TRANSPORT-COMMUNICATIONS

MONTHLY REVIEW

DECEMBER 1955—No. 104

INDIAN ROADS CONGRESS, NEW DELHI.

TRANSPORT-COMMUNICATIONS

MONTHLY REVIEW

DECEMBER 1955—No. 104

TABLE OF CONTENTS

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

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

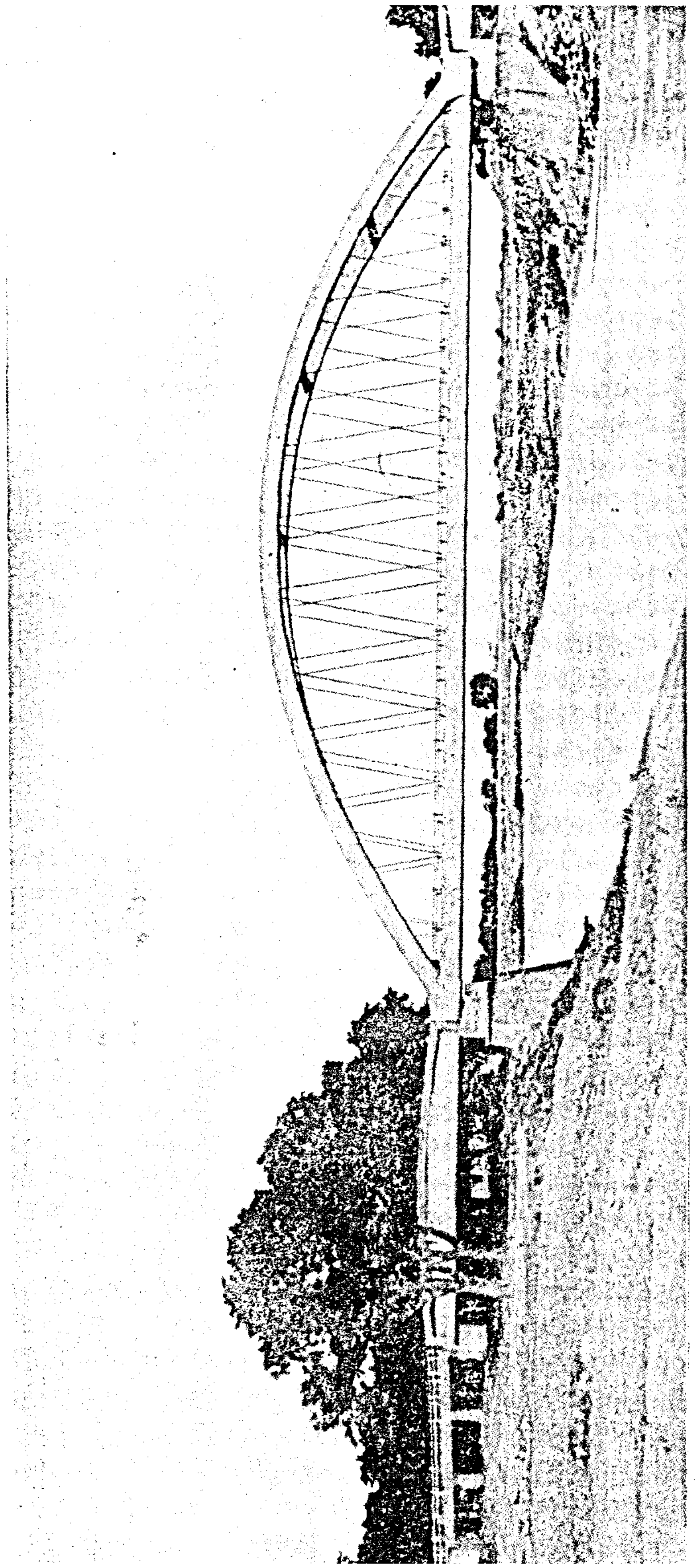
Subscriptions. Annual subscription including postage is Rs Fourteen. Single copy including postage is Rs one and annas four.

To Members of the Indian Roads Congress, Engineering personnel below the rank of an S. D. O. and Engineering students a special reduced subscription rate of Rs eight per annum is offered. Students are required to apply through the Principal of their College.

Advertisements. Advertising rates per insertion

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

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



DURGAWATI BRIDGE

This shows a reinforced concrete bowstring with inclined hangers having a span of 197 ft 3 in. crossing the Durgawati River in Bihar.
The length of the bridge with the two approach spans is 326 ft 6 in.

TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

A REVIEW OF
ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

DECEMBER 1955 1-12

TWENTIETH SESSION OF THE INDIAN ROADS CONGRESS, NAGPUR—JANUARY, 1956

THE 20th Session of the Congress will be held at Nagpur from 7th to 14th January 1956. Eight Papers, brief summaries of which are given below, will be discussed. There will be a Panel Discussion on Surface Dressing. Members will also inspect an R. C. C. bridge of 23 spans of 90 ft each under construction across River Narmada, and pay a visit to the Paper Mills at Nagpur.

Paper No. 180 " Stabilized Soil Construction in the formation of Tuticorin-Tiruchendur Road " by E. C. Chandrasekharan and T. S. Chandrasekhar.

This Paper describes in detail the construction of soil stabilized base course using locally available soils in an area near the sea coast. It was possible to effect a saving of nearly Rs. 7,300 a mile by the adoption of this method of construction in preference to the conventional stone soling employing limestone which is available in the locality only at a distance of about 12 miles.

The Paper also describes experiments on the influence of common salt on the consistency properties and susceptibility to pulverisation of clay.

It is also brought out that use of common types of machinery, graders, rollers, etc., in combination with manual operation is economical and helpful in achieving rapid progress.

Paper No. 181 " The Design of an Experiment to Assess the Cost of Operation of Motor Vehicles on Different Types of Roads " by C. S. Anantapadmanabhan and M. K. Ganguli.

The Indian Roads Congress had appointed a Committee in 1953 to study the cost of operation of motor vehicles on various types of road surfaces and the economy of road improvement. The Committee had collected data from operators throughout the country and their analysis showed that it is desirable that the problem is studied under controlled conditions. This Paper deals with the design of the experiments to evaluate the operation costs under controlled conditions. In view of the large number of factors that have to be taken into account, a factorial experiment is considered necessary. The design of such an experiment for minimising the cost and supplying the required information within a short time is described in the Paper.

Paper No. 182 "Compressive Strength as a Design Criterion for Bituminous Mixtures" by C. G. Swaminathan.

The drawbacks of an unconfined compression test as is used for determination of bituminous mixture compositions are discussed. It is suggested that, in spite of these drawbacks from a fundamental point of view, it could be used as an empirical indicator test for mixtures such as sheet asphalt or sand carpets.

Paper No. 183 "Prestressed Concrete Bridge across the Mahi River at Vasad on National Highway—Delhi—Ahmedabad—Bombay" by V. B. Manerikar and I. K. Naik.

The Paper describes the construction of a bridge with 16 spans of 110 ft centre to centre of piers. An important feature of the bridge is the 66 ft high pier above the river bed and the consequent difficulties in construction. The superstructure consists of two I-section precast prestressed (Lee McCall system) concrete beams. The deck is of R. C. C. slab cast-in-situ, 9 in. thick. The girders were cast on the bank and launched into position by utilizing previously launched girders to carry the rail track. Details of the foundations, construction of piers, precasting of the girders, prestressing and launching the girders into position, and detailed design calculations for the girders are given.

Paper No. 184 "Specifications for Surface Dressing Water-bound Macadam—Critical Notes" by K. C. De and P. N. Sen Gupta.

The use of medium sand for blinding the first coat of surface dressing water-bound macadam is advocated. It is claimed that a good waterproof mat which effectively seals the ingress of moisture into the macadam is formed by this means. Also, when the second coat is blinded with stone chips, the sand mat formed in the first coat, it is claimed, increases the bearing capacity of the stone chippings because of the elastic nature of the supporting area.

Paper No. 185 "Glossary of Highway Engineering Terms and Hindi Equivalents" by Specifications & Standards Committee of the Indian Roads Congress.

This Paper gives definitions of road engineering terms relating to plant, machinery and traffic. Hindi equivalents for the various terms used in road engineering are also included.

This paper will not come up for discussion.

Paper No. 186 "Fact Finding Survey and Highway Planning in Uttar Pradesh" by P. N. Srivastava.

This paper describes how in Uttar Pradesh data for preparing a Master Plan for road development are collected. The data were gathered for each district of the State. The Paper gives details of how this was done for the Barabanki district. The data collected were analysed with a view to find out that network of roads which gave the maximum utility in respect of productivity and population. Details of how a master plan for the district using the data collected has been evolved for the state are also given.

Paper No. 187 "Importance of Traffic Engineering in India" by Dr. R. K. N. Iyengar.

This paper describes the condition of traffic obtaining on roads in India, in order to focus attention on the need for adopting modern methods to reduce accidents.

Paper No. 188 "Light Suspension Bridges in Himachal Pradesh" by A. J. D'Costa and T. S. Rupal.

A survey of light suspension bridges in Himachal Pradesh is made and standards for loading and widths of suspension bridges are suggested. A worked out example of a 200-ft light suspension bridge is given.

THE IMPACT OF ROADS ON AGRICULTURAL DEVELOPMENT

DESPITE the emphasis that is increasingly being placed in all parts of the world on improving food production, one important and closely related aspect of this problem, namely, adequate communications, particularly roads, is still being given less attention than it deserves.

Suitable roads are necessary for food production.

In the brief survey that follows are set forth many of the obstacles to efficient food production resulting from the lack of suitable access roads. The list is by no means exhaustive but the examples are given to illustrate the kind of problem that has to be overcome.

Many countries report that producers are constrained, through lack of farm-to-market roads, or by high freight charges resultant upon inadequate roads, to concentrate on certain crops only, not necessarily the most needed or even the most economic. The growing of perishable crops, in particular, is subject to these particular difficulties. In other countries, for example in India, a large acreage of the cultivable land is allowed to lie idle as much because of the lack of roads as because of the lack of water. However, while irrigation schemes are being given priority, no provision is being made for the building of the equally essential roads. In such circumstances planned agricultural production cannot be introduced nor can the land be put to the "best possible use" from the viewpoint either of national or world economy. Another instance of the hampering effect of inadequate road facilities is provided by the Gold Coast where most of the food now imported at great cost to feed the cocoa planters could have been grown in the hinterland if roads had been available to carry the produce.

Apart from the marketing of crops the transport of cattle in poorly roaded areas also presents serious problems. Where trucking is not practicable the alternatives of droving, or of carriage by rail, both lead to very considerable loss of weight and consequently to diminished yields and profits for the producer.

Roads are necessary for introducing efficient methods of farming.

Perhaps the most serious result of poor roads in agricultural areas is that farmers are prevented from introducing more efficient farming methods and new techniques. For instance, suppliers of agricultural machinery, tools, spares, maintenance mechanics, etc., may be unable to deliver to or visit the farms, or the use of combine harvesters and other heavy plant may be precluded because of difficulties of access. Moreover, the increased cost to the farmer arising from heavy freight charges due to inadequate access roads may drain away his reserves to such an extent as to make it financially impossible for him to effect needed improvements. In Egypt, Cuba, East Africa and India, in particular, this problem is a very real one. New Zealand, on the other hand, provides a useful object lesson in this respect; in that country, before modern roads were built, large areas of land were unproductive, but, with the coming of roads, the scientific application of fertilisers became possible and these same districts now rank among the most productive in the country. In New Zealand, also, the reclamation of marginal land in inaccessible hill country has only been made possible by the modern technique of aerial top dressings and here again roads are essential if the aeroplanes are to be kept supplied with manures.

Another problem which faces the producer—the control of disease—is made difficult, if not impossible, when road communications to the farm are inadequate. In addition, measures to eradicate insect pests, where speed is essential, may for the same reason be rendered ineffective. Other hindrances to efficient farming, namely inadequate labour supplies and absentee landlordism, are exacerbated where road communications are poor. Better rural roads are essential also if the drift to the towns is to be arrested since roads make possible the enjoyment of increased amenities, educational and social, by the rural labourer, making him a more efficient worker. In parts of Africa and India even such facilities as banks are often inaccessible to rural workers, and this lack contributes both to the manpower problem and to the lack of economic development. Again, efficient production is dependent on healthy manpower—in the rural communities where roads do not exist medical facilities cannot exist either. Consequently, if the rural areas are to be developed, roads are essential to ensure a healthy, adequate and mobile labour force.

However, an adequate road network cannot play its full part unless the utmost endeavour is likewise made to ensure cheap road transport, without undue restrictions. It will only be when both these aspects are taken care of that the drive for increased production will reach its maximum power and that the agricultural potentialities of each country can be utilised to the full.

BENEFITS DERIVED FROM ROAD DEVELOPMENT

NEWZEALAND

The difficulties described give some idea of the size of the problem. By way of contrast, it is profitable to consider the achievements of a country where rural roads have not been neglected. In New Zealand, before modern roads were built, all the difficulties described were met with, yet with the coming of roads these problems disappeared and New Zealand's agricultural output has increased markedly—indeed, one well-known economist pointed out some years ago that the dairy industry was largely the creation of road transport. The importance of road development as a factor in increased farm production is illustrated by the following figures:

Year	Total milage of roads	Milage of dustless surfaced roads	Production index
1930	49,121	2,086	100
1940	53,086	5,355	123
1953	55,463	8,961	152

NICARGUA

In Nicaragua, an increased road network has led to substantial agricultural development as can be seen from the fact that in 1940, when there were, only 20 kilometres, 15 miles of roads, there were six farm tractors in use, whereas in 1951, when the road milage had increased to 900 kilometres, 600 miles, there were 1,200 tractors.

MEXICO

The Mexican Roads Association has realised the need for farm roads in the national economy and estimated that 80,000 miles of farm-to-market roads are required; already the Association is responsible for having built some 3,000 miles of such roads since 1950. It is significant that, as a result of this policy, in some areas as much as 25 per cent more land is under cultivation, corn production has increased six-fold and the fruit crop has trebled.

AFRICA

In Africa, where the development of transport is in its beginnings, to quote from the F.A.O. Report of August 1954, entitled "The State of Food and Agriculture, 1954", "The remarkable expansion of exports during the past 50 years has gone hand in hand with the development of transport and this is still the essential basis for future progress ... Transport improvements are also essential for the integration of the subsistence producer with the rest of the economy ... Roads are required to link the hinterland with the more developed areas based on the export of agricultural and mineral products so that it becomes profitable to produce a surplus of food crops for sale."

(Continued on page 11)

FILLING AND SEALING MATERIALS FOR JOINTS IN CONCRETE ROADS

INTRODUCTION

JOINTS in concrete road slabs are required to relieve the stresses developed in the slabs by temperature and moisture changes. They form breaks in the continuity of the road and are filled with jointing materials. Such materials must:

(a) Permit expansion and contraction of the concrete.

(b) Prevent the passage of water down the joint, which might soften the subgrade and undermine the slabs, or might cause frost heave.

(c) Prevent the entry into the joint of grit which, if trapped, would cause spalling.

(d) Preserve an even riding surface.

In the earliest practice, joints were usually filled with a bituminous compound to the full depth, the compound being either poured hot into the joint or installed as a preformed strip during construction. Neither method was satisfactory since the bituminous material almost invariably extruded from the joint and very soon became quite ineffective in preventing the entry of water and grit.

TYPE OF JOINT

Three forms of joint are used in modern concrete roads; in all forms only the top inch or so is sealed. These forms are:

The expansion joint. Joints of this type, Fig. 1 a, are designed to accommodate both contraction and expansion of the concrete. A compressible preformed joint filler is installed when the concrete is laid, a slot 1 in. deep being provided above it to accommodate the sealing compound. This slot should not be less than $\frac{3}{4}$ in. wide.

The contraction joint. Such joints are designed to accommodate only contraction of the concrete in the butt joint Fig. 1 b. No joint filler is used, the two concrete faces being directly abutting. Slots about $\frac{3}{4}$ in. wide and 1 in. deep are provided at the top of the joints to contain the sealing compound.

The dummy joint, Fig. 1 c, is a special form of contraction joint. Under some circumstances it may be desirable to control the cracking of concrete slabs by forming planes of weakness or dummy joints. These consist of slots in the concrete one-third to two-fifths the depth of the slab. The slots are usually formed in the top of the slab and are in this case filled with sealing compound. Deep dummy joints may be packed to within 1 in. of the surface with sawdust or other caulking material, using sealing compound only in the top inch of the joint, thus reducing the quantity of sealing compound required. After cracking has occurred, joints of this type function as contraction joints. They are used as such in "continuous" construction.

SPACING AND WIDTH OF EXPANSION JOINTS

The factors affecting slab movement vary so much that no method has yet been developed for calculating the spacing required between joints from a knowledge of the characteristics of the concrete and the subgrade. It is still largely a matter of experience. Table 1 gives joint spacings recommended, as being suitable for most of England and Wales, by the Committee for Co-operative Research with the Cement and Concrete Association. In places where the climate is cool, equable and damp, spacings may be increased by 50 per cent,

Table 1

Spacing of Joints

Thickness of slab (in.)	Whether reinforced	Maximum spacing of expansion joints (ft)		Spacing of dummy joints or contraction joints (ft)
		Summer construction	Winter construction	
6 and 7	Unreinforced	90	45	15
8 and 9	do	120	60	15
6 and 7	Reinforced*	120	60	30—40
8 and 9	do	150	60	50—60
20 to 12	do	180	60	60

The width of expansion joints should be selected according to the spacing of the joints. If the joint spacings given in Table 1 are used, the expansion joints should be $\frac{3}{4}$ in. to 1 in. wide.

If expansion joints are more closely spaced the joints may be narrower. For instance, where expansion joints are 30 ft apart, joints constructed in winter need only be $\frac{1}{2}$ in. wide, and in summer they may be reduced to $\frac{3}{8}$ in. In all cases the top inch of the joint should be at least $\frac{3}{4}$ in. wide to accommodate the sealing compound.

Properties Required

Preformed joint fillers are rigid or semi-rigid strips of compressible material of a specified thickness and depth. They are used only in expansion joints and are placed in the concrete at the time of construction, their principal function being to provide the required gap between the slabs. They also provide a support for the sealing compound.

To function properly a preformed joint filler should be :

(a) Compressible without extrusion.

(b) Elastic so that after compression it recovers when the joint opens.

These properties are characteristic of material of cellular structure, and all materials found suitable have been of this type. Such materials are compressible and usually recover most of their thickness after compression. Some falling off in the recovery after repeated loading can be tolerated provided the joint is kept sealed to prevent the entry of grit.

Standards are available in America which include laboratory tests to assess the compressibility of preformed joint fillers and their recovery after compression. Such tests provide a useful guide to the properties of joint fillers when new, but may fail to identify fillers that will deteriorate after several years in the joint. In any event the joint fillers available can be readily classified by inspection into different types, each type having well-defined properties such that the engineer will have no difficulty in selecting the type of filler most suitable for his needs.

Types of Preformed Joint Filler

The following materials, all of cellular structure, have been used satisfactorily as preformed joint fillers :

(a) Softwood

(b) Impregnated fibreboard

(c) Cork

(d) Cellular rubber

* "Reinforced" means containing at least sufficient reinforcement in a longitudinal direction to control cracking, i.e., to prevent the opening of cracks. The minimum amount of reinforcement required to do this is not known, but experience indicates that it would be at least 7 lb per sq. yd. If 10 lb per sq. yd. or more is used, the dummy joints may be omitted.

Softwood.—This material has been found to be one of the most satisfactory joint fillers. It is compressible and shows reasonably good recovery partic ularly when damp. The precaution of soaking before when installation is not necessary as the stresses which could be developed in the concrete by filler swelling in the joint are not dangerously high. Such swelling is indeed an advantage in that it helps to ensure that the filler occupies the full width of the joint at all times. In the United Kingdom there appears to be little value in treating the wood to prevent rotting, as there are instances of untreated wood remaining in good condition after 20 years. Wood that is to be used as a preformed joint filler should be free from knots.

On lightly-trafficked and footpaths where the chief source of trouble at the joints arises from the entry of grit, causing spalling, softwood may be used to fill the joint completely without the use of a sealing compound.

Impregnated Fibrewood.—Materials of this type consist of compressed wood fibreboard impregnated with either a tar distillate, such as creosote oil, or a light cutback bitumen. These materials are compressible and show reasonably good recovery.

Cork.—There are several types of cork preformed joint filler. Some are made of strips of cork cemented together, others of granulated cork bound with rubber or resin. Granulated cork bound with rubber is a particularly tough material which retains its elastic properties even after a long period of use. Like softwood, it can be used on lightly-trafficked roads and footpaths to fill the joint completely without any sealing compound. All other cork fillers should be used with a sealing compound to prevent damp and grit entering and causing the filler to deteriorate.

Cork joint fillers are compressible and recover well after compression. An exception is the case of cork granules bound with bitumen. Joint fillers of this type flow when compressed, and extrude from the joint; their use is not recommended.

Cellular rubber.—Two types of cellular rubber are used as joint fillers—sponge rubber, in which the air cells are interconnected, and expanded rubber, in which each cell is completely enclosed by rubber. Both natural and synthetic rubbers are used ; some materials made with natural rubber swell in the presence of water, particularly in the sponge-rubber form. Of the examples examined, those made with synthetic rubber were not affected by water.

Cellular-rubber fillers are easily compressed and show complete recovery after compression. They are very flexible and because of this require special support during placing. A further effect of this extreme flexibility has been found on some heavily trafficked roads, where the sudden vertical movements at the joints under traffic cause the material to work up out of the joint. This effect has not been found on lightly trafficked roads such as on housing estates.

(To be continued)

(From 'Road Note No. 7', Road Research Laboratory, Department of Scientific and Industrial Research).

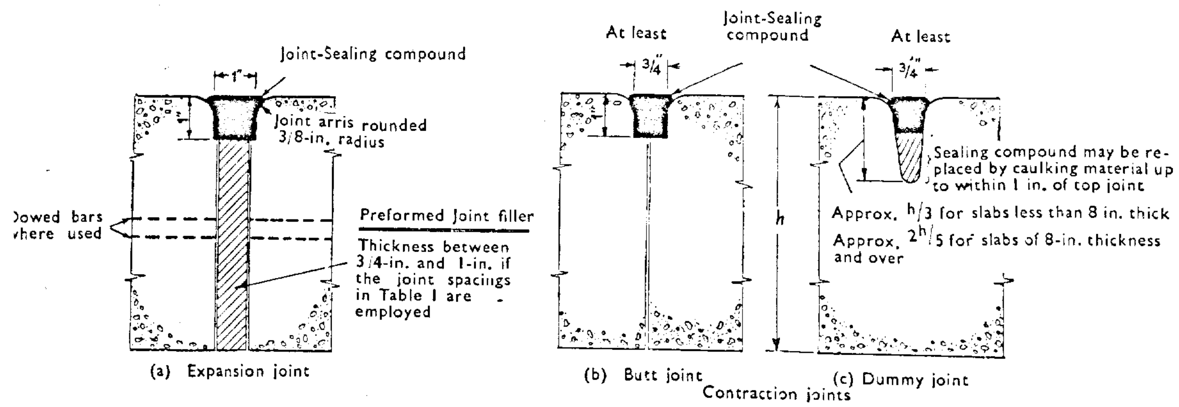


Fig. 1. DIMENSIONS OF SIMPLE JOINTS OF DIFFERENT TYPES

HORIZONTAL AND VERTICAL ALIGNMENT

THE physical controls or influences which act singly or in combination to determine the type of alignment are topography and subsurface conditions, existing highway and cultural development, likely future development, and the location of highway terminals. The control of assumed design speed affects also the general location of the highway, but as design proceeds to more detailed alignment and profiles it assumes greater importance. Design speed exerts an influence on design by limiting certain conditions of horizontal alignment and profile. The influence of design speed on the over-all character of alignment is not specific, as it is on curvature, gradient, sight distance and superelevation. It is, rather, a general control calling for greater care to obtain a well-co-ordinated, flowing alignment for highway design speed.

Horizontal alignment and profile are among the most important design elements of the highway, and warrant the most thorough study.

Horizontal and vertical alignment should not be designed independently. Each is the complement of the other, and poorly designed combinations of vertical and horizontal alignment can spoil the good points and aggravate the deficiencies of each. Excellence in the design of horizontal alignment, profiles, and their combinations improves appearance, encourages uniform speed, and increases safety, almost always without additional cost.

It can only be obtained by careful study of specific controls and attention to the following general principles.

(i) A proper balance between curvature and grades should constantly be sought. Tangent alignment or flat curvature, at the expense of steep or long grades, and excessive curvature with flat grades are both poor design. What the designer must strive for is a logical compromise between the two which will offer the most in safety, capacity, ease and uniformity of operation, and pleasing appearance within the practical limits of terrain and area covered.

(ii) Vertical curvature superimposed on horizontal curvature, or vice versa, should be analysed carefully for effects upon traffic. By superimposing one upon the other a more pleasing design generally results. Vertical changes are less pronounced in appearance and successive changes in profile are hidden from view when they occur in combination with horizontal curvature. This is particularly true for a rolling profile, where tangent alignment may show up as a series of humps visible to the driver for some distance ahead. Apart from unattractiveness, a rolling profile often results in dips which hide a vehicle from an approaching driver who, reasonably, assumes that the road is clear for passing when he sees no approaching vehicle for a great distance. The use of horizontal and vertical alignment in combination may result in hazardous arrangements, which should be avoided as discussed below.

(iii) Sharp horizontal curvature should not be introduced at or near the top of a pronounced summit vertical curve. This condition is hazardous in so far as the driver cannot perceive the horizontal change in alignment, especially at night when the headlamp beams diverge from the roadway surface. To alleviate the hazard of this arrangement it is helpful if the horizontal curvature, leads the vertical curvature i.e., if the horizontal curve is longer than the vertical curve.

(iv) Akin to the above, horizontal curvature should not be introduced at or near the low point of a pronounced sag vertical curve. Because the road ahead at this point is fore-shortened and vehicular speeds especially of trucks, are often high at the bottom of grades, a dangerous situation may be created, especially at night.

(v) Where vertical curvature is superimposed upon horizontal curvature, either or both should be designed above the minimum required for the design speed.

(vi) Horizontal curvature and profile should be made as flat as possible at highway intersections where sight distance along both highways is important and vehicles may have to slow down or stop.

(vii) On divided highways, variation in the width of median and the use of separate profiles and horizontal alignment should be considered to derive the design and operational advantages of one-way highways. Vehicles operate in one direction only at a time, and where traffic justifies the provision of 4 lanes, a superior design, without additional construction cost, generally results from thinking and designing on the logical basis of one-way roadways.

The co-ordination of horizontal and vertical alignment should not be left to chance. Study should begin with the preliminary design, a stage at which adjustments can be readily made. Whilst a specific order of study for all highways cannot be made, a general procedure applicable to most cases can be outlined. It is, first, important that the designer should use working drawings of a size, scale, and arrangement that will enable him to study long, continuous stretches of highway in plan and profile and to be able to visualise the whole in three dimensions. The working drawings should be of such a scale, say 1 in. = 100 ft or 1 in. = 200 ft, plotted jointly with the profile, so that this can conveniently be done. By this means, adjustments can be made to either horizontal or vertical alignment to obtain the desired co-ordination. At this stage, it is only necessary to consider major controls and not to be concerned with other calculations. This study should be made largely by graphical analysis. The criteria and design controls previously established should be available and checked graphically. In this way all aspects of terrain, traffic operation, and appearance can be studied before costly and time-consuming calculations and the preparation of constructions plans to larger scales is begun. An experienced designer can usually visualise the outcome of his work at this stage, though it may be necessary to supplement this procedure by models or perspective sketches at points where the effect of certain combinations of line and grade is questionable.

(From 'Roads and Road Construction,' August 1955).

(Continued from page 6)

FUTURE NEEDS

Much, however, remains to be done. Even where it is recognised that the national highway system is of vital importance the needs of rural communities are not necessarily taken into account. An example of this is Iraq where a large scale highway programme has been initiated, but where the problem of feeder roads has not, as yet, been given the attention it deserves. This is the more remarkable in that irrigation and flood control schemes are being inaugurated with the aim to increase food production. Without feeder roads, however, there is little possibility that the means will be available to move the extra produce resulting from such schemes.

Logically, transport development and maximum land utilization are two aspects of increased food production. By coordination between the Food production organisation and the planning of roads, the country will be in a better position to achieve the ultimate objective of increased standards of living for all countries.

(From "World Highways International Road Federation," London, June, 1955).

EFFECT OF METHODS OF USING SMALL VIBRATING SCREEDS ON THE DEPTH OF COMPACTION OF CONCRETE

RECENT experiments have shown that if a concrete road slab is to be fully compacted, the correct surcharge must be provided, i.e. the height above the forms to which the concrete is spread must be correct. Hand-operated vibrating screeds, however, are generally made so that the vibration causes the screed to slide along the forms during the finishing pass and, in practice, the screed is often used in this way for the compacting pass as well, in order to reduce the amount of work. When the vibrating beam is of normal rectangular section experience has suggested that such an arrangement causes some of the surcharge to be screeded off, which results in poor compaction at the bottom of the slab.

It was considered desirable, therefore, to examine whether the beam could be adapted in any way so that full compaction in a slab 8 in. thick could be achieved when it was allowed to slide along the forms or whether it was essential for the beam to be moved along in steps and lifted on to the uncompacted concrete at each step. The modifications included the provision of some form of leading edge or the use of the beam at an angle to the vertical so that its front edge was above form level.

The tests

The methods of using the vibrating screed are shown diagrammatically in Fig. For the first two tests the screed of normal rectangular section was allowed to slide along the forms and was used as follows:

1. A single pass.
2. Two passes, additional concrete being spread on the compacted surface between the passes. For five tests the screed, modified as described below, was allowed to slide along the forms for one pass.
3. The beam was fitted with a half round toe consisting of a $1\frac{3}{4}$ in. dia. pipe cut in half lengthways.
4. The beam was fitted with a leading edge, 3 in. wide, which was $\frac{3}{4}$ in. above the forms at the front.
5. A leading edge similar to that used in test 4 was fitted, but in this case it was $1\frac{1}{2}$ in. above the forms at the front.
6. Wooden wedges were attached to the rear of the beam above the forms so that it was supported with the front edge $\frac{3}{4}$ in. above form level and the rear edge in contact.
7. Similar wooden wedges were used so that the beam was supported with the front edge $1\frac{1}{2}$ in. above the forms.
8. The screed of normal rectangular section was moved forward in steps equal to one half its width; at each step it was lifted on to the spread concrete and allowed to vibrate until the ends were in contact with the forms.

Results

When only one pass was made with the normal rectangular beam running along the forms (test I) the concrete was well compacted only for the top 1 in. and below this the density steadily decreased until at the bottom of the slab the concrete was almost uncompacted. When the beam was moved in steps and lifted on to the spread concrete at each step (test 8) the concrete was well compacted for the full depth of the slab. All the other methods of using the beam gave results about midway between these extremes. A slightly greater depth of good compaction appeared to be achieved when the leading edge was $1\frac{1}{2}$ in. high (test 5) or when the beam was tilted so that the front was $1\frac{1}{2}$ in. above the forms (test 7) than when the height of the leading edge or the tilt was less (tests 4 and 6) but the difference was small.

The small differences between the results when the screed was modified in various ways (tests 3 to 7) were examined more closely by calculating the equivalent depth of good compaction for each core from each slab. This equivalent depth of good compaction was obtained by measuring the area bounded by the density depth curve for the core, the density of uncompacted concrete and the top and bottom of the slab, and dividing this figure by the difference between 98 per cent of the theoretical maximum density which could be achieved and the density of uncompacted concrete. The value of 98 per cent of the theoretical maximum density was chosen because experience has shown that with the materials used in these tests this value is rarely exceeded so that the surcharge used in the tests was determined on this basis.

From the depth of good compaction of the cores the average depth of good compaction in each slab and the standard deviation were determined; the results are given in Table. An analysis of these results showed that any of the modifications of the use of two passes of the normal rectangular screed gave better compaction than one pass of the normal screed but gave poorer compaction than that obtained when the screed was lifted. There was, however, no significant difference between the results when the screed was modified in different ways or when two passes were used.

Thus in order to obtain full compaction in a slab 8 in. thick, a hand-operated vibrator must be moved forward in steps and lifted on to the spread concrete at each step. Allowing for the additional depth of compaction produced by some reflection of the vibration from the base, a slab 6 in. thick would probably be fully compacted in one pass with the vibrator running on the forms if the vibrator were tilted or fitted with some form of leading edge. In practice the vibrator is difficult to handle when tilted and a leading edge is preferable. Of the two forms of leading edge examined the half round toe has been found to be of more assistance during the finishing pass and is probably the better form. If no leading edge is provided at least one extra pass of the vibrator is necessary in order to achieve the same amount of compaction; this will result in reduced output and increased costs.

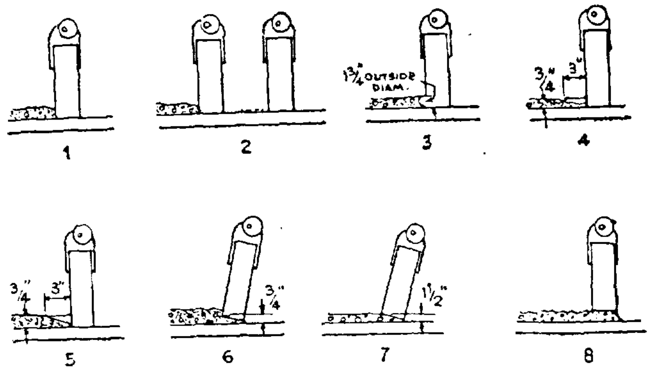
The conclusions of the tests are given below:

(1) To obtain full compaction in a slab 8 in. thick the vibrator must be moved forward in steps and lifted on to the spread concrete at each step.

(2) Full compaction in a slab 6 in. thick can be obtained if the vibrator is tilted or is fitted with some form of leading edge and allowed to slide along the forms. The most practical arrangement appeared to be the provision of a half round toe on the leading edge.

(3) If no leading edge is provided and a plain rectangular beam is used a second pass of the vibrator will be required as well as a finishing pass in order to obtain full compaction of a slab 6 in. thick, with a consequent reduction in output and an increase in cost.

(From "The Surveyor" 7th August, 1954.)



Diagrammatic arrangement of screeds in tests 1-8.

TABLE

The Equivalent Depth of Good Compaction

Test	Method	Equivalent depth of a good compaction in.	Standard deviation in.
1.	One pass of rectangular screed sliding on forms ...	5.48	0.54
2.	Two passes of rectangular screed sliding on forms ...	6.51	0.10
3.	Screed fitted with half round toe and sliding on forms ...	6.22	0.40
4.	Screed fitted with $\frac{3}{4}$ in. high leading edge and sliding on forms ...	6.48	0.53
5.	Screed fitted with $1\frac{1}{2}$ in. high leading edge and sliding on forms ...	6.83	0.37
6.	Screed tilted with front edge $\frac{3}{4}$ in. above forms and sliding on forms ...	6.65	0.40
7.	Screed tilted with front edge $1\frac{1}{2}$ in. above forms and sliding on forms ...	7.14	0.54
8.	Screed moved in steps and lifted at each step ...	8.08	0.25

VISCOUS THEORIES OF CREEP IN CONCRETE

THERE are a number of theories put forward to explain the phenomenon of concrete. The viscous theories assume the creep in concrete to be of the form of viscous flow with movement of particles, one over the other.

According to Thomas[1], concrete consists of two parts: (a) cementitious material, which behaves in a viscous manner when loaded, and (b) inert aggregate, which does not flow under load. When the concrete is loaded, the cement flow is resisted by the presence of the aggregate, and as a result of this resistance the aggregate becomes more highly stressed while the stress on the cement decreases with time. Now, since the creep of cement is proportional to the applied stress, the rate of creep will be progressively reduced as the load is transferred from the viscous to the inert material. Hence, Arnstein and Reiner[2] infer that the rate of creep should depend *ceteri paribus*, on the nature of the cement but not on the nature of the aggregate. The author believes, however, that the magnitude of the deformation will, under the circumstances, also depend on the modulus of elasticity of the aggregate, and may be affected by the creep of the aggregate itself, in view of the high stresses induced in it.

Arnan, Reiner, and Teinowitz[3] recognise part of non-elastic strain in concrete as delayed elasticity but consider the true creep to be viscous in nature. Arnstein and Reiner compare creep of concrete with the behaviour of a sand-water mixture. There, the angle of repose increases as water is added to dry sand. This continues up to an optimum water content above which an increase in the water content results in a decreased angle of repose. The aggregate is assumed to correspond to the sand, the cement paste to the water, and the rate of creep to the angle of repose. Arnstein and Reiner further assume an analogy between viscous flow and elastic strain, and take the co-efficient of viscosity to correspond to the modulus of rigidity in their calculations. Neat hardened cement is, according to them, a very viscous liquid, whose viscosity "stands roughly in the same relation to the viscosity of pitch as the viscosity of pitch to the viscosity of water." Since hardened cement paste is known to be partly crystalline, this statement can be regarded only as representative of the magnitude of the movements of the three materials under stress.

Reiner[4] explains creep on the assumption that cement actually flows, the aggregate forming an inert suspension. But the creep of neat cement can be as much as 15 times as great as the creep of 1:6 concrete under similar conditions, and the rate of creep of neat cement has been observed to be twice that of a 1:3 mortar[2]. If the aggregate were purely inert it would decrease the creep of neat cement numerically in proportion to the aggregate-cement ratio. Thus it appears that the action of the aggregate in resisting creep cannot be ignored, the aggregate has, in fact, a considerable influence on the magnitude of creep[5].

It may be noted that any form of viscous flow would require a constant volume condition of the concrete. As shown earlier, the volume of concrete changes with time under sustained loading, and the viscous flow cannot, therefore, be responsible for all creep.

From the fact that the volume of concrete specimens under a constant load decreases with time, Reiner[6] infers that creep is the case of volume or isotropic flow. Experimental evidence, however, shows that the lateral pressures required to maintain constant lateral dimensions of sealed concrete specimens under constant axial load, decrease rapidly in the first few days after loading and more slowly in the later stages. And though for constant lateral dimensions the creep is directly proportional to the decrease in volume of the specimen, Davis, Davis, and Hamilton[7] found that the axial creep

under conditions of constant lateral dimensions is of the same order of magnitude as the creep observed in an identical concrete specimen free to move laterally. Thus there is little to substantiate the isotropic flow theory of creep.

REFERENCES

1. Thomas, F. G., "Creep of Concrete Under Load," *International Assn. of Testing Materials*, 1937.
2. Arnstein, A., and Reiner, M., "Creep of Cement, Cement-Mortar and Concrete," *Civil Engineering and Public Works Review* (London), V. 40, 1945, pp. 198-202.
3. Arnan, M. A., Reiner, M., and Teinowitz, M., *Research on Loading Tests of Reinforced Concrete Floor Structures*, Research Council of Israel (Jerusalem), 1950, pp. 52.
4. Reiner, M., *Deformation and Flow*, H. K. Lewis, London, 1949.
5. Davis, R. E., and Davis, H. E., "Flow of Concrete Under Sustained Compressive Stress," Proceedings, ASTM, V. 30, 1930, pp. 707-730.
6. Reiner, M., "On Volume — or Isotropic Flow as Exemplified in the Creep of Concrete," *Applied Scientific Research*, V. A1, No. 5-6, 1949, pp. 475-488.
7. Davis, R. E., Davis, H. E., and Hamilton, J. S., "Plastic Flow of Concrete under Sustained Stress," *Proceedings*, ASTM, V. 34, 1934, pp. 354-386.

(From 'Journal of the American Concrete Institute, September, 1955').

DEFINITIONS OF HIGHWAY ENGINEERING TERMS

BASE EXCHANGE: A property by virtue of which certain minerals, notably the Zeolites can exchange ions of, say calcium for sodium, magnesium, potassium, or any element of the alkaline earth group, when in a suitable environment.

BINDER: The fine cohesive soil (clay) fraction inherent in or added to sandy and gravelly soils.

FRUIT OF PERSONAL EXERTION

A good character is, in all cases, the fruit of personal exertion. It is not inherited from parents; it is not created by external advantages; it is no necessary appendage of birth, wealth, talents, or station; but it is the result of one's own endeavours—the fruit and regard of good principles manifested in a course of virtuous honourable action.

J—HAWES.

STATISTICAL ANALYSIS OF LIQUID LIMIT AND PLASTICITY INDEX DATA RELATING TO PUNJAB SOILS

By

L. R. Chadda and A. P. Jerath

Plasticity index of a soil is the numerical difference between Liquid Limit and Plastic Limit and represents the range within which the soil remains plastic. Its value is not only related to Liquid Limit, but is also largely influenced by sand content present in a soil. Efforts have been made in the laboratory to find out an algebraic relation between P. I., L. L. and sand content for Punjab soils. The statistical study of the data has revealed good correlation of P. I., with Liquid Limit and sand content. The relationship between these 3 characteristics of the soil is given by the equation:—

P. I. = 3.4 + 0.35 L.L. − 0.09 (sand per cent)

The above equation was applied to soil analysis data collected from various roads in Punjab likely to be constructed in stabilized soil. Applying the test of significance to the observed and calculated values of P. I., the value of 't' was found to be 0.0234. This value of 't' is non-significant, proving that the calculated values agree well with the observed ones. This testifies the 'goodness of fit' of the equation given above. Results of observed and calculated values are given in Table I.

Table I

Relationship between P.I., L.L., and sand content*

Sample No.	Locality	Liquid Limit	Sand content	P. I. (observed) Y_o	P.I. (calculated) Y_c	$(Y_o - Y_c)$
1	Batala Khanu-wan Road	31.2	17.9	13.1	12.7	.4
3	,,	30.8	18.1	12.9	12.6	.3
5	,,	32.2	13.6	14.0	13.5	.5
7	,,	25.6	45.1	9.1	8.3	.8
9	,,	23.9	42.5	7.5	8.0	−.5
11	,,	36.4	7.2	16.1	15.5	.6
13	,,	33.4	11.1	14.9	14.1	.8
15	,,	35.1	8.0	16.1	15.0	1.1
17	,,	32.4	14.9	13.8	13.4	.4
19	,,	36.9	5.5	16.3	15.8	.5
21	Nawanshar Chak-dana Road	31.1	20.0	13.7	12.5	1.2
23	,,	20.9	60.1	4.6	5.3	−.7
25	,,	20.6	54.1	5.1	5.7	7.6
27	,,	20.4	64.0	2.1	4.8	−2.7
29	,,	22.1	56.1	6.1	6.1	—
31	,,	22.7	47.5	6.6	7.1	−.5
33	,,	23.5	49.0	7.3	7.5	−.2
35	,,	20.3	62.1	3.9	5.0	−1.1
37	,,	25.5	44.1	9.1	8.4	.7

* Particulars relating to nearly 105 samples are given in the Original. Interested readers may obtain this from Secretary, Indian Roads Congress.

Sample No.	Locality	Liquid Limit	Sand content	P. I. (observed) Y_o	P. I. (calculated) Y_c	$(Y_o - Y_c)$
39	Sonepat Gohana Road	33.8	20.9	12.3	13.4	−1.1
41	,,	31.7	17.8	11.8	12.9	−1.1
43	,,	32.8	15.1	11.9	13.5	−1.6
45	,,	30.5	22.8	10.3	12.0	−1.7
47	,,	28.8	24.3	11.7	11.3	.4
49	,,	31.9	26.2	12.3	12.2	.1
51	,,	28.8	32.8	8.7	10.5	−1.8
53	,,	29.0	28.9	10.3	11.0	−.7
55	,,	24.7	33.1	7.1	9.0	−1.9
57	,,	25.7	36.9	7.3	9.1	−1.8
59	,,	25.9	44.8	6.8	8.4	−1.6
61	,,	45.5	4.7	19.2	18.9	.3
63	Colony Roads Rewari	23.5	46.0	7.3	7.5	−.2
65	,,	23.9	49.2	8.0	7.3	.7
67	,,	24.3	49.0	7.0	7.1	−.1
69	,,	25.1	42.5	8.9	8.4	.5
71	,,	25.4	34.5	8.8	9.2	−.4
73	,,	25.4	31.9	9.6	9.4	.2
75	,,	25.9	34.8	9.2	9.3	−.1
77	Colony Roads Gurgoan	23.2	47.2	6.8	7.3	−.5
79	,,	23.2	48.4	6.7	7.2	−.5
81	,,	22.8	52.6	6.2	6.7	−.5
83	,,	24.6	46.9	8.4	7.8	.6
85	,,	24.5	40.0	9.5	8.4	1.1
87	,,	23.5	38.0	9.0	8.2	.8
89	Sonepat Gohana Road	23.3	45.0	7.7	7.5	.2
91	,,	24.6	34.0	9.7	8.9	.8
93	,,	25.1	35.0	10.3	9.0	1.3
95	,,	24.5	35.0	10.7	8.8	1.9
97	,,	26.8	40.0	10.0	9.2	.8
99	Colony Roads Rohtak	24.9	38.1	8.9	8.7	.2
101	,,	25.9	40.0	9.2	8.9	.3
103	,,	25.1	29.5	10.1	9.5	.6
105	,,	24.1	41.0	8.8	8.2	.6

The above equation is an improvement over that worked out by the P. W. D. Research Institute, Lucknow and is given as:—

P. I. = 0.8 (L. L. − 15)............(2)

Data relating the soil from Bhagewal-Kalaner Road was analyzed using equations (1) & (2). Values obtained showed that equation (1) gave closer values than equation (2).

References

(1) Statistical Methods for Research Workers by R. A. Fisher.

(2) Methods of Correlation Analysis by Mordecai Ezekiel.

(3) Annual Report for the year 1952-53, P.W.D Research Institute, Lucknow.

HERE AND THERE

1. MOTOR VEHICLE INCREASE AND ROAD DEVELOPMENT IN JAPAN

THE number of motor vehicles in Japan has arisen from 156,000 in 1946 to 1,300,000 in 1955. This tremendous increase in motor vehicles has made road improvement acutely necessary. As the first step, the Government inaugurated in 1954 a 5 year programme and designated the gasoline tax as a source of financing.

Regulations for a system of toll roads were established in Japan in 1952, with 30 completed or under construction since that time. These include an underwater tunnel connecting Honshu and Kyushu, and an arch bridge with the third longest span in the world.

Under another programme, Japan plans the construction of a 327 mile expressway between Tokyo and Kobe. Surveys and investigations for locating the route, which follows the Pacific Coast, are now under way.

(From 'World Highways International Road Federation,' London, August 1955.)

2. HOW OBJECTS ON SHOULDERS AFFECT DRIVERS

"SHOULDERS along a highway expedite traffic and contribute to driving comfort and safety. This study was undertaken to determine how driver behaviour is influenced by parked vehicles or other objects placed on shoulders at various distances from the outer edge of traffic lanes. The objects selected were a passenger car, a truck, and a barricade. Each was placed at the pavement edge 3 ft from the edge, and 6 ft from the edge. Passenger and commercial vehicle speeds and lateral positions were recorded on two-lane highways carrying light to moderate traffic volumes and on a four-lane divided highway carrying up to 3,400 vehicles per hour in one direction.

"For all vehicle types it was found that speeds were not affected significantly by objects on the shoulder. Such objects affected the lateral position of only those vehicles travelling in the adjacent lane. Objects placed at the pavement edge had the greatest effect and lateral shifts decreased sharply when objects were set 3 and 6 ft from the edge. The narrower the pavement, the further the traffic shifted left, away from the object on the shoulder. On a two-lane 16-ft highway, the shift was 3.3 ft, while on a 24 ft surface the shift was 1.8 ft. The various objects—car, truck, and barricade—caused about the same degree of shifting. On narrow two-lane roads, some vehicles shifted over the centre line when the object was placed at the pavement edge."

(From 'Roads and Streets', October 1955).

3. PRESTRESSED CONCRETE IN RUSSIA

A BRIEF description of the various anchoring devices and methods of stressing used in Russia is given below.

Pretensioning

Straight-line prestressing with bond-anchored wires is much the same as it is

in England. Special anchoring devices are used for the wires over 3 mm. in diameter to improve the bond between the wires and the concrete.

Post-tensioning

Two prestressing methods are employed in post tensioning: Korovkin cable, and continuous wire winding similar to the American "merry-go-round" system.

Korovkin Cable:—This method is used chiefly in bridge construction or in cases where long-span beams are involved. The cable contains from 20 to 65 wires 5 mm. in diameter which are arranged in concentric rings. The anchoring device comprises a short steel tube which is placed on a circular end plate. The end plate is provided with a threaded collar and a hole to receive the cable. When the wires are inserted through the hole they are held in position by a steel ring and a short rod, which is hammered in between the wires. The wires are then doubled back radially inside the tube which is filled with high-grade concrete. Special gripping devices are placed over the end plate collar and the cable is tensioned by a hydraulic jack. When the required extension has been gained, steel washers, the thickness of which varies between 2 mm. and 25 mm., are inserted between the end plate and the concrete.

Continuous Wire Winding:—A Precast unit is placed on a revolving table and is stressed by winding a tensioned wire around its core. Gunite concrete is applied to provide the cover. The method is applicable both to pretensioning and post-tensioning.

Further improvements could be made by developing prestressing in all directions and planes. This will permit the application of the method to be extended to space frames.

While experimenting with the new technique, an extensive study of tensile strength of concrete had been made by the Russian Central Institute of Scientific Research for Industrial Structures. The purpose of the research was to ascertain the true magnitude of tensile strain of concrete. Since the standard strain gauges give only the average values of deformations, a new method of testing was developed to investigate local strain.

If the hardened cement paste is tensioned together with some other elastic body, the deformation is of a more uniform character and consequently the strain is greater; this would ensure better co-operation between the prestressed units and the in-situ concrete.

Expanding agents exert a uniform pressure on the cement particles, ensuring a larger elongation without damage to the cement structure.

(From 'Highway Research Abstracts,' September 1955.)

4. SPANCRETE

SPANCRETE is a pretensioned floor and roof deck material that also has potential use as a wall panel. It consists of three layers, of which the two layers at the surface consist of wear resistant sand concrete while the bulk of the inner material consists of light-weight concrete. The use of light-weight concrete reduces the weight of the plank by about 5½ pounds per square foot.

The planks are prestressed with cold-drawn 0.120 in. diameter two-wire twist which is loaded to an initial tension of about 140,000 per sq. inch. Tests indicate that the surface concrete attains a strength of 4,000 per sq. in. in five days, and goes well into the 7,000 per sq. in. range in 28 days.

The planks are cast in thickness of 4, 6 and 8 inches.

(From 'Concrete'—October, 1955.)

strength of curing concrete in an absolutely or partially dry state. It is normal practice to keep concrete wet for four or five days after placing.

The results of the present experiments show, however, that as far as strength is concerned the curing can be done at any time. Thus if the concrete is allowed to become dry for a period and is then re-wetted, it will continue to increase in strength as though the dry period had never existed.

The experiment work was done in two parts, the first to find the effect of curing concrete in absolutely dry air, and the second in ordinary room atmosphere.

(Continued from page 20)

the analyzer, is placed in the light beam beyond the model. By rotating the polarizer and analyzer, the lines of principal stresses for various directions are obtained and may be used to draw "flow lines."

For plane stress models, a plastic known as CR-39 is the most convenient material to use, stated Prof. Smith. Celluloid, lucite and plexiglass, while cheap, are too insensitive optically. Another bakelite plastic, Catelin 61-893, is supplied in sheets and is suitable for stress freezing. For the study of earth dams or tunnels, gelatin is used. Fosterite, developed by Westinghouse, is a superior material with high optical sensitivity. The polarizer, analyzer, plate and diffuse light materials may be purchased for about 100 dollars. Commercial polariscopes range in price from 600 dollars to 5,000 dollars. Optics are usually purchased, but some of the other components may be home-made.

Sometimes stresses exist that are unsuspected until failures begin to appear. For example, surface tension stress was the cause of fatigue failures in railroad axles where the car wheels were shrunk to the shaft, until a combination of redesign and artificially reduced surface compression stress cured the trouble. The tension stress was shown up by the photoelastic method.

Many great stress problems remain that cannot be solved by the photoelastic method. In many instances this method may be of great assistance.

(I.W. Smith in his Paper "Photoelasticity for design Improvement"—Roads and Engineering Construction, August, 1955.)

Pol. Sc. Prof.: The Constitution of the Democratic Republic of India believes in the dignity of man and does not allow exploitation of man by man.

Student: Does it, then, Sir, allow exploitation of man by woman?

SELECTED RECENT LITERATURE IN ENGINEERING JOURNALS

XVI. TAR AND BITUMEN (INCLUDING SURFACE DRESSING)

1. **Close Control of Binder Distribution in Surface Dressing**; D. A. Robinson, *Road Tar*, March 1954, pp. 13-15.
2. **The Use of Tar in a Graded Stone Foundation, an Account of Roadwork Recently Completed on the Great North Road**; J. N. L. Sellick, *Road Tar*, March 1954, pp. 18-19.
3. **Rolled Asphalt Road Surfacing Materials**; A. W. Attwooll, *Roads and Road Construction*, April 1954, pp. 113-117.
4. **Rock Asphalt on City Streets**; *Contractors Record and Municipal Engineering*, April 4, 1954, page 10.
5. **Selection and Application of Surfaces for Trunk Roads**: *The Surveyor*, April 10, 1954, pp. 287-290, *Highways and Bridges and Engineering Works*, April 14, 1954, pp. 1-3 and 4.
6. **The Trinidad Asphalt Lake**; *Contractors Record and Public Works Engineer*, March 1954, pp. 21-24.
7. **Nomograph for Visco-Elastic Properties of Bitumen**, *Highways and Bridges and Engineering Works*, March 31, 1954, p. 9.
8. **Simple Procedure Against Asphalt Contamination during Shipment**; *Roads and Streets*, February 1954, pp. 75 and 99.
9. **Heater-Planer Used in Resurfacing Turnpike Settled Areas**; *Roads and Streets*, February 1954, pp. 76-77.
10. **Wire Mesh in Texas Overlay Job**; *Roads and Streets*, February 1954, pp. 78-79 and 81.
11. **Asphaltic Bitumen**; A. W. Jadman, *The Journal of the Institution of Highway Engineers*, April 1954, pp. 59-65.
12. **The Effect of Jet Aircraft on Airport Pavements; Investigations Conducted by the Corps of Engineers**; Gayle McFadder, *Separate No. 316, Proceedings of the American Society of Civil Engineers*, October 1953.
13. **Anti-Stripping Additives**: Frank D. Gans, *Western Construction*, March 1954, pp. 53-55.
14. **Studies of the Hardening Properties of Asphaltic Materials**; Jarl T. Pauls & J. York Welborn, *Public Roads*, August 53, pp. 187-202.
15. **Surfacing and Penetration Work with New Road Emulsion 'Lebigo' — Characteristics and Method of Using**; M. Roalet, *Strasse Und Verkehr*, December, 1953, pp. 462-463 (in French).
16. **The Selection and Application of the Running Surface of a Trunk Road**; J. McInnes, *Roads and Road Construction*, May 1954, pp. 150-151.
17. **Methods of Producing Rougher Road Surfaces**; *Strasse and Verkehr*, April 1954, page 166.
18. **Pitfalls and Pointers in Asphaltic Concrete Production**; J. Rogers Martin, *Roads and Streets*, May 1954, pp. 109-113, 119, 120 and 122.
19. **Stearine Amine Additive for Highway Works**; *Highways and Bridges and Engineering*, May 12, 1954, p. 4.

20. **Symposium on Asphalt Job Control**; *Roads and Streets*, May 1954, pp. 124, 127 and 128.

21. **Direct Density Test for Bituminous Mixtures**; *Roads and Streets*, May 1954, p. 129.

22. **Experimental Bases Designed to Meet Budgetary Limitations**; James G. C. Cooney, *Better Roads*, May 1954, pp. 21–23 and 36.

23. **Base Courses for Flexible Pavements**; *Better Roads*, May 1954, pp. 42 and 44.

24. **Low-Cost Dustless Surfacing for Secondary Roads**; J. R. Dougherty, *Highway Research Abstracts*, March 1954, pp. 25–32.

25. **Experimental Work on Adhesion in Coated Macadam**; L. C. Hopkins, *The Surveyor*, June 12, 1954, pp. 487–489.

26. **Determining Bitumen and Moisture Content of Bituminous Mixes by a New Field Type Extractor**; Ernest Zube, *California Highways and Public Works*, March-April 1954, pp. 30, 31 & 39.

27. **Emulsion Stabilised Shale Roads at Tynemouth**; *Highways and Bridges and Engineering Works*, June 16, 1954, p. 4.

28. **Design of Flexible Pavement—Problem of Bengal**; K. C. Ray, *The Civil Engineer*, 1953–54 (Bengal Engineering College, Sibpore, Howrah), pp. 5–16.

29. **Bituminous Maintenance Mixer in Calcutta**; *World Construction*, May-June, 1954 p. 25.

30. **Experimental Road Surfacings in Somerset**; *Highways and Bridges and Engineering Works*, July 7, 1954, pp. 1, 3 and 4.

31. **Actual Surfacing Problems**; *Strasse Und Verkehr*, July 1954, pp. 282–284 (in German).

32. **Solidification of Ungraded Gravel**; Walter Paganini, *Strasse Und Verkehr*, July 1954, pp. 285–287 (in French).

33. **Modern Concrete Technology**; J. Pachtold, *Schweizerische Bauzeitung*, July 24, 1954, pp. 433–437 (in German).

34. **Highway Construction Progress in Nigeria—Economic Saving of Surfaced Roads**; *Highways and Bridges and Engineering Works*, July 21, 1954, pp. 1 and 3.

35. **The Rapid Analysis of Asphalt Mixtures**; D. H. Bax, *Highways and Bridges and Engineering Works*, July 21, 1954, pp. 6 and 7.

36. **Method for Measuring Bitumen in Bituminous Material**: *Highways and Bridges and Engineering Works*, July 28, 1954, p. 9.

37. **Colorado Puts Rubber Roads to the Tests**: A. H. Bunte, *Western Construction*, July 1954, p. 60.

38. **Physico - Chemical Aspects of Adhesion in Road Industry**; *Th. Reis and M. Ceintrey*, La Technique Moderne Construction, June 1954–*Part-I*-Pages 171–178 (in French) and July 1954–*Part II* Pages 240–255 (in French)

39. **Precoated Materials**; R. David, *La Technique Moderne Construction*, June 1954–pp. 179–191 (in French).

40. **Asphalt Cements**; John M. Griffith, *Asphalt Institute Quarterly*, October 1953–pp. 10–11.

41. **Modernization with Asphalt in the North West**: Rodney P. Ryker, *Asphalt Institute Quarterly*, January 1954, pp. 4–5.

42. **Asphalt " Surrounds " Worn Concrete in Texas**; Hugh A. Wallace, *Asphalt Institute Quarterly*, January 1954–p. 6.

43. **Base Course and Bituminous Pavement Requirements**; W. J. Turnbull & O. B. Ray, *Separate No. 424-Proceedings of the American Society of Civil Engineers*, March 1954.

44. **Welded Fabric Reinforcement in Bituminous Resurfacing**: Norman G. Smith, *Highways and Bridges and Engineering Works*, August 11, 1954–pp. 6 and 8.

45. **Heat-Resistant Properties of Additives for Bituminous Materials**; *Highways and Bridges and Engineering Works*, September 8, 54, p. 11.

46. **Successful Surface Dressing Newport Works Superintendent's Formula for Achievement**; *Highways and Bridges and Engineering Works*, September 8, 54, p. 12.

47. **Seal-Coats Economical Usage**; W. R. Lovering, *Western Construction*, April 54, pp. 60–63.

48. **Some Characteristics of New Asphaltic Concrete Surfacings**; Dr. L. Deile, *Strassen Und Tiefbau*, August 54, pp. 431–434 (in German).

49. **Cold Bitumen, a New Binder Type for Winter Time**; Ewald Flister, *Strassen Und Tiefbau*, August 54, pp. 416–417 (in German).

50. **Concretes of Hydraulic and Hydrocarbon Materials**; M. Dariez, *Travaux-Part I—July 54*, pp. 593-602 (in French)

—Do – *Part II*-September 54, pp. 706–712 (—Do—).

51. **Rubber in Today's Bituminous Road Construction**: Jewell R. Benson, *Western Construction—Part I*—September 54, pp. 61-63.

52. **Heavy Flexible Pavement Base for Big Jets**; *Roads and Streets*, August 54, pp. 73-78.

53. **Developments in Present Day Flexible Type Pavements**; C. N. Conner, *Roads and Streets*, August 54, pp. 102-106.

54. **Getting a Good Lay-down on Asphalt Paving Work**; L. A. French, G. F. Helleroc and H. H. Haris, *Roads and Streets*, August 54, pp. 107–108.

99598

55. **A Review of Rubber in Roads**; A. R. Smee, *Roads and Road Construction*, October 54, pp. 310–312.

56. **Mechanised Spreading of Precoated Chippings on Cold Asphalt**; Lt. Col. S. Mayrard Lovell. *Surveyor*, October 9, 54, pp. 859-862.

57. **Cold Asphalt Not a ' Summer Only ' Surfacing Material**; William F. Rees, *The Surveyor*, November 6, 54, pp. 961–963.

58. **The Effect of Various Rubbers on the Properties of Petroleum Asphalts**; Richard H. Lewis and J. York Welborn, *Public Roads*, Vol. 28, No. 4, October 54, pp. 64–89.

59. **A Laboratory Study of Rubber-Asphalt Paving Mixtures**; Harry M. Rex and Robert A. Peck, *Public Roads*, Vol. 28. No. 4, October 54, pp. 91-98.

60. **Resurfacing Starts on Penn Turnpike**: *Engineering News Record*, October 21, 54, p. 39.

61. **Experience of the Recent Years with Bituminous Road Construction**; Dr. Skopnik—*Strassen Und Tiefbau*, October, 54, pp. 533-536 (in German).

62. **Photo electric Estimation of Binder / Aggregate Stripping**; B. V. Enustun, *Highways and Bridges and Engineering Works*, December 1, 54, p. 8

63. **Road Surfacing Experiments in Manchester**; *November 24, 54*, pp. 6 & 8. See also Roads and Road Construction, December 54, pp. 393–395.

Lee, Reprinted from the Journal of Applied Chemistry, 1953, pp. 62-70 (Road Research Laboratory, Middlesex, England) Acc. No. 001840.

18. "**Specifications for the Construction of Housing Estate Roads Using Soil-Cement,**" Road Research Road Note No. 15 (1953), (Road Research Laboratory, Middlesex, England). Acc. No. 001841.

19. "**Concrete Masonry Construction for Economical & Fire-Proof Building,**" Hindi edition No. 34 (Concrete Association of India, Queensway, (New Delhi). Acc. No. 001842.

20. **Thirty-fifth Annual Report of the Highways & Local Government Department, South Australia 1951-1952** (Highways and Local Government Department, South Australia, Adelaide), Acc. No. 001843.

21. "**Influence of Primary Creep on Stresses in Structural Parts**" **(No. 66, 1953)** by Folke K. G. Odquist (Kungl. Tekniska Hogskolans Handlingar, Stockholm, Sweden), Acc. No. 001844.

22. **Reprint from Proceedings of the United Nations Scientific Conference on the Conservation & Utilization of Resources, 17 August–6 September, 1949, Vol. IV, Water Resources** by A. N. Khosla (A. N. Khosla, Additional Secretary to the Government of India, Ministry of Irrigation and Power and Chairman C. W. and P. C., New Delhi). Acc. No. 001845.

23. **Thirty-ninth Annual Report of the Country Roads Board for the Year ended 30th June 1952 (1952-53),** (Country Roads Board, Exhibition Building Carlton No 3, Victoria), Acc. No. 001846.

24. **Some Economic Effects of Highway Improvement.** (H. R. B. Bulletin No. 67, (1953), (Highway Research Board, Washington, U. S. A.), Acc. No. 001847.

25. "**Wood Preservation**" by L. K. Arnold, R. E. Walker, Iowa State College Bulletin No. 174 (1953), Iowa State College, Ames Iowa, (U.S.A.), Acc. No. 001848.

26. "**Apparatus for Engineering Tests of Soils Asphalt Concrete Materials,**" (Soil Test, Inc. 4520, W. North Avenue, Chicago-39 Illinois, Acc. No. 001849.

27. B. S. 1579 : 1953. "**Connectors for Timber**" (British Standards Institution, 24, Victoria St., London S.W.I) Acc. No. 001850.

28. B. S. 1916 : Part I - 1953—"**Limits and Fits for Engineering**" Part I : Limits and Tolerances, (British Standards Institution, 24, Victoria St., London S. W. I.) Acc. No. 001851.

29. B. S. 1926 : 1953, "**Methods of Specifying Ready Mixed Concrete**" (British Standards Institution, 24, Victoria St., London, S.W.I.) Acc. No. 001852.

EXCHANGE

An old farmer, visiting town, came to a building bearing the words "Employment Exchange" and nearby "Women's Exchange." He entered and was met by the glare of a woman behind the counter.

"Is this the Women's Exchange?" he inquired.

"It is," scowled the woman.

"Oh," he said, "are you the woman?"

"Yes, I am."

"Thank you," he said, and turning to go, added, "I'll stick to my Martha."

BUDGETS AND ADMINISTRATION REPORTS

UTTAR PRADESH PUBLIC WORKS DEPARTMENT (BUILDINGS AND ROADS BRANCH) ADMINISTRATION REPORT CONSOLIDATED FOR THE YEARS 1948-52

The following is a brief Summary of the Public Works Department (Buildings and Roads Branch) Administration Report of Uttar Pradesh for the years 1948–52 with reference to communications.

The First-Phase Programme of Post-War Road construction started by the State Government in 1945–46 at an estimated cost of Rs 21.5 crores came to a standstill in August 1949 due to various difficulties and most of the post-war Roads nearing completion were left at an unfinished stage. It was only during 1951-52 that attempts were made to consolidate the work already done for which a sum of Rs 78.23 lakhs was provided by the Central Road Fund and Rs 6.0 lakhs by the State Government. At the end of March 1952 the progress attained was as follows :

		Miles
(1)	New metalled Road construction	
	(a) Completed up to Soling Coat Stage	1055
	(b) Completed up to inter-coat stage	832
(2)	Reconstruction of local roads	2100
(3)	Construction of Other District Roads and Village Roads	
	(a) Earth work	4593
	(b) Bridges and culverts	2503
(4)	Cement, Concrete tracks	
	(a) Earth work	405
	(b) Materials collected	139
	(c) C. C. Tracks	29

There are nine National Highways in the State covering 1497 miles of which 1396 miles lie outside Municipal limits and are financed by the Government of India.

During 1951-52 important road works taken in hand or completed in the year included work on National and State highways and the construction of a few roads under the Grow More Food and Jute Scheme.

In March 1952, there were 15,821 miles of roads maintained by the Public Works Department of which 8,491 miles were metalled and 7,330 miles unmetalled. The total expenditure on renewal and maintenance of provincial metalled roads during the year 1951-52 amounted to Rs 2,05,04,792 from the following sources.

Civil Works Provincial	Rs 2,04,98,012
Uttar Pradesh Road Fund	Rs 6,780
	Rs 2,05,04,792

The importance of bridge construction had already been well realised by the State which has a network of large rivers and the State had prepared designs for 26 bridges but much progress could not be made due to short supply of materials like steel, cement, timber, ballast, etc and difficulties of rail-transport. However, works on six major bridges were either completed or were in progress during 1951-52.

The expenditure incurred due to monsoon damages were as follows in the different years :

Years	Rs
1948-49	23,67,022
1949-50	96,403
1950-51	10,94,296
1951-52	17,77,808

The following statements give the milage of Public Works Department roads in the State and the expenditure on Civil Works during the years 1948 to 1952 :

Statement of Public Works Department Road milage

Years	1948-49	1949-50	1950-51 (in miles)	1951-52
1. Cement concrete	427	435	435	461
2. Black-top	1630	1808	1808	2006
3. Water-bound	5605	6019	6019	6024
4. P. W. D. roads maintained by other departments	17	17	17	17
5. Unmetalled roads	6836	7512	7512	7330
Total (P. W. D. roads)	14515	15791	15791	15838

Statement of expenditure on Civil Works

Civil Works - Provincial-Revenue Expenditure (in lakhs of rupees)

		1948-49	1949-50	1950-51	1951-52
Buildings	Original Works	16.48	51.43	18.56	16.36
	Repairs	8.81	12.16	12.31	12.79
Communi-cations	Original Works	7.62	175.68	6.64	117.21
	Repairs	141.72	228.76	225.52	204.91
Miscel-laneous	Original Works	0.14	0.29	0.98	0.55
	Repairs	1.91	4.16	2.83	2.59
Establishment		6.42	15.44	29.19	20.80
Tools and Plants		2.59	2.42	4.59	5.22
Suspense		-9.50	-1.95	8.96	-36.75
Grants-in-aid		43.89	46.98	21.87	26.80
Charges in England		0.14	-0.24	0.12	0.07
	Total	220.22	535.13	331.57	370.55

Civil Works - Provincial-Capital Expenditure

(in lakhs of rupees)

	1948-49	1949-50	1950-51	1951-52
Buildings	123.21	180.53	130.93	119.26
Communications	3.25	355.60	0.06	51.61
Miscellaneous	306.35	3.36	2.84	7.37
Establishment	1.18	25.90	11.23	14.24
Tools and plants	23.24	4.19	3.02	-0.15
Charges in England	5.10	0.72	0.04	0.02
Suspense	0.26	18.53	6.34	-17.16
Repayment charges	38.13	—	—	+3.17
Deductions	-183.01	-198.08	-2.36	—
Total	317.71	390.75	152.10	178.36

NOTE : (Figure of expenditure do not include Central Outlay on Civil Works).

LIST OF APPROVED WORKS ON NATIONAL HIGHWAYS

S. No.	Job No.	Name of work	Amount (Rs in lakhs)
		BIHAR	
1.	1459 BR 33	Construction of N. H. No. 33 from Qutudih (Mahuliga) to Baheragora.	23.47
2.	1483 BR 33	Improvement to Ranchi-Budu-Tamar section of N. H. No. 33 in Bihar.	14.93
3.		Two works each costing less than 2 lakhs.	1.48
		BOMBAY	
4.		Three works each costing less than 2 lakhs.	2.53
		HIMACHAL PRADESH	
5.		Two works each costing less than 2 lakhs.	1.27
		HYDERABAD	
6.	1457 HD 7	Construction of the diversion below Atvelli Tank in mile 22/0 of the Hyderabad-Nagpur Road—(N. H. No. 7) including the bridging of the surplus courses.	2.28
7.	1474 HD 9	Black topping mile 124/0 to 173/3 of Hyderabad-Sholapur section of N. H. No. 9 in Osmanabad District.	8.08
		JAMMU & KASHMIR	
8.	1475 JK 1-A	Widening formation width and road crust from the junction of North approach road to Kazigaund.	7.34
		KUTCH	
9.	1472 KH 8-A	Construction of the Samakhiali-Surajbari Chirawala *Timbo* Section of Kandla-Ahmedabad N. H. No. 8-A (Excluding cross drainage works).	11.03
		MADRAS	
10.	1463 MD 45	Construction of a bridge across the Cauvery at Tiruchirapalli on N. H. No. 45.	39.62
11.	1464 MD 4	Widening the existing B.T. surface in mile 54/0 to 70/0 and 71/0 to 81/6 in North Arcot District, N. H. No. 4.	7.24

A limited number of co[illegible]
publications of the Indian Roads Congress
are available for sale.

No.	Publications.	Price inclusive of postage, etc. Rs. A. P.
1.	Volume IX—Part 4—October 1945	3 0 0
2.	Volume IX—Bound—1945	10 0 0
3.	Volume X—Part 4—August 1946	3 0 0
4.	Volume XI—Part 4—May 1947	3 0 0
5.	Volume XII—Part 2—January 1948	3 0 0
6.	Volume XII—Part 3—April 1948	3 0 0
7.	Volume XII—Part 4—March 1948	3 0 0
8.	Volume XII—Part 5—September 1948	12 0 0
9.	Volume XII—Bound—1947-48	3 0 0
10.	Volume XIII—Part 1—December 1948	3 0 0
11.	Volume XIII—Part 2—January 1949	3 0 0
12.	Volume XIII—Part 3—January 1949	11 0 0
13.	Volume XIII—Bound—1948—49	3 0 0
14.	Volume XIV—Part 1—September 1949	3 0 0
15.	Volume XIV—Part 2—December 1949	3 0 0
16.	Volume XIV—Part 3—December 1949	3 0 0
17.	Volume XIV—Part 4—July 1950	8 0 0
18.	Volume XIV—Bound—1949-50	3 0 0
19.	Volume XV—Part 1—August 1950	3 0 0
20.	Volume XV—Part 2—November 1950	3 0 0
21.	Volume XV—Part 3—January 1951	3 0 0
22.	Volume XV—Part 4—August 1951	9 0 0
23.	Volume XV—Bound—1950-51	3 0 0
24.	Volume XVI—Part 2—March 1952	3 0 0
25.	Volume XVI—Part 3—April 1952	3 0 0
26.	Volume XVI—Part 4—October 1952	8 0 0
27.	Volume XVI—Bound—1951-52	3 0 0
28.	Volume XVII—Part 1—December 1952	3 0 0
29.	Volume XVII—Part 2—January 1953	3 0 0
30.	Volume XVII—Part 3—January 1953	9 0 0
31.	Volume XVII—Bound—1952-53	3 0 0
32.	Volume XVII—Part 4—December 1953	3 0 0
33.	Volume XVIII—Part 3—January 1954	3 0 0
34.	Volume XVIII—Part 4—March 1955	3 0 0
35.	Volume XIX—Part 2—May 1955	3 0 0
36.	Volume XX—Part 1—October 1955	3 0 0
37.	Volume XX—Part 2—November 1955	5 0 0
38.	Road Research Bulletin No. 1	5 0 0
39.	Road Research Bulletin No. 2	
40.	Proceedings of the Chief Engineers' Conference at Nagpur on the Post-war Road Development in India	2 8 0
41.	Type Designs for Highway Milestones	0 8 0 } plus packing and postage
42.	Route Marker Signs for National Highways	0 8 0 } plus packing and postage
43.	Dimensions and Weights of Road-Design Vehicles	0 8 0 } plus packing and postage
44.	Recommended Practice for the Location and Layout of roadside Motor Fuel Filling Stations.	0 8 0 } plus packing and postage
45.	Type Designs for Furlong and Boundary Stones	
46.	Paper No. 167—Design of Small Bridges and Culverts by Goverdhanlal	2 0 0

Copies can be had from the Secretary,
INDIAN ROADS CONGRESS,
JAMNAGAR HOUSE, SHAHJAHAN ROAD,
NEW DELHI-2.

Printed by K. S. Krishnan at the Progressive Printers, 17, Coral Merchant Street, Madras-1 & Edited and Published by J. Subrahmanyam, Hony. Secretary, Indian Roads Congress, Jamnagar House, Shahjahan Road, New Delhi-2—950.

2

(1)	(2)	(1)	(2)