

70

Transport.
Communications.
Monthly Review.
February — 1954
NO — 82.



02

D411m2, N48
N54.82
29529

ANNUAL NUMBER

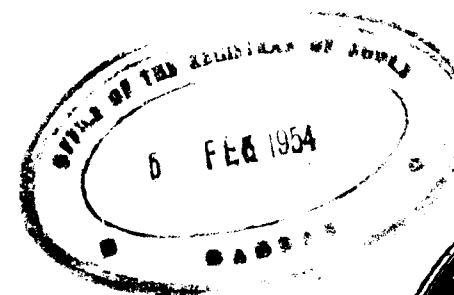
375 **TRANSPORT-
COMMUNICATIONS**

MONTHLY REVIEW

FEBRUARY 1954 — No. 82

375
1-54

70



INDIAN ROADS CONGRESS, NEW DELHI.



CONCRETE ROADS

Concrete roads can be designed for any conditions of load and service.

Whether it is a creteway to carry farm produce to market or a road in an industrial area for heavily loaded goods-vehicles, concrete provides the best solution.

AEC

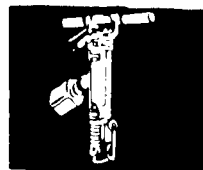
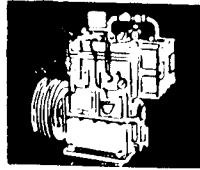
THE CEMENT MARKETING COMPANY OF INDIA LTD.
Sole Proprietors of
THE ASSOCIATED CEMENT COMPANIES LIMITED

BOMBAY AGRA ROAD

CRETEWAY IN THE PUNJAB

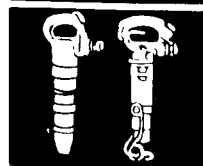
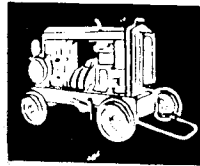
COMPRESSED AIR EQUIPMENT

**STATIONARY
COMPRESSORS**
Two Stage. Displace-
ments from 80 c. ft./
min. to 638 c. ft./min.



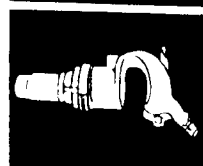
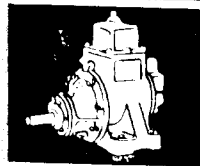
ROAD RIPPERS
Weights from 43
lbs. to 75 lbs.

**PORTABLE
COMPRESSORS**
Two Stage. Displace-
ments from 130 c. ft./
min. to 360 c. ft./min.



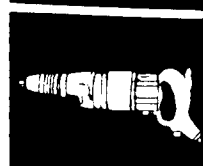
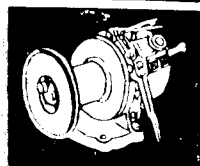
PICKS & SPADERS
Weights from 20
lbs. to 26½ lbs.

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



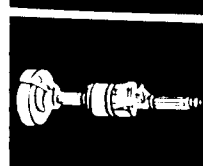
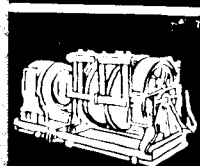
HAMMERS
Weights from 7½
lbs. to 13½ lbs.

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



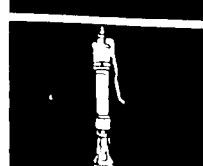
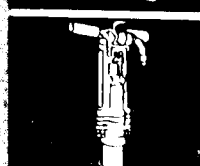
ROTODRILLS
Hand and screw-
feed. Capacities
to 3 ins.

SCRAPEHAULERS
Specially designed for
scraper loading. Rope
pulls from 2200 to
5600 lbs.



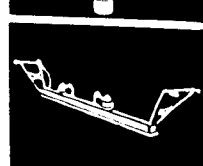
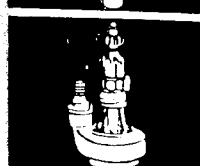
ROTOGRINDS
Radial and sur-
face types. Taking
2" to 6" wheels.

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



RAMMERS
Weights from 9
lbs. to 40 lbs.

ROTOPUMPS
For water, oil or
sludge. Will give 10
g.p.m. with 140 ft.
head to 140 g.p.m.
with 10 ft. head



**CONCRETE
COMPACTORS**
A new machine for
Concrete compac-
tion.

The machines and tools illustrated here are but a few of the products manufactured by Holmans. There are also Drifters, Sinkers, Stoppers, Airlegs, Holbits and tungsten carbide tipped Drill Rods, all of which are world famous.

SOLE AGENT IN INDIA

BIRD & CO. LIMITED
CALCUTTA . DELHI . KANPUR

KILLICK NIXON & CO. LTD.
BOMBAY.

BEST & CO. LTD.
MADRAS.

Please mention this journal when replying to advertisements.

the 'COMET' 90



for Passenger Transport

Made in 2 wheel bases for passenger vehicles, Leyland's latest, the 'COMET' 90, is an answer to the growing demand for reliable, heavy duty buses needed to augment the country's existing fleets. The 'COMET' 90 passenger buses require less fuel and lubricating oil, last longer and reduce maintenance costs.

Leyland DIVISION

ASHOK MOTORS LIMITED
Progressive Manufacturers
 ENNORE, MADRAS

Please mention this journal when replying to advertisements.

“ MASTER ”

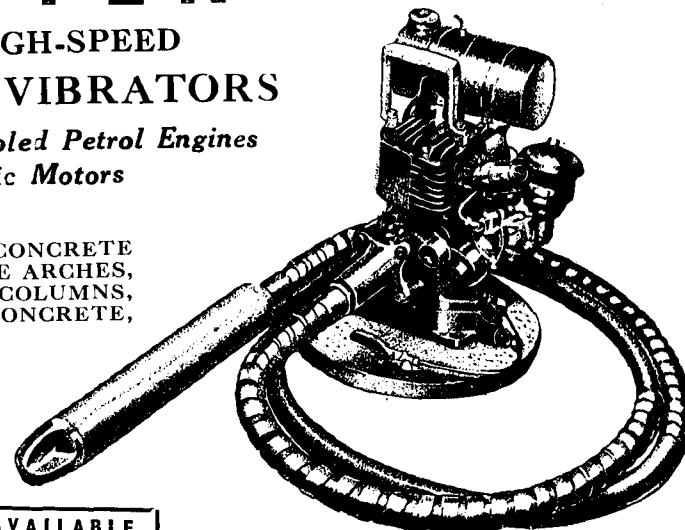
SUPER HIGH-SPEED CONCRETE VIBRATORS

*Fitted with Air-cooled Petrol Engines
or Electric Motors*

For use on

HIGHWAY, REINFORCED CONCRETE
BRIDGE PILES, CONCRETE ARCHES,
FOOTINGS, GIRDERS, COLUMNS,
FLOOR SLABS, MASS CONCRETE,
ETC., ETC.

LARGE NUMBERS IN USE
WITH GOVERNMENT
PUBLIC WORKS, DEVELOPMENT
PROJECTS & BUILDERS THROUGH-
OUT INDIA.



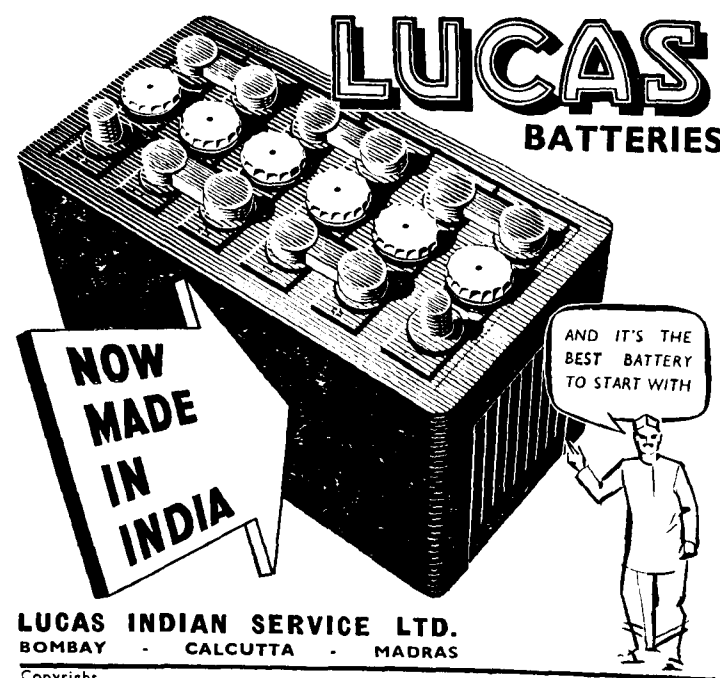
AVAILABLE
EX-STOCK

Sole Aents :

INDO-AMERICAN COMMERCE LTD.

15, PARK STREET, CALCUTTA-16

Telephone : City 5292
Telegram : “ WESTDAX ”



LUCAS INDIAN SERVICE LTD.
BOMBAY - CALCUTTA - MADRAS

Copyright

Please mention this journal when replying to advertisements.

TRANSPORT- COMMUNICATIONS

MONTHLY REVIEW

FEBRUARY 1954—No. 82

70

TABLE OF CONTENTS

	Page
GENERAL	
The Sun Temple of Konarak	... 1
Road Development in Uttar Pradesh	... 5
Road Problem in Hyderabad State	... 7
Development of Roads other than National Highways in Bihar	... 8
TECHNICAL	
History of the Theory of Beams	... 9
Modern Development of Structural Engineering	... 11
Stabilized Soil in Road Construction in Madras State	... 14
Compacting Concrete by Vibration	... 22
HERE AND THERE	
1. Road Policy	... 26
2. American Association of State Highway Officials Committee Procedure for Design Policies	... 26
3. Regulation limiting size of commercial signs held valid	... 27
4. Equador's Highway Development Plans	... 27
5. Rules of Thumb for Concrete	... 27
6. Recent additions to Documentary Films on Road Engineering	... 28
7. New Zealand Roads Fund Established	... 29
8. The Open Road	... 29
CURRENT LITERATURE	
Book Review	... 30
Selected Recent literature in Engineering Journals	... 31
Publications Added to the Roads Wing Library During December 1953	... 36
BUDGETS AND ADMINISTRATION REPORTS	
(i) Madhya Pradesh Budget 1953-54	... 37
(ii) Summary of the Punjab P.W.D. Administration Report 1951-52	... 39

ALSO : True Definition of a Committee—Statistics—Definitions of Highway Engineering
Terms—Yes Men.

Transport-Communications Monthly Review is published on the 25th of each month by the Indian Roads Congress, New Delhi.

This Review is sponsored by the Roads Organization, Ministry of Transport, but the Government of India accept no responsibility for any views or opinions expressed.

Subscriptions. Annual subscription including postage is Rs Fourteen. Single copy including postage is Rs one and annas four.

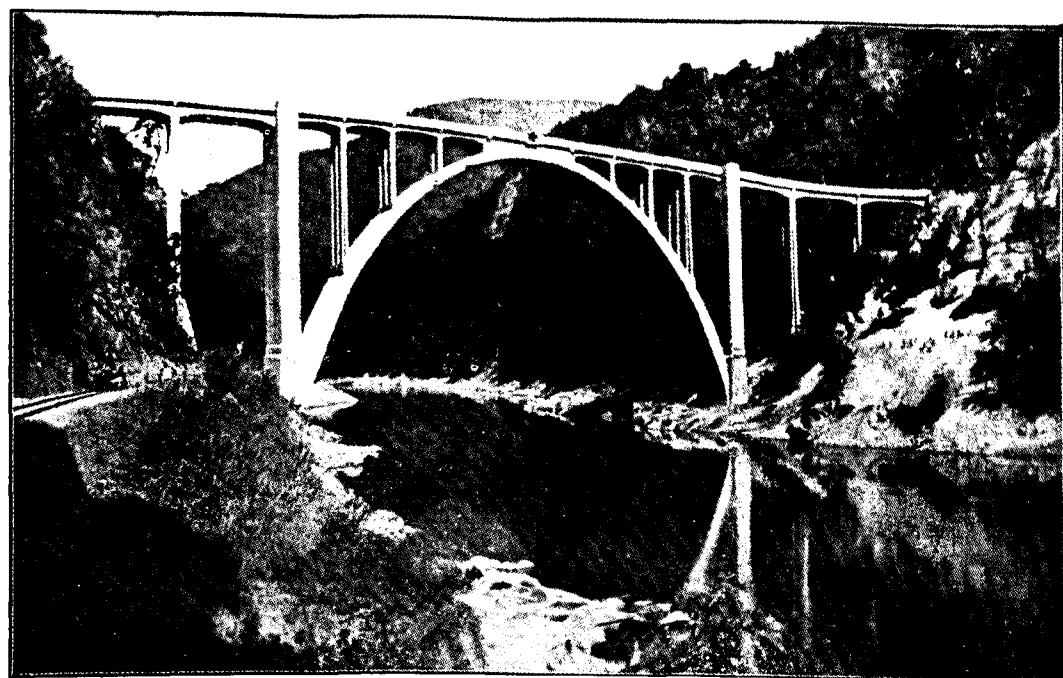
To Members of the Indian Roads Congress, Engineering personnel below the rank of an

S. D. O. and Engineering students a special reduced subscription rate of Rs 8 per annum is offered. Students are required to apply through the Principal of their College.

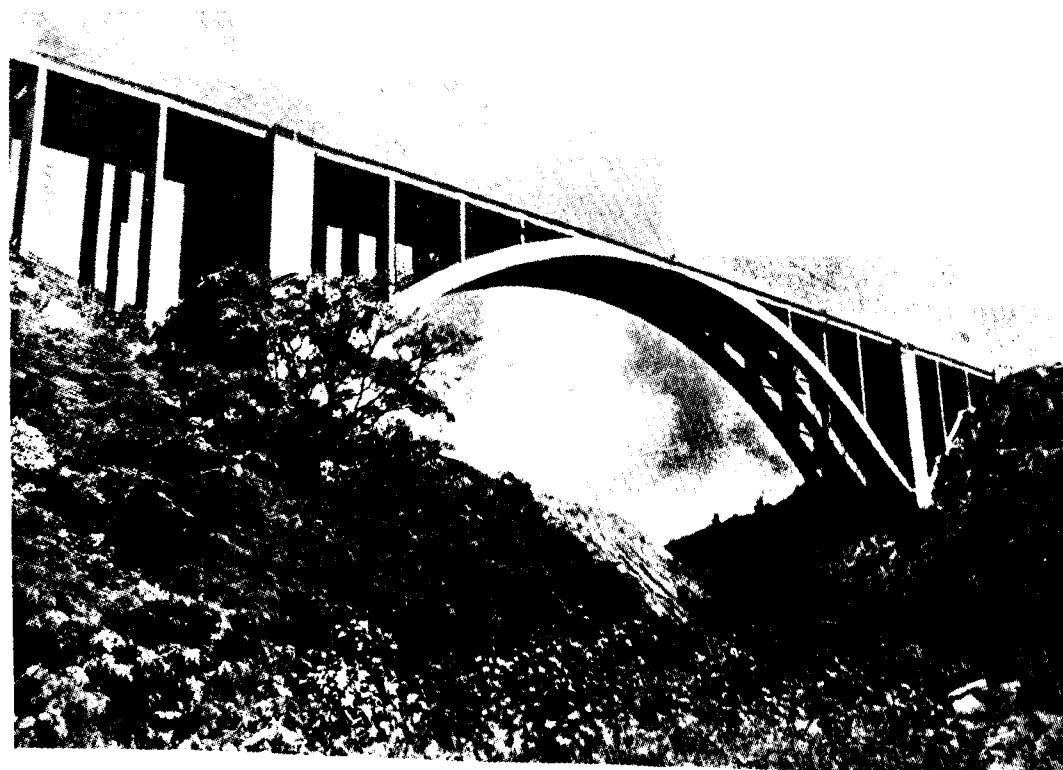
Advertisements. Advertising rates per insertion

	Full Page	Half Page
Inside front cover	Rs 100/-	—
Inside back cover	100/-	—
Outside back cover	120/-	—
Ordinary position	75/-	45/-

Detailed rate card can be had on application to the Secretary, Indian Roads Congress, Jamnagar House, Shahjahan Road, New Delhi-2.



A Reinforced Concrete Bridge of span 268 ft across the Teesta River in West Bengal—INDIA.



A Prestressed Concrete Arch Bridge of span 498 ft in Venezuela.

TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

A REVIEW OF
ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

FEBRUARY 1954

THE SUN TEMPLE OF KONARAK

(Adapted from 'Panoramic India', October 1953, and 'Orissa Review' — Director of Public Relations Department, Government of Orissa).

[The Indian Roads Congress is holding its Eighteenth Annual Session at Bhubaneswar. In and around Bhubaneswar one finds a series of remarkable monuments representing different faiths, viz., Buddhism, Jainism, Saivism, Vaishnavism, etc. These monuments present a panorama of history from the 3rd century B. C. to the 16th century A. D. Of these monuments it is said that the Sun Temple of Konarak is the grandest.

This article has been included in this issue in the hope that members attending the Session of the Congress will find it interesting.—Ed.]

KONARAK is the European's version of the Sanskrit word 'Konark' meaning 'Sun's corner'. Dedicated to the Sun-god, conceived in Hindu mythology as rising from the ocean and riding on his chariot drawn by seven celestial horses, the famous temple, built on the seashore some twenty one miles north-east of Puri, is an architectural image of that mythical chariot speeding through the heavens. In point of sculptural profusion and symbolical conception Konarak has hardly any parallel in India.

Grand in conception and great even in its ruin, the stupendous undertaking stands with its disfigured beauty in a desolate tract. Why such a desolate place was chosen for the erection of this architectural masterpiece is that it was not as forlorn seven centuries ago as it is today. The Prachi and the Chandrabhaga, the two derelict local rivers, must have been wide and navigable in the 13th century and Che-li-ta-lo and Wu-tu, the two thriving ports mentioned by Hiuen Tsang appear to have been at the confluence of these rivers with the sea within easy distance from the place where the sun-temple stands. Other accounts also go to prove that the immediate vicinity of the shrine

was then sufficiently prosperous to justify its construction there.

Construction : Legend & Facts

Legend ascribes the origin of the temple to Lord Krishna's handsome son Shamba who once incurred the wrath of his father, and being cursed by him lost his good looks and was turned into a leper. When he pleaded innocence and begged his father's pardon, Krishna asked him to undertake a twelve-year penance and propitiate the Sun-god who alone could cure him of the foul disease. Shamba did that and at the end of the penance built the present temple as a thanksgiving to the God who had cured him.

In point of historical fact, the temple was built by King Narasimhadeva I (1238-1264 A. D.) who had gained several victories over the Muslims and, therefore, thought it fit to build a temple worthy of his high prestige. It is said that 12 years' revenue was expended on its construction, which took 1,200 craftsmen 12 years to complete. Although the exact date is not available, it may be put down with certainty that the temple was completed in the third quarter of the 13th

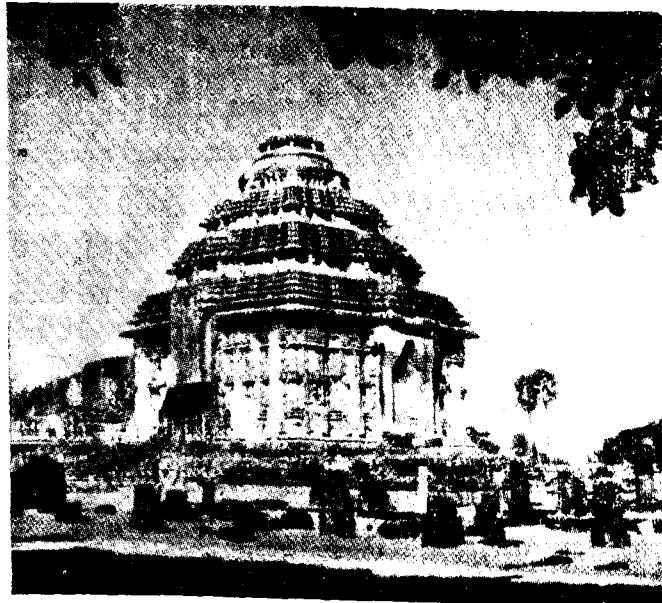
century. Apart from the Orissa records, the first account of the temple is to be found in the *Ain-i-Akbari* which reads—“near Jagannath is a temple dedicated to the sun. Its cost was defrayed by twelve years' revenue of the province—Twenty-eight temples stand in its vicinity six before the entrance and twenty-two without the enclosure each of which has its separate legend.” (Jarret's translation of the *Ain-i-Akbari*).

The Temple

The porch of the principal temple and fragments of only two or three of the ancillary shrines have been subjected to the ravages of seven long centuries. The enclosing wall is also gone and is now marked by its ruins running round the temples. The quadrangular area on which the edifices stand is approached from the west and the visitor after passing the last belt of trees (planted there to arrest the encroachment of the sea-sands), suddenly comes face to face with a monument magnificent even in decay. Sir John Marshall, the ex-Director-General of Archaeology, Government of India, has recorded that there is no monument of Hinduism that is at once so stupendous and so perfectly proportioned as the 'Black Pagoda'. The early Portuguese mariners called the temple the 'Black Pagoda' to distinguish it from the plastered and white temple at Puri, both of which were important landmarks for them from the Bay of Bengal.

The joint structures of the Vimana of the main shrine and Jagamohana were conceived in the form of a *Ratha* or wheeled car, and have therefore been based on an immense terrace with 24 giant wheels being dragged as it were by seven richly caprisoned horses, the remains of which still exist on both sides of the eastern doorway. The Jagamohana had three doors, each with a flight of steps for approach, but all of them now been blocked up and the interior filled with

sand to prevent the walls from collapsing. The pyramidal roof consists of three tiers diminishing as they ascend, and each opening out into a platform containing life-size statues mostly with musical instruments. The whole roof is a stepped pyramid, and first and second tiers having six steps or *pidas* each and the topmost one only five. The apex of the pyramid is crowned by a huge *amalaka* or the fluted finial. The beautiful roof with its receding shelves is so dexterously designed as to allow the maximum play of light and shade and Fergusson, the celebrated archaeologist says that there is no roof in India where the same play of light and shade is obtained with an equal amount of constructive propriety nor one that so

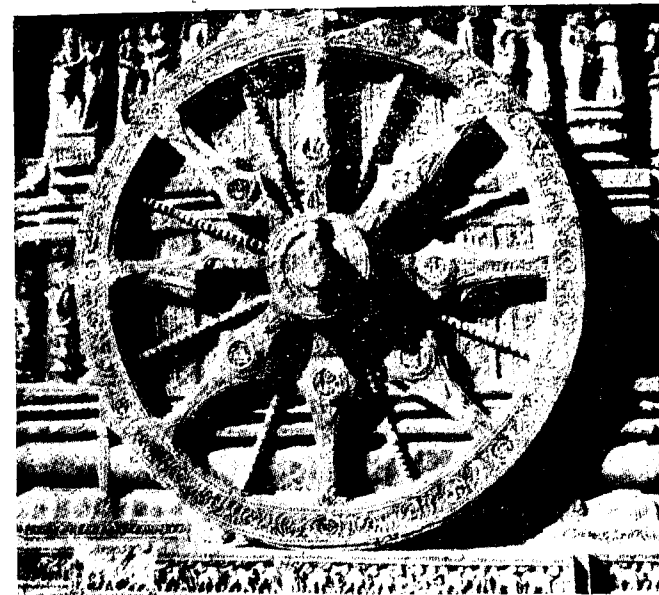


A General View of the Konarak Temple

harmoniously supplements the graceful walls that support it. The total height of the structure is 129 ft 8 inches. There stood in the compound of the temple a beautiful monolith of 34 ft height with an image of Aruna, the charioteer of the Sungod, at the top, but it was removed to Puri in the eighteenth century by the Mahrattas and has now been set up in the eastern gate of the Jagannath temple.

The temple (and the *Jagmohan*) face due east on which side a broad flight of

steps reaches the main entrance. This, alas, has been blocked by masonry the interior of the porch having been filled up with sand and rubble to prevent the walls from collapsing. On both sides of these steps are the seven celestial horses, now mostly broken, straining at the great weight of the chariot. On the northern and southern walls of the platform are the twelve pairs of wheels, each having a diameter of about nine feet, which in sheer delicate artistry are the *ne plus ultra* of the temple. The walls of the platform as also those of the *Jagmohan* are covered with such a profusion of intricate carving in laterite and sand stone as not to leave even a single square inch of the entire surface unadorned.



The Famous Konarak Wheel

The seat of the deity immediately to the west of the porch has been cleared of a mass of superincumbent ruins which once formed the lofty spire. When Fergusson visited Konarak in 1837, a portion of the Great Tower was still standing, but was gone by 1869. Around the fallen walls of the sanctum on the north, south and west, there are three magnificent images of the Sun-god, sculptured in hard, green chlorite radiating, so to say, the glory of life. All creation depends on the life-giving rays

of the sun and it is, therefore, the Sungod who commands the world and all life in it. The noble bearing of the god in all these chlorite pieces is perfectly in accord with the underlying mythological conception of the divinity as the supreme preserve of the universe. A similar, but a much larger image, once stood on a richly carved throne of which only the pedestal now remains in the sanctuary. This presiding deity had the figure of *Maitraditya* holding a lotus in each hand with ornaments on the body and a crown on the head. It was seated on the chariot drawn by seven horses driven by the charioteer Aruna. The image can still be seen in the temple of Indra within the enclosure of the Jagannath temple at Puri where it was concealed, so the report goes, at the time of the Muslim invasions.

A little to the east of the main shrine is a smaller structure which was probably used as a subsidiary audience hall. It is now without a roof but its walls and the surface of its many pillars are covered with minute carvings of the most elaborate kind. Access to the high plinth of this *mandapa* is by a staircase to the east guarded on either side by two spirited lions with upraised paws and trampling on couchant elephants. In ferociousness of appearance and demeanour there is hardly anything in India to compare with them. The same high praise is also applicable to the two famous Konarak horses and the life-size elephants guarding

respectively the southern and the northern approaches to the main temple. Not only these bigger specimens but also the minute friezes of elephants, horses and lions on the temple walls leave no room for doubt that the Konarak artists had studied intensively the anatomy and the moods of these noble animals.

In the museum nearby many beautiful pieces of sculpture found in the vicinity may be seen, but the pride of place goes to the long chlorite slab depicting the features

of the nine planets conceived in Indian astrology. This slab used to decorate the eastern entrance to the temple. After its collapse, some antiquarians attempted to remove it in 1893 to the Museum at Calcutta, but after dragging it for 200 yards gave up the attempt; while the old builders after excavating the block in the hills and carving it, had carried it 80 miles across swamps and unbridged rivers to Konarak! The power of the Konarak architects to move and raise huge blocks of stone must have been stupendous, for the crowning slab of the existing porch is twenty-five feet thick and is estimated to weigh not less than 2,000 tons.

Erotic Carvings

Much has been said in denigration of the carvings on the outer walls of the temple a large proportion of which is highly erotic in character. Although not peculiar to Konarak – for the erotic motif has been widely adopted in the temple sculpture of central and southern India—it must be admitted that the Orissa temples exemplify this tendency to a very pronounced degree. The explanations offered by noted archaeologists are that these figures were there either to test the genuineness of the piety of the devotees or to ward off evil spirits. In any case it must be stated that there is nothing

objectionable as soon as the roof is reached where, on the three successive terraces, exquisitely carved celestial beauties play on the drum, the flute or the cymbals or are busy arranging their coiffure or playing with lotuses or other flowers representing the nobler attainments of the human mind. The placing of these elegant figures higher up the structure serves an excellent symbolic purpose. As the temple rises towards the sky the base and the crude are gradually left down below and the mind of the devotee soars to receive the benedictions of his beloved God.

A Saga of Life

Abul Fazl, the famous chronicler of Akbar's court had said of this monument—“even those whose judgment is critical stand amazed at its sight.” What the original temple looked like can now only be imagined. Whatever little of it remains to-day is still a marvel depicting the whole gamut of human experience from the lowest to the most sublime with a liveliness and exuberance of vitality that takes one's breath away. It is as though the master architect who designed this temple of the Sun had realised that since the sun warms all life every form and expression of it is sacred.

Goethe, the famous German poet, concludes towards the end of his life, that, after having tasted all aristocratic professions, the highest was that of the state engineer. His Faust states in sight of irrigation work he conceived: “.....und so schafft ich Raum für Millionen, dies ist des Glückes höchstes Glück,” which means that in opening living space to millions of creatures man finds the highest satisfaction in his life.

—Extracted from Bengal Engineering College Bulletin No. 6
—Aspects of Indian Civil Engineering—Feb. 21, 1951.

ROAD DEVELOPMENT IN UTTAR PRADESH

Development Before the War

BEFORE the advent of the railways, roads were the chief means of communication. Even now they form the backbone of the communication system.

The first road to be made in Uttar Pradesh was the Grand Trunk Road from Calcutta to Lahore, constructed in 1839-49. By 1860, the Lucknow-Kanpur, Lucknow-Barabanki, Faizabad-Banaras, and Bahatpur-Baragaon roads had been metalled in portions. By 1908, the road mileage in the State was 6,172 miles of metalled and about 23,000 miles of unmetalled (katcha) roads. In the next 10 years only 183 miles of metalled roads were added. These were of kankar or stone metal. From 1924 efforts were made to improve the road surfaces and, by 1937, 77 miles of cement concrete roads and 723 miles of black top roads had been constructed. A road programme involving construction of 1,388 miles of new metalled roads at a cost of Rs 1.58 crores was launched by the U. P. Government in 1939, but due to the outbreak of World War II the programme had to be postponed.

Post-war road Programme

According to the Nagpur Plan formulated in 1943, by the Chief Engineers of all States, Uttar Pradesh with an area of 1,13,409 sq. miles and a population of 632.15 lakhs needed 13,477 miles of metalled and 37,825 miles of unmetalled roads for its economic development. Against this requirement, the State had, in 1946, only 9,044 miles of metalled and 23,688 miles of unmetalled roads, out of which only 4,901 miles of metalled roads were in the charge of the State P. W. D., the remaining mileage being with the district boards. Realising the total inadequacy of road communication, the State Government, immediately after independence, launched a road programme to remove the deficiency. The State P. W. D. started planning the road system

on a scientific basis. Economic survey of the districts were carried out and traffic censuses were taken on all metalled roads in the State to determine the intensity of traffic on them and to decide on the nature of surface the road would require. Thus, after a detailed scientific investigation, Phase I Programme, estimated to cost Rs 21.5 crores, was launched by the State through its Public Works Department in 1947. This programme provided for the construction of 1,642 miles of new metalled roads, 5,655 miles of new unmetalled roads complete with bridges and culverts, 501 miles of cement concrete tracks for sugar-cane traffic, and 2,419 miles of reconstruction of local metalled roads. The programme also included modernizing with cement concrete of 45 miles of State Highways, decking of six railway bridges, construction of 11 major bridges etc.

Road Classifications

All roads in the state have been classified into four main categories: (1) National Highways, (2) State Highways, (3) main district roads, and (4) other district roads and village roads. Nine roads, which are of inter-statal importance, have been classified as National Highways. Their total length is 1,510 miles. The Government of India pays Uttar Pradesh approximately Rs 42 lakhs every year for the maintenance of National Highways. The State Highways are the main trunk or arterial roads of the State which connect National Highways, highways of adjacent states, district headquarters, important cities within the State and serve as main arteries of traffic. There are 17 State Highways in the State linking up all district headquarters and principal centres of industry. Main district roads are the roads which serve the traffic needs of the districts in which they lie. The standard of these roads is practically the same as that of State Highways. Other district roads and village roads are kutchas at present and have been so planned that nearly all important villages in the State are within 2 miles of these roads.

Brief Review of Road Work, (1947-53)

In the execution of Phase I road programme mentioned above numerous difficulties were encountered, such as, shortage of controlled materials like steel, cement, and coal, shortage of railway transport, shortage of petrol, etc. In the year 1949 the subsidy from Government of India was completely stopped and this had a disastrous effect on the progress of the States, first post-war road programme. The State had to face the deteriorating condition of labour and rising prices of materials. All these difficulties were boldly faced by the State Highway Engineers and the progress achieved is really remarkable. By March 1953 the State P. W. D. had completed 918 miles of new metalled roads, thus opening large tracts of undeveloped areas. Also, 2,138 miles of local roads which were taken over by the State P. W. D. in a most appalling condition have been brought to the required standard; 4,627 miles of unmetalled roads have been completed and they have linked many important villages with the State's highway system; 15 new bridges including several important boat bridges have been constructed and opened to traffic; 38 miles of cement concrete tracks to facilitate the transport of sugarcane to the mills have been laid; thirteen miles of state Highways have been surfaced with cement concrete. The total amount of expenditure incurred in Phase I road programme upto March 1953 is approximately 16 crores of rupees. The development of road communication in the State since 1946 may be summarized as given in the table below:

Milage of Roads Maintained by P.W.D.		
Year	Metalled	Unmetalled
1946	4,901	770
1952	8,201	8,029
1953	8,511	4,006 *1
1954 (expected)	8,819	3,681 *2

* (1) 3,975 miles of completed unmetalled roads have since been transferred to District Boards for maintenance and 103 miles have been metalled.

* (2) 361 miles are expected to be metalled during 1953-54.

Road Programme for 1953-54

The road programme for the year 1953-54 also is heavy. There is a provision of about Rs 190 lakhs in the current year's budget for roads, with which it is expected to add 300 miles of new metalled roads, reconstruct 50 miles of local metalled roads, and lay about 80 miles of cement concrete tracks for sugarcane traffic. Twelve major bridges will be brought to an advanced stage of construction. Out of these twelve bridges, the one over the Alakhnanda at Kirtinagar on the Hardwar-Badrinath Road, is a steel suspension bridge of 300 ft length, which will remove great inconvenience to thousands of pilgrims every year. The other important bridge is on Chalthi River on Tanakpur-Pithoragarh Road. It is a R. C. arch bridge having single span of 325 ft. It is claimed to be the biggest single span R. C. arch bridge in India. The third one is over the Ghat River on the same road and is a 225 ft single-span steel truss bridge. The State P.W.D. has undertaken to construct the first pre-stressed concrete bridge of 12 spans of 66 ft each on Agra-Bah road in Agra district. Major bridges over the Baigul and Bhakra Rivers on the Meerut-Bareilly Road (National Highway) at an estimated cost of 24 lakhs are in an advanced stage of construction. Both these bridges have 4 spans of 120 ft each of reinforced concrete bowstrings girders. It will, therefore, be seen that considerable progress has been made in bridge construction in the State since the dawn of independence. About 2,300 rft. of major bridges have been constructed and opened to traffic at a cost of Rs 26.0 lakhs. Major bridges, 2700 rft. costing Rs 30 lakhs are in advanced stages of completion. Major bridges, 1900 rft. costing Rs 22 lakhs, will be started shortly.

Modernization

All out efforts are being made by the State P. W. D. to upgrade the existing kankar surfaces and on an average 300 miles are being modernized every year. It is hoped that the whole length about 500 miles of the Grand Trunk Road in

ROAD PROBLEM IN HYDERABAD STATE

THERE are, in Hyderabad State to-day, only 6,780 miles of roads of different categories to serve a total area of 82,600 sq. miles. This means only 0.08 mile of road per square mile, a very poor show in comparison with the neighbouring States.

There are about 22,000 villages in the State and 80 to 90 per cent of the total population lives in them. Assuming that on the average a mile of road is required per village to connect it with the neighbouring villages and markets, a total length of 22,000 miles of roads is required for the State.

In the State there are 17 districts, of which nine, comprising the eastern and central parts of the State, have fairly good soils and rocks of gneissic origin. The remaining eight districts are mostly Deccan traps with a thick covering of black-cotton soil. Sedimentary rocks and laterite occur in large patches over the central and western regions of the State, where good road building materials are not available.

Economical road construction is possible only where gneissic rocks exist. In areas, having deep black cotton soil, moorum is available but moorum surfaces cannot stand the monsoon and therefore even village roads require water-bound macadam surfaces the cost of which runs high.

The cost of constructing roads, with the

formation width varying from 18 ft to 24 ft and with the metalled width of 12 ft ranges from Rs 50,000/- to Rs 75,000/-. These figures include the cost of culverts and small bridges. At these rates the State has to invest large sums on road development essential for balanced economy. But its finances are limited and there are competing demands on its resources for development in so many other fields, viz., irrigation, agriculture, etc.

A compensating feature, however, is that for eight months in the year, small nalas are generally dry and bigger streams are mostly fordable. Across small river, it is sufficient to provide causeways and submersible bridges. In fact, many such structures already exist and they are functioning satisfactorily on the whole. Major river crossings, however, do require high level bridges.

During the year 1944, a post-war road development scheme was drawn up for the State (on the basis of the Nagpur Plan) for constructing 19,600 miles of new roads of different categories within a period of 20 years at the then estimated cost of Rs 40 crores. At the present day rates, the cost will be Rs 80 to Rs 90 crores. The proposals could not be implemented due to lack of funds. Only a few roads were partially constructed. These incomplete roads have been included in the current 5-Year Plan, which provides for an outlay of Rs 1.25 crores.

TRUE DEFINITION OF A COMMITTEE

A conference is a meeting of those who can do nothing individually and who agree collectively that nothing can be done.

DEVELOPMENT OF ROADS OTHER THAN NATIONAL HIGHWAYS IN BIHAR

Introduction

THE area of Bihar south of the Ganga, specially Chota Nagpur, is very well served by Road communications. In this region road building materials are available in abundance in close proximity of the roads.

The picture in North Bihar is, however, almost exactly the opposite. Before 1947 there was not a single mile of road in this region in-charge of the Public Works Department. There were very few hard surfaced roads and the entire road system was under the management of the District Boards. This paucity of roads in North Bihar was, no doubt, due to the scarcity of road building materials within economic distance.

Post-War Development Plans

The Nagpur plan envisaged the construction of 5,511 miles of surfaced roads in Bihar. In the Post-War Road Development Plan of the State about 800 miles of roads were included for improvement by the Public Works Department in North Bihar alone. In February 1949 the Government of Bihar revised the Plan. The revised Plan included the following categories of roads:

- (a) District Board roads which linked district or subdivisional head-quarter or connected areas of production with centres of trade and consumption either through National Highways or P.W.D. roads.
- (b) Such hard surfaced important roads under the District Boards not included in category (a) that had considerably deteriorated for want

of proper maintenance and had to be kept in a good state of repair for maintenance of law and order.

- (c) Railway feeder roads considered necessary for connecting market places in the interior.

According to this Plan, 2,421 miles of roads were proposed to be improved at a cost of about Rs 17 crores.

The First Five-Year Plan

In the First Five-Year Plan which is now under execution the provision for development of roads other than National Highways in Bihar is Rs 8 crores. This programme includes the works which were planned under the post-war road development programme of the State and 300 miles of creteways areas where sugar factories exist.

Road Expenditure

The State Government spent Rs 188 lakhs on road development upto 1951-52.

In 1951-52, i.e., the first year of the current Five-Year Plan, a sum of Rs 192 lakhs was spent, followed by an expenditure of Rs 215 lakhs in 1952-53.

The revised budget for 1953-54 amounts to Rs 178 lakhs.

Roads Improved

So far 1,853 miles of roads have been taken over by the P.W.D. In this lot 1,165 miles have been metalled up to the end of 1952-53, out of which 800 miles have also been black-topped.

(Continued on page 35)

HISTORY OF THE THEORY OF BEAMS

(Extracted from 'The Structural Engineer'—May 1938)

Galileo Galilei (1564-1642)

THE earliest writer to interest himself in the theory of beams was Galileo Galilei, the Italian astronomer who invented the thermometer and developed the telescope.

Galileo was lecturer in Mathematics in the University of Pisa and later became Professor of Mathematics at Padua.

His attention was drawn to the beam problem during a visit to the arsenal and dockyards at Venice and in a book published in Holland in 1638 he deals with the fracture of beams and rods. A diagram in this book shows a cantilever loaded at the free end and the problem which he discussed was to determine the breaking load in terms of the dimensions of the beam.

It is remarkable that Galileo supposed the fibres of a strained beam to be inextensible but it must be remembered that Hooke's Law was not discovered until 1678 or 40 years later. His theory was not supported by experiment and was found by later writers to be incorrect.

The problem which Galileo attempted to solve without having any idea of elasticity was attempted by many subsequent writers until it was finally settled by Coulomb in 1776.

Mariotte, the French physicist, who invented the Rain Gauge in 1677 and formulated the Laws of Gases contemporaneously with Robert Boyle, conducted experiments in 1680 which showed that some of the fibres of a loaded beam are extended whilst others are shortened.

Baron Leibnitz, the German mathematician and philosopher, who shares with Isaac Newton the credit of inventing the Calculus contributed to the solution of Galileo's Beam Problem by

applying Hooke's Law to the individual fibres but assumed the material to be strained in tension only and incompressible.

The position of the neutral axis was thus assumed to lie at the concave surface of a deflected beam or cantilever and it is remarkable that Euler made the same assumption in the original publication of the theory of a deflected strut.

In 1705 James Bernouilli stated that the position of the neutral axis was indifferent and unimportant and doubted the application of Hooke's Law.

In 1776 Charles Augustin Coulomb, the French Engineer, gave the three fundamental conditions of the beam theory, namely (a) the total tension on the section on one side of the neutral axis = the total compression on the other side, (b) the Moment of Resistance of the internal stress = the Bending Moment due to the loads, (c) the Shear on a Section = the Load. The Neutral Axis according to Coulomb lies in the middle of the depth for a rectangular section.

It thus took 138 years for mathematicians to solve Galileo's Problem and to arrive at an elementary stage of the beam theory.

Coulomb's theory was not universally accepted and even as late as 1817 or 40 years after its publication there were writers like Peter Barlow, Professor of Mathematics at Royal Military Academy, Woolwich, who neglected Coulomb's method and gave a wrong theory for finding the neutral axis.

Eaton Hodgkinson adopted Coulomb's theory of beams and gave it its true place.

The experiments carried out by William Fairbairn and Eaton Hodgkinson in

connection with the design of Robert Stephenson's tubular railway bridges contributed much information on the behaviour of wrought iron beams.

By the year 1850 we find that the theory of the strength and deflection of beams was sufficiently developed to enable accurate calculations to be made.

Clapeyron

It is noteworthy that Britannia Tubular Bridge over the Menai Straits which is 1,511 ft long and continuous over four spans was designed and erected some seven years before Clapeyron published his Theorem of Three Moments for Continuous Beams. This was first given in a memoir published in Paris in 1857 for the case of uniformly loaded spans of uniform cross-section and varying lengths. Its application to other and general cases was developed by later writers.

In 1859, William H. Barlow, a son of Professor Peter Barlow, proposed the construction of continuous girders as a series of beams and cantilevers by introducing joints at the points of contra flexure to admit of the expansion and contraction of the girder.

This principle was used in the Forth Bridge in 1890 and has been employed in many structures both in steel and in reinforced concrete.

In Rankine's "Manual of Applied Mechanics," which was first published in 1858, and in his "Manual of Civil Engineering," published in 1862, we find the standard formulae for the deflection of beams and cantilevers with various types of loading.

Otto Mohr (1838-1920)

In 1868 Professor Otto Mohr of Dresden, extended the beam theory of deflections by showing that properly chosen fictitious loads on a beam cause bending moments which are numerically equal to the deflections and shear forces numerically equal to the slopes.

This principle of conjugate beams considerably simplifies the study of slopes and deflections by eliminating higher mathematics and is known as the Area-Moment Method. It is the basis of the graphical method of obtaining the elastic line for a loaded beam and also of the so-called Cable Theory of deflection.

STATISTICS

The Chairman in introducing a famous statistician who was about to deliver a lecture on Statistics to the Congress told the following story.

"A certain senior Government official was told to tour the provinces and enquire into a matter on which the Central Government wished to frame a policy. He travelled round the country with his staff and collected a vast amount of statistics relating to his subject. At the final station, after all statistics had been collected, his principal assistant came to him and said:—

*"Sir, now we have collected all the statistics we require"—pointing proudly to a huge bundle of files.
"Tell me what you want to prove and we will prove it".*

The Chairman hastened to add that the principal assistant referred to was no statistician but merely a layman who no doubt had entirely wrong ideas of the uses to which statistics should be put.

MODERN DEVELOPMENT OF STRUCTURAL ENGINEERING

(Extracted from Highways and Bridges, October 1953)

THE following extracts from the Presidential address of Lt. Colonel R. F. Galbraith, the President of the Institution of Structural Engineers for 1953-54 concern reinforced, prestressed tubular and aluminium construction:

The use of deformed bars either cold twisted bars or twin bars has been advocated as a means of saving steel by using higher stresses, and a report on the use of deformed steel bars in reinforced concrete has recently been published by the Institution. This certainly does reduce the total quantity of steel required but the fact that the increased stress will result in an increased strain with a consequent increase in the total width of cracking must be borne in mind. Special steps must be taken in all structures exposed to the weather to design so that a large number of fine cracks will develop rather than a few large cracks. This can often be obtained by introducing secondary reinforcements near to the surface.

Welding has been used to eliminate hooks and anchorages, and to fabricate the reinforcement of certain reinforced concrete members. This is particularly suitable for precast units.

Steel forms, metal props and resin bonded plywood sheets have all been utilized in the construction of form-work. The cost of formwork often represents a third of the total cost of reinforced concrete work, and the designer can often help to reduce this proportion by careful consideration of the shapes and sizes of his members.

Considerable attention has been paid in recent years to the actual mix used to obtain concrete of a given quality. It seems desirable that we should specify the

minimum strength required at 3, 7 and 28 days, together with any special water cement ratio required, and then leave the contractor to adjust the proportions used according to the aggregate, cement and plant available. This would tend to decrease the cost of concrete by not using concrete of a higher strength than is actually required, and not obtaining a higher grade than needed by specifying definite proportions. A properly made 1:2:4 nominal mix to-day may well have a 28-day strength of 5,000 lbs. per sq. in., whereas the Code requirements is 3,000 lbs. per sq. in. and the working strength 760 or 1,000 lbs. per sq. in.

Consideration should also be given to the age of concrete when its full working load will be applied. The concrete, say, in a lower length of column may well be nine to twelve months old before it carries its full design dead loading, and even much older before its full live load will be applied. Yet the size of the column is proportioned on the basis of the 28-day strength of the concrete. It seems desirable to permit the use of higher working stresses for those parts of a structure which by virtue of their position must be highly matured before they can receive their full design load, care being taken of course to avoid accidental loading.

Mixing plant also plays a large part in the quality of concrete, and there has been considerable improvement in the design of such plant in recent years.

The handling of wet concrete on a site has also received attention. Small power driven barrows, and the new type of mobile crane are of great use to the contractor. The concrete pump also has its field of use. It is possible to pump

concrete at the rate of 8 to 10 yds. per hour, 125 ft vertically or 1,500 ft horizontally and to deliver the concrete by pipeline just where it is required. Concrete which can be pumped must of necessity be good concrete.

Prestressed Concrete

Although early attempts had been made to improve reinforced concrete by applying tension to the steel reinforcement it was not until the early 1900's that Monsieur Eugene Freyssinet the celebrated French Engineer studied prestressing and evolved a theory.

It was another twenty years before he could put his theory into practice. He had realised the importance of creep and in 1928 Faber and Glanville published the results of their research carried out in England on the creep of concrete, so confirming Freyssinet's deductions, and enabling him to formulate and perfect his theory of prestressing. The use of prestressing as a practical form of construction really dates from this time. Since then many developments have occurred, but all fall into two main divisions, pretensioning and post-tensioning. Pretensioning implies that the steel reinforcement is first tensioned to the required stress, concrete is then cast around the reinforcement, and becomes bonded to it and finally when the concrete is sufficiently matured the steel is released from its anchorage and the stress in the steel transferred to the concrete. The usual method of pretensioning is known as the "long line method" in which the steel wires are stretched between anchorages often 300 ft apart. The concrete units are then cast around these wires with a small space between each. After hardening the wires are cut between each unit and the stress transferred. In making small units sometimes the steel wires are anchored at one end of the mould and tensioned from the other. This tends to speed up production and in the event of a slip occurring at the anchorage only one unit would be affected.

Post-tensioning on the other hand implies that the concrete is first cast and matured, the steel wires are either placed in the mould in tube before concreting or

else threaded through a hole left in the concrete, and then tensioned and anchored at the ends of the concrete unit. Much ingenuity has been devoted to the means of applying tension to the wires and the methods of anchoring them. Two main systems being devised by Monsieur Freyssinet and Professor Magnel.

The third system of post tensioning is the Lee-McCall system using high tensile alloy bars instead of wires, with special threaded ends and nuts, which develop the full strength of the bar used. Whichever system is used high grade concrete and steel are required. The production of high grade concrete means careful control, both in mixing, placing and consolidation. Vibration is nearly always used and often some kind of artificial curing, such as steam, is used to speed up production and release the forms or moulds.

The steel wire usually used is either 8 gauge or 2 in. diameter, drawn steel wire with a breaking stress of 110 to 120 tons per sq. in. It is usually supplied in large coils 8 ft diameter to avoid the difficulties of straightening.

Shell Roofs

The use of shell roofs originated in Germany. The general theory was evolved by U. Finsterwalder and F. Dischinger, whilst Professor A. L. L. Baker of Imperial College has proposed a simple method of designing shell roofs based on the ultimate strength theory which has been confirmed by tests.

Tubular Construction

The structural use of steel tubes is another development which has been of particular advantage during the steel shortage. Roof trusses, space frames, portal buildings have all been carried out in this form of construction. In May, 1953, a Code of Practice (CP. 113: 201 1953) was issued giving recommendation for the design and fabrication and erection of steel tubes.

Aluminium

Aluminium, or rather the aluminium alloys have become a very definite struc-

tural material. The alloys bulk for bulk are about one third the weight of steel and are from a half to three quarters the strength of steel. In any structure where the dead weight of construction forms a high proportion of the total load aluminium alloy becomes a competitive material. Small units such as roof trusses for housing where repetition allows the use of mass production methods form another field where the light alloys can hold their own.

Apart from the cost aspect no maintenance is required. Light graceful members can be constructed, and no surface decoration is needed. The Institution's report on the "Structural Use of Aluminium Alloys in Buildings" published in 1950 gives much information on the design and use of aluminium.

Future Developments

It is hard to forecast the direction that technical developments will take in the future, but there are several needs in the structural engineering world which no doubt will be met in the future. Concrete which has a high crushing strength is a heavy material. The light weight concretes produced by air entrainment are not really strong enough for many structural purposes, so there remains a demand

for a light weight concrete of high strength. If it can be produced at a competitive cost the scope for its use in structural engineering is immense. The great defect of concrete, mainly its high dead weight, would disappear and precast members could be increased in size without a comparative increase in the capacity of lifting tackle. Perhaps the solution lies in the direction of hollow glass spheres which have great crushing strength, cemented together with a silica gel.

The strength of nylon thread has been exploited in the use of rope for ship fitting. Can this strength be used for structural purposes in the form of a non-corrosive reinforcement? Whilst in the similar manner glass ropes and toughened sheet glass may become structural materials. In the field of plastics, materials are being developed which soon may be of use to the structural engineer. The hardened resin and glass combination is an engineering material the application of which has hardly yet been touched. It is about one third the weight of steel and two thirds the weight of aluminium, with a very high strength weight ratio. Glass reinforced plastics have a high impact strength and are extremely resistant to corrosion.

It is worthy of observation that the most imperious masters over their own servants are at same time the most object the slaves to servants of their master.

—Seneca.

Wyoming (U.S.A.) approved a constitutional amendment to prohibit the use of highway-user revenue for other than highway purposes.

—Better Roads, September 1953.

STABILIZED SOIL IN ROAD CONSTRUCTION IN MADRAS STATE

Stabilized Soil—What Is It?

THE word “stabilized” or “stabilization” is used loosely and often sounds of complex and mysterious processes. In a very general sense, stabilization is any method or process which enables soil to serve a specified purpose better than it will in its natural condition.

The technique of applying some kind of readily available granular material like sand over a muddy path in a farm or garden, the use of lime and jaggery water mixed with soil for constructing durable mud walls, turfing of embankments as a protection against erosion, are all examples of stabilization.

Phenomenal progress was made in the use of stabilized soil for road and airport construction during the Second World War, when the urgency of the work severely restricted import of orthodox and high quality construction materials and compelled recourse to the utilization of local soil to the maximum. Mechanized methods which involved least manual labour were developed and stabilized soil fully lent itself for such a method. On the termination of the war, these developments were naturally extended to peacetime operations.

Briefly, the case for use of stabilized soil in road constructions may be stated as follows:—

- (1) In locations where the conventional construction materials are to be conveyed from long distances, considerable economy can be effected by the use of local soil.
- (2) In places where speed of construction is a prime factor as in a war theatre or in development projects

and where modern machinery is available.

Scope

Stabilized soil is not to be mistaken to answer all the problems in modern road construction. It is primarily a device to obtain, as economically as possible, stable road foundations (bases, sub-bases, or subgrades) by fully utilizing locally available materials. For the traffic conditions now obtaining in India, with inevitable existence of narrow iron-tired animal-drawn vehicles, the use of stabilized soil for surface courses requires extensive investigation and study. Nevertheless, where soil is used in wearing surfaces as in moorum, a scientific construction is possible only with the application of the principles of soil engineering. Also, unlike the conventional stone soling, stabilized soil can be successfully used in ‘stage construction’ of roads.

Methods of Stabilization

Because of the wide variation in the type of soil and the varied nature of their requirements in roads, a number of methods of stabilization is possible. Out of these, certain methods have crystallized out by practice. These may be considered under three main groups, viz.:—

- (1) Densification of the subgrade soil:
- (2) Stabilization with admixtures such as :
 - (a) soil and soil-like materials,
 - (b) agents as cement, lime, bitumen, chemicals, etc.:
- (3) Special treatment with heat and electrical energy, etc.

The method that has been adopted extensively in road construction is the densification of the subgrade soil with or without imported soil admixtures.

Where the local soils are not capable of yielding a structural material of the desired characteristics economically, they may be treated with external agents. Portland cement has been largely used for the purpose. To some extent lime also has been employed successfully. Bituminous materials, chemicals, fly ash, etc., have also been used in lesser degrees. Treatment with heat or electrical energy is employed only in special cases.

Principle

The essential principle in soil stabilization is to obtain a material that is durable and that can withstand the designated superimposed loads. This is effected, in most cases by intimately mixing soils with or without external materials, compacting them at suitable moisture contents to required densities and curing the surface, where necessary.

Problem

Stabilized soil road construction with an intensive use of mechanical equipments has been found economical for the soil, traffic and other conditions obtaining in western countries. How far would this be true for the Indian conditions, especially with reference to the traffic requirements (iron tired) and the availability of relatively cheap manual labour? That is the problem posed to the Highway Engineering profession in India.

Stabilized Soil Roads in Madras State

The first experiment was on a road nearby Madras in the year 1948 and the results were encouraging. This led to an extension of the experimental works for different soils and traffic conditions in other parts of the State. A stage of development was then reached when full-scale projects could be undertaken with confidence wherever the conventional method of work was costlier by comparison.

Table No. 1 shows the type, and nature of the works that have been undertaken.

* “Moorum here refers to soil materials with clay binder and considerable amount of coarse fractions of size + 2mm or gravel.”

† A versatile machine that can pulverize soil, control addition of water and effect an intimate admixture of the soil materials with speed and efficiency.

The locations of the different works are indicated in Fig. 1. Fig. 2 gives the progress up to December 1953. Procedure followed is described in the following paragraphs.

Investigation and Design of Stabilized Soil Roads :

Investigation : Typical samples of the subgrade soils and local soil materials available nearby were obtained and tested in the Soil Research Laboratory of the Department for significant engineering properties.

Design of Mixes : For the first few experimental works the design for * moorum-sand and sand-clay mixes were in strict conformity with the U. S. practice with regard to both gradation and plasticity requirements. Later, however, gradation was not considered critical and the design was mainly based on considerations of maximum density, bearing power and plasticity.

The soil used for soil-cement was either the subgrade soil or a mixture of two local soils. The design mix was such that the compacted soil-cement material satisfied certain tentative requirements of compressive strength and durability which were based on the recommended practices in the United Kingdom and the U. S. A. Eight per cent of cement by volume of the compacted soil-cement was found suitable and was adopted.

Design of Thickness : The thicknesses of the stabilized soil layers were arrived at in accordance with the current practices in other countries, suitably adopted for local conditions.

Equipment : The equipments that were available for use on the different projects were motor grader, tractor, smoothwheeled power roller, lorry, disc-harrows, level and nail drags and a soil testing field laboratory. Sheepsfoot roller was used only in a few cases. On Ramnad—Mandapam Road a “ † pulvimixer ” was available for use.

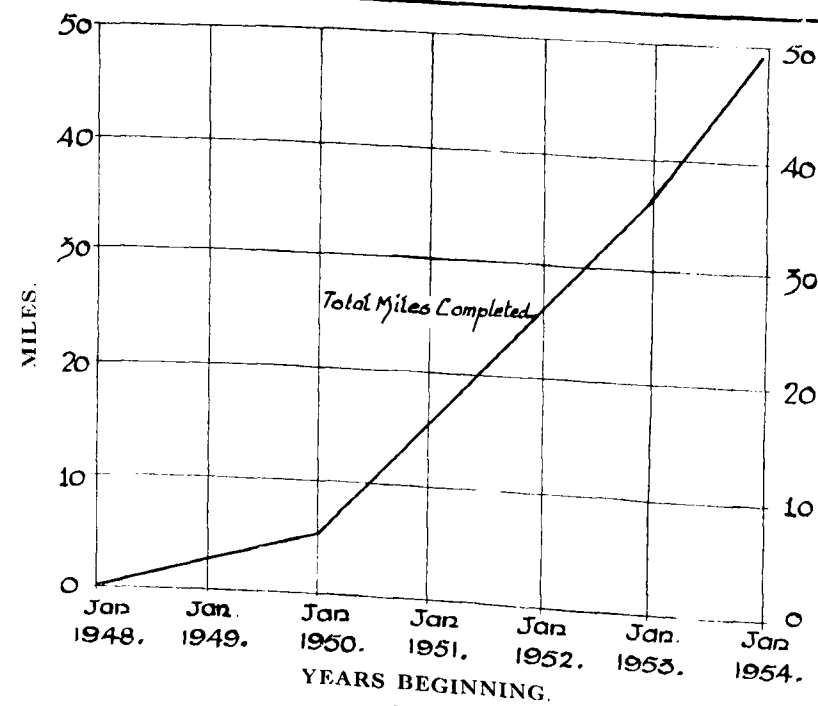
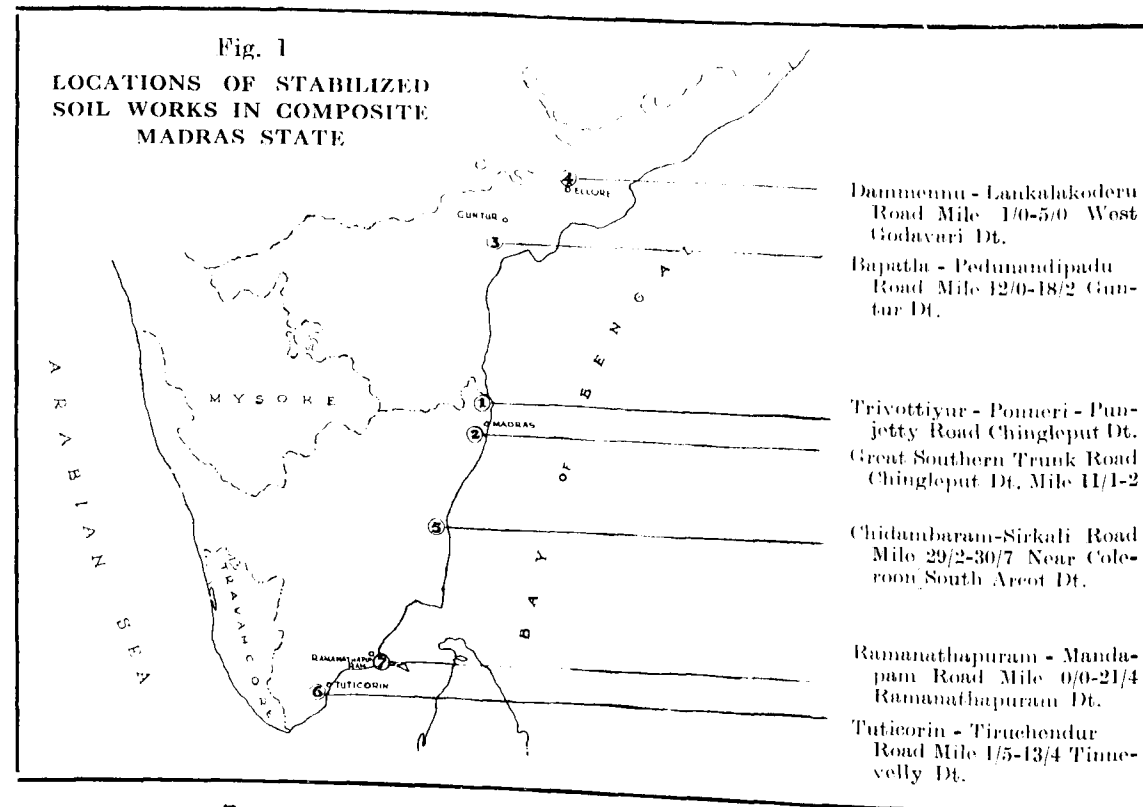


Table No. 1
THE NATURE AND TYPE OF SOIL STABILIZED SOIL ROAD WORKS TAKEN UP IN THE COMPOSITE MADRAS STATE

Sl. No.	Name of work	Nature of Sub-grade Soil	Nature of foundation courses and wearing surface				Approximate cost (per mile) by using		Equipments available for use on the work	Remarks
			*Sub-base	*Base	Wearing Surface	Berms	Stone Soling Rs 8	**Stabilized Soil Rs 9		
1 (a)	Tiruvottiyur-Ponneri-Punjetty Road 5/0-8/5 Major District Road near Madras.	Sand	—	20' x 6" Sand-Clay (1 : 1)	3 1/2" Water bound Macadam	—	18,000	8,000	Motor grader, Tractor, Sheepfoot roller, Lorry, Disc harrows, Smooth wheeled power roller.	Clay was pulverized by power roller and sieved through 1/8 inch mesh screen.
		Medium Plastic Clay	22' x 1' sand	Mooram-Sand (2 : 5)	do	—				
(b)	Tiruvottiyur-Ponneri-Punjetty Road 3/0-5/0	Medium Plastic Clay	22' x 3" sand	20' x 6" Mooram-Sand (2 : 5)	do	—	18,000	12,600	Same as per 1 (a) except Sheepfoot roller.	—
2	Great Southern Trunk Road 11/1.2 National Highway No.	Sandy Soil	10' x 6" Mooram-sand-Subgrade soil (4 : 7 : 4)	9' x 5" Water bound Macadam	4" Cement Concrete	—	21,000	17,000	do	—
3 (a)	Bapatla-Pedumandipadu Road 12/0-18/2 (Andhra State)	Black Cotton Clay	22' x 4" sand	20' x 4 1/2" Mooram-Sand (1 : 2)	3" Water bound Macadam	3' x 3 1/2" Mooram-Sand (1 : 1)	27,000	18,000 (Sub-base and Base)	do	Cost is for sub-base and base courses only.
(b)	Bapatla-Pedumandipadu Road 10/0-12/0 (Andhra State)	do	do	do	do	do	27,000	18,000 (Sub-base and Base)	do	do
4	Dammennu-Lankalakoderu Road 1/0-5/0 (Andhra State)	do	22' x 4" Sand	20' x 4 1/2" Mooram-sand (3 : 4)	do	—	22,000	19,000 (Sub-base and Base)	do	do
5	Chidambaram-Sirkali Road 29/2-30/7	Sand	—	18' x 5" Roadside Soil-clay (3 : 1)	3" Water bound Macadam	—	—	—	do	Clay was pulverized by power roller and sieved on 1/8 inch screen.
		Medium Clay	—	18' x 5" Sand-Clay (2 : 1)	do	—	—	—	do	—
6	Tuticorin-Tiruchendur Road 1/6-13/4	Sand	—	18' x 5" Sand-Clay (5 : 1)	3" Water bound Macadam	2 1/2' x 3 1/2" Gravel-sand (1 : 1)	14,000	7,500 (Base)	do	Clay power was collected by scraping a clay ground with a grader and sieving the material through 1/8 inch mesh screen.
		Clay	20' x 4" Sand	18' x 5" Sand-Clay (5 : 1)	do	do	—	2,500 (Berms)	do	
7	Ramanad-Mandapam Road 0/0-21/4	Sand	20' x 6" Sand-Clay (1 : 1)	12' x 3" Soil-Cement 8% cement	1 1/2" Asphaltic Concrete	—	25,000	11,000 (Base and Sub-base)	Pulvimixer, water pumps and equipments listed in Project 1.	Pulverizing and mixing operations were done with the pulvimixer. When pulvimixer was sick, manual operations were resorted to.

P. S.:—*The proportions of materials in the soil mixes mentioned are only typical ones for a major portion of each of the works.
**The width of stabilized soil foundations adopted were considerably more than that adopted for the conventional methods.

Collection of Materials and Construction:

(i) Moorum - Sand Mix.

The materials were collected in scheduled quantities and stacked in the form of windrows at convenient locations on the road side or nearby.

The subgrade or sub-base was strengthened, where necessary, by loosening the top 3 to 4 inches of soil and rolling it at its optimum moisture content. The surface was brought to proper camber and grade.

The materials in the windrows were dry mixed uniformly with spades, re-stacked roughly in windrows and bayed at suitable intervals. Measured quantity of water as recommended by the Laboratory, was added and allowed to soak overnight.

The next day the windrows were wet-mixed, and the mixed material was spread over the prepared subgrade or sub-base to proper camber and compacted at optimum moisture content in one or two layers. In the case of Project No. 1 the compaction was effected first by a sheepsfoot roller then by pneumatic tyred wheels and finally with a smoothwheeled power roller. For subsequent works of moorum-sand mix sheepsfoot rolling was not done.

Field Control Test: Mechanical analysis of the mixed soils was conducted where necessary to check the uniformity of the mixes obtained. The moisture content of the soil was determined at different stages during construction to control moisture. The density and bearing power of the compacted soil were determined at least in four places in a furlong.

(ii) Sand - Clay. For all sand-clay constructions in Projects 1 to 6, the clay was used in the form of a powder obtained either by moving a smoothwheeled power roller on suitably dried clay spread on a prepared ground or by scraping about $\frac{1}{2}$ to $\frac{3}{4}$ inch of the top surface of a clay ground by means of a grader. The latter method was found to be faster and easier. The pulverized clay in either method was sieved through a $\frac{1}{8}$ inch wire mesh. The

clay material used for the work was of poor or medium plasticity, and was capable of pulverization.

The construction procedure was very similar to that described for moorum-sand except that extra care was taken to prevent the clay powder from caking or getting unworkable.

In project No. 7 viz., Ramnad-Mandapam Road the clay was collected and spread to suitable depth on a prepared sub-grade and pulverized with a few passes of the pulvimixer. The pulverized clay and the subgrade soil below were intimately mixed in specified proportions by adjusting the tynes of the pulvimixer. Suitable quantity of water was supplied either through the nozzles provided in the spray bar near the mixing chamber of the pulvimixer, or separately from outside whichever was found convenient. In the former case the water was taken in a buffer tank towed by a tractor and pumped to the spray bar by means of a pump attached to the pulvimixer. The amount of water supply was controlled. The wet-mixing was done with pulvimixer and rolling effected with a sheepsfoot roller and pneumatic tyred wheels and finished with a smoothwheeled power roller.

When the pulvimixer got sick occasionally the pulverizing and mixing operations were done as in Projects 1 to 7. The other methods of operations were the same as described in the para above.

Field Control Test: The control tests on density, moisture content and bearing power were conducted as in the case of moorum-sand mix.

(iii) Soil-Cement:

The method adopted for soil-cement construction was almost the same as for sand-clay in Ramnad-Mandapam Road, except that proper amount of cement was added on to the pulverized soil or soil mixtures as recommended by the laboratory and the wet-mixing and compaction were completed within six hours of the addition of cement. The soil-cement surface was moist cured at least for a week before exposure to weather and traffic.

In all cases where the stabilized soil was intended for foundation courses only pneumatic tyred construction traffic was allowed before laying the wearing surface.

Field Experiments: A few experimental stretches of sand-clay base course have been laid in the Tuticorin-Tiruchendur Road using clay pulverized to $\frac{1}{2}$ inch size. The tentative specification adopted in all other cases provided $\frac{1}{8}$ inch size material. The field-control tests of density and bearing power on these experimental stretches showed no significant decrease in the test values. The experimental lengths are standing well.

A number of important field experiments have also been undertaken on the Ramnad-Mandapam Road using different percentage of cement for the soil-cement base and various combinations of foundation and wearing courses. The details are given in Table No. 2. The experimental portions are under observation.

Findings: To revert to the problem posed to the highway engineering profession re: the usefulness of stabilized soil road construction under conditions obtaining in India, the progress made to date in the Madras State have brought forth certain basic features of this growing science of soil stabilization. These are:

1. Stabilized soil does lend itself to a successful and economical processing with a judicious combination of manual labour and well known earth moving and construction equipments, provided necessary scientific investigations are made and suitable controls are exercised from the commencement to the completion of the project.

2. In locations where the cost of stone materials is excessively high, stabilized soil can be profitably used for all foundation courses of roads.

3. While the use of costly and specialized types of machinery enable speedy construction and could increase the efficiency of work, the limitations imposed by high initial cost, non-availability of quick servicing, adequate spare

parts for sudden replacements, and need for additional sets of highly mechanized units to engage in the so-called 'train operations' should be realized.

4. The satisfactory performance of moorum-sand berms as wearing surfaces for side traffic in a few cases is a positive proof of the suitability of the stabilized soil for improving the service quality of gravel and earthen roads in this country. Considering the immensity of the problem, further full-scale field experiments would be necessary.

5. Stabilized soil work needs extremely careful planning at the various stages of work, viz., field investigation, laboratory testing and design, supply of machinery, collection of materials, construction and field control. The construction operations should, as far as possible, be undertaken in the non-rainy seasons since moisture control plays a vital role in the whole process.

6. Each project is an individual case by itself and merits separate investigation, testing and study.

Future Trends:

1. The projects already completed should serve as important field laboratories, where studies on the behaviour of stabilized soil surfaces under traffic should furnish valuable data for the development of rational methods of design and construction.

2. Laboratory investigation on the feasibility of using local materials as lime, burnt coal ash, etc., for improving the properties of soil for road construction have been started.

Conclusions:

Soil stabilization is an old art and a new science. Despite the apparent limitations, it has an important place in low cost road construction in India. Considerable research and experimentation are necessary both in the laboratory and in the field.

Table II—Showing the Particulars of Experimental Lengths on Ramnad-Mandapam Road 0/0-21/4.

Sl. No.	Sub-base	Base	Wearing coat
Normal specification.			
	Sand-Clay 21' x 6"	Soil-cement 12' x 3" Cement 8%	Asphaltic concrete 12' x 1½"
Experimental.			
1.	Sand-Clay 21' x 6"	Soil-cement 12' x 4" Cement 8%	Asphaltic concrete 12' x 1"
2.	Sand-Clay 21' x 6"	Soil-cement 6% cement 12' x 4"	Asphaltic concrete 12' x 1"
3.	Sand-Clay 21' x 6"	Soil-cement 6% cement 12' x 6"	Asphaltic concrete 12' x 1"
4.	Sand-Clay 21' x 6"	Soil-cement 4% cement 12' x 6"	Asphaltic concrete 12' x 1"
5.	Sand-Clay 21' x 6"	Soil-cement 2½% cement 12' x 6"	Asphaltic concrete 12' x 1"
6.	Sand-Clay 21' x 6"	Soil-cement 8% cement 12' x 4"	Asphaltic concrete 1½"
7.	Sand-Clay 21' x 6"	Soil-cement 6% cement 12' x 4"	Asphaltic concrete 1½"
8.	Sand-Clay 21' x 6"	Soil-cement 6% cement 12' x 6"	Asphaltic concrete 1½"
9.	Sandy-Clay 21' x 6"	Soil-cement 4% cement 12' x 6"	Asphaltic concrete 1½"
10.	Sandy-Clay 21' x 6"	Soil-cement 2½% cement 12' x 6"	Asphaltic concrete 1½"
11.	—	Sand-clay 21' x 6"	Sand carpet 3"
12.	Sand-Clay 21' x 6"	Sand-carpet 3"	Premix asphaltic concrete 1"
13.	Sand-Clay 21' x 6"	Soil-cement 8% cement 12' x 3"	2-coat of surface dressing using for the 1st coat 4½ cft. of ½" chips and 45 lbs. of asphalt 80/100 per 100 sq. ft. and for the 2nd coat 3½ cft. of ¼" chips and 25 lbs of asphalt per 100 sq. ft.
14.	Sand-Clay 21' x 6"	Soil-cement 8% cement 12' x 3"	Priming coat of asphalt (Socofix or its equivalent .7 at 15 lbs per 100 sq. ft. 2-coat of surface dressing.—1st coat using 6 cft. of ¾" granite clay and 35 lbs. bitumen per 140 sq. ft. 2nd coat using 3½ cft. of asphalt per 100 sq. ft.
15 to 26	Items 1 to 12 repeated with priming coat (Socofix primer or its equivalent) at 15 lbs per 100 sq. ft.		

NOTE:—One set of experimental stretches has been laid from 10/0—13/0 with the experimental and normal specifications in alternate furlongs. In each experimental furlong one half was laid with a tack coat and the other half without it.

COMPACTING CONCRETE BY VIBRATION

(Extracted from *Journal of the American Concrete Institute*, June, 1953)

DRY mixes with low-slump, which tests had proved would produce the better concrete, were not favoured in the early days because of the extra effort and expense required to thoroughly compact them.

Then it was discovered that fresh concrete, even though dry and harsh, acquired entirely different rheological properties when shaken or subjected to high frequency vibratory impulses. When converted to a tremulous state, the consistency of harsh concrete changed to a plastic one, and plastic concrete became semi-fluid. Apparently, friction between various particles in the mix was reduced by the rapid vibrations to such an extent that the whole mass became fluid. When the vibrations stopped, friction again immobilized the concrete. Under violent agitation, and in the quasi-liquid state, the force of gravity caused the mix to subside and seek its greatest density.

With this discovery, an economical way for compacting unmanageable, stiff, dry concrete presented itself. Machines for imparting the quivering motion to the concrete were developed and reluctance to the use of anything but the sloppy mixes disappeared.

Advantages of vibration

The advantages of compacting concrete by vibration include: lowered costs of concrete through ease of placement and by reduced cement content; greater density and homogeneity in the concrete; greater strength; improved bond with reinforcement; greater bond at construction joints; greater durability; and reduced volume change or shrinkage.

Research on vibration

Studies have been undertaken to discover what basic conditions produce effective compaction. They have included measure-

ment of the velocity, acceleration, and amplitude imparted to concrete particles in the concrete as well as observations of the same movements by the vibrator. A conclusion from one set of tests is that frequency of vibration is of lesser importance than acceleration. For satisfactory consolidation the acceleration must be greater than some critical value, varying with the mix, but for most mixes this will be 4 g. Recent laboratory tests undertaken to determine the effect of vibration upon the characteristics of fresh concrete show that the workability of concrete, expressed in terms of deformability, change with time of vibration. The tests also indicate that, depending upon the initial workability of the concrete, deformability, may be decreased as well as increased by vibration.

VIBRATOR TYPES

Vibration has been imparted to concrete by two general methods, external and internal. The external method may be further classified to include surface vibration, form vibration, and vibration of moulds. In surface vibration, the vibrator rests or floats upon the concrete surface. Form vibration is achieved by attaching or applying the vibrating machines to the forms so that they (the forms) transmit the impulses to the concrete. Vibrating tables are used to compact precast units by placing the moulds and contents upon them. When the vibrator element is inserted or pushed into the concrete, it is said to be vibrated internally.

Surface vibrators

The platform vibrator illustrated in the upper right corner of Fig. 1 was one of the earliest types devised to impart vibrations to the surface of concrete. It has been superseded on mass concrete work, however, by one-man and two-men internal vibrators similar to those shown in Fig. 2.

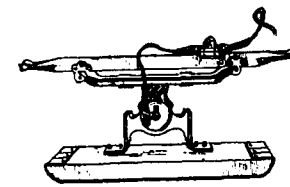


Fig. 1

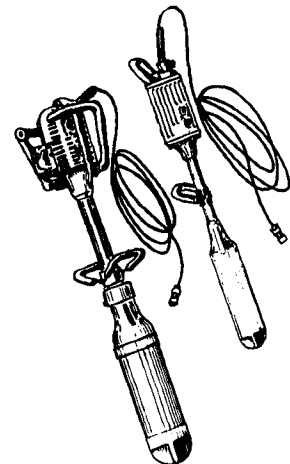


Fig. 2

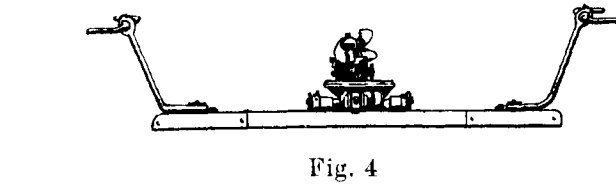


Fig. 4

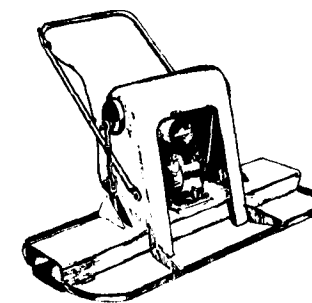


Fig. 3

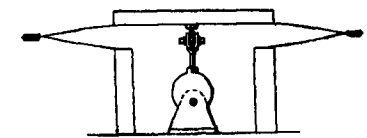


Fig. 5

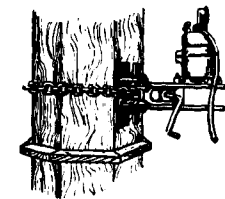


Fig. 6

Another surface vibrator, which can be operated easily by one man, is depicted in Fig. 3. When in vibratory motion very little friction exists between the screed and the concrete surface so that the operator may direct it quite freely in any direction. It is useful on all types of slabwork floors, pavements, and driveways.

The two-men vibrating screed, Fig. 4, has the vibrating element, electromagnetic, electric motor or gasoline engine drive, mounted upon a narrow and long screed. It can be used for levelling and finishing pavement or floor slabs as well as compacting the concrete in them.

Vibrating tables

In these the pulsating element is clamped to, or built into, a spring-supported table or platform which supports the moulds during the compacting period, Fig. 5. Such apparatus lends itself to precast unit production.

Form vibration

Often when concrete is to be placed in narrow forms, or in the manufacture of thin-walled concrete products, such as pipe and other precast pieces, vibration of the form itself is one of the simplest, most efficient means of compacting the concrete. This is generally accomplished by clamping or attaching to the form, one or more vibrating units comprising a built-in electric motor and eccentric, Fig. 6. Pulsating electromagnetic units are also used. They have been an aid to the manufacture of concrete block and precast concrete products by attaching them variously to block machines. These units have also been used to induce flow of granular materials from hoppers or bins, or to control the feed of such material from bins and chutes.

Internal vibrators

It is generally conceded that internal vibration is the most efficient method for

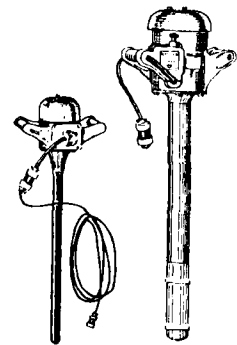


Fig. 7

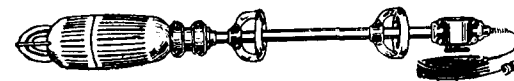


Fig. 8

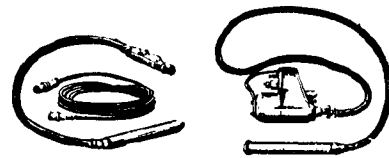


Fig. 9



Fig. 10

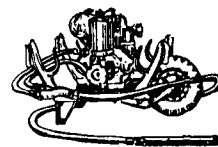


Fig. 11



Fig. 12

general construction work, and equipment for accomplishing it has found the widest usage. Vibratory motion is secured in all internal types by means of a rotating eccentric weight. In some instances, such as the ball or torpedo type, the unbalanced rotor of the electric motor, which comprises that part of the vibrator inserted in the concrete, induces the vibratory motion. In most cases, however, the motor is distinct and apart from the portion carrying or housing the eccentric unit. The connection between motor and vibrator unit may be a short spline drive, as depicted for the rigid-type vibrator in Fig. 7, or it is more often a flexible shaft sheathed in a flexible metal and rubber tube. Other types of internal vibrators are air-and oil-driven, in which designs the motors are small turbine rotors built within the spud (the vibrator element itself) and connected to the eccentric rotating weight by a spline.

Torpedo or ball type

The chattering which an electric motor must endure when comprising the vibrator spud, as in the torpedo or ball type, imposes strains on parts and bearings which result in heavy repairs and replacement. Nevertheless, this type of vibrator soon replaced the platform surface vibrator for mass concrete work. As the demands for higher frequency arose, it became

evident that wear and tear on motors could be avoided by making motor and eccentric unit separate. A grounded wire, part of the power supply cable, attached to the handle and case, is imperative for this type of vibrator to avoid the chance of electric shock to the operator.

Vibrators for mass concrete

These have been built with both induction motor and air motor drives, with motors (Fig. 2) at the top, or handle end of the vibrator. Only the eccentric weight end of this type of vibrator is inserted into the concrete. Some designs are completely rigid; others have a short flexible tube, with flexible cable drive, between motor and vibrator element. Others have that section between motor and spud bent so that the spud may easily be laid horizontally in the concrete to enable it to be used on slab work. When powered by electric motor, operating frequencies near 7000 rpm are secured by doubling the usual 60-cycle alternating current with frequency converters. Grounded lead wires are also essential to this equipment when electric powered.

High cycle vibrators

Difficulties were encountered by manufacturers in attempting to develop high speed in internal vibrator of the torpedo

or ball type. Some vibrator manufacturers have not, however, abandoned the idea of electric motors built into the spud, believing that an induction motor operating with very high frequency alternating current can be successfully built to stand the extreme vibration and jolting which it must endure. With higher frequency alternating current, much greater rpm. can be secured (which is desirable for vibrator performance), and a much more powerful but smaller motor can be built. Concomitantly a smaller rotor also reduces the load on bearings. Such a design eliminates the need for flexible shaft drive and avoids much of the maintenance which flexible cables demand. By using 180-cycle alternating current generators, frequencies of 9500-10,000. rpm. are secured. A vibrator of this type is illustrated in the top center of Fig. 2. An alternating current generator, or frequency converter (not shown), is a necessary adjunct.

Vibrator with mechanical frequency conversion

A vibrator, made in Sweden, is on the market which secures high-frequency oscillation of the spud even though the motor and the flexible cable drive operate at low (3500) rpm. In appearance it is similar to the electric motor drive type illustrated in Fig. 9. Although the flexible shaft and motor operate at low speeds (and therefore have long life and little maintenance) a simple mechanical frequency converter steps this up so that the spud itself will vibrate at 13,000 rpm.

Pneumatic drive vibrator

Air driven vibrators, illustrated in Fig. 10, avoid much of the repair and service difficulties met with vibrators driven by flexible shaft. Having a small turbine motor built into the vibrating spud, they are capable of delivering high frequencies

as long as a plentiful supply of air at sustained high pressure is provided to operate them. The illustration shows an automatic oil dispenser which trickles oil into the air supply to keep the air motor in this type of vibrator well lubricated. Alcohol can also be added in this manner to prevent moisture in the expanding exhaust air from freezing.

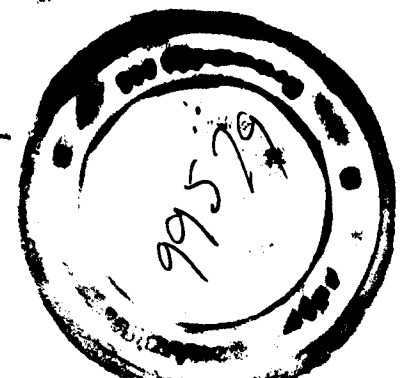
Hydraulic drive vibrator

In Fig. 11 is shown an internal vibrator hydraulically driven. The spud contains not only the eccentric weight but also a small liquid turbine motor. Oil is supplied to this motor at high pressure and in considerable flow from a gasoline engine driven pump. As return flow of oil to the pump is required, two hose lines (in contrast to one with a pneumatically driven vibrator) are necessary. The two lines are contained in a single housing from the operating valve to the spud unit for ease in handling.

Gasoline engine drive

The flexible shaft, petrol engine driven vibrator shown at the top left corner of Fig. 12 is the most popular type of internal vibrator built to compact concrete on small isolated pieces of work where electric or pneumatic power is not available. While excellent for this purpose, when kept in good repair and operating condition, experience has shown that they do not give as dependable service as the electric or pneumatically driven types. Petrol engines, driven at the speeds required for efficient compaction, require constant care, adjustment, and invariably they fail at crucial moments when need for the vibrator is greatest. The engine and mount are often too bulky to permit the vibrator to be effectively placed and moved on scaffolding or crowded runways.

5L
D411-2, N48
NS4-82



HERE AND THERE

1. A ROAD POLICY

THE argument of road users that because their contribution is so great more should be spent on roads is not relevant. It is a hangover from the origin of the taxes and the use to which they were once put. It is plausible and on the surface logical, but is really only a debating point. It would be almost as relevant to contend that because the cinema-goer pays so much entertainment tax the Government should spend more on the making of British films.

The fact is, the road user is unfairly treated and discriminated against because he is accessible carrion to the Treasury vultures. Expenditure on the roads should no longer be assessed in relation to taxation but by needs and by determining how far the national economic situation enables them to be met and what proportion of the total available capital investment could be allocated to transport having regard to the availability of materials and manpower.

Nor must road expenditure be regarded in isolation. Transport of all forms requires capital expenditure, not least the railways whose needs are second only to the roads. Railway maintenance has about caught up, but increased expenditure in modernisation would reap as great an economic reward as road expenditure. But here again it is a question of priorities not only within each transport form but as between them.

2. THE AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS COMMITTEE PROCEDURE FOR DESIGN POLICIES

THE concerned committee as a whole meets, selects and discusses the subject and agrees on a general outline for the development of that subject. Then an individual or one small group,

quite often the secretary of the committee, is assigned to work out the details. A study is begun on a particular subject: all available data are assembled, examined and a draft or first writing is prepared

Tolls and Loans

One reason why railway is more readily conceded than road expenditure is because of its simpler financing. The railways are revenue producing and their financing by loans comparatively easy. Here is a pointer to the financing of the road: Adequate maintenance should constitute no financial problem; the necessity for it is so great and the economic advantage to be gained therefrom so indisputable that it must be afforded and can be current economic conditions; finance should not be allowed to stand in the way.

When it comes to a long-term plan for major improvements and new construction serious consideration must be given to its financing otherwise than by taxation. Various proposals, of which the chief are tolls and road loans, have been made by the automobile organisations and others. To institute tolls would be retrogressive because it would reduce the advantages of new construction since their collection entails delay and their imposition would artificially influence the use made of the new roads. Further, it would be unsound financing with costs at their present level. There is much more to be said for financing by way of loan. Roads are a capital investment and initial expenditure can legitimately be spread over a number of years. By limiting the annual charges to interest and amortisation, budget difficulties need no longer serve as obstacles to urgent construction.

(Extracted from 'Modern Transport' November 28, 1953.)

for the committee. The committee members review this in detail and meet to consider it completely, indicating the adjustments, the subtractions, the additions they feel are necessary to round it out into desirable form. The assigned workers then revise the draft and the review process is repeated, perhaps a third or fourth time.

Eventually the product obtains the approval of the committee as a whole. The policy goes through a process of letter ballot by the member State highway departments. When a majority of them approve, it is considered to be adopted by the Association.

(Extracted from 'American Highways' —Oct. 1953).

3. REGULATION LIMITING SIZE OF COMMERCIAL SIGNS HELD VALID

THE Supreme Court of Florida U.S.A. has held that a regulation adopted by the Dade County Commissioners, limiting the size of commercial signs to be erected in limited and special business zones to 40 sq. ft., is a valid exercise of the police power to promote the general welfare of the public, and is not unconstitutional as being arbitrary or unreasonable.

The regulation in question was adopted by the county. Nevertheless, the owner of certain property situated in a "limited and special business zone" proceeded to erect a sign more than four times the maximum size specified, insisting that the regulation was an arbitrary and unreason-

able exercise of the police power, because there was no relationship between the object of the rule and of the health, safety, morals or general welfare of the public. The Circuit Court for Dade County refused to enjoin enforcement of the regulation.

The court agreed that the factors of health, safety and morals were not involved, but disagreed with the landowner in his contention that the restriction could not be sustained on aesthetic grounds alone.

(Extracted from the Highway Research Correlation Service, Washington, D. C., September 1953).

4. ECUADOR'S HIGHWAY DEVELOPMENT PLAN

IN Ecuador, highways are to be administered by the National Roads Commission, a corporate body to be attached to the Ministry of Public Works, which will be responsible for a project involving the planning, development and construction of the country's highway net-work over a maximum period of five years. Funds will be provided by certain taxes on

petrol, which are already imposed, a new tax of U. S. cents 4 on each gallon of petrol sold inside Ecuador, and also funds raised through taxes, charges or tolls on vehicles using highways built and maintained by the Government.

(Extracted from Highways and Bridges, November 18th, 1953).

5. RULES OF THUMB FOR CONCRETE

IN the deluge of technical literature on concrete, we frequently lose sight of basic fundamentals, states the National Ready Mixed Concrete Association (U.S.A.). In this and future notes, we

hope to state some of these fundamentals in terms of "rules of thumb" which can be easily remembered and can be applied almost universally. As a starter, we shall consider some of the factors which

affect strength of concrete. The following generalisations assume a given set of materials such as might be available to a ready-mixed concrete producer—that is to say, the rules of thumb cannot take into account sudden changes in strength-producing properties of cement or a change in type of aggregate.

1. For concrete of a given slump and a given maximum size of aggregate, the addition of one sack of cement per cubic yard, within the range of typically used cement factors, will increase the 28-days compressive strength approximately 1,000 psi.
2. For concrete having given proportions of dry ingredients, each increase of one inch in slump will be accompanied by a reduction in 28-day compressive strength of about 200 psi.
3. For properly proportioned mixtures of the same slump, doubling the

maximum size of aggregate (say from $\frac{3}{4}$ to $1\frac{1}{2}$ inch, 1 to 2 inch or $1\frac{1}{2}$ to 3 inch) will result in an increase in 28-day compressive strength of about 400 psi.

4. For properly proportioned mixtures, comparable as to cement factor and slump, air entrainment in usual amounts will affect strength approximately as follows:
 - (a) In lean mixtures, no effect or a slight increase in strength.
 - (b) In mixtures of intermediate richness, a reduction in strength of 2 to 3 per cent for each per cent of air.
 - (c) In rich mixtures, a reduction in strength of 4 to 5 per cent for each per cent of air.

(Extracted from 'Highways and Bridges', November 11th, 1953).

6. RECENT ADDITIONS TO DOCUMENTARY FILMS ON ROAD ENGINEERING.

THE Burmah-Shell Oil Co., New Delhi have presented the following films to the Film Library of Consulting Engineer (Road Development):

1. Asphaltic Bitumen

This film relates the production and use of asphaltic bitumen to its properties, in terms of physical constitution. The part the research Laboratory plays in improving the quality of the product and the efficiency of its use is also explained. The theory of the Colloidal constitution of asphaltic bitumen and the effect of this theory on the grade and type of bitumen is told in simple terms by the use of animated diagrams. The film ends with a summary of the main uses and properties

of the substance. Running time 20 minutes.

2. Hot-mix Asphaltic-Concrete

This film features the preparation of Asphaltic Concrete in a Hot-mix Plant and the subsequent machine spreading on a main road and on an airfield. Running time, 12 minutes.

3. Emulsion Retread

The film describes the process for the economical reconstruction of water-bound roads as it was carried out on two types of road, the first a country lane and the second a suburban street. Running time 15 minutes.

7. NEW ZEALAND ROADS FUND ESTABLISHED

THE New Zealand Minister of Works, Mr. W. S. Goosman, has announced the establishment of a National Roads Fund, to provide money for the development of State and main highways, and subsidies to local bodies. The fund provides for an expenditure of nearly £ 15 million a year, which will come from motorists generally, with a Government grant of £ 1 million a year. The motorists' contribution will comprise increased registration and licence fees, heavy traffic

charges, and milage and tyre tax. Petrol tax will be increased by 3d. a gallon, but this will not be passed on to the public. The fund will be administered by a Roads Board, which will comprise representatives of the Counties Association, the Municipal Association, private and commercial owners of motor vehicles, and the Commissioner of Transport.

(Extracted from 'Highways & Bridges'—Nov. 25, 1953).

8. THE OPEN ROAD

IT never seems weary, this beckoning road,
And whether the day be sun or rain,
Through many a village and stately town,
On by the farms and the fields of grain,
It takes its slender and arrowy way,
Out on the wide and wind swept plain.
There is ever a lure in the open road,
As I follow its winding way.

—Geo. D. Thompson.

(Extracted from the 'Highway Magazine'—October, 1953).

DEFINITIONS OF HIGHWAY ENGINEERING TERMS

INTERSECTION: The area common to two or more roads which meet at an angle, whether or not one such road crosses another.

BENCH MARK: A well defined permanent mark or point of known or assumed elevation used for ascertaining the levels of other points.

CURRENT LITERATURE

BOOK REVIEW

PRESTRESSED CONCRETE by Dr. Kurt Billig—Macmillan & Co., Ltd., London (1952).

During the last decade prestressed concrete has made great strides in Europe and other western countries. The text book now published supplies a long felt want.

The book is divided into three parts. The first part dealing with Fundamentals, Specifications for materials, the Plant required, contains 17 chapters.

The second part deals with the design of prestressed concrete structures, the basic principles and assumptions, the various loading stages, losses in prestress, bond and anchorages, diagonal tension,

partial prestressing, etc., and contains 19 chapters.

The third part gives a number of worked out examples, viz., beams subjected to bending, box girder, a road overbridge, Vierendeel pole for electric transmission lines, a Radio tower, shell roof, storage tank, and Railway sleepers. A worked out example on design of pavements for runways and highways is also included. Methods of prestressing road slabs are described.

A draft Code of Practice for Prestressed Concrete is included in the end.

Each chapter of the book contains an exhaustive list of references.

YES MEN

"I had some dealings with the permanent officials who determined British Far Eastern policy and found their ignorance unsurpassed except by their conceit. America has invented the phrase "Yes-men" for those who flatter great executives. In England we are more troubled by "no-men", who make it their business to employ clever ignorance in opposing and sabotaging every scheme suggested by those who have knowledge and imagination and enterprise. I am afraid our "no-men" are a thousand times more harmful than the American "yes men". If we are to recover prosperity, we shall have to find ways of emancipating energy and enterprise from the frustrating control of constitutionally timid ignoramus."

Bertrand Russell in his book—*The impact of Science on Society*—general effects of scientific technique.

SELECTED RECENT LITERATURE IN ENGINEERING JOURNALS

II. FINANCE AND ORGANIZATION

1. **Cost Control in a Country Highways and Bridges Department:** S. POOL, *Highways and Bridges and Engineering Works*, December 9, 1953, p. 3—part 1.
2. **Highway Official Call Construction Funds Most Pressing Problems for Nation's Roads:** J. ROLAND CARR, *Engineering News Record*, November 19, 1953, pp. 25-26.
3. **Economics of Highway Transportation with Special Reference to the Design of Highways for Overall Economy in Transportation Costs:** K. K. NAMBIAR, *Indian Concrete Journal*, December 1953, pp. 434-436.
4. **Some Economic Aspects of Waterway Projects:** HAYWOOD R. FAISON, *Separate No. 318, Proceedings of the American Society of Civil Engineers*, October, 1953.

III. PLANNING, LAYOUT AND SURFACE CHARACTERISTICS

5. **New York State Thruway—Construction Standards Designed to Attract Traffic:** J. B. MCMORRAN, *Civil Engineering*, September, 1953, pp. 742-745.
6. **Road Side Planting, California Highways and Public Works,** September—October, 1953, pp. 29-30.
7. **Some Problems in Planning Transportation:** P. P. SVEISTRI, *Transport and Communications Review* Vol. VI, No. 2, April—June, 1953, pp. 24-28.
8. **Shopping Centres:** LLOYD B. REID, *Traffic Engineering*, November, 1953, pp. 52-53.
9. **Redevelopment and Traffic:** WM. H. CLAIRE, *Traffic Engineering*, November 1953, pp. 54-56.

10. **New Concepts of Highway Design Standards:** D. W. LOUZENHEISER, *American Highways*, October 1953, pp. 20-22.

IV. SOIL ENGINEERING AND DRAINAGE

11. **Design and Construction of Earth Dams and Embankments in America:** S. RODIN, *Civil Engineering and Public Works Review*, Part 2, October 1953, pp. 953-955, Part 3, November 1953, pp. 1058-1060.
12. **Low-cost Compacted Earth Lining Shows Low-Seepage Losses on Friant-Kern Canal:** J. J. WADDELL, *Civil Engineering*, October 1953, pp. 684-687 and 734.
13. **Cuts Stabilized by Drilling Horizontal Drains on Lookout Point Reservoir Relocation Work:** JACK E. NEWBY, *Civil Engineer*, October 1953, pp. 688-691.
14. **Construction in Permafrost:** STANLEY F. THOMPSON, *Western Construction*, October 1953, pp. 63-65.
15. **A Deep Sewer and Inverted Syphon, York, Involving Soil Stabilisation by Freezing:** CHARLES J. MINTER, *The Journal of the Institution of Municipal Engineers*, December 1953, pp. 311-319.
16. **Grouting of Railway Embankments:** *The Engineer*, October 30, 1953, p. 551.
17. **Automatic Headgear for Tunnel Driving:** O. DAWSON & A. S. BERTLIN, *The Engineer*, October 30, 1953, pp. 553-554.
18. **Swedish Pneumatic Mining Equipment:** *The Engineer*, October 30, 1953, pp. 569-570.
19. **A Road - Roughness Recorder:** *The Engineer*, November 20, 1953, p. 680.
20. **An Investigation of the Bearing Capacity of Some Bored and Driven Piles in London Clay:** G. G.

MEYERHOF and L. J. MARDOCK, *Geotechnique*, September 1953, Vol. III, No. 7, pp. 267-282.

21. The In-Situ Measurement of Young's Modulus for Rock by a Dynamic Method; P. P. BROWN and JACK ROBERTSHAW, *Geotechnique*, September 1953, Vol. III, No. 7, pp. 283-286.

22. Consolidation of Soils (a Mathematical investigation) [Consolidation Des Sols C etale Mathematique]; J. MANDEL - , *Geotechnique*, September 1953, Vol. III, No. 7, pp. 287-299 (in French).

23. Shearing Strength of a soft Clay Deposit Near Rio de Janeiro; FRANCISCO PACHES IILVA, *Geotechnique*, September 1953, Vol. III, No. 7, pp. 300-305.

24. Estimating the true Consolidation Behaviour of Clay from Laboratory Test Results; JOHN H. SCHMESTMANN, *Separate No. 311, Proceedings of the American Society of Civil Engineers*, October, 1953.

25. The Structure of Inorganic Soil; T. WILLIAM LAMBE, *Separate No. 315, Proceedings of the American Society of Civil Engineers*, October 1953.

26. The Compaction of Soils; H. PETETMANN, *Der Bawingenieur*, October, 1953, pp. 373-374 (in German).

V. SOIL STABILIZATION AND LOW-COST ROADS

27. Soil - Cement and Concrete Roads- (Part II); *Engineering*, December 4, 1953, p. 724.

28. Soil - Cement Roads; W. P. ANDREWS, *The Journal of Institution of Highway Engineers*, October 1953, pp. 41-46.

VI. ROADSTONE AND AGGREGATES

29. Jet Piercing Method Applied to Quarrying Aggregate; *Civil Engineering*, September 1953, p. 55.

30. Size and Quality of Stone Road for Surface Dressing; A. R. LEE, *Road Tar*, Vol. 7, No. 4, December 1953, pp. 6-9.

31. Lightweight Aggregates - Expanded - Part 2; JOHN W. SHAVER, *Concrete*, November 1953, pp. 12-18.

32. Short Talks on Lightweight Slag Concrete; HENRY E. DE WEERDT, *Concrete*, November, 1953, pp. 28-29.

33. Blending Crushed Sand with Natural Sand; *Concrete*, November, 1953, p. 20.

VII. CONCRETE

34. Comparative Tests on Prestressed and Reinforced Concrete Floors During and after Fires; L. A. ASHTON, *Civil Engineering and Public Works Review*, November 1953, pp. 1035-1038.

35. Blast Furnace Cement for Scottish Hydro-Electric Scheme; *Civil Engineering and Public Works Review*, November 1953, pp. 1046-1047.

36. Fly Ash Improves Concrete and Lowers its Cost; A. S. PEARSON and T. R. GALLOWAY, *Civil Engineering*, September 1953, pp. 38-41.

37. Pressure Prehydration Increases strength of Hydraulic Cement Mortar Specimens; THOMAS H. WHITEFIELD, *Civil Engineering*, September 1953, pp. 57-58.

38. New York State Thruway -- Concrete Pavement 9 in Thick Supported by 4 ft of Selected Material; CONRAD H. LONG, *Civil Engineering*, November 1953, p. 44-46.

39. The Improvement of Concrete Strength by Electro Osmosis; Dr. A. POGANY, *Civil Engineering Public Works Review*, October 1953, pp. 931-932.

40. Lean Concrete Compacted by Roller; *Concrete and constructional Engineering*, October 1953, pp. 339-340.

41. Research on Concrete Roads; *Concrete and constructional Engineering*, November 1953, pp. 367-369.

42. The Vacuum Concrete Process; D. F. ORCHARD, *The Journal of the Institution of Municipal Engineers*, December, 1953, pp. 289-298.

43. Relation of Shrinkage to Moisture Content in Concrete Block; GEORGE L. KALOUSEK, and others, *Journal of the American Concrete Institute*, November 1953, pp. 225-240.

44. Determination of Setting and Hardening Time of High Alumina Cements by Electrical Resistance Techniques; J. CALLEJA, *The Journal of the American Concrete Institute*, November, 1953, pp. 249-256.

45. Would the Strength Grading of Ordinary Portland cement be a Contribution to Structural Economy, Notes 1, 2, 3 and 4; *Proceedings of the Institution of Civil Engineers*, Part III, Vol. No. 3, December 1953, pp. 448-479.

46. Cold Weather Ready Mixed Concrete -- Heating of Ingredients and Use of Accelerators; *Highways and Bridges and Aerodromes*, December 2, 1953, p. 4.

47. Report on the Construction of Reinforced Concrete Pavement -- Using Only Contraction Joints and the Installations of Various Contraction Joint Load Transfer Assemblies on the Eastbound Road way of the Wilber Cross Highway Route 15 in the Town of Vernon, G. ALBERT HILL, *American Highways*, October, 1953, pp. 7, 22-26.

48. Reinforced Concrete in India Today *Proceedings of the Symposium Held at Roorkee*; *The Indian Concrete Journal*, December 1953, pp. 446-455.

49. Recent Trends in Non-Destructive Testing of Concrete; K. T. SUNDARA RAJA IYENGER, *Indian Concrete Journal*, December 1953, pp. 456-460.

50. Workability of Concrete III; D. C. CHATURVEDI, *Indian Concrete Journal*, December, 1953, pp. 464-467 and 472.

51. Movements in the Structural Concrete at Conowingo Hydro Plant; STANLEY MAYER and VIGGO HANSAN, *Separate No. 308, Proceedings of the American Society of Civil Engineers*, October, 1953.

52. Non Elastic Stressing of Concrete; A. MEHMEL, *Der Bawingenieur*, October 1953, pp. 371-373 (in German).

VIII. OTHER MATERIALS AND CONSTRUCTIONAL DETAILS

53. Concrete Arch Erection at Whidbey Island; *Engineering News Record*, November 1953, p. 42.

54. Tunnels for Machkund Hydro-Electric Project, South India; *Engineering*, November, 27, 1953, p. 683.

55. Aluminium - Alloy Bascule Bridge at Aberdeen; *Engineering*, October, 16, 1953, pp. 481-483.

56. Welding of Reinforcing Bars in Reinforced Concrete Work; R. N. JOSHI and M. P. APTE, *Journal of the Institution of Engineers (India)*, September 1953, pp. 161-64.

57. American Road Construction Methods and Their Possible Application in Scotland; D. B. WATERS, *The Journal of the Institution of Highway Engineers*, October 1953, pp. 50-67 (Part I).

58. Sheving Frame Aids Bridge Underpinning; *Engineering News Record*, November 19, 1953, p. 28.

59. Open-Cut Tunnel Apply Novel Method to go Under Canal; *Engineering News Record*, November 19, 1953, pp. 67, 70-72.

60. The Construction of Tignes Dam and Malgovert Tunnel; JEAN PELLETIER; *Proceedings of the Institution of Civil Engineers*, Part III, Vol. 2, No. 3, December 1953, pp. 480-521.

61. Stabilised Soil-Cement Blocks for Building Construction; J. A. SEHGER, *Indian Concrete Journal*, December 1953, p. 473.

62. On the Practice Relating to Steel-structures After 1945 ; OTTO SUDER-GATH DER STAHLBAU, November 1953 pp. 241-254 (in German.)

XI. TRAFFIC AND ROAD USER CHARACTERISTICS

63. Traffic Studies ; — C. G. BEER, *California Highways and Public Works*, September-October 1953, pp. 31-36.
64. The "Dangerous Pedestrian" defended—a Lawyer's View of the Causes of Road Accidents ; *The Surveyor*, October 3, 1953, pp. 673-674.
65. Driver's Characteristic and Highway Operation ; T. W. FORBES, *Traffic Engineering*, November 1953, pp. 49-51.

XII. TRAFFIC MARKINGS, SIGNS AND SIGNALS

66. New Overhead Signing Used on Boston Parkway ; EDGAR F. COPELL, *Traffic Engineering*, November 1953, pp. 47-48.

XIV. SAFETY AND ACCIDENTS

67. Road Safety ; A. MUIR, *The Journal of the Institution of Highway Engineers*, October 1953, pp. 46-49.
68. Far-Side Bus Stops Cut Accidents in Tucson, Arizona ; FRED EMERY, *The American City*, November 1953, p. 129.

XV. PLANT, MACHINERY AND APPARATUS

69. Uses for Bailey Bridging ; *The Overseas Engineer*, December 1953, p. 173.
70. A Tubular-Frame Building ; *The Overseas Engineer*, December 1953, p. 179.
71. Hydraulic Power and Control of Civil Engineering Plant ; FRANK H. SLADE, *Civil Engineering and Public Works Review*, November 1953, pp. 1043-1046.

72. Dynamic Testing of Wire Ropes and Their Fasteners ; *Engineering*, December 1953, p. 734.

73. Special Instruments Measure WASHO Road Test Data ; W. N. CAREY, *Civil Engineering*, October 1953, pp. 681-683 and 733.

74. The Isodynamometer ; J. WNIGHT, *Civil Engineering and Public Works Review*, October 1953, pp. 938-942.

75. The Isodynamometer ; J. WNIGHT, *Engineering*, November 20, 1953, pp. 665-667.

76. A Jack for Tensioning Single Wires ; *Concrete and Constructional Engineering*, November 1953, pp. 369-370.

77. Performance of Jaw Crushers ; K. GAULDIE, *Engineering*, Part I — October 9, 1953, pp. 456-458 and Part II — October 16, 1953, pp. 485-486.

78. The Use of Electrical Resistance Strain Gauges on Concrete Structures ; J. C. LUCAS AND R. NEWTHAM, *Engineering*, October 16, 1953, pp. 487-488.

79. Blast-Furnace Slag Cement Plant at Cluanie Dam ; *Engineering*, October 30, 1953, p. 557.

80. Optical Marking-Off System for Plates and Sections in Shipbuilding ; IR. J. H. KRIETEMEYER, *Engineering*, October 30, 1953, pp. 570-572.

81. Lightweight Jacking Unit for Prestressing Concrete ; *Engineering*, November 6, 1953, p. 606.

82. Shop-Built Travelling Form Speeds Sewer Job ; J. R. OWEN, *Engineering News Record*, November 19, 1953, pp. 50-54.

83. A Controllable Self Propelled Vibrating Compactor ; DR. LUTZ ESLENBACH—DIE BAUTECHNIK, November 1953, pp. 337-339 (in German).

XVI. TAR AND BITUMEN (INCLUDING SURFACE DRESSING)

84. Developments in the use of Road Tar ; W. E. CINE, *The British Constructional Engineer*, December 1953, pp. 28-31.

85. 54 Miles of Highway Surfacing ; *Western Construction*, October 1953, pp. 77-79 and 103.

86. Surface Dressing in Manchester ; R. NICHOLAS, *Road Tar*, Vol. 7, No. 4, December 1953, pp. 17-19.

87. Symposium on Surface Dressing of Roads—Materials and Practice—A note on Surface Dressing of Roads ; C. L. N. IYENGAR, *The Journal of the Institution of Engineers (India)*, September 1953, pp. 123-125.

88. Fine Cold Asphalt ; H. E. CASTER, *The Journal of the Institution of*

Highway Engineers, October 1953, pp. 68-74 (Part 1).

89. Mixed-in-Place Marl Asphalt ; H. F. STANTON, *The American City*, November 1953, p. 96.

90. Wire Fabric Reinforces Asphaltic Concrete ; *Better Roads*, November 1953, pp. 27-28.

91. The Effect of Jet Aircraft on Airport Pavements : Investigations Conducted by the Corps of Engineers ; GAYLE McFADDEN, *Separate 316, Proceedings of the American Society of Civil Engineers*, October 1953.

92. The Effect of Jet Aircraft on Airport Pavements : Investigations Conducted by the Bureau of Yards and Docks ; J. A. BISHOP, *Separate No. 317, Proceedings of the American Society of Civil Engineers*, October, 1953.

(Continued from page 8)

Bridges

Seven major bridges have so far been completed and two more are nearing completion on roads other than National Highways.

The Future Programme

Rs 725.00 lakhs worth of work will be completed by about the middle of 1954-55. The State Government will be able to spend a further sum of about Rs 400 lakhs during the remaining period of the First Five-Year Plan. The necessary details of

schemes are being submitted to the Government of India.

There has been no progress on "creteways" as there was uncertainty as to whether the work should be done by the P.W.D. or the District Boards. It has now been decided that the P.W.D. should do it. A start will be made soon.

The Second Five-Year Plan has also been prepared and it is contemplated to spend a sum of about Rs 15.00 crores on road development during that period. The Plan is under consideration with the State Government.

**PUBLICATIONS ADDED TO THE ROADS WING LIBRARY
DURING DECEMBER 1953.**

1. Socio-Economic Survey of 49 Villages (A First Hand Field Work by the Author in India & Pakistan). by Dr. Karuna Mukerji (H. Chatterjee & Co., Ltd., Booksellers & Publishers, 19, Syama Charan De Street, Calcutta, 12).
2. ABHANDLUNGEN UBER BODEN-MECHANIK UND GRUNDBAU (Soil Mechanics and Foundation Engineering)—Report of the Committee on Soil Mechanics of the German Research Association). by Goerner (ERICH SCHMIDT VERLAG, Berlin, 1948).
3. Stable Concrete Mixes, Swedish Cement and Concrete Research Institute Bulletin No. 24, by Sven G. Bergstrom (Swedish Cement and Concrete Research Institute at the Royal Institute of Technology, Stockholm, 1951).
4. DIMENSION AMENTO EXPERIMENTAL DAS ESTRUTURAS—Publication No. 21 by Manuel Rocha (Ministry of Public Works, Lisbon, 1952).
5. The Bombay Civil List corrected upto 1st July 1953. (The Director, Government Printing and Stationery, Bombay).
6. 1952-Book of ASTM Standards including Tentatives—Part 3—(Cement Concrete, Ceramics, Thermal Insulation, Road Materials, water-proofing Soils). (American Society for Testing Materials, 1916, Race Street, Philadelphia 3, Pa).
7. The carriage of Dangerous Goods and Explosives in Ships. (Her Majesty's Stationery Office, London, 1952).
8. Flow in Open Channels—a chart by D. T. Thomson (The Institution of Engineers, Australia Science House, Gloucester & Essex Streets, Sydney, N. S. W.).
9. All India Civil List—A complete Directory of the Indian Civil and Administrative Services & other Higher Services Under the Union and State Governments (As corrected upto 31st March 1952). (The Associated Advertisers and Printers Ltd., 505, Arthur Road, Tardeo, Bombay 7, 1953).
10. The First Five-Year Plan (Planning Commission, Govt. of India, New Delhi).
11. Scientific Exploitation of Soil—A Popular Series Leaflet No. I, by S. R. Mehra (Indian National Society of Soil Mechanics and Foundation Engineering, Simla, 1951).
12. Mechanical Engineering, August, 1952, containing an article "A Suggested Filing system for keeping abreast of Technical Literature & General Information of Interest to the Engineer" on pp. 647-48. (American Society of Mechanical Engineer, 20th & Northampton Streets, Easton, Pa).
13. Prestressed Concrete (2nd edition). by Kurt Billig (Macmillan Co., Ltd., St. Martin's Street, London, 1952).

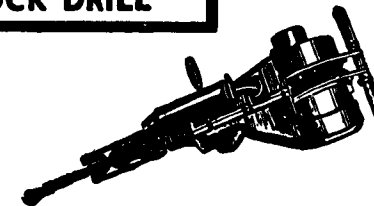
BUDGETS AND ADMINISTRATION REPORTS

1. MADHYA PRADESH BUDGET 1953-54

The following extracts pertaining to Civil Works have been taken from the Madhya Pradesh Budget for the year 1953-54 :—

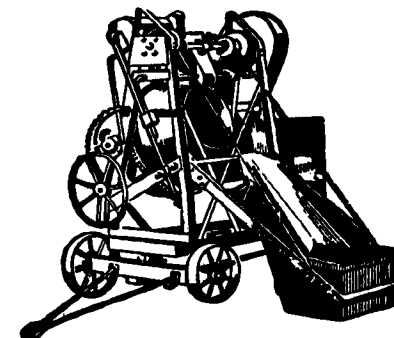
	(In lakhs of rupees)		
	Actuals 1951-52	Revised Estimates 1952-53	Budget Estimates 1953-54
I. Revenue (Civil Works)			
1. Rents	6.68	5.91	6.00
2. Ferry Receipts	3.53	3.83	3.70
3. Tolls on roads	2.17	2.14	2.14
4. Recoveries of expenditure	0.67	0.50	0.25
5. Transfers from Central Road Fund	2.30	7.00	14.75
6. Miscellaneous	3.89	2.01	1.75
7. Deduct-Refunds	-0.18	-0.22	-0.04
Total :	19.06	21.17	28.55
II. Expenditure (Civil Works)			
1. Original Works	50.70	26.99	60.15
2. Repairs	107.22	106.90	114.80
3. Post-War Development Scheme	46.08	120.34	124.82
4. Reserve	—	—	2.00
5. Suspense	-1.89	3.00	1.00
6. Grants-in-aid	0.55	3.13	1.86
7. Lump deduction on a/c of economy in expenditure	—	—	-10.00
8. Establishment	32.95	34.91	27.33
9. Tools and Plant	8.23	15.05	8.44
Total :	243.84	310.32	330.47
III. Expenditure (Communications)			
1. Original Works	27.41	8.13	15.50
2. Original Works-Post-war Development Scheme	23.60	73.34	51.61
3. Repairs	87.73	85.53	92.41
Total :	138.74	167.00	159.52
IV. Revenue From Roads			
1. Receipts under Motor Vehicles Acts	38.78	39.02	39.02
2. Sales Tax on Motor Spirit & Lubricants	33.17	37.00	37.00
Total :	71.95	76.02	76.02

WAR SOP ROCK DRILL



The most modern self-contained One Man power-tool for

1. Stone Quarrying
2. Surface Mining
3. Prospecting
4. Trenching for power, water & sewage lines
5. Breaking concrete & general demolition



BENFORD CONCRETE MIXERS

Mixers from 5 c.ft. max. input and 3½ c.ft. max. output to 10 c.ft. input and 7 c.ft. output—with Diesel, Kerosene, Petrol or Electric drives—available from stock.

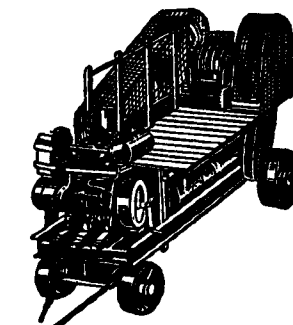
PEGSON ROAD & QUARRY PLANTS

The full range of Pegson machines includes:

1. Jaw Crushers & Granulators
2. Gyratory Crushers
3. Vibrating & Rotary Screens
4. Complete Crushing & Screening plants, capacity from 3 to 400 tons per hour.

Apply for details to:

Garlick & Co. Ltd.
ENGINEERS
JACOB CIRCLE BOMBAY II



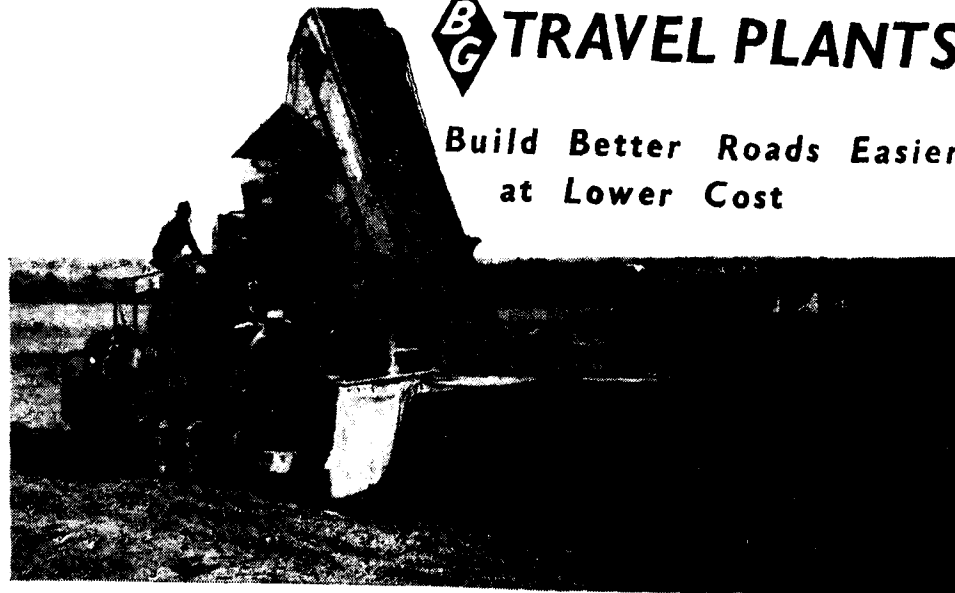
Branch Offices:

P. O. Box 168, NEW DELHI
26, Errabalu Chetty St.,
G. T. MADRAS
Cox St., COIMBATORE

Barber-Greene

B-G TRAVEL PLANTS

**Build Better Roads Easier
at Lower Cost**



Minimum Equipment—Easy to Operate

The Barber-Greene Travel Plant sets the standard all over the world for the highest quality bituminous or stabilized "mixed-in-place" materials for surfacing roads, city streets, airport runways, etc. Besides reducing the required labor force, the Barber-Greene Interlocked Proportioning and Continuous Mixing process reduces material costs.

Only in the Barber-Greene Continuous Mixer is the ratio of aggregate to bitumen mechanically interlocked. The volumetric proportioning is calibrated by weight, the ratio set and locked, and the entire job run with interlocked proportioning. The Barber-Greene Travel Plant consists of two simple units—the PORTABLE B-G

Mixer and a B-G Bucket Loader. The Loader, towing the mixer, picks up the aggregate, which has previously been placed in "windrows." The elevated aggregate is fed into the mixer hopper by the Bucket Loader.

The desired ratios of aggregate and bitumen, mechanically interlocked for positive proportioning, are fed into the twin-shaft pugmill for mixing. A continuous stream of uniformly coated mix is discharged behind the plant ready for spreading with petrol grader or the Barber-Greene Finisher.

Literature for a complete understanding of the principles and results is available. Write to:

Barber-Greene Overseas, Inc.

DISTRIBUTORS OF BARBER-GREENE PRODUCTS MANUFACTURED BY
BARBER-GREENE COMPANY, AURORA, ILLINOIS, U.S.A.
BARBER-GREENE OLDING & CO., LTD., ENGLAND • BARBER-GREENE CANADA, LTD., CANADA

Please mention this journal when replying to advertisements.

viii

Remember

BLACKSTONE

for

The Best in

PAKUR STONE

BLACKSTONE PRODUCTS LIMITED

59-60, STRAND ROAD

CALCUTTA

Phone No. Jorasanko 3348

Tele. 'BLAPROLD'



HAVE YOU CONSIDERED

"DARAKOTE"

Asphalt Anti-Stripping Agent
to improve adhesion to paving
aggregates etc.

"DAREX AEA"

Cement Air Entraining
Agent to improve cement
workability and placeability
For Better Roads?

Contact:

KILLICK, NIXON & CO., LTD.

P. O. Box 109 - BOMBAY I

Please mention this journal when replying to advertisements.

THE HINDUSTAN CONSTRUCTION COMPANY LIMITED BOMBAY.

CIVIL ENGINEERS & CONTRACTORS.

We specialize in the following:

ROADS,
RAILWAYS,
ROADS AND
RAIL BRIDGES,
FOUNDATION
WORKS,
PRE-CAST PILING
BUILDINGS,
JETTIES,

EARTH WORKS,
RAILWAY AND
HYDRO TUNNELS,
CAISSON AND
MONOLITH SINKING
BY DREDGING AND
COMPRESSED AIR,
DOCKS,
POWER HOUSES,

etc., etc.

CONSULT US FOR GUNNITING, CORE DRILLING, GROUTING
AND SEWAGE PURIFICATION PROBLEMS.

We undertake Piling Works under HINDUSTAN-ZEISSL system.

Head Office:

"Construction House",
Ballard Estate, Bombay, I.

Tele { Phone: 26036
Grams: HINCON



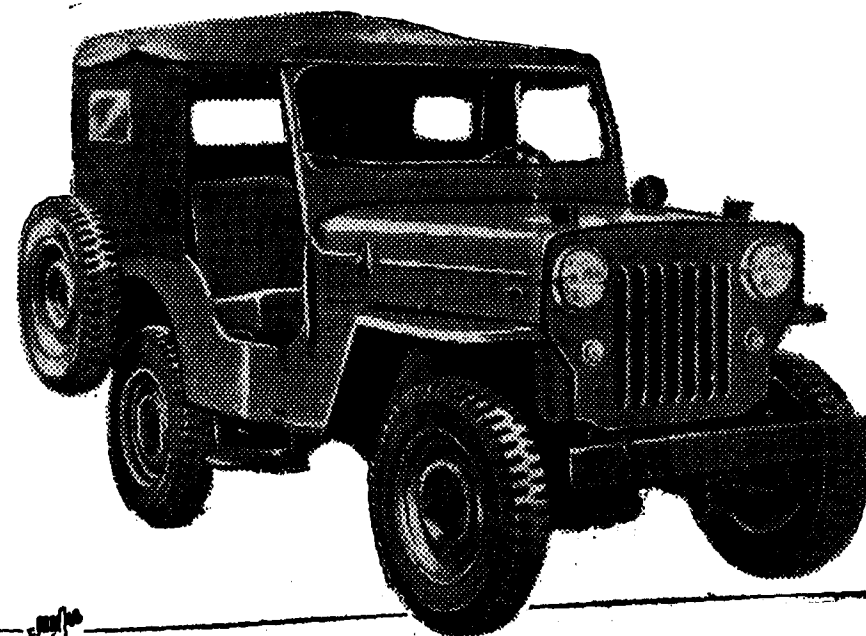
The CALCUTTA COLLAPSIBLE GATE Co. Ltd.
77, NETAJI SUBHAS ROAD (OLD 82, CLIVE ST.), CALCUTTA-1

Please mention this journal when replying to advertisements.

x

S-P-R-E-A-D costs with the 'Jeep'

With the new 4-Wheel Drive Universal 'Jeep',
you can spread the cost over a number of jobs.
Every day, 'Jeep'-owners all over India are
discovering new uses for this versatile and
rugged vehicle on and off the road.



MAHINDRA & MAHINDRA LIMITED
BOMBAY • CALCUTTA • DELHI • MADRAS

Authorised Distributors:

SPEED-A-WAY LTD., 35/5, Mount Road, Madras
MADRAS, MYSORE, COORG, HYDERABAD,
TRAVANCORE-COCHIN
WALFORD TRANSPORT LTD., 71, Park Street, Calcutta
WEST BENGAL, BIHAR, ORISSA AND ASSAM
UNIVERSAL MOTORS, 46/8, Peddar Road, Bombay
BOMBAY
NEW INDIA MOTORS LTD., 12, Connaught Circus,
DELHI, EAST PUNJAB, MEERUT,
JAMMU AND KASHMIR

NARAIN AUTOMOBILES, Shahnajaf Road, Lucknow
UTTAR PRADESH AND VINDHYA PRADESH
SIND AUTOMOBILES, Sir Mirza Ismail Road, Jaipur
RAJASTHAN
MOTORS INDIA LTD., Manorama Gunj, Bom-Agra Road, Indore
MADHYA BHARAT
PROVINCIAL AUTOMOBILE CO., Kingsway, Nagpur
MADHYA PRADESH
METRO MOTORS, (KATHIAWAR) LTD., Gondal Road, Rajkot
SAURASHTRA AND OUTCH.

Please mention this journal when replying to advertisements.

xi

For
DURABILITY
DEPENDABILITY
'HOTFIX' ASPHALT
'COLFIX' BITUMEN
EMULSION
 can be safely used
 To
ENGINEERS' REQUIREMENTS
FOR PARTICULARS
Please write to:—
Messrs McLEOD & CO., LTD.
 3, NETAJI SUBHAS ROAD
 CALCUTTA.

MILLARS' MACHINERY

Concrete Mixers—Tilting and non-Tilting Types.
Asphalt Mixers—for Hot and Cold Mix.
Roller Pan Mixers—for Mortar.
Diaphragm Suction Pumps for effective lift up to 25 ft.
Self-Priming Pumps for handling Seepage at lowest possible cost.
Tower Hoists for speedy construction.
Wellpoint Pumping Equipment for dewatering—the only successful method of combating running sand.

TIMBER
 HARDWOODS - SOFTWOODS - PLYWOODS
MILLAR'S TIMBER & TRADING CO., LTD.
 (INCORPORATED IN ENGLAND)
 VICTORIA HOUSE, VICTORIA ROAD, BOMBAY-27.

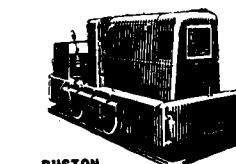
Telephone: 41077

Telegrams: JARRAH

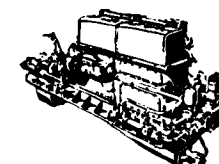
Branches and Agents throughout the World.

Please mention this journal when replying to advertisements.

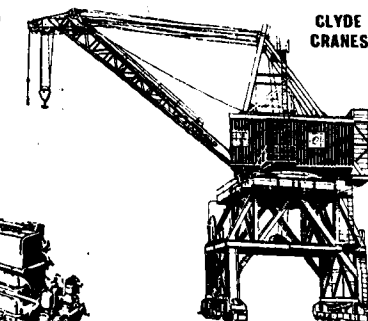
MECHANICAL EQUIPMENT For Indian Industry



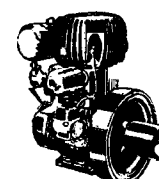
**RUSTON
DIESEL LOCOS**



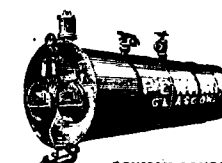
**RUSTON MARINE
OIL ENGINES**



**CLYDE
CRANES**



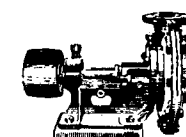
**WOLSELEY
KEROSENE ENGINES**



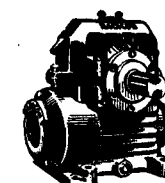
**PENMAN LANCASHIRE
STEAM BOILERS**



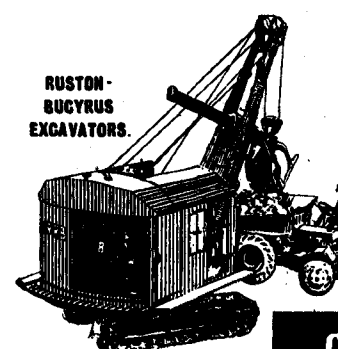
**RUSTON HORIZONTAL
OIL ENGINES**



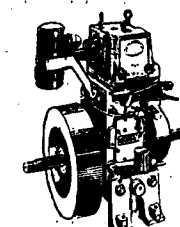
**RUSTON
CENTRIFUGAL PUMPS**



DAVID BROWN GEARS



**RUSTON-
BUCYRUS
EXCAVATORS**



**RUSTON VERTICAL
OIL ENGINES**



**STREAM-LINE LUBRICATING &
TRANSFORMER OIL FILTERS**

**AVELING-BARFORD
DIESEL SHUTTLE DUMPERS**

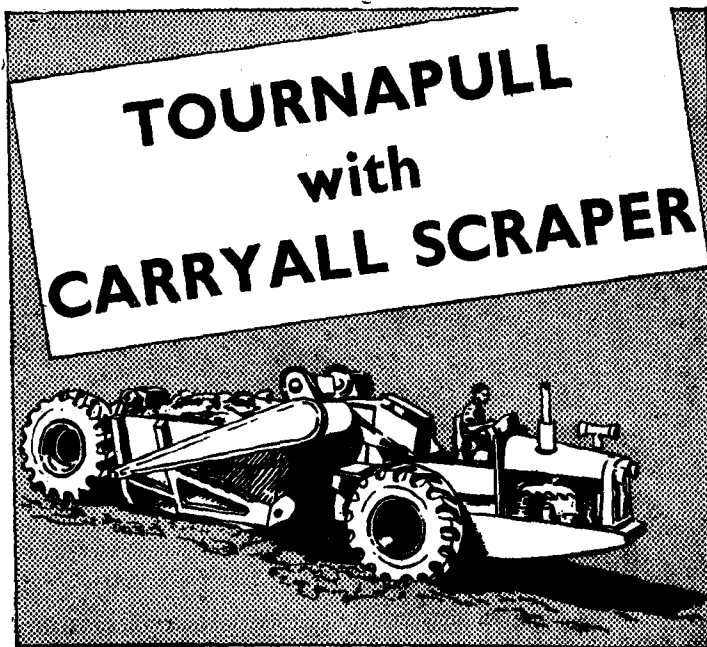
Greaves Cotton & Co., Ltd.,

Mechanical Engineering Department

1, Forbes Street, Bombay.

Branches: Ahmedabad, Calcutta, Kanpur, Madras, New Delhi.

Please mention this journal when replying to advertisements.

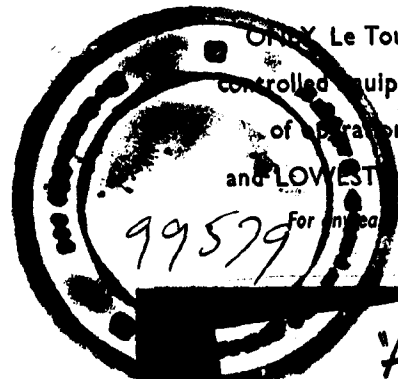


This complete unit loads, hauls and spreads
earth at speed upto 35 M. P. H.

Sizes available from 7 cu. yd. to 42 cu. yd.

ONLY Le Tourneau Westinghouse electric
controlled equipment gives you high speed, ease
of operation, trouble-free maintenance
and **LOWEST NET COST PER CUBIC YARD.**

For any earthmoving job whether big or small



"Ask Jacks"
William Jacks & Co. Ltd.
Calcutta Bombay Madras

WJX 143

JL

D411m2, N48

Please mention this journal when replying to advertisements.

N54.82

xiv

PUBLICATIONS OF THE INDIAN ROADS CONGRESS

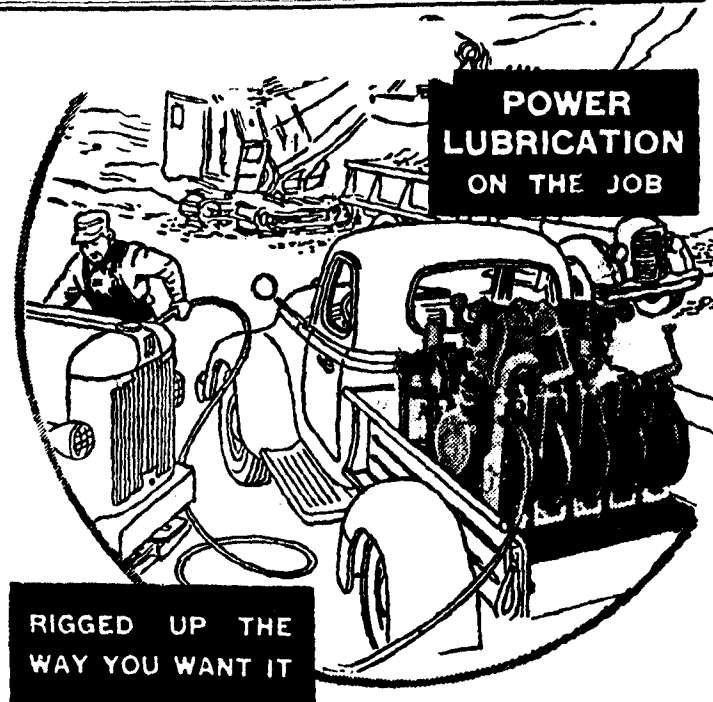
*A limited number of copies of the following
publications are available for sale.*

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—(Parts 3 & 4) 1947	6	0	0
6.	Volume XII—Part 2—January 1948	3	0	0
7.	Volume XII—Part 3—April 1948	3	0	0
8.	Volume XII—Part 4—March 1948	3	0	0
9.	Volume XII—Part 5—September 1948	3	0	0
10.	Volume XII—Bound—1947-48	12	0	0
11.	Volume XIII—Part 1—December 1948	3	0	0
12.	Volume XIII—Part 2—January 1949	3	0	0
13.	Volume XIII—Part 3—January 1949	3	0	0
14.	Volume XIII—Bound—1948-49	11	0	0
15.	Volume XIV—Part 1—September 1949	3	0	0
16.	Volume XIV—Part 2—December 1949	3	0	0
17.	Volume XIV—Part 3—December 1949	3	0	0
18.	Volume XIV—Part 4—July 1950	3	0	0
19.	Volume XIV—Bound—1949-50	8	0	0
20.	Volume XV—Part 1—August 1950	3	0	0
21.	Volume XV—Part 2—November 1950	3	0	0
22.	Volume XV—Part 3—January 1951	3	0	0
23.	Volume XV—Part 4—August 1951	3	0	0
24.	Volume XV—Bound—1950-51	9	0	0
25.	Volume XVI—Part 2—March 1952	3	0	0
26.	Volume XVI—Part 3—April 1952	3	0	0
27.	Volume XVI—Part 4—October 1952	3	0	0
28.	Volume XVI—Bound—1951-52	8	0	0
29.	Volume XVII—Part 1—December 1952	3	0	0
30.	Volume XVII—Part 2—January 1953	3	0	0
31.	Volume XVII—Part 3—January 1953	3	0	0
32.	Volume XVII—Part 4—December 1953	3	0	0
33.	Volume XVIII—Part 1—December 1953	3	0	0
34.	Volume XVIII—Part 2—December 1953	3	0	0
35.	Volume XVIII—Part 3—January 1954	3	0	0
36.	Road Research Bulletin No. 1	5	0	0
37.	I. R. C. Standard Specifications and Code of Practice for Road Bridges in India (1937)	1	8	0
38.	Proceedings of the Chief Engineers' Conference at Nagpur on the Post-war Road Development in India	2	8	0

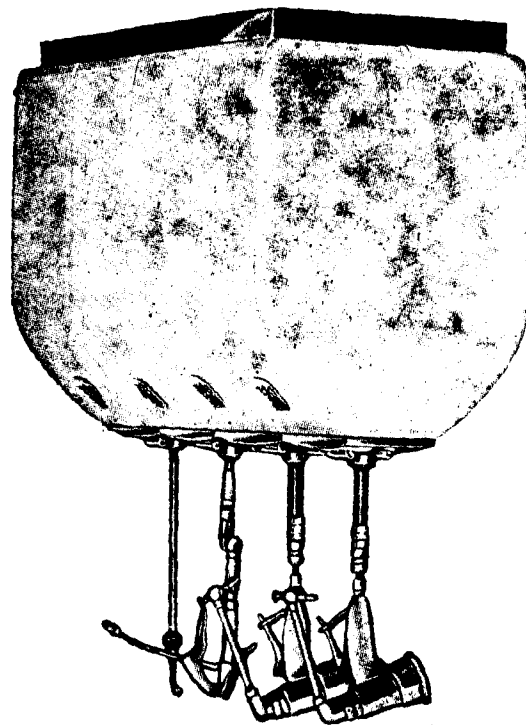
Copies can be had from the Secretary,

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

ALEMITE PORTABLE SERVICE STATIONS



OVERHEAD REELS SET-UP
SPACE SAVER



FIVE LARGE PORTABLE ALEMITE SERVICING UNITS (TRUCK-MOUNTED) HAVE BEEN SUPPLIED TO BHAKRA NANGAL AND SEVERAL MORE TO OTHER PROJECTS. AVAILABLE FROM READY STOCKS.

Nowhere is correct lubrication more vital than on dusty, dirty construction jobs...where grime and dirt in bearings can stall valuable equipment—can mean the difference between profit and loss on your hauling contract.

With an Alemite Portable Service Station you can cut your downtime for lubrication to an absolute minimum and avoid costly bearing repairs due to faulty lubrication. You can rig these sectionalized platform units for your own needs to fit a truck you already have.

THERE IS AN 'ALEMITE' OUTFIT FOR ALL TYPES OF JOBS TO SUIT INDIVIDUAL REQUIREMENTS.

Distributors:

DELHI GARAGE LIMITED

Connaught Circus

NEW DELHI

CALCUTTA: P.34 Mission Row Extension.

LUCKNOW: 10, Shahnajaf Road.