75

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SEPTEMBER 1954
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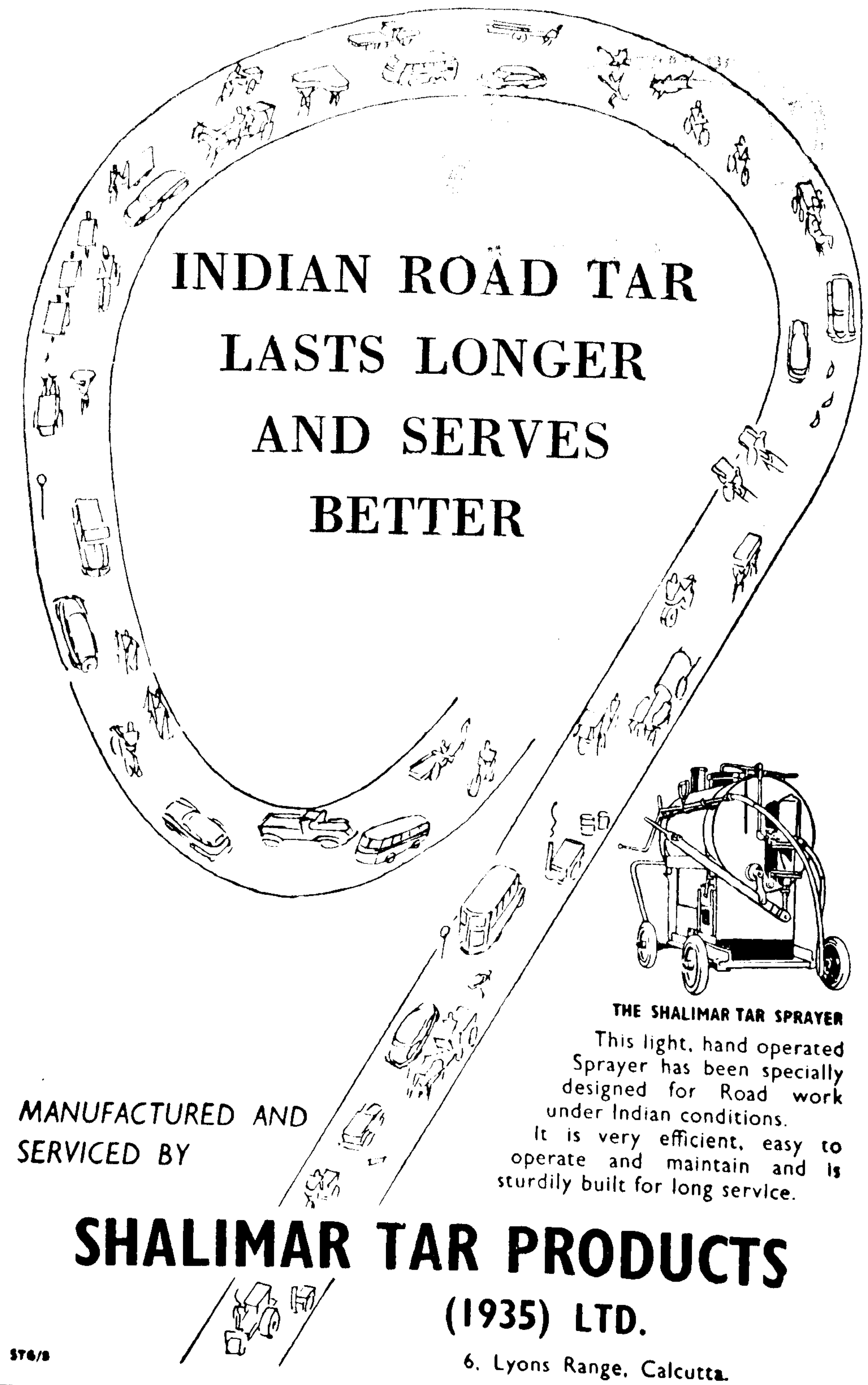
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TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

SEPTEMBER 1954—No. 89

TABLE OF CONTENTS

75

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BHANDARA BRIDGE

This submersible bridge is across the Wainganga River at Bhandara in Madhya Pradesh. There are 18 spans of 86 ft each. The overall length is 1,644 feet.

TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

A REVIEW OF
ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

SEPTEMBER 1954

AN ACCOUNT OF THE FUNCTIONING OF THE MAIN ROADS ACT NEW SOUTH WALES, AUSTRALIA

THE Main Roads Act came into force on the 1st January, 1925, and has, since the end of 1932, been administered by a Commissioner for Main Roads and an Assistant Commissioner. The organisation under their control is named the Department of Main Roads, the headquarters of which are located in Sydney.

The department's responsibilities are discharged either by providing financial and technical assistance to the Shire and Municipal Councils or by the Department itself carrying out works on main roads.

THE MAIN ROADS SYSTEM

Public roads, except those within the inner part of the City of Sydney, in Commonwealth Territories and in the Western Division outside Municipalities, may be proclaimed as Main or Developmental roads upon the recommendation of the Commissioner for Main Roads, or declared as Secondary Roads.

There are five classes of proclaimed roads which are described hereunder:

Main Roads

State Highways.—The State Highways are the principal avenues of road communication between the coast and the interior, or throughout the State and connecting with such avenues in other States.

Trunk Roads.—The Trunk Roads are the secondary avenues of road communication which connect the State Highways and with them, complete the framework of the general system of inter-communication by road throughout the State.

Ordinary Main Roads.—The Ordinary Main Roads provide a network of roads connecting towns and important centres of population with the State Highway or Trunk Road routes and with each other.

Secondary Roads

The Secondary Roads are roads within the County of Cumberland only (i.e., the Metropolitan area and rural environs) which carry a substantial amount of through traffic and thereby relieve a neighbouring main road of traffic which it would otherwise have to bear.

Developmental Roads and Works

Developmental Roads and Developmental Works are roads or works as the case might be which will serve to develop or further develop any district or part of a district; or will serve to develop any area of Crown or private land by providing access to a railway station or a shipping wharf or to a road leading to a railway station or a shipping wharf. A developmental work generally consists of a short length of road construction, or the construction of a bridge on a road which is otherwise passable but which in the absence of the bridge is impassable after heavy rains.

The total mileage of public roads in the State is 126,971. The mileage under the assistance of the Department at the 1st July, 1953, was as follows:

Classification	County of Cumberland	Country	Western Division	Total
Main Roads—				
State Highways	193	5,008	1,335	6,536
Trunk Roads	...	2,874	1,351	4,225
Ordinary Main Roads	650	9,037	2,880	12,567
Total Main Roads	843	16,919	5,566	23,328
Secondary Roads	75	...	...	75
Developmental Roads	14	2,897	...	2,911
Unclassified	...	...	2,620	2,620
Grand Total— All Roads	932	19,816	8,136	28,934

MAINTENANCE AND CONSTRUCTION WORKS

The Department's activities in respect of works carried out with its ordinary Main Roads funds are confined, as a general rule, to works for the improvement of the carriageway of the road. In those cases where a country main road passes through a city or town, the Department's assistance is in ordinary circumstances limited to a width of twenty feet of pavement.

The works towards the cost of which the Department contributes are not necessarily restricted to those carried out on the pavements only, but may extend to ancillary works of value to the road pavements and to the traffic which uses the pavements. Examples of these works are drainage, kerbing and guttering, tree planting, road signs and acquisition of property for road widening purposes.

The Department exercises control over such matters as tree preservation, road openings, overhead wiring, kerbside petrol pumps, and also over advertising signs or hoardings whether these are on or in some special cases adjacent to main road. Having advised the Shire and Municipal Councils of the Department's policies regarding these matters, the Department for the most part relies on the Councils for their implementation, although an overriding supervision is exercised by the Department.

The work of constructing and maintaining the main roads is, to a large extent, in the hands of the local governing Municipal and Shire Councils. It is only on the State Highways that the department directly controls any considerable length of road. As at the financial year ended on 30th June, 1953 the position was that 85 per cent of the main roads system was under the control of local authorities and the remaining 15 per cent under the direct control of the Department. These percentages exclude roads in the Western Division, all of which are directly controlled by the Department, mainly through Public Works Department District Engineers.

A feature of this form of distribution of responsibility has been the movement of officers between the engineering services of the Department and local authorities. Young men have been trained in Departmental practice, both in the office and in the field and, after some years, have secured employment as Engineers or Assistant Engineers with Councils. It has been possible for them to gain experience of special phases of road work by transfer from branch to branch within the Department and this has well fitted them to fulfil their responsibilities for the general engineering supervision of council works.

DECENTRALISATION OF ADMINISTRATION

Divisional offices under the charge of divisional engineers have been established throughout the country so that responsible officers may keep continuously in touch with the local councils and their officers and secure an intimate knowledge of requirements in individual areas. These officers are authorised to finalise conduct of work as far as possible without prior reference to the head office in Sydney. Administration is thus decentralised and the volume of correspondence between local and central authorities is kept to a minimum. At the present time there are twelve such divisions.

It is usual for local offices to be established on the site in the case of the Department's day labour works and for engineering and clerical officers to be stationed

at these offices for the purposes of supervision and administration. The number of local offices varies from time to time according to the location and volume of works in hand.

The Department maintains a central workshop and store in the metropolitan area where employees are engaged in the repairing of plant, etc., required in connection with the Department's works. A central laboratory for testing and research is also established in the metropolitan area.

SYDNEY HARBOUR BRIDGE

The Department is responsible for the administration of the Sydney Harbour Bridge, the finances of which are by statute separate from the Main Roads Funds.

The cost of maintaining the bridge as well as the cost of interest and sinking fund payments is met from the proceeds of toll charges. Road tolls are collected directly by the Department, while, rail, tram and omnibus tolls are collected and remitted to the Department by the authorities which operate the services concerned.

FINANCE

Provision is made for the establishment of three funds for the purposes of the Main Roads Act. These are:

The County of Cumberland Main Roads Fund, for expenditure on Main and Secondary Roads within the County of Cumberland. (The County of Cumberland embraces an area within approximately 40 miles of Sydney including the Metropolis, but for the purposes of the Main Roads Act it excludes the inner part of the City of Sydney.)

The Country Main Roads Fund, for expenditure on Main Roads in the area outside the County of Cumberland. The expenditure on all roads, whether proclaimed Main Roads or otherwise, in the unincorporated areas of the Western Division of the State is also financed from this Fund.

The Developmental Roads Fund, for expenditure on the construction of Development Roads and Development Works as distinct from Main Roads.

The Financing of Works on Main and Secondary Roads

A different system of administration, principally in relation to finance and rates of assistance for works, is provided for in the County of Cumberland as distinct from the rest of the State. This will be referred to later.

The principal sources of the Department's regular revenues for works on main and secondary roads are the proceeds of motor vehicle taxation collected by the State Department of Motor Transport, and of petrol taxation collected by the Commonwealth Government.

The revenue collected by the Department of Motor Transport from motor vehicle taxation is paid to the Department of Main Roads for expenditure on main roads works, except the tax collected in respect of motor omnibuses, taxi-cabs, private hire cars and motor vans in the Metropolitan and Newcastle Transport Districts. The amount received by the Department of Main Roads is paid into the County of Cumberland and the Country Main Roads Funds in the proportions of 20 per cent and 80 per cent respectively.

From a tax of 10 d. per gallon on imported petrol and 8½ d. per gallon on petrol refined in Australia (excluding, in both cases, petrol used for aviation purposes) 6d. and 3¼d. per gallon, respectively, is made available to the States by the Commonwealth in terms of the Commonwealth Aid Roads Act, 1950, as follows:

(a) 65 per cent (less £600,000 per annum expendable directly by the Commonwealth on strategic roads, roads of access to Commonwealth properties and the promotion of road safety practices) is for expenditure on roads generally in the States, provided that an amount not exceeding one-sixth of that paid to the States may be expended on other works connected with transport by road or by water.

(b) 35 per cent is set aside for expenditure on rural roads, but excluding proclaimed Main Roads, in the States.

After payment to Tasmania of 5 per cent of the amounts payable to the States under (a) and (b) above, the balance is distributed between the remaining States on the basis of three-fifths populations and two-fifths area. (The effect of this provision is that New South Wales receives 28.2 per cent of the money distributed to all States). The amount received by New South Wales under (a) is spent almost entirely on the maintenance, improvement and construction of proclaimed Main Roads. It is allocated between the County of Cumberland and the Country Main Roads Funds in the proportions of 20 per cent and 80 per cent respectively. Of the amount received by New South Wales under (b), £ 225,000 per annum is at present devoted to proclaimed Developmental Roads ; the balance is spent on rural roads other than proclaimed Main and Developmental Roads, and is distributed to the Municipal and Shire Councils by the Department of Public Works.

In addition to the two principal sources of revenue of the County of Cumberland and Country Main Roads Funds (motor and petrol taxation), provision is made in the Act for the proceeds of a regular annual levy on Councils in the County of Cumberland to be paid into the County of Cumberland Main Roads Fund. This levy is based on a maximum of ½d. in the £ on the unimproved capital value of all lands ordinarily rateable under the Local Government Act, and situated in the Councils' areas, except that the levy in the case of lands used principally for rural primary production is reduced by one-half. The maximum rate was levied from 1925 to 1932, since when a rate of 7/16d. (reduced to 7/32d. for primary production lands) has been adopted. In the case of the County of Cumberland, the Department meets the full cost of approved works carried out on proclaimed Main Roads irrespective of their relative importance and half the cost of approved work on proclaimed Secondary Roads.

The Main Roads Act does not provide for a rate to be levied by the Department on the Councils in the area outside the County of Cumberland area. In that area, that is the country area, the main roads are divided into three classes, viz., State Highways, Trunk Roads and Ordinary Main Roads, according to their relative importance. The Department meets the full cost of works on State Highways in the country, and the Councils' share is usually at the rate of one-quarter in the case of Trunk Roads and one-third in the case of Ordinary Main Roads. The present rates of contribution by the County of Cumberland which are applicable to all works on main roads in the country, are, broadly, as follows:

	Construction and Maintenance of Roads and Maintenance of Bridges.	Construction of Bridges.
	per cent	per cent
State Highways	100	100
Trunk Roads	75	100
Ordinary Main Roads	66⅔	75

Provision is made in the Act for such loan moneys to be appropriated for the use of the Department as Parliament may decide should be spent on specified works on main roads. Loans of this nature are made available, as required, to the Department by the State Government, and it is usual for the interest, exchange and repayment of the loans to be made a charge against the Department's revenues. The outstanding loan liability of the Department in respect of main roads works at the 30th June, 1953, was £3,850,808.

It is competent under the Act for money to be received into the two Main Roads Funds for the carrying out of special works. Defence Works and Unemployed Relief Works and extensive work at present being carried out on behalf of the Snowy Mountains Authority are examples of such special works executed by the Department.

The Department is required to meet the full cost of all approved works on roads in the Western Division of the State other than those in the six municipalities in that Division. The classified roads in those municipalities are subsidised on the same basis as are the classified roads in the country portion of the rest of the State.

The main features of the financing of main roads expenditure may be briefly summarised as follows :

(1) The sources of the Department's revenue are motor vehicle tax, petrol tax, loan moneys, special funds which are not regular or statutory provided from Government sources and, in the case of the County of Cumberland, a direct levy on Councils which is met by the owners of the land in that area.

(2) Twenty per cent of the motor vehicle and petrol tax available for expenditure on main roads is spent in the County of Cumberland, and 80 per cent is spent in the country area of the State.

(3) Contributions by Councils in the country are made by way of direct payments towards the cost of works carried out whereas contributions by Councils in the County of Cumberland are provided by a uniform levy based on the unimproved value of land.

(4) The full cost of approved works on main roads in the County of Cumberland is paid for from the funds available to the Department.

(5) The Department's subsidy for approved works on main roads in the country varies generally according to the classification of the roads on which the money is spent.

THE FINANCING OF WORKS ON DEVELOPMENTAL ROADS

The money available for expenditure on proclaimed developmental roads and works has, for some years past, been met from the proceeds of petrol taxation paid to the State by the Commonwealth Government. The Department's assistance in respect of developmental roads and works is restricted to approved construction works in respect of which the Department usually meets the full cost, subsequent maintenance being the responsibility of the Councils.

[*Extracted from Main Roads, June 1954.*]

DEFINITIONS OF HIGHWAY ENGINEERING TERMS

Curve Vertical: A curve in the longitudinal section of a roadway to provide for easy change of gradient.

Curve Summit: The vertical **Convex** Curve connecting two intersecting grades.

Curve Valley: The vertical **Concave** curve connecting two intersecting grades.

ROADS IN THE 5-YEAR PLAN

THE total milage of roads in India is far short of the country's requirements. The country has over 230,000 miles of roads, i.e., on an average only 19.6 miles of roads per 100 square miles of area. This indicates roughly the vast leeway she has to make up in road building.

Moreover, the Indian road system is unbalanced. For instance, the trunk roads are, as a whole, much more developed than the roads in the districts and villages. Thus, although many fertile tracts of land are well served by rivers and are potentially rich in agricultural wealth, they remain undeveloped for want of roads. A large number of villages are not linked by road with any town, market or railway station. Also, most of the rural roads are fair-weather roads.

THE NAGPUR PLAN

The Nagpur Road Plan of 1943, which called for an increase of road mileage from 265,000 to 400,000 and an improvement of the existing roads, reflected this need. The Plan visualized the growth of a network of road communications at a cost of Rs 372 crores within ten years. The programme, however, has had to be drastically reduced owing to a shortage of money, material and trained personnel.

Up to the end of 1950-51, 110 miles of new roads, 10 large bridges and many smaller bridges had been constructed on national highways and 1000 miles of roads improved.

ROADS IN THE 5-YEAR PLAN

The Five Year Plan provides for the construction of 925 miles of new roads and 68 large bridges, besides a number of smaller bridges. In addition, about 3,000 miles of roads will be improved. Of this programme, about two-thirds will be completed by 1955-56.

The Plan has earmarked Rs 27 crores for the national highways, Rs 6.84 crores for roads in the Andamans, Sikkim and the North-East Frontier Agency areas and for certain selected roads and Rs 21.15 lakhs for the establishment of a Central Road Research Institute for the study of technical problems relating to roads and their construction.

According to the schemes drawn up for State roads, the length of metalled roads will increase from 10,007 miles in 1950-51 to 12,453 miles by 1955-56 in Part A States and from 7,588 miles to 8,129 miles in Part B States. The plans for the development of roads in Part C and Part D States and in the tribal areas have been framed with a view to constructing as many new roads as possible to open up inaccessible areas. The total provision for the road development in the States is Rs 75.53 crores, out of which Part A States account for Rs 50.59 crores, Part B States (excluding Jammu and Kashmir) Rs 18.27 crores and Part C States Rs. 6.67 crores.

Recently, the Government of India have approved of special grants aggregating Rs 10 crores being made to the States for the development of roads of inter-State importance or which may help the economic advancement of the backward territories.

Special attention is also being paid by the State Governments to the maintenance and construction of village roads. In certain States, for example, they are already being developed with the active co-operation of the villagers themselves. The Roads Wing of the Ministry of Transport has formulated a model scheme on Co-operative basis, for which Rs 60 lakhs will come out of the Central Road Fund Reserve for specific projects spread over a period of three years from 1953-54.

Financial assistance has also been offered to the State Governments to popularize the use of wide tyred bullock cart wheels to reduce the harmful effects on the road surface. Meanwhile, the Central Road Research Institute has been entrusted with the task of evolving a suitable design for the axle system of bullock cart wheels.

Also it is estimated that 16,000 to 17,000 miles of *kutcha* roads will be constructed in the village units as part of the community development projects.

ACHIEVEMENTS

Out of Rs 27 crores set apart in the Plan for the development of national highways for the five-year period, Rs 8.19 crores were for 1951-53. About Rs 6.88 crores of this amount was expended during the first two years of the Plan.

During the plan period, 925 miles of new roads were planned for construction and 3,000 miles of the existing roads for improvement. Of these, 640 miles and 2,500 miles respectively are to be completed. During 1951-53, about 190 miles of new roads have been constructed and 750 miles improved. The building of additional 450 miles and the improvement of 1,500 miles of national highways are in progress.

Out of the 68 large bridges planned for the five-year period, 40 are to be completed. During 1951-53, 10 bridges have been completed and another 20 are under construction.

Among the important projects in progress on the national highways, mention may be made of the construction of the Calcutta-Siliguri Road, the Hindustan-Tibet road beyond Narkanda and up to Chini, the Pennar bridge on the Madras-Calcutta Road, the Palar bridge on the Madras-Dindigul road in Madras, the Mahanadi bridge at Arang in Madhya Pradesh and the Brahmani, Baitarni, and Subarnarekha bridges in Orissa on the Bombay-Calcutta Road. A bridge across the Chambal river on the Agra-Bombay road has also been designed and sanction accorded to its construction.

A sum of Rs 6.84 crores has been provided in the plan for the development of certain selected and other roads. By the end of 1952-53, about Rs 146.5 lakhs had been spent on these roads. Nearly 128 miles of new construction and one major bridge have also been completed, while work on another 233 miles and on two major bridges is in progress.

The new constructions and improvements in the States were of the order of 3,300 miles in 1951-52 and 3,900 miles in 1952-53. In financial terms, as against a total planned expenditure of Rs 75.53 crores for five years, the actual expenditure has been Rs 11.29 crores in 1951-52 and Rs 16.73 crores in 1952-53.

* * *

[*Extracted from "Transport and the Plan" issued by The Publications Division, Ministry of Information and Broadcasting, Government of India.*]

SAFETY ON ROADS

The driver is safer when the roads are dry. The roads are safer when the driver is dry.

THE ROAD

When a road is once built, it is a strange thing how it collects traffic, how every year as it goes on, more and more people are found to walk thereon, and others are raised up to repair and perpetuate it, and keep it alive.

THE PRESERVATION OF STEEL STRUCTURES

IRON and steel, are for ever trying to slip out of our possession under the guise of an iron oxide. Their accomplices in this vanishing trick are principally oxygen and moisture together. Taken singly these agents are unable at ordinary temperatures to seduce the ferrous metals from performing their allotted task but as allies they are eminently successful in this nefarious conspiracy.

The ferrous metals, unless adequately clothed or otherwise protected from the devastating climate of moist oxygen are doomed to a speedy metamorphosis. It would almost seem that iron resents being smelted out of the ore in the blast furnace and for ever after exhibits a violent urge to return to its more stable and comfortable state reserved for it by nature.

CORROSION OF STEEL AS ROLLED

The oxygen of the atmosphere reacts with red hot steel whilst it is in the ingot form and whilst it is passing through the rolling mills. A variety of oxides are formed on the surface of the steel. One of these oxides is magnetic oxide Fe_3O_4 which does not differ greatly in appearance from the steel itself. It adheres firmly in patches to the surface of the steel and may be found still adhering to it many years after the finished rolled bar or plate has been put into service as part of a structure. It is, therefore, a protector and corrosion preventer of the steel underlying it. Unfortunately it is cathodic to the iron or steel and in the presence of moisture causes anodic wasting of surfaces not actually protected by it. If, however, it were possible to ensure complete covering of the steel member with this oxide there would be no corrosion. In fact Barff's process for protecting iron articles from rust consists in coating them with a film of magnetic oxide by subjecting them whilst red hot to the action of superheated steam.

Other oxides which are formed whilst the bars are manipulated in the rolling mills are ferrous oxide, FeO and ferric oxide, Fe_2O_3, are not so closely adherent to the steel and to some extent fall away in the form of scale before the metal cools but in part they also adhere in varying degrees for as long as six months after rolling and then only part company from the steel under the effect of weathering and brushing with wire brushes.

The presence of this mill scale constitutes a problem which is dealt with in various ways following the ideas of the engineer who draws up the specification. For example removal by wire brushes coating with boiled linseed oil, pickling with phosphoric acid, etc., A more recent treatment is flame cleaning by oxy-acetylene jets which reduce the oxides to metallic iron globules and dust removable by a soft brush. The priming coat of paint is applied whilst the members are still warm and by this means all moisture should be excluded. The merest trace of moisture under a paint film is sufficient to instigate corrosion with resultant penetration of the film.

METALLIC PRIMERS

Red lead pigment in a vehicle of linseed oil is a traditional primer which still retains favour in spite of its soaring price. It should be remarked that the word "pigment" when used in connection with paints means more than a colouring material as it is in addition the substance which gives body to the paint.

The research chemists have not yet dethroned red lead from its place at the top of the list of metallic primers. It is said to inhabit corrosion and undoubtedly does seem in practice to give results at least as good as any other primer. Quite frequently when the top coats have gone, the red lead can be seen still giving good service in almost indissoluble affinity with the base metal. A non-setting variety of red lead is recommended which does not settle in a solid mass at the bottom of the container. It should never be sprayed on account of the danger of lead poisoning to the operator and because spraying does not work into the pores of the metal in the manner achieved brushing.

(Extracted from "Highways and Bridges" May 5th, 1954)

In repainting the preliminary cleaning should be done without abrading the metal and if there is any scale to be removed, hand, and particularly power operated chipping hammers should be used with care to avoid indenting the metal as indentations are liable to be accompanied by sharp ridges or points which cannot be adequately coated by the paint film. Red lead is largely wasted unless it comes into actual contact with the bare metal. It is quite erroneous to suppose that a little residuary rust does no harm under the primer since no known paint has the property of reducing oxide to its parent metal and this is a claim, sometimes made which is totally unjustified.

APPLICATION OF OXIDES TO PREVENT OXIDATION

Primers in general have their pigment component in the form of an inert oxide. Chemical inertness is one of the main properties sought after in concocting any kind of paint and since oxides are as a class more inert than any other category of chemical compounds, it follows that they play a big part in the composition of paints.

Red lead consists of a combination of two oxides of lead, namely, litharge and lead peroxide and is manufactured from metallic lead. This latter fact explains its high cost.

The primer popularly known as red oxide has an iron oxide pigment which gives the best results when it is of the "Micaceous" variety. This does not contain any mica but is a nearly pure ferric oxide having a physical resemblance to black mica. Red oxide is much cheaper than red lead and there is nothing toxic about it as there is with red lead.

The general run of oxides of iron are of a spongy nature and far from affording protection they harbour moisture hold it in contact with the metal and foster rapid corrosion.

They play a big part, however, as pigments in certain finishing coats, such as Venetian red and burnt sienna, where these paints are not in direct contact with the bare metal. Red oxide paints possess the great advantage of being able to protect the oxidised oil film from the destructive effects of ultra violet rays of light. It is frequently overlooked that actinic light is one of the most potent causes of the decay of exterior painting.

Whilst dealing with the subject of anti-corrosive primers it would be wrong to omit reference to the use of zinc chrome, this time not an oxide but derived from chromate of zinc, which has a delicate pale yellow hue.

GUIDANCE ON PURCHASING PAINT

It used to be the custom to buy the ingredients of paint separately. The pigments were supplied ground in oil in the form of a stiff paste and the painter mixed them in the specified proportions. This practice has now been abandoned and the purchase of ready mixed paints is the rule. The manufacturers can make a better mixing by machine at the factory than a painter can do by hand. It follows, however, that the user must repose his faith in the maker unless, of course he prefers to draw up a precise specification and to exact that the paint should be made accordingly.

There is an (Indian) Standard colour chart giving a nomenclature for the various colours and tints and it is helpful to all concerned to quote from this most useful guide.

Paint technologists have succeeded in producing a wide range of basic types of paint which should all be within the knowledge of those responsible for the use of paint in quantity. There are the oxides of lead and iron used in oil as metallic primers to which some attention has been devoted in this article. Then there are aluminium, graphite, chlorinated rubber and synthetic paints, none of which can be ignored with impunity and finally there are the bituminous paints.

It should be remembered that having once used a bituminous paint, any subsequent coat must be of the same material, as bitumen retains its solubility in oil and consequently would bleed through an oil film.

* * *

BASIC PRINCIPLES OF CONCRETE-MIX DESIGN

OUTLINE OF MIX DESIGN

THE purpose of mix design is to select the most economical proportions of each of the available materials to produce a hardened concrete of the required minimum quality, usually specified in terms of compressive strength. The cost of the concrete will depend on the variation in strength which is likely to be obtained: if the range of variation can be reduced, by improved methods of control, the average strength required to ensure that the minimum standard is maintained will be lower than if the variation is great, and the cost of the materials will therefore be lower. However, any reduction in the cost of the materials must be considered in relation to the cost of any extra supervision and equipment which may be required to secure the improved control.

The choice of the degree of quality control to be used and therefore the probable variation in quality, is an essential preliminary to the selection of suitable mix proportions, because relationship between strength or other properties and mix characteristics are expressed in terms of average values, and the design must therefore be worked out for the average conditions. The degree of control which may be economically justified on any particular job varies principally with the quantity and quality of the concrete required and must be based on the contractor's own experience of operating costs because, up to the present, precise data of this kind have not been published.

The cost of concrete includes the cost of the materials and the cost of placing the concrete. The cost of materials is governed by the weight of cement per cubic yard of finished concrete although a rough indication is given by the cement/aggregate ratio of the mix; but it should be noted that a reduction in the cement content is accompanied by an increase in the proportion of aggregate, and the saving in the cost of the cement must therefore be offset by the cost of the extra aggregate used. The cost of placing the concrete in a particular section depends to a large extent on the mix having sufficient workability, using the term in a restricted sense to mean a measurable property of the plastic concrete, and on its having sufficient cohesiveness, the property by which segregation of the constituent materials is resisted. The basic problem in mix design, therefore, is to obtain adequate quality in the hardened concrete and sufficient workability and cohesiveness of the plastic concrete with as lean a mix as possible.

In general, the compressive strength and durability of concrete of a given richness and made with a particular type of cement improve with a reduction in the proportion of water to cement, provided the concrete is fully compacted, but at the same time the workability decreases, making compaction more difficult, and the cohesiveness may be affected. On the other hand, the workability and cohesiveness can usually be increased, for the same compressive strength by increasing the richness of the mix, changing the type of aggregate or adjusting the nominal maximum size or grading of the aggregate. The cost of materials for a given strength and workability is therefore governed by the properties of the aggregates and cement.

Low Workability

For an economical mix design the workability should be as low as possible consistent with satisfactory placing under the particular conditions of the job. If, therefore, the efficiency of placing can be improved, so that lower workability can be adopted without increasing the cost of placing or decreasing the effectiveness of compaction, it would be possible to reduce the cost of materials. The choice of the desired degree of workability therefore depends on the method of compaction to be employed, but it is also governed by the shape and size of the section to be filled and by the amount of reinforcement.

The relative efficiency of different mixes or techniques may be gauged from the relationship between the strength, workability and richness, without reference to other characteristics of the mix. For example, it is difficult to estimate the effect of any particular admixture on the properties of concrete, so it is advisable to make comparative tests under site conditions to determine whether the use of the admixture would lead to any advantage. Similarly, a comparison of gap and continuously-graded aggregates might be made in this way. The leanest mix giving the required compressive strength is usually the best for technical reasons, as well as for economy.

The most important properties of concrete are its compressive strength and durability in the hardened state and its workability and cohesiveness in the plastic state. The relationship between these properties and the characteristics of the mix are fundamental to the problem of mix design and naturally govern the procedure by which mix proportions are selected.

Minimum Compressive Strength

As the compressive strength of concrete made under site conditions varies during the progress of the job, it is usually specified in terms of a " minimum " value to safeguard against the quality becoming poorer than the required standard. However, a mix can only be designed for average conditions, assuming average quality of materials and average care in batching, compacting and curing. The selection of mix proportions must therefore be based on an estimate of the average compressive strength needed to ensure that the specified minimum value will be exceeded with the degree of quality control to be exercised on the site.

Unfortunately, as in all processes, a mix cannot be designed so that there is absolute certainty that no test result will fall below any given limit, because it is always possible that one result in a group may fall appreciably below the rest. The problem of relating the required average compressive strength to the specified minimum strength is therefore one which, fundamentally, requires a statistical approach: either the term " minimum value " should be defined more precisely in the specification or else the designer has to decide what chance he will accept that a cube result may fall below the minimum. In either case, the minimum value should be regarded as that value below which not more than one result in some stated number may be expected to fall.

If, as in the past, the minimum value is taken to be the absolute minimum, and drastic action may be demanded if any result falls below the specified limit, it may be thought wise to fix the risk of a result falling below the minimum as high as 1,000 to 1 against. This would mean that the average strength would have to be higher, and therefore the mix would have to be richer than if the specification defined the minimum as the value below which, for example not more than 1 result in 100 may be expected to fall. For an average job with a moderate degree of control this may amount to a difference of 500 lb./per sq. in. in the average strength and a change in the cement-aggregate ratio by weight from 1 : 6 to about 1 : 5½ due only to a difference in the interpretation of the specification.

Data have been published which relate the minimum strength to the average strength for different degrees of control; sometimes the statistical basis has been stated, but where this is not so it may be assumed for practical purposes that the minimum strength is that value below which not more than about 1 per cent of the individual cube results would be expected to fall. If the results were to be expressed as the average of a group of cubes, however, the possibility of a result falling below the minimum would be lower. In estimating the required average compressive strength, therefore, a lower value can be adopted for a particular degree of control if the minimum applies to a group of cubes than if it applies to individual cube results as in some specifications.

The relationship between minimum and average strength for a particular degree of control has been expressed both as a ratio and as a difference, but there is some evidence to suggest that expressing the relationship as a difference is probably the more appropriate for most structural concrete.

Durability

As the durability of concrete made with a particular type of cement is governed mainly by the water/cement ratio, the requirement for compressive strength is sometimes intended to cover also the requirement for resistance to weathering or chemical attack. However, strength is sometimes of relatively minor importance and some data have been published giving maximum values of the water/cement ratio suitable for concrete, made with Portland cements, which is to be subjected to various conditions of exposure. These values apply to the "nominal" or average water-cement ratio of the mix, so that some variation in the quality of the concrete is automatically accounted for. However, where only small quantities of concrete are required and little control is justified, it may be wise to adopt more conservative values of the water-cement ratio (and therefore a richer mix for the same workability) or, if excellent control measures are to be adopted, somewhat higher values may be acceptable.

Choice of aggregate

The type of aggregate is often fixed because there is only one economically available in the area, or sometimes because a particular type is required for architectural reasons. Where there is a choice, a type with smoother and more rounded particles will probably result in a leaner mix for concrete of moderate strength, because of the effect of particle shape on workability and cohesiveness. On the other hand, if very high strength is required, it is probable that a crushed rock coarse aggregate, used with a natural sand, will lead to a leaner mix than a gravel coarse aggregate; if two types of aggregate are available, trial mixes should be made with each to determine which is the more suitable.

The maximum size of the aggregate should be as large as possible, consistent with the conditions of placing. Not only does an increase in the maximum size lead to an increase in the workability of a given mix with the same ratio of fine aggregate to coarse aggregate, but the proportion of fine aggregate can be reduced without detriment to the cohesiveness, and this leads to an additional increase in the workability. The nominal maximum size of the aggregate is usually limited to one quarter of the smallest distance between opposite faces of the section, or to ¼ in. less than the minimum cover to the reinforcement, or to ¼ in. less than the spacing of the main reinforcing bars. However, there is some evidence to suggest that, where the spacing of the reinforcing bars is the criterion, a slightly larger maximum size of aggregate could be used if the concrete is to be compacted by vibration rather than by hand.

Where very large aggregate is used for mass concrete, as in dam construction, an analysis of published information suggests that there is little to be gained from the use of an aggregate larger than 6 in. nominal maximum size.

Choice of workability

The degree of workability required depends primarily on the type of section to be cast and on the method of compaction to be employed. Although the workability should be no higher than necessary, it is important that the concrete should be sufficiently workable to ensure that progress will not be impeded because of difficulty in compacting the concrete. An allowance should therefore be made for the probable variation in workability when selecting the average workability for mix design purposes.

If the section is of varying complexity, a mix which is workable enough for the concrete to be placed satisfactorily in the worst part will be more workable than necessary for the other parts of the section, but this situation is normally dealt with by varying the rate of placing rather than the mix proportions; however, it means that the choice of the degree of workability should be based on the requirements of the most difficult part of the section.

A more workable mix is required for sections which have a large surface area in

relation to the volume of concrete or which include many corners without fillets. The workability should also be increased in relation to the congestion of the reinforcement, particularly if the cover or clearance between the bars is small compared with the maximum size of the aggregate, and where the concrete is to be placed in relatively inaccessible parts of the mould. For all these reasons the bottom of the section is often the most difficult part for compacting the concrete.

Vibration is a more effective means of compacting concrete than hand placing, and it enables a mix of lower workability to be used. With intensive vibration, the efficiency of compacting very dry mixes can often be increased by subjecting the surface of the concrete to a relatively small pressure. In normal structural work the intensity of vibration is often smaller than might be expected: care should therefore be taken to avoid overestimating the effectiveness of the equipment.

The required degree of workability may sometimes be governed entirely by other considerations, such as pumping or underwater placing of the concrete.

Choice of grading

The choice of the required overall grading of the aggregate is primarily the choice of an appropriate proportion of fine aggregate so that the mix will have adequate cohesiveness and be capable of being fully compacted in the mould.

More fine aggregate is required where:

- the mix needs to be more cohesive to resist segregation (which may be caused by such conditions as transporting the concrete in jolting containers, discharging it down inclined chutes or dropping it into the mould over the reinforcement);
- the concrete is to be pumped or placed under water;
- the section to be cast is small in relation to the maximum size of the aggregate;
- the section has many corners without fillets;
- the section is heavily reinforced; or mortar is likely to leak through the shuttering.

The choice of grading will be influenced by the type and size of aggregate, the workability and the richness, but these characteristics will have been fixed definitely or approximately by other considerations before the grading has to be selected. A higher proportion of fine aggregate is required to give a particular degree of cohesiveness if:

- the aggregate particles are angular, flakey or elongated and of rough texture,
- the maximum size of aggregate is small,
- the mix is to have high workability, or the aggregate/cement ratio is high.

This part of the design, therefore, is largely a matter of experience, but it is fortunate that the choice of grading is not critical and can easily be altered if the quality of the concrete made in trial mixes indicates that this is necessary.

The workability and the cohesiveness of concrete made with gap-graded aggregates are more sensitive to small changes in the proportion of fine aggregate than for the corresponding mix made with continuously-graded aggregates; furthermore, gap-graded mixes of relatively high workability are more liable to segregate. It is therefore important that the choice of a gapped grading should be restricted to conditions where there is to be good control of the quality of the concrete and where the mix will have a relatively low workability, suitable for compaction by vibration.

Definition of water-cement ratio

It is generally agreed that the calculation of the water-cement ratio should be based on the weight of moisture contained in damp aggregates as well as on the weight of water added at the mixer, but there may be some ambiguity as to whether the ratio should include the weight of both the absorbed and surface water in the aggregate or only the weight of the surface water. The difference may not be great if the aggregate will only absorb a little water but if, for example, a particular gravel aggregate and sand absorb 2 per cent of water, the difference between the "free water-cement ratio" and the "total water-cement ratio" would be as much as 0.12 by weight for a 1 : 6 mix by weight. This might make a difference of over 1,000 lb. per sq. in. in the compressive strength at 28 days, and change the workability from "High" to "Low".

It would seem natural that the definition of water-cement ratio should be based on the surface water only, because it would not be expected that the absorbed water would contribute to the workability or affect the strength of the concrete. However, there are several difficulties in framing such a definition and there is yet no generally accepted method of determining what might be termed the "effective water-cement ratio". In using data relating to compressive strength, durability or workability to water-cement ratio, it is therefore important to know whether the values are based on the free or the total water; if they are for total water-cement ratio, some indication is required of the absorption characteristics of the aggregate to which the data refer.

[*Extracted from Highways & Bridges May 19—1954.*]

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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 the ruling 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

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MODEL STUDIES OF TAPERED INLETS FOR BOX CULVERTS

MODEL studies of box culverts on steep grades were conducted in co-operation with and sponsored by the Oregon State Highway Commission and the Bureau of Public Roads. Objectives of the experiments were: (1) clarification of the theory of operation of box culverts; and (2) modification of the design of the Oregon State Highway standard inlet in order to increase the over-all effectiveness of the culvert as a drainage structure.

Test data were taken from a 1:12 scale model of a 4 by 4-ft box culvert 82 ft long. This model was provided with a trapezoidal approach channel and a section of embankment slope with means for installing different types of inlets without major changes in the model.

The programme consisted of testing three basic types of inlets: the Oregon State Highway Commission standard inlet with no flare or taper, an inlet with a taper in the sides and top of 1 to 10, and an inlet designed primarily for operation under entrance control. All three of these inlets were provided with wing walls at an 8 to 12 angle with the axis of the culvert. Essentially, the initial testing consisted of three general types of comparisons: (1) analysis of the operation of all three inlets in non-submerged states, (2) operation of the standard inlet as a sluice gate, and (3) full-flow operation of the standard and tapered inlets.

The non-submerged operation of the inlets followed the theory of entrance control with critical depth, and it was indicated that designs for entrance control could be based upon critical depth theory with little or no modification. In the submerged state the standard inlet operated normally as a sluice gate, while the 1 : 10 tapered inlet showed no sluice contraction and flowed full automatically as it became submerged, with a resultant increase in flow as compared to the standard inlet. It was discovered that the increase in capacity was the result of: (1) the shift in the lower energy reference from inlet to outlet of the culvert and (2) the increase in the effective area of flow due to elimination of the contraction at entrance which occurred with the standard inlet. Test results indicate that the standard inlet flowing as a sluice can be treated with existing orifice theory and that existing theory regarding pipe flow can be used for the full-flow conditions of the tapered inlet.

It was discovered that the culvert with standard inlet could be made to flow full artificially by temporary elimination of the sluice contraction and would remain full so long as air was prevented from entering the inlet section. Under ordinary full operation, however, air admitted through the action of vortices in the upstream pool caused the culvert to revert to sluice operation.

A practical approach to assurance that the culvert barrel would flow full and remain full upon submergence of its inlet was to modify the inlet to eliminate the contraction at that location. The procedure followed was to form a taper in the entrance by extension of the top slab of the culvert upstream from the parapet wall over the wing walls and the extension of a portion of the wing walls to meet the top slab; thus the tapered section was formed by the wing walls and the top slab. The shortest practical length of extension was determined experimentally to be that required to produce an area ratio of entrance to culvert barrel of 2 to 1. The resulting inlet design showed a substantial increase in capacity, upon inlet submergence, over any other inlet tested. Effectively, this inlet allowed no change in headwater level from the discharge

(Continued on page 30)

HERE AND THERE

1. BANIHAL TUNNEL PROJECT

● THE GOVERNMENT of India have awarded the work of constructing the Banihal Tunnel (1st stage) in the State of Jammu and Kashmir to Messrs Baresel and Kunz of Germany at an estimated cost of Rupees 37.03 lakhs. The first stage involves driving a pilot heading of about 10 ft × 10 ft section.

The tunnel will be bored at an altitude of 7,250 ft and will remain open for traffic throughout the year. It will provide an all-weather road to the Kashmir valley which, at present, remains cut off in winter months. It will save, when completed, a distance of 18 miles in the length of the road and the benefits accruing to the trade and economy of Kashmir will be considerable.

The tunnel will be 8,200 ft long and will be one of the twelve longest road tunnels in the world. It will also be the longest among the road and railway tunnels in India.

[Extracted from Press Information Bureau, Government of India.]

2. CASH VALUE OF COURTESY

● COURTESY like safe driving pays ready dividends. Safe drivers can be divided into two categories. First is the fellow who presses on recklessly depending on his skill and the deterrent effect of his ruthlessness on pedestrians as well as other vehicles.

It is a fact that such people are rarely involved in accidents. But the narrow margin in which they escape from accidents leaves much to be desired.

The other type is the courteous man who gets out of trouble himself and thoughtfully observes the small details in regard to road manners and through intelligent driving of his vehicle ensures that others are not involved in accidents either.

The first type is a liability and the second a credit particularly for those who are engaged on commercial vehicles. For those who are embarassed or victimised by the bad driving or by the reckless driving of the first category are not likely to have any goodwill for the firm which employs him. Thus road manners are more than merely a public service as they can increase sales and pay dividends.

[From 'State Transport Review' Bombay, April 1953.]

3. EFFECT ON BEAMS OF STATIC AND DYNAMIC LOADS

● TESTS made on reinforced concrete beams to determine their behaviour when subjected to static and dynamic loads, are described in a Paper presented to the American Concrete Institute recently by Mr. Joseph Penzien and Mr. Robert J. Hansen.

The Author's conclusion is as follows:

(1) The effective strains in the concrete of beams subjected to static loading may be calculated with reasonable accuracy by the straight-line theory, provided that the beams contain compressive reinforcement. If no compressive reinforcement

is used, strains may be considerably larger than those given by this theory. (2) The maximum strains in a beam subjected to a dynamic load may considerably be larger than those in the same beam when a static load of equal magnitude is applied. (3) Internal damping existing in beams subjected to dynamic forces reduces the maximum strains considerably. (4) Internal damping which exists in beams has characteristics similar to the damping properties of liquids. (5) The damping coefficient or percentage of critical damping in the beams tested varied between 6 and 8 per cent. (6) The same damping coefficient applies reasonably well to all frequencies and loads. (7) The yield point of the reinforcement is considerably higher under dynamic loading conditions, than under static loading conditions, provided that the rate of dynamic loading is sufficiently great. For rates of loading within the range 1.2×10^6 and 8.5×10^6 lb. per square inch per second, standard reinforcement (A. S. T. M. Designation A15–48) has a dynamic yield point about 35 per cent higher than its static yield point. (8) A reinforced concrete structure designed to withstand dynamic loads should have a load percentage of reinforcement. (9) Both the dynamic magnification factor and increase in the yield stress of the reinforcement should be considered.

[Extracted from "Concrete and Constructional Engineering", July 1954, Vol XLIX, No. 7.]

4. SUCCESSFUL STABILISATION OF A RETAINING WALL

● BECAUSE of unusual difficulty in maintaining the level and line of the rail tracks at a spot where the railway runs 42 ft above a river the British Railways have stabilised the retaining wall which supports the tracks.

This portion of railway, was opened in 1840, and the double track, following the general course of the river, is carried on a shelf constructed on the slope of a natural hillside.

The presence of deep-seated instability in the support of the track was discovered. Records confirmed that outward movement of a section of the wall was taking place, accompanied by a lesser vertical settlement. As a first step a re-alignment of the two running lines was carried out whereby they were pulled some 5 ft inward towards the hillside and away from the retaining wall. Rail straps to safeguard against the effects of local settlement were added to both tracks and a speed restriction of 5 m.p.h. over the length affected was imposed. Despite the serious deformation of the wall which had taken place up to this date, the face work was found to be generally sound.

Meanwhile, a strengthening scheme was prepared which provided for continuous steel piling to be driven in front of the toe of the retaining wall throughout the length adjacent to the river, to be followed by the provision of mass concrete between the piling and the wall, taken down to a level some 3 ft lower than the foundation level of the old wall.

Provision was made in the scheme for the subsequent construction of counterforts, if found necessary, still further to safeguard the general stability of this length of retaining wall.

Although some difficulty was experienced in obtaining the penetration of the piles as provided for in the scheme, the work was carried out generally in accordance with the plan. Excavation and concreting between the piling and the wall was carried out in sections, involving considerable pumping. During the progress of this stage of the work, the records of movement of the wall showed progressive reduction and eventually no further movement was recorded.

Whilst the ashlar face of this heavy retaining wall appeared to be in very sound condition, some uncertainty existed as to the condition and quality of the masonry of the wall behind the facing.

During the progress of the strengthening work in front of the wall, trial pits were opened out behind the wall and examination made of the masonry. It was apparent that considerable voids existed in the main body of the wall. Experimental work was, therefore, undertaken in pressure grouting from the outside face of the wall, but it was found that grouting conditions were particularly difficult.

It was decided, therefore, that eight concrete buttresses should be built from the new concrete strengthening work to safeguard the general stability of the wall along the length where the greatest movement had taken place. These buttresses were built without difficulty, being securely bonded into the masonry of the wall as provided for.

There was little doubt that one of the factors which had given rise to the development of instability in this retaining wall was the considerable penetration of surface water from the adjacent hillside into the wedge of filling supported by the wall. After stability had been confirmed during the progress of the strengthening work to the wall, the tracks were reinstated to their original alignment, and the opportunity then taken to provide improved surface water drainage and conveyance arrangements in the cess at the foot of the hillside.

[*Extracted from "Highways & Bridges"-May 5th, 1954*]

5. HIGH COURT IN U.S.A. DISSOLVES INJUNCTION PROHIBITING STATE FROM BUILDING MEDIAN STRIP

● THE OWNER of an automobile garage abutting on U. S. Highway 60 in West Virginia (U.S.A.) was granted an injunction by the Circuit Court of the county, enjoining the general contractor and the district engineer for the state road commission from building a median strip on the highway, which would restrict entrance to the garage. Upon appeal, the Supreme Court of Appeals of West Virginia dissolved the injunction on the ground that the complaint did not state grounds on which an injunction could be granted.

In asking for the injunction it was alleged that the construction of the proposed centre island or median strip would require all east-bound traffic on U.S. 60 to proceed about 300 feet beyond the property in order to turn and approach the garage, which would greatly damage the business. In granting the injunction, restraining the state from proceeding with the construction of the centre island or median strip, the lower court ordered the State to leave a gap in the centre island or strip 100 feet in length in front of the property.

The High Court found no specific allegations in the bill of complaint to the effect that the garage owner had suffered, or would suffer, injury from the proposed construction of the median strip different in kind from that suffered by other property owners similarly situated. Nor did the complaint disclose that the contractor and the district engineer acted arbitrarily, capriciously or fraudulently in constructing the proposed median.

The court held as in an earlier case that the State Road Commissioner has power "Upon petition and hearing, or after due investigation, upon his own initiative, to discontinue any road no longer necessary" and such power is not subject to the control of the courts, except where its exercise is capricious, arbitrary, or fraudulent.

Where the State road commissioner, in the lawful exercise of the powers vested in him, makes a change in a primary State road, owners of property affected by such change, cannot, by mandamus, require the restoration of the road to its original location where reasonable access to and from their property is provided.

In the earlier case, the court stated that "the legislature having granted this power in the broadest possible terms, courts are not at liberty to interfere with the exercise of the same by those entrusted with its execution, except in cases where capricious, arbitrary, or fraudulent conduct is involved."

In line with this and other decisions, the state supreme court found it necessary to reverse the decree of the lower court and order that the injunction be dissolved.

[*Extracted from Highway Research Board, Circular No. 242*]

6. NATIONAL HIGHWAY CONNECTING RANCHI—JAMSHEDPUR—BAHRAGORA

● THE CONSTRUCTION of the National Highway connecting Ranchi-Bundu - Tamar - Jamshedpur - Bahragora will, it is understood, be taken up immediately after the rains. The proposed construction of a highway from Ranchi to Bahragora will connect the Grand Trunk Road at Barhi to the Bombay Calcutta Trunk Road at Bahragora. Necessary survey for this work has already been completed and the total cost has been estimated to be about two crores of rupees including the cost of construction of bridges and culverts. The formation width of the road will be about 32 feet and the width of the metalled and the pitched portion will be 12 feet. This national highway will facilitate further development of tea industry at Palandu, the lac industry at Bundu, which is one of the largest lac producing areas in India. Jamshedpur is already a highly developed industrial centre with its iron and steel products and Ghatsila which has perhaps the only copper producing concern in India. The new alignment will shorten the distance between Ranchi and Jamshedpur from 130 miles to 80 miles.

[*Extracted from "Automobile News" of August 1954*]

ENGINEERS, ALL

We have become accustomed to men who used to bear the honourable title "mechanic" calling themselves engineers. In America, it seems, all sorts of office managers and others are now inflating themselves by using the word "engineer" in describing their calling. Recent examples from the U. S. A. are sales engineer, administration engineer, management engineer, topographical engineer, traffic engineer, materials engineer, instrument engineer, application engineer, development engineer, cartographic engineer, surveying engineer, operations engineer, soils engineer, project engineer, and architectural engineer. No doubt these people believe it adds to their value in the employment market as well as to their self-esteem that they should be known as engineers, but we see little relation between engineering and, for example, map-making, traffic control and management.

[*Concrete & Constructional Engineering, July 1954.*]

CURRENT LITERATURE

ABSTRACTS

U.D.C. No. 624.15 "FOUNDATION ENGINEERING" By R. B. Reck, W. E. Hanson and T. H. Thornburn. John Wiley & Sons, Inc., New York.

In "Foundation Engineering" as in all branches of Civil Engineering accumulated experience is the essence. The book which puts all the knowledge on the subject into one cover serves as an introduction to the field of Engineering. It is intended to provide the reader with ability to :

(1) investigate and evaluate sub-surface conditions,

(2) select suitable type of foundation for a given site,

(3) judge the performance of each type in service,

(4) design the structural elements of the type finally selected.

Accordingly, the work is divided into four parts namely :

Part A. Properties of surface materials.

,, B. Types of foundation and methods of construction.

,, C. Selection of foundation type and basis for design.

,, D. Structural design of foundation elements.

In the five chapters under part A the technique of subsurface investigation, classifications of rocks and field identification of soils, character of deposits, physical property of soils such as : "Stress strain characteristics", shearing resistance etc., are presented.

Part B containing 7 chapters, describes the current practice regarding the types of foundations and their methods of construction such as Open execution, Pull foundation and Raft foundation.

PART C presents a digest of experience with various types of foundations and subsurface conditions under the heading "Foundations on sand", clay, silt and loess and non-uniform soils.

PART D deals with the design of footings, bridge pier foundations, retaining walls and abutments.

U.D.C. No. 624.131.371. A STUDY OF THE BLACK COTTON SOILS WITH SPECIAL REFERENCE TO THEIR COLOURATION by S. Singh.

The Journal of Soil Science, July 1954.

A study of the dark colour of some Indian black soils has been made by oxidation with H_2O_2. The calcareous soils containing even traces of MnO_2 decompose the H_2O_2 and their colours remain almost unchanged; but after a pre-treatment of these soils with dilute hydrochloric acid to decompose the carbonates, their basic dark colours are completely decolorized by H_2O_2 associated with the organic matter so oxidized have been discussed.

Although the organic carbon of the black soils appears more resistant to the H_2O_2 oxidation as compared with the carbon of the adjoining red soils, it has been shown that this apparent resistance is due to their Ca-saturation. The clay fractions, which are very similar in colour to their original soils, contain less H_2O_2 resistant organic carbon than their adjoining red examples. The nitrogen of all these soils is very resistant to this reagent.

The regur or black cotton soils of central and peninsular India or the 'Kabar' soils of Bundelkhand contain organic matter which behave similarly on H_2O_2 oxidation to that of the 'Karail' soils of the Gangetic alluvium, thus giving an indication of their formation under somewhat similar intermittent anaerobic conditions.

UDC. No. 625.712.14 URBAN TRAFFIC CONGESTION - Highway Research Board Bulletin No. 86-2101 Constitution Avenue, Washington 25, D.C.

The Bulletin contains two Papers :

"Economic cost of Traffic Congestion" and "Urban Congestion Index Principles."

THE first Paper is a review of available data and literature in the field and presents the subject under excess gasoline consumption, extra wear on tyres and equipment, time losses and accident losses. The economic benefits of expressways are discussed. The need for further research is stressed and lines work suggested. A comprehensive list of references is included.

The second Paper discusses the need for an index to measure congestion. The index may be put to many uses such as (1) A means of comparing congestion in one place with the congestion in another place, (2) An aid in fixing priorities for remedial measures to relieve congestion. After discussing the characteristics of congestion three possible alternatives to the development of the index are put forth. These are the operational characteristics, freedom of movement, and volume-to-capacity concepts. Constructive discussions on the Paper are also included.

U. D. C. No. 532.613 INVESTIGATIONS INTO THE MECHANISM OF SOIL ADHESION by E. R. Fountaine, The Journal of Soil Science, July 1954.

INVESTIGATIONS into the mechanism of the adhesion between soil and foreign surfaces in normal loading tests are described. The adhesion is found to be entirely due to the water film between the joined surfaces, and its magnitude is approximately equal to the moisture tension in this film multiplied by its area. The effects of the soil, the foreign material, and the testing technique on the tension in the moisture film are discussed.

U. D. C. No. 624.131 PROCEEDINGS OF THE THIRD INTERNATIONAL CONFERENCE ON SOIL MECHANICS AND FOUNDATION ENGINEERING, Switzerland, 1953–Volume III *

THE Volume contains the speeches made at the conference, minutes of the executive committee and a record of discussions on the eight sections under which the Papers were discussed.

Ten lectures delivered at the conference on the different subjects are included. Of these following lectures are in English :

1. The Subsoil of Switzerland ;
2. Creep Problems in Soils, Snow and Ice ;
3. Soil Mechanics and Foundation Problems of the Marmorea; and the lecture "Fifty years subsoil Exploration" by Professor Terzagi which summarises the knowledge on the subject.

Of the lectures which are given in French the following are of interest to road engineers :

1. Application of Soil Mechanics to road construction in Switzerland.
2. Geotechnical considerations on the bearing capacity of roads. Summaries in English for the lectures in French are included.

U. D. C. No. 532 HANDBOOK OF APPLIED HYDRAULICS, Editor-in-chief C. V. Davis. Second Edition, McGraw-Hill Book Company, Inc., New York, 1952.

THE book is a general reference volume on Hydraulic Engineering and contains 25 chapters on the various aspects of the subjects. Structures such as: Gravity dams, Arch dams, Earth dams,

* See Transport - Communications Monthly Review........for abstract of Volume I and II.

Rock-fill dams, Buttress dams etc., as well as Hydrology, Hydraulic models, water supply, water power and other related subjects. Each of the chapters is written by an expert in the field.

" PICTOGRAPHS AND GRAPHS "-" HOW TO MAKE AND USE THEM ", By Rudolf Modley and Dyno Lowein-stein--Harper and Brothers, Publishers New York.

THE book is an up-to-date guide to the technique of pictographs and graphs. The selection of symbols, uses of statistical material and its adaptation to the needs of particular cases are discussed.

Two chapters are devoted to charts. One details the conventional methods such as line and flow charts. The second chapter " Cheating with Charts " describes the illusory effects which can be produced by selecting inappropriate scales. Practical hints to produce a true picture are given.

U. D. C. No. 625.84 CONCRETE RESURFACING OF CONCRETE PAVEMENT IN VARIOUS STAGES OF DETERIORATION.

(Bulletin 87-Highway Research Board, Washington, D. C.)

THE bulletin describes the construction and performance of two experimental sections of concrete resurfacing of concrete pavement built in America, the first in 1932 and other in 1936. In the 1932 investigation two sections of concrete resurface were built, one with a minimum thickness of 4 inches, the other 6 inches. Each section was about ¦ mile long and purposely located so as to cover old pavement containing subsections in all stages of deterioration. In the 1936 resurface, totalling 11 3/4 miles, three thicknesses of 4, 5, and 6 inches were used depending on the relative condition of the old pavement.

An accurate record of the old pavement condition as observed at periodic intervals was kept through the years and permitted correlating the defects that developed in the resurfacing with those in the old pavement.

In evaluating the performance of the concrete resurface, various criteria were available for consideration. Also various pertinent conditions, materials and design features influenced the resurface behaviour. All these variables are inter-related and some could not be isolated from others ; however, an attempt was made to identify and study the effects of: (1) thickness of resurface, (2) condition of old pavement, (3) drainage, (4) expansion joints, (5) cross-section design, and (6) marker seal centre joint.

Appendices are included covering (1) effects of old pavement condition on the condition of resurfaces based on study of individual defects, (2) a study of economic considerations in the selection of resurface thickness, and (3) a method of spacing transverse joints in concrete resurfacing.

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WHAT IS A GOOD DESIGN

A good design is a complete design. It must have technical excellence, attractive appearance, and be of suitable cost.

Technical excellence springs from a careful and judicious balance of all the influencing factors. The design must, like a living being, grow under a combination of influences.

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X. BRIDGES AND OTHER STRUCTURES

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2. **New Lifting Bridge at Deptford Creek** ; *The Surveyor*, March, 27, 54 - p. 235.

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3. **New Army Portable Bridges** ; HERBERT MILEOIT - *The Military Engineer*, March-April 54-pp. 123-126.
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5. **The Design of Simply Supported Prestressed Concrete Beams for Ultimate Loads** ; FREDERICK WILLIAM GIFFORD - *Paper No. 5909—Proceedings of the Institution of Civil Engineers, Part III, Vol 3*, No. 1 April 54, pp. 125-143.
6. **The Elimination of Moments in Shell Roofs by Prestressing** ; PROFESSOR WILLIAM THOMAS MARSHALL, *Paper No. 5964, Proceedings of the Institution of Civil Engineers, Part III, Vol 3*, No. 1, April 54, pp. 276-282.
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9. **Wood Head New Tunnel, Construction of a Three Mile Main Double-Line Railway Tunnel** ; *The Surveyor*, March 27, 54, pp. 251-252.
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12. **Composite Prestressed Beams and in Situ Slabs** ; ALAN H. MATTOCK - *Concrete and Constructional Engineering*, April 54-pp. 123-132.
13. **Recent Wharves and Jetties in France** ; *Concrete and Constructional Engineering*, April 54, pp. 133-139.
14. **Record Three-hinged Arch Spans 278 ft** ; *Engineering News Record*, April 8, 54, p. 38.
15. **Inner-Outer Prestress Produces Record Span** ; Jwazeriso Bridge Across the Sans Francisco River at Jwazerso, Brazil - *Engineering News Record*, April 8, 54, pp. 57, 58 & 60.

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18. **Baytown (7. S) Highway Tunnel, Special Features of Design** ; *Highways and Bridges and Engineering Works,* April 21, 54, p. 6.

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20. **New Span Record Set for Welded Girders** ; W. F. Smith, *Engineering News Record,* April 1, 1954, pp. 32-35.

21. **Long-Span Prestressed Concrete Beams used in Army field House** ; Robert E. Snetzer, *Civil Engineering,* April 54, pp. 41-43.

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24. **Design of Continuous Foundation Still Demands Engineering Judgement** ; Thomas H. Dale, *Civil Engineering,* April 54, pp. 69-71.

25. **Simplifying Compression Reinforcing Diagram** ; Jack Moyse, *Civil Engineering,* April 54, p. 71.

26. **Analysis and Design of Beams Under Given End Conditions** ; Harold V. Hill, *Civil Engineering, and Public Works Review,* March 54, pp. 257- 259.

27. **Design and Construction of a Prestressed Framework** ; *Part* (I), Esic Sheplay, *Civil Engineering, and Public Works Review,* March 54, pp. 259-261.

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    Part (4) -Do- June 54, pp. 624-626.

    Part (5) -Do- July 54, pp. 735-738.

31. **Combined Steel and P. C. Bridge** ; *Civil Engineering, and Public Works Review,* March 54, p. 283.

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33. **Large Dutch Traffic Tunnels** ; *Civil Engineering and Public Works Review,* April 54, 366.

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36. **Another Big Bridge for San Francisco Bay** : *Highways and Bridges and Engineering Works,* April 28, 54, pp. 1 & 3.

37. **A Tunnel Under the Straits of Gibralter** ; Julio Navascues, *Road International No.* 11, Winter 1953-54 pp. 29-32.

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39. **New Tramline Bridge in Mannkeim** ; W. Pfaff, *Der Bauingenieur,* March 54–p.p. 85–89 (in German).

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41. **"Height Pre-stressing Method in the Road Bridge at Donaumunster"** ; Karl Seytter *Beton und Stahlbetonban* March 54 p.p. 60–63 (in German).

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52. **Concreting the Giant Tunnel of Ontario Hydro at Niagara falls** ; E. Weics, *Der Bauingenieur* April, 54 p.p. 152–155 (in German).

53. **Dynamic Stresses in Cast-iron Girder Bridges,** *The Surveyor,* May, 54, p. 356.

54. **Reconstruction of Tefenez Bridge (France), Part I** ; J. Courbon and H. Dela Serve, *La Technique Modern Construction,* April 54, pp. 101–112 (in French)

55. **The Compensation for the Loss by Friction during the Tensioning of Prestressed Concrete Reinforcement** ; *La Technique Modern Construction,* April 54 p. 128 (in French).

56. **Fifty Years of Building Code Requirements** ; Frank Kerekes and Harold B. Reid, *The Journal of the American Concrete Institute,* February, 54, pp. 441–470.

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64. **Test of a Prestressed Building Frame**: E. SHEPLEY - *Magazine of Concrete Research No. 15*, March 54, pp. 115-122.

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73. **Railway Bridge with an Arch of 300 ft. Span**; *Concrete and Constructional Engineering*, May 54, pp. 174-176.

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81. **New Prestress Method for Digest water Tank**; *Engineering News Record*, May 20, 54-pp. 32-34.

82. **"Saddle" Roof, 2¼ in. Thick, Spans 233 ft**; *Engineering News Record*, May 20, 54, pp. 64-66.

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5. **Basic Road Statistics, Great Britain and Northern Ireland, 1953** (British Road Federation, 4-a, Bloomsbury Square, London W. C. I.)

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6. **Census of India, 1951, Volume IX, Hyderabad, Part I-B - subsidiary tables, PCC. III,** by C. K. Murthy. (2 copies)

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WORDS TO LIVE BY

Remember that there is no short, easy road to success. If you are to make your individual differences work for you and amount to something superlative, you must first learn to conquer your own emotional liabilities, whether they be unwillingness to learn, procrastination, laziness or a handicapping, stifling trait of an entirely different nature.

AN EXPERT

An expert is one who can complicate simplicity.

BUDGETS AND ADMINISTRATION REPORTS

Administration Report of the Buildings and Roads Branch, P. W. D., Government of Madhya Pradesh for the year 1951-52.

The main features of the Report are summed up below:

I. Expenditure from the Road Development Fund.

	In lakhs of Rupees		
Year	Madhya Pradesh share	Govt. of India Reserve	Total
1950-51	0.48	0 29	0.77
1951-52	1.61	0.69	2.30

II. Expenditure on Central Works.

The expenditure on Central Works (Civil Archaeology etc.) amounted to Rs 28.49 lakhs out of which about Rs 28.11 lakhs was accounted for by communications alone. Distribution of the expenditure is shown below:

	Original Works	Repairs	Total
Communications	11.93	16.18	28.11
Others	0.32	0.06	0.38
Total	12.25	16.24	28.49

III. Expenditure on Provincial Works.

The expenditure on Buildings and communications during the year was as follows:

	Original works	Repairs	Total
Buildings	42.63	18.81	61.44
Communications	51.02	78.23	129.25

Of the expenditure of Rs 51.02 lakhs incurred on communications—Original works, a sum of Rs 24.93 lakhs was met from Provincial Revenues, Rs 2.49 lakhs from Road Developement Fund and Rs 23.60 lakhs from funds for Post-War Development Schemes.

IV. Road Milage.

Comparative figures of road milage maintained from Provincial funds as at the end of 1950-51 and 1951-1952 are given below:

	Milage as on 31—3—1952	Milage as on 31—3—1951
Class I Roads	6055	6038
Class II and Class III Roads	3737	3793
Total	9792	9831

The increase in the length of Class I roads is accounted for by improvements of some of the Class II and Class III roads in Class I. The figures do not include the roads maintained by Janapada Sabhas from their own funds.

V. The year under report recorded appreciable improvement in the condition of roads due to increase in the provision for maintenance and additional renewals. Two hundred miles of roads were black topped under the Five-Year Programme of black topping.

VI. Provincial Works executed through the agency of Local Bodies.

Total expenditure under this head amounted to Rs 10.45 lakhs, the major part of which is accounted for by Buildings and Communications as shown below:

(In lakhs of Rupees)

	Original Works	Repairs	Total
Buildings	0.06	0.59	0.65
Communications	—	9.50	9.50
Total	0.06	10.09	10.15

Expenditure on Grants-in-aid amounted to Rs 0.30 lakhs. The total expenditure of Rs 10.45 lakhs included a sum of Rs 1.40 lakhs on account of Supervision Charges at 15½ per cent (Establishment 14 per cent and Tools and Plant at 1½ per cent) paid to the Local Bodies.

(Continued from page 15)

required to just submerge the inlet to that required by the culvert flowing full. With the culvert on a 4 per cent grade and operating at the head of submergence, the modified inlet allowed an increase of approximately 100 per cent over that obtainable from the culvert equipped with the standard inlet. Experiments with flat, 4, and 8 per cent grades confirmed a hypothesis that, within limits, the ratio of areas required for the foregoing type of operation is the same, regardless of the slope or angle of wing walls.

Conclusions dervied from the experiments were: (1) a significant saving of materials could result from designing culverts on steep grades to flow full, (2) the formation of a tapered inlet by the extension of the top slab and wing walls would be a practical solution to the problem of assuring full flow, and (3) by proper application existing theory is adequate for the design of culverts on steep grades.

[Authors' Summary—Highway Research Board Special Report No. 15-B.]

LIST OF APPROVED WORKS ON NATIONAL HIGHWAYS

S. No.	Job No.	Name of work	Amount (Rs in Lakhs)
		VINDHYA PRADESH	
1.	923 VP 27	Black topping 10⅛ miles of Mangawan-Chak Section of N. H. No. 27 in Vindhya Pradesh	1.35
		BOMBAY	
2.	924 BM 8/A	Improvements to the Bhayala-Bhagedara Section (mile 26/0 to 37/0) of the Ahmedabad-Kandla Road—National Highway No 8-A	6.43
		PUNJAB	
3.	925 PB 1	Acquisition of land for construction of bye-pass on G. T. Road at Ludhiana	3.19
4.	931 PB 8	Widening miles 20 to 35 of Delhi-Alwar Road (N. H. No. 8) in Gurgaon District	7.38
		ORISSA	
5.	926 RS 42	Realignment of N. H. No. 42 at 25th mile (near junction of Raj Athgarh Railway station and Khutni Village)	0.52
6.	927 RS 5	Realignment of National Highway No. 5 between Chatrapur and Ruslikulya bridge from miles 649/7-60 ft to 654/5	2.78
		UTTAR PRADESH	
7.	928 UP 2	Construction of an approach road from Agra-Etawah-Fatehpur road (Ferozabad bye-pass) to the Inspection House at Ferozabad—N. H. No. 2	0.05
		MADRAS	
8.	929 MD 47	Black topping miles 236/6 to 265/6+320 ft of the Salem-Cochin Road—in Salem (South) Divn.	5.60
9.	930 MD 47	Black topping miles 266/0+500 ft to 293/6+160 ft of the Salem Cochin Road in Coimbatore (North) Divn.	7.56
		DELHI	
10.	932 DLH 10	Improvements to Rohtak Road from mile 9 to 15	1.42
		WEST BENGAL	
11.	933 BG 6	Preliminary survey of the river Rupnarayan at Kolaghat on N. H. No. 6 in the District of Midnapur	0.13
		BIHAR	
12.	934 BR 31	Ground survey in connection with the construction of road bridge over Mahananda river at Dinghroghat, on National Highway No. 31	0.14

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7.	Volume XII—Part 3—April 1948	3	0	0
8.	Volume XII—Part 4—March 1948	3	0	0
9.	Volume XII—Part 5—September 1948	3	0	0
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11.	Volume XIII—Part 1—December 1948	3	0	0
12.	Volume XIII—Part 2—January 1949	3	0	0
13.	Volume XIII—Part 3—January 1949	3	0	0
14.	Volume XIII—Bound—1948-49	11	0	0
15.	Volume XIV—Part 1—September 1949	3	0	0
16.	Volume XIV—Part 2—December 1949	3	0	0
17.	Volume XIV—Part 3—December 1949	3	0	0
18.	Volume XIV—Part 4—July 1950	3	0	0
19.	Volume XIV—Bound—1949-50	8	0	0
20.	Volume XV—Part 1—August 1950	3	0	0
21.	Volume XV—Part 2—November 1950	3	0	0
22.	Volume XV—Part 3—January 1951	3	0	0
23.	Volume XV—Part 4—August 1951	3	0	0
24.	Volume XV—Bound—1950-51	9	0	0
25.	Volume XVI—Part 2—March 1952	3	0	0
26.	Volume XVI—Part 3—April 1952	3	0	0
27.	Volume XVI—Part 4—October 1952	3	0	0
28.	Volume XVI—Bound—1951-52	8	0	0
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30.	Volume XVII—Part 2—January 1953	3	0	0
31.	Volume XVII—Part 3—January 1953	3	0	0
32.	Volume XVII—Bound—1952-53	9	0	0
33.	Volume XVII—Part 4—December 1953	3	0	0
34.	Volume XVIII—Part 1—December 1953	3	0	0
35.	Volume XVIII—Part 2—December 1953	3	0	0
36.	Volume XVIII—Part 3—January 1954	3	0	0
37.	Road Research Bulletin No. 1	5	0	0
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