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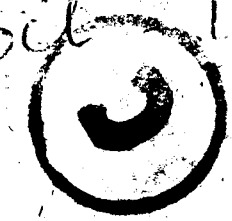
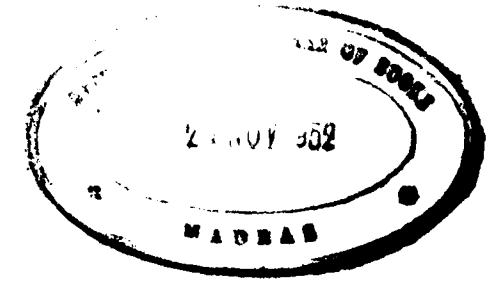
Journal of the

The Indian Roads Congress

~~1951-52~~

Oct 1952

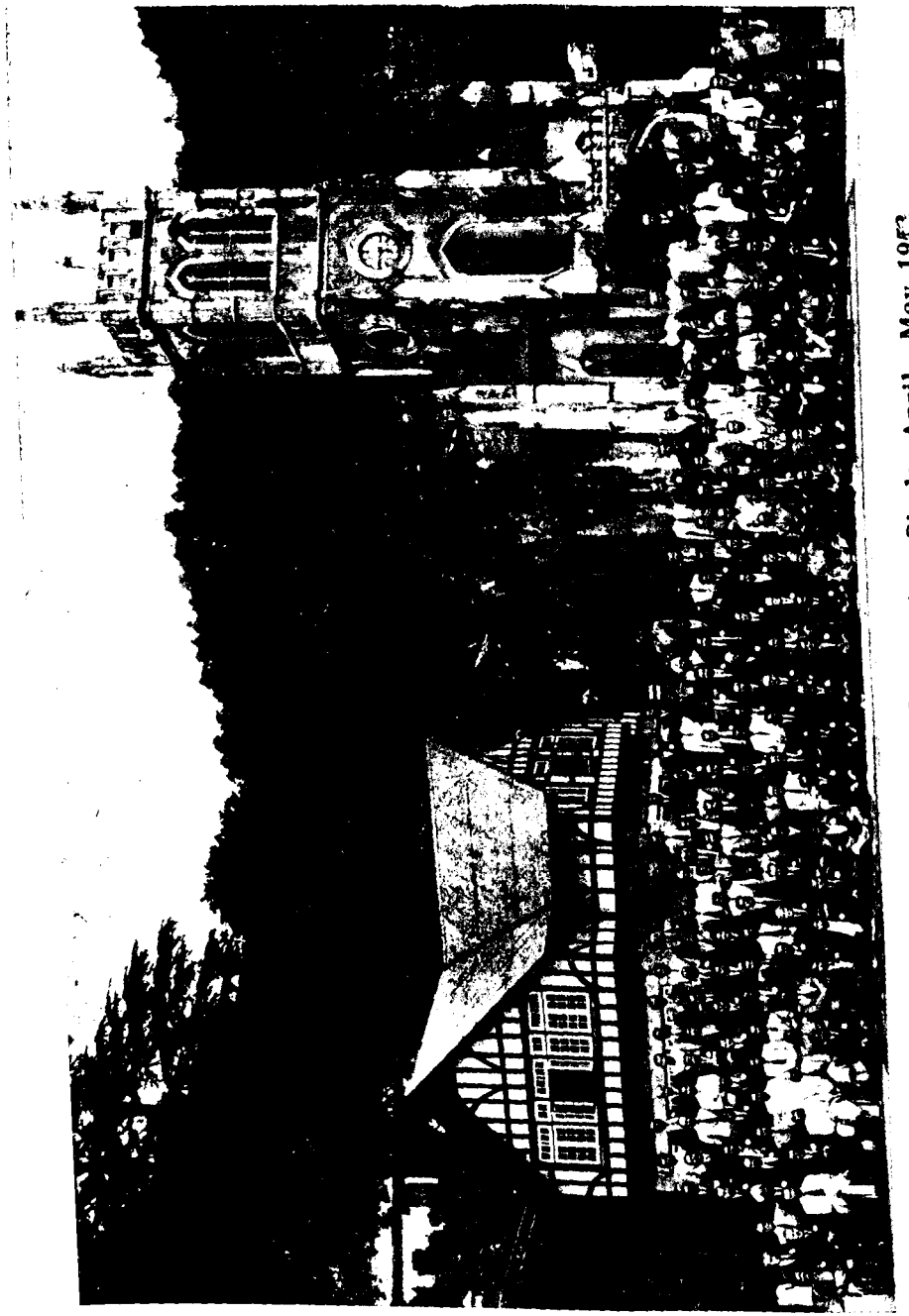




LIST OF MEMBERS OF THE COUNCIL FOR 1951-52.

1. F. P. Antia.
2. M. L. Bahl.
3. R. K. Batra.
4. K. G. Bhate.
5. U. J. Bhatt.
6. S. N. Chakravarti.
7. M. L. Champhekar.
8. P. V. Divatia.
9. C. J. Fielder.
10. D. N. Gupta.
11. R. N. Joshi.
12. Kishore Lal Mathur.
13. M. Meeran.
14. C. P. Misra.
15. A. C. Mukerjee.
16. K. K. Nambiar.
17. Brig. Partap Narain.
18. L. R. Patel.
19. B. S. Puri.
20. Raghbir Singh.
21. V. N. Rangaswami.
22. R. C. Roy.
23. M. L. Saberi Yusuf.
24. D. C. Sharma.
25. N. K. Sinha.
26. E. Sivaraman Nair.
27. M. S. Thirumale Iyengar.
28. R. L. Varma.

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—Sixteenth Session, Simla, April - May 1952.

Mr. G. M. McKELVIE, C.I.E., O.B.E., I.S.E., President 1951-52.

Mr. McKelvie was born in February 1896 and received his education at Allan Glen's School, Glasgow and Glasgow University. His practical training included periods totalling 2½ years mostly in a bridge-building firm in Glasgow. He also served in the army for more than three years in the first World War.

He spent the first 17 years of his service from December 1920 in the Central Provinces (now Madhya Pradesh). During this period he was responsible for the design and construction of many roads and bridges and had considerable experience of buildings and water works construction and famine operations. He compiled in the Central Provinces, Specifications for Roads in 1927 and the C. P. Scarcity Manual in 1932.

His services were placed at the disposal of the Government of India in 1938 after which he was employed on the construction of buildings, roads and airfields throughout India. During the Second World War he organized a large airfield construction programme in Eastern India. He was appointed Consulting Engineer (Roads) in 1943 and Road Development Adviser and Joint Secretary to Government in 1950. He is a foundation member of the Indian Roads Congress and a full member of the Institution of Engineers (India).

NOTICES AND ANNOUNCEMENTS

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

The next General Session of the Indian Roads Congress is likely to be held *sometime in January-February 1953*. The exact date, place, and programme of the Session will be communicated to Members in due course.

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

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

3. **The *complete* Paper, if intended to be read at the next Session, should preferably be submitted within the next four months, but not later than September, 1952.**

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 Office before publication.

5. **Medals** : The following Medals are available for award :—

(i) **The Mitchell Medal** :

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

(ii) **The Indian Roads Congress Medal** :

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

6. The Council have reserved the right to award more than one Medal in any year or to withhold the award of a Medal in any year without assigning any reason.

7. Rules and Regulations for the contribution of Technical Papers and the Award of Medals are published on pages 8 to 13 of Volume XVI-1 of the Journal of the Indian Roads Congress, November 1951.

To

Stamp.

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II. WORLD PETROLEUM CONGRESS

1. The Fourth Session of the World Petroleum Congress will be held in 1955 in Italy, most likely in Rome. It has been decided tentatively to hold the Session from the last week of May to the 1st week of June 1955.

2. In general the set-up of the 1951 Congress at The Hague will be adhered to viz., a fully petroleum—technical and non-political discussion, split up into ten sections. In order to stimulate and guide the submission of papers a programme committee will be formed for each section. In addition to calling for papers to be submitted individually, these committees will invite experts in the various technical fields of the oil industry to write reviews of the recent developments in their spheres between 1951 and 1955.

III. NEW ADMISSIONS

LIST OF MEMBERS OF THE INDIAN ROADS CONGRESS ENROLLED FROM 7-3-1952 TO 25-5-1952.

Serial No.	Roll No.	Name.	Address.
1471	1615	Hukam Singh.	Superintending Engineer, Jullundur Circle, P. W. D., B. & R., JULLUNDUR CANTT. (Punjab).
1472	1616	B. S. Grewal.	Executive Engineer, Ferozepur Provincal Division, P.W.D., B. & R. Branch, FEROZEPUR CANTT. (Punjab).
1473	1617	Tek Chand Prabhadas Bolakani.	Executive Engineer, Central P.W.D., Incharge Famine Division, AJMER.
1474	1618	B. G. Gulnani.	Assistant Engineer, P.W.D., B. & R. FEROZEPUR CANTT.
1475	1619	V. D. Bhandari.	Superintending Engineer, Central P.W.D., 25, Ashoka Road, NEW DELHI.
1476	1620	D. N. Gupta.	Executive Engineer, Cachar Division, SILCHAR (Assam).
1477	1621	Yoginder Kumar Mehta.	Senior Assistant Engineer, The Concrete Association of India, 1, Queens Road, BOMBAY-1.
1478	1622	G. C. Vij.	Superintending Engineer, Ambala Circle, P.W.D., (B. & R.), AMBALA CANTT.
1479	1623	A. E. L. Collins.	The Society of Motor Manufacturers & Traders Ltd., P.O. Box 178, NEW DELHI.
1480	1624	D. N. Gupta.	Chief Engineer, P.W.D., JAMMU. (Jammu & Kashmir).
1481	1625	G. F. D. Gonsalves.	Senior Scientific Officer, Central Road Research Institute, P. O. Okhla, NEW DELHI.
1482	1626	Sheo Nandan Prasad.	Bihar Engineering Service, Badri Nath Lane, Mithapore, PATNA-1. (Bihar).
1483	1627	B. Satyanarayana.	Assistant Engineer (Highways), Ramchandrapuram, EAST GODAVARI DIST. (Madras State).
1484	1628	A. K. Bose.	Sales Engineer, Armco (India) Ltd., 21, Esplanade Mansions, CALCUTTA-1.
1485	1629	G. S. Desai.	Deputy City Engineer, Ahmedabad Municipal Corporation, Shanti Sadan Co-operative Housing Society, Ellis Bridge, Near Sharda-Mandir, AHMEDABAD-6.
1486	1630	Niranjan Paul.	Assistant Engineer (W & B), Odlabari Construction Sub-Division, P. O. Manabari, District JALPAIGURI.
1487	1631	P. K. Parmar.	Deputy Engineer, Roads Sub-Division, P.W.D., Government of Saurashtra, Mess Building, RAJKOT.
1488	1632	K. D. Lahkar.	P.W.D. Engineer, Rehabari, P. O. GAUHATI (Assam).
1489	1633	D. P. Mainthia.	Assistant State Engineer, C/o. P.W.D. Office, BHUJ. (Kutch).
1490	1634	A. C. Chakravarti.	District Engineer, GAYA (Bihar).
1491	1635	Gautam Prasad.	District Engineer, Dumka, District SANTHAL PARGANAS. (Bihar).
1492	1636	I. D. Mirchandani.	Assistant Professor, Civil Engineering, Punjab Engineering College, ROORKEE. (U.P.)
1493	1637	N. Amanulla.	Sub-Divisional Officer, P.W.D., Bihar, Yusuf Building, Fraser Road, PATNA-1. (Bihar).
1494	1638	A. S. Gill.	Assistant Engineer, Development Sub-Division, ROHTAK. (Punjab) (I).
1495	1639	D. V. Rao.	Chief Engineer, C.&B., P.W.D., Hyderabad. HYDERABAD-DECCAN.
1496	1640	G. Nanda Gopal.	Assistant Engineer, Corporation of Madras, Hanover House, Harley's Road, Kilpauk, MADRAS.
1497	1641	G. S. Ganapathy.	Divisional Engineer (Highways), OOTY, (Nilgiris District), (Madras State).
1498	1642	Mukteshwar Prasad.	Assistant Engineer, P.W.D., P. O. DUMKA. (S. P.) (Bihar).

Serial No.	Roll No.	Name.	Address.
1499	1643	H. R. Gupta.	Superintending Engineer, P.W.D., Madhya Pradesh, NAGPUR.
1500	1644	N. C. Bhargava.	Assistant Engineer, Factory Division, Robertsganj, District MIRZAPORE.
1501	1645	M. Natarajan.	Municipal Engineer, DINDIGUL. (South India).
1502	1646	John A. Pouptis.	Manager, Greaves Cotton & Co., Ltd., 1, Forbes Street, BOMBAY.
1503	1647	M. Subbarao.	Municipal Engineer, ADONI, Bellary District. (Madras State).
1504	1648	S. K. Bose.	Executive Engineer, Himachal Pradesh P.W.D., 7, Craig Dhu, SIMLA.
1505	1649	S. C. Chakravarti.	Assistant Engineer, W. & B., 21/6A, Mohendra Gosain Lane, Beadon Street, P. O. CALCUTTA-6.
1506	1650	B. N. Majumdar.	Assistant Engineer, 2/1, D. L. Roy Street, CALCUTTA-6.
1507	1651	V. R. Deuskar.	Executive Engineer, Dharwar Irrigation Division, DHARWAR. (Bombay State).
1508	1652	A. C. Ganguli.	Assistant Engineer, (W. & B)., 1, Andulraj Road, CALCUTTA-26.
1509	1653	M. S. Maitra.	Assistant Engineer, (W. & B.), 29-A, Ballygunje Place, CALCUTTA-19.
1510	1654	K. K. Kartha.	Chief Engineer, Travancore-Cochin, TRIVANDRUM.
1511	1655	A. K. Aga.	Chief Town Engineer, No. 8, Office Road, JAMSHEDPUR. (Bihar).
1512	1656	S. C. Javali.	Deputy Engineer, Bridge Construction Sub-Division, Bhivandi, District THANA. (Bombay State).
1513	1657	M. D. Kale.	Executive Engineer, Executive Engineer's Bungalow, P. W. D., KAIRA. (Bombay State).
1514	1658	A. Sivarama Pillai.	Assistant Engineer, P.W.D., TRIVANDRUM. (Travancore-Cochin).
1515	1659	K. Jacob Thomas.	Special Engineer, Bridge Works, MAVELIKARA P. O., (Travancore-Cochin.)

Serial No.	Roll No.	Name.	Address.
1516	1660	B. D. Ahuja.	Executive Engineer, Simla Central Division, C.P.W.D., SIMLA.
1517	1661	V. R. Bhatnagar.	Executive Engineer, P.W.D., B. & R. JAIPUR. (Rajasthan).
1518	1662	K. Satyanarayana.	Municipal Engineer, KAKINADA. (Madras State).
1519	1663	H. V. Dhamdhere.	Deputy Engineer, P.W.D., BHUSAWAL. (Bombay State).
1520	1664	C. J. Venkatesa Das.	Technical Assistant to the Chief Engineer of Mysore, BANGALORE.
1521	1665	C. P. Srivastava.	Executive Engineer, P.W.D., NOWGONG. (Vindhya Pradesh.)
1522	1666	G. S. Toki.	Executive Engineer, Ambala Provincial Division, P.W.D., B. & R., AMBALA CANTT. (Punjab).
1523	1667	N. S. Deviah.	Supervisor, (Highways), Pennar Bridge Works, NELLORE. (Madras State).
1524	1668	M. H. Manchigiah.	Executive Engineer, Buildings Division, BANGALORE. (Mysore State).
1525	1669	M. Kumaran.	Divisional Engineer, Highways, PALGHAT. (S. Malabar).
1526	1670	L. W. Kale.	Executive Engineer, Building Project Division, POONA-2.
1527	1671	Syed Abdul Latheef.	Supervisor (Highways), Usilampatty MADURAI DISTRICT. (South India).
1528	1672	Qazi Mohd. Afzal.	Assistant Engineer, C/o H. Azimbaba, 4th Bridge, P. O. Sri Ranbirganj, SRINAGAR. (Kashmir State).

ASSOCIATE MEMBER

1	47	Mugneeram Bangur, Memorial Engineering College.	JODHPUR. (Rajasthan).

IV. DEATHS

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

Serial No	Roll No.	Name of Members.	Address.
1	24	M. A. Korni.	114, Regent Estate, Tollygunj, Calcutta.
2	110	R. L. Varma.	Chief Engineer & Secretary, P.W.D., Assam, Shillong.

—o—

V. 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, Indian Roads Congress.

Serial No.	Roll No.	Name of Members.	Address.
1	652	Guruswamy, S.	No. 8, Appaswami Koil Street, P.O. Mylapore, Madras.
2	1026	Hege, W. D.	Asphalt Sales Engineer, C/o. Caltex (India) Ltd., P. O. 165, Ballard Estate, Bombay.
3	90	Mohd. Abu Turab.	Superintending Engineer (Retired), A/8 No. 220 Lane, Opposite Raj Mahal Talkies, Lingampally, Hyderabad-Deccan.
4	797	Mohana Rao, T. K.	Assistant Engineer, P.W.D., Nidadavole. (NIDAWAVOLE). West Godavari District.
5	1120	Wadia, K. C.	Officer on Special Duty, Finance Department, Hyderabad-Government, Hyderabad-Deccan.

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PROCEEDINGS OF THE SIXTEENTH SESSION OF THE INDIAN ROADS CONGRESS

Vol. XVI-Part 4 SIMLA April-May 1952

PRESIDENTIAL ADDRESS

The Sixteenth Session of the Indian Roads Congress was held at Simla from the 26th April to the 2nd May, 1952, and was formally opened by His Excellency Shri Chandu Lal Trivedi, the Governor of the Punjab, at 11.00 a. m. on the 27th April, 1952 in the Davico's Ballroom. The proceedings opened with an Address by Mr. G. M. McKelvie, the President, the full text of which is given below:

The Indian Roads Congress is most grateful to your Excellency for having spared the time to come here today to open this, the sixteenth session of our Congress. We are also grateful to our honoured guests for having graced this occasion with their presence.

Since this Congress was founded in 1934 we have met at many places in India, from Delhi in the North to Trivandrum in the South, from Bombay in the West to Calcutta in the East. This is, however, the first occasion that we have had the privilege of meeting in the Punjab although, during our first session in 1934, we toured through the Punjab and inspected some of your excellent roads. On that occasion we were entertained to lunch by your Minister for Agriculture of those days, the Hon'ble Sir Jogendra Singh. How long ago it all seems although it is only eighteen years.

This time by courtesy of the State Government we meet in Simla the beautiful, the present capital of the State and a place of thriving activity. From here we can see the mighty Himalayan ranges of which many of us have so far only heard. Here we can breathe fresh mountain air and exercise our leg muscles.

Punjab is famous not only in India but in the world for its engineering works. The old traditions are being maintained and during this session we are going to see work in progress on the New Capital construction at Chandigarh and on the Bhakra and Nangal dams. We have already seen when coming up this hill something of those fine engineering achievements, the road and the railway from Kalka to Simla.

The road (as usual) came first and only road engineers can appreciate the difficulties that were overcome and the problems that were solved during its construction. Appropriately, we shall be discussing a Paper on hill roads during this Simla Session.

The mountain railway is itself with its 103 tunnels totalling five miles in length, its long viaducts and lofty bridges, an example of engineering skill of no small magnitude. We are too apt to take roads and railways for granted as we take mountains and rivers and the air we breathe but what would Simla be without its road and railway.

But we do not need to preach on the value of roads to the people of the Punjab and the neighbouring State of Himachal Pradesh. What they have done in the past, are doing now, and propose to do in future, is an indication of the value they place on roads.

THE INDIAN ROADS CONGRESS

It is customary for the President on the occasion of our annual Sessions to say a few words on our Society, what we have done in the past, and what we are trying to do. We started in 1934 with 73 members and now we have nearly 1300. We exist "to promote and encourage the science and practice of the building and maintenance of roads".

Our Society gives opportunities to its members to pool their collective experience and ideas on all matters concerning roads,

Mr. G. M. McKelvie delivering the Presidential Address.

by discussion at our annual meetings and by service on committees and on the Council. We interest ourselves in road research, education of the highway engineer, standards, specifications, and highway finance. Among our objects we include the suggestion of legislation for the development and improvement of roads and we lay special emphasis on the dissemination of information and knowledge that may be of use to our members and the profession generally.

Our journal now finds its way to most countries in the world and recently, through our monthly publication, the Transport and Communications Monthly Review, we have been making an effort to explain our standards, designs, and specifications to overseers and other road officials who are not members of our Society.

On the purely technical side, our Bridge Code, unfortunately still incomplete, is perhaps our best effort and one that has earned high praise from abroad. The Nagpur Plan (described recently in a well-known Indian journal as "of hallowed memory") was inspired by this Society and owes much to our deliberations.

Incidentally, the Plan is not dead but is still the basis of all road planning in India. The Planning Commission have embodied the Nagpur Plan principles in their own first five-year plan and have quoted the saying often repeated by us :

> "A country pays for its roads whether it has them or not—and it pays more for those it does not have."

During this session we are going to discuss some interesting Papers. One of these criticises the internal organization of our highway-engineering departments and contains some valuable suggestions. We shall also probably find time to discuss a very interesting and instructive account of bridge development and design in Canada recorded by the bridge engineer of the Roads Organization of the Ministry of Transport who visited Canada last year (and, incidentally, won somewhat of a name for himself there).

Then, many of our members will be spending all the time they can snatch from the discussions on Papers to work from morning till evening on our technical committees. Our junior members will have an opportunity to "listen in" at these discussions and we expect discussions and arguments on technical matters will go on far into the night between groups of enthusiasts.

We have provided a small exhibition—nothing like the very extensive display we had last year at Calcutta because of the

difficulty of bringing much machinery to Simla, but a good and interesting exhibition for all that—and we shall show interesting films on road construction and listen to lectures given by experts.

ROAD POLICY

Having said something about the technical work we shall be doing during this session, I turn to what can be called wider issues. It is indeed customary every year for the President of our Society to voice from this platform the collective view of our members on such matters as road policy, road finance, and road administration.

Several years ago the founder of this Society, Sir Kenneth Mitchell, said that since we had among our members nearly every road engineer in India we could claim with some justification that we knew more about roads, their possibilities, and what was wrong with them, than any other body of men in the country. We were, therefore, entitled to say what we thought both on the technical and the non-technical aspects of road development.

As a Society we have often in the past given the Central and State Governments advice on policy questions and it is a matter of gratification that our advice and recommendations have so often been accepted and acted on. It was at our Gwalior Session in October 1943 that our Council first passed a Resolution urging the Central Government to designate a system of roads as "National Highways" but long before that we had been pressing Government to consider the same suggestion although we had then spoken of "Federal Trunk Roads".

In 1945 we suggested that Government should invite an engineer—administrator from abroad to advise on our Nagpur Plan and "methods of organization, planning, construction and research". The President of the United States of America himself in response to the request of the Government of India sent his two most experienced officers, General Fleming and Mr. Thos. H. MacDonald. The latter officer had at that time been in charge of the Federal Roads Administration in the United States of America for a period of no less than 27 years. Our members know how valuable was the advice given us by those officers. We discussed our problems with them endlessly and we have based much of our policy on their advice.

We also advised on sending road engineers abroad for practical training and no fewer than 59 were sent in subsequent years much to the benefit of Indian roads. Coming nearer home, we advised on the setting up of a committee to study

motor vehicle taxation and road-rail relations in India and we followed this up with advice on the co-ordination of all forms of transport-communications (a recommendation that was strongly endorsed by the Governor of the United Provinces), on village road improvement and village road co-operative schemes, on road finance and administration and on many such matters.

BASIC PRINCIPLES OF ROAD POLICY

The principles we recommend for inclusion in the common road policy to be adopted by the Central and State Governments are as follows :

(1) The road net-work of each State should be an integral part of the road net-work of India.

(2) All classes of roads should be regarded as of importance for the national welfare; one class should not progress at the expense of another; development should be balanced as between classes and should proceed in a planned sequence.

(3) Roads should **NOT** be developed ahead of the requirements of the traffic they carry or will carry in the immediate future. A national highway can have an earth surface and a village road, a concrete surface if the traffic in each case requires these surfaces.

(4) Roads should be free to all: there should be no toll barriers except in special cases to finance loans taken to construct large bridges and important road works. The tolls should cease as soon as the loans are repaid.

(5) Road maintenance to proper standards should (with hardly an exception) have priority over the construction of new roads.

(6) Roads are a service to nearly all forms of development and road development should form part of almost all development schemes.

(7) The road plan should be statutory with regular funds set aside by Statute for road maintenance and development. Road development is a long-term measure and should not be subject to the vicissitudes of temporary changes in political philosophy.

(8) Statutory provision, essentially common throughout India, should be made for regulation of traffic, control

of ribbon development, the levy of betterment taxes on roadside lands, and removal of encroachments.

Stated like this, the road policy we recommend for adoption in India may appear simple and obvious. Yet, in every day practice, departures are being made from even the most fundamental concepts of this policy. A road does not exist by itself, it is fed by and feeds other means of transport-communications. Yet concrete roads have been built in the past, isolated from connecting roads, railways, etc., and today those expensive roads carry hardly any traffic at all—the traffic cannot get on to them.

Every one agress that, since roads are fed by and feed other roads, there should be balanced development as between the various classes of roads, yet how many States' budgets show that adequate provision has been made for village and minor district roads? Rather the demand is to spend more and more money on the National and State highways.

The Royal Commission on Agriculture commented in 1925 on the evils of the then existing unbalanced development of roads in India and its remarks were endorsed by the Indian Road Development Committee (the Jayakar Committee) of 1928 but the position is not very different now, a quarter of a century later. The Nagpur Plan suggested that, on the whole, not more than about one-fifth of the total road expenditure should be on national highways and half should be on major and minor district roads and village roads.

The ratio to be adopted in individual States will, of course, depend on local conditions but we are glad to note that the Planning Commission have adopted the Nagpur ratios in drawing up in broad outline their all-India five-year plan for road development.

BALANCED DEVELOPMENT

I have mentioned that the money provided for roads in the States does not always allow for balanced development. The difficulty is partly organisational or administrative. The national highways are now the responsibility of the Centre, the principal State roads, of the State Governments, while district and village roads are mainly the responsibility of local authorities. How is there to be a common road policy when there are so many different authorities responsible for roads?

"An Act is Necessary"

This division of responsibility exists in most advanced countries. The problem has been solved by them and it can

be solved by India. The American experts told us that they had learnt by painful and costly experience that the road plan should be statutory. This is what they said—

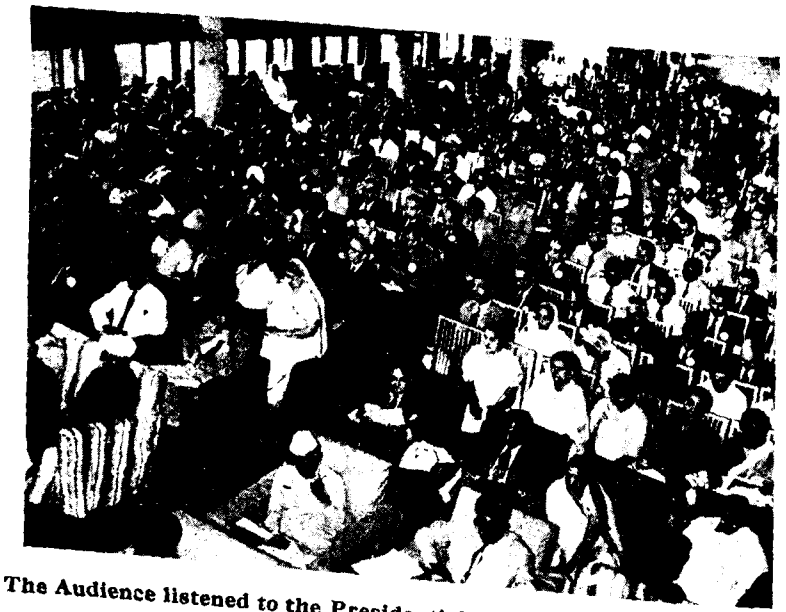
> "An Act is necessary. In such a form the Plan becomes a Charter for action by a large number of agencies and makes possible, what is not otherwise possible, a uniform understanding of the Plan.
>
> "Also in this form the Plan becomes less subject to the vicissitudes of changing political philosophy..... The attainment of an adequate system of highways to serve all the requirements of so large a country as India is a time-consuming process."

On this advice and as a result of our own studies, our Society has worked out in outline what the statutory road plan should be. Most of our recommendations have been embodied in three Bills, the (Model) Highway Bill, the Motor Vehicle (Priniciples of) Taxation Bill (required by Entry 35 in List III of the Seventh Schedule of the Constitution of India) and the Central-Aid Roads Bill. The first bill was circulated to the States some three years ago and the other two were considered last year, first by a Committee of our Council (the Chief Engineers of Part A & B States) and later, by the Transport Advisory Council. The recent elections have delayed progress on these three Bills but we may hope for some advancement in their consideration in the near future.

ROAD FINANCE

It will be evident that the Bills deal mainly with financial matters but finance is the crux of the whole problem. Here our critics will say that we engineers are treading on sacred ground and that we should stick to our own subject, engineering. Our answer is that it was not until the engineers of other countries interested themselves in road finance that the road problem of those countries was solved.

By their training and experience engineers are accustomed to think along practical lines, they deal with facts. We are sometimes inclined to think that our financial pundits regard finance as something mysterious, something not to be talked about. For example, the terms of reference given in 1943 to the Nagpur Conference of Chief Engineers enjoined them to plan "undeterred by financial considerations".



The Audience listened to the Presidential address with rapt attention.

The Chief Engineers of those days, being practical men with long administrative experience to their credit, ignored this direction and added chapters on administration and finance to their report. They said that they had during their deliberations been cognisant throughout of the obvious limitations of finance and that their plan was based on India's capacity to pay for roads having regard to the direct and indirect revenue receipts that would follow from a development of the road-communications system of the country.

Recently, the whole question of road finance was ably analysed by the Motor Vehicle Taxation Enquiry Committee. What they said in effect was that the Central tax on the road transport industry should be divided into two parts—

(1) a tax levied on the same basis as that applicable to any other industry, *plus*

(2) a "user" tax or fee, in other words, a road rent, the proceeds of which should be spent on roads.

They added as an illustration that the taxes alone paid per ton-mile by the ordinary goods lorry were already more than

twice as much as the total cost, including taxes, of carrying goods by rail. Only a fraction of the taxes collected from the road user was spent on roads.

For the States they recommended that all the proceeds from the taxation of the road user should be spent on roads. They said this was being done in most of the advanced countries.

If we consider the taxes at present levied on the motor vehicle user we find that petrol is taxed in India at a higher rate *ad valorem* than gold, than diamonds, than beer or whisky, than golf balls—it is taxed as though it were a luxury of luxuries. But other countries are also taxing petrol heavily. The difference is that in our case the tax is almost entirely a revenue tax while in many other countries the "luxury element", *i.e.*, that part of the tax which exceeds the level of taxes on non-luxury articles, is regarded in their case as a toll or fee or as "road rent" and the proceeds go to the roads. In some countries the whole of the tax is regarded as road rent and the proceeds are spent on roads.

The same remarks apply to the tax on the motor vehicle itself and on its spare parts, a tax that goes as high as 96 per cent *ad valorem*. The Motor Vehicle Taxation Enquiry Committee recommended this tax should be reduced and that in any case the proceeds from the "luxury element" of the tax should be spent on the upkeep of roads.

When you buy a railway ticket you pay for the train, the engine, the station Master, **and the permanent way**. When all these have been paid for, what is left goes to general revenues. But when you buy a bus ticket, you pay for the bus and its driver and hardly anything directly for the roads on which the bus runs. The roads must get what they can from general revenues.

A Fundamental Principle

The fundamental principle underlying road finance in most advanced countries is that those who benefit from roads must pay for the roads. We have tried to embody that principle in the draft Bills I told you about. In our discussions on this question we were much heartened by the observations of the Planning Commission.

> "A certain continuity in the supply of funds (for roads) is essential if wasteful expenditure is to be avoided

and programmes, however modestly they may be drawn up, are to be pursued without interruption,"

and again

"..... it is important that it (progress in road development) should be steady, balanced, and continuous."

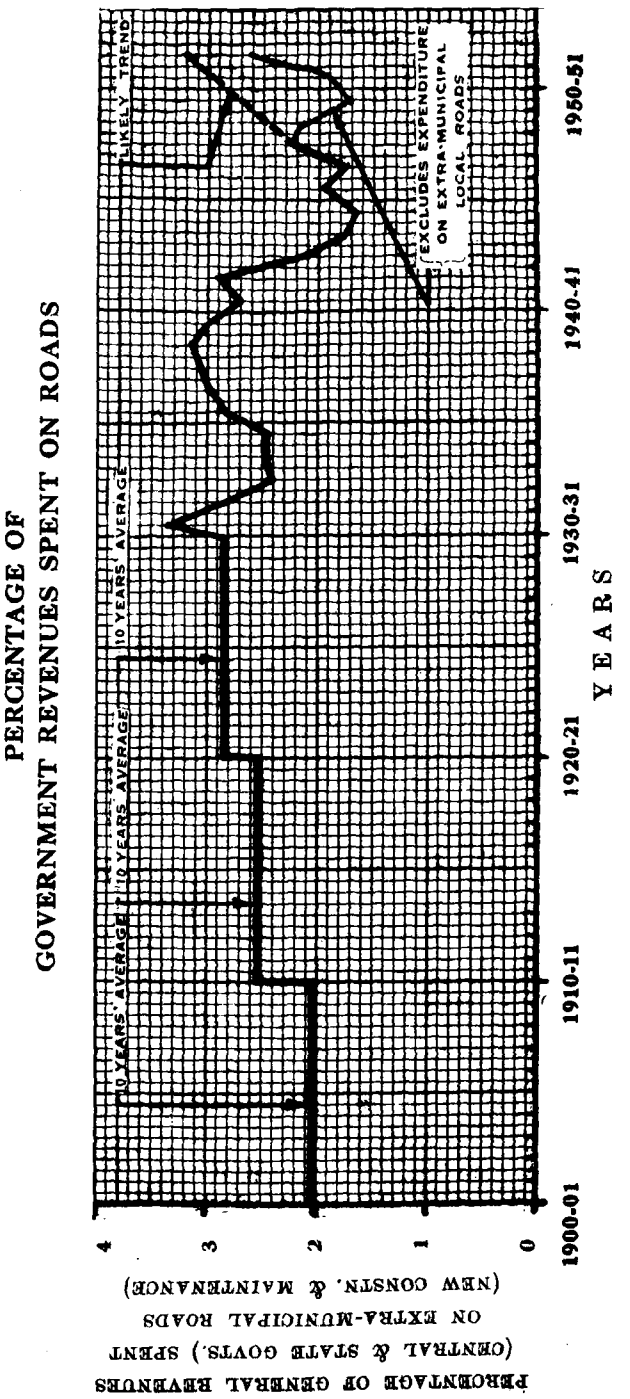
WHY ROADS ARE LACKING IN INDIA

What we are concerned with is the upkeep and development of Indian roads and for this we must have assured funds. We have much leeway to make up. You may not know that India has fewer roads per square mile of area, fewer per million of population, fewer per million of rupees of national income, fewer per million of rupees of national expenditure, than perhaps any other advanced country.

Look at the budgets of other countries and then look at ours. We seem to provide a lower percentage of our resources for roads than most countries. Why is that? Do we want roads less than they do? The answer is that we probably have a greater need for roads.

I had a graph drawn by a statistician to indicate what percentage of Indian revenues had been spent on roads, other than town roads, during the last 50 years or so. The graph has been printed. You will see that before the days of the motor vehicle, we spent from 2 to 2½ per cent of our total revenues on roads. Then the percentage rose to nearly 3 except during the depression years in the nineteen thirties. The Statistician could not tell me whether we were back to 3 per cent now as the figures relating to expenditure by local bodies were not available. Perhaps we are spending more than 3 per cent and, if we add capital expenditure, more than 4 per cent. But contrast that with 6 to 9 per cent spent by some of the Commonwealth countries.

Let us examine a little further. How have the other countries managed to spend a greater percentage of their revenues on roads than we have done? Is it because they are richer than we are—or is it the other way about, are they richer because they have paid more attention to roads and have not wasted so much of their resources on uneconomic transport? How many of us have seen, here in India, a bullock cart struggling through the mud with the poor bullocks straining at the yoke and half a dozen men pushing at the wheels and shouting at and belabouring the bullocks—and when we looked at the cart, have we not seen that it is only half loaded? This is our economy.



Who will "grow more food" when it costs so much to take a crop to the market that there is no profit in the business?

WHY WE MUST HAVE ROADS

Roads serve not only railways, waterways, and airways, they serve nearly every form of development. If there is to be agricultural development, there must be roads to carry the agricultural products to the distributing centres; if industrial development, again roads help to bring the raw products to the industries and take the manufactured products to the consumer; if public health is to be improved or literacy increased, again there must be roads, and so on.

It is not necessary for me to elaborate on this to you who have shown by coming here what value you place on roads. We all, I think, agree with what the late Lord Wavell said—

> "Among the social services, I put communications first since I do not see how it is possible to effect any great improvement in health and education in the villages of India until they can be reached surely and quickly at all times."

It seems to me that everyone agrees with this, all the newspapers, all public speakers, everybody. But when it comes to action there are difficulties. Roads are not spectacular, they are not "news". Much money is required to build or improve a road and, when it is built, we take it for granted and do not even notice it. There is no kudos or limelight attached to road building and those that want to be in the limelight spend their energies on something more personally rewarding. You have only to look at your daily newspaper to realize this.

APPRECIATION

But the common man, the villager, does appreciate roads. For a century there was a jingle repeated in Highland villages in Scotland—

> "If you had seen these roads before they were made,
> "You would lift up your hands and bless General
> 'Wade'."

Here, in Simla, the villagers still call the India-Tibet road "Kengree (Kennedy) Sahib ki Sarrak" although the road, (really a mule-track for most of its length) was constructed almost exactly 100 years ago. I also remember in my early service

frequent reference by villagers, and reference, mark you, in a tone of warm approval, to "Kampani ki Sarrak" when they referred to one or other of the roads built more than a century previously by the old "John Company".

Let me repeat. I have told you about the road policy this Congress has recommended for adoption by the Central and State Governments and this led me to touch on some legislative measures we have suggested. I have spoken on why we must have roads if India is to develop at all and why roads are lacking in India. This in turn led to some remarks on our suggestions regarding road finance. We have made our suggestions and now it is for others to consider them and act on them.

ORGANISATION

But we still have a big part to play. Certainly we must do everything in our power to develop our technical knowledge. The Papers we read at these annual sessions, the Standards and Codes of practice we are working out, the research and model-testing work we are controlling with Government's encouragement, are all efforts in this direction. Perhaps our most important work in this sphere is done through our Committees and I would urge those Members who have some contribution to make to join the Committees and to do Committee work not only now, at the annual session, but throughout the year.

There is, however, much more that we should do. I would suggest that we now take up another question, a very important question, how we should re-organize our engineer agencies to carry out efficiently and economically the programme of work we are urging the Centre and State Governments to undertake.

Let us suppose we are given all the money for roads that we ask for, and let us suppose our funds are assured and we become like our opposite numbers in America and Australia and elsewhere who do not have seriously to consider such silly things as "lapses of grants" and the very wasteful "rush of expenditure at the end of the financial year" which comes right in the middle of our busy working season, let us suppose that all we have recommended is accepted and then let us ask ourselves whether we are sufficiently organised as engineering administrations to handle efficiently and economically all the work we shall be given.

FRUSTRATION

You will say, perhaps, that the reorganization that is necessary is not in our power. But if we make up our minds about

what should be done, and if what we say is reasonable, I am sure we shall get what we want.

During the last two or three years I have been reading the speeches made by senior engineers all over India on the occasion of the annual meetings of our Institution of Engineers and its branches and of other Engineering Societies. Nearly all these speeches give vent to a feeling of frustration. They talk of "a positive deterioration of efficiency", "technical talent not being put into full gear", conditions that militate against the development in our officers of "self-confidence, original thinking, initiative, and the habit of taking decisions".

What is the reason for this feeling of uneasiness, this malaise among us? The reasons are many and each speaker has dealt with one or more reasons and has suggested cures. Ultimately, however, it seems to me that the underlying reason for all our troubles is the low value at present placed in India on the engineer. Even our engineers themselves do not always appreciate the dignity of labour and have turned themselves into clerks instead of spending their time on works.

Engineers in other Countries

I mentioned that our Society has for years been recommending that selected engineers should be sent abroad for short periods of practical training and to broaden their outlook. Fifty-nine road engineers have now had a chance to see a bit of the world. They have found in other countries that engineers are controlling affairs, they are the administrators, the people in charge, the people to whom their Governments turn for advice, and to whom they entrust the management of affairs. I do not think India will advance and hold her right place in the world unless her engineers take their right place in the national economy.

Recently I was told of two young men who were in school and college together. One was brilliant, always first in everything, and the other was quite good. The first went on for further study to an engineering college and did brilliantly there. He is now an Assistant Engineer on Rs 440 a month. The other, who had a much poorer record in all respects, was ultimately selected for the new Indian Administrative Service and he is now drawing, I am told, Rs 600 a month and will soon perhaps be in charge of an engineering department and be giving orders to a Chief Engineer nearly twice his age. Is this all that India thinks of her engineers?

India needs good engineers very badly and should encourage the pick of her young men to enter the profession. But she

must value her engineers at least as highly as the advanced countries value theirs. Let us ask ourselves whether the best of our youngmen are attracted to engineering or whether the fine talent that really exists in the country is being driven to seek other employment.

An All-India Engineer Service

Before 1931 there was very keen competition for posts in the Indian Service of Engineers and many candidates had the distinction of having been first in their University and then first in their Engineering College.

In that year the Service was abolished and nothing was done to replace a source of employment that had originally an annual intake of 15 to 20 officers. The recruitment of Class I Engineer Officers throughout India from 1931 onwards (I am quoting from Sir Arthur Dean's Report on the Staff Position of the Public Works Departments, 1945) was—

1931,	2;	1932,	*Nil*;	1933,	4;	1935,	6;
1936,	1;	1937,	4;	1938,	9;	1939,	17;
1940,	45;	1941,	21;	1943,	13; &	1944,	33.

There has not been such keen competition since the Indian Service of Engineers was abolished. But, much worse, in the period 1931 to 1938 only 26 officers were recruited in the Class I Service instead of at least 90. It is just this very class of officers, a class containing picked men with from 15 to 20 years of experience behind them, that we are in such great need of now. This backbone of selected trained men is lacking with us today. I do not know what vast loss India has suffered from the absence of this talent.

I think the first thing we should press for is the creation of an All-India Engineering Service of Civil Engineers. Let us make sure, however, that it will be worth the while of the best candidates to compete for entry into this service. The pay must be reasonable but, much more essential, the conditions of Service must be reasonable. The Service will be a *Corps-d'-elite* and the officers should be given powers and responsibilities accordingly. It was said long ago that no business concern would give its highly paid officials so little real power as Government does. We must press for an improvement in this respect also.

In the meantime there is much we can do to set our own house in order. Many suggestions have been given in a Paper

we are going to discuss this Session. We may also consider the following :

(1) Let us always think of economy in the execution of our works. An engineer is a man who can do for one rupee what any fool can do for two. Let us be engineers.

(2) Let us tighten up discipline and abolish slackness.

(3) Let us treat Audit as our friends and not as nuisances. They can show us where things are going wrong in our management or control and we can look into their " objections " and put things right.

(4) And, above all, let us take a pride in our profession and think of what good we can do to our fellow man by honest, hard work. Let us resolve to do our duty with all our soul and heart and might.

If we can do all this it will soon be found that our young-men will be prouder than ever of being engineers. We shall attract the best talent to our Services, greatly to the benefit of India.

There are many details we shall have to discuss in Committee, our freedom to exercise our responsibilities (this is fast disappearing), the relation of power to responsibility, the present-day increase in paper work at the expense of real work, the ever-growing forest of rules and regulations that hampers progress and stifles initiative—in fact we shall have to discuss why we are ceasing to be engineers and becoming glued to our office chairs. Ultimately we will perhaps be able to say what strength our cadres should have and how our work should be administered.

I hope you have not found too tedious what I have tried to say. Engineers are trained to act rather than to speak but there are times when it is our duty to speak. If you will bear with me a little longer I shall go over very briefly what I have just said and then I'll have done.

I have commented on the useful work done by this Congress in the matter of developing our knowledge of engineering science and techniques and in disseminating the results of our studies. I have also spoken of our studies on road policy and road finance and have expressed our gratification that Government have so often acted on our advice in administrative and financial matters. I have stated in some detail the principles that we consider should govern the road policy of the Central and State Governments. These principles have now been embodied in three draft Bills and I have expressed the hope that these Bills will soon be considered by Government and our legislators. In tendering advice as we have done we have followed the example of a sister association, the American Association of State Highway Officials, who have been instrumental in suggesting much of the American Government's highway policy.

Lastly I have taken full advantage of the privilege accorded to the President of this Society to throw out suggestions for the consideration of our Council and Members. I have suggested that we should now press for the creation of an all-India Service of Civil Engineers and that in the meantime we should redouble our efforts to cut the mesh of red tape, a hundred times worse than it ever was before, that is strangling us and preventing us from doing our work properly. I have also done a little preaching suggesting that " work is worship " and that the best way we can serve God and India is to work hard and honestly.

And now I must thank you for giving me a patient hearing By your presence here you have encouraged us in our work of developing India's roads. For this too I must thank you on behalf of our Society.

—o—

INAUGURAL ADDRESS

In declaring the Session open His Excellency Shri Chandulal Trivedi said :—

Mr. President, Ladies and Gentlemen,

May I, at the outset, express my grateful thanks to the Indian Roads Congress for the honour it has done me by inviting me to inaugurate its Sixteenth Session? May I also, both on behalf of the Punjab Government and my own behalf, extend a most cordial welcome to the delegates and visitors to the Congress, who have come here to-day from all over India? We, in the Punjab, greatly appreciate the compliment you have paid us by the selection of our Capital as the venue of the present session of the Congress. I am sure you will find the fine climate and lovely surroundings of this hill-station an inestimable aid in your arduous deliberations. I hope also that you will carry back with you pleasant memories of your stay amongst us.

His Excellency Shri Chandulal Trivedi inaugurating the Session.

In you, Mr. President, I hail an old friend and comrade. Both you and I spent the major part of our service in Madhya Pradesh, known as the Central Provinces and Berar in our time. There we had our early roots; there we learnt our work and were trained and thus grew and developed, each in our respective sphere. Both of us owe a great deal to the Madhya Pradesh, its Government, its system of training and administration and,

above all, to its good and kindly people. I have permitted myself to be reminiscent, partly because I am delighted to see you, Sir, in the Presidential chair and largely because I wish in this way to emphasize the very great importance of the proper and systematic training of our young officers and the inculcation in them of the spirit of selfless service, steadfast devotion to duty, a continuously progressive outlook and the highest standards of Public conduct. By and large, good engineers and good administrators are made, and not born, and it is training, study, zeal, energy and hard and conscientious work which make them.

All of us have listened with great interest to your address which, if I may venture to say so, was most instructive. You have covered a very wide ground. Of all the States in India the Punjab in the past took, perhaps, the greatest interest in the development of roads. It is, therefore, not surprising that Sir Kenneth Mitchell, a Punjab engineer, was the founder of the Indian Roads Congress in 1934. Since then, the Congress has grown from strength to strength. You have done well, Sir, to remind us all of the great and lasting contribution of the Congress to all aspects of road development, for example, road policy, road finance, the Bridge Code, the Nagpur Plan and the evolution of the concept of National Highways, not to mention other matters. Moreover, the advice which the Congress has given from time to time to the Central and State Governments has been most valuable. These are achievements which the Congress has every reason to be proud of, and today our gratitude goes out to all those, whether in official or non-official walks of life, who have given their best to make the Congress what it is to-day. Your Congress is at present a great and beneficent force, making its weight felt in everything which pertains to the development of communications, with particular reference to roads.

I need hardly stress the great importance of roads in this road-minded gathering. To Napoleon is attributed the saying that an army marches on its stomach. It would be, perhaps, equally true to say that in war a nation marches to victory, and in peace to progress, mainly on its communications, of which roads are a very important element. Some of us may rightly feel that the Five-Year Plan does not provide sufficient funds for the development of roads. In particular, I know that my friends in the Punjab feel sore that the amount allotted to roads in the Punjab plan is only Rs 75 lakhs out of a total estimated outlay of a little over Rs 15 crores. I hope it may be possible to augment this provision. On the other hand, the primary aim of the Five Year Plan is to increase production both in the spheres of agriculture and industry, and the Punjab has special

problems arising out of partition and the mass migration of populations, the solution of which cannot brook delay. Priorities have had, therefore, to be assessed with great care. We in the Punjab however, realise that transport facilities must keep pace with increase in production, and I may disclose that we propose to make a provision, of Rs 2 crores in the Bhakra-Nangal Project for the development of roads in the areas which will receive irrigation, and in which the road communications, particularly those originating from villages, are either non-existent or not at all good. The establishment of new mandis or markets is also a part of the Project. I would, therefore, ask you, my friends the engineers, not to feel disappointed, much less frustrated, on what may seemingly look like an inadequate appreciation of the vital role of roads in any co-ordinated scheme of development.

You, Sir, have referred to questions of remuneration of engineers and also relations between them and lay administrators. Though I am one with you in regarding these questions as important, may I venture to say that these matters should not give rise to despondency. A feeling of frustration is not healthy at any time, and more so now when great engineering works like Bhakra - Nangal and Chandigarh Capital Project, are under construction in the Punjab, and other large engineering works are under way elsewhere in India. The great tasks, which the engineers are called upon to undertake at present, are their opportunity, and should, I suggest, fill them with glow and zest. Knowing the engineers as I do it is hardly necessary for me to say this, for usually they are not given to gloom, but I thought it might be just as well to say it. The truth is that never was the engineer, be he engaged on constructing a road or an irrigation system, more important than he is in India of to-day.

With your permission I would now like to underline some of the points which you have made in your illuminating address. Speaking purely personally, I entirely agree with you in your suggestion for an All-India Engineers' Service. So far as I am aware, the constitution of an All-India Service for Irrigation and Electricity is already under contemplation. If this comes through, the next step might well be the establishment of an All-India Service for Buildings & Roads. Belonging as I do to an All-India Service, I may be pre-possessed in favour of such Services, but I believe it will be generally recognised that All-India Services have done a great deal, in the past, to break down provincial barriers to promote unity in administrative and other spheres and generally in maintaining at a very high level standards of work and conduct. I am glad that you have stressed the importance of economy. Economy is vital at all times, and

particularly at present when costs are very high, and I express the fervent hope that none of my friends, the engineers, will ever forget the indispensable necessity of the greatest possible economy both in design and construction. You have observed, Sir, that an engineer is a man who can do for one rupee what any fool can do for two. Let this be the constant ideal of every engineer. Might I, in this connection voice the feeling that I have come across that an engineer is sometimes, if not often, a man who can do for one rupee and eight annas what an ordinary man with common sense can do for himself for one rupee!

Lastly, you have rightly stressed the place of village and minor district roads in any programme of road development. Many of us are not tired of emphasising the importance of such roads, but when it comes to framing a programme, these humble but very necessary roads are forgotten. I hope that what you have said will stimulate greater interest in rural roads. Perhaps, your Congress can do valuable service by concentrating on devising and developing specifications for constructing cheap and reasonably durable village roads. If we are to make progress worth the name in this direction, it is essential to enlist the voluntary help of rural people in the construction of such roads, and, as you all know, the Planning Commission has very rightly emphasised this aspect.

I would like here to refer to one matter which does not find a place in your address. I am under the impression that the road engineers, if not your Congress have been at work for a long time on devising wheels for the bullock-cart, which will cause less wear and tear to the roads than the wheels in use in bullock-carts at present. I trust that by this time your researches and experiments have resulted in something concrete.

Once again, I thank the Congress for asking me to inaugurate this Session. I have great pleasure in inaugurating it, and wish its deliberations in the cool air of Simla a complete success.

Thank you Mr. President, ladies and gentlemen.

—o—

President's Concluding Remarks.

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

You spoke, Sir, of the need for improving the bullock-cart wheel and asked what was the result of the study our Congress had made of this subject. The result of the labours of one of our Committees has been published in five Papers in our Journal and, although you did not know it, Sir, I am very soon going to ask you to present a medal to the Convenor of the Committee in token of our appreciation of the good work he did in guiding the Committee and writing the Papers.

We appreciate what you have just said about the necessity for economy in design and construction. May I say Sir, that the engineer does not claim to buy his materials at half the market rates or to pay his workers half the normal wages. What he should do, and generally does, is so to design and construct his structures that the minimum of labour and materials are used.

And now, Sir, may I request you to present the "Indian Roads Congress Medal" to Shri B.V. Vagh for his Papers on "A Design of Bullock-cart wheel"? And may I also request you to announce the names of the Authors of the following two Papers which have been highly commended?

Paper No. 152 "Organization of Bridging Activities" by G.R. Nangea.

Paper No. 154 "Behaviour of Brick Metal in Tar Carpets" by K. C. De.

MESSAGE FROM

The Hon'ble Dr. B. V. Keskar, Deputy Minister for Transport & Railways, Government of India

It is a pleasure to note that the Indian Roads Congress is developing and has made substantial progress during the last few years. The 16th session of the Congress, which is meeting now, will be having before it the very important task of helping in the implementation of the Five Year Plan, which means so much for the future stability and prosperity of the country. On the eve of the beginning of the Five Year Plan it is evident that the realisation of the plan depends to a great extent on the co-operation of engineers and technicians.

The engineers of the Indian Roads Congress are a specialised people and they can contribute substantially in the carrying out of this great task of national importance by helping the implementation of that part of the 5-Year Plan which pertains to roads and bridges. No plan will be complete without these two. The ingenuity and skill of the Road Technicians will lie in making the best use of the resources at our disposal and make them last as long as possible.

I am glad to note that we have passed the corner as far as the acute financial crisis that threatened us is concerned. Our position is not so critical; in fact it is slightly easier, and let us hope that it will permit us to devote more funds for the development of our roads. There also the engineers can help in trying to do the largest amount of work at the cheapest rates possible. This will also give an impetus to the ambitious plan that we had envisaged for the road network of India.

I hope the Congress will carry on more intensive research work and find new materials and ways of road treatment and bridge building, which will permit us to utilise our local material and the cheapest available material too. This will go a long way in helping us in the implementation of the Five Year Plan.

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

I regret that I shall not be able to attend the Session, but I have great pleasure in sending my good wishes for its success. I have great interest in the Indian Roads Congress. It is helping

to produce a tradition of experiment, research and knowledge regarding the problems of construction and maintenance of roads, which is of the greatest importance for the development of this country.

Please convey my cordial greetings to all the engineers attending the Session.

Greetings and Good wishes for the success of the Session were also received from England, Australia and America.

TECHNICAL EXHIBITION

OPENING ADDRESS BY THE HON'BLE CHOWDHURY LEHRI SINGH, MINISTER FOR PUBLIC WORKS, THE PUNJAB.

Mr. McKelvie, delegates of the Indian Roads Congress, and Gentlemen:

I am most thankful to the Indian Roads Congress for having asked me to open the technical exhibition of the Sixteenth Session of the Congress. I am glad to see that the Indian Roads Congress has not confined itself to spread the theoretical knowledge of latest advances in Road Engineering Science through Papers and discussions, but has also organized a technical exhibition to show the actual work that is being done in the field of research, planning, design, and construction of roads in the various States of the country. This exhibition will also provide an opportunity to your members to come into personal contact with the manufacturers and suppliers of road materials and machinery that are so essential for successful completion of your work.

The Hon'ble Ch. Lehri Singh, P. W. D. Minister Punjab, opening the I.R.C. Exhibition at Simla.

But, I consider, that a greater advantage of this exhibition lies in the education, that it will impart to the general public, who will be able to see by a visit to the exhibition, the work that the road engineers are doing for improvement of communications in the country, which is so vital for fulfilling the three great needs—food, shelter and clothing. They will be able to get an idea of the technical skill and hard work that a road engineer has to put in constructing roads and will thus be able to appreciate better your work. With these few words I declare this exhibition open and wish that it may be successive and serve the purpose for which it has been organized.

Minutes of the 38th Council Meeting of the

INDIAN ROADS CONGRESS

Held at Simla on the 26th April, 1952

Present :

G. M. McKelvie—President

M. L. Bahl	C. P. Misra
R. K. Batra	T. Mitra
C. M. Bennett	E. A. Nadirshah
Brijmohan Lal	K. K. Nambiar
S. N. Chakravarti	D. V. Rao
C. J. Fielder	R. C. Roy
D. N. Gupta	D. C. Sharma
K. K. Kartha	J. P. Singh
H. P. Mathrani	N. K. Sinha
M. Meeran	

J. M. Trehan—Secretary.

The following Co-opted Members attended :

Goverdhan Lal	D. P. Nayar
W. A. Griffiths	H. P. Sinha

Dr. E. Zipkes

The following attended by invitation :

K. F. Antia	H. Sunder Rao

1. Confirmation of the Minutes of the 37th Council Meeting.

The Minutes of the 37th Council meeting held at Calcutta on the 21st February 1951 as published at pages 610 to 611 of Volume XV-4, August 1951 of the Journal of the Indian Roads Congress were confirmed.

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

The minutes of the Meetings of the Executive Committee held at New Delhi on the 1st December 1951 and the 29th March 1952 were approved.

3. (i) Audit Report for the year 1950-51.

The Report of the Auditors for the year 1950-51 was recorded.

(ii) Draft Report of the Council to the General Body of Members for the period 1st January to the 31st December 1951.

The draft Report was approved.

4. Budget.

The budget estimate for 1951-52 was approved.

5. Venue of the next General Session.

The Council noted that an invitation to hold the next Session of the Congress had been received from the Government of Orissa. The Chief Engineer, Jammu, too, extended an invitation on behalf of the Government of Jammu & Kashmir to hold the next Session of the Congress at Srinagar.

The decision was left to the new Council which will meet on the 30th April, 1952.

6. Miscellaneous:

(i) The Council of the Indian Roads Congress accepted a proposal to publish I. R. C. Codes both with and without explanatory notes.

(ii) It was decided that all Committees of the Indian Roads Congress should have Member-Secretaries who should be officers of the Ministry of Transport, Roads Organization.

(iii) The Council authorised the Executive Commitee to spend upto Rs 50,000/- on various methods of expanding the activities of the Congress. This would include the recruitment of additional staff, buying new equipment, models etc., printing of additional pamphlets etc., equipment of a museum and such other projects as the Executive Committee might consider suitable.

(iv) The Council decided to revive, if possible, its half-yearly meetings and to encourage subcommittees also to meet at the time of these Council meetings.

Minutes of the Business Meeting of the INDIAN ROADS CONGRESS held at Simla on the 29th April, 1952

The Sixteenth Annual General Business Meeting of Members was held at Simla on Tuesday the 29th April 1952, at 14.30 hours. In all 193 Members and 7 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 Calcutta on the 21st February 1951, as printed at pages 579 to 609 of Volume XV-4 of the Journal were confirmed.

3. Audit Report.

(i) The Audit Report for the period 1st October 1950 to the 30th September 1951 (Annexure II) was recorded.

(ii) It was decided to re-appoint M/s. Walker, Chandiok & Co., Chartered Accountants and Auditors, Delhi to audit the accounts of the Indian Roads Congress.

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. Resolution of Thanks.

The following resolutions were passed with acclamation :—

(1) The Indian Roads Congress thank the Government of the Punjab for their kind invitation to hold the Sixteenth General Session at Simla and for the efficient arrangements made in connection therewith.

(2) The Indian Roads Congress thank His Excellency Shri Chandulal Trivedi, Governor of the Punjab for inaugurating the Sixteenth Session of the Indian Roads Congress and for his permission to print his Address in the Journal of the Indian Roads Congress.

(3) The Indian Roads Congress thank the Hon'ble Dr. B. V. Keskar, Deputy Minister for Transport and Railways, Government of India, for his message of good wishes for the Annual Session of the Indian Roads Congress.

(4) The Indian Roads Congress thank His Excellency Shri K. Santhanam, Lieutenant Governor of the Vindhya Pradesh, for his message of good wishes to the Members of the Indian Roads Congress.

(5) The Indian Roads Congress thank the Hon'ble Chowdhri Lehri Singh, Minister for Public Works, the Punjab, for kindly declaring open the Technical Exhibition organized by the Indian Roads Congress on the occasion of the Sixteenth Session and for his inspiring Address on that occasion.

(6) The Indian Roads Congress thank Shri Brijmohan Lal, Chief Engineer, Shri D. P. Nayar, Superintending Engineer and Shri H. R. Dhir, Executive Engineer (Local Organizing Secretary), other officers and staff of the Punjab P. W. D., for the excellent arrangements made by them for the session and for the convenience of the delegates.

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

(8) The Indian Roads Congress thank the Simla Municipality for permitting the Congress to hold their Technical Exhibition on the open space on the Ridge, and for providing other conveniences like electricity, transport, etc.

(9) The Indian Roads Congress thank the Director of Public Instruction, Punjab and the staffs of the Central Training and B. M. Colleges and other institutions for a variety concert arranged by them during the Session.

(10) The Indian Roads Congress thank the Northern Railway authorities for arranging a special train for the delegates visiting the Bhakra and Nangal Dams.

(11) The Indian Roads Congress thank the various authorities and concerns who kindly afforded facilities to delegates to visit their works.

6. Scrutineers for the Election of the Council Members.

Messrs. S. N. Chakravarti, C. M. Bennett, H. P. Sinha and C. J. Fielder were appointed scrutineers for the election of Members to the Council under rule 9-i of the Memorandum of Association, Rules, and Regulations of the Indian Roads Congress.

7. The following announcement was made from the Chair with regard to the elections:—

"Only those members of the Congress who are not in arrears regarding their subscription are entitled to vote. Voting slips will be given to those Members who wear their badges or can give their roll numbers".

8. Elections.

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

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

F. P. Antia	R. N. Joshi
C. J. Fielder	E. A. Nadirshah
W. A. Griffiths	L. R. Patel

g. Representative of District Board Engineers.

B. N. Roy

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

M. Meeran

i. Representatives elected by the General Body.

N. Durrani	C. P. Misra
G. C. Khanna	R. C. Roy

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

9-a	Name of participating Administration.	Name of representative.
	Assam	R. L. Verma
	Bihar	M. L. Bahl
	Bombay	U. N. Mahida
	Madhya Pradesh	R. K. Batra
	Madras	K. K. Nambiar
	Orissa	J. Shaw
	Punjab	D. P. Nayar
	Uttar Pradesh	M. S. Bisht
	West Bengal	S. N. Chakravarti
	Hyderabad	D. V. Rao
	Jammu & Kashmir	D. N. Gupta
	Madhya Bharat	P. V. Divatia
	PEPSU	Raghbir Sihgh
	Rajasthan	Kishore Lal Mathur
	Saurashtra	U. J. Bhatt
	Travancore-Cochin	K. K. Kartha
9-b	Engineer-in-Chief, Army Headquarters	Brig. Partap Narain
9-c	Central P. W. D.	M. S. Mathur
9-d	Consulting Engineer (Roads)	H. P. Mathrani

10. A vote of thanks to the President, the Secretary and the Executive Committee for the able manner in which they had conducted the activities of the Congress was passed by the General Body of Members.

Annexure I

LIST OF MEMBERS WHO ATTENDED THE SIXTEENTH SESSION OF THE INDIAN ROADS CONGRESS HELD AT SIMLA IN APRIL-MAY 1952.

S. No.	Name of State etc.	No. of delegates who attended the I.R.C. Session at Simla.
	ABSTRACT	
1.	**Government of India:**	
	(a) Ministry of Transport, Roads Organization	19
	(b) Engineer-in-Chief's Branch	3
	(c) Ministry of Railways	1
	(d) Central P. W. D.	5
	(e) Central Water & Power Commission	1
2.	**Council of Scientific and Industrial Research**	5
3.	**Indian Agricultural Research**	1
4.	**Assam**	4
5.	**Bihar**	15
6.	**Bombay**	21
7.	**Madhya Pradesh**	6
8.	**Madras**	21
9.	**Orissa**	1
10.	**Punjab**	21
11.	**Uttar Pradesh**	12
12.	**West Bengal**	28
13.	**Hyderabad-Deccan**	5
14.	**Jammu & Kashmir**	2
15.	**Madhya Bharat**	3
16.	**Mysore**	2
17.	**Patiala & East Punjab States Union**	3
18.	**Rajasthan**	4
19.	**Saurashtra**	3
20.	**Travancore-Cochin**	4
21.	**Delhi**	4
22.	**Himachal Pradesh**	2
23.	**Kutch**	1
24.	**Tripura**	1
25.	**Vindhya Pradesh**	1
26.	**Ceylon**	1
	TOTAL:	200

LIST OF MEMBERS WHO ATTENDED THE SIXTEENTH SESSION OF THE INDIAN ROADS CONGRESS HELD AT SIMLA IN APRIL-MAY 1952

S. No.	Roll No.	Name.
		GOVERNMENT OF INDIA
		(a) Roads Organization, (Ministry of Transport).
1.	322	Bazaz, S. L.
2.	266	Bhagat, D. G.
3.	1446	Bhalla, R. S.
4.	783	Bhargava, T. N.
5.	—	Chakravarti, S. (Invited)
6.	758	D'Costa, A. J.
7.	—	Gomes, J. G. (Invited)
8.	879	Goverdhan Lal.
9.	785	Hardyal
10.	1288	Mathrani, H. P.
11.	54	McKelvie, G. M.
12.	950	Nagarsheth, M. P.
13.	885	Poonen, P. C.
14.	724	Rajagapalan, S. K.
15.	191	Sinha, H. P.
16.	1210	Subbiah, C. P.
17.	723	Subrahmanyam, J.
18.	389	Sunder Rao, H.
19.	918	Trehan, J. M.
		(b) Engineer-in-Chief's Branch
20.	—	Deb, A. K. (invited)
21.	16	Partap Narain, Brig.
22.	—	Sihota, G. S., Col. (Invited)
		(c) Ministry of Railways
23.	43	Venkataramayya, V.
		(d) Central P. W. D.
24.	1660	Ahuja, B. D.
25.	977	Bahl, D. R.
26.	1425	Jain, K. C.
27.	1380	Mahal, P. S.
28.	620	Malik, C. P.
		(e) Central Water & Power Commission.
29.	562	Annaswami, V. S.

S. No.	Roll No.	Name.
		2. COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH.
30.	913	Chatterjee, P. K.
31.	1170	Dinesh Mohan.
32.	1625	Gonsalves, G. F. D.
33.	847	Uppal, H. L.
34.	1535	Zipkes, E.
		3. INDIAN AGRICULTURAL RESEARCH INSTITUTE.
35.	—	Raychaudhuri, S. P. (Invited).
		4. ASSAM.
36.	1620	Dutta, D. N.
37.	1632	Lakhar, K. D.
38.	945	Pal, S. C.
39.	1452	Sharma, P.
		5. BIHAR.
40.	1655	Aga, A. K.
41.	399	Bahl, M. L.
42.	733	Bhagwat Prasad.
43.	1634	Chakravarti, A. C.
44.	—	Chandrika Ram (Invited).
45.	1541	Chowdhury, D. C.
46.	471	Gupta, S.
47.	434	Misra, C. P.
48.	1642	Mukteswar Prashad.
49.	492	Ram, G. S.
50.	1299	Roy, B. N.
51.	1291	Sinha, N. K.
52.	754	Sinha, S. K.
53.	856	Sirkar, S. K.
54.	1373	Verma, D. N.
		6. BOMBAY.
55.	1241	Antia, K. F.
56.	329	Bhate, K. G.
57.	1336	Daftary, N. D.
58.	1497	Deshpande, D. V.
59.	1651	Deuskar, V. R.
60.	1663	Dhamdhare Hari Vasudeo.
61.	1129	Iyengar, C. L. N.
62.	1656	Javali, S. C.

S. No.	Roll No.	Name.
63.	1646	John, A. Pauptis.
64.	596	Joglekar, G. D.
65.	315	Joshi, S. B.
66.	1657	Kale, M. D.
67.	636	Macha, T. K.
68.	553	Mahida, U. N.
69.	983	Mone, V. T.
70.	23	Nadirshah, E.A. [Represented the I. E. (I), too].
71.	1479	Narke, S. P.
72.	342	Nicolaides, E. P.
73.	795	Otia, J. C.
74.	163	Rege, D. Y.
75.	376	Sandhawalia, N. S.
	7. MADHYA PRADESH.	
76.	978	Batra, R. K.
77.	1395	Borwankar, S. G.
78.	1643	Gupta, H. R.
79.	1283	Inamdar, H. M.
80.	782	Kumar, G. L.
81.	1392	Mehta, J. V.
	8. MADRAS.	
82.	544	Balasubrahmanyam, M.
83.	994	Chandrasekharan, E. C.
84.	633	Chetty, K. A. N.
85.	1594	Damodaram Naidu, A. N.
86.	1667	Deviah, N. S.
87.	246	Durrani, N.
88.	409	Ganapathy, G. S.
89.	80	Griffiths, W. A.
90.	671	Meeran, M.
91.	268	Nambiar, K. K.
92.	1640	Nandgopal, G.
93.	1645	Natarajan, M.
94.	1662	Satyanarayana, K.
95.	233	Sayoji Rao, H. R.
96.	472	Seshagiri Rao, N.
97.	1311	Subbaraju, Bh.
98.	1647	Subbarao, M.
99.	1345	Swaminathan, C. G.
100.	630	Thadaney, K. V.
101.	1572	Thillainayagam, R.

S. No.	Roll No.	Name.
102.	1173	Venugopal, C.
	9. ORISSA.	
103.	204	Bennett, C. M.
	10. PUNJAB.	
104	68	Balwant Singh.
105.	892	Basant Singh.
106.	1593	Berry, R. K.
107.	462	Bikramjit.
108.	42	Brijmohan Lal.
109.	1243	Dhir, H. R.
110.	1227	Gupta, I. C.
111.	1407	Kapur, S. P.
112.	729	Kewal Krishan.
113.	466	Khanna, G. C.
114.	187	Kikkeri, S. A.
115.	500	Krishna, R.
116.	1302	Mehndiratta, M. R.
117.	154	Nayar, D. P.
118.	427	Nayyar, S. L.
119.	1121	Ram Bilas.
120.	504	Sharma, D. C.
121.	1400	Tandon, G. S.
122.	1666	Toki, G. S.
123.	491	Varma, P. L.
124.	622	Vijh, G. C.
	11. UTTAR PRADESH.	
125.	1644	Bhargava, N. C.
126.	—	Hart, C. A. (Representative of I.C.E., London). (Invited.)
127.	1193	Kar, S. M.
128.	1182	Kochhar, R. K.
129.	284	Lakshman Swarup.
130.	1203	Mathur, G. D.
131.	1636	Mirchandani, I. D.
132.	302	Mirza, M. A.
133.	264	Parmara, D. S.
134.	1157	Prem Mohan.
135.	1255	Sahni, K. S.

S. No.	Roll No.	Name.
136.	960	Sinha, K.
	12. WEST BENGAL.	
137.	1350	Baul, R. D.
138.	1628	Bose, A. K.
139.	17	Chakravarti, S. N.
140.	323	Chambers, J.
141.	1589	Chattopadhya, S. N.
142.	45	Chatterjee, D.
143.	41	De, K. C.
144.	21	Edwards, W.
145.	231	Fielder, C. J.
146.	1652	Ganguli, A. C.
147.	1030	Ghosh, A. K.
148.	1604	Ghosh, B. N.
149.	808	Ghosh, S. K.
150.	1556	Gupta, A. K. Das
151.	936	Gupta, Sachindra Nath,
152.	44	Laurie, F. J. K.
153.	6	Madden, W. J.
154.	1653	Maitra, M. S.
155.	1650	Majumdar, B.
156.	1309	Majumdar, S. N.
157.	316	Mitra, T.
158.	73	Ratnagar, R. D.
159.	1544	Ray, S. N.
160.	766	Roy, R. C.
161.	1553	Samaddar, S. K.
162.	1679	Sambhu Ch. Chakraborty.
163.	1032	Sen, D. M.
164.	1570	Sethna, H. K.
	13. HYDERABAD-DECCAN.	
165.	1043	Daver, F. K.
166.	29	Narasimham, J. S.
167.	751	Raju, S. P.
168.	1639	Rao, D. V.
169.	388	Shiva Raj, A.
	14. JAMMU & KASHMIR.	
170.	1624	Gupta, D. N.
171.	1583	Wanchoo, P. N.

S. No.	Roll No.	Name.
	15. MADHYA BHARAT.	
172.	149	Bhalla, P. N.
173.	567	Dhumal, R. J.
174.	581	Naik, B. G.
	16. MYSORE.	
175.	1668	Manchigiah, M. H.
176.	1664	Venkatesa Das, C. J.
	17. PATIALA & EAST PUNJAB STATES UNION.	
177.	1134	Khanna, P. N.
178.	1449	Singh, J. P.
179.	1612	Uppal, M. G.
	18. RAJASTHAN.	
180.	826	Adaviyappa, S.
181.	827	Bhargava, I. D.
182.	1661	Bhatnagar, V. R.
183.	834	Mathur, B. D.
	19. SAURASHTRA.	
184.	214	Bhatt, U. J.
185.	34	Mehta, J. T.
186.	1313	Patel, N. C.
	20. TRAVANCORE-COCHIN.	
187.	988	Balakrishna Menon, T.
188.	1654	Kartha, K. K.
189.	1658	Sivarama Pillai, A.
190.	1659	Thomas K. Jacob.
	21. DELHI.	
191.	1183	Nazareth, C. V.
192.	1314	Sani, G. H.
193.	40	Shahani, T. C.
194.	1432	Sujan Singh

S. No.	Roll No.	Name.
	22. HIMACHAL PRADESH.	
195.	1648	Bose, S. K.
196.	338	Nangea, G. R.
	23. KUTCH.	
197.	1633	Mainthia, Devidas P.
	24. TRIPURA.	
198.	307	Sen, A. K.
	25. VINDHYA PRADESH.	
199.	1665	Srivastava, C. P.
	26. CEYLON.	
200.	822	Williams, L. C.

Annexure—II

INDIAN ROADS CONGRESS

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 30th SEPTEMBER, 1951.

(Excluding Transport - Communications Monthly Review).

EXPENDITURE		Rs	A.	P.	Rs	A.	P.	INCOME		Rs	A.	P.	Rs	A.	P
To Opening Stock of Journal as on 1st October, 1950	...	17,975	12	0				By Sale of Journal	...	3,635	14	0			
„ Cost of Printing	...	11,001	13	6				„ Advertisement	...	6,573	8	0	10,209	6	0
„ Cost of Paper	...	7,799	0	6											
		36,776	10	0				„ Government and States Grants	...				52,000	0	0
								„ Members Subscription :—							
Deduct : Closing Stock of Journal as on 30th September, 1951	...	28,353	13	0	8,422	13	0	Ordinary	...	25,735	0	0			
								Associate	...	2,980	0	0			
								Life Membership	...	1,066	0	0	29,781	0	0
„ Establishment	...				20,492	1	3								
„ Local and other Allowances	...				12,786	12	6								
„ Provident Fund Contribution	...				1,075	0	0	„ Entrance Fees :—							
„ General Printing & Stationery	...				2,171	13	2								
„ Postage & Telegrams	...				2,467	13	3	Ordinary Members	...	1,800	0	0			
„ Uniforms to IV Class Servants	...				179	10	0	Associate Members	...	480	0	0	2,280	0	0
„ Audit Fee for 1949-50					750	0	0								
„ Membership Subscription to other Societies	...				997	7	0								
„ Miscellaneous Expenses	...				1,946	6	9								
„ Bank Charges	...				166	8	6	„ Interest on Government Securities	...				410	8	0
„ 15th Session Expenses	...				6,524	8	6								
„ Publicity	...				500	0	0	„ Miscellaneous Income	...				2	2	0
„ Honorarium to Secretary	...	1,200	0	0											
„ Honorarium to Govt. of India Staff	...	300	0	0	1,500	0	0	„ Receipts on account of :—							
								Delegation Fees	...	6,950	0	0			
„ Depreciation	...				663	0	0	Transport Charges, etc.	...	2,130	0	0	9,080	0	0
„ Difference being Excess of Income over Expenditure carried to Surplus Account	...				43,819	2	1								
TOTAL					1,03,763	0	0	TOTAL					1,03,763	0	0

Kashmere Gate,
Delhi,
Dated, the 13th day of November, 1951.

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

INDIAN ROADS CONGRESS

INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDED 30th SEPTEMBER, 1951.

Transport - Communications Monthly Review

EXPENDITURE		Rs A. P.	INCOME		Rs A. P.
To Opening Stock as on 1st. October, 1950 ...		634 14 0	By Sales and Subscription ...		1,879 0 0
„ Purchases of Paper ...		5,239 13 3	„ Advertisement Proceeds ...		13,938 15 6
„ Printing Charges ...		6,427 0 3	„ Miscellaneous Income ...		2 13 0
		12,301 11 6			
Less : Closing Stock as on 30th Septr., 1951 ...		1,648 13 1			
		10,652 14 5			
To Postage ...		1,096 12 0			
„ Miscellaneous Expenses ...		43 3 0			
„ Balance being Excess of income over Expenditure carried to Balance Sheet ...		4,027 15 1			
TOTAL ...		Rs 15,820 12 6	TOTAL ...		Rs 15,820 12 6

BALANCE SHEET AS AT 30th SEPTEMBER, 1951.

LIABILITIES	Rs A. P.	Rs A. P.	ASSETS	Rs A. P.	Rs A. P.
SUNDRY CREDITORS			SUNDRY DEBTORS		
For Expenses ...	1,272 3 9		Due for Sales & Subscription ...	114 0 0	
Advertisement Fee received in advance for 1951—52 ...	1,296 0 0	2,568 3 9	Due for Advertisements ...	3,888 6 6	
AMOUNT HELD IN SUSPENSE ...		5 0 0	STOCK IN HAND		4,002 6 6
DUE TO GENERAL ACCOUNT ...		2,054 5 9	(Certified as to quantities and values by the Secretary) ...		1,648 13 1
SURPLUS ACCOUNT			STAMPS IN HAND ...		0 15 6
Balance being Excess of Income over Expenditure as per annexed Income & Expenditure Account ...	4,027 15 1				
Less : Debit balance as per last Balance Sheet ...	3,003 5 6	1,024 9 7			
TOTAL ...		Rs 5,652 3 1	TOTAL ...		Rs 5,652 3 1

Kashmere Gate,
Delhi.
Dated, this 13th day of November, 1951.

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

Annexure III

INDIAN ROADS CONGRESS

REPORT OF THE COUNCIL TO THE GENERAL BODY OF MEMBERS FOR THE PERIOD 1ST JANUARY TO THE 31ST DECEMBER, 1951.

[The Report covers the period from the 1st January to the 31st December 1951, though a few matters referred to in it are carried beyond the latter date for convenience and completeness of record.]

1. GENERAL.

The Fifteenth Session of the Indian Roads Congress was held at Calcutta in February 1951 when 211 members and six invitees attended the Session. The eight Papers published in the Journal of the Indian Roads Congress Volume XV-Parts 1 to 3 were read and discussed. Two Committees and ten Subcommittees were reconstituted to deal with various engineering and administrative problems. The Bullock-cart Subcommittee appointed by the Council at their meeting held during the Gwalior Session in October 1943 to study the question of evolving an improved design for the bullock-cart wheel, was dissolved as it had completed most of its work.

The Executive Committee held two meetings at New Delhi on the 1st December 1951 and the 29th March 1952.

The President of India has been pleased to accord his Patronage to the Indian Roads Congress during the tenure of his office.

2. ADMINISTRATION.

Shri G. M. McKelvie, Road Development Adviser and Joint Secretary to the Government of India, Ministry of Transport, was elected President of the Indian Roads Congress at the Calcutta Session. Shri H. P. Mathrani, Consulting Engineer to the Government of India (Roads), continued as Honorary Treasurer. The Executive Committee, at their meeting held on the 1st December 1951, elected Shri Goverdhan Lal, Deputy Consulting Engineer (Roads), as Honorary Deputy Treasurer.

Shri J. M. Trehan continued as Honorary Secretary. Shri N. Sen continued to work as Honorary Assistant Secretary till the 24th May 1951, when he was transferred as Engineer Liaison Officer, Bihar. In his place, Shri T. N. Bhargava was appointed as Honorary Assistant Secretary with effect from the 25th May 1951.

3. OFFICE.

The office continued to function in New Delhi. During the period under report, the office disposed of 6,945 receipts and issued 16,489 letters against 5,507 and 20,486 respectively in the previous year.

The staff worked satisfactorily.

4. MEMBERSHIP.

(1). **Ordinary and Associate.**—The number of members on the rolls increased from 1,243 (1,217 ordinary and 26 associate) on the 1st October 1950 to 1,292 on the 30th September 1951 (1,265 ordinary and 27 associate). There were 78 new admissions to the Society and 29 removals from the rolls due to resignations, deaths, and non-payment of arrears of subscriptions for a long time.

(2). **Life Membership.**—During the Congress year from the the 1st October 1950 to the 30th September 1951, nine members enrolled themselves as Life Members. The fees received from them have been transferred to a separate reserve after deducting Rs 10 per member for initial expenses. The Life Membership Reserve amounted to Rs 6,547/9/- on the 30th September 1951. This reserve is to be utilized for such purposes as the Council may decide from time to time. The Council has not, so far, utilized any part of the reserve.

5. DEATHS.

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

(1) P. V. N. Sarma
(2) K. V. Chowdhury
(3) H. J. Kothari
(4) S. G. Lakhani
(5) B. R. Kagal

Letters of condolence were sent to the families of the deceased.

6. FINANCE.

The budget for the year 1951-52 and the "Actuals" for 1950-51 were approved by the Executive Committee at their meeting held on the 1st December 1951. The estimate will be submitted to the Council at its 38th meeting. The "Actuals" for 1950-51 show a surplus of Rs 15,555 against an estimated deficit of Rs 17,114. The improvement in the budgetary position

resulted from economy in expenditure, increased contribution from the Centre, and realization of some bills that had remained unrealised at the end of the previous year. Income from advertisements was more than usual as publicity through the "Journal" and "T.C.M.R." became more and more recognized.

The total contribution received from the Centre and the States during the year was Rs 45,000. The outstandings from the States on the 30th September 1951 were Rs 28,000. Efforts are being made to persuade the States to expedite payments.

As decided by the Executive Committee at their meeting held on the 1st August 1949, Part 'A' States were requested to contribute **one-two-hundredth** part of their allocations from the Road Fund or a fixed sum on the same basis. Some of the State Governments agreed to contribute their share on this basis while others, whose share according to the formula was much more than what they were already paying, agreed to increase their contributions considerably. But, as the amounts still fell short of the amounts suggested by the Congress, these States were requested to reconsider the matter. In response to this the Government of Madras increased their contribution further by Rs 1,000. The Council hope that other Governments, too, will agree in due course to the contributions proposed and thus place the finances of the Society on a sound footing.

As regards Part 'B' States, it was reported last year that the Indian Roads Congress would continue to accept the present contributions. The Government of Saurashtra, who had been making an unduly low contribution, have agreed to increase theirs to Rs 1,000.

The Government of India have increased their annual contribution from Rs 6,000 to Rs 10,000.

The arrears of subscription from 267 Members at the beginning of the Congress year 1950-51 were Rs 10,723. Of this sum, Rs 2,198 were realized from 62 Members. After adding the arrears for 1950-51, the total arrears on the 1st October 1951 stood at Rs 17,830 due from 368 Members, of whom 98 had been in arrears for more than two years. The names of 54 Members who had died, retired from service, or migrated outside India and had been in arrears for a long time were removed from the rolls. Consequently, a sum of Rs 4,778/8/- standing against these Members was written off by the Executive Committee at their meeting held on 1st December, 1951. The Members who are still in arrears are being pressed to clear off their dues. Members in arrears with their payments are not being supplied the Journal,

nor are they being allowed any of the benefits or privileges of Membership of the Society.

7. AUDIT.

At the Fifteenth Session at Calcutta it was decided to appoint Messrs. Walker, Chandiok & Co., Chartered Accountants and Auditors, Delhi, to audit the accounts of the Congress for 1950-51. Their report was examined by the Executive Committee at their meeting held on the 29th March, 1952, and by the Council at their 38th meeting on the 26th April, 1952.

8. PUBLICATIONS.

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

Bound volumes of the Journal Nos. XII, XIII, and XIV became available during the year. Parts of Vol. XII which had been lost during the 1947 distrubances and almost the whole of Vol. XIII which was lost in an accidental fire in the press in March 1949 had to be reprinted. This was done because these volumes contain Papers of great importance to the profession.

Circulars to all State Governments, other administrations, and engineering firms suggesting that they purchase these publications for their libraries and engineering staff were issued. Announcements regarding these publications were also made in the Journal and the T.C.M.R. As these volumes contain many valuable Papers on Standards and useful information on Plant, Machinery, etc., they are in great demand.

As all previous copies of the Nagpur Report had been sold and there was still a big demand for this publication, 1,000 copies were reprinted during the year. Out of these 203 copies have already been sold.

It is expected that bound copies of Vol. XV will be available for sale at the Session.

The balance of the publication as on the 31st December 1951 was as under:

Name of Proceedings	*Volume*	*Balance*
I.R.C. Proceedings	... I to VI, VII-1 & VIII	Sold out
Do.	... VII-part 2	47
Do.	... IX-part 4	124
Do.	... IX-Bound	197

Name of Proceedings	*Volume*	*Balance*
I.R.C. Proceedings	... X-part 4	285
Do.	... X-parts 1 & 2 (Bound)	Sold out
Do.	... X-parts 3 & 4 (Bound)	Sold out
Do.	... XI-part 4	184
Do.	... XI-parts 1 & 2 (Bound)	134
Do.	... XI-parts 3 & 4 (Bound)	254
Do.	... XII-part 1	25
Do.	... XII-part 2	423
Do.	... XII-part 3	462
Do.	... XII-part 4	582
Do.	... XII-part 5	466
Do.	... XII-parts 1, 2 & 3 (Bound)	586
Do.	... XII-parts 4 & 5 (Bound)	499
Do.	... XIII-part 1	311
Do.	... XIII-part 2	410
Do.	... XIII-part 3	352
Do.	... XIII-parts 1 & 2 (Bound)	572
Do.	... XIII-parts 3 & 4 (Bound)	164
Do.	... XIV-part 1	324
Do.	... XIV-part 2	445
Do.	... XIV-part 3	427
Do.	... XIV-part 4	465
Do.	... XIV-parts 1 to 4 (Bound)	563
Do.	... XV-part 1	870
Do.	... XV-part 2	391
Do.	... XV-part 3	500
Do.	... XV-part 4	571
Road Research Bulletin No. 1		246
Old Bridge Code (1937 Edition)		204
Nagpur Report		797
Paper on 'Water Bound Macadam'		74

It is noticed that there is a smaller demand for Part 4 (Part 5 in 1948) than for the other Parts of these Journals. This may be because the last Part of each Volume does not cantain any Papers. But the discussions on Papers are printed in the last Part of each Volume and the discussions are quite often as important as the Papers themselves since they correct mistakes in the Papers and bring out fresh points of view. It is hoped that with this explanation, the demand for these issues will improve.

Those Members who do not possess a complete set of the Proceedings of the Society are advised to complete their series before the old volumes are sold out.

On a reciprocal basis, copies of the publications continue to be supplied to several technical institutions in India, the United States of America, the United Kingdom, Australia and Offices of the United Nations Organization in the Far East.

The Indian Roads Congress has entered into an agreement with the Central Road Research Institute to publish Road Research Notes of the Institute in the Journal of the Congress.

The publication "**TRANSPORT - COMMUNICATIONS MONTHLY REVIEW**" has become popular and the subscribers now number over 250. The Congress has decided to expand this publication in pursuance of the Society's policy of making available valuable information to engineers who do not have access to all the literature and resources that are available at the headquarters of the Indian Roads Congress.

From January 1952, two series of most useful and informative articles have been started in this publication. One of them covers Highway Standards issued by the Indian Roads Congress in recent years and the other gives salient features of the important bridge and highway works executed in the last five years. Two issues—viz., those of January and February 1952—were distributed free in large numbers to all States in India, and the Chief Engineers were requested to circulate the Review to all engineers and subordinates.

Further, it was decided to make this publication available to subordinate engineering staff in the country at the concessional rate of Rs 8 a year which is charged from the members of the Society.

Complimentary copies of the Review are being issued to State Governors, Rajpramukhs, and Chief Commissioners, Ministers at the Centre and in the States, Members of the Standing Roads Committee of Parliament, the Chief Engineers concerned with roads and others. Also, complimentary copies of the issue for March 1951 were supplied to all the Members of the Indian Roads Congress.

The Council request Members and readers of the Review to send articles and other suitable contributions for publication.

9. INFORMATION.

Numerous enquiries received from Members as well as non-Members on problems relating to highway engineering and allied subjects were attended to. Some of the subjects on which information was sought for are given below:

(1) I R.C. Bridge loadings;
(2) Type Designs for Slab Culverts;
(3) Abutments, abutment piers, and piers for arches of various spans;
(4) Slopes of approaches to bridges and culverts;
(5) Carrying capacity of existing bridges on roads;
(6) Load-carrying capacity of masonry arches;
(7) Sieve analysis and methods for sampling and testing of mineral aggregates;
(8) Grading of aggregates;
(9) Information on stabilization of soils;
(10) Classification of roads in India;
(11) Widths of different classes of roads;
(12) Maximum gradients;
(13) Superelevation on curves;
(14) Standards for mile and furlong stones;
(15) Parking places in congested areas of big towns and in the open;
(16) Statistics about the milage of roads;
(17) "Coslettizing", the phosphate anti-corrosion treatment for iron;
(18) Standard road signs;
(19) Methods of testing concrete piles.

10. LIBRARY.

In addition to a large number of technical journals of Institutions in India and abroad received in exchange for the Indian Roads Congress publications, a large number of books and Standards of the British and the Indian Standards Institutions were added to the Library of the Congress. Members can borrow books from the libraries of the Congress and the Consulting Engineer (Roads) by writing to the Secretary, Indian Roads Congress. The rules regarding the loan of books are published in Vol. XVI—part 1 of the Journal of the Indian Roads Congress.

Lists of additions to the library are published monthly in the "Transport-Communications Monthly Review". Members are requested to study these lists and ask for books which they wish to consult.

Seventy-five books were issued on loan during the year under report. This is a very small number considering the Society has nearly 1,300 Members. **It is urged that Members should make more use of these splendid libraries.**

11. MEDALS AND PRIZES.

At their 36th meeting held at Calcutta in February, 1951, the Council considered the recommendations of the Papers Sub-committee for the award of Medals for Papers read and discussed at the 14th Session. The following awards ware made:—

The "Indian Roads Congress Medal"

(i) Shri K. G. Bhate for I. R. C. Paper No. 142 on "Failure of a Five Span Masonry Arch Bridge across the Bhogeswari River near Pen, District Colaba in the Province of Bombay."

(ii) Shri A. Nageswara Ayyar for I. R. C. Paper No. 147 on "An Adaptable Steel Centring for R. C. Bridges."

12 COLLECTION OF PARTICULARS OF BRIDGES.

The Indian Roads Congress has been collecting particulars of bridges or lengths above 100 feet for publication in book form. The compilation work is still in progress. As soon as it is complete, the question of its publication will be taken up.

13. MEMBERSHIP OF SOCIETIES AND INSTITUTIONS.

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

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

(3) Shri H. P. Sinha was nominated to represent the Indian Roads Congress on the Engineering Division Council of the Indian Standards Institution.

(4) The following were nominated as the Principal and Alternative representatives of the Indian Roads Congress on the Building Division Council of Indian Standards Institution:

Principal representative: Shri S. B. Joshi

Alternative representative: Shri H. P. Sinha

(5) The other representatives of the Congress on the various Sectional Committees of that Institution are:—

EDC:	2—Cement	Shri E. P. Nicolaides
EDC:	20—Drawings	Shri H. P. Sinha
CDC:	7—Bitumen & Tar Products	Shri K. K. Nambiar Shri Brijmohan Lal

(6) The following are the Principal and Alternative representatives of the Indian Roads Congress on the Road Tar Sub-committee of the Indian Standards Institution:

Principal representative: Shri R. N. Chatterjee

Alternative representative: Shri G. C. Khanna

14. REPRESENTATION ON OTHER ORGANIZATIONS.

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

15. TECHNICAL ACTIVITIES OF THE CONGRESS.

(1) Specifications and Standards Committee:

The Committee met at Calcutta during the Fifteenth Session and discussed the following subjects:

(a) Vertical Curves for Highways:

(b) Type Designs for Mile and Furlong Stones.

The Standards on "Vertical Curves for Highways" recommended by the Committee have been published as Papar No. 156 in Volume XVI— part 1 of the Journal of the Indian Roads Congress and will be discussed during the present Session of the Congress at Simla.

As regards type designs for milestones, the possibility of presenting the legend in English, Hindi and the local language is being examined.

The type designs for furlong and boundary stones were finalised.

The Standard form for recording data for cement concrete road pavements, presented by the Committee for general discussion during the Roorkee Session of the Congress in 1948, was finalized in the light of the comments offered.

A draft note on "Design of Traffic Rotaries" has been prepared for discussion in Committee during the Session at Simla.

The following subjects were also studied :—

(1) Recommended practice for siting roadside petrol-filling stations

(2) Recommended practice for roadside advertisements.

(3) Specifications for joints in cement concrete pavements.

(2) Bridges Committee

The Committee met at Calcutta during the Fifteenth Session in February 1951.

As suggested by the Committee, the Convenor of the Soil Research Subcommittee was requested to call for written comments from the members of his Subcommittee suggesting methods for ascertaining safe bearing pressure on sub-soils for foundations of bridges. The Convenor has since circulated a note on the subject to the members of the Subcommittee for comments. After the comments are received a joint meeting of the Bridges Committee and Soil Research Subcommittee will be arranged to discuss this subject.

The resolution passed by the Committee recommending to the Government of India to make proper arrangements for carrying out tests of bridge structures and to purchase various types of modern bridge testing equipment was forwarded to the Government of India.

The Committee authorized the printing of Sections I and II of the Indian Roads Congress Bridge Code. The Member-Secretary has been requested to release the matter for the press.

Subcommittees were appointed by the Committee to draft the following Sections of the I.R.C. Bridge Code :

Section IV—Masonry Structures

Section V—Steel Bridges

Section VI—Prestressed Concrete Bridges

A preliminary draft of Section V was circulated to the members of the Subcommittee for their comments.

(3) Technical Subcommittee

(a) *Test Track Division* :

The subcommittee held four meetings on the following dates

19- 2-51—Calcutta
10- 4-51—Agra
30- 11-51—New Delhi
2- 1-52 Calcutta

At their meeting held at Calcutta on the 19th February 1951, the Subcommittee recommended that as it would be uneconomical to remove the Test Track to a new site, attempts should be made to have on a permanent lease the land on which the present Test Track at Calcutta is laid. The Government of India, Roads Organization, did not consider it necessary to pursue the matter at this stage as the Calcutta Port Commissioners have not refused so far any request for the extension of the lease.

In April 1951, the members of the Subcommittee inspected the experimental length laid in 1945 in mile 735/36 of the Bombay-Delhi Road (near Agra). The Subcommittee requested the Director, Central Road Research Institute, to analyse samples of road crust taken from the road. The report of the Director, which has been published in Volume XVI-Part 2 of the Journal, was discussed on the 30th November 1951 and it was decided that further tests were necessary and should be carried out in the vicinity of the Central Road Research Institute on the Delhi-Mathura Road.

The Indian Roads Congress have requested the Government of India to sanction a sum of Rs 20,000 for the proposed tests.

In their last meeting the Subcommittee decided that the Government of Uttar Pradesh should be requested not to carry out extensive repairs to or repaint the experimental length but to allow it to deteriorate to the point of destruction. This would enable members to watch the effect of the quantity of bitumen on the life of the surfacing. The Government of Uttar Pradesh were requested accordingly.

At the same meeting the Subcommittee discussed the final report on the results of the 1949-50 series of tests which were carried out to ascertain the performance and economy of different kinds of foundations for roads. All members of the Subcommittee were requested to give their own conclusions in writing and their suggestions for the next series of the tests.

It is hoped that during the present Session at Simla the Subcommittee will draw up the programme of the next series of tests to be carried out at the Test Track.

(b) *Research Organization Division* :

The Subcommittee held a meeting at Calcutta in February 1951. They desired to obtain reports on the road research work done and the programme of work for the next year of the research institutions of various administrations, engineering colleges, universities, as well as of industries concerned with road materials, and the Army.

The Consulting Engineer to the Government of India (Roads) addressed all concerned in May 1951. Some replies have been received.

Reports of the work done in the Buildings and Roads Research Laboratories in the Punjab and Uttar Pradesh were received by the Indian Roads Congress. These have been published in brief in the "Transport-Communications Monthly Review".

(4) Road Transport Subcommittee :

The Subcommittee held a meeting at Calcutta during the Fifteenth Session in February 1951.

(1) Duration of permits for public carriers.
(2) Delay in issue of permits.
(3) Inter-regional permits.
(4) Inter-State permits.
(5) Restrictions on long-distance transport.
(6) Weight restrictions.
(7) Formation of an Indian Road Transport Congress.

The Subcommittee considered the marginally noted subjects but as they had been dealt with by the Motor Vehicle Taxation Enquiry Committee, the Chief Engineers, and the Bridges Committee of the Indian Roads Congress respectively, they did not make any specific recommendation. They were of the opinion that after the proposed Indian Road Transport Congress had come into existence, this Subcommittee would have no functions to perform. They would, however, continue to do the preliminary work in regard to the formation of the Indian Road Transport Congress.

(5) Soil Research Subcommittee :

The Subcommittee held two meetings on the following dates:

2-2-51 at Ramnad
17-2-51 at Calcutta

In their meeting held on 2-2-51 the Subcommittee recommended that engineering colleges and universities in India be addressed to include in their civil engineering curricula the study of the basic principles of soil science and soil mechanics. The Executive Committee at their meeting held on 1st December 1951 decided that, before the engineering colleges and universities in India were addressed on the subject, the results of the deliberations of the All-India Board of Technical Studies should be awaited.

Last year the Subcommittee recommended that steps should be taken to collect, collate, and publish data of typical Indian soils by assigning parts of the country to the various laboratories working in India. The Subcommittee at their meeting held at Calcutta on 17-2-51 set up a working committee to deal with the classification of Indian soils with respect to their engineering properties.

At the same meeting the Subcommittee considered a note on "Special method of soil stabilization by addition of sludge and sodium silicate" prepared by the Council of Scientific and Industrial Research and decided that copies of the note may be sent to such of the administrations who may be in a position to carry out tests under actual field conditions.

The Council of Scientific and Industrial Research who were addressed in the matter considered that field tests proposed by the Indian Roads Congress should pend till the completion of the experimental studies at the Buildings Research Institute, Roorkee, and tests at the Cental Road Research Institute.

In view of this, the matter was kept in abeyance. The results of the tests mentioned above are awaited.

On a request of the Indian Roads Congress made last year, the Government of India agreed to provide funds to carry out experiments on surface dressing work with tar on stabilized soil roads in the Punjab and Madras. The detailed estimates for the proposed experiments are awaited from the Chief Engineers of Punjab and Madras.

(6) Education Subcommittee:

This Subcommittee held a meeting at Calcutta in February 1951. Its recommendations on post-graduate courses in engineering; specialized training in highway engineering to young engineers; research studies at various research institutions when set up; and lecture courses in highway engineering at the Central Road Research Institute, New Delhi; were forwarded to the Government of India and are now under consideration by the All-India Board of Technical Studies in Engineering.

The Executive Committee at their meeting held on the 29th September 1950 decided that all State Governments should be

requested to organize departmental refresher courses for their engineers. A circular letter was accordingly issued to the State Governments on 27-1-51. As the nature of the replies received indicated that many of them desired to have a general outline of the scheme and its financial implications, the Education Subcommittee was asked to work out details. The Subcommittee propose to discuss this subject at their next meeting.

In addition, the Subcommittee were entrusted with the task of studying some examination papers of engineering colleges and making suggestions regarding their suitability and standard. Question papers and syllabi received from various engineering colleges were forwarded to the Convenor of the Subcommittee. The Subcommittee propose to discuss this subject, too, at their next meeting.

(7) **Papers Subcommittee** :

This Committee held its meeting at Calcutta in February 1951 and recommended the award of Madals for some of the Papers presented at the 14th Session.

Fourteen Papers were received during the year but only five were accepted Five Papers were rejected, two returned to Authors for revision, and two were kept pending for consideration after the forthcoming Session

(8) **Manufacture of Road Making Machinery and Mechanization Subcommittee** :

The Subcommittee held a meeting at Calcutta in February 1951 The minutes of the meeting were considered by the Executive Committee at their meeting held on the 1st December, 1951. It was decided to recommend to the Government of India that they consider the possibility of placing bulk indents for stone crushers with firms willing to manufacture them in India.

The Government of India who were addressed in the matter have undertaken preliminary enquiries.

16 MISCELLANEOUS

(1) **Maintenance of "Earth Roads"**.

As desired by the Council in their meeting held at Ranchi in February 1949, details of the practices adopted in the various States for the maintenance of earth roads were collected and passed on to the Soil Research Subcommittee to study them and draw up specifications to suit varying conditions of climate, soil, rainfall, etc

(2) **Research Problems.**

The Executive Committee at their meeting held on the 29th September 1950 considered that, as the staff in engineering colleges might not generally be familiar with the practical problems on which research was needed, the Indian Roads Congress should compile a list of such problems and circulate it to engineering colleges.

With that end in view the members of the Council and the Convenors of Committees and Subcommittees of the Indian Roads Congress were addressed to suggest suitable problems. Some suggestions have been received and will be vetted by the Research Organization Division before circulation to colleges.

(3) **Need of Roads for the "Grow More Food Campaign."**

While considering the points arising out of the Presidential Address delivered at the 14th Session, the Executive Committee at their meeting held on the 29th September 1950 decided that it should be suggested to Ministries of Food and Agriculture at the Centre and in the States that the development of roads was a necessity if the "Grow More Food Campaign" was to be a success and that they should finance road building projects in areas where the "Grow More Food" campaign was to be launched. These recommendations were forwarded to the Governments concerned and they were requested to intimate whether they were considering the question of setting aside for the construction or improvement of roads a reasonable percentage of the funds voted for the "Grow More Food" campaign. It was suggested that at least 15 per cent of the availabe funds should be set aside for this purpose. Further, they were informed that the Indian Roads Congress or the Members of the Congress serving in the areas where the "Grow More Food" campaign had been launched would be glad to offer technical advice.

Some of the replies received indicated that under the rules governing the financial assistance for the Grow-More-Food Schemes, no funds could be diverted for the construction or improvement of roads. On the other hand, certain States gave the assurance that the suggestions made by the Indian Roads Congress would be given due consideration.

(4) **International Conferences.**

Three delegates of the Indian Roads Congress attended the **International Engineering Conferences** in Bombay and New Delhi in January, 1951.

Minutes of the 39th Council Meeting of the
INDIAN ROADS CONGRESS
Held at Simla on the 30th April, 1952.

The business commenced with Mr. G. M. McKelvie in the Chair.

Present :

M. L. Bahl
R. K. Batra
C. M. Bennett
U. J. Bhatt
Brijmohan Lal
S. N. Chakravarti
N. Durrani
C. J. Fielder
W. A. Griffiths
D. N. Gupta
K. K. Kartha
G. C. Khanna
U. N. Mahida
H. P. Mathrani
M. Meeran
C. P. Misra
K. K. Nambiar
E. A. Nadirshah
D. P. Nayar
D. V. Rao
B. N. Roy
R. C. Roy
J. M. Trehan—Secretary.

The following Co-opted Members attended :

K. F. Antia
H. R. Dhir
Goverdhan Lal
Laxman Swarup
T. Mitra
G. R. Nangea
H. P. Sinha
P. L. Varma
E. Zipkes.

The following attended by invitation :

D. R. Bahl
S. L. Bazaz
P. N. Bhalla
R. S. Bhalla
D. N. Dutta
S. B. Joshi
B. D. Mathur
J. P. Singh
H. Sunder Rao
Sujan Singh

Item 1. Co-options and Invitations.

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

Item 2. Confirmation of the Minutes of the 38th Council Meeting.

The Minutes of the 38th Council meeting held at Simla on the 26th April 1952 were confirmed.

Item 3. Office Bearers.

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

President	...	T. Mitra
Vice-Presidents	...	W. A. Griffiths.
	...	K. K. Nambiar.
	...	P. L. Varma
Honorary Secretary	...	J. M. Trehan.

At this stage, the newly elected President, Mr. T. Mitra, took the Chair.

Item 4. Venue of the next General Session.

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

Item 5. Committees and Subcommittees.

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

(1) Specifications & Standards Committee	...	G. M. McKelvie
(2) Bridges Committee	...	H. P. Mathrani
(3) Technical Committee :		
(i) Test Track Division	...	T. Mitra
(ii) Research Organization Div.	...	H. P. Sinha
(4) Road Transport Subcommittee.	...	E. A. Nadirshah
(5) Education Subcommittee.	...	E. A. Nadirshah
(6) Bituminous Treatment of wet Aggregates Subcommittee.	...	W. A. Griffiths
(7) Highway Layout Subcommittee.	...	U. N. Mahida
(8) Provincialization of Local Bodies Engineering Services Subcommittee	...	B. N. Roy
(9) Papers Subcommittee.	...	G. M. McKelvie
(10) Manufacture of Road-Making Machinery & Mechanization Subcommittee	...	H. P. Sinha
(11) Organization Committee	...	G. M. McKelvie.
(12) Soil-Research Committee :		
(i) Field Experiments and General Division.	...	S. R. Mehra.
(ii) Laboratory Division.	...	E. Zipkes.

2. The Executive Committee were authorised to decide the functions of the two divisions of the Soil-Research Committee.

3. The following additions were made to the personnel of the Committees and Subcommittees named below :—

Road Transport Subcommittee	...	N. D. Daftary
Test Track Division	...	E. A. Nadirshah
Education Subcommittee	...	P. L. Varma
		S. R. Mehra.

The Convenors of the Committees and Subcommittees gave an account of the work done by their Committees during the year.

Item 6. Representation to Part 'C' States on the Council of the Indian Roads Congress.

The Council directed the Executive Committee to consider the question of giving representation to Part 'C' States on the Council and to submit their recommendations.

Item 7. Railway concession to the delegates attending the Sessions of the Indian Roads Congress.

The Executive Committee was authorized to approach the Railway Board or other authority for obtaining travel concession for delegates going to attend Indian Roads Congress Sessions.

Item 8. Panel Discussions.

As Members had evinced a keen desire for panel discussions on important subjects the Council decided that in future the Sessions should if possible be extended by one day, so that more time may be available for panel discussions.

Item 9. Miscellaneous.

(1) The Council was of the opinion that for efficient and uniform road development in the country engineer officers and staff of district boards should be taken over by the State Buildings and Roads departments. To make an effective approach to the Central and State Governments for this purpose the Chief Engineers of States should be requested to examine this question and evolve a workable system which could be recommended for adoption by State Governments. The Organization Committee was directed to deal with this question.

(2) The Council discussed a proposal to recommend to the State Governments to set up Highway Departments in their States. Further action was referred to the Executive Committee.

(3) A proposal to substitute the word "Chairman" in place of the word "Convenor" in the personnel of the Committees/Subcommittees was considered but it was decided to retain the word "Convenor".

Item 10. The Council placed on record their deep sense of the loss sustained by the Indian Roads Congress and the engineering profession in India by the premature demise of Shri R. L. Varma, Chief Engineer, Assam on the 25th April, 1952.

The Council resolved that a message of condolence should be sent to the bereaved family.

Tour Notes of the
SIXTEENTH INDIAN ROADS CONGRESS
Simla, April—May 1952

1. Local Inspections: 29—4—1952

At the invitation of M/s Shalimar Tar Products (1935) Ltd., the delegates visited the work of surfacing with wet aggregates in progress near the Victory Tunnel, Cart Road, Simla.

The demonstrations were to the following specifications:—

Wet Aggregate with Shelmac "D" (renewal coat).

(1) The surface was cleaned thoroughly with soft and steel brushes.

(2) Water was sprinkled over the surface of the road and over the chippings to create wet conditions.

(3) Lime at 5 lb per $\frac{9}{10}$ sft was spread over the wet surface and brushed to make slurry.

(4) Shelmac "D" heated to 300 deg. F. was sprayed at the rate of 23 lb per $\frac{9}{10}$ sft over the wet-limed surface by means of a sprayer.

(5) Wet chippings 3/8 in. gauge were first mixed with lime at the rate of 1 lb per cft and then spread at the rate of of 3½ cft per $\frac{9}{10}$ sft over the surface painted with Shelmac "D".

(6) The surface was rolled and opened to traffic the same day.

1-in. Wet Sand Tar Carpet.

(a) The surface was cleaned with brushes and dusted with gunny bags.

(b) A tack coat of Road Tar No. 3-A, heated to 230 deg. F., was applied at the rate of 18 lb per $\frac{9}{10}$ sft with a Tar Sprayer.

(c) Wet sand was thoroughly mixed with slaked lime at the rate of 1½ lb per cft of sand.

(d) Sand coated with lime at the rate of 7 lb per cft of sand was premixed with Road Tar No. 3-A in open pans and with shovels.

(e) The premixed sand was laid at the rate of 10 cft per ¾ sft.

(f) The surface was rolled with an 8-ton power roller.

Opening to Traffic.

The road should be opened to traffic immediately the carpet has set. This takes as long as 4-5 days in hot weather in the plains but in Simla, it can be opened after 24 hours.

NOTE—The only practical way of premixing wet sand is in a paddle type mechanical mixer The small batches used in the demonstration were mixed in heated pans with shovels but such mixing is uneconomical.

CHANDIGARH—THE NEW CAPITAL OF PUNJAB

(Inspected by the Delegates on the 1st May 1952)

Immediately after the political partition of the country in 1947 the Government keenly felt the need for building a Capital for the State of Punjab in India and also to provide a central nucleus for business, education, and other interests which had been uprooted.

So far the headquarters of the Government have been at Simla. As this station, besides being inconvenient to the public in general and the Government in particular, could not provide the requisite facilities required for proper and effective administration, a site was selected in 1948 close to Chandigarh where building operations are now underway.

The Site.

The site is bounded on the North by the Lower Shiwaliks, on the East and West by the Sukhana Cho and the Patiala Rao and on the South by the PEPSU territory. It has a good climate, is well wooded, and provides beautiful natural surroundings. The average rainfall is about 50 in per year. The chos after being dammed and reclaimed will provide suitable parks and meadows. Most of the building materials are available locally or can be easily manufactured.

While approving the site the Prime Minister of India, Shri Jawahar Lal Nehru, remarked "The site chosen is free from existing encumberances of old towns and old traditions. Let it be the first large expression of our creative genius flowering on our newly earned freedom."

The Master Plan.

The work of preparing the Master Plan for the new city was in the first instance entrusted to the well renowned firm of Town Planners, Messrs. Mayer and Whittlesey of New York. The plan drawn up by them has been modified subsequently as a result of general collaboration between Mr. Albert Mayer, Monsieur M. Le. Corbusier, and the senior architects Messrs. Jeanrette & Fry and Miss Jane Drew engaged by the Punjab Government. This collaboration resulted in considerable changes in the original master plan and in the location of the sites for some of the important buildings.

Major Land uses

The total area proposed to be acquired for the town is 8,919 acres, out of which 5,224 acres will be developed and the balance of 3,695 acres will be treated as undeveloped for the purposes of this project.

The allocation of the undeveloped area of 3,695 acres is as follows: 336 acres for industrial development; 110 acres for the Engineering College; 306 acres for the Punjab University; 2,943 acres for green belts, parks, etc.

The land-usage for the developed area of 5,224 acres is as below:

1.	Secretariat, High Court, Capital and Government House including parking ...	220	acres	4.3%
2.	Hospital sites. ...	96	,,	1.8%
3.	Public Buildings. ...	192	,,	3.7%
4.	Main commercial centre and District Offices. ...	166	,,	3.2%
5.	Roadside Commercial Buildings and Reservation.	235	,,	4.5%
6.	Town Hall. ...	28	,,	0.5%
7.	Area of District centre. ...	58	,,	1.1%
8.	Parks and Parkways (Central Park).	609	,,	11.6%
9.	Main Roads. ...	412	,,	7.9%
10.	Sectors (Residential, including local parks, school roads inside sectors). ...	3,208	,,	61.4%
		5,224	Acres	100%

The roads for fast-moving traffic occupy an area of approximately 240 acres. Housing communities range from a maximum of 15,000 persons to a minimum of 1,200 persons in the upper class sectors. Each sector provides all the necessary amenities for its inhabitants.

Architectural Control.

The Government is contemplating to build a large number of houses and public buildings according to the standards to be laid down by them. All buildings undertaken by private enterprise will have to conform not only to the standards of buildings, sanitation and hygiene as set out in the building bye-laws, but also will have to be got approved by the Architectural Branch of the State P.W.D.

Allocation of Cost.

The entire cost of the project has been split up into two subheads (a) the Development Costs and (b) the costs of works which are a direct charge on the State.

In category (a) are grouped the following :—

(1) Survey and Land Acquisition.

(2) Communications—Roads and Railways.

(3) Water Supply—Domestic and Irrigation.

(4) Drainage and Sewerage.

(5) Temporary supply of electricity

(6) Landscaping and Horticulture.

(7) Construction of Dam over Sukhana Cho.

(8) Community Buildings and Civic Works.

(9) Contingent charges.

In category (b) are included the following :—

(a) Unproductive works consisting of Government Offices, High Court, Assembly Chamber and Government House.

(b) Residential Buildings for Government servants, quarters for M.L.As. and Chambers for Advocates of High Court.

Survey and Land Acquisition :

As the area had hitherto been unexplored detailed surveys were not available. Arrangements were made for an aerial survey

of the site. On the basis of this detailed survey, contour maps were prepared by the Survey of India. Proposals for land aquisition included the barest minimum area required for the construction of the town. Land acquisition also involved several other problems, e.g., the evaluation of the existing lands and buildings to be acquired and the re-settlement of the dispossessed in the adjoining areas. A considerable amount of agitation prevailed in the initial stages of the project over land acquisition but this was finally got over.

Communications—

(*a*) *Roads.*

The road system of the State is being replanned so as to provide a focus on to the New Capital. Several arterial communications have been provided which will make the Capital easily accessible from almost all districts of importance in the State. The three main arteries are :

(1) Main approach from the railway station to the city centre and beyond to the University.

(2) The main arterial approach road passing through markets, administrative and city centres.

(3) The main approach road from Ambala to the centre of the full city development.

These roads will be wide enough to accommodate all types of traffic and will have frontages reserved for business and commercial buildings.

The internal communications of the town have also been very carefully planned with respect to their functional aspects. Their layout has been so arranged as to provide reasonably self-contained neighbourhoods and at the same time to minimise the peak-load traffic. In order to afford maximum efficiency, safety, and pleasure, to each road user, traffic with different characteristics has been segregated as far as possible.

The total cost of the roads is estimated at Rs 128.06 lakhs which includes not only the cost of the links but also cost of the city road, the footpaths and cycle tracks, roads in the industrial area, arboriculture, bridges and culverts, etc., etc.

(*b*) *Railways.*

The Railways have carefully surveyed the possible re-alignment of the broad gauge line from Ambala to Kalka so as to bring the new city on to it. This has been agreed to and the work is

likely to be taken in hand in the near future. Suitable provision for the cost of this diversion has been made in the estimate but it is hoped that when the line becomes remunerative from the railway's point of view, the railway will pay the cost.

Water Supply—

Provision for water supply for domestic purposes for a population of 1,50,000 has been made in the estimate at 30 gallons of water per head per day. The water supply will be from the tube-wells, a good number of which have already been taken in hand. The distribution will be done by G.I. Pipes. The design provides a continuous supply of water to the town with adequate storage facilities and a good tail pressure. The cost of the domestic water supply is estimated at Rs 108 lakhs and that for irrigation supply is estimated to be Rs 58.9 lakhs, the total cost being Rs 167 lakhs. The consumption of water will be charged on a meter basis for domestic supplies and on an acreage basis for irrigation supply. It has been estimated that at the rates proposed to be charged the return will be 4.82% which justifies the expenditure on this part of the scheme being termed "Remunerative."

Drainage—Storm Water and Sewerage.

In the heavily populated areas storm water will be taken care of by sewers in exceptional cases whereas in other areas by open drains.

As good drainage facilities exist at this site on account of the natural steep slopes, the entire storm water drainage problem is expected to be tackled efficiently at a modest cost of Rs 63.5 lakhs.

A completely water-borne sewerage system is proposed to be designed for the town with self-contained disposal works. The total cost of this system is estimated at Rs 129 lakhs (with temporary disposal works).

The total cost of the drainage scheme is Rs 192 lakhs.

The Sukhana Cho Dam

In order to reclaim the Sukhana Cho which borders the Eastern side of the town, it is proposed to construct a small earth dam at a cost of Rs 58 lakhs. Nearly 2,000 acres of land are intended to be reclaimed after this dam is constructed.

Community Buildings.

A new town of the type proposed to be constructed requires a large number of community buildings and no efforts have been

spared in providing these. The following important buildings are proposed to be constructed :—

	Cost in Rupees
Civic centres such as Municipal Offices, Town Hall, Public Library, Museum and Picture Gallery.	19.50 lakhs
Educational Buildings consisting of a nursery, Middle and High Schools, two Colleges for men and women, a Veterinary College and Hospital, and a Polytechnic Institute.	125.85 ,,
Medical Buildings consisting of a 100-bed hospital, five health centres and one Maternity Hospital.	54.80 ,,
Miscellaneous buildings like a Sarai, Community Centres, Swimming pools, Stadium and other essential buildings.	24.15 ,,
Total	224 lakhs.

Development Cost.

In the development of a new city of the type visualised all items of expenditure that cater for the daily or periodical needs of the citizens individually or collectively as a community have to be considered as a legitimate charge on the development costs of the land. Where, however, services are rendered on a commercial basis like railways and electric and water supply, these utility services have not been considered a part of the development charges. The items which are taken as constituting the development charges are as below :

(a) Survey and Land acquisition.

(b) Road Communications.

(c) Drainage and Sewerage.

(d) Temporary Electric Supply.

(e) Landscaping and Horticulture.

(f) Dam over the Sukhana.

(g) Railway siding.

(h) Community buildings and Civic works.

(i) Contingent charges on a proportionate basis for establishment, etc.

The total for all these items aggregate to Rs 337.6 lakhs and, as the gross total acreage under the scheme is 8,919, the development cost per gross acre comes to Rs 9,367.

Plot Values.

Besides the areas reserved for residential accommodation for Government servants, a large number of plots will be needed by public and the success of the scheme will depend on public co-operation. No straightline formula can be evolved for assessing the values of plots for residences, shops or other areas but a reasonable means has been struck after taking the various factors into consideration.

The prices which are proposed to be charged for the residential areas are detailed below :—

5-Marla Plots.	Rs 1,500/ each.
10-Marla plots.	Rs 2,500/ ,,
1-Kanal Plots.	Rs 4,000 ,,
2-Kanal Plots.	Rs 6,000 ,,
4-Kanal Plots.	Rs 10,000/ ,,
6-Kanal Plots.	Rs 14,000 ,,
8-Kanal Plots.	Rs 18,000/ ,,
10-Kanal Plots.	Rs 22,000/ ,,

(Each Marla equals 25 sq. yards and each Kanal equals 500 sq. yards.)

The prices of plots in the shopping and commercial areas will, however, be considerably higher depending upon the location of the plot and the use to which it will be put.

The large areas which are proposed to be given to the University and the Punjab Engineering College have also been suitably priced.

It is intended to realise in the first year 25% of the value of the plots to be sold to the public. The balance will be recovered in three equal annual instalments with interest at the rate of 4½% per annum. The total number of plots available for residential purposes is just over 20,000 and the return expected from the sale thereof is Rs 628.83 lakhs.

CONSTRUCTION OF CAPITAL FOR PUNJAB AT CHANDIGARH

GENERAL ABSTRACT OF COST

				Rs in lakhs.
1.	Cost of Land Acquisition and Surveys.			101.14
2.	Cost of Internal Roads and Bridges.			128.06
3.	Cost of Domestic Water Supply.			107.83
4.	Cost of Irrigation Water Supply.			58.88
5.	Cost of Storm Water Drainage			63.5
6.	Cost of Sewerage.			128.73
7.	Cost of Landscaping			21.77
8.	Additional charges for supply of Electricity			20.00
9.	Cost of Civic Works			224.30
10.	Cost of non-productive Government Buildings			286.31
11.	Cost of productive Government Buildings			270.00
12.	Cost of Dam across the Sukhana			58.00
13.	Cost of Railway siding			25.00
14.	Contingent charges—			
	(a) Establishment	114.0		
	(b) Research	10.0		
	(c) Machinery T. & P	32.0		
	(d) Machinery for Public Health Works.	12.0		168.00
				1664.52
Deduct :				
	(a) Credit for Machinery.	32.0		
	(b) Credit for Public Health Machinery.	12.0		(–) 44.00
Net Cost.	...	...		1620.52

THE BHAKRA—NANGAL PROJECT

(Inspected by the Delegates on the 2nd May, 1952. The Northern Railway kindly arranged to run a Special Train from Kalka to Delhi via Nangal Dam.)

General :

The Bhakra-Nangal project, India's greatest and one of the biggest single hydro-cum irrigation-projects in the world has been planned to service about 6.5 million acres of farm land and to yield a total of 4,00,000 kw of electric power. On completion, it will provide power and extra irrigational facilities to a large portion of the Punjab and the adjoining States of PEPSU and Rajasthan. The total cost of the project is estimated to be Rs 127.3 crores.

The Bhakra Dam was conceived in 1908 and finalised in 1919 while the Nangal Dam was planned in 1946. First construction operations were started on both the dams in 1946. A serious setback was, however, received by the project as a result of the political partition of the country in 1947 and a fresh start could not, therefore, be made till 1948. The project had to be revised and the present work is being carried out according to the revised scheme.

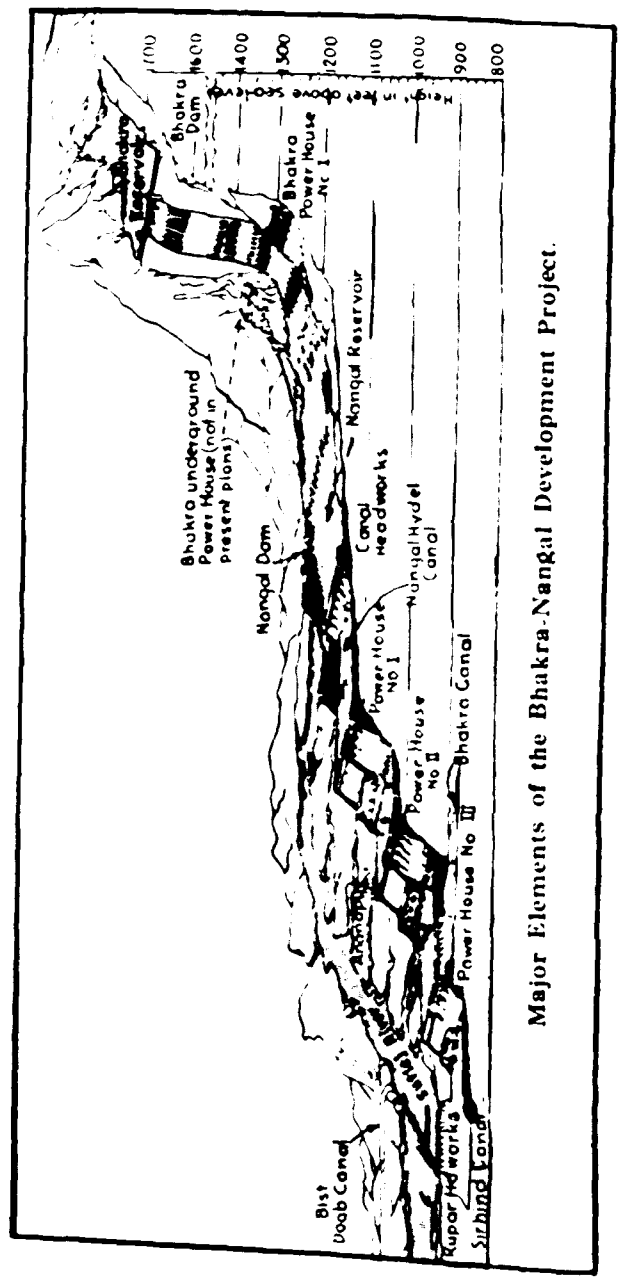
A view of the Sutlej showing the suspension bridge.
(Photo by Courtesy—Dr. E. Zipkes, Director, C.B.R.I., New Delhi)

The Present Stage of Work :

Up to now, construction operations on the project have been entirely preparatory in so far as the Bhakra Dam is concerned. These have included the building of access roads and a 40-mile rail line from the nearest railhead at Rupar, development of housing colonies, driving the diversion tunnels (now about two-thirds complete), and some abutment scaling. Elsewhere on the project, the Nangal Dam has been brought to virtual completion. The excavation of the power canal and building of some 40 siphons and aqueducts to carry intersected streams across the canal are under way, as is also work on the two cannal power-houses. As soon as the steel gates can be installed in the twenty-six 30-ft wide bays of the Nangal Dam, it will be ready for use. The canal headworks, also a low dam with eight 24-ft wide openings located adjacent and approximately at right angles to one end of Nangal Dam, are complete.

THE BHAKRA DAM

The dam on the river Sutlej at Bhakra gorge will be 680 ft high above the deepest foundation and will be a straight gravity dam. The total capacity of the reservoir will be 7.4 million foot acres of which 5.73 million foot acres will be utilizable storage.



Major Elements of the Bhakra-Nangal Development Project.

(With acknowledgments to the Engineering-News Record, March 27, 1952.)

The length of the lake will be about 56 miles and the area will be about 38,000 acres.

Before the dam can be constructed the existing flow of the river including that during the floods has to be diverted through the two tunnels—one on either side of the river. These tunnels are half-mile long each and will be 50 ft diameter when finished, but the excavated diameter is 60 ft. The strata met with in these tunnels ranges from jointed sandstone to indurated clay

Entrance to a tunnel.

(Photo by courtesy—Dr. E. Zipkes, Director, C.B.R.I., New Delhi)

The top width of the dam is 30 ft whereas the base width is 575 ft. The downstream face has a slope of 0.8 to 1.0. The upstream face is vertical upto a depth of 350 ft from the top and then slopes at 0.35 to 1.0 up to the toe. The dam will be equipped with the usual system of drainage in the foundations and inspection galleries.

Diversion Tunnels: The construction of two diversion tunnels is the first step towards the completion of the dam. As already indicated the inside diameter of the excavated tunnel is 60 ft and the finished diameter will be 50 ft. The maximum velocity anticipated in these tunnels is 50 feet per second and the maximum capacity of both the tunnels is 2,75,000 cft per second. This capacity corresponds to a flood of 21 years' frequency. These diversion tunnels are, in fact, the largest ever constructed so far in such a difficult strata as is met with on the Bhakra gorge ranging from jointed sandstone to indurated clay. The design of these tunnels is based on model experiments carried out in the U.S.A., data collected during the course of geological

investigation at the site, and a detailed survey of the gorge as carried out in 1948–49. As the velocities through the tunnels during the floods will be very high, even a small kink in the alignment can play havoc during operation. The alignment has, therefore, been checked and re-checked with the precision theodolites on completion of the pilot headings.

Tunnelling The pilot heading through each tunnel was absolutely necessary for thorough investigation of the strata, correct alignment and proper design of the supporting ribs. The general plan followed for excavating the tunnel was to enlarge from an 8 × 10 ft pioneer bore, holed through earlier as a part of the foundation exploration. Driving is from both ends of the half-mile long tunnels. Drilling for these headings was done with the help of pneumatic hammers which was supplemented by blasting with the aid of high explosives. The strata encountered with varies from place to place and therefore, full face blasting was not possible. The debris was removed by a 2-ft narrow gauge track carrying 1 cubic yard push tip wagons worked by manual labour.

Work in progress at the mouth of a tunnel.
(Photo by courtesy—Dr. E. Zipkes, Director, C.B.R.I., New Delhi.)

Artificial ventilation was provided from each face of the pilot heading which forced fresh air through an air duct. After the completion of the pilot heading and before its enlargement, proper flood protection work in front of all the 4 faces of these headings were constructed to prevent the flood water entering the tunnels during the monsoons. The enlargement is carried out by putting in steel ribs spaced 2 to 4 ft apart at the centre and supporting the top. After necessary compacting of the top, the side trenches are made about 10 ft deep so as to fix the curved segments on each side. A complete ring of 10 ft length is concreted by means of 'pumpcrete' using about 700 cft concrete in a 10 feet length of the arch. In each ring of 10 ft width, 5 grouted pipes are inserted before concreting so that any inter-space left between the concrete and the excavated rock may be filled up with cement grout. The initial grouting is done at a pressure of 30 lb per sq. inch.

After completing the concrete roof the mass excavation of the central portion will be easy and can be accomplished quickly by means of shovels and trucks. This method ensures full protection to the labour working inside the tunnel. The concreting of the invert of the tunnel is done with the help of a travelling gantry, after fully excavating the bottom.

The maximum progress in the pilot heading was 10 ft a day on either face, but the progress so far achieved on enlargement is 5 ft to 6 ft a day.

Main Features: The main features of the Bhakra Dam are given below :—

Height.	...	680 ft
Length at Road level.	...	1700 ft
Width at top.	...	30 ft
Length of lake.	...	56 miles
Area of lake.	...	38,000 acres.
Reservoir level above sea.	...	1,680 ft
Reservoir capacity.	...	7.4 million acre ft
Utilisable storage.	...	5.73 -do-
Spillway capacity	...	4,00,000 cusecs.
Outlet capacity.	...	1,17,000 cusecs.
Excavation in dam and abutments	...	2.8 Million Cyds.
Total Concrete.	...	5.12 -do-
Installed capacity (Power house No. 1).	...	4 units of 93,200 KVA each.

THE NANGAL DAM

The Nangal Dam is a low concrete dam and is located 8 miles downstream of the Bhakra Gorge. It is primarily intended to feed the Nangal Hydel Channel on which 3 Hydro Electric Power stations of a maximum generating capacity of 1,64,000 kw are situated.

In the pre-Bhakra stage it is proposed to set up two sets of 24,000 kw whereas in the post-Bhakra stage there will be 3 sets of 24,000 kw. Until the Bhakra Dam is complete, these will operate on the water impounded daily in the Nangal reservoir. More appropriately they will be run-of-river plants.

This dam is designed as a concrete barrage across the river Sutlej with a clear waterway of 780 ft provided by 26 bays of 30 ft each, separated by 7-ft wide piers. The overall length of the dam between the two flanks is 955 ft. The height from the bottom of the foundations to the top of the breast wall is 95 ft and the length of the impervious floor is 338 feet.

The principle data and quantities are given below:—

Maximum Flood Discharge of the river Sutlej at Nangal.	...	3,50,000 cusecs.
Anticipated Highest Flood Level.	...	1140.00
Low Water Level	...	1101.00
Maximum Pond Level.	...	1154.00
Lowest Foundation Level.	...	1065.00
Average width of the river.	...	1000 ft.
Slope of the river.	...	1/700
Storage capacity of the Balancing Reservoir.	...	24,000 ft Acres
Authorised Full Supply Discharge of the Canal at the Head.	...	14,500 cusecs.
Concrete.	...	70,00,000 cft.
Shingle.	...	70,00,000 cft.
Sand.	...	40,00,000 cft.
Cement.	...	10,00,000 bags.
Steel.	...	2,000 tons.
Cost.	...	Rs 3,18,84,000

The maximum progress of concreting achieved on a single day was 52,152 cft. on 27-5-50.

Foundations: Before the actual construction was started the strata was carefully checked by means of core drills. It was found to consist of thick layer of sand-conglomerate below R. L. 1069.0. Although the depth of conglomerate was generally quite great, absolute reliance on its impermeability and strength could not be placed because of the interlocked laminations of sand which were met with at different levels and which could get washed away in the course of time. As no risk on such foundations could be taken, it was finally decided to design the dam as if it were resting on sandy foundations. The foundations of the piers go down to sound conglomerate in all cases while the work down-stream of the curtain walls rests on gravel.

The dam is built of mass concrete and is separated from the up-stream floor, the down-stream floor, and the flank walls by means of expansion joints of "V" shaped copper plates. This had been done to prevent the possibility of any cracks occurring due to unequal settlement of the foundations or variation in temperature and also to maintain the effectiveness of cut-offs.

Sub-surface Flow : Uplift Pressure—The uplift pressures have been worked out on the theory of independent variables. In place of the usual sheet piles, concrete curtain walls have been provided in the open trenches. The deepest curtain walls has been securely keyed to the underlying layer of conglomerate in which cement was injected under pressure to ensure homogeneity and also to increase the effective depth of the curtain. Four curtain walls have been provided. The details were seen at the site. A net work of subsurface drainage has been provided from the down-stream end of the top curtain wall to the tail end of the impervious floor. These are led into two main drains, one down-stream of the inspection gallery and the other just down-stream of the central curtain wall. To reduce the entry of seepage from the up-stream end of the impervious floor, a shroud of clay puddle has been provided on the up-stream curtain wall. Also, a 2-ft thickness of compacted clay has been provided all along under the up-stream floor and it is hoped that this arrangement will not only arrest seepage, but will prevent the development of indeterminate conditions consequent on the occurrence of any local cracks on the up-stream floor.

Drainage and Inspection Gallery: As the dam will be subjected to a differential head of 53 feet and has a large mass of concrete under the crest, it was considered desirable to provide inspection facilities in the body of the dam to watch the occurrence of any cracks due to seismic forces, and to trap the flow of water leaks. To that end, a drainage and Inspection gallery 5 ft 7 ft has been provided 67 ft below the pond level and 25 ft

below the crest level. This gallery can be approached from the left flank by means of an inclined approach and from the right flank through a shaft which will be fitted with an electric lift. The right flank has also got an inspection gallery running along its length at the same level as the gallery in the Dam.

In the gallery, open drain pipes go down to the foundation every 10 feet and grout pipes every 5 feet. The drain pipes are provided to trap any seepage flowing under pressure and lead it into the drain along the upstream face of the gallery, which ends into sumps one in either flank from where the water will be pumped back into the river. These will not only provide a pressure release, but also indicate the points of weakness. High pressure grouting can be done through grout pipes to close the faults and to save the structure from possible damage.

Pressure Observation Pipes: In order to watch the uplift pressure at the various points across the section of the Dam, 9 points will be kept under observation in every fifth bay, and 3 points in each bay. Standard practice has been followed in providing 3 ft 1½ in.-diameter filters at the points of observation.

Piers: The main piers are designed to stand the full hydraulic thrust of the ponded up water as transmitted by the gate and the breast wall, a differential head of 10 ft between the two adjacent bays, the load of the road bridge, the railway bridge, the superstructure, the bulk-head-gate bridge, and their own weight.

The road bridge has been designed for the "I.R.C. Class AA" loading It is 22 ft wide with 5 ft side walks on either side and built with pre-cast I-beams of reinforced concrete which have been placed alongside each other and then covered up with 4½ in. thick of R. C. Slab and a 3 in. wearing coat. Details of this bridge were examined at the site.

Construction:

Excavation work was started in January 1948, the first bucket of concrete was poured on the 28th April 1948. The left half of the dam was completed by March 1949. The excavation of the right half was started after the floods of 1949. As more machinery had since been procured, almost all the excavation in the right half was done by draglines and shovels assisted by Euclid trucks, dumpers, and bulldozers. The progress attained during excavation was nearly 1 lakh cft per day.

Pumping on the job was also modified by draining of all the seepage into a central pumping station wherefrom pumping was as much as 38 cusecs in a single stage. This is a record seepage

discharge dealt with at any headworks in India The pumping arrangements have been quite effective and the whole of the working area was kept dry

Concrete Mixing Instead of following the usual practice of batching concrete by volume, proportioning by weight was adopted, special batching plants being used for the purpose Laboratory tests of the strength of concrete indicated considerable uniformity. The use of extensive machinery on the job resulted in a considerable saving in cost and added to the speed of construction The maximum rate of concreting achieved in a single day was 52,000 cu.ft.

On this job extensive use was made of compressed air for running the paving-breakers, jack hammers, pressure grouting machines, sump pumps, concrete vibrators, chippers and grinders. The total consumption was as high as 1,600 cu.ft per minute.

DABATWALI & DONALI BRIDGES—RUPAR-GUZAR-NANGAL ROAD

(Inspected by the Delegates on the 2nd May, 1952)

The bridges on the Dabatwali and Donali Khuds are of the balanced cantilever type. The Dabatwali bridge has five spans and the Donali bridge four spans, each of 65½ ft, centre to centre The length of the end cantilevers is 13 ft and that of the suspended spans 39½ ft (see longitudinal section at page 499). The Dabatwali carries a discharge of 16,500 cusecs and the Donali 15,000 cusecs.

The overall width of the superstructure is 23½ ft, the carriageway being 22 ft, with a 9-in kerb on each side.

Each pier rests on a circular well of 18 ft outer diameter and 4 ft thick steining of 1 : 3 : 6 cement concrete. The wells are plugged with 1 : 3 : 6 cement concrete at the top and bottom with a hearting of sand. The well caps are reinforced concrete (1 : 2 : 4). The piers are of 1 : 5 : 10 cement concrete faced with brickwork in cement.

The superstructure consists of 4 T-beams, with an 8-in. R. C. slab, surfaced with a 1½-in thick premix carpet (see cross-section at page 500).

The bearings consist of 1/8-in. copper plates over ½-in. M. S. plates.

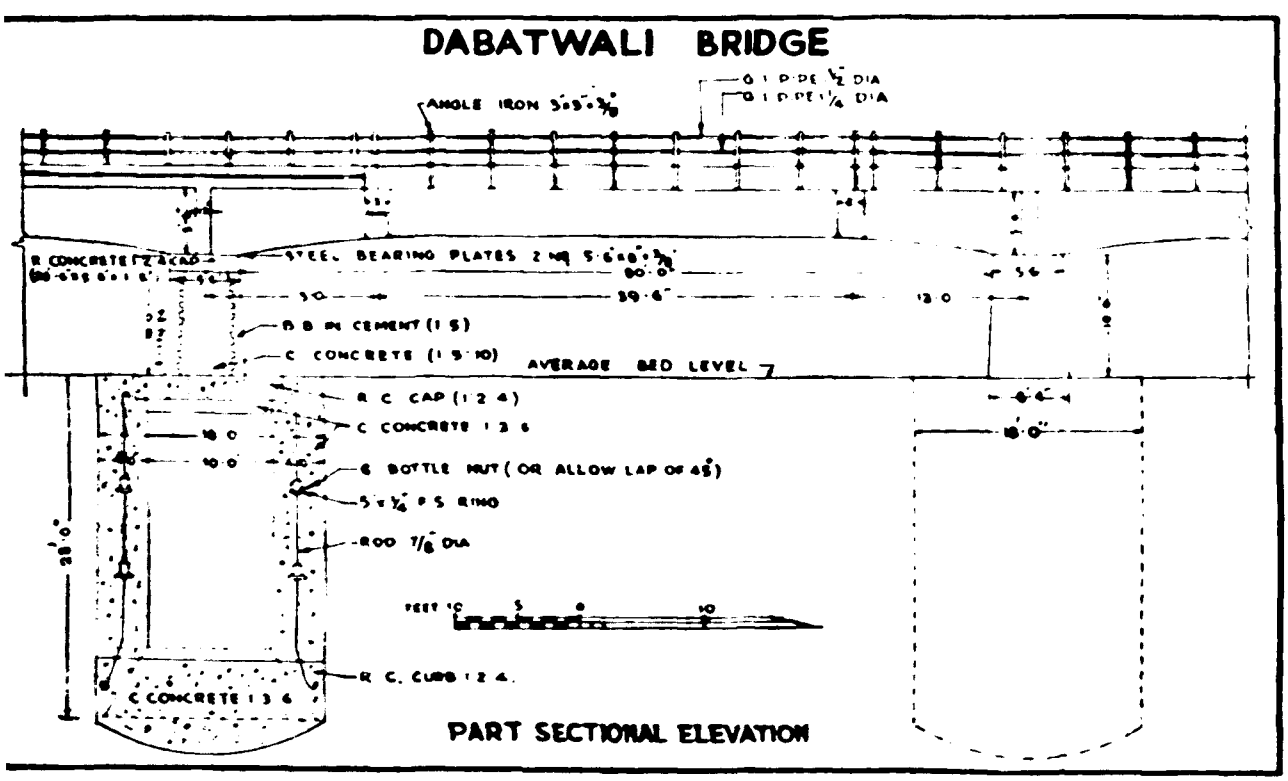
The bridges were designed departmentally and built on contract.

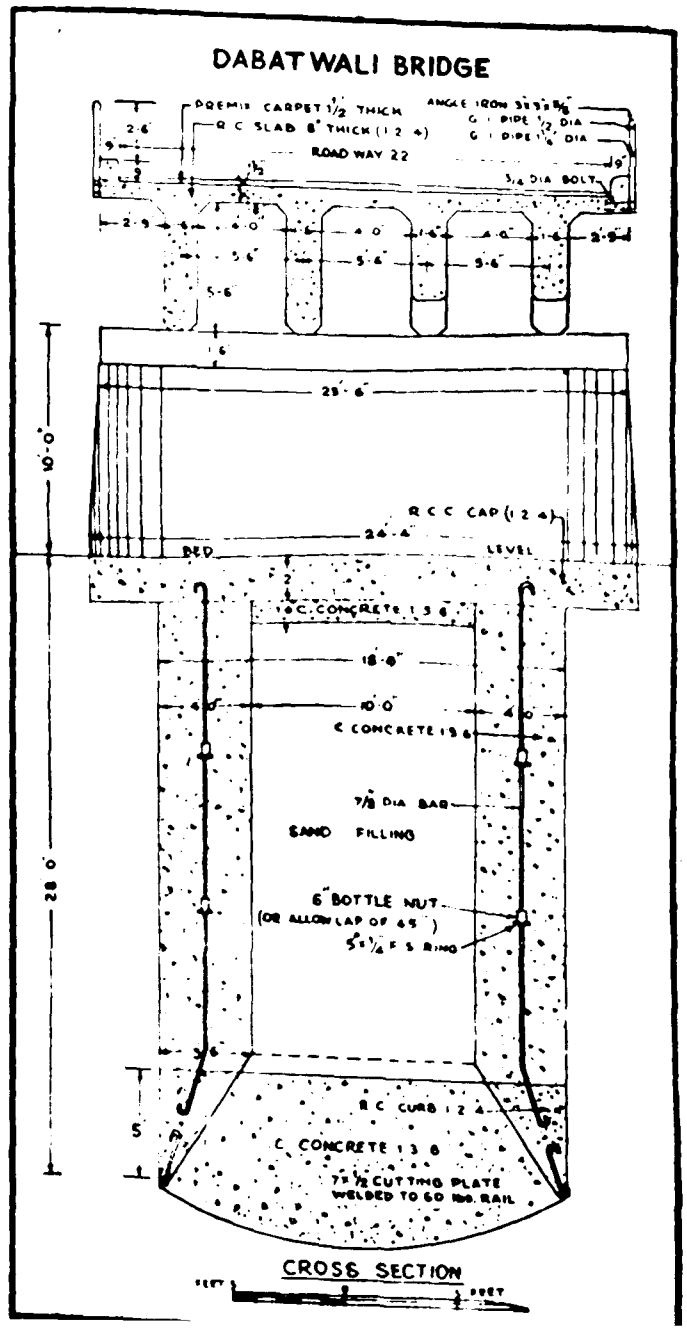
The Dabatwali bridge cost Rs 375,200, or Rs 1,097 per running foot. The corresponding figures for the Donali bridge were Rs 217,700 and Rs 837 per running foot.

Further data are given in the Table below.

DABATWALI AND DONALI BRIDGES

Sl. No.	Particulars	Dabatwali	Donali
1	Year of construction	1948-49.	1948-49
2	Nature of banks	Well defined sandy clay	Well defined sandy clay.
3	Nature of bed	First 6 ft sandy, 7 to 28 ft sand mixed with shingle and boulders	Sand mixed with shingle.
4.	Cost : Total Rupees	375,200/-	217,700/-
	Per running Foot : Rupees	1,096/11/-	837/5/-
5.	H. F. L. Maximum	1022.50	1047.00
	Actually observed	1022.50	1046.50
6	Maximum depth of scour in the natural channel under H. F. L.	10 ft	7 ft by Lacey's or 10 ft by Brown's formula
	Expected	5 ft	12 ft
	Observed	...	8 ft near Right abutment
7.	Average velocity under bridge, ft per second	11.	10.
8.	Discharge through the bridge, cusecs	16,500.	15,000





Sixteenth Session of the

INDIAN ROADS CONGRESS

Technical Exhibition, Simla, April-May 1952

The technical exhibition which has come to stay as a regular feature of the Annual Sessions of the Indian Roads Congress was organized on the open space at the Ridge which is one of the busiest spots in Simla.

The exhibition was declared open on the 27th April by the Hon'ble Chowdhury Lehri Singh, Minister for Public Works, Punjab. The Minister was later conducted round the stalls

Madras showed some good road & bridge models. This photo shows a model of the Pugalur Bridge.

(Seen in the photo are, L to R: Shri Brijmohan Lal, Chief Engineer, Punjab; Hon'ble Shri Lehri Singh, Minister for Public Works, Punjab and Shri G. M. McKelvie, Road Development Adviser to the Govt. of India and President of the Congress.)

Speaking on the occasion, the Minister observed that it was gratifying to note that the Indian Roads Congress had not confined itself only to the theoretical aspects of its activities, viz., discussion of Papers, meetings of the committees and sub-

committees, etc., but had also organized this technical exhibition which brought home to the layman what road construction and maintenance meant and what status roads had in the economy of the country. Continuing, the Minister said that such an exhibition would enable the general public to appreciate what the road engineers were doing to improve roads which were a **sine qua non** of any form of development in the country.

The citizens of Simla and the delegates showed a keen interest in the exhibits which included models, photographs, and explanatory charts of roads and bridges; and machinery and materials used for the construction of the modern roads.

The following organisations took part in the exhibition. Brief particulars of the exhibits are recorded below:

1. Government of India

Roads Organization:

(1) *Statistical*—Statistical and Graphical presentation of data of road accidents, etc. Chart showing the Organization of the Ministry of Transport.

(2) *Standards*—Standards for Vertical and Horizontal Curves. Improvements to road junctions.

(3) *General*—Charts entitled "Roads for Tomorrow" as programmed in the Nagpur Plan; Sample copies of periodicals received in the library of the Roads Organization.

2. Punjab

The Buildings and Roads Research Laboratory, Karnal, exhibited:—

(1) Charts illustrating properties of soils;

(2) Samples of Indian soils;

(3) Models of stabilized soil, base courses and wearing courses, surfaced and unsurfaced;

(4) Soil testing apparatus;

(5) Samples of stones etc. as found and used for the construction of roads in the Punjab.

3. Madras

Cross Sections of

(1) a stabilized road constructed in a sandy tract;

(2) a stabilized Major District Road constructed in a Black Cotton Soil area;

***Models*:**

(1) a model of the prestressed concrete bridge across the River Palar (N.H. No. 46);

(2) a model of a precast and prestressed concrete beam;

(3) a model of the continuous T-beam bridge across the River Cauvery at Pugalur (N.H. No. 7);

(4) a model of a Mobile Laboratory for testing cement concrete

Plant, Machinery & Apparatus:

Soil testing apparatus manufactured by the Madras Highways Department was also exhibited.

4. West Bengal

(1) A model of the road test track, Alipore, Calcutta

(2) A model of the tractor with test carts (mobile test carts).

(3) Models of 1950-1951 test specimens.

(4) An album of photos showing 1950-51 tests.

(5) Explanatory photographs (selected and enlarged) showing the 1950-51 tests.

(6) Charts and diagrams depicting the results and conclusions of tests carried out in the past.

(7) A photograph showing a bird's eye view of the Test Track.

(8) Road Development plans of West Bengal

5. Himachal Pradesh

Road Development plans

Photographs of bridges, etc.

6. State Transport, Bombay.

Spare parts for motor vehicles manufactured by them

Models of structures.

Literature and Photographs.

Layout of Workshops, Depots, Bus stations, etc

Firms

M/s. Armco (India), Ltd., Calcutta
M/s. B. K. Khanna & Co. Ltd., New Delhi
M/s. Bengal Chemical & Pharmaceutical Works Ltd., Calcutta
M/s. Burmah Shell Oil Storage & Distributing Co. of India, Ltd., New Delhi
M/s. Concrete Association of India, Ltd.
M/s. Greaves Cotton & Co., Ltd., Bombay
M/s. Hindustan Construction Co., New Delhi
M/s. Kailash Brothers, Delhi
M/s. Killick Nixon & Co., Ltd., Bombay
M/s. Larsen & Toubro, Ltd., Bombay
M/s. Millar's Timber & Trading Co., Ltd., Bombay
M/s. Mousell & Co., Ltd., Bombay
M/s. Shalimar Tar Products, Ltd., Calcutta
M/s. Tata Iron & Steel Co., Ltd., Jamshedpur
M/s. Tractor & Equipment Corporation, Ltd., Delhi
M/s. Tractor (India), Limited, Calcutta
M/s. Wilcox (Buckwell-India), Ltd., Delhi
M/s. William Jacks & Co., Ltd., Calcutta

Displayed Catalogues, Charts, Photos, Models. In some cases actual machinery for the construction of drainage, latest type of surveying and mathematical instruments, testing machines, etc., etc.

LECTURES, PANEL DISCUSSIONS, & TECHNICAL FILMS.

Lectures :

An interesting talk on "Causeways or Submersible Bridges" was given by Dr. S. P. Raju, Director, Engineering Research Laboratories, Hyderabad (Deccan) on the 27th April 1952. The talk was later followed by a film.

Another interesting talk on the "New Punjab Capital at Chandigarh" was given by Shri P. L. Varma and Miss Jane Drew on the 29th April 1952.

Panel Discussions :

In order to exchange views on the practice adopted in India for the construction of cement concrete pavements and to take stock of the experience of various members, a panel discussion was arranged on the 29th April 1952. Earlier, a brief questionnaire to form a basis for the discussion was circulated. It is intended to make such Panel discussions a regular feature at the Sessions of the Indian Roads Congress.

Technical Films :

In the evenings technical films connected with highway engineering were shown.

—

Discussion on Paper No. 156.

"Vertical Curves for Highways."*

By

THE SPECIFICATIONS & STANDARDS COMMITTEE OF THE INDIAN ROADS CONGRESS

Sunday, April 27, 1952.

Shri H. P. Mathrani, (Chairman) calling upon Shri H. Sunder Rao to introduce the Paper said that in the past the subject 'vertical curves' had not received attention mainly owing to traffic being confined to the slow moving carts using the road. Even though motor vehicles had come to use Indian roads long time back, their number was small and was mostly confined to cities. It was only recently that fast moving vehicles had taken to roads of all types and were therefore a very important factor in present day road design. A Paper on horizontal curves was presented to the Congress by the Specifications and Standards Committee earlier and the present one was a supplement of that Paper. The Paper together with the Paper on horizontal and transitional curves gave an idea of the geometric standard required for modern traffic.

In his opinion speed on causeways must be reduced to prevent the danger of the driver of a vehicle entering into flood water before he can pull up. He thought that the suggested speed of 50 miles per hour in problem No. 4 given on page 60 of the Paper was hazardous. He suggested that the gradients to the approaches to the causeway should be about 1 in 12, thus reducing the speed.

Referring to bridge approaches Shri Mathrani said it was not necessary to restrict speed on the approaches.

Shri H. Sunder Rao introducing the Paper on behalf of the Specifications & Standards Committee said that in the early days of road designs in India specifications were vague and the problem of curvature both horizontal and vertical received special attention only with the development of high speed traffic. A number of authorities had shown how various forms of curves could be designed to suit modern traffic. He hoped that Prof. Hart, the

* Published at pagas 22 to 76 of Vol. XVI-1 of theurnal oJof the Indian Roads Congress, November, 1951.

Vice-Chancellor of the Roorkee University and the joint Author of a text-book by Collins & Hart would give the benefit of his comments on the Paper.

The Committee had considered all the available literature on the subject and had evolved designs considered suitable for Indian conditions. Briefly stated the procedure of design was as under: After plotting the longitudinal profile of the ground on which a new road was to be constructed or of the existing road to be regraded it was customary to draw the grade line keeping in view the standards regarding grades. The chief consideration in fixing the grade line, among others, was the balancing of cut and fill, not the balancing of the physical quantities but of economical balancing and the consideration of any adjacent water level and drainage.

Any change from one grade to another had to be affected through a curve which had properties affecting safety, speed, and comfort of travel. It was a common experience that while travelling on curves convex upward the centrifugal force acted in opposition to gravity and on concave curves in unison with gravity. Also on a summit curve (convex upward) the rising ground in front prevented the driver having a view of the road beyond. Therefore, provision of a curve which gave adequate sight distance was very important. In a valley curve the whole valley was open to view and so the provision of adequate sight distance was not a consideration except for night driving.

The Paper, he said, explained why a square law parabola had been chosen for the summit curve and the cubic parabola for the valley curve. Equations in sections 4 and 5 and Plates I to IV gave complete details of the design of the curve. In section 6 worked out examples were given showing how the principles advocated in the Paper could be used to everyday problems, such as bridge approaches, causeway approaches etc. Plates V and VI gave curves and a nomogram for the design of approaches to low culverts where the height of roadway did not obstruct the view across the humps.

The minimum length of a summit curve to provide adequate sight distance for a design speed was a function of the total change of grade and the speed (equations 7-11, pages 35-36). The desired standard was secured by providing adequate length of a curve. Where the provision of an adequate length involved either uneconomic cuts or fills or could not be secured due to terrain limitations it might be possible to reduce the grade so as to enable the desired speed to be secured as shown in problem 2 (page 57). In such cases the readjustment of the grade had effect

on the adjacent section of a road and the grade line had to be so fixed to secure best operating conditions.

A factor which had not been mentioned in the Paper was night visibility. It was an observed fact that night speeds were considerably less than speeds that were possible during day. Data based on observations under Indian conditions were lacking. It was suggested that speeds of the order recommended for hilly countries might be maintained under night driving conditions. For night driving conditions in hilly areas, speeds of about 20 miles per hour for National Highways and Provincial Highways and 15 miles for other categories of roads were suitable.

During night travel the following two conditions govern vision of the road —

(a) Rear end collision sight distance;

(b) Sight distance limited by the visibility of an object illuminated by the headlight e.g. the rear reflector attached to the mudguard of a cycle. This would be about $1\frac{1}{2}$ ft in height and observed only when illuminated by the headlight of a car.

For day driving the height of the observed object has been assumed as 4 in. but for night driving purposes the object may resonably be assumed to be 1.5 ft in height as was the American practice.

It was seen that for summit curves designed for overtaking sight distance, the sight distance at night between a headlight at 2.5 ft above the road surface and an object 1.5 ft in height would be about 0.7 times the one for which the curve was designed. The following table showed the sight distance that could be secured on curves for various overtaking sight distances and the stopping distances for the designed speed :—

Speed m. p. h.	Sight distance ft	Stopping distance ft	Sight distance between headlight and tail light ft
50	1450	400	1015
40	1000	300	700
30	600	200	420
25	450	160	315

Therefore curves designed for overtaking sight distance as per Plate I were safe for night driving too.

It was also seen that the length of the curve required to secure non-overtaking sight distance is more than that required to secure visibility at night. So curves designed as per Plate II of the Paper were safe for night driving also.

On valley curves while sight distance was not the criterion of design for day driving the Committee considered that the night driving speed in India being much less than the speeds for day time driving visibility during night need not be the governing factor for the design of valley curves.

Shri. K. A. N. Chetty was of the opinion that the graphs presented in the Paper would be very helpful in the systematic upgrading of existing roads.

He enquired whether a cycloid had been considered. The cycloid had two peculiar properties namely—

(i) the time taken by a ball to roll from a higher point to the lowest point was the shortest along the cycloid;

(ii) all balls let from various levels of a cycloid plane reached the lowest point at the same time. Therefore, he thought that the middle third or middle half of a cycloid of suitable dimensions might be a shock proof curve and hoped that further studies on the subject might yield useful results.

Only one-fourth to one-third of the total length of roads in India were of superior type, with reasonable money allotments, where it might be possible to apply the principles indicated in the Paper. The remaining 3/4 to 2/3 had very poor allotments. The worst portion of these roads were the unbridged dips. Due to insufficient staff and poor allotments it was not possible to attempt regrading such dips in the manner indicated in the Paper. He, therefore, was of the opinion that a simpler method not involving the use of levelling instruments was necessary.

Even though a catenary might not be a perfect shock proof curve as a cubic parabola or lemniscate, yet it would be a great improvement on the V's or trapezoids. By trial and error it was possible to mark out with the help of only a string and a few pegs a reasonably shock proof catenary.

He suggested that for new projects on National Highways, Provincial Highways, and Major District Roads where adequate staff was available, the principles laid down in the Paper should be followed. At the same time an intensive programme of

regrading dips which do not involve elaborate calculations or the use of levelling instruments of higher precision should be tried. He thought that the adoption of catenary of suitable profile in such cases would have a good field.

Shri Bikramjit enquired about the method of application of Hewes rule recommended in page 27 for Compensation in Grades for Horizontal Curves in the case of transitions where the radius of curvature changes from infinity to a minimum at the centre. In case it was the intention that the varying radius of curvature should be used, a sort of summit curve would automatically result. A section on the application of compensation to transitions might be added.

Summit curves were to be designed on the following considerations :

(i) Overtaking sight distances.

(ii) Minimum sight distances where topographical or other considerations prevented design for the overtaking sight distances, and

(iii) comfortable riding.

Referring to para. 4.10.4 on page 39 the speaker thought that the curve designed for (i) and (ii) satisfied the requirements of comfort only in case of steep gradients.

Prof. C. A. Hart congratulated the Authors on the clear exposition of the subject in which he had been interested for a very long time. He wondered, however, whether the problem had been dealt with in an elaborate manner regarding certain aspects. He said that the usual exaggeration of vertical to horizontal scale of the longitudinal section (often 10 to 1) made a small deviation angle look much greater on the drawing.

He felt that the comfort factor or rate of change of gradients had not been brought out sufficiently in the Paper and he had found the method of calculating the length of a vertical curve by the method of rate of change of grade simple and effective. For example, if the upgradient at a junction is plus 2 per cent and the down gradient is minus 4 per cent, the length of the curve for a rate of change of gradient of 2 per cent per 100 ft was

$$\frac{2+4}{2} \times 100 = 300 \text{ ft.}$$

Assuming a simple parabola equation $y = cx^2$, the rate of change of slope $\frac{d^2y}{dx^2} = 2C$ is a constant. The summit occurs when the

slope is zero, i.e. [illegible] = 100 ft from the start of the curve.

He pointed out that for a change of grade as above which was 'not exceptional', there was practically no difference between a simple parabola and a circular arc and in his opinion it was hardly necessary to go in for niceties under present day road and traffic conditions in India.

Regarding vision distance, he felt that there are many factors which had to be considered, such as reaction time and efficiency of brake, etc. While he had worked at this problem, he felt that comfort and safety were primary considerations and it was rare that adequate vision distance could not be secured for reasonable provision of comfort and safety. He suggested that for unavoidable hump-backs a curve could be drawn to indicate limiting points for consideration.

Regarding transitions for valleys, he wondered whether it was right to consider the cubic parabola as the rule rather than the exception. Since for ordinary changes of gradient there was no shock in moving into simple vertical parabola. He thought that some limit of condition could be made, e.g., where the topography demanded a long valley curve or sharp changes of approach gradients.

He hoped that the Specifications & Standards Committee would emphasise the undesirability of horizontal or vertical changes of direction at the same time wherever this could be avoided.

He thanked the Chairman for the courtesy in inviting him to make a few remarks and this he had welcomed particularly because his work had been mentioned.

Shri P. A. Krishnaswamy* enquired the maximum value of radial acceleration for which graphs in Plates I to IV had been drawn. Referring to the remarks that the " consensus of opinion appears to be that for a comfortable riding the radial acceleration should not exceed 2.5 ft per second", in para. 4.10.2, and the recommendation that the centrifugal ratio on summit curves should be kept down to 10 per cent to allow for shock at entry (vide paras. 4.9.2 and 4.9.3) and the examples worked out in problem No. 3 wherein radial acceleration of 3.4 ft and 3.1 ft per second had been allowed, Shri Krishnaswami asked for clarifi-

* This and subsequent communications were received in writing and read out at the meeting by the Chairman.

cation. He pointed out that the impact factor of 17 per cent recommended in para. 5.10.1 gave a radial acceleration of 5.4 ft per second per second.

Shri B. R. Sen said that during night driving the light from the headlights was cut off on a valley curve with the result that visibility was restricted. On short valley curves the pavement was lighted for a distance that might be considered less than the safe non-overtaking sight distance according to the formula

$$S = 2 \times 1.47\ V + 0.083 V^2$$

where S = non-overtaking sight distance

V = design speed in miles per hour.

If parabolic curves were assumed the length of valley curves for safe headlight visibility might be computed by the formulae

$$L = \frac{NS^2}{2\,(h + 0.0174S)} \text{ When } L > S$$

$$L = 2S - \frac{2\,(h + 0.0174\,S)}{N} \text{ where } L < S$$

where L = length of the curve in feet

S = sight distance in feet

h = height of the headlight from the pavement in feet

N = algebraic difference in grade.

Limiting the vertical acceleration to 2 ft per second per second from considerations of comfort, the length of the valley is equal to WV^2.

Since the length obtained from considerations of comfort is less than that obtained from considerations of night visibility, the speaker was of opinion that the curves obtained by the formula $L = NV^2$ should be used only in the design of city streets where sight is not a criterion.

It was also pointed out by some members that —

(1) the gradient of 1 in 12 suggested by the Chairman would be very hard for bullock carts.

(2) Since the curves are designed for adequate sight distance the question of a motor car suddenly entering flood water would not arise.

Shri H. Sunder Rao, referring to **Shri K. A. N. Chetty's** remarks, said that the Committee had not considered the catenary and the cycloid as they confined their examination to simple curves. The cubic parabola recommended is the one with a rate of increase of radial acceleration of 2 and so is the same for all grade changes for any particular speed and as such was adaptable for laying out with templates. He hoped that Shri Chetty would place the procedure he had adopted for a catenary at the disposal of the Committee who would examine the procedure for simplicity.

Referring to the enquiry by **Shri Bikramjit** on the calculation of compensation on curves as per Hewes formula, he said that the minimum radius of the curve at the centre should be taken for purposes of calculation.

Welcoming the suggestion of **Dr. Hart** for simplifying the design he hoped that the Committee would take into consideration the suggestion while finalising the standard.

Shri Krishnaswamy had enquired about the maximum value of centrifugal acceleration permissible. It had been mentioned in para. 4.10.2 that the experience of different Authorities about the maximum allowable centrifugal acceleration had been varied. Even an acceleration of 18.9 per second^2 was pronounced as not uncomfortable. The centrifugal acceleration acts against gravity on summit and so was not the deciding consideration on summit curves. It was also seen that the maximum centrifugal acceleration for the curves recommended in Plates I and II varied from 0.554 to 1.21 feet per second per second.

In valleys centrifugal acceleration acts along with gravity and was important. Since the Committee had recommended a cubic parabola which had transitional properties, the maximum centrifugal acceleration which is a measure of shock at entry is not important The criterion of comfort was the rate of change of centrifugal acceleration which was limited to 2.

For the valley curves recommended in Plate III the centrifugal acceleration is given by the formula $1.73\sqrt{VN}$ and the impact was equal to $5.37\sqrt{VN}$. Therefore the centrifugal acceleration corresponding to the maximum impact of 17 per cent was $\frac{17 \times 1.73}{5.37} = 5.4$ and the maximum centrifugal acceleration for the curves recommended in Plate III was 3.77.

A chart showing the length of valley curves limiting the centrifugal acceleration to 2, 2.5, and 3 was exhibited (vide page 515).

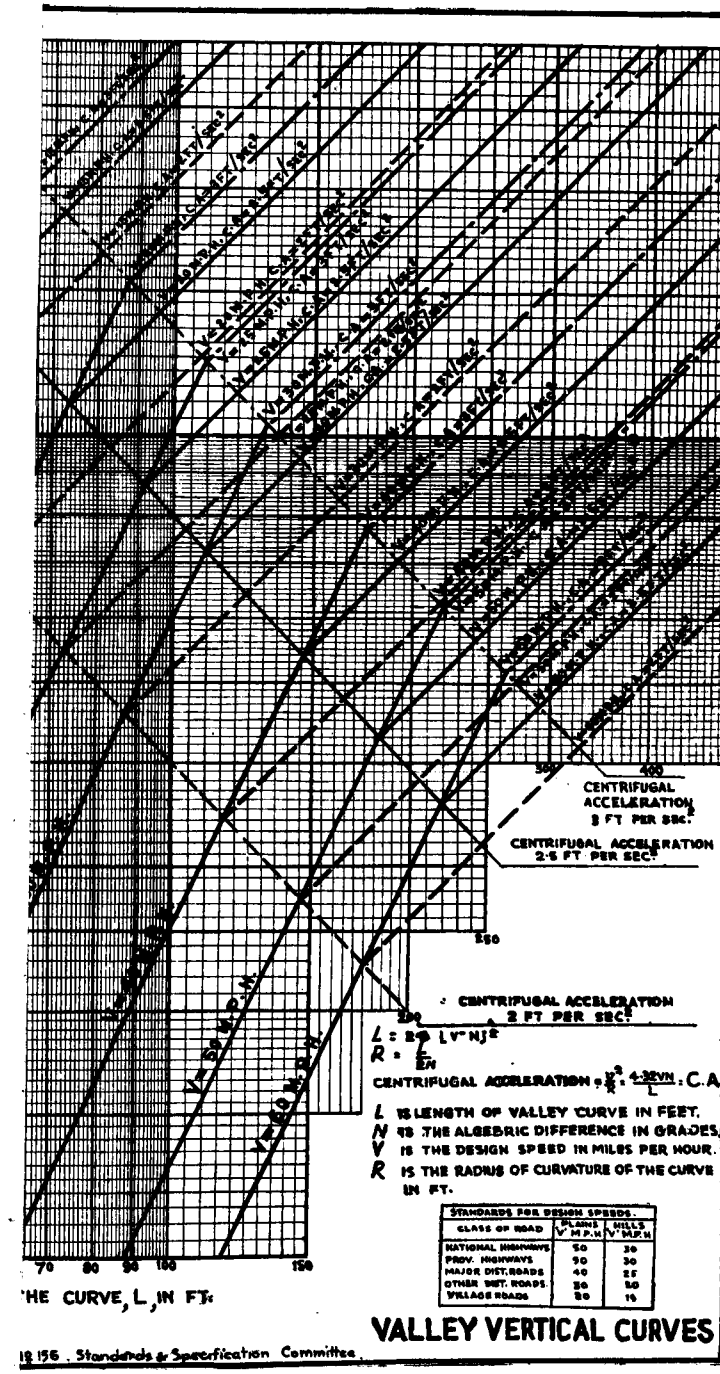
The formulae suggested by **Shri B. R. Sen** were for parabolic curves and did not apply to cubic parabolae recommended. The Committee considered that travel speeds at night being much less than day time design speeds night visibility was not the governing factor of design.

Shri H. P. Mathrani (Chairman) concluding the discussions said that acceptable suggestions would be incorporated in the final standard. Referring to Shri Bikramjit's comments he said that the compensation alone would not affect the radius of the vertical curve but that it would necessitate reduction of grade only when the latter exceeded the maximum permissible. Where the gradient was less than the maximum permissible the compensation might not play an important part.

While welcoming the suggestions of Dr. Hart he pointed out that in practice it would not always be possible to separate vertical and horizontal curves, especially in hilly country.

Referring to the approaches of causeways, he pointed out that if the gradient was flatter than the natural slope there would be silting in times of flood besides increased cost of cutting. So he advocated that a gradient of 1 in 12, which is the one that can be easily negotiated by a motor vehicle, should be the maximum. Such a gradient in his opinion would compel the driver to reduce speed.

Concluding the discussions he thanked the Specifications & Standards Committee for their valuable Paper and the Members for their interesting comments.



Discussion on Paper No. 157.

"Grouted Concrete Roads."*

By

E. A. NADIRSHAH

Monday, April 28, 1952.

Shri C. M. Bennett (Chairman) called upon Shri E. A. Nadirshah (Author) to introduce his Paper.

Shri E. A. Nadirshah in introducing the Paper said that more experimental lengths had been laid at Dhanbad, Bangalore, Calcutta, and Nagpur subsequent to writing the Paper. Information about these experiments was given in Appendix VIII circulated earlier at the Session.† A brief summary of these experiments was given in tabular form similar to Appendix VII.**

Certain mistakes had been noticed in Tables 1 and 2 of Appendix I and corrected Tables had been circulated to Members.‡

He stated that all the experimental lengths were periodically inspected. The road at Dadar (see page 533) had not shown any sign of wear or cracking. However, the concrete at the joints and near the edges of manholes had spalled off. This was apparently due to the difficulty experienced in finishing the concrete at those places.

The road opposite Victoria Gardens (see page 130), too, had developed some cracks on the side subjected to greater traffic but the surface was free from other defects. The cracks might be attributed to inadequate thickness. He suggested that the use of dowel bars to transfer a part of the load to the opposite side of the joint would, perhaps, have minimised cracking.

The stretches on the Kalka-Simla Road had developed some cracks. There, too, it was suspected that the thickness of 4 in. as provided was inadequate for the traffic. The cracks were severer near the joints than elsewhere.

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* Published at pages 77 to 130 of Vol-XVI—1 of the Journal of the Indian Roads Congress, November, 1951.

** Published at page 534.

† Published at page 532.

‡ Published at pages 535—536.

The conventional 1 : 2 : 4 concrete slab of the same thickness laid contiguous to the grouted concrete slab was faultless.

Shri Nadirshah further pointed out that in para. 3.4 of the Paper average compressive strength of grouted concrete surfaces tested in the U.K. was given. At that time no data was available about the strength of grouted concrete for stretches laid in India. However, cores from the Coimbatore road were subsequently tested by the Madras Highway Department and were found to have a strength of 3,000 lb per sq. inch.

Shri N. C. Bhargava observed that the construction of concrete roads was very often discouraged because of the high initial cost and, hence, any modification which promised to effect a saving in the initial cost should be heartily welcome. In Uttar Pradesh concrete roads had been constructed on a fairly large scale. Originally 9"-6"-9" slabs were used, but their cost was very high. Thinner sections were consequently tried and, even though the section had been reduced to as little as 3 inches by 1937, the initial cost was still quite high. Since it was appreciated that concrete roads were the most economical in the long run, efforts were continued to explore other ways of reducing the cost.

Experiments on rolled concrete, grouted concrete, and even granite roads had been carried out in Uttar Pradesh as early as 1936-39. Details of and reports on these experiments were submitted to the Congress at its Eighth Session and were published as Paper No. B-41 in Volume VIII of the Journal. The results of the experiments were not satisfactory. Even the colloidal concrete surface showed signs of wear and pot-holes appeared on the surface within a year's time. A wetting agent as recommended by the Author was, no doubt, not tried. It might be that, by ensuring better penetration of the grout, the life of the road would increase.

Shri Bhargava went on to remark that no data had been given about the compressive strength of the grouted concrete in the Paper. In the supplement to the Paper circulated separately it had, however, been stated that cores from the Coimbatore road were found to have a compressive strength of 3,000 lb per sq. inch. The speaker wanted to know if this was the result of one test or an average of a number of tests. If the latter, how many cores had been cut at each spot ?

Shri Bhargava thought that the inspection reports of the experimental lengths laid were not very encouraging. The Author himself had stated that, on the Kalka-Simla Road while the 4-in. grouted slabs had cracked, the adjoining slabs of 1 : 2 : 4 concrete of the same thickness had stood well, and that for the intensity

of traffic that the road had to stand up to a grouted slab thicker than 4 in. would be necessary. It, therefore, followed that for a certain intensity and type of traffic the thickness of the grouted road would have to be greater than that required for the conventional concrete slab with 1 : 2 : 4 mix. The difference in costs of the two types of constructions would thus be negligible and would defeat the very purpose for which grouted roads were being advocated.

Referring to the experimental lengths laid in Dhanbad and Bangalore, the speaker observed that, as they were subjected to only restricted traffic, the results of such experiments could not be conclusive.

There was the danger of airtraps and water pockets in this type of construction and the speaker wanted to know what precautions were necessary to avoid them.

The Author's contention, as stated in para. 3.7, page 84, that the grading of aggregate was of no importance, was not very convincing. It was true that the strength of concrete did not depend on the grading of aggregates, but as the quantity of grout required was a function of voids in the coarse aggregate, its grading would certainly have some effect on the net requirement of cement.

In experiment No. 1 the quantity of cement used was 4.16 cwt per cu. yd. but in comparing the costs of the premixed and grouted roads the Author had taken this figure as 3.51 cwt per cu.yd. The speaker enquired whether this was because the percentage of voids in the coarse aggregate used in the experimental bay was actually about 45 per cent, although it was assumed 38 per cent only in the analysis.

As regards the design formula given in para. 3.4, the speaker said that Sheets' formula with protected corners was

$$d = \sqrt{\frac{2.4\ WC}{S}}$$

He, therefore, enquired whether there was a mistake in the value of the constant given in the Paper, or whether Sheets had evolved another formula for grouted roads.

It had been suggested that for preparing the grout the order of mixing the ingredients should be firstly water, then dispersing agent and cement, and lastly sand. It would be interesting to know the effect if this sequence was changed.

Concluding his remarks, Shri Bhargava said that, while the potentialities of the grouted concrete road could not be denied, he felt a lot more of experimental work was needed to ascertain its merits. It would be worthwhile to compare grouted slabs with composite concrete slabs. In 1940 twelve bays of 3 in. thick composite slabs were laid in mile 51-52 of the Agra-Aligarh Road. The base coat consisted of only 1½ in. thick lean concrete of brick ballast. These bays had been behaving satisfactorily for over 12 years.

Shri G. D. Joglekar said that the life of a premixed concrete road was taken as 20-25 years whereas the life of a grouted concrete road remained to be ascertained. The Author had shown that the cost of construction of the grouted concrete road was 30 per cent less than that of the premixed concrete slab of the same thickness. The overall economy would depend on the ultimate life of the grouted concrete road. Although there was a saving of 30 per cent in the initial cost of construction it might, in the long run, prove more costly than the premixed type if its life was less than 14 years.

The construction of a grouted concrete road presented certain difficulties. Penetration of the grout right up to the bottom of the slab had to be ensured. If this did not happen weak spots were sure to be left. Besides, if the percentage of voids in the coarse aggregate was high, more grout than anticipated would be required. This would increase the cost.

The speaker observed that the function of the cement grout in a grouted concrete slab was to coat the aggregate. There was no advantage in having this binder very thick as any excess would act as a lubricant allowing the aggregate to slide. By premixing it was possible to coat effectively the aggregates without any waste of binder.

Referring to the experiments carried out in Bombay (page 95), Shri Joglekar remarked that only two stretches had grouted concrete as a wearing course while the rest had grouted concrete as a 'base' course. For the latter, premixed wearing courses varying in thickness from 0.63 in. to 0.9 in. had been provided. Such thin wearing courses required very small aggregate which meant greater expenditure. Hence, any economy that might be effected by going in for a grouted base course was likely to be offset by the extra expenditure on a thin premixed wearing course.

Photographs of cores taken from the pavement opposite Victoria Gardens, Bombay, showed that the penetration of the grout was not uniform throughout. There were spots both without any grout and with excess of grout. Uneven penetration of the grout was bound to affect the strength and life of the grouted slab.

Shri B. R. Sen wanted to know whether the chemical added was a dispersing agent or a wetting agent. In the Paper, both the words had been used synonymously. He pointed out that the function of a dispersing agent was different from that of a wetting agent.

The speaker remarked that the Author had mentioned that grouted concrete required 20 per cent less cement than 1 : 2 : 4 premixed concrete. He thought that 1 : 3 : 6 premixed concrete with a dispersing agent would perhaps have the same strength as a grouted concrete and would effect a saving in cement of approximately 27 per cent.

The cost per 100 sq. ft. of cement grouted pavements varied from Rs 60 to Rs 72. The thickness ranged from 4.40 to 5.75 inches. It appeared that a minimum thickness of 4½ in. of coarse aggregate was considered necessary. If the grout did not penetrate to the full depth, the effective thickness of the slab would be reduced. The speaker enquired whether the cores taken from the pavement indicated complete penetration of the grout or not.

Shri Sen thought that it was doubtful if stress and modulus of rupture in grouted concrete could be as high as that for premixed concrete. It was necessary that extensive laboratory tests correlated with those carried out in the field should be undertaken before a rational value could be arrived at.

Lastly, Shri Sen suggested that some method should be evolved to assess the workability of the grout.

Shri K. A. N. Chetty remarked that the construction of grouted concrete roads was more intricate, needed greater attention and was less fool-proof than the conventional type. It was not likely to withstand heavy traffic for a long time. The economy in cost claimed by the Author should have been based on the life and compressive strength of the two types. Cheaper types of pavements with comparatively short life would be worth consideration only if the saving in the initial cost was appreciable, i.e., of the order of 50 to 75 per cent. According to the Author the saving in the initial cost was about 20 per cent. It was doubtful if the reduction in the life of the pavement would be in the same ratio or more.

The speaker remarked that in his experience grouted pavements in which dispersing or wetting agent had been used had a compressive strength barely half that of the conventional type of cement concrete pavements. Defects during construction might have been responsible for the reduction in the strength to some extent, but that could not account for the entire difference. He suggested that some more cores from the experimental stretches should be obtained and tested.

Shri Chetty continued that it appeared rather difficult to finish all the operations of grouted concrete work within the initial setting time with the result that the final strength of concrete was likely to be adversely affected.

It had been claimed that consolidation with a power roller reduced the voids in the coarse aggregate to about 30 per cent and, thus, ensured a more compact surface bound by cement mortar. If perfect grouting could be achieved, this would surely be a point in favour of the new type, but in practice the penetration of the grout was not found to be perfect. Hollow pockets did remain at the bottom. To some extent this defect was absent in the rolled concrete surfaces which also had all the advantages claimed for the grouted concrete.

Rolled concrete was laid near Madras on the Grand North Trunk Road for a length of about a mile. The proportion adopted was 1 : 2½ : 8. Cores cut from this pavement, when tested, showed more or less the same strength as the conventional 1 : 2 : 4 concrete pavements. About 20 per cent saving could be effected with this method if the proper type of truck-mixers were used and the work executed on a large scale.

Grouted concrete pavements, continued Shri Chetty, had their own place, but were certainly not a substitute, and much less, an economical substitute, for the conventional type of cement concrete surfacing. They might, however, be adopted with advantage on roads not subjected to heavy traffic.

Shri E. P. Nicolaides said that as far as he knew the first grouted concrete was laid in England sometime during 1932-33 by Gammon and Morgan. First, they devised a special machine to mix thoroughly cement and water. Later, a sand drum was added to the machine and the process was applied for grouting aggregates.

In 1936 a small strip of colloidal concrete was laid on the Bombay-Poona Road but the experiment proved unsuccessful,

firstly, because the 3 in. thickness of the slab was found to be inadequate, and secondly, because a well packed surface could not be obtained.

Although during the last War colloidal concrete was extensively used for paving landing grounds, etc., it must be admitted that the process was only partly successful.

The speaker pointed out that if the size of aggregate was small, the grout would not penetrate properly whereas if size was large, the penetration would be better, but the top surface would have a number of weak spots unless treated specially with extreme care on every square foot of the area. Those weak spots were really responsible for subsequent deterioration. It was true that the top could be improved by re-capping the surface with stone chippings, but from practical experience it had been found that such a procedure was costly and needed great care.

Shri Nicolaides stated that one way to overcome the problem of surface finish was to limit the grouted concrete to about 1½ in. from the top and cover it with a wearing course of conventional concrete. This procedure was, however, not a solution of the problem, but just a compromise.

The speaker did not agree with the Author's statement that colloidal concrete required a larger quantity of water than grouted concrete with a dispersing agent. To ensure proper penetration of the grout having a dispersing agent a minimum water-cement ratio of 0.7 appeared necessary. Colloidal concrete did not require any more water than that. On the contrary, as the colloidal concrete pump delivered the grout under pressure, the water cement ratio could be lowered even further.

Shri Nicolaides did not agree that the grout should have a consistency of thick cream (vide para. 1.2 of the Paper) because he was certain that such a thick grout would leave a larger number of voids in the coarse aggregate.

Shri S. K. Ghosh mentioned that he had recently laid at Berhampore (West Bengal) an experimental stretch of grouted concrete road about 4½ in. thick, 800 ft long and 10 ft wide. The proportion of the grout was 1 : 1½ (cement : sand) by weight. A dispersing agent at ¼ pint per cwt. of cement was added. A concrete mixer of 3½/5 cu. ft. capacity with a tilting drum was used for mixing the grout. A grouting pump was tried for some time but was discontinued later as it was not possible to feed it continuously. Hand pouring was, therefore, resorted to, but it was felt that on a big job a pump would be necessary.

Various specifications were tried. In some stretches coarse aggregate was spread to proper grade and camber and grouted, whereas in others the coarse aggregate was lightly rolled before pouring the grout. Stretches that had not been rolled prior to grouting contained 48 per cent voids against 40 per cent in those which had been lightly rolled. In all the cases the surface was finished by tamping.

At first seven gallons of water per cwt. of cement were [illegible]. On bright days it was found that shortly after the grout [illegible] poured and the surface had been finished, surface cr[illegible]ared —evidently on account of shrinkage caused by rapid [illegible]. A different brand of cement was tried but that did not improve matters very much. The water content was then reduced from seven gallons to six. This eliminated surface cracks, but it was found that the consistency of the mortar was too thick to ensure penetration to the full depth. Honey-combing was observed at places. The difficulties were ultimately obviated by grouting in two stages, one closely following the other. Grout using seven gallons of water per cwt. of cement was poured to about half the depth and was followed by grout having six gallons of water per cwt. of cement.

In the absence of any core-cutting machine, the speaker had prepared some cylindrical specimen by filling in moulds, 6 in. in diameter and 12 in. in height. A few specimens were prepared by filling in aggregate and grout in moulds 4 inches deep. For a comparative study specimens of the same shape and size were prepared from the conventional 1 : 2 : 4 cement concrete, too. Tests indicated that the results of the grouted specimens were not very encouraging. Since the work was still in an experimental stage, Shri Ghosh did not consider it fit to give the actual results of tests for compressive strength.

The Author had mentioned that the crushing strength obtained at Madras was about 3,000 lb per sq. inch. The sizes of the specimens tested were necessary for appreciating fully the results and such further details should be given.

The speaker expressed doubt on the extent of economy as claimed by the Author. He said that the Author had based his calculations on the assumption that coarse aggregates had 38 per cent voids. But tests carried out at Bombay revealed that the void content of the coarse aggregate was 50 per cent when loose and 45 per cent when rolled lightly. More voids meant more quantity of grout.

Moreover, a comparison of costs of grouted concrete and 1 : 2 : 4 premixed concrete was not justified. Since grouted concrete was weaker in strength than the conventional 1 : 2 : 4 concrete, it would be more rational to compare its strength with that of leaner premixed concretes.

Shri Ghosh agreed with the Author that further experimental work in a planned and systematic way was necessary.

Shri K. V. Thadaney said that he had been connected with two small experimental lengths of grouted concrete road laid at Coimbatore two years ago. He was of the opinion that this method of construction was really very simple provided proper equipment was used. The practical difficulties pointed out by the Author in para. 1.4 were entirely due to inadequate equipment employed in laying the experimental lengths. A properly finished and even surface could be achieved if the coarse aggregate was properly rolled before and after grouting.

As the initial setting time of Indian Cement is more than 100 minutes, the whole operation could be completed within this period if a grout mixer of adequate capacity was used.

Segregation of the grout could be prevented by mixing the grout properly in a mixer and keeping it constantly agitated in a tank.

For a rate of construction of one furlong of 10-ft wide and 10-in. thick road per day, Shri Thadaney suggested the following mechanical equipment :—

1. Two tilting-drum type mixers, each capable of handling two-bag batches to grout.
2. A pump for conveying the grout.
3. Two power rollers—a 10-ton roller of the ordinary type for the initial consolidation of the coarse aggregate, and an 8-ton tandem roller for rolling the grouted surface.

Shri N. D. Daftary observed that as stated in para. 1.3 the cost of construction by the new method was as much as 30 per cent less than that of the orthodox premixed concrete. This saving was based on figures given in Tables 1 and 2 of Appendix I.

If figures for the 5-in. grouted slab given in Table 2, page 110, were reduced by 20 per cent to get the corresponding figures for a 4-in grouted slab, the quantities would be as given below :—

Cement 4.41 cwts. against 3 cwts. shown in Table 1, page 102 ;

Sand 12.67 cft. against 8 cwts. shown in Table 1 ;

Coarse aggregate same as shown in Table 1 ;

Labour Rs 8 against Rs 5.

Consequently, the cost of the 4-in. grouted slab would be increased by Rs 14.03 vide details below :

Cement 1.41 × 5	Rs	7.05
Sand 4.67 × .75		3.50
Labour —		3.00
Contingencies		0.48
		14.03

That is to say, the total cost would be Rs 65-1-0 against Rs 51-1-0 given in Table 1 at page 102. The resultant saving was, therefore, reduced to 10 per cent approximately. If 1 : $1\frac{1}{2}$ grout was used, there would be practically no saving at all.

The cost of preparing the subgrade should have been the same in both the cases. This was, however, not so in Tables 1 and 2 at pages 102-3. If correction was made for this, the saving would be further reduced by 2 per cent. But even a saving of 8 per cent was worth having if it could be really possible.

Some of the aggregates, the speaker went on to say, were liable to get crushed under the weight of the roller and, as a result of this, some spots might get packed tightly. Consequently the grout would not penetrate to the full depth.

Grouted concrete was weaker than the premixed concrete for the following reasons :—

(i) Leaner mix,

(ii) Ungraded aggregate, and

(iii) More quantity of water.

Referring to para. 5.1, the speaker pointed out that 22, 44, and 88 cu. ft. respectively of cement, fine aggregate, and coarse aggregate yielded 100 cu. ft. of 1 : 2 : 4 concrete. Thus, 1 cu. yd. of 1 : 2 : 4 concrete would require 23.76 cu. ft. of coarse aggregate, 11.88 cu. ft. of sand and 5.94 cwts. of cement instead of 20.76 cu. ft., 10.30 cu. ft. and 4.30 cwts. respectively mentioned by the Author. The speaker thought that the difference was perhaps due

to the Author's assumption that the water added increased the volume of concrete. The speaker observed that this was not so as some of the water combined chemically with cement during hydration, some of it evaporated, while the rest escaped during tamping.

In para. 5.2 the percentage of voids given was 38 whereas at page 109 it had been mentioned as 45. Again, the quantity of cement for 1 cu. yd. of grout taken was 3.51 cwt. against 4.16 cwt at page 108. Thus, the saving in cement would be about 16 per cent only and *not* 20 per cent as stated at page 92. Continuing, the speaker said that the quantity of grout actually required would be more than was calculated in para. 5.2 as, in addition to filling voids in the aggregate, grout was needed to coat the aggregate from all sides. Consequently, thinner slabs would need more grout. This was borne out by the figures given in Tables 2 and 3 at pages 110 and 112 respectively. For a 6-in. slab the quantity of cement required was 5.51 bags per 100 sq. ft. while for a $4\frac{3}{8}$-in. slab it should have been only 4.82 bags, but actually 5.16 bags were needed.

Shri T. K. Macha said that instead of comparing the grouted concrete only with premixed concrete the Author should have considered other types also.

Further, Shri Macha observed that it was difficult to adhere to specifications regarding water-cement ratio and the time required for all the operations. Also, while consolidating the layer of aggregates after sprinkling some water, there was possibility of mud oozing up.

Shri N. C. Patel said that the immediate need was to have a cheap but durable surface. He suggested that composite slabs should be laid simultaneously with the grouted concrete slabs and their strength, life and costs compared.

Shri K. K. Kartha said that a few miles of colloidal concrete roads had been constructed in Travancore-Cochin. His experience had been that this type was not as durable as the conventional 1 : 2 : 4 slab. Within about two years the colloidal concrete pavement showed signs of wear and developed cracks at right angle to contraction joints. Staggering of joints made no improvement. Where the gradient was very steep (1 in 4) the grout was found to flow down.

Shri Kartha went on to say that in the case of a grouted concrete road too, of the type advocated in the Paper, segregation

was bound to take place while concreting steep gradients as grout would flow down the gradient leaving voids in the upper portions.

Shri H. R. Dhir said that half the width of the grouted stretch on the Kalka-Simla Road was laid without dummy joints or without being rolled after grouting; the surface was only hand tamped. The other half had dummy joints and was lightly hand-rolled. A short length of 1 : 2 : 4 premixed slab, too, was laid contiguous to the grouted length for a comparative study. All the slabs were 4 inches thick.

The first half of the grouted slab developed cracks almost after a week the road had been thrown open to traffic. These cracks, however, did not widen out further with the passage of time. The second half was comparatively better.

The cost of the grouted surface worked out to about Rs 69 per 100 sq. ft. against Rs 108 nearly for the premixed slab. Though there was a saving of about 36 per cent, yet in the long run the grouted slab was not likely to be as durable as the 1 : 2 : 4 slab.

Shri K. F. Antia suggested that each State should lay about a mile of grouted concrete roads and study their behaviour. Also, the Central Road Research Institute should carry out investigations. The intensity of traffic and the maximum unit load, too, should be taken into account, while studying the behaviour of experimental stretches. Referring to Shri Daftary's remarks, the speaker said that it was not always true that the quantities of cement, fine aggregate, and coarse aggregate required to yield 100 cu. ft. of 1 : 2 : 4 concrete were 22, 44 and 88 cu. ft. respectively. This was an old "rule of thumb" and had been superseded by more scientific and rational methods of designing concrete mixes based on the requirements of strength. To obtain the exact figures for the quantities of materials required the "absolute volume" method which had been adopted by the Author was, perhaps, one of the best methods.

The speaker disagreed with Shri Daftary's opinion that water did not occupy any volume in the concrete.

Shri E. A. Nadirshah (Author) was then called upon to reply.

Referring to the comments made by **Shri N. C. Bhargava** the Author stated that the strength given was based on one core only, which was 5½ inches in diameter and 4½ inches in height and had been cut from a pavement about 2 years old. As soon as facilities for extracting more cores were available, further tests

would be undertaken. Experience and proper equipment would, probably, overcome the initial handicaps. It would not, therefore, be fair to presume that for identical conditions the thickness of a grouted concrete road should be more than that of a conventional 1 : 2 : 4 slab.

The chances of air-and water-pockets forming in the slab were remote as grout worked its way from the bottom to the top. Sheets' formula pointed out by Shri Bhargava was identical with the formula given in the Paper for an impact factor of 2.

The order in which various ingredients had been recommended to be mixed was based on practical experience.

The Author did not agree with **Shri Joglekar's** statment that the function of the cement in a grouted concrete slab was merely to coat the aggregate. He also stated that premixed wearing courses were not recommended for all cases.

Shri Joglekar's remarks about the penetration, as revealed in the cores extracted at Bombay, were not correct. Penetration of the grout had been uniform and the cores had been found to be quite satisfactory.

In reply to **Shri B. R. Sen** the Author said that a premixed lean concrete with a dispersing agent would neither reduce the cost of labour nor permit as much outturn of work as was possible by the grouting process.

Referring to Shri Sen's criticism about synonymous use of the words "wetting" and "dispersing" agents, the Author remarked that it was difficult to differentiate between the two as their function was similar.

Cores cut out and examined so for showed satisfactory penetration of the grout. To detect whether or not the grout was penetrating satisfactorily holes could be scooped in the surface. Also, the flow-cone method could be used to control the flow of the grout.

The Author agreed with Shri Sen that before an acceptable value of the modulus of rupture could be obtained, laboratory and field tests were necessary.

Referring to **Shri K. A. N. Chetty's** comments, the Author remarked that, if correct specifications were adopted, there would be no difficulty regarding the penetration of the grout. He did not agree that rolled concrete was better than grouted concrete. Experiments on grouted concrete roads had been carried out only

recently and it was too early to conclude that their life was less than that of the premixed type, or that they were suitable only for lightly trafficked roads.

Replying to **Shri E. P. Nicolaides,** the Author said that, if the coarse aggregate was rolled prior to grouting, a fairly even surface could be obtained. Also, it would obviate the possibility of pockets of mortar forming on the surface. The surface could be improved further by finishing it with small chips.

The Author disagreed with Shri Nicolaides that colloidal concrete needed no more water than grouted concrete with admixtures of wetting agents. His experience about colloidal concrete work on the Bombay-Poona Road, the Author continued, had been that the quantity of water required was much more than would have been necessary had grouted concrete with a dispersing agent been used. The Author, however, agreed that, if pressure grouting did not disturb the coarse aggregate, it would be preferable to grouting by gravity. Certain discrepancies pointed out by the speaker had been corrected in the supplement to the Paper.

Shri S. K. Ghosh had mentioned the appearance of surface cracks as a result of grouting the entire depth in one operation. The Author remarked that it was rather strange. As the cause of the trouble appeared to be rapid drying or an absorptive aggregate, wetting the coarse aggregate before grouting might be an effective method offsetting the difficulties experienced by Shri Ghosh. Grouting in two stages appeared to be impracticable.

The Author agreed with **Shri K. V. Thadaney** that proper equipment was a pre-requisite for satisfactory work.

With reference to **Shri N. D. Daftary's** criticism the Author admitted that the water-cement ratio for a grouted concrete road was slightly greater than that required for the premixed type. Since some of the water, he added, was absorbed by the subgrade, etc., the residual quantity was much less than that originally mixed. Shri Daftary's apprehensions about the coarse aggregate getting crushed under the weight of the roller were not justified as heavy rollers were not to be used.

While computing the yield of concrete, chemical action between cement and water need not be taken into account as the yield was based on the absolute volumes of the various ingredients. It was true that with the reduction in the thickness of the slab a slightly greater quantity of grout would be necessary. The Author agreed that there was need for further experiments.

Replying to Shri T. K. Macha, the Author said that the subject of the Paper was to compare the economic aspects of the grouted and the conventional (1 : 2 : 4) concrete only and not of all types of pavements. The difficulties mentioned by Shri Macha had not been experienced in any of the works carried out by the Author.

Referring to **Shri N. C. Patel's** suggestion regarding premixed composite slabs, the Author remarked that this could be tried where durable aggregates were expensive. In such cases, he suggested, it would be worthwhile to have an unrolled grouted base course using an inferior aggregate and a premixed wearing course using a durable aggregate.

In reply to **Shri K. K. Kartha,** the Author said that to check the grout from flowing down steep gradients the rate of grouting could be reduced. Longitudinal cracks near transverse joints could not be attributed merely to the quality of the concrete. They could also arise on account of heaving or unequal settlement of the subgrade.

Referring to **Shri H. R. Dhir's** remarks, the Author said that, as stated before, it would take some time more to ascertain the ultimate life of this type of construction. He, however, expressed the hope that there would be no prejudice against grouted concrete.

The Author concurred with **Shri K. F. Antia's** views that experimental stretches, at least one mile long, should be laid by each State and investigation should be carried out by the Central Road Research Institute, too. Further, he agreed that both the intensity of traffic and the maximum unit load should be considered while designing roads.

Shri C. M. Bennett (Chairman), winding up the discussion, thanked the Author for his interesting Paper and replies to the comments. He agreed with the various speakers that more information and research was necessary before definite conclusions could be drawn.

Appendix VIII.

EXPERIMENTAL WORKS FOR GROUTED CONCRETE

DHANBAD:

The experimental stretch at Dhanbad was 820 ft long and 15 ft wide and was laid on 3 in. thick stone soling blinded with moorum. A 4-in. layer of metal was laid and rolled with a 10-ton roller. The proportion adopted for the grout was 1 : 2. Since the sand used was moist, the resultant proportion of the grout was richer than 1 : 2.

The method of construction was the same as described in the case of other roads. The work was completed in October 1950 and it cost approximately Rs 49 per 100 sq. ft. against Rs 60 per 100 sq. ft. for an ordinary 1 : 2 : 4 premixed concrete road of the same thickness. Being a private road in the compound of the Fuel Research Institute, it was not subjected to heavy traffic.

BANGALORE: The Hindustan Aircraft Factory at Bangalore laid a stretch 30 ft wide, 800 ft long and 4 in. thick. The proportion for the grout was 1 : 1½. The cost of this pavement worked out to Rs 63 per 100 sq. ft. against Rs 68 for a premixed concrete road.

CALCUTTA & NAGPUR: The experimental lengths at Calcutta (Berhampore) and Nagpur were more or less of the same nature. At Calcutta a stretch 1,200 ft long, 5 in. thick, and 10 ft wide was laid in February 1952. This length was subdivided into four parts as follows :—

(a) 300 ft without preliminary rolling; grouting by hand

(b) 300 ft -do- ; grouting by pump

(c) 300 ft lightly rolled with an 8-ton machine; grouted by hand

(d) 300 ft -do- ; grouted with a pump.

In this experiment coarse aggregate, 2 in. and under in size and having about 43 per cent voids, was used. The proportion for the grout was 1 : 1½ (by weight), and the water/cement ratio seven gallons per cwt of cement. Adequate quantity of a dispersing agent was added.

The cost of this experimental stretch was only 6.6 per cent lower than that of the premixed type. It would have been much lower, however, had it not been for some extra expenditure necessitated by the following items :—

(a) Washing of the coarse aggregate.

(b) Short lengths of the stretches.

(c) Hand-grouting.

(d) Even though 4 in. was the minimum thickness yet at many places the thickness ranged from 4½ to 5 inches as the subgrade was uneven.

BOMBAY (Dadar): In addition to the experimental length mentioned in the Paper the Bombay Municipality laid over the existing painted water-bound macadam surface another stretch at Dadar about 700 ft long, 15 ft wide, and 4½ in. thick. The existing surface was picked up and properly levelled before spreading fresh material. The proportion for the grout was 1 : 2 and had a dispersing agent added to it. A special pump loaned by Messrs Mousell & Co., Ltd., Bombay, was used. The work was completed in February 1951.

The cost of this road worked out to Rs 71 per 100 sq. ft. against Rs 83 for a premixed 1 : 2 : 4 concrete road of the same thickness. The traffic on this road was, however, light.

SUMMARY OF IMPORTANT DETAILS

(Supplement to appendix No. VII. page 130)

Appendix VIII. *(Continued)*

Experiment	Length ft	Breadth ft	Proportion of grout for wearing coat or for base	Materials consumed per 100 cft. of finished work	Joints Typed spacing E: Exp. ft. C: Construction D: Dummy Jt.	Cost per 100 cft. of finished work	Percentage saving in cement over 1 : 2 : 4 Ct Concrete road.	Percentage saving in cost over usual 1 : 2 : 4 cement concrete road
BANGALORE 4 in. thick pavement in the compound of the Hindustan Aircraft factoy.	800	30	1 : 1½	Cement: 13½ bgs. C. A. 123 cft. F. A. 30 ft	Details not available yet	189	28.5%	8
DHANBAD 4 in. thick pavement in the compound of the Fuel Research Institute.	820	15	1 : 2	Cement : 13½ bgs. C. A. 113 Cft. F. A. 33 Cft.	E at 140 ft D at 35 ft	147	28.5%	16%
BOMBAY (DADAR) 4½ in. thick pavement Sir Bhalchandra Road.	700	15	1 : 2	Cement: 16 bgs. C. A. 136 Cft. F. A. 45 Cft.	E at 33 ft to 35 ft	195	12½%	15%
BERHAMPORE (Calcutta) 4" in. thick pavement on P. W. D. Road.	1200	10	1 : 1½	Detailed report not yet in hand				6.6%

Appendix I.*

Table 1. (Para. 1.3) [Corrected]

Approximate quantities and cost per 100 sq. ft of grouted pavement 4 in. thick, 1 : 2 mix.

1951

	Description	Quantity	Rate	Amount Rs	A.	P.
1.	Stone metal (1½ in. to 2 in. size)	35.5 cu. ft	Rs 45 per 100 cu. ft	16	0	0
2.	Sand	8.5 cu. ft	Rs 75 per 100 cu. ft	6	6	0
3.	Cement	3.5 cwt.	Rs 5 per cwt.	17	8	0
4.	Preparation of subgrade, spreading metal, mixing mortar and rolling.	100 sq. ft	Rs 5 per 100 sq. ft	5	0	0
5.	Curing	100 sq. ft	Rs 1¾ per 100 sq. ft	1	12	0
6.	Expansion joints, etc.	lump sum		0	8	0
7.	Tools & Plant			2	8	0
				49	10	0
8.	Contingencies, 5 per cent			2	8	0
			Total.	52	2	0

* Certain mistakes were noticed in the Tables printed in Appendix I at pages 102 & 103. Corrected figures are published here.

Appendix I. *(Continued).*

Table 2. (Para. 1.3)

Approximate quantities and cost per 100 sq. ft. of premixed concrete pavement 4 in. thick, 1 : 2 : 4 mix.

1951

Description	Quantity	Rate	Amount Rs A. P.
1. Preparation of subgrade, including watering and cleaning before laying concrete.	100 sq. ft	Rs 3 per 100 sq. ft	3 0 0
2 Cement	5.12 cwt	Rs 5 per cwt	25 10 0
3. Fine aggregate	13 cu. ft	Rs 60 per 100 cu. ft	7 13 0
4. Coarse aggregate-1½ in. to ¾ in., 20 cu. ft. ¾ in. to ⅜ in. 10 cu. ft.	26 cu. ft	Rs 45 per 100 cu. ft	11 11 0
5. Concrete mixing, placing and finishing.	33.34 cu. ft	Rs 24 per 100 cu. ft	8 0 0
6. Curing	100 sq. ft	Rs 1¼ per 100 sq. ft	1 12 0
7. Expansion joints etc.			0 8 0
8. Tools and plant			3 2 0
			61 8 0
9. Contingencies, 5 per cent			3 2 0
		Total.	64 10 0

Discussion on Paper No. 158.

"Construction of Shillong-Silchar Road."*

By

S. C. PAL AND R. C. DAS

Tuesday, April 29, 1952.

Shri K. K. Nambiar (Chairman) called upon Shri S. C. Pal to introduce the Paper.

Shri S.C. Pal said that the road construction work referred to in the Paper was undertaken at a time when the resources at the disposal of the Assam engineers were limited and conditions arduous. Also, they were handicapped because no reconnaissance had been carried out and nothing was known of the required alignment and the work that would be involved. Earthwork alone might account for quite half the total expenditure on a project of this nature.

With sufficient attention paid to the layout and earthwork of a hill road, substantial economy could be effected. For this reason he had felt that there was need for drawing up some standards for the different operations necessary for the construction of a hill road. He hoped the Paper would prove useful in this regard.

In the State of Assam a number of hill roads (for example, the Jowai-Badarpur Road ; the Mawphlong-Balat Road—to name the two most important) were still under construction. The milage was likely to increase in the near future, as communications for the Districts included in the Sixth Schedule of the Constitution had to be provided.

Some of the defects in the road described in the Paper, viz., narrow sections, sharp curves, steep grades, etc., particularly between miles 178 and 195, which could not be attended to before the work was suddenly stopped in 1949 for financial reasons, had since been partially removed.

Shri G. R. Nangea remarked that it was rather tragic to see an important work suspended because of financial stringency. Apart from the fact that the huge amount of money already spent did not yield a substantial benefit to the community, bigger than

*Published at pages 151 to 204 of Vol. XVI-2 of the Journal of the Indian Roads Congress, March, 1952.

normal amounts were required to maintain a hill road in an unfinished state. Besides, sudden stoppage of the work had a disheartening effect on those responsible for its execution. He would like to know what steps has been taken by the Assam engineers to impress upon their Government the immediate necessity of making available more funds for this road.

Agreeing with the statement made in para. 6.5.2, viz., "the length of the finished road will necessarily be somewhat less than that of the 'trace'", Shri Nangea said he too had experienced that a gradient actually laid as 1 : 17 worked out to be about 1 : 15 on completion. As such, in Himachal Pradesh the original trace was laid out to an easier grade than that intended for the road when complete.

Referring to catchwater drains, he said that in some cases he had found more than one catchwater drain, one above the other, very useful. The catchwater drains should be discharged at convenient rocky places instead of at katcha spots.

Relating his experience on the Amritsar-Kulu Road—section Chakki to Nurpur—where all culverts got choked up with debris brought down by the streams, Shri Nangea said that to avoid this trouble, culverts with spans of 4 to 8 ft and with a vertical height of 6 ft were adopted.

In para. 11.4., the Authors had stated that some portions of the road were as steep as 1 in 8. It must be admitted that such steep grades limited the utility of a hill road and were likely to hamper the economic development of the area it served.

The speaker continued that in Himachal Pradesh hill roads were under construction in areas having altitudes from 1,500 ft to 12,000 ft. The Hindustan-Tibet road ran at an altitude ranging from 7,000 to 9,500 feet. He suggested that engineers responsible for the construction of hill roads in one area should inspect those in other areas.

Shri N. Durrani wanted to know if —

(1) aerial survey was resorted to;

(2) modern road-making machinery was used;

(3) food rationing was in force.

He would suggest that a pedometer, a Photo-theodolite, and a good camera were always useful while surveying.

Shri D. M. Sen referred to paras. 1.6 and 1.7 in which the Authors of the Paper had given the genesis of the present project.

From Plate II it appeared that a possible route for Shillong to Silchar could have been something as follows —

(i) From Shillong to Dauki near Pakistan border following about 50 miles of the excellent motor road built in 1933 as mentioned in para. 1.5, which is part of the old truncated Shillong-Sylhet-Silchar road ... 50 miles

(ii) From Dauki to Badarpur—new road running parallel to the Pakistan border over a more or less level ground at about 1,000 ft above sea level, and at a distance of 5 to 10 miles as desired ... 44/45 miles

(iii) Badarpur to Silchar following the existing metalled road ... 15/16 miles

Total say 110 miles

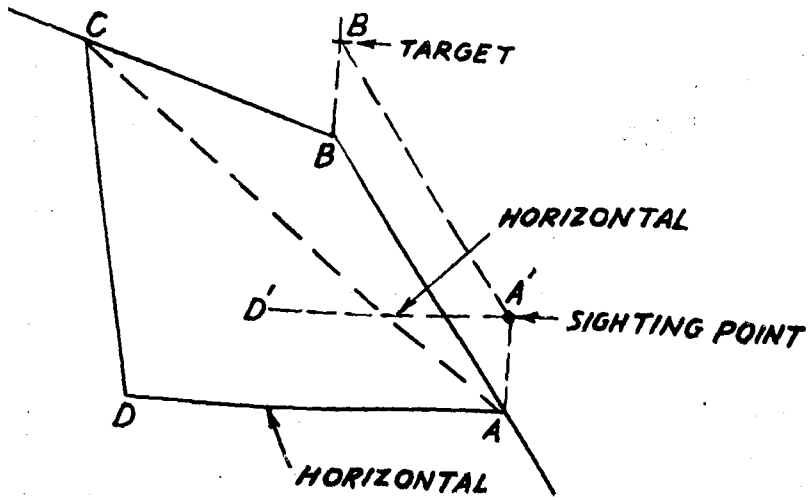
Of this only about 45 miles from Dauki to Badarpur would have been new construction instead of a 218-mile road with 163 miles of new construction (para. 4.10). Such a road parallel to the Pakistan border and a short distance from it would have had considerable strategic value and would have prevented the border raids so often reported in the newspapers. Those 45 miles would have cost much less and would have provided a fairly level road in contrast to the present one with gradient as steep as 1 : 8 (para. 11.4) at some places. The speaker wanted to know if this alignment was considered. If so, with what results? Referring to para. 4.9.3, he asked why it was not possible to take the new road through Haflong town.

In para. 6.9, the cost of the survey and preparation of estimates for 89 miles of the road in Haflong Division alone were given as Rs 47,700. The total cost of the road for the entire project should have been given. Also, the composition of the survey party and the time taken to survey were necessary.

The speaker suggested that among the principal requirements for survey work in areas such as those the Authors had to traverse were two or more armed escorts and a field wireless set with an operator and the Government should have supplied these. The wireless set would incidentally provide not only the quickest means of communication but might also be used to receive A.I.R. programmes, perhaps the only amenity available to keep up the morale of men and labour. The incidents mentioned in para. 3.9 and para. 3.10 justified the proposals.

From the speaker's point of view it would be incorrect to adopt the method mentioned in para. 6.6.3 and illustrated by Fig. 3. The reason was that, when the angular measurements were

taken, the sighting point would not be A but A′ where AA′ was the height of the instrument. Therefore, the angles read would not be DAB and DAC but D′A′B and D′A′C where DA and D′A′ were horizontals through A and A′. The correct thing would be to mark on the 'target' a point at a height from its base equal to AA′ and to take angular measurements of only that point when the target was held alternatively at B and C. The Authors



did not say whether similar intermediate readings were taken when instead of humps as in Figs. 2 and 3, there was the reverse case of a depression in the slope CA.

In para. 6.7.1, it was mentioned that a compass survey was carried out. Shri Sen wanted to know whether any theodolite or traverse survey was carried out in addition.

In para. 6.8 (soil surveys), two rates were mentioned for medium and hard stones requiring blasting (items 7 and 8). In paras. 8.7.3 and 8.7.5 it had been stated that advance measurements of boulders were taken during excavation. Naturally these boulders must have been very irregular in shape and not accurately measurable. The payment could perhaps be made on the number of blastings done. Any debris not totally blown off by blasting could be stacked and removed and paid for by volume.

In para. 7.1 under specifications and standards, the maximum limits of sloping back had been given for various soils. Shri Sen

pointed out that the information was incomplete without the corresponding natural hill slopes met with. Also, knowledge of the maximum and average dip of the strata cut through was desirable.

Referring to para. 8.2, the speaker said that in addition to the names of three P. W. D. Divisions set up, the number of sub-divisions and sections and their strength should have been included.

In paragraph 10.1, the Authors had mentioned the great difficulty felt regarding accommodation for officers and staff. For one division it had cost more than Rs 3.5 lakh. He thought that tents, tarpaulins and camp furniture worth Rs 50,000 should have sufficed for one division. Besides being cheaper, these would be readily available for the project under reference and could also be utilised later on other works. The speaker suggested that every Circle, if not every permanent Division, should have a full set of camping equipment for survey and executive staff.

Under para. 3.7, sub-para Transport, page 158, the Authors had stated that the load per porter for carrying ration and other things was at first 40 lb per head which was later on reduced to 30 lb per head. But in Appendix III, page 187, they had worked out a formula on the basis of 50 lb per porter. Again in determining the number of porters required to supply rations for 100 workmen on a 10-day march, they had made a mistake. They had actually worked up to the 9th stage, i.e., porter required for a 9-day march. If they had worked one step further they would have found that 187 men would be required to supply 100 workmen for a 10-day march from the base. In view of the above, the speaker concluded, it was not surprising that supplies of ration ran short and people had to starve occasionally (para. 10.2.2).

Shri T. K. Macha endorsed the views expressed by Shri Nangea about the sudden stoppage of work and the resultant damage to the road. He feared that if these hill roads were left unprotected they could hardly be expected to be there after some time. He favoured the use of road-making machinery on such jobs.

Shri K. K. Nambiar pointed out that in Plate VI of the Paper, where the Authors had given a design for a timber bridge of 15 ft span, trackways had been provided near the kerb. Trackways were 3 ft wide and were shown to hug the kerb on either side, leaving a clear gap of 4 ft 6 inches. It was not understood how these trackways could be used by vehicles which

had normal wheel-tracks. Perhaps, it was a mistake. The Authors might confirm.

Secondly, on page 167, para. 6.5.2, it had been stated that the original trace should be laid out to an easier grade than that intended for the road when complete. The allowance made varied with the nature of the ground. In general, 1 in 22 would work out to 1 in 20, and 1 in 17 to 1 in 15. Shri Nangea agreed with the Authors in this respect although at first sight this looked like a mathematical fallacy. Once a gradient was laid from one point to another, even if there was subsidence, the total of the rises and falls should be the same so long as the height to be climbed remained constant. Perhaps the reason for the observed fact was that, when a certain gradient was obtained by equalising the cut and the filling, the portion in cutting did not sink while the embanked portion did.

Shri Brijmohan Lal said that the Paper gave an account of a typical example of a work which was undertaken in a great hurry without proper alignment, survey, design, and adequate finances. As the work had been left incomplete without any retaining or breast walls and other important road structures, it was likely to suffer damage in a few years resulting in a heavy loss to the State.

Shri Nambiar had pointed out that there was some fallacy in the statement of the Authors that a grade of 1 in 22 was likely to result in a steeper grade of 1 in 20 after construction. The speaker observed that there was no fallacy at all. Perhaps the phenomena was possible because during the rapid survey the road was likely to be measured a little longer than the finished road.

Dealing with **Shri Nangea's** remarks, the **Authors**, in their written replies, said that, as already explained by Shri S. C. Pal while introducing the Paper, some of the defects in the road, viz., narrow sections, sharp curves, steep grades, etc., particularly between miles 178 and 195 had been partially removed. These defects were left in stretches which remained unfinished when the work was suddenly stopped and would disappear when the formation was completed according to the approved design.

The provision of more than one catch-water drains, one above the other, as suggested by Shri Nangea would, no doubt be useful, but even one good drain, if properly maintained had been found effective.

In reply to **Shri N. Durrani** the **Authors** stated that no aerial survey was carried out.

Some second-hand D-8 & D-4 bull-dozers purchased from the Army were used but their use was abandoned very soon as great difficulty was experienced with regard to spare parts, trained personnel, facilities for repairs etc. At times spare parts had to be flown out and this had proved very costly. Apart from all these drawbacks, it had been observed that during rains it was almost impossible to work with this heavy equipment as the soil was often very soft. On one occasion, a D-8 tractor sank in soft strata and was extracted with great difficulty.

Food-rationing was in force and arrangements had to be made to procure rations through Government supply contractors at the various rail-heads from where the road contractor had to make his own arrangements for transporting rations to the site of the work.

Shri Sen had suggested that the alignment from Shillong to Silchar via Dauki and Badarpur (see Plate II at page 200) would have been shorter and more economical than that via Garampani-Haflong. The Authors pointed out that Garampani and Haflong were obligatory points on the alignment.

The road was not taken through Haflong town itself, as such an alignment would have interfered with some of the important structures on the existing railway.

The Authors were responsible for only a part of the work and were not in a position to give the cost of survey of the whole road.

The composition of one survey party was as follows:—

Assistant Engineer	...	1
Surveyors	...	2
Field Assistants	...	3
Khalasis	...	20

It took about eight months for two such parties to carry out surveys in the Haflong Division (89 miles). No theodolites were used; only chain and compass survey was made. A Division had three sub-divisions under it and a section had to look after 7 to 12 miles.

Referring to Shri Sen's criticism about the measurement of vertical angles (vide para. 6.6.8 and Fig. 3 of the Paper) the Authors pointed out that all readings were meant to be taken to a target of a height equal to the height of the instrument.

Measurement of rock stacked after blasting was generally deprecated in Assam as this method gave inflated figures. A solid boulder, even though irregular, could be measured fairly correctly and this method had proved more economical than the method referred to by the speaker.

Tented accommodation had been tried, but was found unsuitable for the climate of Assam. The temporary structures mentioned in the Paper had proved very useful and had been in use for over 4½ years for housing some of the offices that were required to continue after the work was suspended in 1949. Tents and tarpaulins did not survive even two rainy seasons.

The load that could be carried by a porter depended on the type of the porters employed and on the nature of the path. When materials had to be carried through dense forests or through areas where there was no proper foot-path (as was the case in the reconnaissance stage described in para. 3.7) the normal load had to be reduced. Fifty lb per porter assumed in the calculations in Appendix III was taken for illustrating the working of the formula. The actual capacity of a porter depending upon local conditions should be used in any particular case.

The calculations given in Appendix III were correct for x_{10} workmen maintained at the 10th stage.

Replying to **Shri T. K. Macha**, the Authors stated that steps had been taken to remove some of the most serious defects in the road, and, with proper maintenance, there was no possibility of its being rendered unserviceable.

The Authors confirmed that, as pointed out by **Shri Nambiar** the central gap between the trackways in Plate VI should have been 2½ ft instead of 4½ ft.

The reason why the original trace should be laid out to an easier grade than that intended for the road when complete was that kinks in the original trace got straightened out during construction and the length of the road decreased. The gradient, therefore, became steeper.

Shri K. K. Nambiar (Chairman) winding up the discussion congratulated the Authors for their excellent attempt. The Paper, he said, would surely benefit those engineers who were not conversant with the difficulties encountered with during reconnaissance, layout, and construction of a hill road. He hoped in future there would be more such instructive and interesting Papers.

Discussion on Paper No. 159.

"Importance of Organization".

By

R. P. CHANDA

Monday, April 28, 1952.

Shri S. N. Chakravarti (Chairman) called upon Shri S. N. Gupta to introduce the Paper on behalf of Shri R. P. Chanda who could not attend the Session.

Shri S. N. Gupta observed that the Paper was the outcome of a study of the difficulties encountered by Shri Chanda himself during the period he was in charge of three administrative districts. He had a heavy road programme, which included three major bridges on National Highways, to rush through.

Although the division he took charge of was not exactly new, it had not yet been fully organized and he had many practical difficulties to contend with. He felt that many other executive Engineers had been similarly placed all over India. This feeling prompted him to write a Paper which he believed would appeal to every Construction Engineer who had had to shoulder the responsibility of new construction works.

Shri D. P. Nayar said that, as a result of the partition of India in 1947, both Bengal and Punjab, were truncated. Like Bengal, the Punjab, too, had to face the difficult conditions which followed partition. Lack of staff, absence of stores, dislocation of economic life, and an almost complete breakdown of the administrative machinery were some of the handicaps under which the engineers in the Punjab were called upon to tackle problems of a vital and important nature which needed immediate attention.

Works could not be carried out efficiently without proper organization for which co-operation and efficient management was necessary. People should be conscious of their responsibilities and must not shirk them. Another quality necessary was the development of the sense of leadership, that is to say, the Engineer ought to be able to guide and amicably extract work from those working under him. He suggested that the Engineer :—

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* Published at pages 205 to 221 of Vol. XVI-2 of the Journal of the Indian Roads Congress, March, 1952.

(1) should develop mental discipline to do even distasteful work,

(2) should do his work as if he were personally responsible for the success of the entire project on which he was engaged,

(3) should develop a pleasing personality and cultivate an optimistic outlook,

(4) should NOT fail to respect the authority of others and the personal dignity of his subordinates, and

(5) should endeavour to anticipate the needs and difficulties of the contractors and try to assist them as best as he could.

Referring to the present-day increase in routine work, the speaker said that a certain amount of office work was definitely essential for any organization and that only by keeping a firm alround control could the engineer in charge of any work expect to discharge his duties successfully and efficiently.

Shri K. Sinha wished that the Author had included in his proposals the Public Work Departments of Local Bodies such as Municipal and District Boards where the conditions were much worse even than as described in the Paper. In any re-organization of the Public Work Departments of the State Governments for the improvement of roads, the local bodies should not be neglected as they were still in charge of a substantial milage of roads in the country.

A serious drawback with the local bodies, continued Shri Sinha, was their financial instability. Their sources of income being limited, they had not been able to keep pace with the increase in work during and after World War II. Most of them found it difficult to balance their budgets. A local body struggling for economy found it most convenient to cut down its expenditure on roads.

All the other important departments, Education, Public Health, Water-works, etc., were at present subject to control by the State Government, at least in the Uttar Pradesh, but the Public Work Departments of local bodies were still uncontrolled by the State. The result had been that the roads in charge of such bodies continued to deteriorate.

In conclusion, Shri Sinha suggested that the engineers of local bodies should be free to take advantage of the proposed central store, machinery depot, library, etc., to be established by a State Government. In short, they should have the same facilities as the engineers of the State Government.

Shri S. B. Joshi observed that public-works contractors might disappear as a class in the not too distant future and Government engineers would then have to execute their schemes departmentally. It was imperative, therefore, that the engineering departments of Government should be organised so as to be able to shoulder this heavy responsibility.

For efficient and expeditious work, modern methods of management adopted by business houses should be followed by the engineering departments of the Government. With this in view, he would lay stress on the following :—

(1) It was correct to base the selection of a new graduate on the basis of his performance in his examinations but, while making selections for higher executive posts, weightage should not be given merely to academic abilities.

(2) Officers should not try to evade responsibility.

(3) Senior engineers should look after their juniors with fatherly care.

(4) Much labour could be saved and decisions expedited by (a) mutual trust, (b) delegation of authority at different levels, and (c) periodical departmental and inter-departmental conferences for final decisions of cases.

(5) Senior officers should do less table-work and more field work.

(6) So as to derive benefit from past experiences, a special investigating branch of engineers trained in statistics and quality control should be established. It would be interesting to analyse a few cases every year and trace them to their source. Such a study would, he thought, bring out what an amazing amount of time and money could sometimes be wasted on defective processes and how improvements could be effected.

(7) Cost accounting should be introduced in the methods for working plant and machinery and for maintaining stores.

Shri S. N. Gupta suggested that a standard "works-load" should be fixed for the average division and sub-division. With this should be fixed corresponding standard "strength" of officers

and other staff and standard "requirements" of office equipment, forms, stationery, tools and plant, and so on. If this were done, a division or sub-division would be sanctioned as soon as they were justified by the "works-load" and all the rest could follow automatically, no separate sanctions being required for staff, equipment, etc..

The executive engineer or the superintending engineer, as the case might be, should have full authority, to recruit the required staff for the sub-division or the division (except the gazetted officers), and to buy the required equipment, stationery, etc.. It would then be the responsibility of the Divisional Engineer to make all his arrangements for accommodation, temporary and permanent.

Establishment of a Central Store for a State would probably not be very economical and efficient in West Bengal because of the problem of transport. A divisional store might serve better the purpose of a subdivision.

Shri Gupta emphasized that there should be Construction and Maintenance Manuals with deatailed specifications and standards.

In West Bengal the need of such manuals was keenly felt. He pointed out that very few States had any manuals which could be called up-to-date and could be relied upon. As soon as such manuals were published, Shri Gupta continued, standard instructions regarding duties should be issued for the guidance of all supervising staff. There should be standard forms to be filled in by them in respect of all works.

Shri F. K. Davar said that the Paper depicted a typical cross-section of the present-day difficulties of engineers in, perhaps, all the States. He suggested that:—

(i) mechanical engineering staff should possess certificates of competency, issued by the Department after proper training had been given to this staff,

(ii) lubricants should be of good quality, stocked at site, and supplied departmentally,

(iii) a practice similar to that existing in the Military (the overhauling of vehicles in rotation on particular days of the week) should be insisted upon,

(iv) both a central store and a fully equipped workshop should be maintained at the headquarters of every circle so that breakdowns in costly machinery belonging to Government might be attended to quickly.

Shri A. K. Ghosh agreed with the Author that the difficulties referred by him were experienced by a majority of engineer officers. He however, observed that some of these difficulties and inconveniences were to be removed by the administrative officers who were at the headquarters. But, much depended on the particular Executive Officer who was in charge of the work. He must have a thorough idea of the resources at his disposal and at his administrative officer's disposal. Also, he must keep himself abreast of all possible information about availability of materials and help from other sources.

Continuing, Shri Ghosh said that he appreciated the Author's suggestion regarding training of officers, but he felt that the officer himself could train those junior to him and treat them sympathetically.

Whether the store for materials, tools and plant etc., should be situated centrally or in a particular zone or at different railheads would depend on the circumstances of each case. He, however, preferred the zonal system.

In order to put an end to the encroachments on roads and roadside lands, Shri Ghosh asked, in view of the apathy of the local civil administration in dealing with such matters, whether it would not be better to invest the executive engineers and assistant engineers with magisterial powers instead of raising the highway police.

Shri K. F. Antia said that he agreed with what Shri Joshi had said regarding personnel. He complained that it was quite usual with officers to shirk responsibility. The rules that governed promotions in Government service needed overhauling. With regard to Shri Joshi's remark that a time might come when the class of contractors would become extinct, he wished that this would not happen. He wanted works to be executed both departmentally and through the agency of the contractors. As regards central depots, he suggested that the Roads Organization of the Ministry of Transport should study the methods adopted by the Railways and work out a scheme.

Shri G. S. Ram suggested that in addition to the divisional and central stores for all sorts of materials and tools and plant, and a fully equipped workshop at a headquarters place for carrying out expeditious and economical repairs as suggested by the Author, some sort of arrangement should be evolved by the Government for the benefit of the District Board Engineers. Shri Ram agreed with the Author that, as the engineers had to do lot of statistical and clerical work, they could not devote sufficient time to the design and execution of engineering works which were their main duties.

Shri N. D. Daftary said that he fully agreed with the Author about the necessity of having a well equipped library, but suggested that the library should provide not only books, journals, magazines, etc., but should also have a well informed and efficient librarian who would be able to produce or suggest relevant references. Further, he observed that it would be worthwhile to circulate amongst the junior engineers abstracts of important information and articles, etc., appearing in various publications.

He called attention to another difficulty which the junior engineer experienced when put in charge of an executive job. He was often asked to furnish a number of plans, estimates, etc., but had no facilities for producing these. The speaker considered it would be worthwile to have most plans and estimates prepared in a Central Design Office. If this was done, a great deal of correspondence would be avoided and the necessary plans and estimates would be prepared to standard designs and so could be sent out for immediate use on the execution of works.

The Author, he continued, had referred to the question of training. He felt that training should be given not only to junior engineers but to the clerical and other staff also. It was generally found that there were no arrangement for training clerical or other subdivisional staff like mistries etc.. Something should be done if quick and efficient work was wanted.

Shri Daftary went on to say that the next question that faced the junior engineers was that of transport. With car prices now so high, they found it impossible to keep cars of their own. The alternative, therefore, was either to take recourse to hired conveyance, which was not always easily available, or to avoid going out on inspection of works. It would be worthwhile to provide the required transport at the expense of the State.

Referring to the question of transfers, Shri Daftary observed that for the last few years frequent transfers had been the order of the day. Officers had been transferred from place to place at six months or shorter intervals. This was not only very inconvenient to the officers concerned, but was also detrimental to the interests of work.

The speaker highly commended the Author's suggestion for doing work departmentally. This would bring home to junior engineers the difficulties which had to be overcome during construction. Besides, work undertaken in that way would be done quickly and cheaply. The "piece work system" should be encouraged.

Concluding, Shri Daftary said that at present a very large number of "returns" were constantly being called for by higher authorities. Sometimes, he felt, these returns were not even read on receipt. There should be a periodical review of "returns" and those that were found unneccssary should be discontinued.

Shri P. L. Varma while relating some of the difficulties that had to be faced in his State proposed the appointment of a Committee consisting of the nominees of the Indian Roads Congress and the Institution of Engineers (India) to go into the points raised by the Author in his Paper. The Committee would put up proposals to the Government of India in the form of a report.

Shri K. K. Nambiar said that in Madras they had no, grouses, complaints, or difficulties of the nature referred to in the Paper. The problems discussed in the Paper were, perhaps, peculiar to some of the States due to the special circumstances prevailing there. In Madras they already had an organised Highway Department under a separate Chief Engineer. This arrangement had been in existence for over five years.

The Highway Department looked after nearly 39,000 miles of roads belonging to the Government and the District Boards and spent nearly nine crores of rupees every year on maintenance and construction.

As suggested by the Author, they had a central workshop for attending to major repairs and overhauls of tools and plant and machinery in their charge as also for manufacturing certain appliances required for the maintenance and construction of roads.

At the headquarters of each Superintending Engineer they had a central store dealing with the purchase and distribution of articles required for road maintenance. They also had regional repair yards to attend to minor repairs, overhauls and adjustments of road plant and machinery.

Also a small Research laboratory for carrying out experiments connected with problems regarding road construction and maintenance existed.

Referring to the Central library advocated by the Author, Shri Nambiar said that they had a Central library in Madras with several hundred useful books dealing with highway maintenance and construction. The latest publications on matters connected with highway engineering were added from time to time. They had adopted an indexing system by which literature dealing with

any particular subject could be obtained at short notice by any member of the Highway Department.

As regards a Construction Manual for the use of the Department, Shri Nambiar disclosed that the compilation of their manual was actually in hand more exactly, it was nearing completion. It would be an up-to-date compendium of very useful information on matters connected with road maintenance and construction, organization of the department, and rules and regulations pertaining to execution of works.

Shri Nambiar agreed with the Author that untrained persons should not be put in charge of the new divisions or sub-divisions. In Madras generally the officer who suggested a new division or a sub-division was asked to take charge of that unit.

Winding up his comments, Shri Nambiar remarked that although engineers should proffer advice, the same engineers should themselves take steps to act on that advice. If this attitude was adopted, he felt the Paper would have more than justified itself. The speakers should each indulge in a certain amount of introspection to see whether each of them was doing what was expected of him.

Shri Hardyal observed that the seniors should treat their juniors sympathetically and try to solve their difficulties by offering constructive criticism. The seniors should do all in their power to create in their juniors a feeling that they were all members of one big family. Mutual confidence which was so important for team work would thus be developed. The seniors and the juniors should meet periodically and discuss freely their difficulties and programmes.

He added that for good work the relationship between departmental officers and contractors should always be cordial. Departmental officers and contractors should consider themselves as jointly responsible for the proper execution of schemes. To ensure this, officers should always give reasonable facilities to contractors to carry out their work efficiently.

Certain administrations while letting out contracts added a clause in the agreement to the effect that, if the work was completed before the stipulated period, the saving in the charges for departmental supervision would be awarded to the contractor as a bonus. This, continued the speaker, had often acted as a potent incentive to contractors for efficient and speedy execution of works.

Lastly, Shri Hardyal suggested that, like the employees of commercial firms, Government servants, too, should be rewarded for outstanding work by being given bonuses, accelerated promotions, increased increments, etc..

The Author, in a written reply to the discussions, said that some of the speakers had touched on higher administrative matters which had been omitted intentionally from the Paper. The Paper was intended to focus attention on other things of greater importance.

He appreciated **Shri D. P. Nayar's** reference to organization, management, and responsibility and agreed that his plea for the development of the sense of leadership was timely.

Office work could certainly be curtailed by having precise and unambiguous correspondence.

Replying to **Shri K. Sinha** and **Shri G. S. Ram** the Author said that, while general problems of local board engineers could not be solved by Roads Organizations, there was no reason why resources at the disposal of State Public Work Departments in matters of stores, machinery and workshops should not be made available to them at reasonable hire rates. Also, at times local boards too might render help to Public Work Departments. He could quote as an example a time when he had hired 3 steam road rollers and 5 pile driving sets for several months from a District Board who could spare these. In West Bengal many important sections of roads had been taken over by the State Government from the local boards, thus reducing the milage in their charge.

Referring to **Shri S. B. Joshi** and **Shri K. F. Antia's** criticism the Author admitted that only a part of the problem had been dealt with in his Paper. He hoped that the class of contractors would not vanish but would thrive and continue to improve their 'know-how', resources, and equipment. Contractors had introduced many economical methods of doing work resulting in better and cheaper construction in a comparatively short period. If healthy competition existed, the country would benefit. At times the department would have to stand on its own legs entirely.

The Author said that **Shri Joshi's** views on the selection of personnel were reasonable but some yard-stick like a University or Departmental examination was necessary to ensure justice and to eliminate 'personal factors'. Surely a few minutes interview would not always be sufficient to make a right selection. The prescribing of certain standard examinations was unavoidable for service in any organization. Things, of course, might be different when experts or experienced hands were recruited directly.

The matter of promotion was a more difficult issue. He thought that, as in the Military services which dealt in large numbers, some kind of scientific basis for selection might be introduced to suit a particular department. He would suggest a system of awarding merit "ratings" to all officers annually. The average of such ratings, subject to a minimum period of service, should be the criterion to decide accelerated and ordinary promotions. These matters should not depend entirely on impressions of the Administration at any particular time or on the usual reports made available to the Public Service Commission.

Continuing, the Author remarked that extra official contacts between officers of different grades were necessary. While 'mess nights' might not be possible, a start could be made by arranging conferences of departmental engineers (State-wide or Zonal), followed by dinners. Also, conferences of Engineers and Audit and Finance officers should be held to iron out difficulties. Inspection tours of senior officers should be reasonably frequent but not hurried.

The Author suggested that the Roads Organization of the Ministry of Transport should organise periodical courses suitable for officers of different cadres like the refresher or instruction courses run by the Defence Department.

He agreed that for every departmental work, cost-accounting was necessary. Under the existing circumstances the only possible solution lay in devising simple forms to be filled in daily and periodically to obtain ready analysis and evaluation.

Besides Central and Divisional Stores, as pointed out by **Shri S. N. Gupta**, there might be 'zonal' stores, too. The location, etc., of each type would, however, depend on several factors. Duplication or over-lapping should be avoided. The Central Stores would hold a reserve stock and might often serve as a "marshalling" yard. One Central Store at Calcutta was apparently unavoidable for the North Bengal Districts.

Shri F. K. Daver was correct when he said that short courses for training mechanical staff were desirable but there was hardly any facility available at many centres. In West Bengal lubricants and grease were supplied by the Department but the trouble arose in their proper use. He agreed with the speaker that one day in the week should be reserved for overhauling equipment.

While replying to **Shri A. K. Ghosh**, the Author pointed out that the qualities indicated by him were necessary for every officer irrespective of the fact whether there was a good organization behind him or not. If there was no good organization, time

and energy would be wasted on efforts which should have been better spent on jobs in hand. Besides, the training of staff when one had a busy programme in hand could be very costly. In the Paper, employment of Highway Police on important sections of the road was suggested to serve a prosecuting agency. This would release engineers for tasks more properly theirs.

As remarked by **Shri Daftary**, a library service was desirable and a modest start could be made in the Designs or Drawing Office in a state. In the West Bengal Roads Organization, draft detailed estimates, etc., were often prepared in the higher offices and then sent down to the construction divisions for being checked. Periodical returns were unavoidable but forms, which were not complicated and yet provided all necessary information, should de devised.

Referring to **Shri P. L. Varma's** suggestion—the Author hoped that the appropriate authorities would take up the matter.

As regards **Shri K. K. Nambiar's** comments, the Author said that it would be worthwhile studying the Madras Highways Department. Other States could adopt the Madras Government's Manual when published. Shri Nambiar's concluding remarks with regard to 'introspections' were appropriate.

Replying to **Shri Hardyal** the Author observed that inspection tours could help achieving some of the objects mentioned by him. Engineer-Contractor relationship was sure to improve with the increase in the number of qualified resourceful contractors. The introduction of a bonus system as suggested by the speaker might not be feasible always.

He, however, preferred the award of merit 'ratings' once or twice a year which might form the basis of future promotions.

Shri S. N. Chakravarti (Chairman) winding up the discussion thanked the Author for a very interesting Paper and said that it had given enough food for thought to many. Commenting on Shri Nambiar's statement, the Chairman remarked that Madras Highway engineers did not appreciate the need for the Paper, because they were in a more fortunate position. There had been expansion in Madras 20 years ago whereas in other States expansion had to be done overnight. Several projects had been launched and many more would be launched in the near future. As such, it was necessary to have proper organization. Unless this was done all would have to muddle through and the result would depend largely upon personal initiative.

He agreed with most of what Shri Joshi had said.

Discussion on Paper No. 160.

"Design of Road Beds."*

By

G. SRIRANGACHARY

Monday, April 29, 1952.

Shri U. J. Bhatt (Chairman) called upon **Shri Bh. Subbaraju** to introduce the Paper on behalf of Shri G. **Srirangachary**.

Shri Bh. Subbaraju in introducing the Paper said that it was very unfortunate that the Author had not been able (as he had wished to do) to attend the Session and introduce the Paper himself. All comments made on the Paper would be communicated to the Author who would no doubt reply to them in writing.

Shri B. G. Naik said that in most States road construction was based on practical experience and rule of thumb. Apart from its high cost the defects of the conventional stone soling were too well known and the sooner these were replaced by the stabilised base courses, the better it would be.

He did not, however, understand how the width of the carriageway required by traffic could be the main criterion in road design. It was of course understood that as far as the widths of the subgrade, the formation, and the base course were concerned, it would be the deciding factor, but he wished the Author would enlighten them on how it affected the thickness of the pavement.

Secondly, in example 1 given on page 342, the best stabilised soil mixture was said to be 1 part of moorum to three parts of sand. The speaker wanted to know whether the proportions were decided upon after mechanical analysis or by trial and error. It would have been very useful if the results of the mechanical analysis had been given.

At page 343 for the base course having a bearing strength of 400 lb per sq. inch, 3 in. thick water-bound macadam was found adequate. What would be the thickness of a laterite or a moorum wearing course? Was it not possible to determine the thickness of different types of wearing courses?

* Published at pages 301 to 358 of Vol. XVI-3 of the Journal of the Indian Roads Congress, April, 1952.

Further, Shri Naik wanted to know whether to withstand wheel loads not exceding 400 lb per sq. in. it would be necessary to interpose a water-bound macadam surface between the stabilised base course having a bearing strength of 400-450 lb per sq. inch and a 1½-in. thick premixed carpet.

Shri B. R. Sen* referred to the equilibrium-moisture-distribution curves in soils above the ground water level mentioned in para. 1.7.7 and as illustrated by Fig. 4, and did not agree that " in the case where water is being supplied from both directions, after some time both top and bottom get saturated, and the line of capillary potential will be MKP (Fig. 4-a)." The curve PQ, indicated the equilibrium condition for supply of water from the top only, and this did not hold good if the soil was in an unsaturated stage. Russel and Spangler (1), the speaker observed, had studied the permeability of soil to unsaturated moisture movements and had found it to be dependent upon the value of the soil suction. It decreased rapidly as the suction was increased. There was evidence that the permeability of cohesive soils was reduced to zero at the plastic limit of the soil.

The Uttar Pradesh P. W. D., (B & R) Research Station, Lucknow had been conducting investigations on the suction-moisture content relationship of a large number of soils of different textures ranging from sandy loams to heavy cohesive clays and it would not be out of place to mention some of the interesting results obtained during the course of that study, which in the opinion of the speaker had a direct bearing on the problem of subgrade moisture conditions. It was possible to estimate within very close limits the equilibrium moisture content at a given height above the water table.

Irrespective of the type texture of the soil, at $pF = 2.2$, the soil was approximately at the liquid limit—the term pF being used to designate the logarithm of soil suction in terms of equivalent height of water column in centimeters. Or in other words, whatever the soil, at a height of 168 cms. or approximately 5½ ft from the water table, the moisture content of the soil would be very close to its liquid limit. Further investigations were in progress and the speaker believed that it would be possible to establish the pF status of soils having different consistency limits.

Some data on actual moisture conditions beneath pavements and in subgrade soils had been mentioned in para. 1.7.9. The

* Written comments received by post and read out at the Session.

(1) Russel, M. B. & M. G. Spangler: "The Energy Concept of Soil Moisture and Mechanics of Unsaturated Flow." Proc. Highway Research Board, Washington, 1941, 21, pp. 485-49.

speaker would like to know how the moisture content was determined. He himself was developing an electrical soil-moisture gauge which might record continuous changes in moisture content at several points of a sample.

Regarding the value of wheel load adopted for design, he felt that impact due to unevenness of the wearing course should be taken into account.

Also, the question of vehicle speed and frequency deserved to be considered as it affected the performance of the road structure. While repetitions of loads would tend to consolidate the subgrade and add to its stability, its possible damaging effect on the pavement needed further study.

Holl(2) recently published a mathematical analysis of a plate resting on an elastic foundation and studied the vibration of the plate due to moving concentrated loads. The speaker was trying to extend Holl's analysis to study the effect of fast moving vehicles on wearing courses and subgrades.

The same method could be applied to study the effect of traffic intensity or vehicle frequency. The effect of a slowly moving train of heavily loaded bullock carts might also be investigated in this manner.

The speaker would like to know the number of cases actually studied on which the design curves given in the Paper were based.

Finally, he referred to the compaction of subgrades. Specifications for the compaction of subgrades were generally based on the results of the Proctor Test and the performance of compaction equipment was not taken into consideration. This was rather an unrealistic approach, as there was often a considerable difference between the laboratory and field results.

Further, if the subgrade was compacted at its optimum moisture content, the soil might subsequently swell or shrink, owing to the moisture content adjusting itself to some equilibrium value and, consequently, deformation of the road surface might result. The speaker suggested that the proper method would be to place the fill at its equilibrium moisture content and to use the type of compaction plant which gave its best performance at this moisture content.

(2) Holl, D. L. "Dynamic Loads on Thin Plates on Elastic Foundations"—Proceedings of the Third Symposium in Applied Mathematics, Vol. III, pp. 107-16, McGraw Hill, New York—1950.

Concluding the speaker remarked that there was need for a separate Subcommittee of the Indian Roads Congress to coordinate and collate research work on this problem and to put forward detailed recommendations suitable for the soil and climatic conditions obtaining in different parts of this country.

Shri E. C. Chandrasekharan said that, enumerating the chief considerations in the design of a road-bed, the Author stressed the need for the component parts of a road structure and suggested with illustrations a method of designing road-beds based on practical experience in Madras State.

The importance of providing a foundation of adequate strength and stability after taking into consideration all the factors that influenced it could hardly be overemphasised. A small expenditure incurred on the preliminary soil testing and the intelligent use of design methods would and should lead to fewer road failures and lower costs of construction and maintenance.

The method suggested by the Author pertained to the empirical method using a bearing-strength test and comparing it with the previous field observations. The design of the thickness of the different layers consisted of finding out the bearing-strength after fully soaking the compacted sample for 3 days and reading out the corresponding thickness of the pavement from a tentative chart with 4 curves based on certain arbitrary standards.

The background and basis for the evolution and development of these design curves were not even mentioned. In the opinion of the speaker, an empirical method of this type should be based on the results of extensive investigations on roads, old as well as new, and on different soils.

The speaker agreed that the cone penetrometer was a simple and convenient apparatus for both laboratory design and field control tests and was in line with recent trends for the compaction of soils for highway construction. He, however, disagreed with the Author's statement that, where the bearing-strength test after soaking the soil for 3 days was almost nil, the soil should be discarded. The Author's rule would not apply to areas which were comparatively dry and where the moisture content of the subgrade might not reach the point of saturation even under the worst conditions.

In paras. 1.7.9 and 2.5.6, the Author used the expressions 'full-saturation', 'saturation-moisture', 'theoretical water-absorbing capacity' and 'theoretical water-capacity' synony-

mously. Saturation moisture was always referred to the maximum moisture that the soil could hold at a given density. **Theoretical water-absorbing** capacity, in the opinion of the speaker, referred to the maximum water that the soil was capable of ABSORBING freely.

Shri J. S. Narasimham referred to capillary moisture and design methods mentioned by other speakers. The subgrade moisture tended to reach a static equilibrium with the ground water-table below. An apparatus known as the 'Capillary Tensometer' had been evolved and from this the Capillary Potential of the subgrade soil could be determined. The fluctuation in the movement of the ground water-table could be determined and made use of in the design of thickness of subgrade, sub-base, base, etc.

In para. 1.9.9 and 1.9.10 at page 323, the Author had mentioned that a thin asphalt and sand mixture on the macadam surface gave good performance, in binding the aggregates, (see Fig. 10). Shri Narasimham was of the opinion that sand-asphalt mixtures were not economical if their purpose was merely to interlock the aggregates. He, however, agreed with the Author that effective interlocking of the aggregates was to be aimed at. To achieve this, he continued, a special type of Tandom Roller had been developed in the U.S.A. While the front wheel and the back wheel consolidated, the centre wheel produced oscillations at the rate of 3,000 per minute with an amplitude of 1 inch. This vibration caused the aggregates to interlock effectively and a greater density resulted.

In Fig. 6, para. 1.7.9, the Author had stated that the moisture content in the subgrade and sub-base was under equilibrium condition for a certain road bed in Madras State. He would like the Author to explain how he came to this conclusion. Some data regarding the moisture contents at various depths of the subgrade and the adjoining area, void-ratios of the strata, and the depth of the water table below the subgrade, should have been given.

In para. 1.7.11, the Author had recommended that sandy clay soils should be compacted to the maximum density to get maximum strength. The Author, perhaps, meant the Proctor's Maximum Density. Experience had shown that in sandy clay soils where there was a preponderance of sand, compaction aimed at attaining the "Critical Density" which in certain tests was found to be about 80 per cent of the Proctor Density. At the Critical Density, the mixture could withstand unlimited shearing strain without change in volume.

Referring to the design curves given in Fig. 14, Shri Narasimham wanted to know how these curves had been evolved. He opined that actual field observations of pavements which had given good service for at least ten years should form the basis of such curves. The Author's curves were similar to those adopted by the Colorado (U. S. A.) Highway Department. From the speaker's point of view, thickness-design should not be based entirely on the Penetrometer method but should be finalized after comparing it with the C. B. R. method.

Shri Narasimham added that the cone penetrometer method was being replaced by other methods. He considered the Minnesota method, which, too, was an empirical method but was based on the co-relation of observations in the field and in the laboratory under identical field conditions, was more rational than any other method in use at present.

Shri A. Shivaraj observed that the Author had suggested a rational method of designing a road where the conditions of the soil and drainage were not favourable. At page 301, the top width should be 21 ft instead of 22 ft. The Author had advocated the construction of the road in two stages. In the first stage he proposed to put the whole of the metalled portion on one side. If that was done there was the possibility of the traffic using the berms or the shoulders frequently. They would, thus, wear out much earlier than if the metalled width had been placed in the centre. He did not understand what objection there could be to construct the central portion first and then extend it towards the sides. Further, the Author had recommended all along the use of stabilised shoulders but he had not given the details of stabilisation, etc.

Referring to the Author's suggestion of a sand-asphalt carpet for the protection of a water-bound macadam surface, the speaker wanted to hear of something more economical. He wished the Author could carry out experiments to see whether any of the locally available soils could be used profitably to maintain the interlock in a water bound macadam pavement. It would have been more informative if the details of cost had also been given so that one could have an idea of the saving, if any, over the conventional methods.

Shri S. A. Kikkeri remarked that the Author had stated that the whole design of the road bed depended on one factor alone viz. the intensity of traffic. But, in his opinion, four factors should be considered:—

(a) Density of the traffic,

(b) Character of the traffic,

(c) Assumed maximum speed, and

(d) Weight of the traffic.

The Author, in reply to **Shri Naik,** stated that, before designing the soil mixture described in example (1) at page 342, the soils were first subjected to a mechanical analysis. On the basis of this analysis the final proportions of the mix were fixed by trial and error.

The Author was not sure that moorum could be used as a material for a wearing course.

As regards the speaker's querry about the applicability of the curves given in Fig. 14 to water-bound macadam surfaces of laterite aggregate, the Author remarked that the curves were applicable.

Replying to **Shri Sen** the Author said that he did not understand the remarks of the speaker that the permeability of cohesive soils was reduced to zero at the plastic limit, and that, whatever the soil at a height of $5\frac{1}{2}$ ft from the water table, the moisture content of the soil would be very close to its liquid limit.

The Author concurred with Shri Sen that there was need for a separate Subcommittee of the Indian Roads Congress to co-ordinate and collate research work on the design of road beds.

Referring to the remarks made by **Shri Chandrasekharan** the Author agreed that the design curves given in Fig. 14 in the Paper were tentative and required verification by intensive investigations in the field.

With reference to **Shri Narasimham's** comments the Author pointed out that his (tentative) design curves were based on bearing values given by the Cone Penetrometer and were therefore similar to those adopted in the North Dakota States (U.S.A.). Referring to the speaker's criticism about the reliability of the Cone Penetrometer the Author observed that he had found it quite reliable, not only in the laboratory but also in the field. He had found it to be as accurate as the C. B. R. method. In the absence of any comparative data obtained by the various methods mentioned by the speaker the Author could not appreciate that the other methods advocated by the speaker were in any way better. The Author went on to say that the Ninth International Road Congress held at Lisbon in September-October 1951 had recorded* that "the conical penetrometer had been found very

* Conclusions of the Lisbon Congress are published in I. R. C. Journal, Volume XVI-2.

useful for taking the mechanical strength of the stabilized mixtures, especially in the case of sandy soils" (see I. R. C. Journal, Volume XVI-2, page 278). The Author recommended the use of this simple and cheap instrument, at least as a starting point until more experience of other methods was available.

In reply to **Shri Shivaraj** the Author said that soils like the "rotten granite soil" mentioned in Table 3 at page 322 could be used as a good binder in water-bound macadam construction.

Criticising the order of construction by stages suggested by the Author Shri Shivaraj had proposed a different order. The Author was of the view that construction by stages obviously involved some sort of compromise. But whatever the order adopted, the fundamental principles of road bed design had to be borne in mind.

In reply to **Shri Kikkeri** the Author said that the "traffic width" of a road depended upon the requirements of traffic and once this width was determined the design of the road bed would follow as described in the Paper.

Shri U. J. Bhatt (Chairman) in his concluding remarks congratulated the Author on a very interesting Paper. He observed that before designing the pavement all the necessary factors had to be considered. The fundamentals of soil mechanics had to be applied to stimulate the use of materials locally available. It was, however, not possible to lay down specifications which could be applicable to all the parts of the country. He hoped that the Soil Research Subcommittee of the Indian Roads Congress would lay down general principles for the design of pavements, etc.

INDIAN ROADS CONGRESS

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

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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.
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I. Roads in General.

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2	A methed 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
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2	Earth road Development and stabilization with gravel.	Lt.-Col. A. V. T. Wakley	I	4	68-89	5
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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
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7	Collection of material for and consolidation of water-bound macadam.	R. Trevor Jones	V	k(i)	1(k)-5(k) 6(kf)-40(kf)	55

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10	Low Cost Roads for the East.	Col. F. L. D. Wooltorton	XII Parts 3 & 5	125	288 to 327 -3 & 412 to 424-5	125
11	Low Cost Roads in India and Use of Soil Science for their improvement.	G. Sriranga-chary	XIII Parts 1 & 4	135	59 to 146-1 & 112 to 132-4	135

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BOOK REVIEWS

(I) B.S. 63 : 1951—"Single-sized Roadstone and Chippings" —(British Standards Institution, 24 Victoria Street, London, S.W.I.), *pp. 21, 3 shillings net, post free.*

This Standard covers nominally Single-sized aggregate for use in the construction and maintenance of roads and gives requirements for grading and particle shape and methods of sampling and test.

This Standard was first published in 1913. The present revision has been caused by the revision of B.S. 812, " Sampling & Testing of Mineral Aggregates, Sands and Fillers," which specifies the methods of test used.

The most important change in the revised standard in the adoption of the flakiness test for particle shape instead of the elongation test formerly specified. In addition, a glossary of ock and mineral names in group classification is included.

(II) B. S. 812: 1951—"Methods for the Sampling and Testing of Mineral Aggregates, Sands and Fillers"—(British Standards Institution, 24 Victoria Street, London, S.W.I.), pp. 57, 6 shillings net, post free.

The present edition is a complete revision of the one that appeared in 1943 and is intended to bring the standards up-to-date and to cover and co-ordinate more closely the test methods for all the various uses of aggregates, sands and fillers. The standard has been re-arranged so that tests of a similar kind are grouped under one heading.

Tests which have proved unsatisfactory or have given results of doubtful significance have either been omitted or replaced by new tests expected to give more reliable results.

The methods of test described include sieve analysis determination of clay, fine silt, and fine dust; measurement of aggregate shape; density and absorption; organic impurities; impact strength, crushing strength, and aggregate crushing strength; an abrasion test; and dry and wet attrition tests.

Instructions for sampling and for some of the tests have been made more detailed than they were in the previous editions.

A new section has been added to give rock and mineral names in very great detail.

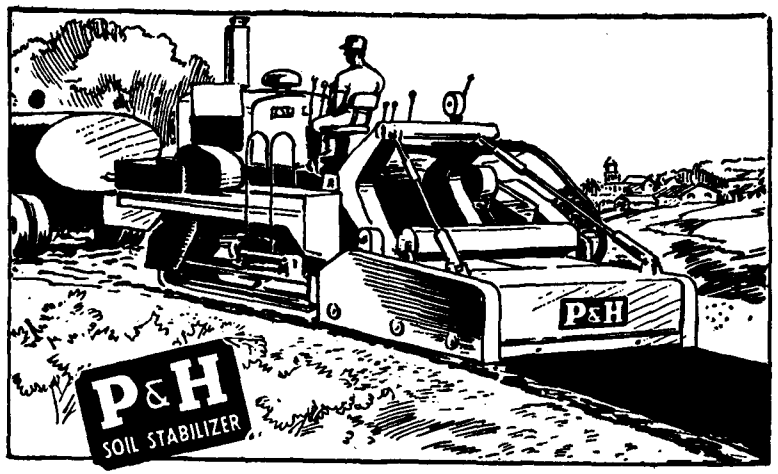
The Standard will be a useful addition to a road engineer's library.

(III) Basic Road Statistics of India—Second (1951) Supplement.

Compiled by the Consulting Engineer to the Government of India (Roads) and published by the Manager of Publications, Delhi; Imperial Octavo; pp. 59 Rs 2/10/- (or 4 sh. 3d).

This useful publication brings up to the end of 1950 the statistical information contained in the Basic Road Statistics of India, 1948, the first supplement to which was published in December 1950. The publication admirably continues to fill a long felt need for a reliable reference book of statistical information required by road engineers and others in their daily work. Any one who is directly or indirectly connected with transport will find it useful to have on his shelf a copy of this book for everyday reference.

This second supplement contains for the first time the latest statistics relating to shipping in India.



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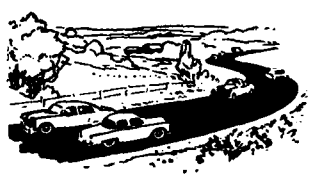

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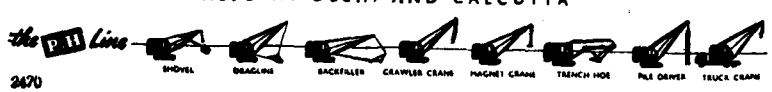

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