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MONTHLY REVIEW (TCMR)

FEBRUARY 1962—No. 178

INDIAN ROADS CONGRESS

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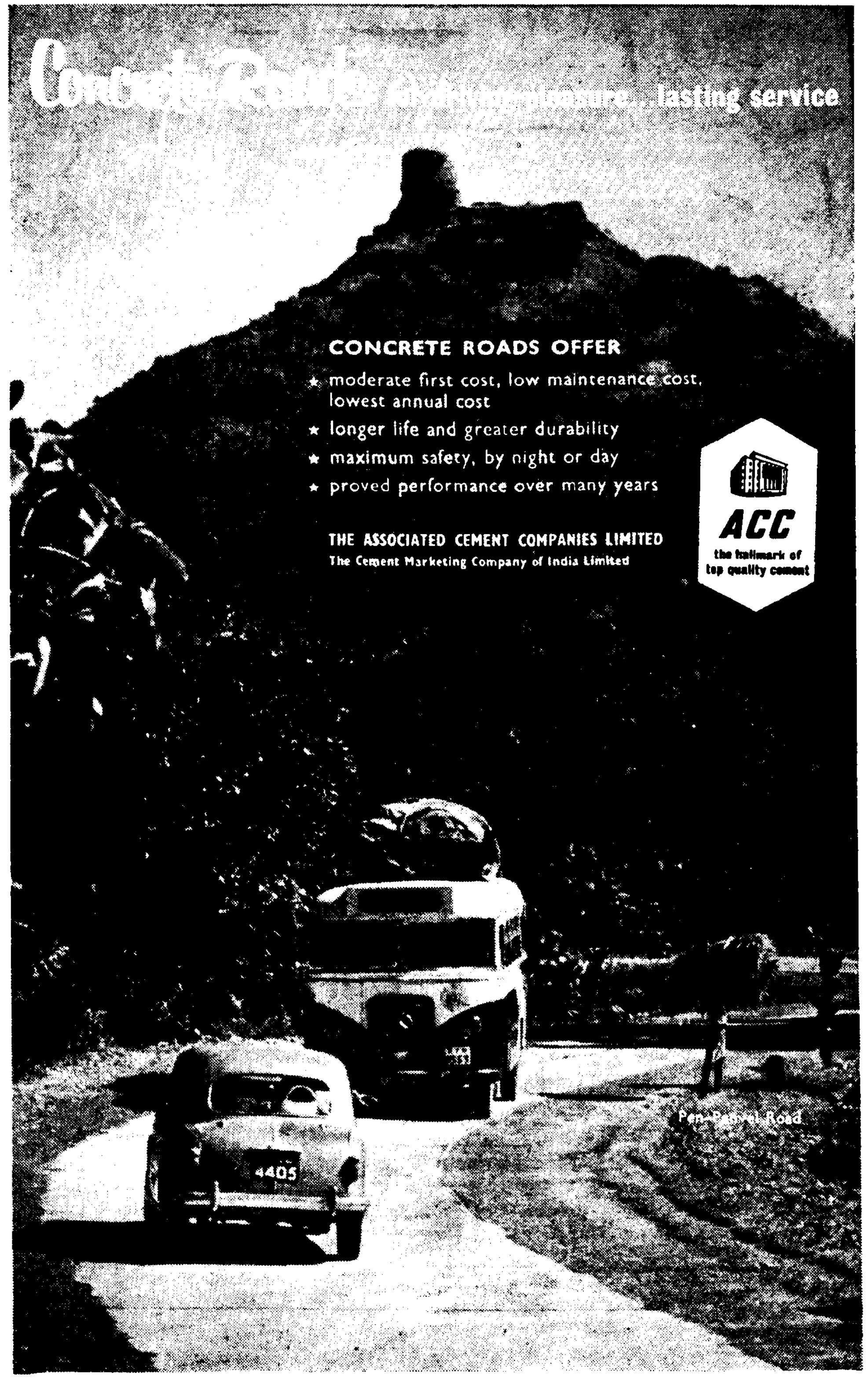
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TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

FEBRUARY 1962—No. 178

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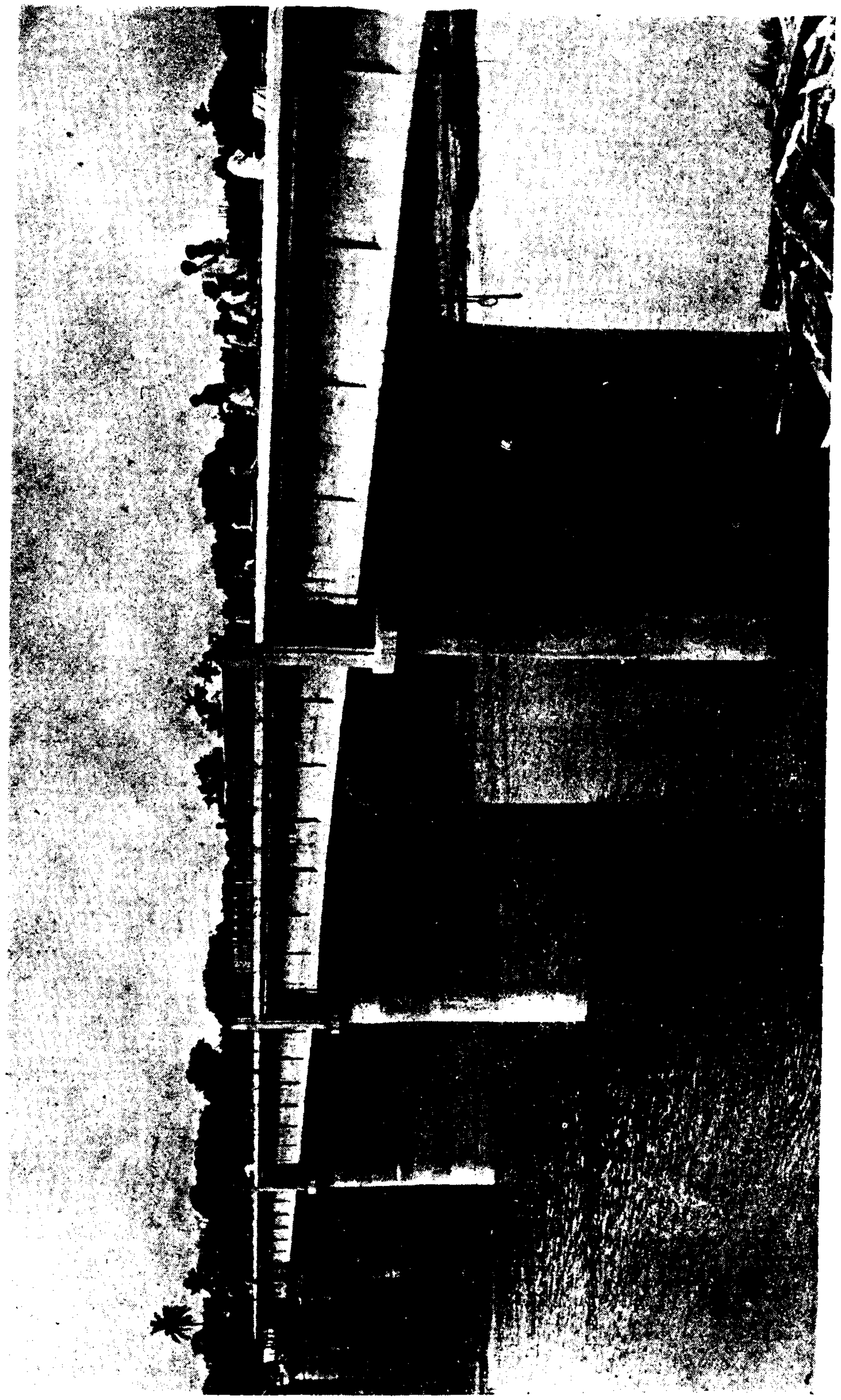

BRIDGE OVER PURNA RIVER NEAR NAVSARI, IN MILE No. 187 OF B.A. RD. N.H. No. 8
8 SPANS OF 114'-0" EACH. ESTIMATED COST Rs 17,56,000

TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

A REVIEW OF
ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

FEBRUARY 1962

EXECUTIVE POSITIONS IN ENGINEERING ENTERPRISES

THE CLAIMS OF THE ENGINEERS IN INDIA

By

SHRI B. SESHADRI *

SOME administrators, of late, have been setting forth the claims of the Civil Service in India for occupying executive positions in public sector enterprises. This has caught the attention of engineers everywhere, as it had to. The debate on the merits of civil servants versus engineers has been, over the past few years, gathering itself to a head. "The other side of the picture"—the claims of the engineers to be executives in engineering enterprises—is here presented.

What are the basic principles of management? They are: planning, design and selection of men, material and machines and construction. Where, may one ask, at which of these stages, does the civil servant have the edge over the engineer? We are thinking, in both professions, of men of proved ability and experience.

There is little doubt, and this is not open to argument, that management of engineering enterprises in India has, by and large, failed. This has been due to an incapacity in those in managerial responsibility to use the available human and material resources. This incapacity has sprung, let us be clear, over an approach, or the lack of it—a tendency to fuss over the technological revolution that has spread into the very vitals of India, a revolution the sweep of which the executives in managerial positions could not even grasp, even if they tried. The fact is, the civil servant, by the very nature of his background and training, has simply failed to apprehend the new impacts, and has continued, privately if not in public, to deprecate the fastening of human controls like those on nature, controls which beget a dimension of freedom which it is not in his nature to appreciate.

So, then, the whole business of management conflict and engineer repression has been blown up out of all proportion by nice-Nelly or self-conscious civil servants, until it has assumed the shape of a conflict between the civil servant and the engineer, where none existed—both had due claims in their respective fields of service.

Let this be said in no uncertain terms. The record of civil servants in the administration of engineering and technological projects in this country during the last decade has been honoured more in the breach than the observance of the basic principles of management. The civil servant is basically a product of bureau-

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cracy, and mindful of this string of loyalties from the level of wherever he is to the level of wherever he thinks his actions will be noticed, is always prepared to meet the demands of politics and time—a hopless marriage.

The policies of the civil servant are necessarily very different from those of a technical administrator, because while the former bases his decisions, when these are taken with the passage of time, so that they are acceptable to the bureaucracy to which he is responsible, the latter arrives at his conclusions simply by a scientific reasoning. The bureaucracy, in dictatorial control of the public enterprise, possess only an infinitesimal knowledge of the circumstances of the venture. If their preconceived notions of the yearly dividend from the venture are satisfied by the civil service, administrator, they show no further concern. Scientific diagnosis of the best interests of the undertaking just does not enter the picture.

Why should the engineer—someone called him the 'Aristocrat of the Twentieth Century', I cannot recollect who—be preferred for management? First, engineering training and experince are basic assets for management. What, in essence, a manager does is, to first decide what has to be done, and, next, how best to do it. The second stage often calls for compromises, and the engineer is able to make the best of the bargain, when a bargain has to be made. On the other hand, if he is relegated to a subordinate position, he has, first, to convince a man who does not understand his problems in any case, that what he advocates is the best possible solution under the circumstances.

The engineer has—he has no other choice—necessarily to have a wide range of contacts with the individual and the community, something which is inescapably denied to the best-intentioned civil servant. In fact, of all the professions, engineering offers—and I mean 'offers' in the best and widest meaning of the word—the best opportunities to come into contact with the community at large. This being so, clearly then, the engineer is best fitted to translate the hopes of the community into action by means of the project in which he is engaged. This particular aspect of his work is so patent that I must confess of a feeling of stressing the obvious.

It is not correct that the United Kingdom reserves the top executive posts for its civil servants. I will say nothing of the £25,000 a-year-job given to an engineer a few months ago—a subject on which a great deal has been said, let it be said, none detracing of the appointment. As one who has possibly access to look at more engineering journals than any others in this country, I would like to record that there have been a stream of articles in recent months in British engineering journals emphasizing the rapid displacement of the routine administrator by the engineer in the top executive positions in the running and management of the great industrial complexes which constitute the backbone of Britain's existence in the bitterly competitive world market of today.

And what of the United States and Russia, with their diametrically opposite approaches to captial, private and public enterprise? Admittedly a substantial percentage of American executives have risen from the ranks of accountants and salesmen, but—leaving the big financier apart—the average executive of today was an engineering graduate some number of years ago. While in Russia, "up to and far beyond the plant directors the overwhelming majority of Russian executives are engineers" (Engineering, 9th September, 1960). Who can argue Soviet industry has not advanced beyond recognition? If it has so advanced, how was it that the Soviets, with their practical approaches to problems least complicated by emotion, chose the engineer and not the sedate and cautious professional 'administrator' to administer their technical undertakings? All this has a lesson. A lesson to be learnt if we wish, to be discarded if we would rather continue to think of the indispensability of the manual-bound civil servant.

The Engineer not only creates but, it has been said by engineering economists, can do for a fraction of the cost what anyone else can do for the whole. This is something more than saving, in that, assuming the rest of the money would have been spent, resources are freed to do another job sooner. Since money and the conditions of trade are inseparable from running a solvent enterprise, the engineer who is something more than aware of this side of life has an important contribution to make.

Have we then that surplus and abundance of money that it is not material that the best use should be made of it? The application of money to the best advantage means translating it into angles and rods, I-sections and cleats. The idea is to make something for the least expenditure, and put it to the use of the community in which we all live.

The engineer in India is often harassed, even hamstrung, by the administrator, the auditor, and the accountant. This point needs no labouring, and it is not only the engineer who knows it, but all sections of the community are aware of this malaise, a handing-down from a tradition which has long outlived itself. Both the professional administrator and the professional accountant have expertised in 'looking back' and discussing faults—'hindsight'—while the engineer has not this convenient eminence to occupy—he has to look ahead and plan tomorrow's things. A radical difference in outlook therefore exists between the two groups of men. But if an engineering enterprise is to be built, what is needed? 'Hindsight' or 'a look at tomorrow'?

Basically, there should be no difference in outlook between one in charge of a public sector project and one in charge of a private sector project. The function of both is to cut the cost of building the project and cut the cost of producing the goods thereafter. No thinking financier in the private sector abroad puts his engineering enterprise in the hands of those who are non-engineers. The object of the financier is to expand the market for the products of his factory and make the best profits, and this he does by cutting costs of construction and production. Similar conditions may not obtain in this country, but the average financier here is still well behind times in matters of this sort.

If the above should be the case in the private sector, why should a different state of affairs exist in the public sector? The responsibilities in the public sector are greater still, as the funds involved are those of the people and the profits that may accrue are for ploughing back to the common good. Technical know-how and initiative belong to the engineer, and it is the thesis of this article that he should be given the opportunity to use both for the good of us all.

It is not true that running a district and running a steel mill, boil down to the same thing. The first is non-creative, while the second is creative. The former, in its essence, comprised revenue-collection, and has not basically changed. The latter does mean the managing of the collective efforts of a group of men towards a certain goal for its speedy and successful accomplishment. But to assume that this speed and success can be achieved by a civil servant, however good he may be at running a district—an entirely different proposition—, is to grossly under-estimate the intricacies of modern technology and techniques.

Vast plans have been made for industrial expansion. I am not thinking merely of the Third Plan only, but of the further Plans to come. These are foredoomed to disappointment and failure to achieve intended targets if the present practice of putting civil servants at the head of technical projects is persevered with in preference to engineers of ability and experience.

(From "The Institution of Engineers (India) Journal, Vol. 13—4 December, 1961).

[Please also see the acticle by Major General Harkirat Singh on "Engineers and Administration" re-produced in the T. C. M. R. of April 1961—Ed.]

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TRAFFIC ENGINEERING

EFFECTS ON LONDON TRAFFIC

THE contribution traffic engineering has to make to improving the speed and flow of traffic is being convincingly demonstrated in Central London where, despite increased traffic volume, the speed of traffic has gone up for the first time in nine years. Year by year surveys by the Road Research Laboratory have revealed a decrease in speed corresponding to the increase in traffic, two per cent each year between 1952 and 1960. Recently, the London Traffic Management Unit of the Ministry of Transport conducted a survey which showed that on 40 miles of main streets, journey speeds were about nine per cent higher compared with a four per cent increase in traffic. The present average speed is about 10.7 miles per hour. Dr. Charlesworth is to be congratulated on this improvement, which is largely due to initiation of traffic engineering measures during recent months and which the Ministry, local authorities, London Transport and the police have co-operated in applying. The schemes have not involved any major construction or great expenditure, but constitute common-sense restrictions on parking and loading, and waiting at or near intersections; on prohibition of right-hand turns; one-way working on the large scale, as in the Tottenham Court Road-Gower Street area; channelization of traffic at major inter-sections and rephasing of traffic signals. The shortsightedness of those affected parties who in the first place objected to such restrictions is shown by this achievement and it is to be hoped that the improvement in traffic flow will forestall repetition of unreasonable objection and enable further measures which are contemplated to come into operation more speedily and to be effectively enforced.

(From "Traffic Engineering & Control", November 1961.)

(The Indian Roads Congress has recommended to all States to establish traffic engineering cells.—Ed.)

EXPERIMENTAL WORK ON THE GRANTHAM BY-PASS

APPLICATION OF LATEST IDEAS ON DESIGN OF REINFORCED CONCRETE ROADS

CONCRETE carriageways embodying the latest ideas on the design of reinforced concrete roads are being laid on the Grantham by-pass under the supervision of the Road Research Laboratory.

The whole scheme, part of the Ministry of Transport's programme for the improvement of the Great North Road, covers some ten miles of the A. I from Colsterworth to Gonerby Moor. For Contract purposes it is divided into Section I, covering the reconstruction, realignment and regrading of four miles of existing roads, and Section II, a six-mile by-pass from Little Pontoon to Gonerby Moor.

The following notes on the experimental work were issued when the Institution of Municipal Engineers, East Midlands District recently visited the works in progress.

Continuously reinforced slabs

Experiments are being carried out on the Grantham by-pass on the design of reinforced concrete road slabs. Experience has shown that reinforcement is essential for the satisfactory performance of heavily trafficked concrete road, and the ability of steel fabrics to control effectively the opening of cracks has been demonstrated by roads which are now over 25 years old. The use of reinforcement enables joints to be spaced more widely and this is desirable from the aspects of maintenance and appearance although it is no longer necessary from the aspect of riding quality as improved methods of construction have eliminated the undulations which used to occur at joints.

Reinforcement is an expensive item in the construction of a concrete road and it is therefore desirable to use it as efficiently as possible. The minimum weight of reinforcement fabric needed to prevent cracks of unacceptable width will be determined from the Grantham experiment where fabrics weiging $2\frac{3}{4}$, $6\frac{1}{2}$, $10\frac{3}{4}$ and $16\frac{1}{4}$ lb. per sq. yd. are included in slabs ranging from 40 ft to 900 ft long. Some sections with dummy joints at 15, 30 and 80 ft intervals will be included.

The use of continuously reinforced concrete in which the only joints are end-of-day tied construction joints has met with varying success in the United States where a number of experimental lengths have been laid. By eliminating the structural weakness due to the joints continously reinforced slabs are stronger but the effective control of cracking is a problem on which more design data is needed. Further information on the behaviour of this type of construction will be provided by 4 slabs on the Grantham by-pass having lengths of 4,000 or 4,500 ft and including reinforcement weights of $10\frac{3}{4}$ and $16\frac{1}{4}$ lb. sq. yd.

To determine whether better control of cracking can be obtained sections of the road will be laid with deformed wire fabric having higher bound strength and with fabrics containing extra cross wires having higher bond anchorage. Other sections will be laid with mild-steel fabrics to compare its behaviour with the cold-drawn steel normally used for road fabric. The distribution of the reinforcing steel across the width of the road will be varied in some slabs; in some cases the steel will be heavier in the most intensively tracked part of the road and in other cases it will be heavier at edges of the slabs. In other slabs the amount of transverse steel will be increased and the central longitudinal joint omitted.

Road base tests

A further experiment on the by-pass

will consist of laying slabs directly on the lean concrete base in one carriageway, and in the other carriageway on a special sliding layer consisting of a double layer of plastic film on waterproof paper laid on the lean concrete. The incidence and width of cracking in these two lengths will be compared.

Realignment and reconstruction of the A. 1 at Colsterworth, part of the scheme for improving ten miles of the Great North Road at Grantham. This part of the contract is for flexible construction, surfaced with two coats of hot rolled asphalt.

Cracks surveys will be made after the slabs are laid and at frequent intervals afterwards. Gauge points will be installed along selected lengths of the road so that changes in the widths of joints and any cracks that form can be measured. Alongside these sections reference blocks will be constructed to enable longitudinal movement of the slab to be determined. The occurrence of cracks is influenced by the weather conditions during and after laying the concrete and two weather stations are being set up alongside the by-pass, one on the higher ground at the south end and one on the low-lying ground at the north end. The weather stations will include concrete slabs in which thermocouples are set at various levels. All measurements made on the road will be related to the temperature conditions occurring at the time.

The thickness of the road is in accordance with normal recommendations for the soil and traffic conditions at Grantham, which require 9 in. of concrete in cuttings or 10 in. on embankments over 4 ft. high. In both cases a 3 in. lean concrete base is used. All constructional operations are being closely controlled. Density, moisture content, and classification tests are being made on various subgrade soils, the crushing strength of the lean concrete base is being determined and on the concrete for the road slabs the flexural and crushing strengths and elastic moduli are being measured. The workability and air content of the wet concrete will be measured and wet analyses made to check its proportions.

The performance of the road as shown by the crack surveys and other measurement will be analysed in relation to the design variations to enable conclusion to be reached. It is expected that observations on the road will continue for a period of ten and twenty years.

S.G.M.E. laying train

On the second section the contractors are using Belgian (S.G.M.E.) plant for the main concrete laying train. A standard S.G.M.E. spreader is used to lay the 3 in. dry lean sub-base and a Stothert and Pitt standard $18\frac{1}{2}$ cwt. tandem vibrating roller is used for compaction. The main concrete base plant consists of two spreaders and two finishers each of which is of special design in many respects, to meet the requirements of the Road Research Laboratory on the experimental lengths.

The spreader comprises 4 cu. yd. hopper with controlled discharge. The speed of the machine and the rate of travel are 50 ft per min. The spreading level is adjustable from 4 in. below the forms to $4\frac{1}{2}$ in. above. The finishers are fitted with articulated carriage to even out irregularities in the forms. Plant following the train includes a curing compound spraying machine, a carriage carrying a small mixer for the construction of the white margins and specially designed movable curing covers.

The Road Research Laboratory has provided a profilometer for the purpose of measuring surface accuracy.

The concrete for the by-pass carriageways is supplied from two mixing plants, one at Gorse Lane and the other at Barrowby. The mixer unit comprises fiormert 1.3 cu. yd. turbo mixer which is gravity fed from a holding box which in turn is fed by a belt conveyor from the batcher. The batcher, comprises high level hoppers divided into three compartments fed by

22.RB draglines. Weighbatching is by Parsons automatic weigh gear. Cement is fed into the mixer by an airslide from a high level hopper, and there are two additional cement hoppers to give a total storage of 90 tons of cement. Twelve special side tipping Commer lorries are used to draw from these plants. The capacity of each mixer is up to 400 cu. yds. per day based on a mixing time of 30 secs.

Section I—construction

Section I of the scheme is being constructed to give an effective width of between 80 and 140 ft made up of two 24 ft carriageways divided by a 24 ft central reservation and bounded by verges, 4 ft 6 in. of which is constructed as hard shoulders.

The carriageway construction is as follows :

On filling: granular sub-base, 3 in. : 20 to 1 lean mix concrete foundation sprayed with 55 per cent bitumen emulsion, 16 in. ; two coat hot-rolled asphalt surfacing laid in $2\frac{1}{2}$ in. and $1\frac{1}{2}$ in. thickness, 4 in.

On rock: 20 to 1 lean mix concrete levelling-up course, 3 in.; 20 to 1 lean mix concrete foundation sprayed with 55 per cent bitumen emulsion, 8 in.; two coat hot-rolled asphalt, 4 in.

All materials are machine laid.

The concrete haunches to the carriageway follow the truncated motorway section, being 12 in. wide at the top widening to 35 in. at the bottom over the depth of 20 in. The concrete is to M.O.T. Class A standard to have a minimum strength of 4,000 lb at 28 days. It is laid to have dowelled expansion joints at every 50 ft and is reinforced throughout with 8 lb per yd. steel fabric. The top 1 in. is finished in a proprietary white mix concrete.

The maximum depth of cut is 30 ft, the excavated material being mainly fragmented and boulder lime stone.

Embankment depths are up to 25 ft and these have been filled up to 2 ft and consolidated in loose layers to give not more than the maximum air void content specified. Cutting faces and slopes vary from 1 to 1 in rock to $4\frac{1}{2}$ to 1 in clay.

There is no piped channel drainage. The surface water flows on to the verges into "French" drains which are piped to connect to the land drainage-systems.

Section II—construction

This section covers the by-pass construction which follows a route to the west of Grantham over a length of six miles of new road. It involves the construction of five overbridges and three underbridges six of which carry or cross incoming roads and two span the railways. The by-pass follows motorway construction lay-out with no connections to incoming roads except at the two Class A roads which are connected

This section of the Grantham by-pass is being constructed principally in reinforced concrete under the supervision of the Road Research Laboratory. The photograph shows the slip road and offices looking north.

by half clover leaf junctions. The north end of the by-pass, at Gonerby Moor where it joins the existing dual carriageway is terminated by a 200 ft dia. island.

The effective road width is 93 ft made up of two 24 ft carriageways divided by a 13 ft central reservation and bounded by verges 10 ft of which is constructed as hard shoulders.

The maximum depth of cutting is 30 ft the excavated material varying from fragmented and boulder limestone, at the Little Pontorn end to the Harlaxton Road, Route A.607, and from this point onwards blue clay with gravel pockets.

Embankment depths are upto 35 ft and these have been similarly filled and consolidated as for Section I except that in the top 2 ft below formation the air void percentage is not to exceed 5 per cent and this is causing some difficulty.

Many difficalties have been experienced in the clay stratum due to slips where slopes of $4\frac{1}{2}$ to 1 have been necessary to ensure stability.

The blue lias clay has a very low water content and this is causing some problem in consolidation where watering methods were attempted to raise its plastic nature. It has now been decided to reject the use of this material in the 2 ft below formation due to possible future swelling.

Except at the approach to underbridge where flexible carriageway construction is followed the dual carriageways throughout are being constructed in concrete to the specification of the Road Research Laboratory.

General Design Data.

		Section I	Section II
Overall effective road width	...	80 to 140 ft	93 ft
Width through overbridge	...		88 ft
Widths between parapets through underbridge	...		88 ft
Dual carriageway	...	24 ft (including haunches)	
Min. Horizontal visibility	...	500 ft	500 ft
Min. Vertical visibility	...	500 ft	500 ft
Min. Curve radius	...	2,750 ft	3,100 ft
Speed design factor	...	60 m.p.h.	60 m.p.h.
Sight line visibility at incoming roads	...	50 ft × 600 ft	
Minimum gradient	...		1 in 25

All works and materials complying with the Specifications for Road and Bridge Works, prepared by the Ministry of Transport and Civil Aviation covering trunk road schemes.

Materials Specification

Lean mix: 20 parts by weight of 'all-in' ballast as raised to one part cement by weight.

Ballast, 65 per cent to 80 per cent passing $\frac{3}{4}$ in. sieve.

Fines, 33 per cent to 43 per cent passing 3/16 in. sieve. Mixed to have total free water content of $5\frac{1}{2}$ per cent.

Asphalt: $2\frac{1}{2}$ in. base course as B.S.S. 594 Schedule II (Gravel).

$1\frac{1}{2}$ in. wearing course as B.S.S. 594 Schedule I (Granite).

White cement finish to haunches: Mixture by wt.

White cement, one part; 5 per cent titanium oxide, 1/20 part; calcined flint, four parts supplied by Wylie & Wilson, Ltd., as a dry ready mixed product.

Plastic waterproof underlay: Lubrithene 0.03 in. total thickness—two layers of polythene with a special chemical slip layer in between, on No. 80 Ibeco waterproof paper.

(From: "Surveyor and Municipal Engineer" dated 5th August, 1961).

AUTOMOBILE PRODUCTION IN INDIA

FOREIGN EXCHANGE—Rs 32 CRORES

THE Union Government has finalised the expansion of the automobile industry and made foreign exchange allocations to the seven Indian manufacturers of cars, jeeps and commercial vehicles. After the implementation of the various schemes, it is reported the production of all types of automobiles will increase by 150 per cent.

The seven automobile manufacturers are understood to have asked for an allocation of Rs 87.54 crores in foreign exchange to implement their expansion programmes. These companies are Telco, Hindustan Motors, Premier Automobiles, Standard Motors, Ashok Leyland, Simpson Engineering Co., and Mahindra and Mahindra.

The total foreign exchange allocation for the purpose is about Rs 32 crores. This is inclusive of the requirements of the manufacturers for raising the indigenous content to 85 per cent. It is, however, inclusive of the requirements for equipment for forges and foundries.

The Government has also earmarked Rs 8 crores for the development of ancillary industries and Rs 3 crores for scooters and mopeds. In addition there will be foreign investment of Rs 3.33 crores and withdrawals from free sources of the order of Rs 3.75 crores. An additional sum of Rs 2.15 crores has been set aside for the general needs of the industry.

Under the new policy, the automobile plants will work on double shifts, the output in the second shift being 75 per cent of that of the first shift.

Manufacturers of cars and jeeps will be allowed to increase their production to one and a half times of their current production and that of commericial vehicles will be permitted to be doubled over the same period.

The Government has further decided to allow an additional 20 per cent capacity to be created to cover up requirements of spare parts.

The new policy is aimed at securing an indigenous content of not less than 80 per cent.

The Government has, however, rejected the plea of some manufacturers to allow them to instal assembly lines and has recommended the setting up of production lines based more or less on the pattern developed by TELCO, under which the transfer machines, installed at certain key points and with general purpose machine tools for organising the total production serve the necessary purpose. Such a mixed set-up of production lines not only gives a fair degree of economy in production, but also reduces the total cost of the scheme.

While cutting down the foreign exchange figure to about Rs 32 crores the Government has specially taken into account the availability of certain components from Hindustan Machine Tools, Praga, Kirloskar, Excello and other machine tool manufacturing units. Moreover, while a major portion of the foreign exchange is to be met from D.L.F. credits, the capital goods are to be bought either from the U.K. or West Germany and this procedure will result in a net saving of about 33 per cent in foreign exchange.

This estimate has been made on the basis of TELCO's purchases during the last few years when it was found that the basic machinery was 33 per cent dearer in the U.S. compared to the U.K. or West Germany.

Dies, Jigs, and fixtures and an appreciable part of the investment for cars and commercial vehicles are 70 to 80 per cent costlier in the U.S. than in the U.K. or West Germany.

Surface Dressing with pre-tarred Gravel after $3\frac{1}{2}$ Years. Although some crushing has taken place, no stone has been lost

Pre-coating procedure

The quantity of tar found to be necessary is about 1 per cent, the tar being of the viscosity normally used for making tar-macadam.

It is essential that the gravel should be thoroughly dry and for this reason, and also to get a quick set on the tar, it should be heated to about 200 deg. F. in the dryer. Care must be taken that the gravel is not grossly overheated, or the result will be a coating of brittle pitch which will reduce the strength of the bond between the tarred gravel and the film of tar on the road.

In order to make sure that the aggregate is dry, samples should be taken from the storage hopper, after drying and before mixing to check that there is no further loss of weight on drying in the laboratory.

Samples of coated gravel were taken and immersed in cold water for 24 hours. They were then weighed surface dry and the increase in weight was found to be 1.4 per cent.

Owing to the fact that most mixing plants are very busy during the spraying season, it has been found that the best way of ensuring adequate supplies for spraying is to order well in advance so that the material can be mixed in off-peak periods and delivered to stockpiles handy to the site where spraying is to be done.

This procedure gives plenty of time for tests to be made to ensure that the coated chippings do not hang together, but will flow freely through a mechanical gritter.

Advantages of pre-coated gravel

These are as follows :

1. The stream of hot air in the drier removes all small particles of dust from the surface of the gravel and thus improves adhesion.
2. All water is driven off from the pores and thus there is no tendency for the film of tar on the stone to be replaced by water.
3. The complete coating prevents subsequent re-absorption of water and thus prevents subsequent stripping.
4. The adhesion of the coated gravel to the freshly sprayed tar on the road surface is instantaneous and the quantity thrown up by passing traffic is negligible provided that the film of tar is sufficiently thick.

It is observed that, although only 1 per cent of tar is used, it is retained on the surface of the gravel for long periods. Even after three-and-a-half years, the difference in colour of the road surface when coated gravel is used, is most marked.

Viscosity of tar and rate of spread

It will be seen from the foregoing that the tar used must fulfil the following requirements :

1. It must hold each individual piece of gravel firmly from the moment of impact.
2. It must be sufficiently fluid to rise gradually between the gravel under traffic.
3. Under extreme intensity of traffic it must not rise above the surface level of the gravel.

To comply with the conditions outlined above it is obvious that there must be a minimum quantity of binder necessary, which should not be reduced whatever the atmospheric conditions at the time of spraying.

It rarely happens that heavily trafficked roads have a soft surface and in consequence these roads give very little embedment of the gravel in spite of the heaviness of the traffic.

The result is that extra tar is needed to support the gravel and this support is sufficient only if the viscosity is high.

Using $\frac{3}{8}$ in. pre-coated gravel, this minimum is bound to be $4\text{-}4\frac{1}{2}$ sq. yds. per gal.

This is a complete abandonment of the old principle that 'The greater the traffic the less tar to be used,' but the circumstances are unusual. In fact, a new principle has been established, viz. : That where very viscous tars are used the tendency for it to rise up the chippings is retarded and the film must be thicker to ensure a firm bond.

It is interesting to express the E.V.T. in deg. F., which is the scale most commonly used, rather than in deg. C.

38 deg. C. = 101 deg. F.
42 deg. C. = 108 deg. F.
46 deg. C. = 116 deg. F.
50 deg. C. = 123 deg. F.

The maximum shade temperature to be expected, and this very rarely, is about 85 deg. F. which gives a road temperature of about 120 deg.

It was found that a tar of 46 deg. C. E.V.T. could be used safely during the heat wave of 1959, with no 'bleeding' or movement of the gravel.

In specifying the viscosity of the tar to be used, this should be considered daily in conjunction with the weather forecast, so that the probable temperature at the time of spraying can be estimated and the viscosity adjusted accordingly.

There is a lower temperature limit below which high viscosity tar should not be used, and for a tar of 46 deg.C. E. V. T. this has been found to be about 60 deg. F. (shade).

Observations on completed work

It is noticeable that the film of tar, although very thin, is retained on the surface of the gravel for a considerable period, and after $3\frac{1}{2}$ years the colour of surface dressing using pre-tarred material is noticeably darker than surface dressing carried out at the same time using natural gravel.

During this time, no pitting or loss of stone has occurred. Although crushing has taken place, the pieces of the pre-tarred gravel are still firmly held in position.

The laboratory determined polished stone value for flint is between 0.30 to 0.40, but tests taken on the road with the pendulum described in B.S.S. 812 give much higher results, viz. :

On work 6 months old 0.59—0.63
On work $3\frac{1}{2}$ years' old 0.55—0.60

These results are much higher than was anticipated and can only be explained by the persistence of the film of tar on the surface of the gravel.

Provided that there is an adequate film of tar on the road surface, the adhesion of the pre-tarred gravel as it falls from the mechanical gritter is instantaneous, and no further movement was observed, even when heavy rain fell immediately after spraying.

(From "The Surveyor & Municipal & County Engineer", 2nd September, 1961.)

HOW TO FIGURE STEEL WEIGHT IN BRIDGES

By

HENSON K. STEPHENSON

ENGINEERS and contractors can use data in graphical form to determine minimum weights of steel in highway bridges. Such information is useful in estimating the dead load to be used in designing such bridges and in determining the weights of steel required for estimating construction costs.

6-in. non-composite concrete deck supported by steel stringers, designed according to the 1953 AASHO (American Association of State Highway Officials) Standard Specifications for Highway Bridges. However, if the design is made according to the 1957 AASHO Specifications, the minimum steel weights will be about 6 per cent less than

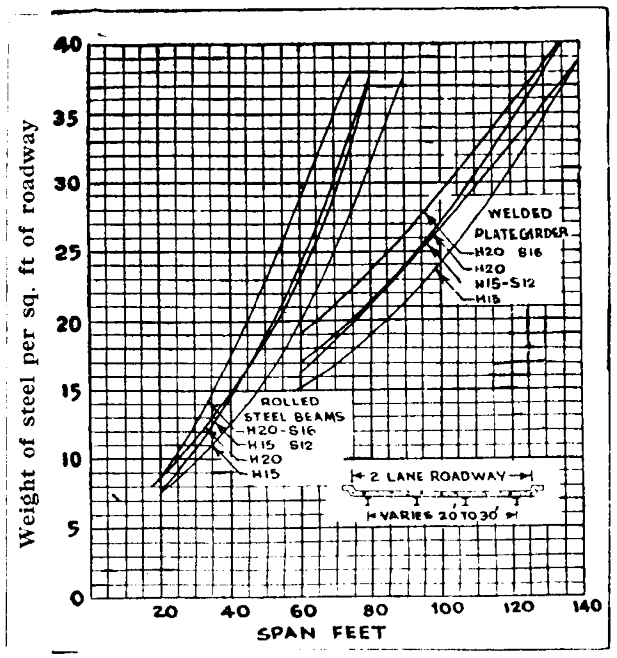


Chart gives weight of steel in highway bridges and aids in estimating design dead loads and construction costs

The chart gives the minimum weights of steel per sq. ft. of roadway required for interior stringers in simple span bridges of various lengths and loading designs based on the use of rolled beams or welded plate girders. These weights include no allowance for beam supports, such as bearing plates or rockers, but do include a small allowance for diaphragms or lateral bracing.

The minimum steel weights indicated are those required for bridges consisting of a those given in the chart. The steel weights indicated also may be adjusted for variation in thickness of the concrete deck. For example, an increase in thickness of the deck from 6 to 7 in. will result in increases in the indicated steel weights varying from about 3 per cent for the shorter spans to about 5 per cent for the longer spans.

For purposes of either estimating or design, it may be assumed for any given steel beam bridge that the exterior stringers

An article on "Design of Road Bridge of spans 20 to 80 ft together with the weight of steel work for I.R.C. class 'A' and class 'AA' loading" by D. S. Desai is published in Jan. 1962 ssue of T.C.M.R.

will be the same size and weight as indicated by the chart for the interior stringers. Although the exterior stringers in certain cases may weigh a little less than the interior ones, the difference would ordinarily be so small as to have but little, if any, influence on a given design or estimate.

The following examples illustrate use of the data :

Example 1 : A two-lane, 50 ft beam bridge (49.0 ft c.c supports) designed for an H15 loading according to the 1953 AASHO Specifications is to consist of a 6-in. concrete deck supported by two inside and two outside steel stringers spaced at 8.0 ft on centers. It is desired to know the minimum weight of steel required for each interior stringer. For this case the chart shows the steel weight to be 15.5 psf of roadway tributary to each interior stringer. The minimum steel required would be 15.5 × 8.0 = 124.0 lb per ft; or a total weight of 124.0 × 50.0 = 6,200 lb for each interior stringer.

Example 2: For the two-lane, 50-ft bridge of H15 design described in Example 1, suppose, it is desired to know the total weight of steel required for the four supporting stringers. Since each outside stringer will weigh about the same as each interior stringer, the total weight required for all four stringers would be about 4 × 6,200 = 24,800 lb.

Example 3: For the two-lane, 50-ft bridge described in Example 1, suppose, it is desired, to know how much additional cost would be involved for the superstructure if the bridges were designed for H20 instead of H15 loading. For the H20 loading and a 49.9-ft span the chart shows the interior stringer weight to be 18.2 psf of roadway tributary to each interior stringer. Therefore, each interior stringer would weigh 18.2 × 8.0 × 50 = 7,280 lb; or a total weight of 4 × 7,280 = 29,120 lb for the four stringers. This represents an increase of 29,120 – 24,800 = 4,320 lb. If the unit cost of steel in place is assumed to be 15 cents per lb, the increase in cost of the H20 as compared with the H15 design would be about 4,320 × 0.15 = £ 648.00.

Acknowledgment

Reprinted from Engineering News-Record Feb. 16, 1961, with kind permission of McGraw—Hill Publishing Company Inc.

Next month Table of Simply supported slabs for spans 3 to 30 Ft for I.R.C.'AA' Loading will be published.—Ed.

TESTING OF HIGH TENSILE STEEL STRAND

REINFORCEMENT used in pre-stressed concrete can be either high tensile wire or cables made of high tensile wire. Whereas ordinary mild steel reinforcement has a tensile strength in the order of 30 tons per sq. in., the high tensile strength wire has a strength of about 110 tons per square inch. In the testing of reinforcement for pre-stressed work the breaking strength and the elastic properties of the wire must be recorded. This is done by measuring the extension of the wire for each increment in the load.

Difficulty was found at the Central Testing Laboratory of the Department of Main Roads in gripping stranded high tensile steel cables in the tension machine. The load on the wires was considerable and the steel grips usually employed to hold the specimen cut the wires and caused them to snap, thus giving low readings for tensile strength and false reading for strain.

Various ways were tried to overcome this problem. Flat pieces of aluminium plate were inserted between the test specimen and the steel grips. This stopped the tendency towards shear failure at the grips, but the flat grips held only one strand each side and permitted serious deformation of the specimen under load which prevented accurate extensometer readings being made. Another method tried was pouring molten solder on the ends of the test specimen to form a cushion between the machine grips and the specimen, but the specimen under test pulled out of the solder pads at moderate loads.

One of the Department's staff put forward the suggestion that if two pieces of split aluminium tubing were placed around the end of the test specimen before it was inserted in the testing grips, the tubing would flow under pressure and conform to the general contours of the cable to be tested. This would allow a firm all-round grip on the cable to be obtained. It was found that tubing was not available with sufficient wall thickness, so aluminium rod was obtained and drilled to a diameter just smaller than the cable to be tested. For 3/8 in. dia. cable 1/2 in. dia. aluminium rod was drilled to 5/16 in. and for 1/2 in.

Split aluminium sleeve before and after use

(Continued on page 25)

NUCLEAR SOIL TESTING METHODS

Speedy field tests for determining density and moisture content of subgrades and embankments, promises to end costly delays to contractors on earthmoving equipment work.

A NEW "push-button" nuclear device for determining density and moisture content of compacted material is described as an inspection tool "with tremendous potential" by Texas Highway Department Engineers.

The conclusions came after a test of the "Hydro-Densimeter" on 54 different sites, involving a variety of materials used in highway fill, base and pavement construction. Research Engineers with the department have indicated that the new instrument—which requires no destruction of test materials for sampling—may be used also for determining the density of finished pavements.

The Texas Highway Department obtained the first "Hydro-Densimeter" made available by the distributor for private testing purposes. Materials engineers in the department promptly subjected it to series of tests to determine its applicability to highway construction.

"Results to date show promise that we may soon replace conventional methods with this fast, inexpensive technique to give us better control over quality in the construction of highway embankment."

The "Hydro-Densimeter" is a portable electronic system, distributed in the U.S. by Tellurometer, Inc., of electronic distance measurement fame. It is composed of two pieces of equipment, which can be carried around a project or operated from an inspector's or contractor's vehicle. One unit is an 8in × 3in × 14in probe, which, placed flat on the compacted area, material or pavement, radiates gamma rays and fast neutrons to the depth desired. The probe simultaneously picks up those which are not absorbed, the number of which indicate, respectively, the density of the material below and its moisture content. The denser the material, the fewer gamma rays absorbed; the greater the moisture content, the fewer fast neutrons absorbed.

The other component, a $11\frac{1}{2}$ in. × $11\frac{1}{2}$ in. × 11in. counter, contains the "counting" equipment and 6-volt power supply.

The manufacturer claims that it takes only 60 seconds to make a reading with the "push-button" device. (The operator merely places the probe on the ground, holds a button down for 60 seconds, then records the reading on the panel of the counter.) A series of three measurements are usually taken at each location to assure accuracy, usually in a triangular pattern, with test points 15 inches part.

The surface probe can measure density at depths of $2\frac{1}{2}$ in.; moisture to a depth of 4 in (Another probe is also available which can be used to measure density at greater depths. It is a small cylindrical tube which can be lowered through a two-inch hole to the desired depth).

According to the Texas engineers, such a process takes about five minutes. Results are available at once.

"This is where the real advantage of such a testing system comes in, "Daniel N. Hanna, Jr., senior laboratory engineer of District 12, told Road and Streets. "There is considerable saving of inspection and testing time, compared to our traditional testing methods, of course. It takes about 1/7th time to make a measurement with the "Hydro-Densimeter" as with our current techniques."

"But the greatest savings will undoubtedly be in the fact that we will be able to tell a contractor whether he is meeting specifications considerably faster than with existing test methods. In short, we can make 'on-the-spot' decisions. What this will save for him by reducing idleness of men and equipment and cutting production delays, we can't presently estimate. But I am sure it would be significant".

For example, the engineers pointed out after a night or weekend of rain, there are

Data for the contractor without waiting. A Texas engineer takes a " reading " on a base course with the nuclear device which radiates gamma rays and fast neutrons to determine density and moisture content.

frequently several hours of uncertainty during which time neither the inspectors nor the contractors are sure enough of conditions to permit resumption of compaction operations. The result in last time can be costly, first to the contractor and inevitably also to the state since such contingencies figure in the bid.

The instrument could presumably be used too only on the grading job, but also at the mixing plant during paving operations to determine moisture content of aggregate and sand stockpiles.

Mr. Henna's tests of the "Hydro-Densimeter" for accuracy were reassuring. The instrument was tested in comparison with a Rainhart rubber balloon Volumeter and oven drying on precisely the same spots. Tests were made at 54 sites, including surfaced roads under traffic and unsurfaced road beds under construction. The materials examined included iron ore gravel with and without cement treatment, sand-shell with and without cement and lime treatment, silty and topsoil, and plastic clay with and without lime treatment.

" It was obvious that the nuclear device performed with a reliability at least equal to that of the rubber balloon methods ", Hanna stated.

A report on comparison of the Hydro-Densimeter measurements with sand replacement methods by the manufacturer indicated a close correlation on a wide variety of materials. The materials tested ranged from 100-150 lb. per cu. ft. density with 1 to 12 per cent moisture content.

The " Hydro-Densimeter " consist of two portable components—a probe, here being set on the ground, and a counter in back-ground. When calibrated for the local soils its two types of rays, when " backscatterd," or recovered, indicate the density and moisture content.

Supervising Research Engineer M. D. Shelby in the department's headquarters office pointed out a major matter of caution with the nuclear device. " It is obvious ", he said, "that the general curves supplied with the manufacturer for computation cannot be adopted without modification. The instrument must be calibrated for a variety of materials in a state, and individual curves determined. It is just unrealistic to assume that the manufacturer of such an instrument can produce scales to cover all of the materials construction engineers might encounter within one state. This is something each user will have to bank on doing himself."

A check with the manufacturer indicates that calibrating a system for local materials would take two men about a working day. Once done, these curves would be usable thereafter.

In spite of this initial "do-it yourself" requirment, Mr. Shelby said the, " Hydro-Densimeter " is " very promising ". It was a major advantage, also, the fact that an Atomic Energy Commision license is not necessary, as with some such equipment. " The AEC is a pretty strict regulatory agency. We would not want to have to work under their requirements, if we could avoid it ".

Other Highway departments and contractors have indicated an interest in the nuclear equipment for such purposes as :

1. Density measurements and compaction control in earthfull, sub-base and base of highways, air strips, and earth dams.
2. Non-destructive testing of concrete pavements.
3. Control of stabilizer distribution in bitumen stabilized soils.
4. On-location determination of optimum moisture curves for compaction control.
5. Testing of compaction equipment.
6. Location of leaks in earth dams, canals, dikes, etc.
7. Checking of moisture content in sand at pre-mix concrete plants.
8. Measurement of density in stock-pile materials (coal, grain, etc.) for accounting purposes.
9. Checking soils stability.
10. Location of pilings for bridges.
11. Evaluation of fills, backfills, and borrow pits in mines, earth embankments, highways, etc.
12. Checking for potential pavement failures.

An additional advantage of a device of this type is that it is non-destructive, and as such, is particularly appropriate for testing of finished pavements and stabilized materials.

(From " World Construction October, 1961 ".)

Note by Editor : National Laboratories in India are also working on perfecting a nuclear soil testing device.

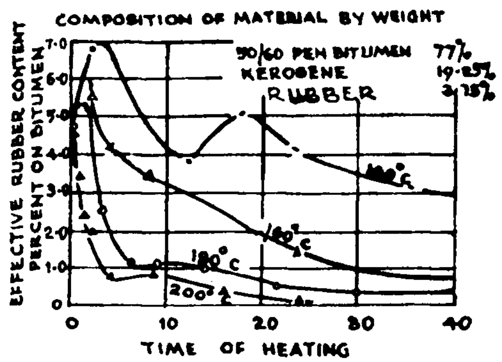
USE OF RUBBER IN ROAD SURFACE PREPARATIONS

THE inclusion of rubber with bitumen material for road surface preparations is found to produce a great viscosity than possessed by the original bitumen, plus an increase in the elasticity. The changes are dependent on the amount and type of rubber, the temperature and time of heating, and the degree of dispersion. In general, the viscosity of a rubberized bitumen mix initially rises with time and after reaching a maximum decreases. The temparature required to produce maximum viscosity is usually between 140° and 180° C, depending on the type of rubber. The initial increase is associated with an increasing degree of dispersion of the rubber throughout the bitumen and slight vulcanization of the rubber due to the presence of sulphur in the bitumen. The subsequent decrease in viscosity is related to the degradation of the rubber.

With nearly all types of rubber there is an increase in softening and a decrease in penetration compared with the values for the base bitumen. These changes have the most effect when the rubber is added in the form of latex, and least when added as a vulcanized powder.

The effective rubber content is defined as the concentration of un-degraded rubber which must be added to bitumen to give the same specific viscosity as the test sample. It enables differentiating between the various types of binders which may be prepared with the same amount of rubber but which, through differences in the periods and degrees of heating, may finally have considerably different rheological properties.

Natural rubber used in bituminous road surfaces generally consists of one of the following: harcrumb, a lightly unvulcanized powder containing some 96 per cent rubber; pulvatex, an unvulcanized rubber powder containing about 40 per cent of infusorial as a filler, manufactured at present in Holland; rohorub, a powder produced in Malaya, lightly vulcanized and containing 75 per cent rubber; latex and



Variation of effective Rubber Content with Time and Temperature of heating

revertex, concentrated natural emulsions of rubber containing 60 to 70 per cent rubber and 40 to 30 per cent water.

In the preparation of rubberized bitumen, blending is by heat and agitation; the more violent the agitation and the higher the temperature the shorter the blending period required.

The technique of laying is different from that required with a straight bitumen, the stiffness of rubberized mastic asphalt generally requiring the material to be pushed into position with the float.

Research work on the use of rubberized bitumen is being conducted jointly by the Natural Rubber Bureau, the Road Research Laboratory at Harmondsworth, and the Natural Rubber Producer's Research Association. Several sites throughout the country are being used for full scale experiments with rubberized materials, and in all cases there has been an increased resistance to cracking. A report —* Natural Rubber for Research, a Review of Research and Development—describing the joint work has been published by the Natural Rubber Bureau as Technical Note No. 3. The Natural Rubber Bureau, 19 Buckingham Street, London WCI.

(From "Engineering", November, 1961).

* Available for reference from the Library of the Indian Roads Congress.

MINERAL FILLERS IN ASPHALT MIXES

AN asphalt paving mixture consists of three ingredients: coarse and fine aggregates, mineral filler (normally present in the mix of supplemented by design), and asphalt cement. When all these ingredients are suspended in fine balance, the theoretical end result is an ideal pavement.

The role of the coarse aggregate fraction is fairly well understood by the paving technologists. This is true also of the fine aggregate fraction. Inevitably, the curiosity of the investigator has focussed on the mineral filler.

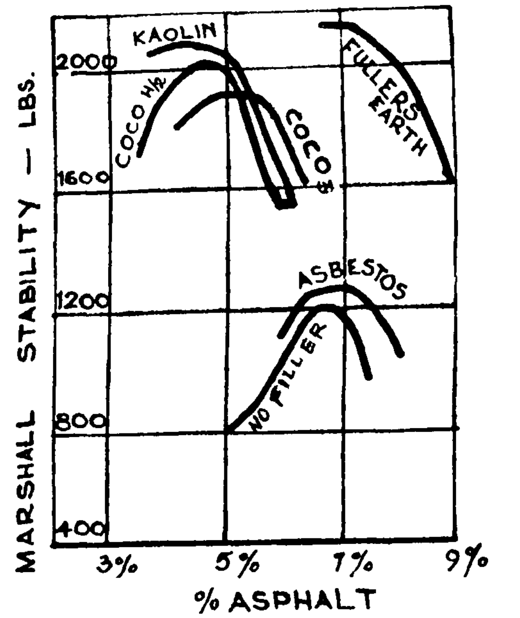
What function does this fraction of the paving mixture serve? How do the various types of filler react with the asphalt cement? By altering the mineral filler content of the mix, how do we upset the fine balance of ingredients? Questions generated more questions, faster than tentative answers could be formulated.

Project began in 1957

The Asphalt Institute, already embarked on a laboratory research programme in South Africa as far back as 1957, expanded its project. Studies started with diatomaceous earth kaolin clay, limestone dust and portland cement were widened to include ground quartz sand, hydrated lime, Fuller's earth and short asbestos fibre. Later, other fillers were added.

It is axiomatic in pavement design that great resistance to densification can be achieved by reducing the asphalt contents. But you pay for this gain with a corresponding loss in pavement durability. A dry brittle pavement won't last. On the other hand, a mix over rich in asphalt content will offer greater resistance to fatigue, but there is a matching loss in stability. Bleeding and flushing of the asphalt occurs, along with displacement, under heavy wheel loads.

From experience, we know the most successful and durable pavement is the one that contains the greatest possible amount of asphalt, without sacrificing stability. The critical importance of mineral filler in arriving at these new, maximum stability pavements was suggested by the success of mastic-type pavements commonly used.



Laboratory investigations at The Asphalt Institute have been conducted in two areas —combinations of asphalt cement and the several fillers, and mixtures of filler-asphalt combinations and aggregates. All the fillers were used in sheet asphalt mixtures and many were used in dense-graded mixes.

These investigations by the laboratory team began accumulating data which, at times, appeared to be contradictory, frequently confusing. For example, early in the game it was discovered that the asphalt filler mixes of higher viscosity usually showed higher softening points. Yet, sometimes this was reversed. The viscosity of asphalt-asbestos fibre mixtures at 77° F. is lower than that of an asphalt combined with Fuller's earth or diatomaceous earth. But the softening point of the asbestos-asphalt mixture was higher than any of the other filler-asphalt systems under study. Similarly, combinations of asphalt with hydrated lime showed higher viscosities (but lower softening points) than combinations of asphalt with kaolin clay.

The jumping off place

It was learned that the surface areas for the eight mineral powders under study varied widely. Activated alumina, for instance, retained about one hundered time more glycerol (in the glycerol sorptive test) than ground quartz sand, and those fillers which retained more glycerol also absorbed more asphalt, as a general rule.

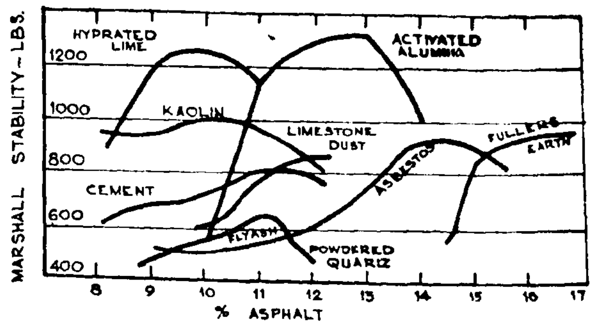
But there were conspicuous mavericks in the statistical herd. For example, alumina retained the highest amount of glycerol, but showed only a moderate affinity for asphalt. And kaolin clay retained only about one-fifth as much glycerol as the activated alumina—but showed a far greater affinity for asphalt. Further, it was discovered that the glycerol retention method couldn't be used to test two of the fillers—lime and portland cement—because of a chemical reaction that produced erratic test data.

It was found that the glycerol retention of fillers correlated, to a degree, with the hygroscopic moisture content (rate of water vapour sorption) of the fillers. For example, a sheet asphalt type mix with fillers of high hygroscopicity tended to weaken rapidly when immersed in water. The investigators asked themselves: Should we test filler for hygroscopicity? Perhaps that must come.

Probe continues

Meanwhile, the investigation proceeded like opening up an artichoke; as each leaf was peeled away it opened up additional research. In addition to testing normal mixtures, other tests were conducted with samples in which the mineral filler was premixed with the asphalt cement. This produced some interesting data. It was found that, generally, the susceptibility of paving mixtures to water could be reduced by pre-mixing the filler and asphalt before blending with the aggregates.

For example, a normal mixture of sheet asphalt with a diatomaceous earth disintegrated upon immersion. When pre-mixed with the asphalt cement, on the other hand, it produced the highest stability curve. On the other hand, mixes with quicklime (highly reactive to water) disintegrated readily under both conditions.



A general relationship between the surface areas of the fillers (as determined by the sorption test method) and the viscosity of the filler-asphalt mixture was established. Mineral fillers with the largest surface areas absorbed the greatest amount of asphalt. Viscosities of the mixtures generally, but not consistently, increased with the increasing fineness of the filler. And increasing concentrations of filler resulted in increased viscosity and non-newtonian flow behaviour of the mixture.

Speculation has zeroed in on two closely related aspects of the study: surface areas of the fillers and their capacity for absorbing asphalt. Polar attraction probably enters into the picture at this point, but to what extent we don't know at this time. Spectrophotometric and gravimetric tests confirm this, but a more sophisticated method of measurement is needed.

Asbestos gets high mark

As this investigation probes deeper and deeper into a very complex subject, information gathered to date gives a high mark to asbestos fibre filler. It appears to meet most of the requirements of a sound, working filler with minimum of the "bugs". Other fillers—kaolin clay and hydrated lime—showed some of the desirable characteristics under most conditions.

Field testing, of course, is the ultimate proof of the value of a filler material. Dense-graded mixtures containing asbestos filler are now being field tested in several locations. Similar field tests should be made with mixes containing kaolin clay and hydrated lime fillers.

(From "African Roads & Transport", September/October, 1961.)

TECHNICAL TOPIC[illegible]

ASPHALT, CONCRETE AND G[illegible]

Asphalt concrete can match twice its thickness in gravel—in terms of support value—reports Prof. Martin Ekse, of the University of Washington, in a summary review appearing in the October issue of Asphalt Institute Quarterly.

"The considerable data derived from these tests", he writes, referring to evidence gathered over a several years period at the university's test track, "made it possible to express strength of an asphalt paving mat in terms of 'gravel equivalent'.

"For example," he continues, "a [illegible] inch mat is as effective [illegible] and one half inches of crushed gravel base course in distributing a moving wheel load on the subgrade soil, producing the same maximum pressure intensity on the soil. Similarly, a three-inch mat was shown to be the equivalent of about seven and one-half inches of gravel base."

(From "World Highways", Nov. 1961.)

SMOOTHER RIDING

The sawing of skewed transverse joints in highways, angled so that only one wheel of a vehicle can be on the joint at any given time, is reported to be highly effective in alleviating the rhythmic thump-thump that occurs when a car passes from slab to slab.

The new method of sawing concrete was used in a recently completed highway in California.

(From "World Highways", Oct. 1961.)

(Continued from page 18)

dia. cable 3/4 in. dia. rod drilled to 7/16 in. The aluminium rod supplied by manufacturers was found to be too hard for the purpose and did not allow for sufficient "flow" into the test specimen to give a satisfactory grip. This difficulty was overcome by annealing the pieces or rod at a point immediately below the melting point of aluminium (650°C).

The method developed has given satisfactory results; the pieces of annealed aluminium tube hold the specimen to be tested firmly in the test machine grips and deformation of the specimen does not occur during test. Accurate extensometer readings may be taken and perfect tensile breaks obtained at the ultimate load.

The original suggestion for this method of gripping test pieces was made by Mr. R. B. Facey, and the method of producing suitable aluminium tubing was developed by Mr. K. C. Hearne, both of the Department's Central Laboratory staff.

(From "Journal of the Deptt of Main Roads", Dec., 1961.)

ROAD RESEARCH IN GREAT BRITAIN 1960

BY 1970 there are likely to be 17 million vehicles and by 2010 some 36 million. These estimates are contained in the report of Sir William Glanville, C.B., C.B.E., D.Sc., M.I.C.E., F.R.S., Director of Road Research, for 1960. He states:

Recent trends in traffic flow and vehicle ownership probably give the most reliable guide to trends over the next five years or so. Past experience, however, indicates that long-term predictions of future vehicle ownership cannot be made by simple extrapolation of past trends. A recent comparison of rates of growth in different areas has, however, enabled a new assessment to be made of the prospects for the more distant future.

The annual precentage rate of increase of motor vehicles per head of population during the period 1956 to 1959 in counties or groups of countries in Great Britain was examined. In those counties where at present there are more vehiles per head, the rate of increase tended to be less. Assuming a straight line relation between these quantities, it can be deduced that an area with about 0.6 vehicles per head would not be showing any further increase, but that in any area with fewer than this number of vehicles per head would still be increasing. Thus 0.6 vehicles per head may be regarded as the current saturation level. Similar calculations have been made for periods before 1956 and also for the United States of America. Thus in Great Britain the saturation level has been rising steadily to its present value of about 0.6, while in the United States it has for some years been fluctuating about a constant level of about 0.7. Whether these saturation levels will ever be achieved is of course uncertain, but they can perhaps be regarded as minimum estimates of the ultimate demand, provided that there is sufficient economic progress to enable this demand to be satisfied.

Accepting 0.6 vehicles per head as the ultimate level, and assuming a current rate of growth of 7 per cent per year, it can be shown how the level of ownership in Great Britain may develop over the next 50 years assuming that the population will rise to 60 million. The curve gives the following estimates of numbers of vehicle licensed in various years:

1960 9 million
1970 17 million
1980 25 million
1990 30 million
2000 34 million
2010 36 million

The following are further extracts from the report.

Road System Survey.

To provide a more comprehensive picture of the road system of Great Britain than is usually available, a sample survey has been carried out by the Road Research Laboratory during the last three years. The sample consisted of over 1,000 points (the exact number was 1,111) at which various measurements and observations were made, and of sections 1, ½ or ¼ mile long associated with each point. A representative sample of junctions was selected from those lying along the sample sections.

The results of the survey scaled up to provide estimates for the whole road system, other than some of the less important rural unclassified roads and the roads on certain Scottish islands. A selection of the results is given in the table below. The heading "rural" refers to administrative rural districts, while "urban" refers to all other areas.

	Urban				Rural			
	Trunk	Class I	Class II	Other	Trunk	Class I	Class II	Other
Average width (ft)	29	29	25	21	23	21	18	14
Per cent curves (less than 3,000 ft radius)	8	10	18	10	22	18	21	18
Average gradient	0.009	0.016	0.021	0.021	0.012	0.018	0.019	0.022
Per cent with 1 or 2 footpaths	93	89	70	78	41	27	16	7
Junctions per mile	8	9	7	10	2	2	2	2
Per cent lit	74	75	64	74	11	11	7	4

Motorway Speeds

Speed measurements made on M.1 at regular intervals since the opening of the motorway have shown that the speeds of cars have remained fairly constant but that the speeds of goods vehicles have increased slightly over the first eight months. The table below compares mean speeds on straight level sections of the motorway with the results of similar measurements by the Laboratory on the Preston By-pass motorway and on motorways in certain countries on the continent of Europe. The speeds of cars and light goods vehicles on the London-Birmingham Motorways are substantially higher than those on the European motorways and the speeds of medium goods vehicles are slightly higher; the speeds of heavy vehicles on the London-Birmingham Motorways are, however, much the same as on the Continent. These differences may be partly attributable to an upward trend in

Motorway Speeds
Mean speed (miles an hour)

	London-Birmingham Motorway (May 1960)	Preston By-pass (June 1960)	European Motorways (June 1957)			
			Germany	Netherlands	Belgium	France
Cars ...	59	53	54	53	52	52
Goods up to 30 cwt. unladen wt. ...	52	46	46	45	40	43
Goods more than 30 cwt. unladen wt., 2 axled ...	42	37	40	41	38	36
Goods more than 30 cwt. unladen wt., multi-axled ...	38	33	38	40	35	35

vehicle speeds during the three years between the measurements on the Continent and those on the London-Birmingham Motorway, due to a reduction in the proportion of older vehicles in the traffic and to technical advances in vehicle design. A probable contributory factor, however, is the greater width of carriageways on the London-Birmingham Motorway; most of this road, including the site where the measurements were taken, has three-lane carriageways, while the European motorways studied had two-lane carriageways. The table shows that mean speeds of all classes of vehicle on the London-Birmingham Motorway are 5–7 miles an hour higher than on the Preston By-pass.

Rectifying Signs Night Illegibility

Road signs are usually turned in slightly towards on coming traffic with the result that at night their legibility is sometimes spoilt by specular reflection of the light from vehicle headlamps. Measurements made of the legibility distances and angle of turn of a number of signs showed that specular reflection from a driver's own headlights could be prevented, within the legibility range, by turning the signs through a small angle away from on coming traffic rather than towards it. The large advance direction signs on the M.1 motorway have been erected in this way with an angle of turn of about 2-3 degrees with satisfactory results. It was thought, therefore, the considerable advantages would ensue if all traffic signs, including those that are self-illuminated, were aligned in this manner. It was found, however, that the ordinary sign, frequently stove enamelled, is not as flat as the large fabricated sign on the motorway, and a somewhat larger turn out was necessary. It was concluded that general purpose signs should be aligned as follows:

(i) The signs should be in a vertical plane.

(ii) Signs sited on straight sections of road, and on right-hand bends, should be turned through an angle of 5 degrees from the normal to the road, in a direction away from on coming traffic.

(iii) Signs sited on left-hand bends should be turned 5 degrees away from the perpendicular to a chord joining a point on the edge of the carriageway at the site of the sign to a similar point 50 h.ft. in front of the sign, where h is the letter height, in inches, of the message.

These rules apply for motorways, except that the angle of turn can be reduced to 2-3 degrees for the reasons given.

(From "British Road Federation Bulletin", September, 1961).

HERE AND THERE

1. LONGEST CONCRETE BRIDGE IN THE WORLD

New concrete bridge on the Danube, in Novi Sad

● THE NEW concrete bridge for motor vehicle and railway traffic over the Danube at Novi Sad, was opened to traffic on October 23, 1961. With its two arches of 211 and 166 m span, this is the longest concrete bridge in the world for road and railway traffic. The bridge was designed by Mr. Branko Zezelji, Civil Engineer, Director of the Institute for Testing Materials in Beograd; the erection was performed by the building enterprise "Mostogradnja" of Beograd.

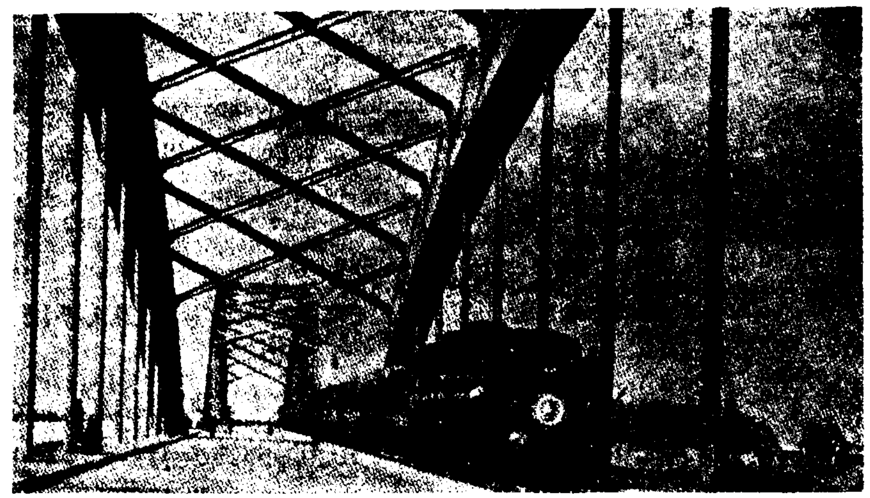
The bridge spans the Danube in the dock area of Novi Sad at a place where the river makes a sharp bend. The bridge is designed for motor vehicle and railway traffic.

The bridge structure is of reinforced and prestressed concrete and its total length between the abutments is 466 meters. The navigable part of the river is spanned by an arch 211 m long, the remainder by an arch 166 m long. The bridge roadway slab is partially suspended from the arches.

The clear width between the arches is 14 m, with the railway clearance 4.4 m and the motor way 9.0 m wide; the effective width of the sidewalk 5.15 m with service path of 1 m.

Both arches were designed on same principles: with fixed ends, height and span ratio being f : L — 1 : 6.5, and with the moment of inertia decreasing towards the abutments. The arches have a box-shaped cross-section.

The 211 m span has a height of the cross-section of the arches in crowns of 4.4 m, and 3.20 m at the supports; above the roadway, the width of the arches is 2.50 m; side walls of the cross-section are 25 cm thick and vertically prestressed; both, upper and lower panels are of varying thickness, approximately. 80 cm.



Opening to traffic of the new concrete bridge on the Danube, in Novi Sad

The arches are inter-connected with latticed wind bracing of prefabricated prestressed concrete.

The foundation of all the three main piers was pneumatic with the ciassons resting on sand and gravel.

The things that might be considered

characteristic and new in this concrete bridge are as follows :

The abutments take up great horizontal thrusts of 8,700 and 5,600 tons. The back walls of these abutments are free to move and, through a system of hydraulic cushions, can develop what might be called a prestress in the soil behind the abutments, thus preventing an outward movement of the abutments. In this way it was possible to construct such a large concrete bridge on flat land, on soil with a medium bearing capacity.

The center caisson 39/24.5 m, with a plan area of 833 sq. m with narrower rounded parts was erected on shore and pneumatically sunk to its floating depth, and then towed to the middle of the river.

During construction it was necessary to ensure a free river passage, 100 m wide, and therefore an arch centering of 108 m span was constructed of prefabricated concrete elements, freely assembled—the elements being supported by steel links.

The centering was designed only for 40% of the weight of the arches, which was made possible through the application of the new system of concreting the arches.

After concreting the arches remained open at the crown for another 6 months. During this period, all the deformations were compensated by means of hydraulic jacks.

The arches were inter-connected by latticed wind bracing of prefabricated prestressed concrete.

After the arches were completed the centering was removed, and the roadway assembled, with suspending ties and transverse beams of prefabricated prestressed concrete.

The various phases of work—although frequently difficult and new in the technique of bridge construction were performed successfully and according to plan.

The test loading of the bridge was carried out with a load of over 700 tons and the results obtained were very satisfactory, indicating excellent road carrying characteristics and safety of this large concrete bridge.

(From "Commercial News of Yugoslavia", January 1, 1962.)

2. EUROPE'S HIGHEST BRIDGE

Views of Austria's towering Europa bridge, five miles south of Innsbruck, one of the most imposing features of the Autobahn which will eventually link southern Germany with Italy's Autostrada del Sole. The bridge's main pier, more than 600 feet high, rises out of the gorge of the river Sill to rival the height of Ulm Cathedral—Europe's tallest. With a total length of 2,673 feet, the span will reach from the alpine village of Patsch to Schonberg. Work on the project is expected to be through in time for the 1964 Winter Olympics.

(From " World Highways," Vol. XII, No. 11, November 1, 1961.)

3. CONTINUOUS STEEL GIRDERS PLACED ON GATHURST VIADUCT

● LAUNCHING method guides 900 ft beams weighing 400 tons over river, canal and railway.

The last pair of steel girders more than 900 ft long and weighing 400 tons is due to be placed on the Gathurst Viaduct early next month, says the Ministry of Transport, reporting good progress on the M. 6 Birmingham-Preston motorway.

This is one of three large viaducts which were put in hand in advance of the road works for the M. 6. Work is now in progress along the whole length of the 78-mile road from Dunston in Staffordshire to the Preston by-pass and is scheduled for completion in 1963.

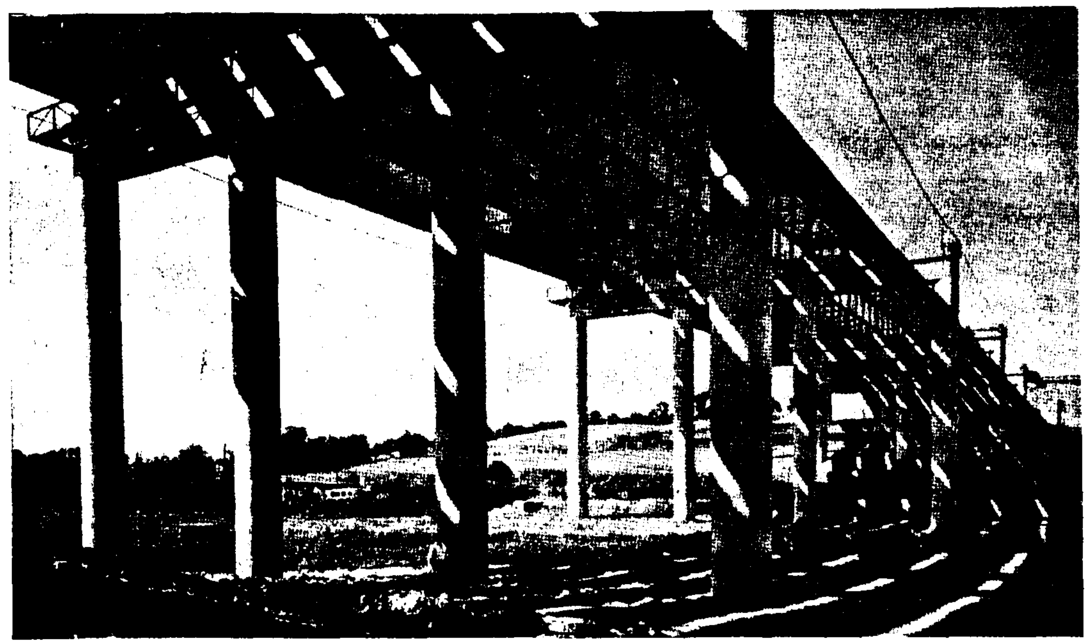
The Gathurst Viaduct, some three miles west of Wigan, will be completed by the end of this year. Cresswell Viaduct, adjoining the Stafford by-pass, should be ready early next year, and the mile-and-a quarter long Thelwall Viaduct, three miles east of Warrington, will be completed in about a year's time. Piled foundations.

Piled foundations

The Gathurst Viaduct, more than a quarter of a mile in length, crosses an 85-ft deep-valley, the River Douglas, the Leeds-Liverpool Canal, the Wigan-Southport railway and a minor road.

It consists of four 150 ft spans and two side spans of 100 ft each, with a 400-ft long embankment at the northern approach and a 200 ft embankment to the south, and is being built by Messrs. A. Monk and Col. Ltd., at a cost of more than £ 800,000. Between parapets, the viaduct will be 108 ft wide, while the approach embankments will be 124 ft wide atfinished road level.

More than 700 piles had to be driven into the silty clay overlying shale and sandstone for the foundations. The total length



Eight pairs of steel girders have been placed on the Gathurst Viaduct on the Birmingham-Preston motorway, and the last pair is due to be placed next month. The viaduct is 800 ft between abutments and the girders are carried on 6 ft dia. reinforced concrete columns varying from 36 ft to 70 ft above the footings.

of piles driven amounted to 30,000 linear feet. Foundations of the three centre piers had to be formed in permanent steel sheet piled cofferdams, due to the proximity of the canal and river.

Abutments and piers in reinforced concrete vary in height from 36 ft to 70 ft above the footings; the pier columns are 6 ft in dia. All the concrete for this work was weighbatched, mixed and pumped directly where required, as access to individual sites by ordinary transport was difficult because of the railway, canal and river.

The steel girders for the viaduct are designed as continuous beams over the full 800 ft. There are ten of these girders of 10 ft overall depth and of welded construction. They are fabricated in sections up to 93 ft long, weighing about 23 tons.

Week-end 'Launchings'

At the back end of the launching area, high on the north embankment, the girders are off-loaded by temporary gantries and positioned on the launching track which is 380 ft long, with 2½ in. steel balls in pairs in channels to form a ball-race. The two girders to be launched are then braced together and rolled into position for attachment to the 110 ft long latticed launching nose, used to keep the loads on the piers to a minimum during launching.

The girders are then moved from the abutment out over the piers, usually for a length of one or two spans-150 ft or 300 ft-at time. Work on the launching can take place only from Saturday midnight to Sunday midafternoon, to avoid interference with railway working below.

When the full length of 800 ft of girder and 110 ft of launching nose is being rolled, a load of some 440 tons is involved. Tests on the steel balls gave a value of 4 per cent friction to be overcome: and, as the girders are moved up a 1 in 200 gradient, the calculated force required at the launching platform is in the region of 20 tons. This is applied by using sheave blocks between the pulling frame and a six-ton electric winch.

The rate of movement of the girders varies between 1-1½ ft per minute.

When the launch of a pair of girders is completed, the launching nose is dismantled at the south embankment and returned by road to the north embankment for re-erection. Eight girders in four pairs have already been placed in position by this method.

It is expected that the final pair of girders will be in position during August.

About two acres of 9 in. thick reinforced concrete will then be laid to form the deck slab, waterproofed and surfaced with 3 in. of hot rolled asphalt. All this work should be completed by December.

(From "The Surveyor of Municipal & County Engineer", 22nd July 1961.)

4. BRIDSTOW BRIDGE ON THE ROSS MOTORWAY

● IN ITS COURSE from near Tewkesbury in Gloucestershire to Ross-on-Wye in Herefordshire, the Ross motorway passes through some of the loveliest country in England. The eye could hardly fail to be enchanted by this spacious, withdrawn, pastoral countryside with its distant views of the Welsh hills. Such a landscape, however, is a great responsibility for the designers of engineering works. How easy—and how unforgivable—it would have been to ruin the landscape with artifacts that were eyesores! But the bridges on this new motorway are a triumph of admirable and varied design.

One of the most important of them Bridstow Bridge, carries the Ross By-pass, a trunk road improved as a continuation of the motorway route, over the river Wye.

It is a three-span structure, with an overall length of 353 ft and a width of 79 ft 6 in. The approach spans are 75 ft long, and the clear span in the centre is 203 ft long, made up of two 66 ft 6 in. cantilevers supporting a 70 ft central suspended section.

The central span is supported on reinforced concrete boat-shaped piers which run the full width of the bridge. Embedded in their tops are the lower parts of steel rocker-bearings, the upper parts being cast into each of the main beams. The elegant shape of these piers arises from a design requirement—to reduce to a minimum the obstruction to the flow of the river in times of flood. The wing walls of the reinforced concrete abutments are also curved—again as a result of the engineering design.

Close-up showing the fine quality of the point-tooled surface, in combination with the plain concrete and the sandstone blocks

Opened in September 1960, this prestressed concrete dual-carriageway bridge is most distinguished, both in its long, low line and in the surface treatment of the exposed concrete. In fact, it enhances the riverscape as seen from the town of Ross.

The foundations of the piers and of the abutments are of mass concrete and bear on a bed of red sandstone 16 ft below the level of the river banks. The pier foundations are continuous along their length; the abutments are formed of a retaining wall backed by buttresses at 18 ft centres, each of which rests on a separate foundation.

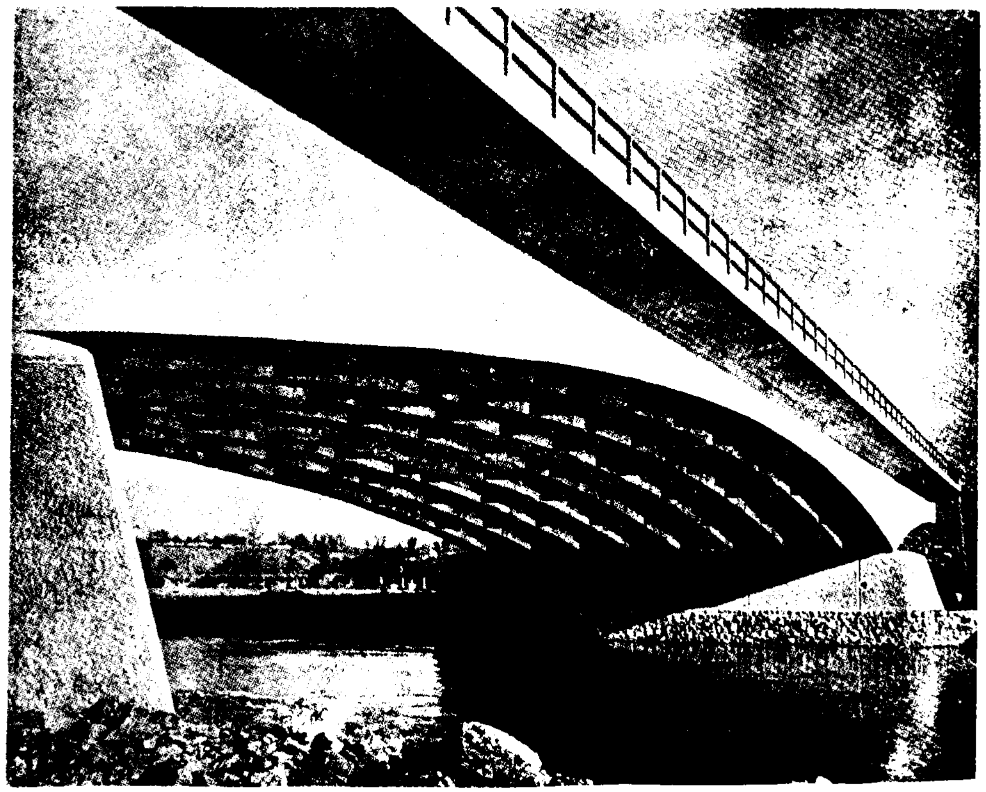
The structure itself consists of nine prestressed concrete beams at 8 ft 6 in. centres, interconnected by reinforced concrete diaphragms at 20 ft centres ; these act in conjunction with the 8 in. in situ concrete deck slab to provide transverse stiffness. The beams of the side spans and cantilevers were cast in situ, each beam being 141 ft. 6 in. long and varying in depth from about 13 ft over the piers to about 6 ft at the ends to 5 ft at mid-span. They were cast and prestressed near the bridge site. All the beams were prestressed with post-tensioned cables, each made up of twelve 0.276 in. high tensile steel wires.

The dual-carriageway is divided down the centre by concrete paving slabs flanked by concrete kerbs, and similarly paved footways are provided on each side. The neat tubular steel-and-mesh parapets are set in concrete kerbs.

The point-tooled concrete surfaces of the piers and of the exposed webs of the fascia beams provide one of the finest examples in the country of this type of finish. The mix for this concrete included Mountsorrel granite and red Herefordshire sand, to give a pinkish tone. This colouring is echoed, in a more intense form in the facing of the abutments, wing walls, and the sides of the pier foundations visible above the water-line. Here old red sandstone, the stone of the region, has been used, in random rough-surfaced blocks. The remainder of the concrete provides a complete contrast, its surfaces exposed straight from the forms.

The bridge was designed for the Ministry of Transport by Scott and Wilson, Kirkpatrick and Partners, with Ansell and Bailey as consultant architects. Tarmac Civil Engineering Limited were contractors.

(From "Concrete Quarterly No. 49)



A bold contrast is created by the elegant simplicity of the bridge's arch and the patterning of prestressed beams and diaphragms on the arch's soffit

BUDGETS AND ADMINISTRATION REPORTS

MADRAS STATE BUDGET FOR 1961-62

(A Brief review with reference to Civil Works)

THE budget estimate of revenue receipts for the year 1961-62 is Rs 8,750.09 lakhs and the expenditure on revenue account is estimated at Rs 9,035.33 lakhs with a consequent defficit of Rs 285.24 lakhs.

The revised estimate of the revenue for the year 1960-61 is Rs 8,928.96 lakhs and the expenditure on revenue account is estimated at Rs 8,806.24 lakhs leading to a surplus of Rs 122.72 lakhs. The actuals for 1959-60 revealed revenue receipts of Rs 8,110.66 lakhs and expenditure of Rs 8057.71 lakhs resulting in a surplus of Rs 52.95 lakhs. The Budget Estimate of revenue expenditure on civil works for the year 1961-62 is Rs 1,282.69 lakhs which is 14.66 per cent of the total State revenue. The expenditure on civil works for the year 1960-61 (revised estimate) and for the year 1959-60 (actuals) is Rs 1,318.79 lakhs and Rs 1,281.68 lakhs respectively, giving a percentage of 14.77 per cent and 15.8 per cent respectively with respect to the corresponding figures of total State revenue for the year 1960-61 and 1959-60 respectively.

The expenditure on communications alone (original works and repairs combined) works out to Rs 307.50 lakhs for 1961-62 which is 3.51 per cent of the total State revenue. The expenditure on communications is Rs 317.15 lakhs (revised estimate) in 1960-61 and Rs 306.27 lakhs (actuals) in 1959-60, which amounted to 3.55 per cent and 3.78 per cent respectively of the corresponding figures of the total State revenue, for the year 1960-61 and 1959-60.

The capital outlay on civil works outside the revenue account is estimated at Rs 546.18 lakhs for the year 1961-62. The revised estimate and the actuals for the years 1960-61 and 1959-60 are Rs 465.13 lakhs and Rs 375.70 lakhs respectively.

WEST BENGAL STATE BUDGET FOR 1961-62

(A Brief review with reference to Civil Works)

THE total revenue of the state is estimated at Rs 9,548.13 lakhs for the year 1961-62 as against Rs 10,220.76 lakhs (revised estimate) for 1960-61 and Rs 9,163.62 lakhs (actuals) for 1959-60.

The corresponding expenditure figures are Rs 9,867.82 lakhs for 1961-62 (Budget Estimate) Rs 9,766.03 lakhs for 1960-61 (Revised Estimate) and Rs 8,587.62 lakhs for 1959-60 (actual).

The Budget estimate of expenditure on Civil Works to be met from revenue for 1961-62 is Rs 494.25 lakhs against the corresponding figure of Rs 488.85 lakhs (Revised Estimate) for the previous year (1960-61). The provision of Capital Expenditure on Civil Works outside the revenue account in the current year (1961-62) is Rs 947.87 lakhs, out of which Rs 448.00 lakhs have been allotted for Development of State Roads. The corresponding figure for Revised Estimate for the previous year (1960-61) is Rs 842.80 out of which Rs 335.00 lakhs have been allotted for development of State Roads. The actual Capital Expenditure on State Road, in 1959-60, outside the revenue account was Rs 223.16 lakhs only.

ERRATA

The following has appeared erronoously in the TCMR for August 1961 : No. 172
Page No. 40 (Item No. 2 line 1)
for 'Bhasurai' *read* 'Ghaswala'.
(Item No. 3 line 1)
for 'Gleaswala' *read* 'Ghaswala'.

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

1. **Report on the experimental performance of different types of base courses for roads under adverse moisture conditions tested on road test track at Majherhat, Alipore, Calcutta (1949-58).** Published by Indian Roads Congress, New Delhi.
2. **Report of the committee on co-operative processing appointed by the national Co-operative Development and warehousing Board, April 1961.** Publised by the National Co-operative Development and Warehousing Board, New Delhi.
3. **Cabinet Secretariat Report 1960-61.**
4. **Department of Atomic Energy Report 1960—61.**
5. **Government of India (Allocation of business rules, 1961).** (As corrected upto April 30, 1961) published by Manager, Government of India Press, New Delhi.
6. **Dar Stahlbau January—December 1957.** Bound Vol. 25.
7. **Der Stahlbau 1959.**
8. **Der Stahlbau, January—December 1960.** Bound Vol. 25.
9. **Index to the Government of India Gazettes, January—June 1951, Vol. I.** Published by Manager of Publications, India.
10. **Index to the Government of India Gazettes, July—December 1951, Vol. II.** Published by Manager of Publications, India.
11. **Index to the Government of India Gazettes, January—June 1954, Vol. I.**
12. **Index to the Government of India Gazettes, July—December 1954, Vol. II.**
13. **Central Board of Irrigation India publication No. 38. Annual Report (Technical) 1946, Part II.** Editor N. D. Gulhati.
14. **Central Board of Irrigation and Power, Publication No. 80. Manual on River Behaviour canal.**
15. **Central Board of Irrigation and Power, Publication No. 60. Manual on River Behaviour Canal.**
16. **Central Board of Irrigation and Power, Publication No. 58. Investigation Manual of Storage Reservoirs.**
17. **Central Board of Irrigation and Power, Publication No. 6. Fluming.**
18. **Roads and their traffic by Davies and Ernest.** Published by Blacheve and Sons, London.
19. **Central Board of Irrigation and Power Publication No. 54. Symposium on determination of costs and benefits of river valley projects 1953.**

LIST OF APPROVED WORKS ON NATIONAL HIGHWAYS

S. No.	Job No.	Name of the work	Amount (Rs in Lakhs)
1.	2690-GR-8A	Preparation of plans & estimates for the construction of an overbridge crossing with the Railway Line on the diversion outside Nadiad town on N. H. No 8 for payment as deposit to Railway authorities.	0.14
2.	2691-RJ-11	Acquisition of land and buildings for Jaipur bye-pass Zone A (between Jaipur-Delhi Road, N. H. No. 8 and Jaipur-Agra Road, N. H. No. 11).	2.09
3.	2692-MR-4	Construction of a bridge across Nira river at Sarola in mile 29/5 of Poona-Bangalore Road, section of N. H. No. 4.	4.34
4.	2693-GR-8A	Construction of approaches to bridge over Machhu river near Mahika Bomanbore-Wankaner section of National Highway No. 8A.	1.23
5.	2694-GR-8	Additional land for widening and strengthening the South approach road to Narmada bridge on National Highway No. 8.	0.21
6.	2695-BR-IDA	Purchase of road rollers for schemes proposed to be financed from loan from the I. D. A. in Bihar.	27.42
7.	2696-BG-IDA	Purchase of road rollers for schemes proposed to be financed from loan from the I. D. A. in West Bengal.	12.65
8.	2697-ORS-IDA	Purchase of road rollers for schemes proposed to be financed from loan from the I. D. A. in Orissa.	7.62
9.	2698-MR-IDA	Purchase of road rollers for schemes proposed to be financed from loan from the I. D. A. in Maharashtra.	4.62
10.	2699-MR-6	Electrification of Inspection Bungalow at Erandol on Surat Dhullia-Edlabad Nagpur Road N. H. No. 6.	0.03
11.	2700-GR-8A	Construction of a bridge across the little Rann of Kutch on N. H. No. 8-A.	85.71
12.	2701-MR-4	Widening the carriageway width to 24 ft by providing 2 ft wide full grout asphalt surface on each side in miles 34/0 to 63/0 of Bombay-Poona Road, N. H. No. 4.	3.94

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Section I—General Features of Design (1960) Price Rs 1.50 per copy including postage.

Section II—Loads and Stresses, Second edition, 1962, Price Rs 2.50 per copy including postage.

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