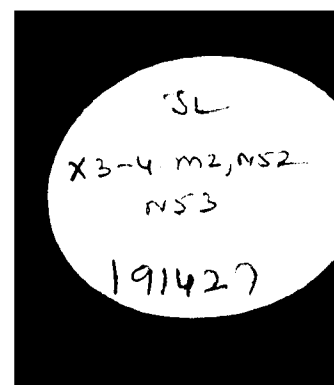


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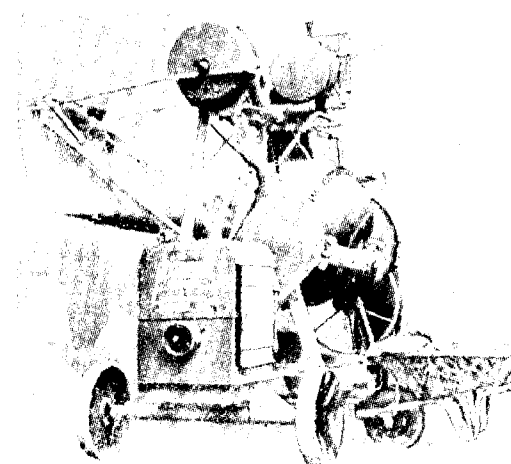
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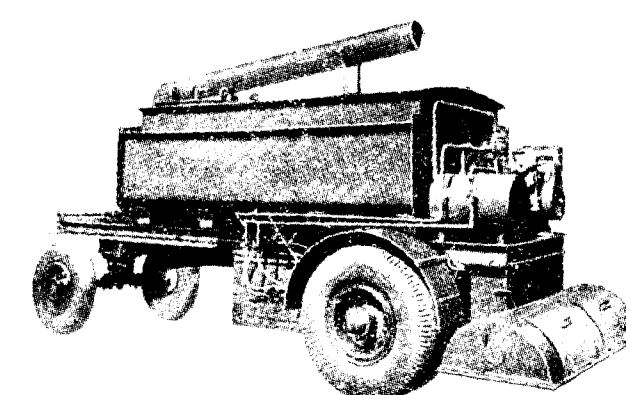
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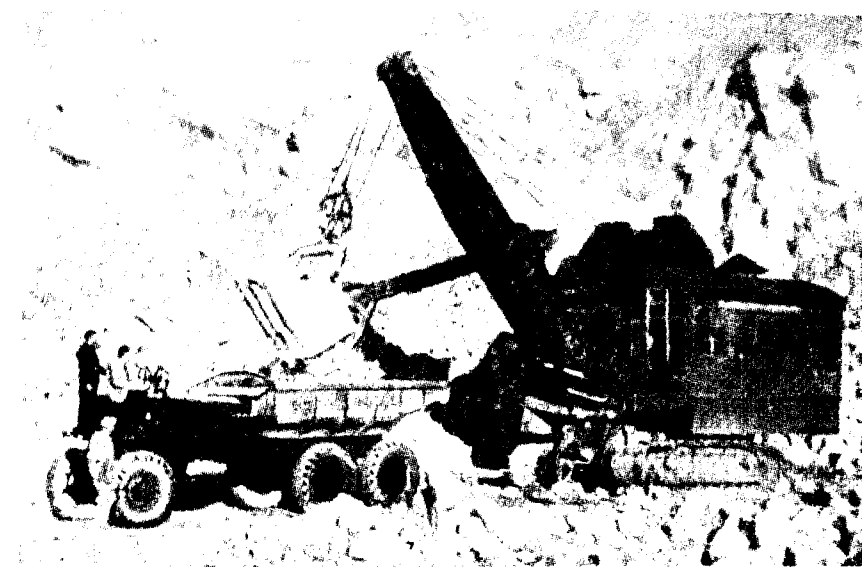
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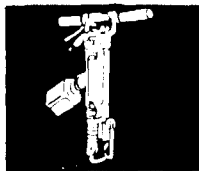
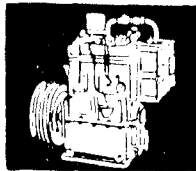
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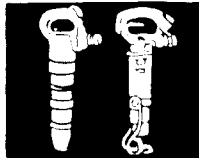
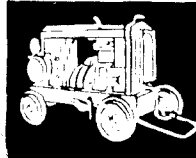
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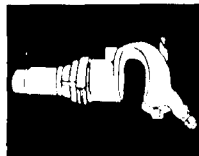
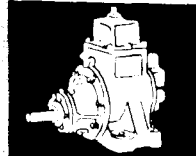
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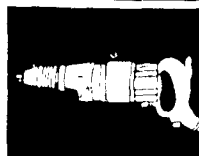
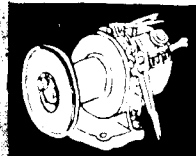
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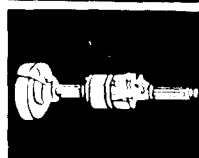
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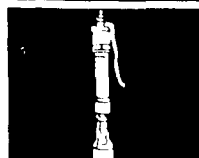
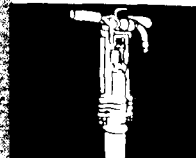
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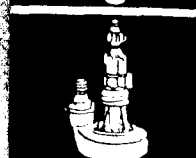
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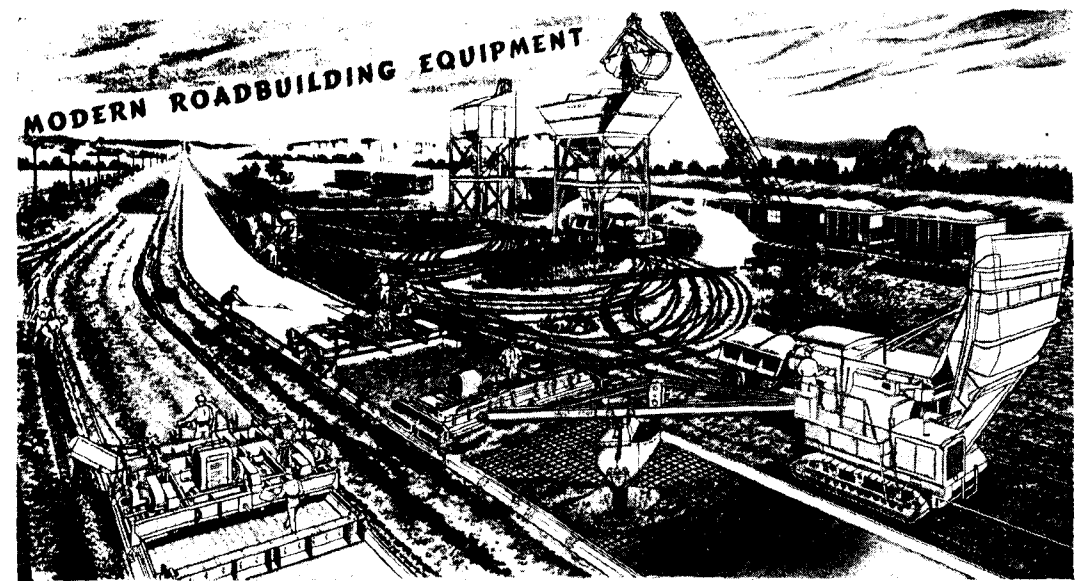
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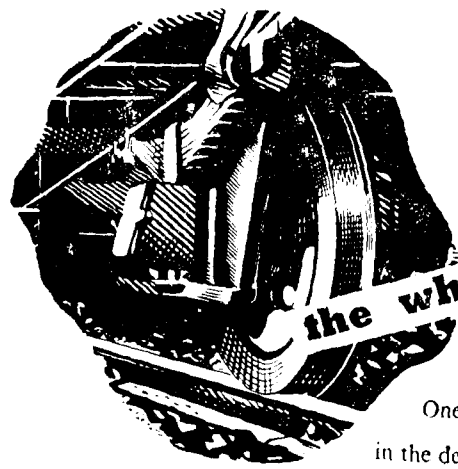
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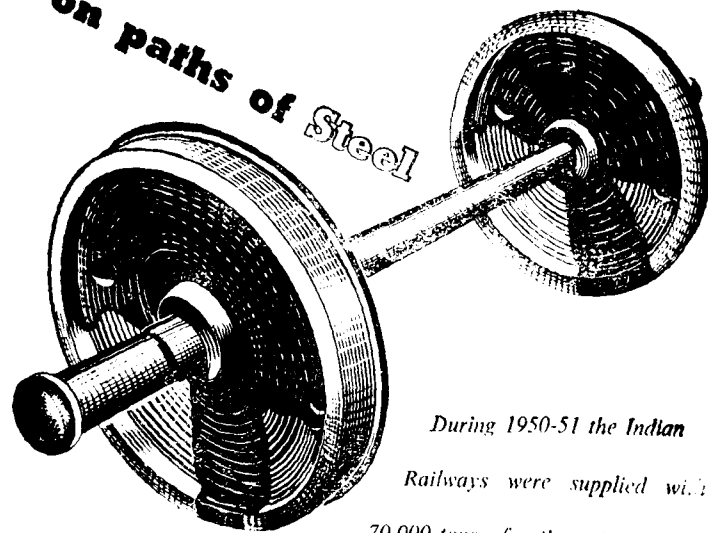
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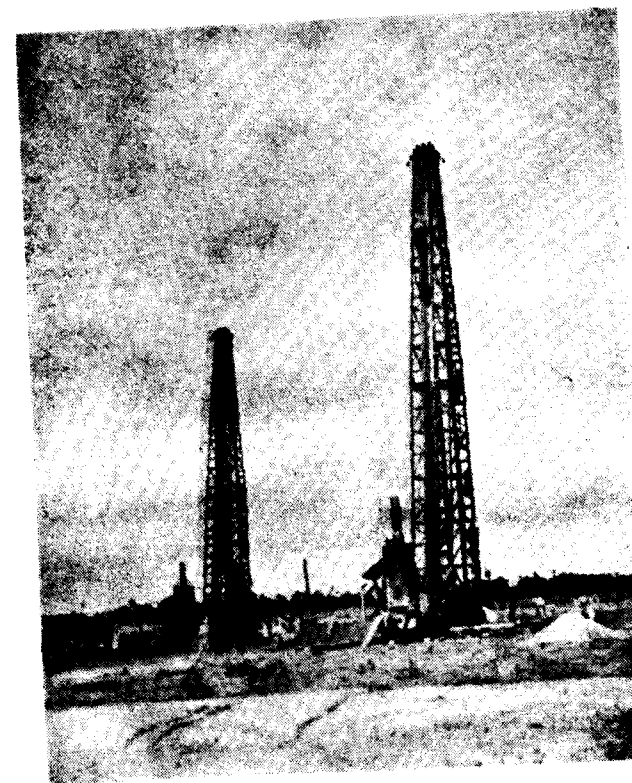
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RESEARCH ON RESEARCH WORKERS

THE last few years have seen the beginnings of many research institutes in India. The Central Government have set up eight such institutes and propose to set up another three. Some of the States have also established their own research laboratories. These laboratories have been fitted with the latest instruments devised in the most advanced countries. But stone walls or mere instruments do not in themselves provide all that is required for research: the research worker is the soul of a research institution. It is not the instrument that matters so much as the man behind the instrument.

An Engineering delegate from one of our States who went to the Lisbon Road Congress in September 1951 found the same desire in some of the less advanced parts of Europe to set up *ab initio* fully developed research stations. In Lisbon itself he saw an engineering laboratory in a fine new building, stocked with the latest types of American apparatus, some of it not even assembled and set up. Against this he found that the Road Research and Building Research Laboratories in London were housed in cheap brick sheds, though these institutions had been working for more than 20 years and were doing very valuable work.

In his report he suggested that some of the less developed countries should concentrate more on developing the spirit of research in their young men than on providing from the beginning such elaborate research centres.

So far so Good

India has given and is giving her research workers a good start in fine, well equipped buildings. So far so good. Now effort should be concentrated on training the research workers and developing the talent that is undoubtedly available in the

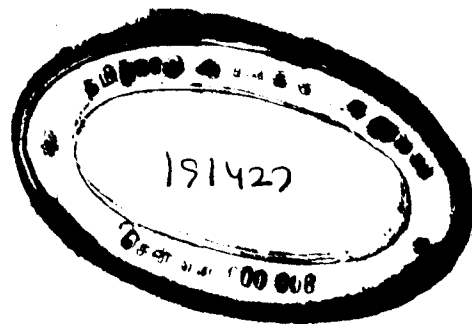
country. There is always the danger, unless the true spirit of research is recognised, sponsored, and developed, that for too long undue attention may be given to repeating experiments conducted elsewhere and the mere following of well established techniques.

Certainly the research worker must first bring himself up to date in his own line. He must first repeat the experiments conducted by others, learn their techniques, and study all the literature available on his special subject. Moreover, he must keep himself up to date in the work being done throughout the world in his own field, and so must spend long hours in the library. India has given our research workers wonderful opportunities to do this part of their work, but the research worker must not be content with this. As soon as he has found his feet, he must start work on his own lines. Here is where Government or his employer must help and here it is that he will have difficulty in convincing others that help is required.

The good research worker will find his own problems, develop his own techniques, devise and **make** his own instruments, and take infinite pains in his search after facts. He will not seek publicity nor will he be willing to publish half-baked theories or the results of incomplete experiments. Research is a slow and painful process and the best research workers are the anonymous "back room boys."

His employer will want quick results but the research worker must resist pressure put on him to come to premature conclusions and he must resist the desire for cheap publicity. He must fight undue restrictions on his freedom and he must accept only the authority of the fact as it exists and not as it might be conceived by his seniors or others.

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 therein.



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Qualities desirable in Research Workers

What are the requirements and qualities desirable in a research worker? A research project on the recruitment and training of scientific personnel for the Office of Naval Research in the United States of America was carried out recently. Activities and products of about 500 research workers were studied by observers who were themselves experienced research workers in responsible positions. The main qualifications required in a research worker were classified as follows:

- (1) **Formulating Problems and Hypotheses**—including identifying and exploring problems; defining the problems; and setting up hypotheses.
- (2) **Planning and Designing the Investigation**—including collecting background information; setting up assumptions, identifying and controlling important variables; developing systematic and inclusive plans; developing plans for the use of equipment, materials, or techniques; anticipating difficulties; determining the number of observations.
- (3) **Conducting the Investigation**—including developing methods, materials, or equipment; applying methods and techniques; modifying planned procedures; applying theory; attending to and checking details; analysing the data.
- (4) **Interpreting Research Results**—including evaluating findings and pointing out implications of data.

- (5) **Preparing Reports**—including describing and illustrating work; substantiating procedures and findings; organizing the report; using appropriate style in presenting report.
- (6) **Administering Research Projects**—including selecting and training personnel; dealing with subordinates; planning and co-ordinating the work of groups; making administrative decisions; working with other groups.
- (7) **Accepting Organization Responsibility**—including performing own work; assisting in the work of others; subordinating personal interests; accepting regulations and supervision.
- (8) **Accepting Personal Responsibility**—including adapting to associates; adapting to job demands; meeting personal commitments; being fair and ethical; showing interest in work.

In each of these categories, behaviour incidents were classified as being 'effective' or 'ineffective.' The behaviours were then consolidated as a series of fundamental actions, which were then arranged to form a check list. It was intended that this check list should be used for evaluating the effectiveness of on-the-job performance of scientific personnel.

A portion of the check list relating to sections of category (1) is given in Table 1.

About 2,500 critical incidents in the activities of these 500 research workers were collected and analysed. Evaluation of the observed activities was made on the spot.

A summary of the findings was that the differences found chiefly related to the importance of administrative behaviours for certain professional grades, and for certain scientific functions. There was some relationship in age, experience, and

education, but on the whole it was concluded that the evaluation charts could be applied without serious modification to a wide variety of scientific and engineering jobs.

TABLE 1—A Portion of the Check list for evaluating the performance of scientific personnel.

Ineffective	Effective
1. Identifying and Exploring Problems	
(1) Failed to investigate chance findings or comments suggesting a new problem.	(1) Investigated chance findings or comments suggesting a new problem.
(2) Failed to investigate results or difficulties encountered in work.	(2) Investigated completely unexpected results or difficulties encountered in work.
(3) Worked on a problem which had already been solved or proved unproductive.	(3) Chose for investigation a problem for which solution was urgently needed.
(4) Allowed a successful technique to be dropped without further application to new problems.	(4) Suggested a new problem which could be studied with an already successful technique.
(5) Overlooked a problem in current work needing further research.	(5) Proposed an entirely new problem or line of research.
	(6) Suggested that a previously unsolved problem could be studied with methods or materials recently made available.
	(7) Conducted preliminary investigations to see whether phenomena merited experimental as well as theoretical study.
	(8) Conducted preliminary investigation to furnish basic data essential to work on a practical problem.
	(9) Applied material from a current course of study to problem.

Though India is not yet ripe for such a study, research workers would do well to try and develop the qualities described in this article. Great responsibility rests on those scientists who are administering research projects, for one of their functions

is to select and train scientific personnel. The term "scientific personnel" is intended to include basic research, applied research, design, development, production engineering, testing, evaluation and administration of research programmes.

BRIDGING INDIA'S RIVERS

THE CHAVARA BRIDGE

THE Quilon-Alleppey section of the West Coast Road crosses the Trivandrum-Shoranur navigation canal at Chavara, about nine miles from Quilon. There is a rickety old bridge there which has been in a dilapidated condition for several years. As long ago as 1937 heavy traffic over the bridge was banned. Although proposals to build a new bridge were mooted in 1938 it was only in 1948 that a design for building a three-span R. C. skew bridge of the girder and slab type was approved. The estimate, based on the lowest tender, was Rs 3,99,860/-.

Later it was thought advisable to adopt a single span, bow-string girder type bridge. The canal carries a heavy day and night traffic of cargo and passenger

boats, and piers built in the waterway would have constituted a serious traffic hazard. Accordingly an all-concrete bow-string girder bridge with a central span of 104 ft 6 in. and two cantilever spans of about 20 ft each, was designed.



View of the Underside of the Decking.

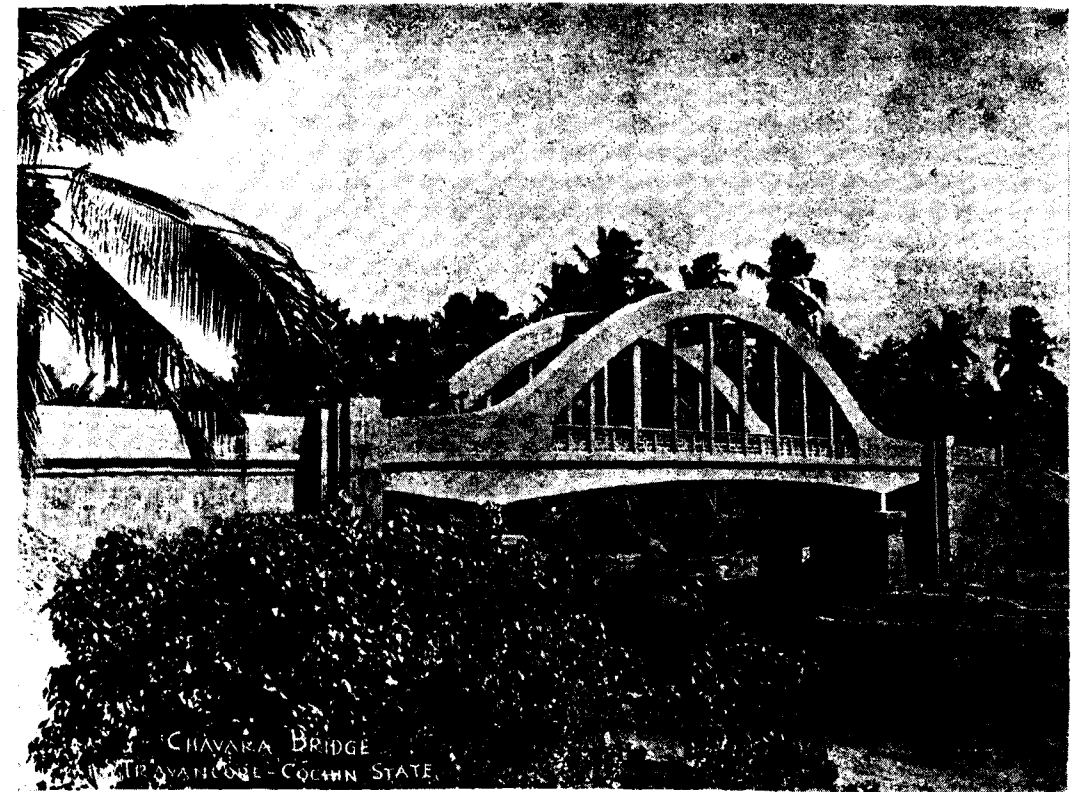
As even the lowest prices quoted by contractors were too high, the bridge was built by departmental labour. Construction started in February 1949.

To avoid the sharp curves on the approaches to the old (square) bridge, the new bridge has a skew of 60 degrees. The total length of re-designed approaches is about half a mile.

The bridge has been designed to I. R. C. Class A loading.

The total length of the bridge superstructure end to end of cantilevers is 143 ft 10½ inches.

* All photos by Courtesy of the Chief Engineer, Trayanore Cochin.



A view of the completed bridge.

The main span, 104 ft 6 in., is divided into 11 bays of 9.5 ft each, and has a rise of 21 ft (very nearly 1/5 of the span). The profile of the centre line of the arch is parabolic. At the crown the arch is 38 in. deep and 21 in. wide. The two arches are braced with two overhead wind braces. The clear distance between the arches is 21 ft and the carriageway on the bridge is 20 feet. There are no footpaths.

The deck consists of a 7½ in. R. C. slab and a 3-in. plain cement concrete pavement.

The bearings are two R. C. Rockers over one pier and two R. C. pivots over

the other. They are designed for a safe load of 155 tons.

The piers, abutments, and wing walls are of reinforced concrete. The abutments and wingwalls have shallow reinforced concrete foundations. The pier on the Quilon side is founded on 12-in., octagonal, reinforced concrete piles and that on the Alleppey side on a combination of such piles and an R. C. well. The pier foundations are protected on the canal side with interlocking R. C. sheet piles.

The volume of earthwork in the approaches was 850,000 cu. ft. Of this 225,000 cu. ft came from borrow pits and 625,000 cu. ft was dredged from the canal.



Another view of the completed bridge.
(The old bridge is seen in the background)

Costs

The bridgework has cost about Rs 2,05,000. The length including abutments being 150 ft, the cost per lineal foot works out to about Rs 1,360/-. The

approaches have cost Rs 1,40,000 including the acquisition cost of land and buildings and the rent of the dredger.

The bridge was opened to traffic August 1951.

BUSINESS RESEARCH

Two businessmen who had been very successful thought that it would be a good idea to put some of their profits into setting up a research laboratory in their works—and incidentally thus avoiding paying excess profits tax.

They consulted a famous research worker who agreed to accept employment if they provided him with a good well-equipped laboratory to his design. This was done and ultimately a beautiful and expensive laboratory was produced and the research worker moved in.

That day the businessmen had a directors' meeting, during the course of which one asked the other, "Has that research Johnny joined?"

The reply was, "He joined this morning."

"Well, let us go and see what he has discovered."

"Oh, but he has just joined, let us go after lunch."

DURING A FLOOD

(Extracted from 'The Surveyor' - September 13, 1952)

THE prime cause of the flood was a sudden cloud-burst on the night of August 15th, which happened to occur on the water shed of the two Lyn rivers running to the north and the Barle and Exe running southwards to Exeter. Nine inches of rain fell in 12 hours, a quantity that has fallen only twice in England since accurate records were kept, and then in Somerset.

Great damage was spread over a wide area; not only were houses and business premises completely washed away, cars in lightly built garages swept bodily miles down river, and many hundreds of fully-grown trees uprooted, but a great deal of stock was lost, farm fences broken down, private chattels irreparably damaged by muddy water, and thousands of tons of boulders and silt were strewn over fertile land. In other cases fertile top soil was washed completely away, leaving virtually bare rock. The whole valley of the beautiful river Barle, noted for its fishing, wide where it runs by fertile land, narrow where it runs between rocky gorges, is a scene of desolation, covered with uprooted trees. This is an extremely hilly countryside, the heights being stony moors, the valleys steep and densely wooded. Rocks and boulders abound. * * *

Blocked Bridges

Pending arrival of reinforcements, we made a hurried reconnaissance of the five bridges near Dulverton and found two of them practically completely blocked with a solid mass of large trees, many 30 ft long and perhaps 9 ft in girth, interlaced with brushwood. The others were partially blocked. The water level had already dropped some 10 ft, but it was still up to the crowns of the arches and was exerting enormous pressure on the bridges. It was this blocking of the arches that caused the damage. During the night, water had passed over the bridge approaches in a sudden rush, demolishing rows of cottages,

and leaving nothing behind, all stone, slates and other material being swept miles downstream. The current was still very strong indeed and there were large standing waves all over the river.

At Dulverton bridge, which by reason of its three small spans had caught more timber than the others, we quickly got a hand winch to bear, taken from our quarry nearby. We knew that the power winches on the way would be far more effective, but we wished to allay public anxiety as soon as possible, and, incidentally, to use men standing idle.

Two powerful R. A. S. C. mobile winches, that had previously been requested, arrived and one was sent to the Rural District Council sewage works, which were out of action, the other being kept at Dulverton bridge. This was a splendid tool for the job and was able, despite the great strength in the water, to clear one arch, after which the water level dropped 2 ft, reducing considerably the pressure on the other arches.

When the 10-ton recovery vehicle arrived, it was stationed on the bank and it did excellent work. The slow, steady pull, under complete control because of the hydraulic action, was able to withdraw the heaviest timbers to a point under the crane jib. This was then used for lifting clear of the water and dropping on to the road, when the trees were dragged by tractor to the site of a demolished cottage. Later, when lorries could work, the crane placed the timbers direct on them.

The first contractor's mobile winch was sent to the bridge immediately upstream, together with roadmen, under an engineering assistant brought down from head-office.

Sightseers Hamper Work

During the afternoon sightseers came pouring in by car. They impeded the

movement of plant and men. They craned over the bridge parapet and were in great danger should a rope have broken or a tree snapped. The police, however, kept them moving so that although we were hampered we were able to carry on. Reinforcements of men and plant had experienced a slow journey, for they had to travel along a considerable length of main road which was very popular with through tourist traffic. This traffic, always at its heaviest on a Saturday, reached its peak at about midday.

By dusk, two bridges had been cleared and immediate danger in the event of a normal storm was over.

The Assistant County Surveyor had in the meantime reached Dulverton, and on his report parties were sent to Simonsbath and Exford to clear roads of fallen retaining walls and blockages of stone washed down from adjoining land. By nightfall most of the dangerous places were known and had been lighted.

On Sunday, things were far easier. The three remaining bridges were cleared and the river fell nearly to normal summer level. Five bridges were completely demolished and eight were severely damaged. A number of footbridges were lost. A large number of retaining and parapet walls were extensively damaged and embankments washed out. There were numerous deep holes and channels caused by scour, some two feet deep beside roads and hundreds of yards long. Many surfaces had been lifted off.

Offers of help had come from various branches of the Army and contact was therefore made with the Chief Engineer, South-Western District. He readily

agreed to co-ordinate all these offers and was asked to erect one Bailey bridge for a start. Soon after he was asked to erect a suspension bridge to take the place of Tarr Steps, a famous stone footbridge.

Dangerous Trees

At our request the Devon River Board, who have authority over the two rivers, made a joint reconnaissance with us of the state of these rivers. We found that there were literally hundreds of trees, varying in size from fully-grown to withies, lying on the banks. Some were uprooted and had been transported by water great distances, while others were insecure, having been scoured out or knocked down by floating timber. While safe for the moment, these had to be cleared before the coming on of normal winter spates. Some could be hauled away by tractor, but many were in inaccessible positions, far from roads. We now had a call on 150 soldiers, but it was difficult to arrange for their supervision. The River Board called up all their available foremen and river bailiffs, who divided the military into small manageable parties and obtained excellent results.

The faults made were relatively minor. On the first Saturday works were hampered by very large numbers of sightseers. Police kept cars moving, but movement for our vehicles was slow and crowds of pedestrians got in the way. It would have been better had the police been asked to cordon off the whole area. This was done the following week-end, with noticeable benefit. Complaints subsequently came in from the public but the job was substantially finished, and we did not worry.

ULTIMATE ANALYSIS

"In the ultimate analysis the game of business is won not by star quarterbacks, but by the co operation of a corps of men and women working in harmony and a common spirit of endeavour, as a smoothly functioning unit. Management's greatest challenge in its internal problems is to create such a team."

—From 'The Engineer'—July 25, 1952.

AREA AND POPULATION OF INDIA (1951 CENSUS)

(Extracted from the Basic Road Statistics of India - Second Supplement)

Name of State	Area in sq. miles	Percentage of Area	Population ('000) 1951 Census	Percentage of Population
PART 'A' STATES				
1. Assam	54,084	4.75	9,129	2.56
2. Bihar	70,368	6.18	40,219	11.27
3. Bombay	115,570	10.15	35,944	10.07
4. Madhya Pradesh	130,323	11.44	21,328	5.98
5. Madras	127,768	11.22	56,952	15.96
6. Orissa	59,869	5.26	14,644	4.10
7. Punjab	37,428	3.28	12,639	3.54
8. U. P.	112,523	9.88	63,254	17.72
9. West Bengal	29,476	2.59	24,787	6.95
Total Part 'A' States	737,409	64.75	278,896	78.15
PART 'B' STATES				
1. Hyderabad	82,313	7.23	18,653	5.23
2. Jammu & Kashmir*	...*	...*	...*	...*
3. Madhya Bharat	46,710	4.10	7,942	2.22
4. Mysore	29,458	2.59	9,072	2.54
5. PEPSU	10,099	0.89	3,469	0.97
6. Rajasthan	128,424	11.27	15,298	4.29
7. Saurashtra	21,062	1.85	4,136	1.16
8. Travancore-Cochin	9,115	0.80	9,265	2.60
Total Part 'B' States	327,221	28.73	67,834	19.01
PART 'C' STATES				
1. Ajmer	2,425	0.21	693	.19
2. Bhopal	6,921	.61	838	.23
3. Bilaspur	453	.4	128	.04
4. Coorg	1,593	.14	229	.06
5. Delhi	574	.05	1,744	.49
6. Himachal Pradesh	10,600	.93	989	.28
7. Kutch	8,461	.74	568	.16
8. Manipur	8,620	.76	579	.16
9. Tripura	4,049	.36	650	.18
10. Vindhya Pradesh	24,600	2.16	3,577	1.00
Total Part 'C' States	68,296	6.00	9,995	2.79
PART 'D' STATES AND OTHERS				
1. Andamans	3,143	0.28	31	.01
2. Sikkim	2,745	0.24	136	.04
Total Part 'D' States and Others	5,888	0.52	167	.05
GRAND TOTAL (INDIA)	1,138,814	100.00	356,892	100.00

* Part B State of Jammu and Kashmir was not included in the 1951 Census. The area of Jammu and Kashmir is 82,258 sq. miles and the estimated population in 1950 was 4.37 millions.

PRINCIPLES OF EMPLOYMENT OF MECHANICAL ROAD-MAKING AND CONSTRUCTIONAL PLANT

(Contributed)

1. Introduction

1.1. UNDER the Five-Year Plan India has undertaken a large programme of development to be completed within a specified time. To implement this programme huge constructional works have been started all over the country. Factories are being built, new industries are being established, agriculture is being expanded, rivers are being bridged, and new ports are being developed.

1.2. To complete successfully this large programme of development within a reasonable time there must be a great increase in the use of mechanical constructional plant. Unaided by machinery even India's labour potential will not be able to cope with the work. While manual labour will continue to be used, there will be cases where it will be preferable to use machinery.

1.3. There are operations which can only be done mechanically, e.g., heavy pile driving. There are other operations which can be carried out by machines as well as by manual labour, e.g. consolidation of road metal or mixing asphaltic concrete. But these and some other operations are performed much better and much quicker by machinery than by manual labour.

1.4. Sometimes machines have to be used on works which are ordinarily carried out by hand when there is local shortage of labour or when the works have to be completed in a limited time.

1.5. When it has been decided to use machinery on a project, steps should be taken to ensure that the right type of machinery is selected and employed in such a way as to yield the most economical results. A peculiar feature of constructional mechanical plant, in which it

differs from most other forms of machinery, is that, while the plant may appear to be working normally, the efficiency of its output can vary very widely without the operator being aware of or fully realising such variations.

1.6. For instance, whereas a pump running at a constant speed delivers continuously the same quantity of water per hour with only small variations, it is possible for the quantity of stone turned out by a stone crusher to vary from two tons to ten tons per hour, simply by a slight change in the adjustment of the machine and the efficiency or otherwise with which boulders are fed into it.

1.7. Again, actual measurements have shown that in excavation by bull-dozer it is possible, for no immediately obvious reason, for one machine to give as little as 15 per cent of the output of a similar machine on a neighbouring site. When such possible variations are translated into equivalent cost per unit of outturn, it is clear that the efficiency or otherwise of an operation by mechanical methods may have a most serious effect on the cost of a project. Moreover inefficiency of operation means that the project will take longer to complete.

1.8. The steps required to obtain the best results from a mechanical plant fall under the following headings:

- (1) Planning and organization;
- (2) Operation;
- (3) Management and supervision;
- (4) Maintenance.

2. Planning and Organization

2.1. It is often not realised that machines are far less versatile and require more careful planning than manual labour.

If 1,000 labourers are brought on to a work, their distribution between the various tasks, e.g., excavating and loading earth, collecting and breaking stone, mixing and placing concrete, handling materials in general, and so on, can be adjusted from time to time to suit the amount of each type of work to be done and the relative progress of the various phases of the work. With machinery conditions are entirely different. Machines suitable for excavating earth may or may not be suitable for loading it or moving it, but will certainly not break stone or mix concrete.

2.2. The first step, therefore, in the organization of construction work by mechanical methods is to analyse the various operations which have to be performed in the course of the work and to select the right type of machine for each operation. The sizes and number of the machines of each type must then be balanced so as to ensure that the outputs of all the various machines are in due proportion to the total quantities of work to be done. For example, it is useless to excavate a large quantity of earth by excavators if the lorries or dumpers are not sufficient to move it.

2.3. In addition to planning the types, sizes and number of the machines required, the programme of work must also be carefully thought out to ensure that each phase of the work can proceed in proper sequence.

2.4. Having selected the plant required and planned the programme of work, the next step is to ensure that each machine is properly laid out, keeping in view the proper and logical sequence of operations so as to cut out unnecessary handling and long leads.

2.5. The relative levels of plant should also be decided carefully; for instance a stone crusher should, if possible, be sited between the quarry and the point where broken stone is to be delivered into trucks, and the level of the crusher should be below the former and above the latter. This will facilitate a steady movement of materials through the crushing plant.

2.6. In designing plant layouts under Indian conditions it should be recognised that certain operations, particularly those

connected with the handling of materials, can often be carried out more economically by hand. It is, therefore, important that distances should be kept short and stock piles conveniently arranged so that workmen do not get into each other's way and hinder the progress of the machines on which they are working.

3. Operation

3.1. Even with the most carefully selected and laid out plant its output depends, to a large extent, on its correct operation and the skill of the operator. It is worth while taking great trouble to ensure that operators of the right type are selected or specially trained for the work. This is very important to complete a work economically. Suppose a bull-dozer costing Rs 90,000/-, and Rs 6/- per hour for its fuel and lubricants, is capable of excavating 2,000 cu. ft of earth per hour in the hands of a good driver, it is an obvious mistake to entrust such a machine to a driver capable of obtaining an output of only 1,000 cu. ft per hour. All machines do not call for the same degree of personal skill on the part of the driver, but the driver of a machine, however simple it may be, must be conscientious in keeping his machine running steadily and efficiently.

3.2. The driver is also responsible for giving his machine the necessary daily attention by way of cleaning, lubricating, etc., and for taking prompt action if any part of the machine needs adjustment. In machine operation and maintenance, the principle of "a stitch in time" is of supreme importance. A loose bolt which can be tightened with a few turns of the spanner may, if neglected, cause the breakage of an important part of the machine. Even if such a breakage does not occur the machine may wear out rapidly.

4. Management and Supervision

4.1. Careful overall supervision is required to ensure that the machines on a job work to the programme as planned. The Engineer-in-charge must be constantly on the alert to spot idle time and to trace out and eliminate bottle-necks which, although often apparently small, may have a serious effect on the work as a whole. For instance, it may be noticed that a con-

crete mixer is not turning out its batches regularly every one and a half minutes or two minutes (or whatever the appropriate time may be). It is then the duty of the supervising engineer to find out the cause of this. Is it shortage of aggregate, sand, cement or water, or is it shortage of labour for loading these materials, or inadequate transport for taking the concrete away from the mixer as soon as it is ready? Having traced the trouble, he should remedy it immediately.

4.2. Operations should be timed frequently and careful records kept of output and time, both for future estimating (including the estimating time required to complete jobs) and for ensuring continuous efficiency of operation. If a particular operation, e.g., excavating, carrying and dumping with a tractor and scraper, takes five minutes on one trip but takes ten minutes on the next, it indicates that something is wrong and that with proper management each such trip could be completed within five minutes with consequent speeding up of output. Again, timing of successive batches in a concrete mixer might show that the crew were either attempting to rush their work with consequent adverse effect on the quality of the concrete, or, on the other hand, were growing tired or idle.

5. Maintenance

5.1. It must be the aim of all concerned to ensure that a machine does not remain idle through mechanical defects. The first step towards this is regular daily and weekly maintenance. Every machine manufacturer now-a-days gives adequate instructions as to the methods of lubrication, adjustment, etc., and the intervals at which these tasks should be carried out. The responsibility for doing the simple routine maintenance lies on the driver. Routine maintenance calling for higher skill than the driver may reasonably be expected to possess, or for tools not included in the service kit of the machine, should be carried out by trained fitters. The whole system of maintenance should be supervised by a responsible officer to ensure that it is carried out in accordance with instructions.

5.2. In connection with lubrication, it should be noted that modern machines,

diesel engines in particular, require the best quality of lubricants for satisfactory operation. In this respect the makers' recommendations should always be followed, unless the engineer-in-charge is himself a lubrication expert and can decide what may be acceptable as a substitute. The use of low-priced lubricants is unwise economy since even if their use does not cause a breakdown it will inevitably result in rapid deterioration of the machine. An actually observed case of this nature was that of a large tractor on which a common grade oil had been used. The wear after 600 hours' operation was equal to that on a similar tractor using proper lubricants after 4,000 hours operation.

5.3. In addition to routine maintenance, all machines must be overhauled from time to time. The work should be planned to allow of overhaul at regular periods, which may, as far as possible, fall between the execution of different projects or of different phases of a large project. The object in planning an overhaul programme should be to ensure that the work on the constructional job proceeds smoothly and without any dislocation. Apart from overhauls, there will of course be accidental breakdowns, but their incidence will be much reduced by careful operation and proper attention to routine maintenance. The repair organization must be such that a broken down machine can be put into service with the minimum possible delay. This calls for a **good workshop**, not too far from the site of work, trained staff, and an adequate supply of spare parts.

5.4. In the past the supply of spare parts of machinery has been inadequate in India. It is hoped that with the increase in mechanization, manufacturers and agents will improve their system for the supply of spare parts. When purchasing machines the fact whether or not the firm has an adequate spare parts organization should be a most important consideration in the selection of the make of machine purchased. At the same time, with the long distances in this country, it may not always be possible to have near the site of work a full reserve of spare parts available for every machine. All repair workshops should, therefore, be prepared to do a considerable amount of reconditioning of old parts. Also, in many

cases spare parts of certain types can be manufactured locally provided the workshops have the proper equipment for this.

5.5. The whole question of maintenance organization, including workshops, is a large one. It is strongly recommended that no department should undertake large-scale use of mechanical constructional plant unless either it can organize its own workshop service or fall back upon the workshop service of reliable firms or Government organizations.

6. Grouping of Machines

6.1. From what has been said above about planning, supervision, and maintenance, it follows that the employment of odd machines here and there is not likely to give satisfactory results, and that mechanical plant should in general be used only when the work is of such a size and the programme can be so planned, as to justify the concentration of a number of machines on one job.

6.2. As regards planning, the larger the number of machines employed the better can a proper balance be achieved between the total capacities of the machines of various types which are used for the different operations. If one machine only of a type is at work and that breaks down the whole programme is dislocated; but if say four machines are employed and one breaks down, the effect is only to slow that operation down by 25 per cent. This will have less serious effects on the work as a whole. Thus grouping enables a better plan to be made and makes it possible to follow the planned programme with fewer interruptions.

6.3. The grouping of machines leads to better operation since it produces a spirit of healthy competition and mutual encouragement among the drivers. It enables better results to be obtained from semi-

skilled drivers since they are able to obtain advice, instruction, and supervision from the more skilled and experienced drivers working close by. Grouping also leads to economy in operating staff, since for certain simple stationary machines one driver can take charge of two or more machines at a time. Further, the larger the group of machines the smaller the proportion of reserve drivers required to cover sickness, short absences, and other casualties.

6.4. The saving in the higher grade supervising staff and the greater efficiency of supervision which can be effected by grouping machines is obvious. In maintenance the gain in efficiency is still greater. The need for skilled fitter staff, and good workshop facilities within a reasonable distance has been pointed out. It is impracticable to provide these for odd scattered machines, but when mechanical plant is grouped in reasonably large 'teams', the provision of suitable maintenance arrangements is neither unduly difficult nor disproportionately expensive.

6.5. If conditions do not allow of using a team of plant on a particular job, it should be very seriously considered whether that job should be done by mechanical methods at all.

7. Conclusion

7.1. To sum up :

- (a) a considerable expansion in the use of mechanical constructional plant in India is both desirable and unavoidable;
- (b) if such plant is to be used, the achievement of satisfactory results should be ensured by proper organization, layout, operation, management, and maintenance;
- (c) machines should be grouped to obtain the highest efficiency.

ROADS UNDER FLOOD

The photos on this page show some of the roads and bridges in Cooch Behar in the floods of August—September 1952.



Photos 1, 2, & 3 show floods passing over roads which were damaged severely



Photos 4, 5, 6. Many bridges collapsed and were washed away



Photos by courtesy of Shri R. P. Chanda, Executive Engineer, Cooch Behar.



HERE AND THERE

1. REDUCING HIGHWAY ACCIDENTS

THE Table below has been extracted from the Journal of the Institution of Municipal Engineers dated the 2nd December 1947. It shows the effect and value of the following improvements made between June 1, 1935, and May 31, 1936 on all the intersections on the rural sections of four of the main roads of Oxfordshire, England.

(a) The junctions were opened out to improve vision by cutting back hedges and walls.

(b) Where the minor road did not already enter the major road at right angles, the junctions were 'squared'.

(c) All the cross roads were 'staggered', that is to say, converted from direct cross roads into two simple junctions by moving the points of entry of one of the minor roads to the left or to the right of its original position.

Reduction in Accidents by Improvement of Intersections

Accidents at 58 junctions	Average during 4 years before improvement	Average during 3 years after improvement	Reduction in accident rate
Fatal ...	11	2	76 %
Serious injury ...	22	6	64 %
Slight injury and damage only...	116	68	22 %
Total ...	149	76	32 %

Note the greater reduction in fatal and serious than in less serious accidents.

2. RESEARCH IN ENGINEERING COLLEGES

ENGINEERING schools, of whatever type of organization, should not be considered from the academic standpoint alone; account should be always taken of other contributions that may be asked of them and of their professors, in addition to that of training engineers. In this country (United Kingdom), for example, the work of research and development, as it touches engineering over the range from the most fundamental study to the most practical application, is carried out in

university departments, in Governmental research establishments, in the laboratories of the industrial research associations, and in the research and testing departments of industrial companies.

Though there are, happily, no rigid lines of demarcation between the contributions of each to fundamental and to applied research, in general the universities are looked to for fundamental research. In some countries, especially in

the smaller, in the absence of the other facilities available here, the engineering schools are called upon to provide a much greater part of the contribution of applied research necessary from the national point of view. The conditions under which the professors work in the two cases will be very different. These conditions will affect the mental attitude of the professor, and thus his methods of teaching his subject, two things which will go far in determining the outlook of his pupils.

Again, we work in this country against a background of special libraries, such as those under Government direction at H. M. Patent Office and at the Science Museum, and those of the engineering and scientific societies. If these were not available, the technical and scientific libraries of the universities would be called

ed on to render general services to the country; this would change their character from that of easily-accessible specialist collections of books to that of highly-organized reference libraries.

In addition, in this country, through the media of the scientific and technical societies and of a highly-developed scientific and technical Press, publication of the results of research and other new work is well provided for, and our professors of engineering do not need to concern themselves unduly in that field. In smaller countries, the principal means of publication depend often, and necessarily, on the editorial activity of certain professors.

(Extracted from 'Engineering' - July 18, 1952)

3. AN UNHAPPY EXPERIMENT

WORKMEN were cleaning up several blocks of Chicago streets last week in the final phase of an unhappy paving experiment on busy Michigan Avenue Bridge.

The experiment was a test installation of a recently developed pelletized rubber for surfacing bridge decks and playgrounds. An asphalt emulsion had been sprayed on the asphalt planks of the bridge floor, after which the rubber pellets (about $\frac{1}{4}$ inch in diameter) were spread over the surface.

The day was hot.

Tyres of automobiles passing over the bridge—instead of pressing the pellets tighter to the bridge deck—picked them up

(along with gobs of sticky asphalt) and spread them along Michigan Avenue for several blocks. The pellets also were slung by tyres and attached themselves to pedestrians, cars and the bridge sidewalls.

Sand was hastily dumped on the deck in an attempt to dry up the mess. Trouble was, the bridge had to be opened for a ship, and when the two bascule leaves were raised the sand became airborne, further harassing pedestrians and motorists.

Chicago officials attributed failure of the experiment to failure of the asphalt emulsion to harden as had been expected by promoters.

(From 'Engineering News Record'—August 21, 1952.)

4. A "FIT" HOUSE

IN order to qualify for improvement grants under the Housing Act, 1949, a house in Britain must, after the proposed improvements, come up to the standard of a "fit" house. Although this term has not been legally defined, a definition has come to be established in practice.

The standards of fitness recommended by the Central Housing Advisory Committee are that the dwelling should:

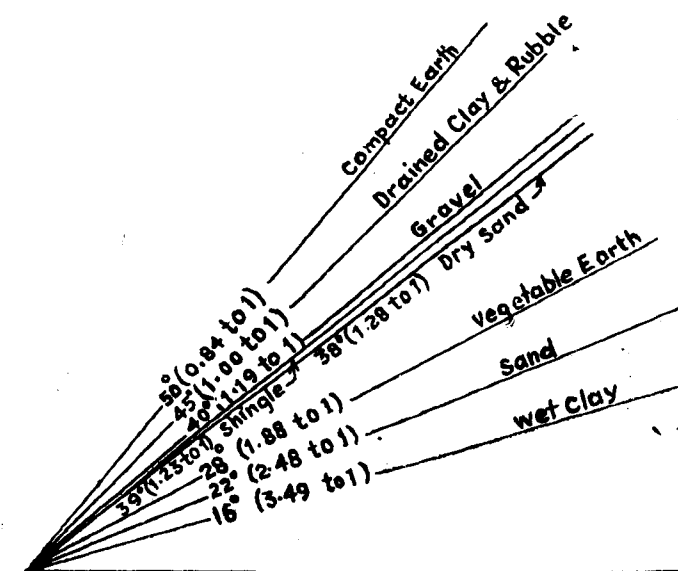
- (i) be in all respects dry;
- (ii) be in a good state of repair;

- | | |
|---|--|
| (iii) have each room properly lighted and ventilated; | (x) have a proper drainage system; |
| (iv) have an adequate supply of wholesome water laid on for all purposes inside the dwelling; | (xi) be provided with adequate points for artificial lighting in each room; |
| (v) be provided with efficient and adequate means of supplying hot water for domestic purposes; | (xii) be provided with adequate facilities for heating each habitable room; |
| (vi) have an internal or otherwise readily accessible water closet; | (xiii) have satisfactory facilities for preparing and cooking food; |
| (vii) have a fixed bath, preferably in a separate room; | (xiv) have a well-ventilated larder or food store; |
| (viii) be provided with a sink or sinks and with suitable arrangements for the disposal of waste water; | (xv) have proper provision for the storage of fuel; |
| (ix) be provided with facilities for domestic washing, including a copper, preferably in a separate room; | (xvi) have a satisfactory surfaced path to out-buildings and convenient access from a street to the back door. |

(Extracted from 'The Surveyor'—September 13, 1952).

5. NATURAL SLOPES OF EARTH WITH THE HORIZONTAL

The formation of batters or side slopes ensure that there is no slipping, the resistance to slipping depending solely upon



NATURAL SLOPES OF EARTH WITH THE HORIZONTAL

the natural adhesion, i.e., friction, between the particles of the earth concerned. The presence or absence of moisture may make a great deal of difference to the natural angle of repose of the earth particles or grains.

Alternate frost and thaw will particularly tend to destroy any adhesive qualities. The nature of the soil, therefore, has everything to do with the fixing of the inclination of batters and side slopes. The angle of inclination at which a soil will remain quite stable by friction alone, without slipping or sliding down, is termed the natural slope.

The following table, which was given to me some 25 years ago and which I have found very helpful, gives the **natural slope** for various kinds of soil.

Earth	Angle of Repose	Designation of Natural Slope.
Wet Clay	16 deg.	3.49 to 1
Sand	22 „	2.48 to 1
Vegetable earth	28 „	1.88 to 1
Dry Sand	38 „	1.28 to 1
Shingle	39 „	1.23 to 1
Gravel	40 „	1.19 to 1
Drained Clay	45 „	1.00 to 1
Rubble	45 „	1.00 to 1
Compact Earth	50 „	0.84 to 1

(Extracted from 'Highways & Bridges'—October 1, 1952.)

6. ECAFE'S HIGHWAY CONFERENCE IN BANGKOK

ALL over Asia today, road construction is in the forefront of economic planning and there is considerable interest in ECAFE's activities in this field. The session of ECAFE's highway sub-committee, which was held in Bangkok from August 18 to 23, 1952, dealt with certain specific proposals designed to speed up road construction and to save Governments money by making road construction and maintenance more economical.

Road Registers

Perhaps the most important of these proposals, on which work has been going on for some time but which have now been finalized, is the highway inventory. A standard form has been evolved to record highway expenditures in a manner that will permit comparisons being made of the construction and maintenance costs of various types of the highway system, correlated to traffic using the road. A study of the performance records of the various types of road surfaces and their useful 'service lives' is essential for balanced economic road development.

The inventory will also show the present value of the total capital investment on the asset from its earliest stages of evolution to the present date, and the amounts

spent from time to time to preserve the asset.

This register will, above all, form the basis for all future programming and planning of all new construction and improvement of existing highways.

Registers for Bridges

Other standards discussed were those for recording in a uniform manner all data on bridges and concrete roads. These would form useful adjuncts to the Highway Register.

Standard Forms for Road Projects

The outstanding document discussed related to the preparation and presentation of project schemes in a uniform manner for quick engineering appreciation and administrative and financial sanction. There is urgent need for such a guidance as in several countries of the region works were under way involving the preparation by several officers of a large number of estimates and plans for project schemes varying widely in their types, scope, specifications and traffic requirements.

The form prepared by the Secretariat was very comprehensive and detailed to meet all requirements.

Instruction Manual

On the transport side the sub-committee expressed considerable concern over the delay in compilation of standard instruction manual for motor vehicle drivers and mechanics and it strongly urged the

ECAFE secretariat to take this up as a regional project, either with ILO or Technical Assistance Administration.

A special resolution was approved urging that immediate steps be taken for the early completion of the manual.

7. BEAUTY IN BRIDGES A PLEA

IT is by no means certain that the inflection of totalitarian austerity as exemplified by the withholding of all ornamentation from national and civic buildings, even in times of extreme stress, is in the long run to the public advantage. The people are liable to become starved of opportunity for exercising aesthetic perception and they subconsciously crave after some display of ornament. Artists, sculptors and other craftsmen despair of ever finding patronage and the machine assumes dictatorship.

In the rough and tumble of city life it is soothing to be able to contemplate examples of gracious handicraft and there is no

better place for the display of some works of art in stone and metal than on or near a big bridge where both natives and visitors love to linger and look about them.

Continental cities have suffered too, many of them more than London, but they do not disdain to provide moral edification in artistic masterpieces as adornments of their civic structures. There is always time, in the feverish pursuit of material objectives, to pause to admire, and to be enlightened by artistry.

(Extracted from 'Roads & Roads Construction'—Aug. 1952)

8. ROADS IN THE PARLIAMENT

REPLYING to Shri Rishang Keishang (Outer Manipur Res-Sch. Tribes) on the 10th December 1952, the Deputy Minister for Railways and Transport, Shri O. V. Alagesan, said that prior to the integration of the Manipur State to

the Central Government a total amount of Rs 70,500/- had been spent on the construction of the road between Litan and Ukhrul. The Government had not abandoned the idea of completing the said road.

9. THE EFFECT OF LOW TEMPERATURES ON REINFORCED AND PRESTRESSED CONCRETE BEAMS

IN an article in the Belgian magazine "Precontraint" (No. 1, 1952), M. G. Huyghe describes tests carried out at the University of Ghent to determine the effect of low temperatures on reinforced concrete and prestressed concrete beams. Two reinforced concrete beams of T shape and two prestressed concrete beams of I shape were made. The reinforced beams were 24 in. deep with a web 6 in. wide and an upper flange 12 in. wide by 3½ in. deep. The prestressed concrete beams were 15½ in. deep with webs 2 in. wide and flanges 12 in. wide by an average of

2 in. deep. The beams were 21 ft long overall and were tested in bending on a span of 19 ft 8 in. One beam of each type at an age of 28 days was placed in an insulated wooden box and prisms of carbon snow were placed along the webs; after thirty-six hours in the boxes the temperature of the beams was lowered to 43 deg. C. The beams were then removed and loaded to destruction, the temperature of the beams at the end of the test being -40 deg. C. The remaining two beams were tested at normal temperatures in a similar manner.

The tests showed that

(a) The modulus of elasticity increases as the temperature drops from 20 deg. C. to -40 deg. C. (this is confirmed by the reduction in deflection of the beams);

(b) The tensile strength of the concrete is at least doubled as the temperature is lowered to -40 deg. C.;

(c) The compressive strength of the concrete is increased considerably under the same conditions.

A comparison of the behaviour of the beams tested at normal temperature showed that there was a considerable increase in the load required to cause failure in both the reinforced concrete and the prestressed concrete beams at -40 deg. C., and that the load first causing cracking was much nearer to the ultimate load.

(Extracted from 'Concrete & Constructional Engineering' - November, 1952)

THE LESSONS OF WAR AND PEACE ARE THE SAME

In Peace

"I have come to the conclusion that one thing to which we must give topmost priority is roads—roads of all kinds, not only very up-to-date bitumenized or cement roads, but roads of any kind, to open out vast areas of this country which are closed up today and which you cannot reach unless you walk or ride.....I give roads first priority."

Shri Jawaharlal Nehru.

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

Lord Wavell.

In War

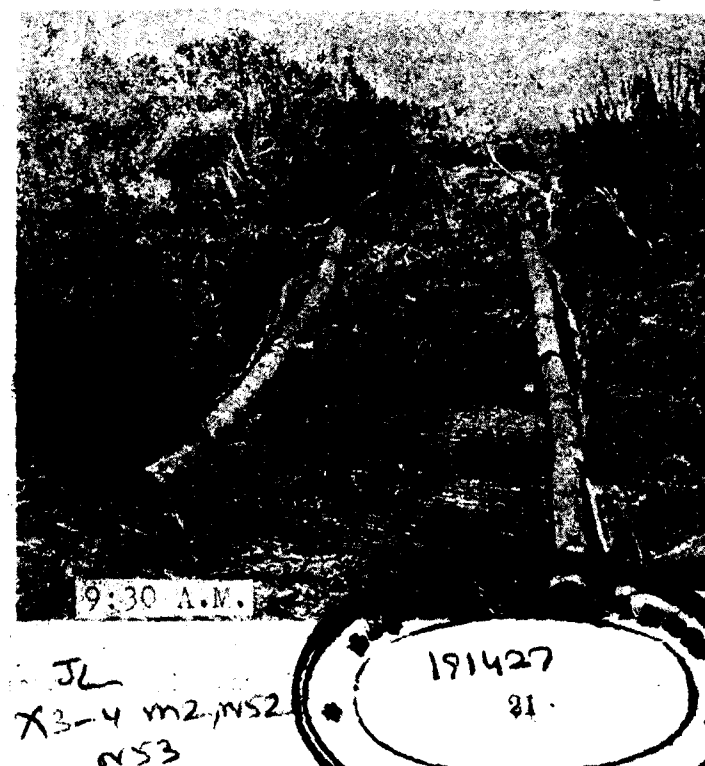
"The more experience I have had of both peace and war, the more I appreciate its general truth. After some years in high military command, I am inclined to put forward as a parallel dictum that 'War is Transportation.' Certainly it is the ruling factor in military operations; and no campaign has better illustrated this than that on the North-East frontier of India and in the north of Burma."

Lord Wavell.

BUILDING A ROAD ON A SWAMP

IN September 1951 we published brief extracts describing how an experimental light-weight cellular concrete road was poured directly on the surface of a swampy bog and supported a 5,750 lb. truck six hours after pouring.

Further details have been obtained from Messrs. Higgins Incorporated of New Orleans, who have developed this light-weight concrete and are given here. The experiments were carried out to prove that a roadway of light cellular concrete could be poured over water-soaked and unstable soil, thereby providing a roadway or a surface for landing aircraft or dispersal areas in swampy regions.



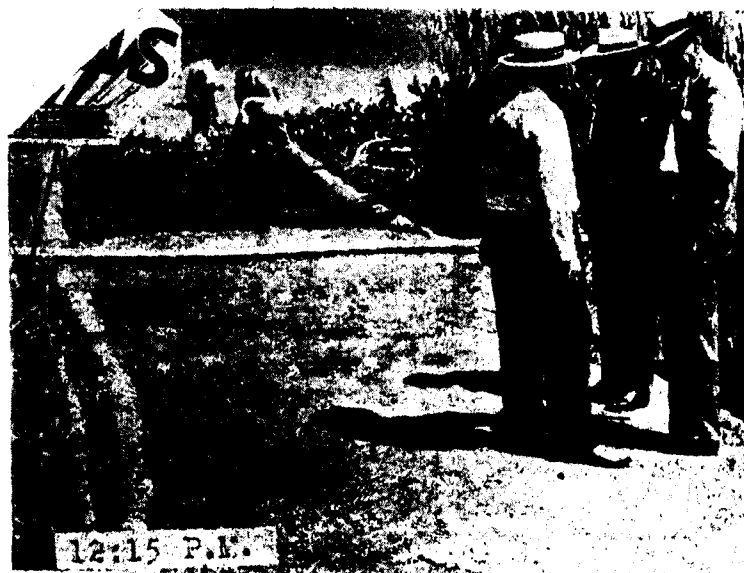
In the first experiment (carried out in August 1950) the site selected was a swampy bog, caused by a drain outfall, having approximately 2 in. of flowing water running across it. The site was located between a roadway and a canal and was roughly fan shaped, being about 20 ft wide at the road and fanning out to approximately 75 ft at the canal.

Attempts were made to walk from the road to the canal, but were discontinued as one would sink up to one's hips in the soft muck. Planks were then laid on the surface of the bog

for support and from these platforms it was possible to cut the cat-tails, cane, weeds, and undergrowth to form an opening approximately 12 ft wide.

A slanting approach from the edge of the road to the edge of the bog was then bulldozed and two layers of 4 in. x 4 in. x 6/6 wire mesh were laid on the surface of the marsh. Two rows of log-cores were then laid in parallel rows 8 ft apart on each side of mesh to retain the concrete on the edges. High chairs for the support of the top layer of mesh were then made of the same mesh, bent so as to form an angle support standing 7 in. high. These were set on top of the bottom layer of mesh 7 ft on center and a third layer of 4 in. x 4 in. x 6/6 mesh draped across the top of these high chairs.

Water for mixing was pumped directly from the canal and was muddy and brackish (exact salt content not determined).



An attempt was made to maintain a thickness of 8 in. but on account of the uneven ground it is assumed that the slab varied from 6 in. to 12 in. in depth.

Summary

Road obtained	8 ft 4 in. wide x 78 ft long
Sacks cement used	192
Pouring time	95 minutes
Cubic footage of cellular concrete	480
Sq. footage poured	650
Rate poured	5 cu. ft or 6.84 sq. ft per minute

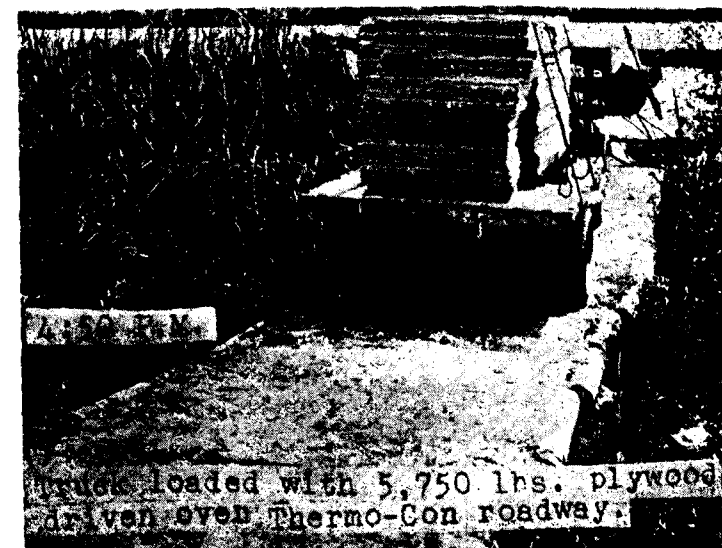
Observations

(1) The Cellular Concrete supported the weight of a 225 pound man in 1 hour 10 minutes.

(2) Six hours after the roadway was poured a truck having a total weight of 5,750 lb. was driven on to the slab. No impression was made in the surface

nor was there any indication of cracking, fatigue, or displacement. Future tests may show that the time can be further reduced.

The second experiment was carried out (in December 1950) by a U. S. Naval Research Laboratory in conjunction with M/s. Higgins Inc. The site selected in this case was at the end of a tidal lagoon which was subject to two tidal actions a day. At full tide the water was approximately 3 ft to 4 ft deep and at low tide the site was empty of water.



Roadway poured partway across tidal flat at Point Mugu, Calif.

Inspections at low tide proved the bottom to be of a saturated mud composition and analysis proved it to be of 50 per cent water content. Average depth of this mud was 7 feet.

Forms

Forms were constructed in 20 ft sections. The sides were of 2 in. x 12 in. planks, 8 ft apart; across the bottom was laid canvas which was turned up on 2 in. x 12 in. side and tacked. The sides were held 8 ft apart by 2 in. x 2 in. bracing on 5 ft centres. Over these 2 in. x 2 in.

was laid two layers of mesh and 7 in. up from bottom of form another series of 2 in. x 2 in. bracing was nailed, over the top of which one layer of mesh was laid.

The mesh specified was 4 in. x 4 in. x 6/6. However, this was not obtainable; therefore mesh used was

a mixture of 2 in. x 2 in. x 8 and 6 in. x 6 in. x 6 in. All mesh used was in an advanced rusty condition. Longitudinal edges of mesh were not lapped and tied, as should have been done. They were only butt jointed. This was pointed out as improper and as not taking full advantage of mesh strength.

These forms were then laid on the lagoon bottom at low tide, pierced steel plank (P. S. P.) matting being laid on mud to support the weight of the men.

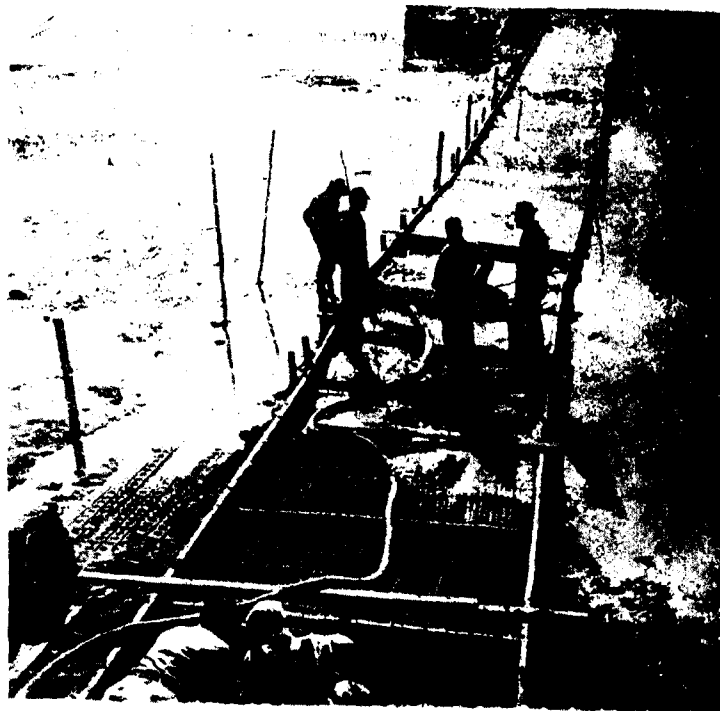
As form sections were being laid it was noted that where sections butted mesh

layers did not lap. Failure was expected to occur at these spots.

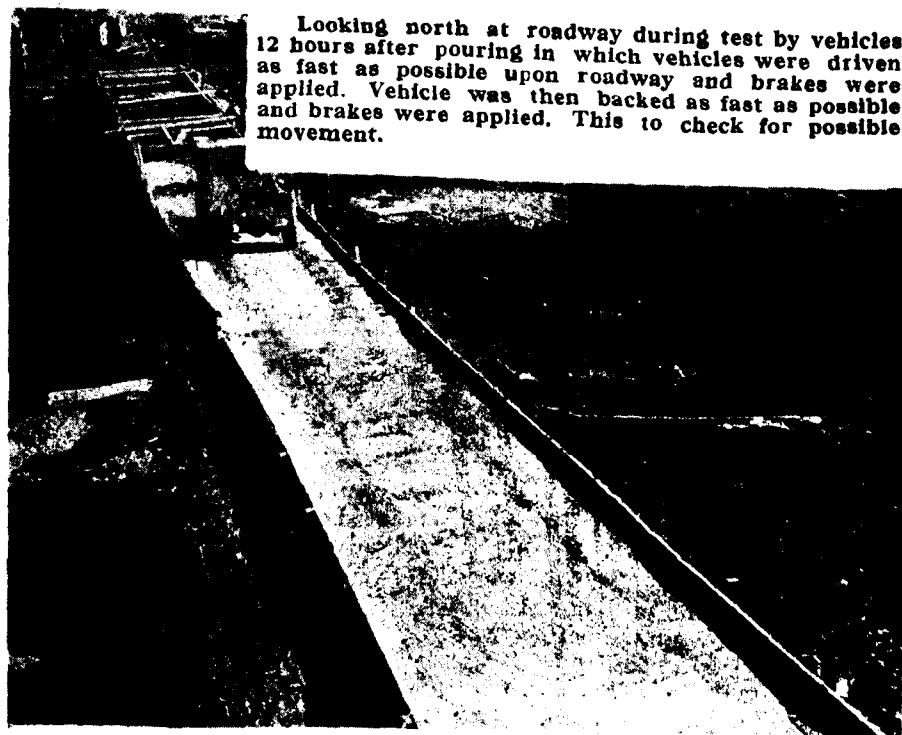
Actual pouring of concrete got under way at 4-30 p. m., December 14th, and continued until 8-40 p. m.

A very hard rain started at 9-10 p. m. Some concern was felt for the freshly poured concrete as it was only 30 minutes from time of last batch until it was flooded by the aforementioned rain, and in four hours would be covered with a full tide.

The roadway was inspected next morning and showed no damage from the hard rain or being covered by tide waters. Tests were begun 12 hours and 45 minutes after the completion of pour.



Pouring of ocean end of roadway.



Looking north at roadway during test by vehicles 12 hours after pouring in which vehicles were driven as fast as possible upon roadway and brakes were applied. Vehicle was then backed as fast as possible and brakes were applied. This to check for possible movement.

For first tests a jeep (total weight 2,610 lb) was used. Runs were made at each of the following speeds: 5 miles, 10 miles, 15 miles, 20 miles per hour.

These tests were continued, each time adding 400 lb until 4,500 lb weight had been reached.

Roadway was inspected and no damage was noticed. In areas where brakes had been applied it was noticed that rubber had been worn from jeep tyres.

It was intended to bring the load on the roadway up in gradual increments, but intermediate weight equipment was not obtainable.

The next piece of equipment available was an oil field type truck, weighing 10 tons. The age of slab was then only 18½ hours. If the material could stand that load over such a foundation it would have great possibilities.

The truck was driven slowly out onto the slab to the end, where it remained stationary for two minutes. There was no visible settling or deflection. The truck was then backed off.

Ten runs out onto slab and back were then run, using this truck, at a speed of 8 to 10 miles per hour. It was noted that the slab deflected in a wave-like motion and returned to its former position as the load passed away.

At the end of this test, five transverse hairline cracks were noted which were traced back to the aforementioned improper mesh installation.

In subsequent tests weights were added until a total weight of 15 tons was reached. It was during runs at this weight

that two failures occurred, both failures being at spots which had been previously pointed out as likely failure points.

It was noted as loads got heavier that mud on each side of roadway for a distance of 20 yards vibrated and shook like a bowl of jelly, and the roadway itself would sink and recover as the load passed along.

A complete photographic record of roadway was made by the Navy.

Observations

1. The type of the soil the road was laid over was extreme, in that it was 50 per cent water. The fact that the roadway stood up as long as it did indicates that this type of concrete was suitable for temporary roadways over that type of soil, and certainly suitable over soils of a less extreme nature.

2. The partial failure of this road was due directly to improper placement of the reinforcing mesh.



Abrasion caused by sudden stops of vehicles moving at 15. m.p.h.

3. More tests of this type conducted over various types of unstable soils, over slabs of various ages, are suggested.

INDIA'S RESEARCH INSTITUTES

It was announced by the Indian Council of Scientific and Industrial Research that Professor James W. McBain, F.R.S., the first Director of the National Chemical Laboratory, Poona, had laid down his office on July 16th and was leaving for the United States to rejoin the research laboratories of Stanford University in California. He has been associated with the Laboratory since its inception in 1946, and will be succeeded by Professor G. I. Finch, F.R.S., Professor at the Imperial College of Science and Technology, London.

Eleven Institutes

The National Chemical Laboratory is one of the eleven central research institutes governed by the Council of Scientific and Industrial Research. The initiative for their inception is largely due to Mr. Jawaharlal Nehru, who combined the portfolios of Prime Minister and Minister of Scientific Research in the early days of the National Government. Mr. Nehru himself is a science graduate of Cambridge University and has throughout been very enthusiastic about the creation of national research laboratories in India. The ambitious programme involving an expenditure of more than Rs 6 crores (£ 4.5 million) was taken in hand soon after the war, and the last of the institutes to be opened was the Central Road Research Institute at New Delhi, officially inaugurated by the Prime Minister on July 16th.

The remaining institutes and their Directors are (1) National Physical Laboratory, under Dr. K. S. Krishnan; (2) National Metallurgical Laboratory, Jamshedpur (Dr. G. P. Contractor); (3) Fuel Research Institute, Jealgora (Dr. J. W. Whitaker); (4) Central Glass and Ceramics Research Institute, Calcutta (Dr. Atma Ram); (5) Central Building Research Institute, Roorkee (Dr. J. N. Mukherjee); (6) Central Drug Research Institute, Lucknow (Dr. B. Mukherjee); (7) Central Food Technological Research Institute, Mysore (Dr. V. Subramanyam); (8) Central Leather Research Institute, Madras (B. M. Das); (9) Central Electro-Chemical Re-

search Institute Karaikuli (Dr. A. Joga Rao). The Road Research Institute is under Dr. Ernst Zipkes.

The National Chemical Laboratory

Scientific work at National Chemical Laboratory falls under seven major divisions: bio-chemistry, organic chemistry, inorganic chemistry, high polymers, chemical engineering, physical chemistry, survey and information.

In the chemical engineering division experiments are being made for the production of certain phosphatic fertilisers not yet manufactured in India. A plant is being assembled both for the production of phosphorus from phosphate from Trichinopoly in the south and subsequently for processing this phosphorus into the fertiliser known as triple super-phosphate. The division is also setting up a pilot plant for the preparation of cellulose pulp from indigenous raw material such as bamboo, reeds, grasses and certain varieties of wood. The object is to use this pulp in the manufacture of rayon, plastics, certain kinds of paper, and photographic film.

The biochemistry division has recently been successful in developing a process for the production of citric acid and calcium gluconate by the fermenting action of fungi on sugarcane and glucose. Developed in the Laboratory with a view to commercial exploitation, the process has been made over to a firm which is being advised in the setting up of a bench pilot plant.

In the plastics and polymers division, methods for making resins by the exchange of ions are being investigated, use being made of such indigenous raw materials as coal, cashew-nut shell liquid, agricultural waste and naphthalene.

The survey and information section gives advice to would be small investors and advises the State Governments on the development of cottage industries.

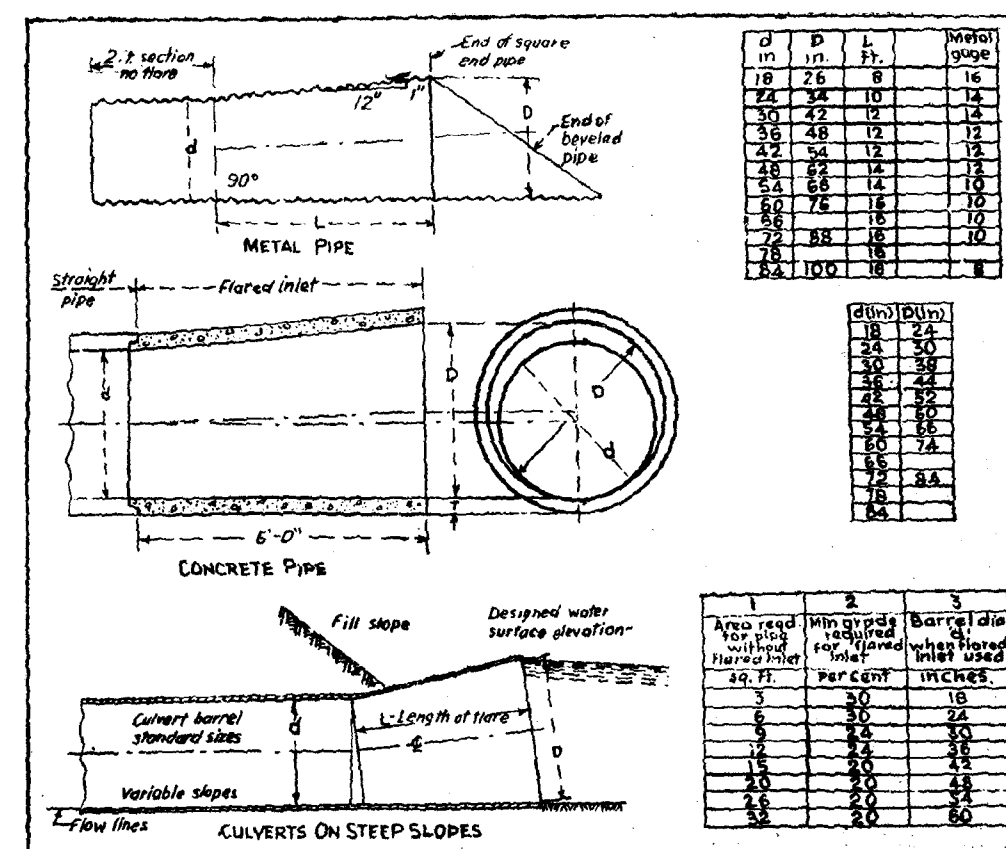
(Extracted from 'The Engineer'—August 8, 1952).

TECHNICAL INFORMATION

1. COST SAVINGS ANTICIPATED FROM NEW CULVERT DESIGN

A METHOD for designing culverts that could produce considerable savings in culvert costs if widely adopted has been under study by Division 8 of the Bureau of Public Roads at Portland, Ore., for some years past. Now it has advanced to the stage where a research project has been set up at Oregon State College to make more exact determination of the various factors involved in the method. Sponsors are the Bureau and the Oregon State Highway Department.

Basic concept of the plan is a reduction in the size of the main barrel of the culvert through the use of a flared inlet to improve the hydraulic efficiency of the structure. It is a well known fact that a culvert of uniform cross-section, with the inlet full or submerged, does not run full due to contraction of flow at the inlet. Flaring the inlet eliminates the contraction and so increases the quantity of water than can pass through the culvert.



To illustrate the savings involved in a particular instance, assume the runoff calculations indicate that an 8 x 7-ft box culvert is required. If a flared inlet conforming to the design indicated is used, a 6 x 6 barrel can be used without decreasing the capacity of the culvert or increasing the height of the headwater pool.

On the Pacific Highway in Oregon, use of flared inlets for some large arch culverts made it possible to substitute 10-ft arch barrels for culverts that would have required 12-ft barrels had no flared inlet been used.

These advantages are obtained only when the grade of the culvert is over 1 per

cent, hence flared inlets are not recommended except for culverts where the grade can be above that amount.

Inlets may be enlarged by flaring all four surfaces, or both sides and top, or both sides only. The most common method used is to flare both sides and top.

It is anticipated that a report of the findings will be made at the annual meeting of the Highway Research Board in December.

(Extracted from *Engineering News-Record*—July 17, 1952.)

2. NEW VARIETIES OF CEMENT

BEFORE 1947 there were in existence British Standard Specifications for four varieties of cement, namely, ordinary and rapid hardening Portland cements, blast-furnace Portland cement and high alumina cement.

Waterworks engineers have often been heard to remark that a low-heat cement would be of great value in reducing temperature rises which are troublesome in the construction of large mass concrete dams. This demand has now been met. In 1947 B. S. 1370 for Low Heat Portland Cement was issued. It will be interesting to see the extent to which the new cement will be used.

Another product, namely masonry cement, is now on the market. It has long been the experience of the building trade that mortar with Portland cement is too strong and sets too fast, whilst mortar with lime is too weak and hardens too slowly. A compromise has been found by gauging cement mortar with an admixture of lime. Now there is an opportunity for trying out the masonry cement. In cases where engineers have rejected the lime addition as being contrary to text-book procedure, trials of the new cement will no doubt be made and one imagines they will have the blessing of the bricklaying tradesmen who prefer a fatty mortar, such

as is obtained when lime is added, to one without any lime, assuming that in each case the sand is the same.

Another variation in concrete work which emanates from America is the use of an air-entraining material such as a very small quantity of a special resin which may be added at the cement mill or in the concrete mixer. The effect of the admixture is to impregnate the concrete with minute air bubbles and to impart a soapy texture to it.

It comes about that this concrete develops a high resistance to surface scaling and disintegration when under the influence of freezing and thawing. Kerbs are particularly liable to deterioration in this manner by virtue of their exposed situation. Other advantages, such as improved workability and uniformity, are claimed.

A new departure in British cements is the sulphate-resisting Portland cement (S. R. P. C.). Considerable alarm and despondency have been aroused by the realisation that in many kinds of ground are to be found deposits of sulphates. As so often happens, there has been a good deal of exaggeration about the harm which results from these salts and there has even

(Continued on page 34)

P. E. P. S. U. CIVIL WORKS BUDGET, 1952-53.

The following extracts pertaining to Civil Works have been taken from the P. E. P. S. U. Budget for the year 1952-53.

	(In lakhs of Rs)		
	Actuals 1950-51	Revised Estimates 1951-52	Budget Estimates 1952-53
I. Expenditure (Civil Works)			
(1) Original Works	13.68	16.50	45.22
(2) Repairs	21.04	21.37	23.64
(3) Establishment	23.74	10.16	9.57
(4) Tools and Plant	.6	.19	1.10
(5) Suspense	—	-2.12	-2.12
(6) Deduct—Working expenses electricity deducted from receipts.	-16.37	—	—
Total	42.45	46.10	77.41
II. Expenditure (Communications only)			
(1) Original Works	2.44	3.40	18.50
(2) Repairs	15.03	14.00	15.00
Total	17.47	17.40	33.50
III. Receipts from Roads			
(1) Receipts under Motor vehicle Acts.	3.89	4.00	4.00
(2) Receipts from Sales Tax on Motor Spirit.	n.a.	n.a.	2.50
Total	—	—	6.50

A BRIEF REVIEW OF THE P. E. P. S. U. BUDGET.

THE total revenue receipts of PEPSU for 1952-53 are estimated at Rs 522.36 lakhs and revenue expenditure at Rs 585.02 lakhs leaving a deficit of Rs 62.66 lakhs. The revised estimates for 1951-52 indicate a surplus of Rs 97.82 lakhs with the revenue receipts amounting to Rs 559.00 lakhs and revenue expenditure to Rs 461.18 lakhs.

Revenue expenditure on Civil Works for 1952-53 estimated at Rs 77.41 lakhs

forms 14.8 per cent of total State revenue in the year. The corresponding percentage figures for the previous two years 1951-52 (revised estimates) and 1950-51 (Budget estimates) being 8.2 and 7.5 respectively. Expenditure on Communications (Original Works and Repairs) in 1952-53 estimated at Rs 33.50 lakhs forms 6.4 per cent of the total revenues in the year, the corresponding figure in each of the previous two years being 3.1 per cent.

ADMINISTRATION REPORT OF VINDHYA PRADESH P.W.D. 1950-51

I. Vindhya Pradesh became a centrally administered area in January 1950. The length of roads maintained by the State Public Works Department is as follows :—

	Miles
(1) National Highways	119
(2) Other roads :	
(i) Metalled	993
(ii) Unmetalled (fair weather)	1109
	<u>2221</u>

II. The receipts of the Public Works Department during the two years 1949-50 and 1950-51 were as detailed below :—

	Rs Lakhs	
	1949-50	1950-51
(i) House rent	.09	.49
(ii) Ferry Receipts	.09	.09
(iii) Fines & Penalties	.09	.17
(iv) Sale of fruits	.03	.23
(v) Extraordinary	.03	.27
(vi) Recovery of overpayments	.06	.30
(vii) Miscellaneous	.05	.16
Total	.44	1.71

III. The expenditure of the Department is shown in the following statement :—

	Rs Lakhs	
	1949-50	1950-51
(i) Original Works	10.05	22.49
(ii) Repairs	9.72	27.42
(iii) Tools and Plant	0.32	4.55
(iv) Irrigation & Survey	—	0.29
(v) Suspense, non-budgeted and transfer	9.24	3.51
(vi) Establishment	1.42	3.40
Total	30.75	61.66*

IV. Expenditure on Communications alone mounted to Rs 31.10 lakhs in 1950-51 of which Rs 9.15 lakhs was on original works and Rs 21.95 lakhs on repairs. The corresponding figures for 1949-50 are Rs 12.78 lakhs, Rs 5.04 lakhs and Rs 7.74 lakhs respectively. It will be seen that the expenditure on Communications (original works and repairs) formed 62.3 per cent of total expenditure on Civil Works (Original Works and Repairs) in 1950-51 and 64.9 per cent in 1949-50.

* This includes Rs. 06 lakhs spent from the Central Road Fund.

ABSTRACTS

624. 138.—SOIL STABILIZATION

1. "Coquina" Asphalt Street in Florida :—L. J. Ritter. (American Highways, Vol. XXXI No. 2, April 1952 pp. 14-15 and 25-27).

Describes work done in 1949 for the City of Jacksonville Beach to aid the design and construction of low cost streets with local materials since conventional aggregates for the stabilization were scarce and very costly. After preliminary investigations, local sand (top soil), Coquina, and hardpan were experimented with. The chief purpose was to "develop a sort of mixture which would serve either as a combined base and wearing surface or as a base which would require only a very thin surface treatment to withstand the abrasive effects of traffic." Results of tests are tabulated.

Large-scale field experiments are described as conducted between 14th December 1950 and 3rd January 1950. Results as observed in August 1951 under moderately heavy traffic and occasional very heavy loads are stated to be satisfactory. Rapid-curing cut-back asphalt (R C - 1 S) was used for the stabilization. Calcium chloride was used in one of the sections to aid compaction in obtaining a higher density.

624. 21.—BRIDGES

2. Expediting Overstress Analysis in Highway Bridges :—J. Trueman Thompson and Bernhard H. Boone III. (American Highways Vol. XXXI No. 2, April 1952, pp. 8-13.)

Describes the method employed to quickly ascertain the overstress in old bridges due to the maximum effects produced by legally permitted load and axle arrangements. For expeditious work approximate methods were adopted by taking average values of axle spacing, and loading; but the placements of the dead, live, and impact loads were according to the Standard Specifications for Highway Bridges.

Graphs are worked out for centre line bending moment, relationship of live and impact load moment and reactions in floor beams for different load classes.

625. 7.—ROADS IN GENERAL

3. Highway Definitions Part IV :—(American Highways Vol. XXXI, No. 1, January 1952, pp. 16, 30 & 31) Right-of-way terms are defined in this.

4. "Critical Aspects of the Current Highway Programme" :—T. H. MacDonald, Commissioner of Public Roads, and "Pennsylvania's Rental Method of Financing Needed Highway Improvements" (American Highways, Vol. XXXI, No. 1, January 1952, pp. 4-8).

These are published in the issue.

5. Current Problems of State Highway Departments :—A. E. Johnson. (American Highways Vol. XXXI, No. 2, April 1952, pp. 7, 23-25). Read at the 15th Anniversary meeting of American Road Builders Association.

Gives reasons for subsidising the road project works on farm-to-market or land service type of roads if these carry only small volume of traffic.

Road tests ought to aid to eliminate such possibilities as uneven compaction of subgrades, non-uniform soils and moisture contents. Load tests are needed to confirm or disprove the presently used designs and construction methods and to determine the result of various axle loadings upon construction and maintenance costs in order that an equitable distribution of supporting costs could be assessed to various classes of highway users.

625. 746. ROAD TRAFFIC ACCESSORIES

6. "Lighting Pedestrian Crossings at Night :—(Highways and Bridges, 13th February 1952, p. 6).

The ten systems of lighting pedestrian crossings in Lewisham, to make zebra markings visible during nights, experi-

mented upon by the Road Research Laboratory, Department of Scientific and Industrial Research (in collaboration with the Ministry of Transport and the Lewisham Borough Council) are briefly explained.

625. 76—MAINTENANCE OF HIGHWAYS

7. **Surfacing and other works in Stretford.**—R. Moody (Highways and Bridges, 5th March 1952 p. 5).

The successful use of cold asphalt in road works like surface dressing and pre-coated chipping carpet, and reconditioning of R. C. Structures by the use of cement gun are explained.

625. 84—CONCRETE ROADS

8. **Compaction of Concrete Slabs by Vibrators:** (Highway Research Abstracts, October 1952, Vol. 22, No. 9)

Test Results of experiments conducted at Road Research Laboratory, London. Small variation of workability affects surcharge required and depth of compaction, and so effect of method of compaction alone was studied. With constant acceleration and vibration numbers, increased compaction resulted in increased depth of compaction. Change of acceleration alone did not affect depth of compaction. Depth

of Compaction varied inversely with speed of travel. Depth of compaction is unaffected by acceleration if amplitude and number of vibrations be constant, but is related to the product of amplitude and number of vibrations with a limiting value depending on concrete mix and vibrator characteristics. Vibration with constant acceleration is to be adopted with large amplitude and low frequency. High frequency results in the best surface finish.

631. 4—SOIL SCIENCE

9. **A New Concept—Using Chemicals for Soil:**—C. L. Swanson (Journal of Soil and Water Conservation, Vol. 7. No. 2, April 1952).

How the use of Krilium in soils high in clay content improves their structure, increases their porosity and permeability making them easier to work with while reducing cracking and crushing of the soil surface is described. Soil and berm erosion can also be controlled by its use.

10. **Recording the intake of water into the soil.** Maurice B. Cox (Journal of Soil and Water Conservation, Vol. 7. No. 2 April 1952).

Measurement of infiltration of water into soils by using the rain gauge instead of the Concentric Ring Infiltrometer is dealt with in the article.

TO SEE OR NOT TO SEE

No one knows better than Nicholas Nelson that driving magic has its limits. Nelson, a professional magician, has toured the nation, driving while blindfolded through heavy traffic in most large cities.

Some time ago, he gave the Omaha police and safety officials the jitters while driving blindfolded through downtown streets during noon-time traffic. He performed the feat without as much as a tiny dent to a fender, as he had in all his other exhibitions.

In contrast, recently the magician, this time minus his blindfold, smacked into another car at an intersection. To a police officer he explained: "The sun got in my eyes."

—From 'The Highway Magazine'—September 1952.

List of Approved Works on National Highways

S.No.	Job No.	Name of work	Estimated cost Rupees	Remarks
BOMBAY				
1.	658 BM 8	Construction of the Bariavi—Vasad Section of the Bombay-Ahmedabad National Highway	12,66,500/-	
2.	662 BM 8	Land acquisition for the Himmatnagar-Raigarh section of the Bombay—Ahmedabad National Highway (Length 13.5 miles).	1,09,600/-	
3.	665 BM 8	Improving approaches to the bridge over the Tapti river at Kathor on the Bombay—Ahmedabad National Highway.	92,300/-	
UTTAR PRADESH				
4.	651 UP 2	Painting miles 259-270 of N. H. No. 2 (Miles 125-136 of Agra-Etawah-Fatehpur Road).	4,68,500/-	
5.	661 UP 2	Painting miles 452-471 of N. H. No. 2 (Miles 487-468 of Grand Trunk Road).	7,85,800/-	
6.	664 UP 2	Painting miles 364-387 of N. H. No. 2 (Miles 566-543 of Grand Trunk Road).	8,70,000/-	
PUNJAB				
7.	663 PB 10	Construction of a bridge over the Ghaggar river in mile 162 of Delhi-Fazilka National Highway.	1,67,000/-	
MADHYA BHARAT				
8.	667-A MB 3	Widening and block topping different stretches of the Indore-Gwalior section of N. H. No. 13 between miles 13/6 and 45/5.	3,85,800/-	
9.	667-B MB 3	Black topping miles 45/5 - 58/0 and 60/0-72/2 of Indore-Gwalior section of National Highway, No. 3.	2,98,000/-	

S.No.	Job. No.	Name of work	Estimated cost Rupees	Remarks
(Continued)				
RAJASTHAN				
10.	659 RJ 8	Widening miles 7.56 (exclusive of mile 21) of Jaipur-Delhi Road.	3,46,900/-	
11.	660 RJ 8	Widening Jaipur-Ajmer Road from mile 9 to mile 52	3,74,500/-	
DELHI				
12.	655 DLH 8	Widening of Delhi-Gurgaon Road (N. H. No. 8) between miles 6.2 and 13.5.	3,53,400/-	
13.	A-666 DLH 1	Survey and fixing of boundary stones on upper Bela Road (N. H. No. 1).	3,500/-	
14.	668 DLH 1	Acquisition of buildings on the Upper Bela Road (N. H. No. 1) in Delhi State for the purpose of increasing its land width.	1,64,600/-	

(Continued from page 28)—NEW VARIETIES OF CEMENT

been hesitancy about depositing a few loads of concrete hardcore lest the dreaded sulphates should get to work. But there is a real danger in certain places to in-situ concrete where strong selenitic ground waters are in movement.

The S. R. P. C. is claimed to give protection against 2 per cent of SO₃ in the soil and 500 parts per 100,000 in the water. Further experience with this cement will be awaited with interest.

It is perhaps wrong to claim that there is much of a novel nature about light-weight concrete as in one form or another it has been put to considerable use. However, some of its applications to engineering, as distinct from building construction work, have proved highly successful. Foamed slag has been used as an aggregate given a concrete weighing some 90 lb per cu. ft with a sufficient strength for inert purposes.

[Extracted from "The Surveyor"
June 16, 1951]

POLITICS ARE AMUSEMENT

"When I disengaged myself from private business, I flatter'd myself that, by the sufficient tho' moderate fortune I had acquir'd, I had secured leisure during the rest of my life for philosophical studies and amusement." So wrote Benjamin Franklin in his *Autobiography*, and though the latter part of his long life was to be spent in the service of his country in the political sphere—which, possibly, provided the amusement—the years between 1746 and 1753 were largely devoted to the pursuit of natural philosophy.

—From 'Engineering'—July 25, 1952.

Books added to the Roads Organisation Library during December 1952

United States Department of the Interior, Geological Survey, Washington, 1951.

1. Application of Electro-Osmosis to the execution of Certain Work on Water-bearing soils - Translation No. 21. (Translated by Mrs. Severine Britt) by G. Remenieras.

2. Soil Silification-Translation No. 22 (Translated by Mrs. Severine Britt) by Albert Debeq.

3. Electric Treatment of Plastic Clay-Translation No. 24, (Translated by Mrs. Severine Britt) by Y. Poisson.

4. Determination of the Angle of Internal Friction and of the Cohesion of Soils in Situ by means of dynamic drilling-Translation No. 23 (Translated by Mrs. Severine Britt) by A. Couard.

5. Device for the rapid test in Situ of the resistance of Foundation grounds-Translation No. 25 (Translated by Mrs. Severine Britt) by Rene Deguillaume.

Her Majesty's Stationery Office, London.

6. The Weathering Preservation and Maintenance of Natural Stone Masonry (Part II)—Building Research Station Digest No. 21.

7. The short bored Pile Foundation-Building Research Digest No. 42.

8. Report on the Administration of the Road Fund for the year 1938-39.

9. do, 1939-40.

10. do, 1940-41.

11. do, 1946-47.

12. do, 1947-48.

13. do, 1948-49.

14. do, 1949-50.

15. do, 1950-51.

16. The load transmission test for flexible paving and base courses Part II-Triaxial test data on Structural properties of granular base materials—Tech. Development Report No. 144, by William M. Aldons, Raymond C. Herner, and M. M. Price (Civil Aeronautics Administration, Technical Development and Evaluation Center, Indianapolis, Indiana, June 1951).

17. Statistics of Class I Motor-Carriers for the year ended Dec., 31, 1949—Statement No 5127. Issued by Interstate Commerce Commission, Bureau of Transport Economics and Statistics (U. S. A.) (Superintendent of Documents, U. S. Government Printing Office, Washington 25, D.C.)

University of Illinois, Urbana, Illinois.

18. A study of combined bending and axial load in reinforced concrete Members-Bulletin Series No. 399, by Eivind Hognestad

19. What do we know about diagonal tension and web reinforcement in Concrete? A Historical Study Circular Series No. 64, by Eivind Hognestad.

20. New Roads for Lancashire (British Road Federation, 4-a, Bloomsbury Square, London, W. C. I.)

21. Forces in Framed Structures by T. Lyle Morgan (E. & F. N. Spon Ltd., 22, Henrietta Street, London, W.C. 2. 1952).

22. Hand book of Aerial Mapping and Photogrammetry by Lyle G. Trorey (Syndics of the University Press, Cambridge, 1952).

23. Here's how projects are used to further street and highway Accident Prevention. (National Association of

- Automotive Mutual Insurance Companies, 20 North Wacker Drive, Chicago 6, Illinois.)
24. **Le Beton Precontraint Elements De calcul.** (The Prestressed Concrete, elements of design) by J. Baretz (Eyrolles, 61, Boulevard Saint-Germain, Paris 57.)
25. **Development of design and Fabrication in Recent British Structures—contained in "Transactions of the Institute of Welding, Vol. No. 14, No. 3 June 1951"** by W. S. Atkins (The Institute of Welding, 2, Buckingham Palace Gardens, London S.W.1.)
26. **The French Industry of Mining Machinery** (Syndicat Des Constructeurs De Materiel De Mines, Group IV M.T.P.S., 102, Rue de L'Université, Paris (7^e).
- Society of Automotive Engineers, Inc., 29 West 39th Street, New York 18, N. Y.**
27. **How safe Can a Highway Be?**—Reprint of paper presented at a meeting of the Southern New England Section of the Society of Automotive Engineers on 2nd October 1951 by Roy E. Jorgensen.
28. **A study of Vehicle, Roadway and traffic relationships by means of Statistical Instruments** by T. J. Carmichael and C. E. Haley.
29. **Roughness and Skid Resistance—Bulletin No. 37**—presented at the 30th Annual Meeting, 1951. (Highway Research Board, 2101, Constitution Avenue, Washington 25, D. C.)
30. **Control of Cracking in the Metal Arc Welding of High Tensile Structural Steels—Contained in the Journal Welding Research Vol. 5, No. 4, August 1951**, by C. L. M. Cottrell, M. D. Jackson and J. G. Whitman. (British Welding Research Association, 29, Park Crescent, London W. 1.)
31. **Possibilities of the Prestressing of Metallic Constructions—contained in "Transactions of the Institute of Welding," Vol. 14, No. 5, October, 1951**, by Prof. Jr. W. Soete (The Institute of Welding, 2, Buckingham Palace Gardens, London, S.W.1.)
- The Institution of Municipal and County Engineers, 84, Eccleston Square, London, S.W.1.**
32. **Model Specifications for Concrete Roads.**
- No. 1—Using Mechanical Methods of Compacting the Concrete.**
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33. **No. 3—Using Pitched or Hardcore Foundations and Single Course Tarmacadam Surfacing.**
34. **No. 4—Using Pitched or Hardcore Foundations and Rolled Asphalt or single course Bitumen Surfacing.**
35. **Notes for Short Course in Properties of Soils and Applications to Highway Construction** by H. P. Pickering (Institute of Transportation and Traffic Engineering, University of California, Berkeley, Los Angeles, California, 1950).
36. **Zoning and Traffic** by Edward G. Mogren and Wilbur S. Smith. (The Eno Foundation for Highway Traffic Control, Saugatuck, Connecticut, 1952).
37. **Transportation and Communication Deptt., Chamber of Commerce of the United States, Washington 6, D. C. Who's going to pay for our new roads** (Reprinted from the Traffic Review, Winter, 1952 issue) by Harold F. Hammond.
38. **Effects of Freeways on adjacent Properties** (Reprinted from "Traffic Engineering," March 1952), by Henry K. Evans.
39. **Thirty-First Annual Report of the Commissioner of Main Roads for year ended 30th June, 1952.** (Main Roads Department, Queensland, 1952).

40. **Rules of Procedure and Conduct of Business in the Council of States.** (Council of States Secretariat, New Delhi, 1952.)
- John Wiley and Sons, Inc., New York, 1948.**
41. **Concrete Plain and Reinforced, Vol. I—Theory and Design of Concrete and Reinforced Structures** (4th edition) by Taylor, Thompson and Smulski.
42. **-do- Vol. II—Theory and Design of Continuous Beams, Frames, Building Frames and arches, (Fourth Edition)** by Taylor, Thompson and Smulski.
43. **Reinforced-Concrete Bridges with Formulas Applicable to Structural Steel and Concrete**, by Taylor, Thomson and Smulski.
44. **Statistical Abstract, India, 1950**, (The Manager of Publications, Delhi, 1952)

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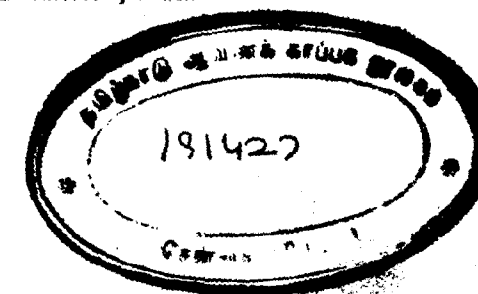
—From 'California Highways & Public Works,' March
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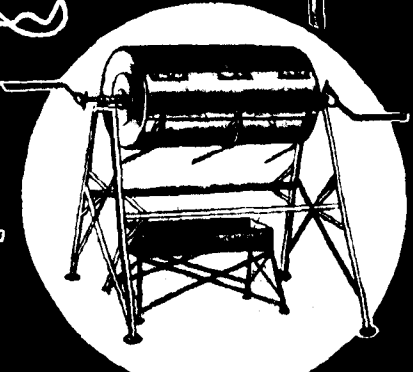


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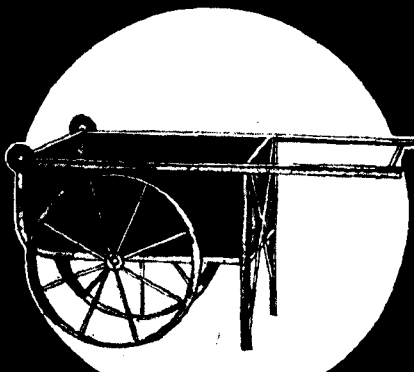
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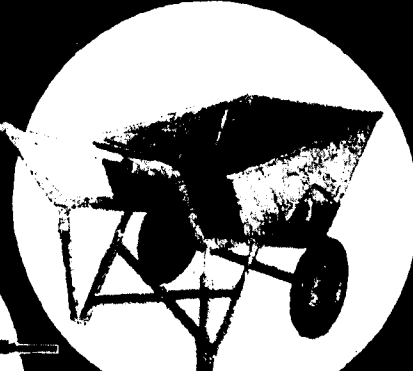
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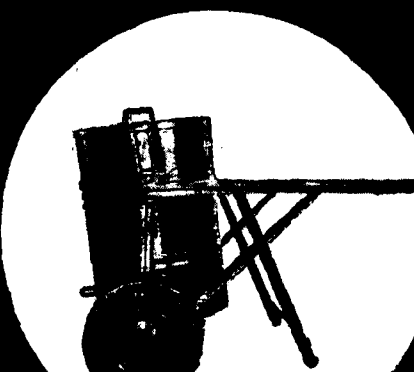
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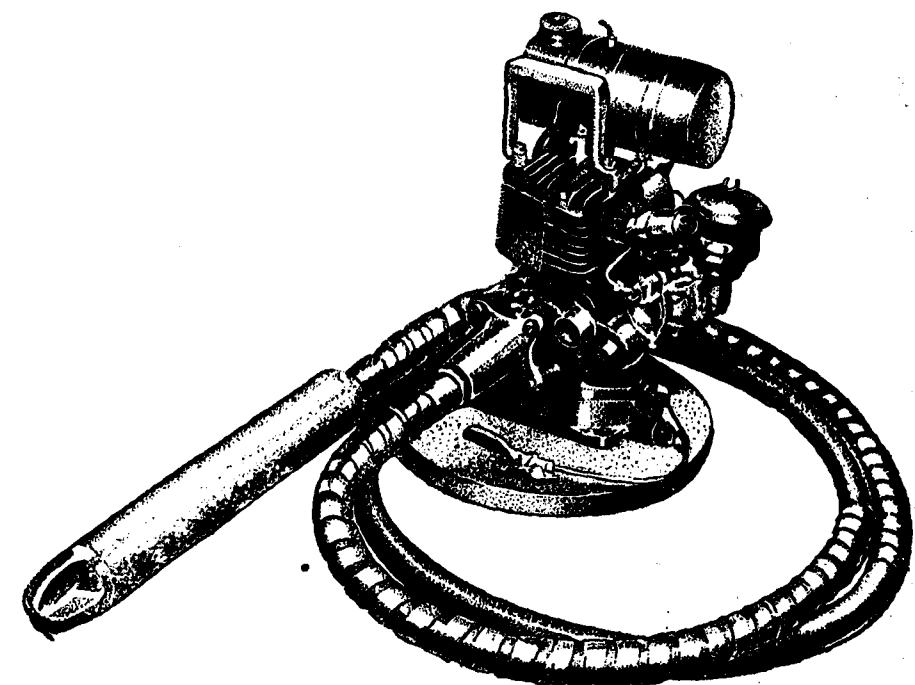
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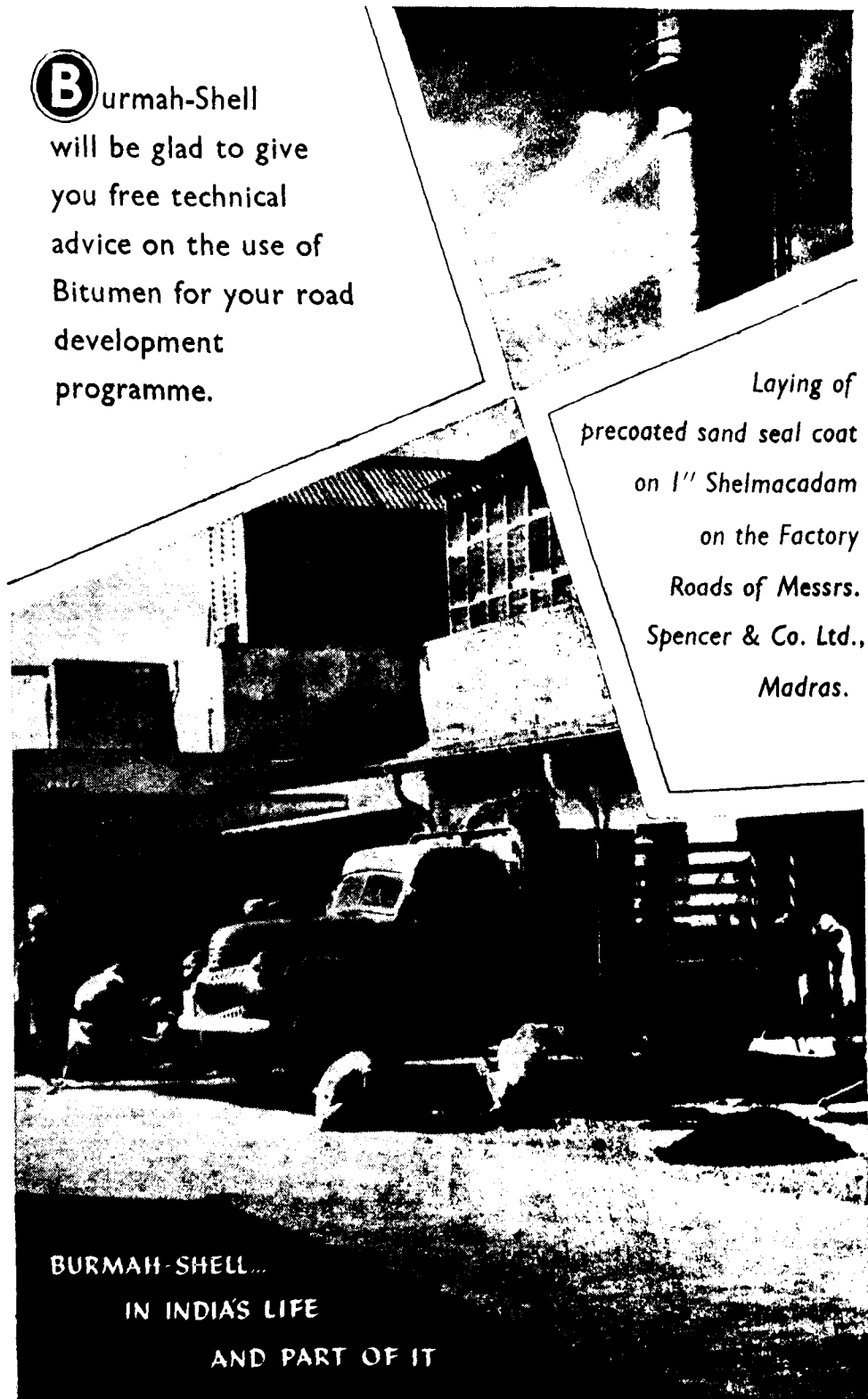
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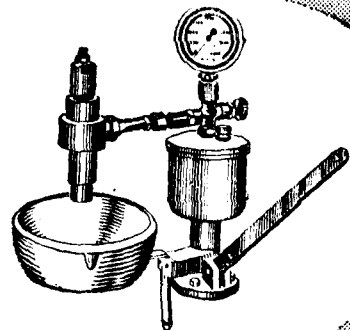
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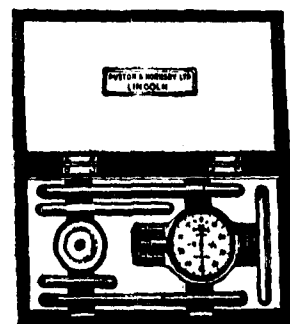
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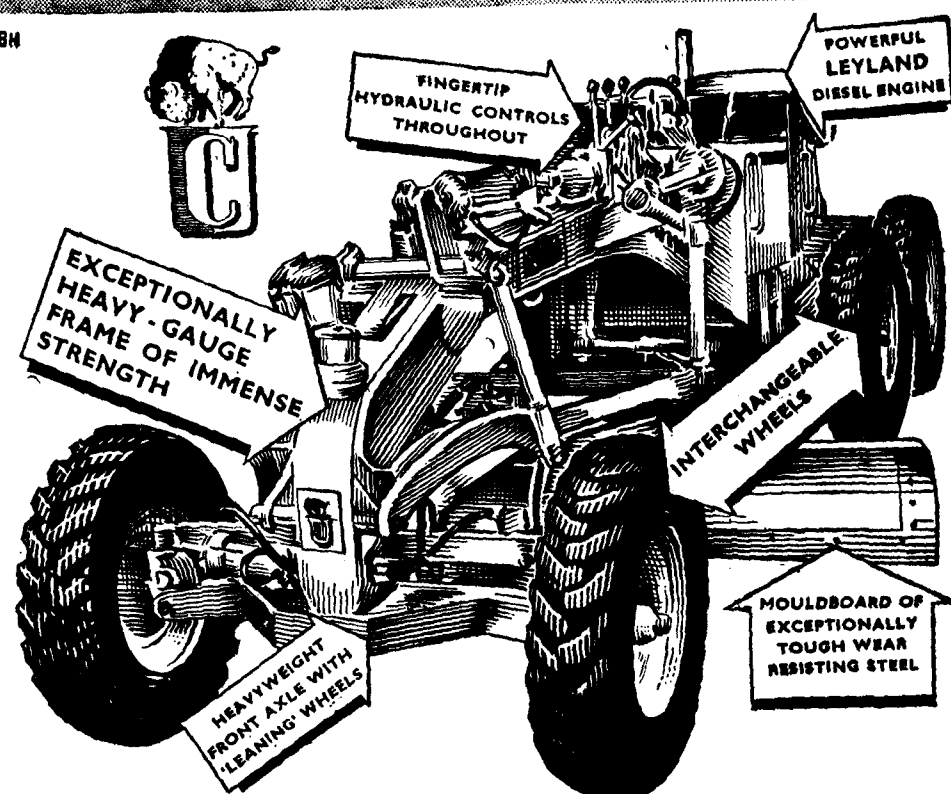


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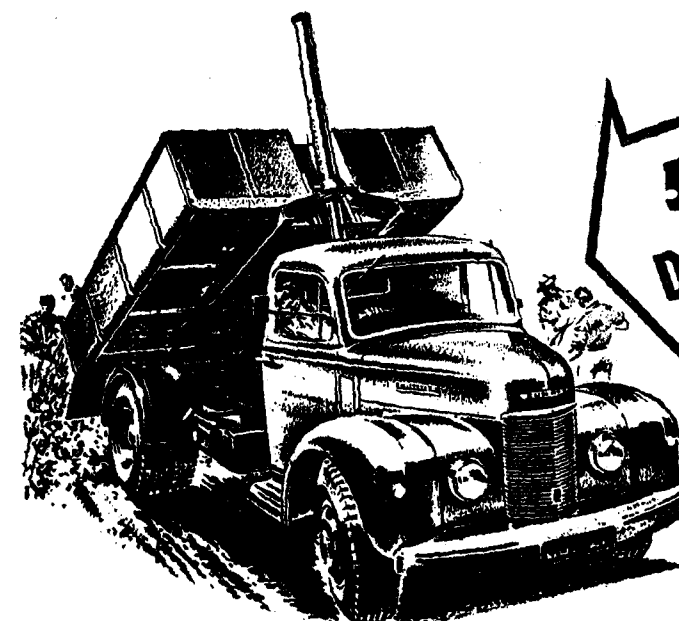
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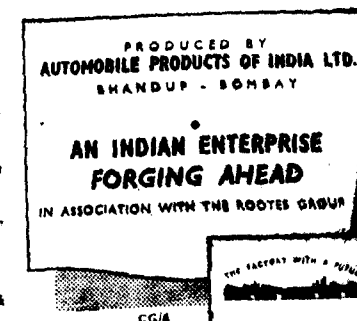
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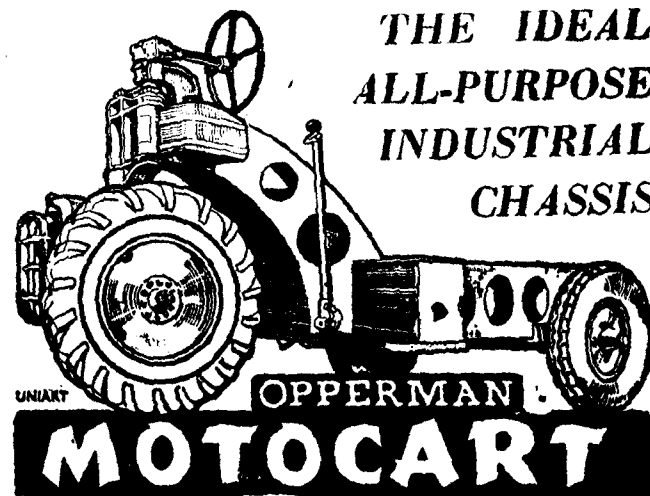
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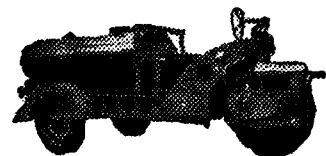
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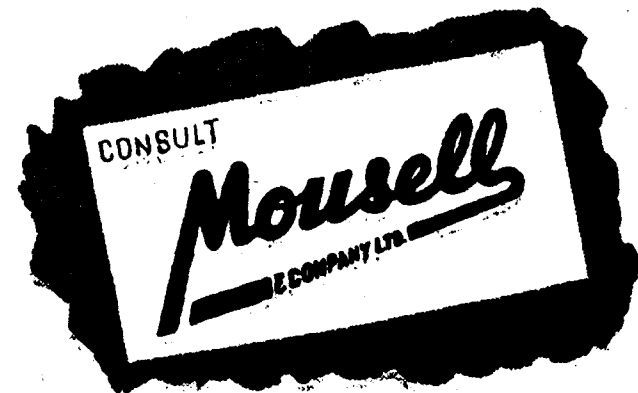
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