.	
29.	1001	...	Ahuja, P. R.
		2. DELHI.	
30.	39	...	Basil Gray.
31.	203	...	Das Gupta, J. N.
32.	41	...	Hardit Singh.
33.	72	...	Khanna, I. N.
34.	82	...	Rangaswami, V. N.
35.	1314	...	Sani, G. H.
36.	40	...	Shahani, T C.
37.	489	...	Sheth, K. L.
38.	1432	...	Sujan Singh.
		3. MADRAS.	
39.	91	...	Ayyangar Doraiswami, M. R.
40.	80	...	Griffiths, W. A.
41.	671	...	Meeran, M.
42.	1197	...	Mohandas, S. M.
43.	268	...	Nambiar, K. K.
44.	633	...	Nunjundeswara Chetty, K. A.
45.	1460	...	Narasimha Rao, K.
46.	267	...	Narayana Murti, B.
47.	1125	...	Padmanabnan, C. V.
48.	1419	...	Reddy, B. V
49.	39	...	Shenoy, B N
50.	618	...	Srirangachary, G
51.	1311	...	Subbaraju, Bh.
52.	1210	...	Subbiah, C. P.
53.	1312	...	Subramaniam, P. S.
54.	791	...	Sundaram, S.
55.	630	...	Thadaney, K. V.
56.	1438	...	Thirumale Iyengar, M. S.
57.	685	...	Thirupuvanam, C. N.
58.	1178	...	Veeraraghavan, T. M.
59.	1173	...	Venogopal, C.

S. No.	Roll No.		Name.
			4. BOMBAY.
60.	242	...	Adke, A. S.
61.	33	...	Allen de Sa.
62.	1198	...	Amin, M. P.
63.	32	...	Antia, F. P.
64.	1414	...	Apte, K. V.
65.	1481	...	Bakeri, R. D.
66.	253	...	Bamji, H. F.
67.	383	...	Batliwala, H. S.
68.	1463	...	Bhagwagar, K. D.
69.	1050	...	Bhambhani, B. I.
70.	14	...	Bhandarkar, G. P.
71.	329	...	Bhate, K. G.
72.	1004	...	Chandratreya, S. V.
73.	704	...	Chougule, Y. K.
74.	261	...	Daftary, G. D.
75.	1336	...	Daftary, N. D.
76.	1477	...	Dalal, M. N.
77.	1487	...	Daruwala, P. K.
78.	1483	...	Deodhar, M. D.
79.	1322	...	Desai, C. N.
80.	1466	...	Desai, N. K.
81.	773	...	Desai, R. V.
82.	1497	...	Deshpande, D. V.
83.	1484	...	Deshpande, K. S.
84.	1468	...	Dhanokar, T. H.
85.	30	...	Engineer, M. H.
86.	858	...	Gandhi, J. H.
87.	1129	...	Iyengar, C. L. N.
88.	655	...	Gurjar, N. P.
89.	1474	...	Jagus, P. J.
90.	1180	...	Jategaonkar, V. L.
91.	787	...	Jathal, M. N.
92.	526	...	Joglekar, G. D.
93.	1169	...	Joglegar, M. V.
94.	1450	...	Joglekar, K. V.
95.	1430	...	Joshi, R. N.
96.	315	...	Joshi, S. B.
97.	1016	...	Kantawala, K. M.
98.	874	...	Kanga, F. J.
99.	1453	...	Karandikar, S. K.
100.	217	...	Krishnan, O. C. K
101.	1458	...	Lakshmi, S. G.
102.	636	...	Macha, T. K.

S. No.	Roll No.		Name.
103.	1401	...	Mane, P. M.
104.	1494	...	Madhavarao Parasharam Karkare.
105.	952	...	Makhan Wahla, R. B.
106.	1485	...	Manibhai Makanji Desai.
107.	1473	...	Masarwala, V. J.
108.	1472	...	Mastoor, A. R.
109.	810	...	Mehta, D. J.
110.	1002	...	Mehta, M. A.
111.	1464	...	Mewada, M. N.
112.	10	...	Modak, N. V.
113.	1482	...	Modi, I. K.
114.	696	...	Mohile, N. H.
115.	755	...	Murti, N. G. K.
116.	309	...	Murti, N. V. S.
117.	1012	...	Nadgauda, P. M.
118.	23	...	Nadirshah, E. A.
119.	1100	...	Naegamvala, J. P.
120.	949	...	Naik Ishwar Lal Kasanji.
121.	1479	...	Narke, S. P.
122.	342	...	Nicolaides, E. P.
123.	1206	...	Patel, M. M.
124.	1492	...	Patel, M. M.
125.	653	...	Patel, N. B.
126.	1313	...	Patel, N. C.
127.	1491	...	Patel, O. H.
128.	1476	...	Pinto, C. J.
129.	327	...	Puri, A. N.
130.	25	...	Ranade, J. Y.
131.	498	...	Rathod, M. P.
132.	163	...	Rege, D. Y.
133.	376	...	Sandhawalia, N. S.
134.	66	...	Sanjana, N. P.
135.	993	...	Sawai, D. B.
136.	1148	...	Shivdasani, P. D
137.	1478	...	Thosar, G. S.
138.	1494	...	Umrigar, E. J.
139.	1475	...	Unwalla, B. T.
140.	84	...	Vagh, B. V.
			5. WEST BENGAL.
141.	17	...	Chakravarti, S. N.
142.	323	...	Chambers. J.
143.	913	...	Chatterjee, P. K.
144.	1496	...	Chattopadhaya, K. P.

S. No.	Roll No.		Name.
145.	41	...	De, K. C.
146.	231	...	Fielder, C. J.
147.	1462	...	Ghosh, D. N.
148.	808	...	Ghosh, S. K.
149.	936	...	Gupta, S. N.
150.	35	...	Hugues, H.
151.	1498	...	Manindra Nath Guha.
152.	1071	...	Mason Jerry.
153.	316	...	Mitra, T.
154.	488	...	Nagarker, D. B.
155.	21	...	Patel, L. R.
156.	1008	...	Raghavan, P.
157.	766	...	Roy, R. C.
158.	1459	...	Sailendra K. Mitra.
159.	1456	...	Sailendra Nath Banerjee.
160.	990	...	Satya Nand.
161.	910	...	Sudhi Ranjan Banerjee.
		6.	**PUNJAB.**
162.	42	...	Brijmohan Lal.
163.	457	...	Dogra, R. N.
164.	277	...	Mehra, S. R.
165.	504	...	Sharma, D. C.
166.	847	...	Uppal, H. L.
		7.	**UTTAR PRADESH.**
167.	634	...	Agarwal, R. M.
168.	205	...	Bisht, M S.
169.	896	...	Charan, S. K.
170.	115	...	Hari Shankar Sharma.
171.	750	...	Kartik Prasad.
172.	284	...	Lakshman Swarup.
173.	264	...	Parmara, D. S.
174.	45	...	Srivastava, M. P.
175.	505	...	Verma, H. G.
		8.	**MADHYA PRADESH.**
176.	978	...	Batra, R. K.
177.	782	...	Kumar, G. L.
178.	1454	...	Rajwade, M. V.
179.	1467	...	Sharma, S. A.

S. No.	Roll No.		Name.
		9.	**ORISSA.**
180.	272	...	Bhuyan, M. N.
		10.	**ASSAM.**
181.	156	...	Romesh Chandra.
		11.	**BIHAR.**
182.	399	...	Bahl, M. L.
183.	733	...	Bhagwat Prasad.
184.	271	...	Jayaswal U. S.
185.	1259	...	Lall, Y. K.
186.	434	...	Misra, C. P.
187.	492	...	Ram, G. S.
188.	1299	...	Roy, B. N.
189.	1321	...	Sahay, T. K.
190.	1291	...	Sinha, N. K.
191.	754	...	Sinha, S. K.
192.	871	...	Sinha, S. N.
193.	856	...	Sirkar, S. K.
		12.	**HYDERABAD-DECCAN.**
194.	256	...	Asadullah.
195.	1495	...	Bedekar, V. V.
196.	1043	...	Daver, F. K.
197.	250	...	Dildar Hussain.
198.	326	...	Mohd. Usman.
199.	407	...	Ramaswamy, K.
200.	922	...	Vepa Krishnamurthi.
		13.	**MYSORE.**
201.	1482	...	Hutchveeriah, T.
202.	1469	...	Lakshminarayana, V.
203.	1490	...	Raja Rathnam, K. V.
204.	746	...	Raju, R. L.
205.	1470	...	Ramiah, V.
206.	1269	...	Ramaswamy, S.
207.	1465	...	Subba Rao, K.
		14.	**UNITED STATES OF TRAVANCORE & COCHIN.**
208.	1486	...	Rajagopalan, K.
209.	982	...	Sivaraman Nair, E.

S. No.	Roll No.	Name.
		15. P. E. P. S. U.
210.	1053	... Jugdev Singh Marya.
211.	1449	... Singh, J. P.
		16. SAURASHTRA.
212.	214	... Bhatt, U. J.
213.	34	... Mehta, J. T.
214.	1488	... Sompura, G. B.
		17. VINDHYA PRADESH.
215.	1455	... Chopra, P. C.
		18. MADHYA BHARAT.
216.	149	... Bhalla, P. N.
217.	455	... Bhonsale, N. K.
218.	581	... Naik, B. G.
219.	392	... Phadke, P. G.
		19. RAJASTHAN.
220.	1480	... Gadhoke, S. R.
221.	551	... Mansukhlal, J. Shah.
		20. KUTCH.
222.	1471	... Vora, P. K.
		21. CEYLON.
223.	822	... Williams, L. C.

THE IN

E AND EXPENDITURE ACC

(Excluding Transf

Rs. A. P.	Rs. A. P.		Rs. A. P.	Rs. A. P.
	10,301 1 6			85,600 0 0
	21,545 12 0			
	9,128 14 0			
	40,975 11 6		19,460 0 0	
			2,700 0 0	
7,835 2 0			1,061 0 0	23,221 0 0
7,763 7 8				
17,225 6 0	32,823 15 8			
			910 0 0	
			600 0 0	1,510 0 0
				535 8 0
				335 15 0
			9,850 0 0	
			2,355 0 0	12,205 0 0
	751 10 0			
	300 0 0			
		Rs. 1		Rs. 1,23,407 7 0

Annexure III.

INDIAN ROADS CONGRESS

REPORT OF THE COUNCIL TO THE GENERAL BODY OF MEMBERS FOR PERIOD 1st JANUARY, 1949 TO 31st DECEMBER, 1949

GENERAL.

The Thirteenth Annual Session of the Indian Roads Congress was held at Ranchi (Bihar) in February 1949 when 235 members and two invitees attended the Session. Eight Papers published in the Journal of the Indian Roads Congress, Volume XII, part 5 and Volume XIII, parts 1 to 3, were read and discussed. Two Committees and ten Subcommittees were reconstituted to deal with various engineering and administrative problems.

As the Indian Road Transport Congress which was recmmended by the Indian Roads Congress had not been yet formed, the Subcommittee to deal with road transport matters was revived. An "Organization Committee" to investigate the question of organization of Highway Departments in Provinces, etc., was also appointed.

The Executive Committee held three meetings on the following dates:—

20th May 1949
1st August 1949
26th December 1949
} at New Delhi.

2. ADMINISTRATION.

Mr. Brijmohan Lal, Chief Engineer and Secretary to the Government of East Punjab, was elected President of the Indian Roads Congress at the Ranchi Session. Mr. G. M. McKelvie and Mr. H. Sunder Rao continued as Honorary Treasurer and Honorary Secretary respectively. Mr. A. J. D'Costa continued to work as Honorary Assistant Secretary till the 5th August 1949. Owing to his transfer as Engineer Liaison Officer, West Bengal, Mr. J. M. Trehan took over charge.

3. OFFICE.

The office continued to be located at New Delhi.

During the period under report, the office disposed of 11,413 receipts and issued 18,864 letters against 5,284 and 11,886 respectively in the previous year. There has been a considerable increase in correspondence and accounts work owing to increase in the

Membership of the Society as also on account of the circulation of the Transport-Communications Monthly Review. The number of enquiries for the supply of technical information has also increased.

The staff worked satisfactorily.

4. MEMBERSHIP.

(*a*) **Ordinary and Associate.**—The number of Members increased from 1,136 on 1st October 1948 (1,111 ordinary and 25 associate) to 1,265 on the 30th September 1949 (1,240 ordinary and 25 associate). There have been 175 new admissions to the Society and 46 withdrawals, etc. It is encouraging to note that there has been a steady increase in the Membership of the Congress as shown in the table below:—

Year.	No.	Year.	No.
1934	73	1942	544
1935	173	1943	596
1936	255	1944	612
1937	342	1945	748
1938	393	1946	919
1939	448	1947	1030
1940	489	1948	1136
1941	484	1949	1250 (approx.)

(*b*) **Life Membership.**—During the Congress year from 1st October 1948 to 30th September 1949, nine ordinary Members had themselves enrolled as Life Members. In accordance with rule 7 (*v*) of the existing Memorandum of Association etc., the fees received have been transferred to a separate reserve after deductiug Rs. 10 per Member for initial expenses. The Life Membership Reserve amounted to Rs. 4,196 on the 30th September 1949. This reserve is to be utilized for such purposes as the Council may decide from time to time. The Council has not, however, utilized any part of the amount so far for any purpose.

5. DEATHS.

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

1. K. S. Ramamurti.
2. S. Narayanaswami.
3. Bhagwat Prasad.
4. P. M. Chowdhury.

Letters of condolence have been sent to the families of the deceased.

6. FINANCE.

The budget estimate for the year 1949-50 and the "actuals" for 1948-49 were approved by the Executive Committee at their meeting held on the 26th December 1949 preparatory to their submission to the Council at its 34th meeting. The figures for 1948-49 show a surplus of Rs. 16,763 against an estimated surplus of Rs. 2,923. This was due to arrears of subsidies and donations realised during the year, and to some bills remaining unpaid at the end of the year. The increased activities of the Society involve a much larger expenditure than hitherto incurred and the need for increased income is keenly being felt.

The total contribution received from Provinces and States during the year was 51,250. The outstanding from the Provinces and States was Rs. 28,350 on the 30th September 1949. Efforts are continued to persuade Provinces and States to expedite payments.

The Executive Committee, at their meeting held on the 20th May 1949, approved of the proposal to issue an appeal to Provincial Governments for increased contributions towards the funds of the Indian Roads Congress. The appeal was issued on the 3rd November 1949. The Provincial Governments have been requested to contribute *one two-hundredth part* of their share of Road Fund allocation from the Centre or a fixed sum on the same basis. The Government of Assam have kindly agreed to contribute their share. The Council of the Indian Roads Congress hope that other Provincial Governments will also agree to the contributions proposed and thus place the finances of the Congress on a sound footing and assist the Society to provide for increased activities.

As decided by the Executive Committee, the Government of India, the States and Unions of States will also be addressed in due course for increased contributions.

Steps have also been taken to increase the income of the Society by enhancing the rates of subscription of ordinary Members from Rs. 20 to 25 with the usual rebate of Rs. 5 if the subscription is paid within three months of the due date.

The arrears of subscription from 267 Members at the beginning of 1948-49 were Rs. 9,904. Of this amount Rs. 2,174 were realized from 74 Members. A sum of Rs. 1,490 standing as arrears against 27 Members who had died, retired or migrated outside India and whose names had, therefore, been removed from the Membership roll were written off with the approval of the Executive Committee. After adding the arrears for 1948-49, the total arrears on the 1st October 1949 stood at Rs. 11,871-5-8 due from 277 Members.

Among the defaulters there are about 97 Members who are in arrears for more than two years and the amount payable by them is Rs. 6,888. Under Rule 8 (i) of the Memorandum of Association, etc., such persons automatically cease to be Members. Of the above 97 Members 18 have been removed from the roll with the approval of the Executive Committee after giving due notice where possible. Repeated requests have been made to the other 79 Members to pay their dues and the question of writing off the arrears is under the consideration of the Executive Committee. These Members are not being supplied with the Journal nor are they given any of the benefits of Membership of the Society.

7. AUDIT.

At the Thirteenth Session at Ranchi it was decided to appoint M/s. A. F. Ferguson & Co, Chartered Accountants and Auditors, to audit the accounts of the Indian Roads Congress for 1948-49. Their report was examined by the Executive Committee in their meeting held on the 26th December 1949. Certain recommendations made by the Auditors in the accounting procedure were accepted. The audit report will be placed separately before the Council for their consideration.

8. PUBLICATIONS.

It was reported last year that the Indian Roads Congress Journal, Volume X, which contained Sections I & II of the Draft Specifications and Code of Practice for Road Bridges in India had all been sold out Order for this useful volume, however, continued to pour in throughout the year under report. Since the drafts have now been finalized the printing of these sections will be taken up soon and issued as a priced publication.

A circular letter was issued to the Provinces and States about the publication of the Road Research Bulletin No. I, as a result of which 351 copies were sold. A steady demand still continues for this Bulletin.

Bound copies of Volume XII-parts 4 and 5, were recently received from the Press. Bound copies of parts 1, 2 & 3 of this volume will also be ready shortly for sale. The Indian Roads Congress Journals and Publications find a ready sale and consequently many issues are out of stock. The position on the 1st December 1949 was as under :—

Name of Proceedings.	*Volume.*	*Balance.*
I. R. C. Proceedings ...	I	... Sold out.
Do ...	II	... Sold out.
Do ...	III	... 50

Name of Proceedings.	*Volume.*	*Balance.*
I. R. C. Proceedings ...	IV	... Sold out.
Do ...	V	... Sold out.
Do ...	VI	... Sold out.
Do ...	VII—part 1	... Sold out.
Do ...	VII—part 2	... 51
Do ...	VIII	... Sold out.
Do ...	IX—part 1	... Sold out.
Do ...	IX—part 2	... Sold out.
Do ...	IX—part 3	... Sold out.
Do ...	IX—part 4	... 128
Do ...	IX (Bound)	... 242
Do ...	X—part 1	... 72
Do ...	X—part 2	... Sold out.
Do ...	X—part 3	... Sold out.
Do ...	X—part 4	... 330
Do ...	X (Bound) (1 to 4)	... Sold out.
Do ...	X (Bound) (1 & 2)	... Sold out.
Do ...	X (Bound) (3 & 4)	... Sold out.
Do ...	XI—part 1	... Sold out.
Do ...	XI—part 2	... Sold out.
Do ...	XI—part 3	... Sold out.
Do ...	XI—part 4	... 202
Do ...	XI (Bound) (1 & 2)	... 211
Do ...	XI (Bound) (3 & 4)	... 351
Do ...	XII—part 1	... 109
Do ...	XII—part 2	... 498
Do ...	XII—part 3	... 556
Do ...	XII—part 4	... 449
Do ...	XII—part 5	... 553
Do ...	XIII—part 1	... 387
Do ...	XIII—part 2	... 553
Do ...	XIII—part 3	... 372
Do ...	XIII—part 4	... 520
Do ...	XIV—part 1	... 627
Road Research Bulletin No. 1		... 335
Nagpur Report		... 58
Prof. K. B. Madhava's Lecture on "Statistics and Road Research"		... Sold out.
Paper No. 105 'Economics of Highway Types'		... Sold out.

The Council advise Members who have not kept a complete set of the Proceedings of the Society to make up the deficiency before the old volumes are sold out.

Copies of publications of the Society are being supplied free of cost to several Technical Institutions in India, the United States of America, the United Kingdom, and the United Nations Organizations covering the Far East, in exchange for their publications.

The publication entitled "**Transport-Communications Monthly Review**" has been popularised among the Members of the Indian Roads Congress. As a result of a personal approach through a demi-official letter, the number of subscribers has risen to 200 on the 1st December 1949.

The Review contains useful literature abstracted from more than fifty technical Journals which are received in the combined libraries of the Indian Roads Congress and the Consulting Engineer to the Government of India (Roads). Besides this, it contains original articles contributed by individuals. It thus brings to subscribers the latest information on roads and road transport. Other items included in this magazine from time to time are reviews of recently published books, lists of additions made to the library, a technical information service, interesting mathematical problems, particulars of works sanctioned on National Highways and so on.

Complementary copies of the Review are being issued to the Ministers of the Government at the Centre, and in Province, Members of the Standing Roads Committee of the Constituent Assembly (Legislative), the Chief Engineers concerned with roads and others.

The Council request Members to send suitable contributions for publication in the Review.

9. INFORMATION.

Forty-five enquiries received from Members on miscellaneous technical subjects and on the interpretation of standard specification were attended to. Some of the subjects on which information was sought are given below :—

i. Road signs;
ii. Safe stresses for stone slab decks on culverts;
iii. Stabilized Soil Roads;
iv. Practical tunnelling;
v. Roller and Rocker Bearings for R. C. Bridges;
vi. Premoulded joints;
vii. "Colcreting" process;
viii. Bridge abutments; and
ix. Road statistics.

10. LIBRARY.

The combined libraries of the Indian Roads Congress and the Consulting Engineer to the Government of India (Roads) which had been handed over to the Central Board of Irrigation, Simla, in February 1946 for classiffication of books according to the Universal Decimal Classification and Indexing System has since been brought back to Delhi. The Indian Roads Congress library is at present with the Office of the Consulting Engineer to the Government of India (Roads).

A large number of Journals of Institutions in India and abroad were received in exchange for the Indian Roads Congress Journal.

Lists of additions to the library are published monthly in the "Transport-Communications Monthly Review". Members are requested to study these lists and to ask for books they wish to consult. The Rules regarding the loan of books are published in Volume XIV-1 of the Journal of the Indian Roads Congress.

Many requests were received for the loan of books from the library.

11. MEDALS AND PRIZES.

The Council at their 33rd meeting held at Ranchi in February 1949 considered the recommendations of the Papers Subcommittee and decided as under :—

i. A Money Prize of the value of Rs. 250 may be awarded for suitable essays recieved for the Prize Essay competitions.

ii. The name of the "Indian Roads Congress Prize Essay Medal" should be changed to the "Indian Roads Congress Medal" to be awarded for Papers considered by the Council to be of a decidedly more than average merit.

iii. The "Mitchell Medal" should continue to be reserved for Papers of exceptional merit.

iv. The Papers Subcommittee was requested to study the Papers presented for discussion at the Thirteenth Session with a view to selecting those deemed suitable for the award of "Mitchell Medal" and "Indian Roads Congress Medal" and to submit their recommendations for the decision of the Executive Committee. It was also decided that the Papers read at the Roorkee Session (1948) should be considered for the award of the Indian Roads Congress Medal.

The recommendations of the Papers Subcommittee in regard to the selection of Papers for the award of Medals when received will be considered by the Executive Committee for necessary action.

Six essays on the subjects selected by the Council have been received. These will be considered by the Papers Subcommittee for the award of the prize of Rs. 250.

12. INDIAN NATIONAL SOCIETY OF SOIL MECHANICS AND FOUNDATION ENGINEERING.

Under the provisions of the statutes of the International Society of Soil Mechanics and Foundation Engineering as adopted at the second International Conference, the National Committee for India constituted an Indian National Society of Soil Mechanics and Foundation Engineering with its headquarters at Simla. The Secretary, Central Board of Irrigation, Simla, is also the Secretary of this new Society.

As decided by the Executive Committee in their meeting held on the 15th January 1949, the Indian Roads Congress became a Member of this Society and pays an annual subscription of Rs. 100. In addition to the five volumes received last year, two more volumes of the Proceedings of the Second International Conference on Soil Mechanics and Foundation Engineering were added to the library.

Mr. S. R. Mehra, Superintending Engineer, East Punjab, represented the Indian Roads Congress on the National Committee of the said Society during the year.

13. COLLECTION OF THE PARTICULARS OF BRIDGES.

The Indian Roads Congress had been collecting particulars of bridges of lengths above 100 ft. for publication in book form. The compilation work is in progress. As soon as sufficient information is received it will be taken up for publication.

14. INDIAN STANDARDS INSTITUTION.

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

15. TECHNICAL ACTIVITIES OF THE INDIAN ROADS CONGRESS.

(i) **The Specifications and Standards Committee.**—At the last Session held at Ranchi, the Paper entitled "Policy concerning Maximum Dimensions, Weights, and Speeds of Motor Vehicles in India as related to Road Standards" was discussed.

A "Standard form for recording data for cement concrete pavements", modified in the light of discussions at the General Session at Ranchi, is being printed for circulation to provinces, States and others.

The note on road-rail level crossings circulated to members during the Ranchi Session was forwarded to the Railway Board for their comments which are awaited.

The following subjects will be considered by the Committee during the Fourteenth Session:

(a) Standard abbreviations;
(b) Layout of roads;
(c) Type design for mile stones;
(d) Road-rail level crossings; and
(e) Glossary of highway engineering terms Sections 32 and 33.

(*ii*) **Bridges Committee.**—The Committee met at Ranchi in February 1949 during the Thirteenth Session. Sections I & II of the draft code practice for the design of highway bridges have been finalized. A draft of Section III of the code relating to Reinforced Concrete design has also been revised in the light of the discussions held at Ranchi. It will be published as a Paper for discussion at the Fifteenth Session.

(*iii*) **Technical Committee.**—

(a) *Test Track Division.*—The 1949 series of tests at the Test Track are designed

(1) to assess the relative behaviour of different types of base course commonly in use in West Bengal; and

(2) to find out whether any reduction in cost of base course can be effected by introducing stabilized soil course laid to different specifications over clay embankments 3 ft. high in water-logged areas common to West Bengal, where the water table is sometimes about one to two feet below the road level.

The present lease of the land on which the test track is laid expires on the 31st March 1950. The Calcutta Port Commissioners who are the owners of the land have been requested to extend the lease by another year.

(b) *Research Organization Division.*—The suggestions received from most of the Research Institutions and Scientists who were consulted regarding the tentative proposals for the setting up of a Central Road Research Institute (referred to in the last year's Report) are under examination.

There was some difficulty in securing possession of the land selected for the Institute near mile 7 of the Delhi-Muttra Road. The area proposed for acquisition was, therefore, reduced from 70 to 31 acres and it is now proposed to locate the staff quarters on land reserved for a new township nearby. As it is evident that the construction of permanent buildings on the scale outlined in the scheme will have to wait till the finances of the Government improve, plans have been prepared for the temporary laboratory in which research could be undertaken for the present. It is hoped that it will be possible to start the erection of this building immediately the land is acquired. Meanwhile, it is proposed to make a start on research on some urgent problems and for this purpose, the Director, National Physical Laboratory, has been approached to spare some room for road research work in the new buildings for the Physical Laboratory. Action has also been initiated by the Council of Scientific and Industrial Research to recruit suitable staff.

The appointment of architects for the preparation of plans for the main institute and laboratories is under consideration.

Dr. S S. Bhatnagar, Director, Council of Scientific and Industrial Research, who recently visited Europe and America, interviewed a few candidates for the posts of Director of Road Research Institute, and Director of Technical Co-ordination. It is felt that it will be some time before these two posts are filled.

Some equipment for research work on soils has been collected by the Roads Organization of the Ministry of Transport. The Council of Scientific and Industrial Research has also collected some miscellaneous equipment and is making arrangements to purchase useful apparatus from the Disposals Directorate and elsewhere in India and abroad.

(*iv*) **Road Transport Subcommittee.**—The Council in their meeting held at Ranchi in February 1949 expressed the opinion that although the Indian Roads Congress is not primarily concerned with road transport, it is vitally interested in the matter. In view of the fact that the Government of India has not yet agreed to establish the Indian Road *Transport* Congress, the Road Transport Subcommittee of the Indian Roads Congress was revived by the Council so that the Roads Congress may be able to maintain its interests in road

transport matters. The Council directed that this Subcommittee should keep in touch with the Indian Roads and Transport Development Association and other transport interests with a view to studying the scientific aspects of road transport problems.

(*v*) **Bullock-cart Subcommittee.**— A grant of Rs. 17,000 was sanctioned by the Government of India for 1949-50 for meeting the establishment charges of the Bullock-cart Subcommittee. As most of the work of the investigation has been completed, the establishment was disbanded in November 1949.

Further progress made by the Subcommittee is indicated in the Appendix to this report.

(*vi*) **Soil Research Subcommittee.**— On the recommendation of the Soil Research Subcommittee, the Chief Engineers of Provinces, Unions of States and major States, were requested to carry out experiments on the use of stabilized soil for base course and to report results. Their reports are awaited.

As the Soil Laboratory at Karnal in the East Punjab has now been fully equipped, a fresh scheme for the training of engineering and scientific personnel of the other Provinces and States was prepared. The Government of India, Ministry of Transport recommended to the Provinces, States and Unions, to take advantage of the offer. Owing to shortage of personnel and other reasons, such as the opening of soil laboratories in other Provinces also, the response has so far been poor

(*vii*) **Education Subcommittee.**— Arising out of the Presidential address at the last Session, the Council of the Indian Roads Congress requested the Education Subcommittee to submit their recommendations to the Council in regard to the provision in Engineering Colleges of *Post-graduate Training* for students who wish to take the Master of Engineering degree and for qualified candidates from the services nominated for post-graduate study by the Provincial or other Governments. The recommendations of the Subcommittee are awaited.

(*viii*) **Bituminous Treatment of Wet Aggregates Subcommittee.**— This Subcommittee had been investigating methods designed to render the bituminous treatment of wet aggregates both feasible and effective under Indian climatic conditions. On the recommendations of this Subcommittee, some Provinces carried out experiments with specifications using bituminous binders and wet aggregates.

The reports received show that experiments have been carried out in high altitude locations, such as Simla, Darjeeling and Dehra Dun, down to locations near sea level with uniformly satisfactory results.

A statement giving the results of experiments together with a set of the specifications adopted have been circulated to the Chief Engineers of Provinces where the experiments had been carried out and their comments on the suitability of the specifications have been invited.

(*ix*) **Highway Layout (Architectural) Subcommittee.**—This Subcommittee deals with the question of layout, design, construction and maintenance of highways and streets throughout the country.

The Government of India in the Ministry of Works, Mines and Power were requested to give representation to the Indian Roads Congress on all Committees which have been or might be set up to discuss the Master Plan for Greater Delhi. The Punjab and Orissa Governments were also requested to give representation on Committees which may be set up by those Governments to plan their new Capitals.

The Government of Orissa intimated that there is no committee other than a Council of Ministers to decide the planning of new Capital at Bhubaneswar and, as such, no representation could be given to the Indian Roads Congress. The Government of India in the Ministry of Works, Mines and Power have also intimated that they do not consider it necessary to give representation to the Indian Roads Congress on the committees considering the plans for Greater Delhi as the Chief Engineer, C. P. W. D., and the Superintending Engineer, C. P. W. D., who are Members of the Indian Roads Congress are already Members of the Committee and as the Roads Organization of the Ministry of Transport which is intimately connected with the Indian Roads Congress is also duly represented on these Committees. A reply from the Government of the East Punjab is awaited.

The Subcommittee has been requested to furnish their views on the subject.

(*x*) **Provincialization of Local Bodies Engineering Services Subcommittee.**— No report was received during the year under report.

(*xi*) **Papers Subcommittee.**— The work of this Subcommittee is to examine technical Papers contributed for discussion at the General Sessions of the Indian Roads Congress and to record their views regarding their suitability for publication in the Society's Journal.

Seventeen Papers were received during the year and six were accepted.

(*xii*) **Manufacture of Road Making Machinery and Machanization Subcommittee.**—The Mechanization and Manufacture of Road Making Machinery Subcommittee which have been converted into a single committee held their meeting at Ranchi in February 1949.

On the recommendation of the Manufacture of Road Making Machinery Subcommittee, the Chief Engineers of all Provinces (including the C. P. W. D.) States and Unions of States were requested to intimate forecasts of their yearly requirements of nine selected items of road-making machinery for road works as well as for irrigation and other projects for the quinquennium 1950-54. The information has not been received from most of the authorities and they have been asked to expedite submission of their lists.

The Mechanization Subcommittee expressed the opinion that it was desirable to utilize plant and machinery on road construction schemes in a larger measure than at present owing to the fact that the cost of labour had increased considerably in recent years and labour was less plentiful than formerly so that emergent jobs took a very long time for completion by employing manual labour only and cost more than would have been the case if machinery had been used. On the recommendation of the Subcommittee, the Government of India were requested to purchase, as and when necessity arose, some specialised equipment and maintain it to form a Central Pool from which loans could be made to the Provinces and States. The Government of India, Ministry of Transport (Roads Organization), have agreed to purchase only such items of plant as are not commonly required by Provinces for their own works. They have so far authorized the purchase of boring machinery for trial bores and core drills against certain specific works. This machinery will probably be transferred to the Central Plant Pool after the completion of the works for which it has been purchased.

(*xiii*) **Rules Committee.**—On examination certain lacunae were noticed in the Indian Roads Congress Rules and the constitutional changes in the country also necessitated several further changes to the Memorandum of Association, etc.

Accordingly the Council of the Indian Roads Congress in their meeting held at Roorkee in April 1948, appointed a Committee of five Members (Rules Committee) to suggest the changes that were required in the Memorandum of Association, etc.

The Rules Committee met at Ranchi in February 1949 and later at New Delhi in April, May and November 1949. The Rules as drafted by the Rules Committee, and revised by the Executive

Committee in their meetings held in May and December 1949 will be placed before the Council.

16. MISCELLANEOUS.

(*i*) Arising out of the Presidential Address, the Council of the Indian Roads Congress in their 33rd meeting held at Ranchi in February 1949 passed the following resolution on the subject of the maintenance of earth roads—

> "It was agreed that the subject of MAINTENANCE of earth roads should be studied intensively and experiments conducted in every Province, as these roads will remain the backbone of the Country's road system for a long time to come."

In order to study the practice adopted in the various regions and for various kinds of soils with a view to getting the best results, it was considered desirable that an expert Committee of the Indian Roads Congress should study the subject and make suitable suggestions. The Chief Engineers of Provinces, States and Unions of States were, therefore, requested to give details of the practices adopted in their respective jurisdictions regarding the maintenance and repairs of earth roads.

It is hoped that when the subject is studied properly by the Indian Roads Congress, the advice given will go a long way towards adopting methods which will make for improving the condition of earth roads.

(*ii*) On the request of the Director, Transport and Communications Division, Department of Economic Affairs of the United Nations, Lake Success, New York, an article on "The Present Situation and Plans for the Development of Roads in India" was prepared and sent to him for the U. N. publication entitled "Transport and Communications Review."

APPENDIX.

Progress Report of the Bullock-cart Subcommittee.

1. Tests on the wear and tear of road surfaces which were in hand last year were completed.
2. The following further tests were carried out at the College of Engineering, Poona during this year :—
   - (i) Tests on tractive effort on wheels of 2″ and 3½″ tyres with various bearings.
   - (ii) Tests on tractive effort on self-aligning wheels.
   - (iii) Tests on flexibility.
   - (iv) Tests on Mr. Raju's Roller Wheels.
   - (v) Tests on tractive effort during travel on pot-holes.
   - (vi) Tests on tractive effort of various wheels employing bullocks.
   - (vii) Tests on the tilting of wheels by measuring tyre-contact.
   - (viii) Tests on the tilting of wheels by measuring wheel incline.
3. A report on all these tests is embodied in Mr. Vagh's Paper on "A Design of Bullock-cart Wheels : Part IV: Report on Tests" which has been submitted to the Congress.
4. All the testing chalked out has been completed and the testing establishment disbanded on 1st November 1949.
5. Two pairs of wheels, one employing rubber fixtures in wheels built at present as suggested by Mr. Vagh and the other built on Mr. Nageswara Ayyar's design employing a spherical C. I. hub, are proposed to be handed over to the Agricultural Institute, Pusa, New Delhi, for field tests.
6. It is also proposed to manufacture in various Provinces four pairs of wheels made to different designs.
7. Provinces have been asked to supply particulars of the present designs at certain stations to complete the All India Survey, which could not be finished at the time the establishment of the Bullock-cart Subcommittee was disbanded.

Minutes of the 35th Council meeting of the

INDIAN ROADS CONGRESS

held at Bombay on the 17th and 18th January 1950.

The meeting started with Shri Brijmohan Lal in the Chair.

Present:

F. P. Antia	G. M. McKelvie
M. L. Bahl	C. P. Misra
R. K. Batra	E. A. Nadirshah
K. G. Bhate	D. B. Nagarkar
M. N. Bhuyan	K. K. Nambiar
M. S. Bisht	K. Narasimha Rao
S. N. Chakravarti	Brig. Partap Narain
C. J. Fielder	L. R. Patel
N. P. Gurjar	V. N. Rangaswami
Hari Shankar Sharma	M. S. Thirumale Iyengar
S. B. Joshi	H. Sunder Rao—Secretary
	J. M. Trehan (Elected Secretary at this meeting *vide* item 3.)

The following co-opted Members attended:

K. F. Antia	S. R. Mehra
H. S. Batliwala	T. Mitra
W. A. Griffiths	N. V. Modak
K. M. Kantawala	B. N. Shenoy
H. P. Mathrani	B. V. Vagh

The following attended by invitation:

U. J. Bhatt	Vepa Krishnamurthi
N. K. Bhonsle	E. S. Nair
P. C. Chopra	J. P. Singh
S. R. Ghadoke	K. Subba Rao

H. Sunder Rao [Name added by the Council to the list of invitees after Election of office bearers (item No. 3)]

Item 1. Appointment of Convenors of Committees and Sub-committees:

The Convenors of Committees and Subcommittees were appointed as under:—

Specifications and Standards Committee.	G. M. McKelvie
Bridges Committee.	H. P. Mathrani
Technical Subcommittee:	
(i) Test Track Division.	Chief Engineer W. Bengal (T. Mitra)
(ii) Research Organization Division.	K. S. Raghavachary

Road Transport Subcommittee.	F. P. Antia
Bullock-cart Subcommittee.	B. V. Vagh
Soil Research Subcommittee.	S. R. Mehra
Education Subcommittee.	V. N. Rangaswami
Bituminous Treatment of Wet Aggregates Subcommittee.	W. A. Griffiths
Highway Layout Subcommittee.	H. S. Batliwala
Provincialization of Local Bodies Engineering Services.	S. K. Sinha
Papers Subcommittee.	G. M. McKelvie
Manufacture of Road Making Machinery & Mechanization.	H. P. Mathrani
Organization Committee.	G. M. McKelvie

Item 2. Confirmation of the 34th Council meeting.

The Minutes of the 34th Council meeting held at Bombay on the 14th January 1950 were confirmed.

Item 3. Office Bearers.

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

President	Romesh Chandra
Vice-Presidents.	A. C. Mukerjee
	N. P. Gurjar
	S. B. Joshi
Hon. Secretary.	J. M. Trehan

The Council placed on record their great appreciation of the work done by Shri H. Sunder Rao during his tenure of office as Secretary.

At this stage, the newly elected President, Shri Romesh Chandra, took the Chair.

Item 4. Venue of the next General Session.

The Executive Committee was authorised to fix the venue and date of the next Session of the Indian Roads Congress.

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Tour notes of the

FOURTEENTH INDIAN ROADS CONGRESS

Bombay, January 1950.

I. THE ROADS IN THE CITY OF BOMBAY

Inspected by the delegates on 18. 1. 50.

Introduction. Total lengths of City roads and the types.

There are about 269 miles of roads in Bombay City. The surface types are :

3″ sheet asphalt in two courses on cement concrete (1: 3: 6) foundation 6″ thick.	...	52 miles.
Sett stone pavement on cement concrete foundation.	...	10 ,,
All concrete roads (1: 2: 4) 6″ thick or with 9″–6″–9″ section.	...	30 ,,
B. T.	...	171 ,,
Macadam.	...	6 ,,
	Total :	269 miles

Condition of roads in the city.

Before the outbreak of the war, a large area of sheet asphalt surfaces had become due for renewal as they had finished their estimated service life of 15 years. Due to inadequate maintenance and the heavy army traffic during the war their condition became still worse. It was found in 1947 that out of a total area of 9,94,300 square yards of sheet asphalt, nearly 7,56,300 sq. yds were in need of renewal. Similarly, out of the total area of 31,72,920 sq. yds. of bituminous construction, an area of about 14,05,929 sq. yds. was in need of renewal.

Different methods of treating sheet asphalt surfaces.

The speed of renewal was governed by the capacity of the municipal asphalt plant at Worli which could renew about 500 sq. yds. of sheet asphalt surface per day or about 1,00,000 sq. yds. per year as the Plant could be worked only during fair weather. At this rate, it would have taken about 8 to 10 years to renew an area of 7,56,300 sq. yds. The problem was how to speed up renewals to bring up the surfaces to a tolerable condition in a reasonably short time. It was decided to entrust the work to a contractor owning a suitable plant, who could salvage a large portion of the deteriorated asphalt material by re-treatment so as to keep down the costs. Negotiations were opened with Messrs. 'Recondo' and the renewal of 1,60,000 sq. yds. of sheet asphalt

area with 'Recondo' was entrusted to them. They started work in October 1948 and by December 1949 had renewed 1,41,000 sq. yds. The surfaces treated by this method had been found satisfactory.

Details of process.

The 'Recondo' or 'reconditioned' asphalt is a process of reviving the life of the asphalt surface and is carried out as under :—

A preliminary examination of the existing surface is made with a view to ascertaining whether it can be reconditioned. The old surface is then dug up, removed from the road, crushed, re-heated and re-constituted at a minimum temperature with the addition of new bitumen and fresh mineral matter to obtain a mixture adequate to withstand the climatic conditions and traffic demands. The reconstituted mixture is then relaid and consolidated with a power roller in the usual way.

The surface is laid in two courses of the following composition :—

	1½ in. Binder Course.	1½ in. Wearing Course.
Bitumen	7.50%	9.20%
Metal	45.00%	40.00%
Sand	36.50%	40.00%
Filler	11.00%	10.80%
	100.00%	100.00%

The average cost of re-conditioning is about Rs. 8 per sq. yd. against the cost of a new surface viz. Rs 10 per sq. yd. giving a saving in cost varying between 15 to 20 per cent.

The plant consists of :—

(1) Crushers.
(2) Conveyor belt for the crushed material.
(3) Bucket Elevator.
(4) Drier.
(5) Asphalt mixing plant.
(6) Dust extractor.

The 'Recondo' surface is of the asphaltic concrete type, and was first laid in 1948. It appears to be hard and nonskid and according to present expectations, it should last for about 15 years but a valid comparison cannot be made without experience extending over a sufficiently long period.

Renewal of surfaces with sheet asphalt (fresh)

in two courses, the binder or the bottom course 1¾" thick and the top or wearing course 1¼" thick.

The proportion, by weight, of the materials used is as follows :—

BINDER COURSE

Bitumen.	4.50%
Fine Aggregates. (sizes less than 3/16")	26.50%
Larger Aggregates. (Sizes 3/16" and above)	69.00%
	100.00%

WEARING COURSE

Bitumen.	11.00%
Filler Powder.	14.50%
Fine Aggregates.	74.50%
	100.00%

The cost per sq. yd., complete including excavation etc., works out to Rs. 10/.

Providing a sealing coat of pre-coated chips.

While examining the surfaces of the Sheet Asphalt Road for fixing the priority for renewal, it was noticed that some of the sheet asphalt surfaces though cracked or uneven at places could be made to give a longer life if their surfaces were covered with a sealing coat. A ¾ in. to 1 in. layer of pre-coated chips was tried for a short length in the hot weather of 1948 to find out the performance of such treatment during the monsoon. As this method proved fairly satisfactory, it was adopted not only for sheet asphalt surfaces but also in the case of other bituminous types.

In this treatment, the proportions are :—

1/2" chips	4 Cft.
Grit	2 ,,
Bitumen	28 to 30 lbs.

These materials are mixed in a small mixer of the puddle type. A drier has been ordered to heat the chips. The mixing of materials takes 5 minutes per batch and 14 batches make one lorry load. The daily output is sufficient to cover an area of about 500 sq. yds. The temperature of the mix is 300°F. The cost of spreading and laying inclusive of materials comes to about Rs. 2-8-0 per sq. yd.

ASPHALT PLANT AT WORLI. The Asphalt Plant at Worli was purchased in the year 1939 at a cost of Rs. 65,222. has a capacity of 12 tons per hour, to cover an area of 7.2 sq. y 3" thick and comprises of the following :—

(1) **Boiler** :— Locomotive type of 12 H. P. : Work pressure 150 lbs. per sq. inch.

(2) **Engine** :— Single cylinder, non-condensing, high spe enclosed type steam-engine of 40 B. H. P.

(3) **The Drying Drum** :— Revolving type with chan flights inside for raising and spilling the material. It is heated fuel oil burners fed from an oil tank on the top of the drum. hot gases pass first round the drum, then through it and finally charge through the suction fan of the dust extractor into the ch ney.

(4) **Cold Elevator** :— Bucket and chain type. It rai and discharges the cold aggregate into the drying drum through chute.

(5) **Hot Elevator** :— It lifts the hot aggregate from drying drum to the screen at the top. It is of the same type the cold elevator, except that it is encased by steel plates to p vent loss of heat and works faster.

(6) **Screen** :—It consists of a revolving screen fitted w screen plates with holes punched according to the grading of aggregate required.

(7) **Storage Bin or Hopper** :— The hot aggregate, af it is screened, discharges into a hopper which has two compartmer one for sand, and the other for metal, corresponding to the secti of the screen above. These compartments are fitted with slid doors and hand levers for the discharge and control of the agg gate. They are arranged in such a position as to allow the mate to flow direct into a fixed measuring box situated beneath hopper and over the mixer box.

(8) **The Weigh-Bridg** is of the suspended type and has f beams for weighing separately the tare weight of the bin, and t of the three different aggregates. Sliding indicators are attac to beams to adjust the position according to the weights requir

(9) **The Asphalt-Melting Tanks** :— There are two me ing tanks each of about 2,000 gallons capacity which is sufficie for one full day's work. One tank is in use at a time.

(10) **Bitumen Lifter**:— In order to lift the melted asphalt to the mixing platform a pneumatic bitumen lifter is provided. This consists of a steam-jacketted closed cylindrical reservoir. Melted asphalt through a non-return valve flows first into the lifter by gravity, and is forced up the delivery pipe with compressed air at 25 lbs. per sq. inch The air compressor is capable of compressing air upto about 100 lbs. per sq. inch to lift the heavier natural asphalt, and is provided with a compressed air reservoir.

(11) **Mixer:** It is in the form of a box open at the top with a sliding door at the bottom. The box has a capacity of 800 lbs. and it is provided with a steam jacket to keep the contents at a uniformly high temperature throughout the process. The inside of the box is provided with renewable special-wearing hard manganese steel liners. For mixing, two parallel shafts running at 6 r. p. m. in opposite directions are provided with mixer blades of renewable manganese steel.

(12) **Dust Extractor Plant**:— It consists of a duct line of 18 in. diameter taken from the heating furnace to a suction fan of 18 in. diameter running at 960 r. p. m. From the duct the dust is collected by gradual settlement through a special downward flow spiral passage, volatile gases passing into the chimney above.

II. INSPECTION TOUR TO GANGAPUR DAM NEAR NASIK.

General:—The G. I. P. Railway authorities had arranged a special train for the delegates from Bombay to Nasik. The journey on the 19th January 1950 from Nasik to Gangapur Dam and back to Bombay was performed in Bombay Transport buses.

This earth dam across the river Godavari is under construction for irrigating the lands in the Godavari Valley. The site of the dam is situated at 8½ miles from Nasik just below the confluence of rivers Godavari and Kashapi.

After considering various alternative sites, it was decided to construct the dam in earth at the present site because it offered good arrangement for the temporary spill way which would be required during the construction and offered a good site for the permanent waste weir. The decision to adopt earth work for the entire construction was influenced primarily by the deep foundations required for the masonry dam. In addition, the all earth dam was found to be cheaper by about 60 lakhs and was considered easy from the construction point of view, as it would require only one type of equipment viz., Earth Moving Machinery. The masonry dam would have been more difficult of construction in these days particularly as it would have required a large force of masons and labourers. The question of labour housing would have been particularly difficult.

The project provides for utilising most of the supplies on the high level canals starting off the dam.

The dam will be 12,000 ft. along with a waste weir of 600 ft. on the Left Flank. The lake will hold 7,200 Mcft. of water when the work is complete. The dam will be 120 ft. high above the river bed which is at R. L. 1895. A free board of 7 ft. up to the crest of the dam is provided for. The top of the dam is 30 ft. wide (vide cross section on p 476). The slopes vary from 2 : 1 at the top to 3 : 1 at the bottom on the Left Flank. The hearting slopes are at 1 : 1 on either side. The upstream face is protected by a 2½ ft. dumped rubble pitching backed by 6" of metal and quarry spalls.

The hearting is being constructed of selected clay which is found to be adequately impervious and gives satisfactory shear values. The local soils suitable for this purpose are coarse murum and *man*. The area near the dam, about 1,000 ft. upstream and downstream, has been surveyed for quarries for these materials. Soils having permeability less than 10 cms. per sec. per unit gradient, shear equivalent to tan θ=0·35, and cohesion not less than 150 lbs. per sq. inch are selected for the hearting.

The casing is made of murum which is available in plenty near by. The upstream 2/3rd section of the hearting comprises of selected good clayey materials. At the outer edges of the casing selected hard murums are placed.

Compaction is being carried out by sheepsfoot rollers and tractors. The sheepsfoot rollers give an intensity of 350 lbs. per sq. inch. A close watch on the moisture and compaction is being kept with the help of a Soil Mechanics Laboratory which is set up on the job. Density equivalent to 95 per cent of those obtained at optimum moisture and at American High Way Officials Standard Compaction is considered adequate. It is interesting to note that the densities obtained are higher than those of the soils in their natural condition in the borrow pits.

The stability of the enbankment is analysed by the slip circle method. Factors of safety of 1·3 for the upstream slope against a quick draw-down and 1·5 for the down-stream slope against steady flow conditions are specified. On account of the weaker foundation on the Right Flank the section of the dam has to be wider so as to be within the strength of the foundation materials to give an adequate factory of safety. Direct shear tests are being carried out to find the strength of the enbankment materials and unconfined compression tests and triaxial shear tests are being carried out to find the strength of the foundation materials.

The permanent waste weir is designed for the incoming floods 81,000 cusecs, flowing for 7 hours 20 minutes. After deducting the flood absorptive capacity of the lake, a provision against 48,000 cusecs is made at the spill way. In addition, a breaching section is provided on the Right Bank.

The risk of the dam being breached during construction is reduced to a minimum by providing a temporary waste weir channel, 450 ft. wide, located in hard rocky material. It is proposed to complete the gorge portion from river bed to R. L. 1950 in one year so that the river will flow for the monsoon through this temporary channel. The quantity of earth work required to fill in the gorge up to this level is 25 Mcft. which is considered to be well within the plant capacity during one working season.

The total earth work involved in the construction of the dam is 120 Mcft. Commencing in 1949 it is proposed to complete the work in four years with the aid of modern earth moving equipment which in the main comprises 12 Scrapers, 12 15 cu. yd. capacity, 14 tractors (90 to 130 h. p.), and one $\frac{3}{4}$ cu. yd. shovel. A few 15/17 cu. yd. capacity rock carriers are also purchased to handle about 8 Mcft. of rock from the waste weirs.

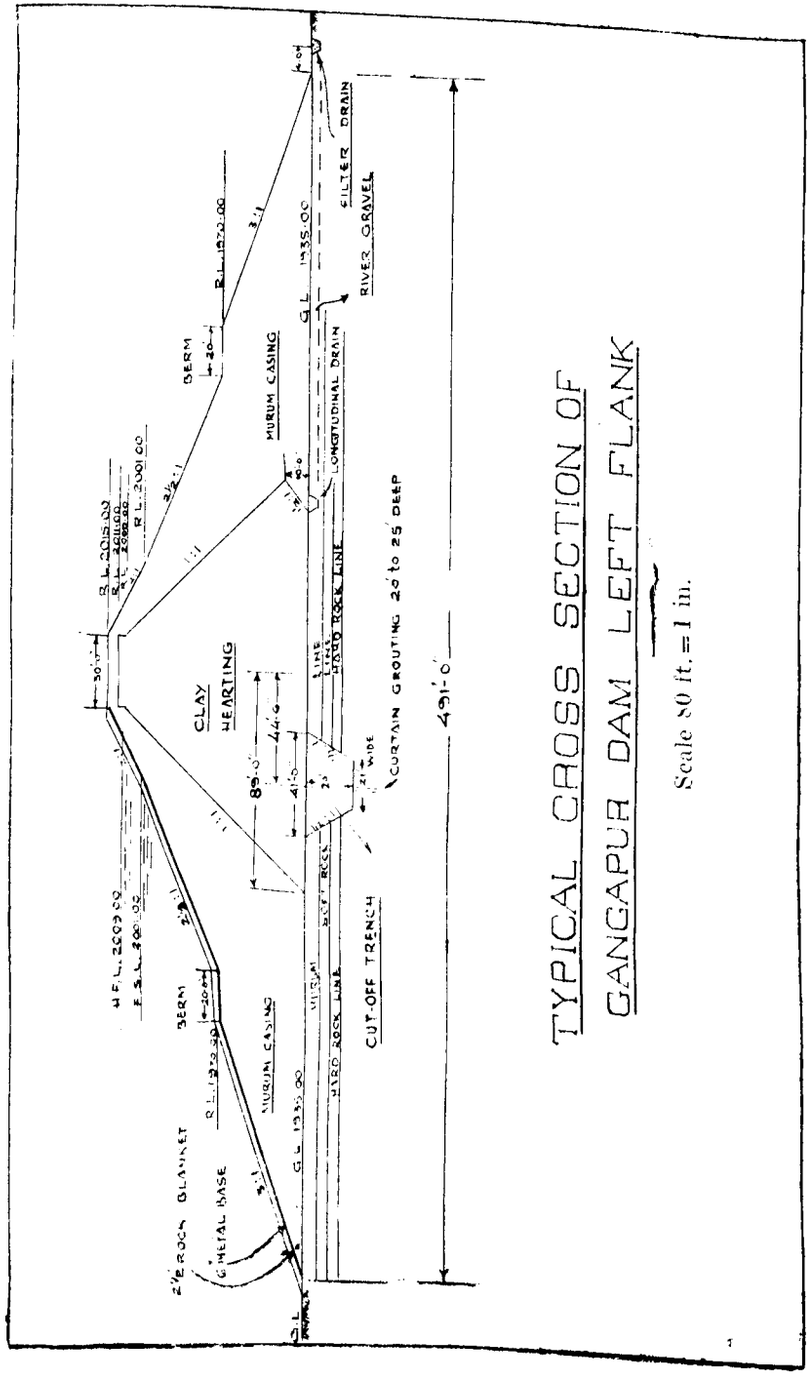
The two irrigation outlets, one on either bank, are located on rock foundations.

The cost of the work is estimated at Rs. 235 lakhs. inclusive of overheads, land acquisition, etc., which account for about 85 lakhs.

The work on the dam was begun in March 1949 and suffered from great handicaps in the beginning due to insufficient equipment, unskilled operators, inadequate strength of technical personnel and unfavourable weather. A production of over 1,000 brass per day is being achieved now by working two shifts.

A number of workshops are set up at the dam for the maintenance of the equipment.

A township has been set up near the dam to house about 500 families, and provides most of the modern facilities such as electric light, water supply, school. hospital, etc.



III. THE VAITARNA WATER SUPPLY SCHEME.

(Inspected on January 20th 1950.)

Introduction:— Piped water supply was introduced in the City of Bombay in the year 1860 by the construction of the Vehar lake. As the demand for water increased due to the increase in population and the expansion of industries, two additional sources —Tulsi and Tansa lakes—were added. The overflow of the Tulsi lake runs into the catchment of the Vehar lake. Tansa, the major source of supply was developed to its present capacity of 90 million gallons per day in three stages.

The total capital expenditure incurred on the water works of the city amounts to about Rs. 9½ crores and maintenance, including interest and sinking fund charges, amounts to about Rs 68 lacs per annum.

Defects in the Existing Water Works:— The present supply is not only inadequate to meet the present requirements of the City even when the lakes are full at the close of the monsoon but it is also unreliable as it is entirely dependent upon the vagaries of the monsoon. The total dependable supply from the Tansa lake would be only 57 million gallons per day and that from the remaining two lakes 15 million gallons per day making a total of 72 million gallons per day.

The present population of the City including the suburbs served by the City's Water Works is estimated roughly over 30 lacs. New industries are springing up in the suburbs and a great demand for water is being created. Time has also come when the City's limits should be extended to include some of the suburban areas to ensure their development on right lines. For this purpose, a Master Plan for the Greater Bombay Region has been prepared and is receiving the attention of the Government of Bombay. A stock was, therefore, taken of the immediate and future requirements of the City and the Greater Bombay Region and it was found that any scheme for the augmentation of the City's water supply must be capable of increasing the present dependable supply of 72 million gallons per day immediately to 160 million gallons per day, to 200 million gallons per day in the course of the next 10 years and ultimately to 440 million gallons per day at the end of 25 to 50 years.

Out of a few alternative schemes for achieving this objective the choice fell on the Vaitarna river scheme from the economical and utilitarian points of view. When the scheme was examined from the hydrographical and geological points of view, it was found that it would be economical to take full advantage of the

potentialities of the Vaitarna river from the very commencement by increasing the storage there to obtain a combined supply of 220 million gallons per day, the estimated requirements of the City in the course of the next 10 years.

General outline of the scheme undertaken :—To obtain a combined supply of 220 million gallons per day from the two lakes it was found that a useful storage capacity of 46,000 million gallons had to be provided for the Vaitarna lake to supplement that which had been already provided by the present Tansa lake.

For this the Full Supply Level of the lake will have to be kept at R. L. 535, about 113 ft. higher than the F. S. L. of the Tansa lake. The shape of the waterspread of the Vaitarna will be a narrow expanse. It will extend about 12 miles in the Vaitarna river and a few miles into the tributary river Kengri.

Tunnel :—It is proposed to drive a tunnel of 10 ft. diameter from the Vaitarna lake to the Tansa lake, a total distance of 4½ miles to bring water from the Vaitarna into the Tansa lake.

Pipe lines :—In addition to the tunnel, a 96 in. diameter pipe line will be required to be laid over a distance of 40 miles.

Details of the Scheme :—The scheme now under construction comprises the following main works :—

(1) Construction of a cement concrete dam across the Vaitarna river of adequate height to impound the requisite storage. (Consumption of cement estimated at 1,20,000 tons). The removal of overburden is in progress ;

(2) A tunnel to convey Vaitarna supply to the City either directly as mentioned at (4) below or else through the Tansa lake ;

(3) Laying of a 96 in. diameter pipe line from Tansa to Powai, a distance of 40 miles ;

(4) Laying of an independent 96 in. diameter pipe line 6½ miles long from the end of the tunnel to meet the pipe line from Tansa ;

(5) Constructing two more balancing reservoirs and remodelling the distribution system of the City ;

(6) Constructing additional relief sewers in Bombay and providing adequate pumping units at the various sewage pumping stations to deal with the extra discharge.

The scheme works can be broadly classified under two heads, viz. :—

A. **Preliminary Works** :—(1) Approach Roads to the dam site and to the tunnel faces.

(2) Ramps and boats for transporting materials, etc., across the Tansa lake.

(3) Temporary and semi-permanent quarters for the staff.

(4) Water Supply :—The construction of three weirs for water required in the construction work.

These weirs are being constructed by a new process which consists of preparing an emulsion of cement, sand, and water by a mechanical stirrer and pouring the emulsified grout into the properly hand packed dry rubble wall. Rising in 2 to 3 foot lifts, with well-made concrete faces, the construction ensures a solid and impervious structure. During construction a portion was purposely pulled down to inspect as to how the grout travelled and also to ensure that all voids were filled in. The results of tests were found to be satisfactory.

(5) The Amenities provided are a Police Guard, a Post Office, a Telephone, a Primary School, a Dispensary, an Anti-malarial unit, and a Shopping Centre : (restaurants, grocery shops, grinding mills, a fish and vegetable market, and a dairy).

B. **Major works** :— The principal Major Works in progress are :—

(i) Driving of tunnels ;

(ii) Construction of embankment and laying of pipes.

Tunnels :—The work of driving a tunnel (10 ft. diameter 'horse-shoe' type) is estimated to cost Rs. 1·38 crores. The total length of the tunnel, about 21,000 ft., consists of the following three sections :—

Between faces no. 1 and 2 ... 8,716 ft. (in progress)
,, ,, ,, 3 and 4 ... 1,875 ,, (completed)
,, ,, ,, 4 and 6 ... 9,675 ,, (in progress)

The tunnel has an inlet channel some 400 ft. long and a tail channel at the Tansa end about 3,000 ft. long. During the progress of the work of excavation of tunnels, when the excavation

had proceeded to a considerable length, the working conditions inside became unsuitable for various reasons, such as mucking, bad ventilation, etc , which pointed to the necessity of sinking a few shafts at suitable places. Permission was, therefore, granted to the contractors to sink a few shafts, the work on which is in progress.

Construction of Embankment and Pipe Laying Works:— The work of widening the formation from Tansa to Powai for accommodating the proposed 96 in. diameter steel pipe line is estimated to cost Rs. 72.6 lakhs. The following figures will show the extent of work done so far:—

Nature of work	Total quantity of work to be done	Work done up to 1-12-1949
(1) Cutting and Embanking	1,20,000 Brass.*	45,000 Brass
(2) Rock Cutting	22,000 ,,	1,500 ,,
(3) Culverts extended	243 Nos.	60 Nos.
(4) Overbridges to be rebuilt	39 Nos.	Nil
(5) Cost of work	Rs. 68,00,000	Rs. 10,00,000

Commenced January 1942. To be completed: June 1950.

Surveys & Investigations (1) *Preparation of contour map of Vaitarna Valley*—As it was necessary to work out correctly the contents of the Vaitarna lake formed by the proposed dam, the work of preparing the contour map of the Vaitarna Valley is in hand by aerial survey.

(2) *Plotting out the F. S. L. Contour*:—To enable clearing of the jungle, in the basin of the river, which would be submerged as the lake level rises to F. S. L. Total perimeter at F. S. L. about 53 miles; 28 miles marked out.

(3) *Hydrographical and Rainfall survey*:—Rain gauges have been established in the catchment area: and data as regards hourly rainfall, intensity, and duration are being collected. Weather information such as humidity, hourly change of temperature,

*One brass = 100 cu. ft.

maximum and minimum temperatures is also being collected at the dam site. The work of collecting additional data such as evaporation losses, rainfall in other parts of the catchment area remains to be taken in hand.

(4) *Geological survey*:—Thirty-one bore holes were taken (20 along the dam site and 11 at the two flanks) and the cores obtained from them were examined and tested. The samples from various cores were tested for crushing strength. Seven bore holes were also taken along the tunnel line to ascertain the type of strata that would be met with. The borings indicated that both along the dam site and along the tunnel alignment the rock that would be met with, would be suitable for foundation as well as for tunnel driving except at three places where welded tuff was met with.

(5) *Hydraulic experiments*:—A series of experiments were carried out at the Central Waterways, Irrigation and Navigation Station at Khadakwasla, for determining the design of the hydraulic structures.

Fourteenth Session of The

INDIAN ROADS CONGRESS

Technical Exhibition, Bombay, January 1950.

The exhibition was declared open at 2-30 P. M. on the 15th January 1950 by the Hon'ble Shri K. Santhanam, Minister of State for Transport and Railways, Government of India.

The following Organizations took part in the exhibition organized by the Indian Roads Congress. Brief particulars of exhibits are recorded below for the benefit of our readers.

1. **Government of India: Roads Organization.**

(*a*) *Statistical:* Expenditure and sources of expenditure on roads; revenue from motor spirit; revenue from motor transport; production and despatches of cement in India.

Graphical presentation of data of road accidents in Delhi; etc.

(*b*) *Standards*: Charts on standard Nomograms; Pocket Discs of Curve Standards; Standards on Land Widths, Building Lines, and Controlled Widths, etc., and Plans showing proposed improvements to some road junctions in Delhi.

(*c*) *General*: Maps showing roads in India during Hindu, Muslim and British periods. A map entitled "Our India" illustrating service rendered by Roads to Agriculture and Industries, etc.

Publications of statistical interest including copies of "Basic Road Statistics of India, 1948".

2. **Ministry of information & Broadcasting. Publications Division**: Literature and Publications.

3. **Bombay**: Local road material and valuable mineral products: Photographs; Index plans and statements of Post-war Road Planning for each District, Report on cheap and durable roads 1938. Type designs of culverts and bridges.

4. **Punjab**: *Exhibits from Soil Research Laboratory, Karnal*: Various types of soils found in India; Soil structure and particle size distribution of soils, Preliminary survey for stabilized soil construction; Optimum Moisture and Density Relation. Sectional pieces of stabilized soil road showing effect of binders on soils; Field laboratory equipment, etc.

Cement soil road sections surfaced and unsurfaced. Black cotton stabilized soil sections: photos of stabilized soil houses etc.

5. **Madras**: *Exhibits from Soil Research Laboratory, Highways Department, Madras:*

Scale model cross sections of (i) a road in water logged country, (ii) a road showing a common failure of macadam road owing to inadequate foundations and (iii) an existing road with heavy traffic proposed for cement concreting.

Apparatus manufactured in Highways Department, Madras and a model of a skew arch showing method of construction.

6. **Bengal**: Scale model of Kosmor Bridge in Bengal.

7. **Madhya Bharat**: A map showing proposed roads.

8. **Firms**:

*M/s. Armco (India), Ltd., CALCUTTA.
M/s. William Jacks & Co. Ltd., CALCUTTA.
M/s. Larsen & Toubro, BOMBAY.
M/s. Associated Instruments, BOMBAY.
M/s. Standard Vacuum Oil Co., BOMBAY.
M/s. Greaves Cotton & Co., BOMBAY.
M/s. B. K. Khanna & Co., NEW DELHI.
M/s. Shalimar Tar Products, CALCUTTA.
M/s. Cement Marketing Co., BOMBAY.
M/s. Millars Timber and Trading Co., BOMBAY.
M/s. Blackwood Hodge, NEW DELHI.
†M/s. Precious Electric Co., BOMBAY.
M/s. Marshall, Sons & Co. (India) Ltd., CALCUTTA.
M/s. Balmer Lawrie & Co., Ltd., BOMBAY.

Displayed Catalogues, charts, photos, models and in some cases actual machinery for the construction of roads and bridges; latest surveying and mathematical instruments testing machines, etc., were on display.

*Members of the Indian Roads Congress who are interested in the catalogues, of M/s. Armco (India), Ltd., may write to them (No. 21, Esplanade Mansions, Calcutta.

†The lighting in the exhibition was by M/s. the Precious Electric Co., who did it *free of charge* and made the exhibition brilliant and attractive.

LECTURES AND TECHNICAL FILMS

Lectures: An interesting lecture on "Pre-stressed Concrete' was given by Dr. K. F. Antia, Deputy Chief Controller of Standardization, Central Standards Office for Railways, Government of India, New Delhi.

Technical Films: The following technical films on road engineering subjects were shown:-

(1) *Government of India, Roads Organization:*

(i) Pennsylvania Turnpike
(ii) Building a Highway
(iii) Arteries of the City
(iv) Horizons Unlimited
(v) Boulder Dam
(vi) Road for San Pablo

(2) *M s. Larsen & Toubro, Bombay:*

(vii) Material on the Move on 'Caterpillar' Scrapers.
(viii) Link-Belt speeder shovel cranes

(3) *M s. Armco (India) Ltd., Calcutta:*

(ix) Assam Rail Link Construction

(4) *M/s. William Jacks & Co., Calcutta:*

(x) Austin-Western 99-H Power Grader

(5) *Indian Roads and Transport Development Association:*

(xi) Kuruvandi Road

(6) *M/s. Caltex (India) Ltd., Bombay:*

(xii) & (xiii) Two interesting films on the importance of lubrication in the maintenance and use of earthmoving machinery.

(7) *M/s. B. K. Khanna, New Delhi:*

(xiv) Films on earthmoving machinery.

Discussion on Paper No. 142.

"Failure of a Five Span Masonry Arch Bridge across the Bhogeswari River near Pen, District Kolaba in the Province of Bombay."*

By

K. G. BHATE

Monday, January 16 1950.

Shri N. P. Gurjar (Chairman) called upon Shri **K. G. Bhate** (Author) to introduce his Paper

Shri K. G. Bhate (Author) traced the genesis of his Paper to the Trivandrum (11th) Session where Members were invited to contribute Papers on bridge failures for educational purposes. He did not, however, look upon the collapse of this bridge as a failure at all. The bridge was at least 70 years old when it gave way.

Amplifying the geological description of the Deccan trap given in para 8. 12, the Author described how the trap was found to exist in layers, each layer being divided into three zones. Due to erosion it often happened that zone No. 3 (hard rock) was seen on the banks but the softer zones No. 1 and 2 of the next lower layer might occur in the bed of the stream, or the erosion in the bed might have gone almost to the bottom of zone No. 3 of the lower layer. It sometimes happened that the piers were founded on such bed rock assuming that it existed as a thick stratum. This assumption had apparently been made in the foundations of a bridge he had recently examined near Poona. Even though rock was exposed it was necessary, in trap areas, to take a boring at least 10 feet deep into the rock to make sure of the depth of the stratum.

In most of the old bridge failures examined by him, the main cause was that the waterway provided was insufficient because the engineers of those days did not have sufficient data. It was really to the credit of the engineers of old that the structures designed with little or no data had stood so long.

There was no such thing as an absolute maximum highest flood. Any known past high flood might be surpassed by some flood in the future. This observation had led, in foreign countries, to a study of flood frequencies and their bearing on the economics of engineering structures. In the case of a storage reservoir, where failures might lead to a disastrous loss of life and property, the

*Published at pages 21 to 46 of V. XIV-1 of the Journal of the Indian Roads Congress, September 1949.

structures would probably be designed for a flood having a 1000-years frequency. A bridge in a city area might perhaps be designed for a flood with a 500-year cycle; and for designing highway bridges in general, a 50-year flood might do.

A typical frequency chart showed the following relations :-

Frequency of flood	Discharge expressed in terms of 50-year frequency flood as base
1,000 years	250
500 years	200
100 years	125
50 years	**100**
10 years	60

The clear waterway through the bridge discussed in his Paper was, at the time of failure, actually much less than 60 per cent of the natural unobstructed waterway of the river.

The practice followed in determining waterway in new designs in the Bombay State was not to cause an obstruction of more than 20 per cent.

In the case of rivers where the normal flood was carried by the main river gorge, it was usual to bridge the gorge portion completely. The approaches were graded down to the natural terraced bank so that an extraordinary flood, say a "100-year" flood, might overtop the embankment and breach it but cause no damage to the bridge structure.

Where, however, as in the case under consideration, the river had no terraced banks, but was passing through a deep gorge, the question of clearance was all the more important. In such a case, local conditions such as the possibility of big floating trees coming down with the flood should be considered and a greater clearance provided than that laid down in the Indian Roads Congress Code of Practice for Road Bridges. The chances of the waterway getting blocked by debris should be eliminated as far as possible by adopting big spans with liberal vertical clearances.

In calculating flood velocities and discharges they usually in his State did not take account of the fact that, where a river rose rapidly, the velocity and the discharge were maximum at a stage a little lower than the peak level when the stream level was steady. Sir William Willacks had given the following figures for the Tigris river :—

15 ft gauge, when rising	1,80,000 cusecs
20 ft gauge, at peak	1,20,000 ,,
15 ft gauge, falling	90,000 ,,

Figure 4 on page 26 gave some idea of the rapid rise in the river described in the Paper. A river like the Tigris would not rise so rapidly as a hill stream like the Bhogeswari. The calculated velocity of 18 ft per second and the flood discharge of 46,600 cusecs on the assumption of steady flow was, therefore, an underestimate. The Author was inclined to increase it by at least 50 per cent.

In his studies of some other bridge failures the Author had noted two defects in maintenance which had possibly contributed to the collapse :—

(1) Washing out of mortar from the pier masonry.

(2) Tree growth.

In one case, the stones in the hearting of piers were found to be absolutely without any mortar left adhering to them.

Periodical inspection of foundations by actual probing was necessary. A regular authentic record of the measures undertaken from time to time should be kept.

In 1947 there were some failures in his State of some small arched culverts. The arches were of plain cement concrete. Big pieces, 30 to 50 sq. ft in area, of 15 in. thick arches were carried away to a distance of 200 feet or so. The effect of swiftly flowing water in lifting up huge flat bodies was well known. It was, therefore, not only necessary to ensure sufficient weight by reducing voids but penetration of water, and consequent uplifting, should be guarded against by having a homogeneous compact masonry mass acting as a solid.

The Author was not aware of any arch bridge having failed from the causes usually assumed in designing. The probability of simultaneous occurrence of the conditions assumed in design was generally rare. Very close attention was paid to the structural design but this fundamental factor, the discharge for which a bridge was to be designed, was left almost to guess work. It was necessary to maintain stream flow records by meters and observation of hydraulic gradient in high floods. These data would help to establish the co-efficient of rugosity and to evaluate the flood velocities and discharges at the different stages of a river.

Exhaustive research on the resistance of river beds to erosion with reference to velocity, duration of flood, and structure of rock met with, was also necessary.

Shri M. G. Oza said that the river had a thickly wooded, and steeply hilly catchment of 46 square miles with an annual average of 115 inches of rainfall, if the records at Pen were taken to represent the whole catchment.

From the rainfall graph for the years 1875 to 1947, it could be seen that a maximum annual rainfall of 164 inches was recorded in the year 1933 and still the bridge had stood. Even in 1946, it would be seen that on the 29th August there was 6·3 inches of rainfall and the same amount of rainfall was again recorded on 9th September, the date of the collapse. This gave an indication why the bridge had failed.

The bridge had withstood all the previous heavy floods, because the catchment was then thickly wooded and had acted as a balancing reservoir allowing the rain-water to come to the bridge site slowly without causing high floods.

During the recent war years, many forests were laid bare by indiscriminate fellings. The de-forestation resulted in increased discharge and this led to the failure of the bridge.

The first heavy rain on 29th August had completely saturated the catchment and the second rainfall of equal intensity on the 9th September proved disastrous because the whole precipitation came to the bridge site and that too simultaneously due to the peculiar shape of the catchment area.

The failure of the bridge was due not to any structural defects but to hydraulic and geological factors which sometimes do not receive sufficient attention but are vital to the stability of the structure. In the case under discussion, the waterway had been restricted unnecessarily. The obstruction due to the bridge structure should not be more than 15 to 20 per cent of the natural waterway.

The arch provided the most economical bridge form. If the shape of the arch were selected properly it would be wholly in compression. The materials of which the arch was generally constructed viz., stone, brick, plain concrete, etc., were suitable for high compressive stresses. In the case under discussion, the dead load had induced only compressive stresses and the live loads that might have passed over the bridge were not likely to be heavy enough to induce tensile stresses. The Author had mentioned "Fatigue" in relation to modern heavy traffic loads. This would not apparently apply to arched structures; there were arched bridges in existence which were over 200 years old.

The present failure of the bridge was due to inadequate waterway which led to the scouring of the foundations. The bridge might have withstood the pressure due to velocity but pier No. 4 failed due to the undermining of foundations.

On page 27, para 5.3, it was stated that the bridge was designed for H. F. L. 103. 25, while on page 28 it was stated that

"the exact year of construction of the bridge was not known and no recorded plans were available." It was not clear how the Author had got the design H. F. L. as 103. 25.

Shri. Oza wanted to know the values used by the Author (vide para 7.1 (b), page 33) for

(i) the co-efficient of friction between flowing water and the bridge;

(ii) the suction effect on the downstream side of the bridge;

(iii) reduction in waterway due to floating debris.

Shri Oza also wanted to know whether the pounding effect of heavy timber floating down and dashing against the structure had been taken into consideration.

Shri E. A. Nadirshah remarked that the description of the conditions which led to the failure of the Bhogeswari Bridge gave very useful information to a bridge builder. The first point that struck the reader while studying the Paper was the lack of reliable data as regards rainfall, run off, etc., available to engineers. This difficulty was particularly felt in the case of rivers just emerging from hill and forest areas. The speaker suggested that the authorities should take some steps to fix rain gauges in the upper reaches of hilly and wooded catchments and that the I. R. C. Council might take up this question with the authorities concerned.

Regarding the bridge site, Shri Nadirshah wanted to know if the sudden change of curvature in the course of the river about 600 feet downstream of the site of the bridge (Fig. 5, page 28) had made matters worse by obstructing the free flow of flood waters through the bridge. In his opinion, this must have obstructed the free discharge considerably.

It was interesting to observe (para 5·4) that the results of the empirical formula of Inglis and Kutter's Channel Formula, with H. F. L. at R. L. 106, were in close agreement. For parallel conditions, the use of Inglis formula would therefore be advisable, but the speaker's personal experience showed that the Inglis formula always gave a high figure.

Regarding the foundations, it was surprising how piers numbers 3 and 4 were made to rest on soft rock when a little extra depth would have taken the foundations to the hard rock below. Such a mistake was not probable and it was practically certain that after sixty years the original rock had disintegrated. He recommended all concerned to make a note of the deceptive

appearance of the second zone of Deccan trap while adopting shallow foundations. A close study of the exposed trap in the vicinity was always necessary.

The old practice of cutting down the weight of the structure by keeping the haunches hollow might be correct from the view point of reducing the weight on the foundations but, when there were high horizontal forces due to flood water, the lighter a structure the more vulnerable was it to destructive horizontal forces. It was also important to note that the bridge was provided with a waterbound road surface. On being overtopped, the road crust might have been easily washed off by the flood waters carrying with them also the haunch filling and thus considerably reducing the dead weight of the bridge. This added to the uplift resulting from buoyancy and reduced the stability of the bridge. The speaker suggested that the Indian Roads Congress might stipulate that in all future bridge constructions, the road surface should be of a more permanent and impervious nature.

Shri Nadirshah concluded by suggesting that, in the case of all the old bridges near foot hills

(a) the waterways as provided should be verified on the basis of Inglis' Formula, which gave safer figures than other formulae;

(b) the condition of the foundation rock should be geologically examined;

(c) the road surface should be of a permanent and impervious nature; and

(d) all joints should be periodically cement pointed.

Shri B. N. Shenoy felt that Nature had been very kind to the Indian Roads Congress in providing them more and more instances of collapsed bridges to write about. He thought that, in future, these discussions might be more on collapsed bridges than on the construction of new bridges.

The speaker thought that probably the design of the bridge under discussion was made without careful investigations at the site by well qualified engineers. It was creditable that even such an ill-designed bridge should have stood for such a long time, but that was poor consolation. Bridges should stand for centuries and not merely for six or seven decades. There were many good examples of such old bridges in the West and quite a fair number in India as well.

Shri Shenoy thought that a cross-section of the river, if given in the Paper, would have been useful as well as a description of

the nature of the bed. As the river flowed with a steep fall it was necessary to know whether the bed material was coarse sand, shingle, or boulders. The value of such Papers depended upon proper analysis and assessment of the history, geography, and the physical conditions at the site; otherwise the lesson was lost. The speaker felt that in the case under discussion, rolling shingle or small boulders and pebbles must have been moving in contact with the bed round the shallow foundations and caused progressive erosion.

On page 29, para 5·4, the Author had stated that "it was noticed that the high flood had risen to reduced level 106." This statement had to be reconciled with that on page 38, last line: "As the Bhogeswari bridge collapsed during the night time, nobody had observed the extent of the flood and the afflux at the time of its failure..."

The speaker wanted to know whether this flood level of 106 was upstream or downstream of the bridge. In another place (para 5.5) the afflux was computed and the resulting H. F. L. was given as 108·78. This should naturally be the level upstream. The speaker wanted to know categorically which was an observed and which was a computed level. Again, he wanted to know which cross-section—downstream or upstream—was used to obtain the discharge of 46,000 cusecs by Kutter's formula.

The speaker asserted that people had become slaves of formulae as was illustrated by the attempt, in Chapter 5 of the Paper, to reconcile the violently different figures given by Beal's, Strange's and Inglis' formulae, varying from 27,300 cusecs to 45,600 cusecs. To say that one of these agreed with the discharge given by Kutter's formula was to make it all a matter of convenience to the man arguing the case.

The speaker had some doubts about the propriety of using Kutter's formula as usually applied. It was usual to take a cross-section of the river in the dry season and apply to it the velocities derived from the surface fall that developed during floods and work out the discharge. It was common knowledge that during floods a river flowed through a much bigger section because of scour. According to the Author, there had been a certain amount of scour, in the case under discussion; so the discharge arrived at by Kutter's formula should be a little less than that given by the empirical formula applied to the catchment area.

Engineers in Madras used Ryve's formula ($Q = CM^{2\cdot5}$) with C = 2,000 in most cases. But it was found that, for bridges across hill streams, it was necessary to adopt much higher co-efficients (3,000 or even 4,000) where there was an indication that such floods could be accommodated by the configuration of the valley.

The Author had worked out the structural strength of the collapsed arch bridge to see if it was safe for the I. R. C. Class A loading. As such a load probably never went over the bridge the calculation was not realistic.

Shri Shenoy stressed that engineers should rely more on their personal observations than on theoretical calculations based on formulae. If an engineer who had been trained in the college and outside to see and observe things went to the site himself and made a personal appreciation of the flow conditions at site and arrived at tentative ventways, he would find that in most cases his results would be borne out by calculations. Calculations were for the engineer who sat in the office and took decisions. But there was no reason why an Executive Engineer building a small bridge, a Superintending Engineer a bigger bridge, and a Chief Engineer a much bigger bridge should not assess all the factors fairly correctly by personal inspection at the site.

As regards the probable reasons for the collapse of the bridge under discussion, Shri Shenoy thought that the construction of a bridge of five spans of 40 feet each, when the bed of the river was 250 feet wide between well defined steep banks, thereby bringing in the abutments, was an error in first principles. For a deep canalized river like that, the face of the abutments should have been somewhere at the middle of the banks and the abutments and wings should have been recessed into them. This had been partially rectified by increasing the ventway by 26 feet in the new bridge.

Shri Shenoy was of the opinion that even when sheet rock was encountered in the bed, it was desirable to take the foundation into the sheet rock below scour level. In the case under discussion, if piers No. 3 and 4 were on soft rock, it would have been more appropriate if the pier foundations had been trenched into the rock three or four feet deep.

Shri S. V. Chandratreya said that the Indian Roads Congress had published a number of Papers on bridge failures. It was high time that a course of action were evolved. He felt that there should be substantial separate grants for annual repairs to the bigger bridges.

With reference to para. 8·1, where the Author had mentioned the growth of vegetation in the piers, Shri Chandratreya wanted to know whether the register of masonry works had been inspected. It often happened that either inspections were not carried out properly or there were no funds and repairs suggested in the inspection reports were not done. The important work of inspection of masonry works should not be left to inexperienced

engineers and should be dealt with by a Special Section of the P. W. D.

The speaker suggested that the Indian Roads Congress might lay down a code for the inspection of bridges, and the existing bridges which did not come up to the standards which might be laid down should be modified.

Shri J. T. Mehta said it had been stated that the haunches of the arch ring were partly hollow and the water had risen to a level of 108.78 on the upstream face *i.e.*, just above the highest point on the intrados (R. L. 108·54). The worst flood effect would occur at that stage. An accurate estimate could not be made of the forces acting upon the bridge at such a time. The upward pressure on the intrados of the arch would be nearly 150 pounds per square foot. The speaker asked whether an arch with hollow haunches would be stable against buoyancy. The large floating trees blocking the waterway introduced serious complications affecting the value of the forces due to the static head, the impact of water, the friction of water, etc.

Shri S. B. Joshi commended the Government of Bombay for having consented to report the details of failures of bridges in their State. Such Papers were extremely useful in the preparation of new designs. There appeared to be some confusion in the minds of Members when they tried to compare Inglis' formula with Kutter's formula. These two formulæ had nothing in common between them. Inglis' formula estimated the maximum discharge in a catchment and Kutter's formula gave an expression for the velocity of water in an open channel in terms of the hydraulic mean depth and the surface slope. The coefficient of roughness in Kutter's formula was a function of the surface slope and the hydraulic mean depth. After having found the maximum discharge by the use of Inglis formula, Kutter's formula could be used for estimating the maximum high flood level. Actually Shri Joshi doubted the advisibility of using an obsolete formula like Kutter's which was based upon an arbitrary classification of channels as small and large. Kutter had defined large channels as those whose hydraulic mean depth was greater than one meter and small channels as those whose hydraulic mean depth was less than one meter.

Referring to the stress calculations given in the Paper, Shri Joshi suggested that the Author should take into account the simultaneous direct and tangential stresses acting at a point whenever he was considering stresses at the time of failure. Shri Joshi observed that the shear strength of a material depended upon the simultaneous normal stresses acting at the point. Similarly the direct or tangential stresses at the time of failure were governed by the simultaneous direct stresses acting along the three axes.

Shri Joshi suggested that the Author might study the trace in plan of the mass centre of moving water with the water level at different reduced levels. In some cases it would be found that this line changed position over a very wide range bringing about inclined flow of the current and causing dangerous stresses on the piers. Flow of water at very great inclinations to the direction of the piers was also likely to occur by the blocking of some of the spans by trees.

After a careful observation of catchments in the Ghat region of the Bombay State, the speaker was of opinion that it would be advisable to put a single arch or at the most 2 or 3 arches across a river in such hilly tracts. He surmised that the Author must also have a similar solution in his mind, but limitations of finance stood in his way.

Referring to the possibility of shingle and pebbles abraiding the bed of the river, Shri Joshi observed that the velocity at the bed of the river could not be as high as 18 ft. per second. There was a parabolic variation between the maximum velocity and the velocity at the bed. The danger of the bed of the foundation being disintegrated by the moving mass of water would be greatly reduced if the side gap round the pier foundations was filled up to bed level by impervious clay or cement concrete. This was certainly an expedient worth adopting in the interests of the safety of bridges in the Deccan.

Referring to the bridge near Poona mentioned by the Author in his opening remarks, Shri Joshi expressed the opinion that the risk of founding the bridge on the rock available in the bed of the river at the top or even on "Geroo" was worth taking, as the extra cost involved in taking the foundations down to a depth of 20 to 25 feet was not warranted by the circumstances of that bridge.

Shri K. K. Nambiar said that although the Author had not categorically stated the reason for the failure of the bridge, his analysis of the various details of design and discussion about the possible causes of failure were very instructive and interesting.

On going through the design data it had to be pointed out that the waterway provided was insufficient, being only 65 per cent of the natural waterway, resulting in a high velocity of 18.4 feet and an afflux of 2·78 feet making the floods surge up to the intrados of the arches (para 5.5). This, coupled with the rather insufficient thickness of the arch ring and the hollow haunches, had presented the most vulnerable set of circumstances for the failure of the bridge when the precipitious floods charged the bridge with battering rams of floating trees.

The Author's reference to the need for weighting down the haunches was very important. The speaker himself had come across one instance of an engineering subordinate trying to relieve the stresses on an arch by removing the filling on the haunches. Fortunately, he was warned in time. One of the surest ways of destroying an arch was to relieve the load on the haunch and to add load on to the crown.

Describing how a good earth filling in the haunches add to the safety of the arch, in a way acting monolithically with the arch and adding to the thickness of the arch ring, as it were, the speaker mentioned the case of a masonry arch in Malabar, the earth filling of which remained sufficiently intact to carry traffic even after the arch ring had collapsed.

With reference to the case of the Meena river Bridge, (para 8·5 -8·8) the Author had referred to the uplift pressure of water (para 8·8). It might have caused piping through the masonry. But uplift by itself, if the water were stagnant, might not destroy an arch. The speaker had seen a two-span segmental masonry arch bridge submerged under seven feet of water. There was not much of a velocity as the water slowly headed up. When the flood subsided after 48 hours, the bridge was intact.

In the case of the new bridge, the Author had stated that the girders were continuous over two *supports* (Para 9·2). Probably he meant "continuous over two *spans*". But the object of doing this had not been explained.

Shri Nambiar also wondered whether it was wise to reduce the spans of the new bridge to 25 ft. when floating trees were to be expected in times of floods. The old bridge had 40 ft. spans.

Shri P. S. Subramaniam agreed with the Author's conclusion that the excessive diagonal shear stresses in the piers were the main cause of the collapse.

The Author had mentioned flood water shooting through masonry and washing out the mortar. In Madras also similar erosion of mortar joints in masonry had been experienced in one of the major aqueducts. Timely precautionary measures were taken and the masonry was grouted with cement mortar under high pressure. A span of about 35 ft. had consumed about 100 bags of cement.

For the prevention of erosion of the bed there was a common practice in Madras to provide irrigation works as well as bridges with flooring and aprons both upstream and downstream of a structure. None of these structures in Madras had failed on account of this cause.

Many Members had spoken about the computing of discharges and a lot had been said about the discharges being theoretically worked out or assessed by observation. An experienced engineer could fix the required length of a bridge and the spans by inspection and his conclusions would be confirmed in most cases by subsequent calculations. Bridge designs was not just a question of computing the discharge by formula: it was a question of taking into consideration the condition of the banks, the bed of the river, the soil conditions and so on. These could only be judged by careful observation at the site.

With regard to the question of foundations, whether it was necessary to go down to solid rock invariably or how far it was necessary to pierce into clay, the speaker referred to Lacey's formula for the design of foundation depths. The speaker had found that this formula was not always applicable. There were certain rivers, especially in Madras, where the floods were controlled. In such cases foundations designed according to Lacey's formula, became wastefully deep. There was a case where the actual depth of flow after the river had been flood-controlled, was only about 10 feet. The soil was, for most of the part, fine sand. Lacey's formula gave a depth of 80 feet. Actually, there was another bridge downstream founded only at a depth of 40 feet in clay. Discussion was still going on as to whether the depth of foundations should be 40 feet or 90 feet. The speaker had quoted these figures in order to illustrate that it was not advisable to let mere theoretical considerations of 100 or 1000-year floods to prevail in design work.

Shri M. Meeran thought that Papers investigating into the question of failures were more valuable than Papers dealing with original constructions, for it was by the study of failures that many obscure and uncertain factors affecting strength and stability were brought to light.

The speaker pointed out that the afflux of 2.78 feet had been worked out for a bridge opening 65.5 per cent of the natural water way (para 5.5 page 29). As the water way was assumed to have been still further reduced by about 25 per cent on account of the floating matter obstructing the vents, the afflux must necessarily have been very much higher than 2.78 feet. Scour under a bridge increased at an enormous rate for every extra foot of afflux, and might be as deep as 20, 30 or even 40 feet. The interesting thing about scour was that the scour holes got automatically filled up as the flood subsided with the result that these extraordinary scours often went un-noticed. The Author might look into the possibility of something of the sort having occurred in the case under examination.

The Author was gratified to find so many Members taking part in the discussion of his Paper. A subject like the one under discussion gave rise to a host of independent questions requiring lengthy treatment. For example, methods of calculating discharges and flood frequencies, the relative merits of discharge formulae, and so on. He did not feel called upon to give replies to all those theoretical questions which raised side-issues.

He agreed with **Shri M. G. Oza's** suggestion that the de-forestation of the catchment area had something to do with the failure. On that question different people held different views. In the case of very high floods, the run-off from a wooded catchment was the same as from a bare catchment. The speaker had stated that the bridge withstood the heavy rains of 1933 when the annual rainfall was maximum (164 inches). The Author pointed out that the figure for the annual rainfall had nothing to do with high floods.

Shri Oza had recommended that the obstruction due to the bridge structure should not be more than 20 per cent. As mentioned by the Author in his introductory remarks, this was already the practice in the Bombay State.

The High Flood Level of 103·25 had been ascertained from local enquiries.

For information regarding the co-efficient of friction, suction effect, impact of flowing water, etc., the Author referred Shri Oza to Paper No. I, "Some Notes on Submersible Bridges", by D. Nilsson, published in Volume V of the I. R. C. Journal.

Shri E. A. Nadirshah's statement that, owing to want of proper rainfall and other hydraulic records, bridge designs were still being based on very rough, approximate, and scanty data was only too true. Such designs were always risky. The Author readily agreed that this question might be taken up by the I. R. C. Council in right earnest.

The Inglis formula recommended by the speaker for hydraulic calculations was already in use in Bombay.

Shri Shenoy had asked for information about the nature of the bed at the bridge site. The bed material was exposed sheet rock at the toe of the left bank, and shingle, under-laid with murum and soft rock, towards the right bank.

The flood level (R. L. 106) was inferred from the usual marks after the flood had subsided. This flood level (R. L. 106) was the downstream of the bridge. The corresponding upstream level (108·78) was calculated from the Molesworth formula for afflux.

The discharge of 46,000 cusecs was calculated for the cross-section at the bridge site.

Shri Shenoy had pointed out that the cross-section of a river changed during floods due to the scouring of the bed. This was true for soft erodible beds. Such a change of cross-section was not possible in the case under discussion where the bed was rocky.

Only 4-ton or 6-ton buses plied on the bridge and the arch was strong enough for this traffic. The design was tested for the I. R. C. loading with a view to knowing its real strength.

While agreeing with **Shri Chandratreya's** suggestion that there should be separate grants for current repairs to major bridges, the Author further suggested that separate accounts should be kept for the annual maintenance of major bridges.

In reply to **Shri Mehta**, the Author said that a masonry arch, even though submerged, was always stable as the static head due to afflux was converted into a velocity head and very small uplift pressure was exerted. This was counter-balanced by the submerged weight of the arch and superstructure.

Shri S. B. Joshi had suggested that simultaneous direct and tangential stresses acting at a point should be taken into account while finding out the ultimate stresses. All forces like the direct vertical load and the shear forces due to horizontal forces had been taken into account and stresses calculated. The results were given on page 34 of the Paper.

In reply to **Shri K. K. Nambiar**, the Author stated that the R. S. girders were continuous over three equal spans with their ends free.

Smaller spans had been adopted in the new design because of the difficulty of getting the required mild steel round bars for R. C. C. work or structural steel for steel girders. The Bombay P. W. D. had some old R. S. girders which were used in the re-construction of the bridge.

The openings of 25 feet provided in the new bridge were not considered too narrow for floating trees.

Provision of flooring and aprons, upstream and downstream of the river, for protecting the bed from scour, as suggested by **Shri Subramaniam**, would not be a satisfactory and economical measure in a fast stream with a rocky bed. To house the foundations deep into hard rock would be better. The piers of the new bridge had been taken into solid rock and had been founded well.

Lacey's formula referred to by the speaker was applicable only to alluvial rivers and did not apply to the Deccan rivers.

Shri M. Meeran had asked whether the obstruction due to the floating trees had been taken into account while calculating the afflux of 2.78 feet. The Author revealed that this had not been taken into account and only the obstruction due to the structure had been considered. The increased depth of scour due to the increase in afflux could apply to sandy or alluvial beds only. In the case under discussion the bed consisted of hard material and the effect of an increase in afflux on the scour could be neglected.

In conclusion the Author suggested that all bridge foundations should be carefully examined periodically (say once a year before the rains) with a view to detecting any leaching of mortar, scouring of the bed, and deterioration of the material of the structure. Proper attention should then be given to the repairs revealed to be necessary. For this purpose a case history of the bridge with completion plans, nature of repairs carried out from time to time, etc., should be maintained. The foundations should be periodically examined by actual probings. A regular programme of thorough inspection and special repairs should be drawn up. This might obviate costly renewals and traffic hold-ups.

Discussion on Paper No. 143.

"A Small Scale Traffic Survey in New Delhi."*

By

C. S. ANANTAPADMANABHAN, B.Sc., (Hons.), F.I.A.,

Sunday, January 15, 1950.

Shri S. N. Chakravarti (Chairman) called upon Shri C. S. Anantapadmanabhan (Author) to introduce the Paper for discussion.

Shri C S. Anantapadmanabhan (Author) in introducing his Paper said that traffic surveys were not anything new. A large number of them had been carried out in foreign countries and, even in India, several surveys had been carried out, particularly in rural areas. His reasons for presenting his Paper were threefold:

(1) to point out how success could be achieved even with very modest resources;

(2) to point out that while excessive refinements might be out of place, a degree of accuracy adequate for practical purposes could be easily gained by a judicious selection of procedure;

(3) to emphasise, at least partially, how the results of such surveys could be of practical use.

From the statistical aspect, there was a danger of diverging to one or other of two extremes. On the one hand, the pure statistician might treat the data at the academic level and apply to them tests which would not be justified, with naturally disappointing results. On the other hand, the purely practical engineer might not appreciate that any good commensurate with the labour and expense involved ever came out of these surveys. The Author believed that the present Paper struck the golden mean between these two extremes, and would at least stimulate the interest of those who had not had the opportunity of making a special study of the possibilities of traffic surveys.

The application of the data collected in the study and the analysis of accident statistics given in the latter part of the Paper would, the Author believed, give an indication of the great possibilities that existed in the direction of the practical use of traffic survey data.

* Published at pages 47 to 121 of Vol. XIV-1 of the Journal of the Indian Roads Congress, September 1949.

Shri E. A. Nadirshah observed that one of the important aspects of proper planning of roads was the initial survey of traffic. The perusal of the Paper would show that proper attention had not always been paid in the past in this direction by the engineers and the departments concerned. Though the scheme started purely as an experiment, the results of the Paper would assist various other engineers who intended to carry out similar surveys in their areas in future.

In this survey, the procedure adopted was to enumerate traffic at one junction everyday and the results were, therefore, based on the assumption that the amount of traffic did not vary materially from one day to another. The final picture could not, therefore, be taken as representative of a single day's traffic in the whole city. However, in view of existing difficulties, the shortage of funds for instance, the method of simultaneous counts could not always be adopted.

In the speaker's opinion, it would have been better if the positions of the counting posts had been shifted from the junctions to the centre of the road lengths connecting the junctions. This would have obviated a number of difficulties and resulted in better accuracy of counts.

On page 63, para 2.9, the Author mentioned that one might be tempted to make an estimate of the total number of cycles in the whole of the Delhi city by using the known number of cars, motor-cycles and tongas. According to the speaker there was bound to be extreme disparity in figures arrived at by this method even as an academic curiosity. The wide difference between the figures of the total number of cycles that would be arrived at by this method and the real figures would be mainly due to the differential movement rate of the cars, motor-cycles and tongas. Thus, a fast moving vehicle would cross a number of road junctions and, being allotted a count at each junction, would be allotted a larger number of counts in the gross figure. The deduction would probably be that, in New Delhi, the per vehicle speed and mobility of the motor-cycle was maximum, next the car, and last of all the tonga. What about the cycle, the speaker asked.

Maps II and III presented a very interesting picture showing the intensity of cycle traffic alone in each direction in the city, separately during the morning and evening hours. This brought out very clearly one factor: that special attention should be paid to this type of traffic which constituted nearly 40 per cent of the total amount in this city.

Studying the figures I-a, I-b and I-c, the speaker found that, in the case of cycles, the wave line of heavy traffic in the morning

repeated itself in a similar manner in the evening, while in the case of the mechanically propelled vehicles, the representative line did not show a similar tendency at all and followed an irregular course. This type of behaviour was attributed by the Author to the enumerated number of vehicles being too small as one of the many reasons, but further investigations were necessary to find out why the wave lines, in the case of mechanically propelled vehicles for morning and evening, did not tally and the causes for curves of such diversity.

Shri Nadirshah concluded by enumerating the main points brought out in the Paper and suggested that a Code of Procedure should be recommended by the Indian Roads Congress Council for future traffic surveys and road designs therefrom :

1. That proper attention should be paid to the initial survey of traffic before designing a road. The system of taking traffic census before designing a road, or improving existing roads, should be adopted in all big cities.

2. That appropriate funds be made available for the purpose of traffic survey by the method of simultaneous counts so that the results could represent the exact condition of traffic.

3. That special attention should be paid to the segregation of cycle traffic in the design of the roads, and

4. That statistics of road accidents should be maintained and the roads improved by modifying the curves and installing suitable road signs to warn the traffic.

Shri R. L. Gursahani felt that the method of traffic survey as adopted was quite suitable for big cities, but for rural roads in general a simpler method would be needed if the observations were required to be taken periodically say twice or thrice a year, depending upon the volume of traffic at different periods.

2. The five-minute counts on the road-side were not possible owing to various difficulties specially because enough literate staff could not be spared for this regular periodical traffic survey which generally needed to be observed for all the twenty-four hours continuously for a week. It might, however, be possible to have day and night counts separately, or the day observations might be split up into three periods of morning, mid-day and evening.

The observations discussed in the Paper gave only the numerical side of census and not tonnage. The design of thickness

of road pavement was based on the tonnage, whereas the geometrical features depend on the quality and the volume of traffic. For a particular locality, with more or less fixed weights of laden or unladen vehicles, the numerical figures might give an approximate idea of the tonnage also.

On page 64, para 3.6, it had been suggested that two 12 ft. cycle tracks should be substituted by one 24 ft. track with a possible division of 8 ft. and 16 ft. tracks for non office and office traffic. This would lead to disregard of traffic rules and the same track would have cycles going in one direction in the morning and in the opposite directions in the evening or cycles from both directions would be using the same track for cyclists residing at both ends and going to office at the opposite end ; and in case of non office people, the 8 ft. track would be under two way traffic at all hours of the day. This would cause confusion and it would be difficult to observe traffic rules.

According to **Shri J. T. Mehta**, the methods employed for the traffic survey were sketchy and so were the results. If at all a thing was worth doing, it was worth doing well. Some tangible results might have been obtained if regular origin and destination survey could have been undertaken in an accepted manner.

The time of six hours chosen for this small scale traffic survey would not yield reliable data. Different hours or combination of hours would produce results varying in accuracy. Since it was impossible to include all hours, or all possible combinations of hours, for analysis in this study, a most important consideration would be the hours to be selected. An 8-hour study would have supplied more reliable data and Shri Mehta thought that 8 a.m. to 12 a.m. and 3-30 to 7-30 p. m. would have yielded better results.

Shri K. K. Nambiar congratulated the Author for the very interesting treatment of this otherwise commonplace subject. The Author had dealt with the subject in a comprehensive manner, intelligently analysed the factual data, and scientifically discussed the relationship between the number of accidents and the intensity and nature of traffic. The maps and graphs drawn up were also very illuminating.

As regards the traffic flow maps, the speaker had one suggestion to offer to the Author. The map with the thickened arrows to show heavier traffic was of course useful. But a more striking way of indicating the intensities of traffic would be to make a three dimensional map as was done in the planning survey section of the Highway Transport Research in the United States of America. Such maps would show how traffic "peaked up" near certain

junctions giving the appearance of sky scrapers or lamp posts at certain crowded junctions. A map like that, exhibited in a glass case, would be an interesting addition to the Indian Roads Congress Exhibition.

The suggestion given by the Author in para 3.6 on page 64 deserved serious consideration, *viz.*, that, instead of two cycle tracks of 12 feet on either side, a single track of 24 feet width might be provided on one side which could be divided into two lanes of 16 feet and 8 feet width according to the exigencies of traffic. Such a system was actually in vogue in Chicago in the United States of America. Shri Nambiar believed that it was a 5 lane highway divided into 3 lanes for the incoming traffic and two for the outgoing in the forenoon and the otherway about in the afternoon. The division was accomplished by "Retractable kerbs", made of wood or concrete and raised or lowered by hydraulic power. For the common cycle track suggested by the Author some method had to be devised for rearranging the lane demarcations in the forenoon and afternoon.

Another suggestion to flatten down the peaks in traffic intensities was to copy the method adopted for the traffic going to and from the Pentagon at Washington. The Pentagon, the Headquarters of the American Army, was the building with the largest plinth area in the world. Forty thousand people worked in the building. About 25 thousand automobiles arrived and departed from the building everyday. If all of them had to arrive and leave at the same time it would be impossible to regulate traffic. So working hours were staggered in three shifts with intervals of half an hour between one another for arrivals as well as departures. Some such arrangement might be thought of in Delhi by staggering office hours say, 9-30 a.m. for some, 10 a.m. for some and 10-30 a. m. or 11 a. m. for others and similarly staggering the departure timings also to suit. To accomplish this, an origin and destination survey, or a 'gallup' poll had to be taken questioning all cyclists and car owners and tabulating the results. From the data obtained in this manner it would be possible to work out suitable staggered timings for some of the offices if the process did not involve any administrative difficulties. The speaker had made a similar suggestion to the Government of Madras to flatten out the peak in Bus and Tram Traffic in the morning and evening hours, in connection with his inspection report on the working of the Madras Tramways.

Regarding the evaluation of the cost of accidents to the Nation and making out a case for appropriating a like amount for building safety into our roads, Shri Nambiar agreed with the Author that the matter deserved serious reflection and implementation to the extent possible.

The Author, in reply, said that, as had been mentioned in the Paper, the survey was purely an experimental effort. It was gratifying to find that it was possible to extract some useful results out of such purely experimental efforts.

Shri Nadirshah's criticism that the final picture could not be taken as representative of a single day's traffic in the whole city was of a minor nature. This did not detract much from the value of the final results because ultimately, if any use of this data for planning purposes was to be made, it would be necessary to allow a margin greater than the daily range of fluctuations and it would not make any material difference if counts were taken at one point on one day and at another the next day, or at different points in a single day.

The fluctuations in the figures for motor vehicles as obtained in the morning and evening counts were probably due to the small numbers counted. According to the principles of statistics, as the number of cases decreased the proportionate error due to random fluctuations increased. Another possible reason was that different types of vehicles other than bicycles were grouped together. The Author was not sure whether a deeper examination of this point would help much. In the case of motor cars, and motor cycles all the people did not go to office exactly at the peak period; some might go ten minutes earlier and others later.

Shri Gursahani's criticism about two lanes, had been replied by Shri Nambiar. The Author believed that in some foreign countries the flow of traffic was controlled, for example in some streets there was traffic flow in one direction in the morning and in the reverse direction in the evening.

Shri Mehta had suggested that because of the unsuitability of the period chosen the results obtained were not accurate. The accuracy did not depend on the period at all; it depended only on the accuracy of counting. The graphs in the Paper would show that the period selected was suitable. In any case, it was only a matter of detail.

The Chairman, in his concluding remarks, thanked the Author for his interesting Paper. Engineers had heard about traffic surveys and had, on occasion, utilized them for designing roads. While many had been talking about the subject for years, he had his own doubts whether all had really taken the trouble to find out what type of information would really give them ideas about highway design. So much was heard about American books and papers on traffic surveys but he was not aware that any use of such surveys had been made in India. In the United Provinces a lot of work had been done in this connexion and statistics of traffic during 24-hour count periods at 150 stations had been

collected. The net result of all that was that a mass of papers — practically a room-full — had been collected and had been lying there without any use being made of them because of the problem presented by the necessity for sifting the data. And only after this problem had been tackled would it be possible to decide what use could be made of the data.

Some speakers had commented that the process, as suggested by the Author, might not give a complete idea of the traffic problems. The Chairman was sure that it would not. But unless resort was had to some sort of system like 'sampling' and an attempt was made to get actual statistical figures, one would be confronted with the same mass of papers as the speaker was confronted with in the United Provinces. About 10 clerks* had been set the task of sifting the data and they had said that they could complete the work in six months.

As regards the period of survey, the speaker agreed with the Author's suggestion about selecting some hours a day and carrying out surveys by turns — for example, at one time where the traffic goes in one direction and at another when it goes in another direction. By this process of sampling it would be possible to get certain ideas which could be of great use in design. The Chairman was of the opinion that in the initial stages even if there was only 25 per cent accuracy, it would not matter so much.

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*[but no statistician to interpret the data ..... Ed.].

Discussion on Paper No. 144.

"Well Foundations of the Kathjuri Bridge."*

By

S. N. GUPTA

Sunday, January 15, 1959.

Shri A. N. Chopra (Chairman) called upon Shri S. N. Gupta, the Author, to introduce his Paper for discussion.

Shri S. N. Gupta, (Author) in his introductory remarks, gave a brief summary of the Paper which was descriptive in character and did not deal with the details of the design.

Shri E. A. Nadirshah asked whether the pneumatic well sinking process was considered for the foundation work of this bridge, and the reasons that led to the preference for open well sinking. The pneumatic process might have been more efficient and more economical for at least some of the piers. The Author might give some cost figures for open well sinking per foot depth.

Information about the weight of the gelignite charge which was normally used in order to facilitate sinking, and the heaviest charge that would be considered safe would also be useful. The speaker believed that blasting would be a useful expedient to speed up work even at the earlier stages of sinking and would be quite safe if properly used. He also wanted to know the percentage of plums used in the 1 : 3 : 6 concrete in the steining.

From para 8.1, it would appear that the sand used in the concrete was tested for bulking just once, and an addition of 20 per cent was authorized to allow for bulking. As the moisture content in the sand varied from batch to batch and from hour to hour, it would have been desirable to carry out more frequent tests for bulking. These tests were simple and quickly performed with the aid of suitable apparatus. Follow-up tests to confirm the quality of the concrete produced, made at every stage of the work, were, however, a satisfactory feature of the work.

After well No. 2 was plugged with 1 : 3 : 6 concrete and water pumped out, it was found that water continued to ooze through the plug. The Author might describe the steps taken in the case of that well to remedy the leakage.

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* Published at pages 153 to 192 of Vol. XIV-2 of the Journal of the Indian Roads Congress, December 1949.

The speaker wanted to know the precautions taken to ensure that the plug concrete laid under water by means of the improvised buckets was properly levelled and that no cavities or voids were left in the concrete. Were any divers sent down from time to time to see that no weak spots were left?

Dr. R. K. N. Iyengar did not agree with the reason given in the synopsis of the Paper on page 153 for adopting open well sinking: that the river remained dry for most of the year. He suggested that the correct reason would be that open well sinking was thought to be suitable and comparatively economical in the strata of ordinary sand and clayey soil expected to be encountered.

He wanted to know the size of the explosive charges used in sinking and said that on the Kalabagh bridge over the Indus, where blasting was extensively used, generally $\frac{1}{4}$ to $\frac{1}{2}$ lb. of geliguite was used at a time and some times even one pound, depending upon the strata and obstructions met with. It was rather surprising that the services of experienced divers could not be procured, even on such an important work. Divers would have been most useful for the proper laying of explosive charges and for periodical inspection when difficulties were experienced in sinking. The need for divers was again felt when grabs were caught up in sand blows and could not be released for a long time (para 10.4.4).

Dr. Iyengar suggested that two other expedients could have been advantageously adopted for sinking the wells: (1) water or compressed air jets, and (2) inclined rail cutters or chisels. Divers could have been used to operate the water jets at or near the cutting edge both inside and outside the wells (the jets being fitted with $\frac{3}{4}$ inch or 1 inch nozzles, the quantity of water discharged being about 150 gallons per minute with pressures up to about 120 lbs. per square inch). This would have helped to loosen the sticky clay and thus reduce the skin friction. The inclined rail cutters would have dug into the stiff clay near the cutting edge and torn up the soil which could then have been easily dredged out.

The speaker thought that by a careful study of the boring chart, the possibility of Artesian action could have been foreseen and suitable precautions taken in time. Major accidents were known to have occurred in the past from such causes during foundation work on other bridges.

He suggested that for rectifying tilt a combination of kentledge on the high side, eccentric dredging (more on the high side and less on the low side), water jets to loosen the clay, and occasional light explosive charges (more on the high side and less on the low) would surely have given far better results, as had been observed during foundation work on the Kalabagh bridge on the Indus and the Ava bridge on the Irrawady.

He thought that separate plant should be reserved for the important work of load testing of wells, so that this did not have to wait for the slack season or be otherwise delayed.

He asked whether the thicker bottom plugs in 1 : 2 : 4 cement concrete mentioned in para 13.3 were tested for water-tightness after allowing the concrete to set.

The top plug was stated (para 13.5) to consist of one foot of 1 : 3 : 6 cement concrete. This thickness appeared to be insufficient; two to three feet thick plugs would have been better.

While the average power used in well sinking had been given (para 14.1), it would have been useful to give figures of the cost of sinking, as also comparative charts showing sinking costs on the various wells.

Shri Sachindra Nath Gupta referred to the method of testing the wells. The test loads were said to have been designed to give the same unit pressure under the steining as would have developed under the whole area of the well when plugged. This was apparently based on the assumption that the inside sloping face of the curb was supported to its full height on earth whose bearing resistance was to be tested. Probably this never happened as the sinkage under the test load was not more than six inches. The result would, therefore, give a lower bearing power than the correct figure for the strata under test. If it were argued that the sand filling under the well curb, which for practical purposes should be treated as confined sand, transmitted the pressure to the earth below for the entire cross-section of the steining, the area of earth that would be brought into play to resist the load would be larger than that of the steining. The result indicated would, therefore, be an exaggerated figure.

With reference to the sand filling of a well before applying the test load, he asked if there was any alternative or cheaper method. Had load testing been ever done without sand-filling?

He also wanted to know whether a well had ever been tested under a test load equal to the full load that was likely to come over the capping slab when the superstructure had been completed. If so, under what circumstances had such a test been carried out?

The object of load testing was to determine the bearing resistance of the soil in the sump. This might possibly be done by a

simple bearing test with a plate two square feet in area. This might not be feasible in deep wells but might conveniently be adopted in shallow wells. He wanted to have the views of more experienced Members on this suggestion.

With reference to the final sand filling above the bottom plug in the completed well he asked whether this sand filling could not be eliminated, thus releasing the dead load on the bottom plug without detrimental effect on the steining due to pressure from outside. He understood that the practice in America was to keep the wells empty or to fill them up with water. There were obvious defects in both these methods but he wanted to find out the practice prevalent in the U. S. A. as well as the reasons and objects of that practice.

Shri H. G. Verma congratulated the Author on bringing out an excellent Paper which was specially welcome at a time when the country was embarking on a big bridging programme.

The main cause of the difficulties experienced in sinking the wells in the case described in the Paper was the adoption of twin circular wells which should not be used when they have to pierce dense or hard clay. The unequal distance of the cutting edge from the dredger action always caused trouble in clayey strata. When the boring chart revealed dense clayey strata, single circular wells should have been adopted.

Another fault lay in the design of the curb. The angle of the curb at the cutting edge was about 40 degrees. It should have been about 30 degrees. The object of the well curb was to push forward the earth into the dredge hole and it was obvious that the steeper the angle the better the work done by the curb.

Horizontal reinforcement in the well steining was nowhere mentioned in the Paper. The speaker was of the opinion that horizontal reinforcement in the form of half-inch thick mild steel plates should be provided at every ten feet to keep the suspension rods in position. This would also be useful when some unexpected stresses developed from unforeseen circumstances.

He did not agree with the Author's view that the use of explosives in well sinking was not safe. In the U. P., a bridge over the Asan river in the Dehra Dun district collapsed in 1947, where four out of ten spans of 50 feet were damaged. In reconstruction, the site of the piers was changed by altering the spans; still heavy masonry blocks of the old bridge were met with at twelve to eighteen feet depth below the bed. Various methods of breaking these blocks and removing the obstruction were tried. One method adopted was to hammer the block with a ninety-pound rail of about fifteen feet length sharpened at one end and worked with a steam

winch. It was lifted and dropped with a heavy jerk. This method was useful when the obstruction was not very big. In the case of large obstructions blasting had to be done on a large scale. Services of deep sea divers had to be requisitioned to drill holes in the blocks. In spite of repeated blasting no damage had been noticed in the wells. The only precaution taken was that the holes were not made too near the well periphery.

Where, however, extensive blasting had to be done, or heavy kentledge had to be used, it might pay to increase the thickness of the steining. Many authorities advocated heavy wells as they were easy to sink and saved money, labour and time by reducing the use of the various sinking devices.

He failed to understand why the services of a diver were not requisitioned. Divers were not difficult to obtain and were very useful. On a work lasting for some time it might even be possible to train local men, as was done on the Asan.

On page 167 the Author had hinted that Artesian action could possibly be anticipated from the boring charts. How could this be done?

The speaker pointed out that a plumb bob or a level should not be used in the construction of foundation wells. The well masonry should be built in a straight line from the bottom to the top. Very often the mistake was committed that masonry on a tilted well was laid vertically. This mistake had to be avoided as otherwise sinking became very difficult and the well shifted laterally. This could be one of the reasons of the abnormally high shift of 2.5 feet in well No. 13.

When a well tilted on account of an obstruction under the curb, several methods for reducing the cant and removing the obstruction could be used in addition to those mentioned by the Author. To prevent further tilt as the dredger worked, the well was, in one case known to the speaker, pulled by a crab winch on the raised side by means of a wire rope wrapped round the well with vertical sleeper packing between the rope and the well steining. The rope was tightened every time the well was straightened by dredger action on this side. At the same time the tilted side of the well was pushed by struts and wedges and the well was loaded heavily on the raised side. The lowered side was held up by iron hooks placed under the curb and kept tight with a rope worked by a steam winch.

Referring to sand blows, the speaker said that they were common when the well was light and the remedy lay in making

the well as heavy as possible. A well usually gave trouble when it left sand and entered clay. The trouble occurred one or two feet above the clay and the reason was that even if the strata were level, sand always found it easier to run in under some part of the well curb. If the strata were not level, the matters became worse. Sand blows necessitated dredging the dredged stuff over and over again and sinking stopped.

A method successfully used to prevent blows was to load the well before it reached the clay strata. Such strata were known from the boring charts and if loading were done in time, sand blowing might be eliminated completely.

The specifications for the design of the bridge laid down (page 183) that the top of the steining should not be higher than six inches above the lowest water level in the dry season. Why had this condition been included? The top of the steining should be about one to two feet above the low water level. This would enable the maintenance engineer to see for himself how the piers stood on the wells. No engineer who had placed his wells true and sunk them straight would have any objection to this and if the piers were badly placed on the well tops it was all the more reason for the maintenance engineer to be able to see.

Shri D. N. Ghosh thought that the steining as designed appeared to be too light and should have been made thicker so as to avoid the necessity of heavy kentledge which was costly and delayed the work. He requested the Author to furnish, if possible, the figures showing the sinking effort on which the design of the steining was based and the actual effort necessary during sinking.

Shri S. K. Mitra wanted to know whether the water level inside the wells in which Artesian action was experienced remained constantly higher than the river water level of 47·00. This was the true criterion of Artesian action.

He thought that the concrete piers should have been anchored down to the well cap in order to counteract any possible tension there.

Shri S. K. Ghosh said that the causes giving rise to cant, as described in para 10·2·1, were more or less of a general nature but no mention had been made of the main cause of tilt in an oblong well of this type with a "draughtsman's pair of circular dredging holes"—to quote Sir Francis Spring. "When the dredging holes were so designed that the dredging tool could not equally nearly approach all parts of the cutting edge, two pernicious hummocks of undredged material were

apt to occur, perhaps for a few minutes only at a time, at XX (See Fig. 1). But these few minutes or few seconds might be very fatal, for when the well took its next jump downwards it balanced itself on these two hummocks. One of the hummocks sometimes broke down before the other, and the well tilted over towards one side."

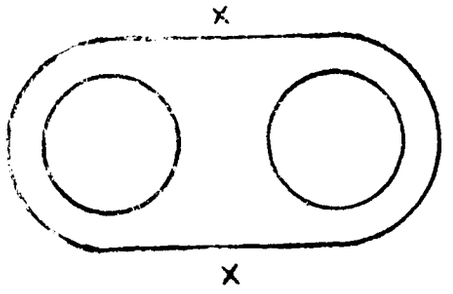

FIG. 1

The tilt and shift were found to occur mainly when the cutting edge was passing through stiff black clay in which the hummocks were most likely to form. The table (on page 169) of shift and cant across the well (probably those along the well were not worth mention) supported the speaker's view that the adoption of this particular type of well was not a very happy choice for the kind of strata the well had to sink through.

The method of rectifying cant by fixing props on the leaning side could not be expected to be effective as with the next downward jump of the well the strongest strut was sure to give way. A system of two inclined struts AB and BC, hinged at B and loaded (as shown in Fig. 2) would exert a steady push on the well

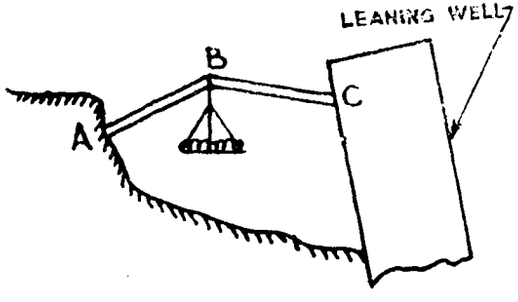

FIG. 2

and would automatically adjust itself as the well sank. The device was, however, effective only in the case of small tilts.

The proposal (para 13·2) to undercut the well curb and form a concrete bulb plug should not have been considered at all as this would surely be impossible unless the design of the well was so bad that, even after complete de-watering, the weight of the steining would not overcome the skin friction.

Criticising the method of concreting the plug under water, the speaker described his personal experience that sometimes the concrete did not leave the container just when it was being pulled up but suddenly dropped down when the box had been raised up several feet. Consequently the ingredients of concrete were badly segregated. The oozing of water through the bottom plugs, mentioned by the Author, might have been due to the bad quality of concrete resulting from this method of depositing it.

The "Contractor's method" of placing concrete through a pipe would have been much more satisfactory as recent experience in West Bengal had shown.

The Author had stated that the wells had been designed for a soil bearing capacity of 7 tons per sq. ft. and in order to test it well No. 6 was subjected to a load of 1,200 tons. Presuming that the water in the well pockets was allowed to remain where it was and that the resistance due to skin friction in this condition was just sufficient to hold the weight of the steining, the speaker found, from the data available, that the pressure under the area of the steining caused by the superimposed load of 1,200 tons was only 4·4 tons per sq. foot and not 7 tons. Even with this reduced pressure of 4·4 tons, 25 feet of sand filling, mentioned in para 12·2, appeared to be rather too small to prevent upheaval (provided the frictional resistance of the column of sand which would come into play when there was a tendency to upheaval were neglected). He wanted to know how the depth of 25 feet of sand-fill had been arrived at.

Shri S. B. Joshi expressed his preference for a wedge shaped cutting edge made of two steel plates—the outer one in the shape of a cylinder and the inner one in the shape of a frustum of a cone, instead of an angle iron cutting edge as described in the Paper.

Referring to the tests given in Table 1, he inquired whether the test blocks were removed before the expiry of the curing period of 21 or 28 days for sending them to Alipore for testing, because it appeared from the Table that the date of testing was exactly 21 or 28 days after the respective dates of moulding. The result might be unsatisfactory curing unless special methods were adopted for curing the blocks in transit from the work site to the Alipore Test House hundreds of miles away.

The Author had stated that kentledge loading was adopted only after dewatering and blasting had failed to produce satisfactory results. Shri Joshi thought that loading should have been

* Paper No. 103 entitled "Design and Construction of the Purnabhava Bridge" by J. Chambers and discussions thereon, printed in the I.R.C Journal, Volume X—1945-46.

resorted to before dewatering and blasting. Dewatering involved to some extent a risk of sand blows and tilting of the well. So also blasting was a very dangerous procedure to adopt and should be discouraged as far as possible since, if some mistake were made, the steining itself was likely to be cracked.

Regarding sand blows, Shri Joshi expressed the opinion that one of the many reasons for sand blows was the difference in level between the water in the well and outside, the difference being created by dewatering either by pumping or by the water being taken out during dredging.

Shri Joshi thought that cant and shift could be very well analysed and controlled if the following observations were made from day to day (*a*) the displacement of the well-top centre across the well (*b*) displacement of the well-top centre along the well and (*c*) inclination of the steining with the vertical. From the observations taken from day to day it was always easy to locate geometrically the centre of rotation of the well and knowledge of this would be of great value in devising measures for arresting the Shift as well as the Cant. These observations also gave a complete picture of the shift of the centre of the bottom of the well.

Regarding bearing capacity of the soil, Shri Joshi thought that it would not be possible to get the correct bearing capacity from test samples sent for testing to a Test House because the bearing capacity depended upon so many factors such as the orientation of the test sample in the foundation, its moisture content, its size, and the damage done to it during its removal from the foundation bed. If at all any sample were to be tested, it would be much better to take the test on the site of the bridge.

Regarding load tests, Shri Joshi asked what the result would be if the well were not filled with sand during the test. The correct test load could be found, according to the speaker, by the following expression:

(Sectional Area of steining × Bearing capacity) + (Outer area of the well steining already sunk × Frictional resistance per square foot).

The resistance per square foot would be of the order of 4 to 6 cwt. per sq. ft. It would be very useful if data were maintained regarding the sinking effort from time to time.

Shri Joshi endorsed the Author's observations in para 15 regarding the false public belief that human sacrifices were required for the successful construction of a bridge.

The Author, in a written reply to the discussion, remarked that some members appeared from their comments not to have appreciated that contractors had been permitted to submit alternative designs for this bridge when making their tenders. It was left to the discretion of the contractor in this case whether he should use thick steinings and save on kentledge loading or thin steinings and rely on special sinking devices. It was also open to the contractor to employ or not employ divers at his discretion. In this case the contractors were a very experienced firm who had built a great number of bridges in India and discretion regarding details of the work was rightly left to them.

With reference to the question asked by **Shri Nadir Shah**, it was found that well sinking on this bridge cost Rs. 350 to Rs 400 per foot. Pneumatic sinking was expected to cost much more. The same contractor had done well sinking by the pneumatic process on the Assam Rail Link Project where the cost came to about Rs 5,000 per foot depth.

The heaviest blasting charge which could be used safely would depend on the nature of the strata, the conditions under which the charge was applied, the depth of the sump, the diameter of the well, etc., etc. In this case the usual charge was two sticks of gelignite (six sticks to the pound).

Fifteen to twenty per cent plums were used in the 1 : 3 : 6 concrete in the steining.

The extra percentage of sand allowed was the average figure obtained from frequent bulkage tests, which were carried out bearing in mind all the factors mentioned by Shri Nadir Shah.

In well No. 2, the oozing of water through the 1 : 3 : 6 concrete plug was stopped by adding another four feet of 1 : 2 : 4 concrete.

Plugging under water was done by expert labour and the results obtained justified the process. This was confirmed when some of the wells were de-watered completely and no appreciable oozing was noticed.

Replying to **Dr. Iyengar**, the Author said that the fact that the river remained dry for the whole of the working season was one of the main factors in favour of open well sinking. Had there been a permanent depth (say 15 to 20 feet) of water at the bridge site, some other means would probably have been considered for the same strata.

All the expedients suggested by the speaker to facilitate the sinking work had been tried whenever they were considered necessary or expected to be effective.

The methods suggested by the speaker for rectifying cant were well known and had been tried and most of them had been mentioned in the Paper.

If Dr. Iyengar had really studied the boring charts on page 189, he would have found that the preliminary bores did not go down to the Artesian strata at all. These bores went down to the depth of the piers of the railway bridge 800 ft. upstream on which no Artesian action had been encountered. There was thus no reason to anticipate such action. Once the existence of the water bearing strata was known, all precautions were taken. Deeper foundations for this bridge than those of the railway bridge were considered only when this strata was discovered.

When equipment was not fully available for essential construction work, it was not easily possible to keep it standing by, as suggested by the speaker, for the occasional testing of the wells.

It would be interesting to know how the speaker got his figure of 2 or 3 ft. for the thickness of the top plug. Probably he had overlooked the reinforced concrete capping which was to come over the plug. The thickness of the plug hardly mattered in fact, as the well cap was designed to span across the dredge holes without reliance on support from any filling material. He would be interested to know that some of the wells had no top plugs at all i. e., when they were left hollow (without the sand filling).

Shri Sachindra Nath Gupta seemed to object to certain assumptions made in designing the test load. Some assumptions approximating to actual conditions obtaining after plugging would have to be made in any case. If it was remembered that the sand filling inside the wells did not heave during the tests and thus balanced the test load transmitted through the steining, the speaker would agree that the assumption that the test load was taken up by an area equal to cross-section of the steining was justified. In any case the method adopted appeared to be the nearest approximation to actual conditions.

Sand, being available locally and free of cost, was the cheapest material for filling in for the test. The results of applying the test load without sand filling were obvious; the well would sink as under kentledge.

One of the wells had actually been tested under a load of 1,800 tons gradually increased in 100-ton stages, without any detrimental effects. This test load would roughly correspond to the full load that was likely to come on a capping slab after the bridge had been completed.

A simple bearing test with a 2 sq. ft. plate, besides not being feasible, would not do in such cases unless steps were taken to ensure that there was no heaving up around the plate when fully loaded.

The speaker's concern for the bottom plug was really misplaced. A little reflection would show that the sand filling actually helped this plug by counteracting the thrust below it. Keeping the wells empty had been tried on bridges elsewhere and some wells on this work were also being left empty.

The art and science of well sinking on a large scale was developed in this country. The West actually looked to India for precedents in this type of work. The Author expected the speaker, who had been a member of one of the Indian delegations to America, to give information about American practice.

Shri H. G. Verma had suggested that "single circular" wells should have been adopted instead of the twin circular type. Spring on the subject of separate circular wells had said: "I scarcely need trouble myself to say anything about double circular wells. They are a pestilent relic of antiquity and have no good points about them that I can see but very many bad ones. Still one sometimes finds designers complacently using them having heard perhaps nothing better."

In quoting this the Author presumed that Shri Verma meant two separate circular wells so strongly denounced by Spring and not just one circular well about 35 ft. in diameter, which no doubt would have driven Spring mad with righteous indignation and drawn some real invective from his pen.

In the official design of the curb an angle of about 33 degrees had been proposed for the cutting edge. The cutting edge as constructed was the contractor's design. The effective angle of the curb taken as a whole was, however, not materially different from that suggested by Shri Verma.

Horizontal reinforcement in the well steining was nowhere mentioned because the Paper did not go into all the details of the design. Actually ¾ inch diameter bars at 2 ft. intervals were used as horizontal reinforcement in the steining. Half inch mild steel plates (width not mentioned) at every 10 ft., as suggested, would not have been equally effective.

The use of explosives seemed to exercise the minds of many Members. Even those who had taken part in the discussion held different opinions. While Shri Verma would blast his way down, others like Shri Joshi thought blasting to be a most dangerous

process to be used only when unavoidable. The Author had, however, already replied to this point: they were not afraid of using explosives on this work but exercised restraint in their use.

The Author regretted the impression created in the minds of the Members that divers were not available at any stage of the work. The references in the Paper were only to the initial stages of the work. Subsequently diving machines and divers were used on the work.

The presumption that the masonry of well No. 13 was probably not built in a straight line, thus giving rise to a shift of 2½ ft was not correct. All wells were built straight

Cant and shift had developed in some of the wells on this bridge work only when they had gone far down and when nothing very effective could really be done*. It had been noticed that most of the corrective methods were useful only in the early stages of the work.

Regarding the suggestion that sand blows occurred generally when the well curb was going through sand and was one or two feet above a clay stratum, it should be mentioned that the wells on this work had not given any trouble at that stage.

Dealing with the remark that it would be helpful to the maintenance men if the top of the steining were one or two feet above low water level and not merely six inches, the Author mentioned that the river bed was practically dry most of the time.

Shri D. N. Ghosh was correct when he said that a heavy well was easier to sink. The official design provided for a 4 ft 10½ in. thick steining but the firm whose tender was accepted had quoted for wells with a 3 ft steining. This was approved as there was no objection from other considerations. The firm was well within its rights to weigh the comparative economies of a heavy and costly steining in *all* the wells against a lighter steining in all wells with an occasional heavy kentledge on *a few* of them. The Author was, however, convinced that a heavier steining would have proved better and more economical on the whole.

The Artesian conditions met with were truly Artesian in the terms of the criterion laid down by Shri S. K. Mitra.

In designing the piers buoyancy had been fully allowed for and no anchorage had been found necessary as no tension was found to develop according to calculations.

*Pulling the top of the well had been tried on wells No. 15 and 16 after the Congress Session without any appreciable improvement.

Replying to **Shri S. K. Ghosh** the Author disclosed that the official design was a twin octagonal well, as recommended by Spring. That would have avoided the formation of hummocks.

The ingenious method of hinged struts, loaded at the hinge for removing cant, though very attractive on paper would not perhaps have been practicable on a work of this magnitude where wells went down as much as 100 ft or more. Sh i Ghosh had himself admitted the limitations of his suggestion.

Referring to the objection to the very idea of a bulb plug, the Author mentioned that it was frequently possible to de-water wells completely when sunk through a good depth of hard clay.

With regard to the suggestions that the "contractor's method" used on the Purnabhava bridge in Bengal would have been more successful in depositing concrete at the bottom of the well, the Author thought that it was difficult to claim perfection for any method of depositing concrete under water. Some dispersal of cement was bound to occur. The method adopted on the work gave quite satisfactory results. In any case, the Author felt that the comparison of the Kathjuri bridge wells, which were about a 100 ft deep, with the tiny 30-ft wells of the Purnabhava bridge was not appropriate.

The test load of 1,200 tons was designed to simulate actual working conditions giving stresses slightly in excess of those which would develop under the expected full superimposed load. The depth of the sand fill was obtained from the usual Rankine's method for finding the depth of foundations. As there was no heaving of the sand fill during tests, the assumption would appear to have been justified.

Shri S. B. Joshi's suggestion about the design of the cutting edge was a matter of detail. The function of the edge would remain unaffected.

The Alipore Test House was only a night's journey from the work site. No special curing arrangements on the journey were, therefore, needed. The blocks were sent to Alipore on the last night of the curing period.

The usual procedure was to apply kentledge before resorting to other sinking devices. But when all the available kentledge material was already in use, this sequence could not be observed on newly started wells and other devices were naturally adopted instead of waiting till kentledge could be released.

Detailed observations regarding cant and shift were taken on all the wells and measures were adopted to control the defects as soon as they were noticed.

The testing of soil samples in the laboratory was subsidiary to the full scale load tests and was carried out only to find out whether it would be possible to correlate the laboratory and field results.

The factors suggested for calculating the test load were taken into account. Under conditions of scour, the frictional resistance would decrease or disappear to a great extent but then buoyancy would come into play. Still one well was tested under 1,800 tons, as already stated.

Shri A. N. Chopra (Chairman), concluding the discussion, said that the work on the Kathjuri Bridge was in progress with the Author as resident engineer and expressed the hope that he would be benefitted in his future work by the comments made by so many engineers.

He mentioned that two types of foundations were adopted on two bridges under construction simultaneously: twin wells on the Kathjuri bridge and double circular separate wells on the Kuakhai bridge. These two types of wells suited the bed materials in the respective rivers.

He hoped that further Papers describing the construction would be read at the Congress Sessions after the Kathjuri bridge was completed.

WRITTEN CONTRIBUTION.

Shri K. A. N. Chetty, in his written comments, presumed that Lacey's formula had been adopted in designing the foundations and wanted to know the silt factor assumed. As different soils were met with at different depths, he wanted to know which of the soils should be taken into account for this purpose. While concrete with 10 in. plums might be good enough in mass concrete foundations, Shri Chetty doubted if it would be an improvement on homogeneous concrete for steining work.

The cutting edge for the curbs seemed to be of an unduly heavy section. He requested the Author to say whether there were any special reasons for adopting such a heavy section.

Other questions on which he desired to have information were :—

(1) Were wells taken to one third more than the scour depth from the maximum flood level even in stiff clay?

(2) What special considerations had led to the adoption of this type of well? Two independent rectangular wells with rounded corners might possibly have been easier to tackle.

AUTHOR'S REPLY.

Lacey's formula for determining the depth of scour was taken into account using a silt factor of about unity. As, however, silt and sand did not go down to the maximum depth of scour as found by Lacey's method, other considerations determined the depth of foundations.

In such cases where the nature of the strata varied, the silt factor assumed in the calculations would be an average figure derived from the silt factors of the different strata actually met with and the depths of these strata. The figure adopted would depend on the judgement of the designer.

A 3 ft steining was thick enough to permit the use of plums without adversely affecting the strength of the structure.

The cutting edge design used was normal for such wells.

The rule for taking wells to depth of one third more than the scour depth does not ordinarily apply to wells sunk through clay strata. But such wells have to be taken down to a reasonable depth below scour to give effective grip for stability.

The suggestion about two independent wells had already been dealt with in reply to Shri H. G. Verma.

Discussion on Paper No. 145.

"Stability of Densified Soil under Adverse Moisture Conditions."*

By

SACHINDRA NATH GUPTA

Monday, January 16, 1950.

Shri B. S. Puri (Chairman) called upon Shri S. N. Gupta, the Author, to introduce his Paper.

Shri Sachindra Nath Gupta (Author), introducing the Paper, said that the problem of highway construction was more acute in areas with heavy rainfall, high water table, and bad drainage conditions, than in areas which were more favoured in those respects. In the Author's State, namely the deltaic area of West Bengal, and in some parts of South India it was necessary to select soils which should be able to withstand the detrimental effects of excessive moisture, both surface and underground.

In the United States of America, the Author got an opportunity to make an original study on some aspects of soil science, and naturally he turned his attention to this subject. The time at his disposal was limited and the study could not be very exhaustive. He wanted to study a West Bengal soil too in addition to the two American Soils but unfortunately the sample he had asked to be sent to him, arrived on the eve of his departure from the United States of America.

The Paper was a study of the effects of excessive moisture on the stability of compacted soil. The first portion of the Paper was devoted to a theoretical discussion on compaction and the various factors that affected compaction followed by a discussion of the previous work done in the field and the interpretation of results in relation to his own investigation.

The study, as described in the Paper, consisted in subjecting two separate samples of soil similar to that found in West Bengal to varying degrees of compaction at their respective optimum moisture contents and subjecting them to continuous soaking until there was no swell. The density and crushing strength of each sample, before and after soaking, were determined to find the loss of strength in each case. The object was to find, if possi-

*Published at pages 193 to 246 of Volume XIV-2 of the Journal of the Indian Roads Congress, December 1949.

ble, an optimum compactive effort for a particular soil at which the best results, so far as stability under adverse moisture conditions was concerned, could be obtained.

This information, if obtained on a number of soils, might enable an investigator to predict the behaviour of a soil of known classification without going into detailed tests. It might even be possible to evolve a simple empirical formula giving the optimum compactive effort by calculation. The Author suggested that the results obtained should be taken as an incentive to continue investigations.

Shri E. A. Nadirshah said that the Paper opened to the mind of the average engineer the trends in the development of soil testing in relation to the methods adopted for soil stabilised construction and also in relation to the behaviour of the soils when in actual use. As the Author had admitted, the field was one involving a large number of investigations before simple formulae could be evolved relating gradation and other physical characteristics of soils to pavement design and selection of construction equipment.

The presentation of the Paper was rather too inter-connected in parts leading to a repetition of observations. Quite often doubts arising out of some statement in one part of the Paper found their explanation in another part. The data provided being very comprehensive, few comments were possible but the following might help in bringing out the practical value of the investigation.

(1) The issue of stability, as related to optimum compactive effort, determined by percentage swell in soaking, appeared, in the aims of the investigation, to lead to the design of pavements of lesser thickness and longer life at an economical cost. The speaker observed that this investigation did not include the long time behaviour of the soils concerned.

(2) The experiment seemed to simulate conditions where stabilised soil was kept away from exposure to the atmosphere, thus preventing loss of moisture by evaporation. This was far from the conditions obtaining in practice.

(3) In spite of the general trend of behaviour of soils during construction (depending mostly on physical characteristics), the consequences of differential chemical behaviour and ionised clay particles should be considered in relation to the physical tests for interpretation.

(4) It appeared doubtful to the speaker whether the relationship obtained between compactive effort and maximum density could be put to any practical use unless a very large range of equipment was maintained to meet the large differences in soil

characteristics. It would be very welcome if the Author could explain the maximum compactive effort or the range of compactive efforts obtained in the United States of America at present.

(5) The soils selected by the Author for testing belonged to the A2 group of the PRA classification, and were looked upon as fairly good material for road construction. The problem of swell and expansion requiring study in India was that presented by the high clay type soils like black cotton soil. Improving its properties by admixtures of other materials had not so far yielded successful results. Possibly, a study of black cotton soil modified by various economic methods might reveal certain characteristics leading to an improvement of the existing specification for successful construction in such soils.

(6) The Author had brought to prominence the limitations of the existing standard tests and had thus established the need for further studies of Indian soils and the problems connected with them.

Shri G. Srirangachary, continuing the discussion, stressed the importance of the investigation and suggested that the Author, with the facilities which he had under the Government of Bengal, might continue his studies with Indian Soils.

It might not be out of place to point out in this connection another investigation on this subject. The results of that investigation were published as a Paper by Mr. Mullis in the proceedings of Am. S. C. E. 1939. The object of that investigation was to find, by examining the behaviour of a large number of roads, the maximum amount of water that the subgrade might absorb without serious detriment to its bearing power. The investigation showed that in all cases where the moisture absorbed did not exceed 70 per cent of the plastic limit of the subgrade soil, the behaviour of the subgrades was quite satisfactory.

Mr. Mullis had suggested a new term, namely "theoretical water absorbing capacity", which could be calculated easily for any soil, given the specific gravity of the particle and the bulk density after compaction.

Work done at the Soil Research Laboratory of the Highway Department, Madras, based on the investigation of Mr. Mullis, indicated the possibility, under existing conditions of traffic loads in India, of adopting a lower factor of safety for water absorption so far as the subgrade was concerned.

After all, what appeared to be important was the effect of repetition of loads, such as might occur on a road during the course of one or two years. The cumulative settlement produced

by repetition of loads, such as the formation of tracks or change in the shape of the road cross section might or might not be important depending on the importance of the road itself. Whatever it might be, the design of stabilised soil to withstand severe conditions of water logging had to take into account repetition of loads. Laboratory tests of compressive strength, which amounted to only one application of load did not appear to be enough.

It had been found from experiments elsewhere that for a given deformation or settlement, the permissible load for 10,000 repetitions might be only 60 per cent of the load for one application. The speaker suggested that the Author might conduct some such experiments so as to arrive at reliable data for the use of stabilized soil in road foundations to withstand the severe conditions met with in India.

Shri Bh. Subbaraju said that the Author's statement in para 3·5 of the Paper that for compaction the moisture content was not critical and the density produced was qualitative required some clarification.

Paragraph 3·7 stated that the strength of a plastic soil varied inversely as its moisture content within certain limits of plasticity. It was well known that, whatever be the plasticity of a given plastic soil, the strength was inversely proportional to the moisture content for that soil. There was no restriction regarding the plasticity of the soil and the Author's statment that this would apply within certain limits of plasticity seemed to require clarification.

In paragraph 6·4, the Author had tried to show the difference in the bearing power of a soil compacted at different moisture contents. The data furnished did not seem to support the Author's statement that the bearing power, after soaking, of the soil which had been compacted at 8·5 per cent moisture was 33 times the bearing power, after soaking, of the same soil compacted at a drier condition than the previous one. This seemed to require clarification and the Author might furnish full data on this point.

In para 15·15, the Author had stated that compacting more particles into a given space resulted in higher density and also more pores. What exactly the Author meant by more pores was not clear. Higher density always resulted in less volume of the pores otherwise called, the void space. This void space was a three dimensional feature and so it was not understood what the Author meant by saying that there would be more pores. The Author's contention that the increase in pores resulted in greater saturation and consequently greater decrease in density did not appear to be supported by any theory of soil mechanics.

In para 17·4, the Author, in re-stating the aims of his investigation, had indicated that, by laboratory tests of compaction of different types of soils, it might be possible to predict an optimum compactive effort for a particular type of soil. If it was meant that we should evolve different degrees of compactive efforts for different types of soils, it was not clear what practical use such investigation would be from a constructional point of view.

It seemed to the speaker, on the other hand, that one kind of compactive effort might be adequate for dealing with most of the soils in India.

Regarding the general objects of the investigations conducted by the Author in America, the speaker's own experience showed that such investigations would be of great value for the design of a stabilized soil base course in localities subjected to water logging. The Author's investigation might be pursued further so that suitable tolerances might be evolved for different conditions in different parts of India.

On page 224, para 17·6, it was stated that the sheep-foot rollers always left one or two inches of loose soil at the top. Again para 17·10 mentioned the practice of making trip after trip until the feet no longer penetrated. These two statements were contradictory.

The first statement was borne out by the speaker's own experience.

On page 236, the Author had given the dry densities of the samples in cans No. 5 and 6 as 102·8 and 111·9 respectively. Calculations by the usual formula, Dry density $= \frac{100\ Dw.}{100+m}$

where Dw = weight of the wet sample.

m = percentage of moisture

gave about 106 and 109 respectively. The Author might explain whether he had used any other formula in getting his results.

Dr. H. L. Uppal questioned the Author's statement that the results were applicable to subgrades as well as to embankments.

On page 200, the Author had mentioned, without explanation that the percolation rate was many times more in the case of soils compacted dry than for soils compacted wet. The work carried out in the Soil Research Laboratory at Karnal showed that percolation decreased upto optimum moisture, but with a little excess moisture than optimum, the clay on the surface swelled slightly

and retarded further percolation. It had also been shown at the Karnal Laboratory that as density increased, percolation decreased but, in the case of coarse sandy loam and silty loam, the compacted mass was not impervious even up to a density of 2.0 A silty clay soil, on the other hand, could be made impervious when compacted to a density beyond 1·96. This showed that the blending of soils before compaction was justified and, within certain limits, could reduce the intensity of the compacting force.

On page 204 the Author had mentioned that the compressive strength increased with the moisture and the mode of compaction. Detailed work had been done on the compressive strength of soils and was published elsewhere in the Journal under the joint authorship of the speaker and Shri Mehra. It showed that the compressive strength was governed by one factor and that was the density determined at the time of compaction.

The Author, replying to the points raised by **Shri E. A. Nadirshah**, admitted that the long time behaviour of the soils was beyond the scope of the investigation, but pointed out that it was known that the long time behaviour of compacted soil in the field, as compared to uncompacted soil, followed the same trends as in the laboratory. The tests simulated conditions to which a subgrade under a highway pavement was subjected and it needed no explanation that a subgrade was not exposed to atmospheric evaporation. This investigation was not connected with stabilized soil as used in the surface course.

The consequences of differential chemical behaviour and ionised clay particles were beyond the scope of the investigation but the Author agreed that these should also be studied for a proper interpretation of soils.

There should be no apprehension that a wide range of equipment would have to be maintained. On the other hand, to use the same compactive effort for all types of soil and for all intensities of traffic all over India would be uneconomic and unscientific. In fact, even the existing practice was to use different compactive efforts ranging from a 2 ton roller on an earth road to a 12 tonner in water-bound consolidation. Probably three or four different compactive efforts might economically take care of all the soil types in India.

As far as the Author knew, compactive efforts ranging from 500 lbs. to 2,000 lbs. (static) per square inch were in common use in the U. S. A. while higher efforts were not unusual. The U. S. A. War Department was said to have experimented with a 30-ton 8-ft diameter sheepsfoot roller, 12 ft long, which could compact

a 2-ft thickness of soil; but the cost proved prohibitive for use on civil works.

Shri Srirangachary had suggested that the Author might continue the investigations in his home state of West Pengal; at the moment there was no scope for this but attempts were being made to develop a soils laboratory in that State.

The Author was thankful to the speaker for his description of the investigations of Mr. Mullis and his own experiences in the Madras Soil Laboratory. The information would surely be useful to soil engineers in India.

The effects of a repetition of loads came under long term behaviour. Though that was beyond the scope of the Paper, it was a very useful suggestion which should be borne in mind by all investigators.

Replying to **Shri Bh. Subbaraju**, the Author said that the indiscriminate use of the two terms "Compaction" and "Densification" made it necessary that they should be defined clearly. This had been attempted in the Paper. In "compaction" the moisture content was not critical and the objective was only the quality of consolidation. Consolidation under traffic, for instance, was "compaction", the result was qualitative. In "densification", on the other hand, the moisture content was critical, i.e, controlled in order to attain the optimum density, and the density produced was quantitative.

The statement in the Paper (para 3.7) that the strength of a soil varied inversely as its moisture content, within certain limits of plasticity, would apply when 'strength' was used to denote 'stability' as distinguished from resistance to penetration, shear, etc.

Experiments had shown that a Soil compacted at 8.5 per cent moisture content retained a bearing power of 330 lbs. per sq. inch after soaking while the same soil compacted dry would retain a bearing power of only 10 lbs. per sq. inch after soaking, showing thereby that the former was 33 times stronger than the latter.

The Author admitted that swell was a direct function of pore volume or void space but, by bringing in the conception of "more" (i.e, a larger number of) pores giving rise to a greater swell, he was only attempting to explain the phenomenon observed during the tests—viz., the phenomenon of a higher swell for a higher compactive effort.

The Author did not agree with Shri Subbaraju's contention that one compactive effort would be suitable for all soils in India under all conditions.

The discrepancy in paragraphs 17.6 and 17.10 was only superficial. Compaction by a sheepsfoot roller was continued till there was no penetration beyond the usual one or two inches of loose soil.

The dry density formula used by Shri Subbaraju for checking the Author's figures was correct. There were apparently some arithmetical errors in his calculations but these errors did not affect the conclusions or the trend of results.

In reply to **Dr. H. L. Uppal** the Author said that the tests referred to a subgrade though the knowledge thus gathered might be useful in designing embankments also.

Shri B. S. Puri, (Chairman), concluded the discussion by thanking the Author for his Paper.

WRITTEN CONTRIBUTIONS

Shri R. P. Chanda, in a written contribution, said that he had no comments to make on the subject-matter of the Paper, viz., the behaviour of artificially compacted soils. The Paper, however, raised in his mind the question of how road embankments, not compacted artificially but settled naturally by the action of one or two monsoons, would behave. The problems of special interest to Indian Engineers would be :

(*a*) how far different types or classes of soil would be compacted naturally in one (the first) rainy season (which might average 50 in. rainfall in about 5 months) and

(*b*) how much more compaction would result in the subsequent monsoon seasons. Shri Chanda requested the Author to give his own experience and observations on the subject.

Secondly, he suggested that favourably placed road engineers should undertake systematic investigations on the natural compaction of road embankments in different soils. Out of selected sections of such embankments, undisturbed samples might be taken from year to year and their densities, bearing power, moisture contents, etc., checked. He also recommended these problems to the Indian Roads Congress for consideration, for the following reasons :—

(*a*) Compaction of embankments by rolling could not yet be widely adopted ;

(*b*) Monsoon compaction or hydraulic fills were free ;

(*c*) Construction of pavements over new fills had to await stable condition of the bank.

Shri Fateh Chand commented by letter that while he himself had been responsible for improving, at a nominal cost, many miles of rural roads in the *Uttar Pradesh for light* bullock cart traffic by the use of soil from the beds of dried up pords and while similar improvements had been made in Assam and elsewhere by stabilizing earth roads with gravel he was not aware that much practical use had been made in India of the theory of compaction at "optimum moisture", although this theory had been known and talked about for a number of years. He wanted facts and figures about road milages improved by these theories about "optimum moisture" and "optimum compactive effort". He also suggested that the results of all soil stabilization roads experimets in the Punjab, successful or unsuccessful, should be published in the Indian Roads Congress Journal.

The present was the time when such economical methods of road improvement were most needed. When, later on, India became industrialised such methods would become out-of-date and India would probably have plenty of money and materials for better roads.

AUTHOR'S REPLY.

In his written reply to **Shri Chanda's** comments the Author said that the suggestion about a long term experiment on the compaction of soil in embankment by monsoons over a number of years was interesting but he doubted its usefulness as the monsoon was a variable factor beyond human control. He would however bear the suggestion in mind.

The Author did not feel called upon to reply the writer's other suggestions which were addressed to all the I.R.C. Members. The Author readily agreed with **Shri Fateh Chand's** suggestion that wherever any experiment was carried out, however humble it might be, and with whatever results, those results should be published and made available to engineers in general for the good of all. If this country had not put the theory of soil stabilization to practical use, it would not do to become sceptical of its correctness and practicability ; the reason had to be sought elsewhere. It was a regrettable fact that this country had been slow or conservative in the development or adoption of improved techniques and specifications. Without research and field adoption of the results established by that research, engineering knowledge and practice in India would remain stagnant.

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Discussion on Paper No. 146.

"Glossary of Highway Engineering Terms."*

By

SPECIFICATIONS AND STANDARDS COMMITTEE OF THE

INDIAN ROADS CONGRESS.

Monday, January 16, 1950.

Shri Komesh Chandra (Chairman) called upon the Member-Secretary of the specifications and Standards Committee, **Shri K. S. Raghavachary**, to introduce the Paper.

Shri K. S. Raghavachary introducing the Paper, on behalf of the Specifications and Standards Committee, said that the great development in the technique of road construction of recent years had almost transformed the art of road making into the science of highway engineering. The development had necessarily increased the vocabulary of the road builder and a scientific terminology had become a necessity. In India, commonly used words such as Moorum, Gravel, Binder, etc., were interpreted differently by different highway authorities. There was need, therefore, for an accepted Glossary of terms giving the exact significance of words used in highway engineering to avoid confusion in the interpretation of specifications, orders, etc.

Tracing the history of the Paper he said that the preparation of a Glossary had been taken up by the Specifications and Standards Committee in 1945 on the directive contained in the Nagpur Report. A comprehensive list of words was drawn up and grouped into eight major sections and Sub-sections. Draft definitions were circulated to the officers of the Roads Organisation and discussed at weekly meetings. The definitions were circulated to the Members of the Specifications and Standards Committee and discussed in detail at the meetings of the Committee. He said that, at the meeting of the Committee held earlier during the Session, the definitions of another 180 terms had been finalised. Draft definitions for about seven hundred more terms would have to be finalised to complete the Glossary which would then contain about one thousand terms.

Continuing Shri Raghavachary said that the aim of the Committee had been to prepare the Glossary so as to give philological

* Published at pages 247 to 272 of Volume XIV—3 of the Journal of the Indian Roads Congress, December 1949.

exactitude and to serve as a common basis for understanding the technical literature published in India and abroad. When an idea was expressed by two or more synonymous terms, the term recommended had been given first followed by the alternative term or terms in the order of perference. Terms recommended to be 'deprecated' had been put in brackets and given below the recommended term or terms. The Committee hoped that the use of alternative or deprecated terms would gradually fall into disuse in favour of the recommended standard terms. Schematic presentation of some frequently confused terms would be included to enable a precise meaning to be assigned to them The Glossary gave the generally accepted meaning of the term but the definition should not be regarded as taking the place of specifications.

Wherever a word in the Glossary had a legal meaning, the Committee had endeavoured to so define the term as to keep its sense in general agreement with the legal meaning or definition under Acts of Parliament though the Glossary definitions were intended for use in an engineering sense only

Referring to the arrangement and numbering of the terms in the Glossary, he said that those in each section had been arranged alphabetically with a four digit number. The first and second digits commencing from the left represented the section and sub-section and the last two digits the serial number of the term in the sub-section. For example, term 23·13 was the 13th term of the third sub-section of section 2. When terms were used with different meanings in different branches of Highway Engineering, appropriate definitions had been given in the corresponding sections of the Glossary with suitable cross-references.

He concluded by suggesting that the English version of the Glossary would be helpful as a basis for the Hindi compilation when required at a future date.

Shri K. G. Bhate said that, in view of the considerable time and effort required in the preparation of the Glossary in English, a Hindi version should also be taken up immediately taking the help, if needed, of the work already done by the Mahrashtra Sthapatiya Mahasabha, the Institution of Engineers (Hindi Section) and a body of scientists and engineers engaged in compiling Hindi versions of technical terms. He also felt that the Specifications and Standards Committee should have a Hindi Section for publishing the Standards in Hindi.

Shri B. N. Shenoy suggested some amendments to the definitions of the terms, "Blind Alley", "Byepass road", and "Driveway".

Shri S B. Joshi congratulated the Specifications and Standards Committee on completing a formidable task in a very short time. He urged every member to go through the Paper carefully and to bring to the notice of the Committee any mistakes or omissions he came across He felt that the definitions of some of the terms might be slightly modified to make their meanings precise and terse. He cited the definitions of 'Bearing" (22.02) and "Magnetic Bearing" (22.14) to illustrate his point. According to the definition "Bearing" meant "the angular deviation of a survey line at any point in the line from a known direction through that point". This definition was correct but it would be more precise if the definition had also stated that the angular deviation must be a clockwise deviation. Also, the words "Section by a Vertical Plane", and "Horizontal Plane" might be substituted for "Vertical Section" and "Plane" respectively in the definition of Cross-section (22.07) and Datum (22.08).

Shri Joshi expressed disagreement with Shri Bhate who had suggested that the Indian Roads Congress should start on the compilation of a Hindi Glossary immediately. There was not any unanimity of opinion with regard to Hindi terms and it would not be wise for the Indian Roads Congress to issue at this stage an authoritative Hindi Glossary. It would be better, in the first instance for a Member to contribute a Paper on the subject.

Shri T. K Macha suggested that the term "Other District Road" should be substituted by "Minor District Road".

Brig. Partap Narain desired that the term "Jeep Track" should be included in the Glossary.

Shri K. Narasimha Rao suggested that a section defining terms fixing Standards for "Traffic Worthiness" be added to the Glossary.

Shri K. S. Raghavachary, in replying to the discussions, thanked the Members for their suggestions which he promised would be carefully considered by the Committee. He appealed to other Members to send in their comments to the Committee for consideration. Possibly there were some omissions, and the Committee were anxious to include in the Glossary all the words in use in Highway Engineering. Certain terms suggested for inclusion by some Members had already been put in and would be appearing in appropriate sections in a future Paper.

While welcoming Shri Bhate's suggestion for a Hindi version, he said that it might be a little premature to start one till the present Glossary in English had been completed. The technical words would have to be given appropriate Hindi equivalents, and, in many cases, it might be necessary to adopt the existing English terms which, by constant usage had become generally well known and would therefore be more easily understood by the technical and non-technical public. Many of the so-called English terms had been borrowed from other languages.

Referring to **Shri Narasimha Rao's** suggestion for the inclusion of a section on Standards for assessing the trafficability of roads, he said that it would be beyond the scope of the Glossary which aimed only at giving definitions of terms without explanation or specifications.

Shri Romesh Chandra (Chairman) in concluding the discussions supported the suggestion that a beginning should be made for bringing out a Glossary in the National language with translations in the other Indian languages as well. In his view a word was difficult only so long as its use was not practised. Therefore, in order to familiarise engineers with the Hindi words, it would be necessary to make a start immediately. Concluding he congratulated the Committee for having done a most useful work and hoped that the remaining sections would also be ready for publication at a very early date.

WRITTEN CONTRIBUTION

Shri K. A. N. Chetty felt that the definitions of the following terms might conform to those given in the Nagpur Report.

1.	National Highway	11.20
2.	Provincial Highway	11.22
3.	District Road, Major.	11.07
4.	District Road, Other	11.08
5.	Village Road.	11.33

He suggested some modifications in the definitions of the terms, "Magnetic Bearing" (22.14) and "Radius of Curve, Absolute Minimum" (23.30). He desired the inclusion of other common terms, such as "Consolidation" and "Spreading" in the Glossary.

Shri Fateh Chand considered that the publication of the Glossary of highway engineering terms was very opportune, and would serve a useful purpose. He felt that an attempt should be made straightaway to bring out a Hindi version, deferring for later consideration the difficult technical words for which Hindi equivalents could not be readily found. He suggested some alterations in the definitions of Field-path; Service Road; Centre Line; Bye pass road; Diversion; Ground Level; Trimming.

Shri S. C. Paul was of the opinion that the word "Alignment" (21.01) should be defined as 'the course along which the outer edge of the roadway was located in plan' and suggested alterations in the definition of the terms "Alignment Posts" (21.02); "Cross Section" (22.07) and "Longitudinal Section" (22.13) so that they should be in conformity with the definition of "Alignment".

Discussion on Paper No. 147.

"An Adaptable Steel Centring for R. C. Bridges."*

By

A. NAGESWARA AYYAR,

Sunday, January 16, 1950.

Shri Thirumale Iyengar (Chairman) called upon the Author, Shri A. Nageswara Ayyar, to introduce his Paper for discussion.

Shri A. Nageswara Ayyar (Author), in introducing his Paper, pointed out some printing mistakes (see footnote).†

While perusing some of the tenders for reinforced concrete bridges, the Author had found that the quotations for their construction, when compared to pre-war rates, were far higher than could be justified by the actual increase in the cost of materials and labour. The rise in costs was, to a considerable extent, traced to the abnormal rise in the price of timber for centring. The alternative was to provide steel centrings which could be adapted to the needs of different structures and which could be used repeatedly. Properly designed trusses would avoid the need for supports from the bed of the river and enable the work to be continued even during floods. Military bridges of the Hamilton, Bailey, or Inglis types gave a clue to the analogous design for trusses required for centrings.

About December, 1948, the Author suggested to Shri Brij Narayan of the Central Roads Organization an outline of a design for steel centrings. Shri Brij Narayan gave some valuable suggestions and desired that the Author should work out the details and produce a complete design for scrutiny. The design was accordingly worked out but, owing to his pre-occupations Shri Brij Narayan could not find time to scrutinize it before his retirement.

The design was, therefore, submitted as a Paper for the present Indian Roads Congress session for general discussion. As it was then already late for submission of Papers, several portions which required elaboration could not be scrutinized. For instance in page 274 para 7, there was the bald statement that the design

* Published at pages 273 to 291 of Volume XIV-3 of this Journal of the Indian Roads Congress, December 1949.

† On page 280, lines 19 and 21, for 120 in. read 135 in.; in lines 21 and 22, instead of 105 read 118 and instead of 1.37 read 1.47. In line 23, for 68 tons read 63 tons and in line 27 instead of the words "are nil" read "are A_2 B_2 and H_2 K_2". On page 281 line 14, there should have been a full stop after the word "side". The words "Uniformly distributed" should have gone to the next line.

could be adapted for use on other types of bridges and other spans How this could be done was not explained. As it was felt that this claim might be disputed, the Author had placed on the table sketches and calculations showing how the adaptation could be made for spans of 30, 60, 80 and 100 feet, whether for bowstring girders, for T-beam structures, or for cantilever suspended spans. For spans below 30 feet the cross girders could be directly used. It was assumed that the loads would be ascertained and stresses calculated by a qualified engineer before adaptation.

The Author went on to mention a few of the salient features of the design The stresses in the members of the lattice truss with three tiers for 150 feet span were indeterminate and there were differences of opinion about their determination. The stresses were calculated assuming the lattice girder to consist of three independent girders $A_1B_1C_1D_1E_1$——, $A_2B_2C_2D_2E_2$——, and $A_3B_3C_3D_3E_3$——, each with its own loading and adding the stresses for the members common to all the three. This necessitated the assumption of the temporary supports for the trusses at A_2, A_3—— and distribution of the reaction stresses at the assumed supports to the members between those assumed supports and real supports at A_1 and K_3.

Messrs. P. S. Subramaniam and G. Srirangachari had calculated the stresses on the assumption that the shear stresses at any point were shared equally by the inclined members on account of their symmetry. Although the stresses given by these two methods did not differ very much, there was substantial variation in some of the diagonals. For safety, the higher of the stresses given by the different methods was adopted for any particular member.

The cross girders supporting the deck forms at each panel point had been designed as two units so that, after concreting the deck, centring for each panel could be eased and removed separately.

It was very important to use an adequate number of bolts for each joint taking into account the maximum stresses.

Shri E. A. Nadirshah remarked that the cost of centring was a major item in any R. C. C. bridge construction. To save on this item, it was no doubt worth considering the utility and cheapness of materials other than timber for this purpose. Steel would probably serve to this end better than any other material.

According to the Author the centring described in the Paper had been initially designed for a 150 ft span bowstring girder bridge with a 22 ft roadway but could be adapted for use on other

types of bridges and other spans. The speaker questioned the adaptability of the same centring for greater road widths and enquired whether this type of centring had so far been used on any bridge constructions in India.

No mention was made of the lateral pressures exerted by wet concrete in the arch rib. Probably these were to be resisted by the wind braces on the top and cross girders at the bottom of main girders. Shri Nadirshah wanted to know how the lateral thrusts from the arch centring affected the rigidity of the main girders.

The manner of connecting the cross girder to the main girder was not described. The cross girder was at a level below the bottom boom of the main girder and therefore the bolts at the joints would be in direct tension.

Neither the text nor the drawings made it clear whether timber shuttering was to be used for supporting the concrete road slab.

Shri Nadirshah suggested that a comparative analysis should be made for this type of centring and timber centring, taking into consideration the depreciation on both in order to give a rough idea of the actual nett cost of centring to be included in the total cost of the structure.

In his opinion, however, the utility of this type of centring would be a maximum where there was a heavy programme of bridge construction in any area. The cost of the centring for three consecutive spans would be justifiable even in the first stage of construction and would ultimately be much less than the expenses incurred on timber or any other similar type of centring. Besides the ease of operation the type of centring described in the Paper would eliminate a lot of congestion which was a common feature of timber centrings.

Shri K. A. N. Chetty, thanked the Author for writing the Paper at a most opportune time when the country had a heavy bridging programme in progress.

According to the Speaker one important requisite of any structure erected to serve as centring for R. C. work was that it should be practically unyielding. The structure under consideration was bound to undergo some deflection under load. The question naturally arose as to whether deflection obtaining during actual execution had been calculated. The expected deflection had to be provided for by suitable camber so that the centring might take the designed shape of the bowstring girder, and ensure that the finished superstructure did not present the appearance of

having sagged. The Paper did not mention any such camber having been provided for in the girder. The provision of camber might present practical difficulties having regard to the objective of standardisation and interchangeability of parts. It was, therefore, desirable to think out these details also and standardise them.

The intermediate horizontals had been left out of account in calculating the stresses in the diagonals. This might have appeared to be a safe procedure, but very often a redundant member was the cause of many unexpected stresses. After all, without the intermediate horizontals, the structure was reduced to a big lattice girder, and in such girders the stresses in the diagonals were often calculated by assuming that the shear at any section was wholly taken up by the diagonals in tension. The Speaker suggested that the effect of the horizontals should be studied in some detail before assuming that it was safe to omit them in stress calculation.

Then there was the all-important question of erection. Unless the method was made simple and codified as for the common type of military structures, there might be difficulty. It was presumed that the girder was to be built up section by section on the bank and moved forward into the span on specially designed cribs. If such was the case, it appeared that the part of the lower boom gussets projecting down might be a source of interference.

One of the objectives kept in view in designing the centring was that it should be capable of being moved from span to span without being totally dismantled. It would be interesting to know what method the Author had in view for moving the girder.

Considering the huge size of the steel members and the enormous weights involved, attempts should be made to find alternatives which would be lighter to handle. The main cause of the enormous sizes was that the whole length of 150 feet was proposed to be spanned without any intermediate supports. In certain situations it might be economical to provide one or two supports for the centring from an R. C. Crib or even a well sunk to sufficient depth to take about 100 to 200 tons load

Alternatively, if the whole centring were designed in pairs or fours so that a combination of two or four of these trusses took the load for 150 foot spans, it might be possible to reduce the sizes although it might invlove an overall increase in the total weight. Callender Hamilton units, when improvised for centring, were used in as many as eight lines and this accounted for their being of smaller sections.

Shri P. S. Subramaniam suggested that the design should be taken as a typical one as a code of practice for road bridges had been evolved, and widths and other details standardized.

Some years ago a timber truss had been adopted for a similar bridge in Madras across one of the rivers in the Tinnevalley district. The span was only 40 ft and the design was a simple T-beam one. Timber trusses were adopted because the river was subject to sudden floods without even a few hours notice. To avoid the risk of the centring being washed away timber trusses were designed to be supported on the piers, so that the work could proceed even if the floods came overnight. It was seen that the cost was about half that of centrings built up from the bed of the river in the usual manner.

The speaker found that the costs as calculated in the Paper did not provide for replacements of bolts, nuts, and perhaps a few members also to cover loss in transit, wear and tear, etc. This was necessary as this type of truss was meant to be transported from place to place and used over a number of years. The cost had been worked out to be Rs 5½ lacs. Normally, for ordinary timber centring erected from the bed of the river for a span of this type of 150 ft., the cost would be about Rs 8,000 to Rs. 10,000. If this steel truss was to be more economical than the orthodox type of centring, it was necessary to have a repetition for at least 100 times.

Of the total weight of steel work (212 tons) for one span except for 130 tons *i.e.*, the weight of two main trusses, the balance would have to be dismantled and re-erected. Assuming Rs. 40 per ton for dismantling and re-erection, the cost would come to Rs. 3,000. All these details would have to be gone into before the design could be put into use.

The Author had mentioned that the trusses could be rolled from one span to another. In the sketch attached to the Paper the gussets projected about 3 ins. below the bottom boom channel. The projection would prevent the free movement of the trusses over their roller bearings.

Shri S. B. Joshi was greatly interested in the very original Paper submitted by the Author. He said that the importance of the Paper lay not so much in the girder that had been designed as in the very conception of such a centring. Apart from the saving in the cost of centrings there were many other aspects of the construction of bridges which made the use of centrings of the type devised by the Author obligatory. Many rivers in the Deccan were subject to floods in the construction season during December

and January and centrings supported from the river bed were likely to be washed away during these months. Secondly, when centrings were supported from the bed of the river, the work of concreting the spans and erecting centrings had to be completely stopped during the four monsoon months. So the centrings of the type proposed by the Author were undoubtedly useful to bridge engineers.

The speaker had devised similar centring units for the bridges constructed by him in the province of Bombay. He had prepared centrings adjustable for any span upto 45 ft. In fact, his men got trained in erecting such centrings during the monsoons when the river was flooded. They, first of all, erected a sort of suspension bridge by connecting the piers by two wire ropes with a timber platform running on these wire ropes. They then erected centrings firstly by loose bolting and tightened all the bolts afterwards. This enabled the speaker to go on with the concreting work during the monsoons.

The question of deflection of centrings was very important. It would be necessary to load the centrings by sand bags of weight equal to the weight of the concrete and then to remove the sand bags gradually as the concreting progressed.

Shri Joshi requested the Author to study the question of buckling of these girders during the time they were rolled from one span to the next.

In the Speaker's opinion, Shri Joshi suggested that the general impression that the bow-string girder was costly on account of the high cost of its centrings was not correct. In fact, the great advantage of the bow-string girder was that it had potentialities for effecting considerable savings in the cost of centrings. The two concrete arches along with the suspension tie bars could first be erected and the arches alone concreted. The whole of the centring could then be supported from the two arches.

Shri B. N. Shenoy noticed that the cost of Rs. 5½ lacs was for the supporting structure only. To this it was necessary to add the cost of erection and dismantling and the cost of the shuttering, brackets etc. Also there was the cost involved in holding up the trusses with guys during their movement from one span to the next after the connecting cross-girders had been removed. The gusset plates could move in grooves in the cutwaters of the piers when the trusses were rolled forward.

Shri M. Meeran enquired whether it was suggested by the Author that these adaptable trusses should be manufactured by the Government and let out to contractors at some predetermined

rates? The cost of these trusses being so high, no contractor would venture to invest so much amount unless he were assured of a succession of contracts.

Shri K. L. Sheth agreed with Shri Meeran that the Government should undertake the manufacture of the adaptable centrings.

The Author replying said that he had made this design to meet a real want because, in many cases, where bridges of one or two spans had to be built, it became necessary to purchase a lot of material for centring. For instance if a bridge of a single span of 150 feet of the bowstring arch type were to be built, it would be practically impossible for any wooden centring to be constructed at a cost of anything like Rs 8000 as suggested by **Shri Subramaniam**. In such a case, the cost of centring for a 150-ft span would not amount to less than Rs 30,000.

There was also the further difficulty of constructing a bridge on a river like the Godavari which was subject to floods during eight months in the year. The height of the piers from the bed of the river to the underside of the girders would be anything up to 50 ft. To build up supports from the bed would be a very formidable task and the cost would be considerable.

Shri Nadirshah had expressed his doubts about the feasibility of the use of the proposed centring for different spans and for widths of more than 22 ft. As a matter of fact, most of the present bridge designs were based on a 22-24 ft width of roadway over the bridge. Bridges of more than 24 ft roadway were not contemplated in the mofussil area and consequently this standard centring would be suitable for most of the bridges. In Municipal areas where four lanes of traffic or possibly more were required, it would be more advantageous to have two bridges side by side so that the traffic could be segregated.

Shri Nadirshah had doubts about the capacity of trusses to resist the lateral pressure of wet concrete. The lateral pressure of wet concrete in the arch rib would be small and the form work for the arch rib had been designed with heavy channels which would take care of the lateral pressure. These channels were to be attached to the horizontal wind braces at the panels and there would be no lateral pressure on the trusses from the wet concrete being laid in the forms. It would be found from the plans that there were lateral wind braces connecting the two trusses at every panel joint at the top and cross girders at the bottom. In addition to this, as indicated in the plans, wooden bars in the middle served to stiffen the girders and also formed the supports for the arch rib.

Shri Nadirshah had suggested that comparative costs of steel and timber centring should be worked out to prove the comparative economy of the steel centring. The Author pointed out that the adaptable centring described in the Paper enabled Engineers to stock materials from which a selection could be made for building up a centring for any type of reinforced concrete bridge up to 150 ft span and 22·24 feet road way conforming to Indian Roads Congress standards. A 150 feet span bowstring girder bridge was chosen for purposes of design as centring for this would give sufficient materials for any type of bridge commonly met with. The proposal to stock centring materials would be akin to stocking tools and plant for use when required. Owing to the varied uses to which the materials could be put, it was difficult to work out the economics of the steel as compared to wooden centring. The economics would, however, be worked out as far as practicable and published in a supplementary Paper.

Both **Shri Chetty** and **Shri Subramaniam** had referred to the gussets projecting below the bottom booms by four inches. These were necessary because the booms were to be connected by channel bars which had to be bolted to the extended gusset plates in order to give sufficient continuity and stiffness to the bars. When the trusses were moved horizontally it was necessary to ensure that the whole weight of the girders did not come on the channel bars themselves and so it was necessary to insert wooden bars at the bottom which would project below the gussets. These wooden bars would rest on rollers and would take the stresses while rolling out from one span to the next.

Such timber supports were necessary even in the case of Hamilton or Inglis trusses so that no parts of trusses should be subjected, in the course of erection, to transverse stresses for which they were not designed.

Shri Chetty had said that the huge girders could be reduced in weight and cost if central supports were provided and the units made for smaller spans of 50 or 60 ft. The Author had dealt with this in the Paper where he had made it clear that it was not necessary to use all the three tiers always (vide page 277, para 21). One or two tiers could be used according to the requirements of the case. This would reduce the weight of the centring by about one half and make it quite handy whenever it was possible to provide intermediate supports between piers.

Typical methods showing how the materials of the centring for a 150 feet span bowstring bridge could be utilized for building up centrings for other types of structures and for different spans had been worked out and placed on the table. These would be amplified and published in the Indian Roads Congress Journal at a later date, he hoped.

The question of deflection had been raised both by **Shri Joshi** and **Shri Chetty**; possibly they considered this to be a truss with pin joints. Owing to the large number of bolts at each panel joint, the trusses would act as if riveted. The amount of deflection would be slight and might be allowed for in the form work or by means of wedges. The method suggested by Shri Joshi to load the centring and to remove the load as concreting proceeded was practicable and could be generally adopted.

Shri Joshi had suggested that the arches and ties of a bowstring bridge could be cast first and utilized to support the centring for the rest of the structure. This would be possible if one or two spans only were to be constructed and time were no factor. Normally, it would entail considerable delay as the arches and ties would require curing for two weeks; great care would be required at the junctions of cross girders and ties; and overhead charges would be heavy. It would not be economical especially when a number of similar spans had to be constructed.

The comparative lightness and ease of erection of Callendar-Hamilton trusses had been adverted to by Shri Chetty. Those trusses were designed to take only very light loads apart from their own weight. For a 140 ft span, the girders weighed 79 tons and the total weight they could carry (including the timber decking) was not more than 75 or 80 tons, whereas the loads contemplated in the present design were of the order of 950 tons. To take up this load, Hamilton girders weighing 300 tons would be required. The trusses as designed were stronger than Hamilton, Inglis, or any other of the usual army type trusses, and were lighter in relation to their load carrying capacity. The principle objective of the Author's type was that its materials could be used for building centrings for any type of bridge up to 150 feet span.

The Author agreed with **Shri Shenoy** that the cost of transport, erection and dismantling, and removal back to stores had to be provided for in the estimates for the bridge in which the centring was to be used.

The question had been asked whether it was intended that contractors should have these centrings made. The Author suggested that each State Government should own these, treat them as tools in stock, and issue them to work as required, on a fair rent, whether a work was done departmentally or on contract, or by any other agency.

Why a 150 ft span was chosen for the design was that the Godavari bridge to be constructed would have about 60 spans;

150 feet. Several other smaller bridges had to be constructed for which many parts of 150 feet span trusses could be used. It would be a real source of economy if Government owned the centrings and loaned them out to contractors or to the departments.

The Chairman concluded the discussion by congratulating the Author on his excellent suggestions and the type designs which he had given for steel centrings for bridges. While the interchangeability of parts in a temporary structure of this kind was a basic principle, the main advantages claimed were the use of the same design for varying spans and types of superstructure and launching the centring from one span to the next without dismantling. In Madras, work on the Godavari bridge of nearly fiftyfive 150 ft spans of bowstring type had been started and such a centring would be extremely useful there. There were various details which had to be worked out as regards the joints, and some special arrangements had to be thought of for moving the girders over the piers. Otherwise something might happen to the piers.

The Chairman presumed that all these details would be worked out by the Author and presented to the Indian Roads Congress.

In working out the sections of the members of the trusses, the Author had taken the safe stress of structural steel as 8 tons in tension and 7½ tons in compression. These figures seemed to be a little on the high side considering the fact that the members would be subjected to a reversal of stresses and wear and tear. The factor of safety allowed might have to be a little higher.

WRITTEN COMMENTS.

Shri Fateh Chand, in his written comments received after the Session, referred to the Author's statement that the cost of timber had gone up to 4 or 5 times of pre-war prices while the cost of steel had only doubled. In Uttar Pradesh, it was not so. According to the P. W. D. Schedule of rates and in the market too, the usual price of timber had gone up by about 200 per cent only while steel could not be had in the open market for anything less than four times the pre-war rates. Steel was not available to Local Bodies at controlled rates even for the most urgent works. To talk of a steel centring under such conditions would be moving in the realm of theory.

The handling and the cartage of the steel centring would certainly be difficult and relatively costly—particularly on katcha roads and when there were few spans to be concreted. It was neither practicable nor economical for small units like 'Local Bodies' to resort to steel centrings. It could be useful to big engineering Departments and business firms only and there too when bridges of similar design were to be constructed in large numbers.

Non stoppage of work during floods and economy in time were the two chief advantages of such a type of centring.

AUTHOR'S REPLY.

In his written comments **Shri Fateh Chand** had pointed out that timber had not increased in price to the same extent as steel and that there would be no economy in the use of steel for centring. This might possibly be so near the Himalayan regions where perhaps timber remained cheap. In Madras, Casuarina posts largely used for supports for centrings, could be had for about Rs 10 per ton in pre-war days but at present they could not be had even for Rs 60 per ton. Good timber scantlings sold in pre-war days at Rs 1-8-0 to 1-12-0 per cft. but they are not now available for anything less than Rs 6 to 8 per cft The controlled price of steel which was Rs 7 to 8 per cwt pre-war was now Rs 16 per cwt. For the small spans which Shri Fateh Chand obviously had in mind, a few cross girders and plates would be all that were required as centring. These could be easily selected from stock from a nearby P. W. D. store where the materials for the proposed adaptable centring would be stocked if the scheme were adopted. No doubt, for such petty works it would not be economical to convey steel centring parts over long distances. The economy of steel centring would be apparent only when many large spans had to be constructed and the centring could be repeatedly used

INDIAN ROADS CONGRESS

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

SUBJECT INDEX

Classification

I. Roads in General.
II. Road surveys, Design, Lay-out and Construction.
III. Soil and Earthwork; Soil Science as adapted to road foundation, Banks and Earth Surfaces, Soil Stabilization, etc.
IV. Water-bound Macadam Roads, such as moorum, brick and other forms of trackways.
V. Tar and Bitumen Surfacing Carpets, etc.
VI. Concrete.
VII. Miscellaneous materials and processes; Aggregate, Tests, Sizes, etc.
VIII. Bridges, Retaining Walls and other structures.
IX. Traffic Statistics; Regulation and Control of Traffic; Economics of Roads and Road Transport.
X. Road Maintenance and Road Usages.
XI. Standardization, Designs, Loadings, Impact, Specifications.
XII. Research and Experiments.
XIII. Administration and Finance.
XIV. Plants, Machinery and Apparatus.
XV. Miscellaneous.

I. Roads in General.

Serial No.	Name of Paper.	Name of author.	Reference to Proceedings. Volume No.	No. of Paper in Volume.	Pages.	Serial No. of Paper in general index.
1	Roads and Public Health in India with special reference to malaria, borrowpits and road dust.	Raja Ram	III	33	64-73	37
2	Safe wheel load for Indian Roads.	K.G. Mitchell & Jagdish Prasad	IV	E	1(e) to 32(e)	49
3	Corrugations on road surfaces.	C.B.E. Trustcott	IV	G	1(g) to 24(g)	51
4	Ribbon Development.	A.S. Trollip	V	M	1(m) to 30(m)	58
5	Slip and subsidence in a hill road.	D.C. Datta	VI	1-39	16(i) to 17(i)	72
6	The Broad classification of Traffic and contributory causes of wear and tear of roads.	Sir Kenneth Mitchell	VIII	A-41	1 to 4 (b)	85

Serial No.	Name of Paper.	Name of author.	Reference to Proceedings. Volume No.	No. of Paper in Volume.	Pages.	Serial No. of Paper in general index.
7	Drainage in Hill Roads.	M. Mahapatra	X Parts 1 & 4	106	183 to 184-1 724 to 729-4	106
8	Cycle Tracks.	R.S. Fateh Chand	X Parts 3 & 4	111	429 to 433-3 796 to 809-4	111

II. Road Surveys, Design, Layout and Construction.

1	Construction of Shillong Jaintipur Road, Khasi Hills, Assam.	F.E. Cormack	II	30	390-397	34
2	A method of rapid road reconnaissance.	Captain W.G. Lang Anderson	II	31	398-416	35
3	Some notes on the layout of rural and suburban roads in the Punjab.	R. Trevor Jones	III	32	10-26	36
4	Optimum weight of vehicles on extra-municipal roads.	K.G. Mitchell	III	39	92-105	43
5	Layout of roads.	R. Trevor Jones	V	k(i	4 k to 17(k) 18 k to 43(k2)	5
6	Transition curves for roads.	W.R. Fleury	VII	C.40	15 to 47	78
7	Calculation of the Structure of Roads.	Brigadier Lang Anderson	IX Parts 1 & 4	98	1 to 6-1 1 to 18-4	98
8	Basis of Road Planning.	Jagdish Bahadur	XII Part 5	134	267 to 282 and 448 to 455	134
9	Fundamentals of Highway Needs and Highway Planning.	D.G. Bhagat and Jagadish Bahadur	XIII Parts 3 & 4	141	377 to 417-3 and 193 to 197-4	141

III. Soil and Earthworks, Soil Science as adapted to Road foundation, Banks and Earth surfaces, Soil stabilization, etc.

1	Earth road construction and maintenance by machinery.	G.W.D. Breadon	I	3	90-105	4

Serial No.	Name of Paper.	Name of author.	Reference to Proceedings. Volume No.	No. of Paper in Volume	Pages.	Serial No. of Paper in general index.
2	Earth road Development and stabilization with gravel.	Lt.-Col. A.V. T. Wakley	I	4	68-89	5
3	Roads in Rural areas (village roads).	Rao Bahadur Chowdhary Lal Chand	II	23(a)	191-194 227-233	25
4	Oil as binder for earth and gravel roads.	T.G.F.K. Hemsworth	II	24	205-233	28
5	Soils in relation to Roads—A bibliological study.	G.W.D. Broadon	V	N	1(n) to 12(n)	59
6	The use of soil stabilization in unmetalled and metalled roads in India.	S.R. Mehra	V	O	1(o) to 21(o)	60
7	Stabilization of unmetalled berms of metalled roads.	S.R. Mehra	VI	F-39	1(f) to 25(f)	69
8	The use of soil stabilization in unmetalled and metalled roads in India.	S.R. Mehra	VII	H-40	135-156 (g)	88
9	Some experiments to stabilise moorum roads in Chota Nagpur.	K. Gupta	VIII	D-41	57 to 74 (b)	88
10	Fundamentals of soil mechanics.	F.L.D. Wooltorton	VIII	L-43	211 to 298(b)	96
11	Road Construction in Black Cotton Soils.	D.B.A. Nageswara Ayyar	X Parts 1 & 4	104	125 to 132-1 697 to 712-4	104
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
13	Stability of Densified Soil under Adverse Moisture Conditions.	Sachindra N th Gupta	XIV Parts 2 & 4	145	193 to 246-2 & 523to531-4	145

IV. Water-bound macadam roads and other low-cost roads such as moorum, Brick and other forms of trackways.

Serial No.	Name of Paper.	Name of author.	Reference to Proceedings. Volume No.	No. of Paper in Volume.	Pages.	Serial No. of Paper in general index.
1	Corrugation of water-bound macadam road surface in the Bombay Presidency, and a Cure.	Henry J.N. Cousins	I	10	184-189	12
2	Some physical aspects of roads and tyres.	G.L.W Moss	I	12	190-198	12
3	Treatment with molasses of Bangalore Mysore Road.	N.N. Ayyangar	II	19	105-109 125-130	21
4	Gravel Roads.	N.N. Ayyangar	II	23(b)	199-203 227-233	26
5	Vitrified bricks for surfacing roads in deltaic districts.	Gopalacharya	II	23-(c)	111-116 125-130	27
6	Roads under Local Bodies and how to maintain them.	R.S. Fatoh Chand	IV	F	1(f)-20 (f)	50
7	Collection of material for and consolidation of water-bound macadam.	R. Trevor Jones	V	k(i)	1-k)-5(k) 6(ki)-40 ki)	55
8	Some notes on the maintenance of water bound macadam.	R.B.A.L. Rao	VIII	G-43	151-155 H.	91
9	Water-bound macadam.	G.M.McKelvie & K. S. Raghavachary	XI Parts 2 & 4	117	177 to 284 -2 & 566 to 568-4	117
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

V. Tar and Bitumen Surfacing: Carpets, etc.

Serial No.	Name of Paper.	Name of author.	Reference to Proceedings. Volume No.	No. of Paper in Volume.	Pages.	Serial No. of Paper in general index.
1	Recent methods used for the treatment of roads with bitumen and tar in Delhi Province.	A.W.H. Dean	I	1(a)	21 to 50 56 to 67	2
2	Progress made in the use of tar and bitumen in the Punjab since the last International Road Congress in Washington in October 1930.	S. G. Stubbs	I	5 a)	121-134 168-182	6
3	Notes on the use of tar, bitumen and emulsions in the Punjab.	R. Trev r Jones	I	5 (a)	135-145 168-182	7
4	Asphalt Roads.	G.G.C. Adami	I	6	146-182	8
5	Necessity for surface treatment of important tourist lines and some aspect of economical works in that direction.	V.S.S.Acharya	II	18	74-83 93-104	20
6	The Road problem in India with some suggestions.	Col. C.E. Sopwith	II	20	84-104	22
7	Further notes in the treatment of Roads in Delhi Province, with bitumen & tar.	A.W.H. Dean	III	34	27-63	38
8	Some aspects of bituminous road construction in India.	Col. C. E. Sopwith and W.A. Griffith	V	L.	1(l) to 24(l)	57
9	Revitalisation of tarred or bitumened surfaces by mix-in-place methods using cutback asphalt.	Capt. R.C. Graham	V	P.	1(p) to 12(p).	61
10	Surface treatment of concrete roads when outworn.	W.A. Radice	V	Q.	1(q) to 18(q)	62

Serial No.	Name of Paper.	Name of author.	Reference to Proceedings. Volume No.	No. of Paper in Volume.	Pages.	Serial No. of Paper in general index.
11	Present-day methods of bituminous road surfacing work in Chota Nagpur, Bihar.	S.A. Amir	VI	E-39	1 e) to 15 e)	68
12	Light bituminous surfacings.	Ian A.T. Shannon	VI	G-39	1(g)-50 (g)	70
3	An economical substituto for waterbound macadam.	A. L. Rao	VI	N-39	1(h)-to 10(h) 18(g-50 (g	71
4	Primers, their nature and uses.	N. Das Gupta	VII	F-40	79-86	81
5	Notes on drag spreading and drag brooming.	W. L. Murrell	VII	1-40	157 to 190(0)	84
6	Revised specification for bitumen roads in the Punjab.	Abdul Aziz	VIII	1-43	161-184 j)	93
7	Bituminous treatment of wet aggregates.	C. J. Fiolder	IX Parts 1 & 4	39	7 to 54-1 19 to 35-4	99
1	Track Spreading.	W. J. Madden	XII Parts & 5	124	241 to 253 -2 406 to 411-5	124

VI. Concrete.

The use of cement concrete for the construction of roads in the Bombay Presidency.	L.E. Greenings	I	7	214-216 236-252	9
Cement concrete roads.	W.J. Turnbull	I	8	217-230 136-258	10
Concrete roads in Hyderabad (Deccan).	M.A. Zaman	I	9	231-252	11
Cement bound roads.	W.J. Turnbull	II	25	117-130	29
Economy and development of bonded brick concrete roads plain and reinforced.	A.K. Datta	III	35	106-146	39

Serial No.	Name of Paper.	Name of author.	Reference to Proceedings: Volume No.	No. of Paper in Volume.	Pages.	Serial No. of Paper in general index.
6	Evolution of the thin concrete road in the United Provinces.	W.F. Walker	VI	A-39	1 a - 31(a)	64
7	Repair and maintenance of cement concrete roads.	R.B.A.C. Mukerji	VI	B-39	1(b) to 34 b)	65
8	Trackways for rural road development.	Sir K.G. Mitchell	VII	D-40	49-65 j)	79
9	Cement concreting the Bombay-Poona Road.	W.H.E. Garrod	VIII	K-43	203 to 216(h).	95
10	Bonding a thin wearing Coat of Cement Concrete to an old Cement Concrete Road Surface.	H.M. Surati	XI Parts 2 & 4	115	153 to 159-2 510 to 552 -4	115
11	Standard Form for Recording Data on Cement Concrete Surfaces.	Specifications & Standards Committee.	XII Parts 1 & 5	122	87 to 97-1 382 to 392 -5	122
12	A Study of Cement Concrete Roads with Special Reference to Bombay Province.	L.T. Aminbhavi	XIII Parts 1 & 4	136	147 to 168-1 133 to 157-4	163

VII. Miscellaneous materials and Processes : Aggregates, Tests, Sizes, etc.

1	Indian "Road aggregates" Their uses and testing.	R.L. Soudhi	III	37	146-176	41

VIII. Bridges, retaining walls, and other structures.

1	Permissible stresses in concrete bridge design.	W.J. Turnbull	II	28	358-389	32

Serial No.	Name of Paper.	Name of author.	Reference to Proceedings: Volume No.	No. of Paper in Volume.	Pages.	Serial No. of Paper in general Index.
2	Submersible bridge across Parbati at mile 231, Agra-Bombay Road.	R.B.S.N. Bhaduri	III	38	176-234	42
3	A Method of calculating the stability of braced pile piers.	Gathlac Wilsen	IV	A(i)	1(a)-1(a) & 23 a)	44
4	The Dhakuria lake bridge.	"	IV	A(ii) (a)	17(a)-23	45
5	Franki Pile Foundations for bridges.	W.A. Radice	IV	B.	1(b)-29(b)	46
6	Reinforced cement concrete bridges of 24 ft. span constructed in Gwalior State.	R.B.S.N. Bhaduri	IV	C.	1(c)-20 (c)	47
7	Reinforced concrete bridge across the Godavari at Shahgadh in Hyderabad State.	Dildar Husain	IV	D.	1(d)-46 (d)	48
8	Some notes on submersible bridges.	D. Nilsson	V	I.	1 i)-45 (i)	53
9	Design of reinforced concrete bridges of short span for Indian roads.	Brij Mohanlal	V	J.	1(j)-55 (j)	54
10	A serious failure in the painting of a steel highway bridge	W.L. Murrell	V	R.	1 r -10 (r)	63
11	The Sai Bridge.	M.A. Korni	VI	D-39	1(d)-5(d)	79
12	Intermediate screw piles for the foundation of bridges in soft soils	M.S. Doraiswamy Iyengar	VII	A-40	1 & 2	76
13	Failure of a multi-arched masonry Bridge.	R.S.S.K. Ghosh	VII	B-40	3 to 14 (g)	77
14	Sevoke Bridge.	Lt.-Col. J. Chambers	VIII	G-40	27-34(h)	82

Serial No.	Name of Paper.	Name of author.	Reference to Proceedings. Volume No.	No. of Paper in Volume.	Pages.	Serial No. of Paper in general Index.
15	Boat bridge across the Indus at Gazighat.	G.C. Khanna	VIII	F-43	91-149 (k)	90
16	Submersible bridge over the Ujh river in Jammu Province.	S.B. Tayabji	VIII	H-43	157-158 (j)	92
17	Masonry Arch Bridge across the Krishna at Deosagar, Hyderabad (Deccan).	Md. Farhatullah	VIII	M-43	299-303	97
18	Stable causeways on unstable foundation soils.	M.A. Mirza	IX Parts 2 & 4	100	55A to 69A-2 37-48-4	100
19	Aj-y bridge—Failure of masonry piers—Remedial measures adopted.	H.K. Nivas	IX Parts 2 & 4	102	101 to 104-2 72-83-4	102
20	Design and Construction of the Purnabhava Bridge.	J. Chambers	X Parts 1 & 4	103	39 to 123-1 655 to 696(b)-4	103
21	Standard Specifications and Code of Practice for Road Bridges—Section 1.	Bridges Subcommittee	X Parts 2 & 4	109	229 to 331-2 746 to 789-4	109
22	Standard Specifications and Code of Practice for Road Bridges—Section II.	Bridges Subcommittee	X Parts 3 & 4	112	435 to 458-3 746 to 789-4	112
23	The Failure of a Steel Bridge in Bihar.	S. A. Amir	XI Parts 2 & 4	116	160 to 176-2 526-535-4	116
24	R.C. Bridges in Travancore State.	S. Rajaraman	XI Parts 3 & 4	118	301 to 325-3 569-576-4	118
25	Well Foundations of the Kalabagh Bridge over the Indus.	R.K.N. Iyengar	XII Parts 1 & 5	120	17 to 64-1 363 to 374-5	120
26	Failure of a reinforced Concrete Bridge in the N.W.F.P.	Hardit Singh	XII Parts 2 & 5	123	211 to 239 -2 & 393 to 405-5	123

Serial No.	Name of Paper.	Name of author.	Reference to Proceedings. Volume No.	No. of Paper in Volume.	Pages.	Serial No. of Paper in general index.
27	The Testing of the R.C.C. Bridge over the Auranga River.	J.A.Taraporevala	XII Parts 4 & 5	129	59 to 78-4 434 to 441 -5	129
28	Some Observations on Load Testing to ascertain the Foundation Bearing Pressures of Bridge Wells in Sandy Strata and on the Alterations required in the Design of a Bridge Foundation owing to one Well of a Pier having gone out of Alignment.	R.B.B.B. Gupta	XII Parts 4 & 5	130	79to 92-4 442 to 443 -5	130
29	Some Type Designs of Unreinforced, Hingeless Masonry Arches.	Bridges Committee	XII Parts 4 & 5	131	157 to 178 -4 & 444 to 447-5	131
30	Successive Failure of Two High Level Bridges over the Barakar.	C.D. Mitra	XII-5 XIII-4	133	247-266-5 95 111-4	133
31	Repairing & Healing of Cracks in Reinforced Concrete Bridges.	M.A. Korni	XIII Parts 3 & 4	139	321 to 346-3 & 178 to 182-4	139
32	Some Causeways on Sandy Bed.	Y.K. Lall	XIII Parts3&4	140	347 to 376 -3 & 183 to 192-4	140
33	Failure of a Five-Span Masonry Arch Bridge across the Bhogeswari River near Pen, District Kolaba in the Province of Bombay.	K.G. Bhate	XIV Parts 1 & 4	142	21 to 46-1 and 485 to 499-4	142
34	Well Foundations of the Kathjuri Bridge.	Sudhindra Nath Gupta	XIV Parts 2 & 4	144	153 to 192 -2 and 507 to 522-4	144
35	An Adaptable Steel Centring for R.C. Bridges.	A. Nageswara Ayyar	XIV Parts 3 & 4	147	273 to 291-3 and 537 to 548	147

IX. Traffic statistics; Regulation and control of traffic; Economics of roads and road transport.

Serial No.	Name of Paper.	Name of author.	Reference to Proceedings. Volume No.	No. of Paper in Volume.	Pages.	Serial No. of Paper in general index.
1	The trend of development in the United Provinces in the matter of improving road surfaces with special reference to recent experiments.	C.F. Hunter	I	2	107-120 168-182	3
2	An analysis of Delhi Road traffic census.	R.L. Sondhi	II	14	7-28 46-62	16
3	Study of relationship between vehicular traffic and road surface as affecting the section of economic road surface.	H.P. Sinha and A.M. Abbasi	II	15	29-39 46-62	17
4	Traffic census and road diagrams.	Lt. Col. W.De H. Haig	II	16	40-45 46-62	18
5	Economics of road maintenance.	S. Bashiram	II	17	63-72 93-104	19
6	Regulations and control of motor transport in Mysore.	H. Rangachari	II	29	134-255	33
7	An aspect of traffic statistics.	Ian A.T. Shannon	IV	H	1(b)-6 (h)	52
8	A note on the reconstruction of roads carried out in the U.P. with special reference to experiments carried out and the use of traffic statistics.	S.N. Chakravarti	VIII	B-41	5-42 f)	86
9	Economics of Highway Types.	K.S. Raghavachary.	X Parts 1 & 4	105	133 to 181-1 713 to 723-4	105
10	Allocation of Road Maintenance Costs between Motor Vehicle Traffic and Non-Motor Vehicle Traffic.	Prof. K.B. Madhava	X Parts 2 & 4	108	218 to 227-2 734 to 745-4	108

Serial No.	Name of Paper.	Name of author.	Reference to Proceedings. Volume No.	No. of Paper in Volume.	Pages.	Serial No. of Paper in general index.
11	A Survey of Traffic on the New Howrah Bridge.	Prof. K.B. Madhava	XII Parts 3 & 5	127	345 to 407-3 427 to 133-5	127
12	A Small Scale Traffic Survey in New Delhi.	C.S. Ananta-padmanabhan	XIV Parts 1 & 4	143	47-1 to 121-1 & 500 to 506-4	143

X. Road maintenance and road usages.

1	Ways and means of improving the bullock cart.	G.L.W. Moss	III	36	73-92	40
2	Steel tyre problem unfolds.	W.L. Murrell	VII	E-40	76-77 (k)	80
3	Raising the Road-Rupee Ratio with a special reference to the steel tyre.	W.L. Murrell	VII	C-41	43 (l) to 56 (p)	87
4	Proposals for an all-India survey of bullock-carts by means of random sampling.	J. Vasudevan	VIII	J-43	185-202 (p)	94
5	A design for bullock-cart wheels, Part I.	B.V. Vagh	IX Parts 2 & 4	101	55 to 99-2 49-70-4	101
6	Maintenance of Gravel (Moorum) Roads under Heavy Traffic.	R.B.B.B. Gupta	X Parts 2 & 4	107	211 to 217-2 730 to 733-4	107
7	The Effect of Road Cambor on Road Maintenance and Wheel Design	B.V. Vagh	XII Parts 1 & 5	121	65 to 85-1 375 to 381-5	121
8	A Design for Bullock-Cart Wheels, Part II.	B.V. Vagh	XII Parts 4 & 5	128	5 to 58-4 375 to 381-5	128
9	A Design for Bullock-Cart Wheels, Part III.	B.V. Vagh	XIII Parts 2 & 4	137	181 to 230-2 158 to 171-4	137

XI. Standardisation, Designs, Loadings, Impact, Specifications.

Serial No.	Name of Paper	Name of author.	Reference to Proceedings. Volume No.	No. of Paper in Volume.	Pages.	Serial No. of Paper in general index.
1	The necessity for a reasonably uniform standard loading for design of concrete bridges and a suitable loading for such and other types of bridges on highways in India.	H.G. Banerjee	II	26	256 to 338 382 to 389	30
2	Design of highway bridges. The necessity for an All India specification.	W.A. Radice, G. Wilson and P.F.S. Warren	II	27	338-356 382-389	31
3	Standardization.	D. Nilsson	VI	K-39	1(k) to 16(k)	74
4	Impact on Reinforced concrete road bridges as compared to steel bridges.	E.P. Nicolaides	VI	L-39	1(l) to 57(l)	75
5	Widths of Highway Pavements.	Specifications & Standards Committee	XI Parts 1 & 4	113	7 to 27-1 493 to 504-4	113
6	Standard Scales & Standard Sizes of Drawings for Highway Projects.	Do.	XI Parts 1 & 4	114	28 to 48-1 505 to 509-4	114
7	Horizontal & Transition Curves for Highways.	Do.	XI Parts 3 & 4	119	327 to 392-3 577 to 587-4	119
8	Policy Concerning Maximum Dimensions, Weights and Speeds of Motor Vehicles in India.	Do.	XIII Parts 2 & 4	138	241 to 2-5-2 172 to 177-4	138
9	Glossary of Highway Engineering Terms.	Do.	XIV Parts 3 & 4	146	247 to 272-3 & 532to536-4	146

XII. Research and Experiments.

1	Test tracks—A suggestion.	C.D.N. Meares	I	18	204-212	15

Serial No.	Name of Paper.	Name of author.	Reference to Proceedings. Volume No.	No. of Paper in Volume.	Pages.	Serial No. of Paper in general index.
2	General review of the results of recent road experiments in India as revealed by modern practice.	K.G. Mitchell	II	21	131-141 160-163	20
3	Road Research results.	C.D.N. Meares	II	22	142-159 160-163	24
4	Development and application of village cement and high silica Portland cements for the construction of concrete roads.	A.K. Datta	VI	C-39	1(c to 28.c)	66
5	Further developments in village cements and high silica Portland cements for the construction of cement concrete roads.	A.K. Datta	VII	E-41	75-91(k).	89
6	Effect of the Physico-Chemical Properties of Soils on Road Performance.	A.G. Asghar & C.L. Dhawan	XII Parts 3 & 5	126	329 to 344-3 and 425 to 426-5	126

XIII. Administration and Finance.

1	Objects and organisation of a permanent Indian Roads Congress.	K.G. Mitchell	I	I	11-20	1
2	Roads in India and Australia—Our difficulties and some suggestions.	W.L. Murrell	VI	73	1(j) to 39(j)	73

XIV. Plant, Machinery and Apparatus.

1	Notes on the plant used for quarrying and granulating and operating costs of the Gauhati Shillong Road, Khasi and Jaintia Hills Division, Assam.	B.F. Taylor	I	11	199-203	17

XV. MISCELLANEOUS

Sr. No.	Name of the Article.	Name of the Author.	Reference to Proceedings. Volume No.	Pages.
1	A Note on "Experiments with cut-backs of Bitumon".	P. C. Nongi.	V	89 to 102
2	Lecture on "Statistics and Road Research".	Prof. K. B. Madhava	X-1	185 to 210
3	Memorandum on "Should Delhi as Capital of India be developed as a Pilot Scheme".	H. E. Ormerod	X-parts 2 & 4	331 to 337 part 2 810 to 814 part 4
4	Essay on "Post-war Goods and Passenger Road Transport and its Economics".	Prof. K. B. Madhava	XI-1	49 to 120
5	Essay on "Road Mindedness—How to Create a Widespread Public Demand for more and better Roads in India".	N. M. Khan	XI-2	285 to 292
6	Notes on the Work & Organisation of the Road Research Laboratory (Harmondsworth), Great Britain.	G. Sriranganchary	XI-3	393 to 406
7	Technical Note No. 1- Selection of Plant for Collection and Loading of Shingle.	Col. R. S. Dalby	XII-2	273 to 276
8	Essay on "Post-war Goods and Passenger Road Transport and its Economics".	N. S. Surya	XII-3	409 to 427
9	Table for Freely supported Reinforced Concrete Slabs for Road Bridges and Culverts.	Bridges Committee	XII-3	434 to 437
10	Technical Note No. 2—A Note on Road Rollers with particular reference to Steam Road Rollers.	Central Roads Organisation	XII-4	107 to 155
11	Note on "A Plea for Rational Weights, Measure & Currency".	Brij Narayan	XII-5	456 to 470
12	A Review on "Modern Road Construction in Concrete".	Lt.-Col. W. P Andrews	XIII-1	169 to 173

Sr. No.	Name of the Article.	Name of the Author.	Reference to Proceedings. Volume No.	Pages.
13	Tentative Proposals for the Establishment of the Central Road Research Institute.	Council of Scientific & Industrial Research	XIII-2	287 to 318
14	Research Information—C. C. Trackways.	Central Roads Organisation	XIII-3	419 to 430
15	Essay on "Village Roads, their maintenance and their effects on the development of rural India".	N. S. Surya	XIII-4	199 to 207
16	Research Information - Analysis of soil Samples.	Indian Roads Congress	XIV-1	123 to 136
17	Information Service - Road Boundary or Furlong Stone.	Central Roads Organisation	XIV-1	137 to 140
18	Research Publications :—			
	(i) Use of Stabilized Soil in Engineering Construction : Part I.	S. R. Mehra & Dr. H. L. Uppal	XIV-3	293 to 310
	(ii) Experimental Trackways for Motor Traffic on the Delhi-Meerut Road.	Central Roads Organisation	XIV-3	311 to 322
	(iii) Experiments on Concrete Trackways on Black Cotton Soil.	Do.	XIV-3	323 to 343
19	Technical Note No. 3—Earth-moving Machinery for Roads.	Do.	XIV-3	345 to 359
20	Information Service—Bituminous Treatment of Wet Aggregates.	Do.	XIV-3	360 to 382

AUTHORS' INDEX

TO

Volumes I to XIV.

Name of Author.	Title of Paper, etc.	Reference to Proceedings.		
		Volume No.	No. of Paper.	Serial No. of Paper in general index
Abbasi, A. M. & Sinha H. P.	Study of Relationship between Vehicular Traffic and Road surface as affecting the section of economic road surface.	II	15	17
Abdul Aziz.	Revised Specifications for bitumen roads in the Punjab.	VIII	I-43	93
Acharya, V. S. S.	Necessity for surface treatment of important tourist lines and some aspect of economical works in that direction.	II	18	20
Adami, G. G. C.	Asphalt Roads.	I	6	8
Aminbhavi, L. T.	A Study of Cement Concrete Roads with Special Reference to Bombay Province.	XIII-parts 1 & 4	136	186
Amir, S. A.	Present day methods of bituminous road surfaceing work in Chota Nagpur, Bihar.	VI	E-39	68
Do.	The Failure of a Stool Bridge, in Bihar.	XI-parts 2 & 4	116	116
Anantapadmanabhan, C. S.	A small scale Traffic Survey in New Delhi.	XIV-parts 1 & 4	143	143
Andrews, W. P.	A Review on "Modern Road Construction in Concrete".	XIII-1	—	—
Asghar, A. G. and Dhawan, C. L.	Effects of the Physico-Chemical Properties of Soils on Road Performance.	XII-parts 3 & 5	126	126
Ayyangar, N. N.	Treatment with molasses of Bangalore Mysore Road.	II	19	21
Do.	Gravel Roads.	II	23 (b)	26

Name of Author.	Title of Paper, etc.	Reference to Proceedings.		
		Volume No.	No. of Paper.	Serial No. of Paper in general index.
Ayyar, A. Nageswara	Road Construction in Black Cotton soils.	X-parts 1 & 4	104	104
Do.	An Adaptable Steel Centring for R. C. Bridges.	XIV-parts 3 & 4	147	147
Banerjee, H. G.	The necessity for a reasonably uniform standard loading for design of concrete bridges and a suitable loading for such and other types of bridges on highways in India.	II	26	30
Bashiram, S.	Economics of road maintenance.	II	17	19
Bhaduri, S. N.	Submersible bridge across Parbati at mile 231, Agra-Bombay Road.	III	38	42
Do.	Reinforced Cement Concrete bridges of 24 ft. span constructed in Gwalior State.	IV	C	47
Bhagat, D. G. and Jagdish Bahadur.	Fundamentals of Highway Needs and Highway Planning.	XIII-parts 3 & 4	141	141
Bhate, K. G.	Failure of a Five-Span Masonry Arch Bridge across the Bhogeswari River near Pen, District Kolaba in the Province of Bombay.	XIV-Parts 1 & 4	142	142
Broadon, G. W. D.	Earth road construction and maintenance by machinery.	I	3	4
Do.	Soils in relation to Roads-A bibliological study.	V	N	59
Bridges Committee.	Standard Specifications & Code of Practice for Road Bridges—Section I.	X-parts 2 & 4	109	109
Do.	Do. Section II.	X-parts 3 and 4	112	112
Do.	Tables for Freely Supported R. C. Slabs for Road Bridges and Culverts.	XII-3	—	—

Name of Author.	Title of Paper, etc.	Reference to Proceedings. Volume No.	No. of Paper.	Serial No. of Paper in general index
Bridges Committee.	Some Type Designs of Unreinforced, Hingeless Masonry Arches.	XII parts 4 and 5	131	131
Brijmohan Lal.	Design of Reinforced Concrete bridges of short Span for Indian Roads.	V	J	55
Brij Narayan.	Note on 'A plea for Rational Weights, Measures and Currency".	XII-5	—	—
Central Roads Organisation	Technical Note No. 2-A Note on Road Rollers with particular reference to Steam Road Rollers.	XII-3	—	—
Do.	Research Information—C. C. Trackways.	XIII 3	—	—
Do.	Information Service—Road Boundary or Furlong Stone.	XIV-1	—	—
Do.	Experimental Trackways for Motor Traffic on the Delhi-Meerut Road.	XIV-3	—	
Do.	Experiments on Concrete Trackways on Black Cotton Soil.	XIV-3	—	
Do.	Technical Note No. 3—Earthmoving Machinery for Roads.	XIV-3	—	
Do.	Information Service—Bituminous Treatment of Wet Aggregates.	XIV-3	—	—
Chakravarti, S. N.	A note on the reconstruction of roads carried out in the U. P. with special reference to experiments carried out and the use of traffic statistics.	VIII	D-41	86
Chambers, J.	Sevoke Bridge.	VII	G-40	82
Do.	Design and construction of the Purnabhava Bridge.	X Parts-1 and 4	103	103

Name of Author.	Title of Paper, etc.	Reference to Proceedings. Volume No.	No. of Paper.	Serial No. of Paper in general index
Cormack, F. E.	Construction of Shillong-Jaintiapur Road, Khasi Hills, Assam.	II	30	34
Council of Scientific & Industrial Research.	Tentative Proposals for the Establishment of the Central Road Research Institute.	XIII-2	—	—
Cousens, Henry, J. N.	Corrugation of water-bound macadam road surface in Bombay Presidency and a cure.	I	10	12
Dalby, R.S.	Technical Note No.1-Selection of Plant for collection and loading of Shingle.	XII-2	—	—
Das Gupta, N.	Primers, their nature and uses.	VII	F-40	81
Datta, A. K.	Economy and development of bonded brick concrete roads plain and reinforced.	III	35	39
Do.	Development and application of village cement and high Silica Portland Cements for the Construction of Concrete roads.	VI	C-39	66
Do.	Further developments in village cements and Silica Portland cements for the construction of cement Concrete roads.	VII	E-41	89
Datta, D. C.	Slip and subsidence in a hill road.	VI	I-39	72
Dean, A. W. H.	Recent methods used for the treatment of roads with bitumen and tar in Delhi Province.	I	1-A	2
Do.	Further notes in the treatment of Roads in Delhi Province, with bitumen and tar.	III	34	38
Dhawan, C. L. and Asghar A. G.	(*See Asghar.*)			

Name of Author.	Title of Paper, etc.	Reference to Proceedings. Volume No.	No. of Paper.	Serial No. of Paper in general index.
Dildar Hussain.	Reinforced Concrete bridge across the Godavari at Shahgadh in Hydorabad State.	IV	D	48
Doraiswamy Iyengar, M. S.	Intermediate Screw piles for the foundation of bridges in soft Soils.	VII	A-40	76
Farhatullah, Mohd.	Masonry Arch Bridge across the Krishna at Doosagar, Hydorabad (Deccan.)	VI	B-39	65
Fateh Chand.	Roads under local Bodies and how to maintain them.	IV	F	50
Do.	Cycle Tracks.	X-parts 3 and 4	III	III
Fielder, C. J.	Bituminous treatment of Wet Aggregates.	IX-parts 1 and 4	99	99
Floury, W. R.	Transition Curves for Roads.	VII	C-40	78
Garrod, W. H. E.	Cement Concreting the Bombay-Poona Road.	VIII	K-43	95
Gathlac Wilson.	A Method of Calculating the Stability of braced pile piers.	IV	A(i)	44
Do.	The Dhakuria Lake Bridge.	IV	A(ii) (a)	45
Ghosh, S. K.	Failure of a multi-arched masonry bridge.	VII	B-40	77
Gopalacharya.	Vitrified bricks for surfacing roads in deltaic districts.	II	23(c)	27
Graham, R. C.	Revitalisation of tarred or bitumened surfaces by mix-in-place methods using cut-back asphalt.	V	P	61
Greenings, L. E.	The Use of Cement Concrete for the construction of roads in the Bombay Presidency.	I	7	9

Name of Author.	Title of Paper, etc.	Reference to Proceedings. Volume No.	No. of Paper.	Serial No. of Paper in general index.
Griffiths, W. A. and Sopwith C. E.	(*See Sopwith.*)			
Gupta B. B.	Maintenance of Gravel (Moorum) Roads under Heavy Traffic.	X-parts 2 and 4.	107	107
Do.	Some observations on Load Testing to ascertain the Foundation Bearing Pressures of Bridge wells in sandy strata and on the Alterations required in the Design of a Bridge Foundation owing to one well of a Pier having gone out of Alignment.	XII-parts 4 and 5.	130	130
Gupta, N. Das.	(*See Das Gupta. N.*)			
Gupta S. N.	(*See Sachindra Nath Gupta and Sudhindra Nath Gupta.*)			
Gupta, K.	Some experiments to stabilize moorum roads in Chota Nagpur.	VIII	D-41	88
Haig, W. De H.	Traffic census and road diagrams.	II	16	18
Hardit Singh.	Failure of a reinforced concrete bridge in the N. W. F. P.	XII-parts 2 and 5.	123	123
Hemsworth, T.G.F.K.	Oil as a binder for earth and gravel roads.	II	24	28
Hunter, C. F.	The trend of development in the United Provinces in the matter of improving road surfaces with special reference to recent experiments.	I	2	3
Indian Roads Congress.	Research Information Analysis of Soil Samples.	XIV-1	—	
Iyengar, R. K. N.	Well Foundations of the Kalabagh Bridge over the Indus.	XII-parts 1 and 5	120	120

Name of Author.	Title of Paper, etc.	Reference to Proceedings.		
		Volume No.	No. of Paper.	Serial No. of paper in general index.
Iyengar, M. S. Doraiswamy.	(*See Doraiswamy*).			
Jagdish Bahadur.	Basis of Road Planning.	XII-5	134	134
Jagdish Bahadur and Bhagat D. G.	(*See Bhagat*).			
Jones, R. Trevor.	Some notes on the layout of rural and suburban roads in the Punjab.	III	32	36
Do.	Layout of Roads.	V	(i)	56
Do.	Collection of material for and consolidation of water bound macadam.	V	k (i)	55
Do.	Notes on the use of tar, bitumen and emulsions in the Punjab.	I	5 (a)	7
Jagdish Prasad and Mitchell, K. G.	(*See Mitchell*).			
Khan, N. M.	Essay on "Road-Mindedness—How to create a Wide-spread Public Demand for more and better Roads in India".	XI-2		
Khanna, G. C.	Boat bridge across the Indus at Gazighat.	VIII	F-43	90
Korni, M. A.	The Sai Bridge.	VI	D-39	67
Do.	Repairing and Healing of Cracks in R. C. Bridges.	XIII-parts 3 and 4	139	139
Lal Chand.	Roads in Rural areas (village roads.)	II	23 (a)	25
Lall, Y. K.	Some Causeways on Sandy Bed.	XIII-parts 3 and 4	140	140
Lang Anderson, W. G.	A method of rapid road reconnaissance.	II	31	35
Do.	Calculation of the structure of road.	IX-parts 1 and 4	98	98

Name of Author	Title of Paper, etc.	Reference to Proceedings.		
		Volume No.	No. of Paper.	Serial No. of Paper in general index.
Madden, W. J.	Track Spreading.	XII-parts 2 and 5	124	124
Madhava, K. B.	Allocation of Road Maintenance Costs between Motor Vehicle Traffic and Non-Motor Vehicle Traffic.	X-parts 2 and 4	108	108
Do.	Lecture on "Statistics and Road Research".	X-1	—	—
Do.	Essay on "Post-war Goods and Passenger Road Transport & its Economics".	XI-1	—	—
Do.	A Survey of Traffic on the New Howrah Bridge.	XII-parts 3 and 5	127	127
Mahapatra, M.	Drainage in Hill Roads.	X-parts 1 and 4	106	106
McKelvie, G. M. and Raghavachary, K. S.	Water-bound Macadam.	XI-parts 2 and 4	117	117
Moares, C. D. N.	Test tracks-A suggestion.	I	13	15
Do.	Road Research results.	II	22	24
Mohra, S. R.	The Use of Soil Stabilization in unmetalled and metalled roads in India.	V	0	60
Do.	Stabilization of unmetalled berms of metalled roads.	VI	F-39	69
Do.	The Use of Soil Stabilization in unmetalled and metalled roads in India.	VII	H-40	83
Do.	A Method of Soil Stabilization for Low Cost Roads.	X-parts 3 and 4	110	110
Mohra, S. R. and Uppal, H. L.	Use of Stabilized Soil in Engineering construction.	XIV-3	—	—
Mirza, M. A.	Stable Causeways on unstable foundation soils.	IX-parts 2 and 4	100	100

Name of Author.	Title of Paper, etc.	Reference to Proceedings. Volume No.	No. of Paper.	Serial No. of Paper in general index.
Ram, Raja.	(*See Raja Ram.*)			
Rangachari, H.	Regulations and Control of motor transport in Mysore.	II	29	32
Rao, A.L.	An Economical substitute for water bound macadam.	VI	N-39	71
Do.	Some notes on the maintenance of water bound macadam.	VIII	G-43	91
Sachindra Nath Gupta.	Stability of Densified Soil under Adverse Moisture conditions.	XIV-parts 2 and 4	145	145
Shannon, L.A.T.	An aspect of traffic statistics.	IV	H	52
Do.	Light bituminous surfacings.	VI	G-39	70
Sinha, H.P. and Abbasi A.M.	(*See Abbasi.*)			
Sondhi, R.L.	An Analysis of Delhi Road traffic census.	II	14	16
Do.	Indian Road aggregates—Their uses and testing.	III	37	41
Sopwith, C.E.	The Road problem in India with some suggestions.	II	20	22
Sopwith, C.E. and Griffith, W.A.	Some aspects of bituminous road construction in India.	V	L	57
Specifications and Standards Committee.	Widths of Highway Pavements.	XI-parts 1 and 4	113	113
Do.	Standard Scales and Standard sizes of Drawings for Highway Projects.	Do.	114	114
Do.	Horizontal and Transition Curves for Highways.	XI-parts 3 and 4	119	119

Name of Author.	Title of Paper, etc.	Reference to Proceedings. Volume No.	No. of Paper.	Serial No. of Paper in general index.
Specifications and Standards Committee.	Standard Form for Recording Data on Cement Concrete Surfaces.	XII-parts 1 and 5	122	122
Do.	Policy concerning maximum Dimensions, Weights and Speeds of Motor Vehicles in India.	XIII-parts 2 and 4	138	138
Do.	Glossary of Highway Engineering Terms.	XIV-parts 3 and 4	146	146
Srirangachary, G.	Notes on the work and Organisation of the Road Research Laboratory (Harmondsworth, G. B.)	XI-3	—	—
Do.	Low Cost Roads in India and Use of Soil Science for their Improvement.	XIII-parts 1 and 4	135	13
Stubbs, S. G.	Progress made in the Use of tar and bitumen in the Punjab since the last International Road Congress in Washington in October 1930.	I	5	6
Sudhindra Nath Gupta.	Well Foundations of the Kathjuri Bridge.	XIV-Parts 2 and 4	144	144
Surati, H. M.	Bonding a thin wearing coat of Cement Concrete to an old Cement Concrete Road Surface.	XI-parts 2 and 4	115	115
Surya, N. S.	Essay on "Post-war Goods and Passenger Road Transport and its economics".	XII-3	—	—
Do.	Essay on "Village Roads, their maintenance and their effects on the development of rural India".	XIII-4	—	—
Taraporevala, J. A.	The Testing of the R.C.C. Bridge over the Aurangabad River.	XII-parts 4 and 5	129	129

S. No.	Roll No.		Name.
			4. BOMBAY.
60.	242	...	Adke, A. S.
61.	33	...	Allen de Sa.
62.	1198	...	Amin, M. P.
63.	32	...	Antia, F. P.
64.	1414	...	Apte, K. V.
65.	1481	...	Bakeri, R. D.
66.	253	...	Bamji, H. F.
67.	383	...	Batliwala, H. S.
68.	1463	...	Bhagwagar, K. D.
69.	1050	...	Bhambhani, B. I.
70.	14	...	Bhandarkar, G. P.
71.	329	...	Bhate, K. G.
72.	1004	...	Chandratreya, S. V.
73.	704	...	Chougule, Y. K.
74.	261	...	Daftary, G. D.
75.	1336	...	Daftary, N. D.
76.	1477	...	Dalal, M. N.
77.	1487	...	Daruwala, P. K.
78.	1483	...	Deodhar, M. D.
79.	1322	...	Desai, C. N.
80.	1466	...	Desai, N. K.
81.	773	...	Desai, R. V.
82.	1497	...	Deshpande, D. V.
83.	1484	...	Deshpande, K. S.
84.	1468	...	Dhanokar, T. H.
85.	30	...	Engineer, M. H.
86.	858	...	Gandhi, J. H.
87.	1129	...	Iyengar, C. L. N.
88.	655	...	Gurjar, N. P.
89.	1474	...	Jagus, P. J.
90.	1180	...	Jategaonkar, V. L.
91.	787	...	Jathal, M. N.
92.	526	...	Joglekar, G. D.
93.	1169	...	Joglegar, M. V.
94.	1450	...	Joglekar, K. V.
95.	1430	...	Joshi, R. N.
96.	315	...	Joshi, S. B.
97.	1016	...	Kantawala, K. M.
98.	874	...	Kanga, F. J.
99.	1453	...	Karandikar, S. K.
100.	217	...	Krishnan, O. C. K
101.	1458	...	Lakshmi, S. G.
102.	636	...	Macha, T. K.

S. No.	Roll No.		Name.
103.	1401	...	Mane, P. M.
104.	1494	...	Madhavarao Parasharam Karkare.
105.	952	...	Makhan Wahla, R. B.
106.	1485	...	Manibhai Makanji Desai.
107.	1473	...	Masarwala, V. J.
108.	1472	...	Mastoor, A. R.
109.	810	...	Mehta, D. J.
110.	1002	...	Mehta, M. A.
111.	1464	...	Mewada, M. N.
112.	10	...	Modak, N. V.
113.	1482	...	Modi, I. K.
114.	696	...	Mohile, N. H.
115.	755	...	Murti, N. G. K.
116.	309	...	Murti, N. V. S.
117.	1012	...	Nadgauda, P. M.
118.	23	...	Nadirshah, E. A.
119.	1100	...	Naegamvala, J. P.
120.	949	...	Naik Ishwar Lal Kasanji.
121.	1479	...	Narke, S. P.
122.	342	...	Nicolaides, E. P.
123.	1206	...	Patel, M. M.
124.	1492	...	Patel, M. M.
125.	653	...	Patel, N. B.
126.	1313	...	Patel, N. C.
127.	1491	...	Patel, O. H.
128.	1476	...	Pinto, C. J.
129.	327	...	Puri, A. N.
130.	25	...	Ranade, J. Y.
131.	498	...	Rathod, M. P.
132.	163	...	Rege, D. Y.
133.	376	...	Sandhawalia, N. S.
134.	66	...	Sanjana, N.P.
135.	993	...	Sawai, D. B.
136.	1148	...	Shivdasani, P. D
137.	1478	...	Thosar, G. S.
138.	1494	...	Umrigar, E. J.
139.	1475	...	Unwalla, B. T.
140.	84	...	Vagh, B. V.
			5. WEST BENGAL.
141.	17	...	Chakravarti, S. N.
142.	323	...	Chambers. J.
143.	913	...	Chatterjee, P. K.
144.	1496	...	Chattopadhaya, K. P.

GENERAL INDEX TO I. R. C. JOURNAL—VOLUME XIV—PARTS 1, 2, 3 AND 4.

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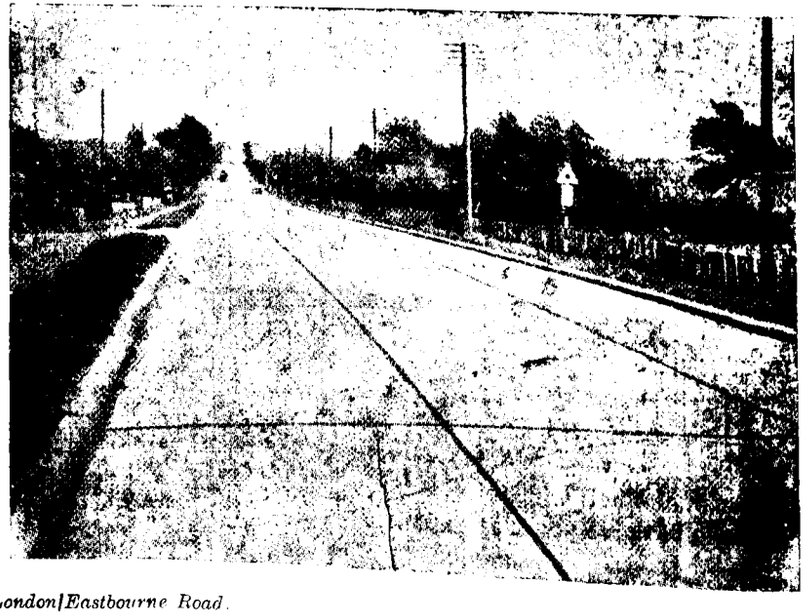

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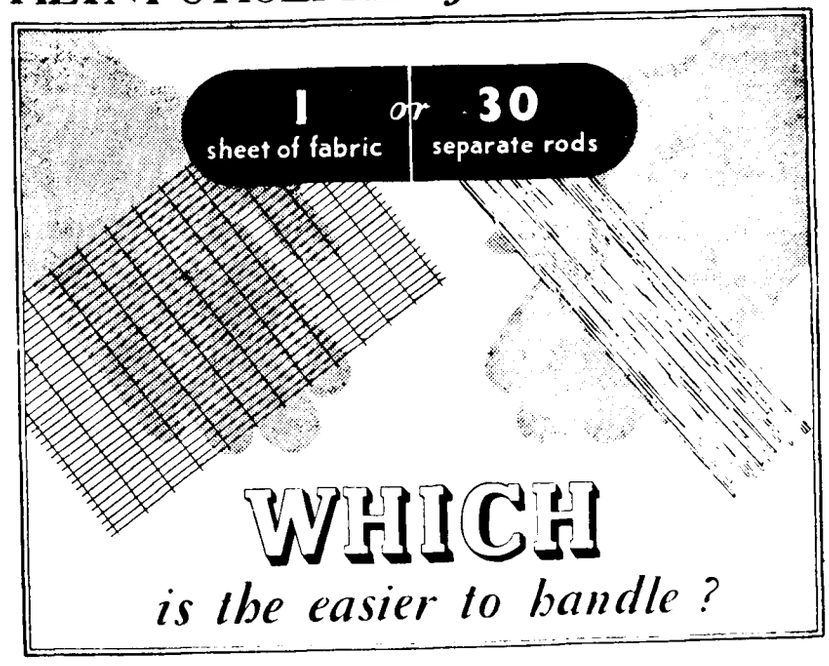

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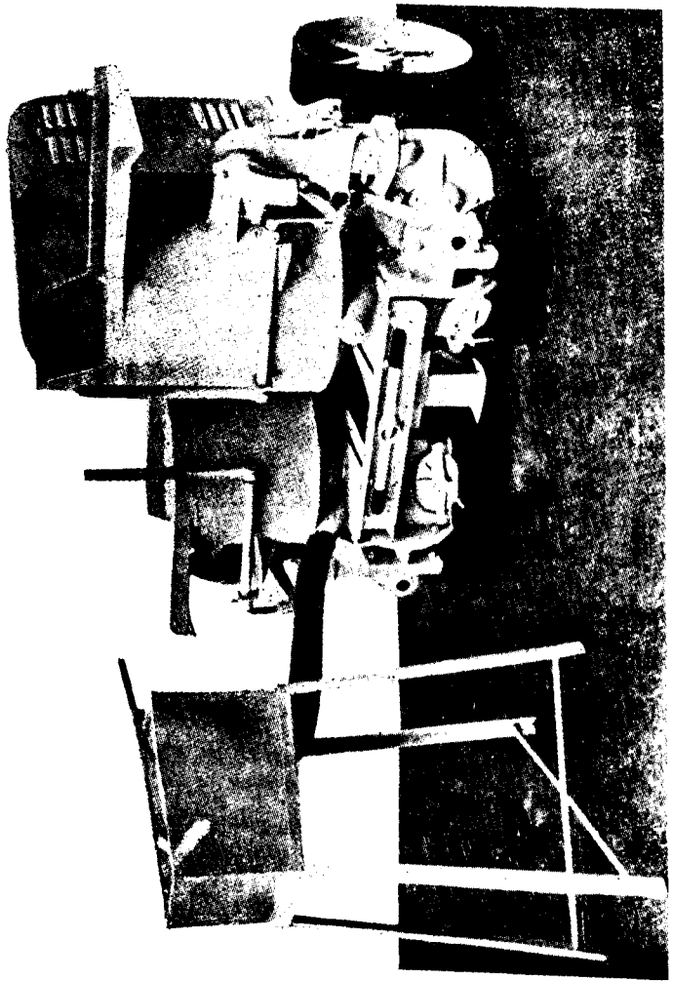

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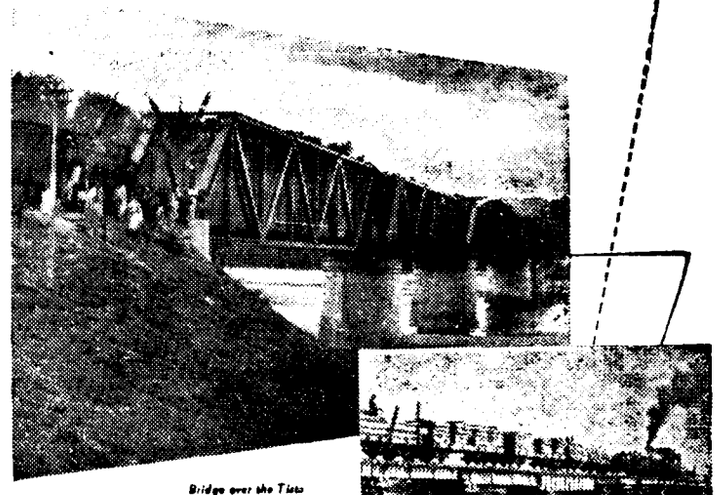

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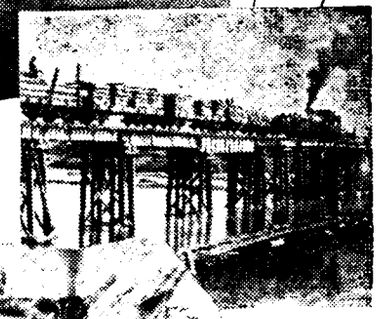

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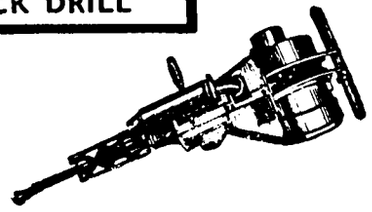

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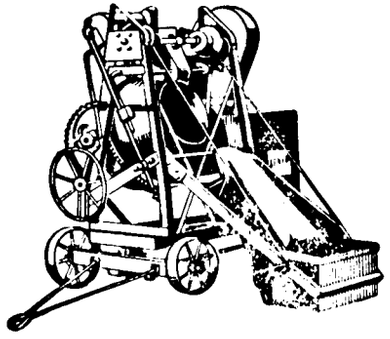

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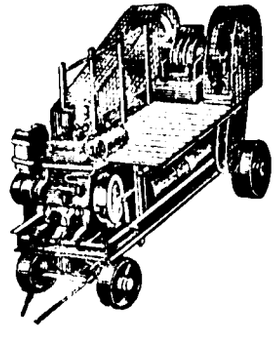

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