TRANSPORT-COMMUNICATIONS

MONTHLY REVIEW

OCTOBER 1953 — No. 78

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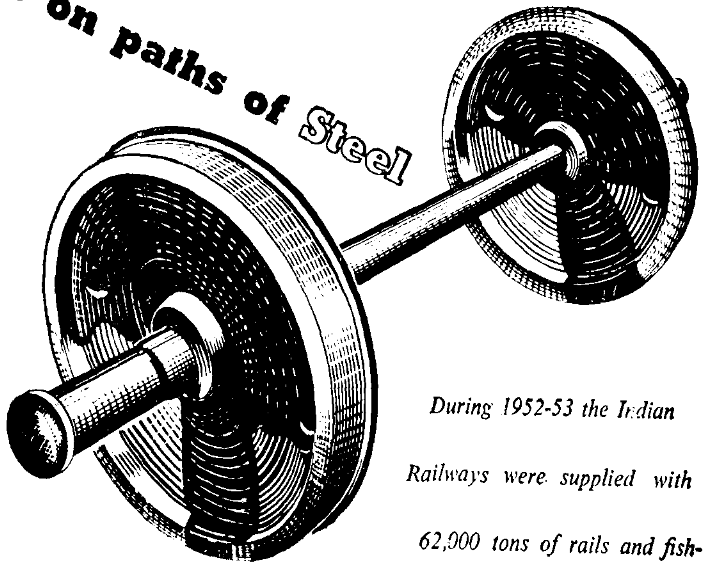

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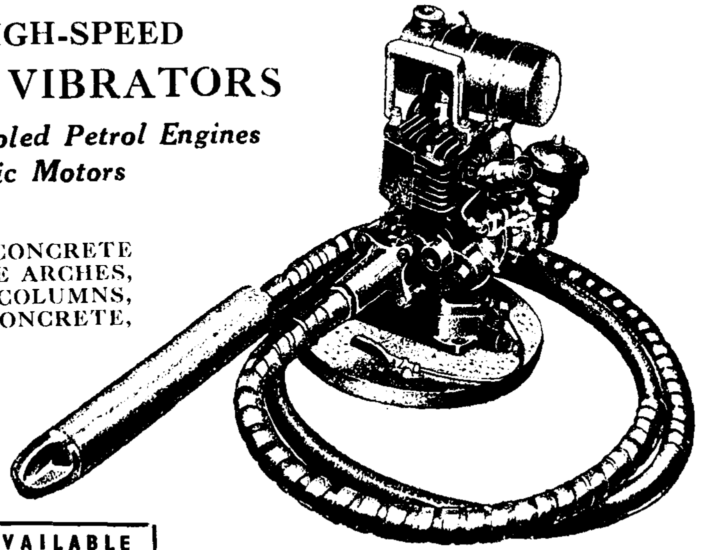

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TRANSPORT-COMMUNICATIONS

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Photo 1.
Semi permanent wooden bridge 14×10'-0" span over Sukhajhora in M 38 F3 of N.H. 31.

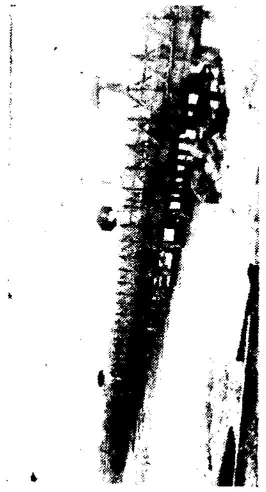

Photo 4.
Semi permanent wooden bridge 50×10'-0" span over Dim Dima River in M 33 F3 of N.H. 31.

Photo 2.
Collapsed bridge over Sukhajhora in 38M 3F of N.H. 31.

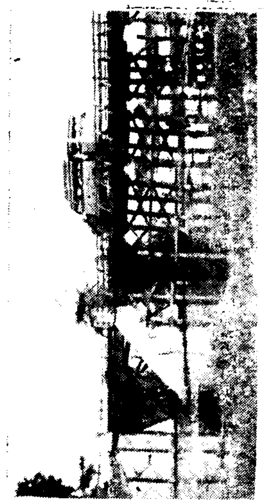

Photo 5.
Chakchaka bridge in 15 M 1 F of N.H. 31 outflanked on both sides by 75'-0" and 106'-0". Semi permanent wooden bridge built at one end 6×15'-0" span and the other end filled up with earth.

Photo 3.
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Photo 6.
Dharaikuri bridge in 14 M 7 F of N.H. 31 outflanked on both sides by 65'-0" and 75'-0". Semi permanent wooden bridge 4×15'-0" span built at one end and the other end filled up with earth.

TRANSPORT-COMMUNICATIONS
MONTHLY REVIEW

A REVIEW OF
ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

OCTOBER 1953 30

HIGHWAY TRANSPORTATION ECONOMICS

(Extracted from 'Public Roads'—August 1952)

HIGHWAY transportation, all things considered, is perhaps the most important of all modes of transport. Not only is it a potent competitive force, but it complements all other modes of transportation and plays an indispensable role in the direct satisfaction of human wants.

What is the proper position of highway transportation in the total transportation field? How should highway costs be assigned among the various classes of motor vehicles, and what responsibility should be assumed by the general public as distinct from highway users? How shall costs and benefits be related? And what is the public willing to pay? How should highway needs be measured in relation to other needs for the general welfare? Extensive research may eventually produce theoretical solutions for some of these problems. But in the final analysis decisions must rest upon collective judgment.

In a very real sense, the story of transportation is the story of civilization and economic progress. It is not surprising, then, that some have said the greatest invention of all time was the wheel. The anthropologist and the historian, the political scientist and the sociologist, frequently find explanation of institutional settings and cultural activities rooted in the prevailing transportation patterns of the times.

Transportation Fundamentals

Transportation service may satisfy human wants directly, as in the case of pleasure driving or vacation travel, or it may play a vital role in the productive process, as in the case of bringing raw materials to the factory and distributing finished goods to the market. In economic parlance, transportation adds place utility to goods and, hence, increases their value; otherwise it would not exist. These ideas may seem self-evident; but the significance of transportation's role in a progressive economy is not often fully appreciated. In fact, transportation is sometimes looked upon as a necessary evil, an unfortunate economic waste. Often neglected is the way in which an efficient transportation system increases our standards of living and contributes to our social well-being. When early man learned to transport fish and game he improved his standard of living. Transportation meant economic progress. Until iron ore and fuel, not 10 miles apart, could be brought together, steel could not be made.

Even today, one of the basic requirements for economic progress in the underdeveloped areas of the world is improved transportation, for the richest of resources have no value unless they can be moved, put into usable form, and then brought to the consumer.

Transportation and Trade

Transportation is the pre-requisite of trade. The travels of a Marco Polo, the explorations of a Columbus, were

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under taken for purposes of trade, which presupposes transportation. Without improved transportation a community, or a nation, is limited to the goods it produces for itself. And transportation plays a more subtle role in our economy than merely permitting us to trade goods we have for those we have not.

Much of our modern economic progress may be attributed to regional specialization or division of labour, which tremendously increases our productive capacity by increasing efficiency and making large-scale manufacturing possible—both by bringing together the materials needed and by distributing the products to expanded markets.

Transportation and Prices

Transportation serves a useful function in equalising and stabilizing prices. Improved transportation effectively stays the development of local monopolies. It assures that a crop failure in one area will not bring disaster, for foods from other areas can be imported. Improved transportation increases competition, for when prices in one area are raised above the cost of transportation, products will be imported. An important feature of our economic system, directly related to the adequacy of transportation, is the extent of healthy competition that takes place between suppliers at the fringes of market areas.

Transportation and Land Use

Today, fertile lands in many areas of the world still stand idle because of prohibitive transportation costs. A reduction in the cost of transportation would tend to increase land values in the remote regions but, at the same time more land would be brought under cultivation and prices would tend to fall.

Examples of the profound and generally beneficial economic effects of improved transportation are almost limitless in number and variety. For instance, urbanization and the later phenomenon of suburbanization would have been impossible without adequate transportation. The main point to be emphasised, however, is that **good transportation serves to reduce the cost of production, even though it is itself a cost of production**.

Passenger Transportation

A comment or two should be added with respect to passenger transportation. That large portion which is indulged in for business purposes is subject to the same economic considerations already suggested. For example, it permits a greater technical division of labour and thereby promotes efficiency in production. On the other hand, personal transportation for pleasure is consumption—the direct satisfaction of human wants. As in the purchase of any other goods or service, the public interest is to get it as cheaply as possible.

A General Conclusion

Transportation is indispensable in a progressive society, but also any lowering of the costs of transportation is good for the general economic welfare. Transportation is one of the costs of production. Whenever any of these costs is reduced economy is strengthened; standards of living can be raised. It is vitally important, however, that we bear in mind a clear concept of economic costs. By lowering the cost of production we mean either: (1) producing the same amount of goods and services with a lesser expenditure of economic resources—labour, capital, and land; or (2) producing a great amount with the same expenditure. From this it follows that when we appraise the costs of transportation service we must include all of the economic cost. It matters not whether the cost are met publicly or privately. Unfortunately, a prevalent tendency in some quarters is to ignore such costs as highway improvement, navigation, development, or airport provision when they are paid for by government.

Competition in Transportation

Highway transportation has changed a situation of virtual monopoly to one of very considerable competition. The competitive relations among carriers are a matter of basic interest to the economist. It is difficult to get a good grip on this problem, however, for each of the carrier groups has distinctive characteristics. In important areas they are complementary rather than competitive. For example, trucking within cities does

not compete with rails or other modern forms of transport. Most trucking from farm to market or railhead is not competitive. Even if certain goods are moved by rail or water or air one time or another, at some time—probably many times—during the flow from producer to consumer the goods are moved by truck. Many such movements are not competitive.

Advantages of Highway Transportation

Little time need be spent here in exploring reasons for the phenomenal growth of highway transportation. Its obvious advantages are flexibility and adaptability and these add up to economy and speed. Of the two, speed—the time elapsed from initiation of the shipment to delivery at the destination—is the more important in many current situations, for time in transit can be quite costly to both consignors and consignees. More rapid transport has fostered the smaller inventory policies of many businesses and has resulted in substantial interest savings. Another of the inherent advantages of highway transportation is the ability of the motor carrier to adapt the size of the vehicle to the shipment, thus making the industry especially capable of handling less-than-carload freight expeditiously. Door-to-door service, less handling of goods, lower packing costs, are among the many other factors that contribute to the success of the trucking industry.

Another factor partly responsible for the initial success of trucking was certain rate-making policies that had been well established while rails had a near monoply of the traffic. For example, predominant emphasis on value-of-service rather than on cost, in fixing rates, and preferential treatment of long-haul over short-haul traffic, provided a situation in which a new group of carriers, already having certain inherent advantages, could rather easily attract a substantial amount of the more remunerative business. Not to be overlooked, also, is the fact that the motor vehicle provided an opportunity for producers to haul their own goods whenever rates seemed out of line or it seemed convenient to do so. The significant fact is that the development of highway transportation has transformed an industry of monopolistic characteristics to one of intense and effective competition—a condition that the general public and policy makers have been somewhat slow to recognise and appreciate.

An outstanding feature distinguishing highway from rail transportation is the public provision, financing, and management of roadways for motor vehicles. This has made it possible for many thousands of operators to enter the transportation industry. One truck or bus is all that is needed to set up in business. The result has been not only competition between rails and motor carriers, but also intense competition among segments of the motor-carrier industry; and hanging over the entire public-carrier industry is the constant threat of private operation of motor vehicles by industrial and commercial enterprises. The motor-carrier industry, despite the development of a few large carriers, is still characterized by thousands of small operations, involving relatively small investments, and often managed on a family or individual proprietorship basis. Progress has been slow in adapting public policies to the realities of this new situation. The regulatory agencies and the courts are just beginning to discard the monopoly concept and come to grips with the problems of " regulated competition."

The Highway Function To-day

There has developed a partnership in transportation, not often fully appreciated, between government, which supplies the roadways, and private individuals and business firms, which supply the operating equipment. It is no easy task to co-ordinate these elements into an efficient transportation service. One of the great difficulties arises from the present-day conflicts of interest among various groups of users of the publicly provided road plant—for example, between truckers and automobile owners and among competing commercial highway users, such as common, contract, and private carriers. Additionally, there is the bitter controversy between motor carriers and other carriers, such as the rails.

Economics of Joint Highway Use

The fact that highways are publicly provided and jointly used by many kinds of vehicles is perhaps one of the greatest economic advantages of highway transportation. The road plant is supplied in response to numerous and varied demands. We have, therefore, an outstanding example of the economics of joint use, on the one hand, and the problems of joint-cost apportionment, on the other.

To illustrate: A basic highway plant may be provided for passenger cars under any circumstances; if trucks are permitted to operate on the same highways and pay all special costs for which their operation is directly responsible, any additional payments they may make go toward defraying the costs of the basic highway, and hence benefit all passenger-car operators by reducing the costs of the basic highway to be apportioned among them.

Conversely, the truck operator who pays all of the direct highway costs assignable to him is benefited by the tax contributions of passenger-car operators that go to defray the overhead costs of the basic highway plant.

The point is that when different groups of users can use the same highway plant both the total costs and the costs for each group will be less than if each were required to supply its own facilities; provided, of course, that each group meets all costs for which it is directly responsible and contributes something to defray the joint or overhead costs of the plant.

Perhaps a purely hypothetical example will help at this point. Suppose that a given stretch of four-lane highway adequate for passenger cars only could be constructed for 200,000 dollars. Suppose the same stretch could be built to accommodate both passenger cars and trucks for 240,000 dollars, and that a two-lane highway costing 140,000 dollars would suffice for trucks alone. Now if two highways were built—one for passenger cars and one for trucks—the total outlay would be 340,000 dollars as compared with only 240,000 dollars for the single highway that would carry both kinds of traffic. The loss to the users—and to the economy—would be 100,000 dollars. Now if, for this single highway, passenger-car operators paid anything less than 200,000 dollars, they would save money. By the same token, if the truck operators paid anything less than 140,000 dollars they, too, would save. Thus, if passenger cars were taxed 150,000 dollars and trucks were taxed 90,000 dollars each group of users would save 50,000 dollars over what it would cost to supply themselves separate facilities. Here, then, we see clearly the economics of joint use.

Problem of Cost Assignment

But, at the same time, the example illustrates the problem of highway cost assignment. In the first place, it might be difficult to prove that it would cost 40,000 dollars more to provide the highway for both kinds of traffic than for the passenger-car highway alone. And, if that hurdle is passed, the problem remains of apportioning the joint cost—that cost for which neither group can be held solely responsible—between them. Shall passenger cars be charged 200,000 dollars—the amount required for a basic highway? If so, the trucks would be charged only 40,000 dollars. Or should truckers be charged 140,000 dollars—the amount they would pay for their own highway? If so, passenger cars would be charged only 100,000 dollars.

The point is that anything the truckers pay over 40,000 dollars helps the passenger-car operators and anything the passenger-car operators, pay over 100,000 dollars helps the trucks. The complexity of apportioning joint or overhead highway costs among users becomes obvious. Even assuming that all direct costs have been ascertained and assigned to the responsible groups, all tha can be said for sure is that truckers should pay at least 40,000 dollars and not more than 140,000 dollars, while passenger-car operators should pay at least 100,000 dollars and not more than 200,000 dollars.

Thus, to apportion the truly joint costs of the highway plant in order to fix reasonable user charges, we must turn to some theoretical basis such as relative use, differential benefit, or value-of-service. Naturally, there is much room for disagreement. The situation is tremendously more complicated in actual practice than in our example. First, we lack the detailed information necessary to ascertain to anyone's satisfaction the direct costs of the entire plant for which any particular group of users should be held

responsible. Second, we are dealing with many kinds and sizes of vehicles, carrying all types of passengers and commodities, using different segments of the highway plant in varying degrees, operating different mileages during the year, and, by administrative necessity, subject to different kinds of imperfect user-tax bases.

Various Concepts of Problem

Many significant differences in approach to highway and other transportation problems are found among observers who presumably are impartial or at the least should not be passionately interested in the outcome.

For example, the highway engineer may be primarily interested in getting roads built to accommodate traffic; the competitive aspects of highway transportation do not trouble him; even the questions of wise allocation of limited economic resources or equitable taxation for highways are likely to be given short shrift.

The transportation economist, on the other hand, is likely to emphasize to the exclusion of all other considerations the competitive aspects of highway transportation and the effects on other carriers; private transportation, the prime generator of highway demand, may be virtually ignored.

The public-finance expert may fail to recognise the competitive aspects of highway provision and treat it as any other function of Government, to be financed under the general tax system; he may see no merit in legal provisions against diversion to non-highway purposes of taxes collected on a user basis; he is likely to advocate annual budgeting of highway funds in the same manner that all other funds are budgeted. He fails to appreciate what the transportation man sees or to recognise the engineer's demand for a reasonably steady and assured flow of income in order to permit long-range planning and orderly development of the highway system.

Divergent Principles

We are prone to treat highways like any other function of Government. We do not distinguish taxes for highways from other taxes. We rely upon political judgment as to how much to spend for highways just as we do in determining how much to spend for schools or welfare. We also rely upon judgment as to how to distribute the cost, with little regard to the possibility of differential benefits to different groups or individuals. We justify expenditures in broad generalities, stressing the general welfare.

One unfortunate aspect of this approach to the highway problem is that we are left without any effective guides either as to the proper amounts and rates of investment in highways or as to appropriate methods and levels of taxation. Our sole criterion is how much we can collect from the taxpayers. When that has been determined, we must decide between many worthy but conflicting claims to the tax dollars on the basis of some vague, almost intuitive feeling of the effect upon the general welfare of alternative courses of action.

Operations in the private economy are, of course, governed by quite different considerations. Basically, the laws of supply and demand; the individual indicates thd benefit he expects to derive from the various goods and services by the prices he is willing to pay. On the other side of the equation, goods and services are supplied if the prices offered will meet the costs of production—the costs of the factors, labour, capital, and enterprise, that go into them. Thus, in effect, the demand-supply equation becomes a benefit-cost equation. It has been suggested that principles applicable in the private economy can be adapted with appropriate modifications to serve as a guide in dealing with basic highway issues.

As we have seen, with the exception of the comparatively brief experience with toll roads, the provision of highways was treated as a general function of government before the advent of the automobile. The development of the motor vehicle has modified our thinking. The extended radius of travel, the types of roads required, the magnitude of finances

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RESEARCH ON INDIAN RAILWAYS

Laboratories on Wheels

SYSTEMATIC research started on the Railways in 1935 when two officers were deputed to determine the maximum loads the then existing engines could haul and the maximum speeds they could attain under Indian conditions. This research was necessary as the engines were designed and built in foreign countries where the coal used has less ash than the Indian coal. Later, these officers were asked to measure the side thrusts that the wheels of the engines exerted on the track. For this work, they built an oscillograph car fitted with very sensitive instruments which record each and every motion of an engine or a carriage. In addition, it can measure the stresses in rails and bridges and observe the behaviour of soil under the fast moving heavy loads.

Later a dynamometer car which is used for measuring the load hauling capacity of engines and resistance to motion of railway vehicles was acquired by the Railway Board. Also the dynamometer car enables the study of brake performance and heating value of different types of fuel.

To these small "Laboratories" on wheels were added other mobile test units such as a Fuel Test Car and a Track Recording Car. The latter records, as it moves, all the defects in the track. As it runs over the railway line, it drops coloured water over defective portions enabling the repair gang to remove the defects.

After World War II, a static research station was established near Delhi. A test track was laid and the nucleus of a small service workshop and a laboratory centre was set up for testing structures and rolling stock. The laboratory was also equipped for testing soil samples for solving building and bridge foundation problems.

Valuable Data Acquired

As a result of the researches carried out so far, it has been possible to assess the effect of locomotives on both bridges and track with a fair amount of accuracy. It has also been possible to stop premature replacement of a large quantity of rails, some of which had begun to fail. Research determined the real cause of their failure and it was possible by replacing only a very small proportion, where particular defects were revealed, to retain the remainder in the track.

In the field of mechanical engineering research has provided useful data for improving the efficiency of locomotive boilers using low grade coal. As coking coal, the supply of which is limited, has to be reserved for manufacture of steel, the railways have to use inferior grades of coal. After numerous trials, both in the laboratory and in the field, it has been possible to evolve a suitable type of fire grate for efficiently burning inferior quality coal.

Researches on stress distribution in light weight coaches were of great help in designing the Indian all-metal light weight coaches.

Investigations have also provided valuable data about the behaviour of black cotton soil which may solve the vexed problem of failure of buildings on this type of soil. Similarly, it was possible to diagnose the cause of the constant sinking of some of the Godavari bridge piers which had been a source of anxiety to the engineers for over half a century.

Location of Research Organization

The Research Organisation of the Railways which previously functioned under the Central Standards Office for Railways, has lately been separated and

placed under a Directorate of the Railway Board with its main centre at Lucknow and two sub-centres at Lonavla and Chittaranjan.

The Lucknow Centre carries out research on fuel, the dynamic effects of vehicles on track and bridges and riding quality and performance tests on locos and carriages. This Centre has a documentation and information service for issuing bulletins and summaries of important researches made in India and abroad.

The Lonavla Sub-centre is carrying out research on soil mechanics and foundation engineering problems. The Chittaranjan Sub-centre has undertaken chemical and metallurgical studies on such items as lubricants, paints, water-softeners and bronzes.

Priority Research Programme

A priority research programme has been drawn up by the Research Controlling Committee on which is represented leading technical men and administrative heads of the Indian Railways. A problem is placed on this programme if it satisfies three important conditions. Firstly, it should be of immediate importance to Railways from the point of view of technical and operating safety, efficiency and economy. Secondly, it is not capable of investigation by any other national laboratory in India. This is necessary as with the limited research resources of the country, it is desirable to prevent duplication and overlapping of work. Thirdly, the investigation of the problem should be such as is likely to bring fruitful results within a short time.

Concrete Results

The research work already conducted by the Research Organization has produced concrete results. It has enabled the design section of the Central Standards Office to improve the riding qualities of locomotives. It has also provided valuable data for designing WP and WG engines, which are now being manufactured at Chittaranjan.

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(Continued from page 5)

involved, the competitive aspects of highway provision in a private-enterprise economy, the need for standards governing the rate of highway investment, all conspire to give the highway function a much deeper economic significance than it formerly had. That the approach to highway problems in terms of the private economy has made headway is evidenced by the elaborate user tax systems founded on a benefit concept that have been developed and revised from time to time in all States (in the U.S.A.). Further refinement and application of this commercial concept to highways may aid in solution of the perplexing problems of cost allocation and investment.

(To be continued.)

ROADS IN THE NETHERLANDS

(Abstracted from the Bulletin No. 126 of the International Association of Road Congresses)

Topography and Early Roads

TOPOGRAPHICALLY the Netherlands can be divided in two parts, the western and northern part, which mainly consist of low lying flat land with a high water table, and the southern and eastern part, with a more undulating topography and lower table. In the former which developed rapidly in the sixteenth and seventeenth centuries due to fertility of the soil and the excellent situation for trade and commerce, the inland communication was mainly done by water and roads were poor and winding with numerous bridge and ferries to cross the creeks and channels. On the high grounds in the eastern and southern parts of the country, however, economical condition which was poor expressed itself in a poor state of the road network. During and shortly after the reign of Napoleon, several important improvements were carried out, mainly for military reasons.

The beginning of the era of motor vehicles, therefore, found a practically non-existing road network in the western and northern parts while in the southern and eastern parts there was an extensive but entirely inadequate network.

Classification of Roads

In 1927 a plan for a system of primary roads was laid by law. This plan contained entirely new roads as well as existing roads which would have to be improved upto standards. Ever since, this primary road plan which had to be revised at least every ten years, has been the basis of the road building activity of the National Government.

At the same time the Provincial Authorities were obliged to publish plans for a secondary road system for each of the Provinces. In 1938 the obligation of making up a tertiary road plan by each of the provinces was laid down by law. All these plans had to be revised at least every 10 years.

One of the principles for the new primary roads which was to be built by the National Government was that access to these roads should be limited to only those points where the connection with another public road would be to the advantage of the traffic. Another principle was that roads which are considered important either because of traffic volume or because of the importance to long distance traffic, should have no level crossings with other roads, and should have two separate carriageways. All these new roads were to be opened to motor vehicle traffic only. This idea of roads exclusively for motor vehicles was readily accepted by the public because the necessary funds for the construction of these roads were to be levied from users of motor vehicles only.

In order to remove the danger to the roads system from encroachments by the expansion of built-up areas along these roads, a law was enacted in 1937 enabling the government to deny access or disapprove a change in access to any of the roads maintained by the National Government.

With the publication of first primary road plan, a large road construction programme was started. During the war road building activity had to be discontinued and after the war because of the lack of funds the activity has been limited. In the secondary system a reasonable number of roads are now up to standards.

Administration and Finance

Whether a road comes under the administration of the National Government, the Provincial Governments, the Municipal Governments or the executive boards of the Drainage Districts, is mainly determined by historical development. Thus there are roads of the primary system administered by municipalities or provinces, and roads having almost little traffic and not belonging to any system administered by the National Government. However, the majority of primary roads are under the National Government, of the secondary roads under the Provincial Governments and the other roads under the local bodies. The necessary funds for improvement and maintenance of the roads are drawn from the general budgets of these bodies.

For the system roads, however, a special arrangement has been made to lighten the burden for the lower governmental bodies. The National Government gives a subsidy to those bodies in proportion to the length of the road system maintained, the amount per unit road length depending on the system to which the road belongs.

The source of these subsidies is the tax which is levied from all motor vehicles. The tax depends on the type and weight of the vehicle. In recent years the tax amounted to about 40 million guilders (Rs 50 million) of which 30 per cent is for construction and maintenance of primary roads, 35 per cent for secondary roads, and 10 per cent for other roads. Large and costly improvements which cannot be provided for by the budgets of the authorities are mainly financed by the issue of a public loan. Amortization and interest of the loans are paid out of the general budgets and the subsidies as levy of tolls is not known in Netherlands.

Type of Surfaces

Practically all of the system roads are surfaced, either with surface treatment on gravel base, or with bricks, concrete or a bituminous surface course on a Macadam or Telford base. Due to the bad soil conditions, even under the best precautions, settlements of the road beds occur frequently, as a result, the pavements are apt to be rather uneven soon after construction.

Bricks, placed in sand, are preferred by many municipal authorities for urban roads and streets because it facilitates repairs on gas and water mains, sewers and cables. For rural roads the type of surfacing used is usually determined by the costs, though it is more and more evident that brick pavements are not suitable for very heavily travelled roads, notwithstanding the development both of the quality of the bricks and of the methods of paving during the last decade. Only where soft subsoils occur and uneven settlements of the road-bed is feared brick pavements are still used on the primary roads.

Maintenance

Maintenance of brick pavements consists mainly of repaving small or large areas, to do away with unevenness in the surface. Maintenance of concrete pavements consists mainly of filling the joints. As a subgrade of pure sand is always used under these pavements, pumping does not occur on these roads. It might be mentioned here, that to prevent uneven settlement between the concrete slabs the practice in recent years has been to support the joints with a separate concrete slab, which is embedded in the subgrade over the full width of the pavement.

The maintenance of bituminous pavements consists mainly of periodical surface or seal treatments of either cut-back or emulsified asphalt and stone chips. On roads maintained by the National Government practically all maintenance work is done by contract.

Traffic

The volume of traffic which is regularly measured on 18 primary roads has increased to about twice that of 1938, and the trend is towards further increase. The highest daily traffic volume occurs in the tunnel of Rotterdam with over 25,000 vehicles per day. Practically all primary roads have an average volume of more than 1,000 vehicles per day. The highest average volume recorded on a rural road is 12,000 vehicles a day.

There is only about one vehicle for 70 persons but the population density is one of the highest in the world, being about 300 persons per sq. km. (780 per sq. mile.)

Mileage

System Roads

(Length in miles)

Authority	Primary	Secondary	Others	Total
National Government	1,482	45	56	1,583
Provinces	122	1,545	445	2,112
Municipalities	211	1,081	1,959	4,123
Others	43		829	
Total	1,858	2,671	3,289	7,818

National Primary Roads by Surface

Surface	Length miles	Percentage
Bricks	544	36.7
Bituminous	607	41.0
Cement Concrete	259	17.5
Stone blocks	52	3.5
Gravel	1	0.05
Wood	1	0.05
Others	18	1.2
Total	1,482	100.00

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Professor: " *A fool can ask more questions than a wise man can answer.* "
Student: " *No wonder, so many of us flunk in our exams.* "

DEFINITIONS OF HIGHWAY ENGINEERING TERMS

HIGHWAY : An important road in a road system.
ROAD LAND : The land secured and reserved for road purposes.

HERE AND THERE

1. THE ENGINEER AS ADVOCATE

OFTEN the engineer is called upon to get his schemes sanctioned by Administrators and those who hold the purse strings. When doing so, he necessarily assumes the role of an advocate, but not essentially as would a barrister defending. His purpose should not be to force through his project, but to explain it. Unlike the barrister with a weak case, he has behind him facts, estimates of cost (and these should be conservative) to support the knowledge and judgment required to penetrate the veil of the future. His advocacy therefore must be of a restrained sort, not seeking to overpersuade the judgment of those less informed, but of a more explanatory nature. It should be so, not because he seeks to avoid future responsibility for a possible error, for this responsibility should always be his, in part at least, but because it is the Administrator or the Financier who should make the decision. It may not be easy for him to speak objectively, to submerge his own bias and prejudice, and it is usually this fault which evokes criticism.

He must beware not to push up an important project before the time is ripe, for even with brilliant advocacy he will not succeed ; if he suffers several failures of this kind, he will lose respect. It would be better to wait until the time is more propitious.

(Extracted from 'The Journal of the Institution of Municipal Engineers,' London—August 1953).

2. NEW ZEALAND ROAD FUND PROPOSALS

A committee investigating the financing of road construction in New Zealand has included the following among its recommendations; a National Roads Board to be established, replacing the main Highways Board, with extended jurisdiction beyond that at present exercised by the latter Board, and with the personnel increased to include the Commissioner of Transport and representatives of municipalities and commercial transport operators.

A National Roads Fund to be established to be administered by the board, its revenue to comprise all motor taxation and Central Government contributions towards roads, and to be used (a) for financing motorways, state highways, and the central authority's share of main highways' expenditure; and (b) to assist local roading (road maintenance) authorities on a subsidy basis with the financing of their roading programmes.

Central Government to contribute approximately 12½ per cent of the national road bill, apart from any form of motor taxation.

All taxation from fuel used on the roads, together with heavy traffic fees, registration and annual licence fees, tyre tax and mileage tax to be paid direct to the Roads Fund without the necessity for annual appropriation by Parliament.

(Extracted from 'Modern Transport'—August 22, 1953).

3. COMPACTION OF SAND FOUNDATIONS

SAND, which is normally a poor foundation for a large heavy building, can now be made to serve as a satisfactory base by the process of compacting and compressing the grains. The new process is called "vibrofloatation" and it is being used in the construction of a large plant in the United States. The plant, which is to cost 12 million dollars, will have no other support than the sand itself.

The machine which does the compacting is called the Vibrofloat. The vibrofloatation process increases the relative density of sandy soil by a shaking and pushing process that packs the grains of sand more closely and tightly together and reduces the voids or empty spaces between the particles of sand. A much more solid sand mass results. The device consists of a tube which is vibrated by an internal electrically driven eccentric. A 10-ton centrifugal force is produced. This apparatus is attached to a follow-up pipe which houses the required water and electric lines.

Suspended from Crane

In operation, the Vibrofloat is suspended from a crane and guided by vertical wooden leads. Vibrating at full speed, it is lowered into the sand while a water jet at its tip forms a saturated mass of sand or temporary "quick-sand" condition, into which the vibrator rapidly sinks Lowered to an average depth of 13 ft the device—by its vibrating action—pounds the sand surrounding it into a tighter mass on all sides. Fresh sand is shovelled in from above, to fill the extra space which has been formed by this compaction.

The vibrator is withdrawn in 1-ft stages, being run at each stage until the sand is packed as solidly as is practical at that stage. An average of 2½ cubic yards of fresh additional sand is added by the time the vibrator is fully withdrawn. The result is a tightly compacted column of sand which is 8 to 10 feet in diameter. The columns are pounded in a predetermined overlapping pattern with about 8 ft between centres. The pattern greatly strengthens the compacted mass, a relative density of 70 to 100 per cent resulting—which is more than enough for high, or very high, bearing capacity.

One of the first buildings which were constructed on top of the compactions showed no measurable settlement after 6 months, though theoretically a settlement of 1 inch would occur.

(Extracted from 'Highways and Bridges' July 15, 1953).

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4. SIX-YEAR PLAN FOR PAKISTAN HIGHWAYS

PAKISTAN has prepared a six-year plan for development of the Federal highways and Provincial roads. The plan envisages a programme of 10,492 miles, out of which 2,226 would be new construction and 8,266 improvements of Federal highways, at a cost of about Rs 510 million. As regards the Provincial roads, the programme provides for the construction of 11,415 miles of new roads and the improvement of 6,047 miles of existing roads at a total cost of Rs 914 million.

The Six-Year Road Plan is the direct result of the recommendations of the transport Advisory Council which at its session in November 1950 emphasised "that a very high priority must be given to highways as the pace of our industrialisation, progress of development and standard of living all depended to a large extent on the existence of roads"

The Six-Year Plan prepared by the East Pakistan Government aims at the improvement of 568 miles of existing trunk roads and the construction of 1,300 miles of new surfaced roads and 4,460 miles of district and feeder roads with low cost surface. The intention is to connect every village with a trunk or a district road.

The Punjab plan envisages the construction of 4,312 miles of new and improvement of 1,362 miles of existing highways. The Provinces of Sind, N. W. F. P., Baluchistan, Karachi and the States of Bahawalpur and Khairpur have also prepared their plan.

The following table will give an idea of the anticipated programme for the whole of Pakistan.

Province or State	Length of Proposed Highways		Total length of proposed highways	Cost in Million Rupees
	New construction	Improvements		
Punjab	4,312	1,362	5,674	232,645
Sind	1,068	828	1,896	149,064
East Bengal	4,460	1,868	6,328	445,000
Baluchistan	931	750	1,681	17,300
N. W. F. P.	134	665	799	15,514
Bahawalpur	376	162	538	18,520
Khairpur	108	195	303	2,600
Karachi	26	217	243	33,273
Total	11,415	6,047	17,462	913,916

Federal Highways

The following are the proposed Federal Highways: Landikhana-Peshawar-Lahore-Khanowal-Rohri-Karachi; Quetta-Kalat-Las Bela-Karachi; Peshawar-Kohat-Bannu-Dera Ismail Khan-Quetta; Kashmor-Dadu-Karachi; Muzaffarabad-Rawalpindi-Khushab-Jhang-Muzaffargarh; Multan-Dera Ghazi Khan-Lorllai-Quetta-Qila Sufod; Gandasinghwala-Lahore-Khushab-Mianwali-Kohat; Gilgit-Swat-Malakand-Nowshera; Jaintiapur-Sylhet-Chittagong-Ukhia; Rangpur-Pabna-Jessore-Khulna; and Ragunathpur-Mymensingh-Dacca-Faridpur-Jessore.

The completion of the Six-Year Plan will increase the high-type road mileage of the country nearly five fold and almost all main cities and agricultural markets will then be connected.

(Extracted from 'Highways and Bridges' – July 8, 1953).

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5. PNEUMATIC ROLLERS REDUCE COSTS AND TIME

FIELD tests of special types of pneumatic rollers conducted over the last five years have demonstrated to the satisfaction of soil experts of the United States Corps of Engineers that both time and money can be saved by the use of such rollers in the construction of rolled-fill dams. Using rollers built to specifications developed by the corps as a result of these extensive test operations, it has been found possible to compact earth fills at about half the cost of obtaining comparable compaction by tamping rollers.

This reduction in cost is a direct reflection of the saving in time. However, it appears probable that the total benefit to a project resulting from the substitution of pneumatic rollers for sheepsfoot rollers may be much greater than the mere saving in the cost of rolling. For example, embankment materials containing a high percentage of cobbles and larger rock can be compacted in thick layers, thus eliminating the high cost of rock removal either by a grizzly operation in the borrow area or raking on the fill.

Aside from cost, advantages now apparent from the use of pneumatic rollers may be summarized as follows:

1. A type of roller has been developed that is suitable for the compaction of a wide range of both granular and cohesive soils to the densities required by design criteria.

2. The compaction of materials can be accomplished at higher moisture content than with tamping rollers. This is of particular importance where materials cannot be dried economically below optimum moisture.

3. Operations may be resumed earlier following rain as the pneumatic rolled fill absorbs less moisture than the tamped fill even though both are rolled with a smooth roller to facilitate drainage before the storm. This feature should be of importance in sub-tropical climates where rains occur daily.

(From 'Commonwealth Engineer' —July 1, 1953.)

6. STABILIZATION OF BLACK COTTON SOIL

BLACK cotton soil is characterized by the large volume changes that accompany seasonal fluctuations in its moisture content, and by its low stability when wet. Attempts by the Road Research Laboratory, U. K., to stabilize it with cement have not been successful but promising results have been obtained on such a soil from Southern Rhodesia with a treatment employing lime and wood tar. The addition of 4 per cent of hydrated lime reduced its plasticity index from 48 per cent to zero, and produced a material having a granular texture. The further addition of one per cent of a local Southern Rhodesian wood tar effected a marked reduction in the ability of the soil-lime mixture to absorb water.

(Extracted from 'Road Research, 1952')

7. THEORY AND THE ENGINEER

THE major advances in constructional methods have been due to improved and new materials and processes rather than to more abstruse methods of calculation. No engineer will dispute the broad truth of this assessment. For example, the Dome of Discovery at the Festival of Britain was designed and erected before the theoretical calculations were completed, as the responsible engineer revealed when describing this unique structure at a meeting of the Institution of Civil Engineers. No eighth-order differential equations, no rigid-frame theory in three dimensions, no strain energy or other theories or abstruse mathematics were brought to bear on the problem before the work started—the dome was merely an architect's idea and an engineer's solution. It is valuable for young engineers who are inclined to be obsessed with mathematics to remember that arches were built before Muller-Breslau published his theory, and that skyscrapers existed before the moment-distribution method of anlysis was devised. Such masterpieces as the lantern tower at Ely Cathedral might never have been accomplished if the fourteenth-century architects or monks had been fully aware of the difficulties which they had set themselves to surmount. Their work can have owed nothing to the differential calculus, which was not invented until three hundred years after their time; there was then no column theory, no theory of simple bending, not even the parallelogram of forces.

The engineer to-day must still rely very largely on what he can carry in his head. He must refuse to be "blinded with

science." His perception of the bare rules and elements of constructional theory must never be obscured by the intricacies of analysis, nor must his vision of practical possibilities be clouded by too close a view of the difficulties that result from applications of the more profound mathematics and physics.

Progress in design and construction will continue to depend more on ideas and imagination and on new materials and methods than on analysis—on practical men and slide-rule calculations rather than on the output of the differential analyser and the electronic digital computing machine The power of mathematical techniques and the capacity of mechanical computers can be usefully applied to improve and refine the product of a designer's inspiration, but they are not in themselves creative instruments. The engineer must therefore keep well informed on novelties of practical construction no less than on the progress of theory. His need is for a balanced outlook, and for sources of information which will help him to maintain a proper balance between theory and practice.

(Extracted from 'Concrete and Constructional Engineering', July, 1953).

8. ROAD GRADIENT AND FUEL CONSUMPTION

IN order to decide whether a proposed highway improvement, involving the elimination of steep gradients, is to be an economical proposition, some reliable estimate is necessary of fuel and time likely to be saved as a result. The approach used in a Paper on this subject by Mr. C. R. Webb, prepared for the Institution of Mechanical Engineers, is of general application, and depends on equating the engine output to the resistance to motion under uniform speed conditions.

It is concluded that, for a light or heavy vehicle, a nearly level surface is best from the economy point of view. Fuel consumption for a journey between two points at the same altitude, on roads sloping at one in four, is nearly three times that for the same journey on the level. At the same time, the journey takes over three times as long.

For a journey consisting of the following percentages of the total distance at the gradients shown:

50 per cent at zero gradient,

15 per cent at 5 per cent up gradient,

15 per cent at 5 per cent down gradient,

8 per cent at 10 per cent up gradient,

8 per cent at 10 per cent down gradient,

2 per cent at 15 per cent up gradient, and

2 per cent at 15 per cent down gradient, under good economy conditions, the average speed would be 34.0 m.p.h., at an average of 37.7 m.p.g., compared with 36.5 m.p.h. at 42.0 m.p.g. if the journey was all on the level. Under maximum speed conditions, the average speed would be 50.7 m.p.h., at an average of 26.1 m.p.g., compared with 60.7 m.p.h. at 26.5 m. p. g. for an all level journey.

(Extracted from 'Highways & Bridges'— July 1, 1953).

9. EFFECT OF QUALITY CONTROL

INVESTIGATIONS on samples drawn from four construction sites have shown in a striking manner the effect of control on the strength and uniformity of concrete. The results are summarized below :

Site	Mean compressive strength at 28 days lb per in.^{2}	Range of strength at 28 days lb per in.^{2}	Co-efficient of Variation Per cent	Samples below minimum strength specified Per cent	Site control
1	2640	1000–4590	27.4	48	Little effort to control quality.
2	3910	2340–6310	19.9	12	Batched by weight, water/cement ratio not controlled.
3	5110	4270–5880	9.0	...	Batched by weight. Concrete pump in use requiring uniform con-sistency for efficient working.
4	6500	5630–7420	7.2	...	Quality control under direction of an officer.

(Extracted from "Building Research" U. K. 1950).

10. QUALITIES NEEDED IN AN ENGINEER

THE qualifications for achieving success in engineering are intellectual and moral honesty, courage, independence of thought, fairness, good sense, sound judgment, perseverence, resourcefulness, ingenuity, orderliness, application, accuracy and endurance. An engineer should have ability to observe, deduce, to correlate cause and effect, and to apply the principles discovered.

Dealing with men, he should have the ability to co-operate, to organise, to analyse situations and conditions, to formulate problems and to direct the effort of others. He should know how to inform, convince and win confidence by skilful and right use of facts. He should be alert, ready to learn, open minded but not credulous. He must be able to assemble facts, to investigate thoroughly, to discriminate clearly between assumption and proven knowledge.

He should be a man of faith, one who perceives both difficulties and ways to surmount them. He should not only know Mathematics and Mechanics, but should be trained in methods of thought based on these fundamental branches of learning. He should have extensive knowledge of the sciences and other branches of learning besides knowing intensively those things which concern his specialities. **He must be a studeut throughout his career and keep abreast of human progress.**

—Shri C. B

11. FLOOD DAMAGE

THE abnormal rainfall during July 1952 in the Jalpaiguri and Cooch-Behar Districts of West Bengal brought down heavy and unprecedented floods. Several old bridges on sections of the Assam Access Road (National Highway No. 31) lying in these districts collapsed or were damaged. Their ventways proved inadequate for passing the abnormal floods.

Rivers and streams in this foothill country are, in the nature of things, very unstable. They are perpetually changing their regime and cutting new courses.

The Assam Access road being the life-line of North Bengal and Assam, the disruption of traffic on it was a serious matter. Temporary diversions and arrangements for crossing rivers had to be improvised quickly and maintained till the construction of timber bridges.

Photos of the damage and reconstruction of some of these structures printed here (see page x) give some idea of the devastation and the struggle it meant.

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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 to-day and which you cannot reach unless you walk or ride........................I give roads first priority."

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 pulling factor in military operations ; and no compaign has better illustrated this than that on the North-East frontier of India and in the North of Burma."

Lord Wavell.

TECHNICAL INFORMATION

1. THE OPERATION OF CIVIL ENGINEERING PLANT

(Extracted from 'Contractors Record'—June 1953)

THE working cost of mechanical plant consists of cost in relation to the following, the whole being reduced to terms of the working cost of the plant per hour:

(1) The allowance for depreciation.

(2) The cost of repairs and renewals.

(3) The cost of the fuel, lubricating oil and grease consumed by the plant.

(4) Licence and insurance costs, if any.

(5) The wages of the plant operator.

In order that the reader may be conversant with the manner in which to build up the working cost of plant per hour each of the above is fully discussed in detail.

The Capital Cost of Plant and the Allowance for Depreciation

In considering the allowance for plant depreciation three factors have to be taken into account, viz.:

(1) The capital cost of the plant.

(2) The average number of hours worked by the plant per annum.

(3) The years of the life of the plant.

Regarding (2) and (3) above, the life of plant, taking into account the average number of hours they work per annum, is derived from experience and recorded data kept in this connection on the works of construction.

The depreciation allowance for plant may be computed several ways, and in this article three methods are dealt with, viz.:

(1) The straight-line method.

(2) The interest on outlay method.

(3) The depreciation on the written down value method.

The straight-line method involves no intricate calculation, and has much to recommend its adoption. The author himself favours it, for it deals with depreciation in a straightforward manner. In adopting this method of interest is allowed on the capital outlay involved. The purchase of the plant is looked upon as a business investment, it being bought to carry out work, a profit being envisaged in doing so.

The interest on outlay method bears a marked resemblance to the straight-line method only in its case interest on the capital outlay is allowed for this usually being in the region of 5 per cent. This method is commonly used, and has, in fact, probably held favour with some contractors for many years past.

The depreciation on the written down value method is chiefly used in the case of plant, such as lorries, cars, etc., the depreciation being arrived at by taking the percentage depreciation on the written value of the preceding year and not on the capital cost of the plant. In using this method the vehicle is always of some residual value, and the actual value is, in general, less than the apparent value.

In order to illustrate these methods, the following examples are shown:

Example No. 1.—Straight-line method.

In adopting this method, the contractor must assess or have a sound conception of the following:

(1) The average number of hours the plant will work per annum.

(2) In working this number of hours, the numer of years it will operate in a highly efficient manner with little cost incurred in relation to repairs and renewals.

(3) The residual value of the plant at the end of this period of time.

(4) The estimated total years of life of the plant.

The contractor may decide to operate the plant only so long as it works in a highly efficient manner, and then dispose of it and buy a new machine. On the other hand, he may prefer to overhaul it and continue to use it for, say, another year, any outstanding reserve then being written off in this last year of its life.

E.g., a mechanical excavator is to be purchased whose cost is Rs 67,500. Based on working 1,800 hours per annum, the contractor considers it will give highly efficient service for a period of three years, after which he will overhaul it and work it for a further two years. Compute the depreciation allowance by the straight-line method.

Capital cost of the plant Rs 67,500.

Period		Amount Rs
First year	...	22,500
Second year	...	22,500
Third year	...	22,500
Total	...	67,500
Credit residual value at the end of three years ...		22,500
		45,000

$$\therefore \text{ Cost per annum} = \frac{45{,}000}{\text{Trhee years}}$$

$$= \text{Rs } 15{,}000 \text{ per annum.}$$

Since the hours worked per annum are 1,800 hours,

$\therefore$ Rate per working hour allowing for

$$\text{depreciation} = \frac{15{,}000}{1800 \text{ hours}} = \text{Rs } 8\text{-}5\text{-}0$$

Referring to the example given, it will be noted that at the end of the third year a residual value of Rs 22,500 is placed on the plant. Should the contractor decide to work the plant a further year, this residual value would be written off in this the fourth year. If it was decided to work it still a further year, however, i.e., five years in all, the residual value of Rs 22,500 would then be written off in two years, i.e., the fourth and fifth years respectively. If the contractor decides to sell the machine at the end of the third year, a credit or debit value would be recorded, depending on whether it was sold at a figure in excess of, or less than, the residual value of Rs 22,500, which was placed upon the plant.

Example No. 2—Interest on outlay method.

This method is fundamentally the same as the straight-line method, only interest is allowed on the capital outlay and consideration given to the total years of life of the plant based on the average hours it works per annum.

For purposes of this example, the same mechanical excavator will be dealt with as in Example No. 1.

E.g., a mechanical excavator is to be purchased whose cost is Rs 67,500. Its years of life based on its working 1800 hours per annum is five years. Compute the allowance for depreciation by the interest on outlay method, the rate of interest allowed being 5 per cent.

Capital cost of the plant	=	Rs 67,500
Allow 5 per cent for period of five years	=	Rs 16,875
	=	Rs 84,375

On a five-year life cost

$$\text{per annum} = \frac{\text{Rs } 84{,}375}{\text{Five years}}$$

$$= \text{Rs } 16{,}875 \text{ per annum}$$

Since the hours worked per annum are 1,800 hours,

$\therefore$ Rate per working hour

$$\text{allowing for depreciation} = \frac{16{,}875}{1800 \text{ hours}}$$

$$= \text{Rs } 9\text{-}6\text{-}0.$$

Example No. 3.—Depreciation on the written down value method.

(Continued on page 22)

RADII OF HORIZONTAL ROAD CURVES

1. The centrifugal force, acting on a vehicle by virtue of its motion along a curve, $F = mg \times \frac{v^2}{R}$, ...(1)

where m is the mass of the vehicle, v its velocity, g the acceleration due to gravity, and R the radius of the curve.

The balancing force $F' = m.g.(e + f)$..........(2)

where e is the superelevation and f the co-efficient of friction between the tyres and the road surface.

For equilibrium, $F = F'$;

$$i.e., \ e + f = \frac{v^2}{Rg}, \quad \text{..........(3)}$$

If we take velocity in m.p.h. as V and R in ft., the above relation becomes :

$$e + f = \frac{V^2}{15R}, \quad \text{..........(4)}$$

2. Now, the maximum permissible value of e, the superelevation, is 0.067. For worst conditions, the maximum value of f is taken as 0.15. Substituting these values in (4).

$$(0.067 + 0.15) = \frac{V^2}{15R}$$

Therefore, $R = 0.3072 \ V^2$, ...(5)

This equation gives the radius of the sharpest permissible curve for the design speed of V m.p.h. The following table is based on Equation (5).

In plains :	V	60	50	40	30	20
	R	1000	800	500	300	150
In hills :	V	35	30	25	20	15
	R	400	300	200	150	100

Rules (1) Adopt the largest possible radius, there being no upper limit.

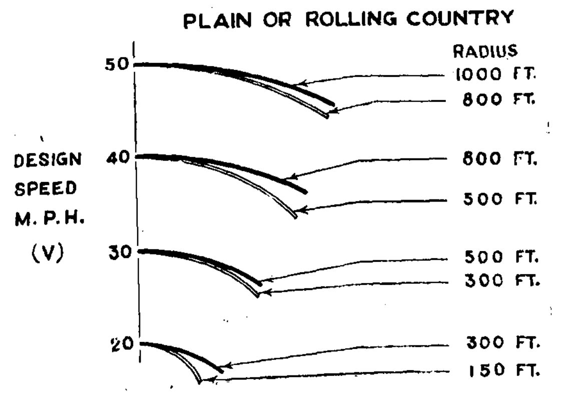
(2) It is desirable that the radius should not be less than the tabulated value for the speed next above the design speed. For instance if the design speed is 50 m.p.h. it is desirable that R should not be less than the tabulated value against 60 m.p.h.

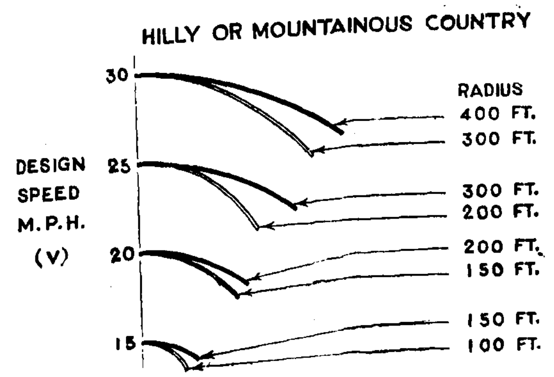
(3) In no case, should R be less than the tabulated value for the design speed.

RADII OF HORIZONTAL ROAD CURVES

The selected radius should be equal to or greater than the radius of the curve shown in full line (See rule 2).

In no case should the radius be less than that of the hollow line (See rule 3).





(Continued from page 19)

This method is commonly adopted in the case of plant, such as lorries, transport vehicles, cars, etc.

For Example, a vehicle is to be purchased whose cost is Rs 18,000, its life being assessed at three years. Allowing depreciation at the rate of 33-1/3 per cent per annum, compute the depreciation table for the vehicle in question :

	Rs.	A.	P.	Depreciation Rs.	A.	P.
Capital cost of vehicle	18,000	0	0			
$33\frac{1}{3}$ per cent depreciation first year	6,000	0	0	6,000	0	0
	12,000	0	0			
Value of vehicle at end of first year	12,000	0	0			
$33\frac{1}{3}$ per cent depreciation second year	4,000	0	0	4,000	0	0
Value of vehicle at end of second year	8,000	0	0			
$33\frac{1}{3}$ per cent depreciation third year	2,666	11	0	2,666	11	0
Value of vehicle at end of third year	5,333	5	0	12,666	11	0

At the end of the third year the residual value of the vehicle is Rs 5,333-5-0. In adopting this method of allowing for depreciation, it will be noted that the plant always has some residual value.

The Cost of Repairs and Renewals and the Fuel and Lubricants Consumed by the Plant

In building up the working cost per hour of a specific item of plant, the cost expended on repairs and renewals in maintaining the plant and also that of the fuel and lubricants used must be taken into account, this being reduced to terms of per working hour of the plant.

Cost in the above connection can only be derived from recorded results of the requisite data, this necessarily having been recorded over a considerable period of time so as to make available as true a value of the cost incurred as possible. In regard to repairs and renewals, it should be noted that both minor repairs carried out by the operator and major overhauls carried out by the plant department and/or the makers must also be taken into account.

The recorded results required are carried out by the operator of the plant and by the fitter or mechanic who carries out any repairs necessary on the site or at the depot, as the case may be.

These results are generally obtained in the following manner :

1. A suitable log sheet (See table on p. 23) is kept by the operator, who records on it daily the following :

(a) The hours worked by the plant.

(b) The hours worked by the operator, ordinary time.

(c) The hours worked by the operator, oiling and greasing time.

(d) The hours worked by the operator on minor repairs.

(e) The fuel and lubricants issued to the plant.

2. Any repairs carried out on the site or at the depot are recorded by the fitter concerned on a plant log sheet, a separate log sheet being kept for each item of plant. The data recorded on this sheet is as follows :

(a) The fitter hours spent in carrying out the repairs.

(b) Any spare parts supplied and fitted.

The data from the operators' and fitters' log sheets are then abstracted week by week and entered on a "Plant Record Sheet" for the item of plant in question. On this plant record sheet is also recorded the cost of any major overhauls or repairs carried out by the makers or other than by the contractors' own personnel. From this "Plant Record Sheet" is then obtained the following :

(1) The hours worked by the plant.

(2) The total cost of repairs and renewals.

(3) The fuel and lubricants consumed.

From the above is computed the cost of repairs and renewals and the fuel and

PLANT OPERATOR'S TIME AND LOG SHEET

Week ending: 10th July 1952
Machine: 10RB Excavator, 3/8 cu. yd.
Machine No: 13
Equipment: Shovel
Fuel: Diesel
Contract: xxx

Name and Address of contractor :.. **Driver :**..

Day	Date	Machine time, hours						Operator, hours						Fuel and lubricants issued			Repairs and renewals carried out by the operator	
		Working	Idle time				Total hours	Ordinary time	Overtime	Greasing time	Minor repairs	Travelling time	Total hours	Fuel, gals.	Oil pints	Grease lbs.	Operator hours	Spares fitted
			Weather loss	No work	Broken down	No driver												
Thursday	July 4th	8½	–	–	–	–	8½	8½	–	½	–	1	10	40	8	3	–	
Friday	5th	8½	–	–	–	–	8½	8½	–	½	–	1	10	–	–	–	–	
Saturday	6th	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
Sunday	7th	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
Monday	8th	8½	–	–	–	–	8½	8½	–	½	–	1	10	40	8	7	–	
Tuesday	9th	7½	–	–	1	–	8½	7½	–	½	1	1	10	–	–	–	1	1 No. fan belt, new
Wednesday	10th	8	½	–	–	–	8½	8½	–	½	–	1	10	–	–	–	–	1 No. ½ in. brass union.
		41	½	–	1	–	42½	41½	–	2½	1	5	50	80	16	10	1	

lubricants consumed in terms of per working hour of the plant.

The following shows a typical plant operator's log sheet relating to a 10 Ruston Bycurus mechanical excavator which is essentially simple to fill in by the operator and at the same time comprehensive in that in it is recorded all the data necessary from which to compute the cost of repairs and renewals carried out by the operator and the fuel and lubricants consumed per working hour of the plant.

In building up the working cost per hour of a specific item of plant the cost of repairs and renewals may be allowed for as a percentage of the capital cost of the machine, this percentage having, of course, been derived from recorded data relating to the cost of the repairs and renewals in relation to the hours worked by the plant and its upset cost.

Licence and Insurance Costs

Licence and insurance costs in connection with plant have to be taken into account in considering the working cost of the plant per hour.

In the case of certain types of plant an annual licence has to be taken out for which a charge is made. As an example of this may be quoted licence costs in connection with lorries. This licence cost in terms of per working hour of the lorry is obtained, knowing the annual cost of the licence involved and the working hours of the lorry per annum.

Plant insurance costs may be dealt with in a similar manner. Apart from lorries and cars, plant insurance is not a large item, as the insurance required is generally only related to damage by fire or theft. In the case of lorries and cars, however, insurance cost is considerable for third party risk is involved, and in such cases insurance must be allowed for in computing the working cost of the vehicle per hour.

The Wages of the Plant Operator

In considering the wages of the plant operator in relation to the working cost of plant per hour the following should be noted :

(1) The hours worked by the operator are invariably greater than the hours worked by the plant, this being due to such factors as time spent in oiling and greasing the machine, carrying out minor adjustments and repairs, etc.

(2) The effective wage rate of the operator must be taken into account, allowing for cost in connection with such items as the employers' contribution to State Labour Insurance and the holidays with pay scheme, travelling time paid to the operator, bonus payments made in relation to the output, etc.

In order to indicate the manner in which to build up the effective wage rate of a plant operator, the following example is shown.

Example

A mechanical excavator operator works 45 hours in a particular week, his basic wage rate being Rs 2-7-0 per hour. He is also paid, in addition, the sum of Rs 22-8-0 as bonus on output and a total of five hours' travelling time since he travels to and from the contract daily.

The employers' contribution to State Labour Insurance is Rs 3-12-0 per week, and for the holiday with pay scheme also Rs. 3-12-0 per week. The actual hours worked by the plant is 45 hours. Compute the effective wage rate in terms of per working hour of the plant.

	Rs.	As.	Ps.
Total operator hours = 45 + 5 = 50 hours at Rs 2/7/-	121	14	0
Bonus payment	22	8	0
State Labour Insurance, Employers' contribution	3	12	0
Holiday with Pay Scheme, Employers' contribution	3	12	0
	151	14	0

∴ Effective wage rate in relation to the hours worked by the plant $= \dfrac{151\text{-}14\text{-}0}{45 \text{ hours}}$

= Rs 3-6-0 per hour.

In order that data may be available from which to build up the working cost per hour of various types of plant, two tables are shown.

Table No. 1

The Cost of Repairs and Renewals as a Percentage of the Cost of the plant and the Average Working Hours per annum and Years of Life of Various Types of Plant

Type of plant		Cost of repairs and renewals per annum as a percentage of the cost of the plant	Estimated: Average plant-working hours per annum	Estimated: Years of life of the plant
Angledozers	Diesel	8	1600	5
Bulldozers	Diesel	8	1600	5
Concrete mixers	Diesel	5	1800	7
Concrete mixers	Petrol	7½	1800	6
Concrete spreaders and finishers	Petrol	7½	1800	5
Compressors	Diesel	7½	1600	5
Compressors	Petrol	10	1600	3
Cranes	Diesel	5	1500	8
Cranes	Petrol	10	1500	6
Cranes	Steam	5	1500	10
Dumpers	Diesel	7½	2000	4
Dumpers	Petrol	12½	2000	3
"Hilift" shovels	Diesel	7½	1800	5
"Hilift" shovels	Petrol	7½	1800	4
Hoists	Diesel	5	1500	8
Hoists	Petrol	7½	1500	6
Locomotives	Diesel	5	1500	10
Locomotives	Petrol	7½	1500	7
Locomotives	Steam	5	1500	12
Locomotive wagons	Steam	5	1500	10
Lorries	Diesel	7½	2200	5
Lorries	Petrol	12½	2200	3
Mechanical trenching plant and endless bucket type	Diesel	8	1800	7
—do—	Petrol	12½	1800	5
Mechanical shovels, draglines & skimmers	Diesel	7½	1800	5
Piling plant, pneumatic	Diesel	5	1500	6
Piling plant	Steam	4	1500	8
Pumps	Petrol	10	1200	6
Pumps	Steam	4	1200	10
Rollers	Diesel	5	1800	8
Rollers	Petrol	7½	1800	5
Rollers	Steam	4	1800	12
Tractors	Diesel	8	1800	5
Wagons	Steam	5	1800	10

(To be continued)

2. IMPACT RESISTANCE OF CONCRETE

(Extracted from 'Civil Engineering'—August, 1953)

INFORMATION on impact resistance of concrete is of vital importance in the design of structures to withstand explosive blasts and earthquakes. To obtain quantitative data, the National Bureau of Standards, U.S.A., structural engineering laboratory is conducting an extensive study of the properties of concrete under impact in co-operation with the Bureau of Yards and Docks, Department of the Navy. In results obtained thus far, the dynamic compressive strength of concrete was found to be up to 84 per cent higher than the static strength, and the modulus of elasticity up to 47 per cent greater.

The compressive strength and modulus of elasticity of concrete are usually determined by tests of 6 by 12 in. cylinders under essentially static conditions. Data thus obtained are adequate for design calculations on structures subjected to static loads, but may not give results applicable to impulse loads in which the peak value and subsequeut attenuation of the force may take place in a fraction of a second. Studies of the effect of loading rate on the elastic properties of plain concrete have been until now confined to rates of straining less than 2×10^{-3} in.^{2} per second. In the current study, directed by David Watstein, the rate of straining of the concrete has been over the wide range 10^{-6} to 10 in.^{2} per second, a range made possible by recent advances in the technique of measuring stresses and strains with bonded-wire strain gauges.

In the National Bureau of Standards investigation, 3 × 6 in. cylinders were subjected to standard static tests in a 60,000 lb hydraulic machine to impact tests in a specially designed drop-hammer machine at various rates of loading up to 10 in.^{2} per sec. The total duration of the impact corresponding to the latter rate of loading was 0.003 second. "Softer" impact tests having a duration of about 1 sec. were made in a hydraulic machine running at full speed. Two types of concrete were used: a weak concrete of 2,500 lb per in.^{2} nominal static compressive strength and a strong concrete of 6,500 lb per in.^{2} nominal static compressive strength.

The drop-hammer machine consisted essentially of a 3,200 lb steel anvil for supporting the test specimen, a 140 lb drop-hammer and a device for catching the hammer on the rebound. The hammer tip, which made contact with the test specimen, had a flat surface. Four compression springs supported the anvil, which was limited in its travel by four shock absorbers and two rubber buffers between the bottom of the anvil and the concrete base of the machine. The anvil was constrained to motion in a vertical plane by means of two hinged sway plates, one at each end of the anvil, which were anchored to the concrete wall back of the machine.

The maximum height of drop was 5.5 ft, and the maximum velocity of the hammer was about 19 ft per sec. Various types of rubber buffers placed on top of the capping plate of the specimen controlled the duration of impact.

Forces were measured by four type-C3 bonded-wire strain gauges arranged around the periphery of a cylindrical dynamometer. The gauges were attached to the dynamometers with nitrocellulose cement and dried in air several hours before curing in an oven at a temperature of 60 deg. C. Upon removal from the oven, the gauges were coated with hot cerese wax to protect the nitrocellulose cement from the effects of atmospheric moisture. Similar gauges on the concrete test specimen provided the strain measurements.

The outputs of the bonded-wire strain gauges on both dynmometer and specimen were fed into a dual channel cathode-ray oscilloscope. The single-sweep trigger,

which initiated the driven sweep of the oscilloscope, delivered an external synchronising pulse in response to the closure of a pair of external contracts by the drop-hammer. The duration of impact ranged from 0.004 to 0.0003 second. The oscilloscope data were recorded on 35 mm. film with a fixed-focus camera having an f. 3.5 lens. The time base was furnished by an audio-frequency oscillator, which modulated the intensity of the beams so that the beams traces become dotted lines; the modulating frequency was varied from 5,000 to 20,000 cps, depending on the duration of the test. In the softer impact tests, the measurements were made with a 4-channel carrier-type bridge and recording oscillograph.

The dynamic compressive strength of a given type of concrete was found to be higher than the static compressive strength, becoming relatively greater as the duration of impact decreased. The ratio of the dynamic to static strength for the weak concrete ranged from 1.09 for a 0.9 second impact to 1.84 for a .00025 second impact. The corresponding ratio for the strong concretes ranged from 1.13 for the longer impact to 1.85 for a .00043 second impact.

The modulus of elasticity of the concrete was affected in a manner similar to that of the strength, that is, the ratio of dynamic to static modulus increased as the duration of impact decreased, reaching a maximum of 1.47 for the weak concrete and 1.33 for the strong concrete. The linear portions of the stress-strain curves became longer and steeper as the duration of impact was decreased. The ratio of strain energy absorbed under dynamic loading to that absorbed under static loading reached a maximum of about 2.2 for both concrete tested.

The significant increases in compressive strength, elastic moduli, and ability to absorb strain energy under impact loading are of importance to the designer. Further studies of the effect of impact on concrete in flexure are in progress to enable the designer to take account of the potential saving of material in structures to be erected where they may be subjected to earthquakes, to bomb blasts, or to similar impact loading.

3. HYDROPHOBIC CEMENT

(Extracted from 'Concrete and Constructional Engineering'—August, 1953)

A Portland Cement that will not be affected by moisture or damp conditions during storage would be a boon to cement makers and users alike. It was found that prisms of mortar made with such a cement called the "hydrophobic cement", made in the U.K., had a greater resistance to the absorption of moisture than similar mortars made with ordinary Portland cement. Six-inch cubes made of 1 : 2 : 4 concrete had a density of 145 lb per cubic foot and a crushing strength of 2,390 lb per sq. inch compared with a density of 147½ lb per cubic foot and a compressive strength of 2,540 lb per sq. inch in the case of similar concrete made with ordinary Portland cement. The tests for permeability and compressive strength were made at fourteen days and seven days respectively after casting the test pieces. These results suggest that a decrease in permeability is counterbalanced by a decrease in compressive strength and in density. The results of tests at such early ages are, of course, of interest but of no real value to cement users, and engineers will look forward to the results of tests over longer periods which will no doubt be available later. Tests of the resistance to moisture of unset "hydrophobic cement" have, however, shown that it is not likely to be affected by poor storage conditions during the period while cement is generally kept on a site or in transit between the cement works and the site.

A short investigation of the subject has recently been made at the Building Research Station (U.K.) and the results confirm the claims made by the British and Russian inventors, although it must be emphasised that these were also short-period tests and are not a guarantee of the durability over a long period, which is essential in most constructional works, of concrete made with such cement. In the tests at the Building Research Station one of the chemicals used was oleic acid. The acid was ground into the cement clinker in proportions from 0.1 per cent to 1 per cent and a simple test of the permeability of the resultant cement was to see if it would float on water. Cement to which no oleic acid was added sank when it was sprinkled on to water; with an addition of 0. 1 per cent of oleic acid the cement floated for seven days; cement to which from 0. 25 per cent to 1 per cent of oleic acid had been added all continued to float on the surface throughout the period of the test, and the report of the Building Research Station suggests that they would be likely to float indefinitely. Tests on 1: 3 mortars with and without oleic acid showed that the initial and final setting times were one hour and 1 hour 10 minutes respectively for the treated cement compared with 2 hours 43 minutes and 3 hours 33 minutes in the case of similar cubes made without the additive. The expansion measured by the Le Chatelier test was the same, namely 1 milimetre, for the treated and untreated cements. Compressive tests on 1 : 3 mortar cubes up to 28 days showed that the addition of oleic acid retarded an increase of strength at very early ages, but that there was less difference at 28 days; the results were as follows in pounds per sq. inch (the strengths of the cubes made with untreated cement are given in brackets): One day, 316 (1090); three days, 2820 (3270); seven days, 5260 (5140); 28 days, 7090 (7600). It is suggested that the low strength of the treated cement at one day is probably due to the water-repellent film remaining on the particles of cement at that early period after casting.

A test on the effect of exposure to air gave some remarkable results. The test was made on 1 : 3 mortar cubes at the age of seven days, the cubes being made with ordinary Portland cement and with cement to which oleic acid had been added and both of which had been spread out in a layer half-an-inch thick and exposed to air at a temperature of 64 deg. F. and at 90 per cent relative humidity for periods up to six months, the cement being stirred and any lumps broken every four days. Cubes of 4-in. sides made with these cement without exposure had similar compressive strengths of about 5200 lb per sq. inch. Cubes made with cement exposed for fourteen days had compressive strengths of 5100 lb per sq. inch in the case of the treated cement and 2430 lb per sq. inch in the case of the untreated cement. At three months the cubes made with untreated cement had no strength. The cubes made with treated cement after three months' exposure had a compressive strength of 5390 lb per sq. inch, and cubes made with treated cement which had been exposed for six months had a compressive strength of 5800 lb per sq. inch.

The addition of the chemical results in the formation of a water-repellent film around each grain of cement, which is rubbed off when the cement is subjected to abrasion with the aggregates during the mixing process. When the chemical is added to the cement clinker, the grinding is facilitated with the result that a finer cement is produced. It would be expected that the finer cement would need more mixing water, but it is claimed that the chemical also acts as a plasticising agent and increases the workability of the concrete so that less water need be added to give a required workability, with the consequent possibility of increasing the strength of concrete with a given cement content of enabling a smaller cement content to be used. The chemical also entrains air in the mixture, and it was at the Building Research Station that the air-entraining property of oleic acid is about the same as 0.1 per cent of one of the air-entraining agents now available. Obviously there is no possibility of such cements being made commercially for years until experience has proved that there is no deterioration with age.

ABSTRACTS

624.131. PROCEEDINGS OF THE THIRD INTERNATIONAL CONFERENCE ON SOIL MECHANICS AND FOUNDATION ENGINEERING (1953), Organizing Committee, Gloriastrasse 39, Zurich 6.

The Papers presented at the Third International Conference on Soil Mechanics and Foundation Engineering are printed in two volumes under eight sections. Also included in Vol. II are the surveys of General Reporters for the eight sections. These general reports review the current progress made in soil mechanics and offer comments upon the studies made in the last five years and the Papers submitted to the Session.

The third volume of the Proceedings, which is not yet published, is expected to contain the opening address and the discussions at the Session.

Volume I

Section 1, Theories and Hypotheses of General Character, Classification, Engineering Geology, contains 19 Papers; the more important of them are :-

(1) Influence of Vegetation on Soil Moisture Contents and Resulting Soil Volume Changes by E. J. Felt of U. S. A.

(2) Relation between the Mean Grain Size, the Size Factor and the Optimum Moisture Content of Compacted Soils by M. S. Youssef of Egypt.

Section 2, Laboratory Investigation, Including Compaction Tests, Improvement of Soil Properties, contains 28 Papers, of which the following are of particular interest:-

(1) Stable Density by C. L. Dhawan and 4 others of India.

(2) Experimental Determination of the True Cohesion and True Angle of Internal Friction on Clays by R. E. Gibson of England.

(3) Construction of Compacted Soil Linings for Canals by W. G. Holtz of U. S. A.

(4) The "Hydration" Method, A New Process of Stabilizing Soils by Inorganic Agents by K. F. G. Keil of Germany.

(5) The Shearing Resistance of a Fine Closely Graded Sand by K. L. Nash of England.

(6) Determination of Swelling Pressure of Black Cotton Soil—A Method by R. M. Palit of India.

(7) The Effect of Heating the Soil on Permeability under Prolonged Submergence of Soil in Water by K. S. Rao and S. K. Wadhawan of India.

Section 3 - Field Investigation, Technique of Field Observations including Compaction Control, Soil Stabilization, contains 19 Papers, the more interesting of these are :-

(1) Quality Control of Earth Embankments by F. J. Davis of U. S. A.

(2) The Compaction of Soil for Earthworks and the Performance of Plant by W. A. Lewis of England.

(3) Investigution of Some Problems in Soil Stabilization by D. J. MacLean of England.

(4) Soil Stabilization in Tropical Areas for Mass Construction of Cheap Permanent Housing by S. R. Mehra of India.

(5) Field Compaction Tests on Lean Clay Soil by W. J. Turnbull and W. G. Shockley of U. S. A.

Section 4 - Foundation of Buildings and Dams, Bearing Capacity, Settlement Observations, Regional Subsidence, contains 31 Papers. The following are some of the interesting Papers :-

(1) Settlement Studies on the National Museum Building, Ottawa, Canada by C. B. Crawford of Canada.

(2) Settlement Observations in Finland by K. V. Helenelund of Finland.

(3) Building Settlement Measurements —Oregon State College by G. W. Holcomb of U. S. A.

(4) The Use of Sand Drains Under Buildings at Port Newark by J. M. Kyle of U. S. A.

(5) The Bearing Capacity of Foundations under Eccentric and Inclined Loads by G. G. Meyerhof of England.

(6) Settlement and Permissible Bearing Pressures by E. Schultze of Germany.

(7) The Foundations of the Bank of China Building, Hong Kong by M. J. Tomlinson and J. B. Holt of England.

(8) Soil Movement and Weather by W. H. Ward of England.

Volume II.

Section 5—Piles and Pile Foundations, Settlement of Pile Foundations, contains 18 Papers, of which the following deserve special mention :—

(1) Investigations of Values of the Dynamic Penetration Resistance to Model Piles in Sand and Clay, Obtained from Tests by H. Grasshoff of Germany.

(2) An Investigation for the Foundations of a Bridge on Dense Sand by G. G. Meyerhof of England.

(3) The Problem of Pile Driving by N. Nanninga of Netherlands.

Section 6—Roads, Runways, Airports (Flexible and Rigid Pavements) and Their Foundations contains 8 Papers, of which the six are in English :—

(1) An Investigation on the Bearing Capacity of Some Flexible Runways at Schipol Airport by R. A. Brzesowsky and C. Van Der Veen of Netherlands.

(2) Prevention of Frost Heaving by Injection of Spent Sulphite Liquor by R. M. Hardy of Canada.

(3) Soil Moisture and Density Measurements at Australian Aerodromes by H. T. Loxton, M. D. McNicholl and H. C. Williams of Australia.

(4) The Design of Road Foundations by D. C. MacLean and M. D. Armstrong of England.

(5) Airport Runway Design and Evaluation in Canada by N. W. McLeod of Canada.

(6) Loading Tests on Concrete Slabs at Schipol Airport by C. Van Der Veen of Netherlands.

Section 7 deals with Earth Pressure, Retaining Walls, Tunnels and Pits in Soils, and contains 9 Papers. The following are some of the interesting ones :—

(1) Measurements of Loads and Strains in Earth Supporting Structures by L. F. Cooling and W. H. Ward of England.

(2) A General Earth Pressure Theory by J. Brinch Hansen of Denmark.

(3) The Behaviour of the Concrete Bridge Built at Klosters by the Rhaetian Railway Company, Switzerland under the Influence of Soil Creep Pressure by R. Haefeli, Ch. Schaerer and G. Amberg of Switzerland.

Section 8 deals with Stability and Deformation of Slopes and Earth Dams, Research on Pore Pressure Measurements, Groundwater Problems, and contains 22 Papers, of which the following are interesting :—

(1) Landslides in Japan by Masami Fukuoka of Japan.

(2) Applications of Soil Mechanics in River Structures (India) by K. L. Rao of India.

(3) Recent Research into the Coastal Landslides at Folkestone Warren, Kent, England, by A. H. Toms of England.

(4) The Design of Earth Dams for Pervious Foundations by F. C. Walker of U. S. A.

388. THE ROAD AND THE VEHICLE
B. G. MANTON, Edward Arnold & Co., London.

The book, published in 1953, is the latest addition to the Roadmakers' Library series. The relationship between the vehicle and the road to take modern traffic is presented in all its manifold aspects. These have been dealt in eight chapters, viz—

(1) Legislation relating to Road Vehicles.

(2) Braking and Acceleration.

(3) The Traffic Capacity of Roads.

(4) Effects of Road Alignment.

(5) Economic Effects of Road Design.

(6) The Design of Junctions.

(7) The Reaction of the Vehicle on the Road, and

(8) Motorways.

The chapter "Economic Effects of Road Design" has been dealt with under the headings : Speed and fuel consumption ; Tractive efforts and gradients ; Savings affected by reduction of gradients and Losses due to checks.

In the chapter "Effects of Road Alignment", the dynamics of vehicle motion on the road is given. Increased tyre wear on curves is mentioned.

Under the heading "Design of Junctions", roundabouts, acceleration and deceleration lanes, junctions with dual carriageways, and staggered crossings are discussed.

In chapter 3, Traffic Capacity of Roads is presented in detail.

Standards for the design of "Motorways" are presented and the practice regarding these in France and U. S. A. is given.

A comprehensive list of references is appended.

MANUFACTURING AN IDEA

Get All the Facts......
Reject the Irrelevant,
Refine the Relevant .....
And Apply the Result of your Thinking.

THINGS THAT MAKE A COUNTRY GREAT

"There are three things that make a country great and prosperous: fertile fields, busy workshops and ready means of transportation from one place to another."

Roger Bacon

SELECTED RECENT LITERATURE IN ENGINEERING JOURNALS

I. ROADS IN GENERAL

1. **The Safety Factor in Construction**: G. ANTHONY GARDNER, *The British Constructional Engineer*, May–June 1953; pp. 22–24.

2. **New Road from Beersheba to Sodom (Israel)**: *Engineering*, June 7, 1953 ; pp. 705–06.

3. **Post-graduate Courses for Engineers** ; PROF. W. A. TUPLIN ; *Engineering*, June 5, 1953 ; pp. 725–26.

4. **Legal Responsibility of the Registered Engineer** ; W. C. SADLER, *Civil Engineering*, May 1953 ; p. 5.

5. **Simplified Method of Prelminary Hydrographic Surveys of Calm Waters** ; *Civil Engineering*, May 1953 ; pp. 50–51.

6. **New York Thruways Big Year** ; *Engineering News Record*, July 2, 1953 ; pp. 38–40.

7. **New Jersey Constructing 165-Mile Toll Parkway** ; *Better Roads*, July 1953 ; pp. 19–20, 34.

III. PLANNING, LAYOUT AND SURFACE CHARACTERISTICS

8. **Spiral Tables for Highway Design** ; H. CRISWEL, *Roads and Road Construction*, June 1953, pp. 152–154, Part II.

9. **The Design of Motorways** ; *Roads and Road Construction*, June 1953, p. 169.

10. **Chart Indicates When A Road is in Tolerable Condition** ; P. C. SHAFER, *Better Roads*, July 1953, pp. 26–27.

IV. SOIL ENGINEERING AND DRAINAGE

11. **Analysis of Corrective Actions for Highway Landslides** ; R. F. BAKER, *Separate No. 150, Vol. 79, Proceedings of the American Society of Civil Engineers*, May 1953, pp. 1-25.

12. **Model Experiments to Study the Influence of Seepage on the Stability of a Sheeted Excavation in Sand** ; ARTHUR MORSLAND, *Geotechnique*, June 1953, *Vol. 3, No. 6*, pp. 223-241.

13. **A Historical Chapter: British Royal Engineers Papers on Soil Mechanics and from Latin Engineering 1837-1874** ; JACOB FELD, *Geotechnique*, June 1953, *Vol. 3, No. 6*, pp. 242-247.

14. **Earth Pressure Measurements in Open Cut : Contract D-8, Chicago Subway** ; TIEN-HSING WU and SIDNEY BERMAN, *Geotechnique*, June 1953, *Vol. 3, No. 6*, pp. 248-257.

15. **Electro-Osmotic Process Stabilizes Power Plant Foundation** ; *Civil Engineering*, June, 1953, p. 80.

16. **Rock Depths Along Canal Route Determined by Seismic Refraction** ; W. E. SCHUBERT, *Civil Engineering*, June, 1953, pp. 58-59.

17. **Scour Holes Easily Contoured for Erosion Experiments** ; C. J. POSEY, *Civil Engineering*, June 1953, pp. 60-61.

18. **Some Recent Foundation Research and Its Application to Design** ; G. G. MEYERHOF, *The Structural Engineer*, June 1953, pp. 151-167.

19. **Soil Stability Problems in Road Engineering** ; RUDOLPH GLOSSOP and GORDON CHARLES WILSON, *Proceedings of the Institution of Civil Engineers, Part II*, June 1953, pp. 219-280.

20. **Leaning Tower of Pisa** ; CHARLES B. SPENCER, *Engineering News Record*, April 2, 1953, pp. 40-43.

21. **Bigger Soil-test Plate Permits Bigger Pressure Under Footings** ; *Engineering News Record*, April 16, 1953, p. 51.

22. **Vector Solution of Soil Pressures** ; *Engineering News Record*, April 16, 1953, pp. 110-114.

23. **Pile Drivers Used as Compactors** ; *Engineering News Record*, June 25, 1953, p. 62.

24. **Determination of dry density of Compacted Layers of Coarse Granular Materials** ; L. WEST, *Survey*, 8th August 1953, pp. 531-32.

25. **Sand Needn't be Treacherous: Foundations for a Paper Mill** ; A. MYSTKOWSKI, *Engineering News Recored*, July 2, 1953, pp. 35-36.

V. SOIL STABILIZATION AND LAW COST ROADS

26. **Stabilized Soil Roads Bases** ; H. E. BROOK-BRADLEY, *The British Constructional Engineer*, May-June 1953, pp. 16-19.

27. **Soil Cement Estate Road Specifications** ; *Highwags and Bridges and Engineering Works*, June 3, 1953, p. 12.

28. **Methods of Soil Stabilization and Their Application to the Construction of Airfield Pavements** ; D. J. MACLEAN and P. J. MACKENZIE, *Proceedings of Institution of Civil Engineers, Part II*, June 1953, pp. 447-502.

29. **Soil-Cement Roads** ; K. E. CLARE, *Indian Concrete Journal*, June, 1953. pp. 247-249.

30. **Stabilizing a Township Road with Salt** ; *Engineering News Record*, June 25, 1953, pp. 43-45.

31. **Stabilized Soil Road Bases** ; H. E. BROOK-BRADLEY *Roads and Road Construction*, August 1953, pp. 226–232.

VI. ROAD STONE & AGGREGATES

32. **The Effect of High Temperatures on the Strength of Road Making Aggregates** ; F. A. SHERGOLD, *Roads and Road Construction*, June 1953, pp. 161-163.

IX. MAINTENANCE

33. **The Design of Structures in Relation to Maintenance, and Inspection**; FRANK TUSTIN & COX, *Part I, Bridges, Part II, Structures Other than Bridges, Proceedings of the Institution of Civil Engineers, Part II*, June 1953, pp. 365-415.

34. **Night Work Speed Repaving, Avoids Heavy Traffic Tieups**; *Engineering News Record*, July 2, 1953, p. 31.

35. **Checking Road Surface Irregularities** ; *Roads and Road Construction*, August 1953, p. 219.

X. BRIDGES AND OTHER STRUCTURES

36. **The Use of Models in Structural Anlaysis** : J. WRIGHT, *Engineering*, June 5, 1953, *Part I*, pp. 710-712.

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40. **"Insurance" Concept Balances Economic Factors in Culvert Design**; RALPH W. POWELL, *Civil Engineering*, June 1953, p. 64.

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44. **Beam Factors and Moment Coefficients for Members with Intermediate Expansion Hinge, Part I**; S. K. SAMADDAR, *Indian Concrete Journal*, June 1953, pp. 245-266.

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47. **Buckling of Rectangular Plates Uniformly Compressed in Vertical Direction with Upper Edge Free**; P. SHULESHKO, *Journal of the Institution of Engineers, Australia*, April-May 1953, pp.58-62.

48. **Fitzroy Bridge, Queensland**; J. A. HOLT, *Journal of the Institution of Engineers, Australia*, April-May 1953, pp. 63–71.

49. **More Rational Column Design, with Comments on A. A. S. H. O. Fallacies**; W. HANSEN, *Journal of the Institution of Engineers, Australia*, April-May 1953, pp. 73–80.

50. **Some Application of Notices to the Analysis of Continuous Beams**; C. A. M. GRAY, *Journal of the Institution of Engineers, Australia*, April-May 1953, pp. 87–90.

51. **Extension of the Method of Influence Lines for the Calculations of Systems Articulated in Space**; G. ROUBAKINE, *Bulletin Technique de la Suisse Remande*, June 1953, pp. 259–266. (in French).

52. **Tests on Reduced Models of Reinforced Concrete Works**; A. VILLARD, *Bulletin Technique de la Suisse Remande*, June 1953, pp. 266-271 (in French).

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54. **Protection Against Rolling Stones and Avalanches**; A. SARRASIN, *Strasse und Verhbhr*, May 1953, pp. 193-194 (in French).

55. **Stresses in Frame of Grand Coulee Pumping Plant Reduced By Construction Procedure**; E. J. SOLID, *Civil Engineering*, May 1953, pp. 52–53.

56. **Economics of Bank-Protection Structures to Prevent Erosion**; R. R. ROWE, *Better Roads*, May 1953, pp 23–24, 34.

57. **The "Traverse" Method of Stress Analysis**; *Concrete and Constructional Engineering*, June 1953, pp. 205-212.

58. **Ferry Slip Unaffected by High Tides; Portals Allow Bridge to Rise 34 ft**; *Engineering News Record*, June 4, 1953, p. 68.

59. **Canadian Engineers' Review in Prestressed Concrete Construction**; *Engineering News Record*, June 4, 1953, p. 26.

60. **Low Cost Warehouse with Prestressed Girders**; *Engineering News Record*, June 11, 1953, pp. 41–42.

61. **"Clampeon" Cofferdam Repairs Swing Pier of B. R. O. Railroad Bridge in Tidewater**; *Engineering News Record*, June 11, 1953, p. 43.

62. **Forms of Sections for Struts**; C. G. WATSON, *The Engineer*, July 31, 1953, pp. 133–136.

63. **Stresses in a Curved Beam**; A. D. RICHARDS, *Engineering*, July 24, 1953. pp. 103–105.

64. **Residential Construction can be made Resistant to Tornado Fringe Effects**; *Engineering News Record*, June 18, 1953, p. 24.

65. **Beams Prestressed for Fast Erection of Mezzanine**; F. W. WILCOX; *Engineering News Record*, June 18, 1953, pp. 32–36.

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67. **Third Longest Vehicular Tunnel to be Completed in Japan in 1956**; *Engineering News Record*, June 18, 1953, pp. 54, 57, 58.

68. **Precasting Fosters High Stability in Bridge Built to be Submerged**; *Engineering News Record*, June 25, 1953, pp. 53–56.

69. **Some Notes on Plane Frames Not Obeying Hook's Law**; J. W. H. KING, *The Engineer*, July 3, 1953, pp. 4–6.

70. **A Statically Indeterminate Prestressed Concrete Building**; *The Engineer*, July 17, 1953, pp. 86–87.

71. **Some Problems in Flexural Testing**; F. A. BLAKEY, *The Engineer*, July 24, 1953, pp. 98–100.

72. **Horizontal Thrust on a Two-Pinned Parabolic Arch**; R. HICKS, *Engineering*, July 10, 1953, p. 34.

73. **Vibrating-wire Strain gauge for Use in Long-Term Tests on Structures**; R. J. MAINSTONE, *Engineering*, July 31, 1953, pp. 153–156.

XI. TRAFFIC AND ROAD USER CHARACTERISTICS

74. **The Engineer's Role in Metropolitan Traffic Planning**; LLOYD BRAFF, *Separate No. 191, Proceedings of American Society of Civil Engineers*, May 1953.

75. **Some Aids to Traffic Flow**; R. A. B. SMITH, *Proceedings of the Institution of Civil Engineers*, Part II, June 1952, pp. 416–446.

76. **Experience on the Traffic Congestion and Traffic on Autobahns**; HANS LORENZ, *Strasse and Verkehr*, May 1953, pp. 203–210 (in German).

77. **The Automatic Traffic Counting in the Month of March**; *Strasse and Verkehr*, May 1953, pp. 210–211.

78. **Traffic Engineering and Road Safety**; V. FORSHAW and J. J. WHITEHEAD, *The Journal of the Institution of Municipal Engineers*, August 1953, pp. 123-148.

79. **"Safe" Highway Capacity**; HERBERT S. LEVINSON, *Traffic Engineering* July 1953, pp. 349–354.

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THE SPIRIT OF INVESTIGATION

If no suggestion for new or additional action can be found in any of the authorities, the investigator should accept the challenge and strain his mental faculties utmost to create his own innovation to cope up with the given situation.

PUBLICATIONS ADDED TO THE ROADS ORGANIZATION LIBRARY DURING AUGUST 1953

1. **The Bombay Civil List, Corrected up to 1st January 1953.** (The Director, Govt. Printing and Stationery, Bombay),

H. M. S. O. London.

2. **Sound Absorbent Treatments —Building Research Station Digest No. 36, November 1951.**
3. **Painting Asbestos Cement— Building Research Station Digest No. 38, January 1952.**
4. **Design, in Town and Village.**
5. **Reactions between aggregates and cement—Part I. Alkali— Aggregate Interaction General —National Building Studies Research Paper No. 14.** (two copies).
6. **Bricks—Ministry of Works Economy Memoranda—Scottish Series No. 3.**

British Welding Research Association, 29, Park Crescent, London.

7. **Welding Research—Vol. 6, No. 2, April 1952,** containing two articles ;
   - (i) **Correlation of Weldability Tests with Structural Joints, Part II.**
   - (ii) **Weld Hardenability of Chromium—Molybdenum Steel Pipe.**
8. **Highway Curves** (4th edition), by Philip Kissam. (Chapman & Hall, Limited, London).
9. **Some Investigations into the Behaviour of Compound Beams in Pure Bending—Research Report No. 14** by E. C. B. Carlett. (The Aluminium Development Association, 33, Grosvenor Street, London W.1.).
10. **India's Food Problem—Eastern Economist Pamphlet No. 18** by P. A. Gopalakrishnan. (The Eastern Economist Ltd., 52, Queensway, New Delhi.)

The Manager of Publications, Delhi.

11. **Census of India 1951—Volume VIII—Punjab, PEPSU, Himachal Pradesh, Bilaspur and Delhi. Part I-B** — Subsidiary Tables—P.C.C. 35, by Lakshmi Chandra Vashishta (two copies).
12. **-do- Part II-B—Economic Tables—P.C.C. 36,** by Lakshmi Chandra Vashishta (two copies).
13. **-do- Part II-A—General Population, Age & Sex Tables P.C.C. 38** by Lakshmi Chandra Vashishta (two copies).
14. **Census of India Paper No. 2, 1953—Religion—1951 Census— P. C. C. 19** (two copies).
15. **Census of India, 1951, Volume VI—West Bengal, Sikkim and Chandernagore-Part II-Tables —P. C. C. 15-A** by A. Mitra (two copies).
16. **Census of India, 1951, Volume VII-Madhya Pradesh-Part II-B —Economic Tables—P.C.C. 39** by J.D. Kerawalla. (Government Printing, Madhya Pradesh, Nagpur, 1952).
17. **Cylindrical Shells-Vol. 1—Cylindrical Roofs** (with one copy of Temporary Appendix) by H. Lundgren. (The Danish Technical Press, The Institution of Danish Civil Engineers, Copenhagen, 1951).
18. **BRUCKENEINSTURZE UND IHRE LEHREN** by Conrad Stamm. (Verlag Leemann, Zurich).

(Continued on page 40)

BUDGETS AND ADMINISTRATION REPORTS

1. GOVERNMENT OF WEST BENGAL-CIVIL WORKS BUDGET 1953—1954

The following extracts have been taken from the Civil Works Budget of the Government of West Bengal for the year 1953-54.

	(In lakhs of rupees)		
	Actuals 1951-52	Revised Estimates 1952-53	Budget Estimates 1953-54
I. Revenue (Civil Works)			
1. Rents	4 63	4.70	4.70
2. Ferry receipts	...	1.11	1.17
3. Tolls on roads	1.74	1.75	1.75
4. Recoveries of expenditure	8.07	5.60	4.16
5. Transfer from Central Road Development Account	53.10	41.12	37.75
6. Transfer from Capital Account of grain purchase schemes of surcharge levied	...	4.91	...
7. Miscellaneous	15.31	6.39	2.60
8. Deduct-Refunds	-0.01	-0.01	-0.01
Total	82.84	65.57	52.12
II. (a) Expenditure (Civil Works)			
1. Original Works	...	162.94	231.08
2. Repairs	...	177.85	166.57
3. Establishment	...	21.97	23.27
4. Tools and Plant	...	8.55	7.55
5. Grants-in-Aid	...	21.04	16.11
6. Suspense	...	-0.88	-4.74
7. Development programme	...	63.03	70.98
Total	...	454.50	510.32
(b) Expenditure (Communications)			
1. Original Works			
1. Ordinary Works		22.42	22.59
2. Road Development Fund Works		41.12	37.75
Total		63.54	60.34
2. Repairs			
1. Executive Divisions etc.		121.42	110.10
2. Deduct Recoveries from the Government of India on account of National Highways		-40.21	-32.60
Total		81.21	77.50
Total—Communications		144.75	137.84

CAPITAL EXPENDITURE ON CIVIL WORKS OUTSIDE THE REVENUE ACCOUNT

	(In lakhs of rupees)	
	Revised Estimates 1952–53	Budget Estimates 1953–54
III. (1) Development Programme		
Original Works		
(a) Buildings	1.99	2 44
(b) Communications	242.27	261.89
Establishment	18.00	22.25
Tools and Plant	16.39	14.83
Suspense	– 0.25	1.48
Deduct – Receipts & Recoveries on Capital Accounts	– 5.25	– 7.89
Total	273.15	295.00
(2) Construction and Improvement of National Highways	70.57	105.83
Deduct—Recovery from the Central Government for National Highways	– 70.57	– 105.83
Total	...	...
Grand Total	273.15	295.00

A BRIEF NOTE ON THE CIVIL WORKS BUDGET OF WEST BENGAL FOR THE YEAR 1953-54

THE revenue and expenditure of West Bengal for the year 1953-54 are estimated at Rs 38,15.87 lakhs and Rs 43,26.63 lakhs respectively indicating a deficit of the order of Rs 511 lakhs. According to the revised estimates for 1952-53, revenue and expenditure figures were Rs 38,29.51 lakhs and Rs 42,13.30 lakhs respectively.

The Expenditure on Civil Works met from the revenue for 1953-54 forms 13.4% of the revenue as against 11.9% in the revised budget for the previous year. Communications alone account for 3.6% of revenue in the current year's budget and 3.8% in the revised budget for 1952-53. Apart from this the provision for road development in the Capital budget for 1953-54 is Rs 295 lakhs i.e., about Rs 1.6 crores more than the total provisions for roads in the revenue budget.

2. UTTAR PRADESH P.W.D. BUILDINGS AND ROADS BRANCH

ADMINSTRATION REPORT FOR THE YEAR 1952-53

(A brief note with reference to Road Development)

Phase I Programme

In 1947 the Uttar Pradesh Government launched through its Public Works Department [Buildings and Roads Branch] the Phase I Programme of Road Development at an estimated cost of Rs 21.5 crores. It provided for the following works.

(a) Construction of 1642 miles of new metalled roads.

(b) Construction of 5655 miles of unmetalled roads.

(c) Construction of 501 miles of Cement Concrete Tracks.

(d) *Reconstruction* of 2419 miles of local metalled roads.

(e) Cement concreting of 45 miles of Provincial Highway Routes.

In addition to these, the construction of several bridges and numerous other road works of improvement and reconstruction had been included in the programme. Works under the programme had however to be discontinued in 1949 on account of financial stringency.

Five Year Plan

In the First Five Year Plan of the Planning Commission, the provision for development of roads other than National Highways in Uttar Pradesh is about Rs 522 lakhs. This programme include most of the remaining works of the State's Phase I Programme besides improvement, reconstruction and modernisation of many other roads.

Road Expenditure in 1952-53

In 1952-53, a sum of Rs 236 lakhs was provided in the State budget for the incomplete Phase I Programme but work was delayed and the target laid down for the year could not be attained. Some of the important projects in hand during the year covered works on five Provincial Highways with an aggregate milage of 344 and the *construction* of about 33 miles of Major District Roads. The estimated total cost of the projects was of the order of Rs 240 lakhs. They were expected to be completed before the end of the year.

Modernization

Efforts have been made to modernize the roads as fast as possible. In 1946 there were only 1842 miles of modernized roads in the State but by 1952 the milage rose to 2540. It is planned to modernize completely all miles on National Highways in the State in the next five years.

Bridges

During the year under report work on 20 major bridges was in progress. These have cost Rs 82.77 lakhs in all.

Programme for 1953–54

Total expenditure incurred on Phase I Programme up to the end of 1952–53 was about Rs 15.6 crores. There were still several items of work which were in different stages of progress in 1952–53. A provision of Rs 239.30 lakhs has been proposed for inclusion in the budget for 1953-54. It is expected to complete additional work on 510 miles of roads by the end of 1953-54. It is proposed to incur an expenditure of Rs 70 lakhs on some miscellaneous works including major bridges, Provincial Highways and other important roads.

Since August 1952, all unmetalled roads except a length of 761 miles have been handed over to the Local Bodies concerned and the responsibility for their maintenance now devolves on them.

National Highways

The total length of National Highways in Uttar Pradesh is about 1510 miles of which about 194 miles fall within municipal limits. The original 5-year programme was estimated to cost Rs 242 lakhs but it could not be completed. The Government of India approved a new 5-year programme of improvement to commence from 1952-53. The approximate cost of the programme was Rs 127 lakhs. During the year 1952-53 the Central Government gave Rs 55.66 lakhs for improvements and Rs 44.65 lakhs for maintenance of National Highways in the State.

Phase II Programme

Planning for the "Second Phase" of road development was also in progress during the year. Plans were nearly complete for most of the districts in the State. Road planning is made on scientific lines based on existing economic data and future trend in traffic so that various schemes can be phased on relative merits of individual roads as and when funds are available. In all schemes of Self Help and in road works carried out in scarcity areas due consideration is given to take up only the works provided in the Phase II Programme so that their permanent utility is not lost.

(Continued from page 36)

19. **B. S. Code of Practice C. P. 112 (1952)—The Structural Use of Timber in Buildings** (Incorporating C. P. 112. 100-Preservative Treatments for Timber used in Buildings). (The Council for Codes of Practice for Buildings, Construction and Engineering Services, Lambeth Bridge House, London S.E. 1.)

20. **LE MATERIEL de TRAVAUX Publics-Tome I—ENGINS DE TERRASSEMENT** (Plant & Machinery used in Civil Engineering, Vol. I —Earthmoving Equipment by M. Pagni and M. Morel. (DUNOD, Paris, 1951).

21. **Bulletin of the Permanent International Association of Road Congresses, Paris—Bulletin No. 132** (Editions Science at Industrie, 2, Rue Paul-Gozanne, Paris (VIII) (two copies).

PURPOSE OF HIGHWAY ENGINEERING

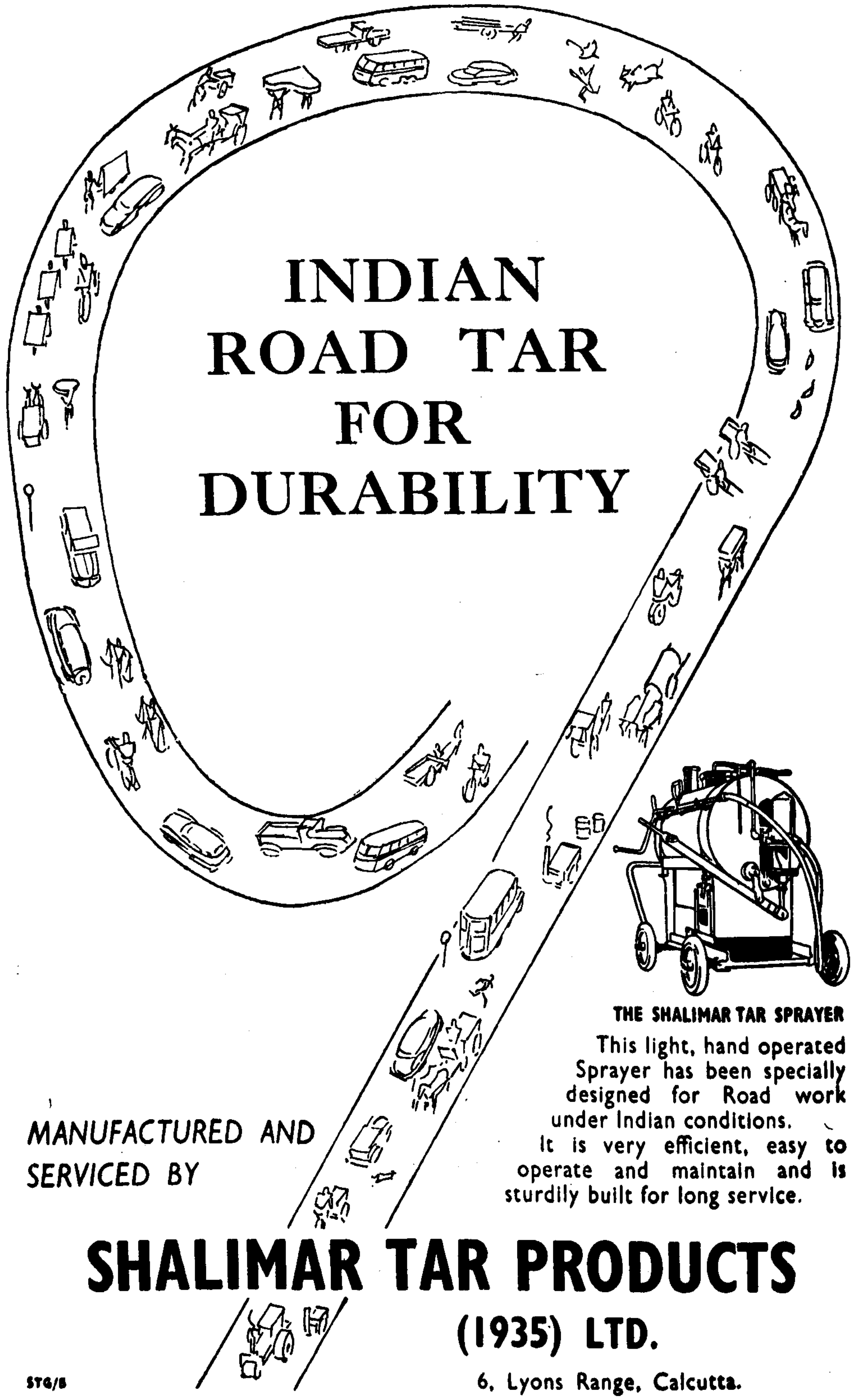
The highway engineer must recognize that the field of highway engineering is not confined to the construction and maintenance of the physical structure of the highway. He must recognize more fully that his responsibility is related broadly to the development of highway transportation generally—that the purpose of highway engineering is to move people and goods quickly and safely.

—Thomas H. MacDonald.

LIST OF APPROVED WORKS ON NATIONAL HIGHWAYS

S. No.	Job No.	Name of work	Amount (Rs in Lakhs)
		HIMACHAL PRADESH	
1.	761 HP 22	Widening of 2 ft trace to 6 ft track on Luri Rampur Road (20 miles and 300 ft from miles 63-5-150 to 83-5-450).	1.02
2.	762 HP 22	Widening of 2 ft trace to 6 ft track from Rampur to Chaura (22 miles from mile 83-5-450 to 105-5-450).	1.80
3.	763 HP 22	Widening 2 ft trace to 6 ft track from Chaura to Wangtu on H. T. Road	1.04
4.	769 HP 22	Widening of 2 ft trace to 6 ft track from Narkanda to Luri (mile 39 to 63/5) on H. T. Road.	1.29
5.	789 HP 22	Construction of rest room for class III touring officers at Theog on the H. T. Road.	0.01
		BOMBAY	
6.	764 BM 8	Remodelling cross drainage works in the Mindhola bridge to Kododra section of the Bombay-Ahmedabad Road. (N. H. No. 8).	0.70
7.	768 BM 8	Land acquisition for the construction of new lengths in the Baroda-Vasad Section of the Bombay-Ahmedabad Road (N. H. No. 8).	2.59
8.	773 BM 8	Providing cross drainage works on the Kathor-Pardi Section of the Bombay-Ahmedabad Road (N. H. No. 8).	0.66
9.	776 BM 8	Providing hume pipe drains and improving grades in miles 163 to 165 of the Bulsar-Navsari Section of the Bombay-Ahmedabad Road (N. H. No. 8).	0.35
10.	780 BM 6	Construction of permanent motor garage and a one seated aqua privy latrine in the compound of Inspection Bungalow at Mhaswa on the Dhulia-Edlabad-Nagpur N. H. No. 6.	0.03
11.	781 BM 6	Construction of a one seated privy latrine in the compound of Inspection Bungalow at Erandal on the Dhulia-Edlabad-Nagpur N. H. No. 6.	0.01
12.	783 BM 8	Construction of the Gamdi-Raigadh Section of the Bombay-Ahmedabad-Delhi Road.	4.89
13.	787 BM 4	Construction of diversion miles 12/5 to 13/3 of the Poona-Bangalore Road—National Highway No. 4.	0.69
14.	788 BM 4	Construction of diversion in mile 30 of the Poona-Bangalore Road–National Highway No. 4.	0.66

S. No.	Job No.	Name of work	Amount (Rs in Lakhs)
		MADRAS	
15.	765 MD 7	Formation of a bye-pass at mile 10/6 of Karur-Pugalur Road-N. H. No. 7, Banaras-Cape-Comorin Road.	0.28
		BIHAR	
16.	767 BR 31	Improvements to the Karagola-Purnea Section of the Ganga - Darjeeling Road (N. H. No. 31).	11.68
17.	777 BR 28 A	Improvement to miles 0/0 to 1/6 and 11/6 to 20/0 of the Chapwa-Sagauli-Raxaul-Nepal Border Section of N. H. No. 28-A.	
		MADHYA PRADESH	
18.	770 CP 7	Improvement and widening of Nagpur Bori Jam Section of the Great Southern Road in the Nagpur Distt. N. H. No. 7.	3.73
19.	785 CP 6	Resectioning and black topping of Amravati-Nagpur Road (miles 14 to 32/2), a section of N. H. No. 6 in Amravati District.	3.04
20.	786 CP 7	Improvement and widening of Hinganghat Nagpur Road (N. H. No. 7) in Wardha District.	3.61
		ORISSA	
21.	771 RS 5	Re alignment of N. H. No. 5 from 672/1 to 673/3 (Khallikote Ghat).	0.07
22.	782 RS 6	Erecting woven wire fencing with a gate to the compound of the Inspection Bungalow at Bargarh. N. H. No. 6.	0.02
23.	784 RS 42	Re-alignment for straightening the curves in miles 82/0 to 82/8 of Cuttack-Sambalpur Road. N. H. No. 42.	0.27
		PUNJAB	
24.	772 PB 1	Construction of 4 ft Span culvert in mile 165 of G. T. Road in Ludhiana District.	0.03
		WEST BENGAL	
25.	774 BG 31 A	Permanent restoration of damages to 31st mile of Teesta Valley Road.	0.61
		ASSAM	
26.	775 AS 40	Providing sanitary fittings in the Inspection Bungalow at Nangpoh.	0.09
		UTTAR PRADESH	
27.	778 UP 2	Easing of sharp curves in miles 439-451 of N. H. No. 2 (G. T. Road miles 500-488).	1.33
		VINDHYA PRADESH	
28.	779 VP 7	Black topping 10 miles of Rewa-Hanumana Section of N. H. No. 7.	1.24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ROAD TAR
FOR
DURABILITY
THE SHALIMAR TAR SPRAYER
This light, hand operated Sprayer has been specially designed for Road work under Indian conditions.
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SHALIMAR TAR PRODUCTS
(1935) LTD.
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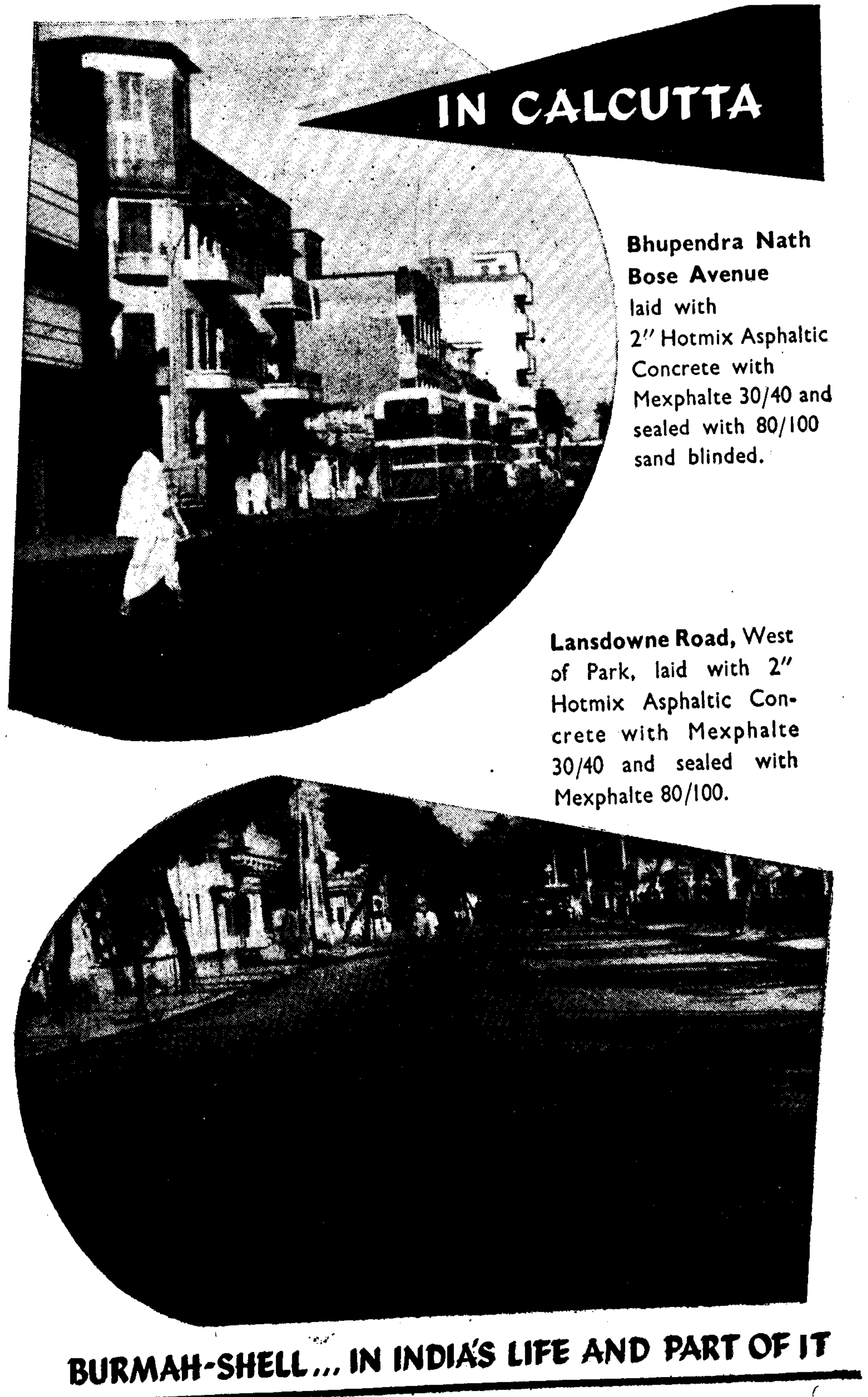
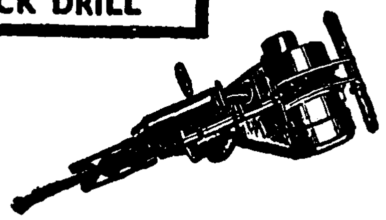
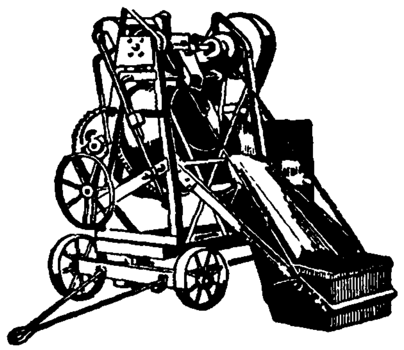
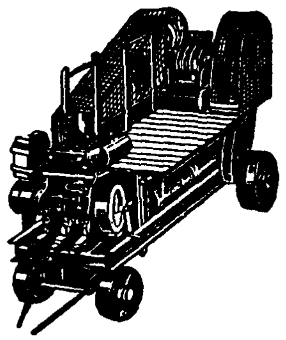
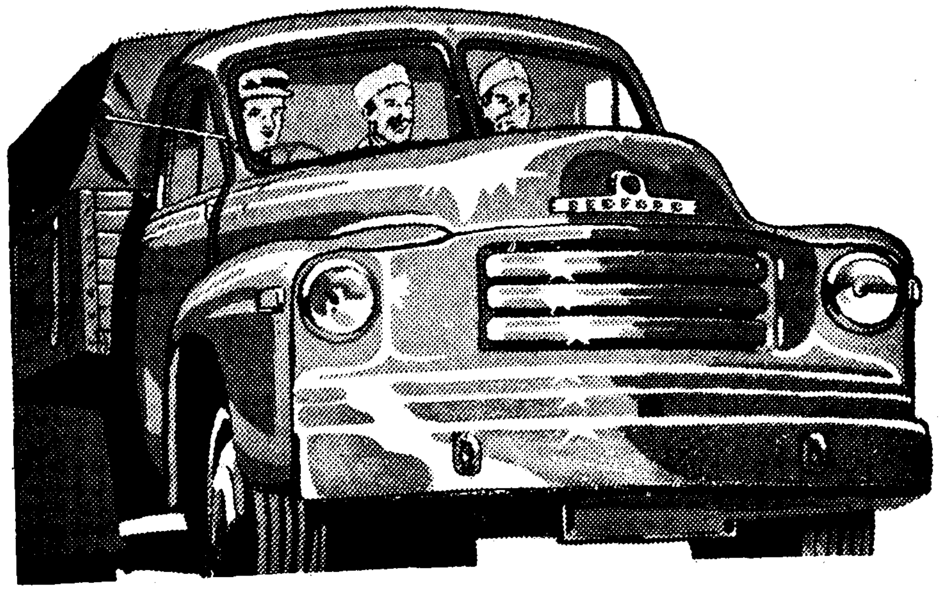

IN CALCUTTA
Bhupendra Nath Bose Avenue laid with 2" Hotmix Asphaltic Concrete with Mexphalte 30/40 and sealed with 80/100 sand blinded.
Lansdowne Road, West of Park, laid with 2" Hotmix Asphaltic Concrete with Mexphalte 30/40 and sealed with Mexphalte 80/100.
BURMAH-SHELL... IN INDIA'S LIFE AND PART OF IT
BSY-665





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