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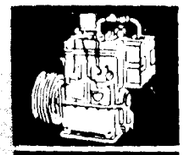
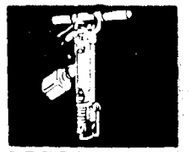
COMPRESSED AIR EQUIPMENT

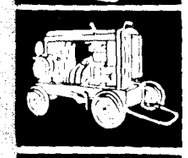
STATIONARY COMPRESSORS
Two Stage. Displacements from 80 c. ft./min. to 638 c. ft./min.



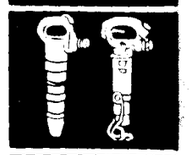
ROAD RIPPERS
Weights from 43 lbs. to 75 lbs.



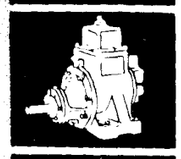
PORTABLE COMPRESSORS
Two Stage. Displacements from 130 c. ft./min. to 360 c. ft./min.



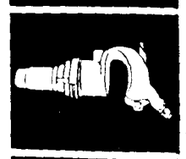
PICKS & SPADERS
Weights from 20 lbs. to 26½ lbs.



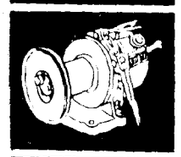
ROTOMOTORS
Vane type air-motors from 1½ b.h.p.



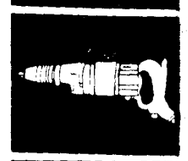
HAMMERS
Weights from 7¼ lbs. to 13¾ lbs.



AIRWINCHES
Lifting capacities from 1400 lbs. at 100 ft./min. to 3000 lbs. at 100 ft./min.



ROTODRILLS
Hand and screw-feed. Capacities to 1¼ ins.



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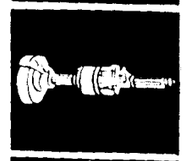
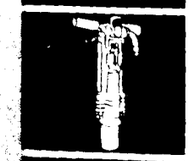
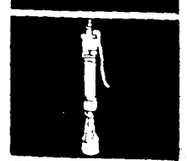


HANDRILLS
Hand-held Rock Drills. Weights from 24 lbs. to 84 lbs.



RAMMERS
Weights from 9 lbs. to 40 lbs.



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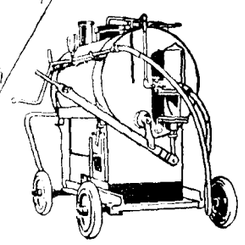

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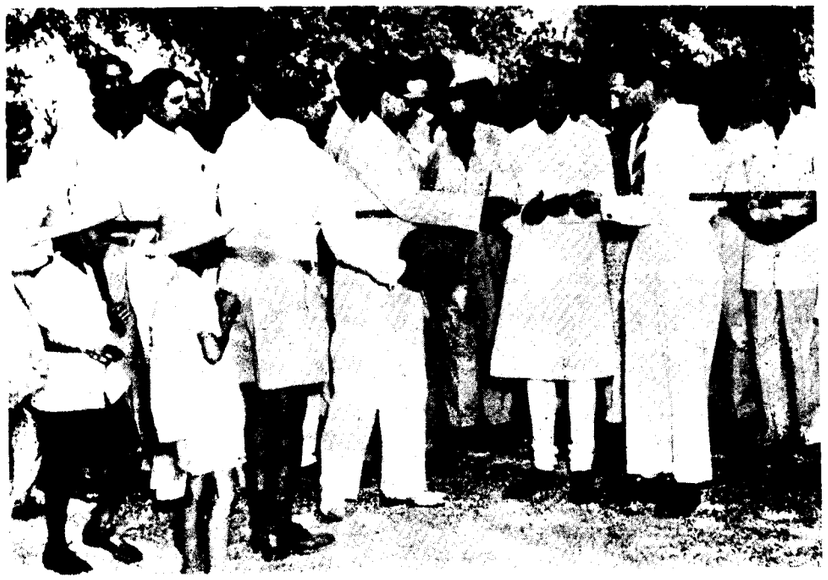
STG/8

TEST TRACK AT DELHI

DECLARING open a test track on the National Highway No. 2-Delhi-Mathura Road-near Okhla on 8th June, **Shri O. V. Alagesan**, Union Deputy Minister for Transport and Railways, stressed the need for road research in the country.

"Of all communications, road communication is the nearest to man. You have to add to human happiness and convenience. It is a truism to say that any branch of activity without its research portion is like man without brains.



Shri Alagesan performing the opening of the Test-track.

He said: "The importance of research in such a subject as roads cannot be exaggerated. And research, patient, painstaking earnest research, in any field, is all the more necessary for a poor country like India, where we have to see that no single pie is spent without the fullest justification, every single pie spent gets its fullest value and also that no single pie that should be spent is left unspent. Under such conditions, any money that research can save for us goes to go to a railway or a waterway or an airway, but the roadway comes to you. In fact, it takes you to the other three. The other communications may look strange, inspire awe and induce wonder. But, the road is simpler, more natural and more human. It is an elongation of our homes. You will understand this better when you remember that children are more often to be found on the road than inside the home.

"The other communications are useless without their respective means of communication. The road is not. Not even the bullock cart is necessary. The oldest and God-given means of communication, viz., the two legs, are enough to carry people on a road. If someone sits and calculates, he will find that at least in our country, the means of communication employed most to carry people and, shall I say, also goods, from one place to another, are the old and tireless, also perhaps tyreless, pair of legs. That is why people everywhere want a road first and then a school and then, perhaps, a hospital where all the three are absent."

Shri H. P. Mathrani, Consulting Engineer (Road Development) and Joint Secretary, Ministry of Transport, giving the background information leading to the present tests, said: "In preparing road projects we have constantly to aim at getting the best out of our money. This is done by improving our standards and specifications so that the cost of construction is lowered and the life of structure increased. These improvements are based on research – research inside the laboratory, followed by experiments on models and then by trials in the field.

"For field experiments it is essential to have a test track. The first test track in India was built in Calcutta in 1935. The Calcutta test track, about a furlong in length, was essentially designed to test the effects of bullock carts on road surface. Typical carts, driven by electrical motors, were used. The equipment was so designed as to produce all the peculiarities of motion characteristic of the vehicles actually in use on our roads. But, at best, such an arrangement was just a simulation of actual traffic conditions.

"In order to go a step further, it was felt that the best thing to do was to have a test track as part of a main road and close to the Central Road Research Institute so that experiments could be carried out under actual traffic conditions and close observation. The present test track is meant to fill that need.

"Large lengths of roads in India are unable to meet the needs and stand up to the strain of the present-day fast motor traffic. Thousands of miles of roads will have therefore to be upgraded. Any improvement in our technique of road building will, therefore, lead to economy as well as efficiency in service. This will have far-reaching effects on our programmes which are always seriously restricted by the funds we have.

"In 1940, experiments on surface dressing were first started at the Calcutta Test Track. The results obtained had, according to the advice of the Technical Committee of the Indian Roads Congress, to be tried in the field. Accordingly, experimental stretches were laid on the Agra-Bombay road, a little south of Agra. Analysis of the observations made on the Agra-Bombay road, gave important ideas and prompted us to continue the research further under better controlled field conditions so that a more economical specification could be evolved. This Test Track near the Road Research Institute at Delhi is meant for that research."

The Council of Scientific and Industrial Research was approached to permit the Director, Central Road Research Institute to conduct the experiment. The cost of diversion of the road and laying down the surfaces to be tested was met from the Central Road Fund.

Dr. Zipkes, Director of the Central Road Research Institute, requesting Shri O. V. Alagesan to open the Test Track said: "This Test Track is the first step of the Central Road Research Institute in field-scale research. On this track will be tested, under normal conditions, various forms of road construction. We have laid nine different forms of surface dressing on this piece of road and there is further scope of expansion of this work on the National Highway just beyond the track.

"To avoid inconvenience to public while the different surface treatments are being applied we have constructed a road diversion. Apart from using this as a mere diversion, it is proposed to utilise it for experiments on cheaper type road surfaces meant for rural roads."

"We also propose experimenting with different forms of road signals for directing traffic.

(Continued on page 5)

ENGINEERS AND MATHEMATICS

(Extracted from 'The Engineer'—March 20, 1953)

HOW important in reality is Mathematics to the majority of engineers? In academic life there can be no doubt about the answer, and, again, research workers in very many fields would be very severely hampered without high mathematical attainments. In design, too, though there are other even more desirable qualities, some of them as much artistic as scientific, the ability to use matematics is very desirable. But relatively few graduates become professors, research workers, or designers. Much larger numbers find their life's work in production and in maintenance and very many of them increasingly discover as they grow older that their problems are as much administrative as technical. Can it really be maintained that engineers in those great fields require so high a skill in the use of mathematics as university courses in engineering attempt to give them?

Fifty years and more ago engineers undergoing training in the works were expected to acquire a skill in the use of tools comparable with that of the men on the shop floor. Now-a-days, their practical training is designed to give them a wide appreciation of the many differing skills required in production and an understanding of what can and cannot be done by skilled work.

Mathematics cannot be applied until a problem has been properly formulated. When, for example, a crop of unexpected failure of some machine occurs, ability to calculate must wait upon the assessment by experienced engineers of the possible causes and upon the exercise of good judgment in deciding upon which to base the mathematical investigation. Moreover, should experiment be necessary, extraneous factors such as time available and estimated cost must influence the decision whether to proceed by "trial and error" methods designed to reveal a solution to the particular problem, or whether to start a fuller scale research intended to yield a "general" solution applicable over a much wider field. In fact, since problems can always be submitted if necessary, to those of high mathematical attainments, **it is more important that an engineer shall have good judgment and a critical mind than that he shall be skilled in mathematics.**

Heaven knows engineering would still be merely a skilled craft, not a profession, without the work of engineers with mathematical attainments. Research workers, without whose labours progress, confined to "trial and error" experiments, would become terribly slow, should not be undervalued. Rules of thumb are a help in trouble when, as often happens, no other reliable information is available. **But those who pride themselves too much upon being practical, express contempt for theorists and researchers, and continue to rely upon rules of thumb when modern research and mathematical theory have provided better answers, merely hold up progress.** What is suggested is that bulk of engineers have less need for actual skill in the use of mathematics, as opposed to appreciation of what can be done by mathematicians, than the academic suppose.

Those who have the aptitude for mathematics should be allowed—nay, actively encouraged!—to press on with its Study. But failure to make the grade into its higher reaches, we suggest, should be no bar to graduation as a trained professional engineer.

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ORGANISATION OF PLANT REPAIR AND MAINTENANCE IN AUSTRALIA

(Concluded from June 1953)

PLANNING OF PLANT REPAIRS

IN undertaking plant maintenance the following principles must be kept in mind :

Good Planning is essential to :

(a) effect minor repairs as soon as required and thus maintain the plant in good condition with resultant high work output and also ensure that unnecessary damage to other parts will not result in breakdown involving major repairs, lengthy job interruptions and the unnecessary supply of valuable and scarce parts and absorption of fitter man-hours ;

(b) permit periodical major repairs at the central workshop to fit in with road works programmes so that major breakdowns in the field are kept to the minimum and valuable field fitter man-hours are conserved for the important work of preventive maintenance and minor repairs ;

(c) reduce time taken for minor and major repairs to obtain the maximum output from the plant fleet which represents a large capital investment.

Good planning can be obtained by :

(a) plant operators reporting noticeable loss of plant efficiency and wear so that action can be taken to obtain parts and make a fitter available to undertake repairs speedily to suit the road work organisation;

(b) plant operators faithfully observing the requirements of the service charts in regard to lubrication, maintenance and adjustments so that normal operating periods are obtained from the plant before major attention is required ;

(c) supervision of plant operators in regard to (a) and (b) by road gangers, foreman and engineers, assisted by inspectors and engineers from the plant section ;

(d) periodic assessment of the number of fitter man-hours required to effect the repairs to all items of plant engaged on each road job and the transfer of plant items involving major repairs to central workshop, if the departmental fitters and private enterprise facilities available locally are unable to effect repairs within a reasonable time ;

(e) the early examination of seasonal-use plant at the end of the season to determine repair work required, obtain required spare parts and have the work undertaken so that all items can be put to use at the start of the next season ;

(f) close watch on issue of spare parts from the Local Office store to determine usage rates and ensure that adequate stocks of fast moving parts are available when required ;

(g) maintaining at central workshop store a record of all spare parts used for the maintenance and repair of all items in the department's plant fleet so that parts can be supplied from stock to any part of the State within 24 hours ;

(h) holding in stock at central workshop reconditioned unit assemblies available for replacement of similar assemblies on plant operating in the field, the old assemblies being returned to central workshop for reconditioning and re-issue as required. This is being done for parts, such as—diesel fuel injectors, super-chargers for diesel engines, crawler track assemblies, magnetos etc. This procedure results in saving of field fitter man-hours and a large expenditure on expensive tools which would otherwise require distribution throughout the State ;

(i) maintaining a record of hours worked since the last major overhaul by each major item of plant, in the plant section at head office, thus permitting the recalling of plant for major overhauls at central workshop before major troubles are experienced in the field. This record will also assist in deciding whether plant broken down in the field should be repaired in the field, if the hours worked are such that early trouble can be expected with numerous other parts of the machine ; and

(j) determining order of undertaking plant repairs to suit road works and then permitting repairs being undertaken without interruption. Frequent interruption to repairs not only increases the cost of individual repairs but results in a serious decrease in the number of units it is possible to recondition with the present day limited facilities.

The experience of the department shows that, under present day conditions, the proper care and maintenance of plant is difficult to obtain even with adequate workshop facilities unless constant attention is given by all concerned to the points essential for good planning of repairs.

In a fewcases where the department has supplied workshop equipment on a scale similar to travelling and mobile workshops it has been found that the cost charges, expressed as a percentage of fitters wages, have been excessive due to the unavailability of sufficient fitters to work under field conditions. A close watch is kept on this aspect and it is unlikely that many additional workshops will be supplied with facilities to the same extent as major workshops. It is considered that the trend will be to supply field workshop facilities in the form of a 3–4 ton lorry, containing shear legs, 3-ton chain block, hydraulic jacks, fitter's bench, large offset vice, hand operated emery wheel, oxy-acetylene welding set, stocks and dies, reamers, taps, socket wrenches, ring spanners, set spanners, breast drill and other small fitters tools. In some areas a light weight electric arc-welding set and a light caravan for the fitter and fitter's assistant may be justified.

The supply of facilities on these lines will decrease capital outlay and increase mobility. It will however decrease the extent of repairs which can be effected in the field and necessitate the more frequent return of plant to central workshop for major repair.

(Extracted from ' Main Roads,' June, 1952.)

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Continued from page 2)

" The planning of the Test Tracks, arranging of funds and execution have taken approximately two years from the inception of the idea. This is not too long a time for the work of this nature.

" The Central Road Research Institute has been built in remarkably short time particularly due to the personal drive of the Director of the Council of Scientific and Industrial Research—Dr. S. S. Bhatnagar and the addition of this track will materially add to its usefulness.

" I assure you of a successful completion of this long-range research and hope that the results will help efficient and economical construction and maintenance of this type of road surface. "

ONE HUNDRED YEARS OF RAILWAYS IN INDIA 1853-1953

PRE-RAILWAY AGE

In the pre-railway age in India, journeys were both arduous and risky. Much of the road communications built in the earlier days by the Mughals and Maharattas had, with the passage of time and through neglect, gone into disrepair. The East India Company were pre-occupied with their own problems of advancement, and so had little time to improve road links connecting the various parts of the country.

Villages, though self-contained units then, lay far apart. They had little or no access to each other. Nor were they knit together by any common bonds of trade or commerce.

It has been recorded that the cotton of Nagpur and Amraoti was transported to Mirzapore, 500 miles away, by oxen. Each animal carried bales of 160 lbs. and travelled at the most seven miles a day. The transport of cotton in this way cost about Rs 200 per ton.

The first idea of rail-road came from the Province of Madras in 1831–32. The line contemplated was one 150 miles along the embankment of the Cauvery river, from Cauverypatnam to Karoor at an estimated cost of Rs 8,000 per mile. The scheme was for laying parallel rails along the road and the vehicles were to be drawn by animals.

More definite railway projects came between 1844–49, culminating four years later in the Bombay-Thana line on which the first train in India ran a hundred years ago.

From small beginning, railway construction has developed steadily, radiating inland from the principal ports and connecting most of the important centres in the country reaching its present route milage of about 34,120.

EXPERIMENTAL LINES

The success which attended the early development of railways in Great Britain showed clearly the many advantages to be derived from the new form of transport in a country of considerable distances, politically unconsolidated, and requiring large-scale movement of troops and military stores. Therefore, contracts for the construction of short experimental lines were entered into with the East Indian Railway Company for a line from Howrah to Raniganj (120 miles), with the Great Indian Peninsula Railway Company for a line from Bombay to Kalyan (33 miles), and with the Madras Railway Company for a line from Madras to Arkonam (39 miles).

AMBITIOUS CONSTRUCTION PROGRAMME

Encouraged by the popularity of railways in the west Lord Dalhousie, who was then the Governor-General, urged the importance of a speedy and wide introduction of rail communications throughout India, pointing out the great social, political and commercial advantages of constructing railways between the chief cities, and recommended, in the first instance, a system of trunk lines, connecting the hinterland of the Bombay, Bengal and Madras Presidencies with their respective principal ports and with each other. The trunk lines suggested were a line from Calcutta to Lahore ; a line from Bombay to North India to meet the Calcutta to Lahore line at some point ; a line connecting Bombay and Madras ; and a line from Madras to the Malabar Coast.

The lines proposed by Lord Dalhousie were accepted by the Court of Directors and by the end of 1859 eight railway companies had been formed with a guaranteed

capital of £52½ million sterling for the construction of nearly 5,000 miles of lines. These eight companies were : (1) the East Indian, (2) Great Indian Peninsula, (3) Madras, (4) Bombay, Baroda and Central India, (5) Eastern Bengal, (6) Indian Branch, later the Oudh and Rohilkund, (7) Sind, Punjab and Delhi, later merged in the North Western State Railway, and (8) The Great Southern of India, later the South Indian Railway.

Almost from the very commencement, Government retained certain general powers of control and regulations within the limits of which the companies were allowed sufficient latitude to construct and manage their undertakings.

It was also laid down that the mails and postal servants were to be carried free of charge. Another condition was that after 99 years, the land and works of the railways were to become the property of the Government, the rolling stock and other movable property being paid for at a fair value. The Government also retained the option of purchasing the lines within six months after the first 50 years.

FIRST PHASE 1849–1869.

During the period the original guaranteed railway companies proceeded with the construction of the main trunk lines. All the original applicants for concessions for the promotion of railways demanded that a minimum return should be guaranteed by the Government on their capital. As companies could not then be promoted without this condition a guarantee of 5 per cent interest coupled with the free grant of all land needed for railway purposes was agreed to. In return, the companies were required to share the surplus profits half yearly with Government, after the guaranteed interest for the half year had been met, the rate of exchange for the remittance of interest charges being reckoned at 22*d.* to the rupee and to sell the railways to the Government, after 25 years, on the basis of specified rates. The companies have also required to permit the Government to exercise control over all expenditure and over the management and working of the lines. The guaranteed rate of interest was high and later experience showed that these conditions assisted little towards either the rapid development of the lines or in economy in the cost of their construction. These conditions may have proved beneficial to the country if the guaranteed interest had been earned. But expectations in regard to profits remained unfulfilled by the high costs of the construction of the new lines.

The increases in the costs of building these lines were attributed to a number of factors. One was that the standard of construction was far higher than required for the general conditions prevailing in the country or for the actual functions which the railways were designed to perform. Many conveniences were provided which, though desirable in themselves, were not essential for the efficient operation of the railways. Some experimental lines were built with double track, the necessity for which did not arise till some generations later. Increases in the costs of construction were also caused by alterations in the alignments, after work had actually commenced. Also the political and military upheaval of 1857 aggravated the position by causing suspension of all work for a time. Consequently, earnings which might have been sufficient to pay interest charges on well controlled and reasonable expenditure proved quite inadequate to meet the guarantee on the heavy outlays actually incurred and Government had to make good the deficits.

By the end of 1859, the eight companies referred to earlier had an authorised capital of £34.13 million of which £27.08 million were actually raised. The amount of guarantee paid by Government to the companies by January 1, 1860, amounted to £3.84 million. The earnings of the railways during this period amounted merely to a little over half a million pounds. During the early 1860s there arose further difficulties. One was the inability of the companies themselves to raise further capital, as a result of which they had to apply for Government aid in the shape of advances. The companies to whom such advances were made were charged interest at 5 per cent and the Government shared in the undertaking in proportion to the amount of such advances.

A further complication arose in consequence of the appreciation in value of the rupee. When the agreements were

made, the rate of exchange for the rupee was 1s. 10 d. and it was stipulated in all the contracts that the rupee should, in the accounts between the Government and companies, be converted into sterling at that rate. When the value of the rupee rose to 2 s. the Government spent in India the equivalent of 2 s. for every 1s. 10 d. paid into the Government's account in England for the expenditure in India. The loss on this account during 1862–3 alone was about £2.4 million. Out of the £ 13.16 million paid by Government during the 14 years 1853–67 to the companies towards guaranteed interest, only £ 3.3 million was paid back out of the earnings of the railways. The annual charge upon the Government under this head had increased in 1865 to well above £ 2.70 million taking into account both the guaranteed interest and losses by exchange operations.

SECOND PHASE— CONSTRUCTION OF RAILWAYS BY GOVERNMENT, 1869-79

Reviewing the first twenty years of railway development in India, Lord Lawrence, who was Governor-General in 1869, wrote: "The whole profit goes to the companies and the whole loss to Government". He concluded by recording a very decided opinion to the effect that the direct agency of Government would be more economical than that of the railway companies and that there would, almost certainly, be advantages to the State financially and, therefore, to the community of India at large, if the Government were to construct railways through its own engineers with money directly borrowed from the market for the purpose.

Approval was accorded to the discontinuance of the guarantee system and to the use of State agencies for new constructions. The Government accordingly undertook a number of new constructions, e.g., the Indus Valley and the Rajputana Railways. It was also decided by the Secretary of State, in spite of strong protests from the Indian Government, to waive the right to purchase the Great Indian Peninsula, the Madras and the Bombay Baroda and Central India Railways, on the expiry of the first twenty five years of their leases.

INTRODUCTION OF METRE GAUGE RAILWAYS

The system of trunk lines proposed by Lord Dalhousie was completed by 1871 and 5,051 miles of Railways, out of an approved total of 7,482 miles, had already been opened. An important decision affecting a change in uniformity of gauge was taken at the instance of Lord Lawrence, who considered that it was more important to extend the benefits of rail communication, even if it involved a break of gauge, than to standardise the broad gauge (5′–6″) throughout India. The cost of construction of broad gauge lines averaged about £17,000 a mile at the time whereas that of a metre gauge was about £10,000 only per mile. It was, therefore, decided that Government should build railways on the metre gauge in order to cover a greater territory. Also by 1875 the allotment for railways was increased, but the Afghan war and recurring famines reduced the funds. The limited ways and means position of Government made it necessary, after 1881, to turn again to companies for the construction of railways under some form of guarantees. The new guarantee system, however, differed from the old one and the lines promoted under the new system were termed "State Railway lines worked by companies". The main differences between the new and the old guarantee terms were that the rate of guaranteed interest was lower and that the terms generally were easier for the Government. The new railway lines promoted were the Indian Midland (1882–3), later merged in the G.I.P., the Bengal Nagpur (1883–7), the Southern Maharatta (1882) and the Assam Bengal (1891) Railways.

The famines of the 1870s in the province of Bihar and the Deccan Peninsula stressed the need for more rapid extensions of railways and a portion of the special Famine Insurance Grant was diverted for expenditure on new lines of a productive nature. In 1883, under the advice of a Parliamentary Committee, the limit of borrowing was increased from Rs 2 crores to Rs 3½ crores annually, of which Rs 3 crores were assigned wholly to railways. In 1888 some funds had to be diverted for

the construction of the costly strategic and unremunerative lines on the North West Frontier but in 1890 the whole available balance of the Famine Insurance Grant was devoted to railway construction. Despite the raising of the limit of capital expenditure, and of the rebate terms in 1893, progress was not considered satisfactory and the terms were revised again in 1896, the companies now being offered either an absolute guarantee of 3 per cent, with a share of surplus profits, or a rebate up to the full extent of the main lines' net earnings to supplement their own net earnings, the total being limited to 3½ per cent on the capital outlay.

The progress of railway development during the last century is summarised briefly in Table I.

to it were transferred control of all matters pertaining to railways in India.

DEVELOPMENTS, 1900—1914

During this period, the annual losses on railway account had disappeared and the gain to the State from its railway investment had become a regular feature. The views that even a total route milage of 100,000 miles "was short of that which will ultimately be found to be necessary in India," and "the steady and even rapid development of the railway system of India should be regarded by Government as one of its important duties," were expressed. New railway constructions, however, continued to progress at a modest rate and during the period 1900-14 only about 10,000 route miles were added.

TABLE I

Progress of Railway Development during the 19th Century

ALL RAILWAYS (In thousands of rupees)

Year	Route mileage	Capital outlay	Gross earnings	Working expenses	Net earnings
1853 ...	20	37,96	90	41	49
1860 ...	838	26,66,00	66,67	37,08	29,59
1870 ...	4,771	90,00,50	6,66,67	3,66,15	3,03,52
1880 ...	8,996	1,28,56,91	12,86,55	6,48,00	6,38,55
1890 ...	16,404	2,13,67,04	20,67,01	10,30,89	10,36,12
1900 ...	24,752	3,29,53,34	31,54,32	15,09,31	16,45,01

The net losses to Government as a result of payment of guaranteed interest to the railway companies, after deducting the amounts recovered from the net receipts, totalled about £ 51½ million.

THE FORMATION OF THE RAILWAY BOARD

In October 1901, a special commissioner for indian railways, Sir Thomas Robertson, was appointed to enquire into and report on the general administration and working of indian railways. As a result of his studies and recommendations, the Central organisation for Government control of indian railways was first formed in 1874 as a state Railway Directorate. In 1905, the Railway Board was set up and

WORLD WAR I

Indian railways contributed appreciably to World War I by diverting much of their resources to meet military requirements. At the end of the war, the rail transport situation in India had become grave and all interests concerned with agriculture: trade and industry were unanimous in demanding drastic and emergent steps to rehabilitate the Indian railway system to meet the economic requirements of the country.

The contract with the East Indian Railway Company was due to expire in 1919. Public opinion had consistently declared its preference for State management and was not satisfied with railways in India being managed by british companies with

Boards of Directors in London. It was held that Government management would result in more positive and earlier measures favourable towards indigenous industrial development than a continuation of company management with a natural bias towards vested interests and good dividends for shareholders. Also, procurement of railway stores afforded a valuable opportunity for encouraging domestic industry by giving it a degree of preference. It was felt that company-managed railways, with Boards of Directors in England, could not be expected to respond to such policies, whereas State management would be more sympathetic towards economic advancements in the country. Table II shows the results of the working of Indian Railways from 1901 to 1923-24.

The Acworth Committee's recommendations were accepted by the Government, and railway finance was separated from the general finance of the country. The Railway Board was reorganised, with a Chief Commissioner and a financial Commissioner, besides technical Members. The technical Directorates were also reinforced and expanded. As regards the policy of State management, the Government was already operating three railways systems, viz. the North Western, the Oudh and Rohilkund, and the Eastern Bengal Railways, and on the 1st of January, 1925, the East Indian Railway Company was taken over by the State and merged with the Oudh and Rohilkund Railway. On the 1st of May 1925, the contract with the Great Indian Peninsula Railway Company expired and this line was also taken under

TABLE II

Indian Railway 1901-24

(In thousands of rupees)

Year	Route mileage	Capital outlay	Gross earnings	Working expenses	Net earnings
1901 ...	25,332	3,39,16,89	33,60,38	15,72,45	17,87,93
1910 ...	32,099	4,30,04,73	51,14,22	27,15,72	23,98,50
1919-20 ...	36,735	5,66,37,77	39,15,32	50.65,65	38,49,67
1923-24 ...	38,039	7,17,93,02	1,07,79,66	68,44,77	39,34,89

TOWARDS STATE MANAGEMENT

A Committee was set up in 1920 with Sir William Acworth as Chairman, to undertake a comprehensive enquiry into questions relating to the management, finance and the future control and organization of railways. The Committee, by a majority, recommended the termination of the contracts with the companies as they fall due. The financial policy of the Government of India, which made no provision for either reserve or for ensuring a steady flow of funds for financing railway construction, improvements, etc., came in for severe criticism and the Committee recommended the separation of the Railway Budget from the General Budget of the country. The need for making adequate provision for depreciation and limiting the demands of the State on railway surpluses was also emphasised.

State management. In 1929, the Burma Railway was taken over by the State and thus five major systems were operated under direct State management by 1929-30.

INDIAN RAILWAYS 1924-37

The first six years after the adoption of the convention instituting a separate budget for Railways witnessed the introduction of a series of other far-reaching charges in finance and organization, such as setting up of depreciation fund, overhaul of administration setup, modernisation of the permanant way, electrification etc.

Railway revenues were also high and after meeting operating expenses and appropriation to depreciation fund, a handsome surplus was left to meet the contribution to the general revenues of Government and to build up a reserve

fund. The financial results of Indian State-owned Railways during 1924-30 are summarized in Table III.

TABLE III

FINANCIAL RESULTS OF INDIAN STATE-OWNED RAILWAYS, 1924-30

(In Lakhs of rupees)

Gross traffic receipts	...	1,01,22
Operating expenses	...	53,40
Depreciation fund	...	11,31
Net traffic receipts	...	36,51
Net miscellaneous receipts	...	80
Net revenue	...	35,71
Interest charges	...	26,94
Surplus	...	8,77
Contribution to central revenues		5,98
Railway reserve fund	...	2,79

THE SLUMP OF THE 1930s.

The years of prosperity came to an unexpected and abrupt end with the world wide slump which commenced in 1931. It was only in 1937-38 that the situation improved slightly. The financial position of Indian Railways during this period of depression is shown in Table IV.

TABLE IV

FINANCIAL RESULTS OF INDIAN STATE-OWNED RAILWAYS, 1930-37

(In Lakhs of rupees)

Gross traffic receipts	...	89,88
Operating expenses	...	50,52
Depreciation fund	...	13,43
Net traffic receipts	...	25,93
Net miscellaneous receipts	...	48
Net revenue	...	26,41
Interest charges	...	32,18
Surplus	...	5,77
Contribution to general revenues		82
Railway reserve fund	...	2,27

WORLD WAR II

It required the traffic demands of World War II to bring prosperity back to Indian Railways and increased earnings commenced from 1939-40 resulting in surpluses which more than made up for the loans previously taken from the depreciation fund to meet deficit in the thirties and pay off the contributions then suspended. During the first phase of the war, Indian Railways were called upon, despite their accumulated deficiencies and difficulties, to release locomotives, wagons and track materials for the Middle East, the defence responsibility of which had been allotted to the Indian command. Over 8 per cent of metre gauge locomotives and 15 per cent of meter gauge wagons of Indian Railways as well as 4,000 miles of track and 4 million sleepers were released for use for military purposes. This necessitated the dismantling of 26 branch lines as well as curtailment of services on many others. Later, India had become the base for a major offensive against Japan and the load on railways increased still further.

During the war years the Assam Bengal, the Oudh and Tirhut, the Bombay, Baroda and Central India, the Madras and Southern Mahratta, the Bengal Nagpur and the South Indian Railways were all acquired and transferred to State Government.

In dealing with the post-war problems of large-scale rehabilitation it has been necessary to keep in view the enormous increases in the volume of traffic, shown in Table V.

TABLE V

VOLUME OF TRAFFIC HANDLED

(In millions)

	1938-39	1942-50
Passengers carried	372	1,081
Freight tons carried	86	105
Passenger miles	12,589	32,844
Freight ton miles	17,047	23,144

The Volume of passenger traffic had increased more than two and a half times. Goods traffic had also gone up substantially.

A large number of locomotives, coaching vehicles and wagons were overage and obsolete. The track had deteriorated to dangerous levels which demanded severe speed restrictions. Partition had also affected the pattern of traffic and the loss of the port of Karachi added to the burden on the Bombay-Delhi route, necessitating augmentation of line capacity, increase of yard capacity and facilities, and readjustment of many other essential operational arrangements.

DEVELOPMENT SINCE 1947-48

The power position called for urgent attention and was tackled first. As a result of special steps large orders were placed with early delivery dates for locomotives, and the timely arrival of these brought about a noticeable improvement. Simultaneously it was decided to set up in the country a modern locomotive manufacturing industry for Indian Railways and the new factory at Chittaranjan designed for an output of 120 engines per annum was completed within two years and has already produced its first 50 engines. The Tata Engineering and Locomotive company, a private company in which Government has shares, is also producing boilers and locomotives now.

Some progress in providing additional carriages has already been made by railway workshops and the resources of the Hindustan Aircraft Factory at Bangalore have also been partially utilized for the purpose of producing more coaching vehicles.

A new system of rates and fares, planned on comprehensive lines, was brought into force in 1948. The four main features of the new system are: firstly, the highly individualisic character of some rates was radically modified and a telescopic bias was imparted to class rates – a reform long pressed for by the commercial community. Secondly, the difference between the rates on railway risk and owner's risk conditions was rather wide under the previous classification and was now narrowed down to about the difference between two successive classes. Thirdly, the large number of special rates was considerably reduced and, fourthly, the terminal charges were standardised throughout the country.

In 1949, design and consultant wings were formed from the engineering cadres of railways in India to replace the well-known firms of british consulting Engineers, who had provided technical guidance for the past three-quarters of a century.

REVISION OF THE CONVENTION

Another important change was the revision in 1949 of the Convention separating the Railway Finance from General Finance. According to the Revised Convention of 1949, the general taxpayer was accorded the status of the sole shareholder in the railway undertaking with a guaranteed dividend of 4 per cent on the loan capital invested as computed annually. The contribution to the depreciation reserve fund was raised to a minimum of Rs 15 crores a year to enable increased appropriations being made to allow for the high costs of replacement at postwar levels of prices. The financial limit for charging to revenue the cost of minor additions and improvements was raised from Rs 10,000 to Rs 25,000 for each individual item. A special provision was also made to cover expenditure on unremunerative projects for improving operational efficiency in excess of Rs 3 lakhs, such costs being charged to a Railway Development Fund intended to finance passenger amenities, staff welfare works and projects which were necessary but financially unremunerative at the time of construction. Finally, the scope of the reserve fund was limited to securing payment of prescribed dividends and to bridging the budgetary gap, should any occur during the currency of the Convention. The convention was to operate for a period of five years. The revised convention is obviously an advance on the original convention and provides deterrents to any tendency towards overcapitalization.

REGROUPING OF RAILWAYS

The regrouping of Indian Railways on a rational and geographical basis, which had been the subject of consideration for nearly a quarter century, had by 1949 reached a stage where it could no longer be postponed. Also the Federal Financial Integration of the Indian States had been

completed then and by April 1, 1950, the railways belonging to these States, varying from the 4 miles route mileage of the Sangli State to the 1,400 miles of Hyderabad State, had become parts of the Indian Government Railway system.

In April 1952 the regrouping was complete. The route mileages of the 6 zones are indicated below.

TABLE VI

ROUTE MILEAGE

	RAILWAY		ROUTE MILEAGE
1.	Southern	...	6,017
2.	Central	...	5,428
3.	Western	...	5,631
4.	Northern	...	6,007
5.	North Eastern	...	4,787
6.	Eastern	...	5,667

REHABILITATION PROGRAMMES AND FUTURE EXPANSIONS

During recent years the Assam Rail Link and the connection from Deesa to the new port of Kandla, each about 180 miles in length but traversing widely differing country, have been the only new lines that could be undertaken. Most of the lines dismantled during the war are being restored, however, and many new constructions are being considered to provide the additional carrying capacity that the Five Year National Development Plan demands. Major projects selected for construction during the next three years include a rail-road bridge across the Gangar in Bihar, expected to consist of nine spans of 600 ft each, new lines and doublings for expansions in the steel, coal and cement industries, a 200 mile connection between the northern and southern metre gauge systems, electrifications of certain steam-traction sections, many works to increase line capacity of intensively worked lengths and new railway factories for producing in India a number of railway components that are still imported.

CONCLUSION

It can legitimately be claimed that Indian Railways present on the whole a progressive and commendable record. Their close association with the State has not impaired the observance of commercial principles of working which are so necessary to maintain efficiency, while the public utility aspect of their functions has been steadily kept to the fore. The efforts made in recent years to improve the stadards of amenities and comfort for third class passengars deserve special mention. Financially also, the position of Indian railways has remained essentially sound, and the large balances accumulated in their reserve funds have been of substantial help to the country.

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FIRST PRIORITY.

After a tour of India's north-eastern border **Shri Jawaharlal Nehru** *said in a press conference at Delhi on the 2nd November 1952:*

The tribal folk are a very fine lot, very attractive, hard working and intelligent. What they want is,

first of all, communications.
secondly, schools.
and thirdly hospitals and dispensaries.

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ENGINEER - CONTRACTOR RELATIONSHIP IN THE UNITED STATES

(Extracted from 'Roads and Road Construction,' September, 1952.)

THE American engineer-contractor relationship is essentially one of co-operation in the execution of a project in which both are interested ; one to secure a good job at the lowest cost, the other to make a profit and build up a relationship which will ensure access to further profitable activities. These points of view are, in American opinion, identical and not opposed.

The Americans believe that without the keen, competitive spirit, the ever-alert ingenuity, and the unflagging energy brought to the task by thousands of independent contractors the highway system could not have been brought to its present state. In highway matters, the conviction does not arise from any abstract ideological principle, or unrealistic dogma, but is based on experiment and fact. In the United States, as elsewhere, the proposal has been repeatedly advanced that State or Government might well "save" the contractor's profit by doing the work with their own forces, on the assumption that they are equally diligent and competent, equally cost conscious, and enjoy equal status in the management of labour.

To settle this point, a comprehensive experiment was carried out in 1934 in which the two methods were compared. In several States throughout the Union, a representative series of projects were chosen for comparative test. The projects so selected were put out to tender in the usual way, in order to establish the costs and unit prices which would have obtained if the work were to be carried out by contract. All the tenders were then rejected and, with the co-operation and supervision of Federal Highway engineers, the work was carried out by direct labour by the highway department concerned. In spite of the initial stimulus offered in this competitive venture, and the fact that the competing highway departments had the contractor's prices as a target figure, "the final result of this experiment showed conclusively that contract construction of these projects would have been more economical".

In terms of principle, these results may be affected by many other considerations, some of them intangible or incapable of solution in this manner, but, these arguments apart, it will be seen that the American belief in the value of the contract system does not rest entirely on ideological principles, or on harmony with any particular political ideal, but is based on the result of factual investigation.

The American view of the basis of contracts is fundamental and revealing. "The features of ingenuity and effort do not stop with the contractor himself but prevail on down through his organisation. The superintendent or foreman knows that he will be suitably rewarded for that last extra bit of effort and thought that pays off so handsomely in contract work. (Here again the profit motive appears again in a very personal and intimate way). The same man working for a Governmental agency, would soon recognise that this last bit of effort will go unrecognised and unrewarded. The Governmental agency, by its very impersonal nature, is compelled to adhere to a rigid and inflexible salary scale, whereas the contractor is not hedged about with similar restrictions. Under the free-enterprise system the labourer knows that by acquiring and using properly the experience he may gain in his work, he may prosper and advance even to becoming a contractor himself. Therefore, if he is an ambitious man he will apply all his thoughts and energies to the job in hand". These are the views of an eminent federal engineer, with

great experience of the matters of which he writes.

Qualifications of Contractors

It is customary to require a contractor to submit proof of his competence to carry out the work, in respect of financial ability, equipment and labour forces, and contracting experience. The last is regarded as being of particular importance and the first two flowing normally from it. The proving procedure is carried out either by pre-qualification or post-qualification. In the first, every prospective contractor is required to submit a periodical statement of qualification, either annually, or half yearly, and his ability to carry out work, is evaluated from it. The contractor is then allowed only to submit tenders for work for which he is considered to be qualified. In post-qualification, tenders are free and the contractor submits his statement of competence with his bid. Pre-qualification is generally preferred on the grounds that it is easier to deny a pro-posal to an unqualified contractor than to exclude an otherwise favourable tender on the grounds that the contractor is not competent to carry out the work. Once qualification has been established the contract goes to the lowest tenderer, unless there are compelling reasons to the contrary.

Where Federal roads are concerned the Federal Government reserves the right to accept or reject either contract procedure or contractor. Contract documents usually require the submission of a guarantee with the tender, the sum being either a fixed amount or a proportion, usually 5 per cent of the tender sum.

Time

The time element as affecting due performance, is also strictly controlled. The time within which the contract is to be completed is specifically stated on the contract documents, usually in terms of days, and delays are penalised in specified amounts. Strict control is maintained during the work and the contractor must apply to the superintending engineer for extensions as required within very close limits as the work proceeds.

The Contractor has initiative within limits

It is not uncommon and quite inaccurate criticism of the American contracting system to say that once the work has begun the initiative passes completely to the contractor and the engineer has little say in its control. This criticism completely misconceives the American point of view. " Within certain prescribed limits the contractor is free to develop such methods for doing the work as may be suggested by his experience and ingenuity. It is true that most specifications are quite detailed as to methods to be followed in performing the work. Much of this detail is necessary in order to ensure that the quality of the work is satisfactory. By their very nature many highway construction features are not susceptible to exact evaluation of results and only by proper control of methods and details can successful work be assured. It is for example customary to specify properties within a loose range of grading and binder content ranges, and then allow the contractor to exercise his function by devising a job mix, of materials from approved sources, within the ranges which satisfies those properties. This, after having been established in collaboration with the superintending engineer, is then very closely watched and maintained.

Control of Progress

In addition to satisfying specification requirements in this way the contractor is required before beginning the work, to file with the engineer a plan of operations, and a proposed progress chart, and to obtain his approval thereto. These requirements assure a thorough study of the operations involved and enable a watch to be kept on progress.

Minimum Wage

Under the terms of the Davis-Bacon Act, which became law in the early 1930s the specification for any Federal work estimated to cost more than 2,000 dollars which is to be let by contract must contan a schedule of minimum wage rates tobe paid to labourers and tradesmen employed on the project ; these rates being determined by the Secretary of Labour, having regard to prevailing wage rates on

similiar work in the vicinity. The Fair Labour Standards Act passed by Congress in 1938, fixed a minimum wage rate of 0.25 dollars an hour, which was subsequently raised successively to 0.30 dollars then to 0.40 dollars and in 1949 to 0.75 dollars an hour. The act also provides for payment of overtime rates at not less than one and a half times the standard rates after 44 hours, later reduced to 40 hours work in any week.

Compensation to Workmen

Compensation for injuries sustained while at work originally rested on the "assumption of risk" basis, under which it was argued that the employer owed the employee nothing beyond the privilege of working, but gradually the theory began to develop that industry and commerce should bear the cost of accidents, including the loss to the employee, whatever the cause of the accident.

Various legislative enactments exist in this regard and it is merely necessary for the employee to establish that he was injured in the course of his employment for him to receive the statutory benefits. These benefits are usually computed on the basis of the employee's weekly wage. In the case of death or permanent total disability payments of up to 5.30 dollars a week may be made to the surviving widow or children for periods up to 600 weeks, surviving children being usually eligible for benefits up to the age of 18. In the event of permanent, partial, or temporary total disablement compensation is payable according to prescribed schedules.

There is room for thought in the fact that a system at once so generous and so free should be so successful in these matters, the affairs of highway engineering merely reflect in microcosm those of the nation in general. The accent throughout is insistance on the quality of the results whilst allowing free enterprise room to function. Close control of results, without any opportunity of burking responsibility by the engineering staff, a responsibility underlined by the fact that there will be no subsequent opportunity to penalize the contractor, has undoubtedly played a large part. The American engineer would attribute an equally large part to the operation of the free enterprise system and to the competition, effort, ingenuity and flexibility which it engenders.

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HIGHWAY GAMBLERS

Many drivers would be offended if they were told they were gamblers, says the California State Automobile Association. Yet the chances they take in traffic are clear examples of betting with their lives for a slight advantage. It doesn't pay to take chances in the traffic game where life or death may be at stake. Take it easy and live longer.

(*Extracted from "California Highways and Public Works" January—February 1953*).

HERE AND THERE

1. THE ROAD RESEARCH COMMITTEE

THE Hon'ble Vice-President of the Council of Scientific and Industrial Research has been pleased to constitute a Road Research Committee, with effect from April 1, 1953. The Committee consists of the following:

1. Shri H. P. Mathrani, Consulting Engineer (Road Development), Ministry of Transport, New Delhi—*Chairman.*

2. Dr. Ernst Zipkes, Director, Central Road Research Institute, Delhi.

3. A nominee of the Institution of Engineers (India).

4. A nominee of the Indian Roads Congress (Shri. H. Sunder Rao, Deputy Standards Officer, Roads Organisation, New Delhi.)

5. Dr. K. Billing, Director, Central Building Research Institute, Roorkee.

6. The Professor of Highway Engineering, College of Engineering, Guindy, Madras.

7. A Soil Physicist.

8. } Two Road Chief Engineers from the
9. } States of India.

10. Shri R. P. Burman, Chief Engineer, C. P. W. D. (Aviation Wing).

11. Maj.-Gen. H. Williams, Engineer-in-Chief, Ministry of Defence, Kashmir House, New Delhi.

12. Director, Scientific and Industrial Research.

2. ONE TON LIGHTER SAVES BUS OPERATOR £600

A reduction of one ton in the weight of a single-decked public service vehicle has been estimated to be worth £600 to the operator.

This estimate is based on actual service results with the Leyland Tiger Cub chassis fitted with a light alloy 44-seater body. This vehicle has an unladen weight of 5 tons 12 cwt. and compared with single-deckers of the same capacity, but in which no serious attempt had been made at weight reduction, showed that a weight saving of one ton gave an improved fuel consumption of one mile per gallon. Thus, assuming an annual milage of 40,000, a minimum life of 12 years and the cost of diesel fuel to be 3s 10 d per gallon, this gave a value to the operator of £ 600 per ton of weight saved. This figure was based on fuel saving alone.

(*From 'Motor Transport'—December 13, 1952.*)

3. FIRE RESISTANCE OF PRESTRESSED CONCRETE

THE behaviour of prestressed concrete during and after fires is being studied at the Fire Research Station in collaboration with the Building Research Station, [U.K.] with particular reference to post-tensioned beams. One series of tests has been completed.

The type of beam selected for these tests was a precast element of rectangular or I-section, which was fully prestressed before a narrow concrete strip representing a floor slab was cast on top, provision being made for composite action. Concrete of the same composition was used throughout

and the size of wire and initial stress in the wire were the same in all specimens. The aim of the tests was to observe within certain limits the effect on fire resistance of load restraint, concrete cover to the cable, and size of beam, together with the improvement given by protective encasements.

Conclusions

Although the following conclusions are tentative, being based on a small number of tests, there are reasonable grounds for believing them valid.

(1) Time to collapse is determined largely by the rate of rise of temperature of the cable. A fire resistance of 2 hours can be obtained with a concrete cover to the cable of about 2½ in. Longer periods are likely if the cover is increased, but it may be desirable to include a light reinforcement, say steel mesh, in the cover to the cable as a precaution against its spalling away if its thickness is increased beyond about 3 in.

(2) For a fire resistance of 4 hours or more an insulating encasement is probably required. Normal in situ plastering with gypsum or cement (lime) sand may give up to ½ hour additional resistance if there is an adequate key with the concrete. Protection incorporating vermiculite should increase the fire resistance by about 2 hours when applied 1 in. thick.

(3) Beams may fail a little earlier if longitudinal expansion is prevented than if they are free to expand. The effectiveness of the restraint is a determining factor, but the results so far do not permit a quantitative statement to be made.

(4) There is little difference in performance between a beam of rectangular section and an I-beam having the same load-carrying capacity and the same concrete cover to the cable.

(5) Explosive spalling, which was observed in very small units made with gravel-aggregating does not seem likely to occur in beams having no part less than about 2 in. total thickness.

(6) Failure is unlikely to be sudden. There is a progressive sagging, which in beams of large span would be most noticeable. The formation and visible extension of cracks with a marked increase in deflection are signs that collapse is imminent.

(7) Beams which have been exposed to a fire of shorter duration than that which would cause failure, representating, say less than half of their fire-resistance, are likely to retain a high percentage of their original strength on cooling, but with a marked residual deflection and loss of prestress.

(Extracted from the "Indian & Eastern Engineer" May, 1953).

4. INTERNATIONAL SOCIETY OF SOIL MECHANICS AND FOUNDATION ENGINEERING—THIRD CONFERENCE, SWITZERLAND, 1953

THE Third International Conference of Soil Mechanics and Foundation Engineering will be held in August 1953 in Switzerland. The Conference will be in two parts, and the first part will be held at Zurich, from 16th to 21st August, 1953, in the Kongresshaus. The programme includes lectures and discussions on the following 8 subjects :

(1) Theories and Hypotheses of a general character, soil properties, classification, and Engineering Geology.

(2) Laboratory investigation including compaction tests, improvement of soil properties.

(3) Field Investigation, technique of field observations, including compaction control and soil stabilisation.

(4) Foundations of buildings and dams, bearing capacity, settlement observations and subsidence.

(5) Piles and Pile foundations and their settlements.

(6) Roads, runways, airports—flexible, rigid pavements and their foundations.

(7) Earth pressure and retaining walls.

(8) Stability and deformation of slopes and earth dams, research on pore pressure measurements and groundwater problems.

The second part of the Conference from August 22nd to 25th includes a tour through Switzerland. The tour has been arranged to give the visitors not only an idea of geotechnical and foundation engineering works but also something of the country's natural beauty.

The final session will take place on August 26 at Lausanne on the Lake of Geneva. Immediately after the session an excursion to the dams of Grande Dixence and Mauvoisin which are under construction has been planned.

Those interested may get further particulars of the Conference from the Indian National Society of Soil Mechanics and Foundation Engineering, Curzon Line Barracks, Curzon Road, New Delhi.

5. CONCRETE ARCH BRIDGES OF MOST DARING DESIGN*

Bridge	*Country*	*Span-L feet*	*Rise-h feet*	*L/h*	*$L^2/8h$*
Sando	Sweden	870	131	6.6	718
Moselle	Germany	352	27	13.2	580
Traneberg	Sweden	593	86	6.9	512
Rio das Antas	Brazil	617	93	6.7	505
La Roche Guyon	France	530	76	7.0	460
Plougastel	France	590	110	5.4	396
Elorn	France	567	124	4.7	322
Castelmoron	France	470	89	5.3	311
Feutelstal	Germany	452	86	5.3	298
Esla	Spain	692	206	3.4	288
La Guaira-Caracas	Venezuela	498	108	4.6	287
Lorraine	Switzerland	493	108	4.6	282

(From 'Engineering News-Record'—March 5, 1953.)

6. SELF HELP IN ROADS

Lungleh—Aijal Road

BEFORE partition the main trade route between India and South Lushai Hills was through Chittagong, large quantities of oranges, pineapples and timber used to be transported along the route. The route was closed after partition and traffic had to be carried by a bridle path. To remove this hardship the Lungleh-Aijal Road, about 128 miles long, was projected. About 100 miles have so far been built: 34 on the Lungleh side and 64 on the Aijal side, with a voluntary labour of about 50,000 Lushai men, women and children from about 470 villages. The road was opened last April by the Prime Minister who described it as a great example of self help.

(Extracted from the Monthly News Letter of I.R.T.D.A., May, 1953).

* As measured by the ratio of the square of the span to eight times the rise.

7. BIGGER SOIL-TEST PLATE PERMITS BIGGER PRESSURES UNDER FOOTINGS

THE effect of size of bearing plate on measured bearing capacity was clearly indicated in tests made to determine the allowable soil pressure for footings for the Elmhurst General Hospital now under construction in the Borough of Queens, New York City. When a 2-ft square plate was loaded, pressure of only 4 tons per sq. ft. could be allowed under the provisions of the New York City building code. But when a 4-ft. square plate was tried, tests showed that a design pressure of more than 6 tons per sq. ft. could be permitted.

Code requirements are that a soil test be made in two steps, in each of which the load must be distributed over an area of at least 4 sq. ft. In the first step, the design unit pressure is applied and readings taken to determine the rate of settlement. This load is maintained until no settlement is noted for a period of 24 hours. Next, a 50 per cent overload is applied, during a 24-hour interval.

The test is considered unsatisfactory if the design load shows more than a $\frac{3}{4}$-in. settlement, or if the increment of settlement that is found under the 50 per cent overload condition exceeds 60 per cent of the settlement obtained for the design load.

Test setup.—Borings taken at various points on the hospital site indicated that the subgrade is principally compact, coarse sand with traces of clay and silt. Excavation showed the presence also of some hardpan.

Loads were applied to the soil with a calibrated hydraulic jack acting against a rigid steel bearing plate. The jack reacted against a steel I-beam attached to a pair of H beams loaded with 1 ton pigs. Carrying a total load of 200 tons, these H-beams were supported on cribbing that was spaced 16 ft apart.

Settlements were measured with two mechanical strain gauges, which permitted direct readings to 0·001 in. The gauges were attached to a steel angle that was independent of the loading equipment and supported outside the area influenced by the load. The average of the readings of the gauges was taken as the settlement.

Higher pressure permitted.—Soil tests were carried out first for the nurses' quarters and staff house. These were made with a 2-ft. square plate. The result was that the footings had to be designed to withstand a 4-ton per sq. ft. pressure.

For the main building, however, tests were made with a 4 ft. square plate. Though soil conditions were apparently the same as for the tests with the smaller plate, the later tests indicated that footings could be designed for 6 tons. Because of the large area of the structure, this made possible a considerable money saving on the footings.

This experience seems to contradict the contention in some textbooks on soil mechanics that for non-cohesive soils, settlement under a given pressure is nearly independent of the size of loaded area. (Theoretically, also, for highly cohesive soils, settlement is proportional to width of loaded area; so if two bearing plates of different size exert the same unit pressure, the larger will settle more than the smaller.)

However, job engineers believed that the behaviour of building footings would be in better agreement with the tests with the larger plate than with those with the smaller plate because the sizes of the footings are closer to that of the larger plate.

(*Extracted from 'Engineering News Records' April 16, 1953*)

8. HELPING PRODUCTION

Role of Road Haulage

IT is no use producing more goods unless their selling cost is lower. This, it may be said, is obvious, and that in any case greater production itself means a lower cost per unit whether it be a motor vehicle or a powder puff. But improvements effected in a factory and co-operation between management and labour can easily be counter balanced by transport costs. Outside the immediate interests concerned, few people realize the extent to which the cost of transport affects the cost of an article by the time it reaches a port —the delivery of raw material from different sources to the factory plus its carriage to the ship.

(*Extracted from 'Motor Transport'— March 27, 1953*).

9. KEY STONE OF DEVELOPMENT

THE root of much world's ills to-day and conversely the solution to many of the troubles, is transportation. Because of the modern miracles of transportation and communications people everywhere are aware of what others have and have not.

This sudden spread of enlightenment, according to students of the subject, has aroused much envy, jealousy and greed. The result is radical dissatisfaction with things as they are and a determination by the undeveloped peoples to do everything possible to develop their own natural and human resources.

Good distribution is the key stone to this development, and highways and highway transportation its pillars. While all forms of communications may complement each other, highway transport is most flexible and economic and road construction has the advantage of requiring relatively little foreign exchange.

It is significant that the value of good highways and expeditious movement of traffic on them was never overlooked by a dictator in accelerating economic development, beginning with the Caesars, down the line to Napoleon, Hitler and Mussolini.

(*From 'Traffic Quarterly,' April, 1953.*)

LEGAL ADVICE

A lawyer was always lecturing his office boy, whether he needed it or not. One day he heard this conversation between the boy and one employed next door.

"*How much does he pay you?*" *asked the latter.*

"*I get five thousand dollars a year,*" *replied the lawyer's boy.* "*Ten dollars a week and the rest is legal advice.*"

TECHNICAL INFORMATION

THE DURATION OF VIBRATION OF CONCRETE

(Extracted from a translation from "Revue des Materiaux de Construction"—April, 1950.)

EXPERIMENTS were carried out on more than 500 specimens to determine the most advantageous duration of vibration of concrete, i.e., the duration of compacting by vibration which is necessary to ensure the maximum strength of concrete made under the conditions outlined in the paper. These experiments also provide information on :

1. The effects on the strength of concrete of excessive or insufficient vibration, and

2. The extent to which it is possible to deviate from the most advantageous duration of vibration without appreciably affecting the strength of the concrete.

Test Conditions

The composition by weight of the tested concrete was as shown in Fig. 1 on page 24.

Crushed slag	...	(0·32 to 0·80 in.) 50 per cent.
Gravel	...	(0·12 to 0·32 in.) 10 per cent.
Sand	...	(0 to 0·12 in.) 20 per cent.
Normal Portland Cement	...	20 per cent.

Mixing was done with a trowel; the quantity in each batch was sufficient to fill a mould for 6 test cubes of 4 in. vibrated simultaneously. After a mould was filled it was placed on a vibrating table on which compacting took place. After vibrating the moulds were placed in a moist atmosphere for 24 hours. The cubes were then de-moulded and kept for 27 days under water after which they were kept in air in the same room at a temperature 18 to 20 deg. C.

Test Results

The results of the tests, which had been carried out are given in Tables I and II.

Figure 1 shows the values of the water-cement ratio corresponding to the greatest crushing strength as a function of the duration of vibration.

The crushing strength and the most advantageous water-cement ratio can be represented by curves asymptotic to straight lines drawn parallel to the axis of abscissae on which is plotted the duration of vibration.

It can be seen that there exists a most advantageous duration of vibration for each value of the water-cement ratio and also that there exists, for each duration of vibration, a value of the water-cement ratio corresponding to the maximum crushing strength. In other words there exists, on the curve relating the duration of vibration to the crushing strength, a maximum the abscissa of which (duration of vibration) varies with the water-cement ratio.

Figure 2 (page 25) shows the disastrous effects of too low a water-cement ratio or, the same, of an insufficient duration of which is vibration for a given water-cement ratio. Even a small reduction of the water-cement ratio with respect to its most advantageous value for a given duration of vibration provokes a reduction of the crushing strength, this reduction of strength is more rapid for dry mixes than for wet mixes.

The effects of an excess of mixing water on the crushing strength are far less severe than that of a lack of water (Figure 1).

Lengthening the duration of vibration beyond the most advantageous figures has no influence on the quality of the finished

TABLE I—Crushing Strength (lbs per sq. in.) at 7 days.

Water-Cement Ratio	Duration of Vibration							
	38″	1′15″	2′30″	5′	10′	15′	20′	30′
0.50	3976	3858.14	4355·14					
0.42	6235.22	6446.8	6248					
0.40	6674	6769.1 4	—					
0.38	—	—	—	7124.14	7483.4			
0.36	7100	7430.86	7359.86	7951.72	7469.2			
0.34	—	—	—	—	—			
0.32	—	7206.5	7455	8236	7714.86	8378		
0.30	—	—	—	8491.6	8491.6	7692.14		
0.29	—	—	—	—	—	8591	9443	8520

TABLE II—Crushing Strength (lbs per sq. in.) at 91 days

Water-Cement Ratio	Duration of Vibration								
	as cast	38″	1′15″	2′30″	5′	10′	15′	20′	30′
0.50	7051.72	7611.2	7171	7406.72					
0.42	—	9089.42	8946	8804	9088				
0.40	—	9430.22	9465.72	9187.4	9187.4	9134.86			
0.38	—	9749.72	9656	9265.5	9272.6	9891.72			
0.36	—	9891.72	9986.86	10224	10317.72	10179.98			
0.34	—	8520	9478.5	10153	10743.72	10459.72	10654.26		
0.32	—	—	8946	10838.86	10942.52	10924.06	10909.86		
0.30	—	—	1597.5	11118.6	11345.8	10773.54	11098.72		
0.29	—	—	—	1398.7	—	—	11753.34	11832.86	11666.72

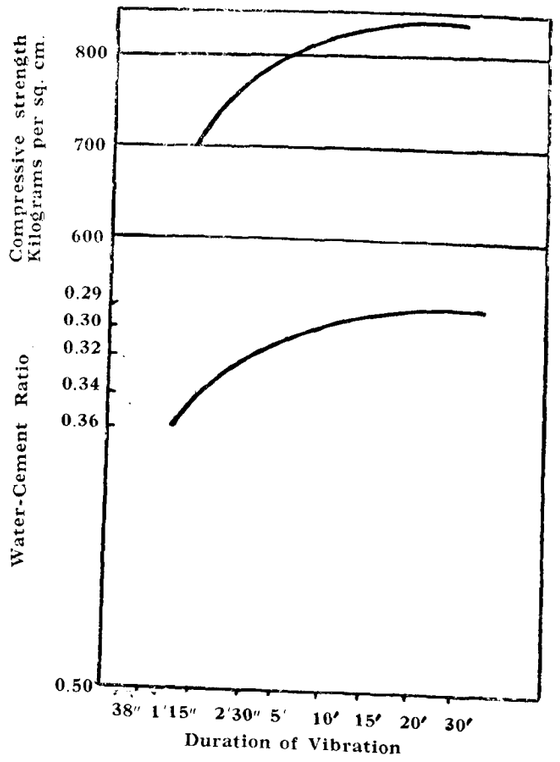

Fig. 1 Values of the water-cement ratio and duration of vibration corresponding to maximum compressive strength.

product, at least for the mixes used in the normal practice of vibrated concrete. It is nevertheless advisable not to exceed the most advantageous duration beyond a certain limit.

In practice there exists not only a technical but also an economical limit of the duration of vibration. For the present series of tests this limit can be fixed at about 5 minutes. Thus, we can see from Table II that, beyond this limit, in order to be able to reduce the water-cement ratio by 1 per cent we have to vibrate three times longer and we will only achieve a gain in strength of 4 per cent (water-cement ratio from 0.30 to 0.29, vibration from 5 minutes to 15 minutes, strength from 11346 to 11753 lbs. per sq. inch) Column 6 of the Table II shows an interesting point: for a wide range of variation of the water-cement ratio (0.36 to 0.30) the highest crushing strengths are obtained with the same duration of vibration (5 minutes).

On the site it is impossible to regulate the consistency and the duration of vibration with the same precision as in the laboratory in order to obtain the highest possible crushing strength. It is, therefore, best to work with a water-cement ratio slightly greater than that indicated by laboratory results.

Finally, it should be mentioned that, as shown by laboratory tests, the end of compacting is indicated by the appearance of the layer of laitance on the free surface of the concrete which gives it a shining appearance and which disappears rapidly after vibration ceases.

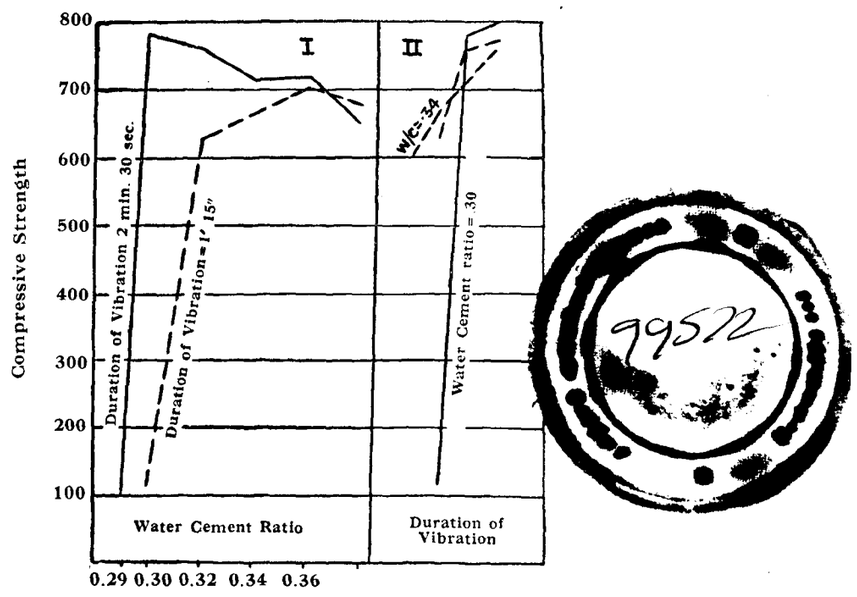

Fig. 2. Effect of insufficient mixing water (I) or of insufficient duration of vibration (II) on compressive strength.

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DEFINITIONS OF HIGHWAY ENGINEERING TERMS

CYCLE TRACK: A way or a part of a roadway designed and formed for use by pedal bi-cycles and over which a right-of-way exists.

FOOT PATH: A way or means of passage for use by pedestrians only and over which there is a right-of-way.

ABSTRACTS

625.731.3*—ROAD SUBSTRUCTURE DRAINAGE

Highway Subdrainage. By the Physical Research Branch, Bureau of Public Roads, U.S.A. (Public Roads, February 1952.)

The Report presents test data on permeability and drainability of soils and their applicability to highway subdrainage. The data are utilized to illustrate methods of calculating vertical capillarity flow, flow into horizontal drains, and lateral drainage of base courses.

The apparatus used are illustrated. The inter-relation of drainage, density and gradation of soils is also discussed.

The tests show that small gradients generally obtained for lateral drainage are not effective for the rapid drainage of dense graded materials on impervious subgrades.

A list of bibliography is furnished.

681.26—WEIGHING MACHINES

Weighing Vehicles in Motion. By the Highway Transport Research Branch, Bureau of Public Roads, U.S.A. (Public Roads April, 1952.)

This describes the development of an electronic weighing device which can measure axle weights, axle spacings, and speeds of vehicles moving at their normal operating speeds along the roadway. It is expected that the scales can be improved so that the accuracy of weights obtained is on a par with that obtained from static weighing machines.

656.1—ROAD TRANSPORT

Highway Transportation Economics.

By Richard M. Zettel (Public Roads, August 1952.)

620.17.693.5 - CONCRETE TESTING

Age-Strength Relations for Air-entrained Concrete. By the Physical Research Branch, Bureau of Public Roads,- U.S.A. (Public Roads, June 1952).

Tests made primarily to obtain data on the rate of development of the strength of "air-entrained" Concrete as compared with the strength of similar concrete without air entrainment are described. Air-entrainment increases resistance of concrete to frost action, but its strength is reduced. The tests showed that (i) the reduction in strength of concrete due to air-entrainment was approximately 10 per cent at an age of 5 years ; (ii) Concrete containing cements relatively low in tricalcium aluminate are lower in strength at 7 and 28 days than similar concrete made of cements relatively high in tricalcium aluminate, but develop substantially higher strength at age of one year or more.

691.32—CONCRETE

The Design of Concrete Mixes J. D. McIntosh. (Journal of the Institution of Municipal Engineers, March 1953).

Concrete mix design and a review of the characteristics of concrete that go to make for its strength and durability combined with workability are dealt with. The method of estimating suitable mix proportions, using the tables and charts furnished by the Cement and Concrete Association in their Research Note 4, is explained. The importance of designing a laboratory trial mix first and then a full-scale trial mix is stressed. Based on laboratory and full scale trials variations are recommended to be made so that while laying the quality of concrete does not vary in the field.

* Refers to Universal Decimal Classification number.

624-68 HINGED ARCH BRIDGES

The Portal Frame Bridge: J. J. Leeming (Journal of the Institution of Municipal Engineers, September, 1952).

Discusses the advantages of the portal frame and its general principle and method of design. Temperature, shrinkage and deflection are also considered, and the practical case of a bridge of the type used for construction in Dorset is quoted as an illustration.

"Bridge on East-side Approach Road at Borough Boundary, Swansea B. Eriksen (Journal of the Institution of Municipal Engineers, October 1952).

Design and construction of a road overbridge, of skewspan 64 ft 3 in. with pin jointed R. C. portal frame are described. The design was to take the Ministry of Transport's (London) new heavy loading, comprising two knife edge loads of 150,000 lb each on a width of 10 ft and 25 ft apart.

"Why America Builds Better Roads" Lt. Col. E. W. W. Richards (Journal of the Institution of Municipal Engineers, December,' 52).

This is an interesting article on the technical and administrative policies of American road building in recent times, dealing with the importance of highway transportation and its effect on American life in economic, financial and international spheres. The extent to which private finance was made use of in improving roads to suit traffic development is also explained. Methods adopted to reduce traffic hazards and accidents are illustrated. The importance of planning and proper execution is also discussed. Engineer-Contractor relationship is also discussed. The progress of highway engineering in America is explained to be due in no small measure to the system of financing adopted in that country. The question of equitable distribution of highway taxation among the various sections of the community is considered difficult to solve, but the principle of applying the funds contributed by road users wholly to their construction and improvement is followed. Reference is also made in some detail to the training given to the graduate-recruit engineer by the U. S. Bureau of Public Roads. Summing up, the American highway development is stated to involve complex factors such as considerations of operational cost and efficiency, human safety, meterials and traffic research, employment conditions, financial and administrative structures, aesthetics of highway design, and contract procedure.

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RESEARCH IN AMERICA

American industrial research was carried on by 300 laboratories with 9,000 employees in 1920, according to the Committee for Economic development. Twenty years later there were 2,200 laboratories with more than 70,000 employees.

(Highway Research Abstracts, March, 1953).

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BUDGETS AND ADMINISTRATION REPORTS

DELHI STATE BUDGET 1953–1954

The following extracts relating to Civil Works have been taken from the Delhi State Budget for the year 1953-54

	(In lakhs of rupees) Revised Estimate 1952-53	Budget Estimate 1953-54
I. Revenue (Civil Works)		
Transfer from Central Road Fund	2 13	1.87
II. Expenditure (Civil Works)		
1. Original Works	4.26	9.59
2. Repairs	16.12	18.79
3. Rent control Establishment	0.14	0.08
4. Grants-in-Aid, Contributions etc.	0.04	0.14
Total	20.56	28.60
III. Expenditure (Communications Only)		
(i) **Original Works**	2.28	6.91
(ii) Repairs	5.00	4.60
Total	7.28	11.51
IV. Receipts under Motor Vehicles Acts	14.99	15.05

A BRIEF REVIEW OF THE DELHI STATE BUDGET

(With special reference to Civil Works)

THE budget estimates for 1953-54 as well as the revised estimates for 1952-53 indicate a balanced position inasmuch as no surplus or deficit is anticipated. The revenue receipts and expenditure in each of the two years 1953-54 (Budget Estimates) and 1952-53 (Revised Estimates) are equal and stand at Rs 425.63 lakhs and Rs 362.53 lakhs respectively.

Revenue expenditure on Civil Works for 1953-54 estimated at Rs 28.60 lakhs forms 6.7 per cent of total estimated revenue in the State during the year (*viz.* Rs 423.63 lakhs). The corresponding percentage figure for the previous year is 5.7.

The expenditure on Communications in 1953-54 amounted to Rs 11.51 lakhs and expressed as a fraction of total State revenue in the year works out to 2.7 per cent, the corresponding percentage for the preceding year 1952-53 being 2.0.

BOOK REVIEW

Resealing joints and cracks in concrete pavement (**Minnesota**) Bulletin 63 - Highway Research Board, 2101, Constitution Avenue, Washington 25, D.C.

THE bulletin describes an experimental project conducted in Minnesota U.S.A. to study the cutting, cleaning and resealing of joints and cracks. The materials, methods and equipment developed to accomplish the work economically are described.

From the experience gained the following conclusions are drawn.

(1) joints and cracks can be effectively sealed with hot-poured rubber-asphalt when properly placed; (2) mechanical agitation and positive temperature control must be provided on the melting and applicator units; (3) all dust and loose concrete must be thoroughly removed prior to the placement of the filler material; (4) overheating of the filler material; must not be permitted; (5) a satisfactory method of payment for is on the basis of Unit price of filler material in place, including cutting, material, and placement.

List of Approved Works on National Highways

S. No.	Job No.	Name of work	Estimated Cost Rs (Lakhs)	Remarks
		ASSAM		
1.	675 AS 38	Extension of one room and providing sanitary fittings in the inspection bungalow at Margherita on National Highway No. 38.	0.10	

WORDS OF WISDOM

Technology without intellectual honesty does not work. Construction without conscience soon crumbles.

Herbert Hoover.
(*Traffic Engineering, April, 1952.*)

List of Books added to the Roads Organisation Library during May 1953

1. **Weighing Vehicles in Motion–Highway Research Board Bulletin No. 50** by O. K. Normann and R. C. Hopkins (Highway Research Board, 2101, Constitution Avenue, Washington 25, D.C., 1952)

   The Manager of Publications, Delhi.

2. **Report by the Railway Board on Indian Railways for 1951-52–Vol.I.**

3. **–do– Vol. II–Statistics.**

4. **Three Reinforced Concrete Bridges over the River Thames Opened by H.R.H. The Prince of Wales, July, 1933 (Photostat Copy).** (The Cement and Concrete Association, 52, Grosvenor Gardens, London, S.W.I.).

5. **Temporary Works and Constructional devices used in Connection with the Construction of the new Waterloo Bridge** by P. R. Alderman and F. E. Prior
   (The Institution of Civil Engineers, Great George Street, Westminster, London, S.W.I.).

   American Society for Testing Materials, 1916, Race Street, Philadelphia 3.

6. **1952 Book of A.S.T.M. Standards including TENTATIVES (A Triennial Publication). Part I Ferrous Metals**

7. **– Do – Part II Non-Ferrous Metals.**

8. **Runway Surfacing–Use of Bitumen.** (Burmah-Shell Oil Storage & Distributing Co. Of India, Ltd., Connaught Circus, Post Box No. 7, New Delhi-1.

   Her Majesty's Stationery Office London.

9. **PROCEDURE RECORDS–Organisation and Methods Division, H. M. Treasury.**

10. **Public Administration, A Bibliography for Organisation and Methods.**

11. **Suggestions, Schemes in Government Department.**

12. **Report of the Machinery of Government Committee (CD. 9230) Haldane Committe Report, Issued by Ministry of Reconstruction, U.K.** by Viscount Haldane.

13. **Contracts and Finance-History of the Second World War United Kingdom-Civil Series**, by William Ashworth.

    Division of Soils, Council of Scientific and Industrial Research, Commonwealth of Australia.

14. **Improvement of Methods for measuring Soil Water Content-Divisional Report 1948**, by J. P. Gurr.

15. **The Mechanical Stability of Soil Aggregates, Factors Affecting Results Obtained from the Dropshatter Method Divisional Report 7/4** by J. P. Quirk.

16. **Specification for the Use of Rammed Cement Soil in Building Construction** (Punjab Public Works Department, Buildings and Roads Branch, Simla). (3 Copies)

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PUBLICATIONS
OF THE
INDIAN ROADS CONGRESS

A limited number of copies of the following publications are available for sale.

	Publications.	Price inclusive of postage, etc. Rs	A.	P.
1.	Volume IX—Part 4—October 1945	3	0	0
2.	Volume IX—Bound—Madras 1945	10	0	0
3.	Volume X—Part 4—August 1946	3	0	0
4.	Volume XI—Part 4—May 1947	3	0	0
5.	Volume XI—Bound- 1947	12	0	0
6.	Volume XII—Part 1—September 1947	3	0	0
7.	Volume XII—Part 2—January 1948	3	0	0
8.	Volume XII—Part 3—April 1948	3	0	0
9.	Volume XII—Part 4—March 1948	3	0	0
10.	Volume XII—Part 5—September 1948	3	0	0
11.	Volume XII—Bound—1947-48	12	0	0
12.	Volume XIII—Part 1—December 1948	3	0	0
13.	Volume XIII—Part 2—January 1949	3	0	0
14.	Volume XIII—Part 3—January 1949	3	0	0
15.	Volume XIII—Bound—1948-49	11	0	0
16.	Volume XIV—Part 1—September 1949	3	0	0
17.	Volume XIV—Part 2—December 1949	3	0	0
18.	Volume XIV—Part 3—December 1949	3	0	0
19.	Volume XIV—Part 4—July 1950	3	0	0
20.	Volume XIV—Bound—1949-50	8	0	0
21.	Volume XV—Part 1—August 1950	3	0	0
22.	Volume XV—Part 2—November 1950	3	0	0
23.	Volume XV—Part 3—January 1951	3	0	0
24.	Volume XV—Part 4—August 1951	3	0	0
25.	Volume XV—Bound—1950-51	9	0	0
26.	Volume XVI—Part 1—November 1951	3	0	0
27.	Volume XVI—Part 2—March 1952	3	0	0
28.	Volume XVI—Part 3—April 1952	3	0	0
29.	Volume XVI—Part 4—October 1952	3	0	0
30.	Volume XVII—Part 1—December 1952	3	0	0
31.	Volume XVII—Part 2—January 1953	3	0	0
32.	Volume XVII—Part 3—January 1953	3	0	0
33.	Road Research Bulletin No. 1	5	0	0
34.	I. R. C. Standard Specifications and Code of Practice for Road Bridges in India (1937)	1	8	0
35.	Proceedings of the Chief Engineers' Conference at Nagpur on the Post-war Road Development in India	2	8	0

Copies can be had from the Secretary,

INDIAN ROADS CONGRESS,
JAMNAGAR HOUSE, SHAHJAHAN ROAD,
NEW DELHI-2.

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எழும்பூர், சென்னை-600 008.

நூலைத்தந்தவர்.

தே. எண் : ப. எண் :

வழங்கிய நாள். (1)	திரும்பிய நாள். (2)	வழங்கிய நாள். (1)	திரும்பிய நாள். (2)

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