TRANSPORT-COMMUNICATIONS

MONTHLY REVIEW (TCMR)

MAY 1962—No. 181

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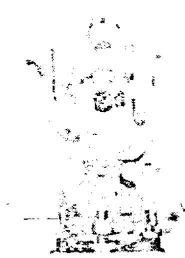

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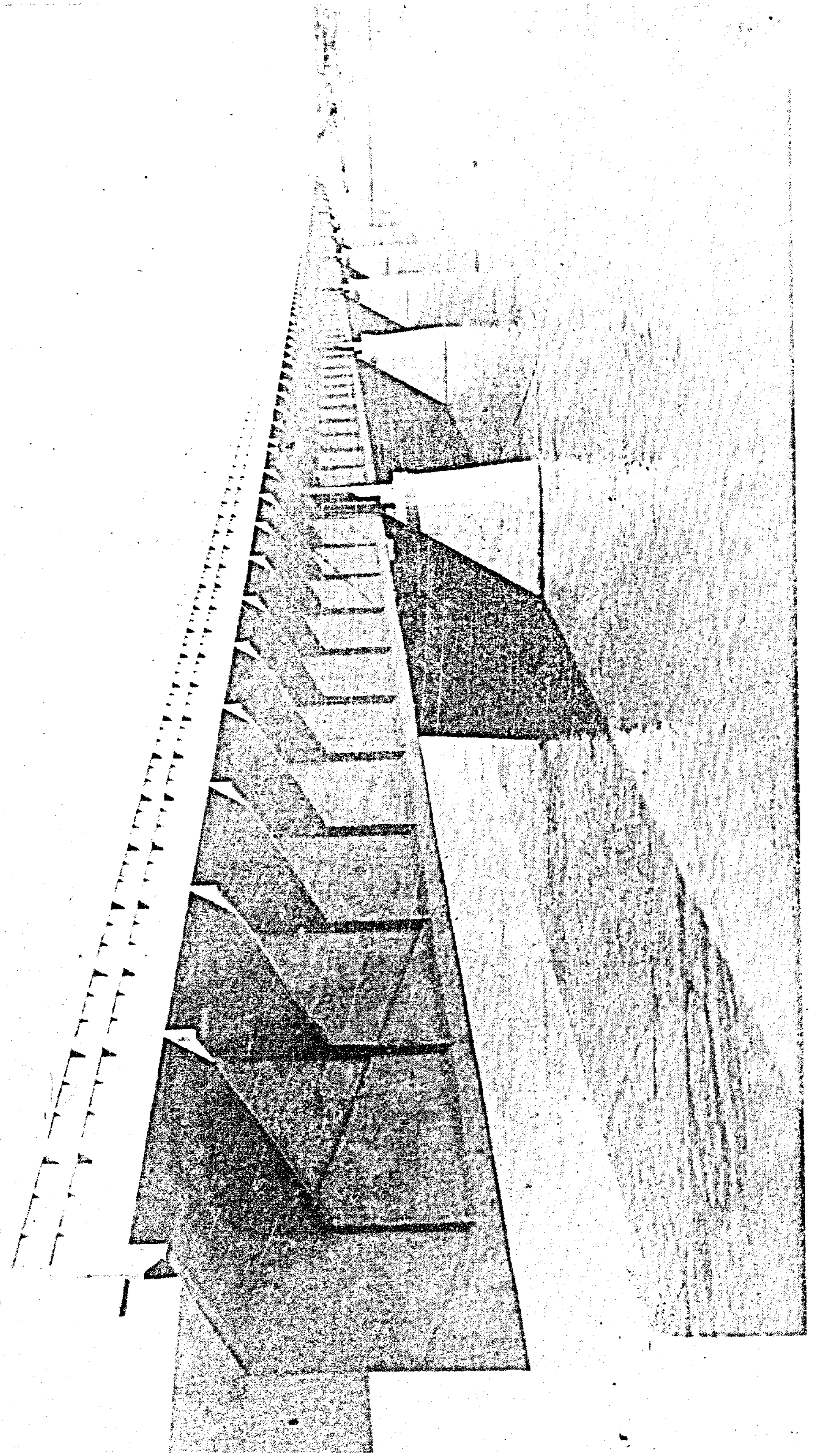


THE YAMUNA BRIDGE

TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

A REVIEW OF
ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

MAY 1962

USE OF SEA SAND AS FINE AGGREGATE IN ASPHALTS CONCRETE MIX

6C

By

SRI S. J. P. DHARMARAJ, B.E., A.M.INST.H.E. †

1. Introduction

The use of the sea sand has neither been specifically permitted nor prohibited as a suitable fine aggregate in asphaltic concrete mixtures in any of the standard specifications. In Madras City, for asphaltic concrete work, river sand from Sholavaram with a long lead had been in use while sea sand in plenty is available on the beach close by. With a view to effect economy, the suitability of sea sand as fine aggregate in the asphaltic concrete work was tested at the Madras Highways Research Station.

2.1. Standard specifications of sand for use in Roads and Bridges, Madras*

The sand shall conform to the following grading requirement for Asphaltic Concrete mixes:

ASTM Sieve size	Per cent wt passing
No. 8 (IS 240)	100
No. 30 (IS 60)	40–85
No. 100 (IS 15)	10–40
No. 200 (IS 8)	0– 3

Fine aggregate shall comply with the following requirements:—

It shall consist of Natural sand, composed of fine granular material resulting from the reduction of rock by the action of elements or crushed stone screenings. The particles shall be clean dry hard tough and durable.

Deleterious substances: Fine aggregate shall be reasonably free from injurious amounts of clay loam softer flaky particles and other deleterious substances and foreign matter.

3. Experimental Study

3.1. Source: Sea sand was collected from the quarry near Napier Bridge on the sea front in the city.

3.2. Description of sand: The sand is a light grey, quartz Magnetite and other heavy minerals being absent. It is mostly medium grained. Sea shells are also present. The sand is devoid of clay, loam, etc.

4. Tests: The tests conducted are (1) Sieve analysis (2) Soundness test using Magnesium Sulphate Solution as per A.S.T.M. C-88-59-L(3) Tests for physical properties and (4) chemical analysis.

4.1. Sieve Analysis: The results of the tests are given in Table No. I Chart. No. I shows the grading compared with limits prescribed by the various standards. The grading of Sholavaram river sand is

* Madras Highways Manual, 1955—Vol. I, Specifications 205, 204 & 714-2.

† Assistant Engineer, Bitumen Laboratory, Highways Research Station, Madras-25.

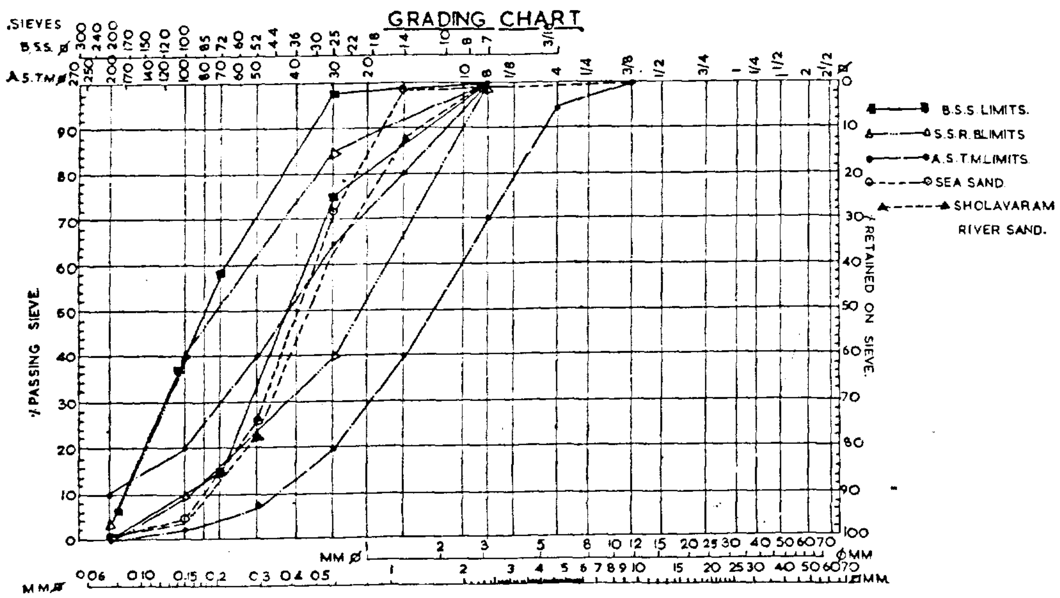


CHART NO: I— GRADING OF SEA SAND TOGETHER WITH STANDARD LIMITS.

Table No. I—Sieve Analysis

Percentage Passing.

Sieve	3/8″	3/16″	7	14	25	52	100	200	Fineness Modulus
Sea sand	100	99.89	99.74	99.09	72.70	25.78	4.36	.46	1.99
Sholavaram sand	100	100	100	87.65	64.00	22.4	3.18	.9	2.23

Table No. II—Results of the soundness test

	Weighed average loss in percentage.	
	Actual Value	A.S.T.M. Limit
Sea sand	7.231	20
Sholavaram river sand	17.914	20

also shown. It is seen that the sea sand very nearly satisfied the SSRB & ASTM standards.

4.2. Soundness Test: The test was carried out as per ASTM Designation C-88-59-T over five cycles using saturated Magnesium sulphate solution for the sea sand and Sholavaram river sand for comparison purposes. The results are given in Table No. II.

As per ASTM Specifications C-1073-59-T the sand subjected to five cycles of soundness test using Magnesium sulphate solution should have a weighed average loss below 20 per cent whereas the weighed average loss for the sea sand is only 7.23 per cent.

4.3. Tests for Physical Properties: The specific gravity of sea sand and Sholavaram river sand are 2.63 and 2.46 respectively.

4.4. Chemical Analysis: The chemical analysis on sea sand and Sholavaram river sand were also carried out by the Chemical Testing and Analytical Laboratory, Department of Industries and Commerce, Madras, and the results are given in Table No. III. The sea sand is found to be equally rich in silica having almost the same properties of river sand.

Table No. III—Chemical Analysis

	Sea Sand	Sholavaram river sand.
Loss on Ignition	1.65	0.86
Silica as SiO_2	83.55	90.0
Alumina as Al_2O_3	4.99	7.00
Ferric Oxide as Fe_2O_3	0.46	0.47
Calcium Oxide as CaO	4.62	0.45
Magnesium Oxide as MgO	2.57	0.28
Alkalies as Chlorides	2.04	1.00
Sodium Chloride as NaCl	0.002	0.0017

5. Conclusion: Results of tests conducted showed that sea sand from the beach in Madras is devoid of clay, loam and other deleterious substances. So it was used as a fine aggregate in the asphaltic concrete pavement construction on the Mount Road and Poonamallee High Road in the Madras City resulting in the use of a local material.

QUALITY CONCRETE PAVING METHODS ON GERMAN AUTOBAHN

Notes and photographs from an inspection visit to a large project in the West Germany super-road program

BY

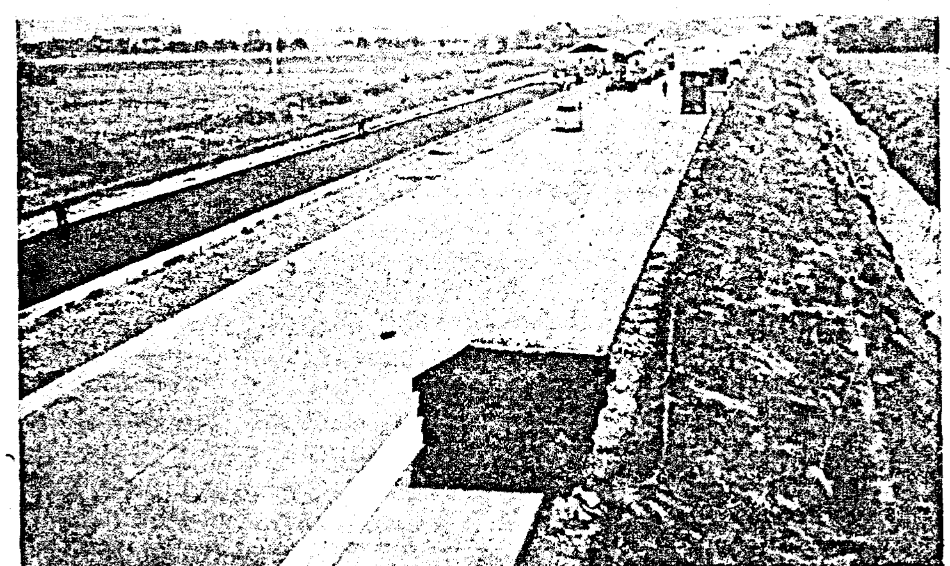
HAROLD J. MCKEEVER

Editor of World Construction

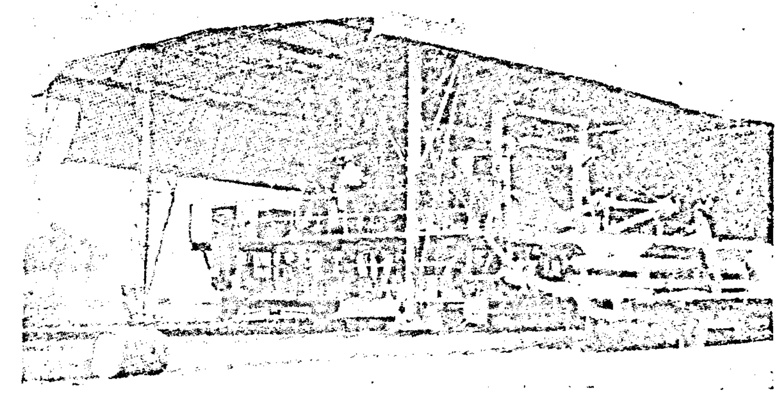
THE federal and state highway building agencies in West Germany, capitalizing on the good performance of portland cement concrete autobahn sections built between 1935 and 1939, are using this type of paving to construct some of the important new autobahn links. These on-the-scene notes and pictures describe briefly a project that is representative of the present design and of typical highly-mechanized job procedures.

The project consists of a 21-mile segment (near Freiburg) on the Frankfurt-Basel autobahn. This highway traversing the Rhine Valley constitutes one of central Europe's most important traffic links.

Design-wise some significant observations can be made on the concrete pavement system presently deemed necessary for West Germany's soils, climate and traffic conditions. The pre-war autobahnen of concrete



New autobahn near Freiburg, West Germany. Concrete pavement, white concrete shoulders, and emergency outer lanes in place for one roadway. Asphaltic base completed for far roadway. Note darkened color of the concrete, to reduce glare. (All photos by "World Construction" Editor)



One of two models of concrete mixers (Sonthofen) used by contractors on the autobahn near Freiburg. Batch truck at right. First of three mixers, this one is for the concrete below the reinforcing. All equipment is protected from rains by rail-mounted tenting. Vatter, contractor

were constructed with the slab resting either directly on the native soil or, at best, on a thin frost layer. The pavement typically then was 22 cm. deep by 6.5 to 7.5 m. wide. Even then it was flanked by a concrete curb. Except for the lack of what is now considered an adequate shouldering, the 1935—1939 road design was indeed advanced in concept for the period. Many miles of these roads are still carrying traffic today. Only the sections where traffic is heaviest and underlying soils and drainage poor have required progressive reconstruction to meet the needs of the 25,000 to 50,000 daily traffic volume.

Any discussion of autobahn pavement designs should also bear in mind the fact that 35 per cent of vehicles are truck trailers. Also that the 9-ton axle load limit is approached by many vehicles travelling at great speeds, there being no speed limit on most autobahn sections.

The present standard concrete pavement system consists of a compacted soil subgrade; a frost-resistant layer of crushed stone or gravel 15 cm. to 35 cm. thick entirely across the grade; 8 cm. of asphaltic mix, a layer of paper, then a 22 cm. by 7.5 m. mesh-reinforced concrete pavement.

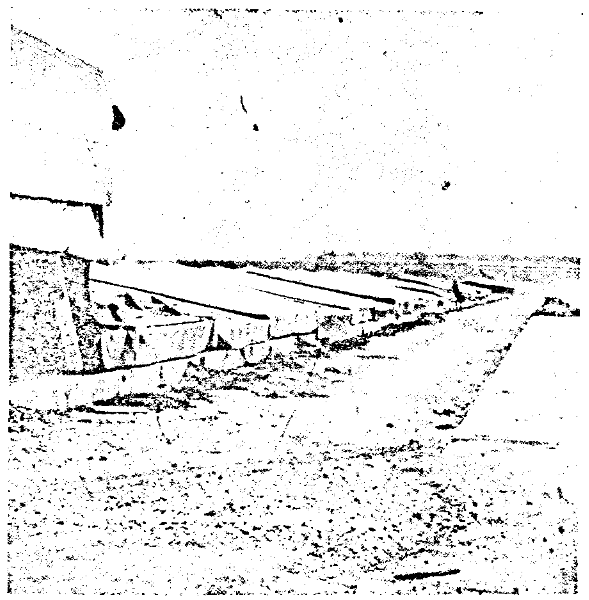
The concrete pavement is placed in two lifts, being struck off and often vibratory compacted at 5 to 7 cm. below the top, steel mesh placed, then the remaining depth placed using mix darkened to a medium gray by addition of iron oxide. The minor darkening is to eliminate glare.

As shown in the accompanying cross-section sketch at page 11, the pavement is flanked by concrete curbs, 0.75 m. wide by 22 cm. thick. The curbs are topped out with white concrete using special quartz stone as well as white cement. Built in advance of the paving, the curbs serve as supports for rails for both the asphaltic base and the concrete equipment. This feature of design, while adding substantially to the total highway cost, is credited with being a major factor in securing the extremely smooth riding pavements for which the German autobahnen is famous.

The asphaltic base layers are placed by a sequence of equipment, well standardized in West Germany. These details will be discussed in another report.

The 21-mile project near Freiburg was divided into three contract sections, including one experimental part, the grading, drainage and bridge had been completed under prior contracts. One section was being paved by Jordan, G. M. B. H., of Karlsruhe. This company used three form-riding concrete mixers (Voegele), which

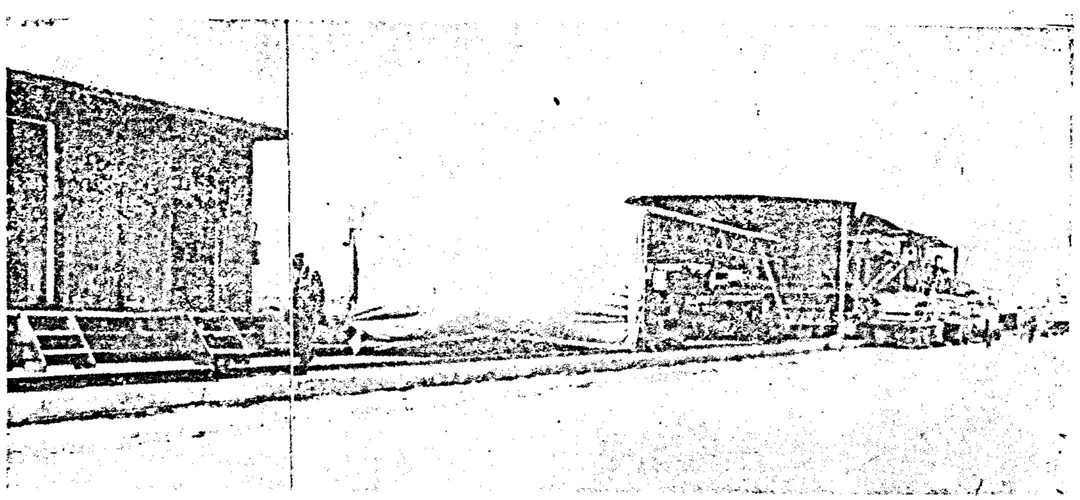
On the contract section of Jordan G.M.B.H., showing one of this contractor's finishers, with the concrete surface nearing final finish. (The rails are mounted on the previously-constructed concrete shoulder sills, and not flush with the pavement surface as is the U.S. practice.)



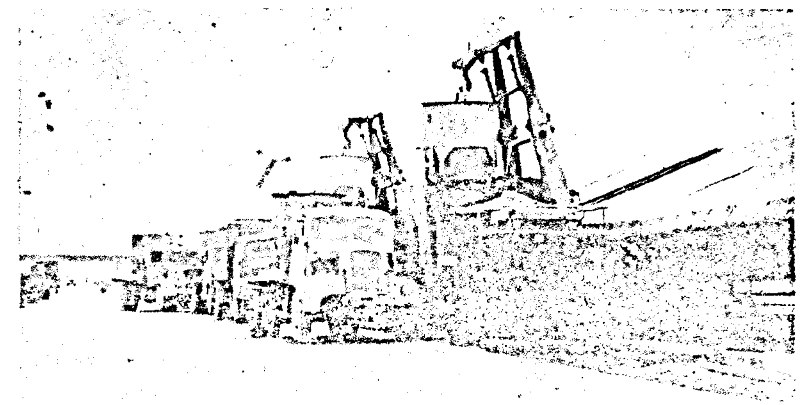
were supplied with dry batches from drop buckets lifted from truck to mixer by a truck-mounted crane with special handling hook.

Two of the mixers deposited for the lower lift, followed by a transverse spreader which laid out the very dry mix with least disturbance, and struck it off by an oscillating screed.

Following placement of steel reinforcing mesh (3.1 kg. per sq. m.), the third mixer dropped concrete for the top lift and was followed by a tamping spreader (ABG manufacture), an oscillating screed, and another finisher with oscillating screed skewed about 15 degrees. Between the second and third finisher any low spots observed were corrected by throwing on shovelfuls of concrete. Generally, however,



A more sweeping view of contractor Vatter's paving train—tool and bunk house at left. First tent, over final subgrade preparation. Large tent, mixers. Far tenting, spreaders and finishers of top concrete layer



Another type of batch delivery (1 bag) as seen on the Jordan contract section Cylindrical drop-buckets contain mixed concrete

the second finisher left a very well formed surface. The third finisher maintained a roll of mortar from 3 to 5 cm. in thickness, leaving in its wave a perfectly formed surface. Two men work along each side with edgers. No hand floating was performed.

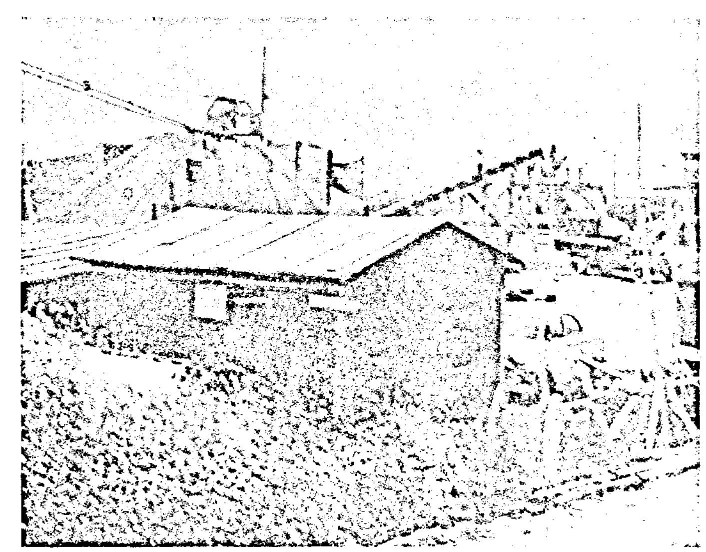
Behind this train followed one or two travelling bridges for use by personnel in the finishing.

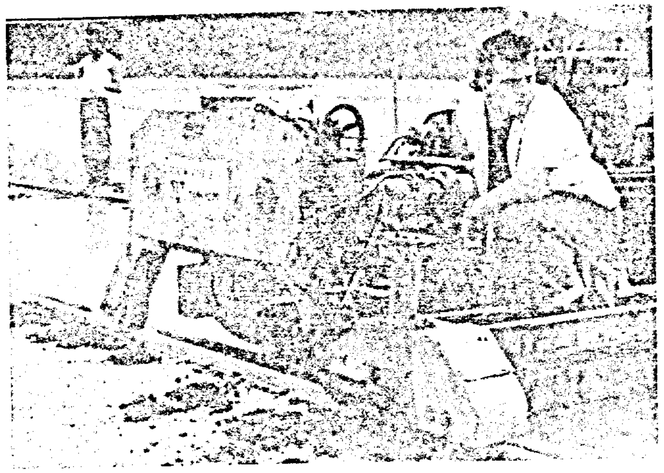
All of the foregoing equipment was operated beneath steel framed canvas tents which also moved forward on rails or rubber-tired wheels resting on the curbs. This feature of the German practice is a logical one, considering that the climate pattern is one of frequent small rain showers throughout much of the long working season.

Behind the finishing train next followed a train of tin-roofed shelter panels, extending some 100 m. or more. These shelters protected the fresh concrete during the initial set. Then in compliance with curing specifications, straw covering was placed, wetted and left for 7 days, with wet curing done for a total of 28 days.

Throughout the steady progress of the equipment procession, a light truck crane and truck took form rails forward and reset them. The light rails were quickly

One autobahn contractor's plant for stockpiling and mixing concrete aggregates. Note centrally-located crane and separation walls. Drag-line bucket manages piles and feeds conveyor hopper for dry-batching





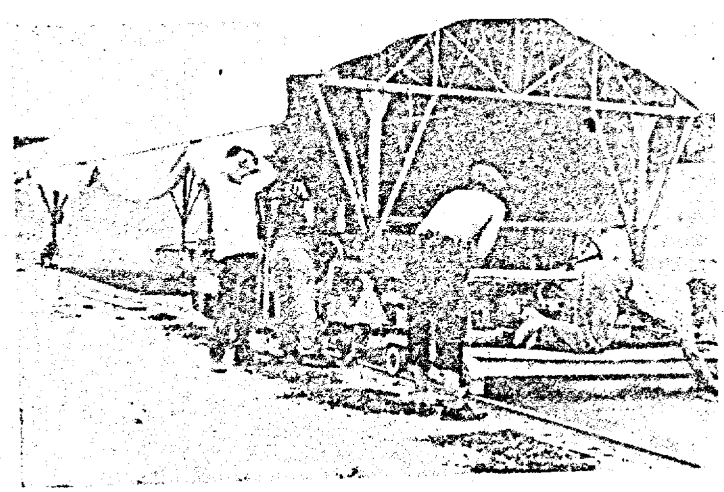
Final concrete finishing pass, using a Voegele unit. Emergency lane was also mechanically finished

interlocked, their skewed joints assuring smooth passage of the equipment wheels.

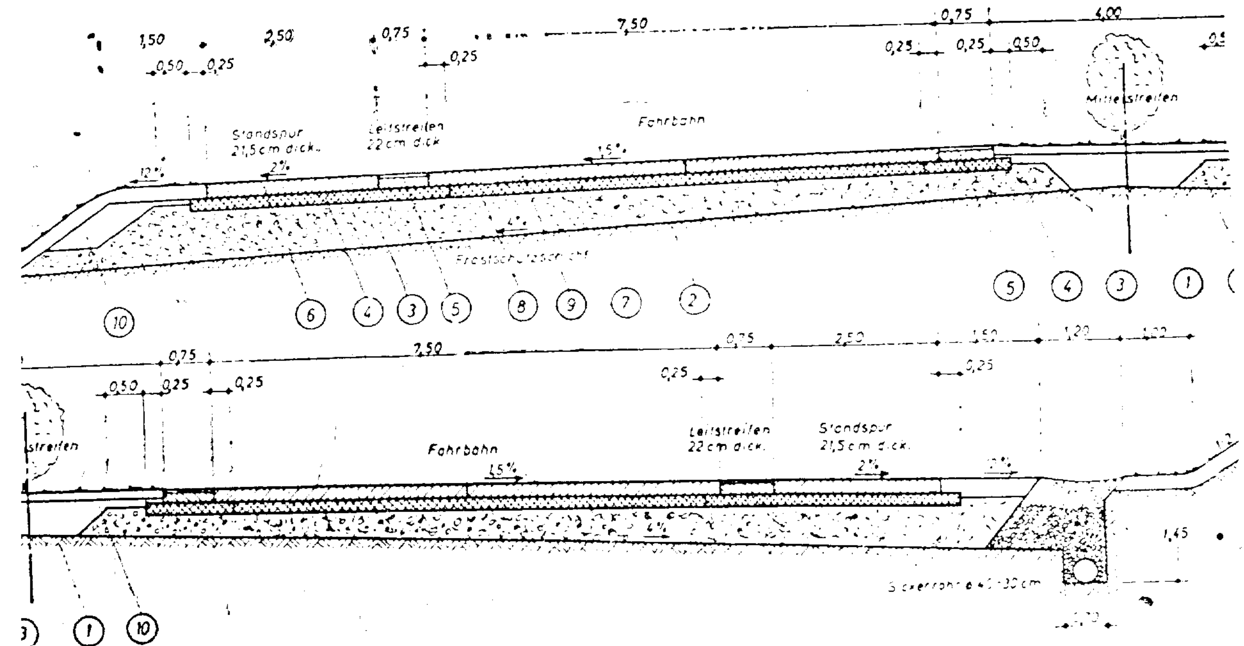
The second contractor, Vatter, of Mannheim, followed quite similar procedures, except that his three mixers were of a different type (Sonthofen). Each of the contractors paced job operations to a daily paving progress of about 300 to 350 m. per day, including all the preliminary preparation and other elements of work. Both firms were utilizing the already-paved northbound roadways as a haulway for trucks and other equipment in paving the southbound roadway at the time the accompanying photos were taken. A feature of the work was the cleanliness maintained.

Behind the roadway paving, in each contract, there followed a separate sequence of spreading, finishing and weather-protective equipment for concrete paving the 2.5 m. parking strips (shoulders). These strips utilized the standard paving mix. The strips 20 cm. thick were laid on a paper-covered base of sand which had been carefully struck off and vibratory compacted. All equipment rode on an outer form rail and inner wheels riding on the curb section.

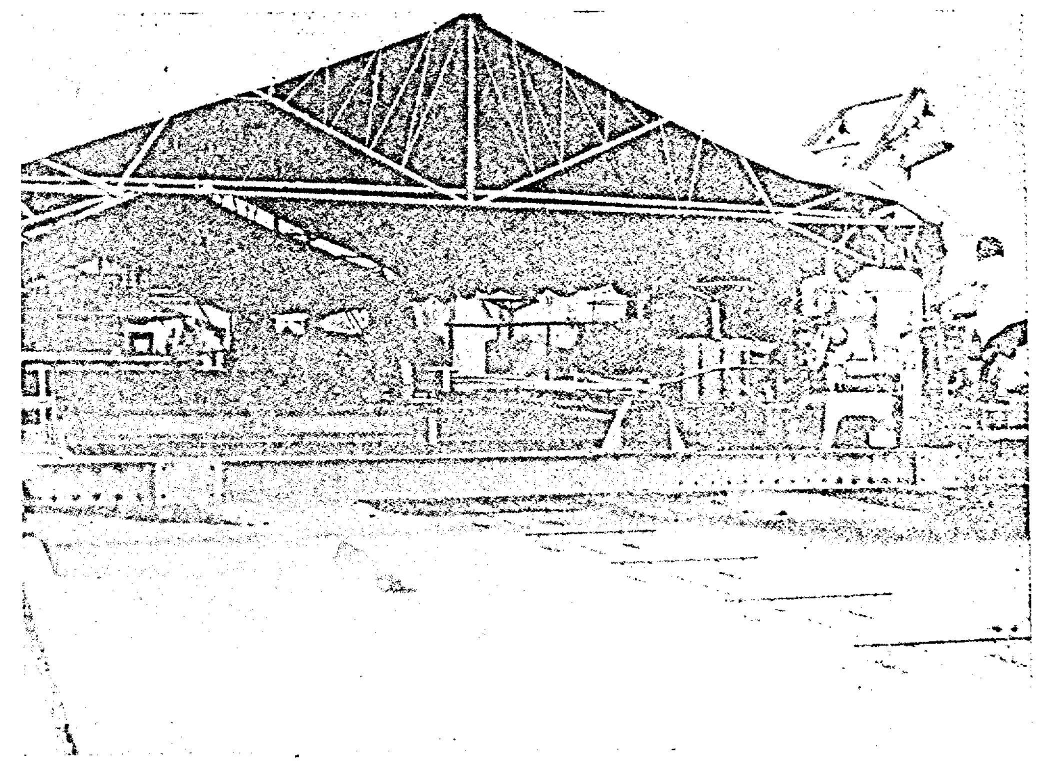
The concrete in the project was of a dryness approaching "no slump" in U.S. parlance, being a mixture that is merely damp and with so little water that the



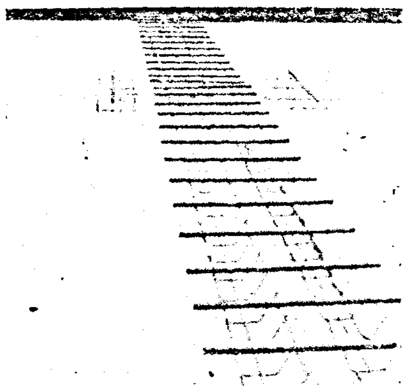
A complete train of form-riding equipment is also used to pave the outer emergency lanes, 2.5 m. wide



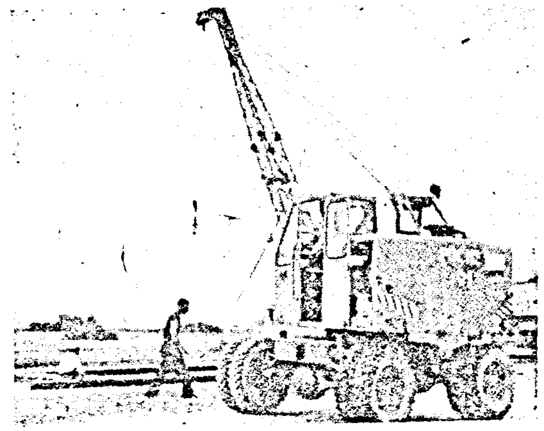
Standard autobahn cross-section for portland cement concrete pavement, providing for two traffic lanes on either roadway. The subbase design is varied according to soil conditions. The median embodies a raised curb often when less than 3 m. median width is available. (1) Drainageway. (2) Compacted subgrade. (3) Granular frost layer or subbase. (4) Bituminous base layers totalling 10 cm. (5) White cement surfaced, concrete shoulders. (6) Emergency lane or outer shoulder. (7) Finegrading layer. (8) Continuation of bituminous base. (9) Portland cement concrete pavement, 22 m. thick. (10) Suitable earth and topsoil layer



Another look at Contractor Jordan's equipment. Concrete is distributed evenly out over a considerable area of paper-covered base, to minimize work of mechanical spreader. Note centerline tie-bars in place

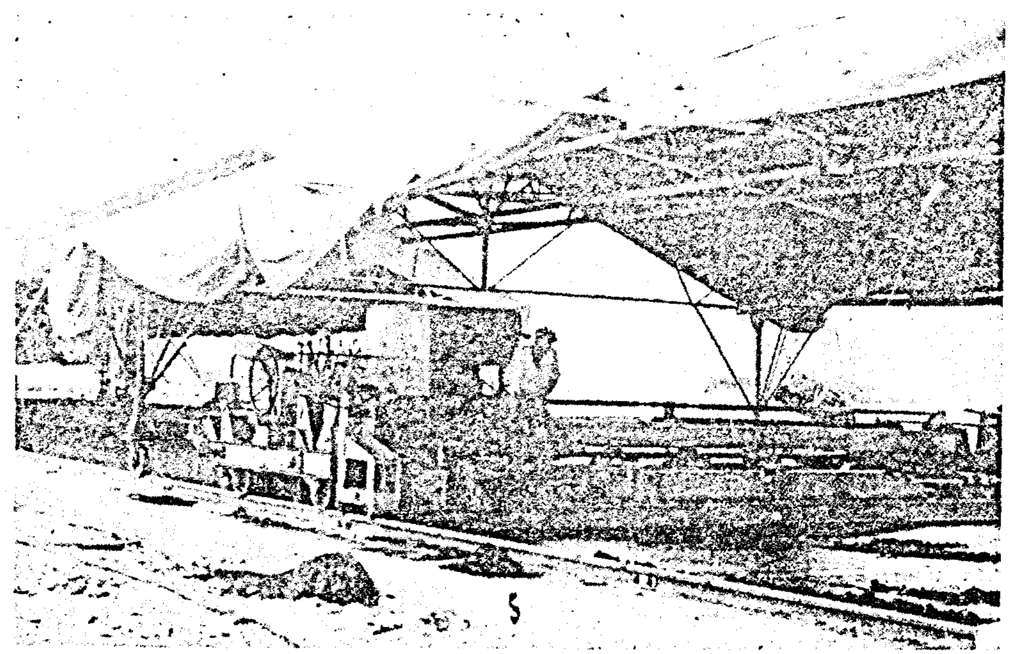


Note extreme accuracy of dowel assembly positioning at expansion joint—one of many evidences of good quality control on this autobahn project



Handling rails for the equipment supporting tracks—one of various types of machines used for this work in conjunction with trailers

successive tamping and screeding flushes out no free water. Only a small mortar roll of a viscous consistency was usually to be ahead of the last finisher. Air entraining agents are used in the mixture, which is designed with a water-cement ratio of 0.4—0.45, using 330 kilo of cement (approx.) per cu. meters for a concrete specified to develop 450 kg./cu. m. compressive strength at 28 days.



One of the preliminary top lift finisher passes

(*Continued on page 39*)

THE MECHANIZATION IN ROAD BUILDING AND ECONOMY IN CONSTRUCTION COSTS

By

M. I. WEITSMAN, Master of Engineering

HIGH labour input is one of the characteristic features of road building; that is why Soviet builders and research institutions are engaged in improving the construction processes and in finding ways and means for cutting down the labour input involved.

Earth work and the construction of road beds, as well as the operations involved in getting and processing stone materials and in preparing asphalt-concrete and cement-concrete mixes, are among the most labour consuming of the wide range of road construction works.

In the construction of motorable roads each kilometre of the road involves excavation-work from 5,000 to 50,000 and more cubic metres in volume. It is but natural that if there were no good means of mechanization, this work would require a vast number of workers. In the USSR the level of mechanization of these operations has reached 98 per cent and the road builders labour productivity has grown to a considerable extent.

Efficient Machines

There are highly efficient machine operating on the country's road-construction projects. Among them are:

(a) Bulldozers with caterpillar tractors of 80/100-140/150-250 h.p. capacities, wheeled bulldozers with shortened base and engines of 300 h.p. and higher are being put into mass production; (b) trailed scrapers with 6 to 8 cu. m. bucket capacities operating with 100 h.p. caterpillar tractors, as well as self-propelled scrapers with up to 10 cu. m. bucket capacity, single-axle type with single-axle 165 h.p. tractor on pneumatic wheels. New and still more powerful types of scraper with 15 and 25 cu. m. bucket capacities are being put into production. They will operate with powerful wheeled tractors with adjustable tire pressure.

These machines are mostly used in planning and finishing work and, in some cases, for erecting earth road beds on low earth banks (upto 0.75-1 metre high).

Elevating graders (both trailed and mounted types) with capacities of 100 to 150 cu. m. per hour are successfully used on level terrain; an original model of self-propelled reversible machine with motor wheels and single-axle 300 h.p. tractor is now being developed.

Extensive use in road building is made of excavators of 0.15 to 2 or 3 cubic metres bucket capacities; the latter are employed in loading and quarry work. Excavators with pneumatic tire drive have found extensive application too.

The following is the chief line in the development of the above group of machines in the USSR: higher capacities of the machines and their working and travel speeds, transition to pneumatic tire drive (60 to 70 per cent of all the machines put out), introduction of hydraulic transformers and devices for the automatic adjustment of machine duty.

Soil Packing Machines

Soviet engineers devote special attention to the development of new kinds and the improvement of the types of soil packing machines. No high quality road with long service life can be built without a reliable packing of the earth bed. The road building sites of the country are provided with newly developed trailed and self-propelled pneumatic tyred rollers weighing from 10 to 50 tons (including multi-sectional rollers), with rolling machines on the basis of 100 h.p. tractors, rollers with falling weights, and can rollers weighing up to 30 tons, as well as 10.5 ton self-travelling vibro-slabs and 0.5 to 3.5 ton vibro-rollers. The designs of these machines are being steadily improved. Soviet designers are devising new devices that provide for the automatic control of soil-packing efficiency during rolling.

Extensive use of local building materials, i.e., those that involve comparatively low transportation costs, presents an important way to cutting down road construction costs. The first thing to be used for this purpose is the soil. Soviet road builders have in recent years developed compound methods for stabilizing the soils with the aid of small quantities of different binding materials (bitumen, cement, lime, etc.). This method of stabilizing soil layers up to 25 cm thick leads to enhancing the strength of the roadbed and reducing the cost of construction. Specialized machinery sets of various productivity have been designed in the USSR with the purpose of developing this new building technology: The sets designed for large volumes of work include, besides the cutterheads, special continuous mixing machines of the travelling type, handling 60 to 80 cubic metres of ground per hour. The sets for the construction of trunk highways comprise a high-efficiency single-pass soil mixer of original design, providing for the combined distribution of bitumen and cement or lime: the machine is driven by a 300 h.p. engine.

Vibro-packing Organ

In cases of metal, gravel-or slag roadbed construction the builders employ an originally designed self-propelled metal-placer provided with a vibro-packing organ which ensures the adequate packing of a 28—30 cm-thick layer. The machine has a capacity of 3,000 to 5,000 square metres of road-bed per shift; it is driven by a 50 h.p. motor. The machine reduces labour input 8 to 10-fold and the required number of heavy motor-driven rollers to three times.

The construction of asphalt-concrete pavements is done, as a rule, with the aid of self-propelled asphalt-placers handling 50—60 and more tons of asphalt per hour and with a series of motor and vibro-motor rollers. The hot mix is delivered to the placing site by 3.5—5-and-7-ton tip lorries.

Cement-concrete pavements are built with special sets of machinery. The machines that work on the construction of state highways and roads of republican importance carry out the finishing of the bed, the placing and vibro-packing of the concrete mix in the pavement, the finish of the pavement surface (this is done by an especially designed multi-support long-base finishing machine), the cutting of seams in the concrete pavement slabs, and the maintenance of the concrete in the process of its solidification by pouring it over with film-forming materials and bitumen emulsions. A new machine is now being developed, which will serve for positioning the supporting rails with an automatic control and checking device. This set of equipment has a material drawback—it involves the input of a great quantity of metal, as it needs as many as 30 supporting rails over which all the machines of the set travel. That is why Soviet engineers have been questing for and have finally devised an experimental set of railless concrete placing and finishing machines or, as they say, machines with a sliding scaffolding. Work is under way to improve the equipment for making prestressed steel-wire-concrete pavements; besides, machines for the construction of precast-concrete slab pavements are being developed.

The construction of roadbase and coverings is practically 100 per cent mechanized. There is, however, still a certain number of auxiliary workers who service the machines of the concrete placing units.

In order to do away with the high labour input into auxiliary operations, work is being done to design and construct equipment and instruments for the automatic control and regulation of the machines' operational duty, care being taken to provide for the levelness and roughened surface finish.

Asphalt-concrete and cement-concrete mixes are produced on specialised linear-type plants; new types of equipment for these plants, consisting of individual transportable units, are being steadily designed. The high labour input at these enterprises has called for developing new progressive technologies and elaborating organizational and engineering measures. In this connec-

(Continued on page 21)

CHARACTERISTICS OF ROLLED ASPHALT

A CONSIDERABLE volume of technical literature has been published in recent years relating to the composition, character and qualities of rolled asphalt. There are, however, only five qualities of this flexible surfacing material that are of interest and importance to the traffic engineer and the community at large. These are:

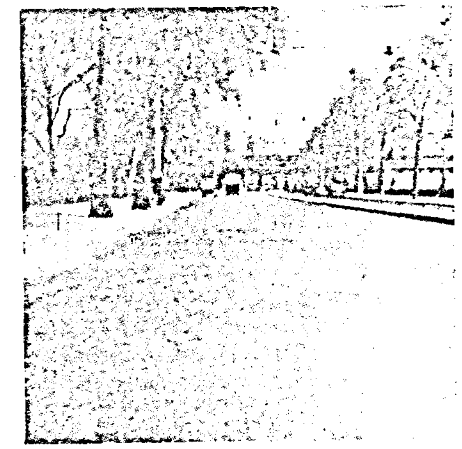
(a) Rapidity in placing and finishing
(b) Colour
(c) Non-skid properties
(d) Riding qualities
(e) Economy

The completion of new roads or the maintenance of road surfaces is of major importance to traffic engineers and the public. In this connection, rolled asphalt can be laid and finished more rapidly than most modern forms of surfacing. It can be brought into service almost as soon as it is finished and provides an impermeable uniform surface. With modern equipment it is not unusual to lay and finish up to 2,000 tons per day which is equivalent to approximately 10,000 yd. super at 4 in. thickness or 40,000 yd. super of 1 in. surfacing.

It is in this field of maintenance that rolled asphalt provides one of its most important advantages. Where the necessity for reinstatement or resurfacing arises, it is possible with modern equipment to deal with large areas which can be removed or burnt off and reinstated daily and a new uniform water-proof surfacing provided which can come into service almost immediately it is laid.

Colour

There is a popular idea that all types of bituminous surfacings are black. With the exception of one or two well-known types this is not so and with the partial stone structure of modern rolled asphalt mixtures and the use of coated chipping surface treatment a pleasing light coloured effect can be obtained. Whilst some of the best known roadstones are dark in colour, there is a wide selection of light-coloured varieties capable of giving good service when employed in a strong close textured asphalt 'mortar'. So far as rolled asphalt is concerned, it is necessary to select a hard, light-coloured stone of rough texture for the surface chippings which has the appropriate non-skid properties. As soon as the bitumen film has worn off a good colour effect is secured. With a durable material such as asphalt, the small additional expense involved in using special chippings is repaid by the improved appearance, while the psychological effect on the motorist is good as he can actually see the stone in the surface.



Victoria Embankment, London, with a hot rolled asphalt surface and is a non-skid finish of bituminous coated granite chippings

The provision of coloured surfaces can be carried a stage further by incorporating a strong mineral pigment in the wearing surface in conjunction with special light-coloured bitumens. In practice the only available colour is a red due to considerations of cost.

There are differences of opinion regarding the desirability of having actual coloured road surfaces and many arguments can be advanced both for and against their general use. Under present conditions and in the light of existing knowledge it is certain that economics will largely determine the extent to which they will be employed. It appears generally accepted, however, that a pleasing shade of light colour is more attractive and less tiring to the road user by day. By night a medium-textured surface of good reflectivity gives the best results under both wet and dry conditions. Here again conditions vary so much that it is difficult to be positive, but this seems to be the conclusion under both cut-off and non cut-off lighting, and also on country roads.

TABLE I

Relation between surface irregularity index and road surface quality (a subjective survey)

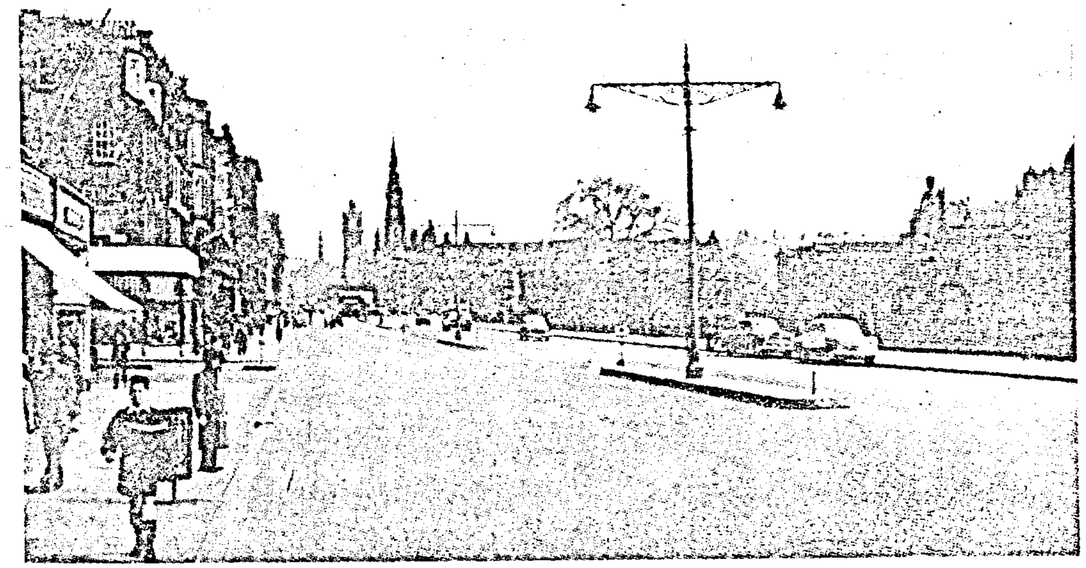
Order	Irregularity index (in./mile) q (from R.R.L. multi-wheeled apparatus)	Irregularity index (in./mile) r (from bump-integrator)	Description of surface quality
1	75	145	Good to excellent.
2	75–130	145–190	Fairly good to fair.
3	130–200	190–270	Indifferent to rather poor.
4 & 5	200	270	Poor to bad.

TABLE II

	Base course					Wearing course				
	per ton	per y. s. $2\frac{1}{2}$ in.		yrs		per ton	per y. s. $1\frac{1}{2}$ in.		yrs	
H.R.A. Granite	% 100.0	8.4	11.9	20	0.595	% 106.0	14.5	7.35	20	0.367
H.R.A. Gravel	63.4	8.4	7.5	20	0.375	83.0	14.5	5.72	26	0.286
Bitmac	45.0	11.2	4.0	5	0.80	49.0	17.0	2.97	5	0.594
Dense Bitmac	54.7	9.5	5.8	8	0.72	63.0	14.6	4.32	8	0.540

Non-skid properties

Considerable research has been carried out by the Road Research Laboratory on the measurement of the resistance to skidding of road surfacing materials. Their assessment of the requirements in this respect is that sideway force coefficient figures of the order of 0.6 are necessary in the case of main roads carrying high-speed traffic and where increased stress occurs as on curves and at roundabouts. Figures of 0.5 are suitable for normal traffic conditions as in through routes in urban areas, etc., while 0.4 is regarded as a safe minimum for slow-moving and light traffic. Rolled asphalt to B.S. 594 meets the most stringent of these requirements.



Princes Street, Edinburgh, surfaced with a light coloured surface of hot rolled asphalt

Riding Qualities

Among the many requirements demanded by the road user today comfort, with safety, is becoming increasingly important. Accuracy in respect of the profile of the road surface did not appear in B.S. 594 until the 1950 edition where a tolerance of up to $\frac{3}{8}$ in. under a 10 ft straight edge is allowed. This has gradually been reduced until in the draft of a new edition of B. S. 594 the maximum irregularity for surfacing mixtures is 3/16 in.

This requirement does not necessarily give a true overall indication of the accuracy to which the asphalt has been laid and the measure of irregularity is in inches per mile referred to as the 'q' value and the 'r' value is the equivalent as measured by the bump integrator.

Road Research for 1951 gives the requirements in respect of surface irregularity as in Table I.

With modern mechanical equipment and technique there is little difficulty in achieving a true running surface and q values at the order of 30—50 are readily obtainable. With rolled asphalt it is possible to obtain as a standard procedure today a regularity of surface that is equal if not better than any contemporary road surfacing materials.

Economy

If the question of durability is related to cost, the advantages of rolled asphalt are shown clearly. In an article entitled 'Hot Asphalts' appearing in the Queen's Highway for July 1961, N.B. Bourne quotes some interesting figures:

'Finally some comparative cost figures are given below for various conditions both for base course and wearing course and by dividing the relative cost per ton for each material by a normal spreading value (or 'supering') the cost per yard super is shown. Assuming then a life for hot rolled asphalt of not less than 20 years, for normal macadams not less than five years and for dense macadams not less than eight years, the final column in the table shows relative costs per yard super per year for each material course. The economy effected by using hot rolled asphalt is thus clearly shown' (Table II).

Conclusion

With the wide scope of B.S. 594 it is possible to design a range of mixtures with desirable characteristics and capable of being laid successfully to any reasonable thickness, while meeting all the conditions of traffic and of climate encountered in this country.

(From "Traffic Engineering & Control", January, 1962.)

BITUMINOUS ROAD MATERIALS RESEARCH

By

J. H. Nicholas, M.A.

The Head of the Bituminous Materials Section of the Road Research Laboratory recently gave two lectures to the London and Counties Road Tar Association, dealing in particular with the properties of the structural elements of the road and the part they play in carrying the traffic, and the part that a bituminous running surface can play in reducing skidding accidents. Some extracts together with a brief of the discussion are given below.

IN 1954 it was estimated by the Road Research Laboratory that traffic on the roads of this country would increase at the rate of 6 per cent per annum, which would mean that it would be doubled in about ten years. Apart from the great increase in traffic volume, not only was the weight of traffic increasing all the time, but the speed was also increasing and, worst of all, acceleration and deceleration were greater than they had ever been.

Moreover, the pattern of road building had altered: mechanization had arrived in a big way, and this had changed the type of material that one could use for road construction. A point which was not often appreciated was that new roads were now expected to take heavy traffic immediately after laying and, with traffic of the magnitude now involved, this presented a serious problem. The lecturer knew of at least three major instances during the last two or three years where surveyors had constructed a short length of road by the traditional methods and had met with disaster, due to the volume of traffic immediately imposed upon the new construction. The safety margin was no longer there: surveyors no longer had the slow-build-up of traffic over the years to provide compaction.

The present need for new and better roads with a limited budget meant that it was necessary to think all the time of the cost factor: but he thought one should think more often about the true economy of road construction rather than the initial cost. He felt strongly that the question of lowest annual cost, including maintenance, over a period of years was more important than the lowest first cost.

Bituminous materials came into the picture of road construction at all stages: in fact, experience had amply confirmed that, as soon as, the initial earth work was completed, the surface should be covered with a layer of tar or bitumen, and a double surface dressing were required in some cases. The speaker recalled a job in the South of England where the Laboratory had insisted on a double surface dressing on that part of the formation to be covered with experimental construction. Despite subsequent heavy rain the experimental part of the construction was carried on without the slightest trouble but the remainder which had not been protected was seriously delayed.

Pavement Design

One of the principal aspects of the work undertaken at the Road Research Laboratory was a study of the role of bituminous materials in the construction of stronger and better roads. They were trying to evolve methods of calculating the thickness of each layer of the road structure. These thicknesses depended upon the strength of the soil itself and the weight of traffic which the road would have to carry. What had not been realized hitherto was the importance of the role played by the strength of the individual layers. The problem was made more urgent by the fact that new types of base material were being envolved such as the cement-bound, tar-bound and bitumen-bound bases, and people wanted to know how best to use them. The increase in traffic made the matter even more urgent. The Road Research Laboratory urgently required experimental sites, which should

be level, heavily trafficked—and not too far from their laboratories at Harmondsworth.

Mr. Nicholas gave details of comparison between the performance of roads made with different types of base. The preliminary series of experiments showed quite clearly that the road structure was much stronger when the surfacing was a dense material, than when an open-textured material was used. With an open-textured surface the difference between bases were quite distinct: with a stronger, denser surfacing the differences were not so apparent, but they were of the same order; with all surfacings a coated base gave better results than an uncoated one. Another implication from these experiments was that an 8 in. thick base was the minimum required for a heavily trafficked road, and, with some deformation taking place, it was wise to wait before putting down the final surface. Unfortunately, motorists were intolerant of temporary surfaces.

Another experiment on a very heavily trafficked road in the Midlands showed that the contribution of the surfacing to the structural performance of the road depended on its elastic modulus, not on its resistance to penetration by water. The same kind of base was constructed throughout (crushed limestone) and this was surfaced with 4 in. of different types of surfacing material (bitumen macadam, hot rolled-asphalt and dense tar surfacing). Surface dressing was used at different levels in various sections to form impervious layers. It appeared that no matter where the surface dressing was put in an open-textured construction, it did not affect the structural performance of the road. The sections under the open-textured surfacing had failed: those under the rolled-asphalt and the D.T.S. were still satisfactory.

The most important pavement design experiment so far started was that at Alconbury Hill, on A1, now almost four years old. This had confirmed the importance of a dense surfacing and had given valuable information on the relative performance of different bases; the best results were being obtained with the dense bituminous base material (rolled-asphalt base course mixture). No dense tarmacadam had been used in this experiment but other measurements on the load spreading properties and elastic moduli of bituminous mixtures had shown that the dense tarmacadam mixtures recently specified by the Laboratory had structural properties similar to those of the rolled-asphalt base-course mixture. Further major experiments were planned to study in more detail the performance and equivalent thicknesses of different base materials.

Load Spreading Properties

A great advantage of black base material was the ease with which it could be laid and be ready for use almost immediately. Within a few hours, as soon as the material had cooled off, the next layer could be put down without trouble. Traffic could be allowed to pass over even quite thin layers as a temporary measure although this was not recommended.

The purpose of road surfacing was to spread the load to the lower layers in such a way that the safe stress in the material itself was not exceeded. A considerable amount of work had been done recently on the measurement of load-spreading properties of tar-bound base-courses and it had been found that a dense material with a hard binder made to Road Note 29 specification gave results comparable with a rolled-asphalt base-course. As a result of this work the Ministry of Transport had agreed to undertake an extensive trial on the Stevenage By-pass motorway, using a dense tarmacadam base course with 54° e.v.t tar, which was being laid at the time of the lecture. A wearing-course of rolled asphalt would be superimposed.

Skid-resistance

Good resistance to skidding on a wet road depended upon a number of factors, among which were the type of stone used, the binder and the surface texture. It had been found that a fine textured material which gave good resistance to skidding at low speeds was inadequate at high speeds. Water could not get away quickly enough for the tyre to make contact with the surface of the road. Some materials, which in the past, had been suitable for main roads, were now, due to the increased speeds of all vehicles, quite unsatisfactory. The stone was probably the biggest single factor involved: all stones polished to a certain degree, and under modern conditions it was necessary to select the correct type of stone for a particular road. No surfacing could have a better resistance to skidding than the stone could provide.

If there were excess tar or bitumen on the surface giving a smooth texture, the sideways force co-efficient was markedly reduced: the engineer's job was to ensure that this did not occur, at least in the early life of the surfacing, but with the extraordinary compaction by modern heavy traffic it was now almost impossible to obtain good durability without the binder coming to the surface to some extent. All binders, when exposed to air, harden and are abraded by traffic. It was, therefore, vitally important when dealing with heavily trafficked roads, that for the surface material one should choose a binder which would wear off quickly, otherwise the stone could not play its part. The capacity of binders for wearing off varies considerably: some bitumens weather slowly: on the other hand, tar wears off more quickly. The tar suppliers' claim that their materials were non-skid was thus quite correct, provided a good stone was used. In rolled-asphalt wearing course material, it had long been the practice to use a proportion of Trinidad Lake Asphalt in the binder because this material also weathers from the surface to give a non-skid texture. The Road Research Laboratory had shown that a similar result could be obtained in rolled-asphalt by mixing about 20 per cent of a soft or medium-soft coal-tar pitch with a petroleum bitumen for use as the binder. Some difficulty was experienced at first with the preparation of a suitable pitch-bitumen mixture but these had been resolved by work at the Laboratory and large-scale trials of rolled-asphalt wearing-course mixture with pitch-bitumen binders were in progress. The first experimental sections of such mixtures were now more than ten years old and indicated that durability was no problem with these mixtures. They were now being exploited on a commercial scale.

For the surface dressing of heavily trafficked roads, a binder was needed which would allow the chippings to play their full part in maintaining a good surface texture and tar was most suitable for this purpose.

Discussion

Asked during the discussion if he was satisfied with the present methods of testing for sideway force co-efficients and to give further information on methods for providing a rough texture to facilitate the removal of surface water and give good skidding resistance at high speeds, Mr. Nicholas replied that the S.F.C. machine could be taken up to 50 m.p.h., but it would be extremely difficult to develop any test that was both simple and suitable for use at high speed. The Laboratory used an X.K. 140 with a trailer. It was clear, from the work undertaken, that the rough-textured road surface required could be obtained by superimposing coated chippings on a dense surfacing material or by surface dressing. The stones need not be more than $\frac{1}{4}$—$\frac{3}{8}$ in. proud, but there must be a good provision of such projections over the road surface.

Replying to a questionnaire who wanted to know whether a solution would not be provided by having a layer of impervious material covered by $1\frac{1}{2}$ in. of open-textured material, to create a labyrinth into which the water could escape, Mr. Nicholas said this had been considered. The problem, however, was that on any road the inside lane tended to get most of the heavy traffic, which travelled along two well-defined wheel tracks, where intense compaction occurred. No material that he knew of could remain open-textured in these circumstances. He thought it was far better to have a solid surfacing, with projections giving the rough texture.

Asked the length of time likely to elapse before the results of the experiments on black bases could be assessed, the lecturer replied that he hoped that it would not be more than two or three years before further information would be available from the other major experiments shortly to be started which, together with the longer-term results from the Alconbury Hill experiment, would enable definite proposals to be formulated.

Mr. R.O. Hanson, A.M.I.MUN.E (Divisional Surveyor, West Sussex C.C), referring to the cold-laid asphalt mixture used by his authority in the 1930's, using a hard powdered bitumen, a slate filler and a flux, which had given good results, asked whether this idea had now gone out of favour. Mr. Nicholas replied that the process was rather complicated and he did not think it was really suitable for modern

methods of road construction. In general the tendency was to use harder binders rather than fluxed materials; for example the use of tar of 50—54° e.v.t. was now standard practice.

Replying to other questions, Mr. Nicholas said that it was necessary to specify very carefully exactly what the contractor was supposed to do when laying base materials. To obtain proper compaction of black bases no layer should be thicker than 3 in. The laboratory had found it wise on a very weak sub-base to lay the first layer of black materials by hand and to use only a light roller—with subsequent layers a heavier roller was used—but it was, of course, more satisfactory to use a sub-base material that would carry normal construction machinery. So far as the possibility of stripping of the binder from the aggregate in black bases was concerned, he said there was no doubt that, where it was intended to leave a base exposed for any length of time before laying a base course and wearing-course, it should be surface dressed to keep the water out. The denser base materials now recommended were unlikely to strip seriously but sealing was a good insurance.

Asked for his views on the question of adhesion of tar-bound to bitumen-bound layers, Mr. Nicholas replied that many people had, with great success for many years, been laying tarmacadam base-course and bitumen-macadam wearing-course. In recent experiments the Laboratory had successfully used rolled asphalt on a close-textured tarmacadam base-course. There had been one or two instances where trouble had been reported; it was suspected that this was due to the soft stone in the base-course which had under the heavy roller led to dust formation, or, more probably, to mud carried on to the base-course by construction traffic. It was essential that the base-course should be kept clean; good adhesion was impossible on a dusty or muddy base-course.

(From "Traffic Engineer & Control", February, 1962.)

(Continued from page 14)

tion, the Soviet engineers' main efforts along this line of production technology are directed towards the complete transition to automatic control of the plants, and certain successes in this field have already been scored. A number of industrial enterprises have already mastered the new technological methods. Thus, there already are in the country mobile units of cement-concrete plants, consisting of two assemblies weighing 10 tons each. These continuous assemblies have an output capacity of 30 cu. m. per hour and are automatically controlled. The industry puts out sets of equipment for automatic lines in asphalt-concrete plants, designed to replace the new functioning machinery. At these plants the number of workers is 2.5—3 times smaller and the mix production cost 15—20 per cent lower than at the conventional plant.

The serious research work conducted at "Soyuzdornii" (Road Building Research Institute) and at Vniistroydormach (Road-Building Machinery Research Institute), as well as a vast army of inventors and work rationalizers, have contributed their share to the steady technical progress scored in road building. "Soyuzdornii", moreover, has a whole network of branches and research stations in the various climatic zones of the country.

White ants in some parts of Africa find paved road surfaces quite to their taste—they eat them.

—World Highways (Nov. 61)

THE TAMAR BRIDGE

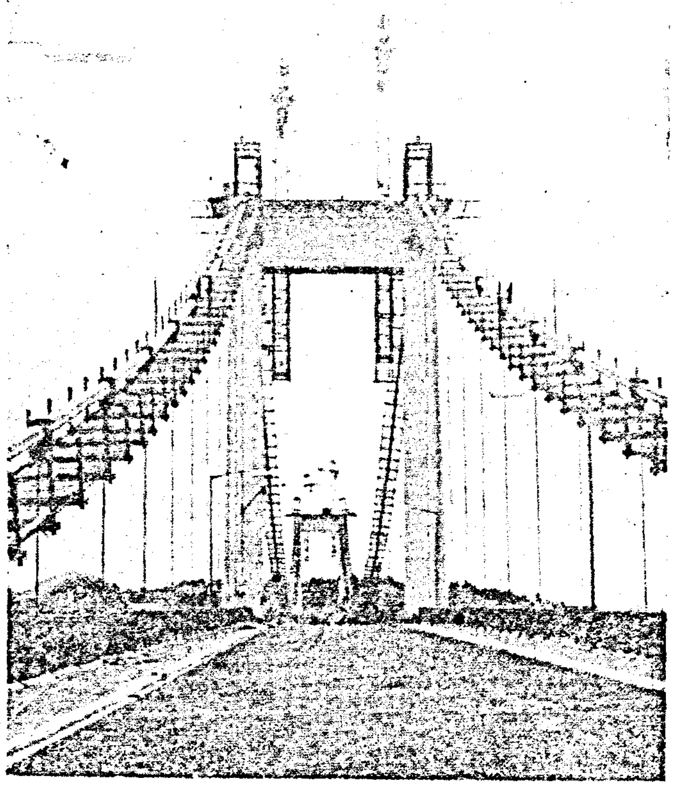
THE Tamar bridge, which was partially opened to traffic on October 24 last, crosses the River Tamar five miles from Plymouth alongside Brunel's 102 year-old Royal Albert railway bridge. It joins St. Budeaux in Devon to Saltash in Cornwall and replaces the slow, small capacity chain ferry which has been the cause of frustrating traffic queues as the holiday exodus to Cornwall has mounted over the past 15 years. No Government grant was forthcoming for this badly needed structure and its construction has been organised through the medium of the Tamar Road Bridge Joint Committee, representing the Cornwall County Council and the City of Plymouth.

Built in just over two years by the Cleveland Bridge and Engineering Co. Ltd., of Darlington, to designs prepared by Mott, Hay and Anderson, the Committee's consulting engineers, the Tamar bridge is the first suspension bridge to be built in Britain for 66 years. It is also the longest bridge of this type, and will remain so until the Forth Road Bridge is opened in 1963. Traffic is carried on a three-lane carriageway 33 ft wide with a 6 ft wide footpath at each side. The roadway is 130 ft above the spring tide high water mark and the central span is 1,100 ft between concrete towers 250 ft high. There are two side spans each 374 ft long, the total suspended length being 1,848 ft.

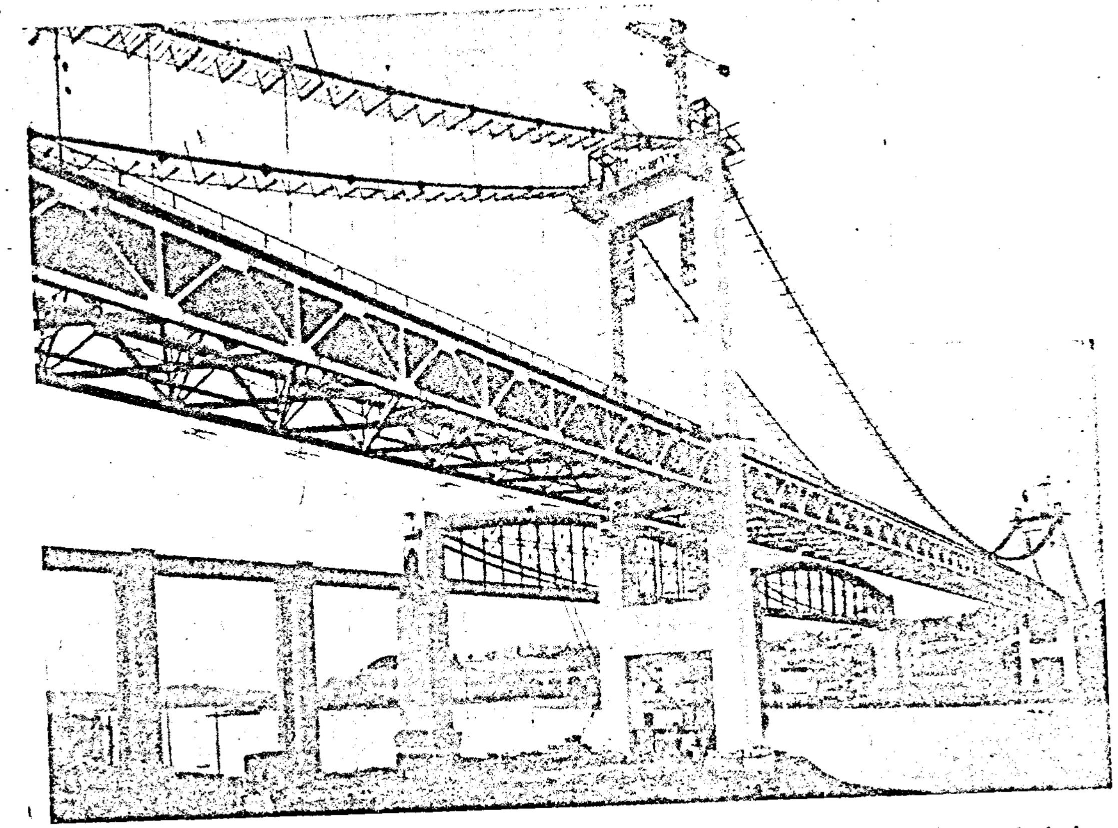
DETAILS OF DESIGN

Main pier foundations consist of twin 30 ft diameter caissons two of these being sited on the Saltash side of the river and two on the Plymouth side of the river. They are founded at approximately 38 ft below o.d. on rock.

The main towers, which are constructed of reinforced concrete and taper from 14 ft square at the base to 9 ft at the top, were founded on these twin cylinders on each side of the river, and extend to a height of about 260 ft above o.d. The side towers were constructed 374 ft shorewards on each side of the river also in reinforced concrete.



View along the deck of the new bridge showing the climbing cranes and the catwalks still in position



The new Tamar Suspension Bridge which has superseded the slow and overloaded chain ferry from St. Budeaux to Saltash. In the background is Brunel's famous railway bridge

Twin anchorage tunnels were constructed in the rock on each side of the river and these penetrate to a depth of roughly 50 ft into the rock. Anchorages consist of 3½ in. diameter high tensile steel prestressed anchor rods sunk into tunnels which, driven into rock, incline at 35 degrees to horizontal and taper from 12 ft wide and 16 ft deep at entry to 20 ft wide and 28 ft deep at base. Extending the full depth of the tunnels, the rods are arranged in pairs to anchor the cable strands.

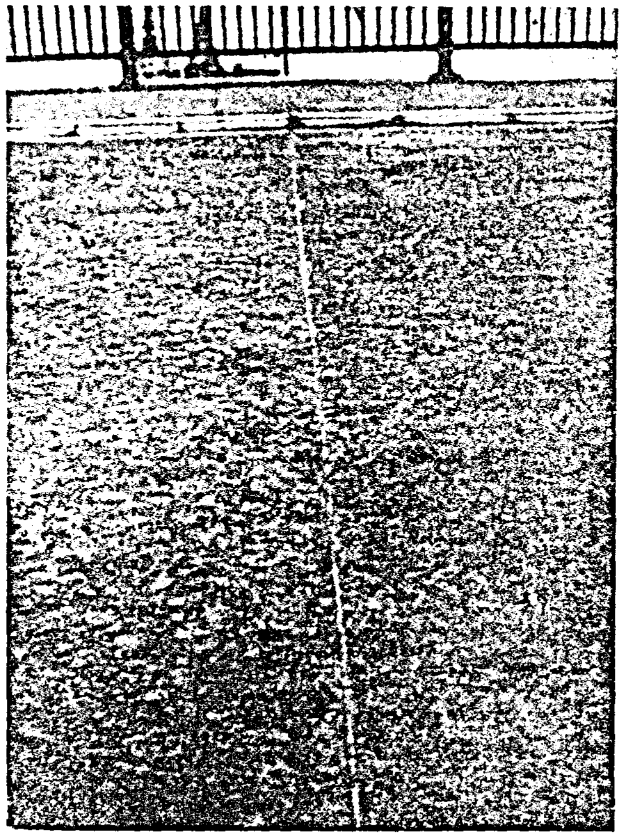
The cables extend from across the river from one anchorage to the other anchorage being supported by the side piers and main towers. Each cable consists of 31 prefabricated locked coil ropes. Clamps are fitted to the main cables suspenders, from these clamps support the stiffening girder of the bridge.

The stiffening girder is a Warren type truss 16 ft deep. This is made up of welded steel box members, the top and bottom chords being 2 ft square in section. The deck of the bridge consists of a reinforced concrete slab 6 in. deep and this is supported on steel stringers. Road surfacing on the bridge deck consists of 1½ in. of hand laid mastic asphalt, with precoated chippings.

The parapets are of tubular steel design. All steelwork has been grit blasted and metal sprayed with zinc, each primed and painted with one coat of paint. Two subsequent coats of paint will be added.

Construction Features

For the foundations to main piers, temporary bunds were tipped into the river on both sides and caissons with cutting edges were constructed and sunk through these to rock level, compressed air being used. The steel cutting edge had concrete added to it and was extended in height as the cutting edge was lowered. Granite facing was added to the caissons as they were constructed.



The mastic asphalt surfacing has been laid in rectangular panels with joints filled with bituminous compound

Each main tower consists of two legs, 250 ft high and 50 ft apart. Reinforced concrete has been employed throughout and each pair of tower legs is joined by three horizontal members. Building the towers brought its problems. The aperture at the top of the hollow rectangular legs was too small for any available type of climbing crane, and it was therefore decided to attach Bailey Bridge panels to the sides of the legs, thus forming two temporary structures within which specially adapted tower cranes could climb as work progressed. One jib always operated 10 ft above the other to prevent fouling. Special shuttering was developed by Kwikform Ltd., to ensure a smooth finish.

Made by British Ropes Ltd., the ropes are of the "locked coil" pattern, never before used on suspension bridge construction. The specification required that the ropes should meet the following demands:—(1) each rope had to be 2.370 in. diameter with a guaranteed breaking load of 334 tons; (2) before manufacture started the accuracy of the rope size had to be forecast to $\pm$ 0.0025 in. diameter; (3) rope diameter after prestressing and suspended under its own weight had to be 2.365 in.; (4) rope diameter when suspended under 100 tons load had to be 2.361 in.; and (5) the residual torque had to be nil or as small as possible.

Subsequent tests showed that the size variations were accurate and that residual torque could be ignored. Site experience confirmed these findings. The 31 ropes comprising each main cable, when arranged in their geometric pattern, needed six aluminium fillers in the corners to make a circle of 14-13/16 in. diameter. Each wire underwent 38 production tests before being submitted to the inspectors.

The ropes were prestressed to 50 per cent of their guaranteed breaking load ten or more times and during these operations the stress/strain relationship was autographically recorded. When all initial constructional stretch had been removed the "apparent modulus" of the rope over its entire length was determined. Then the load was reduced to 100 tons which is the maximum design working load.

At this load the temperature was determined. With the temperature fixed and the load accurate the prestressing machine was locked to maintain that length, changes in load compensating for alterations in temperature. Allowing for temperature corrections, the rope was measured and marked. Sockets were fitted to the end marks and later the entire assembly was proof-loaded to 167 tons, reduced to 100 tons and the length checked by inspectors. The ropes were socketed in the prestressing building, each main cable socket weighing nearly 2 cwt empty, and being filled with 90 lb of white metal.

Prestressed catwalk ropes were the first ropes to be taken across the river. Next chain link fencing made from $6\frac{1}{2}$ S.W.G. galvanised wire with 2 in. mesh was fastened to timber battens at 10 ft centres, the battens carrying steel clips to fit around the ropes. Each assembly was allowed to slide from the tops of the towers towards the centre and the anchorages. The meshes were joined and the clips on each batten tightened on to the ropes. Vertical battens formed the handrail supports. Hand ropes were placed in position, clamped to the supports and tensioned.

At seven points on the catwalk angle iron head frames were erected to hold sheaves for the aerial haulage rope. The latter extended from a winch with a surge drum on the Plymouth side, along the north side catwalk to a point near the Saltash anchorage, where it passed round a tensioning device and returned over the south catwalk to a further tensioning device on the Plymouth side and back to the drum. The two ends of the rope were spliced together.

At Plymouth north anchorage a plate carrier was fastened to the haulage rope and a similar one at the Saltash south anchorage. Thus, with all the main cable units being stored at Plymouth, as one carrier took a main cable rope unit over to saltash the empty carrier returned to Plymouth via the opposite catwalk ready for the next trip. The Plymouth socket was anchored first, $1\frac{1}{2}$ in. short, during which operation a Lucker wedge grip was fitted at the Saltash end and tension applied. This caused the rope to slide towards Saltash and lift itself off the catwalk where it had been lying. The tension was maintained on the Lucker grip until the Saltash end was secured, again $1\frac{1}{2}$ in. short.

The rope unit was allowed to hang "high" over night to attain an even temperature throughout its length. In the morning the anchor nuts were run back until the unit was set to its marks at the main saddles, side tower saddles and splay saddles.

The 120 suspender ropes were made to a specification similar to that of the main cables, but their size was 2.085 in. diameter with a guaranteed breaking load of 246 tons. They also were prestressed and lengths were measured accurately to $\pm\frac{1}{8}$ in.

The centre span was erected in 80 ton sections which were floated out by pontoon and hauled into position by winch. Side spans were erected from the side towers outwards in small sections.

9/1/42

General

The project includes two side spans and approach road works, together with a plaza on the Plymouth side with toll booths and an administration building. Roundabouts have been provided for the road junctions on each side.

The bridge is not due to be officially opened until next spring, but the impelling need for the new crossing has caused the Joint Committee to make it available as soon as possible and also to provide revenue to meet the loan charges. For the time being only two of the traffic lanes and one footway will be in use. This will permit the contractors to finish the mains cables which have to be wrapped with 0.15 in. dia. galvanised mild steel wire, and also to complete the site painting of steelwork.

The lighting for the bridge and the approaches is provided by G.E.C. lanterns equipped with Osram 200-W linear sodium lamps mounted on 25 ft tubular steel columns on the bridge itself, which are built into the hand-rail structure at 90 ft intervals, and on 30 and 35 ft columns on the approaches. There are 75 of these lanterns lighting the bridge and the approaches to it on the Saltash and Plymouth sides.

(From "Roads and Road Construction", November, 1961.)

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VIRGINIA'S FIRST ALUMINUM BRIDGE SPANS APPOMATTOX RIVER

By

J. N. Clary

Bridge Engineer, Virginia Department of Highways

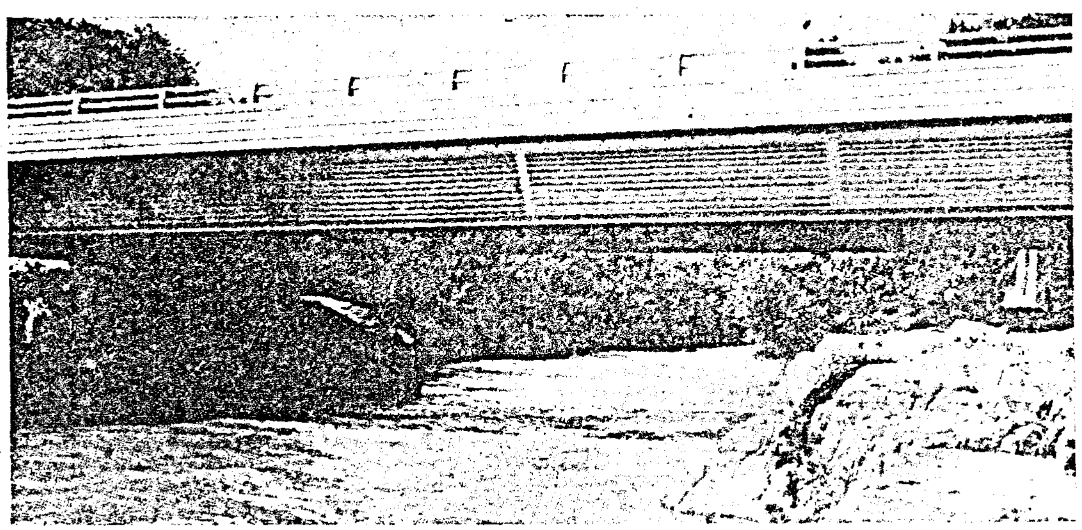
THE Fairchild bridge was developed by Fairchild Aircraft Co., in co-operation with four major aluminum producers. It consists of triangular modules using thin aluminum sheeting.

A modified design of the Fairchild bridge, with many changes, was developed in Virginia. One important change was the use of a heavy extrusion as the bottom flange of each triangular module instead of the continuous thin plate of the Fairchild bridge. These changes were such as to make the design more acceptable to our department.

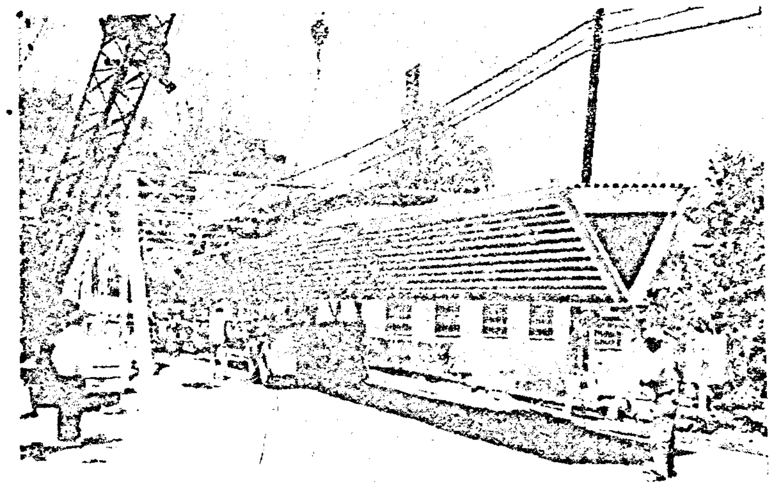
Early in 1960, our bridge division started the design of a conventional welded steel-girder bridge to be constructed across the Appomattox River at Petersburg to replace the 54-year old steel truss span that had become obsolete. The design had to provide for constructing the roadway in two halves in order to maintain traffic during construction.

The state highway department agreed that if the aluminum company would arrange for the preparation of plans for an alternate design in aluminum using its latest design, the highway department would advertise for alternate bids between the steel and aluminum designs. It was required that the aluminum girders have the same depth as the girders in the steel design.

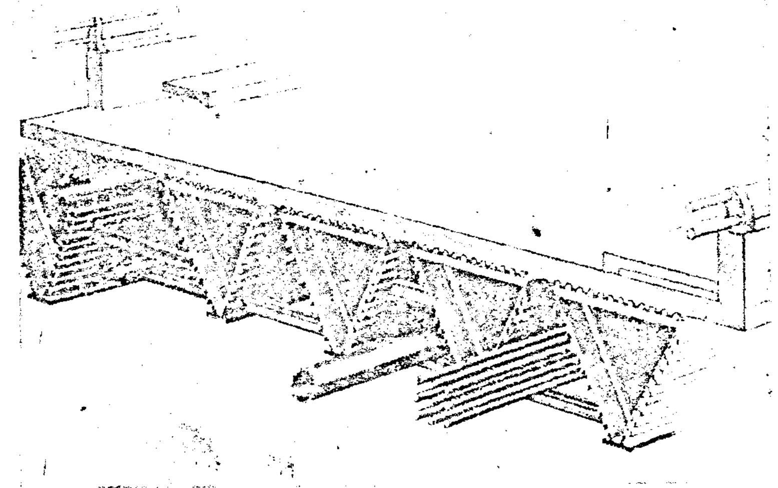
After alternate plans had been completed construction bids were received on July 8, 1960. Sanford Construction Co., Sanford, N.C., submitted the low bid of 88,771 dollars for the aluminum design. The company's bid for the steel design was 93,990 dollars. Although the bidding on



Completed aluminum bridge. Notice the narrow waterway opening



An Aluminum girder is lifted from the pole truck. Note old truss span and over-head electric power lines



A Drawing showing general cross-section and miscellaneous details, including location of utility lines

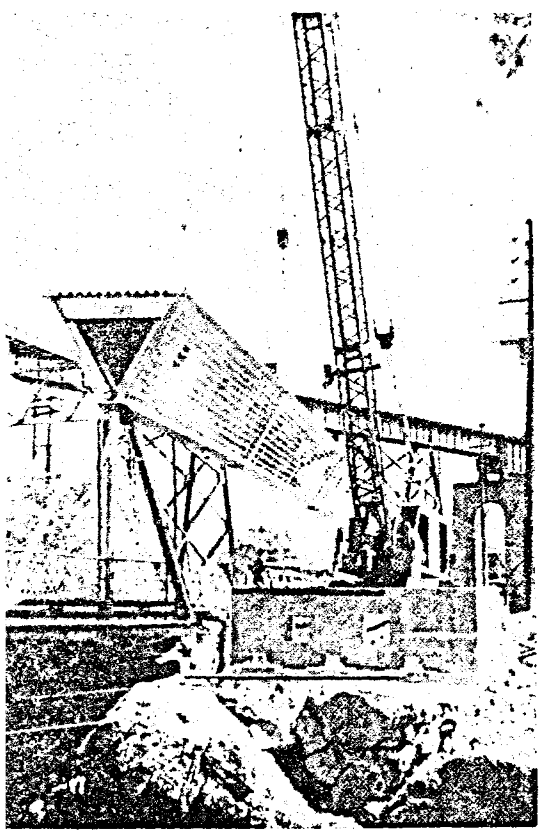
the two designs was strictly competitive in so far as the highway department was concerned, certain extra costs in the aluminium design were absorbed by the aluminium company. It arranged to bid the fabricated aluminium to the general contractors at a price that would make it competitive with the steel design.

The bridge consists of a single-span, 97 ft long center-to-center of bearings. The 28-ft roadway is flanked by a 5-ft walkway on one side and a 3 ft walkway on the other. The five aluminium girders are triangular modules 4 ft 10 in. deep and 6 ft 9½ in. wide at the top. These use one heavy extrusion for the bottom flange and two small extrusions at the top. The webs are made of thin aluminium sheet with adequate stiffeners.

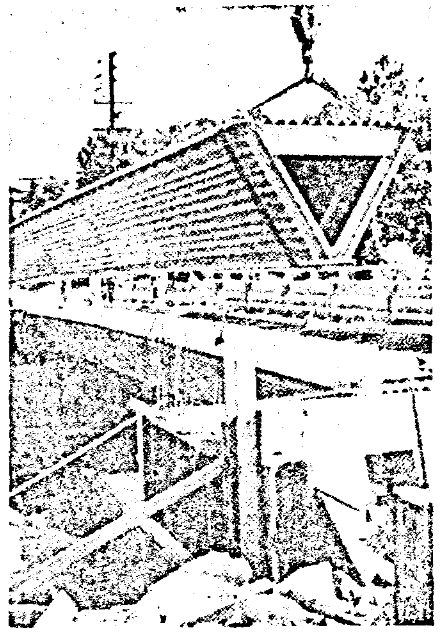
As let to contract the design called for all stiffeners to be vertical. However, after the contract was awarded, it was found desirable to modify the design to use vertical stiffeners on the inside with a spacing roughly equal to the depth of the web and longitudinal stiffeners with adequate spacing on the outside.

Shear connectors are attached to the top flange throughout the length of each of the two flange extrusions. In addition, an especially heavy thermal lug is attached at each end of these flange members. Transverse struts connect the top flanges, and the top is fully enclosed by a longitudinally corrugated plate that serves only as a form for the 7-in. portland-cement-concrete floor slab. The floor slab, although it is conventionally reinforced, is made of light weight concrete weighing approximately 115 lb per cu. ft.

The old steel truss span was moved slightly downstream and carried traffic until half the roadway of the new bridge was ready. Three of the five aluminum girders (modules) were placed on the upstream side and bolted together. These girders were placed on May 2, 3 and 4—one unit each day. The deck slab was poured on May 17.



First Girder is lowered into position. Holes through back wall are for utilities



Final girder is lowered into place. Two cranes were used for accurate placement

Traffic was not permitted to use this section until June 26 because of a delay in completing the necessary roadway approach. After traffic was using the first section of the new bridge, the old 18-ft roadway truss span was removed. On July 24 the last two girders were placed one in the morning and one in the afternoon, and the other half of the concrete floor was poured on August 8. By October 6, all work on the structure had been completed and the full roadway of the bridge was opened to traffic.

All of the connections of the component parts of the aluminium bridge were made by bolting. For fabrication of the web and elsewhere where thin sections were involved, bolts using a patented method of fastening a sleeve over a knurled surface on the bolt were used. Otherwise aircraft-quality bolts with self-locking nuts were used.

Each of the five girders weighs approximately 9,000 lb and the total weight of the aluminium in the bridge is approximately 48,000 lb. This compares with 187,000 lb in the alternate steel design.

The light weight of each girder greatly simplified its handling. Each girder was hauled directly from the fabricating plant in Norfolk, Va., to the job site on a pole-type trailer. It was lifted from the truck by a single crane and maneuvered into its approximately final location on abutments. Final placement of all girders was handled by two cranes because of difficult conditions at the site.

In addition to the old existing truss span that was in place immediately beside the location of the first three girders, two overhead power lines had to be avoided. One power line carries 4,160 volts and the other 13,200 volts across the river at this point. It was necessary to be especially careful to avoid contact with these lines.

When the aluminium bridge was constructed it was necessary to provide for permanant attachment of three utilities—a gas line, a water line and telephone conduits. When the five triangular modules were placed side-by-side in the bridge, four open and inverted "V's" were formed, three of which were used for the utilities. The utility lines can be inspected from the underside of the bridge.

The COMPUTED dead load deflection for the girders was 5½ in., which was to be provided by cambering the girder. The actual camber of the girder, as fabricated, slightly exceeded 6 in. The change in design to use longitudinal stiffeners stiffen the girders sufficiently to reduce computed deflection by ½ in., but this recomputation was not made until after the girders had been fabricated.

In spite of the oversight, no serious problem was faced in taking care of the matter. Because of this dead-load deflection, the last two girders placed were considerably higher than the first three, which had been loaded by the concrete slab. Because each module was bolted to the adjacent module at the point of contact it was necessary to load and pull down the newly placed girders in order to bolt them to the unit previously placed.

The aluminium company received permission from the state highway department to place a large number of strain gauges, widely dispersed, on the first aluminium units placed. Fortyeight gauges were placed.

Approximately 65 per cent of the aluminium consists of extrusions and the remainder is sheet aluminium 0.1 in. thick in the web.

The unusual location plus the need to build the bridge in halves has added to the information obtained during construction. Data obtained so far will be supplemented by further tests from time to time, thus adding to our knowledge of bridges of this type.

(From "Better Roads", November, 1961.)

HERE AND THERE

1. SYNTHETIC RUBBER BEARINGS ON NEW CANADIAN BRIDGE

Use of Neoprene Pads

MORE than one thousand pads made of synthetic rubber are in use as bearings on the new three-Kilometre long Champlain Bridge which now spans the St. Lawrence Harbour at Montreal, Canada. These flat rubber pads, made of neoprene synthetic rubber, act as the bearing support material between the beams and abutments on the 46 concrete pillars of this giant bridge.

Each pad, 30 cms wide, 60 cms long and 3.6 cms thick, consists of three layers of neoprene bonded on to galvanised metal separator sheets 1 mm. thick. The maximum weight carried by each pad is 171 tons, equal to a load of 1,350 lb per sq. in. The metal sheets are sandwiched between the neoprene layers to prevent excessive bulging or shear strain. Multiply rubber bearings interleaved with metal plates give extra thickness to the rubber, thus spreading and reducing the compression strain.

On this bridge, built to speed up the flow of traffic across the harbour, the neoprene pads are capable of taking a displacement of 3.3 cms without any sliding movement. The consulting engineers for the bridge, Societe STUP of Paris, estimate that the actual displacement under maximum load will not in fact exceed 18 mm., thus providing a considerable safety margin.

The pads are located between the seven girders which straddle this 50-metre wide bridge and the concrete pillars. No less than 196 neoprene bearing pads are placed at each section.

(From "The Surveyor & Municipal & County Engineer", January 27, 1962.)

2. A VEHICLE FOR TESTING BRIDGES

A new 45-ton single-axle trailer has been developed by the British Ministry of Transport as an aid to the design and testing of bridges and was used recently on the reinforced concrete spans of the northern approach of the Runcorn-Widnes Bridge.

The trailer which comprises an axle on which varying numbers of concrete weights can be balanced, is used to study the behaviour of bridges, particularly those with prestressed concrete and composite steel and concrete decks. It has a lattice girder towbar which can be extended so that the axle is separated from the towing vehicle by a distance upto 53 ft, thereby making it possible to apply the load at a point on an otherwise unloaded bridge. The resulting deflection of the bridge is measured by instruments capable of reading to 0.0001 in., strains are measured by means of optical and acoustic gauges, reading to 0.000001 in.

The trailer was also used on several of the bridges on the Preston, Lancaster and Catterick by-passes. New bridges on motorways and other roads under construction will be investigated before they come into use, thereby avoiding disruption to traffic. It is not the object to test bridges to destruction or to determine whether they will carry the design load, but is to establish comprehensive data about bridge types, materials and components. These investigations should eventually establish the most economical forms of construction and result in economies by reducing unnecessarily high margins of safety.

(From "Concrete and Constructional Engineering" Vol. 56, No. 10, p-361, October 1961.)

3. HIGHWAY FUND DISTRIBUTION IN THE UNITED STATES

Policy of Federal and State Governments

THE policy of the United States Federal and State Governments for the geographic distribution of highway funds among regions and road systems, was discussed by Mr. Richard Carll, of the Institute of Transportation and Traffic Engineering, University of California, in a paper presented at the annual meeting of the Highway Research Board in Washington in January. Following is a synopsis of his address :

This particular branch of transportation policy is now one of the most important fields of highway economics, especially as road financing has become more and more centralised in recent years, and as Federal-State activities have been extended increasingly into the sphere of local highway affairs.

The unique importance of distribution policy for highway money follows from the peculiar nature of the highway taxation system. Motor fuel and Vehicle taxes are intended to tax road users in proportion to their relative use of highways, roads, and streets. However, this objective cannot be realised unless the distribution of funds is guided by the same principles as the collection of the revenues. As a fiscal subject, the allocation of highway funds has received scant treatment in the theory and research of highway finance.

In the course of devising distribution policy, the Central Governments have resorted to various statutory standards and formulas. Many different factors have been employed as guides for distribution, but three basic considerations (apart from purely sectional politics) have governed the legislation formulated for controlling the spread of funds. These are (a) the need for funds in each region, as indicated by the estimated cost of completing a definite, planned system of highways ; (b) the geographic origin of user tax earnings, as indicated by population, vehicle registrations, or other such measures ; and (c) the amount of financing expected from local sources (as, for example, the matching requirements of Federal highway aids, or the allocation of local rural and municipal road expenses to non-user taxpayers). The problem of the Central Governments has been to adopt these criteria to the diverse conditions of transport found among the separate regions of a large taxing jurisdiction, such as California or the nation.

In a detailed study of California's geographic apportionment of highway money, the method of anlysis has been descriptive and institutional, rather than a scientific test of hypotheses. The development of the separate branches of California's policy has been compared, the aggregate distribution of funds through various channels to each of several regions combined, and the flow of funds to the different classes of regions compared with the basic distribution criteria previously noted. The findings suggested by these facts from the basis for a number of observations about the use of the different distribution standards.

A second contribution of the paper is to enlarge the perspective provided by recent discussions of economic evaluation for individual highway projects. It is recognised that the present methods of project analysis are dependent on the assumptions of a fixed volume of traffic and a 'fixed budget' for highway expenditures. These assumptions make possible the calculation of benefits entirely in terms of 'savings' to users, and permit an economic 'ranking' of alternative highway projects. While this approach has application to the problem of capital budgeting, it does not tell anything about budgetary constraints, or about the total volume of highway investment in relation to traffic growth. The 'users' pay philosophy underlies most of the thinking about aggregate capital formation for highways but has been concerned primarily with the taxation of highway users and the earmarking of the proceeds, rather than the actual direction of highway expenditures.

(From "The Surveyor & Municipal & County Engineer", February, 1962.)

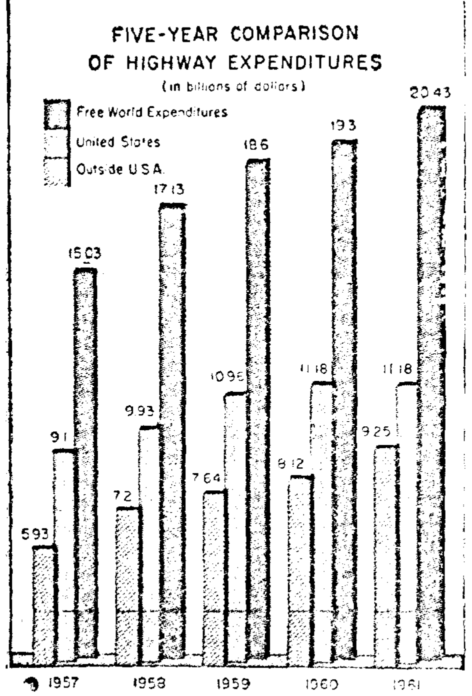
4. RECORD 20 BILLION DOLLARS FOR ROADS IN 1961

Sets New All-Time Global High

FREE-WORLD expenditures for roads and highways last year reached a new all-time high of (US) 20.43 billion dollars according to International Road Federation estimates based on available data from 162 countries and territories.

This figure is a 5.9 per cent increase over the old record of 19.3 billion dollars which was spent in 1960. It is at least the fourteenth straight year that road-spending figures have topped those of the year before, and indicates a 36 per cent increase over the 15.03 billion dollars which was spent five years ago (see Table 1 below).

Table 1



Free-world countries, not counting the United States, spent 9.25 billion dollars on roads in 1961. This was an increase of 14 per cent over the 8.12 billion dollars figure for 1960.

Despite domestic spending figures last year nearly identical with these of the year before, the United States remained far and away the leading highway spender, with an estimated total of 11.18 billion dollars reported.

Second among those nations spending more than the equivalent of a billion dollars a year for roads was West Germany, which spent 1.5 billion dollars in 1961 as compared with 1.2 billion dollars the previous year.

Canada was third, despite a slight decrease from 1.35 billion dollars in 1960 to 1.30 billion dollars in 1961.

Japan, pushing hard to improve her highways, partly because of the 1964 Olympics, broke into the "billion-dollar group" for the first time last year with an expenditure of 1.066 billion dollars or 87 per cent more than 569 million dollars reported in 1960.

France and Great Britain, the other two major highway spenders last year reported sums well over a half-billion dollars.

France's expenditures totalled 711.29 million dollars—a 16 per cent increase over 1960—and Great Britain's expenditures went up 18 per cent over 1960, to reach 611.49 million dollars in 1961 (see Table 2, page 33).

At the other end of the scale, the United States Trust Territories in the Pacific spent only 17,500 dollars on 136 miles of roads serving 490 vehicles.

With respect to motor-vehicle population, the United States again led last year, with more than 76 million automobiles registered.

Great Britain was second, with 7.1 million cars; France was third, with 7 million, and West Germany fourth, with 5.6 million automobiles registered.

At the end of 1961, the United States had 1,230,469 miles of paved roads in a road network totalling 3,546,693 miles, France was second, with 245,000 miles of paved roads out of a 766,300-mile total, and Great Britain took third place with a 201,706-mile system, all of which is reported paved.

The lowest road-mileage figures recorded in 1961 were those of the Falkland Islands in the South Atlantic, which have one mile of paved roadways and an additional 11 miles which are unpaved.

Record Highway Loans

Demonstrating the realization of the importance of highways in foreign economic development is the fact that international and U.S. Governmental agencies quartered in Washington, D.C., alone, made highway loans totaling 418 million dollars during calendar 1961 (see Table 3 for agency breakdown by country).

Highway loans made by the World Bank and its affiliate, the International Development Association (IDA), showed a sharp upswing during fiscal, 1961, reaching a total of 180.3 million dollars—or 25.7 per cent of the 701.9 million dollars total loaned for all purposes by these two agencies (see Table 4).

The last figures reflect not only the rising trend in the actual amount of money loaned for roads but assume particular significance in light of the fact that, during the period from fiscal 1947 through 1951, the World Bank devoted to road development less than three per cent of the 1,087 million dollars total loaned for all purposes.

TABLE 2

Top Ten in Expenditures, Vehicles and Mileages for 1961

Highway Expenditures:

		Dollars
United States	...	11,178,000,000
West Germany	...	1,500,000,000
Canada	...	1,300,000,000
Japan	...	1,065,837,000
France	...	711,288,500
Great Britain	...	611,490,000
Australia	...	346,654,000
Argentina	...	278,000,000
Brazil	...	249,070,000
India	...	213,937,000

Motor Vehicle Population:

		Dollars
United States	...	76,007,000
Great Britain	...	7,081,000
France	...	7,008,500
West Germany	...	5,610,677
Canada	...	5,221,865
Australia	...	2,908,281
Italy	...	2,459,505
Japan	...	2,113,267
Sweden	...	1,342,000
South Africa	...	1,210,000

Highway Mileage:

		Paved	Total
United States	...	1,230,469	3,546,693
France	...	245,000	766,300
Japan	...	16,599	597,704
Canada	...	66,166	470,751
India	...	50,637	398,000
Brazil	...	6,417	307,310
Australia	...	55,335	232,539
West Germany	...	103,750	219,250
South Africa	...	11,750	215,250
Great Britain	...	201,706	201,706

TABLE 3

Highway Loans

January 1, 1961 to December 31, 1961
Made by International Banking Agencies
Located in Washington, D.C.

		Amount (million dollars)	Agency
Argentina	...	$ 48.5	IBRD
Chile	...	6.0	IBRD
Columbia	...	19.5	IBRD
Costa Rica	...	5.5	IBRD
Japan	...	40.0	IBRD
Peru	...	10.0	IBRD
Venezuela	...	45.0	IBRD
		$ 174.5	
Chile	...	$ 19.0	IDA
Columbia	...	19.5	IDA
Costa Rica	...	5.5	IDA
Honduras	...	9.0	IDA
India	...	60.0	IDA
Paraguay	...	6.0	IDA
		$ 119.0	

	Amount million dollars	Agency
Argentina ...	$ 40.0	EIB
Guatemala ...	3.6	EIB
Nicaragua ...	2.0	EIB
Peru ...	20.0	EIB
	$ 65.6	
Argentina ...	$ 6.0	DLF
Bolivia ...	2.0	DLF
Columbia ...	5.0*	DLF
Costa Rica ...	0.125	DLF
Ecuador ...	1.8	DLF
Ethiopia ...	3.6	DLF
Guatemala ...	7.5	DLF
Haiti ...	0.3	DLF
Iran ...	12.0	DLF
Nicaragua ...	7.1	DLF
Peru ...	8.5*	DLF
Tanganyika ...	1.9	DLF
	$ 55.825	
Honduras ...	$ 3.15	IADB
Total ...	$ 418.075	

Note: *Housing and resettlement included in loans.

AGENCY INITIALS:

IBRD — World Bank

IDA — International Development Association

EIB — Export-Import Bank

DLF — Development Loan Fund

IADB — Inter-American Development Bank

About 9,800 feet of the 19,000 foot-total length of the Grand St. Bernard tunnel, linking Switzerland and Italy, have been bored. When completed, this tunnel will provide an all-weather link between Cantine de Proz, Switzerland, and the Italian town of St. Rhemy in the Aosta Valley (World Highways, July, January, 1959; October, March, 1958; December, 1952).

(*From "World Highways", February, 1962.*)

5. SAN BERNADINO TUNNEL

WORK began last July on construction of the four-mile, (US) 16.8 million dollar San Bernadino tunnel between Switzerland and Italy. The project is expected to be completed in 1965. (World Highways, April, 1968).

(*From "World Highways", February, 1962.*)

6. SEVEN-LINGUAL DICTIONARY CONCERNING PRESTRESSED CONCRETE

ON occasion of the Congress of the International Federation of Prestressed Concrete (Federation Internationale de la Precontrainte), which will be held in Rome-Naples from the 27th May till the 2nd June, 1962, a dictionary relating to prestressed concrete will be obtainable in the bookstand of the Congress in Rome.

This dictionary encloses about 2,000 words and terms concerning prestressed concrete and its adjacent domain in seven languages, i.e., English, French, German, Italian, Netherlands, Russian and Spanish and has been composed in co-operation with specialists of the various countries on the request of the Federation Internationale de la Precontainte (F.I.P.) by the Netherlands Study group of Prestressed Concrete, affiliated with the F.I.P.

The price of this dictionary will amount to £ 3 per copy.

However, if the dictionary is ordered before 15th of May next, the price of the dictionary will amount £ 2.10.

Orders to be addressed to the Stuvo, Herengracht 507, Amsterdam. The amount due to be remitted to the Amsterdamse Bank, Amsterdam, in favour of the Stuvo.

CURRENT LITERATURE

LIST OF INSDOC TRANSLATIONS IN THE CENTRAL ROAD RESEARCH INSTITUTE LIBRARY

LEZY (R)

Determination of the proportions for a hydraulic concrete with optimum compactness. Insdoc Trans. No. 3147. Trans. from French from "Annales Des Ponts Et Chaussees, V. 122 No. 6, 1952, p. 717—25, 726—52. 11530.

LKHOTIN (V.V.)

Some methods of determining the physico-mechanical properties of soils. Insdoc Trans. No. 3375. Trans. from Russian, from original. 12460.

MARTIN (O)

Twenty years of Cutback bitumen in Germany. Insdoc Tran. No. 4480. Trans. from German from "Bitumen" Vol. 14. No. 3, 1952, p. 639. 14355.

MATHIEU (G)

Odoliometry: Measurement of the slipperiness of roads in France, during the last quarter century. Insdoc Trans. No. 4274. Trans. from French from "Revue Generale Des Routes et des Aerodromes, 1950, p. 7. 12869.

RUSSIAN STANDARDS ASSOCIATION

Liquid petroleum asphalts for Roads. Insdoc. Trans. No. 4454. Trans. from Russian from "Russian Standard GOST 1972—52". 13593.

SKVORTSOV (S.G.)

Vacuum processing of concrete in construction. Insdoc. Tran. No. 3235. Trans. from Russian from the original. 11685.

SWISS STANDARDS ASSOCIATION.

Cutback: Definition and commentaries SNV. 71420 Insdoc. Tran. No. 4427. Trans. from French from Original. 13876.

SWISS STANDARDS ASSOCIATION.

Cutback: Diagram, SNV. 71411. Insdoc. Trans No, 4429. Trans. from French from Original. 13817

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Cutback: Qualitative Specifications SNV. 71410. Insdoc Trans. No. 4428. Trans. from French from Original. 13816.

TAJIMA (N).

Variation and distribution of soil Moisture. Insdoc Trans. No. 3265. Trans. from Japanese from "Agricultural Engineering Research Journal." V. 18, p. 35 to 38, 114 to 136, 174 to 188. 7613.

VALIETTE (R)

Composition of Concrete. Insdoc. Trans. No. 3342. Trans. from French from Instn. Assoc. for bridge and Structural Engg. Third Congress Liege, 1948, p. 163—172. 11457.

VALIETTE (R)

Concretes made from ungraded material coming straight from the quarry and concrete with minimum quantity of sand, S.N,C.F, Rules. Insdoc. Trans. No. 3156. Trans. from French from "Travaux", Vol. 30, No. 143. 1946, p. 343—44. 11456.

VALLETTE (R).

Rational Granulometry of Concrete: Beivetib (Neo-concrete). Insdoc. Trans. No. 3157. Trans. from French from "Genie Civil, Vol. 123, No. 10, 1946, p. 123—24. 11455.

VILLEY (M)

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ZASHCKUK (I.V.)

Ultrasonic impulse device for research on density properties of Solid bodies. Insdoc. Trans. No. 3216. Trans. from Russian from Original. 12450.

ANONYMOUS

Advanced experiments in road building Organisation. Insdoc. Trans. No. 3214. Trans. from Russian from Original. 11603.

ANONYMOUS

Instructions for Determining the required density and for controlling the packing of pavements. Insdoc. Trans. No. 3376. Trans. from Russian from "Avtetransizdat, Moscow 1955. 12871.

ANONYMOUS

Problems of Road Technique Grain Sizes of the Fine-Aggregate in Mortar and concrete. Insdoc. Trans. No. 3137. Trans. from Italian from "Le Strado." Vol. 30 No. 7-8, 1950, p. 231—33. 11184.

ANONYMOUS

Rapid Methods of Testing Road Building Materials. Insdoc. Trans. No. 3215. Trans. from Russian from Original. 11984.

ANONYMOUS

Slipperiness of roads: Its Measurement by the "SFERB" Method. Insdoc. Trans. No. 4273. Trans. from French from Original. 12875.

(*Continued on page 37*)

LIST OF PUBLICATIONS ADDED TO THE ROADS WING LIBRARY DURING DECEMBER, 1961.

1. IS: 1835—1961: Indian Standard specification for steel wire ropes.
2. IS: 1842—1962: Specifications for surveying chain Pins (Arrows).
3. IS: 1646—1961: Code of practice for fine safety of buildings (General) Electrical installation.
4. IS: 1642—1960: Code of practice for fare safety of buildings (General) and details of construction.
5. IS: 1805—1961: Glossary of stones relating to stones: occurrence querring and dressing.
6. IS: 1809—1961: Specifications for nickel salt for electroplating.
7. IS: 1822—1961: Specifications for motor-starters of voltage up to 650 volts.
8. IS: 1828—1961: Methods for load caliberation of testing mechanics for tensile testing of steel.
9. Highway current literature, Vol. 38, 1959 (Bound Journal).
10. Highway current literature, Vol. 34, 1955; Vol. 35, 1956; Vol. 36, 1957; Vol. 33, 1954; Vol. 27, 1948. (Bound Journal).
11. Indian Concrete Journal, Vol. 13, 1939; Vol. 7, 1933; Vol. 26, 1952; Vol 21, 1947; Vol. 20, 1946; Vol. 19, 1945. (Bound Journal).
12. American Highways, Vol. 29, 1950; Vol. 37, 1958; Vol. 28, 1949; Vol. 26, 1947; Vol. 28, 1958. (Bound Journal).
13. Civil Engineering and Public Works Review, Vol. 13, 1947. (Bound Journal).
14. American Highways, Vol. 29, 1948. (Bound Journal).
15. Symposium on non-linear physical problems, University of Roorkee, December 21, 22. 1959,
16. Summaries of Road Research notes No. 76 Road Research Laboratory, Department of Scientific and Industrial Research.
17. IS: 287—1960: Recommendation for maximum permissible moisture content of Timber, etc.
18. India National Society of Soil Mechanics and Foundation Engineering Brief review.
19. IS: 1707—1960: Specifications for wood for general purposes.
20. IS: 1786—1961: Specifications for cold twisted steel bars for concrete re-inforcement.
21. Recommendations for maximum permissible moisture contents of Timber used for different purposes in different climate zones.
22. BS: 405—1945: Expanded metal (steel) for general purposes.
23. (Concrete Roads Note No. 1) earth work sub-grades and basis by Cement and Concrete Association, London.
24. (Concrete Roads Note No. 2) Slab design.
25. (Concrete Roads Note No. 3) Design of mixes.
26. Concrete Roads Note No. 4) Construction methods.

OBITUARY

The Indian Roads Congress records with deep regret the death of Dr. Ing. E.h. Moritz Klonne, Vice-President of the International Association for Bridge and Structural Engineering, Zurich, at a ripe age of 84 years.

It is with deepest regret that the Indian Roads Congress records the death on the 25th March, 1962 of Mr. Christopher Tatham Brunner, Vice-Chairman of the British Road Federation since 1952.

(Continued from page 35)

HOHL (A)

More recent experience in the treatment of surfaces with cutback bitumen. Insdoc Trans. No. 4481. Translated from German from Bitumen, Hamburg, Vol. 16 No. 5, 1954, pp. 107-113. 14383.

BENARD (E)

The Conditions for successful spreading of Cutbacks or the road surfaces which were formerly treated with tar. Insdoc Trans. No. 4524. from Translated from French from "Via Paris", Vol. 107, 1950, pp. 88—89. 14457.

LEFOL (J)

French Cutback fluids and their impregnation. Insdoc. Trans No. 4450. Translated from French from "Rev. Gen. Route", Vol. 19, No. 207, 1949, pp. 41—42. 14458.

GOVERNMENT OF UTTAR PRADESH BUDGET 1961-62

(A Brief Review with Reference to Civil Works)

THE total revenue of the State for the year 1961-62 is estimated at Rs 14,562.98 lakhs against Rs 13,855.02 lakhs (Revised estimates) for the year 1960-61 and Rs 12,955.25 lakhs (actuals) for the year 1959-60. The corresponding figures of expenditure are Rs 15,412.52 lakhs, Rs 13,826.39 lakhs and Rs 12,815.56 lakhs, respectively for the year 1961-62 (Budget Estimate), 1960-61 (Revised Estimate) and 1959-60 (actuals).

Total revenue expenditure on Civil Works is estimated at Rs 559.50 lakhs for 1961-62 while the corresponding figures for the revised estimate for 1960-61 and actual for 1959-60 are Rs 559.81 lakhs and Rs 403.85 lakhs respectively.

There is a provision of Rs 405.90 lakhs (original works and repairs) on communications in the current year from the Revenue Account and the corresponding estimates for the years 1960-61 (revised) and 1959-60 (actuals) are Rs 388.09 lakhs and Rs 341.95 lakhs respectively.

Total expenditure on Civil Works outside the Revenue Account for the year 1961-62 is estimated at Rs 814.98 lakhs. Revised Estimate for the year 1960-61 is Rs 567.29 lakhs and actuals for the year 1959-60 is Rs 624.61 lakhs.

LIST OF APPROVED WORKS ON NATIONAL HIGHWAYS

S. No.	Job No.	Name of the work	Amount (Rs in lakhs)
		GUJERAT	
1.	2711-GR-8A	Construction of a minor bridge at Ch. 78680 C.D. No. 28 on Wankaner-Morvi Road Section of N.H. No. 8A.	0.58
		MAHARASHTRA	
2.	2713-MR-6	Providing a temporary diversion for Bhusaval-Varangaon Road, N.H. No. 6 passing through Bhusaval town.	1.11
3.	2714-MR-6	Construction of C.D. Works on diversion of Surat-Dhulia Edlabad Nagpur Road, N.H. No. 6 outside Bhusaval town in Jalgaon District.	0.37
4.	2708-MR-6	Land acquisition for diversion of Surat-Dhulia Edlabad-Nagpur Road, N.H. No. 6 outside Bhusaval town.	1.63
		PUNJAB	
5.	2703-PB-1	Providing electric installation in the P.W.D. Rest House at Rai on Mile No. 21 G.T. Road near Sonepat.	0.11
6.	2704-PB-10	Electric installation in P.W.D. Inspection Bungalow Abdul Khurana.	0.01
7.	2709-PB-2	Construction of a bridge over the Gurgaon Canal at mile 21/4.	1.34
8.	2710-PB-1	Providing water supply sewerage S.I. in the P.W.D. Rest House at Rai G.T. Road Sonepat.	0.12
		UTTAR PRADESH	
9.	2706-UP-29	Electrification of Inspection House at Dohrighat on Gorakhpur-Ghazipur Road, N.H. No. 29.	0.05
10.	2707-UP-29	Improvement to the Inspection House at Dohrighat on Gorakhpur-Ghazipur Road, N.H. No. 29.	0.04
11.	2705-UP-29	Construction of a pontoon bridge across the river Ramganga at Moradabad on N.H. No. 24.	5.65
12.	2712-UP-24	Construction of a R.C.C.T. Beam bridge across Kadrabad Nalla on Hapur Garh Road, N.H. No. 24 in Meerut District.	1.83

PERSONAL AND MISCELLANEOUS

The following changes have taken place in the Govt. of India, Ministry of Transport & Communications, Deptt. of Transport, Roads Wing, New Delhi :

1. Shri D. G. Bhagat, Deputy Consulting Engineer to the Govt. of India (Roads) has been promoted as Additional Consulting Engineer to the Govt. of India (Roads).
2. Shri Hardyal, Senior Planning Officer, has been appointed as Deputy Consulting Engineer to the Govt. of India (Roads).
3. Shri J. M. Trehan, Deputy Standards Officer, has been promoted as Senior Planning Officer.
4. Shri M. P. Nagarsheth, Deputy Bridges Officer, has been promoted as Deputy Consulting Engineer (Bridges).
5. Sarvshri J. Subrahmanyam, N. B. Mitra, S. K. Rajagopalan, A. J. D'Costa, and N. Sen, Divisional Engineer Consultants have been promoted as Planning Officers.
6. Sarvshri M. G. Oza, N. S. Ramaswamy, B. Balwant Rao, D. T. Grover, K. M. Chandiramani, Divisional Engineer Consultants have been promoted as Deputy Bridges Officers.
7. Sarvshri S. Seetharaman, N. Sivaguru, H. U. Bijilani, L. R. Kadiyali, and V. K. Arora, Assistant Engineer Consultants have been promoted as Divisional Engineer Consultants.

* * *

Shri S. K. Ghosh, Superintending Engineer, West Bengal, took over as Chief Engineer, Development (Roads) Directorate, Calcutta, with effect from 31st March, 1962 (A.N.).

(Continued from page 12)

Standard jointing consisted of slip-doweled expansion joints at 45 m. intervals with doweled dummy joints (sawed) every 15 m. dowels were also specified for the sawed centerline dummy joint.

The third section of this project is an experimental area. It consists of an 800 m. strip of autobahn pavement constructed to facilitate testing of five variants of design. For each of the five sections, joint intervals also were spaced experimentally, and different types of joints with and without dowels or load transfer devices were used. The sections employed respectively (1) a subbase of twice-crushed stone, with two sizes blended for a 30 cm. maximum gradation, and a base utilizing two natural sands ; (2) a 10-cm. subbase of lean concrete using local sand aggregate, and a 2 cm. base of sand-asphalt ; (3) a lean concrete made of 30 cm. sand only, 100 cm. thick' as the combined subbase and base ; (4) a subbase made with 3 cm. and 7 cm. maximum sand blended, plus a 5 cm. thick base using only 7 cm. sand ; and (5) a 5 cm. thick subbase and 3 cm. thick base utilizing a tar-sand mixture.

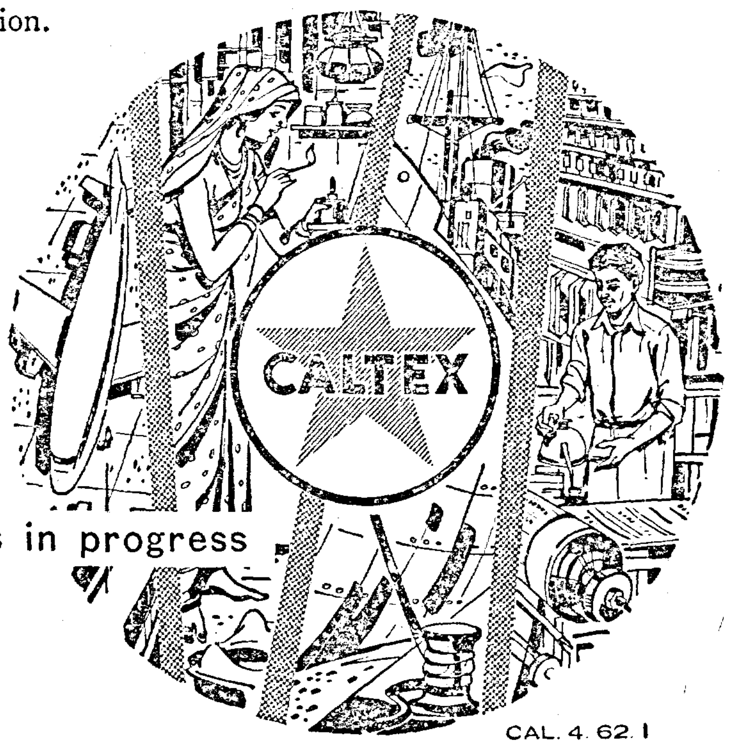
All variants were planned to develop experience in the utilization of cheap locally available materials. The intent was for university students and research personnel to perform various tests of the pavement in place, and after a period to complete the joints and open the section to normal traffic.

The Freiburg project is under the authority of the Autobahn Stuttgart, in the federal program of autobahn development for West Germany.

(From "World Construction", November, 1961.)

Serving the needs of the nation

In Kirti-Nagar, U.P. (population 1000) a woman lights her kerosene lamp, humbly grateful for the steady, soft glow which illumines the enveloping darkness....in the clacking din of a Bombay textile mill, a maintenance man fills the oil-cups of a cotton spindle whirling at top speed....at Dum Dum airport, a superb jet liner glides down to refuel...in Visakhapatnam, a proud new ship slides smoothly down the greased slip-ways out to the open sea. Outwardly, these unrelated happenings seem to have nothing in common.... but they have their L. C. M. — their "Liquid" Common Multiple — Oil, the life-stream of PROGRESS. CALTEX can claim humbly, yet proudly that it has played its part in keeping the wheels of progress in motion.



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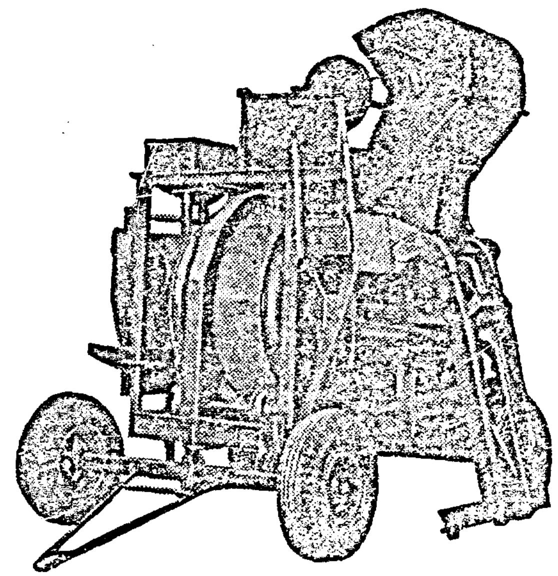

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Most Mobile.

Rapid Mixing.

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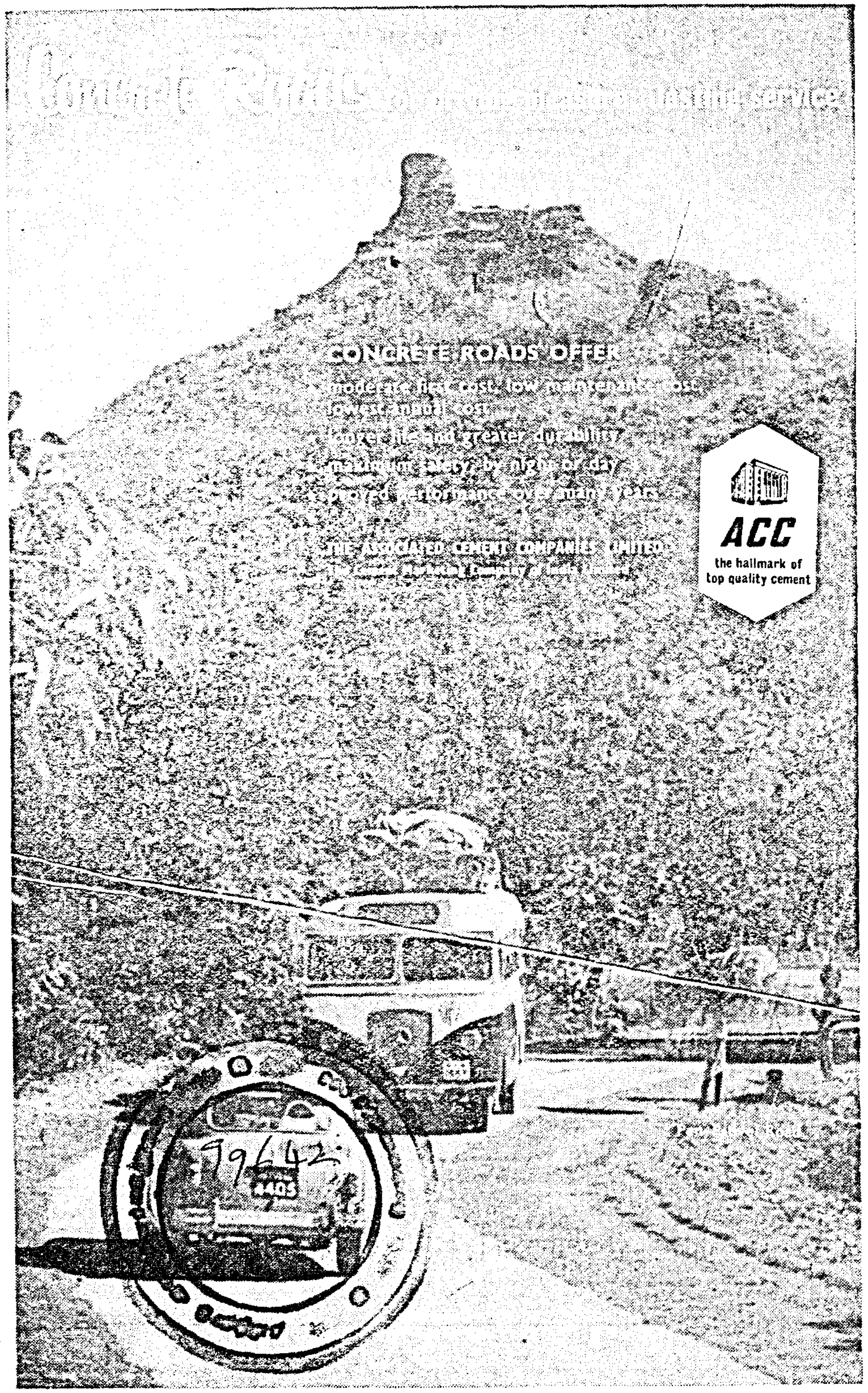
BOMBAY 27.



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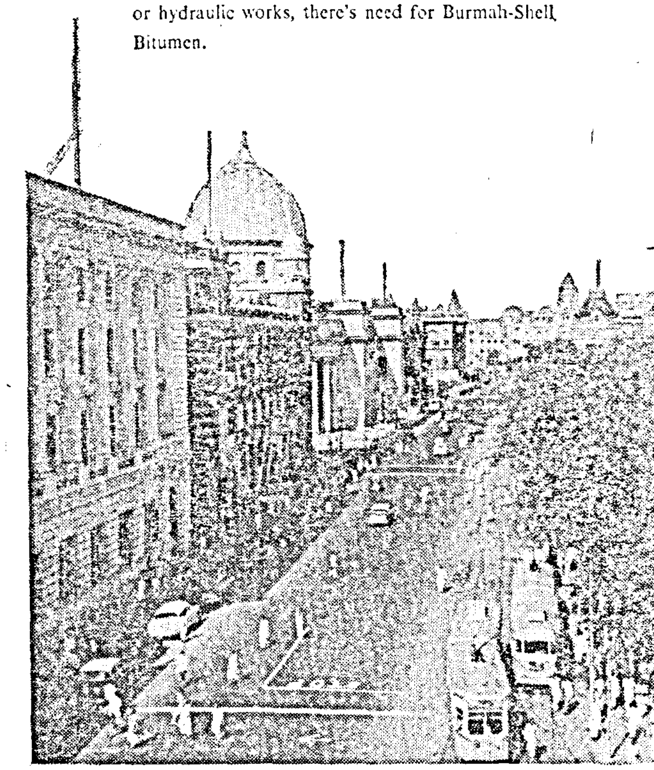

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