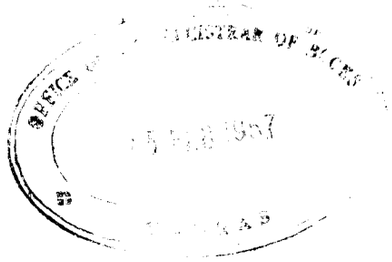
LIST OF MEMBERS OF THE COUNCIL FOR 1955-56.

1. F. P. Antia
2. M. P. Apte
3. C. J. Fielder
4. E. A. Nadirshah
5. Sujan Singh
6. Fateh Chand
7. K. Subba Rao
8. H. S. Batliwala
9. S. N. Gupta
10. M. N. Kamath
11. C. P. Misra
12. C. Seshavatharam
13. B. Choudhury
14. M. L. Bahl
15. W. X. Manscarenhas
16. H. R. Gupta
17. C. M. Bennett
18. D. P. Nayar
19. R. C. Roy
20. M. A. Khayyum Khan
21. P. V. Divatia
22. H. Ananthachar
23. A. C. Malhotra
24. Kishore Lal
25. U. J. Bhatt
26. K. K. Kartha
27. Brig. D. B. Chopra
28. N. G. Dewan
29. T. Mitra



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

The Indian Roads Congress

1955 - 56

INDIAN ROADS CONGRESS

NOTICES AND ANNOUNCEMENTS

CONTRIBUTION OF PAPERS FOR THE TWENTY-FIRST SESSION OF THE INDIAN ROADS CONGRESS

The next General Session of the Indian Roads Congress is likely to be held sometime in April 1957. The exact date, place and programme will be communicated 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 as early as possible.**

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

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. All Members are eligible for the award of the Medals.

7. Rules and Regulations for the contribution of Technical Papers and the award of Medals are published on pages 9 to 14 of Volume XX-1 of the Journal of the Indian Roads Congress—October 1955.

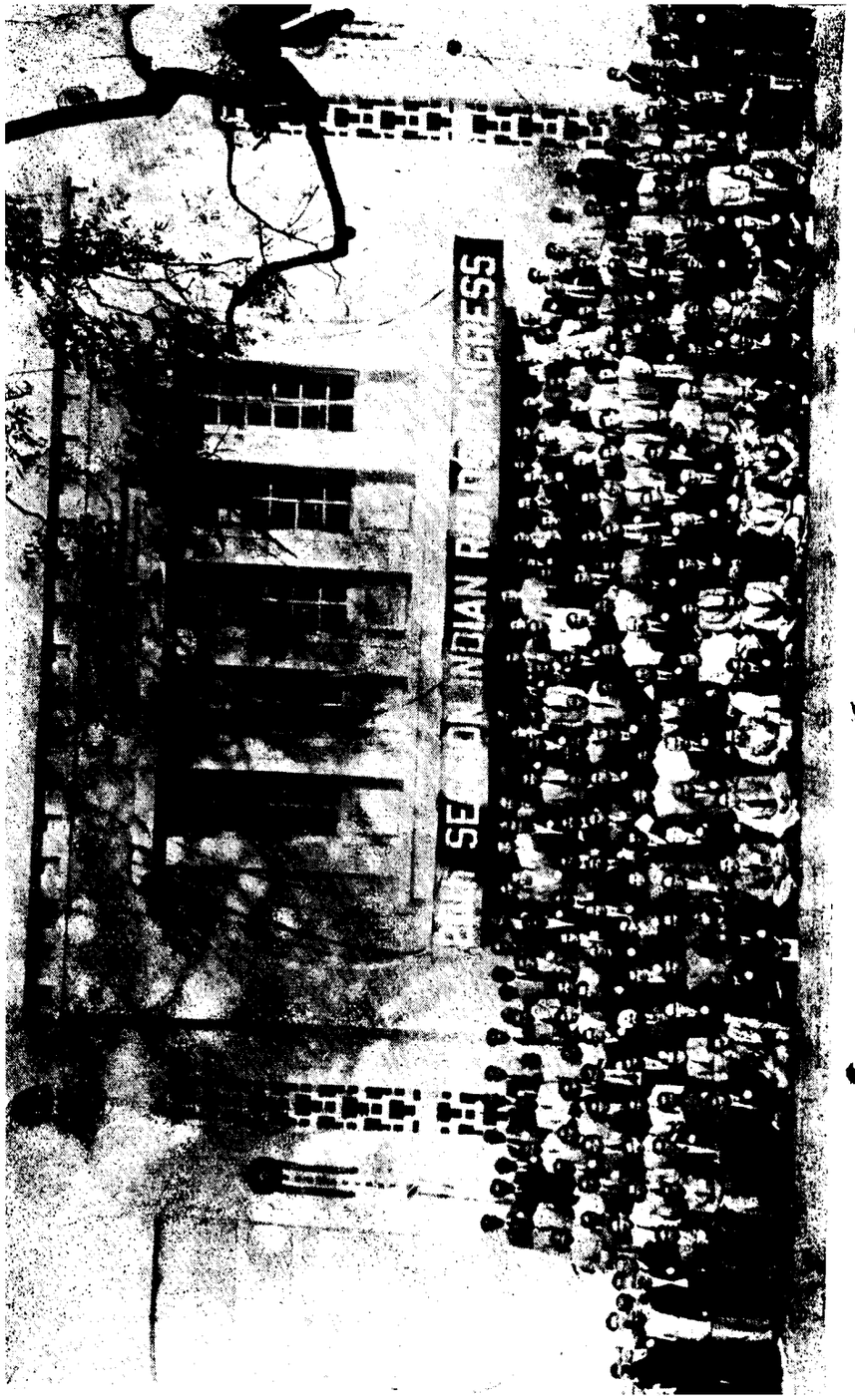
II. NEW ADMISSIONS

LIST OF MEMBERS OF THE INDIAN ROADS CONGRESS ENROLLED FROM 18-11-1955 TO 30-9-1956

Serial No.	*Roll No.*	*Name*	*Address*
1	2003	D. R. Upadhyaya	Assistant Engineer (Consultant), Ministry of Transport (Roads Wing), Jamnagar House, **New Delhi-2.**
2	2004	Sikhar Chand Jain	Assistant Engineer, P.W.D., (R & B), C/o. Provincial Dvn., **Agra.**
3	2005	V. Venkatasubramanian	Asstt. Professor in Civil Engineering (Highway Engineering), Indian Institute of Technology, **Kharagpur** (West Bengal).
4	2006	Santosh Kumar	Assistant Engineer I, P.W.D., **Bareilly** (U.P.)
5	2007	Sudheshwar Nath	Assistant Engineer, I/C. Sasaram Sub-Division, Camp: **Dehri-on-Sone** (Bihar).
6	2008	C. Muthuswamy	Assistant Engineer, Ministry of Transport (Roads), Jamnagar House **New-Delhi-2.**
7	2009	M. B. Singh	Assistant Engineer, P.W.D., **Almora** (U.P.)
8	2010	P. V. Sreenivasaiah	Junior Engineer, C/o. Dr. Rajan, Sreenikethan, New Road, Lashkar, **Gwalior.**
9	2011	N. C. K. Murty	Sub-Divisional Officer, Planning, Chief Engineer's Office, Western Command, **Simla.**
10	2012	Madan Mohan	Sub-Divisional Officer, P. W. D., R. & B., Roads Constn. Sub-Dvn., Tohana, Distt. **Hissar.**
11	2013	D. C. Shah	Deputy Engineer, Roads Sub-Division VIII, **Jetpur.**
12	2014	S. C. Sahasrabuddhe	Assistant Engineer, P.W.D., No. 4 Sub-Division, **Nagpur.**

Serial No.	Roll No.	Name	Address
13	2015	K. H. Patel	Director of M/s. The Modern Construction Co., Ltd., Engineers & Contractors, 2149, Krishnanagar, **Bhavnagar.**
14	2016	C. S. Patel	Managing Director of M/s. The Modern Construction Co. Ltd., Engineers & Contractors, 2149, Krishnanagar, **Bhavnagar.**
15	2017	Badri Prasad Sharma	Assistant Engineer, P.W.D. & Irrigation, Barwani, Dist. **Nimar.**
16	2018	N. Sundaravadivel	Assistant Engineer, Highways, C.R.F. Works, **Madurai** (South India).
17	2019	N. K. Surty	Junior Engineer, P.W.D., Presidency Road, Sadar, **Nagpur.**
18	2020	B. Balwant Rao	Assistant Engineer (Consultant), Ministry of Transport (Roads Wing), 129, Pataudi House, **New Delhi.**
19	2021	S. V. Motwani	Executive Engineer, Special Division No. 1, Central P. W. D., **New Delhi.**
20	2022	Dev Raj Kohli	Branch Asstt. (Highway Engineering), Burmah Shell House, Connaught Circus, **New Delhi-1.**
21	2023	S. Rahman	Executive Engineer, P.W.D. Temporary Survey Division, P. B. No. 3, **Lucknow.**
22	2024	O. Muthachen	Superintending Engineer, Central P. W. D., Talkatora Barracks, **New Delhi.**
23	2025	L. H. Bhatia	Executive Engineer, P.W.D., Akola Division, **Akola.**
24	2026	S. Ramachandran	Executive Engineer, P.W.D., Chanda Division, **Chanda.**
25	2027	S. M. Datta	Executive Engineer, P. W. D., **Shillong** (Assam).
26	2028	N. N. Shah	Superintending Engineer, P.W.D., **Akola.**
27	2029	M. M. Barucha	Sales Engineer, C/o. M/s. Heatly & Gresham Ltd., 9, Forbes Street, Post Box 225, **Bombay-1.**

Serial No.	Roll No.	Name	Address
28	2030	S. Sarkar	C/o. M/s. Heatly & Gresham Ltd., 9, Forbes Street, Fort, **Bombay-1.**
29	2031	R. V. Tambe	Superintending Engineer, P.W.D., **Amaraoti.**
30	2032	D. N. Sinha	Sub-Divisional Officer, P.W.D., G.D. Road, **Purnea.**
31	2033	M. B. Jayawant	Roads Engineer, C/o. Standard Vacuum Oil Co., P.B. No. 181, **Bombay-1.**
32	2034	Brajendra Kumar	Assistant Engineer, P.W.D., Health, Bhukmaria Building, Chandpole, **Jaipur** (Rajasthan).
33	2035	D. D. Sharma	Junior Engineer, C/o. Shri D. C. Gupta, Congress Nagar, **Nagpur.**
34	2036	M. S. Koppikar	Municipal Engineer, **Jamnagar.**
35	2037	A. V. Karnik	Bitumen Assistant, C/o. M/s. Burmah Shell Oil Co., Ltd., Burmah Shell House, Ballard Estate, **Bombay-1.**
36	2038	P. K. Rabindranathan Nair	Assistant Engineer, National Highway Sub-Division, Chief Engineer's Office, **Trivandrum.**
37	2039	T. Nataraja Pillay	Deputy Chief Engineer, **Trivandrum.**
38	2040	M. Bhattacharyya	Assistant Engineer, Govt. Test Track, Majerhat, **Calcutta.**
39	2041	Mohammad Mumtaz	Assistant Engineer, P.W.D., Mohalla Ginnory, **Bhopal.**
40	2042	D. Borgohain	Executive Engineer, Designs, P.W.D., Assam, **Shillong.**
41	2043	G. P. Sen Gupta	Executive Engineer, W. & B. Dept., **Midnapore.**
42	2044	M. A. Karim	Assistant Engineer, Madras Corporation, **Madras.**
43	2045	P. K. Sarkar	Assistant Engineer, Works-Buildings, Govt. of West Bengal, P.O. Chinsurah, Dist. **Hooghly.**



INDIAN ROADS CONGRESS, TWENTIETH SESSION, NAGPUR, JANUARY, 1956.

Shri K. K. NAMBIAR, President, 1955–56.

Shri K. K. Nambiar was born at Cherukunnu, North Malabar (South India) on 14–12–1902 and received his early education there attaining distinction. He graduated with Honours in Civil Engineering from Madras Engineering College in 1926.

Shri Nambiar worked as District Board Assistant Engineer from September 1926 to March 1935 and later as District Board Engineer till 1943. He served as City Engineer, Corporation of Madras from 1943 to 1948. During this period he was responsible for considerable improvements to the road system of the city and for the design and execution of various housing schemes. He was instrumental in the installation of the Central Hot Mix Asphalt Plant at Madras and the mechanised quarry plant at Pallavaram. In 1946, he went abroad to the U. K. and the U. S. A. as a member of the first delegation of "Highway Engineers." He later became Chairman of the City Improvement Trust, Madras. Towards the end of 1949 he was appointed Superintending Engineer (Highways). He was promoted as Chief Engineer (Highways) in September 1951. He has designed and executed very many large bridge works. He is the Author of many Papers and was awarded the Indian Roads Congress Medal for one of his Papers.

Shri Nambiar holds membership of various Technical Institutions in India and abroad. He served as Vice-President of the I.R.C. in 1951-52 and 1952-53 and as Vice-President of the Institution of Engineers (India) in 1946 and again in 1948. He attended the International Road Congress at Istanbul in September-October 1955 as a delegate of the Government of India.

Serial No.	Roll No.	Name	Address
44	2046	D. P. Mukherjee	Asstt. Engineer, N. R. S. Hospital Sub-Division, Works & Buildings Dept., Govt. of West Bengal, Sealdah, **Calcutta-14.**
45	2047	M. M. Nandi	Asstt. Engineer, Development (Roads) Deptt., Midnapore Construction Sub-Division, **Midnapore.**
46	2048	Sailapati Gupta	Assistant Engineer, (W & B), 8/1, Central Park, **Calcutta-32.**
47	2049	A. Y. Gupte	Roads Engineer, Standard Vacuum Oil Co., **Bombay.**
48	2050	C. K. Rangaraja Iyengar	Superintending Engineer, Shimoga Circle, **Shimoga.**
49	2051	P. K. Banerji	Assistant Engineer, Design Division No. 1 (Roads) Shed B, Anderson House, **Calcutta-27.**
50	2052	S. K. Guha	Executive Engineer, Hindustan Steel Ltd., **Rourkela.**
51	2053	C. P. Ganapathy	Assistant Engineer, Hindustan Steel Ltd., **Rourkela P. O.**
52	2054	M. L. Bansal	Assistant Engineer, Roads & Bridges, Himachal Secretariat, **Simla-4.**
53	2055	K. C. Soni	C. M. E., **Kirkee.**
54	2056	S. V. Gopala Setty	Assistant Engineer, Roads & Buildings Sub-Division, **Mysore.**
55	2057	D. C. Palekar	Assistant Engineer, Bombay Municipal Corporation, 95, Shivaji Park Road 1, **Bombay-28.**
56	2058	M. Rangaswamy	Executive Engineer, Special Division, **Warangal.**
57	2059	D. L. Gupta	Executive Engineer, Central P. W. D., Calcutta Division No. II, P-21, Mission Row Extension, **Calcutta.**
58	2060	G. R. Bilolikar	Assistant Engineer, P. W. D., Survey Division No. 2 (B & R), **Nampally.**
59	2061	Shitala Sharan	Assistant Engineer, Uttar Pradesh, P. W. D., **Lucknow.**

Serial No.	Roll No.	Name	Address
60	2062	N. Rahman	Temporary Engineer, Bhorelli Survey Sub-Division, **P. O. Charduar.**
61	2063	L. G. Selvam	Superintending Engineer, Madras Central Circle, C. P. W. D., College Park, Millers Road, **Madras-10.**
62	2064	T. S. Rupal	Executive Engineer, Rampur Division, Himachal Pradesh, P. W. D., **Rampur** (Simla Hills).
63	2065	R. S. Gupta	Secretary and Engineer, District Board, **Bijnor** (Uttar Pradesh).
64	2066	S. I. Mathrani	Assistant Engineer, 6-P Block, Sujan Singh Park, **New Delhi.**
65	2067	L. M. Jali	Bitumen Engineer, C/o. Burmah Shell, Hong Kong House, Dalhousie Square, **Calcutta-1.**
66	2068	R. G. Gokhale	Executive Engineer, C. P. W. D., Bombay Central Division II, 40, Cowasji Patel Street, **Bombay-1.**
67	2069	S. Bagchee	Junior Scientific Officer, Central Road Research Institute, **Okhla,** New Delhi.
68	2070	P. J. Prasad	Assistant Engineer, P. W. D., B. & R., Central Division, **Patna.**
69	2071	S. B. P. Sinha	Assistant Engineer, P. W. D., B. & R., Secretariat, **Patna.**
70	2072	R. S. Marthandam	Assistant Engineer, P. W. D., 44, Marredpally, **Secunderabad-Deccan.**
71	2073	V.N. Sripada Murthi	Assistant Engineer, P.W.D., Iram Manzil, **Hyderabad-Deccan.**
72	2074	N. Misra	Executive Engineer, Mayurbhunj P. O. Baripada, Dist. **Mayurbhunj.**
73	2075	D. V. Sahni	Sub-Divisional Officer, P. W. D., **Chandigarh.**
74	2076	Shaik Mahboob	Executive Engineer, P. W. D., **Osmanabad District,**

Serial No.	Roll No.	Name	Address
75	2077	C. P. Agarwala	Executive Engineer, P. W. D., **Sitapur.**
76	2078	T.G. Krishna Swamy	Executive Engineer, P. W. D., B. & R., Amaravati Division, **Amravati.**
77	2079	K. S. Shah	Director, Shah Construction Co., Ltd., "Megh Doot," 95-B, Marine Drive, **Bombay-2.**
78	2080	B. D. Jayaraman	Special Assistant Engineer, Highways, Kurinjipadi, **South Arcot District** (Madras State), Southern Rly.
79	2081	J. Ghatak	Assistant Engineer, P. W. D., **Moradabad** (Uttar Pradesh).
80	2082	T. E. Kannan	Junior Engineer (Highways), I/C. of L. D. Works, **Pollachi**, Coimbatore Distt.
81	2083	N. H. Koswani	Assistant Engineer (Consultant), Ministry of Transport (Roads Wing), D-19, Nizamuddin Extension (East), **New Delhi-13.**
82	2084	K. Ganguli	Assistant Engineer, (W & B Dept.), Jalpaiguri Construction Sub-Division, P.O. Pillanshat, Dist. **Jalpaiguri.**
83	2085	Chandra Prakash S-Soral	Assistant Engineer, B. & R., Southern Sub-Division, **Alwar.**
84	2086	D. Dasaratharami Reddy	Assistant Engineer (Highways), **Penukonda**, Anantapur District.
85	2087	Peeru Mal Sharma	Assistant Engineer, **Hanumangarh.**
86	2088	M. Khosla	District Engineer, Local Bodies Division, Patiala Road, **Sangrur** (PUNJAB).
87	2089	P. K. Bose	Consulting Engineer, 8 A, Jogesh Mitter Road, **Calcutta-25.**
88	2090	R. C. Jain	Assistant Surveyor of Works, Central Zone, P.W. D., 'L' Block, **New Delhi.**

Serial No.	Roll No.	Name	Address
89	2091	Jal P. Cassad	Mining Proprietor, National Insurance Building, Kingswa **Nagpur-1.**
90	2092	A. N. Sastry	Assistant Engineer, P. W. D **Lakhimpur-Kheri** (U.P).
91	2093	C. Raghavan	Assistant Engineer, Highway **Calicut.**
92	2094	R. S. Prasad	Post Graduate Student, 31, E. I Hostel, **Roorkee.**
93	2095	Pramode Krishnan Lauria	Assistant Engineer, P. W. D B. & R., Bhakra Project Cam **Sri Ganganagar.**
94	2096	N. P. Singh	Assistant Engineer, P.W.D., Proje Sub-Division, **Purnea.**
95	2097	R. Venugopal	Junior Engineer, Highways, Offic of the Chief Engineer, Highway Chepauk, **Madras-5.**
96	2098	K. Palanivelu	Junior Engineer, Office of the Chie Engineer, Highways, Chepauk **Madras-5.**
97	2099	S. H. R. Krishna Rao	Junior Engineer (H), Designs, Offic of the Chief Engineer, Highway **Kurnool** (Andhra Pradesh).
98	2100	B. R. Swami	Assistant Engineer (Civil), M. H. E Scheme, P. O. Anakadali, Vi **Waltair R. S.**, Koraput District
99	2101	Mir Abdur Rashid	Sub-Divisional Officer, C/o. Kh Ghulam Mohiuddin, Under Secre tary, Education, **Srinagar.**
100	2102	D. C. Jain	Executive Engineer, Provincial Division, P.W.D., **Bareilly.**
101	2103	K. D. Chowdhury	Assistant Engineer, Roads, Kalyan Township Scheme, P. O. Kalyani District **Nadia** (West Bengal).
102	2104	D. S. Harwani	Deputy Engineer, Road Sub-Divi sion V, **Junagadh.**
103	2105	P. Atchiraju	Assistant Engineer, Highways, **Vijayawada.**

Serial No.	Roll No.	Name	Address
104	2106	Ravindra Nivas	District Engineer, P.W.D., **Azamgarh**, (U.P.)
105	2107	A. Sunder Raj	Commander, 640 Northern Troops Engineers, C/o. 56 A. P. O., **New Delhi.**
106	2108	Dharm Pal	Junior Engineer, Bridge Section, Chief Engineer's Office, P. W. D., **Shillong** (Assam).
107	2109	P. Ramakrishna Raju	Junior Engineer, Designs, Office of the Chief Engineer (Highways), **Kurnool.**
108	2110	K. R. Saxena	Research Assistant, Hyderabad Engineering Laboratories, Red Hills, **Hyderabad-Dn.**
109	2111	N. S. Rama Sharma	Junior Engineer, Highways, **Srikakulam.**
110	2112	M.Anantha Krishnan	Junior Engineer, Highways, Office of the Chief Engineer, Highways, Chepauk, **Madras-5.**
111	2113	T. Adhiraj	Assistant Instructor, Engineering College, Guindy, **Madras-25.**
112	2114	G. P. Pamnani	Temporary Engineer, Jabalpur Division, P.W.D., B. & R., **Jabalpur.**
113	2115	Mohammed Maqsood Alam	Sub-Divisional Officer, P. W. D., P.O. Raghunathpur, Distt. **Manbhum.**
114	2116	B. L. Agrawal	Assistant Engineer, P.W.D., Garhwa Palamau, (**Bihar**).
115	2117	Alfred A. Thomas	Junior Engineer (Highways), **Tuticorin.**
116	2118	P. Viswanath	Assistant Engineer, P. W. D., Design Office (Irrigation Branch), **Kurnool.**
117	2119	Sushil Kumar	Assistant Engineer, Capital Project, **Chandigarh.**
118	2120	O. P. Kapur	Assistant Engineer, Designs, Punjab P.W.D., B. & R., **Chandigarh.**
119	2121	R. K. Mathur	Assistant Engineer, P.W.D., B. & R., **Banaras Cantt.**

Serial No.	Roll No.	Name	Address
120	2122	M. F. Mehta	Resident Engineer, M/s. Tarapore & Co., Post Box 51, **Camp Sambalpore,**
121	2123	K. R. Srinivasan	125-D, Nehru Hall, Indian Institute of Technology, **Kharagpur.**
122	2124	Yoginder Nath Bahl	Sub-Divisional Officer, Restoration of Damage Sub-Division, P. W. D., B/R, **Jullundur Cantt.**
123	2125	Major A.P.Malhotra	Officer Commanding, Engineer Stores Depot, **Raipur.**
124	2126	Sikandar Lal Malik	Sub-Divisional Officer, P.W.D., B/R, Winterfield, **Simla-3.**
125	2127	A. Aiyaswamy	Junior Engineer (Highways), 97-C, Basant Road, Triplicane, **Madras.**
126	2128	Mohd. Irshadullah	Sub-Divisional Officer, P. W. D., Katihar Distt., **Purnea.**
127	2129	K. S. S. Nayyar	Sub-Divisional Officer, Construction Sub-Division, **Hamirpur**, District Kangra (Punjab).
128	2130	G. M. A. Vijaya Raghavan	Assistant Engineer, Highways, Chinnarutla, Pedda Dornal Post, Via Markapur, **Kurnool.**
129	2131	P. B. Kale	Post Box No. 7, Kingsway, **Nagpur.**
130	2132	S. S. Virdi	Sub-Divisional Officer (B & R), Survey Sub-Division, **Hoshiarpur** (Punjab).
131	2133	K. Ganesan	Junior Engineer, Highways, Office of the Chief Engineer, Highways, **Madras-5.**
132	2134	G. Krishnamoorthy	Junior Engineer, Highways, Office of the Chief Engineer, Highways, Chepauk, **Madras-5.**
133	2135	U. T. Khemani	Executive Engineer, Construction Division, P. W. D., **Jabalpur.**
134	2136	D. Majumdar	Assistant Engineer, (Roads), Road Construction Sub-Division, **Raiganj**, P.O. Raiganj, Distt. **West Dinajpur** (W. Bengal).

Serial No.	Roll No.	Name	Address
135	2137	K. A. Sivagnanam	Junior Engineer, Office of the Chief Engineer, Highways, Chepauk, **Madras.**
136	2138	Kunwar Singh	Sub-Divisional Officer, P.W.D., P.O. Kishanganj Dist., **Purnea.**
137	2139	G. S. Panigrahi	Assistant Engineer, P.W.D., Baripada Sub-Division, P. O. Baripada Distt. **Mayurbhanj.**
138	2140	Mangal Singh	Assistant Engineer, P.W.D., B. & R., Barmer Sub-Division, **Barmer** (Rajasthan).
139	2141	M. M. Swaroop	Assistant Engineer, B & R, P.W.D., **Dausa** (Rajasthan).
140	2142	Jagdish Tewary	Assistant Engineer, District Board, Darbhanga, P.O. **Laheria Sarai** (Bihar).
141	2143	J. P. Kohli	Sub-Divisional Officer, Panipat Provincial Sub-Division, **Panipat** (Punjab).
142	2144	P. M. Mehta	Student in Highway Engineering, C-35, Nehru Hall, Indian Institute of Technology, **Kharagpur.**
143	2145	J. S. Dhaliwal	Sub-Divisional Officer, Karnal Provincial Sub-Division, **Karnal** (Punjab).
144	2146	E. K. Ramachandran	Student, M. Tech. (Highways), 125/D, Nehru Hall, Indian Institute of Technology, **Kharagpur.**
145	2147	B. P. Sinha	District Engineer, Saram, **Chapra,** (Bihar)
146	2148	S. M. Bhagchandani	Sub-Divisional Officer, P. W. D. Kaithal Provincial Sub-Division, **Kaithal,** (Punjab).
147	2149	D. R. Gandotra	Assistant Engineer, P.W.D., Jhajjar Sub-Division, **Kotli-Jhajjar** (J & K State).
148	3150	P. K Patra	Assistant Engineer, Office of the Chief Engineer, P. W. D., Orissa, P.O. New Capital, **Bhubaneswar.**

Serial No.	Roll No.	Name	Address
149	2151	M. A. Hafiz Khan	Divisional Engineer, Highways, Kotli Hills Division, **Sandamangalam,** Salem District. (Madras State).
150	2152	A. Rohatgi	Sub-Divisional Officer, P. W. D., Dumka, District **Santhal Pargana** (Bihar).
151	2153	G. Krishnan	Assistant Engineer, Highways, **Ponneri,** Chingleput Dist.,(Madras State).
152	2154	S. Venkataramiah	Civil Engineer, Expansion Deptt., The Associated Cement Co., Ltd., 121, Queens' Road, **Bombay-1.**
153	2155	Gopal Lal Nog	Technical Assistant to the Superintending Engineer, B & R., 365, Bhupalpura, **Udaipura** (Rajasthan).
154	2156	Ram Dulare Sharan Singh	Assistant Engineer, P. W. D., Jamui Sub-Division, Jamui, **Monghyr,** (Bihar),
155	2157	V. Jagannadha Rao	Assistant Engineer, Highways, **Nazvid,** Krishna District (Andhra Pradesh).
156	2158	A. Natesan	Special Assistant Engineer, Highways, **Paramakudi,** Ramnad District, (Madras State).
157	2159	C. B. Mathur	Assistant Engineer, P. W. D., B/R, **Chittorgarh** (Rajasthan).
158	2160	S. N. Pradhan	District Engineer, 15,Mount Pleasant Road, **Darjeeling.**
159	2161	J. B. Sah	Sub-Divisional Officer, Project Sub-Division, **Muzaffarpur** (Bihar).
160	2162	Lallan Prasad	Engineer Assistant, P. W. D., C/o. Messrs. Thakurlal Som Lal, Dhamintola, **Gaya.**
161	2163	D. K. Kataki	Sub-Divisional Officer, P.W.D., G. S. Road, Sub-Division, **Shillong.**
162	2164	L. Jayachandra Reddi	Assistant Engineer, Highways, **Anantapur,** Anantapur District, (Andhra Pradesh).

Serial No.	Roll No.	Name	Address
		ASSOCIATE MEMBERS	
1	62	M/s. Patel Engineering Co., Limited.	United India Building, Sir Phirozshah Mehta Road, **Bombay-1.**
2	63	M/s Sadiq & Co.	Builders & Haulage Contractors, Kamptee Road, **Nagpur** (Madhya Pradesh).

III. DEATHS

The Council report, with regret, intimations of death of the following Members:

Serial No.	Roll No.	Name	Address
1	158	S. K. Datta	Executive Engineer, P.W.D., Cachar Division, **Silchar** (Assam).
2	2073	Murthi V. N. Sripada	Assistant Engineer, P. W. D., Iram Manzil, **Hyderabad-Deccan.**
3	436	Rasdhari Prasad	Superintending Engineer, South Bihar Circle, **Patna-4.**
4	82	V. N. Rangaswami	C/o. Burmah Shell, Post Box No. 157, Esplanade, **Madras.**
5	1014	P. R. Naga Bushnam	Assistant Engineer, Highways, Famine Sub-Division, **Tiruchirappalli**, (Madras State).
6	916	P. Lakshmi Narasu	Assistant Engineer, Highways, Maharanipet, **Visakhapatnam**, (Andhra).

IV. ADDRESSES 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 them are requested to forward particulars to Secretary, Indian Roads Congress.

Serial No.	Roll No.	Name	Address as last known
1	452	Ajwani, J.M.	C/o. Shri Moti G. Ajwani, No. 56, Bhagwandas Chawl, Bhavani Peth, **Poona.**
2	652	Guruswamy, S.	No. 8, Appaswami Koil Street, P.O. Mylapore, **Madras.**
3	1403	Khosla, B. R.	Garrison Engineer, No. 5, Connaught Place, M.E.S., **Dehra-Dun.** (U.P.)
4	778	Laha, K. P.	Assistant Engineer, (Civil), Construction Division, I. B. & I. D. V. C., **Burdwan.**
5	183	Nawab Ahsan Yar Jung Bahadur	Afsar Manzil, Jubilee Hill, **Hyderabad-Deccan.**
6	417	Parang, Hari Ram	Retired Executive Engineer, Lal Chowk, Qila Gujar Singh, **Lahore.**

V. REMOVALS FROM ROLLS OF THE SOCIETY

List of Members of the Indian Roads Congress whose names have been struck off from the rolls in default of payment of arrears of subscription.

Serial No.	*Roll No.*	*Name of Member*
1	235	N. D. Wale.
2	728	B. Misra.
3	627	B. Lal.

PROCEEDINGS OF THE TWENTIETH SESSION OF THE INDIAN ROADS CONGRESS

Vol. XX - Part 4 NAGPUR January 1956

PRESIDENTIAL ADDRESS

The Twentieth Session of the Indian Roads Congress was held at Nagpur from the 7th to the 14th January, 1956, and was formally opened by Dr. B. Pattabhi Sitaramayya, Governor of Madhya Pradesh at 11.00 a.m. on the 8th January, 1956 in the Independence Hall. The proceedings opened with an Address by Shri K. K. Nambiar, the President, the full text of which is given below :

The Indian Roads Congress is most grateful to you, Sir, for having spared the time to come here to-day to inaugurate this, the Twentieth Session of our Congress. As President of the Congress, it is my cherished privilege to welcome you and the distinguished guests who have graced this occasion with their inspiring presence.

This is the first Session of the Indian Roads Congress to be held in Madhya Pradesh. In this historic place we meet now at the invitation of the Madhya Pradesh Government. We are deeply grateful to them for having so kindly extended their invitation to us and for all the elaborate arrangements they have made for our reception and stay in this city.

The City of Nagpur stands almost at the geographical centre of our Motherland. It is the hub of great Highways, Railways and Airways. Here east passes into west, north into south. Most appropriately, this very place was chosen as the venue of a historic event more than a decade ago. I refer to that landmark in the history of road development in India, the Conference of the Chief Engineers held at Nagpur in December 1943. The deliberations of that Conference aimed at securing for the chequered career of road development a veritable ' Magna Carta '. Although much of the hopes and aspirations of the chief engineers who met here have yet to be fulfilled, their deliberations embodied in a brief but scintillating report, have been to us highway engineers, a beacon light all these long years of trial and tribulation. It is

my earnest hope that this Session of the Congress will be another landmark in the history of road development in our country.

Before I request you, Sir, to declare the Congress open, I would request you to bear with me while I briefly review the constitution and working of this Society for the past two decades and touch upon the immediate tasks ahead of us.

The President delivering his Address

Indian Roads Congress

Until the year 1934, highway engineers in India had no forum for exchange of professional experience and ideas on matters affecting the construction and maintenance of roads, for laying down standards and specifications, and for pooling and dissemination of the experience and knowledge of those engaged in the practice of highway engineering. It was only in the year 1934 that the idea of a common forum took concrete shape under the inspiration of Sir Kenneth Mitchell and the Indian Roads Congress came into existence. Starting with a modest membership of 73, the Congress has to-day on its rolls no less than 1,400 members representing highway engineers of all ranks from Central and State Governments, Military Engineering Services and business concerns associated with highway engineering.

Our Congress has, in socio-legal parlance, come of age, and it seems to be well worth our while to look back into the past 21 years of our growth and activity. During these years we have had 19 general sessions during which we discussed 179 technical Papers, some of which were of a very high order of merit. We have had 45 Council meetings and numerous sub-committee meetings discussing road problems. We have evolved and published several standard specifications among which the Standard Specification and Code of Practice for Road Bridges deserves special mention. Research, education and highway finance are among the important subjects to which we have devoted much thought and attention. Our counsels have been sought by Central and State Governments in shaping their road development policies and programmes. It has been our constant endeavour to emphasize the need for legislation for the development and improvement of roads.

We have built up a very efficient and up-to-date lending library service. Our journal reaches the far corners of the world and is much valued by our compeers abroad. In our monthly publication, the Transport-Communication Monthly Review, we have a useful medium to explain our standards, designs and specifications, and to disseminate significant trends and modern developments in highway engineering to a wide circle of officials and others who may not themselves be members of our Congress.

During the past several years it has been our practice to set up a technical exhibition on a modest scale at each general session. The healthy enthusiasm with which the participants vied with one another to excel has contributed in no small measure to the dissemination of knowledge through picture, chart and model.

This year again we have the usual rounds of sub-committee meetings, panel discussions, the exhibition and some interesting film shows. The 8 Papers to be discussed cover the various aspects of bridge and road construction.

It is well to remind ourselves that the Congress is an association of professional men banded together for the purpose of contributing something individually and collectively to their corporate professional life, and each member is enriched and the association is also enriched in proportion to what he contributes in time and personal interest.

Nagpur Plan in Retrospect

Sitting in session here, the birth-place of the Nagpur Plan, when the First Five-Year Plan is coming to a close and the

Second Five-Year Plan is fast being forged into shape, the temptation to look back and to compare targets with achievements and to re-assess targets with reference to the country's changing needs is irresistible. However, being aware of the fact that a fully statistical appraisal of the situation would try your patience to the limit, I shall confine myself to salient aspects only.

The Nagpur Plan of road development provided for increasing the then existing 88,000 miles of hard surface roads to approximately 123,000 miles. It was envisaged that the earth roads will be increased from 132,000 miles to 208,000 miles (the figures are for the present Indian Union). At the commencement of the First Five-Year Plan the country had approximately 97,000 miles of hard surfaced roads and 147,000 miles of unsurfaced roads. The First Five-Year Plan provided for an addition of about 10,000 miles of hard surface roads and 20,000 miles of earth roads. The Second Five-Year Plan of the various States, as proposed, provides for about 56,000 miles of new roads, of which about 10,000 miles are hard surfaced roads. Thus, at the end of the Second Five-Year Plan, the country will have 117,000 miles of surfaced and 213,000 miles of unsurfaced roads if the demands of the State Governments were to be provided for in full.

At the 1943 level of prices, the proposals contemplated in the Nagpur Plan were estimated to cost Rs 318 crores. But at the level of prices which actually prevailed during the Post-war years, the Plan would have cost nearly Rs 744 crores of which Rs 133 crores would be for National Highways and Rs 611 crores for other roads. Actually, the Nagpur Plan was drawn up by practical engineers who knew all the implications of the Plan. Having regard to the limitations of finance and the capacity of the various agencies for execution of road works, they had set themselves to plan a development which even, if realised in toto, would still have fallen short of our needs. It would have resulted in an insignificant increase in the length of road per square mile and touched not more than the fringe of the problem of bringing roads to communities living in isolation.

Besides laying down the physical targets, the Nagpur Conference also dealt with matters of organization and finance. It emphasised the need for the formation of a Road Board to guide and integrate all road development and also the need for the provision of non-lapsing funds for road works on a statutory basis. While much lip service was rendered to the physical aims and objectives, a solemn silence was maintained about organization and finance, which were apparently considered to be sacred ground on which the work-a-day and realistic engineer had no right to tread.

During the 8 years between the formulation of the Nagpur Plan and the First Five-Year Plan, the roads did not get adequate funds for proper upkeep. In the First Five-Year Plan (1951–56), the provision for road development amounted to about Rs 155 crores inclusive of about Rs 22 crores from the Central Road Fund and Rs 10 crores added for relieving unemployment and constructing inter-State roads or roads of economic importance in rural areas. You can well imagine how inadequate this is compared to the modest aims of the Nagpur Plan and how insignificant a share it is of the total estimated outlay of Rs 2,331 crores under the First Five-Year Plan.

Highway Finance

The situation is nothing new to us; from our past experience if we can trace any single cause as contributing to the backwardness of our roads, it is inadequacy of funds. This question has, therefore, repeatedly and elaborately figured in almost all the Presidential Addresses in the past, and I too feel it my bounden duty to touch upon it again.

Lack of finance for roads is only the result of a certain attitude towards roads in general. This attitude betrays itself in the readiness with which funds intended for roads have been diverted to other purposes and the promptness and severity with which the axe is applied to the road budgets at the slightest excuse. The simple truth is that roads are considered as one of the every day things of life which are taken for granted.

Ten years ago, the then President of our Congress, Mr. A. W. H. Dean, said in his Presidential Address:

"We stand now at the threshold of an era of expanding road construction throughout India, it seems clear that it has at least been appreciated by the various Governments, Central, Provincial and State that we must pursue a policy of plenty. That expenditure in general must be kept at or near its war-time level if we are not to have a slump with large scale unemployment, that wages and the prices of primary products must not be allowed to revert to pre-war figures, and that in providing the necessary employment Government sponsored schemes of public works must play a prominent part. There is a strong desire for improvement abroad and it is for the engineer, as represented at this meeting, to guide this in the direction of a well-planned road construction programme. As regards finance, in the past, this Congress has pressed for loans for roads. We now have available large accumulated revenue surpluses which the Central Government are proposing to allot over the next five years for

expenditure on re-construction. Roads find a prominent place in the programme....."

I quote this passage at length from Mr. Dean's Address because it pulsates with the note of enthusiasm and crystallizes the hopes and aspirations for road development which all Highway Engineers felt and cherished at that time. When considered against the background of subsequent events it spotlights the twin defects in the prevailing system of financing road development: first, the uncertainty of funds, second, their inadequacy. Somehow, the flood gates did not open and let out all those vast reserves of revenue, which Mr. Dean mentions into channels of road development.

Taking for consideration the question of uncertainty of funds, what the Planning Commission has observed is germane to the issue. They said:

"A certain continuity in the supply of funds is essential if wasteful expenditure is to be avoided and programmes, however modestly they may be drawn up, are to be pursued without interruption."

It is needless to describe how much road works and programmes have suffered in the past on account of sudden and sometimes violent fluctuations in the funds allotted for roads. We might have been proceeding smoothly on the basis of the budgets, when, down comes an urgent note from the finance department usually about the time of the revised budget, pointing out the precarious ways and means position, emphasising the need for sharp curtailment of activities, and indicating the drastic cuts to be effected in the various spheres. Faithfully we issue the necessary directives in due course, and are soon mortified by the sight of works suspended "as is, where is", that being the appropriate punishment for works which have been kept up to the schedule of progress drawn up on the basis of the budget.

Non-Lapsing Funds

These situations have acquired a historical sanctity, and will be repeated year after year so long as the highway budgets are doles from the general revenues. They change with changing political climates. To place highway budgets outside the realm of uncertainty, there is only one way, and that, as has been repeatedly urged from this forum, is the creation of a statutory non-lapsing fund for financing all road development and maintenance programmes. If it has been possible to achieve something substantial with the Central Road Fund created on the recommendation of the Jayakar Committee, the success is in no small measure due to the non-lapsing nature of this fund. The principle of this fund should be extended to cover the entire field.

Our Governments to-day are managing what in effect amounts to one part of a transportation service. There has developed a partnership in transportation, not properly appreciated, between Governments, which supply the roads, and private individuals and business firms, which supply the operating plant. The Governments charge the other partners, who may be collectively designated as users, for the service provided by the Governments. Not all the users are directly charged: for instance, pedestrians, cyclists, rickshaws, bullock carts etc. Most of these classes of road users have however to pay to the local municipal or other self-governing authority something for the use of the roads in the shape of licence fees. The largest share of user-taxes comes from motor vehicle operators, private as well as public. In the States sector, these take the shape of sales tax on petrol, motor vehicles and accessories and motor vehicle tax. The Central Government levies a very high excise duty on motor spirit besides import duty on motor vehicles and accessories. Strictly speaking all these are user-taxes. Such road user-taxes should be earmarked for the development and maintenance of roads. At present, the expenditure on roads is less than the user-taxes collected by the Centre and States. All these taxes should be credited to statutory road funds of the Centre and States and their diversion to other purposes should be prohibited by statute. Even after meeting charges for collection and administration, the balance would be sufficient for meeting all normal expenditure on the development and maintenance of roads, provided the road funds of the Central Government are equitably allocated to the States somewhat according to the principle observed in the case of the existing Central Road Fund in order to augment the resources of the States.

All-India Rural Communications Fund

The Taxation Enquiry Commission have stated that "though we are generally against earmarking any revenue for specific purposes, we consider that an exception is definitely justifiable in the context of road development" and have suggested the creation of an All-India Rural Communications Fund which should be "more substantial and non-lapsable". At present the construction of rural roads to serve the villages of India is left to the local bodies who, even though they are in an advantageous position to plan and execute works, have no financial resources. The result is that the construction of rural roads which are essential not only for increasing the standard of living but also for bringing

the urban and rural populations into closer contact lags behind. Therefore, the implementation of the recommendations of the Commission to make an annual contribution from the proceeds of Customs & Central Excise duties on petrol to the extent of 4½ annas per gallon to an All-India Rural Communications Fund and the proposed contribution by each State Government of a sum not less than 25 per cent of the Central grant, to augment this fund, should be done without delay. Without adequate and earmarked funds, rural roads can never receive the attention they deserve and without adequate rural roads the benefit of all round advancement can never reach the rural population.

Highway Bonds

For decades the expenditure on roads had no relation to the actual needs. The net result has been the accumulation of a huge backlog of construction. So, if we really want to meet satisfactorily the growing needs of an expanding economy, funds from other than current revenues will have to be found. Here comes the use of credits which, in the case of highways, generally take the form of Highway Bond Issue. Credit, which is the power to borrow money, permits the current use of future assets. Business and individuals borrow money for capital expenditure. For Governments, no less than for individuals, credit is a useful tool. Borrowing when the use of money is more valuable at the time of borrowing than at the time of repayment holds true for Governments as well as for individuals. The construction of highways brings lasting benefits to the country and borrowing money by issue of highway bonds is, therefore, an appropriate method of raising money for their construction.

A study of the practices of various countries, notably the United States of America, will reveal the fact that the judicious use of public credit in the form of highway bond issues is an effective method of raising funds. The principal of the bond, together with interest, must be ultimately paid from current revenues, in our case, the user tax revenues only, even though the bond issues are secured by the full faith and credit of the Government; in short, the revenues should be more than sufficient to maintain the property and to pay the interest and retirement charges on the bonds.

Broadly speaking, projects which can be financed from bonds may be classified into two categories: those that generate additional revenue; and those that effect a reduction in maintenance expenditure. We may leave out projects of the first category such as toll roads and bridges as unsuitable in the socialistic pattern of society or as entering into the uncertain field of

speculation, but projects of the second category are demonstrably feasible. To this category belong all lasting improvements to existing roads which are subjected to heavy traffic, by the provision of superior surfaces such as of cement or asphaltic concrete, improving geometric elements and shortening distance. All these jointly and severally effect substantial savings in the cost of maintaining the roads and all such savings accruing to the Government can be set off against annual amounts required for the redemption of the bonds.

Such improvements result in other benefits such as saving in vehicle operation costs, allaying dust nuisance, betterment of adjoining properties, value of time saved in travel, and reduction in accidents. The saving in vehicle operation costs may not be so obvious, but is nevertheless real. An expert Committee of the Indian Roads Congress is going into this question of road transport operation costs and the economic justification of road improvement schemes. The Committee is submitting an Interim Report based on the data already made available to it by the various transport organisations in the country. It is definitely established by facts and figures that improvements to roads, such as provision of blacktop and cement concrete surfacings are economically justified in that the savings in vehicle operation costs even at a conservative estimate give a return of as much as 9 per cent of the capital outlay for the improvement.

All the foregoing benefits of an improved highway facility, some of which accrue directly to the Government and others to the road users directly and indirectly, lead to a reduction in the costs of transportation. Since transportation is one of the costs of production, whenever the cost of transportation is reduced our economy is strengthened, and our standards of living can be raised. It matters not whether all the costs are met publicly or privately. Therefore, financing highway improvements by Road Bonds deserves serious consideration holding as they do the promise of a satisfactory solution to the inadequacy of funds.

Service Conditions

We, highway engineers by scholastic and professional training and field experience are no doubt equipped to shoulder responsibilities, but the service conditions in which most of us have to work still leave much to be desired. It is not only the pay and prospects of engineers, but also the administrative set up and the resultant atmosphere that call for a thorough overhaul. The Indian Roads Congress has repeatedly urged, for instance, the provincialisation of the district board engineering services so as to enable these engineers to work in an atmos-

phere free from parochialism and political strings. I might go a step further and suggest that all highway engineers of the rank of Assistant Engineers and above be placed on an all-India footing by the creation of an Indian Service of Highway Engineers. India being a land of endless variety and change, officers should be given reasonable opportunities to serve for a few years outside their native States in order to enrich their experience to the greater benefit of the science and practice of highway engineering in our country.

Separate Highways Department

Turning to broader issues, very few States have till now created separate highway departments. My own State, Madras, is the first State in India to create a separate Highway Department in recognition of the fact that Highway Engineering was fast developing as a specialised field of Civil Engineeering, and that unless the partially provincialised district board engineering services were integrated into a cohesive and well organised Government Department, like the Public Works Department, the people were liable to miss the benefit of modern developments in highway engineering. A brief survey of the stages which led to the creation of the Madras Highways Department might be of interest to you. About 1920 a provincial cadre of District Board Engineers was constituted and in 1939, the service of Assistant Engineers under District Boards was also provincialised. In the year 1935, a Road Development scheme was prepared for the Madras State and a special engineer for road development was appointed to co-ordinate and give technical direction to District Board Engineers. It is interesting to note that he functioned also as Joint Secretary in the Local Administration Department. Eventually this post gave place to three Superintending Engineers (Communications) each with territorial jurisdiction over a number of districts, and in 1942 a Chief Engineer (Communications) was also appointed who later became the head of all the services engaged in the construction and maintenance of roads. The formation of the State Highways Department was the next and logical step from this position.

If to-day Madras has a good system of roads it is in no small measure due to the re-appraisal of the service conditions of her highway engineers from time to time and the reorientation of these conditions to match organisation with the needs. I commend the example of Madras to other States. Without such highway departments dedicated to the task of building and maintaining roads the preparation and execution of our road development projects are liable to be needlessly hampered.

Modern Trends

As public servants it behoves us to see that the funds we expend result in the maximum benefit to the country. One of the fruitful ways in which this can be ensured consists in paying proper attention to modern concepts of highway planning and design.

The basic outlines of our highway systems were laid out long ago and what we can do to-day must necessarily aim at extending and improving them.

Study of trends in the growth of traffic and maintenance expenditure would enable us to choose the roads to be improved before public criticism calls our attention to them. The selection of the road for improvement will be followed by a comprehensive investigation of all relevent matters, to mention only a few, traffic surveys, geometrics such as curvature profile, soil conditions, etc.

The Indian Roads Congress has laid down standards for all the elements of a highway, but the highway engineer should apply his engineering skill and discretion to produce a really good design.

Several methods of pavement design have been developed abroad, ranging from the purely empirical to the highway scientific approach, but, we highway engineers in India have not yet developed any truly indigenous method applicable to our conditions. In this connection, I wish to mention that the question has been tackled at some extent and a tentative solution suggested in the Madras Highways Manual, under issue.

Geometrics

Whether we are designing a new road or an improvement to an existing road we must pay proper attention to their geometric elements such as curvature and gradients so that vehicles may travel in safety and comfort so long as they do not exceed the design speeds. Every surface improvement project affords some opportunity to rectify defective geometrics, and public appreciation of the improvements will be greatly enhanced if we are careful not to let go such opportunities. For new roads, proper geometric design costs next to nothing, and is a gift which the highway engineers can bequeath to society by nothing more than the exercise of their intelligence.

Landscaping

Another aspect of modern highway design practice which does not appear to have received the attention it deserves in India is highway landscaping, otherwise known as roadside development. Let us exercise our aesthetic sense so that the roads we build harmonise with nature. Harmonising with nature calls for gentle side slopes of cuts and fills so that they flow into the natural ground contours with as little break as possible; it calls for a certain correlation of line and grade which aims at avoidance of coexistence of change in direction with change in profile; it calls for the preservation of the natural character of the roadside by the prohibition of unsightly borrow pits, conservation of existing vegetation and supplementing it whenever necessary by new plantation arranged in an informal manner to merge smoothly into the natural landscape beyond the road land. Harmonising with nature is the best insurance we can provide for our works against damage from natural causes and it brings in its wake the blessings of safety and spaciousness and freedom from fatigue to the motorist. It may be contended that the raising of roadside trees costs money; the answer is if some thought is bestowed in the selection of species in order to ensure a fair proportion of fruit yielding trees of which we have a plentiful choice, roadside trees will pay for themselves within a few years as well as yield some additional revenue to the State.

Prestressed Concrete

In the sphere of bridge construction the role of prestressed concrete is self-evident. If we are prepared to accept "an increase of responsibility and effort" we might cut down the cost of bridges by a very large slice or proportionally increase the number of bridges built with the same funds. Fortunately, signs are not wanting of our awakening to this aspect, and prestressed concrete bridges are springing up. I am glad to say my own State, Madras, was the first to venture into the field with the construction of the Palar Bridge the longest of its kind in India. Another bridge, the Coleroon Bridge, bids fair to become one of the finest structures of its kind in the beauty of its lines, in boldness of conception, and in the skill and ingenuity bestowed in execution.

Mechanisation and Employment

I would now speak a few words, Sir, on mechanisation of road works with special reference to employment.

In these days almost any phase of road construction and maintenance can be carried out by mechanical equipment. Such machines were little known and less used in this country. Speaking of Madras apart from the use of power rollers, mechanical equipment for road construction was introduced for the first time only during the thirties when some of the more enterprising district boards purchased a few graders.

During the last war, however, many modern equipments were used in this country in connection with the execution of road projects of military importance. The end of the war and the achievement of independence saw the beginning of intensive construction activity in various fields. The resulting unprecedented demand for labour coupled with the high cost of essential articles made labour exceedingly dear, and scarce in many areas. That was the dawn of mechanisation on a relatively large scale in road construction in our country.

It will be interesting to compare the figures of cost of construction by machinery and by manual labour; but it is impossible to lay down the law in this matter as the parameters involved in the comparison are too numerous.

There is a general tendency to regard construction by machinery more economical than construction by manual labour. With favourable conditions and efficient plant operation, this is probably true. But India is way behind in the manufacture of road making machinery, and can ill-afford to import all the plant required for an extensive mechanisation programme. Besides, such an all-out mechanisation might not be an unmixed blessing from the view point of employment.

Let us consider, for illustration, an annual road works expenditure of Rs 8 crores of which the portion disbursed as direct wages to labour may probably amount to Rs 5 crores. At the rate of Rs 2 for a set of two mazdoors, a man and a woman, this amount represents 500 lakhs work-days or at the rate of 200 work-days per year the figure represents employment for 250,000 labourers all the year round. A glance at the road bills of the country is enough to show what tremendous source of employment road works are.

The lesson for us is that we must watch our step and mechanise more and more, keeping a pace that is consistent with needs. It appears to me that for some time to come at any rate the use of manual labour should continue to be the basic factor in highway construction in our country, supplemented by an adequate number of units of basic road making plant for performing jobs which cannot be satisfactorily performed by traditional methods using manual labour.

Engineers' Responsibility

Gentlemen, I am afraid I have tried your patience sorely.

We, the highway engineers of India, are dedicated to the task of building and maintaining the highway system of our country. Roads are the arteries of civilisation. In days of yore, digging of wells and tanks, building of roads and rest houses, and planting of trees were considered among the highest manifestations of godliness. By virtue of our profession we are the fortunate inheritors of this sublime privilege. Let us be worthy of it. Let us remember that "virtues of character—courage, probity, respect of and love for the task accepted—are infinitely more necessary to the engineer than those of intelligence, which is never more than a tool in the hands of a moral being."

With integrity as the keystone of our professional conduct, with fidelity to the public, and with fairness and impartiality to all, let us rededicate ourselves this day to our task.

Now, Sir, may I request you to inaugurate this, the Twentieth Session of the Indian Roads Congress.

INAUGURAL ADDRESS

In declaring the Session open,
Dr. B. PATTABHI SITARAMAYYA said :

Ladies and Gentlemen,

When first I was asked to inaugurate the Roads Congress Session now being held in Nagpur, I began to wonder what justice there could be in assigning such a duty to me. But it dawned upon me, however, that if I was good enough to inaugurate a Medical Conference, a Nurses' Conference, a Mental Diseases Conference, a Political Science Conference, a Pathology Conference, a Tubercular Conference and finally a Philosophy Conference, there was no reason why I should not be asked to inaugurate a Roads Conference.

The Governor addressing the Congress

The road is the next door companion to the house one lives in. And whichever route one may take, railway, marine, or aerial, a road butts in somewhere, at the beginning or the end of the journey or at both points. Sometimes you may have not dry, solid roads which demand a pair of stout feet to travel upon, the watery streets of a city like Venice which you pass on boats called Gondolas—may be an exception, but roads, solid or liquid, can be truly defined as the life-lines of civilization.

When first I entered the Municipality of the town where I had been practising medicine, roads formed the cinderella of the sisters that claimed the attention of councillors. While the budget of the establishment covering nearly 15 per cent of the revenues could not only not be reduced, it constantly claimed increased grants on account of the natural increments in pay of the establishment and the increase in the total budgeted figure. So did education, lighting, hospitals and general sanitation. The one item which had no body to beat and no soul to lose, was the item of road (pompously described as civil works). Every increment suggested in respect of the other items of expenditure implied and involved a curtailment of expenditure on roads only because roads had no tongue to speak.

But those days of apathy and indifference are gone. There is in our country today a dynamic pulse-beat. The nation is alive and vibrant. In its splendid industrial performance to date there resides a very real hope that the day is nearing when India's people will have attained their lofty goal of a fuller, richer life.

Speaking of roads, I have something to say about bridges as well, for there is hardly a road, be it all-India, provincial, district, that is not interspersed by bridges. I was touring the Madhya Bharat visiting the Maharashtra States of Gwalior, Indore, Dewas and Dhar. At Dhar, we had to cross the river (Narmada) over to Maheswar on the other side. As we were driving over the bridge on the river in the year 1947 or so, the driver of our car suddenly made a detour and began to descend gently to a side while the bridge along which we had been driving appears to be quite intact straight ahead. And when I asked the driver why he made a detour, he told me that the bridge virtually ended there, as there was only another ten yards of its length ahead and then there is the river unbridged about two-thirds of the breadth. It was a disastrous situation to a new person. They did not even place a number of big stones in a line to indicate danger. On careful scrutiny, we found small tin tube road metal pieces arranged in an irregular line across.

Old curves and new risks

I wish to butt in as a layman, though I know that the matter to which I am going to refer is somewhat of a technical character. I am referring to bridges and level crossings. There is one common feature regarding these, namely, that the road on either side of a bridge or a railway level crossing, generally speaking, is given as long a curve as possible before the bridge or the level crossing is reached. I have interpreted the curve as

A Section of Audience.

meant to give a greater length of road so as to make possible an easier gradient. Bridges in Godavari and Krishna districts over the navigation canals are placed very high, obviously to permit boats to pass under, as compared to the level of the road half a mile to one mile away from the location of the bridge. Level crossings also are reached on either side by curved road instead of a straight way, though the question of gradient does not seem to arise, unless the railway line happens to be too low or too high. These curves of roads were innocent of all mischief in former days when traffic was relatively slow, the fastest being a tonga. Now when the motors have come, the sharp or easy curves maintained on the road at bridges and level crossings have become a source of terrible danger, since as soon as the traffic is restarted after the train passes, there is a jumbling of cars, jeeps, tongas and double bullock-carts with the result that a jeep is upset at times. On the eve of the last general elections, the then Chief Minister of Bhopal, Master Lal Singh, had to wait for 20 minutes at the railway level crossing which obstructed his way to the Returning Officer's place where the nominations of candidates had to be registered. The gates were thrown open after 20 minutes and in the melee that took place, the jeep capsized and five people including Mr. Lal Singh, the Chief Minister of Bhopal, died.

I hope you will deal with the new situation of high speed traffic in relation to the sharp bends in the roads approaching level crossings and bridges.

Rail and River Transport, it has been wisely stated, nearly always begins and ends with a good road service. It is true to say that all economic life depends upon good roads, to quote one of the resolutions of the International Chamber of Commerce of 1953.

Roads require planning as much as railways, and buses, river projects, schools and hospitals, for planning means not only a decision whether a work is necessary or not, but also a comparison of the need for the work with that of all the others and the selection of the one most needed.

Road accidents and how to avoid them are an eternal problem. Every town, big and small, has to face them. I read on the 1st January 1955 that Caracas-Venzeula—a city much smaller than the Havana Club, has virtually no accidents because of the following rules :

(1) The car on the right has the right of way at any intersection. As a result you never go before a Judge because of a collision at a crossing. The one on the left simply pays for all damage and also a fine. There are no arguments, no time lost in Court.

(2) Whoever hits another car from behind is always responsible. It makes no difference if the leading driver neglects to signal for a turn. Every car must keep at least 10 yards behind the next.

(3) Finally no one may drive after drinking alcoholic beverages. On Sundays, when dangerous roads to the beaches are jammed, the ' traffic prosecutors ' stop each vehicle and put a special glass device in front of the driver's mouth. If the indicator turns red, he has consumed alcohol and cannot go on driving. He must leave the car and come back another day. A terrible nuisance, but many lives are saved.

I am sorry that these elementary rules of traffic which ensure freedom from danger and risk to pedestrians and property are not observed. In a city like Nagpur not even 2 per cent of the motor owners or drivers care to dim their lights. Lights are there not only to guide the motorist but also the public and neglect to operate them aright results in accidents which are clearly avoidable.

The safe side and suicide

Many a life would be saved and many a motorist would avoid the inconvenience and expense of costly accidents, if all who drive cars would make it an inviolable rule to use the car door away from traffic.

Keep pace with traffic

Accidents can be avoided by keeping pace with the rest of the traffic on road or street. Motorists who drive too fast must pass many other cars, increasing their own hazard. Motorists who drive too slowly cause other drivers to pass them too frequently and often at the wrong time.

Roads and bullock-carts

We have several means of transport:

(1) men and women carrying head-loads,

(2) single and double bullock-carts which are used for local needs and are not put to use for long distances,

(3) lorries and buses,

(4) railways, and

(5) waterways.

The bullock-cart stands to be revived with great advantage, particularly during such emergencies as war-time. When this suggestion is made, it is apt to be laughed at. But if only during the last war, our bullock-carts could have been duly set in motion and mobilized for traffic by a well-organized system, we would not have felt the pinch of shortage of waggons.

I shall give you an example. In 1949, when the controls were still effective, there was a conference of the Prime Minister of India, and of half a dozen Central Ministers, as also of the Chief Ministers of States on the question of controls. I was invited to the conference as the President of the Congress. Two such conferences took place in two successive years 1949 and 1950. At the first of these conferences casually the Food and Agriculture Minister asked the Railway Minister as to when he could expect the waggon he wanted to bring a pump and engine from Bombay to Patna for purposes of lift irrigation. It was the month of July-August. He had asked for it in May, but the waggon was not obtained, but the Railway Minister assured him of early supply. At the next conference held in August 1950 the same question was put to the Railway Minister by his colleague, as unfortunately a year and two months after too, the waggon was not obtained. This I told the latter: If you had loaded a double bullock-cart in May last year the pump

and engine would have arrived in Patna in 45 days, travelling at the rate of 20 miles a day or a total of 900 miles. But a year and two months have passed and yet the waggon has not been supplied.

It would be a most useful addition to our traffic facilities if the double bullock-carts could be serried and form little caravans.

Roads that are built cheaply are expensive to maintain. In a short while, what is saved by cheap construction, is lost in expensive maintenance. Take the case of a battered road. All that havoc was caused by one monsoon. A lot of money will now have to be spent to make it serviceable again. It is a completely different story with concrete roads. They have withstood this year's record monsoon wonderfully—where other roads surfaces broke up badly. And there are hardly any maintenance expenses for concrete roads. Concrete is the ultimate low-cost pavement.

The Engineer and public service

In his effort to serve the public, the Engineer must become accustomed to pressure and criticism and, in spite of it, must maintain an impartial and professional approach to the rendering of public service.

Two motorists met on a road too narrow for two motors to pass. "I never back up for an idiot," yelled the driver. "That is all right," said the other shifting into reverse. "I always do".

Hurry is dangerous

Hurried driving is a cause of accidents. The reason is that a sense of being in a hurry clouds a drivers's judgment and often causes him to take chances.

Did you know? You can shorten a tyre's life by as much as 600 miles if you drive it continually at only one pound under recommended pressure.

Let the other fellow pass. The driver who races with cars that are trying to pass him on the highway is endangering his own life and the lives of others. When being passed, slow down, pull over to the right a little and let the other fellow pass.

The objective of doubling India's per capita income calls for a more adequate road system. The railways are overstrained because of the neglect of other forms of transport. A fairer distribution of transport among different agencies should begin, it is said, with 60,000 additional lorries on roads. The extent of

overall transport deficiency is indicated by indents for 110,000 wagons remaining in arrears in 1954. Without roads, the scope and utility of every other item of development in the plans of the Planning Commission would be severely retarded.

Mr. Wenzil, Vice-President of the Indian Roads and Transport Development Association, speaking at the 27th Annual General Meeting of the Association in Bombay on 4th November last, pointed out how the Nagpur Road Plan of 1943, altogether modest in its scope, envisaged the increase of our road milage from 220,000 to 331,000 miles with unmetalled roads, constituting 63 per cent of the total. In an area of 1¼ million square miles, this milage works out to no less than 1/3 of a mile of road per square mile of territory. It was accordingly hoped that in the Second Five-Year Plan the remainder of the Nagpur programme, namely, 57,000 miles, would be recommended. These hopes do not seem likely to materialize since the Planning Commission have agreed to a total allotment of about 230 crores only or 250 with the addition of the Central Road Fund, instead of the 350 crores expected. We can readily appreciate the difficulties of the Planning Commission, but we are judging the figures only in relation to the objective of doubling the per capita income in the space of 15 to 20 years. Either this noble objective must be weakened or the allotment for roads strengthened. The result has been undue strain on railways and the demand by railways of 1,500 crores out of a total development expenditure of 4,500 crores in the Second Five-Year Plan, i.e., as much as 33.3 per cent.

To increase the length of roads is one thing, to increase the vehicular transport is quite another. Against an average increase of about 12½ per cent per annum in the number of vehicles in the country at the beginning of each 15-year period from 1920-21 to 1950-51, the average increase during the four years ending 1954-55 of the First Five-Year Plan has been only about 3.5 per cent per annum. This calls for notice.

Again, the restriction of goods traffic by lorries to the district and the prohibition of inter-district traffic by lorries and the prohibition of the road transport beyond the 50-mile zones at first and later beyond 75-mile zones or 150-mile routes, has made the law a dead letter except in one or two States.

In U. S. A., no such restrictions exist. A distance of 1,080 miles is covered in two and a half days between St. Louis and New York.

For a long time this State has been known as the Central Provinces which has been latterly changed into Madhya Pradesh.

The name is quite correct because the geographical centre is in this State. The name Madhya Pradesh has been under the State Reorganisation Commission's Report assigned to a newly-created composite State composed of the Jabalpur and Chhattisgarh divisions of this State and three other new States, Bhopal, Vindhya Pradesh and Madhya Bharat. Such a change of name is correct too because the geographical centre is situated somewhere near Jabalpur. Long years ago I remember having read in the proceedings of the Imperial Legislative Council or the Supreme Legislative Council at Delhi as it used to be then termed, that the geographical centre was somewhere near Jabalpur and that, therefore, the new capital of Delhi should be shifted to that point near Jabalpur. After I had taken charge of this State, I caused an enquiry to be made about this point on visiting Jabalpur for the first time. I further learnt that there was a stone somewhere in the premises of the Telegraph Office of Jabalpur and was lost in the vegetation that grew round it and altogether concealed it. We thus rediscovered this stone—2½ feet tall with two other brick and mortar pillars—the three forming a straight line 5 or 6 yards long along the longitude of India. The following inscription was found on the central stone :

G. T. SURVEY
JABALPUR
LONGITUDE STATION
LT.-COL. W. M. CAMPBELL, R.E.
MAJOR W. J. HEAVISIDE, R.E.
MAJOR C. STRATHAM, R.E.
1880—1883

CAPT. S. G. R. GRAND, R.E.
Lenex Cunyngham, R.E. (Officer-in-Charge No. 13 Party)
1890—1893

The Principal of the Engineering College promised to give a note on the subject. He has later prepared a blue-print working out the centre by taking the latitudinal centre also. The centre of India has been located at the point where the road about 4 miles from Umeria is crossed by the river Belkunda which is a tributary of the Hiran river, this point being reached by a jeep from the Sihora Rest House. The point is located on a flat plain girdled more or less on all sides by low hills. It looks more or less like a sauce and looks beautiful. This is a catchment area of a few rivers—Belkunda, Hiran, Son and even Narmada, if we go some distance on the eastern side. At this centre there are a number of fields under cultivation and a number of beautiful

ots for sightseers. A small monument with a concrete base, a ncrete cylinder and a metal pipe with a flag have been fixed at .e spot at 4 p.m. on 9th November 1955, in Karondhi village. his, however, may be regarded as only the first "proof". r. S. P. Chakravarti, to whose adventurous spirit I owe this search, will shortly visit the place once again and I shall ccompany him next month.

PRESIDENT'S CONCLUDING REMARKS

Dr. Pattabhi Sitaramayya, Ladies and Gentlemen,

I thank you, Sir, for inaugurating this the 20th Session of the Indian Roads Congress and for your encouragement. Our Society has been developing standards and technique to suit modern needs, taking into account the high-speed vehicles. You have, Sir, spoken about the congestion at level crossings and the need for improved alignment of roads to minimize hazards. In this direction we have laid down standards and specifications for level crossings, curves, etc. Also it is proposed to convert the more important crossings on N. H's to overbridges. We, the road engineers, have ourselves noticed that the sharp curves given to approaches to bridges, to make them square to the rivers to be crossed to reduce their cost, are very dangerous to the modern fast moving vehicles. We have therefore skew bridges wherever necessary to make the approaches easy.

In our country, the bullock-cart will perhaps be the principal mode of communication for the villagers for many more years to come. The Roads Congress has, after a protracted research, evolved a design for a wheel which will cause minimum damage to metalled roads. Also there is a proposal to encourage pneumatic tyred carts for use in urban areas.

Now, may I request you, Sir, to present the **Indian Roads Congress Medal** to Shri P. C. Varghese for his Paper "A New Approach to the Analysis of Stability of Slopes" and Col. S. K. Bose for his Paper "The Influence of a Superimposed Layer in Increasing the Load Bearing Capacity of Rigid Pavements."

I have to mention that the following Papers have been highly commended:

(1) "Bituminous Treatment of Brick Metal Water-Bound Macadam Surfaces in Uttar Pradesh" by D. C. Chaturvedi,

and

(2) "Design and Construction of Prestressed Concrete Bridge Across Palar River" by K. K. Nambiar.

MESSAGES

to

the Twentieth Session of

The Indian Roads Congress

held at Nagpur from 7th to 14th January, 1956.

Shri O. V. Alagesan, Deputy Minister For Transport & Railways, Government of India.

I have watched with close interest the continued progress made by the Indian Roads Congress and I have great pleasure in sending my best wishes to its 20th Session at Nagpur.

The Congress will be meeting on the eve of the launching of the Second Five-year Plan. All interested in the development of roads in this country should be glad that the targets set in the First Plan for road development have been practically achieved. This success is largely due to the zeal and untiring efforts of Indian Engineers, both State and Central, who were in charge of the execution of the Plan. The size of the Second Plan is going to be somewhat bigger than that of the First Plan though it may not be as large as was expected. The engineers who will be entrusted with the execution of the Second Plan have a great responsibility to ensure that every rupee is spent to the best advantage of the nation. I would, therefore, commend for the special consideration of the Congress the problem of evolving suitable standards, specifications and designs with a view to reducing costs without detriment to the life of structures.

I wish every success to the Nagpur Session.

Shri A. Q. Ansari,

Minister, Public Works & Housing, Bihar.

Network of good road communications connecting villages with towns and cities and main markets would lead to speedy liquidation of poverty and illiteracy. Since India lives in villages and there can be no real progress unless life in villages improves which is not possible without easy communication facilities engineers gathered at this Road Congress Session would be doing

great service to country if they evolve some cheap and easy method for improvement of village roads expeditiously. Nagpur formula adopted by Indian Roads Congress in 1943 proved a turning point in the history of road improvement in this country. May history repeat itself again at Nagpur and Congress give us another formula now for improvement of village roads, in other words a formula for quick development and progress of our country. I wish the Session every success.

Shri K. Santhanam, Lt.-Governor, Vindhya Pradesh.

I have great pleasure in sending my good wishes for the success of the Session. Our attempts to reconstruct the national economic life are being greatly impeded by the absence of roads, bridges and culverts. In the backward areas of the country, the absence of bridges and culverts isolate millions of people for many months in the year during the monsoons. I earnesly hope that the Roads Congress will devote its attention to this matter.

Sir Kenneth Mitchell, Past President, I. R. C

I am afraid that once again I must say that I hope to be with you "another year," but I do very greatly appreciate the courtesy and kind thoughts that prompt the yearly invitation.

This is a Session and site of note. Twenty years is a long time but I still have very clear memories of that first meeting at Delhi when it was my privilege to read the first Paper—proposing the creation of the Congress. It proved to be an auspicious occasion, and what remarkable fruit it has borne. Not only has the Congress done great things for roads in India, but it stands I believe high in International reputation.

You will be meeting, too, at Nagpur twelve years and one month since the Chief Engineers produced the road plan at that hospitable centre. At the time and for a year or two afterward, there was some criticism of the "grid and star" formula. Some critics said that the correct approach was to compile huge lists of roads "needed". They did not see that with road needs almost infinite, particularly if finance was to be partly central aid to "federal" units some rational measure of the "target" must be found.

I dare say that defects of detail in the formula have come to ;ht; and I appreciate that the road plan has to be dovetailed to national plans for all things, but the original thinking in at formula, for which I think my old friend Vesugar was wholly mainly responsible, made mild history in that field—or so think.

So this Session and its venue are noteworthy, and I send the ongress my greetings and best wishes for another successful ession.

Messages of Good Wishes and Success of the Session have also been received from the following Technical Institutions from U. S. A., Australia and Japan.

(1) American Society of Civil Engineers, U. S. A.

(2) American Association of State Highway Officials, U.S.A.

(3) Highway Research Board, U.S.A.

(4) Japan Society of Civil Engineers, Tokyo.

(5) The Institution of Engineers, Australia.

(6) Japan Road Association, Tokyo.

INDIAN ROADS CONGRESS

20th SESSION—NAGPUR—JANUARY 1956

The Indian Roads Congress held its 20th Session at Nagpur, the birth place of the Nagpur Plan, from 7th to 14th of January 1956. The Session was inaugurated by Dr. B. Pattabhi Sitaramayya, Governor of Madhya Pradesh. 247 delegates from all parts of India attended the Session. Shri K. K. Nambiar, Chief Engineer (Highways), Madras, delivered the Presidential Address. He stressed on the need of having non-lapsing funds to ensure proper planning and execution of road works. Without adequate earmarked funds, rural roads cannot receive the attension they deserve, and without adequate rural roads the benefit of all round advancement can never reach the rural population. Therefore, he urged on the necessity of immediately implementing the recommendations of the Taxation Enquiry Commission in respect of an All India Rural Communications Fund.

Messages of goodwill from Shri O. V. Alagesan, Union Deputy Minister for Railways and Transport, Shri A. Q. Ansari, Minister for Public Works & Housing, Bihar, Shri K. Santhanam, Lieut. Governor, Vindhya Pradesh, and several others were received.

Eight Papers were discussed and about seventy speakers took part in the discussions. A Panel discussion on Surface Dressing was also arranged.

'Indian Roads Congress Medals' were awarded to Shri P. C. Varghese for his Paper "A New Approach to the Analysis of Stability of Slopes" and to Col. S. K. Bose for his Paper "The Influence of a Superimposed Layer in Increasing the Load Bearing Capacity of a Rigid Pavement". Also, the following two Papers were highly commended:

(1) "Bituminous Treatment of Brick Metal Water-Bound Macadam Surfaces in U. P." by Shri D. C. Chaturvedi, and

(2) "Design and Construction of Prestressed Concrete Bridge Across River Palar" by Shri K. K. Nambiar.

There was the usual round of technical activities. The Specifications and Standards Committee, the Research Organization Division, the Education Subcommittee, the Soil Research Subcommittee, the Manufacture of Road-Making Machinery & Mechanization Subcommittee, the Road Transport Development

Committee, and the Road Transport Operation Cost Commitee met and discussed various technical problems during the Session. The Council held its 46th and 47th meetings. At the 47th meeting held on the 12th January, Shri P. L. Varma, Chief Engineer, Buildings & Roads, Punjab, was elected President. Shri R. C. Roy, Chief Engineer (Roads), West Bengal, Shri H. R. Gupta, Chief Engineer, Buildings and Roads, Madhya Pradesh, and Shri W. A. Griffiths, Burmah-Shell Co. Ltd., were elected Vice-Presi-

47th Council Meeting.

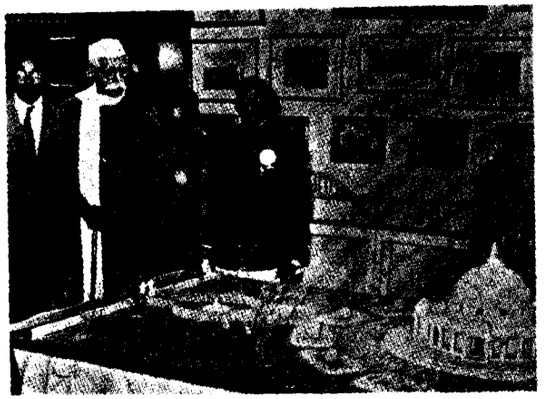
The Governor presenting the I. R. C. Medal to Col. S. K. Bose.

dents. The Council recommended to the various States that one per cent of their allocation from the Central Road Fund should be set apart for research work.

The Chief Engineers of the various States held a meeting during the Session to discuss various technical problems.

Shri R. S. Shukla, Chief Minister, Madhya Pradesh declaring the exhibition open.

The Chief Minister visiting a stall.



Stall of Madhya Pradesh Government.

On the 8th January Shri Ravi Shankar Shukla, Chief Minister, Madhya Pradesh, opened the technical exhibition. Declaring the exhibition open, the Chief Minister said that roasds occupied an important position in the national reconstruction work that was now going on in the country.

"We can't proceed an inch without roads", he said and added, "the utility of roads in any development programme could not be over emphasised."

Paying tribute to the Engineers who had gathered on the occasion of the Congress, the Chief Minister said that they must remember that they were engaged in a great nation-building task.

"We were passing through a time," the Chief Minister went on to say, "when we must have good roads as quickly as possible with the aid of our man power as well as machine power."

Many State P. W. Ds, and engineering firms participated in the exhibition. A list of Govt. Departments and firms, who participated in the exhibition is published at page 462.

On the 13th and 14th of January the delegates visited the Nepa Paper Mills at Nepa Nagar and the submersible bridge under construction across the river Narmada at Mortakka.

List of Government Departments and Institutions ETC who participated in the Technical Exhibition at Nagpur

Central Public Works Department, Delhi.

Central Road Research Institute, Delhi.

Bihar P. W. D.

Bombay P. W. D.

Madhya Pradesh P. W. D.

Madhya Pradesh, Social Welfare Department.

Madhya Pradesh, Publicity Department

Madhya Pradesh, Cottage Industries.

Madras, Highways Department.

Punjab, P. W. D., B & R Laboratory, Karnal.

West Bengal, Road Development Department.

M/s. Concrete Association of India Ltd.

M/s. Burmah-Shell Oil Storage & Distributing Co., Ltd.

M/s. Heatly & Gresham Ltd.

M/s. Kailash Brothers Ltd.

M/s. Kamani Engineering Co.

M/s. Larsen & Toubro Ltd.

M/s. Millars' Timber & Trading Co., Ltd.

M/s. Shalimar Tar Products (1935) Ltd.

M/s. Standard Vacuum Oil Co., Ltd.

M/s William Jacks & Co., Ltd.

Minutes of the 46th Council Meeting of the INDIAN ROADS CONGRESS held at Nagpur on the 7th January 1956.

Present :

K. K. Nambiar - President

F. P. Antia
H. S. Batliwala
C. M. Bennett
U. J. Bhatt
B. Chaudhury
P. V. Divatia
N. Durrani
C. J. Fielder
Goverdhan Lal
W. A. Griffiths
H. R. Gupta
S. N. Gupta
A. Kayyum Khan
A. C. Malhotra
H. P. Mathrani
T. Mitra
E. A. Nadirshah
D. P. Nayar
R. C. Roy

J. Subrahmanyam — Secretary

The following co-opted Members attended :

K. F. Antia
S. R. Mehra
G. R. Nangea

The following invited Members attended :

C. S. Anantapadmanbhan
P. R. Aramadhu
B. V. Vagh
J. M. Trehan
Arjan Singh

1. Confirmation of the Minutes of the 45th Council Meeting.

The Minutes of the 45th Council meeting held at Srinagar on the 18th June 1955 published at pages 629 to 631 of Volume XIX-Part 4 of the Journal of the Indian Roads Congress were confirmed.

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

The Minutes of the meetings of the Executive Committee held at New Delhi on the 20th September and the 8th December 1955 were approved.

3. Audit Report for the year 1954-55.

The report of the auditors for the year 1954–55 was recorded.

4. Draft Report of the Council to the General Body of Members for the period 1st January to the 31st December 1955.

The draft report was approved.

5. **Budget.**

The budget estimate for 1955-56 was approved.

6. **Miscellaneous.**

(1) The Council decided that early steps be taken for the appointment of a Technical Secretary, Indian Roads Congress.

(2) The Council considered issuing Papers as separates. If necessary loose binders may be supplied to members to enable Papers and discussions bound under one cover. It was decided that the economics of this suggestion be considered by the Executive Committee.

(3) The Council decided that the criteria for prestressed concrete be published as a tentative specification for discussion by the General Body at the next Session of the Indian Roads Congress.

It was also emphasised that the remaining Sections of the Standard Specifications & Code of Practice for Road Bridges should be prepared as early as possible.

(4) It was decided that Chief Engineers and other Council members should procure Papers for the next Session of the Indian Roads Congress. The following Council members promised to send Papers for the next session.

K. F. Antia
C. M. Bennett
U. J. Bhatt
N. Durrani
A. K. Khan
S. R. Mehra
K. K. Nambiar

Minutes of the Business Meeting of the

INDIAN ROADS CONGRESS

held at Nagpur on the 11th January 1956.

The Twentieth Annual General Meeting of Members was held at Nagpur on Wednesday, the 11th January 1956 at 10-30 A. M. In all 240 Members and 7 invitees (names and particulars at pages 470-477) attended the session.

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

The minutes of the last Business Meeting held at Srinagar on the 22nd June 1955, as printed at pages 589 to 628 of the Journal—Volume XIX-part 4, September 1955 were confirmed.

3. **Audit Report.**

(i) The Audit Report for the period 1st October 1954 to the 30th September 1955, pages 479-481, 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 (pages 483-502) was taken as read and approved.

5. **Resolutions of thanks.**

The following resolutions were passed:

(i) The Indian Roads Congress thank the Government of Madhya Pradesh for their kind invitation to hold the Twentieth Session of the Indian Roads Congress for their hospitality and for the excellent arrangements made.

(ii) The Indian Roads Congress thank Dr. B. Pattabhi Sitaramayya, Governor of Madhya Pradesh for inaugurating the Twentieth Session of the Indian Roads Congress and for his permission to print his Address in the Journal of the Indian Roads Congress,

(iii) The Indian Roads Congress thank Shri Ravi Shankar Shukla, Chief Minister, Madhya Predesh for declaring open the Technical Exhibition organized by the Indian Roads Congress on the occasion of the Session and for his encouraging speech made on that occasion.

(iv) The Indian Roads Congress thank Sardar Swaran Singh, Minister for Works, Housing and Supply, Govt. of India, for his best wishes for the success of the Session.

(v) The Indian Roads Congress thank Shri K. C. Reddy, Minister for Production, Govt. of India, for his hearty congratulations and encouraging words.

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

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

(viii) The Indian Roads Congress thank Shri A. Q. Ansari, Minister for Public Works and Housing, Bihar for his very inspiring and instructive message to the Congress.

(ix) The Indian Roads Congress thank Shri J. K. Modi, Minister for Public Works and Education, Saurashtra, Shri M. M. Naik-Nimbalkar, Minister for Public Works, Bombay and Shri M. Bhaktavatsalam, Minister for Agriculture, Madras for wishing the Session success.

(x) The Indian Roads Congress thank Sir Kenneth Mitchell and Shri G. M. McKelvie, Past Presidents of the Indian Roads Congress for their good wishes for a happy meeting and a very successful Session.

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

(xii) The Indian Roads Congress thank Shri H. R. Gupta, Chief Engineer, Shri S. N. Tripathi, Deputy Chief Engineer, Shri P. R. Aramadhu, Local Organizing Secretary, Indian Roads Congress, Shri N. N. Shah, Superintending Engineer, Akola, Shri G. V. Nazar, Shri S. G. Borwankar, Executive Engineers and other officers and staff of the Public Works Department of Madhya Pradesh for the excellent arrangements made by them for the Session and for the convenience of the delegates.

(xiii) The Indian Roads Congress thank the Director of Social Education, Madhya Pradesh for kindly arranging variety entertainment for the delegates.

(xiv) The Indian Roads Congress thank the Management of Morris College for placing their Halls at the disposal of the Indian Roads Congress for their meetings.

(xv) The Indian Roads Congress thank the Ministry of Information and Broadcasting, Govt. of India for kindly covering in their newsreel selected moments of the proceedings of the Session.

(xvi) The Indian Roads Congress thank the Director, Publicity, Madhya Pradesh for giving publicity to the proceedings of the Session.

(xvii) The Indian Roads Congress thank the firms and Governments who participated in the Technical Exhibition organized on the occasion of the Session, arranged demonstrations of Road Making Machinery, and offered technical films for being screened.

(xviii) The Indian Roads Congress thank the Nagpur Power and Lighting Co. and the Electricity Department for the co-operation they extended to the Local Organizing Secretary for the success of the Session.

(xix) The Indian Roads Congress thank the Director, All-India Radio for kindly relaying the proceedings of the Session through A.I.R.

6. Scrutineers for the Election of Council Members.

Messrs. C. J. Fielder, C. M. Bennett, Goverdhan Lal and K. F. Antia were appointed scrutineers for the election to the

Council under rule 9-1 of the Rules and Regulations of the Indian Roads Congress.

7. **Election.** The following were elected as Members of the Council :

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

Dr. F. P. Antia	W. A. Griffiths
D. P. R. Cassad	E. A. Nadirshah
C. J. Fielder	L. R. Patel

g. Representative of District Board Engineers.

G. D. Joglekar

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

R. R. Thimaji Rao

i. Representatives elected by the General Body.

J. K. Bannerjee	E. V. S. Iyer
R. N. Dogra	S. R. Naidu

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

	Name of participating Administration.	Name of Representative.
9-a	Andhra	N. Durrani
	Assam	B. Chaudhury
	Bihar	Chief Engineer, Bihar
	Bombay	W. X. Mascarenhas
	Madhya Pradesh	H. R. Gupta
	Madras	K. K. Nambiar
	Orissa	C. M. Bennett
	Punjab	P. L. Varma
	Uttar Pradesh	M. S. Bisht
	West Bengal	R. C. Roy

	Name of participating Administration.	Name of Representative.
	Hyderabad-Deccan	M. A. Kayyum Khan
	Jammu and Kashmir	D. N. Gupta
	Madhya Bharat	P. V. Divatia
	Mysore	H. Anantachar
	PEPSU	A. C. Malhotra
	Rajasthan	Kishori Lal
	Saurashtra	U. J. Bhatt
	Travancore–Cochin	K. K. Kartha
9-b	Engineer-in-Chief, Army Headquarters	Brig. D. B. Chopra
9-c	Central P. W. D.	N. G. Dewan
9-d	Consulting Engineer (Road Development)	H. P. Mathrani

9. During the meeting, Shri K. K. Nambiar, President, Indian Roads Congress gave a talk on the Tenth International Association of Roads Congresses held at Istanbul in September-October 1955.

LIST OF MEMBERS WHO ATTENDED THE TWENTIETH SESSION OF THE INDIAN ROADS CONGRESS HELD AT NAGPUR IN JANUARY, 1956.

S. No.	Name of State etc.	No. of delegates who attended the I. R. C. Session.
	ABSTRACT	
1.	**Government of India:**	
	(a) Ministry of Transport, Roads Wing	... 20
	(b) Engineer-in-Chief's Branch	... 5
	(c) Central P.W.D.	... 5
	(d) Railway Board	... 1
	(e) Central Water & Power Commission	... 1
2.	**Central Road Research Institute**	... 12
3.	**Hindustan Steel Ltd.**	... 2
4.	**Andhra**	... 7
5.	**Madras**	... 13
6.	**West Bengal**	... 28
7.	**Bombay**	... 40
8.	**Uttar Pradesh**	... 17
9.	**Madhya Pradesh**	... 23
10.	**Orissa**	... 9
11.	**Punjab**	... 8
12.	**Assam**	... 7
13.	**Bihar**	... 4
14.	**Hyderabad-Deccan**	... 7
15.	**Madhya Bharat**	... 2
16.	**Rajasthan**	... 5
17.	**Saurashtra**	... 5
18.	**Vindhya Pradesh**	... 4
19.	**Travancore-Cochin**	... 3
20.	**PEPSU**	... 3
21.	**Himachal Pradesh**	... 3
22.	**Mysore**	... 3
23.	**Delhi**	... 6
24.	**Manipur**	... 1
25.	**Bhopal**	... 1
26.	**Ajmer**	... 1
27.	**Pakistan**	... 1
	Total	... **247**

LIST OF MEMBERS WHO ATTENDED THE TWENTIETH SESSION OF THE INDIAN ROADS CONGRESS HELD AT NAGPUR IN JANUARY 1956.

S. No.	Roll No.	Name
		1. GOVERNMENT OF INDIA
		(a) Ministry of Transport (Roads Wing)
1	Invitee	Anantapadmanabhan, C. S.
2	1446	Bhalla, R. S.
3	2040	Bhattacharya, M.
4	758	D'Costa, A. J.
5	1078	Gursahani, R. L.
6	Invitee	Ganguli, Dr. M. K.
7	879	Goverdhan Lal
8	1310	Mitra, N. B.
9	1288	Mathrani, H. P.
10	1274	Murthi, B. S. N.
11	950	Nagarsheth, M. P.
12	752	Ramaswami, N. S.
13	Invitee	Ranganathan, K.
14	191	Sinha, H. P.
15	1210	Subbiah, C. P.
16	1532	Sehra, P. T.
17	723	Subrahmanyam, J.
18	1280	Sadarangani, T. G.
19	918	Trehan, J. M.
20	2003	Upadhyaya, D. R.
		(b) Engineer-in-Chief's Branch
21	1905	Arjun Singh, Col.
22	1818	Bose, Col. S. K.
23	Invitee	Deb, A. K.
24	1689	Ruthnaswamy, Col. V. V.
25	2055	Soni, Lt.-Col. K. C.
		(c) Central P. W. D.
26	2068	Gokhale, R. G.
27	2059	Gupta, D. L.
28	2024	Muthachen, O.
29	965	Rajagopalan, K. G.
30	2063	Selvam, L. G.
		(d) Railway Board
31	43/Ass.	Kumar, S. L., Representing Railway Board, Govt. of India, Ministry of Railways, Central Standards Office.
		(e) Central Water & Power Commission
32	2066	Mathrani, S. I.

S. No.	Roll No.	Name
		2. Central Road Research Institute
33	2069	Bagchee, S.
34	1871	Goel, V. S.
35	1914	Gokhale, Y. C.
36	833	Iyengar, Dr. R. K. N.
37	1474	Jagus, P. J.
38	1857	Khanna, Tejbir S.
39	277	Mehra S. R.
40	1683	Rao, M. S. V.
41	1913	Rao, N. Mohan
42	1720	Sankaran, K. S.
43	1345	Swaminathan, C. G.
44	847	Uppal, Dr. H. L.
		3. Hindustan Steel Ltd.
45	2052	Guha, S.
46	2053	Ganapathy, C. P.
		4. ANDHRA
47	246	Durrani, N.
48	628	Raj, P. V.
49	1265	Rao, K. Rama Mohan
50	1945	Rao, K. V.
51	1112	Reddy, P. R. G.
52	873	Rao, R. R. Thimmaji
53	1647	Subbarao, M.
		5. MADRAS
54	1800	Alexander, G.
55	1301	Bhuvaraghamurthy, R.
56	2044	Karim, M. A.
57	2000	Khader, Abdul
58	1246	Logavinayagam, K. S.
59	671	Meeran, M.
60	268	Nambiar, K. K.
61	654	Naidu, S. R.
62	1795	Subbayya, K. B.
63	969	Sadasivaswamy, P. S.
64	994	Chandrasekharan, E. C.
65	1775	Selvam, T. T.
66	630	Thadaney, K. V.
		6. WEST BENGAL
67	962	Banerjee, J. K.
68	1514	Basu, S. C.
69	1421	Basu, K. N.
70	2051	Banerji, Prasun Kumar
71	1383	Biswas, K. K.
72	45/Ass.	Chatterjee, D.
73	41/Ass.	De, K. C.

S. No.	Roll No.	Name
74	530	Dutt, Priya Ranjan
75	231	Fielder, C. J.
76	936	Gupta, S. N.
77	1604	Ghosh, B. N.
78	2048	Gupta, Sailapati
79	1503	Ganguli, H. D.
80	2067	Jali, L. M.
81	2046	Mukherjee, Deva Prasad
82	316	Mitra, T.
83	1653	Maitra, M. S.
84	1309	Majumdar, S. N.
85	2047	Nandi, Madan Mohan
86	488	Nagarkar, D. B.
87	21/Ass.	Patel, L. R.
88	766	Roy, R. C.
89	1544	Ray, S. N.
90	1785	Shah, Z. S.
91	263	Sengupta, P. N.
92	2045	Sarkar, Prasanta Kumar
93	1500	Sen, R. B.
94	2043	Sengupta, Girija Prasanna
		7. BOMBAY
95	1241	Antia, K. F.
96	32/Ass.	Antia, Dr. F. P.
97	60/Ass.	Amin, D. T. Representing Pashabhai Patel & Co., Ltd., Bombay.
98	1882	Bhosale, B. Y.
99	2029	Bharucha, M. M.
100	383	Batliwala, H. S.
101	343	Choksi, B. K.
102	1145	Dhruva, R. C.
103	1336	Daftary, N. D.
104	80	Griffiths, W. A.
105	858	Gandhi, J. H.
106	2049	Gupte, A. Y.
107	831	Gadre, N. B.
108	1129	Iyengar, C. L. N.
109	2033	Jayawant, M. B.
110	596	Joglekar G. D.
111	1656	Javali, S. C.
112	2037	Karnik, A. V.
113	1657	Kale, M. D.
114	1930	Katti, B. S.
115	1687	Latnekar, S. K.
116	1716	Menon, T. M.
117	1002	Mehta, M. A.
118	1601	Manerikar, V. B.
119	949	Naik, I. K.
120	1012	Nadgauda, P. M.
121	23	Nadirshah, E. A.
122	1565	Nerurkar, M. S.
123	1723	Natu, S. V.
124	1780	Pimple J. S.
125	1840	Parikh, V. N.

S. No.	Roll No.	Name
126	1206	Patel, M. M.
127	2057	Palekar, D. C.
128	1944	Raju, V.
129	1008	Raghavan, P.
130	1506	Shah, S. G.
131	1148	Shivdasani, P. D.
132	2030	Sarkar, Suniti
133	362	Vartak, G. R.
134	84	Vagh, B. V.
		8. UTTAR PRADESH
135	2077	Agrawala, C. P.
136	1114	Bhargava, M. C.
137	222	Fateh Chand
138	2065	Gupta, Ram Swarup
139	1923	Gauba, J. C.
140	750	Kartik Prasad
141	1973	Mathur, Jatan Swarup
142	1203	Mathur, G. D.
143	1433	Nigam, S. P.
144	1416	Prem Manohar
145	2023	Shamshul Rahman
146	2061	Shitala Sharan
147	958	Srivastava, P. N.
148	960	Sinha, K.
149	45	Srivastava M. P.
150	115	Sharma, Hari Shankar
151	Invitee	Vaish, Sohan Lal
		9. MADHYA PRADESH
152	1873	Aramadhu, P. R.
153	929	Bansal, K. S.
154	2025	Bhatia, L. H.
155	1877	Cassad, D.P.R
156	2091	Cassad Jal P.
157	1455	Chopra, P. C.
158	1546	Dube, S. B.
159	1643	Gupta, H. R.
160	1379	Gurbaxani, T. C.
161	2078	Krishnaswamy, T. G.
162	782	Kumar, G. L.
163	1813	Mirchandani, H. P.
164	1830	Menon, A. A.
165	2026	Ramachandran, S.
166	2035	Sharma, D. D.
167	1440	Swaminathan, S. S.
168	2019	Surty, N. K.
169	2014	Sahasrabudde, S. C.
170	2028	Shah, N. N.
171	65	Sujan, S. B.
172	1586	Thaker, H. J.
173	1921	Tripathi, S. N.
174	2031	Tambe, R. V.

S. No.	Roll No.	Name
		10. ORISSA
175	204	Bennett, C. M.
176	1746	Das, N. P.
177	292	Iyer, E. V. S.
178	1115	Kashyap, M. G.
179	2074	Misra, N.
180	1278	Misra, B.
181	1759	Padhi, A. C.
182	690	Padhi, R. N.
183	1327	Rao, A. Rajeswara
		11. PUNJAB
184	457	Dogra, R. N.
185	446	Khanna, G. C.
186	1518	Mathur, B. S.
187	154	Nayar, D. P.
188	1970	Sahgal, O. S.
189	2075	Sahni, D. V.
190	Invitee	Uppal, Dr. I. S.
191	491	Varma, P. L.
		12. ASSAM
192	1918	Bhattacharyya, A. N.
193	2042	Borgohain, D.
194	941	Chaudhury, B.
195	2027	Datta, S. M.
196	2062	Najeebur Rahman
197	55/Ass.	Rajkhowa, P., Representing M/s. Assam Oil Co., Ltd., Digboi.
198	1844	Sarma, Bhabadeb
		13. BIHAR
199	2070	Prasad, P. J.
200	733	Prasad, B.
201	2071	Sinha, S. B. P.
202	1902	Sinha, S. P.
		14. HYDERABAD-DECCAN
203	2060	Bilolikar, G. R.
204	255	Khan, M. A. Kayyum
205	2072	Marthandam, R. S.
206	29	Narasimham, J. S.
207	2058	Rangaswamy, M.
208	2073	Sripada, M. V. N.
209	2076	Shaik Mahboob
		15. MADHYA BHARAT
210	1608	Divatia, P. V.
211	580	Moghe, L. V.

S. No.	Roll No.	Name
		16. RAJASTHAN
212	1707	Gupta, B. N.
213	816	Gupta, H. D.
214	1951	Kuchhal, H. P.
215	331	Mathur, Kishore Lal
216	1917	Sarin, K. K.
		17. SAURASHTRA
217	1852	Bawishi, V. M.
218	214	Bhatt, U. J.
219	2036	Koppikar, M. S.
220	979	Kothari, V. C.
221	1631	Parmar, P. K.
		18. VINDHYA PRADESH
222	1741	Bhattacharya, Phani Bhushan
223	1925	Mitra, J. N.
224	1763	Rao, K. R. Nagaraja
225	1918	Srivastava, C. P.
		19. TRAVANCORE-COCHIN
226	1062	Kuruvila, P. K.
227	2038	Nair, P. K. Rabindranathan
228	2039	Pillai, T. Nataraja
		20. PEPSU
229	1338	Dhillon, Major A. S.
230	1870	Malhotra, A. C.
231	1053	Marya, Jagdev Singh
		21. HIMACHAL PRADESH
232	2054	Bansal, Mohan Lal
233	338	Nangea, G. R.
234	2064	Rupal, T. S.
		22. MYSORE
235	2050	Iyengar, C. K. Rangaraja
236	1668	Manchigiah, M. H.
237	2056	Setty, S. V. Gopala
		23. DELHI
238	1910	Green, John A.
239	2022	Kohli, D. R.
240	58/Ass.	Chandrasekhara, C. S. Representing Indian Standards Institution, Delhi.

S. No.	Roll No.	Name
241	56/Ass.	Kaura, M. R.
242	Invitee	Sehan, Surjan S.
243	40/Ass.	Shahani T. C.
		24. MANIPUR
244	1448	Krishnan, E.
		25. BHOPAL
245	2041	Mumtaz, M.
		26. AJMER
246	1425	Jain, K. C.
		27. PAKISTAN
247	1549	Doctor, P. K.

INDIAN ROADS CONGRESS

BALANCE SHEET AS AT 30TH SEPTEMBER, 1955.

(Excluding Transport-Communications Monthly Review).

LIABILITIES		Rs A. P.	Rs A. P.
SUNDRY LIABILITIES			
Creditors for Expenses	...	3,401 5 0	
Incometax payable on salaries	...	13 14 0	
Shri McKelvie's Silver Salver Fund	...	120 13 6	
Subscription received in Advance from :			
Ordinary Members :			
1955—56 628 6 0			
1956—57 50 0 0			
1957—58 20 0 0			
1958—59 20 0 0			
Associate Members :			
1955—56 55 0 0	...	773 6 0	4,309 6 6
MITCHELL MEDAL FUND (Invested as per contra)	...		2,106 12 0
BUILDING, MUSEUM & TECHNICAL FUND			
Balance as per last Balance Sheet	...	1,41,255 12 0	
Add : Amount of Life Membership Fee	...	159 0 0	
Interert on Investment	...	5,000 0 0	1,46,414 12 0
PROVIDENT FUND			
Deposits	...	24,104 6 0	
Add : Interest Reserve	...	386 3 4	24,490 9 4
AMOUNT HELD IN SUSPENSE			1,086 8 0
DUE TO T. C. M. R.			7,115 0 0
RESERVE FOR BAD & DOUBTFUL DEBTS			10,000 0 0
INCOME & EXPENDITURE ACCOUNT			
Balance as per last Balance Sheet	...	1,13,447 13 11	
Add : Balance being Excess of Income over Expenditure Account as per annexed Income & Expenditure Account	...	8,856 4 3	1,22,304 2 2
Total	...		3,17,827 2 0

(Sd.) J. SUBRAHMANYAM,
Secretary.

We have audited the Balance Sheet of the INDIAN ROADS CONGRESS (excluding Transport-Communications Monthly Review) as at 30th September, 1955, above set forth, and have obtained all the information and explanations we have required.

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

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

Kashmere Gate,
Delhi.
Dated, this sixth day of December, 1955.

ASSETS		Rs A. P.	Rs A. P.
EQUIPMENT			
Balance as per last Balance Sheet	...	6,842 1 6	
Additions during the year	...	897 11 9	
		7,739 13 3	
Less : Written off	...	12 13 0	
		7,727 0 3	
Less : Depreciation written off	...	810 5 0	6,916 11 3
LIBRARY BOOKS			
Balance as per last Balance Sheet	...	1,870 4 3	
Additions during the year	...	478 10 6	
		2,348 14 9	
Less : Depreciation written off	...	234 14 0	2,114 0 9
DRAWING MATERIALS			
Balance as per last Balance Sheet	...	23 3 0	
Less : Depreciation written off	...	1 9 0	21 10 0
STOCK-IN-HAND			
(Certified as to quantities & values by the Secretary)			
Journals	...	50,840 4 0	
Paper	...	6,966 1 0	57,806 5 0
SUNDRY DEBTORS			
Subscriptions in arrears from Ordinary Members	...	12,352 8 0	
Outstandings on Journals	...	858 6 0	
Subsidies receivable	...	41,000 0 0	
Advertisement Charges (of which Rs 428-4-0 are considered bad & doubtful)	...	2,816 12 0	
Session Expenses Receivable :			
Transport Charges	...	560 0 0	
Delegation Fees	...	5,530 0 0	63,117 10 0
INTEREST ACCRUED ON INVESTMENTS			9,637 8 9
INCOME TAX DEDUCTED AT SOURCE			240 0 0
INVESTMENTS			
Rs 6,000/- 5 years Post Office Certificates	...	6,000 0 0	
Rs 54,000/- 12 years National Savings Certificates	...	54,000 0 0	
Rs 50,000/- 10 years Treasury Savings Deposit Certficates	...	50,000 0 0	
Rs 21,300/- 3% Loan 1963-65	...	20,271 10 0	
Rs 11,100/- 3½% National Plan Loan 1964	...	10,984 2 0	1,41,255 12 0
ADVANCES			
Deputy Controller, Stationery & Printing, Calcutta	...	2,258 13 0	
Staff	...	742 14 6	
Others	...	88 13 0	3,090 8 6
PROVIDENT FUND			
12 Years National Savings Certificates	...	17,700 0 0	
Interest accrued thereon to 30th Sept., 1955	...	1,216 4 0	
Balance with Imperial Bank of India	...	2,325 12 0	
Loans Advanced	...	2,767 0 0	24,009 0 0
MITCHEL MEDAL FUND			
Rs 1,600/- 3% Loan 1963-65	...	1,652 14 11	
Interest accrued thereon	...	16 0 0	
Balance with Imperial Bank of India	...	437 13 1	2,106 12 0
CASH & OTHER BALANCES			
With Imperial Bank of India	...	7,463 7 3	
Stamps in hand	...	47 12 6	7,511 3 9
Total	...		3,17,827 2 0

INDIAN ROADS CONGRESS

INCOME AND EXPENDITURE FOR THE YEAR ENDED 30TH SEPTEMBER, 1955.

(Excluding Transport-Communications Monthly Review)

EXPENDITURE	Rs A. P.	Rs A. P.	INCOME	Rs A. P.	Rs A. P.
To Opening Stock of Journals as on 1st October, 1954 ...	46,192 11 0		By Subscriptions :		
,, Paper Consumed ...	12,900 4 6		Ordinary Members ...	26,105 0 0	
,, Printing Charges ...	15,312 4 6		Associate Members ...	3,380 0 0	
	74,405 4 0		Members restored ...	100 0 0	
			Life Members ...	30 0 0	29,615 0 0
Less : Closing Stock of Journals as on 30th September, 1955 ...	50,840 4 0	23,565 0 0			
			,, Entrance Fees :		
,, Establishment ...		36,280 8 0	Ordinary Members ...	2,400 0 0	
,, Local & other Allowances ...		17,184 12 0	Associate Members ...	960 0 0	3,360 0 0
,, Honorarium to Secretary ...		1,200 0 0			
			,, Sale of Publications ...	8,960 11 0	
,, Bank Charges ...		196 8 6	,, Advertisements ...	5,923 8 0	14,884 3 0
,, Provident Fund Contribution ...		1,704 0 0			
,, Audit Fee ...		600 0 0	,, Subsidies (including arrears.) ...		52,000 0 0
			,, Interest ...		39 10 6
,, Postage & Telegrams ...		5,251 14 6			
,, General Printing & Stationery ...		2,720 2 6	,, Receipts on account of :		
,, Uniforms to Class IV Servants ...		247 9 3	Delegation Fees		
			Transport Charges etc. ...	9,120 0 0	
,, Miscellaneous Expenses (includes Rs. 124/14/9 on Mr. McKelvie's Silver Salver). ...		1,450 14 0	Lodging charges recovered ...	1,757 8 0	
,, Publicity Account ...		650 0 0	...	1,171 0 0	12,048 8 0
,, 19th Session Expenses ...		9,716 4 6			
,, Subscriptions to other Societies ...		403 15 0			
,, Bad Debts written off ...		860 0 0			
,, Equipment written off ...		12 13 0			
,, Depreciation written off ...		1,046 12 0			
,, Balance being Excess of Income over Expenditure carried to Balance Sheet ...		8,856 4 3			
Total		1,11,947 5 6	Total		1,11,947 5 6

Kashmere Gate,
Delhi.
Dated, this sixth day of December 1955.

(Sd.) J. SUBRAHMANYAM,
Secretary.

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

INDIAN ROADS CONGRESS

REPORT OF THE COUNCIL TO THE GENERAL BODY OF MEMBERS FOR THE PERIOD 1ST JANUARY TO THE 31ST DECEMBER 1955.

[*The report covers the period from the 1st January to the 31st December 1955, though a few matters of the 1st six months of this period have already been covered in the earlier report.*]

1. GENERAL

The Nineteenth Session of the Indian Roads Congress was held at Srinagar in June 1955 when 224 members and 9 invitees attended the Session. The 9 Papers published in the Journal of the Indian Roads Congress, Volume XIX-parts 1 to 3, were read and discussed. Four Committees and seven Subcommittees were reconstituted to deal with various engineering and administrative problems. The Road Transport Subcommittee was abolished. A new Committee was appointed to study the road transport problems of the country and to make recommendations. The Executive Committee held two meetings at New Delhi on the 20th September 1955 and the 8th December 1955.

2. ADMINISTRATION

Shri K. K. Nambiar, Chief Engineer (Highways), Madras was elected President of the Indian Roads Congress at the Srinagar Session. Shri H. P. Mathrani, Consulting Engineer (Road Development) and Joint Secretary to the Govt. of India, Ministry of Transport continued as Honorary Treasurer, Shri Goverdhan Lal, Deputy Consulting Engineer to the Govt. of India (Roads) continued as Honorary Deputy Treasurer.

Shri J. Subrahmanyam continued as Honorary Secretary.

Shri B. N. Shenoy continued as Technical Secretary till the 3rd August 1955 when he resigned.

3. OFFICE

The office continued to function in New Delhi. It disposed of 9,281 receipts and issued 20,859 letters during the period under report.

The staff worked satisfactorily.

INDIAN ROADS CONGRESS

Transport-Communications Monthly Review

INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDED 30TH SEPTEMBER, 1955.

EXPENDITURE		Rs A. P.	INCOME		Rs A. P.
To Paper Consumed	...	4,110 1 3	By Sales & Subscriptions of the Journal	...	4,466 13 0
,, Printing Charges	...	6,564 0 6	,, Advertisements	...	9,881 15 6
,, Postage	...	1,347 3 0	*Note*:—Subscriptions for unexpired period have not been adjusted in the accounts.		
,, Miscellaneous Expenses	...	48 11 6			
,, Bank Charges	...	5 2 0			
,, Bad debts written off	...	840 0 0			
,, Balance being Excess of Income over Expenditure carried to Balance Sheet	...	1,433 10 3			
	Total ...	14,348 12 6		Total ...	14,348 12 6

BALANCE SHEET AS AT 30TH SEPTEMBER, 1955.

LIABILITIES		Rs A. P.	Rs A. P.	ASSETS		Rs A. P.	Rs A. P.
SUNDRY CREDITORS				**BOOK DEBTS**			
For Expenses	...		78 4 0	For Advertisement of which Rs 222-1-0 are considered doubtful)	...	2,706 13 0	
SURPLUS ACCOUNT				For Sale of Journal	...	83 8 0	2,790 5 0
				DUE FROM GENERAL ACCOUNT	...		7,115 0 0
Balance as per last Balance Sheet	...	9,475 10 6		**STOCK IN HAND** (Certified as to quantities & values by the Secretary)	...		1,081 1 0
Add: Balance being excess of Income over Expenditure as per annexed Income & Expenditure Account	...	1,433 10 3	10,909 4 9	**STAMPS IN HAND**	...		1 2 9
Total	...		10,987 8 9	Total	...		10,987 8 9

(Sd.) J. SUBRAHMANYAM,
Secretary.

We have audited the Balance Sheet of the INDIAN ROADS CONGRESS (Transport-Communications Monthly Review) as at 30th day of September, 1955, above set forth, along with the Income & Expenditure Account for the year ended upon that date and have obtained all the information and explanations we have required.

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

Kashmere Gate,
Delhi.
Dated, this sixth day of December 1955.

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

4. MEMBERSHIP

(1) The number of members on the rolls on the 30th September 1955 was 1379 (1346 Ordinary and 33 Associates). During the year there were 145 new admissions and 36 removals from the rolls. The removals were the result of resignations (26), deaths (8), non-payment of arrears of subscription (2) by members who failed to respond in spite of prolonged efforts.

(2) **Life membership**:—During the Congress year from the 1st October 1954 to the 30th September 1955, 3 members enrolled themselves as life members and the names of two members were removed from the rolls due to deaths. The number of life members on the 30th September 1955 was 125. This number is, however, included in the total number of ordinary members. The fees received from them have been transferred to a separate reserve (Building, Museum and Technical Fund) after deducting Rs 10 per member for initial expenses.

5. DEATHS

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

I. C. Chacko — L. K. Gupta

J. W. Edwin — O. C. K. Krishnan

P. Vervial.

6. BUDGET

The budget for the year 1955-56 and the "Actuals" for 1954-55 were approved by the Executive Committee at their meeting held on the 8th December 1955. The estimates have been placed before the Council at its 46th meeting. The actuals for 1954-55 show a deficit of Rs 10,603 against an estimated deficit of Rs 27,161.

The total contribution received from the Govt. of India and States during the year ending the 30th September 1955 was Rs 42,000. The outstandings from the Central and State Governments on the 30th September 1955 amounted to Rs 41,000. The States concerned are being urged to expedite payment of the outstanding contributions. It is expected that the outstanding contributions will be realized during the current year. Sums, amounting to Rs 18,500 have been received after the 30th September 1955.

As decided by the Executive Committee, the Governments of Himachal Pradesh and Vindhya Pradesh were requested to contribute towards the funds of the Indian Roads Congress. Both have agreed to contribute Rs 1,000 per annum.

Part 'A' States were approached in 1949 to sanction annual contributions for five years at ½ per cent of their share from the Central Road Fund or a fixed sum on that basis subject to a minimum of Rs 2,000. The question of approaching them for fresh sanctions in the light of increased tempo of road development work and consequent increase in the activities of the Indian Roads Congress has been examined and necessary requests will be made to the States.

The arrears of subscriptions at the beginning of the Congress year 1954–55 were Rs 9,270 due from 187 members. The names of 2 members who had failed to pay were removed from the rolls. Consequently, a sum of Rs 225 standing as arrears against these members was written off by the Executive Committee during the year 1954–55.

A sum of Rs 2,250 was realized from 54 members.

After adding the arrears for 1954–55, the total of arrears on the 1st October 1955 stood at Rs 12,352-8-0 due from 222 members. Efforts are being made to realize the arrears.

7. AUDIT

At the Nineteenth Session at Srinagar it was decided to appoint M/s. Walker Chandiok & Co., Chartered Accountants and Auditors, Delhi, to audit the accounts of the Congress for 1954–55. The report was examined by the Executive Committee on the 8th December 1955. It was also placed before the Council at their 46th meeting on the 7th January 1956.

8. PUBLICATIONS

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

The following two standards which had been out of stock were again printed.

(1) Dimensions and Weights of Road-Design Vehicles.

(2) Recommended Practice for the Location and Layout of Roadside Motor-Fuel Filling Stations.

The balance of the publications on the 30th September 1955 was as under:

Name of Proceedings	*Volume*	*Balance*
I. R. C. Proceedings	I to VII-part 1 & VIII	Sold out
Do.	VII-part 2	46
Do.	IX-part 4	122
Do.	IX (Bound)	127
Do.	X-parts 1 to 3	Sold out
Do.	X-part 4	240
Do.	X (Bound)	Sold out
Do.	XI-parts 1 & 2	Sold out
Do.	XI-parts 3 & 4	Sold out
Do.	XI-part 4	178
Do.	XII-part 1	Sold out
Do.	XII-part 2	408
Do.	XII-part 3	394
Do.	XII-part 4	467
Do.	XII-part 5	425
Do.	XII-parts 1 to 3 (Bound)	389
Do.	XII-parts 4 & 5 (Bound)	199
Do.	XIII-part 1	275
Do.	XIII-part 2	367
Do.	XIII-part 3	716
Do.	XIII-part 4	Sold out
Do.	XIII-parts 1 & 2 (Bound)	555
Do.	XIII-parts 3 & 4 (Bound)	132
Do.	XIV-part 1	295
Do.	XIV-part 2	383
Do.	XIV-part 3	304
Do.	XIV-part 4	419
Do.	XIV-parts 1 to 4 (Bound)	496
Do.	XV-part 1	768
Do.	XV-part 2	334
Do.	XV-part 3	346
Do.	XV-part 4	406
Do.	XV-parts 1 to 4 (Bound)	540
Do.	XVI-part 1	Sold out
Do.	XVI-part 2	109
Do.	XVI-part 3	146
Do.	XVI-part 4	162
Do.	XVI-parts 1 to 4 (Bound)	686

Name of Proceedings	*Volume*	*Balance*
I.R.C. Proceedings	XVII-part 1	58
Do.	XVII-part 2	143
Do.	XVII-part 3	24
Do.	XVII-part 4	168
Do.	XVII-parts 1 to 4 (Bound)	730
Do.	XVIII-part 1	Sold out
Do.	XVIII-part 2	Sold out
Do.	XVIII-part 3	71
Road Research Bulletin No. 1		166
Road Research Bulletin No. 2		240
Nagpur Report		148
Paper on " Water-Bound Macadam "		7
Type Designs for Boundary and Furlong Stones		3958
Route-Marker Signs for National Highways		76
Dimensions and Weights of Road-Design Vehicles		1822
Recommended Practice for the Location and Layout of Roadside Motor-Fuel Filling Stations		1521
Type Designs for Highway Mile Stones		17
Paper No. 167—" Design of Small Bridges and Culverts "		786

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

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

On a reciprocal basis, copies of the publications continued to be supplied to several technical institutions in India, the United States of America, the United Kingdom, Australia, Switzerland, Germany, Japan, New Zealand, etc. Copies were also sent to the offices of the United Nations Organization in the Far East. Recently some more Institutions have agreed for the exchange of their literature with our Journal. A list of the periodicals which are being received in the I.R.C. library is given in Appendix.

The Transport-Communications Monthly Review. The Indian Roads Congress is popularising modern ideas on Road Development and Road Engineering for the benefit of executive staff who, owing to their whole time pre-occupation with their

official duties are not able to keep abreast of the latest advance in the science of road engineering. Original articles on various road and bridge works are also being published in this Review.

The members of the Indian Roads Congress, subordinate Engineering staff and engineering students can obtain this publication at a concessional rate of Rs 8 per annum against the ordinary rate of Rs 14 per annum. At present there are 305 subscribers for this publication.

Complimentary copies of the Review are being issued as usual to important persons and engineering colleges in India. Also complimentary copies of the issue for July 1955 were given to all the Members of the Indian Roads Congress.

Members and other readers of the Review are urged to take a hand in making the Reivew more useful by sending articles, photographs, etc., for publication.

9. INFORMATION

Enquiries from members as well as non-members on problems relating to Highway Engineering and allied subjects were attended to. The subjects on which information was sought before 30-6-55 have already been given in the previous report. The subjects on which information was sought after June 1955 are given below:

(1) Road side arboriculture on roads
(2) Cast roller and rocker bearings for major bridges
(3) C.C. road construction
(4) Compaction of soils
(5) Dial deflectometers
(6) Gap graded concrete
(7) Geometric standards for roads
(8) I. R. C. Standard Specifications and Code of Practice for Road Bridges in India
(9) Manholes on main roads
(10) Octroi barriers on National Highways
(11) R. C. C. culverts and beam bridges
(12) Road maps
(13) Standard cross section of different types
(14) Strengthening arch bridges

(15) Superelevation on curves
(16) Testing of bridges
(17) Thickness of steining of circular and rectangular wells
(18) Type designs of village posts, Furlong Stones, and Road Traffic Signs
(19) Stone Metal for soling and wearing courses.

10. LIBRARY

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

Lists of additions to the libraries are published monthly in the "Transport-Communications Monthly Review". Further lists of selected literature classified according to subjects are being published for information of members. Abstracts of more important books and articles are also published. Members are requested to make free use of the library.

120 books were issued on loan during the year under report. This is a very small number considering that the Society has a membership of nearly 1400. *It is urged that members should make more use of these libraries.* Photostat copies of any articles can be supplied on payment.

11. MEDALS AND PRIZES

The Executive Committee in their meeting during the Session at Srinagar accepted the recommendations of the Papers Sub-committee for the award of Medals for Papers read at the Eighteenth Session and announced the following award:

"The Indian Roads Congress Medal" to Shri Goverdhan Lal for his Paper No. 167 "Design of Small Bridges and Culverts", published in Volume XVIII-2 of the Journal.

Paper No. 168 on "Stabilization of Certain Clayey Soils in India by Heat Treatment" by Col. S. K. Bose published in Vol, XVIII-2 of the Journal was commended,

12. COLLECTION OF PARTICULARS OF BRIDGES

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

13. MEMBERSHIP OF SOCIETIES

(1) The Indian Roads Congress is a member of the Indian National Society of Soil Mechanics and Foundation Engineering. Shri S. R. Mehra is the representative of the Indian Roads Congress.

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

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

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

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

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

EDC:	2-Cement	... Shri E. P. Nicolaides
EDC:	20-Drawings	... Shri H. P. Sinha
EDC:	7-Bitumen & Products	Shri K. K. Nambiar Shri Brijmohan Lal
BDC:	1-Terminology Notations & Drawings Sectional Committee	Shri J. M. Trehan (Principal representative) Shri J. Subrahmanyam (Alternative representative)
BDC:	7-Structural Steel Sectional Committee	Shri D. S. Desai (Principal representative) Shri M. P. Nagarsheth (Alternative representative)

BDC:	14-Bridges Sectional Committee	Shri J. Chambers (Principal representative) Shri D. S. Desai (Alternative representative)

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

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

(3) Shri K. K. Nambiar continued to represent the Indian Roads Congress on the Prestressed Concrete Group.

(4) Shri J. M. Trehan was nominated to represent the Indian Roads Congress on the Advisory Board of the Central Road Research Institute in place of Shri H. Sunder Rao.

14. REPRESENTATION ON THE BOARD OF ENGINEERING RESEARCH

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

15. TECHNICAL ACTIVITIES

(1) SPECIFICATIONS AND STANDARDS COMMITTEE

The Committee held meetings on the 18th and 21st June 1955. The following subjects were discussed:

(i) Physical tests for road stones

(ii) Specification for 3/4 in. tar carpets

(iii) Responsibility for fixing warning signs near level crossings

(iv) Hindi equivalents of Highway Engineering Terms

(v) Borrow Pits for highway embankments

Under *item* (i) referred to above, the Committee approved standard methods of tests for determining of aggregate impact value, crushing strength and flakiness index and decided to add a standard test for determining the affinity of road stone for bituminous binder.

Item (ii). The specification for 3/4 in. tar carpets was finalised by the Committee.

Item (iii). The Committee expressed the view that the question of the responsibility for fixing warning signs near level crossings was purely of an administrative nature, the Chief Engineeer, Uttar Pradesh should take up the matter with the Railway authorities direct.

Item (iv). Members of the Committee were requested to send their comments in writing to Member-Secretary. A Paper on this subject has been published in Volume XX-part 3 of the Indian Roads Congress Journal for comments.

The note on "Borrow Pits for highway embankments" referred to as *item* (v) above was approved. It will be printed shortly.

Members of the Committee were requested to send the list of subjects on which standards or specifications were required and they were asked to suggest priorities.

The following other subjects have also been under consideration of the Committee:

(i) Design of Road Inter-sections at Grade

(ii) Testing Road Aggregates

(iii) Tables for Vertical Curves

(iv) Standard Form for Recording Traffic Census

(v) Specification for Water-Bound Macadam

Item (i) will be published as a Paper for the 21st Session.

The standards on Road-Rail Level Crossings are being re-drafted in the light of the earlier discussions of the Committee.

A book on Horizontal and Transition Curves for Highways is under preparation. The book contains:

(i) Tables which enable the selection of the best possible curve suited to any particular site for deviation angles from 6 to 120 degrees.

(ii) Tables giving the elements for setting out Spiral Transitions of various lengths and radii by offsets and by a theodolite.

(iii) Tables giving the various elements of unit transition length for different angles consumed by the transition. These will enable one to design curves in tight locations.

(iv) Worked out example.

These Tables are under print and the book is expected to be put on sale shortly.

(2) BRIDGES COMMITTEE

The Committee has released for printing Sections I & II of the Bridge Code. Section I deals with General Features of Design and Section II deals with Loads and Stresses. It is expected that copies of these Sections will be available for sale shortly. The sections of the Bridge Code dealing with the following subjects have been under study:

(i) Prestressed concrete

(ii) Steel structures

(iii) Masonry structures

(iv) Reinforced cement concrete

(3) TECHNICAL SUBCOMMITTEE

(a) Test Track Division

The Subcommittee held a meeting on the 22nd June, 1955. The specifications adopted for 1955 series of tests being conducted at Road Test Track, Calcutta were approved. The progress of work done was also noted. At present, the following tests are being carried out at Test Track.

1st section — soil-sand stabilized base

2nd section — soil-sand cement stabilized base

3rd section — soil-sand bitumen stabilized base

4th section — sand-sand moorum stabilized base

All these base courses will have 9 in. depth.

The Subcommittee also took the following decisions:

(a) In view of the limitations of the existing Motor Trolley and Tractor, it was resolved that the existing test loads of carts which is quite adequate for such tests should continue.

(b) The premix carpet proposed to be put on the test section should have the normal specifications as adopted in West Bengal.

The Committee advised that two Control Sections with the Conventional soling viz., double layer brick flat soling should be laid on Baraset Basirhat Road and Kriparampur-Sukdebpur-Gotalahat Road where field tests were being carried out so that a comparative study on the road itself could be made.

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

(b) Research Organization Division

The Subcommittee held meetings on the 14th May 1955 and the 18th June 1955. At the meeting held on the 14th May 1955, the Subcommittee discussed a note on "Rapid Road Construction" by Engineer-in-Chief. It was decided to call for more information from the Engineer-in-Chief. After the information is received, the note will be circulated to members. The Subcommittee decided to refer the following subjects to Bridges Committee.

(1) Load classification of civil bridges in India.

(2) Methods for strengthening existing bridges at short notice for carrying heavier loads.

Later at their meeting held on the 18th June 1955, the Subcommittee took the following decisions :

(i) Copies of a research note should be sent to all members of the Division and their written comments invited.

(ii) The written comments should be communicated to the Author, and his replies to the comments obtained.

(iii) The note should then be put up for discussion in a meeting of the Division.

(iv) The same procedure should be followed in regard to the research notes already under consideration with the Subcommittee.

(v) It was further decided that only such research work should be published in which investigations have been carried out to some decisive stage.

The following reports which had been circulated to members were recorded :

(1) Annual report of the Uttar Pradesh, Public Works Department, Research Station for the year 1952-1953. (Circulated by the Lucknow Research Station direct).

(2) Report of the work done in the Soil Research Laboratory, Guindy, Madras, for the year 1952-53.

(3) Annual Report of the Public Works Department (Buildings and Roads Research Laboratory, Karnal) for the year 1954-55.

The list to research problems was approved by the Subcommittee at their meeting held on the 30th November, 1954.

(4) SOIL RESEARCH SUBCOMMITTEE

The Subcommittee held meetings on the 20th June and the 12th September 1955.

At the meeting held on the 20th June 1955, the Subcommittee decided to issue specifications for stabilised soil base courses and wearing courses. For this purpose, it was decided to call for information about the specifications current in different regions of the country. The data when collected will be studied in the Central Road Research Institute and specifications suitable for various climatic and soil conditions evolved and circulated.

It was decided to prepare a list of equipment for soil stabilisation work. For this purpose, it was decided that the States, the Engineer-in-Chief's Branch, and some firms of repute should be requested to send the list of minimum equipment necessary both for construction in the field and investigation in the laboratory. Further action will be taken on receipt of the data.

It was decided to prepare a soil nomenclature for use in India.

The Subcommittee decided to initiate studies with a view to evolving a method of design for thickness of flexible pavements under Indian conditions. This problem will be studied jointly by the Soil Research Subcommittee and the Pavement Design Division of the Specifications and Standards Committee.

The Subcommittee also decided to initiate studies with a view to evolving simple method of fixing the bearing values of soils for deep foundations suitable for Indian conditions. Information already available will be collected before taking further action.

It was decided that the work done in the field of soil research by the Indian National Society of Soil Mechanics and Foundation Engineering should be published in the form of a summary in the Indian Roads Congress Journal.

At its meeting held on the 12th September 1955, the Subcommittee members discussed a note on the stabilized soil road work done on the Ramnad-Mandapam Road and Kovalam—Mahabalipuram Road near Madras. They also inspected these roads.

The Subcommittee also considered a note on "the stabilization of Black Cotton Soil" by E. C. Chandrasekharan. They felt that field research should be carried out but before this was done, each laboratory should be asked to give a report of the work already done.

The other subjects considered by the Subcommittee were:

(i) The use of machinery in soil stabilisation work under Indian conditions.

(ii) The use of soil-cement blocks in place of stones for urgent protection works in rivers.

Information about item (i) is being collected from State P. W. D.'s, Research Laboratories and Engineering firms before taking any further action.

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

The Punjab P. W. D. has already taken up the work in hand and the experiments are being carried out on Sonepat-Gohana Road and on village road from 30/3 of Grand Trunk Road to village Bigham in Rohtak District.

The Highways Department, Madras will also take up the work in hand shortly.

(5) EDUCATION SUBCOMMITTEE

The Subcommittee held a meeting on the 17th June 1955.

The Subcommittee approved the syllabus for Highway Engineering Course for inclusion in the Civil Engineering Degree course. The Subcommittee also recommended that the syllabus be sent to the All-India Council of Technical Education for taking necessary steps for its introduction in Engineering Colleges. The Council of the Indian Roads Congress at their meeting held on the 23rd June 1955 accepted the recommendation of the Subcommittee. Accordingly the details of the syllabus were forwarded to the All-India Council of Technical Education for necessary action. They have since circulated the syllabus to the Universities in India for their views.

The Subcommittee approved details of a Refresher Course for engineers working in Highways Departments. The Executive Committee at their meeting on the 20th September 1955 considered the recommendations of the Subcommittee and decided that, in view of the shortage of officers in the Roads Wing, the possibility of arranging Refresher Course at Roorkee University to begin with should be explored.

The All-India Council of Technical Education have approved the institution of Post-graduate courses in Highway Engineering in:

(i) Punjab Engineering College, Chandigarh, and

(ii) Indian Institute of Technology, Kharagpur.

The institutions have been addressed to send their syllabii which when received, will be studied by the Subcommittee.

(6) PROVINCIALIZATION OF LOCAL BODIES ENGINEERING SERVICES SUBCOMMITTEE

The Subcommittee held a meeting on the 21st June 1955. The Subcommittee again stressed the urgent need of provincialising the engineering services of Local Bodies so as to bring them on to a common cadre under the Chief Engineers of States. The Indian Roads Congress have addressed the Planning Commission on the subject.

The Subcommittee also noted with great concern the transfer of some important roads to the control of District Boards in certain States, without provincialising the services of District Board Engineers.

(7) MANUFACTURE OF ROAD-MAKING MACHINERY AND MECHANIZATION SUBCOMMITTEE

The Subcommittee held a meeting on the 20th June 1955.

The Subcommittee noted that the Government of India have decided to purchase one unit of earth moving machinery for use

on National Highway No. 22 (in Himachal Pradesh) and the same will be put on use shortly.

The Committee also noted the progress made in regard to the manufacture of various other items of Road Making Machinery.

The Executive Committee meeting held on the 20th September 1955 noted that steps were being taken to establish stone crushing industry and Diesel Road Roller industry in India.

(8) ROAD OPERATION COST COMMITTEE

This Committee was appointed at the instance of the Government of India for the purpose of study of (i) the cost of operation of motor vehicles on different classes of roads; and (ii) the economy resulting from road improvements.

The Committee at their meeting held at Srinagar on the 20th June 1955 considered a draft Report giving the data received so far from State Transport undertakings and private operators in response to the questionnaire issued by the Committee. The Committee also took into account results of the extensive experiments conducted in the U.S.A. on the effect of speed, nature of the road surface, frequency of stops, etc., on operating cost. The Committee also had before them a report of experiments carried out by the Bombay State Road Transport Corporation for studying this question.

The Committee felt that the various operators were working under widely different conditions and consequently the figures supplied by them were not comparable. It was, therefore, decided, that two major State Transport undertakings should be requested to carry out scientifically designed experiments under controlled conditions.

The committee has submitted an Interim Report based on the results of the experiments of the Bombay Road Transport Corporation but their final report would be submitted only after the results of the proposed experiments are available.

The details of a suitable design for the experiment in view have since been worked out and a Paper on this subject has been published in Volume XX-part 2 of the Journal of the Indian Roads Congress. The Paper was also circulated widely among technical experts for comments.

(9) CEMENT CONCRETE ROAD SURFACING SUBCOMMITTEE

A meeting of this Subcommittee held at Srinagar on the 18th June 1955 examined Panel Discussions on Cement Concrete Road Construction. The finalized answers to the questions have been circulated to the members of the Council before publication.

16. MISCELLANEOUS

(1) PAPERS

7 Papers were received during the year, 9 were already lying pending. Out of these 16 Papers, 9 were accepted for publication, 2 were rejected, and 5 are under consideration for the next session.

The first and foremost object of the Society is the advancement of the science and art of road building. This object can best be achieved by the contribution of Papers by members who have original knowledge or experience. Members are requested to constantly bear in mind the need for passing on the knowledge they have to their fellow Members and keeping a record of it for benefit of posterity in either of the publications of the Congress, viz., the Journal or the Transport-Communications Monthly Review.

To make the attainment of this object easy, the Council suggest to the members, especially the senior members to practise and encourage the compilation of notes and photographs during the progress of a work with the object of presenting a Paper in the Journal or contributing an article to the T. C. M. R. Such a compilation will lighten the difficult and often the discouraging task of authorship.

It is recognised that even though Engineers have the desire, their preoccupation with their official duties prevents them from devoting any time to the writing of a Paper. But " where there is a will there is a way ". Also, to be known as the Author of a good Paper, which is a work of reference to others, or the recipient of a Mitchell or Indian Roads Congress Medal, is a matter of prestige. Members are urged to consider the satisfaction one derives in having furthered the cause of science and having " set a wanderer on his way " and reflect on the benefits which have accrued to themselves from the work of others who have gone before them.

(2) TEST VALUES OF ROAD STONES

The Government of India, Ministry of Transport circulated a standard form to all State Public Works Departments to supply data on test values of road aggregates. As a result of this circular, information from many State P. W. Ds. was received. During the year under report some more information has been collected. After the information from all States has been received, it will be compiled and published.

LIST OF JOURNALS

1. Modern Castings and American Foundryman.
2. American Highways.
3. Annual Reports of the Institution of Engineers (India), Bombay Centre.
4. Automobile News.
5. Better Roads.
6. British Constructional Engineers.
7. British Road Federation (Bulletin).
8. Bulletin Technique De la Suissee Romande (in French).
9. Bulletin of the Central Building Research Institute, (India).
10. Bulletin of the Institution of Engineers (India).
11. Bulletin of the Permanent International Association of Road Congresses.
12. Bulletin of International Association for Bridge & Structural Engineering.
13. Burmah Shell News.
14. Central Board of Irrigation and Power Abstracts.
15. Commonwealth Today.
16. Concrete Quarterly.
17. Contractors Record and Municipal Engineering, U. K.
18. Cement (In Dutch).
19. De Ingnieur in Indonesia (In Dutch).
20. De l'Institut Technique Du Batiment et Des Travaux Publics (in French).
21. Engineering News of India.
22. Highways and Bridges and Engineering Works.
23. Highways Current Literature.
24. Highway Research Abstracts.
25. Indian Journal of Power and River Valley Developments.
26. Indian Minerals.
27. Insdoc List of Current Scientific Literature.

28. Irrigation and Power (*Journal of* the Central Board of Irrigation and Power).
29. Indian Railways.
30. Indian Standards Institution Bulletin.
31. Indian Construction News.
32. Journal of New Zealand Engineering.
33. Journal of Scientific and Industrial Research.
34. Journal of the Institution of Engineers (Australia).
35. Journal of the Institution of Engineers (India).
36. Journal of the Institution of Highway Engineers, U. K.
37. Journal of the Institution of Military Engineers, India.
38. Journal of the Institution of Municipal Engineers, U. K.
39. Journal of the Institution of Transport, U. K.
40. Journal of the Institute of Science.
41. Journal of the Japan Society of Civil E[illegible] (In Japanese).
42. Link Belt Speeder News.
43. Magazine of Concrete Research.
44. Main Roads.
45. Motor Transport.
46. News-Letter of I.R.T.D.A.
47. Premier Automobile Journal.
48. Proceedings of the Institution of [illegible] London.
49. Power Engineer.
50. Public Roads.
51. Quarterly Technical Bulletin (Indian) (Ministry of Railways).
52. Reinforced Concrete Review, U. K.
53. Road Adstracts, Road Research Laboratory, U. K.
54. Road International.
55. Roads and Road Construction.
56. Science and Engineering.
57. Shovel News.
58. State Transport Review, Bombay.
59. Strassen und Tiefbau (In German).

60. Strasse und Autobahn (In German).
61. Strasse und Verkehr (In German).
62. Surveyor and Municipal and County Engineer, U. K.
63. Texas Engineering Experiment Station News, U.S.A.
64. The Crushed Stone Journal (American).
65. The Highway Magazine.
66. The Indian Concrete Journal.
67. The Indian and Eastern Engineer.
68. The Engineering Journal (Canada).
69. The Structural Engineer, U. K.
70. The Texas Highways.
71. U.N.E.S.C.O. Bulletin for Libraries.
72. World Construction.
73. Wegen (Belgium).
74. Western India Automobile Magazine.

Minutes of the 47th Council Meeting of the

INDIAN ROADS CONGRESS

held at Nagpur on the 12th January 1956.

The Council met with Shri K. K. Nambiar in the Chair.

Present:

Abdul Kayyum Khan
Col. Arjan Singh
J. K. Banerjee
C. M. Bennett
U. J. Bhatt
D. P. R. Cassad
B. Chaudhury
B. K. Choksi
P. V. Divatia
R. N. Dogra
N. Durrani
Goverdhan Lal
W. A. Griffiths
H. R. Gupta
E. V. S. Iyer
G. D. Joglekar
A. C. Malhotra
Kishore Lal Mathur
H. P. Mathrani
E. A. Nadirshah
S. R. Naidu
B. Prasad
R. C. Roy
P. N. Srivastava
R. R. Thimaji Rao
P. L. Varma
J. Subrahmanyam, Secretary.

The following co-opted Members attended:

H. S. Batliwala
S. N. Majumdar
S. R. Mehra
T. Mitra
D. P. Nayar
H. P. Sinha
P. D. Shivdasani

The following attended by invitation:

C. S. Anantapadmanabhan
P. R. Aramadhu
R. S. Bhalla
J. M. Trehan
B. V. Vagh.

Item 1. Co-options and Invitations.

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

Item 2. Confirmation of the Minutes of the 46th Council Meeting.

The Minutes of the 46th Council Meeting held at Nagpur on the 7th January 1956, were confirmed.

Item 3. Office Bearers.

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

President	...	P. L. Varma
Vice-Presidents	...	(i) H. R. Gupta
		(ii) R. C. Roy
		(iii) W. A. Griffiths
Hony. Secretary	...	J. Subrhamanyam.

At this stage, the newly elected President, Shri P. L. Varma, took the Chair.

Item 4. Venue of the next General Session.

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

Item 5. Committees and Subcommittees:

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

(1)	Specifications and Standards Committee.	... Goverdhan Lal
(2)	Bridges Committee.	... H. P. Mathrani
(3)	Technical Subcommittee:	
(i)	Test Track Division.	... T. Mitra.
(ii)	Research Organisation Division.	... H. P. Sinha.
(4)	Soil Research Subcommittee.	... Director, CRRI.
(5)	Education Subcommittee.	... E. A. Nadirshah
(6)	Provincialization of Local Bodies Engineering Services Subcommittee.	... Fateh Chand.
(7)	Papers Subcommittee.	... H. P. Mathrani.
(8)	Manufacture of Road Making Machinery & Mechanization Subcommittee.	... R. S. Bhalla.
(9)	Organization Committee.	... H. P. Mathrani.
(10)	Road Operation Cost Committee.	... H. P. Mathrani.
(11)	Cement Concrete Road Surfacing Subcommittee	... E. A. Nadirshah

(12)	Road Transport Development Committee.	... Dr. F. P. Antia

Item 6. Popularising improved design of Bullock-cart Wheel.

Shri B. V. Vagh traced the history of Bullock-Cart Wheels and various experiments carried out previously. Shri S. R. Mehra explained that the wheel tester at the Central Road Research Institute had been improved and it might be possible to conduct experiments on improved wheel axle system and on evolution of rubber bushing to give flat wheel. Some results might be expected within the next six months. The discussion then centred round the following points:

(i) whether wide-tyred bullock-cart wheel may be introduced;

(ii) whether the self-driving axle may be introduced; and

(iii) how to popularise pneumatic tyred wheels for professional bullock carts in urban areas.

The concensus of the opinion of members of the Council was that the bullock-cart was likely to continue playing an important part in the economy of this country. The expenditure on introducing of improved design of bullock-cart wheel should be spread over the next 20 years.

The Council expressed the view that, as far as possible, pneumatic tyred bullock-cart wheels should be introduced in urban areas. But in rural areas, this was not necessary. Necessary improvements e.g., self alignment, etc., to existing design should, when possible, be suggested.

It was decided that note on the subject should be prepared and circulated to the members of the Council. The possibility of including in the Highway Act a provision of prohibiting the use of unsuitable wheels might also be examined.

Item 7. Maintenance of Revenue Tracks.

The Council discussed a proposal that cart tracks having sufficient traffic leading to village roads should be raised to the standard of village roads and their maintenance be entrusted either to Local body or a Panchayat. Some members explained that it was the general practice in the States that the public vehicles could not be plied on tracks which are not maintained by the P.W.Ds. Such of the tracks as might warrant sufficient traffic were themselves taken over by the

State P.W.Ds. The Council therefore decided to drop the matter.

The Council agreed that building of toll roads in villages was not likely to be a paying proposal. They, however, expressed the view that Panchayat Act in the Punjab provided a suitable solution whereby a contribution of 20 per cent was made by State P.W.D. for such of the roads which the villagers demanded. The balance of expenditure was met by the villagers themselves. The Council, therefore, suggested that other State P.W.Ds. might also consider to follow similar practice.

Item 8. Laden Weight of Motor Vehicles.

The question of allowing vehicles with a laden weight of 18000 lb or more on all roads was discussed. The Council was of the opinion that plying of vehicles with a laden weight of at least 18000 lb should be permitted on all roads, particularly on National Highways. If there were any bridges or culverts on National Highways which could not take vehicles of at least 18000 lb, the particulars of such bridges and culverts should be reported to the Government of India, Ministry of Transport, Roads Wing as early as possible.

Item 9. Allocation of Funds for Road Research.

The Council agreed that in order to avoid duplication of research, it was not necessary to set up road research stations in all States. It would be sufficient if a few well-equipped laboratories do the basic research. But for field research, the Council recommended that research and testing laboratories should be set up in different States to carry out experiments with locally available materials.

The Council also passed the following resolution recommended by the Research Organization Division:

> "Resolved that the Indian Roads Congress should request the Government of India, to take requisite action to ensure that at least 1 per cent of the Central Road Fund allocation of each State is ear-marked for the equipment and maintenance of road research and testing laboratories in the States."

Inspection Tour Notes

INDIAN ROADS CONGRESS—TWENTIETH SESSION 1956

NATIONAL NEWSPRINT AND PAPER MILLS AT NEPA NAGAR

The National Newsprint and Paper Mills at Nepa Nagar are situated on the southern bank of Tapti river in the south-eastern portion of the Madhya Pradesh. This factory is the largest in Asia and produces newsprint wider and faster than any other factory in Asia.

The present consumption of newsprint in India is approximately 100,000 tons per year. Nepa Mills have a production capacity of 52,000 tons per year.

The mills are designed to make a continuous sheet of finished paper 216 in. wide and will operate at a speed of 1,200 feet per minute. The production capacity is 148 tons of standard newsprint in 24 hours. The mills are electrically driven by an electronic device, and will maintain a fixed ratio of speed between component parts of the machine within extremely close limits, thereby eliminating loss of production.

The flow of Tapti river is sufficient for nine months' demand of the mill. To provide for the remaining three summer months, an anicut across the Tapti which will store a billion gallons of water has been built. This storage is expected to supply water for the mill through any dry period of reasonable duration. The steam and electric power is purchased from the thermal plant of the Madhya Pradesh Electricity Board at Nepa Nagar.

The factory consists of: (1) Paper machine building (414′ × 90′), (2) Paper storage building (234′ × 70′), (3) Shifting-room (72′ × 54′), (4) Mechanical pulp section (108′ × 90′), (5) Workshop (234′ × 54′) and (6) Chemical pulp structure.

There is a small township consisting of quarters for the employees of the mill and the Power House. The Company's requirements of residential quarters of various types, numbering 825, are estimated to cost Rs 51.00 lakhs. Out of this, the Company has constructed 180 units and the work on other units

is in progress. Details of the cost of the project are given below :

		(Rs in lakhs)
(1)	Plant and machinery including consultant fees	308.52
(2)	Factory building	54.50
(3)	Mill waterworks and anicut	46.15
(4)	Township and residential quarters	51.25
(5)	Railway siding, effluent disposals, etc.	11.00
(6)	Establishment expenses and contingencies	50.00
(7)	Working capital	63.00
(8)	Unforeseen expenses	15.38
	Total	599.80
	or	600.00

The present production is 20 tons a day for an eight hour shift. When the chemical mill comes into operation it is expected that the manufacture will be done 24 hours bringing the production to 60 tons a day.

ASIRGARH

Asirgarh is an outlying spur of the Satpura range rising to 850 feet high above its base. The top is 2,282 feet above sea level.

Asirgarh is referred to in the Mahabharata as the seat of worship of the warrior Ashvatthama. The name Asir is repeatedly mentioned by the Rajput poet 'Chand' who lived in the 12th century A. D.

In 1295, it was held by the Chauhan Rajputs but was stormed and captured by Ala-ud-din Khilji on his return from first Mohammadan raid into the Deccan. It fell into the hands of the Faruki Kings of Khandesh about 1400 A.D., and was their principal stronghold for the next two centuries. The lower fort, Malaigarh, was built by Adilkhan, the 4th king of the dynasty. In 1600, Akbar conquered and annexed Malwa and Khandesh and took Asirgarh.

The Fort at the top can be reached either by the direct foot-path about 3/4th mile long, or by the "Gun Road", 3 miles long. The gun road is motorable but is narrow and tortuous.

In addition to the battlements of the fort, the Jama Masjid with its clear water-well on the east and the Seven Gateways (Sat Darwaja) on the south at the top of the hill are of archeological interest.

SUBMERSIBLE BRIDGE ACROSS RIVER NARMADA AT MORTAKKA

Khandwa-Indore road is an important route connecting Madhya Pradesh and Madhya Bharat formerly separate States. This road links the Bombay-Agra National Highway and Old Bombay road in Madhya Pradesh. The river Narmada crosses the road in mile 41 furlong 5 near Mortakka. The unbridged Narmada was of great hindrance to traffic, commerce, and movement of agricultural produce between the two States.

The site of the bridge is about 1,000 ft upstream of the railway bridge where the banks are steep and the river flows practically straight for a distance of about one mile on the upstream and downstream sides, Fig. 1 on page 513. The level of the maximum high flood which occurred in the year 1841 was 487.12. The ordinary flood level was 462.00. It would be expensive to construct a high level bridge to pass the peak discharge of 10,79,000 cusecs. It was decided to construct a "High Type Submersible Bridge" with formation level as 467.00 because the average velocity in the unobstructed waterway at peak discharge was observed as 7.12 ft per second. With this formation level the traffic may be interrupted for about a day or two once in about three years.

The bridge consists of 24 R. C. C. arches with a clear span of 88 ft 3 in. each. The arches are two-centered as shown in the longitudinal section. The thickness at crown is 18 in. and that at the springing 27 inches. Arches are reinforced with 1½ in. and 1 in. diameter bars alternately at 4½ in. centres at top and bottom. 1½-in. diameter bars are provided up to 1/10 of span from springing. Details are shown in Plate I, Page 511.

The foundations for each of the piers and abutment piers consist of 2 ft thick cement concrete taken into firm rock at least by 2 ft. The piers are 9 ft 9 in. at top and have a batter of 1 in 18. The skin of the piers is 2 ft thick first class coursed rubble masonry in cement mortar 1 : 4 and the hearting is 1 : 3 : 6 cement concrete with 25 per cent plums. Old 75 lb rails encased in 9 in. by 9 in. cement concrete 1 : 2 : 4 have also been provided in the hearting at 5 ft centres.

The abutment piers are 19 ft 9 in. at top with a batter of 1 in 12. The spandrel will be filled with lime concrete having 25 per cent plums. The face walls are in R. C. C. designed as cantilevers.

Since the summer water level is very low, not much difficulty was experienced in diverting water. The bed of the river is generally rocky. So the excavation necessary was not deep. But in excavating the foundation of pier No. 4 on the Khandwa side it was observed that a soft strata (red earth) 10 ft to 18 ft in width ran right across the foundation diagonally encased by the two sides by a slightly harder strata.

Borings revealed that there was no hard rock at a reasonable depth. So it has been decided that the 4th and 5th spans will be replaced by three spans.

Centering with balli posts heavily cross braced with angle iron rib and planks has been used for concreting the arches.

The road level is one ft above extrados of the arch at crown. The wearing surface is 1 : 1½ : 3 cement concrete 3 in. thick over 3 in. thick 1 : 2 : 4 cement concrete overlying a 6-in. layer of lime concrete.

Expansion gaps of 1½ in. at the centre of each pier and abutment pier are to be filled with board soaked in bitumen.

The carriageway of the approach road will be 12 ft wide and will consist of 2 coats of 3 in. metal each on 6 in. of boulder soling. This shall then be bitumen sealed.

The carriageway will be 22 ft wide between parapets. Collapsible railings 3 ft high will be installed.

MANDHATA OMKARESHWAR

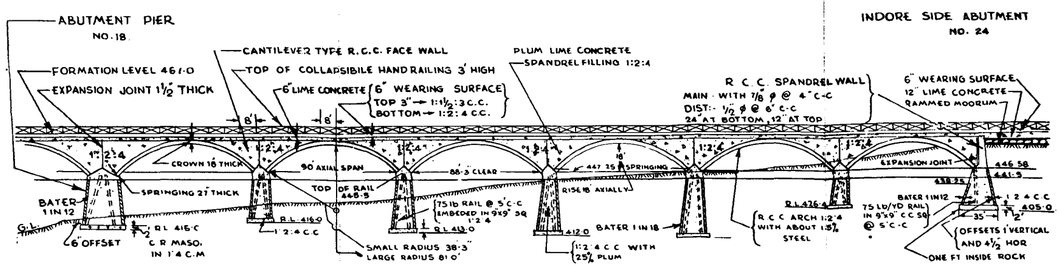
An island roughly about a mile and a half long in the river Narmada about 32 miles north-west of Khandwa is composed of lofty hills. This place is commonly known as Omkar-Mandhata and contains a number of interesting temples. These are generally in the mediaeval Brahmani style.

One of the temples, which is dedicated to Omkareshwar, is four-storeyed. The deity is said to be one of the twelve "Jotirlingas" in India and is much revered by the Hindus.

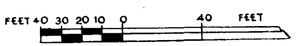
At present, pilgrims to the temple have to cross the Narmada river from the north by a ferry. The Madhya Pradesh Government has sanctioned the construction of foot suspension bridge at a cost of Rs 5,00,000.

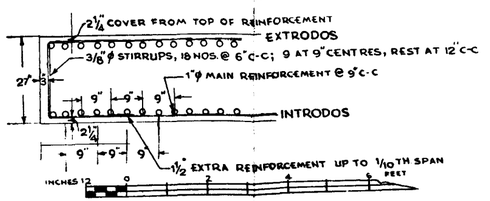
PLATE I

INDORE SIDE ABUTMENT NO. 24

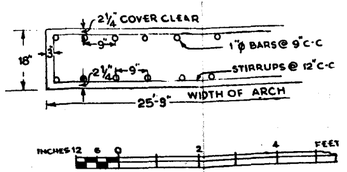


Part Longitudinal Section



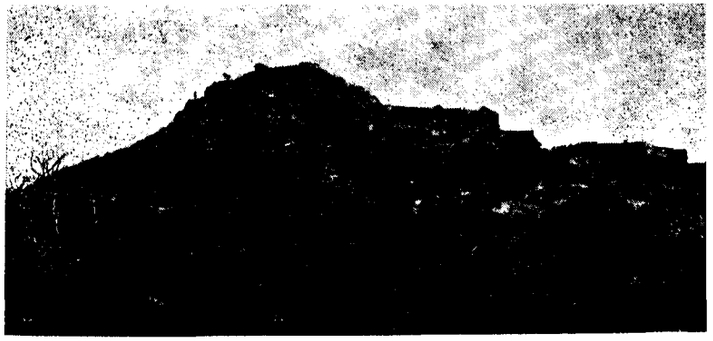


Details of reinforcement at springing



Details of reinforcement at crown

SUBMERSIBLE BRIDGE ACROSS NARMADA AT MORTAKKA



General view of Asirgarh Fort

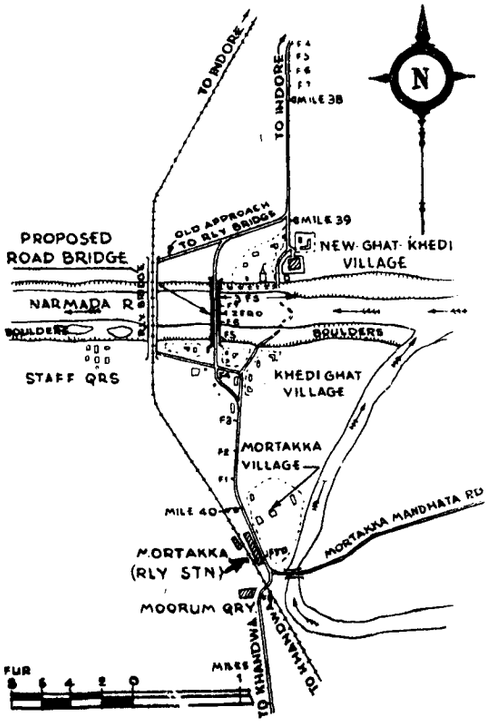


Fig. 1. Site Plan of Mortakka Bridge

Photo 1. **Dewatering foundation for pier No. 4 where there is a fault**

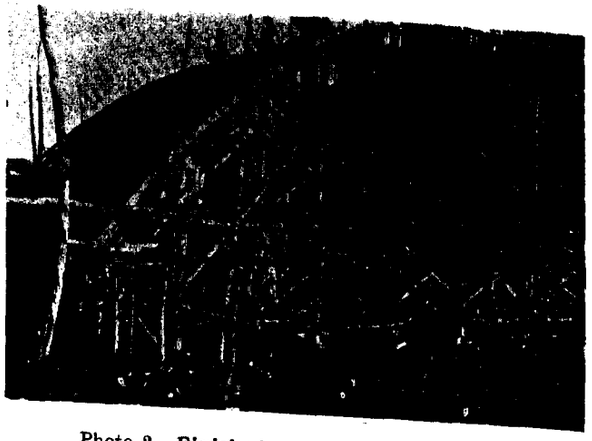


Photo 2, **Finished centering for the arch**

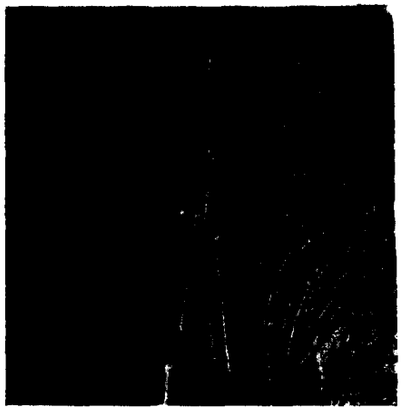


Photo 3. **Reinforcement for the arch**

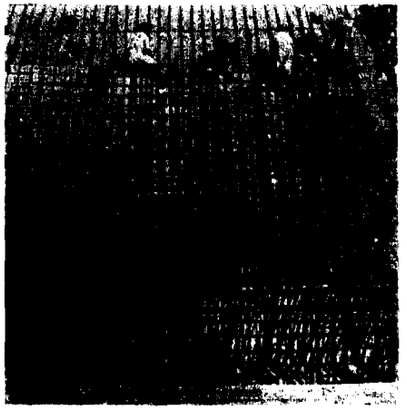


Photo 4. **Reinforcement for the arch**

Omkareshwar Temple, Mandhata with its surroundings.

Siddheswar Temple, Mandhata.

KHAPERKHEDA POWER STATION

Khaperkheda Generating Station, which is situate at about 12 miles east of Nagpur, is one of the many stations in the planned electricity development scheme of Madhya Pradesh drawn up by Sir Henry Howard, long associated with the Madras Province, in the year 1945. This station was intended to supply the power needs of the Nagpur district, the Pench Valley coalfields, the Manganese belt east of Nagpur, the Chanda area, and part of Akola area.

The site of the station was selected by a Committee, after examining the various alternatives, as the best available one from considerations of foundation conditions, availability of water supply, and easy means of transport of coal from the coalfields.

At present the generating capacity of the installation is 30,000 kw. Power will be transmitted to the various consuming centres by means of a 66 kw transmission power lines, 120 miles to Amraoti. The transmission line to the Pench Valley Coalfields, Nagpur, Wardha, Amraoti and Khamgaon will be by a 66 kw single circuit line on reinforced cement concrete poles and will be 360 miles in length. It is expected that a population of about 3 crores living in an area of 12,000 sq. miles will be benefitted by the scheme.

Power House

The civil engineering and building works connected with the project consist of a power house, foundations for the three Turbo alternators, water supply system, coal handling plant, administrative office buildings, workshops, etc. The main power house consists of buildings for housing boilers, turbines and switchgear. The turbine house is a steel framed building with brick walls and a corrugated asbestos cement sheeted roof and has 5 bays each 38 ft long. Steel columns carry crane girders for a 50-ton electric overhead gantry crane with crane rails at 41 ft centres. The height above basement floor level of the turbine operating floor is 22 ft, the crane rails 42 ft and the underside of the roof trusses 53 feet. The heights of the operating floor and crane rails have been arranged to be suitable for larger sets when the station is extended, for which extension provision of a temporary sheeted gable has been made.

Coal Handling Plant Works

Works in connection with the handling of coal consist of a hopper 53 ft long and 14 ft wide for unloading from the 2 ft 6 in. gauge railway. Coal is then unloaded into wagon tippler, which

is 47 ft long and lifted for discharge into a hopper 32 ft long by 12 ft 6 in. wide. Both hoppers form part of a reinforced concrete tunnel structure 22 ft deep from ground level, in the lower portion of which is a conveyor belt on to which the hoppers feed. The conveyor belt which is level under the hoppers then gradually rises at an angle of 18° for 138 ft until it is 32 ft above ground level when it discharges into the receiving hopper of the crushing plant housed in a steel structure. The crushing plant discharges on to a second belt 274 ft long provided with a wing tripper for discharge either to store, or to the reclaiming hopper feeding the main gravity bucket conveyor feeding the station. The reinforced concrete reclaiming hopper is 13 ft by 13 ft on plan and is provided with a concrete apron for the use of mobile coal reclaiming equipment. The gravity bucket conveyor passes horizontally at 12 ft below ground level in a reinforced concrete tunnel 10 ft wide by 16 ft deep to the boiler house foundations. Thereafter it passes vertically upwards, supported by the boiler house steelwork, to the conveyor gallery over the bunkers.

Boiler House

The boiler house in which steam for the working of the turbines is generated accommodates six boilers in two lines of three each. At present only 5 boilers are being installed. The central firing aisle between the two rows of boilers is arranged at right angles to the turbine house.

The boiler units which are manufactured by Babcock and Wilcox Ltd. are capable of a maximum evaporation of 58,000 lb of steam per hour. Normal working pressure at the superheater outlet is 425 lb per sq. in. and the normal steam temperature here is 775° F. The normal temperature of the feed water supplied to the boiler is 210° F.

The economical output of the boiler is 45,000 lb per hour and at this rating the guaranteed efficiency is 81 per cent based on the lower calorific value of the coal. A typical analysis of the coal used is :

Moisture	12.2 per cent
Volatiles	29.8 ,,
Fixed carbon	38.9 ,,
Ash	19.1 ,,
Gross calorific value—British Thermal Units per lb	9017

The flue gases from the boilers are discharged into a main flue. There are two such flues running one each along a

row of boilers. The flue gases from each of these are delivered into a steel chimney 175 ft high. Each of the boilers is provided with one forced draught fan which is arranged in the basement. The boilers are lined with refractory material and enclosed in steel casing so that the loss of heat and ingress of cold air is reduced to the minimum.

Turbo Alternators

The turbine house accommodates three turbo-alternator sets, each with a continuous maximum rating of 10,000 kw but designed to give their most economical rating at 8,000 kw.

The three turbines are identical in design and are single cylinder machines of the axial flow impulse type, running at a normal speed of 3,000 revolutions per minute.

Each turbine is supplied with steam at a pressure of 400 lb per sq. in. (gauge) and a temperature of 750° F. and contains one 2-row Curtis wheel followed by 26 Rateau stages. The blading material was selected to suit the varying conditions of temperature and wetness which will exist in the machines, the moving blading and nozzles of each Curtis wheel being of 5 per cent nickel steel with stainless steel fixed blading while the Rateau stages have stainless steel blading with nozzles of ½ per cent molybdenum steel and rustless steel at the high and low pressure ends respectively. The high temperature end of the turbine casing is of cast steel, the rest of cast iron.

Each of the turbines is connected through a coupling to a 12,500 kw alternator. These alternators are designed to generate 3-phase electric current at a voltage of 11,000 and a frequency of 50 cycles per second.

Switch Gear

This is of the Metropolitan Vickers Electrical Company's 11,000 volt double busbar type, having a short circuit rupturing capacity of 500 MVA.

Water Supply

All water required for the power station is taken from the river Kanhan. Two vertical spindle centrifugal pumps of 1,000 gallons per minute capacity are installed in the pump house on the river bank.

The river water is pumped to three concrete settling tanks with sloping bottoms, and a preliminary treatment with sulphate of alumina is given to quicken the settling of the suspended impurities.

TECHNICAL PARTICULARS

Boiler Plant

Maximum continuous rating	58,000 lb per hour
Most economical rating	45,000 ,,
Steam pressure at stop valve	425 lb per sq. in.
Steam temperature at stop valve	775° F.
Heating surfaces:	
Boiler portion	4,960 sq. ft.
Furnace water-cooling tubes	35.5 sq. ft.
Superheater	3,030 sq. ft.
Economiser	5,550 sq. ft.
Volume of combustion chamber	2,690 cu. ft.
Volume of furnace gases at air-heater outlet at M.C.R.	44,800 cu.ft. per minute
Volume of air at inlets of forced draught fans at M.C.R.	26,100 cu.ft. per minute
Electrical input to induced draught fan	104.5 kw
Electrical input to forced draught fan	28.85 kw
Guaranteed efficiency of boiler unit at most economical rating	81 per cent

Coal Handling Plant

Capacity of belt conveyor from unloading hoppers to crusher house	150 tons per hour
Capacity of "stacking" belt conveyor	150 ,,
Capacity of gravity bucket conveyor to boiler bunkers	75 ,,
Capacity of each crushing plant coal actually crushed	95 ,,
Capacity of side discharge wagon tippler	150 ,,

Turbo-Alternator Plant

Steam Turbines and Condensers

Type	Impulse
Number of cylinders	One

Speed r. p. m.	3,000
Maximum continuous rating (M. C. R.) kw	10,000
Most Economical Rating (M.E.R.) kw	8,000
Normal pressure of stop valve lb per sq. in. (gauge)	400
Normal temperature at stop valve deg. F.	750
Absolute pressure at turbine exhaust (at M.E.R.) inches Hg.	2.25
Circulating water inlet temperature (normal) deg. F.	85
Circulating water quantity (normal) g. p. m.	9,000
Condenser surface sq. ft.	13,500
Steam extracted per hour for feed water heating at M. C. R. lb	10,464
Number of extraction points (including tapping for bled steam evaporator)	3
Feed water temperature at M.C.R. deg. F.	219
Capacity of bled steam evaporator lb per hour	4,000
Steam consumption at M.C.R. lb per kwh	10,185
Heat consumption at M.C.R. British Thermal Unit per kwh	12,236

Alternators

Normal voltage	11,000
Maximum kVAr lagging	7,500
Maximum kVAr leading	8,000
Efficiency at M.C.R. and at 0.80 lagging power factor...per cent	96
Total quantity of cooling air cu. ft. per minute	32,000

Discussion on Paper No. 180*

" Stabilised Soil Construction in the Formation of Tuticorin-Tiruchendur Road "

By

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AND

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Sunday, 8th January 1956

Shri S. R. Mehra (Chairman) called upon Shri E. C. Chandrasekharan to introduce his Paper.

Shri E. C. Chandrasekharan (Author), introducing his Paper, said that the use of stabilised soil in road construction was a common practice in many Western countries where intensive use of special machinery, particularly for pulverizing and mixing the soils, was made. Traffic in those countries was mostly pneumatic tyred whereas in India it was not so. The first experimental stabilization work in India was taken up in the year 1939 in the Punjab. Stabilized soil was used for both foundation and wearing courses on lightly trafficked roads. The Madras State Highway Department took up its first experimental work in 1948 and had so far completed nine works in different soil areas. Because of considerable amount of iron tyred traffic in the State, stabilized soil had been mostly used in foundation courses. The first major work completed was the Tuticorin-Tiruchendur Road. A soil survey of the area nearby revealed the occurrence of sand and clay in close proximity. The estimated cost per mile for stabilized soil foundation was Rs 7,500 as against Rs 15,000 for the conventional stone soling. The essential principle in arriving at the sand-clay design mix consisted in blending the locally available sand and clay to yield a material that showed maximum density and a North Dakota Cone bearing power of not less than 200 lb per sq. in. after soaking for three days.

Experience of stabilized soil construction in the formation of the road and laboratory experiments showed the following:

1. Soils and soil admixtures with a maximum particle size of 0.4 mm. could be mechanically stabilized.

* Published at pages 69 to 118 of Journal of the Indian Roads Congress, Volume XX-1, October 1955.

2. Pulverizing was essential for obtaining a uniform mix. The difficulty in pulverising imposed a severe limitation in the use of fat-clay in soil stabilization. Since no method for determining the degree of the susceptibility of soil to pulverization existed, a simple test in the form of pulverization index had been suggested by the Authors.

3. The degree of pulverization specified in Madras State, viz., 100 per cent of the clay binder to pass through $\frac{1}{8}$ in. sieve was rather severe. Field experiments using $\frac{1}{2}$ in. size had shown very satisfactory results. Further research work was needed to make definite recommendations.

4. There was a need for a clear definition of optimum limits of the plasticity indices of soils considered suitable for use in mechanical soil stabilization. As consistency tests conducted on the minus 40 fractions of mixtures of coarse and fine soils did not indicate their true properties, the Authors had suggested the determination of the plasticity index on minus 200 fractions instead of minus 40 fractions, so that the test values were consistent for the soil mixtures of the same basic type of the binder constituents. The equivalent plasticity index for the whole soil might be determined on the lines worked out by Pereira and the optimum values of plasticity index required for successful stabilization might then be arrived at by a method similar to that worked out by Wooltorton.

Shri Chandrasekharan pointed out some printer's mistakes in page 80, Table 2, items 7 to 11. On page 91, Table 4 of the Paper, serial No. 5 should be read as " Plasticity index on minus 200 fractions " instead of " Plasticity index on minus 40 ".

Shri Fateh Chand was of the opinion that it would be worth while to tabulate the results of all experiments carried out in different places with reference to climatic, soil conditions and other aspects. He wished to know how the 5 in. thickness of the base course was fixed.

Shri H. L. Uppal referred to the Papers on soil stabilization by Shri S. R. Mehra in the various journals of the Indian Roads Congress on the pioneering work done in the Punjab, and said that a 3 to $3\frac{1}{2}$ in. compacted thickness of graded soil with about 40 per cent of brick ballast was equally strong and less costly than the water-bound macadam of $3\frac{1}{2}$ in. consolidated thickness as was proposed by the Authors.

Shri Uppal was of the opinion that it was not necessary to bring the plasticity index of the mixture to 2.5 to 3 unless the subgrade conditions were really very wet. He drew atten-

tion to Shri Mehra's method of using a soil with plasticity index of 5 to 6 and compacting it to a density of about 1.8. Tests at the Calcutta test track showed that the above mentioned specification worked well.

The subgrade soil could have been used by properly blending it with other soils instead of importing soil as was mentioned in para. 6.2, page 76 of the Paper. This would have been more economical. Similar difficulties were met with while constructing stabilized soil roads in the Punjab, but they were overcome by careful survey and by having designs at such short intervals as $\frac{1}{4}$th furlong. The soils at site were blended to a desired specification and stacked close to the site. The Authors could have done the same by blending the soil and stacking it right on the subgrade itself.

The suggestion regarding the determination of the plastic limit of the minus 200 fraction and then working out the plasticity index of the whole soil, referred to on page 92 of the Paper, might not lead to any definite conclusions. The proposal of conducting the test on various fractions had already been considered by the Permanent Committee on Standardization of Soil Testing Methods and Apparatus of the Central Board of Irrigation and Power and it had been decided that there was no evidence warranting change in the existing practice.

He also wanted to know how 5 in. thickness of the base course was obtained and how uniformity of the mixture was ensured. He felt that compaction to 5 in. thickness in two layers would be uneconomical. Tests carried out at the Central Road Research Institute and the Road Research Laboratory at Harmondsworth showed that a 9-in. loose layer could be compacted to a density of 1.8 to 1.85. The density gradient was satisfactory.

The quantity of sodium chloride, referred to on page 99 of the Paper, should be carefully worked out. Addition of $NaCl_2$ up to a limit made the soil less friable. Only when the percentage exceeded the limit did the soil become friable. Experiments at the Central Road Research Institute showed that the addition of lime made black cotton soils friable and easy to handle. In his opinion, addition of lime was preferable to that of sodium chloride.

In Fig. 10 on page 104 of the Paper, the grading from tests in the laboratory were shown. When a moorum sand mixture was handled in the field, segregation was bound to take place and the performance of the mix depended on how segregatien was prevented. In the United Kingdom, attempts were made to evolve special plant. Some success was also achieved by the

addition of 3 to 4 per cent moisture to graded mixture which kept the fines sticking to the coarse aggregate.

It was also worth while to experiment with the addition of sandy soil having some plasticity to the graded moorum mixture.

Shri S. N. Gupta referred to Fig. 3 on page 74 of the Paper and said that a correction was necessary in the sketch wherein it was shown that the sand clay base was 17 ft instead of 18 ft. He also wanted to know whether any treatment to the sandy shoulders and slopes was required. Referring to Fig. 4 he wanted to know as to how the 4 in. sand sub-base was behaving under traffic.

For consolidation of the sandy subgrade, he enquired if there was any special advantage in using pneumatic rollers before curing. Shri Gupta wanted to know the thickness of the dry sand layers used, while consolidating the silty or clay subgrades, mentioned in para. 4.3, page 75, of the Paper. He felt that there might be a tendency for the sand to get into the plastic clay subgrade. In his opinion, the cone bearing power measured immediately after compaction, mentioned in para. 5.4 on page 76 of the Paper, was not a dependable guide.

Comparison of costs taking 18 ft by 5 in. stabilized soil base as equivalent to 13 ft by 6 in. stone soling was not fair. In his opinion, the cost of 2 to 5 in. thick sub-base should also be taken into account. In the Calcutta test track it was found that 7 in. thick stabilized soil base and sub-base were found equivalent to a double layer of flat bricks or 6 in. stone boulder soling.

In serial No. 8 of Table 2 on page 80 of the Paper, the optimum moisture content of all the mixtures was mentioned as 9. That was improbable. He was of the opinion that serial No. 12 in Table 2 on page 80 of the Paper represented the total moisture after 3 days soaking, i. e., the optimum moisture content plus the moisture absorbed after three days soaking. The uniform value for the plasticity index of the minus 200 fraction for all the mixes given against serial No. 5 in Table 4 on page 91 of the Paper needed elucidation.

Referring to page 92, where a modification for the method of determining the plasticity index of a soil was suggested, Shri Gupta wished to know if the values calculated by the proposed method tallied with the actual test values in the case of plastic soils particularly in the light of the results given in Table 4 on page 91 of the Paper. Shri Gupta wanted the details regarding

the adverse moisture conditions obtaining on the road with special reference to maximum and minimum water table.

Referring to the use of moorum sand mixtures, he said that in West Bengal such a mixture did not succeed as a surface course, but behaved better than soil sand mixtures as base course. Also, a priming coat was necessary before a carpet was put on the moorum sand surface without any water-bound macadam intermediate course.

Shri R. N. Dogra was of the opinion that uniformity of mixing and proper compaction were essential for which construction should be done by using machinery. In the Punjab the base course was laid and compacted in a single layer, the mixture consisted of 2 soil: 1 aggregate and had a plasticity index of 7 to 10. He was of the opinion that stabilized soil could be used as a surface course for rural roads carrying 100 to 150 tons of traffic per day. Its cost in the Punjab worked out to Rs 6 per 100 sq. ft. Using a 2-in. stone skin, the cost was of the order of Rs 9 per 100 sq. ft.

Shri J. S. Narasimham said that the movement of subsoil moisture was an important factor in stabilized soil roads and that it might influence the design. The addition of 5 to 10 per cent clay for the blanket course served no purpose. The thickness of the sub-base depended on its bearing capacity, strength characteristics, etc., and should not, therefore, be fixed arbitrarily. In his opinion, the plasticity index should have been between 9 to 12. Data on unconfined compression strength for sand-clay mixtures should also be included in Table 5 on page 95 of the Paper in addition to void ratio and North Dakota Cone bearing power as, in his opinion, the unconfined compressive strength gave better results. Although the addition of sodium chloride was advantageous in effecting easy pulverization, the salt was liable to be leached out during the life of the pavement.

Shri E. A. Nadirshah said the design was a curious combination of the conventional—in his view, outmoded macadam—and a scientifically designed stabilized soil base. It seemed that the combination was the result of apprehension on the part of the designers about the stabilised soil construction under the steel tyred bullock cart traffic. He wondered why the grafting of stone metal into the top course of the stabilized soil construction was not tried instead of the conventional water-bound macadam. A cheaper construction might have been the result. Experience in the Punjab showed that stabilized soil mixed with brick aggregates gave satisfactory service for mixed traffic of about 500 tons per day. Possibly, the success was due to the soft brick aggregate, on crushing, producing a close mechanical

interlock and thereby producing stability greater than that obtained by the use of harder granite aggregate.

Limestone aggregate, which was available with a less lead near the site of the work than granite, which had to be carted for 20 miles and over, might have been used in the Tuticorin-Tiruchendur road.

Even though meticulous care had been taken in grading materials, moisture control, compaction, etc., for the base course, it was desirable to provide surface dressing to exclude moisture instead of depending upon the surface drainage and waterproofing quality of the overlying macadam construction.

Though the details regarding the tests on the various soils were not given, yet it was felt that the soil could have been stabilized with about 8 per cent of cement. The cost of such a course would have been about Rs 39 per 100 sq. ft. as against Rs 42 per 100 sq. ft. for the composite construction of 5 in. sand clay base with 3.5 in. water-bound macadam given in the Paper. The greater load carrying capacity and better riding characteristics of soil cement would have been added advantages.

The mazdoor labour for the construction was on the high side, specially when machinery had been employed. However, soil stabilization work could be attempted with much less equipment.

The addition of sodium chloride, he felt, was not always desirable. He drew the Authors' attention to Dr. Looker's observations on the Paper* on "Surface Chemical Factors Influencing the Engineering Properties of the Soils" by Winterkorn. Dr. Looker had said that "Sodium Chloride does change the nature of clay because of absorption, to make it more plastic." Also, Wooltorton in his book "Scientific Basis of Road Design" observed that the percentages of sodium chloride of up to 6 per cent by weight had no appreciable effect on the plastic index of the soil mixture.

Shri M. K. Ganguli suggested the use of the process of Linear Programming in analysing the data and referred to the work of Coopman and Noel Williams.

Shri A. K. Deb thought that in the design of the mix the Authors considered only easy compactibility and not strength by emphasising more on the consistency requirements than on the particle size gradation. It was

*Proceedings of the Highway Research Board of 1936.

the coarse material which supplied the bearing power and not the fines. He was of the opinion that while there was scope for adopting a value higher than that recommended by British or American practices for the plasticity index, the maximum particle size should be kept at least 2 mm specially for the base course mix.

Salts such as sodium chloride flocculated the clay colloid which was otherwise in a dispersed condition, and so there was reduction in the plasticity index. He thought that the statement of the Authors that the mechanical stability of a soil containing common salt and liable to leaching during its service might be adversely affected by a reduction of the salt content was not fully correct. When sodium chloride (or magnesium chloride) was present in a soil, due to the hygroscopic nature of the salt, moisture was retained and the soil was therefore stable. But when the salt was leached out, moisture quickly evaporated and the soils which were not cohesive were likely to become loose and powdery.

He was of the opinion that the Tuticorin-Tiruchendur road might play an important role in the formulation of the rational design for stabilized soil work and emphasised that the behaviour on the road should be observed under different traffic intensities—dry and wet weather.

Shri S. R. Naidu found in the list of equipment an absence of tractors and he asked as to how transport was feasible in sandy areas without them.

In giving a comparative cost of stabilized soil base course and lime stone soling, rates for carriage along cart tracks were adopted whereas if the rates for transport in sandy areas were taken the amount of saving might be different.

Shri D. C. Chaturvedi* wanted to know as to why sheepsfoot rollers were not used. He referred to paras. 11.2 on page 103 and 12.2 on page 106 of the Paper where it was reported that moorum sand mix for the berms, which had a plasticity index of 9.04, proved ineffective, and thought that a higher value of plasticity index, between 10 to 12, should have been used. The significance of the results of the moisture absorbed after three days' soaking, given in Table 5 on page 95, needed explanation. Shri Chaturvedi wanted to know the basis for fixing the maximum percentage of absorption allowable in each case.

* This and subsequent comments were received in writing.

Shri N. R. Srinivasan said that the one important point which the Paper had brought out was that no great attention need be paid to the grading aspect and that control of consistency requirements was all that was needed to obtain a soil mixture that could be stabilized. Drawing a parallel between the grading of aggregates in concrete making and soil stabilization, he said that in both concrete and stabilized soil it should be possible to have a gradation quite different from the ideal curve and yet obtain satisfactory results.

Another point of interest given by the Authors was that the amount of minus 200 fraction as per Fuller's curve for maximum density was far in excess of what was required for maximum density and stability. Fuller's curve was not applicable here as it was evolved for concrete aggregates containing negligible amount of clay. By limiting the minus 200 fraction the ill effects of even the most expansive clay minerals could be kept under check. Also, Dr. Winterkorn and Choudhry had shown that soils having the same mechanical composition but differing only in the type of clay behaved differently. So, even when the grading requirements for all particle sizes were not fully satisfied the requirement of the finer size should be specified. Also, consistency requirement was, in his opinion, a better index of suitability than mere mechanical grading.

Shri D. N. Khurana wished to know how far the presence of chlorides would affect the mechanical stability when exposed to humid climate.

Shri E. C. Chandrasekharan, one of the Authors, in reply to the discussions agreed with **Shri Fateh Chand** that tabulating the results of all the experiments on soil stabilization carried out in the different soil areas in the country and studying them with special reference to the climatic and other conditions would be very useful. In the Madras State, however, the experimental stage had long passed and at present stabilization was undertaken as a matter of course in places where costs compared with the conventional methods were favourable.

The thickness of 5 in. adopted for the base course was based on the succesful behaviour of similar roads in the State with comparable soil and traffic conditions.

The Authors were happy to state that they had followed with keen interest and enthusiasm the pioneering work of Shri S. R. Mehra on soil stabilization, referred to by **Shri H. L. Uppal**. The comparison of cost and stability made out by Shri Uppal between a 3½ in. thick water-bound macadam and a 3 to 3½ in.

thick compacted graded soil with 40 per cent brick aggregate might be true for conditions in the Punjab. But generalisation based on the conditions in the Punjab needed close scrutiny. In Madras State, brick aggregates (1½ in. size) might be taken as more costly than metal aggregate of the size used in the water-bound macadam. Perhaps in such places where stone metal and moorum were prohibitively costly and brick aggregate and graded soil were comparatively cheap, it might be advantageous to lay wearing surfaces with brick aggregates. The Authors, however, drew his attention to the findings from the tests conducted at the Calcutta Test Track comparing water-bound macadam and compacted graded soil with 40 per cent brick aggregates.* It was observed from these tests that water-bound macadam had shown no visible sign of disintegration while the graded soil-brick aggregate combination, under wet conditions, was not suitable for steel tyred traffic had 'failed presumably because of the presence of excess moisture.'

In pointing out that it was not necessary to bring the plasticity index of the soil mixture down to 2.5 to 3 unless the the subgrade conditions were very wet, Shri Uppal apparently had in mind a clay subgrade and thought that it was proposed to stabilize it with imported (cohesionless) sand. This was not so. The case under discussion was a **sand** subgrade, para. 4.2 of the Paper, which had to be strengthened by the addition of imported clay. Addition of imported material in as small a quantity as possible alone was conducive to economy. This was what exactly was done in keeping the plasticity index of the mixture not higher than 2.5 to 3. Raising the plasticity index to 5 or 6 as recommended by Shri Uppal required addition of the imported clay in greater quantities which would result in increased cost.

The Authors agreed with Shri Uppal on the need for a maximum utilization of the subgrade soil. In fact, the sandy soil available on the subgrade for about 2½ miles on the road was used. In the other reaches, the type of soil varied within very short distances both horizontally and vertically. So, practical considerations and non-availability of adequate trained staff for design and control of work in the field at that time imposed a severe limitation on the minimum length of the road that should be adopted for a given design mix. In Madras, in two other stabilization works taken up subsequently, the minimum length of the road for a particular design mix was taken as one furlong, roughly a days work. In these

* Road Research Bulletin No. 2—Report on Experimental Surfacings tested on the Road Test Track at Maherhat, Alipore, Calcutta, 1942-47, issued by Indian Roads Congress, page 133.

works the subgrade soil was used in the base course to an extent of 50 per cent and more.

Referring to Shri Uppal's remark that the suggestion to conduct the consistency tests on minus 200 fractions and working out the plasticity index for the whole soil mixture might not lead to definite conclusions, the Authors drew attention to para. 6.6 of the Paper and the introduction to the discussions where it was mentioned that the standard method of conducting the consistency tests on the minus 40 fractions of mixtures of cohesionless and cohesive soils did not bring out their true properties. For example, tests conducted on mixtures composed of 4 parts sand plus 1 part clay and 5 parts sand plus 1 part clay 'serial No. 2, Table 4 of the Paper' showed that they were 'Non-plastic', while they contained clay binder to the extent of 20 to 16.6 per cent respectively. The combination of 5 parts sand plus 1 part clay was actually adopted as the design mix for the reach 1/5 to 2/2, Table 3 of the Paper, and it had behaved excellently well in service. If one were to be solely guided by the results of the consistency tests conducted on the minus 40 fractions, the obvious conclusion would be that the combination of 5 parts sand plus 1 part clay was not plastic and if material with any given value of plasticity index (say 5 or 6) was to be obtained, additional binder soil would have to be added. The results of tests conducted on the various sand-clay combinations for this reach had shown that 5 parts sand plus 1 part clay showed maximum density and maximum bearing power after soaking (last four lines of para. 6.4, page 81 of the Paper), and further addition of binder soil resulted not only in a less stable material but in increased cost. This indicated that the standard method of conducting the consistency tests on the minus 40 fractions of soil mixtures and evaluating the plasticity index values for arriving at the design mixes was not adequate. This showing of a soil mixture containing binder fractions as 'non-plastic' by the standard method was due to the presence of the non-plastic 40/200 fractions contained in the sample tested. Hence for purposes of obtaining consistent test results regarding the plasticity of soil mixtures, the Authors had suggested the use of minus 200 fraction, (serial No. 5, Table 4, page 91 of the Paper). The uniform value indicated that these soil mixtures possessed one and the same type of binder material. In as much as there could be a large number of soil mixtures with the same binder constituent in varying proportions and the influence of the binder fraction on the consistency characteristics of these various mixtures should be distinguished, the need to describe the plasticity index of the whole soil mixture taking into consideration the complete granulometry of the soils as done by Pereira had been emphasised. While Pereira had given his formula for obtaining

the plasticity index of a whole soil mixture basing on the values obtained from tests on the minus 40 fractions the Authors extended the idea to the tests conducted on the minus 200 fractions. The values arrived at by such a process were given in serial No. 7 in Table 4, page 91 of the Paper.

The Authors had not suggested that the standard method o conducting consistency tests be changed into another by taking for the tests the minus 200 fractions in place of the minus 40 fractions, as apprehended by Shri Uppal. They had only focussed attention to an inadequacy in the standard method for assessing the consistency characteristics of soil mixtures and in designing the mixes based on such test values. In order to overcome the difficulty for a specific purpose, they had advanced the two suggestions made in page 92 of the Paper as a possible rational method of approach. The Authors believed that in arriving at the standard method of conducting the consistency tests, the Standardization Committee had taken into consideration many factors, the most significant of which was that the method should be in line with the standard methods in use in other countries to facilitate easy intercommunication of ideas. The Authors were of the opinion that a general method might not be always an answer to every special case.

Uniformity of the mixture was ensured, to commence with, by an experimental determination of the particle size distribution of samples of the soil mixture ready for compaction. Later, this test was conducted only occasionally and particularly when changes in the design mixes occurred. Efficiency of compaction was, among other factors, dependent on the nature of soil and the availability of plant. Because of the non-availability of sheepsfoot rollers, the compaction was done in two layers by a combination of pneumatic tyred rolling and smooth wheeled power rolling. In two other stabilization works taken up subsequently in the State, the compaction of the base course (9 in. loose and 6 in. compacted) was done in one layer with the sheepsfoot roller first and later with a pneumatic tyred roller and finally finished with a smooth wheeled roller.

The Authors were in agreement with Shri Uppal on the need for caution in the addition of common salt to plastic soils to make them friable. They were also of the opinion that lime was a good stabilizing agent for plastic soils and desired to point out that research conducted on clay-lime stabilization in the Soil Research Laboratory, (presently Highway Research Station) Guindy, had brought out certain very interesting results establishing the usefulness of lime as a stabilizer for clays. Recommendations were made for adoption of lime stabilization for a road.

Difficulties due to segregation and the success achieved in preventing segregation by the addition of fines, mentioned by Shri Uppal, strengthened the experience of the Authors in moorum-sand stabilization works taken up in a number of places in the composite Madras State. In the moorum-sand work for Tuticorin-Tiruchendur road, however, this difficulty was not there, since the moorum used contained some fines, as much as 19.2 per cent of minus 200 fractions and the material was not bone dry even during the dry mixing operations.

The suggestion regarding the addition of sandy soil having some plasticity to graded moorum-sand mixture implied that the graded moorum contained no binders. The moorum used for the moorum-sand mixture, as already stated, contained considerable fines. If the mixture showed any deficiency it was in the intermediate fraction of 'sand' and not in the binder. If sand of suitable particle size were added, the mixture on adequate compaction could be improved to yield higher density and bearing power. But from a practical point of view, whether such an improvement was worth the increased cost was a matter worth study.

The Authors thanked **Shri S. N. Gupta** for pointing out the correction in Fig. 3 on page 74 of the Paper, regarding the width of the stabilized soil base. No special treatment was given to the shoulders and slopes, except providing grass sods, 1 ft wide and 6 in. thick, for edge protection of the stabilized base course, Fig. 3 of the Paper. Tendency to scour at the edges of the formation and along slopes was noticed especially in high embankment portions where there was little silt or clay binder material in the soil. Boxing the entire surface with about 1 ft of clay would have been of advantage. For a major portion of the road, however, the subgrade and side soil contained some silt or clay. It might be of interest to add that in a stabilized soil work in a sandy area now in progress in the Madras State, namely, Kovalam-Mahabalipuram Road, clay edge bunds with grass sods and side drains with grass sods at the bottom and the edges were provided at suitable intervals. Observations of the road so far in the rainy season had shown that this was satisfactory. The experiment was being watched.

The road surface with the 4 in. thick sub-base of sand was behaving as excellently well as the other reaches and no special study was made of how the sub-base functioned. Examination of such sand sub-bases laid earlier on clay subgrades elsewhere in the composite Madras State had shown that for a height of about 1 to 1½ in. from the bottom, subgrade clay had worked itself up into the sand forming a clay matrix. This had occurred after

the road had been under traffic for about two years. Further observations on the creep of the clay upwards could not be made due to partition of the State. The upper limit of this creep was therefore not known. Observations on similar works would be of advantage to study the diverse functions of the sub-base of sand and in obtaining data for design of road beds.

Not much of an advantage could be attributed to the compaction of the sub-base with pneumatic tyred wheels before curing, except that the procedure adopted was found convenient for making an effective use of the plant. An initial compaction with the pneumatic tyred wheels, however, permitted movement of vehicles for collection of materials. Compaction with the smooth wheeled roller gave a well compacted and undisturbed surface for the base course to be laid on.

The thickness of the thin sand layer spread on the surface of the plastic clay subgrade mentioned in para. 4.3, page 75 of the Paper, might be taken to be of the order of $\frac{1}{4}$ to $\frac{3}{8}$ inch. The Authors agree with Shri Gutpa that there was a tendency for the sand to get into the plastic subgrade. This, however, added to the stability of the subgrade and prevented the clay from sticking to the surface of the wheels of the roller.

Cost comparison had been made in the Paper between the stabilized soil base 18 ft by 5 in., and the stone soling 13 ft by 6 in., which was generally used in the State. The extra cost due to provision of sand sub-base, 2 to 5 in. thick, was not added, since in the opinion of the Authors, this item would be necessary for the conventional stone soling also, if the subgrade clay was not to creep up into the interstices and give rise to foundation failures. Also, the advantage of an extra width of the stabilized base (18 ft as against 13 ft) was not taken into consideration in the cost comparison.

The Authors, in the first instance, had doubts about the correctness of value obtained for the optimum moisture content of the mixtures given on page 80 of the Paper. But repetition of the tests also yielded the same result. The explanation was that the curve for the optimum moisture content versus proportions of sand to clay in the mixes was more or less flat indicating that the optimum moisture content was not critical for the change in the proportions.

The Authors agree with Shri Gupta on the break-up of the total moisture absorption after soaking for 3 days (serial No. 8 in Table 2, page 80 of the Paper) into the optimum moisture and the additional moisture absorbed during soaking.

The question of the plasticity index values calculated by the proposed method given on page 92 of the Paper agreeing with values obtained by tests did not arise as the proposed method of calculation was merely a conversion of the values obtained from tests on certain fractions in terms of an equivalent value for the whole soil mixture including all the fractions. This was suggested to meet a deficiency in the application of the standard method to enable a proper appreciation of the plasticity characteristics of soil mixtures. Such studies if conducted on a large number of stabilized soil works would yield data that might serve as guide for design of soil mixtures.

No systematic observations were made on the adverse moisture conditions existing at the subgrade. The water table was within 5 ft below the subgrade for about 2 months in the year and about 12 ft for the rest of the year.

Shri Gupta's observations on the superiority of moorum-sand over sand-clay combination and the limited usefulness of moorum-sand as a wearing course confirmed the findings on a similar comparison of works undertaken elsewhere in the State. While the Authors had not done bituminous treatment on moorum-sand base courses, they noted with interest Shri Gupta's findings on the need for a priming coat and that a carpet could be put over the moorum-sand base without an intermediate layer of water-bound macadam.

Shri R. N. Dogra's observations on the experience in soil stabilization works in the Punjab, especially the adoption of a combination of soil and brick aggregates for the surface course of lightly trafficked roads (traffic intensity from 100 to 150 tons per day), and the cost particulars thereof, were of much interest and value. These must commend themselves for adoption in other parts of the country with soil and other conditions similar to those prevailing in the Punjab.

The Author agreed with **Shri J. S. Narasimham** in his observation that the movement of subsoil moisture influenced the design of stabilized soil base. The bearing power with the cone penetrometer after soaking for 3 days provided for the worst possible moisture conditions.

No base condition survey of the road was, however, made with a view to study the relative performance of the road on subgrades subject to different moisture conditions.

The addition of 5 to 10 per cent of binder soil to sand was a construction expedient as indicated in para. 5.2 of the Paper. Sand did not lend itself to compaction by the non-vibratory rolling equipment used on the road and addition of some binder material facilitated compaction.

The thickness of not only the blanket course but every other member of a road structure should be designed scientifically. A scientific design of the road was still in the process of development in the country. The adoption of the sub-base, 2 to 5 in. thick, depending upon the degree of plasticity of the subgrade soil, was perhaps one step in the long series of experiments. The provision was made for the Tuticorin-Tiruchendur road on the strength of carlier successful experiments in the use of sand sub-bases on roads of comparable soil conditions else-where in the State.

Shri Narasimham was of opinion that the plasticity index should be between 9 to 12. Practices in this regard in other countries showed that a plasticity index as high as 15 was used. These were described on page 81 of the Paper. Experience in soil stabilization work in Madras State, as also elsewhere, had shown that the current trend was to base the design of mixes on density and stability rather than on the values of plasticity index. For example, taking the specific case of the mix actually adopted for the road, Table 2 on page 80 of the Paper, the combination of 4 parts sand plus 1 part clay with a plasticity index (as per Hogentogler's formula) of 9.08 showed a maximum dry density of 116.5 lb per cu. ft., a cone bearing power after soaking of 189 lb per sq. inch and a moisture absorption of 17.1 per cent as against values of 120 lb per cu. ft., 270 lb per sq. inch and 15.37 per cent for the combination of 6 parts sand plus 1 part clay with a plasticity index of 6.43 respectively. The latter mix had obviously greater strength and stability and was, therefore, adopted. It was, therefore, safe to state that the value of plasticity index served as a rough guide only but was not to be taken as the controlling characteristic in the design. The general indication was that subgrades likely to be subjected to the influence of moisture required foundation courses of little plasticity if they were to remain unaffected by the moisture.

The Authors agreed with Shri Narasimham in his suggestion that mention of the voids ratio in Table 5 would be of advantage for a scientific analysis. The determination of the unconfined compression strength of granular soil mixtures (without any external stabilizer as cement etc.) might not be of real help in arriving at the best possible combination of the soils for the given purpose. For example, a well graded moorum with little fines, which was an excellent material for the base course, might show poor value of unconfined compressive strength (without an external agent as cement) while the worst clay when dry might show a very high value. Shri Narasimham did not indicate the moisture conditions at which the unconfined

compressive strength tests were to be conducted. When an external agent as cement was added, the strength was determined after curing for 7 days, when reproducible conditions of test might be said to have been obtained. In sand clay mixtures, the samples might show a considerable variation depending upon the moisture condition of the samples during the tests. The Authors believed that the unconfined compressive strength tests conducted on saturated clay samples obtained from subgrades afforded methods for analysis of safe stress permissible for design of pavements, but the use of the test for the design of granular soil mixture had many limitations.

The comparison of cost and performance of the two specifications made by **Shri E. A. Nadirshah** needed careful study. Where costs were favourable and traffic conditions were suitable, graded soil plus brick aggregate might be adopted. The traffic on the Tuticorin-Tiruchendur road had grown to 900 tons per day within $1\frac{1}{2}$ years of its completion. In view of such a phenomenal growth in the traffic it seemed undesirable to use wearing courses of soil reinforced with brick aggregates.

The use of limestone for wearing surface of lightly trafficked roads was a common practice in the State. The purpose of using granite and quartz metal was that the road surface should not get worn out even prior to the possibility of laying an improved surface.

The Authors agreed with Shri Nadirshah on the desirability of providing surface dressing over the water-bound macadam. On Tuticorin-Tiruchendur road surface dressing was taken up after the road was under use for about two years.

Shri Nadirshah had furnished a rough cost comparison between soil-cement and the sand-clay base (18 ft by 5 in.) plus water-bound macadam (12 ft by $3\frac{1}{2}$ in.). From experience of other cement stabilization works in the State, the Authors were inclined to estimate the cement requirement as 8 per cent for sand and silty sand, 10 per cent for sandy clay, and 12 to 14 per cent for clay. Besides, the presence of the sodium chloride in the clay would further increase the cement requirement. However, in the opinion of the Authors, it might not be possible to draw cost comparison without actually conducting detailed tests and designing the soil-cement mixtures. Shri Nadirshah had also declared that soil-cement, presumably 6 in. thick, possessed greater load bearing capacity and better riding characteristics than the base course of sand-clay (18 ft by 5 in.) plus water-bound macadam (12 ft by $3\frac{1}{2}$ in.). While agreeing that the soil-cement surface had better riding characteristics, the Authors were doubtful of the structural superiority of soil-cement over

what had been provided especially in the absence of any reference to actual field studies comparing the two. The combined effect of direct iron-tyred and pneumatic-tyred traffic on the unprotected soil-cement surface could be devastating. Secondly maintenance of the wearing surface to the specification which had been used was easier than where soil-cement was used as the base and wearing course.

The only machinery used for the stabilization work, other than what were required for the formation and the water-bound macadam work, was the grader. The grader did the job of preliminary mixing of soils for the sub-base, grading the sand-clay base course and pneumatic tyre rolling. Without the grader, all the above mentioned items of work would have to be done by manual labour, which might not result in uniformly good quality of work.

The Authors were in perfect agreement with the observations made by Shri Nadirshah about the need for caution in using sodium chloride for soil stabilization work.

The Authors welcomed the suggestion of **Shri M. K. Ganguli** in the use of linear programming in analysing the research data.

The design of the sand-clay mix was based solely on considerations of maximum density and maximum bearing power (not less than 200 lb per sq. inch with a North Dakota Cone Penetrometer after soaking for 3 days) for each set of the sand and clay soils, and not on considerations of easy compactability of the soil mixtures as apprehended by **Shri A. K. Deb.** The reference to compactability was made only to indicate that there was no need for adding more binder soil in order to make it compactible. Design of mix for sand-clay based on maximum density and maximum bearing power proved successful in the Tuticorin-Tiruchendur road and the experimental works taken up earlier in the State. The fact that sand-clay mixtures containing coarse fractions with a maximum particle size as small as 0.42 mm (less than 2 mm) had functioned successfully as base courses showed that insistence on the requirement of a maximum particle size of at least 2 mm was not warranted. The Authors were in agreement with Shri Deb that better strength could be had when mixtures composed of coarser maximum sized particles were employed but that would necessitate addition of a third soil. When sand-clay mixtures with a maximum particle size as small as 0.42 mm proved successful with the inherent economy, there seemed to be no justification for recourse to the costly addition of a third material merely to have the maximum particle size as 2 mm.

It was true that the hygroscopic nature of salts provided a dust free (and in that sense, stable) riding surface. But when the salt was leached away, the flocculating properties of the salt were no longer there and the soil showed itself more plastic than what it was in the presence of the salts. The results of tests conducted on a soil with various amounts of sodium chloride were reported on page 99 and Fig. 9 of the Paper. With the progressive leaching of the soil the material became more and more plastic. So leaching would affect the stability of the soil adversely, especially in the presence of moisture.

As visualized by **Shri S. R. Naidu** transport in the sandy areas was a problem, especially in places where the sand contained little or no silt or clay. In such portions the surface was stabilized by incorporating a layer of about 2 in. of clay into the top 4 in. of sand. A major length of the sandy reach, however, contained some silt and this permitted the lorry traffic to negotiate the surface.

The Authors drew the attention of **Shri D. C. Chaturvedi** to the list of equipment that were available for use on the work, para 2.2 of the Paper. If a sheepsfoot roller were available, the compaction would have been done in one layer initially with this roller, later with the pneumatic-tyred wheels and finally finished with the smooth wheeled power roller. The Authors agreed with Shri Chaturvedi that use of sand-moorum mixes of higher plasticity index was desirable for the surface course as indicated in the Paper in the first para. under 11.2.

The purpose of the moisture absorption test was to arrive at the best design mix, which possessed not only maximum density and bearing power but also showed least moisture absorption. Periodic observations on the moisture conditions of a number of stabilized soil bases and their service behaviour would yield data on the moisture absorbed and the maximum permissible absorption.

Shri D. N. Khurana wished to know the effect of the presence of chlorides on the mechanical stability of soils exposed to humid climatic condition. Magnesium and calcium chlorides were deliquescent (possessing the property of absorbing moisture from air) and their incorporation in granular mixes helped in the retention of water during mixing operations. When the stabilized surface became dusty and clay was likely to be lost, application of the chlorides of magnesium and calcium, especially during the humid hours of the day, facilitated in maintaining the surface moist and thus preventing dust nuisance. Besides alleviating the dust nuisance, such a treatment also resulted in maintaining

a desirable moisture content in the interior of the layer. Because of the affinity of the chemical to water, the chemical got into the soil system as water permeated through the capillary passage*.

Sodium chloride retained moisture added to the soil. As had been indicated in the Paper, in para. 9.3, the salt crystalized in the pores near the surface. This enhanced the stability while inhibiting further penetration of water and retarding evaporation of the water already present.

Shri S. R. Mehra (Chairman) thanked the Authors for bringing out a very useful Paper on the subject of soil stabilization which, in his opinion, was of very great importance to road engineers in India owing to the necessity for reducing costs due to paucity of funds. Use of local materials besides being cheaper considerably reduced transport requirements which in itself was an important factor considering that there was shortage of transport. Work on scientific soil stabilization of roads started in India as long ago as 1938 and Shri Mehra said that he had the privilege of being connected with it from the beginning. In the Punjab alone over 250 miles of stabilized soil roads, surfaced and unsurfaced, had been constructed during the last 12 years and some work had also been done in Madras, Uttar Pradesh and Bengal. In the background of experience extending over the last many years, it could be stated with confidence that under the soil, climatic and traffic conditions obtainable in many parts of India, stabilized soil could successfully replace the more expensive conventional methods of road construction. Such roads could equally stand up to iron-tyred and high speed traffic. Even in the few States where work was done, the progress of the introduction of the technique had been extremely slow and, as such, unless a special effort was made by Highway Engineers to give to soil its rightful place in road construction in India, they would be failing in their duty. Shri Mehra then appealed to the road authorities in the various States to seriously take up the question of the use of stabilized soil in road construction on an increasing scale. Shri Mehra, in his capacity as the Director of the Central Road Research Institute, promised that all reasonable technical assistance required would be gladly provided.

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* Wartime Road Problems, No. 5, Granular Stabilized Roads, Highway Research Board, Washington, D. C.

Discussion on Paper No. 181*

"The Design of An Experiment To Assess The Cost of Operation of Motor Vehicles on Different Types of Roads"

By

C. S. ANANTAPADMANABHAN & M. K. GANGULI

Monday, 9th January, 1956

Shri U. J. Bhatt (Chairman) called upon Shri M. K. Ganguli (Joint Author) to introduce the Paper for discussion.

Shri M. K. Ganguli (Joint Author), introducing the Paper for discussion, explained what a factorial design was, why it was necessary, what its merits were, and the factors to be included in such a design.

If only two types of surfaces, say, water-bound macadam and cement concrete, and two conditions of surfaces, say, average and good, were taken into consideration, the comparative advantages of factorial design over classical design were obvious. In the classical design, for a relative comparison of any one factor, one-third of the observations were completely ignored taking only the remaining two-thirds into actual consideration. But in a factorial design all the observations were taken into consideration for all types of comparisons. The essential difference between the two designs was that in a factorial design more than one factor had to be changed simultaneously while a classical design did not permit this.

The most important feature of a factorial design was reduced number of observations. It could be proved that a factorial design would yield results comparable in accuracy to the classical design with only two-thirds of the number of observations required for a classical design.

In India, factorial designs were used mostly for experiments in agriculture. But in foreign countries they were used in solving transport problems as well. After explaining the merits of the design in question, the Author explained briefly how the optimum number of factors to be included in the design had been arrived at.

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* Published at pages 123-140 of the Journal of the Indian Roads Congress, Vol. XX-2, November 1955.

Shri G. R. Nangea looking at the problem from the point of view of hill roads stated that the following basic factors affected the cost of operation of motor vehicles :

(a) **Type of road**. Costs of operation of vehicles running in hills and plains were different. For vehicles using hill roads there was considerable expense on maintenance of efficient steering and brakes. Every time the brakes were applied, some power was wasted. Also, high speeds could not be had in the hills due to limitations of topography.

(b) **High altitudes**. Efficiency of the engine got lowered when vehicles operated in high altitudes.

(c) **Gradients, curves, and width of roads**. For any one vehicle there was a speed at which operation was economical. But if the radii of curves were small, the economic speed could not be maintained and every time brakes were applied, some wastage occurred. Similarly, if curves were not superelevated, there was wastage of energy. Steep gradients required change of gears, and consequently consumption of fuel and lubricants increased.

(d) **Nature of road surfaces**. The motive power expended in running depended on the friction between the tyre and the road surface. If the surface was rough there was substantial expense on tyres. If a vehicle was subject to skidding, there was wastage of fuel and the body of the vehicle was subject to strains.

(e) **Climate, rainfall, snowfall or exposures to winds etc**. Roads in the Himalayan region were subject to extremes of climate, heavy rainfall, snows and sometimes high winds. All these factors adversely affected both the road as well as the vehicle and more consumption of fuel was required.

(f) **Design of vehicle.** The design of vehicles was a very important factor in not only ensuring safe running at the economic speed but also with regard to the personal effort that the driver had to exercise. Vehicles ideally suited for hills might not be economical to operate in the plains and vice versa. For running in the hills, the centre of gravity of the loaded vehicle should be as low as possible. For lowering the centre of gravity in passenger vehicles, some countries had introduced spaces for loading of luggage under the seats, thus helping easy manoeuvrability and operation at economic speed.

The use of special lubricants and anti-freezing measures helped to reduce wear and tear in engine parts, thus contributing to saving in operation costs.

Some of the above mentioned factors had been incorporated in the proposed experiment while others had been omitted. If the authorities conducting these experiments were to include hill roads also within the scope of the experiments, it might help in the correct assessment of costs of operation of motor vehicles on different types of roads with different types of vehicles.

Shri Fateh Chand said that variations in the period of monsoons had to be taken into account.

The results of the experiment which was spread over a period of two years should be published periodically in the monthly magazine of the Indian Roads Congress.

Fuel consumption and depreciation varied considerably on metalled roads and earth roads. It was necessary that operation on earth roads be included in the experiment. The amount spent on metalling earth roads would generally be offset by the reduced cost of operation. Thus the problem of financing improvement of earth roads would also be solved to some extent. Development works could not be carried out until all roads were passable for mechanised traffic, for which metalled roads were necessary.

It was very difficult to find a uniformly good road, or for that matter even a uniformly average road. So a record of local variations in the condition of roads was necessary.

Twenty thousand miles had been assumed as the life of a new car. In his view this was on the high side and might be reduced to 10,000 miles. Servicing and change of tyres at fixed intervals should also be adhered to. In a six-wheeled vehicle, inside and outside wheels must be exchanged with occasional check in the last meter reading. Particular attention should be given to check rash driving and, as an alternative measure, governors must be used.

Repeated halts and starts meant additional cost in operation.

Shri N. D. Daftary referred to Table 1 on page 125 of the Paper where the average miles per gallon for different types of road surfaces had been given, and said that the results given did not throw any light on the consumption of fuel on different types of road surfaces. A test of significance based on the analysis of variance had been applied for comparing the mean values. It was presumed that this was only to indicate the method of analysis. Actually the results did not appear to give a correct picture of consumption of fuel on different types of road surfaces. It would be seen that with one gallon of petrol the milage run was 12.39 on a concrete road, whereas it was 12.6 on a black topped road. This apparent inconsistency might be explained as due to the conditions of road and operations under which data was obtained. So unless the vehicles were operated under controlled conditions the results might not be of much value, whatever might be the nicety in the technique of analysis adopted.

As regards the ideal design of experiment, it had been suggested in paras. 5.1 and 5.2 of the Paper that three types of road surfaces and three conditions of roads, making nine combinations, should be adopted. The main object of the proposed experiment was to find out the cost of operation on different types of road surfaces vis-a-vis the cost of upgrading and modernising the surface and to see in how many years the capital cost with interest could be recouped from the saving in operational cost after providing for maintenance at standard levels. In Bombay, there was large milage of kutcha roads (cart tracks) and their improvement would depend upon the cost of operation on kutcha roads vis-a-vis other types of surfaced roads. It was, therefore, necessary to include a kutcha road for comparison with the three other types of surfaces mentioned in the Paper.

It was difficult to define properly and draw distinct line of demarcation between the three road conditions, viz., good, fair and bad. Since the proposed experiment was to be conducted for two or more years, it was necessary that the conditions of the road remained the same throughout the period. This might not be possible, more so in a period of planned road development. If at all this factor was to be introduced, only two conditions of road, viz., 'good' and 'not good' might be adopted. Good roads might be taken as those maintained in good condition all the time and 'not good' roads other than those included under 'good'.

There was, however, a glaring omission namely depreciation. The nature of the road surface had considerable influence on depreciation of the vehicle and this factor did not appear to

have been included in the detailed design given on page 132 of the Paper.

In paragraphs 6.6 and 6.7 of the Paper, it was mentioned that due to increased cost it was desirable to dispense with replications of the experiment and that the monthly observations on fuel consumption and consumption of spare parts during each of the monsoon and non-monsoon periods might give sufficient replications for analysing the data with a desired degree of precision. Experience had shown that while the consumption of spare parts had high co-relation to the age of vehicles in terms of milage, the milage per gallon of fuel was correlated to it to a lesser degree. As such, monthly observations could not be considered as independent random observations and they might introduce a bias in the estimate of error.

The proposed experiment was to be carried out in Bombay and U. P. If experiments with similar design were carried out in other States also they might form replications of experiment. So some other States which had nationalised transport like Hyderabad, Madhya Pradesh or Travancore-Cochin, might also be asked to carry out the experiment and the results thus obtained would give enough replications to have wider applicability in various parts of India.

Shri M. S. V. Rao stated that comparative tests done in England with a sensitive Paccelerometer showed little difference in the tractive resistance of a concrete and a bituminous surface. The data collected by the Authors showed only a difference of 0.21 miles per gallon. Although the Authors had proved statistically that the difference was not due to chance effect, viewing from the practical side such small difference could be safely neglected and the cost of operation on concrete and black top surface might be treated as the same.

The Authors had taken two factors as affecting operating costs, viz., the type of road surface and its conditions and had included all other factors under 'disturbing factors'. Presumably the Authors had classed the 'disturbing factors' as 'minor factors'. Experiments conducted in London had shown that nearly 40 per cent of the fuel was wasted in route characteristics and traffic congestion. So further thought was essential in deciding what the major and minor factors were in determining the operational costs of vehicles in urban, semi-urban and rural conditions.

Further, it was proposed to conduct the experiment for a period of two years. It would be better to specify the total milage rather than a period of time.

The Authors had proposed the test to be carried out on routes of 60 miles in length. It was very difficult to get different routes with similar route characteristics. It would, therefore, be more specific if controlled tests were carried out on small straight lengths, curves with different radii, grades separately at different speeds and thereby eliminate the variables due to differences in route characteristics.

Shri E. A. Nadirshah remarked that the aim of the controlled experiment was to assess the savings that would accure to vehicles operating under Indian conditions to enable computation of the total savings to the community due to the improvement of roads. A method of relating the savings to the entire vehicle population in the country with the data obtained from the experiment was necessary. What was necessary was a study of data collected from a large number of vehicles representing the various types in use in the country rather than the performance of one or two vehicles under controlled conditions. For example, there were about 3.4 lakhs of vehicles in the country, of which buses for which data would be collected in the proposed controlled experiment were only about 4,900. Even so, only a few makes were to be used. So, the type of vehicle chosen was by no means representative. Also, there was a large difference in the efficiency of utilisation of fuel by diesel vehicles and vehicles using petrol. Therefore, even the main factor, namely, saving due to fuel consumption would not be clearly indicated by this experiment. It would have been desirable to choose goods vehicles operating on petrol for the experiment rather than the vehicles now chosen, since they formed at least about 30 per cent of the vehicles used in the country and operated for profit.

The proposed duration of the experiment, namely, two years, appeared to be rather too long. Uniform conditions would not prevail during this long period. If necessary, a team of vehicles could be asked to be spared for a much shorter period, if need be in different times of the year to account for possible variations due to climatic effects. For estimation of tyre wear, etc., it would not be impractical to detach the mounted wheels and substitute them with spare ones whilst the vehicles were not operated for purposes of the experiment.

The length of routes (90 to 150 miles) chosen was too long for an experiment, as both the road surface conditions and traffic conditions were likely to be very different along the long route. It was very difficult to obtain a uniform horizontal or vertical alignment of the road and roadside conditions to justify comparison of operation over one length with another. He was not certain if there were concrete roads of the above mentioned lengths in one continuous stretch in Bombay State.

The standards set for identifying the condition of the road as 'good' or 'bad' appeared to be arbitrary. It would be desirable to survey the routes by means of a profilometer for comparison of different routes. This would eliminate errors arising out of drivers' efficiency in running the vehicles and engineers' judgment about the condition of the road.

Once the ratios of the costs of operation for different kinds of surfaces were found out for the plains, then the similar ratios could be applied to hill roads.

Shri C. L. N. Iyengar observed that the Paper forcibly brought out that a better understanding of statistics was necessary on the part of the engineer to analyse experimental observations.

Shri Iyengar added that he had many occasions to discuss the basis of computation of several indices for relative savings in fuel costs, tyre wear, oil consumption, etc., with leading experimentors in the field in the U. S. A. and was given to understand that the values accepted by various State Highways Departments and Bureau of Public Roads were those obtained by operation of commercial fleet over long periods and their interrelationships for actual service conditions were determined from simple linear or multiple correlations of observed data. Therefore, the concept of test vehicle for solving the problem appeared to be rather inappropriate.

Further, operation of motor vehicles on long routes under varying traffic and road conditions, if required to be studied, involved several complex combinations of time-space relationships of the vehicle movement, the vagaries of the driver in the control of the vehicle and the limitations of the observer who was not infallible in spite of all his earnestness. To overcome these personal factors and obtain reliable data, simple statistical instruments were evolved to record speed characteristics, braking, engine torque, throttle opening, and fuel consumption*.

In America Shri Iyengar happened to drive himself a test vehicle and had noted that the observer's task was so simple that he had merely to note the numerical recording obtaining on the dial of the instrument at the start and stop of each journey. He would, therefore, strongly commend the use of such equipment for the experiment.

*"A Study of Vehicle, Roadway and Traffic Relationships by means of Statistical Instruments" by Messrs T. J. Carmichael and C. E. Haley in Proceedings of the Highway Research Board, U.S.A., 30th Meeting, 1950.

Shri V. S. Goel said that dust bumps, accelerations and brakings were the main factors which caused increased maintenance and fuel costs.

Dust getting into the chassis suspension, steering mechanism and the wheel bearings caused abrasion. So an instrument might be designed which might assess the amount of dust that would go in the engine per 1,000 miles of travel.

The unevenness of the road surface could be evaluated in inches per mile. But a more accurate method would be to give the root mean square value of the unevenness of the road surface. This would also eliminate the necessity of constantly maintaining the road under experiment in a good or fair condition, which necessarily introduced a variable difficult to control.

Sudden braking and quick acceleration put the mechanism of the whole vehicle under excessive stress. Acceleration caused over heating of the engine and consumed more petrol. The number of brakings and accelerations as well as their quantitative value could be found out and expressed as mean acceleration or deceleration and the time for which it acted.

Shri Y. K. Chougule* said that concrete roads at present were generally in good condition and it would be difficult to find concrete roads in bad condition for the experiment, as the construction of concrete roads was a recent development in the country. So consideration of average condition of cement concrete roads might be omitted.

Truly representative data could only be obtained if the experiment was conducted as a field test on an enclosed tract where all the conditions could be controlled as desired. For this purpose a three to four mile circuit road, but not so small a track as the Test Track at Calcutta, would suit best. Such roads could be had at many race course grounds in the country. This had many advantages. The surface of the track could be renewed as necessary, the maintenance of the road surface could be regulated, and operation of vehicles could be controlled.

Effects of road surfaces on petrol consumption both on new as well as old cars could be studied simultaneously by putting on one new and one old car to run on the same track, but in opposite directions. As there were in all five tests to be completed and each test to cover a distance of about 12,000 to 15,000 miles equivalent to the life of good new tyres, total running anticipated would be from 60,000 to 75,000 miles. Hence it would be

* This and subsequent comments were received in writing.

advisable to engage two cars one new and the other old and of the same make, year of manufacture and in similar condition. The new and old car should be run in opposite directions to eliminate passing. Besides each car should change its direction every day to eliminate the effects of gradients and wind pressure in unilateral runs, etc. Each car should be made to run for five hours in the morning and five hours in the evening, thus covering a distance of about 300 miles every day. This arrangement would provide for timely feeds and rest for the machine. Each test would thus be completed in 40 to 50 days.

Along with the petrol consumption, life of tyres of different companies could be tested. Tyres of similar weights but of two different companies should be mounted on the two rear axles and two other types on the front axle. In cases of punctures occurring during the test runs, they should be mended on the spot. This could be done by stocking one or two spare tubes in the cars. The running should be continued until the base coat of white rubber was exposed. Depending on the judgment of the supervisors to decide whether a tyre was worn out or not merely on the appearance or otherwise of the buttons on them would lead to erroneous results. An accidental cut in tyres by shoe or nails should not be held to count towards the quality of the tyres unless it was on macadam roads in bad condition where such cuts were possible by loose pointed stones. Similarly, retreaded tyres of four different companies should be mounted on the second car and their lives tested.

It would thus be seen that all the five tests could be completed in one year if the effects of rainy seasons were not to be studied. If separate tests for rainy weather were to be carried out the test would have to be continued for two years.

As compared to the proposed expenditure on roads in the second Five-Year Plan, expenditure of a couple of lakhs on experiments was negligible and deserved to be undertaken.

Shri R. Thillainayagam stated that details of how consumption of fuel and lubricants, wear and tear of tyres, consumption of spare parts, and vehicle speeds, were proposed to be measured had not been given and described how they should be done.

Shri D. N. Khurana remarked that it was essential that the mechanical conditions of all the test vehicles remained approximately the same during the long period of testing. Therefore, a record of the engine and transmission condition of each vehicle should be maintained. He suggested that the B.H.P. and draw-bar H. P. test should be made every month.

Shri Khurana suggested that abrasion should be measured by a roughometer and oscillograph for finding out the condition of the road surfaces.

State Transport Department (Bombay) observed that though the experiment dealt with in the Paper was worth while carrying out it would have to be conducted with great care under efficient supervision.

Fuel consumption or even tyre life, to a certain extent, depended on many factors other than road condition. The most important of them were:

(a) standard of maintenance,

(b) driving ability or efficiency,

(c) load to be carried,

(d) age of the vehicle,

(e) engine specifications and design of carburettor,

(f) tyre conditions, etc.

It would be desirable to put the same vehicle or the same make of vehicle or vehicles, which had done the same milage, etc., and having other similar factors on all the roads on which the experiment was to be carried out. As far as possible it would be better if the same vehicles were put on the road for the purpose of the experiment. This would help to eliminate possible errors.

Mechnical breakdowns, punctures or accidents were bound to occur during the experiment and upset the experiment to a certain extent. To avoid this, it was suggested that two or three extra vehicles should be used on each route.

Fuel should be taken only from the pump and fuelling the vehicles from cans should be prohibited. If required, additional tank of a larger capacity could be fitted to the vehicles which would be put on the road for the experiment. The vehicles should start with tanks absolutely full. Also, no one should be allowed to use the fuel from the tanks for any other purpose. The experiment might be carried out for a fixed convenient milage, and the milage need not be unnecessarily high.

Road Transport Department (Hyderabad-Deccan) observed that allotting good experienced drivers for the experiment would not be desirable as the results obtained should have some relation to the average operation conditions.

Where diesel engined vehicles were used in the experiment, engine speeds must be suitably governed and periodically checked to ensure that the governing mechanism had not been interfered with.

In India milometers normally went out of commission at frequent intervals. It was, therefore, desirable that accurate logs of journeys were kept and not much reliance placed on the milometers. Also, a good make of tachiograph might be fitted to vehicles, so that " speeding " might be effectively checked.

It would be desirable to have time recording clocks at the beginning and end of a route and also at one or two intermediate halts, if possible, so that correct times of arrivals and departures might be recorded. These recording clocks in conjunction with tachiographs would provide an effective cross check on each other.

It would be preferable to stick to one make of tyres and not adopt more than one make as suggested in the Paper.

Shri C. S. Anantapadmanabhan (Joint Author) felt particularly gratified to find that the Paper had evoked good discussion. When the Paper was prepared, he personally felt somewhat dissatisfied because it appeared to be too obvious and simple to deserve discussion at a Session of the Indian Roads Congress. To illustrate, forgetting for a moment the factorial design and taking into account only one aspect of the problem to be investigated, say, the life of a tyre on two different types of surfaces, the obvious method was to take two new tyres, run one each on each of the two types of surfaces until it was worn out, and note the milage in each case. This was exactly what the design of the experiment provided and it had already been explained how factorial design had been resorted to for minimising the cost and effort and extracting the maximum information from the experimental data collected.

The discussions showed that no adverse criticism of the design of the experiment had been made. The criticisms and objections mostly related to certain aspects into which the Authors had not and could not enter. For example, the total operational cost of a motor vehicle was, doubtless, a very important piece of infomation on which they were interested, but this did not form the main object of their study. They were mainly concerned with the differential part of the cost of operation between different road surfaces and nothing else. This explained why the experiment did not go into the effects of road gradients and curves, altitudes, etc. These aspects were, so to say, not within the terms of reference of the work and should really be investigated through separate experiments,

Shri M. K. Ganguli (Joint Author), replying to the discussion, said that they were not concerned really with the minimum number of combinations but were interested in the optimum number of combinations. While trying to have a wider inductive basis, it had also to be seen that it was possible to translate the design into practice.

As regards the point about the unreliability of the data in Table 1, it would be found that sometimes black top surfaces were giving more milage than concrete surfaces and sometimes concrete surface giving more milage than black top. It might be mentioned that there was nothing much to choose between a concrete and a black top surface.

Shri U. J. Bhatt (Chairman), in winding up the discussion, remarked that experiments like the ones outlined in the Paper were very important. He thanked the Authors for their Paper.

Discussion on Paper No. 182*

"Compressive Strength as a Design Criterion for Bituminous Mixtures"

By

C. G. SWAMINATHAN

Monday, 9th January, 1956

Shri C. M. Bennett (Chairman) called upon Shri Swaminathan to introduce his Paper.

Shri C. G. Swaminathan, introducing his Paper, said that when concrete and similar materials were used for construction, the main task of the designer was to determine the dimensions of the various members of the structure to carry a given load. Usually, the designer based his design on the engineering properties, such as compressive strength, tensile strength, etc., of the materials used. But the determination of these properties for bituminous mixtures which were used for road pavements was not easy. The mixtures were generally designed by trial and error or by the rule of thumb. A rational approach to the problem had not yet been fully established. Perhaps one of the reasons for adopting the trial and error method was that an asphalt mixture, being a plastic mass, behaved quite differently from other materials which followed a conventional pattern in accordance with the concepts of the theory of elasticity.

For the design of a bituminous mixture for a road there were three stages. Firstly, the traffic conditions had to be translated into a conventional form of loading. Secondly, that loading had to be related to some engineering properties of the material in the form of an intensity of stress. Thirdly, the composition of the mixture had to be worked out based on the first two stages. The Paper, he said, dealt only with the third stage of the problem, namely the property that should be considered for the design of the mix.

Amongst the various mechanical tests such as those for tension, compression, shear, etc., that were usually conducted for the evaluation of stability of bituminous mixtures, the

* Published at pages 141 to 149 of the Journal of the Indian Roads Congress, Volume XX-2, November, 1955,

compression test seemed to be preferable to others because of the following reasons :

(i) A bituminous road surface was not subjected to direct tension except that due to the effects of temperature. As such, the tensile strength of the mixture was not very important. Also, the indentation test measured only tension in one form, the failure taking place as a result of cracks appearing at the periphery of the test specimens.

(ii) The direct shear and the other various forms of stability tests required very elaborate apparatus and the data obtained from them could not be said to be more helpful than those obtained from the compression test.

(iii) The engineer in the field was usually familiar with the compression test.

However, when viewed critically, an evaluation based on compressive strength was far from satisfactory. Probably that was the reason why the A.S.T.M. had incorporated that test as a tentative standard though the test was thought of and was in use as early as 1936. Usually, for bituminous mixtures the compressive strength was interpreted either in the form of an ultimate load at failure or in the form of a modulus of elasticity. Both the methods had their drawbacks. The former did not give an insight into the primary properties of the mixtures, whereas in the latter method the determination of the modulus of elasticity for a plastic material was questionable. The stability of a bituminous mixture depended on both the binder and the filler. Filler influenced friction and the binder cohesion. So any test to evaluate a bituminous mixture, must include both these two factors. Therefore the Paper discussed two methods. In the first method, the angle of friction and cohesion were determined. In the second method, the quantities or percentages of binder and filler required were determined directly.

Taking the first method, fundamentally speaking, the procedure for the determination of C and ϕ given in the Paper could not be claimed as correct. The values of C and ϕ determined from the unconfined compression strength as mentioned in the Paper were not the true values. They were just empirical constants of the mixture for two given heights of the test specimen and for specified test conditions. For want of a different terminology, the notation C and ϕ that was used in soil mechanics was used to denote the two empirical factors of the mixture.

Also, an alternative method by which the compressive strength data could be utilised had been suggested in the Paper. Here again a single value of the compressive strength was used for the evaluation of two quantities, namely, the bitumen content and the filler content as related in the form of an isometric diagram. A chart similar to the one shown in the Paper had to be drawn for a given specimen size and for stipulated test conditions. Once the chart was prepared, the mix design was comparatively easy for any given compressive strength and specification of the mixture. For example, if a mixture was to be designed for a compressive strength of 700 lb and if it was not too rich or lean, any mixture having a filler percentage from 11 to 20 and binder percentage of 9.4 to 8.8 could be used. The various compositions could be got along the 700 lb line of the diagram on page 147 of the Paper. The Author felt that this method would be quite useful for empirical design and for routine field control purposes.

The use of compressive strength for the design of bituminous mixtures was an empirical method and not a rational one. The main purpose of the Paper was to draw attention of the designers to the drawbacks and limitations of the compressive test and to impress that it was only a routine test for field control.

Lastly, Shri Swaminathan made the following modification in para. 4.3, page 144, namely, after the word " are " in the last line, instead of " eliminated completely by providing rubber sheets or some such adequate device " read " neglected in the design calculation."

Shri O. S. Sahgal pointed out that the term bituminous mixtures included 'Bituminous macadam' and 'Penetration construction etc.,' whereas the Paper dealt with only 'sheet asphalt' or 'sand bituminous mixtures'. Therefore he felt that the title of the Paper should be modified suitably.

The Unconfined Compression Test recommended by the Author was only an empirical test and did not give any indication of the engineering properties of the bituminous mixtures. Bituminous mixtures were entirely different from other structural material as, under heavy loads, they would flow rather than rupture. In addition, the temperature and time of application of the load were governing factors. The Cone Penetrometer Test, also a semi-empirical test, was easier to use both in the laboratory as well as in the field than the one advocated in the Paper. In the cone penetrometer test the sample was confined, a condition more analogous to the conditions on the actual roads.

An added advantage in the case of the cone penetrometer test was that besides giving the stability values of various mixes, it gave the 'yield value' and 'viscosity factor', two most important characteristics of bituminous mixes. The test was originally evolved by Messrs Alexander and J. F. T. Blott of the Shell Laboratories, England and was based on Prandtls' Theory. In the test, a 90° cone with a roughened surface was loaded over a test specimen 3 in. by 3 in. by 2 in. and its penetration noted against time. It had been found that, for the type of mixes dealt with in the Paper, there was a straight line relationship between the stability value S, which was the load on the test piece, plus its own weight divided by the circular area over which the load was applied, and $\frac{1}{\sqrt{t}}$. The extrapolated value of S at $\frac{1}{\sqrt{t}} = O$ time was designated as "y" or the yield value. The equation of the straight line was $S = y + \frac{m}{\sqrt{t}}$ where 'm' was the viscosity factor. A definite relationship between 'm' and the cohesion 'c' of the same mixes by the Triaxial shear apparatus existed. When the value of S was given for any particular climatic and traffic conditions, a suitable mix could be easily worked out.

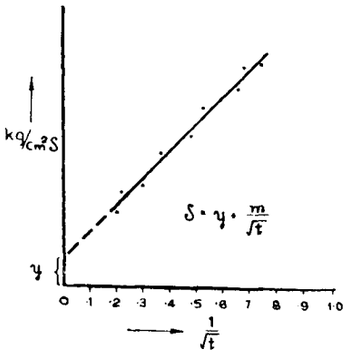

Fig. 1

Shri E. C. Chandrasekharan remarked that the considerations mentioned for bituminous mixtures in the Paper were also applicable to all plastic mixtures used as construction materials, including resins and resin-bitumen combinations. In developing the method for sand stabilization with aniline-furfural resins and aniline furfural bitumen combinations, Dr. Winterkorn primarily relied on the unconfined compression test in conjunction with, of course, durability and other tests.

Shri R. N. Dogra said that in the various laboratories working on this problem, the unconfined compression test had been replaced by the Indentation test or the Extrusion test. The latter was preferred particularly in the U.S.A. because it reproduced conditions which were more or less those obtaining in the field. The internal friction of mineral aggregate as well as the adhesive property of the binder were also taken into account. This test was in use in the Laboratory at Karnal

in the investigation of the temperature stability of bituminous pavements.

Another test which was recently developed in the Harmondsworth Laboratory in England for the testing of bituminous carpet was the Tracking Test. This test consisted of a wheel tracking along a specimen to and fro. The weight of the wheel could be increased as desired. The stability value was measured by the time taken by the wheel to produce unpro-portionate deformation.

Shri Dogra advocated the use of the tests mentioned above in India for future investigations.

Shri J.S. Narasimham referred to the assumption, para. 5 at page 145 of the Paper, that in samples having low values for the ratio of height to diameter the plane of failure under compression load was such that $\tan \alpha = \frac{h}{d}$ where α was the angle of failure, and said that his experience was different with mixtures with a high percentage of binder. The failure of specimens with high binder content took place by the bulging of the specimen and was known as 'plastic failure'. In samples with low binder content, the plane of failure would be so formed that $\tan \alpha$ would closely agree to the well-established formula, $\tan \alpha = \left(45° + \frac{\phi}{2}\right)$, where ϕ was the angle of internal friction. The Author's method of evaluating the values of cohesion and angle of internal friction with the above mentioned assumption was questionable.

In para. 6.2 on page 146 of the Paper, the Author had given reference to the graphical method developed by Mr. Vokac for determining the percentage of binder required for the bituminous mixture of a desired compressive strength. The Author had also indicated that the percentage of binder in the bituminous mixture was calculated to fill up completely the void space in the compressed sand asphalt mixture. It was desirable that the binder should occupy only a fraction of the void space in the compressed mixture. If the void space were completely filled with the binder, bleeding would result during the hot months. He, therefore, suggested that the percentage of binder as obtained by the Vokac method should be suitably reduced.

Shri A. K. Deb observed that unconfined compression test gave indication of the shearing resistance of a material where only 'c' was involved. But for materials having cohesion and internal friction, the triaxial shear test and the Mohr's diagrams gave correct values of the two factors. Though the defects of the

unconfined compressive test were described by the Author yet he had chosen to use it for isometric diagram. He wanted to know whether the assumption tan $\alpha = \frac{h}{d}$ was based on any experimental data.

Col. S. K. Bose felt that the Author's method was not likely to yield better results than those obtained by the application of the method advocated by Nijboer.

Shri C. G. Swaminathan (Author) answering the various speakers said that in the Paper and the opening remarks the empirical nature of the unconfined compression test had been clearly indicated.

Answering **Shri O. S. Sahgal**, the Author drew attention to pages 141 and 148 of the Paper where it was stated that the method was mainly applicable only to sheet asphalts and sand carpets. As for the cone penetrometer it was questionable, whether the yield value and the viscosity factor can be correlated to C and ϕ. So the cone penetration was also an empirical method. In this connection he drew the attention to the statement made by Shri E. C. Chandrasekharan, one of the speakers that Dr. Winterkorn had primarily relied on the unconfined compression test for studies on soil stabilisation with aniline furfural bitumen combinations.

It was well-known that the Indentation and Extrusion tests as well as the new Wheel Tracking Tests were also empirical.

Answering **Shri J. S. Narasimham** the Author said that the values of C and ϕ obtained by the unconfined compression tests were questionable was mentioned in the Paper. For mixtures with high bitumen content the isometric diagram was more suited and that the choice of the correct percentage of bitumen which did not allow either cracking or bleeding could be obtained from the charts.

Answering **Shri A. K. Deb**, the Author said that he had suggested the compression test only for field purposes and definitely not for a rational method of design. Referring to the remark of **Col. S. K. Bose**, the Author said that nowhere was it mentioned in the Paper that the unconfined compression test was better than Nijboer's Tri-axial test procedure.

Shri C. M. Bennett (Chairman) thanked the Author for his interesting Paper.

Discussion on Paper No. 183*

"Prestressed Concrete Bridge Across the Mahi River at Vasad on National Highway Delhi - Ahmedabad - Bombay"

By

V. B. MANERIKAR AND I. K. NAIK

Monday, 9th January, 1956

Shri R. C. Roy (Chairman) introduced Shri V. B. Manerikar and Shri I. K. Naik and called upon them to introduce their Paper.

Shri V. B. Manerikar (Joint Author), introducing the Paper for discussion, said that the Lee McCall system of prestressing was first adopted in India for the bridge described in the Paper. The road surface in the bridge was 79 ft above the bed level of the river. Of this 79 ft, the height of the pier was 69 ft. Also, the launching of the precast prestressed girders was carried out by an ingenious method. The object in presenting the Paper was that the above-mentioned features of the Paper would be of interest to Engineers. He then explained the various features of the design and construction of the bridge.

Shri P. K. Banerjee wanted to know the reasons for accepting tender with the prestressed girder even though it was Rs 40,000 higher than the lowest one. The height of the piers and wells were as much as 100 ft. Therefore, the adoption of spans of 150 ft would have cost less. The presence of the railway bridge near the site seemed to be the reason for the selection of 110 ft spans. In West Bengal the bridge across the Rup Narain river was proposed to be sited 875 ft upstream of the existing railway bridge. The Poona Irrigation Research Station was of opinion that there was no necessity for siting the piers of the road bridge to be in line with those of the railway bridge. Shri Banerjee wanted to know if model experiments were done to ascertain the effects of the road bridge on the foundations of the railway bridge.

The cutting edge of the well was made unusually strong. A single angle 4 in. by 3 in. by ½ in. seemed adequate.

The practice in West Bengal was to place the reinforcement in the well steining in two rows. Such an arrangement increased

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* Published at pages 151 to 217 of the Journal of the Indian Roads Congress, Vol. XX-2. November, 1955.

the effective depth of the steining and catered for the stresses that might develop during sinking Shri Banerjee wanted to know the following:

(1) Steps taken to prevent shifts and tilts in the wells during sinking.

(2) The slope of the bed, the velocity of water, and the maximum calculated depth of scour.

(3) The maximum calculated pressure on the foundation under worst conditions.

(4) The maximum tension and compression developed in the pier after taking into consideration the live load, tractive effort, temperature effects, forces due to water currents and wind force.

In the bridge across Rup Narain river, where the span was 170 ft and the height of piers 30 ft, a section 6 ft at top and 8.5 ft at bottom with a batter of 1 in 24 proved unsafe when all the forces mentioned in (4) above were considered. The working stresses allowed were 16 tons per sq. ft. in compression and 1.6 tons per sq. ft. in tension which, of course, were low. So, reinforced concrete piers, 4 ft at top and 5 ft at bottom, with $\frac{1}{2}$ in. diameter bars at 6 in. centres along the longer faces of the pier and 1 in. diameter bars at 5 in. centres along the cut-water faces to allow for the wind forces, were adopted.

Shri P. S. Sadasivaswamy was of opinion that detailed soil investigations of the foundation conditions would have reduced considerably the cost of foundations. The necessity for taking the wells into stiff clay for more than 5 ft depth, specially when the clay offered considerable resistance to sinking of the wells, was not apparent. It was not understood why pier No. 14 was taken down to—15.59, for nearly 30 ft, into stiff clay.

Shri E. V. S. Iyer thought that the Indian Roads Congress should prepare a specification for the bottom plugging of wells.

It was desirable to test a beam to destruction, specially because the Lee McCall bars were not available in lengths of more than 65 ft and Lee McCall's high efficiency couplers were used.

He drew attention to the specified crushing strength of 5,000 lb per sq. in. and the working stress of 1,500 lb per sq. in. and stated that if the tests carried out showed that the crushing strength was much higher than the specified value,

why could not the working stress be increased to reduce the depth of the beam, and thus the cost of deck system? The cost of the bridge per linear foot was unusually high.

Shri Shital Saran was of opinion that the depth of prestressed girders for a span of 110 ft was on the high side. In Uttar Pradesh, for a bridge of 92 ft span, which was recently designed, the superstructure consisted of 3 prestressed beams 5 ft 3 in. in depth, including the deck slab which was 6 inches. A cube strength of 5,000 lb per sq. in. was specified for the concrete. Shri Saran was of opinion that considerable economy could be achieved by keeping the top flanges of the beams in level with the deck and transversely prestressing the whole structure. Transverse prestressing helped to distribute heavy concentrated loads over all the beams. He wished to know whether any other alternative tenders in prestressed concrete were received.

Two different grades of concrete were used for deck and for the prestressed beams. Calculations showed that a factor of 0.8 had been assumed to allow for the different modulii of elasticity of the two qualities of concrete. Were any tests to determine this value carried out? Also, in the calculations no account had been taken of the differential shrinkage between concretes of the different ages and qualities. The in-situ concrete of the deck slab tended to shrink relatively to precast prestressed beam and thus produced internal restraint and bending moment. This differential shrinkage might produce tension on the underside of the deck slab.

Shri G. C. Khanna remarked that the advantage in making the wells dumb-bell shaped was not understood. Resistance to sinking depended on the superficial area of the periphery of the well and it would have been advantageous to make the dredge holes elliptical.

The steining of the well consisted of reinforced concrete 1 : 2 : 4 with about $\frac{1}{2}$ per cent of reinforcement. In his view it would have been cheaper to adopt either brick masonry or leaner concrete. Steining thicker than 2 ft, which had been adopted, might have helped in sinking the well and thus reduced the cost of providing the kentledge. He enquired whether water jets had been used in sinking the wells through the clay strata, and thought that water jets were more effective than using gelignite. In the United States of America it was the practice to fill the wells with water. Filling of the wells with sand increased the dead weight on the foundations.

It was seen that a continuous pier cap had been used. The load on the pier cap was 250 tons. A pier cap of 5 ft by 4 ft was more than ample and it would have produced a stress of 12.1

tons per sq. ft. on 1 : 3 : 6 masonry. Continuous pier cap increased the bending moments with the result that the cost of the pier cap was high.

The use of Lee McCall system, where prestress was limited to 42 tons per sq. in., resulted in not taking full advantage of the prestressing. If high tensile wires had been used, the stress could have been increased to 70 tons per sq. in. and the result would have been a lighter girder. In one of the bridges in the Punjab, where the span was 90 ft, the depth of the girder was only 4 ft 6 in. as against 9 ft 6 in. adopted in the Mahi bridge.

Shri P. V. Raj remarked that the depth of girders adopted gave a depth span ratio of 1 : 12 and thought that it was rather high.

Referring to para. 6 on page 185 of the Paper, where it was mentioned "For ultimate load investigation, effect of prestress is assumed to be nullified due to plastic elongation of steel causing a stressless plastic strain equal to the elastic strain originally required to maintain the requisite prestress," Shri Raj thought that it would have been useful if the stress of steel at which the plastic deformation in steel was equal to the elastic strain at a stress equal to the original prestress were given. For the cold drawn high tensile steel wires of 5 mm in diameter, the stress at which all prestress was lost was of the order of 97 tons per sq. in. What was the corresponding stress in the Macalloy steel ?

In addition to the factor of safety at the first crack and the ultimate load factor, Shri Raj thought that it was necessary to have a factor of safety for the elastic behaviour of the structure. He suggested that these factors could be 1.25, 1.75 and 2 for the cracking, resilience and the ultimate.

Shri A. Rajeswar Rao referred to para 5.1. on page 154 of the Paper, where it was mentioned that castellations and $\frac{3}{8}$ in. diameter U-shaped bars had been provided between the deck and the girder to ensure composite action, and wanted to have the detailed calculations in support.

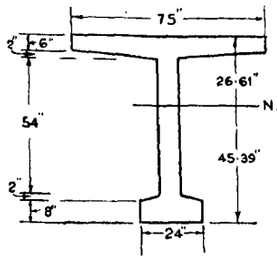
Shri Y. N. Zutshi* observed that the fair cost of concrete given in Appendix 1 on page 178 of the Paper appeared high for the cost of cement given. So, if a richer mix, and consequent higher working stresses, were to be adopted for the two girder R. C. C. design, reduction in the cost of the R. C. C. design was possible.

The lowest tender for the departmental design was Rs 10,73,815. On the basis of the lowest tender, taking into

* This comment was received in writing.

account the savings of Rs 1,73,500 for the prestressed design, a prestressed bridge would have cost Rs 9,00,315 only. But the tender accepted was for Rs 11,13,912 which was an increase of nearly 24 per cent.

Comparison of the quantities of concrete for the R. C. C. design and the prestressed design showed that there was a saving of only 7.7 per cent in the prestressed design. Obviously, this was very much on the low side. Shri Zutshi showed, supported by calculations, that four prestressed girders of the section shown in the Figure would have resulted in a saving of 12,000 cu. ft. of concrete. The savings in money value would be of the order of Rs 90,000 even though some extra quantity of high tensile steel was necessary. In addition, each of the girders would have weighed only 68 tons against 85 tons in the design adopted. That would have meant comparative ease in the launching.



The permissible safe stress for special grade concrete used for prestressed concrete was low. In the proposed Prestressed Concrete Superstructure of Coleroon Bridge*, for a slightly weaker mix, a stress of 2,500 lb per sq. in. was specified as the working stress.

In the design the specified working stress of 1,500 lb per sq. in. had been exceeded. From the Table on page 183 of the Paper it was seen that the stress in the bottom fibre immediately after 13 bars were prestressed was 2,389 minus 740, i.e. 1,649 lb per sq. in. against the working stress of 1,500 lb per sq. in. The 15 per cent reduction of prestress due to shrinkage and creep of concrete and creep of steel should not have been considered at this stage as these losses occurred later and were spread over a considerable period of time. This overstress could have been avoided, (1) if only 12 bars instead of 13 had been prestressed before launching of girders and 3 bars after launching, or (2) if these 13 bars had been prestressed only up to say 38 tons per sq. in. before launching and re-stressed to 42 tons per sq. in. after laying of deck slab.

Comparison of the costs of the substructure and the superstructure lead one to infer that it would have been much more economical to provide 8 spans of 220 ft each instead of 16 spans

*Paper by Shri K. K. Nambiar on "Proposed Prestressed Concrete Superstructure of Coleroon Bridge", Journal of the Institution of Engineers (India), August, 1955.

of 110 ft each. Adoption of 8 spans of 220 ft would have avoided the undesirable feature of alternative piers of the road bridge being located opposite the centre of the spans of the railway bridge.

Shri V. B. Manerikar (Joint Author), in reply to **Shri P. K. Banerjee**, referred to the Table on page 178 of the Paper and said that the Table gave a comparison between the prestressed construction and the conventional reinforced cement concrete at rates considered fair. The Table had no relation to the tender mentioned on page 153 of the Paper. It was considered that the lowest tender was unworkably low besides involving much longer period for the construction than the one based on the prestress design.

110-ft spans were adopted as this gave a balanced design. Therefore it was possible to keep every alternate pier of the bridge in line with the pier of the railway bridge. No model experiments were considered necessary.

The cutting edge of the kerbs of the wells was made extra strong because the work was the first of some magnitude to be taken up in the State. In subsequent designs the vertical flats, which strengthened the angle iron, had been omitted.

The reinforcement for the well steining was not based on any calculations. The rods were kept in the centre of the steining.

The maximum tilt and shift occured in pier No. 12. The maximum and minimum calculated stresses at the well base were:

	Tons per sq. ft	
	Maximum	Minimum
As a deep well	5.69	1.31
As a shallow well	7.25	0.07

The depths of the wells were fixed so that they were not founded at a level higher than that of the railway bridge which had stood the test of time.

Shri P. S. Sadasivaswamy wanted to know why the foundations of pier No. 14 were taken lower than the others. This was done because, as could be seen from Plate III on page 203 of the Paper, the pier was situated at the deepest bed of the river. The last 10 ft of clay into which this pier was sunk was the stiffest.

In reply to **Shri E. V. S. Iyer**, the Author said that the bottom well plug of 1 : 2 : 4 cement concrete was adopted from considerations of water tightness. The economy resulting in the use of 1 : 3 : 6 mix for the purpose would have been trifling in relation to the cost of the bridge.

The Lee McCall high efficiency couplers were tested and found to be as strong as the bars. A working stress of 1,500 lb per sq. in. was adopted in accordance with the standard practice. With higher working stresses, the stress in the bottom flange of the girder would have been excessive before the load from the slab acted on the girder, specially because bars No. 14 and 15 were stressed before the slab was put in.

The cost of the bridge, viz., Rs 2,000 per running foot, included the cost of the approaches which were of the order of Rs 4 lakhs. The high cost was due to the peculiar conditions obtaining at the site.

Referring to **Shri Shitla Saran's** comment about transverse prestressing, Shri Manerikar said that the bridge was not designed for transverse prestressing. Composite action was obtained by casting the deck slab in-situ and bonding it by means of castellations and dowels to the girders. The ratio of modulii of elasticity between the deck concrete and the concrete of the prestressed girder was not obtained by test. It was assumed on the authority of reference books to be 0.8. Stresses of the shrinkage of the deck slab had not been taken into account in the design. It was believed that this would be very small.

Shri G. C. Khanna had referred to the shape of the wells. The twin 8-shaped well was chosen as it was found in practice to be easier to sink and minimised the likelihood of tilts or shifts. Also, it was economical to have reduced width at the centre, so to say a waist, to avoid extra mass of concrete.

The pier cap was adequately reinforced and no bed plates were considered necessary.

Shri Khanna had also referred to the excessive depth of the girder which, he thought, was the result of the adoption of Lee McCall system of prestressing. Actually the accepted tender was based on the Lee McCall system and no alterations were made. The prestressed concrete construction in India was in its infancy and so, at this stage, it was not possible to make correct comparison between different systems of design.

In reply to **Shri P. V. Raj**, the Author said that, as shown in the stress-strain diagram for Macalloy steel on page 217 of the Paper the stress at which plastic elongation equal to the prestress would occur was about 65 tons per sq. in.

Referring to **Shri A. Rajeswara Rao's** comment about the stress at the castellations, the Author gave out that the stress at the plane of the castellation was 23 lb per sq. in. If the forces were assumed to be taken by the castellation alone, it worked out to be 69 lb per sq. in.

Shri R. C. Roy (Chairman) said that the Paper had evoked considerable interest and the discussion was interesting. One of the speakers wished to know how the Lee McCall system with high tensile bars of lower strength compared in cost with other systems where high tensile wires were used. In West Bengal, for a long bridge of 1,580 ft, tenders were received for various types of reinforced concrete and prestressed structures. The tender using the Lee McCall system worked out to be the lowest. The manufacturers claimed that there was practically no creep in the Lee McCall bars. Also, the method for end-fixing in the system was simple.

In his experience he found that wherever a bridge was longer than 300 ft, prestressed concrete design proved to be cheaper than the reinforced concrete one.

On behalf of the Congress he thanked the Authors for their very interesting Paper and the speakers for their comments.

CORRIGENDUM TO THE PAPER

Page 153 Para. 4.1, 7th line from bottom	instead of "13 ft" read "11 ft".
Page 158 Para. 7.3, 2nd line from top	instead of "5-30 a.m." read "8-30 a.m."
Page 175 Para. 11.3, Sub-para. 1, line 3 from bottom	instead of "1⅛ in," read "1½ in."
Page 176 Para. 11.6, Item (2)	instead of "3/16" read "3/8".
Page 178 2nd Column 3rd Column 3rd Column	instead of "856 tons" read "847 tons". instead of "86 tons" read "–134 tons", instead of "—8600" read "—13400". instead of "Rs 1,73,500" read "Rs 1,68,700".
Page 181 Item 3 (4), line 1 from top	instead of "18703" read "187031".
Page 182 Item 3 (4), 3rd line from top	instead of "180731" read "187031"
Page 187 Item 3(6), 5th line from bottom	instead of "100.37" read "100.93"
Page 192, 1st line	instead of "$\sqrt{\frac{f_s}{E_s}+\frac{f_c}{E_c}}$" read "$\left(\frac{f_s}{E_s}+\frac{f_c}{E_c}\right)$"

Discussion on Paper No. 184*

"Specification For Surface Dressing Water-Bound Macadam Roads—Critical Notes"

By

K. C. DE AND P. N. SEN GUPTA

Monday, 9th January, 1956

Shri P. L. Varma (Chairman) called upon Shri K. C. De (Joint Author) to introduce the Paper.

Shri K. C. De (Joint Author) explained in detail the salient points in the Paper. Even though the water-bound crust was designed to withstand the traffic loads, protection from the harmful effects of climate and reducing wear from abrasion of traffic by the application of surface dressing was necessary. Otherwise, the binder in the water-bound macadam was sucked out by the pneumatic-tyred traffic during the dry weather. During the rainy season the matrix of the water-bound macadam surface got washed out from the top layers of the crust. Consequently, rain water penetrated into the base course and made the structure weak. The metal of the surface got dislodged under the action of traffic.

If very small sized hard aggregates, such as coarse medium sand, were used in blinding the first coat, a waterproof layer which would protect water-bound surface from the deteriorating influences mentioned above would result. When small aggregates such as sand were used, due to the capillarity of the small particles, a continuous film of binder could be secured. If, on the other hand, stone chippings were used for the first coat, it was observed that when they were pressed and pushed under the rollers, continuity of the film of binder was disturbed. The hard and sharp edges of the chipping got pressed by the rollers into the binding material of the water-bound macadam, thus preventing a continuous film being formed. Therefore, when one coat of surface dressing was done with chips, it might generally be observed that the surface took a longer time to dry up after the rains. Potholes developed at places and under the action of traffic these got gradually enlarged, making the road structure weak.

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The sand particles though very small in size were hard. They could withstand traffic abrasion as long as they were held in place by the cementing action of the binder.

When dressing was done with stone chips for the second coat before the sand mat formed by the first coat showed any signs of deterioration, the first coat absorbed the requisite quantity of binder used for the second coat and allowed the balance to work up into the interstices of the second coat. The sand mat so formed was a perfect waterproof layer. Also, it acted as a cushion between the bigger metal of the water-bound macadam and the smaller sized chips used in the second coat. In addition, the quantity of binder required for the second coat was comparatively less because the first coat was not rough. Moreover, the chips of the second coat when pressed against the sand mat of the first coat got greater bedding area and, therefore, were in a position to take more load than they could when placed directly in contact with the hard surface of the water-bound macadam aggregates. If single-sized chips were used for the second coat, a uniform surface could be obtained under the kneading action of traffic. That would result in a non-skid surface.

Shri E. A. Nadirshah was of opinion that the success of the method advocated by the Authors required verification under different climatic and traffic conditions. He wanted to know the necessity for a time lag between the applications of the first and the second coats. He wished the Authors to explain if a time lag of six months between the first and the second coat was desirable.

While surface dressing was desirable for roads of low traffic intensity because of lack of funds, its application as an expedient on heavily trafficked roads having high banks, before the final settlement occurred, was not consistent with the current trends in highway construction. If an embankment was compacted under controlled conditions, little settlement was likely to occur. Researches in the United Kingdom had shown that if the air voids in a soil did not exceed 10 per cent there was very little settlement. For subgrades of roads it was considered that air voids of the soil should not exceed 5 per cent. Therefore, when an embankment was properly constructed it was possible to construct the pavement immediately on completion of the earthwork without resorting to the expedient of having to surface dress the road. Also, there was no necessity to allow the newly constructed water-bound crust to be under traffic for a period of time as was the practice. On a soil-cement base, for instance, permanent surfacing could be constructed immediately after the completion of the base course. In Shri Nadirshah's

opinion, there was a possibility that the method suggested by the Authors had a good chance of success when the dressing was made over a stabilized soil road. There was less chance of deterioration under the impact of wheel loads due to the smooth surface of the stabilized soil.

Shri R. N. Dogra said that in the Punjab surface dressing of macadam roads had been practised with considerable success for a long time. The experience in the Punjab showed that binder in excess of 28 lb per 100 sq. ft. in the first coat and 14 lb per 100 sq. ft. in the second coat produced a very fatty surface which was likely to be picked up by pneumatic-tyred traffic. The chips used consisted of water-worn gravel $\frac{3}{4}$-in. size for the first coat and $\frac{3}{8}$-in. size for the second coat. Surface dressing according to the specification mentioned above resulted in a well-knit mosaic surface which was completely waterproof for the rainfall conditions in the Punjab. It was capable of carrying traffic up to 1,000 tons per day. The specification advocated by the Authors in the Paper, using sand for the first coat, was tried in the earlier stages but was found to be unsuccessful. While it gave waterproof surface it had no structural strength to take up the abrasion of traffic. On the other hand, when graded gravel was used, the binder worked into the voids of the gravel particles and formed a carpet more stable than when ungraded aggregate was employed. The normal specification adopted in the Punjab for surface dressing specified that the coarse aggregate should be dressed in two or three grades. After the binder was spread, the coarser gauge gravel was blinded over the medium gauge ones. The finer gauge gravel was spread at the top. Thus a mosaic surface in which the larger particles formed the main structure with the smaller particles filling in the voids was obtained. Shri Dogra thought that surfaces constructed to the specification suggested by the Authors would not be capable of withstanding traffic more than 500 tons a day.

In all road construction, specially thin pavements, preparation of the subgrade was very important. In the Punjab the current practice was to compact the subgrade to uniform density before laying the road structure.

Shri Y. C. Gokhale referred to the specifications suggested by the Authors, viz., 3 cu. ft. of sand per 100 sq. ft. for the first coat and 5 cu. ft. of $\frac{1}{2}$-in. size chipping for the second coat, and thought that it provided no structural stability and had lesser strength than the normal two-coat surface dressing. Therefore, Shri Gokhale was of opinion that the suggested specification could be used for base courses weaker than the water-bound macadam, for example, soil stabilized or gravel base courses.

The quantity and grade of binder for the sand mat had to be properly determined and controlled. Otherwise chippings of the second coat got into the sand mat and the sand might work up to the top.

Shri Gokhale referred to para. 4.4 on page 225 of the Paper, where it was said that the load bearing capacity of the stone chipping of the second coat was 2 to 3 times of what would ordinarily be when two coats of surface dressing were employed, and wanted to know how that had been measured.

Dr. H. L. Uppal said that in addition to controlling the quantity of binder to yield a non-skidding surface, the nature of the aggregate used played an important part in providing a non-skid surface. For example, hard stone like basalt even though it had comparatively greater resistance to abrasion got polished under the wheels of traffic, whereas stone like sandstone exposed a rough surface even under traffic.

Shri J. S. Narasimham said that surface dressing was at best only a dust palliative and could not withstand heavy bullock cart traffic. He referred to the arguments advanced by the Authors in paras. 4.1 to 4.4 on pages 222 to 225 of the Paper in justification of their design procedures, and said that the sand mat proposed for the first coat acted merely as a blanket course and the interlocking between the aggregate chippings, when chippings were used for the blinding, was absent. It was very doubtful whether the sand mat contributed any stability to the water-bound macadam below. Under heavy traffic the sand in the first coat would work up into the voids of the second coat. Therefore, the structure of the sand mat would be entirely disrupted. Also, if there was any time lag between the laying of the first and the second coats, the structure of the sand mat would be destroyed. Thus, the increased bearing capacity claimed for the wearing course could not be had.

Referring to the recommendation of the Authors that rounded gravel could be used for base course, Shri Narasimham said that such rounded aggregate would not produce the necessary interlocking. Also, the affinity of the binder to the smooth surface of the rounded gravel would be less. Therefore, the service performance of the surfacing using rounded gravel aggregates would be very poor when compared with that where crushed angular aggregate had been used.

Shri Narasimham thought that large-scale experiments were necessary before the specifications could be recommended.

Shri Fateh Chand was of opinion that chipping should be used for the first coat and sand for the second coat. On a water-bound macadam surface there were usually gaps of $\frac{1}{2}$ to $\frac{3}{8}$ in. between the two adjacent prominences. If $\frac{1}{2}$ in. chippings were not used, it was difficult to fill in these gaps and ensure a smooth riding surface. If sand were used for blinding of the second coat, the resulting riding surface would be good.

In Uttar Pradesh, rounded gravel had been used for surface dressing and it had given good results. Experience in Uttar Pradesh showed that the first coat required 35 to 40 lb of binder with $\frac{3}{8}$ to $\frac{3}{4}$-in. size chipping and the second coat 25 to 30 lb of binder with $\frac{1}{8}$ to $\frac{3}{8}$-in. grit. The Chief Engineer of Uttar Pradesh had also issued a circular to report on the effect of using sand flushing for chipping carpets. Shri Fateh Chand thought that if sand were used for the first coat and chippings for the second coat, the bullock cart traffic would have the effect of cutting the thin layer of sand, and thus the continuity of the waterproof layer mentioned by the Authors would be completely lost.

Shri R. B. Sen said that in high altitudes it was difficult to work with bitumen of 80-100 penetration. In places 4000 ft above sea level, 35 lb of Road Tar No. 2 or 3 with 3 cu. ft. of sand per 100 sq. ft. had been successfully used. In order to eliminate the cost of re-metalling on hill roads having mixed medium traffic, a stabilizing coat had proved satisfactory. It was not always possible to find out whether 2-coat surface dressing or $\frac{3}{4}$-in. light chipping carpet was cheaper as it depended largely on the availability of materials. Generally, for the conditions prevailing in Bengal the cost of $\frac{3}{4}$-in. light chipping carpet was high.

Shri S. N. Gupta giving the evolution of the specification recommended by the Authors, said that in West Bengal a large milage of roads had water-bound macadam surface which had to be converted into black-top. There was shortage of rollers. Therefore, instead of leaving the water-bound surface exposed to traffic for long without a stabilizing coat, bituminous paint covered with sand in the first instance was put in. Such a stabilizing coat protected the water-bound macadam surface for a period of 1 to 2 years. The second coat with chippings could then be laid over this stabilizing coat. He had adopted the specifications recommended by the Authors on many roads and found them yielding good results.

Shri Gupta thought that 40 to 45 lb of binder for 3 cu. ft. of sand was on the high side. 35 to 40 lb per 100 sq. ft. with 2 cu. ft. of sand, which gave a covering of about $\frac{1}{4}$ in., was, in

his opinion, ample. About ½ cu. ft. of sand should be kept ready at hand and used to blot out patches of fat surface.

Shri C. G. Swaminathan referred to para. 4.1 on page 222 of the Paper, where it was mentioned that sand attracted sufficient quantity of road tar to the surface due to capillary action. He doubted whether there was any capillary movement possible in coarse medium sand, specially when the liquid phase was a highly viscous binder.

Shri Swaminathan was of opinion that the continuity or the discontinuity of the binder film depended on the method of spraying employed rather than on the material used for blinding. Individual void volume in sand was much smaller than that of stone chippings. Also, when sand was employed for blinding, an intimate mixture of the mineral material and the binder was obtained due to the comparatively small sized particles of the aggregate. In surface dressing with chippings, the aggregate got coated completely only after the road had been under traffic for sometime. He remarked that Photos 1 and 3 of the Paper were probably taken immediately after the surface was laid. Recent experiment in the Central Road Research Laboratory showed that for given quantities of binder and aggregate, the surfacing with graded aggregates gave higher stability than that with single sized aggregates. The experience on the test track near the Central Road Research Institute confirmed this. Shri Swaminathan felt that it would be preferable to use chippings in the first coat and sand in the second coat from the structural point of view. He felt that 45 to 50 lb of binder was on the high side for 3 cu. ft. of sand.

Shri Abdul Khader said that ¾-in. pre-coated light chipping carpets with 8⅓ cu. ft of ½ in. chips and 25 lb of bitumen per 100 sq. ft. were extensively used in Madras State. A tack coat of 20 to 30 lb per 100 sq. ft. was first applied before the precoated chips were laid. The cost of such a surface per mile of road worked out to about Rs 10,000 whereas the specification suggested by the Authors worked out to about Rs 13,000 per mile. The advantage claimed by the Authors for their specification, viz., the building of a waterproof mat was achieved by the application of a fairly thick tack coat. It was a disadvantage to apply the first coat separately because it was not strong enough to stand heavy traffic. The specification suggested by the Authors was tried in Areyalur Velangudi road in the Thiruchi district of the State. The water-bound surface was painted with bitumen and dressed with sand. The surface failed within 2 to 3 months of laying even though the intensity

* This and subsequent comments were received in writing.

of traffic was only 700 tons per day. The failure was perhaps due to the thin surface which could not stand heavily loaded iron-tyred bullock carts.

In para. 5.1 on page 226 of the Paper, the Authors had advocated the use of water for reducing dust. This recommendation was liable to be misused and might result in excessive use of water which would adversely affect the surface. He thought that graded aggregates were preferable to uniform sized metal. There were more voids in the uniform sized metal and, therefore, depressions on the top surface might be formed. These depressions acted as a storage for rain water which weakened the surface and provided nuclei for potholes.

Shri D. C. Chaturvedi wanted information on the following points :

(1) the grading of the medium sand recommended for the first coat in para. 5.1 (b) on page 226 of the Paper ;

(2) details of experiments conducted by the Authors for finding out the bearing capacity of the stone chipping of the wearing coat, mentioned in para. 4.4 on page 225 of the Paper ;

(3) details of the actual trials made with the specifications together with the results obtained.

Shri M. C. Bhargava referred to para. 5.2 on page 226 of the Paper and said that in Uttar Pradesh Road Tar No. 3 was found unsuitable for use in the second coat. The temperature in summer was as high as 116 to 118 degrees in some places and the surface started bleeding. The life of the surfacing when tar was used was also comparatively less.

Shri K. C. De (Joint Author), replying to the discussions, said that both asphalt and road tars contained bitumen and, therefore, it was not wrong to call surface dressing work done with road tar as a bituminous surfacing. The findings reported in the Paper were, however, carried out using road tars. Many speakers wanted to know the details of the field experiments done with the specifications recommended and their results. As mentioned by Shri S. N. Gupta, the specifications advocated in the Paper were not new. Several years back it was a common practice in Bihar to treat water-bound surfaces to the specifications recommended by the Authors. The results were quite good. In one case on Ranaghat-Jaguli road in West Bengal on a 2-mile section, opposite the Mission Hospital at Ranaghat, water-bound macadam started unravelling. The condition of the

surface was such that metal got loose even while cleaning. A brush could not be used for spreading road tar and the consumption of binder was as much as 45 to 50 lb per 100 sq. ft. The second coat was blinded with chips. These repairs were done in the year 1939. Subsequent renewals were of the usual type. The road was now in first class condition in spite of the heavy traffic that was using it. Many roads were treated with the specification. Details of some of the works were given by the Author:

(1) Krishnagar-Hashkhali road. First coat using 40 lb of Road Tar No. 2 and 3 cu. ft. of locally available sand per 100 sq. ft. Work was done in 1952. For the second coat which was applied in 1953, 35 lb Road Tar No. 3 and 5 cu. ft. of $\frac{1}{2}$-in. chips were used.

(2) Bashirhat-Pipa Raghabpur road. 40 lb of Road Tar No. 2 and 3 cu. ft. of local sand per 100 sq. ft. were used for the first coat done in 1953. For the second coat in 1954, 35-40 lb of Road Tar No. 3 and $5\frac{1}{2}$ cu. ft. of $\frac{3}{4}$-in. chips were used per 100 sq. ft.

The condition of both the surfaces was good.

Many members had said that graded chips gave better results than single sized chips. When graded chips were spread, the smaller sized chips prevented the larger ones getting contact with the film of binder, with the result that some of the chips got loose and most of them were thrown out of the road by the fast-moving traffic Even if graded chips were used by separating the different sizes, a certain amount of loose chips were bound to be thrown out by the action by pueumatic tyres before they came into contact with the binder. That was because the small chips lying between two bigger ones could not be pressed down without disturbing the larger ones. On the other hand, when single sized chips were used, under the wheels of the roller all the chips got contact with the binder which got gradually squeezed up under the traffic. Thus every stone of the blinding material had a binder matrix on all sides excepting the top. After a good deal of field experiments, the Road Research Laboratory at Harmondsworth, England, had also recommended the use of single sized chippings for surface dressing.

Referring to the comment of **Shri E. A. Nadirshah** about the duration of the time lag between applications of the first and second coats, the Author said that it would depend on several factors, specially the traffic intensity at the time of the year at which the surfacing was done. In all cases the second coat should be applied before the rains.

If high banks were compacted using modern techniques, thereby minimising settlement, the type of surfacing that would be finally adopted could be put in straightaway. Surface dressing of stabilized soil roads was still in an experimental stage and it was too early to make a recommendation in this regard.

Shri R. N. Dogra had said that surface dressing using 35 lb of binder for the first coat had been successful in the Punjab. In the application of the first coat it was necessary that some quantity of binder should penetrate into the interstices of the top layer of the water-bound macadam so that a good bond could develop between the wearing surface and the water-bound surface below. In low rainfall regions such as the Punjab, the object of surface dressing was primarily to bind the blinding materials and waterproofing was perhaps not very important. That was the reason why application with smaller quantities of binder gave good results there. Any specification for surface dressing must, in the opinion of the Authors, be elastic to suit the varying condition such as climate, texture of the surface, traffic intensity, etc. These had been enumerated on page 222 of the Paper.

Shri Y. C. Gokhale wanted to know how the load bearing capacity of the chips over the sand mat was determined. This was done according to the procedure outlined in the Paper by Shri K. C. De on "Behaviour of Brick Metals in Tar Carpets", published in I. R. C. Journal, Vol. XV-3.

Dr. H. L. Uppal had stated that use of basalt stone might lead to the loss of non-skid character of the surface. In the whole of Eastern India, basalt chippings had been used and they did not develop smooth surface. In surface dressing the area exposed to traffic was partly stone and partly binder and, therefore, there was no possibility of the surface developing a dangerously smooth area.

Referring to the comments of **Shri J. S. Narasimham**, the Author said that in all the field experiments that had been done, the sand mat did not get disturbed under bullock-cart traffic. Rounded gravels had been successfully used in Eastern India for surface dressing. It was certainly not a desirable material to be used in carpets where cubical particles with angular shapes were essential for interlocking.

Referring to **Shri Fateh Chand's** remarks, the Author said that it was preferable to use sand in the bottom course. If the sand was used in the second coat, as advocated by Shri Fateh

Chand, the voids in the chips would mostly be filled up with binder as was mentioned in the Paper.

The Authors were thankful to **Shri S. N. Gupta** for having given the evolution of the specifications. The quantity of the road tar required depended, as already mentioned, on the texture and condition of the water-bound macadm. Climate also played a very important part in determining the amount of the binder.

Shri C. G. Swaminathan had expressed doubt regarding the capillary movement for a viscous binder like road tar in coarse medium sand. It was observed that this had actually taken place in the field experiments that had been done, specially when the viscosity of tar was reduced during high temperature.

Even though the method of spraying binder was responsible for ensuring a continuous film on the surface of the water-bound macadam, the presence of dust might impair this continuity. Use of sand blinding helped in spreading the binder evenly in places where such discontinuity had taken place. When the quantity of binder for the second coat was adjusted so that it rose into the voids of the blinding material, there was no danger of bleeding. The resulting surface had non-skid characteristics. If more binder than necessary were used, then there would be bleeding and the surface would become smooth.

Regarding the use of additives, slaked lime* had been used with great success. Also there were available in the market proprietary membrane.

Shri Abdul Khader had referred to the failure of Areyalur–Velangudi road treated with the specifications recommended by the Authors. Probably the failure was due to the subgrade.

Surfacing with precoated chippings employed in Madras State was probably adequate in regions where rainfall was moderate or light.

Referring to **Shri M. C. Bhargava's** comment about the unsuitability of Road Tar No. 2, the Author said that in areas where atmospheric temperatures were likely to be very high it was advisable to use a thicker grade of road tar in the second and renewal coats.

* Paper No. 99 "Adhesion of Bituminous Binders to Stone Metals and the Use of Slaked Lime for the Treatment of Wet Aggregates" by C. J. Fielder. I. R. C. Journal, Vol. IX-1, December, 1944.

Shri P. L. Varma (Chairman) referred to the experiments that had been conducted at the Central Road Research Institute, New Delhi, and said that final results were likely to be available within a year or so.

In the Punjab, even in hills where rainfall was as high as 75 in., the specification adopted, i.e., two-coat surface dressing, using lesser quantity of bitumen had proved a remarkable success.

He thanked the Authors for their interesting Paper and the various speakers for their comments.

Discussion on Paper No. 186*

"Fact Finding Survey and Highway Planning in Uttar Pradesh"

By

P. N. SRIVASTAVA

Tuesday, 10th January, 1956

Shri H. R. Gupta (Chairman) called upon Shri P. N. Srivastava to introduce his Paper.

Shri P. N. Srivastava (Author) mentioned that the Paper presented the details of a fact-finding survey carried out in Uttar Pradesh for use in planning of highways. Such a survey was not new to the State. Economic surveys were carried out in a few of the districts of the State some years ago and two Papers** on the subject were presented to the Indian Roads Congress. He then described the details of the fact-finding survey given in the Paper.

Explaining the principles adopted in the selection of roads for the Master Plan, Shri Srivastava said that priority was given to the gaps in the State Highways, inter-district roads and roads connecting important tehsil headquarters, markets, etc. Efforts were also made to so plan the system that no village with a population of 5,000 or above was more than one mile from a metalled road, and that no village having a population between 2,000 to 5,000 was beyond a distance of 3 miles from a road. Similarly, no marketing centre or other important place was more than 2 miles from a road.

Care was taken to see that the procedure for the survey was made as simple as possible so that the staff of the survey party could contact the people, ascertain their views, judge the necessity of a road.

* Published at pages 297 to 323 of the Journal, of the Indian Roads Congress, Vol. XX-3 December, 1955.

** (1) "Basis of Road Planning" by Jagdish Bahadur, I. R. C. Journal Vol. XII-5, September, 1948.

(2) "Fundamentals of Highway Needs and Highway Planning" by D. G. Bhagat and Jagdish Bahadur, I. R. C. Journal, Vol. XIII-3, January, 1949.

Shri Srivastava stressed the importance of planning in order to ensure that selection of works was above politics and as much benefit as possible accrued to the people.

Dr. R. K. N. Iyengar referred to para. 6.3 on pages 303–304 of the Paper and said that utility of a road in respect of population and agricultural productivity alone was considered in the Paper. It was necessary to include a factor for industrial development also. That was very essential as otherwise the type of road surface planned might become obsolete when heavy traffic developed at a future date. An allowance of 10 to 20 per cent should be made on this account. Also, the expected increase in population in the villages should have been given some consideration.

In para. 7.3 on page 305 of the Paper, it was mentioned that provision had been made in the Master Plan for the reconstruction and modernising of roads. It was necessary to make an allowance for widening road crusts and improving the road surfaces. Special consideration was also necessary for strengthening the culverts and bridges to cater for motor trucks weighing up to 10 tons.

In para. 9.2 on page 306 of the Paper, it was mentioned that all unmetalled roads had been omitted from the second Five-Year Plan. It did not seem to be a correct approach because such an omission meant that the needs of town dwellers and other interested parties who made themselves heard were given more weightage. He thought that the Grow More Food campaign was not quite successful because of lack of facilities for transport of the extra produce from villages to consuming centres In the second Five-Year Plan of the country the targets proposed for agricultural production were high, and hence it was essential that a high priority should be given to the construction of unmetalled roads to facilitate transport.

Shri S. R. Naidu giving the procedure for planning roads adopted in the Madras State, said that even as early as 1942 an officer of the rank of Superintending Engineer who had considerable experience and knowledge of almost the entire State was appointed. He was given some Assistant Engineers and Supervisors. He was able to collect practically all the information on the points mentioned on pages 308-311 of the Paper by discussions with the members of Legislative Assembly and Council, Presidents of District Boards and others. A questionnaire very similar to the one on pages 310–311 was issued to the various district officers and the staff of the Superintending Engineer going round the districts was able to collect all the required particulars within three months.

In the Madras State there were weekly markets scattered throughout the area. The income from the weekly markets was an indication of the amount of traffic using the roads round about the market centres.

Shri Naidu thought that it was difficult to delineate the details on a map of 1 in. = 4 miles. His experience was that a scale of 1 in. = 1 mile was suitable for the purpose.

In the detailed data collected, no mention had been made of unbridged gaps. In the Madras State, it was found that 18 to 19 per cent of the cost of construction of roads was for culverts and bridges.

Shri C. L. N. Iyengar remarked that the Paper covered what might be called a "system planning" and partly "route selection."

Referring to the formula $V/5 + Q/2 + R + 2S + D$, given on page 312 of the Paper, he mentioned that assigning zero value to factor D meant that no improvement was contemplated in the productivity within the next 20 years. If per chance any increase took place it would be difficult to rationalise the road system planned.

Shri Iyengar wanted to know details of the data collected to describe the condition of existing roads. He referred to para. 7.2 on page 305 of the Paper where it was mentioned that priority was given to the State highways even though they were not important to the district and enquired whether there was no prospect of re-aligning them due to the paucity of funds.

Shri T. S. Khanna suggested that economic aspects should also be studied for the purpose of planning a highway system. Without economic evaluation it was difficult to determine priorities for road improvements or extensions. There were three main methods for judging the economic justification for road construction, namely, (1) solvency quotient; (2) benefit quotient; and (3) inter-relation of cost, revenue and benefit. He then described in detail the methods suggested by John Beakey and C. B. MacCullough for the above mentioned methods.

Shri J. S. Narasimham remarked that the planning procedures adopted in the U. S. A. were not wholly applicable to Indian conditions. There was a large percentage of bullock cart traffic on Indian roads. The saving that accrued to the bullock cart owners by using improved communications was difficult of evaluation. Therefore, it was necessary to evolve methods suited for Indian conditions.

In Shri Narasimham's view the Star and Grid formula recommended in the Nagpur Plan was empirical and, therefore, arbitrary. The milage of roads required for any one district should be determined after studying the data obtained from origin and destination surveys and the relative economics of alternative patterns.

In section 2 on page 299 of the Paper the Author had given details of the staff employed, duties of the staff and the procedure adopted for collection of data. It was desirable to enlist the co-operation of students from local colleges and schools, post them to different areas in the region, and obtain factual information on the various routes emanating from the district capital. The information so obtained would be more valuable than the answers to the questionnaire from selected persons. The planning could then be based not only on the replies to the questionnaire but also on a study of the factual data about alternate routes.

On page 303 of the Paper, in para. 5.1 for the purpose of finding out optimum milage in a district, the Author had studied three systems, called A, B and C, which were arbitrarily selected. It would have been better if alternate routes other than those existing were also studied. The relationship between the intensity of population in the district and the vehicle tonnage, including the passenger traffic, and the total milage required could be established on the basis of an origin and destination survey. In para. 6.4 of the Paper the optimum metalled milage required for the district was given as 380. This was based on arbitrarily selected existing road systems. Therefore, the result was no better than that given by the Star and Grid formula.

Locations of chief towns of the district and talukas in India were not planned. They were, on the other hand, influenced very much by political considerations and military strategy. Therefore, it was not correct to take the existing system of roads as the datum and calculate the milage required as an addition to it. If need be, there should be no hesitation in abandoning an existing road connecting two district headquarters if an origin and destination survey revealed that there were more economical routes connecting the two places.

In conclusion, Shri Narasimham pleaded for an approach to highway planning based on origin and destination surveys in respect of passengers and goods.

Shri P. N. Srivastava (Author), replying to the discussion, said that the Paper was confined to the fact finding survey.

The economics of various projects were studied separately but these aspects had not been included in the Paper.

Referring to **Dr. R K. N. Iyengar's** point regarding the weightage to be given to industrial development, Shri Srivastava said that there was sufficient margin for future industrial development in the selected system. Uttar Pradesh was divided by rivers Ganga and Yamuna flowing east-west. Therefore the State roads generally ran east-west even though there were some State roads running north-south. To evolve an integrated system as quickly as possible, highest priority was given to the State highway gaps in the district. Inter-district roads were given the next priority. The data collected from the field, in answer to the questionnaire given on pages 310-311 of the Paper, gave sufficient information on the desirability of widening or modernisation of roads. If widening of any one road was warranted it was included in the Master Plan.

In answer to **Shri S. R. Naidu**, the Author mentioned that the whole-time staff, given on page 299 of the Paper, was engaged only on the collection of data. The selection of highways and the drawing up of the final programme was done at the headquarters of the Executive Engineer and finalized by the Superintending Engineer before it was approved by the Chief.

The tehsil map in the Uttar Pradesh was to a scale of 16 in. to a mile. Even 1 in. to a mile maps were found too big and unwieldy for the purpose of delineating the alignments and marking the information. Information on the desirability of new bridges and culverts and reconstruction of existing bridges and culverts was also collected during the enquiry.

Shri C. L. N. Iyengar had enquired whether there was no prospect of re-aligning some of the inter-State roads to serve local needs. In Uttar Pradesh, the alignments of State highways were first determined and were not changed except for minor modifications to suit local needs.

Referring to the remark of Shri Iyengar about the allowance for agricultural and industrial development, i.e., factor *D* in the formula given on page 312 of the Paper, as zero, the Author said that in some districts where there was a little likelihood of development in the future no allowance for development was made. Barabanki happened to be one such district.

Enquiries about the condition of existing roads, traffic census at various points, and the likely trend of traffic on the roads gave sufficient indication of the extent of improvement necessary for the existing roads.

Referring to **Shri J S. Narasimham's** observations on the importance of origin and destination surveys, Shri Srivastava said that economic surveys had been carried out earlier as mentioned by him in the Paper. These economic surveys, could not be carried out in all the districts.

Shri H. R. Gupta (Chairman), winding up the discussion, said that in Madhya Pradesh they had difficulty in dealing with the numerous demands for new roads and in reconciling conflicting claims. A target of 1,300 miles of metalled roads for an area of 131,000 sq. miles was fixed. When the milages for each district were worked out by the Star and Grid formula, it was found that the existing milage in some of the districts was in excess of the requirement. Therefore, a simple empirical formula to arrive at an equitable distribution was evolved. In deciding this, consideration had been given to the following seven factors:

(1) area in square miles,
(2) population in lakhs,
(3) revenue in lakhs of rupees,
(4) number of towns and villages having a population of 500 and above,
(5) number of police stations,
(6) number of railway stations, and
(7) number of business centres.

Each of the above factors was given equal weightage. If, for instance, the milage determined according to the above mentioned considerations worked out to 800 miles and the existing milage of metalled roads in the district was 500, then 300 miles were fixed as the target to be attained in the next two Plan periods. Of the milage so determined, the length of State and inter-district roads was fixed by the Government on the recommendation of the Chief Engineer and the balance by the Deputy Commissioner in consultation with the District Advisory Committee. The Deputy Comissioner was also to fix priorities. A provision of 500 miles of roads had been earmarked for backward areas in the State. No limit, however, was fixed for the construction of roads with the public participation. The above arrangement though might not be based on any scientific study was simple and proved successful in reconciling conflicting demands.

He thanked the Author for his interesting Paper which had evoked a lively discussion.

Discussion on Paper No. 187*

"The Importance of Traffic Engineering in India"

By

DR. R. K. N. IYENGAR

Tuesday, 10th January 1956

Shri E. A. Nadirshah (Chairman) introduced the Author and said that in advanced countries like the U.S.A. and the U. K. traffic engineering methods were extensively used for the design of roads. Operation of vehicles on roads so designed was economical. These roads also provided adequate safety for the road users.

The Paper by Dr. Iyengar had come in at a time which was opportune to focus the attention of road engineers and the public to the seriousness of the traffic problem.

Dr. R. K. N. Iyengar (Author), introducing his Paper for discussion, said that the chief object of the Paper was to highlight the importance of traffic problem and the urgency of adopting traffic engineering methods in the country. He quoted statistics of accidents in the U.S.A. and in the U. K. and said that research to make roads safer and economical for operation were given prominent place there. Analysing the number of accidents, given in Tables 2 to 6 and 9 of the Paper, the Author said that there was a decrease in the number of accidents in Calcutta, Madras and Bombay, whereas accidents were on the increase in Delhi and Hyderabad. This, he said, was partly due to the large increase in the number of cycles in Delhi and Hyderabad, and partly due to lack of safety measures compared to Calcutta, Madras and Bombay. During the 3-year period 1951-53, on an average, 483 persons were killed and 11,473 persons were injured in the five cites Bombay, Calcutta, Madras, Delhi and Hyderabad alone in a year. The Table below gave the average number of accidents in the five cities:

City	Average number of persons killed and injured per 1,000 vehicles
Madras	178.1
Bombay	141.5
Calcutta	56.3
Delhi	47.7
Hyderabad	18.3

* Published at pages 325 to 357 of the Journal of the Indian Roads Congress, Vol. XX-3, December, 1955.

Studies conducted by the Central Road Research Institute, New Delhi, showed that the road user's behaviour could be influenced by adopting suitable measures such as road markings, marking of pedestrian crossings, installation of traffic signs and signals, and by improving road layout specially at intersections. At present sufficient attention was not paid to these aspects. The traffic engineering was a very vast subject and details were beyond the scope of this Paper.

In the Paper, a proposal to establish "traffic engineering units" in various cities in the country had been put forth. The establishment of such a unit in major cities was very essential to co-ordinate the activities of the Public Works Departments, Traffic Police, Educational organizations, etc. The traffic engineer in charge, assisted by adequate staff, would undertake traffic volume studies, origin and destination surveys, analyse the route characteristics, and devise measures which would mitigate road accidents and would be conducive to better flow of traffic, etc.

Co-ordinated action of the various authorities and the road users was absolutely necessary for the ultimate success of any method that might be devised. It was necessary to handle the problem at the national level and it was suggested in the Paper that a Commission of Road Traffic and Safety should be constituted by the Government of India. The Author emphasised that the Indian Roads Congress should take up the question of establishing "traffic engineering units" in large cities and impress upon the Government of India the necessity for setting up a statutory Commission on Road Traffic and Safety.

Dr. M. K. Ganguly remarked that improvements of intersections or installation of traffic control devices would reduce accidents in the area affected by the improvements. So, the correct approach to demonstrate the usefulness of improvements would be to consider the number of accidents occurring at or near about the place before and after the improvements were effected. Study of accidents for a State or a city as a whole was not likely to give a useful or correct picture. Taking, for instance, the case of the crossing of Connaught Circus with Janpath in New Delhi, the installation of a traffic signal had reduced the number of accidents from 200 to nearly 30 during the last year. But a study of the number of accidents for whole of the Delhi State would not give the correct picture. Formerly, the Delhi Police were reporting accidents only of injuries and deaths, but now all types of accidents, whether bodily injury or death was involved or not, were being reported.

Thus, changes in administrative policies influenced the data significantly.

The data given in the different Tables were confusing. For example, in Table 2 on page 331 of the Paper, three different aspects were being considered simultaneously. The Table showed that up to year 1950 there was an increase in the number of vehicles, but after 1950 the number of vehicles had remained practically constant, whereas the number of accidents was fairly constant throughout the period. If one were to look at the number of traffic signals installed, there was no increase. That showed that the installation of traffic signals had no relation to accidents. All these anomalies had arisen because the accident figures were sought to be studied for the whole city.

Shri Fateh Chand observed that while traffic engineering methods might be of use in reducing accidents in urban area, the problem in the rural area, where bullock cart traffic was predominant, was not susceptible of improvement by such methods. Oftentimes, the bullock cart drivers were sleeping while the cart moved on the road. Transport of long ballies etc. was dangerous. The only remedy, in his opinion, was legislation. Simultaneously with the introduction of legislations, educating the villagers by special folk songs, literature, etc., should be undertaken.

Another impediment to the free flow of traffic was ribbon development allowed by Local bodies all along the road.

Oftentimes, the absence of adequate berms and light signals where the road was closed for repairs was conducive to accidents. These could be avoided by alertness of road engineers in providing good shoulders and adequately lighted signs.

Shri K. K. Nambiar said that "building safety into the roads" was important. Improvements of the surface enabled greater speed to be attained. But unless the geometrics of the roads were also improved, increase in the number of accidents would result.

There was lack of co-ordination between the authorities in charge of construction and maintenance of roads and the police department which was in charge of regulation of traffic on roads. Instances where traffic control-fixtures such as roundabouts, traffic umbrellas, median strips, etc., were laid by the traffic police without prior consultation with the engineer in charge of the roads, were numerous. Under the Motor Vehicles Act and the rules made thereunder by the States, the right to instal mandatory and cautionary warning signs was vested in the road

traffic authorities. The engineers in charge of roads were permitted only to instal informatory signs, such as direction sign posts, etc. In some of the States, authorities responsible for constructing and maintaining traffic rotaries and for installation of centre line markings, etc. were not stipulated. In certain municipal towns, the road authorities did this, meeting the cost from their funds, while in others the traffic police carried out these works at their cost. To obviate this confusion and to effect proper coordination between those in-charge of construction and maintenance of roads and those in-charge of traffic control and safety, it was essential to have separate Traffic Engineering Department.

Traffic engineering units, suggested by the Author on page 354 of the Paper, should work under the Highways Department of the State or in close collaboration with it. Only then was it possible to "build" safety into the roads effectively. Other advanced countries like the U. S. A. had separate traffic Engineering Departments working under or in conjunction with the Highways Department of the States. The Author's suggestion for the constitution of a statutory commission of road traffic and safety was worth serious consideration.

Shri B. S. Mathur said that, broadly speaking, urban traffic could be classified as local and through. To prevent congestion it was essential that through traffic should not be allowed to enter the town. It should be routed through an outer ring road or through a bye-pass. Such a step would lessen the number of traffic accidents.

Ribbon development not only reduced the effective width of pavement but also made future widening of the pavement, when traffic conditions warranted such a step, almost impossible. Ribbon development could be checked by enforcing building line, acquiring land on both sides of the highway, or by legislation.

Shri P. K. Parmar was of opinion that effective measures to enforce observance of traffic rules in rural areas should be devised. The system of road peons mentioned by the Author, in his opinion, was not sufficient for the purpose. Another problem, which was important from the road engineer's point of view, was the damage to roads resulting from slackness in checking overloading and greater speeds. These could be effectively checked only if road engineers were given powers to exercise control over traffic using the roads. Also, the engineer should take a hand in educating the public on proper use of roads. It would be a good thing if he were to speak to school children on traffic rules and regulations occasionally.

Shri C. L. N. Iyengar observed that the Paper, except for vividly describing the traffic conditions and the bad practices prevailing in the use of roads in India, did not mention traffic engineering. As practised in the U. S. A., traffic engineering had two branches, viz., (1) collection of traffic engineering data, and (2) use of data collected in planning of improvements.

Measures such as segregation, one-way traffic prohibition of turning movements, control of parking, etc., belonged to the second branch, and were tried in this country. But no systematic attempt to collect basic data about traffic was made. Evaluation of the degree of success of several engineering measures was possible only through collection of data.

This Paper appeared to over-emphasise the need for traffic engineering from the accident aspect. Traffic engineering methods alone were not likely to provide the desired results. Even drastic steps were not helpful in totally avoiding accidents on the road, e.g., in Saudi Arabia when a fatal traffic accident occurred, the punishment meted out to the offender was death. Even that had not made Saudi Arabia accident free.

Effective education had not brought immunity from accidents. What was really required for the reduction of the accidents on roads was bold leadership which took into account the 3 " E's " of traffic problem.

The Paper emphasised that speed was a potential danger to traffic. It might be said that this approach was not considered satisfactory in solving traffic problems because, one of the main aims of traffic engineering was to arrange for the expeditious movement of traffic under a given set of conditions.

Shri O. S. Sehgal emphasised that when a road was constructed, sufficient thought should be given to the future needs. If this was not done, roads became obsolete within a short time. Congestion and increase in traffic accidents was the result.

Shri E. V. S. Iyer was of opinion that segregation of various types of traffic by providing separate lanes for bullock carts, rickshaws, and mechanised vehicles, would be effective in minimising accidents.

For effective enforcement, a lot of staff was required. For educating bullock-cart drivers and rickshaw pullers in the rules of the road guides, selected from among them should be given training. Legislation alone was not sufficient to minimise accidents; education was very important.

Shri M. Meeran said that in addition to the number of different types of vehicles and accidents given in the Tables, it was necessary that the area and road milage in the city should be given. Without these figures it was difficult to make comparisons about the incidence of accidents.

In para. 3.2 on page 351 of the Paper, the Author had mentioned that it was not possible to adopt all the latest methods practised in foreign countries in India. Shri Meeran said that it was possible to achieve results by adoption of modern methods suited to conditions obtaining in this country. In Madras, under the Traffic Act, the police department was reponsible for the control and regulation of traffic, but the Municipal Corporation was called upon to bear the cost of improvements such as provision of roundabouts, lighted keep-left signals, refugee islands, etc. It was not possible for the Corporation with its tight finances to undertake all this and he was glad to say that the Govt. of Madras had given a grant of Rs 1 lakh for purpose of providing traffic control facilities in the city.

Shri R. N. Dogra agreed with the previous speakers that it was very essential to collect data about traffic before any improvements could be planned. Diagrams showing the alignment of the road on which building, sight distances available at road crossings, the nature of the surface of the road, etc., and the traffic accidents were very helpful in formulating proposals for improvements.

Shri Dogra thought that segregation of cyclists and the slow-moving vehicles from fast traffic was very essential if the number of traffic accidents were to be reduced.

Shri P. L. Varma observed that the improvement of traffic conditions could be looked from two angles mentioned below :

(1) technical level

(2) administrative level

Planning work might be classified into two groups, negative planning and positive planning. By negative planning was meant controls such as 'no right turn', no entry, one-way traffic, signs and signals, etc., on roads which were not up to the standard. The positive side of planning consisted of adopting standards that would serve efficiently and safely the future needs of traffic. He cited the example of Delhi where with the increase in population there was heavy congestion on roads.

This was probably due to the fact that adequate consideration was not given to the provision of future needs. On the other hand, in Chandigarh the capital of the Punjab, ample provision for future needs was made. Positive planning if it had been followed in Delhi would have saved lot of expenditure.

He suggested that units of traffic engineering should be put under the Planning Department of the State where the activities of all the departments could be co-ordinated and steps to improve traffic conditions taken.

Shri M. S. Narurkar supplementing the information for Bombay given by the Author in respect of Bombay, said that installation of fixed-time traffic signals at 13 main intersections in the city was being planned. One had already been installed and it was working satisfactorily. The cost of one signal with all its ancillary equipment was Rs 22,000. In the city an under-pass at a busy street where both pedestrian and vehicular traffic in the morning and evening was very heavy, had been provided. The result was that there was orderly movement of traffic. Proposals for providing an under-pass for the use of vehicles at a very complicated intersection were under consideration. If this was done, great relief in congestion at the locality would result.

Shri R. Thillainayagam* emphasised that the road must be operationally safe over a period of time, say 15 to 20 years.

The Paper gave an impression that employment of some more traffic constables and traffic police officers would solve all traffic problems. The Author had confined his data to cities. But traffic problems were there wherever pavements capable of high speeds were built on poor alignments. The Author had discussed the function of the traffic police rather than that of a traffic engineer.

The Author had suggested in para 2.2 of the Paper, "that suitable persons living nearby areas could be appointed and invested with powers to supervise the maintenance and to enforce traffic rules." Only trained persons and organizations (trained in traffic regulation), Scouts, N. C. C., Automobile Association etc., should be permitted to regulate traffic. The enforcement of traffic laws should continue to be the responsibility of the police officers.

* This and subsequent comments were received in writing.

Shri Thillainayagam enumerated the functions of a traffic engineering unit. These were :

(a) Supervision of design, fabrication or purchase, and erection and maintenance of all traffic control devices.

(b) Analysis of data relating to the causes of traffic accidents and to prepare recommendations for improvements.

(c) Making special studies on speed zoning, establishment of no-passing zones, and proper pavement use.

(d) Co-operation with enforcement officials (police) in the establishment of necessary traffic regulatory measures.

(e) To advise on and assist in traffic control problems.

(f) To co-operate with the design and construction and maintenance divisions of the State Highways Department by reviewing plans affecting traffic movement.

(g) To participate in traffic research.

(h) To handle complaints relating to the ineffectiveness of traffic control or conditions which might involve physical changes.

(i) To design traffic islands and intersections on all highways.

(j) To furnish information to the public about road condition, road closures, etc.

(k) To co-operate with the police, press, schools, automobile associations, safety associations, civil groups etc. in the promotion of traffic safety.

Shri O. Muthachen remarked that a detailed layout for the improvement of one intersection along with recommendations for traffic control, if included in the Paper, would enhance its value.

Dr. R. K. N. Iyengar (Author) felt gratified that the Paper had evoked a good discussion.

In reply to **Dr. M. K. Ganguly** the Author said that the main object in presenting the Paper was to focus attention on the need for employing traffic engineering methods in solving traffic problems. That explained why accident figures for the cities as a whole were given. Before any improvements were suggested, it was no doubt necessary to make a detailed study of the traffic conditions in the locality. Also, to assess the effectiveness of the improvements, after-studies were necessary. But this Paper did not attempt to go into such details.

The Author agreed with **Shri Fateh Chand** that legislation was necessary for controlling traffic on rural roads. Likewise, legislation was also necessary for controlling ribbon development.

The Author agreed with **Shri B. S. Mathur** that when through traffic was routed through by-passes or outer ring roads, there would be reduction in the number of accidents.

Shri P. K. Parmar's suggestion that road engineers should be given powers to check overloading and over-speeding on roads deserved consideration by the authorities.

Shri C. L. N. Iyengar had said that it was the function of the traffic engineer to arrange for movement as speedily as possible. The Author strongly felt that the economy achieved by encouraging higher speeds was not commensurate with the loss that might result by way of greater number of accidents. Loss of human life and injury to persons cost more than the benefits that would accrue by higher speeds. He thought that a balance should be achieved between these two conflicting factors. That Saudi Arabia was not free from accidents in spite of severe punishment for traffic offences, only proved that education of the road users was very important. The Author agreed with Shri Iyengar that bold leadership was very essential for reducing the number of accidents.

Future needs of traffic should certainly be assessed, as suggested by **Shri O. S. Sehgal**, before any improvements were planned.

Segregation of various types of traffic such as cyclists, bullock carts, etc., suggested by **Shri E. V. S. Iyer**, even though very effective in reducing accidents, meant lot of expense.

The suggestion of Shri Iyer that traffic guides should be trained among bullock cart drivers and rickshaw pullers to educate their colleagues was worth consideration.

In reply to **Shri M. Meeran**, the Author said that he had experienced lot of difficulties in securing data from diffeeent cities. That showed that collection of data on a systematic basis was not being made. Even though solutions adopted in other countries could not be employed wholesale for conditions obtaining in India, it was certainly possible to use the ideas employed elsewhere to achieve good results. He was glad that Madras had shown progress in this direction.

The suggestion of **Shri R. N. Dogra** that detailed maps of road intersections giving all the relevant details should be prepared was welcome. The preparation of such maps would certainly be undertaken when traffic engineering units were established in different cities.

The Author commended to others the example of the planning done at Chandigarh, which was cited by **Shri P. L. Varma**.

Thanks were due to **Shri M. S. Narurkar** for supplementing the information given in the Paper in regard to the city of Bombay.

In reply to **Shri R. Thillainayagam**, the Author said that the object of the Paper was merely to focus attention on the importance of traffic engineering. The functions and duties of a traffic engineer enumerated by him were a useful addition.

Shri O. Muthachen had suggested that detailed design of the intersection of Parliament Street with Connaught Circus in New Delhi be prepared. Preliminary studies for this had been undertaken by the Central Road Research Institute and the design would, perhaps, be prepared in due course.

Shri E. A. Nadirshah (Chairman), winding up the discussion, said that the increasing hazards on the roads had focussed attention of the public on the complexity of traffic problem. Measures so far taken to combat the menace were insufficient. However, a beginning in this direction had been made in recent years in some cities. For example, in Bombay, a Traffic Advisory Committee, on which Municipality, Police, Automobile Associations, Road Transport and Life Assurance, Passenger, Tramway Company, etc., were represented, had been set up. The committee met regularly and discussed various problems of traffic engineering and road safety, traffic regulations, etc. As a result of these discussions, various improvements had been effected. Other cities should also take up the matter in right earnest.

It was essential that systematic and scientific study of various aspects of the traffic problem be made to evolve suitable designs. Measures to educate the road users and to enforce traffic laws must be undertaken. The establishment of Traffic Engineering Departments in cities and States to work in close liaison with Public Works Departments, Transport Ministries, Research Institutions and other organizations interested in road traffic and safety, would result in benefits to country as a whole.

He suggested that the Roads Wing of the Ministry of Transport, establish a Traffic Engineering Section.

He thanked the Author for the interesting Paper.

Discussion on Paper No. 188 *

"Light Suspension Bridges In Himachal Pradesh"

By

A. J. D'COSTA AND T. S. RUPAL

Tuesday, 10th January 1956

Shri Kishore Lal (Chairman) called upon Shri A. J. D'Costa to introduce the Paper.

Shri A. J. D'Costa (Joint Author), introducing the Paper, said that it was meant to focus attention on the practical aspects of light suspension bridges. During his tours of Himachal Pradesh, the existing suspension bridges in the region impressed him very much. They harmonised with the landscape very well and had beauty of line and proportion.

In the Paper suggestions about standards to be adopted for width of such bridges and the loadings for which they might be designed had been made. These were not to be taken as rigid and might be modified to suit local needs.

Light suspension bridges were quite suitable for hilly regions. The existing suspension bridges which had stood for the last 50 years could be strengthened and reconditioned to meet the present day traffic. When traffic developed permanent bridges to cater for heavier loads could be constructed.

A worked out example giving the design of a two-hinged suspension bridge of 200 ft span was given in Appendix 2 of the Paper. The example was for only one type of bridge.

Shri G. R. Nangea said that roads and bridges over rivers, which were many and difficult to bridge, were very essential for the development of Himachal Pradesh. In a hill State like Himachal Pradesh, roads were the only means of communication. Development really started in 1950. As work on roads progressed, the necessity for bridges across streams was felt even in the initial stages. Spans up to 50 ft presented no difficulty. For larger spans, a ropeway bridge of the type shown in Plate II of the Paper was the only temporary expedient possible. Such bridges enabled jeeps to cross rivers and thus helped in construction work.

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* Published at pages 359 to 413 of the Journal of the Indian Roads Congress, Vol. XX-3, December, 1955.

In the Himachal Pradesh, roads were generally aligned on the sunny banks of rivers so that they did not get blocked for long by snow in the winter. Villages were situated on both sides of the river. So, unless the stream was bridged, the villages on that side of the river other than the road were not benefitted. In such cases, light suspension bridges were necessary. He said that R. C. arch bridges for spans up to 200 ft or so were preferable in cases where rock was available for founding the abutments and supporting the centrings, but in cases where it was not possible to give supports to the bridge in the middle of the streams, either steel girder or stiffened suspension bridges were the only feasible alternatives. Carriage of girder components was a great handicap and suspension bridges naturally were preferable.

Referring to the standards proposed in Table 1 on page 372 of the Paper, Shri Nangea explained that those standards were adopted after very careful consideration of the developing needs of the traffic in the State.

Giving an account of the behaviour of the streams in the hilly tracts, Shri Nangea said that during the subsiding floods, huge deposits of boulders and even trees etc. got buried under shingle and sand. In the next flood, those deposits acted like embankment and piers of bridges were attacked by the raising currents. Sometimes the river outflanked the abutments and changed its course. He, therefore, suggested spans should be fixed liberally as was done in other European countries like Switzerland, Norway and Sweden.

In 1955, local cloud bursts in the Ravi valley caused huge landslides in the banks of the river. That resulted in the river getting temporarily blocked. So, there was unprecedented rise in the flood level and water touched the deck of the bridge at Chamba shown in Photo 3 of the Paper, even though the deck was 44 ft above low water level. The approaches to the bridge and part of one abutment were damaged. Also, the bridge at Rakh, shown in Photo 4, was washed away. Therefore, the minimum clearance recommended in the revised Bridge Code of the Indian Roads Congress was very much on the lower side so far as the streams in the Himalayan region were concerned. Therefore, in Himachal Pradesh, a free board of at least 10 ft for major rivers and rivers passing through narrow and deep valleys was necessary.

The roads were aligned about 20 ft above the height of flood level to safeguard the foundations of structures like the retaining walls.

When big landslides took place, huge trees got uprooted and thrown in the streams. Junks of rocks rolled down and were

carried along the steep beds of the torrential rivers. Therefore the observation about the difficulty of having intermediate piers in para. 2.4 on page 362 of the Paper was justified. Single span bridges were thus the most practical and economical in the long run even though at first sight the spans looked longer than necessary.

In addition to the reasons advanced by the Authors in para. 2.2 on page 361 of the Paper, in favour of the suspension bridges, there was another important economic consideration. At present the roads did not carry heavy loads and it would take some time, before traffic developed. Therefore, suspension bridges which could be strengthened easily, were perhaps the cheapest type of construction. The ropes and other components could be re-used at new sites.

Aerodynamic instability by oscillations of the structure, which caused torsional bending, were arguments against the use of suspension bridges. But in Himachal Pradesh, which was more or less surrounded on all sides by hills, bridges could easily be sited in a shielded spot not very much subjected to such forces.

Making a plea for the liberal use of suspension bridges, Shri Nangea said that in the U. S. A., Germany and many other countries suspension bridges were constructed over many major rivers. It was easier and economical to have the required head-room for navigation in suspension bridges than in any other type. In the foothill regions, suspension bridges were particularly economical as the foundations for the piers were very expensive and greater free-board to pass the extraordinary floods due to temporary blocking in the higher reaches was required.

Shri H. P. Mathrani, referring to Shri Nangea's comments on vertical clearances, explained that the clearances given in Clause 105 of the Indian Roads Congress Bridge Code were the minimum to be provided. Where it was felt that the clearances given in the Code were not adequate, it could always be increased to suit local conditions.

Shri A. J. D'Costa (Joint Author) hoped that the Paper which was the first of its kind presented to the Indian Roads Congress would evoke interest in the subject.

Shri Kishore Lal (Chairman) thanked the Authors for their Paper.

INDIAN ROADS CONGRESS

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New Features for the Merton Overloader

The improved Merton Overloader—the only British construction plant being exported to the U.S.A.

After two years of success in Britain and in the 22 countries to which it has been exported the British made Merton Overloader now has several important new features. As a result of this success Merton Overloaders are now being exported to the United States of America, Canada and parts of South America. The sole concessionaires in the United Kingdom and in the Americas are Mackay Industrial Equipment Ltd., of Faggs Road, Feltham, Middlesex, who tell us that this is the only British construction equipment now being exported to the U. S. A.

The bucket of the new Merton Overloader, Mark V, has a capacity of ¾ cu. yd. and covers the full width of the front wheels of the tractor. This eliminates any tendency for the front wheels to ride up on the material being loaded and also greatly increases the efficiency of the machine when excavating.

The digging depth of the bucket can be adjusted, simply by the removal and replacement of two bolts, to any position between 2 in. above ground level and 4 in. below ground level. The adjustment to 2 in. above the horizontal will simplify the operation of the machine when it is loading a stockpile on uneven ground when it is important that water or foreign matter from the base should not be mixed with the material being loaded.

The discharge height of the Merton Overloader is now variable. A small hand winch, operated by one man, raises and lowers the overhead structure of the machine by extending and retracting the telescopic rear upright members so that the bucket can be discharged at any height from a minimum of 6 ft. 11 in. to a maximum of 11 ft. 2 in. To change from minimum to maximum discharge heights takes only three minutes and entails the removal and replacement of only four bolts. The reach of the bucket, that is the distance from the inside edge of the bucket when in the discharge position to the rearmost part of the tractor (the tyres), is 3 ft. 6 in. when in the minimum discharge position and 2 ft. when in the maximum discharge position.

From the minimum discharge position the overhead structure can be lowered still further to the travelling position giving the machine an overall height of 8 ft. 5 in.

An enclosed cab is now a standard fitment on the Merton Overloader. It is constructed of heavy gauge sheet steel and fitted with toughened safety glass windows, which give the operator excellent all round vision. The turning radius of the Mark V Merton Overloader is the same as that of the Mark IV—17 ft. 6 in.

A light materials bucket of 1 cu. yd. capacity is available as an optional extra. Other optional equipments are a 6 ft. 9 in. bulldozer blade and a one ton capacity crane hook attachment.

The Merton Overloader of course, does not turn or slew, it shuttles backwards and forwards in a straight line between stockpile and lorry. The power unit is the Fordson Major diesel engine.

The complete cycle from loading the bucket to discharging and back to loading takes 15-20 sec., and during this time the machine can also travel backwards and forwards a distance of twelve yards. It is claimed that it can load blasted rock at the quarry face at the rate of one ton per minute or sand from a stockpile at the rate of 5 cu. yd. in 2½ minutes.