71

Transport

Communications

monthly Review.

May — 1954

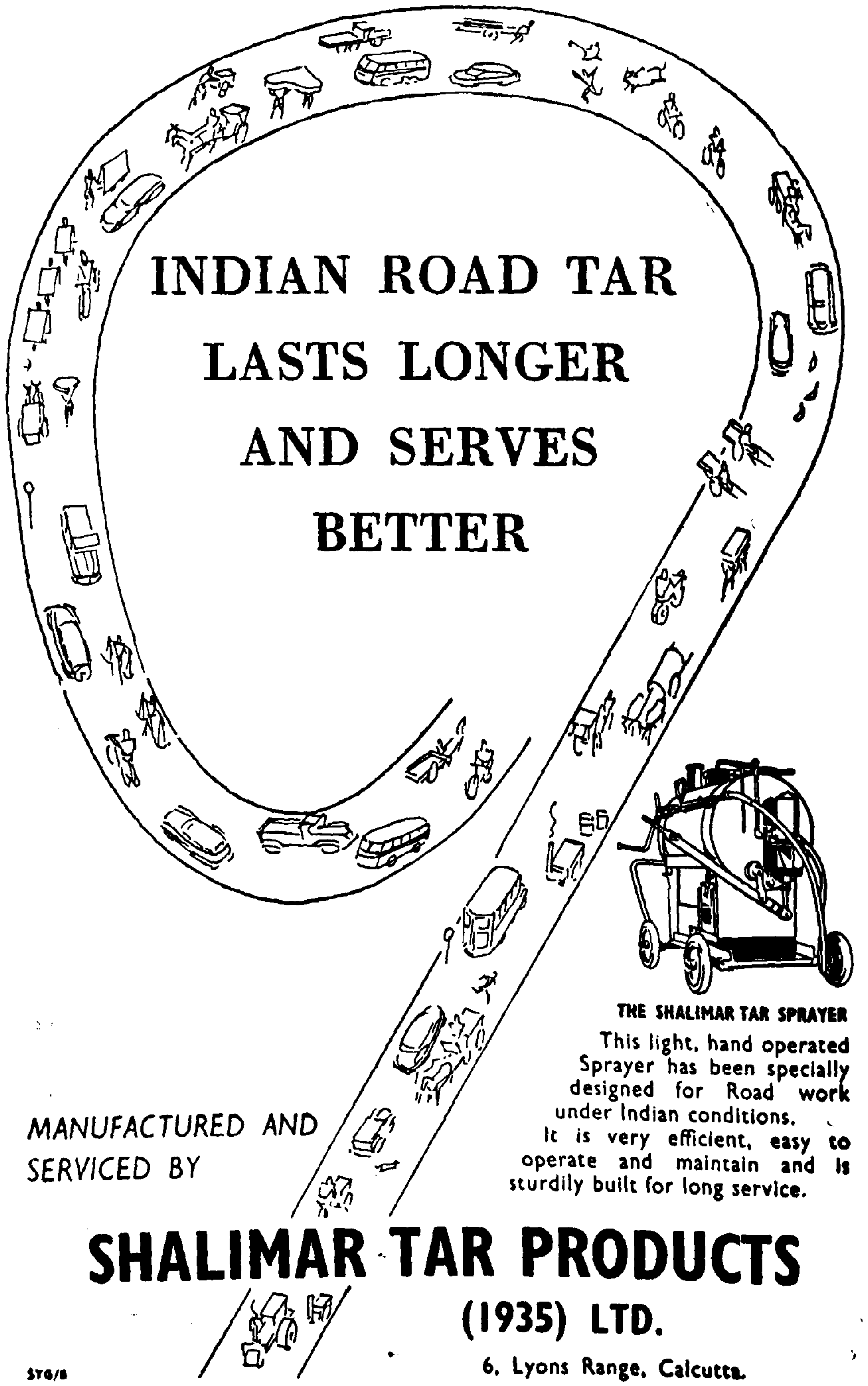
No — 85

TRANSPORT-COMMUNICATIONS

MONTHLY REVIEW

MAY 1954—No. 85

INDIAN ROADS CONGRESS, NEW DELHI.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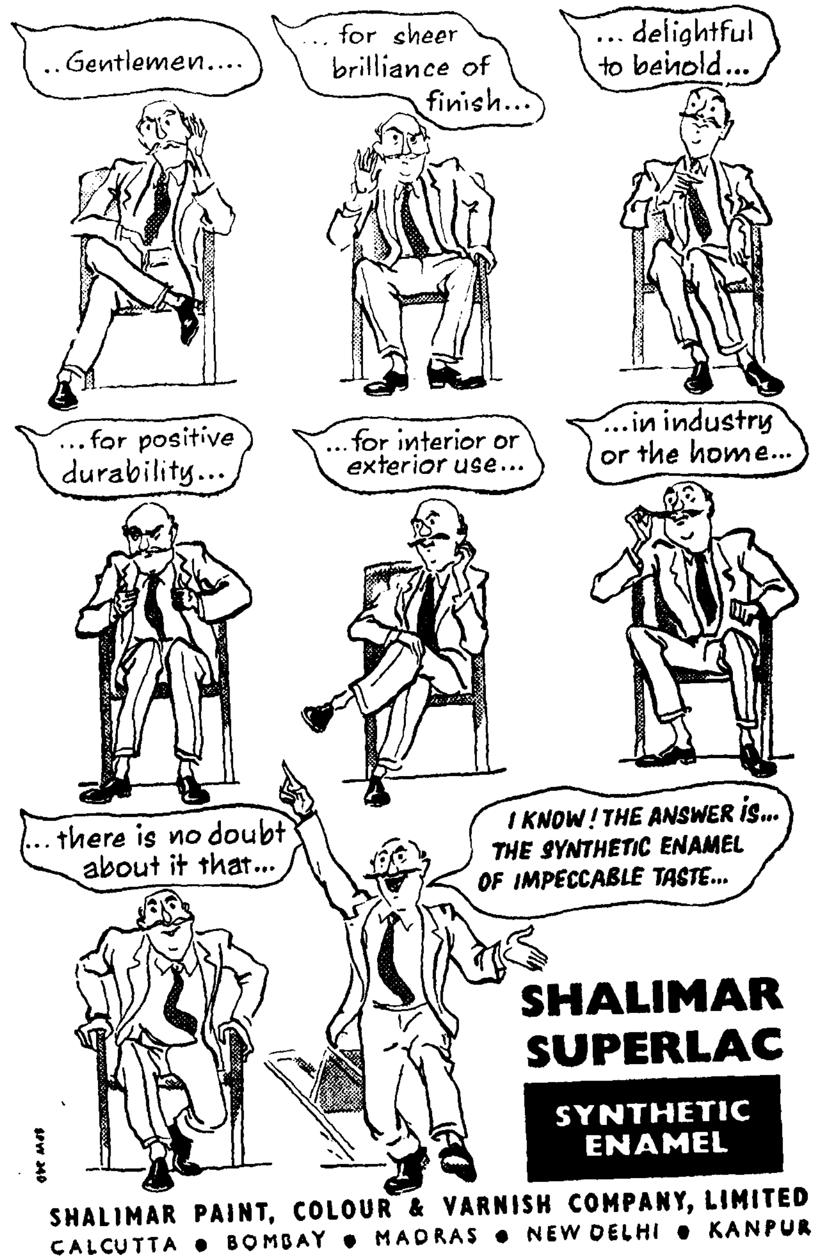
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TRANSPORT-COMMUNICATIONS

MONTHLY REVIEW

MAY 1954—No. 85

71

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.

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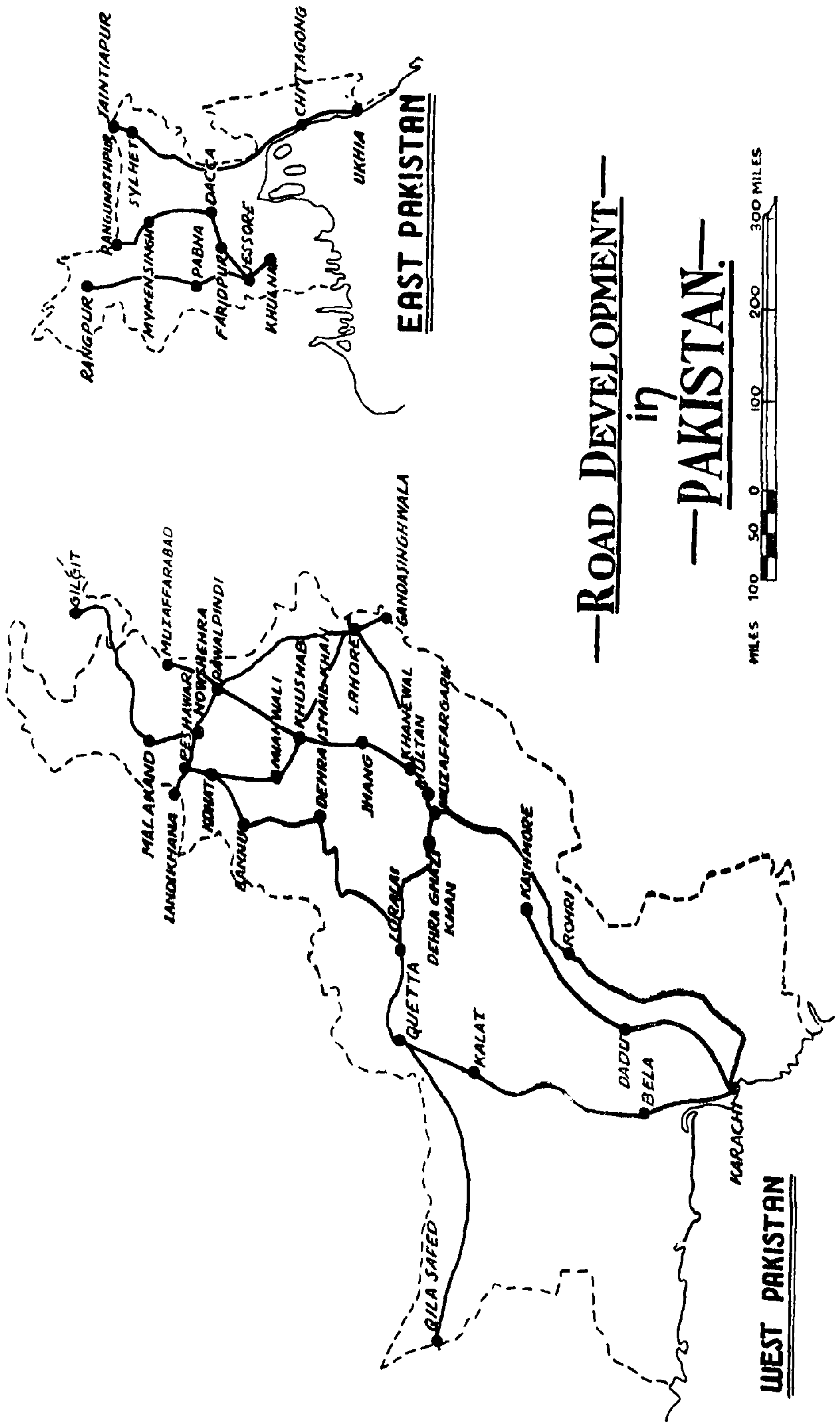

TRANSPORT-COMMUNICATIONS
MONTHLY REVIEW
A REVIEW OF
ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

MAY 1954

ROAD DEVELOPMENT IN PAKISTAN

AFTER partition of India, Pakistan had a road milage of 0.23 per square mile of its area. Nearly 88 per cent of its roads were earth roads.

Transport Advisory Council

A Transport Advisory Council was set up by Government, as recommended by a road conference held in 1949. The Transport Advisory Council met for the first time in November 1950 and made the following recommendations:

(1) The Provinces should prepare six-year programme for the construction and improvement of roads and bridges and the Consulting Engineer (Roads) to the Government of Pakistan should examine these programmes.

(2) The Centre should give such financial assistance, not less than 50 per cent of the estimated cost of the six-year programme, as they deem proper, after consultation with the Provinces.

(3) As a general policy, the whole of customs and excise duty on petrol, import duty on motor vehicles, spare parts, tyres, tubes, etc., and the revenue derived from motor vehicle taxes, driving licences, permit fees, etc., should be earmarked for expenditure on roads.

(4) Funds received by the Provinces from the Centre as contribution should be spent on roads in consultation with the Central Government.

Road Engineers' Association

The road conference (of 1949) also recommended the setting up of a Roads Congress to help evolve a sound policy for road transport and to provide technical advice. The inaugural meeting of the Congress, which is now known as Pakistan Road Engineers' Association, was held in April 1950. The Association was to have a governing body of 20, consisting mainly of government officials nominated to represent various Provinces, States, etc., in addition to five elected members who need not necessarily be officials, and two non-officials.

Road Development Plans of the Provinces

In pursuance of the recommendation of the Transport Advisory Council, the State Governments had prepared six-year development plans, details of which are indicated in the Table below:

Province or State	Length of proposed roads (miles)			Cost in million rupees
	New construction	Improvements	Total	
Punjab	4,312	1,362	5,674	232.645
Sind	1,068	828	1,896	149.064
East Bengal	4,460	1,868	6,328	445.000
Baluchistan	931	750	1,681	17.300
N. W. F. P.	134	665	799	15.514
Bahawalpur	376	162	578	18.520
Khairpur	108	195	303	2.600
Karachi	26	217	243	33.273
Total ...	11,415	6,047	17,462	913.916

East Bengal

East Pakistan is backward in roads and its principal mode of communication is river transport. The milage of paved roads is 450, which works out to 20 miles per million of population. The existing road system is intersected by numerous unbridged rivers. Therefore the usefulness of these roads is, even for local traffic, very little.

Before partition this area, agriculturally rich, used to feed the industrial centre at Calcutta.

The aim now is to make this region self-sufficient and this forms the basis of the proposed road development plan.

In the plan of East Bengal, the figure of 4,460 miles under new construction stands for low cost feeder roads. The figure of 1,868 miles under improvement comprises:

(a) upgrading the surfaces of existing trunk roads — 568 miles

(b) surfacing the existing unsurfaced roads — 1,300 miles

In addition, it is proposed to develop 20,000 miles of village tracks to connect every village with a trunk or district road, a railway station, or a steamer ghat.

The standards proposed for the trunk roads in East Bengal are:

(a)	Land width	100 ft
(b)	Formation width	30 ft
(c)	Carriageway	10 ft
(d)	Design speed	50 m. p. h.
(e)	Bridge loading	H-20

Federal Highways Plan

In the light of proposals made by the Provincial Governments, a plan for Federal Highways was prepared by the Ministry of Communications and considered at the Conference of Chief Engineers of Provinces and States in February 1951. The plan was examined in the light of —

(i) available finances;

(ii) the available technical capacity of various units to execute the programmes; and

(iii) incidence of expenditure on maintenance of new roads after construction.

With a view to evolving a programme which could be financed and executed in a period of six years, the Chief Engineers decided on a programme of constructing 2,226 miles of new roads and improving 8,266 miles of existing roads. The cost of the whole programme was estimated at about Rs 510 million.

The following federal highways were proposed:

PROPOSED FEDERAL HIGHWAYS

Name of road	*Length in miles*
West Pakistan	
Landikhana - Peshawar - Lahore-Khanewal-Rohri-Karachi Road	1,116
Quetta-Kalat-Bela-Karachi Road	417
Peshawar - Kohat - Bannu-D. I. Khan-Quetta Road	519
Kashmor - Dadu - Karachi Road	344
Muzaffarabad - Rawalpindi - Khushab-Jhang - Muzaffargarh Road	367
Multan-D. G. Khan - Loralai - Quetta Road	354
Quetta-Quilla Sufed Road	363
Gandasinghwala-Lahore-Khushab-Mianwali-Kohat Road	308
Gilgit-Swat-Malakand- Nowshera Road	300
Total	4,088
East Pakistan	
Jaintiapur - Sylhet - Chittagong-Ukhia Road	340
Rangpur-Pabna-Jessore - Khulna Road	230
Rangunathpur - Mymensingh - Dacca-Faridpur-Jessore Road	230
Total	800
Grand Total	4,888

Standards

The Chief Engineers' Conference accepted the following standards for federal highways:

(i) width:

150 ft overall, with a minimum formation width of 32 ft, comprising 12 ft of hard surface for single-lane traffic and 20 ft for double-lane traffic.

(ii) Design speed:

Flat topography	50 m.p.h.
Rolling topography	40 ,,
Mountainous topography	30 ,,

(iii) Grades:

	Ruling	Maximum
	per cent	per cent
Flat topography	2	3
Rolling topography	2.5	4
Mountainous topography	5	7

(iv) Traffic:

1,800 vehicles per day

(v) Minimum non-passing sight distance:

Flat topography	500 ft
Rolling topography	350 ,,
Mountainous topography	250 ,,

(vi) Curvature:

	Desirable radius	Minimum radius
	feet	feet
Flat topography	1,000	800
Rolling topography	800	500
Mountainous topography	100	50

(vii) Vertical clearance:

A minimum of 18 feet. Preferable 20 feet.

Conclusion

The completion of the six-year development plan will multiply the high type road milage of the country by about five times. Almost all main cities and agricultural markets will be connected by roads. The collecting, assembling and gainful disposal of agricultural produce would be made possible. Another advantage would be the possibility of prompt transport of people and commodities during unforeseen national emergencies.

(Compiled from "Road International Spring 1953" and International Road Federation Bulletins).

DEFINITIONS OF HIGHWAY ENGINEERING TERMS

REDUCED LEVEL. The level of a point or mark as computed with reference to a prescribed datum.

ROAD SURFACE LEVEL. The surface level of the centre of the normal carriageway in cross section. (In a super-elevated section with extra widening, the road surface level is the level at the centre line of the carriageway without taking into account the extra width).

NATIONAL HIGHWAY No. 34 IN MALDA & WEST DINAJPUR DISTRICTS, WEST BENGAL

(Contributed)

AS a result of the partition of India, the old road and rail communications to Malda and West Dinajpur districts from the rest of West Bengal south of the Ganga were cut off, and expeditious arrangements had to be made to restore road communications. This urgent necessity to establish this route will be seen reflected in the following different types of crossings that will be met on this road.

When the motorist has crossed the Ganga by a power ferry and put his car on the road, the first crossing that he will come to will be a bridge over the Pagla on salpile trestle type piers. This was necessitated by the fact that the final site of this bridge will depend on the location of the Farakka barrage. When the Farakka barrage takes shape, a permanent bridge will replace this structure.

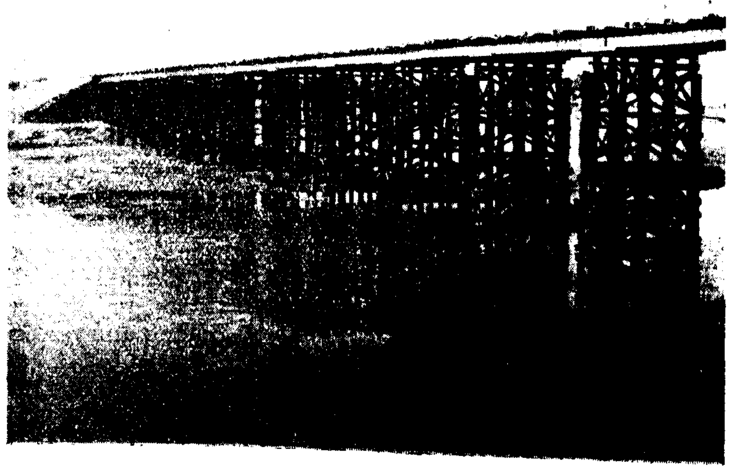

Photo 1.

The traveller will next cross the Tutia Nullah on the timber bridge seen in photo 2. The foreground shows foundation work in progress for the permanent R. C. bridge.

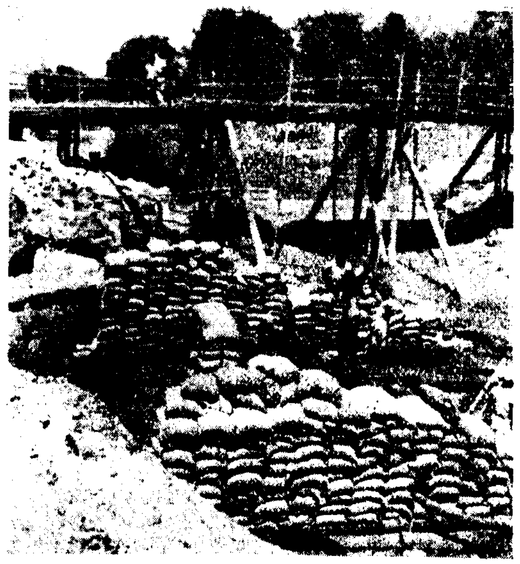

Photo 2.

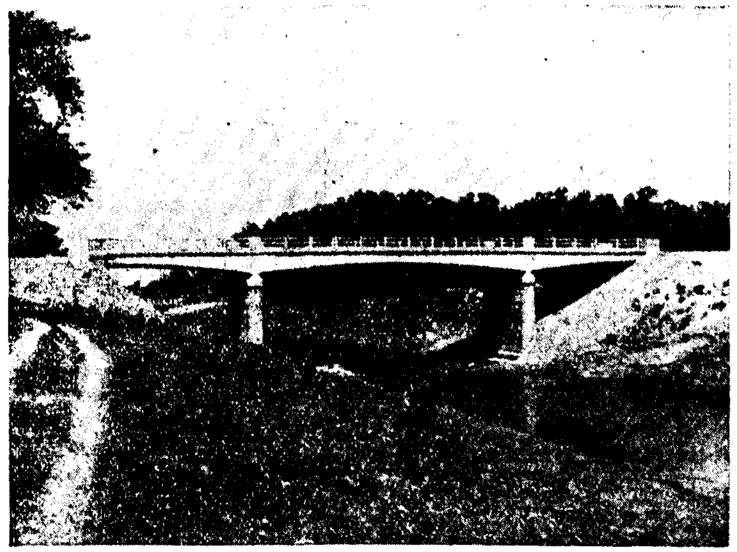

Photo 3.

The next crossing is river Bhagirathi which is now provided with the gracefnl bridge shown in photo 3. This crossing (and many others on this road) had timber bridges of the type seen in photo 2 before this permanent structure was built.

The last of the series is the Boat bridge over the Mahananda near English Bazaar.

Photo 4.

Other major bridges sanctioned for construction on this road are over Behula, Kulik, Gandhar and Nagar.

MAKING CONCRETE

(Extracted from "The British Constructional Engineer, November.—December, 1952".)

GOOD concrete should be durable and strong enough to carry the loads which it is desired to apply to it; where necessary it should wear well and be practically impervious to water. It should be free of such defects as shrinkage cracking, honey-combing and spalling of the surface-defects which, even if they may not affect the durability, spoil the appearance of the concrete.

Crushing strength is generally taken as an index of the quality of ordinary concrete, not because high strength is always of primary importance but because it is usually an indication of other desirable properties such as durability and resistance to frost action and to wear.

Specification of the Mix

Concrete mixes are usually specified in terms of the proportions by volume of cement: fine aggregates: coarse aggregate, such as 1 : 1½ : 3, 1 : 2 : 4 or 1 : 3 : 6, etc., depending upon the properties required of the concrete. A one cwt. bag of cement is taken as 1¼ cu. ft. This method, although simple, does not cover one of the most important factors, i.e., the water-cement ratio, and also the use of such arbitrary proportions will often not make the best concrete with the aggregates available.

An accurate method of designing concrete mixes for both strength and workability, taking into account the physical characteristics of the materials locally available, is given in Road Note No. 4 "Design of Concrete Mixes*".

Main Points to Watch

When the concrete maker has been told the mix proportions to use, there are five main points to watch to make sure that the concrete he produces is satisfactory.

These are:

(1) Quality of the materials.

(2) Quantity of the mixing water.

(3) Careful measurement of the cement, fine and coarse aggregate.

(4) Workmanship in mixing and placing.

(5) Curing.

The following notes show how care and attention to detail can control the quality of the concrete produced.

Choice of materials

Cement.—The cements in most general use are ordinary and rapid hardening Portland cement. For some special purposes, e. g., to provide resistance to sulphur attack, to attain a very high early strength or to produce a concrete with a low heat evolution for use in large masses, special cements may be necessary.

Other types of cement in use are Portland blast furnace cement, high alumina cement and low heat Portland cement.

Aggregates.—The quality of natural aggregates (sand, gravel and fine and coarse crushed rock) differs widely with the type and source of the material. The grading of an aggregate is determined by sieving tests and the results obtained are usually expressed as the percentage by weight of the particles passing various British Standard sieves. The grading of both the fine and the coarse aggregates is of great importance in producing a good, workable concrete. For example, the fine aggregate or sand should contain a reasonably even distribution of particle sizes from $\frac{3}{16}$ in. British Standard Sieve down to the No. 100 British Standard Sieve. A sand containing mainly coarse

* Available in the Library of the Indian Roads Congress.

particles gives a harsh mix which is difficult to place and compact while a sand containing mainly fine particles requires a high water content to give workable mixes.

When a well graded fine aggregate is not available it may be possible to produce a good grading by mixing an aggregate deficient in fines with one that is deficient in coarse material.

The shape of the particles is also important. A well-rounded aggregate produces a somewhat more workable mix than does an irregular or angular shaped material. Aggregate consisting of flat elongated particles makes a harsh mix which is difficult to compact and to bring to a smooth finished surface.

The aggregates used should not contain excessive quantities of organic impurities or of silt and clay. The former can retard the set and strength development of concrete and the latter can result in poor bond between the particles and in the use of excessive quantities of mixing water.

Mixing Water.—The water used must be reasonably free from such harmful materials as clay, silt, organic matter and organic acids, alkalis and other salts. Drinking water from the mains supply is safe and convenient; where there is doubt as to the suitability of water from any source, tests may be made on the setting and hardening of trial mixes of mortar or concrete to compare with similar mixes made with water known to be satisfactory, e.g., drinking water.

Quantity of mixing water

One of the most common causes of poor quality concrete is the use of too much mixing water. Enough must be added to make the mix workable so that it can be thoroughly compacted, but may increase above this minimum leads to loss of strength, lower frost resistance, poorer wearing qualities and increased shrinkage; also the chance of fine material "bleeding" through joints in the form-work, leaving porous honey-combed patches of concrete, is increased.

The ratio $\dfrac{\text{weight of water in a mix}}{\text{weight of cement in a mix}}$

is called the water-cement ratio. For example a concrete mix containing two bags (224 lb.) of cement and a total water content of 13½ gallons (135 lb.) has a water cement ratio of $\frac{135}{224}$ i.e., 0.60.

Experiments have shown that, other things being constant and so long as complete compaction is obtained, the strength of the concrete falls as the water-cement ratio is increased; that is, as the mix is made water. Figure 1 shows the effect of the water-cement ratio on the crushing strength of a concrete mix consisting of 1 part of cement, 2 parts of sand, 4 parts of gravel at an age of 28 days.

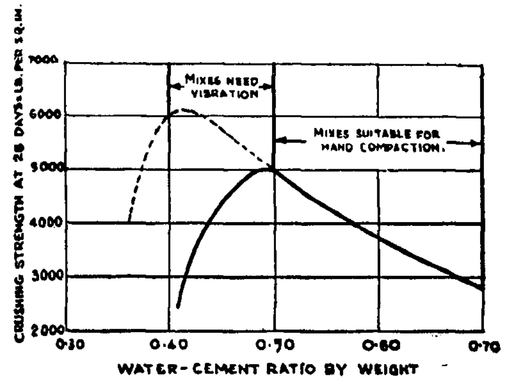

Fig. 1.

With a water-cement ratio of 0·70 and uncrushed gravel the 1 : 2 : 4 mix is very sloppy and easy to work but the resulting concrete is weak. As the water-cement ratio is reduced, more work is necessary to compact the concrete fully, but, with complete compaction, its strength increases steadily. When the water-cement ratio is reduced to 0.50 hand compaction of this mix becomes difficult and if lower water-cement ratios are used a rapid drop in strength results because full compaction is not obtained. With water-cement ratios lower than 0.50 full compaction can be obtained if mechanical vibrators are used and then a further increase in strength is obtained as shown by the broken line in Figure 1. However if the water-cement ratio is further reduced it is found that below 0.40 the concrete cannot be fully compacted even by vibrators and again there is the rapid falling off in strength. When high strength concrete is required, necessitating the use of low water-cement ratios, mixes richer in cement should be used, these being more workable than leaner mixes having the same water-cement ratio. Thus the curve in Figure 1 shows that it is difficult to place and compact $1:2:4$ mix by hand below a water-cement ratio of 0·50; a $1:1\frac{1}{2}:3$ mix with the same water-cement ratio is very easy to compact by hand.

Similar strength and water-cement ratio curves are obtained if crushed rock aggregates are used, but the water-cement ratios for a given workability will be generally somewhat higher than those shown in Figure 1 for the sand and gravel concrete because of the more angular shape of the particles of aggregate.

Although the use of low water-cement ratios is recommended it is equally important that full compaction should be obtained. Compaction should not be sacrificed in order to use a very low water-cement ratio. It can be taken as a working rule that the best concrete is made from the **driest mix that can be fully compacted with the means available on the job.**

Measuring the cement, the aggregates and the water

Once the proportions of cement and fine and coarse aggregates in a mix have been specified, either by weight or by volume, the actual quantities of these materials required for each mix can be determined and it is very important that these quantities should be adhered to as closely as possible. This is not quite so simple as it may at first sight appear and many concrete producers, who in good faith believe that they are making concrete of the specified proportions, would no doubt be surprised at the variations existing in their proportions from mix to mix. Tests carried out by the Building Research Station (U. K.) on a typical site where the materials were measured by volume showed that the combined mix proportions varied between 1 : 4.1 and 1: 5.1 by weight while the sand content varied between 53 per cent and 72 per cent by weight of the total aggregate; the specified mix was a 1 : 4 with 50 per cent sand.

The quantities of the materials for each mix can be measured either by volume or by weight. It is far more accurate to weigh all the materials and this need take no longer than measuring them by volume.

Much volume batching is done in a very rough and slipshod manner without even using gauge boxes. The method of measuring the cement by volume and the aggregates by the shovelful is very bad practice. The density of loose cement varies considerably and thus the weight of a bucketful of cement will vary even supposing that it is filled to exactly the same level each time. Measuring the fine and the coarse aggregate by the shovelful leads to considerable variation in the mix proportions, a shovelful of sand and a shovelful of gravel do not contain the same quantity of material and it is very unlikely that the operatives will always count each shovelful going into each mix.

Good volume batching can be achieved by using properly made gauge boxes for the fine and coarse aggregate, by adding whole bags of cement and careful control of the amount of water added. The gauge boxes should have as small a cross-sectional area as is practicable and should be screeded off level, so that errors due to uneven filling are as small as possible. The size of a single mix should be so arranged that a fixed number of whole bags of cement are used and the use of a half or any other fraction of a bag should not be allowed unless this fraction is weighed out, as may conveniently be done by using a spring balance or a steelyard. When volume batching is used it is essential that allowance be made for the "bulking" of the fine aggregate or sand.

The most satisfactory method of producing uniformly good quality concrete is by weigh-batching all the materials. This method is becoming the rule on large civil engineering projects such as the construction of aerodromes,

(Continued on page 26)

GERMAN MOTORWAYS AFTER 15 YEARS' SERVICE

(Extracted from 'Highways And Bridges,' January 6th, '54)

THE behaviour of the motor roads (Autobhan) has shown that the bearing value of base and subgrade must still be improved. We were formerly of the opinion that granular material was a safe foundation and this is true for static loads. The danger of heavy lorry traffic is in the vibrations, however, which affect granular material more seriously than load or clay. We have experienced serious damage caused by vibration in the case of sand layers provided on top of loam or clay soils as a protection against the rising of capillary water by frost action. We have not observed the famous "pumping" which has given so much trouble to concrete roads in the U.S.A. The layer of granular material on top of loamy soils acts as an effective protection. But we have observed that under heavy traffic conditions vertical movements of the slab ends develop. If the base material or the subsoil is stressed beyond its elastic reaction, permanent settlement develops leading to differences in elevation at the joints of up to 2 in.

The movements of slab ends under heavy traffic are already visible during the elastic settlement process. The differences in elevation at the joints lessens the driving qualities of a concrete road. This is a serious problem and repair is expensive.

Three factors are responsible for this trouble: first, the granular material has not been sufficiently compacted, secondly, the joints are not dowelled, thirdly the joints were not kept tight during and after the war.

Use of Vibrators

During the construction of the motor roads, compaction by vibration has not always been used. We believe that the dynamic effect of traffic loads is best counteracted by vibrators.

The latest development is a machine designed by Professor Lorenz. The new feature of this machine is the regulation of frequency in accordance with type and the reaction of the soil. We are still trying to improve the output of our vibrators which is still too small for large jobs. By using vibrators the granular material of the base can be compacted to resist later settlement by the vibration of traffic.

Behaviour of Dowels

The second measure for preventing uneven joints is the installation of dowels. This had to be given up during the construction of the motor roads because of the shortage of steel.

The inspection of dowels after 15 years of service has led to improvements in design. Since there is no guarantee that joints can be kept watertight, dowels must be protected against corrosion. The painted part of the dowel should extend across the opening of the joint. The present dowels are steel bars of 16 mm. or $\frac{5}{8}$ in. diameter, which is less than the minimum of 18 mm. or $\frac{3}{4}$ in. provided in our specifications. In future designs the diameter of the dowels will be increased from 18–22 mm. ($\frac{3}{4}$ to $\frac{7}{8}$ in.) to 26 mm. or 1 in.

Slab Lifting

The third measure to avoid unevenness at joints is better maintenance. We know that joints have not been re-sealed regularly, so that surface water has found its way into the granular layer, draining out some of the finer particles. After lifting sunken slabs of 12 by 30 ft, holes of several cubic yards have been found. Assuming a uniform distribution of the washed-out material, this would mean a uniform settlement of about 6 in.

If steps develop at joints, repair work should be started as soon as possible, otherwise the steps will grow at an increasing speed. Several methods have been developed to lift sunken slabs.

The oldest method of lifting slabs, using steel beams and spindles, has been abandoned, the transport of the steel beams by workmen being too costly. The method has been replaced by spindles which lift the slab from below. This method demands a concrete support at the foot of the spindle. Another method is used in Hessen. Holes of 1¼ in. are drilled. Compressed air at a pressure of six atmospheres (85 lb. per sq. in.) is employed to lift the slabs. In Wurttemberg the lifting is effected by oil pressure. As under-fill material, dry sand 1–3 mm. 1/32–⅛ in. is used, pressed in at six atmospheres. Grouting is not used because of dangerous softening of the subsoil.

Spacing of joints

The distance between expansion joints varies between 33 and 50 ft. There are test sections with larger slabs.

Cracking governs the length of slab. Cracks and joints are weak spots which cause discomfort to the driver. The ideal concrete road would have no joints at all. This is why test sections of 500 ft length or more without expansion joints have been made. We have studied the results of test roads with continuous reinforcement and no expansion joints in Illinois (maximum length 4,300 ft), New Jersey (5,500 ft) and California (5,300 ft) and have learnt their advantages and disadvantages. Three test sections have been constructed in 1952 on the motor road near Viernheim, of 1,390 ft. Reinforcement consists of steel mats.

The weight is different for each section :

2.43 lb. per sq. ft.
3.06 lb. per sq. ft.
3.75 lb. per sq. ft.

The slabs have shown many hair cracks which was not expected. Some of the cracks stay open. Maintenance work is necessary to fill the cracks with sealing compounds. The Chief Highway Engineer, Dr. Kunde said about this test : "The construction of slabs of more than 330 ft. in length has not proved a success. Test sections of this length with reinforcement up to 2.8 lb. per sq. ft. have shown a large number of cracks developing before the opening of traffic."

"Considering the last 15 years of service and the effect of heavy lorry traffic, we should replace the original spacing of joints of 33, 50 and 66 ft by 170 to 200 ft, provided the soil is well compacted. The slab should be subdivided by two dummy joints. All joints, but specially dummy joints and longitudinal joints should be sawn after the concrete hardened, to guarantee a straight edge, a constant width and a greater strength of concrete along the edges of the joint."

Causes of Cracking

Test Sections were built near Stuttgart in 1935, including slabs of 6, 7, 8 and 10 in. laid immediately on loamy soil, on a 2-in. sand layer and on a 6-in. sand layer. A few slabs were supported by concrete ties under the joints (sleeper joints). No dowels were used. Compressive strength after 28 days varied between 5,500 and 7,700 lb. per sq. in. Core strength varied between 6,100 and 9,600 lb. per sq. in. Cracks were registered in 1939, 1940 and 1951 and classified into three groups :

Less than 0.004 in.
0.004 to 0.02 in.
Greater than 0.02 in.

A very careful study of the cracks showed that the 10 in. and 6 in. slabs had fewer cracks than the others. The good behaviour of thin slabs is attributed to the smaller temperature stresses. We have another section of 6 in. concrete slabs on the motor road between Frankfurt and Darmstadt near Langen built in 1935. This section does not show any difference in behaviour from the neighbouring 9 in. sections.

An extensive investigation on the causes of cracking was completed by Professor Dittrich in 1950. His survey covers 1,855 miles of motor roads in the eastern zone of Germany, and the inquiry lasted two years. The State Highway Administrations helped by lending technical personnel. A report was published in 1953. The survey includes the following technical data for each section of the motor roads : grading, curves, bridges, junctions, agricultural soil use, geological data, contractors, cement works, years of constructions, number of slabs in cuts

and fills, number of broken slabs in each of the four lanes, number of cracks per slab in each of four lanes. Dittrich mentions five factors which influence the frequency of cracking: soil, reinforcement, type of cement, stress and length of slabs. He omits to mention one factor : traffic. If the east-west motor-road has the highest percentage of cracks and has been used by the highest number of heavy lorries, then the primary factor causing cracks might be traffic.

Test Sections of Prestressed Slabs

After much discussion, a test road using prestressed concrete slabs has been built near Mergelstetten. Two different systems are used. In each case, a section has a length of 400 ft; but they are 25 and 28 ft wide respectively. One has a thickness of 6 in., the other 6 in. extending to 8 in. at both ends. In one section prestressing is applied diagonally, in the other the steel net is rectangular. Stress is applied in both directions. The construction of the test sections was finished in September last.

Expert opinion on the behaviour of cement in the motor roads is divided. Both schools of thought agree that the cement has done its duty and that, in spite of criticism from overseas visitors, no change in the qualities required is called for. However, one group claims that the tendency of concrete slabs to crack can be related to the chemical composition of the cements and the fineness of grinding. Professor Dittrich has expressed this relation in a formula. The results of Professor Graf's survey do not fit in with this formula. He states that all the cements selected for the motor roads have proved satisfactory including the blast furnace cement and slag cement. He agrees that cements with high percentages of alumina and magnesia should be handled with care.

Surface Qualities and Effect of Salt

In general the surface qualities of our concrete roads have been satisfactory. The surface still guarantees sufficient friction and we do not complain of too smooth concrete roads as some of the Swiss highway engineers do.

The light colour is an advantage at night. In our climate of more clouded skies than sunshine, glare from sunlight is less troublesome than in the U.S.A. To vary the colour in cases where both lanes and bankettes are concrete, we shall darken the concrete by the addition of iron oxide.

A close check-up of the concrete surface shows that the original texture is still preserved. But in some places we have deterioration of the surface as the result of using salt in winter to combat ice and snow. If the motor roads are to be kept open, the use of salt is difficult to give up but, under certain conditions, the salt will break open the thin cement layer and frost will loosen the aggregates in the concrete. Tests have been carried out to determine the damage caused by different types of salts, to determine the resistance of protective covers and the effect of air-entraining agents.

The most common salts are $CaCl$ and $NaCl$. To be effective against ice they have to be used in quantities of from 0.07 to 0.12 lb. per sq. yd. The destructive effect can be shown in laboratory tests. It depends on the concentration and the quality of the concrete. Tests have been carried out on the protection of the road surface by an oil-petrol mixture with a penetration of 0.05 gal. per cu. yd., but results are not promising.

Air-entraining

In the new edition of our specifications for the construction of concrete roads we have recommended the addition of air-entraining agents in a quantity sufficient to produce a total pore volume of from three to four per cent. With higher quantity, there is an undesirable loss of strength.

Professor Walz has investigated the loss of strength in the type of concrete we use. On two sections of roads near Hanover and Mannheim air-entrained concrete has been used. Observations have led to the conclusion that under our climatic conditions, the use of air-entraining agents would be a protection against the damage from salt and frost.

Another advantage of air-entraining agents is the greater workability.

There is another problem. What is to be done to a damaged concrete surface? As an emergency measure, highway departments have applied a bituminous mixture on top of the deteriorated area. Lately we have tried to repair smaller areas by the use of gunite, which allows the production of layers of different thicknesses down to zero. There is an improvement it is claimed, if polyviny lacetate, an artificial resin, is added to the water. This is sold under the trade name of "Concrete Emulsion." "Concrete Emulsion" is added to the water in the proportion of 1 : 1, the dry mix of cement and sand being 1 : 2 or 1 : 3 by volume.

Latest Construction Methods

During the construction of the motor roads up to 1942, some 600 miles were completed each year. Some 1,400 miles of motor roads are still needed to complete the network. From January 1950 to March 1953 the total length of motor roads increased by 5.9 miles. By the end of 1953 a further 10 miles will be completed.

One of the latest sections of concrete pavement built this year is a length of about three miles on the Munich-Regensburg motor road. Design and construction depart in several ways from the standards of 1940. The quantity of cement per cubic metre of hardened concrete is still the same: 540 lb. per cu. yd. The aggregates used are gravel and sand used in the following four gradings:

0– 3 mm. (0–$\frac{1}{8}$ in.)
3– 7 mm. ($\frac{1}{8}$–$\frac{1}{4}$ in.)
7–15 mm. ($\frac{1}{4}$–$\frac{1}{2}$ in.)
15–50 mm. ($\frac{1}{2}$–2 in.)

The concrete is introduced in two layers. In the upper layer, gravel is replaced by crushed diorite of the grading $\frac{1}{2}$ to 2 in. The water-cement ratio is 0.45. To keep the water-cement ratio low, an air-entraining agent, in this case "Plastiment" is added in the proportion of one per cent of the cement weight. To darken the concrete black oxide of iron has been added in the proportion of two per cent of the cement weight.

The lower layer of concrete is 7 in. thick, the upper layer 2 in. Steel mats of 3.6 lb. per sq. yd. are laid between the two layers. The concrete mixer (of 2 cu. yd. capacity) and the distributor travel on rails. A new feature of this job is the use of poker vibrators (Wacker) for the lower layer of concrete. A set of seven units has been installed in a frame travelling on the rails of the mixer. They compact a width of 12 ft 4 in. The diameter of one poker is 3 in., the length 11 in. The pokers produce 9,000 r. p. m., weigh 60 lb. and have a petrol consumption of one third of a gallon per hour.

The upper layer is compacted by a road finisher equipped with a distributing element in the shape of a wheel, a vibrating plank and a vibrating beam (A.B.G.). The plank can be adjusted to vibrate at frequencies of from 3,000 to 4,500 oscillations per minute. It compacts a depth of 20 in., weighs seven tons and has an engine of 7 h.p.

For compacting the concrete of the bankettes built ahead of the carriageway, pan-vibrators are used. Expansion joints of 20 mm. (0.79 in.) are installed every 100 ft. The joints are dowelled with round steel bars of 22 mm. ($\frac{7}{8}$ in.) diameter. Between each two expansion joints there are two dummy joints. All the joints are sawn in the hardened concrete. A 25 h.p. cutter (Butzer) is used. The width of the dummy joints is 8 mm.; ($\frac{1}{3}$ in.) the depth of all cuts is 50 mm. (2 in.). The cost of cutting is $\frac{1}{8}$ d. per foot for dummy joints, $\frac{2}{5}$ d. per foot for expansion joints.

The cutting method has not resulted in serious cracking. The induced cracks, if any, follow the direction of the insert at the bottom of the joints.

EXPERIMENTAL WORK ON THE DESIGN OF THE PROPOSED SUSPENSION BRIDGE OVER RIVER SEVERN (U.K.)

(Extracted from 'Highways and Bridges, March 17, 1954')

A history of the Severn Bridge Scheme, the factors leading to the choice of the site, the problems and experimental work in connection with the design of the proposed suspension structure were described by Mr. J. F. A. Baker at the Institution of Highway Engineers (U.K.).

The total cost of the bridge with the connecting roads and motorways is in the region of £ 35,000,000 (Rs 46 crores). The main span of the proposed bridge is 3,240 ft and there are two side spans each of 1,000 ft. A clearance of 120 ft above high water is provided for navigation.

So far as the purely technical aspects of the project are concerned the chief interest naturally centres on the design problems connected with the suspension bridge, which will be among the four largest in the world and able to carry loads heavier than any contemplated in earlier examples.

In some bridges, including the one at Tacoma, the stiffening truss was reduced to a plate web girder, 8 ft deep, which was all that was necessary according to the mathematical analysis. Unfortunately, this reduction of the stiffening truss to its simplest and most economical form—a plate girder – brought into prominence a factor of the design that had previously been unimportant—the aero-dynamic properties of the bridge, as distinct from its strength. While all the designer's attention was focussed on stresses and strains, this neglected factor in design became decisive. The susceptibility to oscillation or flutter in the wind is not a matter of strength or even stiffness, but of shape; and it has been shown that the Tacoma shape, with its vertical plate girders and flat deck forming a channel section, is one of the very worst for aerial stability.

The experimental work carried out on this problem for the Severn Bridge design was naturally directed to establishing a shape that would ensure the safety of the bridge against "catastrophic" oscillations and, if possible, immunity even from small oscillations which, although harmless to the structure, may cause discomfort to persons on the bridge. Investigations were undertaken by the National Physical Laboratory under the direction of Dr. R. A. Frazer, and a long series of tests were made, both on small sectional models at Teddington, and on a 1/100 scale model of the proposed bridge in a temporary wind tunnel specially built for the purpose at Bedford. In the large model – about 50 ft long – the actual masses and stiffness of the bridge, as then designed, were reproduced to scale; on the sectional models the true conditions of support were reproduced by adjustable spring-loaded mountings.

It was known at that time that "wind-spoilers", to prevent the formation of a continuous air-stream, should be incorporated in the cross-section of the deck structure. These could take the form of gaps or projections which tend to break up the air-flow into small eddies; large plane surfaces should be avoided as far as possible. In the tentative design, therefore, framed trusses were used rather than plate girders for the deck supporting members and main stiffening trusses, with handrailing (of which there are six lines) of open construction. The roadway deck was divided into two sections with a 10 ft wide air gap on the centre line of the bridge and gaps were provided between the roadways and the cycle-track/footpath sections. The deck level was at the centre of the stiffening trusses and the cables were spaced at 100 ft centres. This was the design reproduced in the large model.

Further development of the design led to the raising of the deck level to the top of the stiffening trusses, to incorporate top lateral bracing and the width was reduced to 80 ft with the footpath sections outside the main trusses. This arrangement was reproduced in the sectional model used in the final test to check the conclusions reached on the large model.

These tests have proved that the bridge would be stable under all conditions of wind likely to occur at the bridge site—including the variations in speed, direction and angle of inclination to the horizontal. In fact, instability could be produced only by covering the sides of the model with flat sheets, so representing the effect of plate-webbed stiffening girders.

Roadway Decks

Another feature of the bridge design that called for investigation and experiment was the design of the roadway decks. In long suspension bridges, more than in other types, it is necessary for reasons of economy to keep the dead load to a minimum, since every addition to the suspended weight requires an almost equal additional weight of cable to carry it. All the American bridges have decks consisting of a reinforced slab resting on steel beams and covered with a wearing surface of asphalt. This is inevitably a heavy form of construction, and it was hoped to devise a lighter and better alternative for the Severn.

One possible arrangement consisted of a flat steel plate stiffened longitudinally and transversely by tee sections welded on the underside and with the minimum practicable thickness of asphalt laid directly on its surface.

Two main problems were involved here. First, the thickness and strength of the plate and its complex system of stiffening members, and second, the permanent adhesion of the asphalt coating and its behaviour under wear. The wheel loads of the "special vehicle" used in the design —11¼ tons on a 15 in. width of tread—are exceptionally heavy and the stress distribution in the plate and stiffeners is indeterminate. Also the possibility of movement and disintegration of the asphalt on the somewhat flexible base could not be overlooked, while corrosion of the steel surface would almost certainly lead to loss of adhesion and failure.

A series of tests was therefore put in hand to check the reliability of the tentative design. Several full-scale test sections of the deck were made, each about 9 ft by 6 ft, with plate thickness varying from ½ to ⅝ inch. One of these was subjected to stress tests, using a segment of the actual wheel and tyre and a small movable slab of asphalt carpet for applying the load, at the Building Research Station Laboratory. Other sections, with $\frac{9}{16}$ in. plate, were laid on suitable foundations at a bus-stop in the Colnbrook By-pass road outside the Road Research Establishment at Harmondsworth and coated in situ with asphalt thicknesses of 1 in., 1½ in. and 2 inches. In addition, a one-third scale model of a 60 ft length of deck (one whole panel of the bridge) was welded up and tested in the laboratory to check the stress distribution in the various members. On the results of the loading tests some minor adjustments were made in the steel scantlings and a $\frac{9}{16}$ in. thickness of plate was adopted.

The conclusions from the road tests, which extended over about a year, may be summarised as follows. The 1 in. carpet showed signs of cracking and lack of adhesion near the boundaries of the panel. Because of this, and the probable difficulty of laying and repairing such a thin coat on a large scale, it was decided to adopt a 1½ in. thickness in computing the dead load on the bridge. The 2 in. thickness appeared to have no advantage.

The surfacing is divided into sections 60 ft long and 24 ft wide with a 1½ in. steel upstand at the edges.

SOIL-CEMENT ROADS

(Extracted from a Paper to the Public Works and Municipal Services Congress.)

Introduction

THE primary aim in soil stabilisation is so to strengthen the soil and increase its resistance to softening by water that it will provide an adequate road foundation in place of such materials as hard core and stone. Of the various methods of stabilising soils, 'soil-cement' has been found from experience to be one of the most satisfactory in performance in the U. K. 'Soil-cement' may be defined as the process in which soil is strengthened and made resistant to the effects of water by the use of cement as the primary additive; secondary additives may be used with the cement for a number of reasons.

The object of this Paper is to give an outline of this process and the associated construction methods, and to describe a few typical examples of its use in this country.

Soil-cement

The production of soil-cement usually comprises the thorough mixing of about 10 per cent (on a weight basis) of Portland cement with the natural subsoil at the road site, and the subsequent compaction of the mixed material by rolling or other suitable methods. The compacted material requires a few days to harden, after which it can be covered with a bituminous carpet, surface-dressing or other suitable surfacing.

Soil-cement cannot be made successfully from all types of soil. All types of gravelly and sandy soils and the lighter types of clay soil can be used, but heavy clays and some types of highly organic soils cannot be satisfactorily treated. Although 10 per cent of cement is often adopted, the limits for satisfactory treatment lie between 5 and 15 per cent of cement, depending on the particular soil type. The most suitable proportion is found by means of simple laboratory tests to determine the strength of the material produced when different proportions of cement are added to the soil.

Secondary additives are sometimes required together with cement to produce a satisfactory result. Hydrated lime in a proportion of about 2 per cent by weight of the soil is of value in making light clay soils more amenable to mixing and in neutralising the effect of organic matter in soils; calcium chloride is extremely effective in similar proportions in neutralising the very active organic materials which often occur in heath sand and which have the effect of preventing or reducing the rate of hydration of cement alone; bituminous emulsions have a beneficial effect with granular soils free from clay in providing some flexibility to a material which would otherwise have the properties of a very low-grade concrete.

In most soil-cement work in the U. K. a layer 6 in. thick of stabilised material has usually been laid. This can be most easily achieved in practice by the 'mix-in-place' method in which the cement is mixed with the soil in situ by means of rotary tillers or other suitable equipment. Although some engineers have successfully treated greater depths of soil in this way, it is usually preferable, where greater thicknesses of stabilised soil are required, to resort to stationary plant mix methods in which the soil and cement are mixed in paddle mixers or concrete mixers, the mixed material being subsequently placed on the road formation and compacted in a number of layers.

In concluding this brief description of soil-cement, it should be emphasised that it should not be regarded as a low-grade concrete, even though cement-stabilised gravelly soils tend towards what is known in concrete technology as lean-mix concrete, but rather as a form of flexible construction behaving in a similar way to a crushed stone or hard core base.

Construction Methods

(a) 'Mix-in-Place' Method

For the 'mix-in-place' method, cement is usually mixed with the soil found *in situ* on the site. Alternatively, suitable soil may be imported to the site when this is convenient, and mixed in place with cement.

This first operation is to remove the top soil, and shape the exposed subsoil to the longitudinal and transverse sections needed on the final base. It is important that this operation should be performed before cement is added, since otherwise a reduced thickness of base may be obtained. After shaping, the soil is broken up and pulverised to a fine tilth. Breaking up can often be conveniently carried out with agricultural rigid-tine cultivators or rippers, and with ploughs, and pulverising is carried out with hand or tractor-operated rotary cultivators. For small works, the hand-operated machines used in market gardening can be used, while for larger works rotary cultivator attachments to ordinary agricultural tractors have been found to be successful. The soil is normally broken up to the depth to which processing is to be taken, which is usually of the order of to 6 to 8 inches.

After pulverisation, cement is spread over the site. This is done by first placing 1-cwt. bags of cement in lines along the site, the bags being spaced at intervals calculated from the specified cement content and depth of processing employed. For example, when a cement content of 10 per cent is employed, 1 bag of cement is needed for each 2 or $2\frac{1}{2}$ square yards of surface. The bags are then split open the paper removed, and the resulting piles of cement spread out as uniformly as possible by hand with rakes.

The cement is then mixed with the soil to the full depth of processing, using the rotary tillers previously employed for pulverisation. Mixing is continued until the soil-cement mixture has a uniform texture and appearance. Water is added from a distributor tank in increments until the mixture is at a suitable moisture content for compaction. Each addition of water is mixed into the treated soil with the rotary tillers.

Initial compaction is obtained with a light smooth-wheeled roller or with a pneumatic-tyred roller, and final compaction is provided with a heavy (8-10 ton) smooth-wheeled roller. When the correct amount of moisture is present in the soil-cement, the material should not 'push' under the rolls.

The compacted base is 'cured' in a manner similar to that employed with concrete, i. e., a covering of some material such as waterproof paper, damp hessian, straw or soil is placed on it, to prevent evaporation of moisture. After a curing period of about a week, the road can be surfaced and then opened to traffic. The characteristics of the surfacing will depend upon local practice and upon the intensity and weight of traffic. For the construction of housing estate roads in recent years, one method has been to apply a single or double surface dressing of tar and chippings soon after construction of the stabilised soil base. This serves as a temporary surfacing to carry lorry traffic during the erection of the houses. When the building is completed, the road is cleaned, kerbs and drainage installed, and a bituminous surfacing 2 to 3 in. thick is laid as the final surfacing.

(b) 'Stationary Plant-Mix' Method.

In this method soil, either from the site or from a nearby borrow-pit, is mixed with cement in a stationary mixing plant, transported to the road site and laid and compacted between forms.

Proportioning is usually done by weight, using the weigh-batching equipment employed in concrete work. When the soil contains a fairly large proportion of stones and little clay, concrete mixers of the vertical-drum type can be used. Pan-type mixers are more satisfactory when the proportions of clay are high enough to cause sticking in a drum-type mixer. Batch type or continuous asphalt mixers have been found to be satisfactory for mixing cement with fine-grained soils. Compaction, curing and surfacing are carried out in a manner similar to that described for the 'mix-in-place' method.

In addition to the advantage of the stationary plant-mix method for constructing a thickness of soil-cement base greater than 6 in. it is also useful for patching and minor improvement works. The output is usually lower, however, than that obtainable with ths mix-in-place method, and the unit cost of the compacted base material is therefore higher.

Preliminary Examination of Soils

The objects of the preliminary examination of the soils available at a road site are first, to determine whether any of them is of type suitable for treatment with cement, and secondly, to determine whether a secondary additive is required and the proportions of cement and secondary additive needed.

For this purpose the responsible engineer should arrange for representative samples weighing about 1 cwt. to be obtained, and the necessary laboratory tests on these samples can then be undertaken.

With regard to the sampling, a single sample will be sufficient where a small area (e.g., a car park) and uniform soil conditions are involved: on the other hand, for a large area (e.g., a housing estate) and variable soil conditions, a number of samples must be taken from points on the centre line of the roads on the site.

The tests will reveal the presence of either an excess of clay or of organic matter which would render the soil unsuitable for treatment. If the samples of soil are satisfactory in these respects, tests are then made in which cylindrical specimens of mixtures of the soil and cement are prepared and subjected to a compression test at an age of seven days, when they should develop a strength of 250 lb. per sq. in. Tests are sometimes needed on specimens made with different proportions of cement and with secondary additives in order to determine the treatment which will give material with the required strength.

Typical Applications of Soil-Cement Construction.

Table I (page 18) gives a number of typical instances where soil-cement base construction has been successfully employed in Great Britain. Serial Nos. 1 and 2 are typical county roads carrying traffic of the order of 500-1000 vehicles per day. Serial Nos. 3 and 4 are respectively examples of urban road construction—of a housing estate road and a more heavily tracked road on a poor subsoil, and the surfacing is of unreinforced concrete. In the former case, the stabilized soil base was given a temporary surface dressing of tar and chippings very soon after construction. A two-course bituminous surfacing was laid as permanent surfacing after completion of house building. The forest road and the car park under Serial Nos. 5 and 6 were only covered with a dressing of bituminous materials and chippings owing to the infrequent nature of the traffic. Soil-cement is said to have behaved quite satisfactorily in other situations as well, like in floors of reservoirs and of assembly shipyards, cycle tracks, building blocks for houses in the colonies, and erosion resistant ditch linings.

TABLE I

DATA RELATING TO TYPICAL APPLICATIONS OF SOIL-CEMENT

Serial No.	Type of Road	Year Laid	Method of Mixing	Construction
1	Country Road	1944	Mix-in place	6 in. Soil-cement base +3 in. tarmacadam surfacing
2	Country Road	1951	Mix-in place	6 in. soil-cement base+3 in. tar-coated stone +1 in. bituminous carpet.
3	Housing-estate road	1949	Mix-in place	6 in. soil-cement base+2½ in. bituminous carpet.
4	Urban road	1950	Stationary plant mix	9 in. soil-cement base+6 in unreinforced concrete
5	Forest road	1949	Mix-in place	6 in. soil-cement base+surface dressing
6	Car-park	1951	Stationary plant mix	6 in. soil stabilised with cement and bituminous emulsion + surface dressing.

Two motorists met on a street too narrow for two cars to pass.

"I never back up for an idiot," yelled one driver. "That's all right," said the other shifting into reverse, "I always do."

HERE AND THERE

1. JAPANESE TOKYO—KOBE TOLL ROAD

U. S. express highways and toll facilities are being studied by the Japanese Government in connection with the proposals to construct the 527 kilometre (328 mile) Tokyo-Kobe toll highway.

The proposed highway will run through Japan's most populated area, containing some 34 per cent of the whole population, 50 per cent of Japan's industrial production and 53 per cent of her motor vehicle registrations.

It is planned that the highway will have four lanes and that it will be free of cross traffic and be a limited access facility only. When completed it should be possible to drive from Tokyo to Kobe in five hours at an average speed of 100 kilometres per hour (62 m.p.h.) According to the present plan there will be some 30 interchanges between the two cities.

The cost, based on calculations made in 1951 is estimated at U. S. $ 318 million (Rs 151 crores).

The proposed toll of 10 yen (Rs 0-2-0) per kilometre (0.62 mile), according to reports, will be equal to approximately half the amount of money saved in motor vehicle operating expenses per kilometre.

The toll revenue is expected to pay for the road's administration and maintenance, as well as amortization. Current plans for financing include a series of loans which would be made available from an original credit as the money is needed. Repayment of the money borrowed in any one year would be deferred initially for 5 years and amortized in 20 years, with an interest charge of 5 per cent per annum.

2. NEW ZEALAND ROAD FUND

FURTHER details are available regarding the National Roads Fund, the establishment of which was reported at page 29 of the February Issue of this journal.

The Road Funds revenue will come in the main from the petrol tax, at present one shilling in the gallon to be increased to one shilling and three pence (Rs 0-13-6) without any increase to the public. This increase is expected to yield £ 10 million (Rs 13.5 crores) annually. Higher registration and licence fees will yield a further (Rs 2.2 crores) £ 1.7 million, heavy traffic fees will provide an additional £ 1¾ million (Rs 2.3 crores) the milage and tyre tax £ 1¼ million (Rs 1.7 crores) and the Government's contribution, as already reported, will be £ 1 million (Rs 1.3 crores).

Expenditure is proposed as follows:

Highways £ 10 million (Rs 13.3 crores)

Subsidy to counties £ 1.530 million (Rs 2.0 crores)

Subsidy to Boroughs £ 1.3 million (Rs 1.7 crores)

Special assistance £ 200,000 (Rs 0.3 crores)

Industrial roads £ 100,000 (Rs 0.1 crores)

Miscellaneous £ 450,000 (Rs 0.6 crores)

The total expenditure, £ 14.7 million, (Rs 18.0 crores) compares with £ 9.8 million (Rs 13 crores) in the current year's estimates.

Existing road subsidies to Counties and Boroughs will be abolished and subsidies will be paid to County Councils of eight shillings (Rs 5-5-0) from the National Roads Fund for every £ 1 (Rs 13-3) collected as general or special roading rates. Additional subsidies will go to Boroughs and those with populations exceeding

6,000 will get £ 1-2-0 (Rs 14-11-0) per capita, while smaller Boroughs will get fifteen shillings (Rs 10-0-0) per capita.

The New Zealand Government has thus re-introduced the principle of earmarking petrol tax and other motor taxation revenue for roads and therefore road petrol taxation, heavy traffic fees, registration and licence fees and the tyre and milage tax revenue will in future be paid direct to the Roads Fund without the need for annual appropriation by Parliament. No local authorities will receive less from subsidy than was received from heavy traffic fees and road subsidies during the present year.

Heavy traffic fees are increased by $66\frac{2}{3}$ per cent. The 50 per cent exemption for farmers trucks is to be continued and applied to all trucks up to six tons gross load. The exemptions now allowed are to be reviewed to make present regulations conform more closely to the principle of user payment in all cases involving use of the roads.

The National Road Board will be the final authority in appeals affecting road classifications and it will also have power to grant special financial assistance to local road authorities in certain cases.

The National Road Board will have a wider organisation than the Main Highways Board, which it supersedes, although the existing relationship between that Board and the Minister of Works will be retained. Local authorities will continue to have full autonomy over their roads.

The Board will consist of the following members:

Minister of Works (Chairman).

Two members appointed by Government.

The Commissioner for Transport.

Two representatives of the New Zealand Counties Association.

One representative of the Municipal Association of New Zealand.

One representative from the private owners of motor vehicles.

One representative from owners of commercial vehicles.

—(Extracted from 'World Highway Report Volume V No 3/4').

3. INTERNATIONAL ROAD CONGRESS COMMITTEES

THE International Association of Road Congresses has set up the following technical committees:

Slipperiness.—Chairman: Mr. Bressot (France); Members. Messrs Giles (Great Britain), Ariano (Italy), Escario (Spain), Van der Burgh (Holland).

Tests of Materials.—Chairman: Mr. Parmentier (France); Members: Messrs. Ariano (Italy), Glanville (Great Britain), Hatt (Great Britain), Mathieu (France), Van der Burgh (Holland).

Runways.—Chairman: Mr. Ariano (Italy); Members: Messrs. Mann (Great Britain), Van der Burgh (Holland), De l' Hortet (France), Von Moos (Great Britain).

Low Cost Roads.—Messrs. W. Adams (Great Britain), Bonnenfant (France), Ferreira Mendes (Portugal), Ondang (Indonesia), A Turkish member, a Belgian member (both to be nominated).

Study of traffic and Road Characteristics in Relation to traffic.—Chairman: Mr. Hondermarcq (Belgium); Members: Messrs. Coquand (France), Bellamy (Great Britain), Escario (Spain), Nelander (Sweden), Dr. Ruckli (Switzerland), Van Gils (Holland).

Study of Road Characteristics in Relation to Safety.—Messrs. Bellamy (Great Britain), Zechini (Italy), Hondermarcq (Belgium), Nap (Holland), Pelissonnier (France).

—From 'Highways and Bridges, March 31st, 1954.'

4. JAPANESE ROAD PROGRAMME

THE Road Bureau of the Japanese Ministry of Construction is working out details of a five-year 270,000 million yen (Rs 350 crores) road programme. This provides for the improvement of some 4,600 miles of main highways, the paving of nearly 3,100 miles of such roads, the construction of 1,700 miles of development roads, the reconstruction of over 4,000 bridges, the maintenance and repair of 4,000 miles of roads and the partial improvement of nearly 600 miles of other roads. The national Government is to provide £ 169 million (Rs 220 crores) and prefectural governments the remaining £ 99.7 million (Rs 130 crores). In July the Government approved legislation assigning revenue obtained from the petrol tax to the highways fund.

(Extracted from 'Modern Transport, February 27, 1954')

5. ENGINEER, PROFESSIONAL

SO diversified are the services required of professional engineers throughout the wide range of industries, public utilities and governmental work, and in the discovery, development and conservation of resources, that men of extremely various personality and physique may achieve success. Qualifications include intellectual and moral honesty, courage, independence of thought, fairness, good sense, sound judgment, perseverance, resourcefulness, ingenuity, orderliness, application, accuracy and endurance. An engineer should have ability to observe, deduce, apply, to correlate cause and effect, to co-operate, to organize, to analyse situations and conditions, to state problems, and to direct efforts of others. He should know how to inform, convince and win confidence by skilful and right use of facts. He should be alert, ready to learn, open-minded, but not credulous. He must be able to assemble facts, to investigate thoroughly, to discriminate clearly between assumption and proven knowledge. He should be a man of faith, one who perceives both difficulties and ways to surmount them. He should not only know mathematics and mechanics, but should be trained to methods of thought based on these fundamental branches of learning. Organized habits of memory and large capacity for information are necessary. He should have extensive knowledge of the sciences and other branches of learning, and know intensively those things which concern his specialities. He must be a student throughout his career and keep abreast of human progress.

Having been endowed more or less completely with qualifications and capacities requisite for a professional engineer, and having developed them with the aid of educational and other institutions and contacts provided by civilised communities, the engineer is under obligation to consider the sociological, economic and spiritual effects of engineering operations, and to aid his fellow men to adjust wisely their modes of living, their industrial, commercial and governmental procedures, and their educational processes so as to enjoy the greatest possible benefit from the progress achieved through our accumulating knowledge of the universe and ourselves as applied by engineering. The engineer's principal work is to discover and conserve natural resources of materials and forces, including the human, and to create means for utilizing these resources with minimal cost and waste and with maximal useful results.

(Extracted from 'New Zealand Engineering'—January, 15, 1954)

6. CONCRETE FOR ZEBRA CROSSINGS

EXPERIMENTAL zebra crossings laid by the Road Research Laboratory indicate that concrete markings are likely to give many years of service. To provide good contrast at night, particularly on roads carrying heavy traffic, the white stripes of each zebra crossing are given a smooth finish and the black stripes a rough finish. Nine crossings, with cast-in-situ white stripes and mastic asphalt black stripes, have been laid in streets of the Metropolitan Borough of Stepney, (U. K.) which carry a great deal of traffic. One of the crossings has had some 14,000 tons of turning traffic over it every day for eighteen months, it is stated, and looks little different from the day it was laid. These concrete stripes were laid either 1 in. or 2 in. thick on a concrete base of 7 in. or 9 in. A white aggregate is essential for the stripes, because it will become exposed with wear; calcined flint was found to be satisfactory and was used in all the experimental crossings. The addition of 5 per cent of titanium oxide was found to make the concrete whiter and give a better contrast with the black stripes. Precoated chippings spread thickly were rolled into the asphalt to provide a rough-textured surface. Eight other crossings have been laid in which the black and white stripes are formed with precast concrete blocks. Three have been in service for five, four and two years respectively, and all of them have behaved well. They use blocks 4 in. thick and 1 ft square. More recent crossings using blocks 3 in. and 2 in. thick have been laid in Stepney. The blocks are made of coloured concrete ¾ in. to 1 in. thick, backed with high-quality ordinary concrete.

(Extracted from 'The Engineer'-January 22, 1954)

7. ROAD SYSTEM PROPOSED IN MIDDLE EAST

A SCHEME to link the capitals of the northern Arab countries from the Mediterranean to the Persian Gulf is being sponsored by the Rockfeller Institute. The cost of the highway network will be 100 million dollars—60 million dollars to be paid by the institute.

The establishment of a high-speed overland link connecting the three Mediterranean ports of Latakia (Syria), Beirut (Lebanon), and Tripoli (Libya) with the three Persian Gulf ports of Basra, Kuweit, and Damman would give overall advantages to the Levant and the Arabian peninsula.

The proposed highway takes into full account the required movement of heavy traffic to the oil producing area of Iraq, Kuweit, Saudi Arabia, Bahrein, and the Qatar Peninsula. Through the Latakia-Allepo-Deiraz Zour-Baghdad route, the oil producing areas from Mosul to Basra could be supplied from the west directly through the ports of Latakia, Beirut, or Tripoli. In the event of anything happening to the Suez Canal which might stop shipping through it, the proposed highway would be extremely important for contact with the west.

(Extracted from 'Engineering News-Record'-3-9-1953)

8. DURABILITY OF CONCRETE—SOME UNSOLVED PROBLEMS

Problem.—Portland cement concrete is the most commonly used structural material where known strength and adequate resistance to the disintegrating forces of natural exposure are important factors. The present state of knowledge enables the engineer adequately to design for strength. It does not make full provision for designing for adequate durability where severe weathering is encountered.

Present State of Knowledge.—The weathering failure of concrete is generally considered to consist of two major types of deterioration, and a combination of these disintegrating factors:

1. Failure in resistance to freezing and thawing, wetting and drying, and associated temperature changes—conditions ordinarily encountered in temperature climates.

2. Failure due to chemical reaction between the cement and certain aggregates frequently used in concrete construction. This reaction is frequently referred to as alkali aggregate reaction.

The chemical composition of the cement has not been shown to have any significant relationship to the resistance which concrete offers to ordinary weathering action.

The inclusion of 4 to 6 per cent, by volume of air in concrete has been found to increase substantially the resistance to freezing and thawing.

High alkali cements (0.80 per cent or more) have been found to be very likely to cause adverse chemical reaction between the cement and certain aggregates, particularly aggregates containing opal, and certain volcanic glasses. There is reason to believe that other characteristics of the cement also effect this reaction or produce similar reactions.

Questions that Need to be Answered:

1. What is the mechanism which causes the failure of Portland cement concrete under normal outdoor exposure to weathering action?

2. What characteristics of the cement and aggregate, physical and chemical, affect resistance to weathering?

3. What are the effects of construction practices, handling, placing, finishing and curing, upon concrete durability?

4. What are the chemical and physical reactions which cause concrete failure with certain cement aggregate combinations?

Present tests for all types of durability are inadequate, and much needed work must be done to develop significant tests to measure these properties.

(Extracted from 'Engineering'—March 19, 1954)

9. CAPACITY OF ROADS

IN rural areas the limiting capacity of various road widths for safe and easy movement has been assessed as follows:

	vehicles per day
Two lane carriageway	3,000
Three lane carriageway	3,000-5,000
Dual two-lane carriageway	5,000-15,000
Dual two-lane carriageway	Over 15,000

(Extracted from 'Surveyor'-17th March 1954)

ROADS IN PARLIAMENT

Answering **Shri Radhelal Vyas and Shri Dabhi,** the Deputy Minister for Transport and Railways, **Shri O. V. Alagesan,** gave out the distribution of the provisional National Highway route milage and the amount expected to be spent on National Highways during the 5-year plan for the various States as under :-

State	Route milage of roads included in the Provisional National Highway system	Amount expected to be spent during the first 5-year plan (Rs Lakh)
Assam	796	84
Andhra	915	240
Bihar	1,173	430
Bombay	1,546	372
Madhya Pradesh	1,199	169
Madras	1,065	89
Orissa	851	128
Punjab	647	169
Uttar Pradesh	1,390	192
West Bengal	722	397
Hyderabad	595	23
Madhya Bharat	491	89
Mysore	330*	-
PEPSU	114	†
Rajasthan	402	37
Saurashtra	284	50
Travancore-Cochin	256	51
Delhi	44	27
Himachal Pradesh	222	102
Kutch	66	33
Vindhya Pradesh	164	1
Ajmer	68	3
Sikkim	39	14
Manipur	98	**
Total	13,477	2,700

Answering **Shri V. Muniswamy** the Deputy Minister of Transport and Railways **Shri O. V. Alagesan** said that the policy in regard to construction of high level bridges under the National Highway Scheme was to provide such bridges at crossings where traffic is interrupted frequently and for long periods. Also bridges on the more important National Highways, classed as arterial, were given precedence over bridges on the less important National Highways.

* Mysore has not yet joined the National Highway Scheme.

† Included in the amount provided for the Punjab.

** Included in the amount provided for Assam.

CURRENT LITERATURE

ABSTRACT

U. D. C. 666-97/.98 (083 13) (54) - CODE OF PRACTICE FOR PLAIN AND REINFORCED CONCRETE FOR GENERAL BUILDING CONSTRUCTION, Indian Standard No. 456-1953; Indian Standards Institution, Civil Lines, Delhi-8, Price Rs 4/12/-.

This Standard deals with the Code of Practice for cement concrete and reinforced concrete for general structural use. For special structures such as tanks, chimneys, shell structures, etc., the Code may be applied with such modifications as are necessary to suit special conditions.

The subject matter is dealt with under the following heads: Terminology; Symbols; Materials; Concrete Mix; Design; Workmanship; Inspection and Testing.

Under the head "Concrete Mix", it is recommended that concrete should be classified as an ordinary concrete or controlled concrete. Proportions and strength requirements for ordinary concrete are detailed. Permissible stresses for compression, shear, and bound, both for ordinary and controlled concrete, are given.

Under the head "Design", a table giving the permissible stresses in reinforcement is included.

In the section "Workmanship", recommended practice for measuring, placing and compacting under subaqueous conditions is given. Rules for formwork and procedure for removing formwork are also given.

Ten appendices giving specifications for cold twisted steel bars for concrete reinforcement, preliminary test for compression strength of concrete, field method of determining the required adjustment for bulking of sand, works test for compressive strength of concrete, slump test, specifications for welding of reinforcements, etc., are included.

U. D. C. [illegible] 166.3 SCOUR AROUND PIERS—Research Report No. 13-B, Highway Research Board, U. S. A. (1951).

The report contains two Papers dealing with scour around piers. The first Paper "Model Studies of Scour Around Bridge Piers and Abutments" is a progress report of an investigation on the subject. The programme of research has been divided into four phases as under :

1. Geometry of Piers and Abutments.
2. Hydraulic characteristics of the stream, primarily the velocity and depth of flow.
3. Sediment characteristics.
4. Geometry of channel cross-section and alignment.

The investigation was conducted on models, dimensional details of which are given. The technique of experiment is fully described.

The investigation is continuing and some of the results obtained are as under:

1. The alignment of the pier with respect to the directions of the current influences the scour depth more than the shape of the pier.

2. The depth of scour increases with the increase in the angle which the central line of the pier makes with the direction of flow.

3. Depth of scour for webbed piers, i. e., piers, with columns connected by a diaphragm, is more when the superstructure is supported by two columns without any web.

4. When there is no web, a separate scour hole is found at each shaft of the pier. At small angles of approach the downstream shaft is shielded, so the depth of the scour hole is shallower. However, as the angle of approach increases the

downstream shaft becomes subject to currents of higher velocity deflected from the upstream shaft so that the deepest scour occurs in the downstream hole.

5. The web has a pronounced effect —a scour depth two times that which is got when there is no web, is attained for current approaching at 30 degrees.

The second Paper " Investigation of Flexible Mats to Reduce Scour Around Bridge Piers " describes laboratory experiments on the subject.

It was found that the two greatest hazards to the effective functioning of such mats were (1) the tendency of upward currents to move material up through the mat, and (2) the tendency of the mat to bridge or buckle due to bottom irregularities, thus opening up underchannels through which bed material is easily transported away.

The best protection was afforded by a heavy completely flexible mat with comparatively small openings. Prototype construction of such a mat could be from worn chains, which with hot-dip galvanizing should have long life. Placing gravel under the mat at the time of installation greatly improved its effectiveness. The size of the gravel was such that it would be unable to pass through the mat. The combination, which apparently functioned as an inverted filter in preventing bed material from being carried up through the mat, provided complete protection against local scour around the pier until the bed of the entire stream had degraded to such a low elevation that the chain mat was no longer able to follow the bed down around its periphery.

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(Continued from page 8)

dams and large reinforced concrete structures. The type of large weigh-batching plant used on such sites is hardly suitable for smaller civil engineering or building sites, but there are on the market several types of small weigh-batching plants, consisting essentially of a weighing hopper fitted with a spring balance, which are excellent for smaller sites and their use is strongly recommended.

The variation in the strength of concrete made using a weigh-batching plant is less than that made using conventional volume batching. This means that if a minimum strength is specified the mean strength for which the concrete mix must be designed will be lower with weight than with volume batching and thus, with a weigh-batching plant, a mix with a lower cement content can be used.

Weigh-batching gives a further simplification in that no allowance need be made for the " bulking " of the fine aggregate. The amount of water presents in both the fine and the coarse aggregate must however be allowed for when determining the quantity of water to be added to the mix. This may amount to several gallons in a large mix but the actual amount must be calculated by determining the water content of representative samples of each aggregate, either by drying them out or by the use of one of the recognised specific gravity methods.

The actual amount of water to be added to the mix can be measured by volume or by weight. Siphon tanks are fitted to many mixers. It is important that these siphon tanks and associated valves and joints are working properly, check tests of the tanks should be made by measuring a discharge of water and comparing this with the reading on the tank measuring device.

(To be continued.)

SELECTED RECENT LITERATURE IN ENGINEERING JOURNALS

X. BRIDGES AND OTHER STRUCTURES

1. **Creep Tests on Prestressing Steel ;** P. W. GRIFFORD, *Magazine of Concrete Research*, No. 14, December 53, pp. 71-74.

2. **The Strength of Plain, Reinforced and Prestressed Concrete under the Action of Combined Stresses, with Particular Reference to the Combined Bending and Torsion of Rectangular Sections ;** HENRY J. COWAN, *Magazine of Concrete Research No. 14*, December. 53, pp. 75-86.

3. **Analysis of Rigid-Jointed Plane Frameworks, Use of an Electronic Digital Computer ;** R. K. LIVERLEY AND T. M. CHARLTON, *Engineering*, February 19, 54, pp. 239-240.

4. **Stresses in a Tanker During Launching - Strain Gauges for Testing Large Structures ;** A. J. JOHNSON AND M. MAK, *Engineering*, February 19, 54, p. 238.

5. **Structural Approach to Aeroelastic Problems ;** D. WILLIAMS, *The Engineer*, February 26, 54, pp. 315-317.

6. **Testing of the Arrovo Seco Prestressed Concrete Bridge ;** *The Engineer*, February 26, 54, pp. 330-331.

7. **Strap Steel for Prestressed Concrete Structures ;** K. P. MILBRADT, *Journal of the American Concrete Institute*, January 54, pp. 357-363.

8. **Municipal Engineering in 1953, Highway Bridge Construction and Maintenance ;** THE SURVEYOR, *Special Annual Issue*, February 27, 54, pp. 6-9.

9. **Welding for Repair and Strengthening of Bridges ;** PERRY V. PENNYBACKER, *Western Construction*, January 54, pp. 77-80 & 84.

10. **Eight-Lane Bridge in Vancouver, BC. ;** *Roads and Engineering Construction*, December 53, pp. 105-123.

11. **Shallow Depth in Bridge, Use of Prestressed Concrete Deck Slabs ;** *Engineering*, February 5, 54, p. 181.

12. **Reinforced Annular Plates, Design for Minimum Weight under Lateral Loading ;** RAYMORD HICKS, *Engineering*, March 12, 54, pp. 335-336.

13. **Fabrication and Erection Methods for All-Welded Expressway Viaduct** H. H. TARZIAN AND P. K. JONAS, *World Construction*, January-February 54, pp. 29-34 & 38 & 42.

14. **Prestressed Concrete Bridge Completed in Queensland ;** *Commonwealth Engineer*, February 54, p. 278.

15. **The Proposed Suspension Bridge over River Severn. Experimental Work on Design ;** *Highways and Bridges and Engineering Works*, March 17, 54, p. 4.

16. **Inclined-Arch Bridge Spans 250 ft Welded Space Girder Consists of a Pair of Tied Arches Supporting a Diagonal Gird-Beam Floor System ;** THOMAS C KAVANAGH AND CAMILO PICCONE, *Engineering News Record*, February 25, 54, pp. 46-47.

17. **Prestressed Multi-Story Building in London ;** *Concrete and Constructional Engineering*, March, 54, pp. 91-96.

18. **Tests on Prestressed Slabs ;** *Concrete and Constructional Engineering*, March, 54, p. 100.

19. **Prismatic Roof with Small Angular Change ;** A. J. ASHDOWN, *Concrete and Constructional Engineering*, March, 54, pp. 105-109.

20. **Groups of Symmetrically-Arranged Fee-Standing Piles ;** C. E. REYNOLDS, *Concrete and Constructional Engineering*, March, 54, pp. 111-112.

21. **A New Type of Prestressed Pile ;** *Concrete and Constructional Engineering*, March, 54, pp. 113-115.

22. **British Highway Bridge Loading: Mr. W. Henderson's Review of Proposed New Regulations;** *Highways and Bridges and Engineering Works,* March 10, 54, pp. 4 & 6.
23. **Jubilee Bridge, Barrow-in-Furress;** *Roads and Road Construction,* March 54, pp. 76–78.
24. **Load Distribution in Prestressed Concrete Bridge Systems;** P. B. Morice and G. Little, *The Structural Engineer,* March 54, pp. 83–111.
25. **High-Tensile Steel bolts for Structural Joints, No. 1;** *The Engineer,* March 19, 54, pp. 415–417.
26. **Woodhead New Tunnel;** P. A. Scott and J. T. Campbell, *The Engineer,* March 19, 54, pp. 418–420.
27. **Portable Bridges for the U. S. Army;** *The Engineer,* March 19, 54, p. 440.
28. **East Delaware Tunnel: Gallery of Up-to-date Tunneling Techniques;** *Engineering News Record,* March 26, 1953, pp. 32–37.
29. **Built-in Deflections Cut Frame Cost;** R. W. Waterhouse, *Engineering News Record,* March 26, 1953, p. 45.
30. **Formula for Tapered Timber Columns-Field and Office;** *Engineering News Record,* March 26, 1953, p. 90.
31. **Stair Handrail Designed for Simple Fabrication-Field and Office;** *Engineering News Record,* March 26, 1953, p. 90.
32. **Oregon's first prestress job:** G. S. Paxson, *Western Construction,* March 1953, p. 57.
33. **Bending of Wire Ropes in Flying Foxes;** S. C. Robertson and R. A. Dunstan, *The Journal of the Institution of Engineers, Australia,* March 1953, pp. 45-51.
34. **Non-elastic Behaviour of Bridges Under Impulsive Loads;** S. J. Fraenkel and L. E. Grinter, *Proceedings of the American Society of Civil Engineers,* Separate No. 185, April 1953.
35. **Cable Trusses Prestress Bridge - The New Villeneuve St. Georges Bridge over Seine River, Paris;** *Engineering News Record,* April 30, 1953, pp. 33–55.
36. **Plastic Design of Plane Frames for Minimum Weight;** Jacques Heyman, *The Structural Engineer,* May 1953, pp. 125–129.
37. **Prestressed Concrete Bridges and other Structures;** Discussion on a Paper by D. H. Lee, *The Structural Engineer,* May 1953, pp. 130–141.
38. **The Construction of Eight Prestressed Concrete Tanks;** Discussion on a Paper by Col. A. R. Mais, *The Structural Engineer,* May 1953, pp. 141–146.
39. **Vibrations and Buildings—Possible Damage Overestimated;** *The Surveyor,* February 14, 1953, p. 114.
40. **Prestressed Concrete Railway Bridge over River Don at Rotherham;** *Highways and Bridges and Engineering Works,* May 6, 1953, p. 4.
41. **Plymouth-Saltash Crossing - Low Level Bridge (a telescopic bridge);** *Modern Transport,* May 9, 1953, p. 7.
42. **The Claenven Dam;** H. D. Morgan, R.T.C. Walton, and R.H. Falkiner, *Proceedings of the Institution of Civil Engineers, Part I, Vol. 2,* May 1953, pp. 249–310.
43. **Seattle Cuts Tunnel Costs with Unit Ventilation:** *Engineering News Record,* May 7, 1953, pp. 43–44.
44. **Maryland Begins First Prestressed Concrete Bridge;** *Roads and Streets,* March 1953, pp. 84–85.
45. **Low Cost Concrete Bridge has Simply Supported Steel Span;** H. M. Hadley, *Engineering News Record,* May 14, 1953, p. 58.

PUBLICATIONS ADDED TO THE ROADS WING LIBRARY DURING MARCH 1954

The Manager of Publications, Delhi.

1. **Import Trade Control Policy for the licensing period January–June, 1954 C. D. 179.**
2. **Census of India, 1951 Digest of the 1951 Census report for Bombay, Saurashtra and Kutch P. C. C. 81,** by J. B. Bowman. (2 copies)
3. **Census of India, 1951, Volume VI, West Bengal, Sikkim and Chandernagore Part IC–Report P. C. C. 26,** by A. Mitra (2 copies)
4. **Census of India, 1951, Volume IV–Bombay, Saurashtra and Kutch–Part I–Report and subsidiary tables P. C. C. 88,** by J. B. Bowman (2 copies)
5. **A Review of the Council of Scientific and Industrial Research, India, 1954.** (Council of Scientific and Industrial Research, Old Mill Road, New Delhi-2)
6. **Half-yearly Civil List for the Hyderabad State corrected up to 1st October, 1953.** (Government Press, Hyderabad-Dn. 1954).
7. **The Study of road sub-grades-Progress made since the Congress at the Hague (1938) up to Congress at Lisbon (1951) general report presented at the 9th International Roads Congress (In French).** International Association of Road Congresses, Paris (VIII).
8. **Barlow's Tables of squares, Cubes, square roots and reciprocals of all integers upto 12,500, 4th edition (new impression), by L. J. Comrie (E. & F. N. Spon Ltd., 22 Henietta Street, W. C. 2, London, 1952).**

THE EFFICIENCY EXPERT

At one factory the efficiency expert asked a worker: "What are you doing?" and received the reply: "Nothing." He asked a second worker the same question, and was again told: "Nothing."

"Ah," said the expert triumphantly. "Duplication."

BUDGETS AND ADMINISTRATION REPORTS

DELHI STATE BUDGET 1954-55

The following extracts relating to Civil Works have been taken from the Delhi State Budget for the year 1954-55.

(In lakhs of rupees)

	Actuals 1952-53	Revised Estimates 1953-54	Budget Estimates 1954-55
I. REVENUE (Civil Works)			
(i) Transfer from Central Road Fund	2.95	2.67	4.86
(ii) Rents	0.34	...	...
(iii) Contribution from the Government of India towards expenditure on local development works	...	1.20	...
Total	3.29	3.87	4.86
II. EXPENDITURE (Civil Works)			
(i) Original works			
(a) Buildings	1.70	2.36	3.11
(b) Communications	1.80	4.61	7.11
(ii) Repairs			
(a) Buildings	7.26	8.89	9.50
(b) Communications	5.01	4.60	4.60
(iii) Rent Control Establishments	...	0.14	0.01
(iv) Grants-in-aid, Contributions etc.	0.04	0.20	0.12
(v) Local Development Works	...	1.20	...
Total	15.81	22.00	24.45
III. RECEIPTS (Under)			
Motor Vehicles Acts.	18.18	18.79	9.99

A BRIEF REVIEW OF THE DELHI STATE BUDGET FOR 1954-55
(With special reference to Civil Works)

THE total revenue receipts of the State for 1954-55 are estimated at Rs 458.31 lakhs and expenditure at Rs 505.83 lakhs which indicate a deficit of Rs 47.52 lakhs which however, is fully covered by an opening balance of Rs 52.52 lakhs. In 1953-54 total revenue amounted to Rs 435.74 lakhs (Revised Estimate) and in 1952-53 it was Rs 378.02 lakhs (Actuals) while the corresponding expenditure figures were Rs 424.52 lakhs and Rs 336.72 lakhs respectively.

The budgeted expenditure on Civil Works for 1954-55 amounts to Rs 24.45 lakhs which is about 5.3% of the total revenue for that year. The corresponding ratios were 5.05 per cent for 1953-54 and 4.2 per cent for 1952-53.

The expenditure on Communications (Original works and Repairs only) estimated at Rs 11.71 lakhs for 1954-55 works out to 2.6 per cent of the total revenue. The corresponding percentages were 2.1 for 1953-54 and 1.8 for 1952-53.

LIST OF APPROVED WORKS ON NATIONAL HIGHWAYS

S. No.	Job No.	Name of work	Amount (Rs in Lakhs)
		BIHAR	
1.	861 BR 31	Construction of a bridge over Salsalia Nalla in the Assam Access Road diversion National Highway No. 31.	1.04
2.	877 BR 31	Construction of a bridge over Bhatta Nalla in mile 3rd of the Assam Access Road diversion-National Highway No. 31.	1.33
3.	A 878 BR 28	Survey of the road National Highway No. 28 from Muzaffarpur to Baranni junction with National Highway No. 31.	0.17
		BOMBAY	
4.	866 BM 8	Construction of a bridge over the Haladpada Nalla in mile 12/0 of the Tawa-Talasari Section of the Bombay-Ahmedabad Road-National Highway No. 8.	0.87
5.	872 BM 8	Construction of a bridge over the Karanjvira Nalla at mile 10/0 of the Tawa-Talasari Section of the Bombay-Ahmedabad Road-National Highway No. 8.	0.65
		DELHI	
6.	876 DLH 2	Constructing a portion of bye-pass connecting National Highway No. 1 with National Highway No. 2 in Delhi State from Railway Siding to Delhi Mathura road near mile 5/2.	14.43
		HIMACHAL PRADESH	
7.	874 HP 22	Metalling and surface painting of full width of road in Matiana Bazar, H. T. Road.	0.19
		ORISSA	
8.	875 RS 6	Construction of a bridge across the Malti Zone on National Highway No. 6 near Sambalpur.	3.33
		PUNJAB	
9.	863 PB 1	Construction of bridge in mile 144/1 of the G. T. Road (National Highway No. 1) near Basantpur village in Ambala Distt.	0.34

S. No.	Job No.	Name of work	Amount (Rs in Lakhs)
10.	864 PB 10	Electrification of P. W. D. Rest House at Bahadurgarh on National Highway No. 10.	0.02
11.	873 PB 22	Widening Ambala-Kalka Road (National Highway No. 22) from mile 6 to mile 19/4.	5.15
		SIKKIM	
12.	862 SK 31-A	Providing flyproof shutters to the existing doors and windows and new clerestory windows in Rangpo Dak Bungalow at Rangpo.	0.04
		TRAVANCORE-COCHIN	
13.	867 TC 47	Black-topping mile 3/7 to 30 of Trivandrum-Quilon Road (National Highway No. 47) in Trivandrum Division.	7.99
14.	868 TC 47	Black-topping Quilon-Alleppey Road (National Highway No. 47) in Quilon Division.	5.64
15.	869 TC 47	Black-topping mile 40/0 to mile 44/4 of Quilon-Alleppey Road (National Highway No. 47) in Ernakulam Division.	1.40
16.	870 TC 47	Black-topping Chala-Kudi Road mile 8/8 to 13/8 and Vaniampara Road mile 5/6 to mile 15/3 (National Highway No. 47) in Tranvancore-Cochin.	3.22
17.	871 TC 47	Black-topping Kurnamkulam and Chewghat Sections (National Highway No. 47) in Trichur Division.	3.35
		WEST BENGAL	
18.	857 BG 34	Construction of a bridge over the Nagar river in the 9th mile of Raiganj-Dalkhola Section of National Highway No. 34.	4.49
19.	859 BG 34	Construction of a bridge over the Gondhar River in the 8th mile of Raiganj-Dalkhola Section of National Highway No. 34.	2.28

Please mention this journal when replying to advertisements.

A l[illegible]ed number o[illegible] [illegible]e followi[illegible]
publications of the Indian Roads Congre[illegible]
are available for sale.

	Publications.	Price inclusive of p[illegible]age, etc. Rs	A.	P.
1.	Volume IX—Part 4—October 1945	3	0	0
2.	Volume IX—Bound—Madras 1945	10	0	0
3.	Volume X—Part 4—August 1946	3	0	0
4.	Volume XI—Part 4—May 1947	3	0	0
5.	Volume XI—Bound—(Parts 3 & 4) 1947	6	0	0
6.	Volume XII—Part 2—January 1948	3	0	0
7.	Volume XII—Part 3—April 1948	3	0	0
8.	Volume XII—Part 4—March 1948	3	0	0
9.	Volume XII—Part 5—September 1948	3	0	0
10.	Volume XII—Bound—1947-48	12	0	0
11.	Volume XIII—Part 1—December 1948	3	0	0
12.	Volume XIII—Part 2—January 1949	3	0	0
13.	Volume XIII—Part 3—January 1949	3	0	0
14.	Volume XIII—Bound—1948-49	11	0	0
15.	Volume XIV—Part 1—September 1949	3	0	0
16.	Volume XIV—Part 2—December 1949	3	0	0
17.	Volume XIV—Part 3—December 1949	3	0	0
18.	Volume XIV—Part 4—July 1950	3	0	0
19.	Volume XIV—Bound—1949-50	8	0	0
20.	Volume XV—Part 1—August 1950	3	0	0
21.	Volume XV—Part 2—November 1950	3	0	0
22.	Volume XV—Part 3—January 1951	3	0	0
23.	Volume XV—Part 4—August 1951	3	0	0
24.	Volume XV—Bound—1950-51	9	0	0
25.	Volume XVI—Part 2—March 1952	3	0	0
26.	Volume XVI—Part 3—April 1952	3	0	0
27.	Volume XVI—Part 4—October 1952	3	0	0
28.	Volume XVI—Bound—1951-52	8	0	0
29.	Volume XVII—Part 1—December 1952	3	0	0
30.	Volume XVII—Part 2—January 1953	3	0	0
31.	Volume XVII—Part 3—January 1953	3	0	0
32.	Volume XVII—Part 4—December 1953	3	0	0
33.	Volume XVIII—Part 1—December 1953	3	0	0
34.	Volume XVIII—Part 2—December 1953	3	0	0
35.	Volume XVIII—Part 3—January 1954	3	0	0
36.	Road Research Bulletin No. 1	5	0	0
37.	I. R. C. Standard Specifications and Code of Practice for Road Bridges in India (1937)	1	8	0
38.	Proceedings of the Chief Engineers' Conference at Nagpur on the Post-war Road Development in India	2	8	0
39.	Type Designs for Highway Milestones	0	8	0 plus packing and postage
40.	Route Marker Signs for National Highways	0	8	0 plus packing and postage
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42.	Recommended Practice for the Location and Layout of roadside Fuel Filling stations.	0	8	0 plus packing and postage

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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—800.