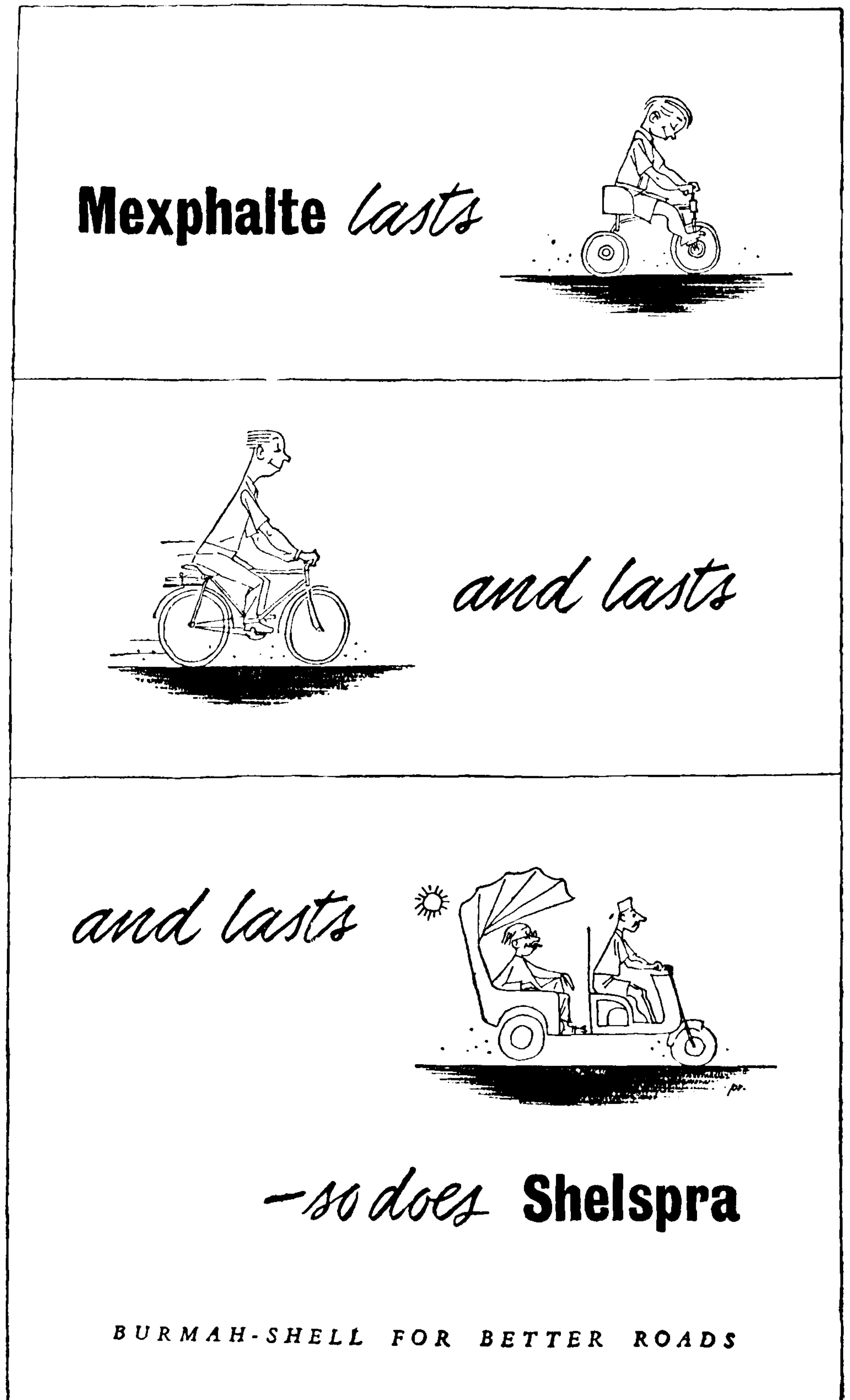
TRANSPORT-COMMUNICATIONS

MONTHLY REVIEW

MAY 1956—No. 109

INDIAN ROADS CONGRESS, NEW DELHI.



TRANSPORT-COMMUNICATIONS
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An Artist's Impression of Road Research Station, Madras.

Lay out of Road Research Station, Madras.

TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

A REVIEW OF
ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

MAY 1956

ROAD RESEARCH STATION FOR MADRAS

THE foundation stone for the building of a Road Research Station for Madras was recently laid by the Governor. The cost of the building, including land acquisition and initially equipping the laboratories, is estimated to cost Rs 13.05 lakhs and will be financed from the allocations to the Madras State from the Central Road Fund. The laboratory will be located on a 35-acre plot of land adjacent to the Engineering College at Guindy. The Government of India have also agreed to meet half the cost of the annual recurring expenditure limited to a maximum of Rs 25,000/- per annum.

The research work at the Station will be carried out in the following four sections:

(1) Soils and Aggregates,

(2) Bitumen and Tar,

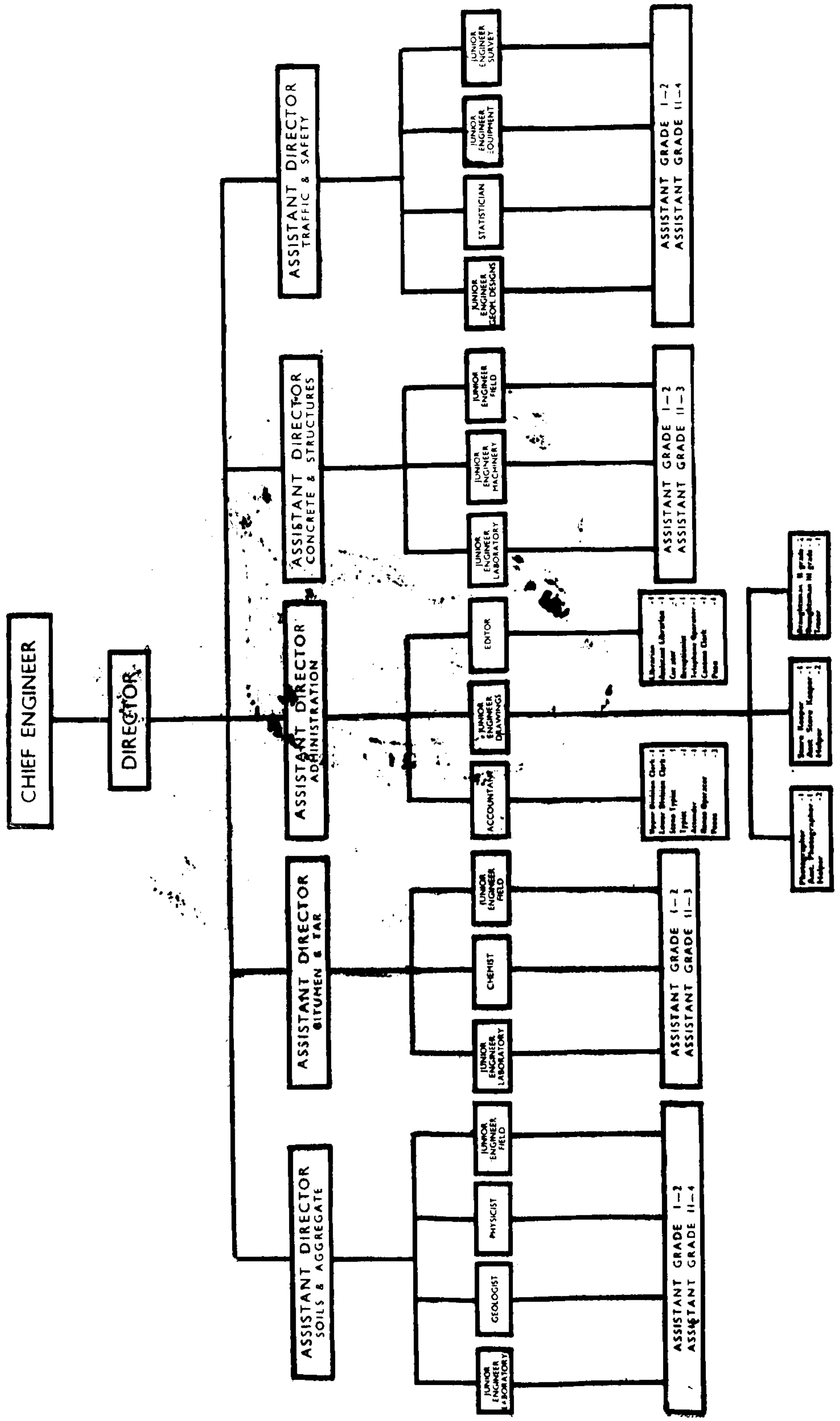
(3) Concrete and Structures, and

(4) Traffic and Safety.

Chart on page 4 gives the organization that is proposed to be set up. The research work in the laboratory will be conducted in co-operation with other highway laboratories, the Central Road Research Institute, and the Indian Roads Congress. A library and a Publications Section with the necessary indexing service to collect and disseminate technical information will also be attached to the laboratory.

The Research Station which will be housed in the new buildings had its beginnings in the year 1948 when a research section consisting of a laboratory, in charge of an Assistant Engineer, was established. This laboratory has been carrying out routine testing of materials and investigating into the foundation problems of bridges. At the initiative of the laboratory a number of experimental soil stabilization works have also been constructed and specifications evolved for utilizing local materials wherever conventional type of road materials have to be imported from long distances. Experience has shown that greater efficiency and economy in road expenditure could be achieved if the activities of research were expanded. The building of this Station is the first step in the scheme of expanding activities.

Requesting the Governor to lay the foundation stone, Shri K. K. Nambiar, Chief Engineer, (Highways), stressed on the need for research and said: "Hitherto we have been depending mostly on discoveries and inventions emerging from researches carried out in foreign lands. The time has come when we should become self-reliant and find solutions for our problems through our own initiative and effort. Failure to do so will consign us to the rank of camp followers of the industrialized nations of the west. No



ORGANISATION CHART—ROAD RESEARCH STATION, MADRAS.

Transport-Communications Monthly Review May 1956

country has ever become great by either secondhand knowledge or by imitative science. It is only when we ourselves contribute to the scientific knowledge of the world, when we ourselves have a share in the shaping of scientific thought in the world and when it is possible for thinkers and leaders of our country to be looked upon as thinkers and leaders of other countries are looked upon by their people that this country would have achieved any kind of greatness.

Also, there is an inherent danger in copying techniques and using materials however successfully adopted in other countries without due consideration being given to their suitability in India as it must be remembered that conditions which are peculiar to this country may not prevail in those countries in which any particular development originated. This is so not only by reason of geography, soil conditions, climate and modes of living but also on account of the non-availability of particular materials and of special equipment in this country which some methods of construction require.

One of the tasks of the Research Stations will therefore be to differentiate between those techniques and materials which are suitable and those which are not and to investigate whether the techniques can be modified to suit Indian conditions. Extensive researches required to evolve new techniques, quite often, cost a lot of money. As the benefits of such new techniques cannot in all cases be protected or cashed back by the individuals, there is ample justification for a national effort in the matter of such research.

The scale of Highway Research in the U. S. A. is very large and the Federal research work is financed from what are termed the "1½ per cent funds" that is to say, 1½ per cent of the total Federal funds allotted to the work on Federal-aid roads is earmarked for traffic studies, surveys and planning and research. This amounts to about Rs 5 crores (roughly about ten million dollars). In addition to the Federal organizations under the Bureau of Public Roads, every State department has its own laboratory. The State laboratories are used primarily for control purposes, but some laboratories undertake research also. The amounts spent by the Government of the United Kingdom on road research amount to about 0.4 per cent of the money spent on road constructions and maintenance. Belgium has planned to spend 0.5 per cent of constructional funds on research on materials and construction; Germany spends about 0.1 per cent of construction funds on research: Holland spends about 1 per cent; Italy about 0.05 per cent; Norway about 0.4 per cent; Spain about 0.1 per cent; Sweden about 0.2 per cent and Turkey about 0.4 per cent per year. "In India road research is lagging far behind others and adequate facilities for investigating into our manifold and peculiar road problems were almost non-existent till recently with the result that we have made extremely little technical progress in road construction. In this connection I may refer to a resolution passed recently at the Chief Engineers' meeting held during the Nagpur Session of the Indian Roads Congress in January 1956, in which it was decided to recommend to Government of India to set apart 1 per cent of the Central Road Fund—State Allocations—towards research and control tests."

The main building which has a plinth area of 35,424 sq. ft is estimated to cost Rs 6.55 lakhs. The cost per sq. ft of plinth area works to Rs 18-8-0.

The total cost of the equipment including apparatus for outdoor experiments needed for the laboratory is estimated to cost Rs 8.00 lakhs.

BRIDGING INDIA'S RIVERS

THE BHAVANIPUR RIVER BRIDGE IN KUTCH

THE Bhavanipur Bridge in Kutch is situated between miles 39/7 & 40/0 of the Roha Bita Road. Prior to the construction of the Bridge, traffic between Bhuj the capital and Bita an important Taluka Headquarters was very much inconvenienced during the rainy season. Among other cross-drainage works provided in the First Five Year Plan was the construction of a Bridge across the Bhavanipur river.

Masonry of Pier in Progress

The work was commenced in February, 1955 and completed in July, 1955 one month ahead of the due date of completion. The completion of the bridge supplied an essential link and is expected to help stimulate local development.

Hydraulic Data:—The catchment area of the river at the site of the bridge is 55.5 sq. miles and the bridge has been designed to pass a maximum discharge of 20,340 cusecs with a velocity of flow of 9.6 ft per sec. The bed of the river is sandy overlying hard brown clay.

Design Features:—The Bridge consists of 6 arches of 40 ft spans each carried over piers constructed in coursed rubble masonry in cement mortar (1 : 4). The piers are 5 ft 9 in. at top with a batter of 1 in 24. The arches were constructed of cement concrete blocks (1 : 2½ : 5).

Since hard and non-yielding foundations were available at depths varying from 20 to 25 ft below the bed, open foundations were adopted. There was considerable rush of water in the foundations from 6 to 8 ft below the average bed level and three pumps, each driven by 10 H.P. engines were employed for pumping out water. The design of abutment piers and the arch was as per I. R. C. Standards.

Loading:—The bridge is designed for I. R. C. class A loading.

Centering for Arches

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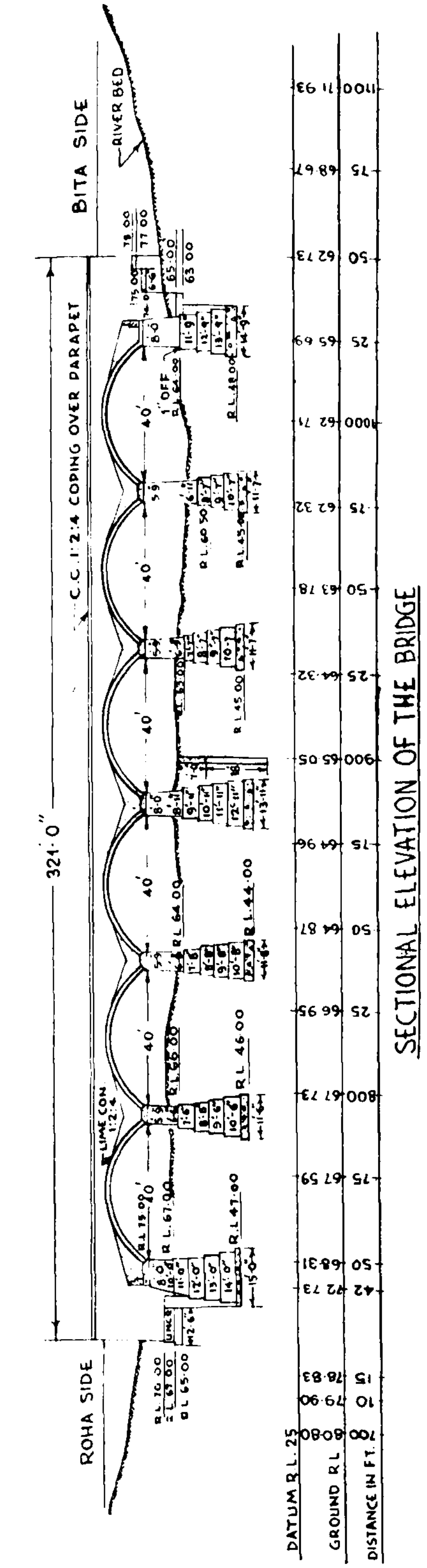
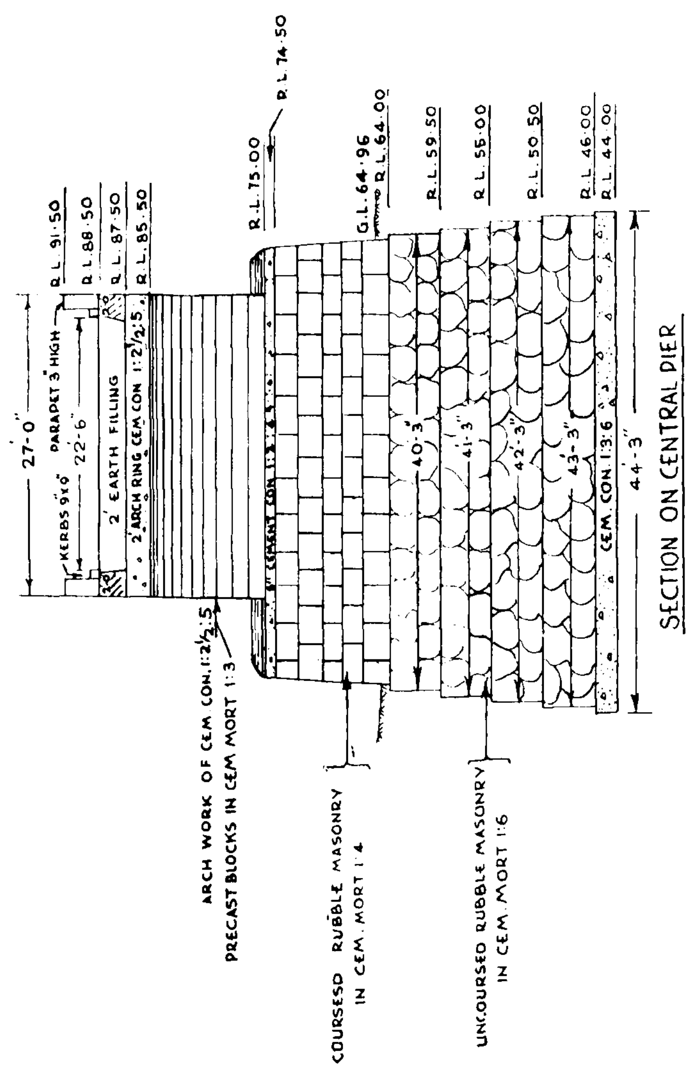




Completed Bridge

Roadway :—A Roadway of 22 ft 6 in. width with masonry parapets 3 ft high.

Materials :—Materials such as stone, metal, lime, etc. were available near the site. Cement was imported from outside.

Cost of the Bridge :— The total cost of the bridge is Rs 1,43,000/- as detailed below :—

Foundation upto bed level	Rs 41,000/-
Piers, abutments, etc. above the bed level	Rs 21,000/-
Superstructure.	Rs 78,000/-
Miscellaneous.	Rs 3,000/-
Total	Rs 1,43,000/-

The cost per running foot of the bridge works out to about Rs 450/-. The cost per sq. ft of carriage way is about Rs 20/-. The total cost per sq. ft of elevation area is about Rs 16/-.

DEFINITIONS OF HIGHWAY ENGINEERING TERMS

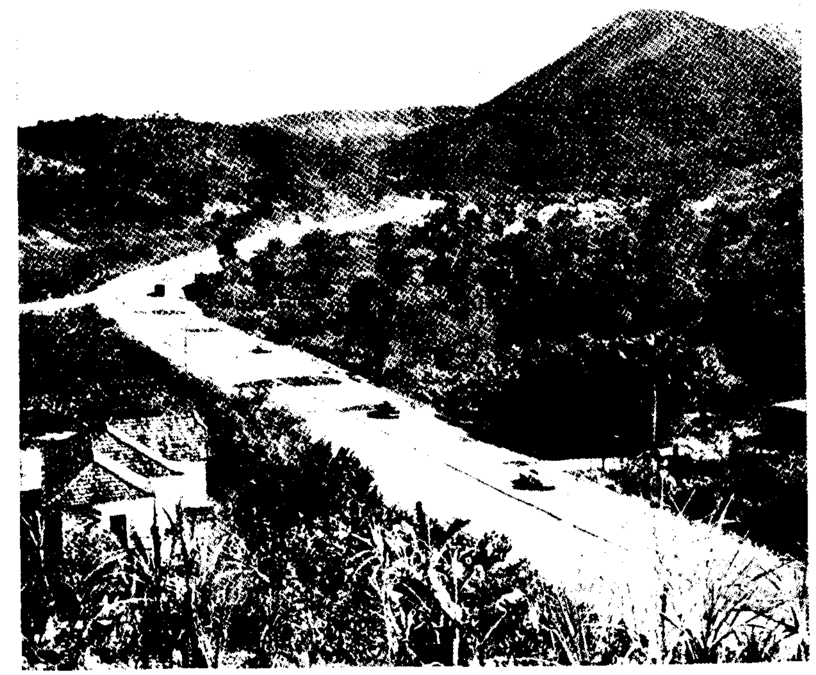
PIER : An intermediate support between the end supports of a bridge or a culvert.

ABUTMENT : An end support of the superstructure of a bridge or similar structure generally sustaining the pressure of the abutting earthwork.

HIGHWAYS IN BRAZIL

Transport in Brazil

HALF of the South American continent is Brazil. It is one of the four largest countries in the world, yet in transportation development it ranks, in relation to its area and population, far below many countries a fraction its size.



A stretch of the MotorWay between Figueira and Tribobo, in the State of Rio de Janeiro

There are approximately 22,000 miles of railway track in Brazil. Its highways, including all classifications, total about 1,90,000 miles, but less than 2,000 miles have paved surfaces. The railways and highways, however, are supplemented by more than 23,000 miles of navigable rivers and 4,000 miles of Atlantic coast.

Transportation, obviously, is the primary bottleneck to more intensive development of the country. Air transport is well advanced but aviation hardly touches the real problem, even though Brazil rates with the leading nations of the world in the length of airlines and volume of traffic.

Brazil needs, possibly more than anything else, a means of moving food and merchandise economically and swiftly, so that more may be offered at prices which a larger proportion of the population can afford to pay.

Especially necessary is cheap and efficient transportation for fuel and raw materials to aid industrial expansion, and also low-cost, flexible transport of goods intended for export, to give the country a better competitive position in world trade. Highway transportation is increasing rapidly in importance in Brazil. The whole trend is toward motor travel, which is becoming the principal medium of transport. In the economic expansion of the country today, emphasis is on highway development.

Road Finance

Steps were undertaken several years ago to correct Brazil's basic transport problems. The first was the prepartion of a road construction plan and, subsequently, on December 27th 1945, a decree law was passed providing legal authority for creating a National Highway Fund, reorganising the National Highway Department and establishing a highway council.

Revenues for highways are derived from levies on liquid mineral combustibles and lubricants, whether imported or produced locally. Forty per cent of the tax is earmarked for the federal highway department and 60 per cent for the States, Federal District and the territories. The apportionment of these funds is governed by considerations such as the requirement that states submit plans for approval, possess satisfactory administrative machinery, and contribute appropriate sums for highway work from their budgets.

Every one of Brazil's 21 states and four territories has an organised highway department.

Priorities

Under Brazil's general plan for road development, priority is given to construction in the populated coastal sectors and to international links with Uruguay, Argentina and Paraguay. With this priority satisfied, it is hoped to build a network of highways in the extreme southern sector and a series of transversal roads which will partially open vast central and north-eastern portions of the country. These would provide extensions to the bordering countries of Bolivia, Peru, Colombia, Venezuela and the Guianas.

Brazil is already planning a 32,000-mile network of transversal national highways.

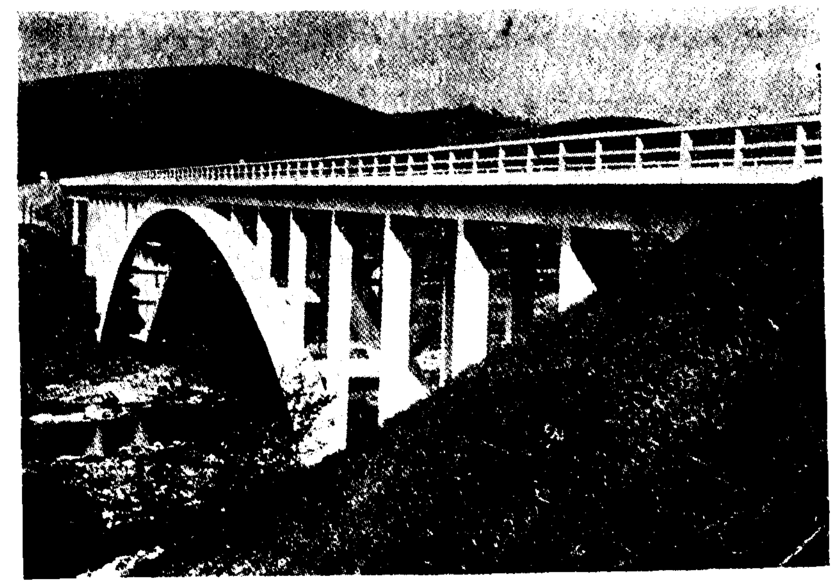
For the time being, road construction activity is concentrated in what is called

The Highway System of Brazil.

Brazil's "economic triangle" formed by Rio de Janeiro, Sao Paulo and Belo Horizonte.

In addition to the national highway programme, many of the state governments have impressive programmes of their own.

"The government expenditures on new highways are being quickly recovered in increased tax revenue from the commercial expansion that the roads make possible. Most importantly, the welfare and living standard of the people are improving as a result of the roads".



In the State of Rio de Janeiro the road expenditures are proving a good investment. "New roads are greatly improving conditions in the State and opening the way to new outlets for local products and increasing economic prosperity", private enterprise is starting new industries, mechanising farming and increasing cattle production.

More than 70 per cent of Brazil's existing roads are in the east and south coastal region. The north, with 40 per cent of the total area, has less than one per cent of the roads ,and railways. Highways are certainly in Brazil's future, as Brazil's future lies in highways.

(From 'International Road Federation Publication' No. 18, Autumn, 1955.)

PRESTRESSED CONCRETE FOR HIGHWAY BRIDGES

PRESTRESSED concrete is, concrete which is placed under stress before it is used to perform its structural task. The prestress can be applied in two main ways: by pretensioning or post-tensioning. In pretensioning the stressing member is tensioned before the concrete is poured around it, and in post-tensioning the stressing member is tensioned after the pouring of the concrete.

Pretensioning methods differ mainly only insofar as they use different sizes of wire or strand. An exception to this is the little-used Chalos or Schorer method, where wires interlaced around a sheath are pretensioned against the reaction of a steel core within the sheath to form a flexible pretensioned cable which is placed in the form work before the concrete is poured. After hardening of the concrete the core is removed and the interior of the sheath is grouted.

Apart from the die-stressed wire-winding methods and the looped cable method, which employ no specially manufactured anchorage unit, post-tensioning systems differ in general only as to the use of wires, strands, bars, or cables and different types of anchorage units.

One difference between post-tensioning methods which is of considerable practical importance is that methods employing button-headed wires, threaded bars or strands with factory fitted end anchorages require the prestressing steel members to be ordered and cut to very exact lengths, whereas the other methods require, at most, only site cutting of steel into approximate lengths.

On the other hand those methods where the anchorage depends upon wedge action have the disadvantage that it is difficult, especially with short tendons, to obtain the required elongation after tensioning and anchoring within close tolerances.

In Table I the types of prestressing tendons now available to the engineer are listed and classified. At the present time they are all of high tensile steel in some form. This situation is very likely to change within the next few years and materials other than steel will be used for the prestressing of concrete. Partially financed by the United States Navy, research work has been going on for some years at Princeton University on the use of rods of glass fibres as prestressing members. The technical results have so far been very encouraging, and a small number of concrete beams prestressed with glass fibre rods are already in structural use. As soon as economic difficulties can be overcome, both rods and ropes of glass fibres and possibly other materials can be expected to enter into the prestressing field.

Table I

MAIN TYPES OF PRESTRESSING MEMBERS

	Classification	System	Country of Development
Pre-Tensioned Steel	Individual Wires	Wettstein Hoyer Weinberg	Austria Germany France
	Individual Strands	Concrete Products of America	U.S.
Post Tensioned Steel	Made-up Cable of wires and sheathed core	Chalos	France
	Cables of Parallel Individual Wires	Freyssinet Magnel Button-Heads Preload-Linear Leoba	France Belgium Switzerland-U.S. U.S. Germany
	Individual Strands	Roebling	U.S.
	Individual Bars	Lee-Macall Stres Steel Finsterwalder	Britain U.S. Germany
	Large Factory Spun Cables	Dischinger Lossier	Germany France
	Looped Cables of Parallel Strands	Leonhardt	Germany
	Individual Wire Passed Thru Die	Preload Circular	U.S.

Special Anchorages Required.

APPLICATIONS

Spans up to 40 Feet

Small bridges with spans of less than 40 ft, can usually only be economically constructed in prestressed concrete when mass-produced and locally manufactured precast units are used. These units are normally in the form of pretensioned beams which are laid side by side to form the bridge deck. Post-tensioning will not be economical for such small spans until anchorage costs can be reduced but may occasionally be used in conjunction with inexpensive mass-produced precast blocks.

Spans 40 Feet to 70 Feet

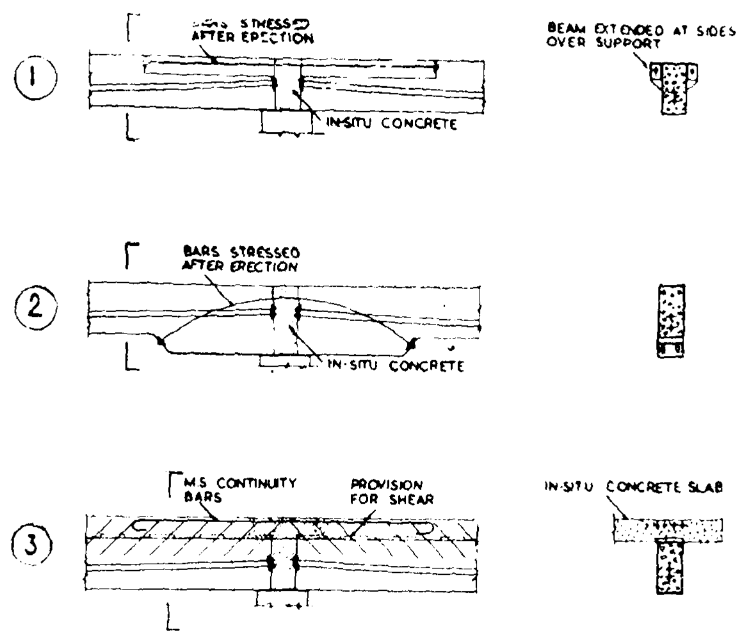
Where clearance or architectural requirements require depth-span ratio about 1/25 to 1/30, bridges in this span range will have a slab section—either full or cored. This slab section may either be cast-in-place or assembled of precast strips for which the economic advantage of pretensioning dies out with increase of span. Continuity may frequently be introduced with economy, especially in conjunction with cast-in-place techniques.

By the use of transverse prestressing in the deck the need for a cap over the pier is eliminated, the biaxially prestressed slab having a higher shear resistance. The resulting slenderness of line is very pleasing architecturally.

Where depth-span ratios between 1/12 to 1/20 are acceptable, the superstructure weight and final cost can be cut down by using composite construction—a conventionally reinforced concrete slab cast-in-place upon and keyed to precast prestressed girders usually at 6 ft to 8 ft 6 in. centers. These girders may be either pretensioned or post-tensioned with post-tensioning more likely for the larger spans. Continuity can also be introduced into such a superstructure, if desired, in one of the ways indicated in Figure.

it is desirable to introduce into the design.

Where precasting has advantages, and this becomes less likely as the span increases because of the greater weights to be handled, a number of T-girders can be placed side by side with their wide top flanges constituting the structural deck slab. Such girders would for the larger spans probably be precast one at a time at the bridge superstructure level and then slide sideways into position. The composite approach can also be used to lighten the precast girder weights at the price of a slight increase in superstructure depth. An example of this is the recently constructed three-span Maria River Bridge in Venezuela which is especially interesting as the 5 ft deep



CONTINUITY BY JOINING OF PRECAST PRESTRESSED SIMPLY SUPPORTED BEAMS

Spans 70 Feet to 200 Feet

In the 70 ft to 200 ft span range different solutions are adopted according to the amount of precasting, if any, that

82 ft and 99 ft long girders were precast in approximately 20 ft lengths and trucked 200 miles to the bridge site where they were assembled on falsework and prestressed together.

With casting-in-place the superstructure cross-section is usually very different to that adopted for precasting. Box girder or open T Sections are normally chosen for cast-in-place spans in this range which may be either simply supported or continuous.

Spans 200 Feet to 400 Feet

With continuous spans and cast-in-place construction the double T-girder superstructure is still economical for the smaller spans in this range. A fine example of this is the recently completed 5-span continuous bridge over the Danube Valley near Ulm in Germany with main spans of 230 ft.

With single spans, however, arched soffit girder bridges are resorted to in order to cut down dead weight. These can be either cast-in-place as will be the 216 ft span counterweighted prestressed box-girder bridge at Little Falls, Maryland or precast as were Freyssinet's five celebrated Marne River bridges near Esbly, France. Precasting would of course, certainly not have been justified in the latter case had there not been several such bridges.

The progressive cantilever method of construction has been used for some large span prestressed bridges in Germany. This method is used for a bridge with a main span of 375 ft. Using high early strength cement the concrete cantilevers are cast-in-place in 10 ft lengths outwards from the piers using a counterweighted and movable steel scaffolding from which is hung an adjustable form. Each newly cast length is prestressed back to the piers using 1 in. dia. high strength bars.

Spans over 400 Feet

Over 400 ft in span one must turn to arch bridges. Such a type is one of three similar bridges carrying a new six lane highway from the capital of Venezuela to its airport.

(From 'Bulletin of the University of Utah' Vol. 46, June, 1955, No. 5.).

THE DICTIONARY LET HIM DOWN

A foreigner employed on building work in Britain did not find the language easy, but with native tenacity did his best with the aid of a dictionary. An official form sent to a Government Department in regard to his stay here was returned to him for correction. He could not understand why. In answering the question "Length of residence in England" he had written 45 ft — after measuring the distance from front to back of the building in which he was housed.

SETTING OUT ROAD CONSTRUCTION WORK

(Concluded from April, 1956, T. C. M. R.)

Setting Out in Rough Steep Timbered Country.

THE procedure is the same as described for easy country above with the differences described hereunder.

Setting Recovery Pegs.—In steep country, it is often impossible to measure a distance from centre-line peg to recovery peg in one stretch of a level tape. In such a case, measure in a series of stretches of a level tape. If the country is particularly uneven, the distance may be measured on the slope, reading the angle of elevation or depression with a theodolite, and applying the slope correction to the chainage.

The distance from the centre-line peg to recovery peg cannot readily be kept at an even distance in many instances in heavily timbered country owing to uneven ground, rocks, trees, etc. It is particularly important to have the recovery distance accurately recorded in these instances.

Where the cross-slope of the ground exceeds 20 degrees, recovery pegs placed on the low side are of little value as timber or stone may cover them or hit them as construction of the road proceeds. In this case, two recovery pegs should be placed on the high side of the road at a minimum distance apart of 20 feet (see Fig. 4).

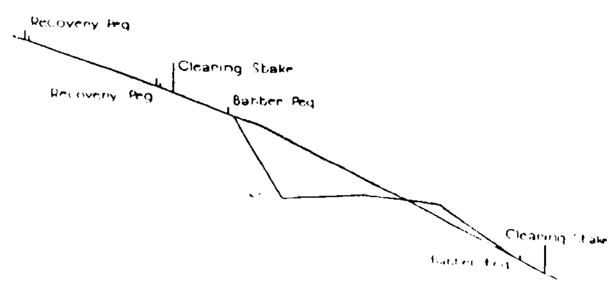


Fig. 4.
Layout of Pegs in Steep Country
Note Two Recovery Pegs on High Side

Batter Pegs.—If the ground is very uneven, the location of batter pegs cannot be scaled off from the plan with sufficient accuracy. If it is not desired to repeat the cross-sectioning survey to greater accuracy in order to scale off the batter distance, one of several alternative methods may be used.

Method A.—As can be seen from Fig. 5, the correct batter distance $d = \frac{W}{2} + hS$,

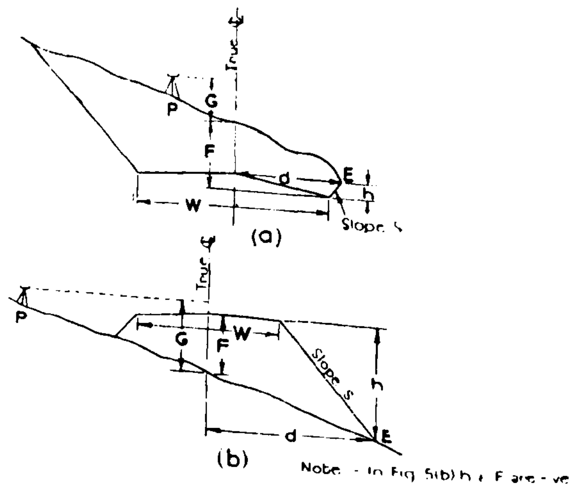


FIG 5
SETTING BATTER PEGS

where W is the width of formation, h is the height of top of batter above or depth of toe of batter below, finished surface level at the edge of formation, and S is the slope ratio ($1\frac{1}{2}:1$, $\frac{3}{4}:1$, etc.).

W and S are known values, and h has to be determined. Set up the level at P and read the staff on the centre-line peg (reading G). The value of F can be read from the plans.

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INDIAN ROADS CONGRESS, NEW DELHI.

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When the staff is at the correct batter position E, the reading on the staff (R) is $G+F-h$, and $h = \frac{d}{S} - \frac{W}{2S}$.

Suppose $G=8.8'$ (read through level).

$F=5.2'$ (read from plan.)

$S=1:1$.

$W=28'$ (read from plan),

then the correct staff reading $=8.8'+5.2' - \left(\frac{d}{1} - \frac{28}{2}\right) = 28' - d$.

The staff is moved until the staff reading agrees with the figure given by formula.

i.e., If d is set at 15′, and R is read at 11.8′. By formula R should be 13′.

Move out to d = 20, and again read R (say 12.8′).

By formula R should be 8′.

Move in to d=17, and read R (say 12.2).

By formula R should be 11′.

Move to d=16, and read R (say 12.0′).

By formula R should be 12.0′ so that the correct batter distance is 16′.

This method has the added advantage that the level of the batter peg can be taken and recorded and under suitable conditions, it can be used as a recovery peg.

Method B.—This method consists of setting out batter peg as scaled from the plan, and correcting them by using a tape, level and staff.

The procedure is as follows :—

(i) From the plan cross-sections scale the distances from the tops or toes of batters to the centre line, and using these measurements place temporary batter pegs. (Pegs A).

(ii) Take levels on the temporary batter pegs and so determine their heights above the finished surface levels at the respective edges of formation.

(iii) Prepare tables giving the distances of tops of batters from the centre line for varying heights of tops of batters above the finished edge of formation levels.

(iv) Using the heights determined in (ii) check from the tables the distances at which the Pegs A have been placed, and then adjust the positions of Pegs A, as necessary, to the table distances, making allowances for any appreciable alteration in level due to the adjustment in the distance. (Pegs B).

The method for making allowance for alteration in level due to adjustment in distance is best explained by an example.

Example :—Scaled batter distance = 15 feet 3 inches (Peg A).

Height of Peg above finished edge of formation level = 2 feet 8 inches.

As per tables, correct batter distance for this height = 16 feet 9 inches.

Therefore correct position for Peg B (at height of Peg A) = 16 feet 9 inches from centre line.

If the ground level at Peg B is 6 inches above that at Peg A, and the batter is $1\frac{1}{2}:1$, the final correct position for Peg B is 16 feet 9 inches + (6 inches × $1\frac{1}{2}$) = 17 feet 6 inches.

Setting Out in Built-up Urban Areas.—Methods of setting out in built-up areas differ from those used in rural setting out, as follows :—

(i) Greater accuracy is required. For concrete road work a finished road surface accuracy within $\frac{1}{8}$-inch should be aimed at. When the subgrade level has been reached, a precise level should be used to set the level for the form work. For both bituminous and concrete roadworks, extra pegs will usually be required, set with a precise level, at street intersections and for drainage control.

(Continued on page 28)

"S"

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"V"

HERE AND THERE

1. FOURTH INTERNATIONAL CONFERENCE ON SOIL MECHANICS AND FOUNDATION ENGINEERING

● THE Fourth International Conference on Soil Mechanics and Foundation Engineering will be held in London from the 12th to the 24th August 1957. The first three Conferences were held at Cambridge, Massachusetts, in 1936, at Rotterdam in 1948, and Zurich in 1953. The object of the Conference is to establish opportunities for discussion of problems between specialists from all parts of the world and to further the spirit of co-operation created by the previous Conferences.

The Organizing Committee for the Fourth Conference under the chairmanship of Dr. W. H. Glanville invites Papers on the following subjects:—

(1) Soil properties and Their Measurement;

(2) Techniques of Field Measurement and Sampling;

(3) Foundations, Other than Piled Foundations, of Structures;

(4) Piling and Piled Foundations;

(5) Roads, Runways and Rail Tracks;

(6) Earth Pressures on Structures and Tunnels; and

(7) Earth Dams, Slopes and Open Excavations.

Papers must be original and must deal with the real advancement of the theory and practice of soil mechanics and foundation engineering. These must be submitted, in the first instance, to the National Committee of the Author's country. The address of the Secretary of the National Committee in India is: Curzon Road Barracks, New Delhi.

2. DATA IS ESSENTIAL FOR PLANNING A PUBLIC WORK

● THE lack of data may have several unfortunate results:

(a) **Under-design or over-design.**—Lack of data results in a too optimistic or pessimistic view being taken either in regard to essential information such as foundation conditions.

(b) **Inefficient Operation.**—Unforeseen circumstances can so alter the operating conditions of a project that it is impossible to render efficiently the service desired. This immediately results in the annual cost of the service rendered being greatly increased.

(c) **Postponement though Urgent.**—Because only meagre data are available a project may be postponed even though the need for it is urgent and the postponement may entail considerable losses both of production and human benefits.

(d) **Construction though not Warranted.**—If the data available are inadequate but are accepted as a true basis for proceeding with the construction of the project then it may be found that the construction was not warranted.

(e) **Political Expediency.**—Where insufficient data are available a project which, with fuller knowledge, would be condemned is more likely to be authorised on account of political expediency than would otherwise be the case.

(From 'The Surveyor and Municipal and County Engineer,' 11th February, 1956).

3. SEVEN ENGINEERING WONDERS OF THE UNITED STATES

● THE Seven Modern Engineering Wonders of the United States designated by the American Society of Civil Engineers are:

Chicago Sewage Disposal System—involving Herculean excavation; reversal of the flow of the Chicago River and construction of the world's largest treatment works.

Colorado River Aqueduct—serving 66 municipalities in Southern California with water brought almost 250 miles, traversing desert and mountains and involving part canal, part tunnel and part siphon.

Empire State Building, New York City—tallest building man has constructed.

Grand Coulee Dam and Columbia River Basin Project, Washington, has world's largest hydro-electric power plant.

Hoover Dam, Arizona-Nevada—world's highest.

Panama Canal—greatest of georgraphical surgical operations.

San Francisco-Oakland Bay Bridge.

(From 'Highways and Bridges and Engineering Works', March 7, 1956).

4. PREPAKT CONCRETE

● PREPAKT concrete is formed by preplacing aggregate in forms and then filling the voids with mortar.

The coarse aggregate for Prepakt concrete is a graded material ranging from minimum size of ½ to ⅜ in. to any maximum size desired. It may be either crushed stone or gravel, and the shape and texture of the pieces have no particular bearing upon the ease with which Prepakt concrete may be manufactured, nor upon the properties of the hardened product. This graded coarse aggregate is first placed in forms. The coarse aggregate mass is then grouted, either under water or in the dry, through grout pipes or through openings in the forms, the grouting operation being started at the lowest point in the forms. The grout mixture is of such composition that it readily displaces water as it rises in the forms, without appreciable dilution at the surface of contact between grout and water.

The grout employed in the Prepakt concrete is a mixture of portland cement, a finely divided siliceous material designated by the trade name "Alfesil", a small quantity of "intrusion aid", fine sand, and water.

'Alfesil' has a specific surface two to three times as great as that of normal portland cement. Its principal constituent is an amorphous silica which reacts with the lime liberated during the process of hydration of the cement to form insoluble strength-producing compound. In the liquid grout the particles of 'Alfesil' tend to prevent agglomeration of cement particles and decrease the tendency towards bleeding.

The 'intrusion aid' performs several functions. As a protective colloid it inhibits early stiffenning of the grout and therefore acts as a fluidifier; it tends to hold the solid constituents of grout in suspension; and it expands slightly before the time of initial set of the grout, thus neutralizing the effect of the setting shrinkage observed to take place in straight portland cement grouts.

The sand used in grout is finer than that employed in ordinary concrete construction.

Water is added in an amount sufficient to produce a grout of the consistency of thick cream.

The proportions of the several materials in the grout depend on the desired strength of the Prepakt concrete. For a 28-day compressive strength in the order of 5,000 lb per sq. in., a mix composed of 3 parts of cement to 1 of Alfesil to 4 of sand is commonly used. The intrusion aid in the amount of 1 per cent of the combined weight of the cement plus Alfesil is ordinarily employed.

The cement content per unit of volume of Prepakt concrete depends, not only on the composition of the grout mixture, but also on the void content of the coarse aggregate after placement in the forms. For a graded aggregate between the sizes of $\frac{1}{4}$ and $\frac{3}{4}$ in., such as is frequently used for thin sections, the void content may be 45 per cent. For a graded aggregate between the sizes of $\frac{3}{8}$ and 6 in., such as may be used in mass construction the void content after placement in the forms may be as low as 33 per cent.

('New Zealand Engineering, Vol. 11, No. 2, February 15, 1956'.)

5. PLASTIC THEORIES OF CREEP IN CONCRETE

● IT has been suggested that the creep of concrete may be of the nature of crystalline flow, i. e., a result of slipping along planes within the crystal lattice. This would be similar to the plastic flow of metals, and Vogt[1] observed that in some respects the mode of deformations of concrete is similar to that of cast iron and most other brittle materials. For instance, if after a period under a sustained load a cast iron specimen is subjected to additional load, the strain increase is small until the stress-strain curve approaches asymptotically the " virgin " curve, i.e., the curve which would have been obtained by direct stress increase. Similar behaviour was observed by Vogt in short-term tests on concrete specimens.

But plastic flow of metals is a non-elastic deformation which occurs only when a particular stress is exceeded. Some experiments have led Bingham and Reiner[2] to suggest that mortar acts as a plastic solid with a yield point of 65 psi, and neat cement acts like a viscous fluid exhibiting creep at the smallest loads applied and having no perceptible yield value. The value of this yield for mortar is so low as to guarantee little accuracy in its determination, and Glanville's[3] experiments show that, if there is a particular stress for concrete below which no non-elastic deformation occurs as a result of loading,the value of this stress is so small as to be negligible. Vogt and Jensen and Richart[4] observed creep at stresses as low as one per cent of the ultimate strength.

Glanville[5] suggested that the creep of concrete at low loads is of the form of viscous flow, and only near the ultimate load does the deformation take the form of slipping. But the relationship between the non-elastic deformation and stress is a continuous one and produces a similar curve for both low and high stresses.[4],[6]. It is, therefore, reasonable to expect the mechanism of deformations at high loads to be similar to that at working loads.

Probst's[7] tests on concrete members subjected to alternating loading show that, after a number of alterations, concrete ceases to creep and behaves like a perfectly elastic material. No permanent lateral deformation results, which is in marked contrast to the plastic flow of metals, in which there is always a permanent lateral deformation and a loss of stress-strain proportionality for some time afterwards. It may be noted also that while in metals there is little change in volume, although a considerable change in the cross-sectional area, the lateral deformation accompanying the longitudinal creep in concrete under a normal working stress is only about a tenth of that necessary for the volume of the specimen to remain constant.

Thus crystalline flow cannot be wholly responsible for creep. In fact, there is no direct evidence of intra-crystalline slip, although Bernal, Jeffery, and Taylor[8] found change in the layer spacing of calcium silicate hydrates due to moisture movement. On the basis of crystallographic work, they admit the possibility of both inter and intra-crystalline movement.

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(From 'Journal of the American Concrete Institute,' September 1955, No. 1, Vol. 27).

6. WHAT MOISTURE CONTENT IS BEST FOR COMPACTION OF SUBGRADES

● IT is essential that little change in moisture content be allowed to occur in road subgrades subsequent to the construction of the pavement. A change in moisture content will, in the case of clay soils result in the development of surface irregularities in the pavement due to changes in the volume of the soil. Although in the case of granular soils, changes in the moisture content will not directly cause volume changes, they may bring the soil into a condition in which traffic stresses and vibrations are able to produce further compaction with resulting lack of support or settlement of the pavement. With all types of soil, an increase in the moisture content of the subgrade after the pavement is constructed will cause a decrease in strength which may affect the stability of the pavement.

Experience shows that the moisture content of soil beneath road pavements in the British Isles tends to a value which is intermediate between the extreme summer and winter moisture contents of unpaved soil and which depends on the moisture properties and previous moisture history of the soil, the position of the water-table and the weight of the superimposed layers of material. It is possible on the basis of laboratory tests to make an accurate estimate of the moisture content likely to be attained beneath the pavement, but, in practice, little change in the moisture content, will usually take place if the soil is compacted at its natural moisture content, measured below the top 3–4 ft of soil which is affected by weather conditions.

The specifications for the moisture content for the compaction of subgrades should be based, therefore, on the results of moisture measurements made below the top 3–4 ft at the site. If the soil below the top 3–4 ft is of a different type from that in the subgrade, allowance would have to be made for this on the basis of the plastic limits of the soils.

(From " Further Studies in the Compaction of Soil and the Performance of Compaction Plant by W. A. Lewis,-Road Research Technical Paper No. 33.

7. MECHANISM OF BOND BETWEEN CONCRETE AND STEEL

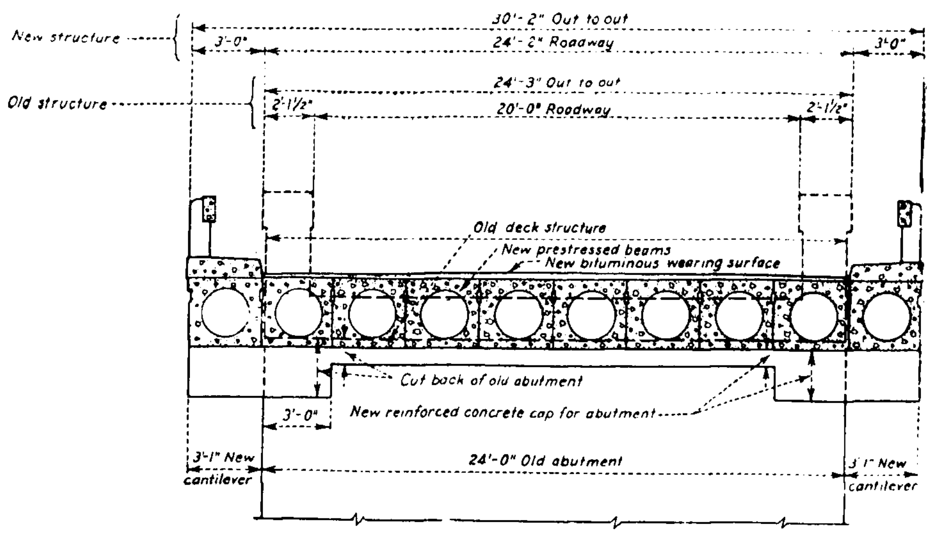
● IT is considered that the bond between concrete and steel consists of three distinct stages. Firstly, the adhesive stage in which the two materials deform together without relative movement. Secondly, the frictional stage in which there is relative movement between the two materials and resistance to this movement is frictional. Thirdly, the bearing stage in which roughnesses or projections on the bar surface press against the concrete in contact with them once sufficient movement between the steel and concrete has developed. The third stage occurs only if the steel has a fairly rough or deliberately deformed surface.

(From 'Journal of the American Concrete Institute' Vol. 27, February 1956).

8. LIGHT-WEIGHT PRESTRESSED PRECAST GIRDERS FOR WIDENING NARROW BRIDGES

● A bridge 44 ft 10 in. clear span between abutments in Cook county, Illinois, U.S.A., had a clear roadway of 20 ft in width. The bridge had large concrete girders very near the edge of the carriageway and they extended vertically several feet above the road level. The narrow roadway with the barrier of these edge-girders was inadequate to meet the increased traffic and it was hazardous for vehicles to pass each other on the bridge. in the centre were placed side by side to form the new bridge. Each of the beams was put in initial compression by stretching $33\frac{3}{8}$ in. 7-strand cables per beam until they were stressed up to 135,000 lb per sq. in. The cables were fastened to anchorages at the ends of the casting beds.

After the cables were stretched, forms were placed around the cables and the



With a view to replace the bridge with one of sufficient width, the abutments were examined and were found to be in good condition. Since a large part of the cost of the new bridge would be saved if the old abutments could be utilized, a light type of construction was decided upon. A new reinforced concrete cap cantilevered 3 ft 1 in. from the edge of the abutments was cast. Precast prestressed concrete beams about 3 ft in width and 3 ft in depth with a circular hollow space concrete poured to make the beams. When the concrete had attained the required strength, the cables were released from their anchorages and in their attempt to shrink back to normal induced the necessary compression in the concrete.

The placing of the beams required only two days compared to several weeks that would have been required had conventional concrete beams been used. A cross-section showing the old and the new bridge is shown in the Figure.

CURRENT LITERATURE

ABSTRACTS

BULLETIN OF THE CENTRAL BUILDING RESEARCH INSTITUTE, ROORKEE, VOL. 3. No. 2. December 1955.

THIS Bulletin contains a narration of the study on the following subjects made at the Central Building Research Institute :—

(1) Foundations on Expansive Clays :

Black cotton soils have high water holding capacity, stickiness when wet and very high shrinkage and swelling capacity, making it unsuitable as a foundation material. A design known as "Mohamed Dean" pattern foundation is claimed to have been successfully used, and a modification of a design based on similar principles is described. It is concluded that these methods take care of the settlement and the opening of cracks but do not provide a satisfactory safeguard against the stresses due to swelling pressure. Further research is indicated.

(2) A Laboratory Study of Indian Black Cotton Soil ;

18 samples from all over India had been analysed for liquid limit, plastic limit, plasticity index, and shrinkage limit.

(3) Blast Furnace Slag as a Building Material.

A review of the available literature on the use of blast furnace slag as a building material is presented and tests on the blast furnace slag produced at the Tata Iron & Steel Co., Jamshedpur, for chemical composition, water absorption, specific gravity and aggregate crushing value are reported. It is concluded that blast furnace slag can be used as an aggregate.

(4) Durability of Sandstones :

(5) Bricks from Black Cotton Soil ;

TESTING CONCRETE BY SONIC AND ULTRASONIC METHODS by K. Ramamohan Rao, Indian Railway Technical Bulletin No. 120, Vol. XIII, February, 1956.

THIS article describes the method of determining the quality of concrete in situ by sonic and ultrasonic non-destructive testing.

The sonic method of testing is based on measuring the resonant frequency of vibrations. From data on this resonant frequencies, weight and dimensions of the laboratory specimen, Young's modulus and the shear modulus elasticity can be calculated. The article gives formulae for this.

The ultrasonic method is based on finding out the velocity and the amplitude of ultrasonic waves in the test medium. There exists a relationship between the pulse velocity and the dynamic modulus of elasticity. By measurement of the pulse velocity, the dynamic modulus can be determined. The article gives these formulae.

Practical methods for detecting internal cracks, determination of the depth of surface cracks, and the setting time of concrete have been developed. These are briefly described.

A bibliography is attached.

BUILDING SANDS FROM NATURAL SOURCES. British Standards 1198, 1199 and 1200 : 1955. British Standards Institution, London.

THIS Standard contains specifications in respect of quality of sands, grading requirements, methods of sampling and testing for (1) external renderings, internal plastering with lime and Portland cement and floor screeds. Two sets of grading limits are given, the first one is suitable for end-coats and the second one being finer is suitable for finishing course for internal cement and lime plastering): (2) internal plastering with gypsum plaster: (3) mortar for plain and reinforced concrete, brick work, walling and masonry.

Sand has been defined as a material mainly passing the 3/16 in. sieve, which should be either a natural sand or one obtained by crushing hard rocks or gravel. The specifications for the quality of sand give the maximum limits of impurities such as clay, silt and organic matter.

ABATEMENT OF HIGHWAY NOISE AND FUMES: Bulletin 110, Highway Research Board, Washington, D. C., Circular 302, December 1955.

THE three Papers in this bulletin discuss methods for detecting and evaluating noise factors and suggest various practical means for traffic noise abatement. Also some preliminary studies on the problem of eliminating toxic gases and unpleasant exhaust fumes are reported.

The first paper, "Abatement of Highway Noise with Special Reference to Roadside Design," is the first report of the study in 1953 by the Special Committee on roadside design to reduce traffic noise, Dust, and Fumes and deals with the noise which emanates from the highway to the surrounding area particularly to abutting property, as well as with what may be done by the highway engineer to make this noise less objectionable to roadside dwellers:

Some of the conclusions are:

(a) To be most effective, barriers, such as walls, embankments, and plantings, should be placed as close as practicable to the travelled way.

(b) The most effective and economic method of abatement for each particular situation should be used. These are:

1. Wider right-of-way and building set-backs: 2. Buffer planting: 3. Fences and walls: 4. Embankments: 5. Any combination of 1, 2, 3 and 4.

(c) A close relationship exists between right-of-way, cross-section, and buffer-planting widths.

(d) Buffer planting which provides privacy to the roadside dweller has a definite psychological value.

Research is Needed on.

(a) Methods of measurement of highway noise from the standpoint of annoyance to roadside dwellers.

(b) Noise levels acceptable for different land-use areas in which highways may be located.

Three photographs of plantings which although designed primarily as visual barriers, have proved beneficial from the noise point of view are included.

The second Paper, "Motor Vehicle Noise Studies," by D. M. Finch, explains the common characteristics of noise and describes recent tests performed at selected sites along heavy traffic routes in California. Technical terminology and mathematics for defining, measuring and comparing traffic noises are given.

The last Paper, "Second Report (1954) of Special Committee on Roadside Design to Reduce Traffic Noise, Dust, and Fumes," by Simonson, emphasizes the need to reduce noise at its source through application of tests and controls on vehicles that are major generators of noise. It also explains actions and precautions that can be taken by highway engineers to reduce the effects of traffic noise in critical areas.

A VIBRATION METHOD FOR MEASURING THE THICKNESS OF CONCRETE ROAD SLAB IN SITU by R. Jones (Magazine of Concrete Research, Vol 7, No 20, July, 55).

A method has been devised for determining the thickness of concrete road slabs by measuring, at the surface of the slab, the velocity of propagation of vibrations at studio and ultrasonic frequencies.

(*Continued on page 29*)

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V. SOIL STABILIZATION AND LOW-COST ROADS

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2. **Soil Stabilisation for Roads;** PETER DAVISON, *Transport*, March 54, pp. 16-17.

3. **Soil Stabilisation in Fine Materials;** S. J. CRISPIN. *The Structural Engineer*, March 54, pp. 73-82.

4. **Stabilization of Beach Sands;** FRED. F. KRAVATH, *The Military Engineer*, March - April, 54, pp. 128-131.

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6. **Stabilised Clay-Sand-Stone Carpets for Roads in Czechoslovakia;** *Highways and Bridges and Engineering Works*, April 7, 54, p. 4.

7. **Stabilization of Soil by Silt Injection Method;** GEORGE E. JOHNSON, *Separate No. 323, Proceedings of the American Society of Civil Engineers*, November, 1953.

8. **Soil Cement Roads in an Urban Area;** H. L. KERR, *The Surveyor*, November 23, 54, pp. 801-802.

9. **Soil Cement and Other Base Courses;** FRED L. GOODMAN, *American Highways*, April, 54, pp. 8-9.

10. **Soil Cement;** A. K. DEB, *The Journal of the Institution of Military Engineers*, January 54, pp. 25-29.

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13. **Trial Lengths of Stabilised Gravel and Quarry Grit—Experimental Section Between Luddenham and Wallacia;** *Main Roads*, June 54, pp. 124-127.

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(Continued from page 17)

(ii) Pegs cannot be placed as freely as desired because of interference with vehicular and pedestrian traffic and the presence of existing concrete and kerb gutter, footpaths, etc.

Pegs should be placed against fences or in the unpaved section of paved footpaths as far as possible, where they are less likely to be disturbed.

(iii) It is often necessary to use spikes or nails driven flush in lieu of pegs.

The schedule of pegs and levels for urban work is of greater importance than the schedule for rural work, as it is often not possible to determine the purpose of a peg and its distance from road centre-line, merely from observation of its location on the ground.

Responsibility for Setting Out.—The responsibility for the accuracy and sufficiency of setting out roadwork rests with the engineer. The amount of work to be carried out by the pegman, is a matter to be determined for each particular job, but in every case, all slope chaining, and all levelling with level and staff, should be done by the engineer.

In all cases when earthworks are nearing completion, the accuracy of the centre-line, in plan, and the accuracy of the level of the sub-grade, together with cross-fall, widening and super-elevation should be checked by the engineer.

(From 'Main Roads, December, 1955').

(Continued from page 24)

A vibration generator acting vertically on the surface of the slab produces vibrations of known frequency which are detected by a pick-up. The pick-up is moved progressively away from the generator and positions are noted at which the vibrations at the generator and pick-up are in phase. The distance between successive positions gives the wave-length of the vibrations; the velocity of propagation is determined from the product of the wavelength and frequency.

From the theoretical analysis, a graph which enables the thickness of the slab to be calculated from the experimental results is prepared.

Tests have been made on slabs of thicknesses varying from 4 to 9 in. some slabs being laid directly on the subgrade and some on prepared bases of soil cement and hoggin. The results have generally been satisfactory and, in many cases, the dimensions of cores drilled from the slabs have agreed with the calculated values of thickness to within $\pm$ 10 per cent. (Author's Summary).

THE USE OF BLAST FURNACE SLAG AS A CONCRETE AGGREGATE by E. F. Farrington, Proceedings of the Institution of Civil Engineers, Part I, Vol. 5, January, 1956.

Iron-blast-furance slag is a non-metallic product developed simultaneously with iron in the furance. At an iron and steel works the slag is plentiful and, following processing, can be used as a concrete aggregate.

The Paper describes the use made of slag as a concrete aggregate at the works of the Appleby-Frodingham Steel Company. It is not suggested that all slags are suitable. Nevertheless, the experience advanced is sufficient to suggest that any iron-blast-furance slag complying with B.S. 1047; 1952 may be suitable as a coarse aggregate for concrete making.

DUST BIN

Give one example of a collective noun: "Dust-bin."

The word virgin is derived from vir, a man, and gin, a trap.

BUDGETS AND ADMINISTRATION REPORTS

ORISSA STATE BUDGET FOR 1955-56

The following extracts relating to Civil Works have been taken from Orissa State Budget for the year 1955-56

REVENUE

Items	(In lakhs of rupees)		
	Accounts 1953-54	Revised Estimates 1954-55	Budget Estimates 1955-56
Rents	5.31	4.36	4.41
Ferry Receipts	0.31	0.14	0.14
Tolls on roads	0.42	0.61	0.61
Recoveries of Expenditure	0.04	1.17	1.67
Transfer from Central Road Development Accounts	4.06	9.93	11.16
Miscellaneous	7.21	3.10	3.29
Khondmals Road Fund	0.02	0.09	0.09
Refunds	-0.53	-0.06	0.09
Total	16.84	19.34	21.28

EXPENDITURE

Original Works	37.75	46.05	23.89
Repairs	54.46	69.30	19.39
Grant-in-aid	—	0.13	0.09
Suspense	57.20	60.75	60.75
Development Scheme	16.01	10.57	9.45
Lump addition for regrant of lapses	—	—	2.63
Establishment Charges	17.17	21.09	38.89
Lump deduction for probable savings	—	(-)2.63	—
Recoveries from State Road Fund and gross credits	(-)56.10	(-)72.37	(-)79.80
Total	126.49	132.89	75.29

Capital Expenditure on Civil Works Outside the Revenue Accounts

Items	(In lakhs of rupees)		
	Accounts 1953-54	Revised Estimates 1954-55	Budget Estimates 1955-56
Buildings	—	—	114.75
Communications	—	49.97	111.30
Repairs	—	—	67.13
New Capital Projects	—	90.70	120.13
Lump sum creditable to other Government, and Developments etc.	—	0.69	1.10
Lump deduction for probable savings	—	(-)0.50	—
Lump addition for regrant of lapses	—	—	0.50
Total	—	140.86	414.91*
Receipts under the Indian Motor Vehicles Act	1.87	2.18	2.42
Receipts under the State Motor Vehicles Taxation Act	9.23	9.50	37.50
Refunds	-0.11	-0.13	-0.13
Total	10.99	11.55	39.79

ORISSA STATE BUDGET FOR 1955-56

A brief review with reference to Civil Works

THE total revenue of the State, including grants-in-aid from Central Government is estimated at Rs 1668.94 lakhs for the year 1955-56 as against Rs 1466.94 lakhs (revised estimate) for 1954-55 and Rs 1226.98 lakhs (actual) for 1953-54. The corresponding revenue expenditure figures are 1856.68 lakhs for 1955-56 (budget estimate) and Rs 1659.50 lakhs for 1954-55 (revised estimate) and Rs 1320.68 lakhs for 1953-54 (actual).

The revenue expenditure on Civil Works is placed at Rs 75.29 lakhs for 1955-56 while the revised estimate for 1954-55 and actuals for 1953-54 amount to Rs 132.89 lakhs and 126.49 lakhs respectively. In terms of total State Revenue the expenditure amounts to Rs 4.51 per cent in 1955-56, 9.06 per cent in 1954-55 and 10.31 per cent in 1953-54. There is a provision of Rs 9.45 lakhs for Development Schemes for the year 1955-56.

The capital expenditure on civil works outside the revenue account is estimated at Rs 414.91 lakhs for the current year while the revised provision for the previous year amounts to Rs 140.86 lakhs.

* This increase in the Budget is due firstly to a large number of projects being expected to be taken up next year in connection with unemployment and drought schemes and secondly, to decision of Government for 114.75 lakhs under the head Buildings and 67.13 lakhs under the head Repairs being transferred from the Revenue Account to the Capital Account.

LIST OF APPROVED WORKS ON NATIONAL HIGHWAYS

S. No.	Job No.	Name of work	Amount (Rs in Lakhs)
		RAJASTHAN	
1.	1562 RJ 8	Construction of Bridges on Kherwara-Bichiwara Section of N. H. No. 8.	3.25
2.		Three works each costing less than 2 lakhs.	0.02
		SAURASHTRA	
3.		Two works each costing less than 2 lakhs.	0.02
		UTTAR PRADESH	
4.	1552 UP 2	Cement concreting certain miles on G. T. Road (N. H. 2) and Lucknow-Jhansi Road (N. H. No. 25) in Kanpur District.	3.49
5.	1552-A UP 2	Cement concreting N.H.No. 2-Agra-Etawah-Fatehpur Road - Miles 42/7 to 4/48 miles 71-74.	2.65
		WEST BENGAL	
6.	1538 BG 31	Construction of a guide bank at right approach of Jaldhaka bridge on the Mynaguri-Jhupguri Section of N. H. No. 31.	11.98
7.	1560 BG 31	Protective measures against the floods of the river Chel on N. H. No. 31.	1.08
8.	1563 BG 6	Construction of a bridge over the river Rupnarayan at Kolaghat on N. H. No. 6.	112.22

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