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MONTHLY REVIEW

MAY 1960—No. 157



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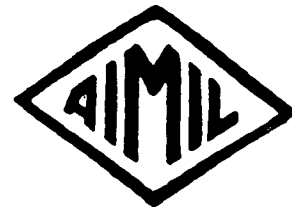
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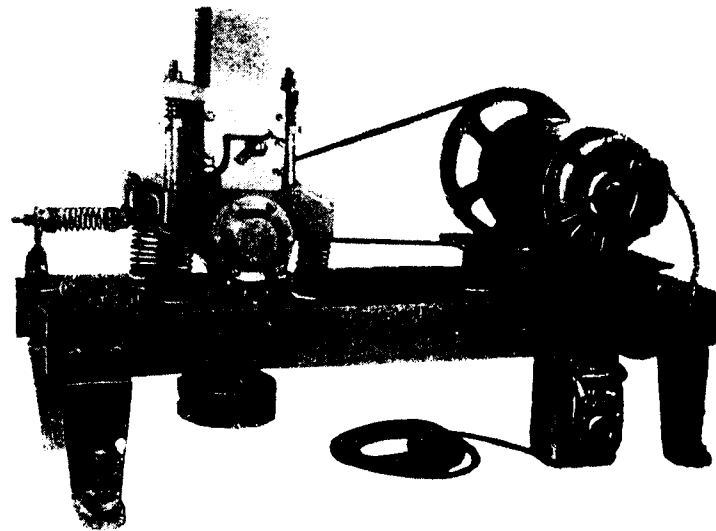
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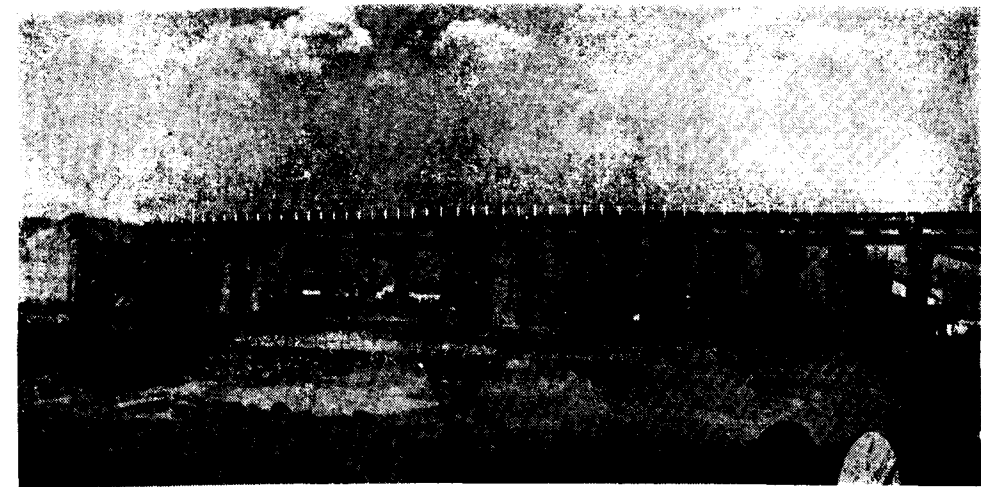
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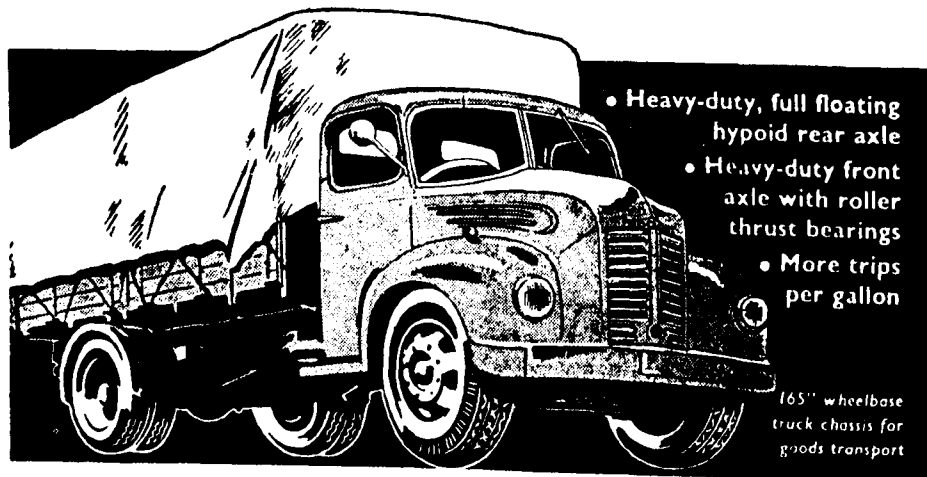
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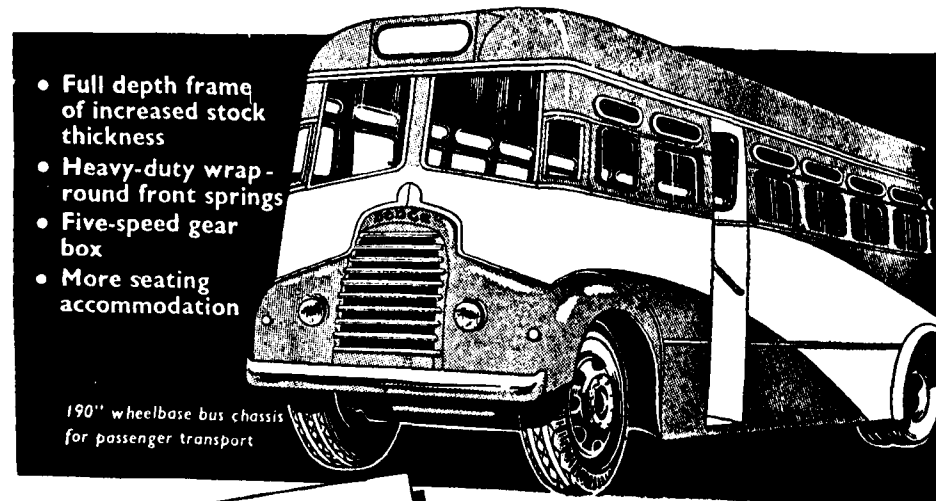
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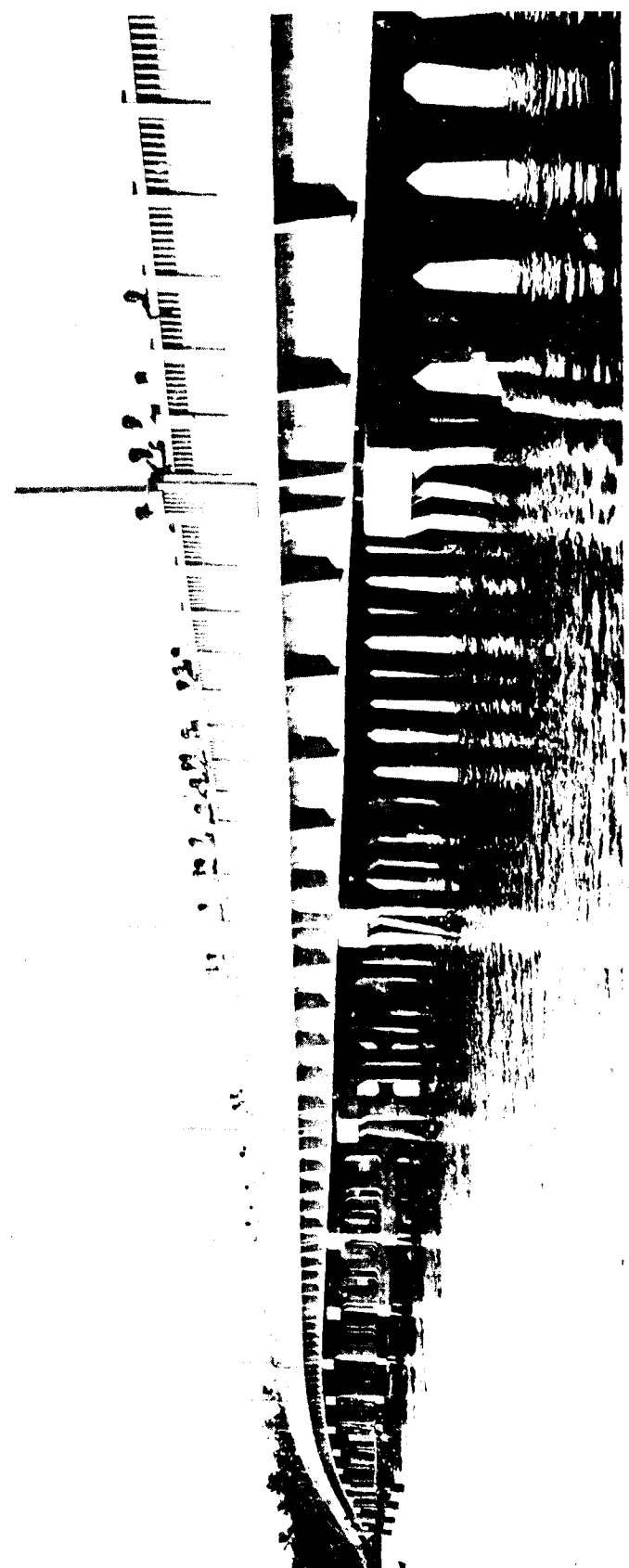
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GENERAL VIEW OF THE COMPLETED AROOR BRIDGE
(Kerala State).
On N. H. 47.

TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

A REVIEW OF
ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

MAY 1960

BRIDGING INDIA'S RIVERS

THE DHARAMTAR BRIDGE*

Introduction

THE bridge across the Dharamtar Creek on Alibag-Khopoli State Highway in Bombay State completed in 1958 has several unusual features not generally met with. It also presented a number of constructional difficulties. The necessity for construction of the bridge was keenly felt for a long time but due to various difficulties the project could not be taken up earlier. Prior to construction of the bridge, there was a ferry service which fulfilled only a part of the traffic needs with great inconvenience.

The Amba river which flows into the Dharamtar Creek has a catchment of only 300 square miles but the creek water spreads for a considerable distance on both sides at high tides. The creek has a main gorge of about 1040 feet with about 5 feet and 21 feet water depths at lowest and highest tides respectively. Hard rock is met with at average depth of 20 feet below the creek bed and strata overlying rock are predominantly silt, sand and clay with occasional boulders. At high tides, country crafts ply upstream of the bridge site.

After a careful study, it was decided to bridge up the entire gorge of the river to

prevent silting of the creek which would have occurred by restricting the flood and tidal waterway. The silting would have been particularly harmful to the existing navigation. To permit this, it was decided to provide 25 feet vertical and 100 feet horizontal clearance for the central span after consultation with the Central Excise Department.

Foundations

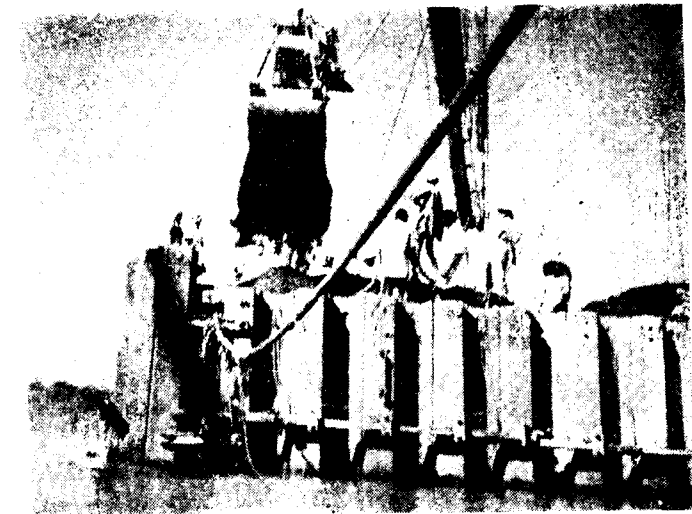
Three alternative types of foundations—viz. pile foundations, open caissons and well foundations were considered for the bridge. Pile foundations were ruled out as no grip would have been available for piles in the silt, clay and sand and piles would not have penetrated boulders. Open caisson required special plant, machinery and labour for floating and sinking them in the creek of high tidal range. Therefore, well foundation was the only choice. End wells were sunk by forming an island with the use of steel sheet piles and for intermediate wells it was decided to provide floating hollow steel kerbs of varying depths depending on the depth of water and mud at the pier. Each pier is founded on two wells each having 13 feet outer and 10 feet inner diameters.

* By courtesy of the Chief Engineer, P.W.D., B. & R., Bombay.



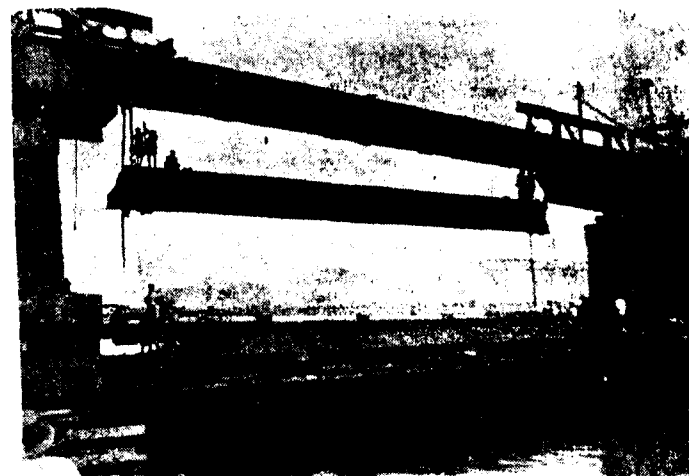
Dharamatr bridge on
Alibag Khopoli Road,
a State Highway,
Bombay State.

The grab throwing off
the dredged sand from
inside of the land
well of Pier No. 1.



89

80 ft suspended span
being hoisted.
One suspended span
already erected
on site



The standard practice is to float and launch steel hollow kerbs at the correct position and ground them at the position by operating a valve which allows water to enter the annular space of the kerb. This method was not considered suitable due to shallow water depths at low tides and existence of mud in the creek bed which would not have allowed plumb grounding. Fabricated steel floating kerbs were brought

from land at the head of a timber pile jetty specially constructed and cranes on a floating staging lifted the well kerb by four chain blocks. The floating staging was launched at the well position and the steel kerb which was suspended by the chain blocks was slowly lowered in water. The kerbs were made stable by filling concrete in the annular space. The length of the steel kerb was such that its top was above



Another close up of steel
floating caisson, one
showing 27 ft height
has been sunk a few ft
while the other has
just been grounded by
filling some concrete
in the hollow
annular space

high tide level after its grounding below mud. The well above the kerb portion was then extended by reinforced concrete steining and sinking upto rock was done by dredgers mounted on the floating platforms. Reinforced concrete well cap 3 feet thick was laid over the two wells which were filled with concrete top and bottom plugs and sand after founding on rock. The maximum height of steel kerbs was 28 feet and it required 0.8 ton of fabricated steel per running foot of a single well.

Coursed rubble masonry piers and abutments with khandki were constructed over the well caps as stone masonry was more economical and resists the saline atmosphere effectively. Reinforced concrete pier cap was laid over the masonry piers to distribute girder loads uniformly.

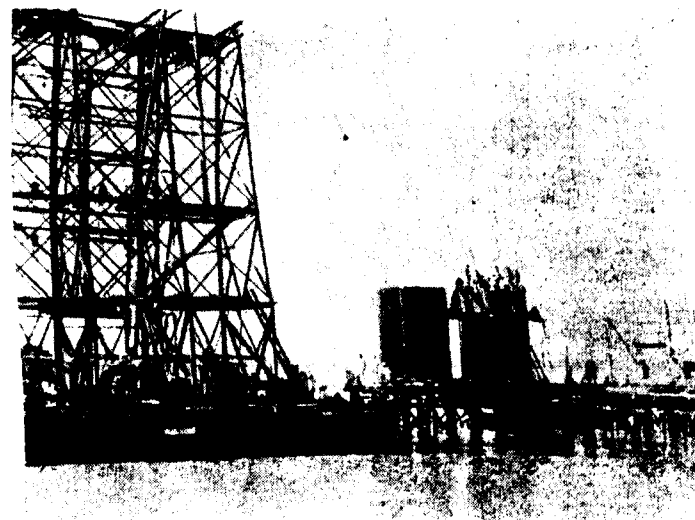
Superstructure

Reinforced concrete superstructure was not favoured due to likely corrosion of the reinforcement in creek area. R.C. arches would have been suitable but they required large piers and foundations involving costly structure in difficult foundation conditions. Prestressed concrete bridges were not built then in India and it would have required import of high tensile steel with anchor-

ages and expert foreign technical help. Therefore, a steel structure was adopted for the bridge.

The superstructure design required two-stage construction with as large span as possible due to heavy foundation cost. This could be only achieved by adoption of plate girder deck designed in such a way that initially two plate girders should be able to take two lanes of Class 12 loading and an addition of two plate girders in the second stage would make the bridge to take two lanes of I.R.C. Class 'A' loading and strong for single lane of Class 'AA' loading. The cross girders and deck slab were designed and constructed to take I.R.C. loading in the first stage only.

It was necessary to provide 25 feet clearance for the central span for navigation. This meant very high embankment height at the ends of the bridge. The embankment height was minimised by provision of 3 per cent down grades on either side of the central span and adopting through type deck with Warren trusses for the central span. These trusses were designed for two lanes of Class 12 loading only and in the second stage the central span would be replaced to make the bridge strong for I.R.C. loadings.



View showing the erection of strakes for steel caissons.

To make feasible as large a span as possible in plate girder, a balanced cantilever system was adopted to have 80 feet suspended spans resting on 20 feet cantilevers of the 120 feet main spans. 7 spans of 120 feet with end spans of 100 feet were provided for the bridge. Plate girder depth was only 5 feet throughout. A modern type of articulation design adopted consisted of one 4 inches diameter pin in each suspended and cantilever girder connected by a link on either side of the web. Such design permits free expansion, contraction and rotation of the girders.

The parts of the main span girders and cantilevers were erected in position on service girders placed on well caps. The service girder height had to be adjusted to accommodate 3 per cent down gradient to deck from the central span on either side. The parts of the plate girders were spliced by site rivetting on the service girders. Suspended span girders were lifted from the

pontoon by means of chain blocks fixed on the temporary columns erected on the cantilever ends. The central Warren girder members were jointed in situ on the service girders.

Cast steel roller and rocker bearings were provided under each girder on the piers and abutments. Grease boxes were provided round the bearings for durability and workability.

The construction work was started in December 1953 and completed in June 1958. The work was held up for 2½ years due to non-availability of steel plates for plate girder fabrication. The cost of the bridge is about Rs 40 lakhs. Total structural steel used on the bridge is 950 tons. The bridge required concrete, masonry and reinforcement steel to the extent of 63,000 cu. ft., 16,000 cu. ft. and 80 tons respectively.

DEFINITIONS OF HIGHWAY ENGINEERING TERMS

- BONING:** The process of locating and driving in pegs so that they are in line and have their tops also in line, carried out by sighting between a near and a far peg previously set to the gradient desired.
- BONING RODS:** Tee-shaped rods of equal height used in sets of three to facilitate the process of boning; two of the rods are held on the near and far pegs to establish a line of sight between them in the desired gradient while the third is used to fix intermediate pegs in line.

RECENT DEVELOPMENTS IN HIGHWAY BRIDGE DESIGN*

By

C. S. CHETTOE, B.Sc., M.I.C.E., and P. F. STOTT, M.A., A.M.I.C.E. †

THE intention of this paper is to outline recent changes and improvements in highway bridge design, with some reference to developments arising out of modern road layout. Most bridges in this country are of comparatively small span, and very long span bridges will not be considered, more especially as this subject has been so well treated recently by Kerensky.¹

Highway Loads

It seems reasonable first to consider the loads to be provided for. These are broadly of two kinds: normal loads which require no special notification; and abnormal loads.

Normal loads are covered generally by the Construction and Use Regulations of the Ministry of Transport. Until recently the heaviest such load was a 22-ton lorry on three axles, the two back axles each of 8 tons: the loads are gross loads. This has now been increased to 24 tons, with back axle loads of 9 tons each.

Abnormal loads are controlled by the Authorisation of Special Types Order. Loads and axle spacings are governed by a formula: the maximum permissible loads for a four axled vehicle are: 150 tons total; bogey of two axles 90 tons; one axle (4 wheels) 45 tons. The maximum wheel load is therefore 11½ tons.

The movement of these abnormal loads requires previous notification to the highway authorities; and, in certain circumstances, also to the police.

The number of movements has greatly increased of late years, and there are many thousand movements a year.

Design Loading

The Ministry of Transport issued their Equivalent Loading Curve in 1931. Together with a knife edge load to represent the excess load of one heavy axle, it was designed to cover the effect of standard trains each consisting of locomotive and three trailers including impact and was to be applied to such parts of a bridge as to give the worst effect on the member under consideration. It was also intended to cover the effect of four 20-ton loads, an idealisation of the abnormal loads then in use.

The British Standards Institution has recently issued a new highway loading as part of the revision of B. S. 153 Design of Steel Girder Bridges. This includes what is called the H. A. loading, to cover normal loads; and the H. B. Loading, for abnormal loads.

The H. A. loading consists of a knife edge and an Equivalent Loading Curve on the same lines as the old Ministry Loading Curve but based not on locomotives and trailers (which hardly now exist) but on a reasonable concentration of modern loads (22 or 24 ton lorries and below). The curve is less severe than the old Ministry curve for long spans, but heavier for short spans. Impact is included.

Transverse reduction is made for lanes greater in number than two. The loading has a rational basis and can be varied to suit conditions different from those obtaining in Great Britain. Loads 80 per cent of H. A. have been adopted in designing some major bridges in Australia.

The H. B. loading is on a unit basis and consists of an idealised bogey vehicle. Forty-five units cover the Ministry of Transport maximum of 150 tons, with reasonable allowance for the weight of a tractor or tractors. No allowance is made for impact.

Normally a bridge would be designed for H. A. loading, and, if necessary, checked for H. B. loading. The H. A. loading will, without variation, cover the effects of abnormal loads up to 80 tons or so, the amount depending on the type of bridge. Bridges on the most important routes would normally be checked for 45 units H. B. loading, or otherwise checked for a smaller number of units, or designed only for H. A. loading according to circumstances.

An amendment to the present BS. 153 wind loading will shortly be issued. This loading, as amended, will be based on recent experiments and practice. The normal pressure to be taken will be 30 lb per sq. ft. corresponding to a wind speed of 90 m.p.h. on an unloaded bridge, with a reduction to 15 lb per sq. ft. (63 m.p.h.) for a bridge loaded with an 8 ft high continuous strip of loading. Allowances are made for screening of one girder by another, and for longitudinal wind load. Overturning is also considered.

Road Layout

The design of bridges under and over roads has been much influenced by developments in layout and by traffic conditions in towns and cities. The modern fast highway has usually dual carriageways each having two or three lanes, and it is the problems involved in carrying or crossing these highways which are most typical of present day design. The development of various types of intersection involving grade separation such as the cloverleaf, the flyover with four slip roads and the flyover roundabout may be specially mentioned in this connection.

The design of major bridges carrying important roads has in recent years been affected by increasing width. The problems arising involve such diverse questions as distribution of load in orthotropic decks, provision for transverse expansion and aesthetic considerations. In some cases wide bridges may be dual structurally with the central reservation either open or covered by a slab. Large dual bridges or

dual viaducts can be designed to give a very handsome effect. The commonest bridge design arising from road works is probably that involving the crossing of a dual carriageway, but no standard form of structure has yet come into general use. Either steel or concrete construction may be used but in this country most bridges of this type have been built in reinforced or prestressed concrete. The present tendency is towards lightness in design especially when bridges require to be frequent as with most new major roads.

The most generally satisfactory form of overbridge is that arranged in four spans. This layout gives good visibility on the road beneath and a feeling of space and lightness. In many conditions it will be the most economical.

Two span bridges have been used for some motorway crossings but the authors feel that they are unsatisfactory except in special circumstances, such as those where difficult ground conditions for embankment formation are met with. They tend to suffer visually from several defects. When a very wide road has to be carried over the motorway the tunnel-like effect produced by the abutments is disturbing not only to the eye generally but also to the motorist. The problem of unresolved duality also appears although this criticism may not apply fully to bridges of this type such as those on the London to Birmingham motorway as the large central cylindrical pier catches the eye.

Both the four-span and two-span bridges require a central support between the two carriageways. This support requires to be made substantial enough to stand after collision damage and yet should be arranged to give as little impression of solidity and obstruction to the motorist as possible. It may be possible to arrange by kerbs or safety barriers protection for the centre pier, and no structural difficulty then arises.

In some cases a single span across the two carriageways is to be recommended; for example, on a bend or more especially in a cutting beyond which a view opens out. Portal frame structures though more expensive than beam and slab construction may be appropriate. Such structures may also be incorporated in a three span layout.

* From a Paper presented at a meeting of the Institution of Highway Engineers, Feb, 5, 1960.

† Respectively consultant to and partner in the firm of G. Maunsell & Partners, consulting engineers.

The earth slopes under side spans should be pitched, a practice which gives some scope for the use of local materials.

Recent designs of bridges for such crossings have provided a considerable body of experience and there will undoubtedly be some tendency towards standardisation in future work. However, except in perfectly flat country, the motorway, its alignment and the views from it, will be constantly changing and there is therefore justification for some judicious variation of the type of bridge having reasonable regard to economy. One design, however good, becomes very monotonous if it is constantly repeated. In deep cuttings, particularly through rock, or for under bridges where foundations are good, arches may be appropriate and provide a welcome variation in design. The use of local materials in suitable cases (for example, facing of wing walls, abutments and spandrel-filled arches) helps to provide variety and add interest.

The most difficult overbridge to design satisfactorily is that carrying a subsidiary road with a steeply rising gradient over a motorway. Ideally, spans should vary slightly from one side of the road to the other, increasing towards the higher side. Portals and arches if used in such cases should be asymmetric to a small extent although boldly asymmetric arches with differing springing angles on the two sides have sometimes been adopted.

In towns and cities, some at least of the bridges associated with newly-developing road layouts can be of the same simple types as would be used in the country, but the introduction of elevated roadways into the urban scene has created quite a new class of structure with its own problems of design. These structures may be required in many differing situations. They may need to run down the middle of or alongside existing roads and in various alignments across them.

In some situations they can be treated very much as normal bridge structures with supports conveniently spread across the entire width of the deck. In many cases, however, there are advantages in using single central column supports especially where it is required to run the elevated roadway in the same direction as and partly above an existing road in order to save

ground space. This form of construction is not necessarily confined to urban elevated roads, but has also been used elsewhere, for example, the Queen-hill Bridge over the Severn² and the Bingen³ and Unkelstein⁴ viaducts in Germany.

The visual aspects of elevated roadways in urban areas need careful treatment if these massive structures are not to dominate and overshadow their surroundings. Construction with a continuous beam of uniform profile can be effective in relatively spacious settings, as in Brussels⁵ but could be monotonous and over-powering in the closely confined streets of London and similar cities. In these instances forms of construction such as that adopted at Ludwigshafen⁴ with repeating arched forms, are probably most satisfying to the eye.

Short viaducts have been used as part of flyover round about intersections. The authors think that this type of intersection requires special consideration as on economic and aesthetic grounds it may be preferable in many cases to treat the bridging problem involved as one of two linked road crossings rather than as a single structure which may introduce long spans over dead ground and may fail to lead the eye to the spans used by traffic.

The design of foot bridges is much less inhibited than that of bridges carrying vehicular traffic. It seems doubtful whether all attractive alternatives have been explored: arches with steps following the arch curve in whole or part; portals; symmetry or asymmetry; there are many possibilities. An interesting type is that with a spiral approach in each side: if ramped as is most usual, such bridges may become the scene of sporting contests with roller skates and the like.

General Design-Theories and Methods

There has in recent years been general progress in the application of advanced techniques of calculation and refined design theories to bridge construction. This advance has taken place in various directions, which include the assessment of ultimate strength, the analysis of stresses and the arithmetical computation of difficult problems.

Irrespective of the actual structural material, a substantial change is taking

place in the method of approach of designers to problems with which they are confronted. The tendency is now to think in terms of the ultimate strength of any particular unit, quite separately from the analysis of stresses on an elastic basis under normal working loads. This approach is by no means confined to the more important members of a structure, but may be used with advantage for minor items, such as safety rails and the balustrading.

In prestressed concrete work, it is customary to carry out a check of ultimate strength in relation to given load factors, which are usually taken to be $1\frac{1}{2}$ on dead-load, and $2\frac{1}{2}$ per cent on live-load. The ultimate bending capacity of the concrete sections is calculated on the Whitney Theory, and many tests on full scale and model sections have shown that this basis provides a reliable estimate of strength. Although so called plastic design of steel building structures based on ultimate strength is now well developed and increasingly applied, its application to steel bridge work has been slight.

The conventional methods of assessment of the ultimate strength in bending of a concrete section are reasonably reliable and accurate, but at the moment no general method exists of predicting ultimate strength when bending is combined with torsion and recourse must then be made to other methods as will be described later. This new approach to problems of strength is particularly valuable in view of the progressive reductions in nominal factors of safety which have taken place over the years as bridge theory has developed and the materials of construction have improved. Working stresses are now generally nearer the limits of the elastic range than formerly and a more rigorous approach to calculations of stress in the elastic range and of overall strength is now required for safety. One example of the reduction in safety margins is that for design in structural steel. The new B. S. 153 envisages that the yield point should not be less than 1.7 times the basic permissible working stress whereas before the war the corresponding factor was 2.

The selection of load factors and factors of safety is a matter of some importance. They have to allow for all reasonable un-

certainities in construction and must also guarantee that stresses in service are likely to remain within the elastic range. It is reasonable to use different factors for different materials and for dead and live load because the uncertainties that have to be allowed for are different. When considering dead load effects the main variations are in strength, characteristics and weight of the materials; live load variations include overloading of vehicles and impact. For small structures the factors allowed may have to cover effects not specifically dealt with in design such as temperature and shrinkage. Possible errors in mathematical or arithmetical calculations are not allowed for. The designer must remember that assumptions in design are never exact in practice and he must take care to ensure that these assumptions are always on the safe side.

The most outstanding advance which has been made in bridge design is the general availability of solutions to problems arising out of the analysis of bridge decks. Research work carried out by a combination of theoretical study and model experiments has produced for general use design data for the solution of such problems of girder bridges as the effect of concentrated loads on simply supported spans^{6,7} including allowance for edge stiffening beams⁸, similar efforts on continuous spans but confined in this case to structures in which torsion can be neglected⁹. For slab bridges a simplified design procedure has been evolved which enables an isotropic slab bridge to be designed very simply^{10,11}. Tests have shown that 0.5 sq. in. mild steel transverse reinforcement per foot as recommended by the Ministry of Transport, is more than adequate in most bridge structures. For skew slab bridge influence coefficients for deflections have been tabulated for point loads and this information will be available shortly.

After the interest created by the work of Guyon⁶ and Massonet⁶ on the analysis of typical deck structures, much of the work referred to above has been carried out by the Research and Development Division of the Cement and Concrete Association, to whom great credit is due, not only for their careful, painstaking and imaginative approach to the problem, but also for making the results of their researches

rapidly available in digestable form to practising designers. Other work which makes a useful contribution to available design techniques has been carried out on the general problem of the analysis of grillages by Hendry & Jaeger¹¹. Current work on grillages deals with their ultimate strength assuming plastic behaviour of the members.

In spite of the increasing use of computers to perform complex calculations involved in the theoretical solution of many important problems, there is still a wide section of practical design work where a theoretical approach cannot yet give an adequate description of what is occurring in a structure, and it becomes necessary to obtain the required information by means of tests carried out on scale models. These model tests fall into two main categories. First of all are those intended to assist stress analysis. These models have been used for such problems as the analysis of the distribution of load in the decks of three-span continuous bridges with beams of varying sections connected by transverse members. For this purpose the bridge model is usually made of plastic material such as perspex, as the properties of the actual material of the structure are generally irrelevant. The second use of models is for the determination of actual behaviour in a complex structure, and here the technique employed is to make the model in the actual material to be used in the prototype. The information to be gained can relate to ultimate strength, as in the case of model tests to discover the ultimate strength of sections under combined bending and torsion, in which case the test is to destruction. In other cases it is required to detect the distribution of stress under normal loads and deflections and stresses are measured for subsequent analysis and transfer into terms of actual stresses and deflections in the prototype.

Mention has already been made of the use of electronic computers. These aids to design, for they are nothing more, can perform two classes of operation useful to the bridge designer. They can undertake simple routine calculations of a repetitive nature. An example of this is the calculation of co-ordinates to determine cable profiles for prestressing tendons in concrete

girders. Computers can also undertake high speed calculations to enable solutions to be obtained of complex mathematical functions and equations emerging from refined analysis of practical problems, which would be prohibitively expensive to produce by manual calculation. A simple example of this is provided by the design of a fixed ended arch. The normal method of calculation is by trial and error to establish the optimum profile, and the mass of calculation required in each trial means that a practical limit is set to the nearness of approach of the solution adopted to the theoretical optimum. By programming a computer to carry out these trials a larger number can be undertaken and the final solution thus improved.

Some programmes which have been developed for computers with special reference to bridge design problems are :-

Influence lines for multi-span continuous beams of varying section.

Analysis for a uniform or varying section grid right or skew.

Calculation of section properties for beams of varying section.

Analysis of forces in simple trussed members.

Composite beam analyses.

Foundations

The development of bridge foundations has of recent years been not so much concerned with methods completely new but rather with improvements in methods of both design and construction.

The general advance in the theory and practice of soil mechanics has brought about a more rational approach to design problems. Site investigation, if adequate in scope and thorough in execution, can now give the designer an accurate description of the ground conditions and enable him to consider the joint problems of foundations and superstructure as one rational whole. The need for engineering judgment in the assessment of foundation requirements is not less than in the past but such judgment can now be on a well informed basis.

(Continued on page 17)

SOME LABORATORY INVESTIGATIONS ON THE SELECTION OF A SUITABLE ANTI-STRIPPING AGENT FOR BITUMENOUS ROAD CONSTRUCTION

By

Dr. I. S. UPPAL*

IT is an established fact that the durability and proper performance of the bituminous surfacing of the roads mainly depend upon the proper adhesion of the binder material to the stones. Bituminous road surfacing must not only resist the stresses induced by traffic and the forces of expansion and contraction but it must also retain these properties under conditions of severe exposure to weather.

The Problem

It has been observed on many roads, particularly those in water logged areas, that the bituminous coating strips off the stones much quicker than it should, resulting in early disintegration of the surface. This defect is more prominent in the areas which have appreciable quantities of Sodium Sulphate and other soluble salts present in the sub-grade soil. Evidently this stripping of the binder and consequent loosening and disintegration of the surfacing is due to the effect of moisture from the ground; and when the soluble sulphates brought up by the moisture concentrate near the surface, the disintegration is accelerated. Also instances have occurred where a freshly laid bituminous surfacing has been ruined due to rains.

The Remedy and the Chemicals Recommended

In order to improve the bond of the bitumen with stones and make it more resistant to the action of water, whether due to rain or under ground, a large number of surface active agents have been developed and recommended. These surface active agents are mostly long chain Amines/Quaternary

Ammonium Compounds¹ which act as intermediary in the adhesion of the stones to the binder because they help in displacing the water from the stone surface. Each molecule of these cationic chemicals has a little 'head' which attaches itself with force to the stone surface irrespective of the presence of moisture on it. The elongated 'body' of the molecule holds on equally strongly to the binder, thus ensuring the solid is coated with an uninterrupted, regular layer of binder.

A Quarternary Ammonium salt presumably 'Cetyl Trimethyl Ammonium Bromide' marketed by M/S Imperial Chemical Industries India Ltd. under the trade name of "Adheria-T" and a long chain Diamine-R. N.H. $C_{18}H_{37}NH_2$ marketed by M/S Armour Chemical Industries Ltd., London, under the trade name of 'Duo meen-T' are the two of the many surface active agents generally recommended for improving the adhesion between the binder and the stone during the surfacing of the roads. Another similar chemical has also been recently placed in the market by M/S Ahura Chemical products (Private) Ltd., Bombay, under the trade name of 'Cationic & Emulsifier'. Sulfonated Castor Oil when used in conjunction with hydrated lime has also been found to improve the adhesion between the bituminous binder and the stones and its use has also, as in the case of other cationic chemicals, been recommended for coating the wet stones² such as immediately after rains when the exigencies of work so require.

Methods of Application

There are several methods by which these surface active agents can be applied but the

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following two are most commonly employed due to their simplicity and being more effective:—

(1) Incorporation of the chemicals into the binder:

In this method the requisite quantity of the chemical is added to the binder through the man-hole of the spray tanker shortly before spraying starts. It should be thoroughly mixed to ensure even dispersion of the chemical through out the binder before it is actually used for the coating of the stones.

(2) Pre-treatment Method:

By this method the stone aggregate is treated with the chemical after it has been dissolved in requisite quantity of solvent like creosote oil. This treatment may be done in a concrete mixer or by any other convenient method, which will ensure that the entire surface of the stones has been effectively coated by the chemical. These pre-treated chips are then used for surface dressing or pre-mix operations as required.

Object of the Study

During the last several years, the water table in the state of Punjab and adjoining areas has been constantly rising and at some places it has reached almost the ground level. This has naturally affected the stretches of roads passing through such areas very adversely resulting in heavy settlement, waviness and disintegration of the surface under heavy traffic. On some light traffic roads where the subgrade settlement or waviness was not appreciable quick disintegration of the surface due to the stripping of binder from stones (attributed to the effect of ground water) has been noticed. There is, therefore, a great necessity for improving the adhesion between the binder and the stones and making the coating stable to the action of water in such areas. A comparative study of the various anti-stripping agents mentioned above was, therefore, undertaken with a view to finding out the most effective and economical one and the results are presented in this note. The physical characteristics of the surface active agents tried are given below:

- 1 **Adhevia-T**:—A dark coloured viscous fluid faintly smelling of

creosote oil. Soluble in water and gives soapy lather.

- 2 **Duomeen-T**: A pale semi-solid smelling faintly of ammonia. Sparingly soluble in cold water. Disperses in hot water giving milky solution.
- 3 **Cationic Emulsifier**: A light brownish lustrous sticky mass smelling of pyridine & having waxy feel. Soluble in water and gives some lather.
- 4 **Sulphonated Castor Oil**:—Bright Viscous orange coloured liquid easily miscible with water.

All these chemicals disperse rapidly in the hot binder.

Materials Used & Procedure Adopted

Round stone Bajri passing 3/4 in. which is generally used for the surfacing and carpeting of roads was selected for use in the study. The binder used was 80/100 penetration bitumen as such, as well as after converting it into a cut back by blending with 25% of its weight with Kerosene Oil. Throughout the study the quantity of binder used was 4% by weight of the stones (normally used in field).

In the absence of any better method available, a visual stripping test, known as *static water immersion* test, was performed. For this purpose 500 gms. of the stone were taken in an enamelled plate and mixed with 20 gms. of the hot binder by means of a steel spatula till all the stones appeared to have been uniformly coated. The mixing was easy even at lower temperatures (100°F) when bitumen cut back was used and no preheating of stones was necessary. But heating of the plate from below was needed for properly mixing the bitumen when used as such.

Observations Made

Method No. 1

The requisite quantity of chemical was properly dissolved in the hot binder before mixing it with the stones. After allowing the mixture to cool and stand for about an hour the coated aggregate was transferred to a glass beaker containing sufficient warm water maintained at a temperature of 45° to

50°C so that the stones were completely immersed. Visual observations were made from time to time for about 24 hours and the minimum quantity of the chemical with which no stripping was noticed was determined.

In the case of sulphonated castor oil, which was found to be effective only in conjunction with lime the oil was added to the binder while lime was mixed with the stones and minimum quantity of each, which gave the best results was determined.

As a result of these investigations, the minimum quantities of each chemical which were found quite effective are given below:—

- 1-Adhevia-T—1.0 per cent by weight of the binder.
- 2-Duomeen-T—1 per cent by weight of the binder.
- 3-Cationic Emulsifier—0.5 per cent by weight of the binder.
- 4-Turkey Red Oil—1.5 per cent by weight of the binder and lime 1.5 per cent by weight of the stones.

With the above percentages of the chemicals no stripping was noticed even when the temperature of water containing the treated stones was raised to 70°C and then allowed to stand at room temperature for a number of days. Also these percentages of the chemicals were found equally effective in coating the wet stones and imparting desired stability to the adhesion of binder against the stripping action of water. On the other hand when no chemical was used and the dry stones were coated with hot bitumen (not cut back) under field conditions, substantial stripping was noticed when the coated stones were subjected to the water immersion test. With the use of cut back on dry stones the stripping was much greater and quicker. But when any of the above chemicals was first dissolved in the cut back or bitumen no stripping was noticed. Use of these chemicals is, therefore, considered to be more suitable with the cut back as it facilitates mixing and uniform coating without much heating.

Method No. 2 - Pre-treatment of Stones Bajri with the chemicals—

In order to facilitate the coating of stones, the three cationic surface active agents viz.

Adhevia-T, Duomeen-T and Cationic Emulsifier were used after dilution with creosote oil and as recommended for the use of Adhevia-T, 8 per cent solution of each chemical in this oil was prepared. The stones were first coated with requisite quantity of the chemical solution and then the requisite quantity of warm bitumen cut back (binder) poured over them and well mixed by means of spatula as in the case of method No. 1, and then subjected to stripping test as before. Minimum quantity of each chemical found effective in this case was 1% solution by weight of stones or in other words 2% active chemical by weight of binder.

These observations will show that the incorporation of the anti-stripping agents in the binder is more economical than pre-treating the stones.

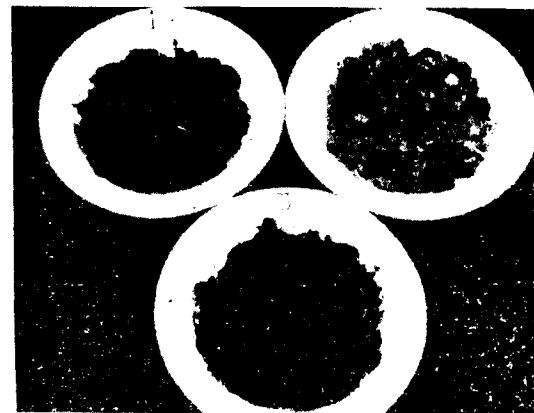
When the 8% solutions of the chemicals in the creosote oil were added to the cut-back as mentioned in Method No. 1, the results were not as satisfactory as when they were added without diluting with creosote oil.

In the case of T.R.O. it gave satisfactory results by both the methods only when it was used in conjunction with lime. Although higher quantities of lime viz. about 2% by weight of the stones without the use of T.R.O. gave fairly good results, yet the stripping could not be completely checked. Moreover the mixing of the Bajri Lime Mixture with the bitumen binder was very difficult. The addition of T.R.O. to this mixture for pre-treating the stones or its incorporation in the bitumen binder considerably facilitated the mixing and improved the adhesion between the binder and the stones as tested by the water immersion test method. The optimum quantities of T.R.O. and lime required for coating the stones before adding the cut back binder were 0.5%, T.R.O. and about 2% lime, by weight of the stone aggregate. Against this if the bitumen binder was pre-treated with T.R.O. as recommended in Method I and lime was mixed with bajri only 1.5% T.R.O. by weight of binder or say 0.06% by weight of stones was needed to give the same results.

While pretreating the stones, best results were obtained when the stones were first coated with the requisite quantity of

T.R.O. before adding lime. A little additional moisture at this stage further facilitated the mixing and uniform coating of the stones with binder.

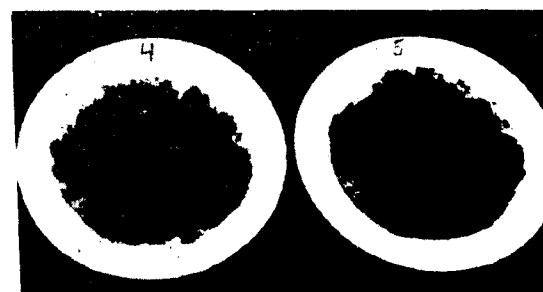
Conditions of stones coated with bitumen using various anti-stripping agents after the immersion test is shown in photographs 1 to 9.



- 1—"Dry stones coated with 4% cutback before test."
 2—"Wet stones coated with 4% cutback before test."
 3—"Wet stones coated with 4% cutback containing 5% cationic emulsifier before test."

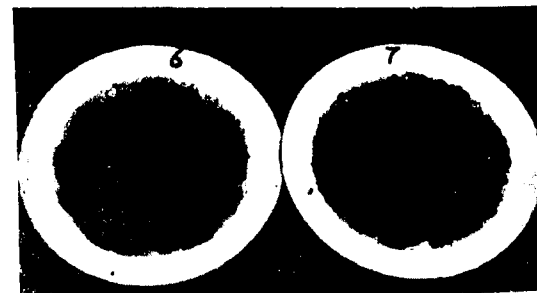
Conclusions

From the foregoing observations it would be seen that the use of T. R. O. and



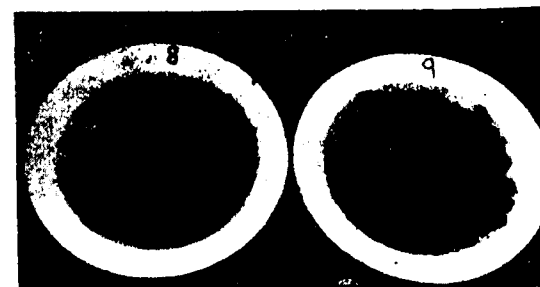
- 4—"Same as No. 1 after test."
 5—"Same as No. 3 after test."

lime would probably be most economical for improving the adhesion between the asphaltic binder and the stones. T. R. O. being an indigenous product has also the advantage of being easily available and can



- 6—"Stones coated with 4% cutback containing Duomeen-T, after test."
 7—"Stones coated with 4% cutback containing 5% Adhevia-T, after test."

even be prepared locally. Its market price is less than Re 1 per lb as compared to about Rs 4 to Rs 8 per lb of other chemicals.



- 8—"Dry stones containing 2% lime coated with 4% cutback containing 1.5% T.R.O. after test."
 9—"Wet stones mixed with 2% lime and coated with 4% cutback."

The proportions of T. R. O. and lime found suitable in the above experiments have actually been tried on field scale and about two chains of 1 in. thick carpet was laid on a road by coating the wet stones with bitumen cutback using the above chemicals (T. R. O. and lime) as anti-stripping agents. The mixing and coating was quite uniform and the carpet has behaved very

well under traffic although construction was done during the rainy season.

The use of T. R. O. for improving the adhesion of the bituminous surfacing with the stabilised soil wearing course was tried on field scale in about one furlong length of a road. For this purpose 1% T. R. O. by weight of the bitumen was incorporated in the hot binder (80/100 bitumen) before spraying it for the first coat. It was observed that the stone chippings spread over this adhered much better and showed very few loose stones as compared to those which were spread over the bituminous layer containing no T. R. O.

In view of these observations the T. R. O. can be used both as anti-stripping agent

as well as for improving the adhesion between the bitumen binder and the stabilised soil wearing course.

References

1. "List of Surface Active Agents for use in Surface Dressing"-D. S. I. R. Research Note No. RN2551: July, 1958.
2. "Treatment of Wet Aggregates with Turkey Red Oil and Slaked Lime for Bituminous Road Construction"-by I. S. Uppal: Indian Roads Congress Journal, Vol. XVI-1, November, 51.
3. "Printed Literature on Duomeen-T-1959"
4. "The Use of Adhevia-T in Road Dressing" Building product Leaflet No. 5; Published by Imperial Chemical Industries India (P) Ltd.

(Continued from page 12)

Soil mechanics theory covers many aspects of the detailed design of foundations and their interaction with the soil. Probably the most important feature of foundation design which has been substantially improved is that concerned with settlement under load. In many circumstances it is now possible to predict the order of settlement to be expected under load both immediate and long term, and to design the bridge accordingly. This applied not only to the foundations of the bridge structure but also to the approach embankments whose interaction with abutments can now be better appreciated and whose stability can be more readily assessed.

When comparing bridges in different countries and districts the influence that foundation conditions have on the structural

forms is not always realised. Unless the ground is particularly suitable the designer generally endeavours to reduce lateral forces to a minimum and beam structures are generally employed to avoid this difficulty with foundations. In some French bridges built since the war there have been designs which envisage the interaction of structure and ground in providing fixity and portal action allowance being made for adjustment by jacking, but general acceptance of this type of approach to foundation work is in the author's opinion rather unlikely as it places a great onus on the maintaining authority in respect of matters vital to the security of the structures.

(To be continued)

(From "Roads and Road Construction" February 1960.)

LEAN CONCRETE AND SOIL CEMENT IN ROAD AND AIRFIELD BASES

A REVIEW OF CURRENT PRACTICE IN GREAT BRITAIN

By

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(Contd. from April TCMR)

Construction Techniques

THE plant and construction techniques used in lean concrete and soil-cement work, with one exception, do not differ greatly. When a borrow pit is used to provide the material for soil-cement, the construction methods used are very similar to those for lean concrete. The exception arises with the mix-in-place method of soil-cement construction. Here it is necessary to use specialised plant in order, firstly, to break up the soil, and secondly to mix in the cement and water with that soil. In order to simplify consideration of the various stages in construction, the processes will be dealt with separately.

Choice of Mixing Plant

Normal concrete mixers have been used for the majority of lean concrete work. A wide range of mixers is available and selection is made by consideration of the size of the work and the output required. A minimum of about 20 cu. yds. of concrete per hour is desirable for road work if men and compaction plant are to be employed with efficiency. Smaller work is, of course, often executed, whilst at the other end of the scale 500-600 tons of material can quite readily be laid daily with one mechanical paver-spreader. The choice of mixer when a "soily" material is being used in soil-cement, requires some care. Paddle type, pan type or continuous mixers are more efficient in mixing small quantities of cement into soils containing high proportions of fine material. Practically all the work done in Britain has used batching by weight, as this is so

much easier to control than proportioning by volume. Uniformity of mixing is of prime importance, particularly in lean concrete where the amounts of cement used are quite small, but no great difficulties have been experienced in this respect. Both ready mixed concrete and transit truck mixers have been used with success for lean concrete in appropriate circumstances. Fig 4 shows a batching and mixing plant used for a lean concrete road base in Glamorganshire.

Transporting and Spreading

No special precautions are necessary in transporting mixed lean concrete or soil cement; covers on lorries are desirable in hot or drying weather and as a protection against rain. Hand spreading of lean concrete is extensively used because it is economical and a gang of six men has successfully spread and levelled 160 cu. yds. of concrete in a day. Bulldozers, graders, concrete spreaders and bituminous pavers have all been successfully used for spreading lean concrete or plant mixed soil cement. Forms are commonly used to retain the spread material, but in some cases the lean concrete and soil-cement have been distributed over the formation without the provision of any side restraint. Pavements formed in this way tend to suffer from lack of compaction at the edges, but this may not be important if the traffic is kept away from the pavement edge by means of a kerb or other methods. Generally speaking, the thinner the layer of spread material, the more accurate is the regularity of the finished surface.



Fig. 4. A batching and mixing plant for lean concrete used in a road base in Glamorganshire. The completed dual carriageway bases can be seen in the foreground

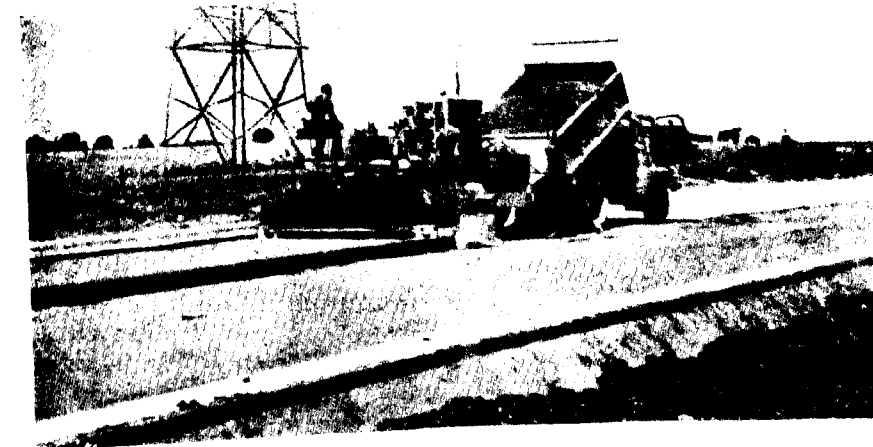


Fig. 5. A 14 in. thick lean concrete base being laid in two layers by mechanical paver on the London to Birmingham Motorway

Pavements with a compacted thickness of upto 9 in. are commonly laid in one layer, the governing factor being the necessity to achieve full compaction at the base of the pavement. Fig. 5 shows 14 in. of lean concrete being laid on the London to Birmingham Motorway (M1) by mechanical paver. If a trial with the compaction equipment available shows that full compaction can be achieved in thicker layers and if the surface regularity is satisfactory, there is no reason why this should not be permitted. Precast con-

crete kerbs laid on concrete bases are sometimes used to contain the spread material and they have the advantage, which is shared with forms, of making it easier to obtain accurate surface levels. Careful attention must be paid to the need to provide sufficient surcharge in the spread concrete or soil-cement to make sure that the full compacted thickness is obtained. The amount of this surcharge is best determined by trial and error, but it is usually about 25 per cent of the compacted thickness for hand-spread material

but less if a spreading machine is used which does some compaction during spreading.

Compaction

Heavy smooth-wheeled rollers or vibratory plant can be used for compacting lean concrete and soil cement. Eight-ton smooth-wheeled rollers and vibrating rollers are usual in Britain, sometimes used separately, but more often together, particularly on large sites where output is important. Fig. 6 shows soil-cement road being com-

of soil-cement are measured frequently at least in the early stages of the work, the sand replacement method being the most popular. Control over moisture content or raw material is exercised by tests carried out at intervals as experience dictates.

Joints

No expansion or contraction joints are formed in lean concrete or soil-cement bases, but construction joints are made by using a transverse form, extra care being taken to obtain full compaction at this



Fig. 6.
Compacting a soil-cement road base with an 8-ton smooth wheeled roller. Note white tape laid as a guide to tractor operator of 6 ft Howard single-pass train

acted by smooth-wheeled roller, and in Fig. 8 a vibrating roller is being used on an airfield base. The compacted thickness in each case is 6 in. to 7 in. Most specifications require that the lean concrete or soil-cement shall be compacted within two hours of mixing, and the greater the amount of fine material in the mixture, the more important it is that compaction should not be delayed if loss of strength is to be avoided. In practice, *in situ* density measurements of lean concrete are not often done as a routine measure, but it is important that the compaction equipment should cover every area of the pavement for at least 8 passes or such other number as trials have shown to be necessary. Site densities

point. Small surface bumps sometimes occur in unsurfaced lean concrete and soil-cement due to expansion, particularly if the base is laid in cooler weather. These bumps usually occur at construction joints and they are remedied by removing the surplus and loose material and replacing it by new before surfacing. Fig. 7 shows an improvement scheme in Monmouthshire carried out in lean concrete with a construction joint in the foreground.

Mix-in-Place Methods

Special British plant has been developed for the mix-in-place method of soil-cement construction. It consists of four types: (a)

a multi-pass rotary cultivator, (b) a 6 ft wide single pass train of equipment which includes a compactor, (c) 3 ft and 4 ft wide single pass rotors, and (d) pedestrian controlled mechanical cultivators about 2 ft wide used for processing small or irregularly shaped areas. The 4 ft and 6 ft wide single pass machines include a mechanical cement spreader, and the accompanying dropping weight compactor a blending rotor for secondary mixing. The first two pieces of equipment will process to a depth of about 7 in., whilst the third has a capacity approaching 12 in. The multi-pass equipment will produce up to 1,800 sq. yds. of completed pavement a day. The speed of operation of the single-pass equipment is between 6 ft and 24 ft a minute, depending

regulate the thickness of soil before processing, no unprocessed soil will be trapped between layers; it is, in any event, unlikely that discontinuous layers of the natural soil trapped between cement treated material are detrimental.

Curing and Surfacing

The curing of lean concrete and soil-cement is almost invariably carried out using a bitumen or tar spray at the rate of about 6 sq. yd. to one gallon. In multi-layer work it is debatable whether it is worthwhile curing the intermediate layers with a bituminous spray because of the plane of cleavage so formed, and the best procedure is probably to lay the subsequent

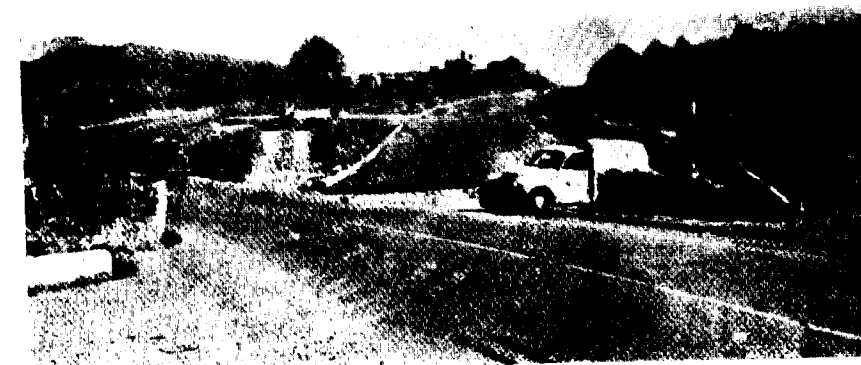


Fig. 7. A road realignment carried out in lean concrete in Monmouthshire. A transverse form is used at the commencement of the lean concrete which is placed between precast concrete kerbs to the full width of the carriageway

on the type of soil being worked. Fig. 8 shows a 4 ft wide single pass train at work at Guernsey Airport whilst Fig. 9 is of a similar train of equipment constructing a housing estate road. The large single pass machine will process all types of soil and a variety of blades is available for its rotors. The smaller machines are very robust and are invaluable for smaller scale work or for improvement schemes, e.g., widening of existing roads. The dropping weight compactor is extremely efficient on all types of soil, but a final pass with a roller is desirable in order to remove ridges formed by the weights.

No great difficulties arise in constructing multi-layer pavements by mix-in-place machinery. Providing care is taken to

layers as quickly as possible, preferably before the material underneath has hardened fully.

As a temporary measure a surface dressing of bituminous material with stone chips is often used. Surfacing have varied in thickness from 2½ in. to 6 in. but 3 in. to 4 in. is common for main roads. In order to avoid waste of surfacing material, it is advantageous to finish the top surface of the lean concrete or soil-cement with as much accuracy as possible. In practice a tolerance within ⅜ in. under a 10 ft straight-edge is quite reasonable to achieve. The surfacing can be laid immediately the base material is spread and compacted, or alternatively left to harden until the plant doing the work does not cause any damage. In

summer weather this will usually be 3 to 7 days after constructing the base. There is no reason why the pavement should not carry traffic as soon as the surfacing has been laid.

Opening to Traffic

It might be thought that as lean concrete and soil-cement contain cement they would require to be left untrafficked for some days. This, however, is not the case because of the low moisture content of the mixes. Light construction traffic can usually be permitted to use lean concrete or soil-cement within three or four days after laying, but this period might have to be extended in weather conditions which reduce the rate of hardening of the material. It is quite usual to allow construction traffic, and occasionally public traffic, to run on unprotected lean concrete and soil cement surfaces and

Pavement Design

Cement bound bases are neither rigid nor flexible and they therefore present some difficulty from the point of view of pavement thickness design. The most common method in Britain of designing these bases is to use the California Bearing Ratio method. Because of their greater strength and elastic modulus, however, these bases have considerably better load-spread properties than other flexible base materials in common use, and therefore the thickness of pavements incorporating cement bound material has, in most cases, been reduced compared with the normal C. B. R. design figures. Although it is not possible to give precise recommendations on the amount of reduction permitted, there are indications as to figures that might be used. For example, plate loading tests by the Air Ministry⁷ have shown that the total thick-

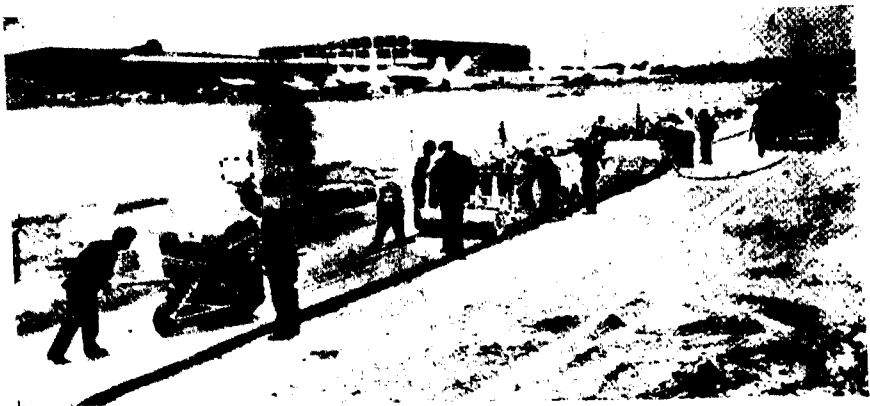


Fig. 8. The 4 ft wide single-pass Howard train constructing a soil-cement runway at Guernsey Airport

experience has shown that the material suffers surprisingly little damage considering its relatively low shear strength. If it is not desired for any reason, to lay the finished surface immediately, the base course can be used for traffic and the top course of the surfacing laid later. Lean concrete and soil-cement bases with surface dressings have been left exposed during the course of a winter, and usually they suffer little damage. Some shallow surface scaling sometimes occurs, and this should be removed before applying the surfacing. On the other hand lean concrete and soil-cement bases have been laid and surfaced and opened to traffic all on the same day.

ness of pavements can be reduced by 30 per cent of that given by the C. B. R. method design, when the entire thickness of base and sub-base is cement stabilised material.

Although there is no direct correlation between the effects produced by plate bearing tests and those by repeated passes of wheel loads, some engineers have applied this 30 per cent reduction factor when designing lean concrete and soil-cement bases for roads⁶. A second approach which is sometimes used is to modify the recommendations for reinforced concrete slab design. This is attractive because there is some evidence that the performance of lean



Fig. 9. Constructing a housing estate road in soil-cement using the 4 ft wide Howard single-pass train. Note extent of bulking of processed soil-cement prior to compaction

concrete and soil cement bases, like reinforced concrete slabs, does not greatly depend on the bearing value of the subgrade soil. An addition of 3 in. to the thickness of reinforced concrete to allow for the omission of reinforcement and for the lower elastic and strength properties of the cement bound material, has been suggested.

Whichever method of designing the thickness of lean concrete and soil-cement is adopted, it is suggested that the thickness of base and of the bituminous surfacing should be not less than the values given in Table 1.

Minimum thickness of surfacings are desirable in order to reduce the tendency for cracks in the base to be reproduced through the surfacing. At the present stage

of knowledge it is probably wise to set a limit to the minimum thickness of lean concrete or soil cement according to intensity of traffic in order to provide a sufficient mass of material.

Lean concrete and soil-cement have also been used as a base for concrete slabs and the Air Ministry have shown by plate loading tests that a 4 in. thickness of lean concrete base enables a reduction of up to 1½ in. to be made in the thickness of superimposed unreinforced slabs.⁷ For practical road purposes it is recommended that when a cement bound base is used the thickness of reinforced or unreinforced concrete slabs laid on it should be reduced by 1 in. compared with the thickness required for "normal" subgrades.^{8, 9}

TABLE 1.

Intensity of traffic. Number of commercial vehicles per day.		Minimum thickness of surfacing (inches).	Minimum thickness of lean concrete or soil-cement base (inches).
Less than 450	...	2	6
450-1500	...	3	7
1500-3000	...	4	8
More than 3000	...	4	9
Motorways	...	4	10

Practical Performance of Lean Concrete and Soil-Cement Bases

In practice some valuable advantages of using lean concrete and soil-cement have been demonstrated. Not only do these bases give excellent performance under traffic, but once laid they protect the subgrade from moisture changes, and also from disturbance by construction traffic: this arises because they are impervious and robust. Only a small construction force is required and the plant, except for that required for mix-in-place soil-cement work, is in common use by local authorities and contractors. The permanent surfacing can be placed immediately after construction, there being no need to delay for several months as is frequently necessary with other base materials in order to allow for preliminary compaction by traffic. By making intelligent use of these materials pavement construction has now become a bad weather job rather than a task to be left until the fine weather. Thus, the more difficult earthworks part of road construction can be carried out in the summer, so spreading the work over a longer period in the year. Once the subgrade soil has been covered with lean concrete or soil-cement, even though the thickness be quite nominal, it has been proved by experience that contractors can move about the site with plant and equipment in all weathers without being bogged down.

Conclusion

Although exact figures are not available, it is apparent that cement bound base materials have in recent years increased in popularity in Britain to a greater extent than any other form of construction. Much remains to be learned about the properties and qualities of these materials, but in the meantime highway and airfield engineers are using them with a confidence which, judging by the performance record, has not been misplaced. Cement is being incorporated into an ever increasing variety of materials, and it is clear that our present distinction between lean concrete and soil-cement is some what artificial. Both materials are concrete by definition in so far as they contain cement, and as experience increases, so they are merging the one into the other. Their advantages can be summarised by saying that they make use of low grade, economical materials, and the

resulting pavements possess the stability demanded by modern high intensity traffic.

References

5. Martin, F. R. A—Heavy-Duty Airfield Pavement Embodying Soil Stabilisation. Proceedings of the Institution of Civil Engineers, Vol. 6. January-April, 1957. 621 pp.
6. Permanent International Association of Road Congresses. XIth Congress Rio de Janeiro-1959. Question 1. Report by Great Britain, Part A. London. George White. 1959. 35 pp.
7. Martin, F.R. Concrete runways. Proceedings of the Meeting of the Pavings Development Group (Concrete and soil-cement), held 17th October, 1956. London Cement and Concrete Association, 1957. 6a pp.
8. Department of scientific and Industrial Research. Road Research Laboratory. Road Research, Road Note No. 19. The design thickness of concrete roads. London, H.M.S.O. 1955. 7 pp.
9. Cement and Concrete Association. Concrete Roads; 2 Slab Design. London. 1959. 12 pp.

APPENDIX

**Soil Cement Testing Procedure as used
by Cement and Concrete Association.**

Notes.—The following test stages are involved:

- (1) *Soil Suitability Tests.* Preliminary tests to establish whether soils are suitable for stabilisation with cement.
- (2) *Main Tests.* Laboratory tests carried out on principal soil types to provide information for design and specification purposes.
- (3) *Uniformity Tests.* Laboratory tests on a larger number of small soil samples to check validity of main test results to whole site.
- (4) *Control Tests.* Site tests to ensure quality of work.

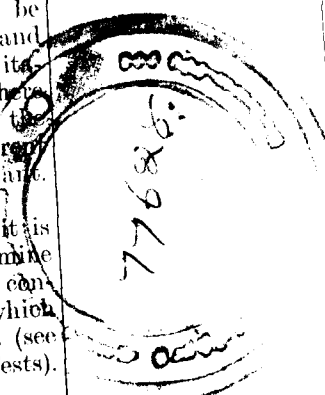
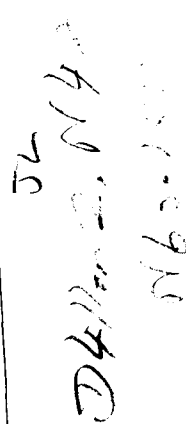
The Standard tests referred to below are contained in :

British Standard 812; Methods for the sampling and testing of mineral aggregates, sands and fillers.

British Standard 1377 : Methods of test for soil classification and compaction.

British Standard 1924 : Methods of test for stabilised soils.

SOIL SUITABILITY TESTS

1. Item	2. Test	3. Purpose	4. Test details	5. Remarks												
Test No. 1 For fine grained cohesive soils.	Measure liquid limit and plastic limit.	Liquid limit to assess whether soil can be processed and what limitations there may be to use of different types of plant. Plastic limit is to determine moisture content at which to process (see Control Tests).	Test procedure laid down in B.S. 1377. 	Soil can be processed if liquid limit is below : 60%—by mix - in - place, single pass machine or suitable central plant mixer. 45%—by mix-in-place, multi pass machine.												
Test No. 1 For soil other than fine grained cohesive.	Sieve analysis.	To discard soils which are unsuitable because of grading.	Weight sample and sieve. 	<table><tr><th>B.S. sieve size</th><th>Amount passing</th><th>Limitation</th></tr><tr><td>$\frac{3}{16}$ in.</td><td>Less than 35%</td><td>Soil unsuitable owing to lack of fine material.</td></tr><tr><td>$\frac{1}{4}$ in.</td><td>Less than 45%</td><td>Poor material. Will give porous construction, but may be suitable for sub-base.</td></tr><tr><td>2 in.</td><td>Less than 80%</td><td>May damage some plants unless stones are soft or brittle.</td></tr></table>	B.S. sieve size	Amount passing	Limitation	$\frac{3}{16}$ in.	Less than 35%	Soil unsuitable owing to lack of fine material.	$\frac{1}{4}$ in.	Less than 45%	Poor material. Will give porous construction, but may be suitable for sub-base.	2 in.	Less than 80%	May damage some plants unless stones are soft or brittle.
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2 in.	Less than 80%	May damage some plants unless stones are soft or brittle.														

Test No. 2

All soils. Unconfined compressive strength at 7 days. (Soil having satisfied Test No. 1).

To test whether soil will economically make sound soil-cement.

(1) Dry as specified in B.S. 1924, Section TWO, paras 3 a and b, but only to reach condition specified in (a) below.

(2) Measure moisture content as specified in B.S. 1924, Method 4 or 3.

(3) Sieve, through $\frac{1}{2}$ in. B.S. sieve rejecting all soil retained.

(4) Add cement (10% of original weight of soil before sieving.)

(5) Bring moisture content up to that at plastic limit in case of cohesive soils, or for other soils such that soil "binds" when squeezed in the hand.

(6) Prepare, cure and test 3 1/4 in. x 2 in. dia. specimens in accordance with B.S. 1924, Section THREE, Method 7, for fine grained soils, for dynamically compacted specimens.

(7) If the soil is likely to contain an organic retardent to the hardening of cement, and/or if, the test results are low for the type of soil, they should be repeated using a cement containing calcium chloride. 28 - day strength should also be assessed.

If 7 day strength is 250 p.s.i. or above soil is very suitable, but if below it is not necessarily unsuitable. For instance, the use of cement containing calcium chloride may bring strength to the required level, or adequate strength may be reached after a longer period, or in some circumstances it may be economical to use higher cement contents.

MAIN TEST. If soil passes suitability tests, proceed as follows:—

1. Item	2. Test	3. Purpose	4. Remarks
Test No. 1	Dry density/moisture content relationship.	To decide optimum moisture content. (For use in Test No. 2 and on site.)	1. Add cement— 10% (where suitability tests gave average unconfined 7-day strengths of) below 300 p.s.i. 7½% (where suitability tests gave average unconfined 7-day strengths of) above 300 p.s.i. 2. Test procedure as laid down in B.S. 1924, Section THREE, Method 4.
Test No. 2	Unconfined compressive strength at 7 days.	To determine amount of cement required.	1. Use 3 cement contents thus:— 5%, 10%, 15% (where soil suitability tests gave average unconfined 7-day strengths of) below 300 p.s.i. 5%, 7½%, 10% (where soil suitability tests gave average unconfined 7-day strengths of) above 300 p.s.i. 2. Make five specimens of each cement content. 3. Test procedure as in B.S. 1924, section THREE, Method 7—statically compacted specimens. Specimens to be made up at the optimum moisture content derived in Test No. 1. 4. If soil suitability tests indicated possible presence of agents which might retard hardening of cement, use cement containing calcium chloride, and crush some specimens at 28 days.
Test No. 3	Immersion test.	Determination of effect of immersion in water.	Test procedure set out in B.S. 1924, Section THREE, Method 8. Strength of immersed specimens to be not less than 80% of normal cured specimens.
Test No. 4	Freeze-thaw test.	Determination of resistance of soil-cement to damage by frost.	Test procedure set out in B.S. 1924, Section THREE, Method 9. Strength of frozen specimens to be not less than 80% of specimens cured normally and then immersed in water.

CONTROL TESTS

1. Test	2. Detail	3. Notes	4. Frequency
Density.	By sand replacement method. See B. S. 1924, Section THREE, Method 5.	In large contracts it is worthwhile constructing test pavements, and ascertaining the density which can be achieved in the particular soil with various types of plant.	Frequently initially then spot checks if results satisfactory.
Moisture content.	Oven drying—B.S. 1924, Section THREE, Method 1.	Basic method. In normal circumstances best method and most accurate.	Frequently initially then spot checks as necessary.
	or By "Speedy meter"	The "speedy meter" is excellent with fine granular soils, can be used with clay, but cannot be used with medium and coarse grained soils.	Note: It is important in granular soils to process as closely as possible to optimum moisture content, since strength will fall very rapidly above or below this point. The number of tests depends on the site and the homogeneity of the soil. The same applies to cohesive soils where it is desirable to process at a moisture content about 2% below plastic limit.
	or Rapid drying in covered pan.	A rapid and reasonably accurate method for medium and coarse grained soils.	
Unconfined compressive strengths.	Control specimens made as work proceeds, to test strength at 7 days (and/or 28 days) to control quality of work. See B.S. 1924 for test method.	Specimens are either taken from processed soil, compacted to same density as that achieved in "density test" above, cured and crushed at 7 days (and/or 28 days) or cores are taken at 7 days (and/or 28 days) and crushed.	Frequency depends on size and importance of project.

Matrimony was probably the first union to defy management.

Happiness is a perfume you cannot pour on others without getting a few drops on yourself.

Emerson.

HERE AND THERE

1. MORE NATIONAL HIGHWAYS

● In exercise of the powers conferred by sub-section (2) of section 2 of the National Highways Act, 1956 (48 of 1956), the Central Government have declared the highways specified in the table given below to be National Highways:

The said highways now declared to be National Highways shall be deemed to be specified in the Schedule to the National Highways Act, 1956, with the Serial Number and National Highway Number indicated in the table:

Table		Description of National Highways.	
Serial No.	National Highway No.		
13A	11	The highway connecting Agra, Jaipur, and Bikaner.	
13B	12	The highway connecting Jabalpur, Bhopal and Biaora.	
13C	13	The highway connecting Sholapur and Chitradurga.	

2. A VISIT TO LATIN AMERICA



A Junction near the Baseball Stadium

● A party of thirty British architects and engineers toured Latin America under the auspices of the Cement and Concrete Association. Their flying tour of some ten thousand miles took in Sao Paulo, Brasilia, Belo Horizonte, Rio de Janeiro, Caracas and Mexico City. According to reports there was much discussion among the members as to the most outstanding features of the tour. Mr. Jack Coia, a Glasgow architect plumped for the road systems. "Get the roads right," he claimed, "and the city follows."



The Centro Simon Bolivar provides for the through flow of traffic between and below office blocks with elevated pedestrian ways and under-ground parking for 1,600 cars

He had been greatly impressed by the city centre of Caracas and the conception of everflowing traffic under and around and through the unit of tall-towered office blocks, level and under-pass dual-carriage way roads, elevated pedestrian ways and ramps, and underground parking garages that make up the famous Centre Simon Bolivar. Also in Caracas his eye had been caught by the helicoidal shopping centre now under construction by private enterprise. This scheme makes use of a rocky hill at the intersection of most of the main routes to or around the city (a road system not as

yet completed, but very bold in conception and very impressive with its interlacing reinforced concrete viaducts and flyunders). The "Helicoidea del Roca Tarpeya" will have traffic ramps winding to the top (up and down traffic separated), with saw-tooth parking space at every level, "outside" as they put it, "the very shop you are visiting", escalators and lifts for pedestrians and a separate 1,000 car garage for shop owners and employees.

(From "Roads and Road Construction", March, 1960.)

3. INCREASING TRAFFIC CALLS FOR ENLARGED HIGHWAY PROGRAMME

● The need for an enlarged highway programme to provide for the increased traffic of the future was one of the points made by the President of the Institution of Municipal Engineers, Mr. David Watson, M.I.C.E., County Surveyor of Warwickshire, in a speech at an Institution dinner in London. The Minister of Housing and Local Government, Mr. Henry Brooke, was the Chief guest.

Mr. Watson, who was proposing 'Her Majesty's Ministers,' said the rapid advancement in scientific discovery and technology had had a very important impact on the work of the Institution which consisted essentially of applying in practice these discoveries, particularly the new techniques in soil mechanics, prestressed concrete—and he included traffic engineering, in addition to work study and incentive bonuses. There was no doubt that all these new techniques would be used to an increasing extent.

We had got to devote much more of our time to traffic engineering and to see that the utmost advantage was taken of the existing highway system. But traffic engineering would only make a partial contribution to our problems, and when we thought that motor traffic was rising at a

constant rate of 8 per cent per annum, and when we thought about the possibility of the standard of living of this country being doubled over the next 25 years, which might well mean there would be one car per family instead of one car for four families at the present moment, there was no doubt we would have to get down very soon to embark on a very much enlarged highway programme. This opened up vistas of schemes on a scale probably not witnessed since the days of the Roman occupation.

On the subject of aesthetics, Mr. Watson said in Warwickshire they were very proud of their wide roadside verges, their hedges, their trees, their woodlands and their spinneys, and they went to no end of trouble in carrying out improvement schemes to avoid ugly scars on the landscape. And he knew that these were the views of his county surveyor colleagues in just the same way as they were of his colleagues in the municipalities, who also had the added advantage of looking forward to the prospect of works on quite a large scale.

(From "The Surveyor and Municipal and County Engineer" 19, March, 1960).

4. STRUCTURAL RESEARCHERS EVALUATE LIGHTWEIGHT CONCRETE FOR ENDURING CONSTRUCTION

● THE structural quality of lightweight concrete can readily be estimated in construction as a result of research findings with various aggregates by the Texas Transportation Institute.

The research was conducted for the Texas Highway Department. It is described in detail by Truman R. Jones, Jr., T. J. Hirsch, and Henson K. Stephenson in a printed report entitled "The Physical Properties of Structural Quality Lightweight Aggregate Concrete."

The work was conducted mainly because of the growing scarcity of sand and gravel aggregates of conventional concrete necessitating expensive hauling and because of the

interest in lightweight structures and special designs creating a demand for knowledge.

Since lightweight aggregates produced in Texas are usually made of expanded clays and shales, the research dealt with them. Lightweight concrete made from these aggregates provided physical properties data.

It was found that the ultimate compressive strength will usually be equal to or better than that of good sand and gravel concrete.

The modulus of rupture (beam break) was discovered to be adequate for structural

quality concrete by normally making 500 psi at seven days of age but usually lacking in meeting Texas Highway Department specifications for pavement concrete (650 psi at seven days). The tensile strength of concrete made with some of these expanded clays and shales is limited by the tensile strength of the aggregate, and after this value is reached, large additions of cement are required to effect small increases in tensile strength, the research indicates.



A two-span, prestressed, precast, multiple-beam bridge which was instrumented to provide data. In the concrete construction the Texas Highway Department used sand and gravel in one span and expanded shale in the other.

The modulus of elasticity of lightweight concrete was considerably less than for sand and gravel concrete. This low modulus is due to the low modulus of elasticity of the aggregate particles and this property will vary depending on the source

of raw material and production process, the researchers feel.

The shrinkage of lightweight concrete was found to be greater than in good sand and gravel concrete. This is due to the lower stiffness of modulus of elasticity of the individual lightweight aggregate particles, the work reveals. As the cement paste dries and shrinks, the low modulus lightweight particles are not as effective in restraining the shrinkage as are the much stiffer siliceous particles in sand and gravel concrete.

The creep of structural quality lightweight concrete under a sustained compressive load is usually about the same as creep when using sand and gravel, the investigators discovered. This is because the larger portion of the creep observed in concrete is due to creep only in the cement paste, it was learned.

The initial plastic weight of the lightweight concrete tested in this program ranged from 96 pounds per cubic foot to 119 pounds per cubic foot.

Variations in the batch proportions which affect the quality of the cement paste (cement content, slump, air, etc.) have the same qualitative effect on lightweight concrete properties as on conventional sand-gravel concrete properties, it was further learned.

(From "Texas Engineering" Experiment Station News" December 1959.

5. 180 METER HIGH BRIDGE PLANNED FOR AUSTRIAN AUTOBAHN

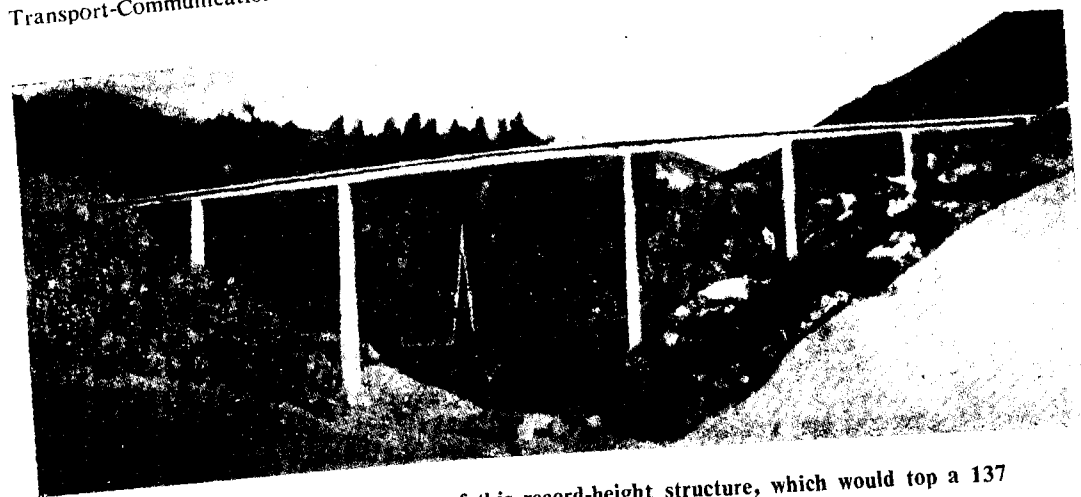
By

PAUL J. FLUSS*

● ONE of the most difficult highway projects in Europe is the autobahn now under construction from Kufstein through Innsbruck and on up to Brenner Pass, in southwestern Alpine Austria. It is part of the ambitious autobahn programme descri-

bed by Dipl. Ing. Alois Seidl in WORLD CONSTRUCTION, November, 1959.

Traversing an entirely new location the new four-lane-divided highway will be an important link in the North-South connec-

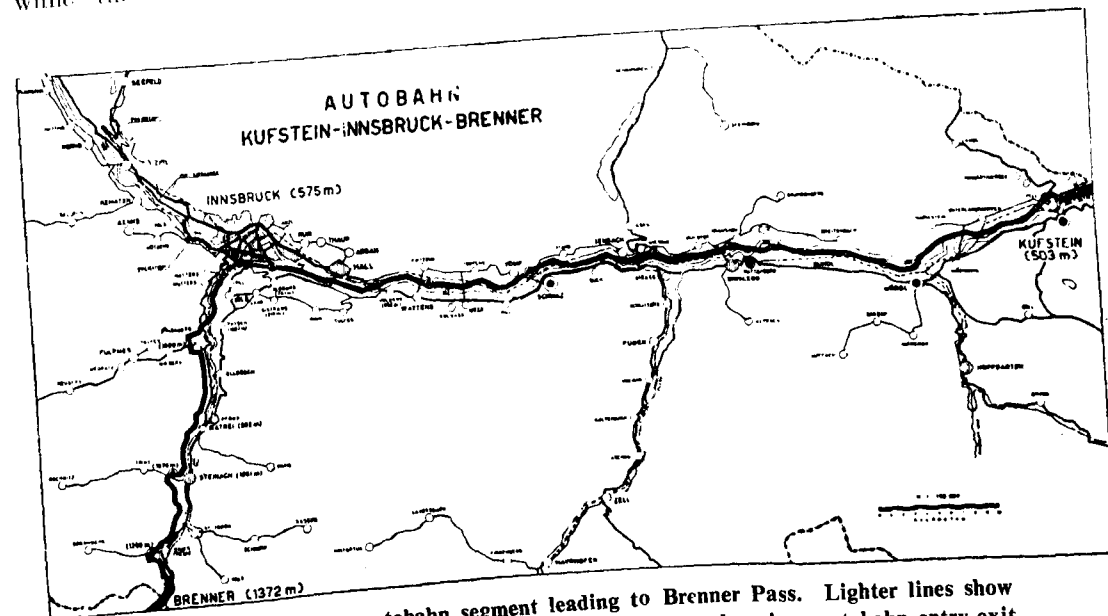


"Europe Bridge" is the name of this record-height structure, which would top a 137 meter cathedral spire (shown sketched into this artist's drawing)

tion from Berlin via Nuernberg and Munich in Germany to Bolzano, Verona, Florence and Rome in Italy. Of even greater significance is the fact that the Brenner Pass, (1,372m), is the lowest crossing of the Alps, and one kept open all year' round and which has never been blocked by avalanches.

For distance from Kufstein (503 m) to Innsbruck (575 m), 75 kilometers, the project follows the valley of the river Inn; while the section from Innsbruck to the

Brenner Pass presents difficulties and problems which are without precedence for a highway of Autobahn design. The extremely rugged terrain and the relatively short distance of 36 kilometers, in which the difference in altitude has to be surmounted, were quite a challenge to the designing engineer. The existing Federal highway from Innsbruck to Brenner Pass has 84 curves while the Autobahn will have only seven—this comparison shows the design accomplishment.



Location of the new autobahn segment leading to Brenner Pass. Lighter lines show lesser roads; shaded areas, towns and markets; triangular sign, autobahn entry-exit

* Testing Engineer, San Francisco Port Authority, San Francisco, reporting from a recent visit to Austrian highway projects.

The river Sill, a tributary of the Inn, which the Autobahn section Innsbruck-Brenner Pass route follows, has to be crossed in several places.

The most spectacular project is the crossing near Schoenberg. It necessitates a 657 m long bridge, which is 180 m above the Sill streambed. This bridge is Europe's highest, for which reason it was named Europe bridge. It is a six-span steel structure (81-108-198-108-81-81 m), supported by hollow reinforced concrete piers built with slip forms. The deck width is 21.60 m consisting of a median strip 2.40 m, two roadways 8.10 m each, and sidewalks 1.50 m. The roadways will be paved with 2 cm thickness of asphalt plant mix and a 2 cm of asphalt mastic wearing surface. Shown here is a model of the bridge. For height comparison, the famous St. Stephens Cathedral, Vienna (137 m), was sketched in.

The section Innsbruck-Brenner Pass will have a maximum grade of 5.3 per cent in certain portions. The smallest radius is 400 m, except for the "hair-pin" curves, where it will be 130 m. It will be a divided

highway, each roadway having a width of 7.10 m. The narrow median strip will be planted with bushes to shield the driver from headlights of cars in the opposite roadway. Where necessary metal barriers will be used. In some portions the two roadways will be at different elevations.

Because of the high altitude the engineers anticipate danger of ice formation on the pavement. For this reason it was decided to use a black asphaltic surfacing, which being more heat absorbent from sun's rays, will lessen the icing.

The cross-section of the roadbed for this highway is as follows: 10 cm frost protective sand layers; 50 cm frost protective gravel; 20 cm bituminous gravel; 4 cm asphalt binder; 3 cm asphalt wearing surface (rough texture); total 87 cm.

Construction of the portion Innsbruck-Schoenberg and of the Europe bridge near Schoenberg was started in 1959.

(From "World Construction" February, 1960).

6. 2ND RESEARCH WORKERS CONFERENCE ON BUILDING MATERIALS

● The second Research Workers Conference was held at the Central Building Research Institute, Roorkee from 11-13th April, 1960.

The Conference was attended by about forty delegates from Research Institutes in the country and representatives of the building industry. In order to increase the utility of the conference and to give an opportunity to the delegates for intensive discussion the conference was limited, to topics, connected with *Building Materials* only.

The deliberations of the Conference were conducted in the following Sessions.

- Session 1. Heavy Clay Products
- Session 2. Cementitious Materials
- Session 3. Concrete
- Session 4. Heat & Sound Insulation
- Session 5. Paints & Painting
- Session 6. Organic Building Materials

Session 7. Dissemination of Results of Research

The Conference was attended by about 15 delegates from the building industry and 20 delegates from the Research Institutions. Five representatives from Govt. Departments also attended the Conference.

Inaugurating the Conference, General Sir H. Williams, Director, C. B. R. I., emphasised the role of the building materials industry and research in meeting the demands of the IIIrd Plan. Thereafter Discussion Leaders appointed for different Sessions, reviewed the present state of knowledge in their respective fields highlighting these problems that still require a solution. This was followed by a general discussion of the thirty papers and a final round-up by respective Chairmen.

(From a letter from the Asstt. Director, Central Building Research Institute, Roorkee)

7. POST GRADUATE REFRESHER COURSE

● THE University of Roorkee will be running the following Post-graduate Refresher and short-term Special Courses commencing from September 1, 1960. Detailed particulars can be had from the Director, Refresher Courses, University of Roorkee, Roorkee, U. P.

- (1) Three months' Refresher Course in Civil Engineering comprising of:

Part I—Canals, Tubewells and Soil Mechanics.

Part II—Concrete Technology and Structures, Hydrology, Flood Control and Dams.

- (2) Four weeks' Special Course in "Heat Treatment of Metals".
- (3) Three months' Special Course in "Public Health Engineering for Serving Engineers and Engineering Subordinates".

(From a letter from The Director, Refresher Courses, University of Roorkee, Roorkee, U. P.)

8. CARS ARE HERE TO STAY

● "MOTOR Cars are here to stay and we have no option but to come to terms with them."

Mr. Ernest Marples, Minister of Transport, made this comment which speaking in London on February 22nd. He said we must budget for 15 million vehicles by 1975 —"quite a lot."

"In these crowded islands the combining of an orderly flow of cars with the retention of our amenities and the preservation of the character of our cities will be quite a formidable task. There is no simple solution or any magical formulae.

"It will not be solved by new road engineering alone, nor just by the ingenious application of traffic engineering techniques. It is a problem of planning the environment of the community as a whole. It involves architects, town planners, landscape specialists, engineers—in fact every ingredient which goes into the creating of a community.

"We are setting up a long-term study group simply and solely to probe into the future of our cities. We must find a design for living in the last quarter of this century."

Mr. Marples said that two of the many points this study group will have to consider are, first, future buildings must provide for the off-street car parks their own cars will need. "Traffic will never flow if cars are dumped into a main street and left there all day."

Segregation

"Second, the comprehensive planned reconstruction of our cities must include some multi-level traffic circulation and the segregation of the pedestrian from the motorist. When a ton of steel moving at 30 miles an hour and 11 stone of flesh and bones moving at 3 miles an hour share the same surface, accidents must happen—and the flesh and bones won't win.

"Perhaps in our busy shopping centres the pavements could be lifted to the first floor and cantilevered out. The existing ground level pavement could then be used to widen the existing road. Thus we could have a wider road plus a safer place for pedestrians at the same time."

(From "British Road Federation Bulletin, March 1960.)

CURRENT LITERATURE

ABSTRACTS

SAMPLING AND ANALYSIS OF CONCRETE. Indian Standards Institution, New Delhi.

TESTING plays an important role in controlling the quality of cement concrete work. Systematic testing of the raw materials for concrete as also of the concrete, both while it is fresh and after it has hardened, is an inseparable part of any quality control programme for concrete. It helps to achieve higher efficiency of the materials used and greater assurance of the performance of the concrete in regard to both strength and durability. The test methods used should be simple, direct and convenient in their application.

With this object in view, ISI has prepared IS: 1199-1959 Methods of Sampling and Analysis of Concrete, which provides a guide to sampling, analysis, and determination of linear changes of concrete. Besides terminology; the standard covers sampling of fresh concrete in the field; securing and preparing test specimens from hardened concrete; tests for workability; analysis of freshly mixed concrete; determination of weight per cubic metre, yield, cement factor and air content of freshly mixed concrete; cement content of hardened concrete; and determination of changes in length on drying and wetting.

The standard published in English is priced at Rs 7.50. Copies are available from the office of the Indian Standards Institution, 'Manak Bhavan' 9 Mathura Road, New Delhi-1 and from its Branch Offices located at Bombay, Calcutta and Madras.

SURKHI FOR USE IN MORTAR AND CONCRETE. Indian Standards Institution.

THE Indian Standards Institution has published IS: 1344-1959 Specification

for *Surkhi* for Use in Mortar and Concrete which covers the manufacture and the physical and chemical requirements of the material. It lays down three tests for the quality of *Surkhi*, namely for fineness, lime reactivity and compressive strength.

In current practice, *Surkhi* is generally obtained as a by-product of the brick industry, by powdering rejected and broken bricks. This is not always a good practice, and some light has been thrown by recent research work on the type of raw material, the degree of burning and the fineness of grinding for obtaining good *Surkhi*. It is the object of this standard to give general guidance in manufacture of *Surkhi* on the basis of these findings, and to lay down requirements and tests ensuring its suitability as a basic material for structural mortar and concrete. As additional guidance to manufacturers, an appendix on the classification and identification of clay minerals and their thermal changes relevant to the manufacture of *surkhi* has been included.

The Standard published in English is priced at Rs 3.00. Copies are available from the office of the Indian Standards Institution, 'Manak Bhavan', 9 Mathura Road, New Delhi-1 and from its Branch Offices located at Bombay, Madras and Calcutta.

HIGHWAY PLANNING IN THE PAST, PRESENT AND FUTURE by Edward H. Holmes' And John T. Lynch, A.M. ASCE, Bureau of Public Roads, American Society of Civil Engineers Transactions. Vol. 124, 1959.

HIGHWAY planning on a comprehensive scale has been conducted jointly by the Bureau of Public Roads, United States Department of Commerce (BPR), and the

(Continued on page 44)

LIST OF "INSDOC TRANSLATIONS" AVAILABLE IN THE CENTRAL ROAD RESEARCH INSTITUTE LIBRARY, NEW DELHI-20.

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| <p>ARIANO (R.)
Absorbing property of aggregates and its measurement.
Insdoc Trans. No. 1314.
Translated from Rev. Gen. Routes et des Aerodromes 1953, 23 (259), 28-30. 5006</p> <p>ARIANO (R.)
Rules recommended for the construction of motor roads.
Insdoc Trans. No. 1730.
Trans. from Italian from "Le Strade, 1955", 35, 135-46 and 188-94. 5945</p> <p>BALTHASAR (K.)
Magnesia Expansion.
Trans. from German from "Tonindustrie-Zeitung 1934", 58 (16), 194-5.
Insdoc Trans. No. 719. 3272</p> <p>BATTA (G.) & PLENGER (R.)
Production in a Pure State of the Principal Constituents of portland cement.
Insdoc Trans. No. 1444
Trans. from "Revue Universelle des mines 1951", 7 (9th Ser), 410-2.
French. 5439</p> <p>BAUER (Max.)
Contributions to the Geology of the Seychelles, especially to the knowledge of Laterite.
Insdoc Trans. No. 950.
Trans. from German from "Neues Jahrbuch für Mineralogie, geologie und Palaeontologie 1898", 2, 163-219. 4513</p> <p>BEPLYKH (I.N.)
Effect of the addition of surface active materials on the adherence of concrete to horizontally laid armatures.
Insdoc Trans. No. 1672.
Trans. from Russian from "Stroitel'naya Promyshlennost 1954", II, 38-41. 5659</p> <p>BESAIRIE (H.)
Soils of Madagascar.
Insdoc Trans. N. 960.
Trans. from French from "Le Sol, 13, 200-221". 4469</p> <p>BOLOMEY (J.)
Determination of the resistance of motors & concretes to compression
Insdoc Trans. No. 1968
Trans. from French from "Bulletin Technique de la Suisse Romande 1925, 51, 126-33, 169-72; 182-84". 6711</p> | <p>BORODACHEV (I.P.) & GARBER (M.R.)
Testing of the Automatic Asphalt spreader D-164.
Insdoc Trans. No. 1297
Trans. from Russian from "Mekhanizatsiya Stroitel" stva 1950, 7 (11), 16, 19. 5030</p> <p>BREYER
Classification and Mechanical Testin of Road making aggregates.
Insdoc Trans. No. 1328.
Trans. from German from "Strasse und Autobahn, 1950, 1 (12), 25-29". 5012</p> <p>BROOME (D.C.)
Physico-chemical properties of bitumen as used in manufacture of mastic asphalt.
Insdoc Trans. No. Nil.
Trans. from "II International Congress Asphalte, Rome, 1954", 7422</p> <p>BRUININKWEERD (D.)
Traffic problems in the heart of the city.
Insdoc Trans. No. 1854.
Trans. from Dutch from "Polytechnisch Tijdschrift, (43/44, 45/46, 46/47)". V10, 770b-777b. 804b-807b. 83sb-841b. 7006</p> <p>BUDNIKOV (P.P.)
Hydraulic properties of hydrothermically treated clay and lime materials.
Insdoc Trans. No. 829.
Trans. from Russian from "Doklady Akademii Nauk USSR, 1951, 79 (1), 109-112". 3447</p> <p>BUDNIKOV (P.P.) E.C.
Theory of acceleration of the production of siliceous building materials through the addition of crystal-hydrates.
Insdoc Trans. No. 1632
Trans. from Russian from "Doklady Akademii Nauk, U.S.S.R. 1952, 84, 1021-24". 5584</p> <p>CAQUOT (A.)
Role of Inert Matter in Concrete.
Insdoc Trans. No. 1969.
Trans. from French from "Memoires de la Societe des Ingenieurs Civils de France 1937, 90(4), 562-82". 6647</p> <p>CASTRO (A.D.) & MUROZ (M.G.)
Variations in atterbergs limits in clayey materials of laminar structure as a function of the saturating cation.
Insdoc Trans. No. 1671.
Trans. from Spanish from "Anales de Edafologia y Fisiologia Vegetal 1954, 13, 1-8." 5658</p> |
|--|--|

CERESETO (A.) & RIO (A.)

Some considerations on the nature and the action of pozzuolan cements.
Insdoc Trans. No. 853.
Trans. from Italian from "La Chimica e l'Industria 1948, 30, 261-4."

3624

CHAFFARDON (M.)

Distribution of binding materials by servo-volumetric pump.
Insdoc Trans. No. 1322.
Trans. from French from "Rev. Gen. Routes et Aerodromes, 1950, 20 (218), 53-54"

5004

CHRISTOPHE (L.)

Laterites and their utilisation as material for road construction.
Insdoc Trans. No. 947.
Trans. from French from "Revue Gen. Routes et des Aerodromes 1949, (212), 38-40."

3767

CIRILLI (V.)

Solid Solution of Fe_2O_3 & Al_2O_3
Insdoc Trans. No. 1415.
Trans. from Italian from "Gazzetta Chimica Italiana 1950, 80, 347-51."

5132

COOPER (W.W.) & CHARNES (A.)

Simple exposition about the aims of linear programming.
Insdoc Trans. No. 2077.
Trans. from Italian from "L'Industria Italia 1954, 3, 421-27."

7447

CROCE.

New road-strewing device.
Insdoc Trans. No. 1162.
Trans. from "Strasse und Autobahn 1952, 3, 59-60", from German.

4596

DE KEYSER (W.L.)

Method of Quantitative X-ray crystallographic analysis of the Polymorphic transformation of silica.
Insdoc Trans. No. 1398.
Trans. from French from "Silicates. Industrials 1951, 16, 296-9."

5128

DE QUERVAIN (F.)

On the classification of rock material for road pavements.
Insdoc Trans. No. 1435.
Trans. from German from "Strasse und Verkehr 1950, 36, 297-301."

5133

DE RYCKER (M.)

Contribution to the study of the wetting of minerals.
Insdoc Trans. No. 1430.
Trans. from French from "Le Technique Moderne construction 1953, 8, 388-91"

5139

DE VRIES (H.H.R.)

Stabilized gravel as road foundation.
Insdoc Trans. No. 1855.
Trans. from Dutch from "Bouw Den Haag, 1955, 10, 961-3."

5987

DECREUSEFOND (M.) & RUMPLER (M.)

Irregularities in the surface of roads and their measurements.
Insdoc Trans. No. 1139.
Trans. from French from "Revue. Gen. des Routes et Aerodromes 1948, 18 (195), 18-21"

4752

DELARUE (J.)

Movement of capillary water in soils and in materials.
Insdoc Trans. No. 1674.
Trans. from French from "Les Mouvements de l'eau capillaire Dans les sols et les matériaux"

5575

DELARUE (J.)

Study of Puddled earth cement in Morocco.
Trans. from French from "Reunion des labs d'Essais et de Rech. Sur les Matériaux et les Constructions (1954), 18, 24-26."

5595

DOYEN (P.)

Automobile taxation in Europe.
Insdoc Trans. No. 1072.
Trans. from French from "Revue generale des routes et des Aerodromes 1953, 23, (256), 31-42."

4597

DURIEZ (M.)

Combined effects of Traffic & surroundings on the behaviour of flexible road & runway surfacings.
Insdoc Trans. No. 1432.
Trans. from French from "Revue. Gen. Routes et Aerodromes 1950, 20, 61-3"

5135

DURIEZ (M.)

Contribution to the measurement of adhesiveness of Hydrocarbon compounds.
Insdoc Trans. No. 1431.
Trans. from French from "Revue. Generale des routes et des Aerodromes 1950, 20, 55-7"

5145

DUTRON (R.)

How to choose a concrete composition, continuous or discontinuous grading.
High strength concrete.
Insdoc Trans. No. 1548.
Trans. from "Technische-Wetenschappelijk. Tidschrift 1951, 10, 222-241."

5440

PUBLICATIONS ADDED TO THE ROADS WING LIBRARY
DURING MARCH AND APRIL, 1960.

1. **Planning of Experiments** by Cox, D. R. and published by John Wiley & Sons, Inc., New York & London, Chapman & Hall Ltd.
2. **Introduction to probability theory and its applications Vol. I** by Feller and published by Asia Publishing House, Calcutta.
3. **Bibliography of Hydrology in India 1936 to 1952** published by the Ministry of N. R. & S. R., Central Water & Power Commission Govt. of India.
4. **Quarterly Bulletin of Statistics, Kerala, Dec. 1958** published by the Department of Statistics, Kerala.
5. **Foundation Engineering** by Peek, Ralph B and published by Asia Publishing House, Calcutta.
6. **Foundation Engineering** by Mammond, Ralt and published by Odhams Press Ltd., Long Acre, London.
7. **Engineering Structural Failures** by Odhams Press Ltd., Long Acre, London.
8. **Pre-stressed Concrete Theory & Design** by Evans R. H. & Bennett, E. W. and published by Odhams Press, Ltd., Long Acre, London.
9. **Bridging India's Rivers (An account of the Bridges built under the 1st & 2nd Five Year Plan** by Indian Roads Congress.
10. **"Bulk Bitumen"** by Burmah Shell Oil Storage & Distributing Co. of India Ltd., Ballard Estate, Bombay-1.
11. **Report of the working Group on Co-operative farming Vol. 1, Dec. 1959** by Ministry of Community Development and Co-operation, Govt. of India.
12. **Military Engineering Vol. XIV—Concrete Part II, Reinforced Concrete Part II Reinforced Concrete design 1950** by Her Majesty's Stationery Office 1951.
13. **Military Engineering Vol. III, Part III, Barley Bridges—Normal uses 1944** by Her Majesty's Stationery Office 1951.
14. **IS-515-1959, Indian Standard Specification for Natural and Manufactured Aggregates for use in mass concrete** by Indian Standards Institution, Manak Bhavan, Mathura Road, New Delhi.
15. **IS-965-1958 Equivalent Metric Units for Scales; Dimensions and Quantities in General Construction work** by Indian Standards Institution, Manak Bhavan, Mathura Road, New Delhi.
16. **Chamber's Twentieth Century Dictionary** by Geddie William and published by W. P. Chambers Ltd., London.
17. **Annual Bulletin of Transport Statistics for Europe** by United Nations Publications.
18. **Railroad Transportation and Public Policy** by Nelson James and printed by Brooking Institution, Washington.
19. **Industrial Traffic Management 1953** by Metre, Thorman and published by McGraw Hill Book Company New York, Toronto, London.
20. **Regime Behaviours of Canals and Rivers** by Blench, T and published by London, Butter Worths Scientific publications.
21. **Ministry of Transport & Communications (Department of Transport) Annual Report for the year 1959-60.**
22. **Highway Act, 1959** by Her Majesty's Stationery Office and printed by Her Majesty's Stationery Office, London.
23. **Hindustan Year Book and Who's Who 1959** by Sarkar, S. C.
24. **British Transport Policy** by T. R. Sargent and published by Oxford University Press 1958.

25. **The Economics of Inland Transport** by A. M. Milne and published by Sir Isaac Pitman & Sons Ltd.
26. **White Paper on Indian States - July 1958** by Manager of Govt. of India Press, New Delhi.
27. **IS : 516-1959 Methods of Tests for Strength of Concrete** published by Indian Standard Institution, New Delhi.
28. **Indian Railways Schedule of dimensions 5 ft 6 in. Gauge 1939** by Indian Railway Board.
29. **Growth of Road Traffic in British Overseas territories since 1946 (Road Research overseas Bulletin No. 11)** by Department of Scientific and Industrial Research, Road Research Laboratory 1960.
30. **Engineering Classification of some Western Higerison Soils, and their Qualities in Road Buildings (Road Research Overseas Bulletin No. 10)** by Department of Scientific Industrial Research, Road Research Laboratory 1960.
31. **The Engineer Buyers Guide** by Department of Scientific and Industrial Research, Road Research Laboratory 1960.
32. **Road Engineering** by Leeming, E. L. and published by Constable & Company Ltd., London.
33. **Building Design and Constitution Vol. 1, 1939** by Sanuely Felig James and Mamann. Conced Wilson and published by Chapmans Hall Ltd., H. Henrietta Street W. C. 2, 1939.
34. **Notes on Building Construction etc. Part III and IV** by Longman Green & Co., London.
35. **Foundations and Earth Pressure** by Wollaston, E Hyde published by Longman Green & Co., London.
36. **Fifth Congress on Theoretical and Applied Mechanics University of Roorkee 1959 and Symposium on Non-Linear Physical Problems**, published by Longman Green & Co., London.
37. **Symposium on Load Tests Bearing Capacity of Soils - Fifth Annual Meeting American Society for Testing Materials Special Technical - Publication No. 79** by American Society for testing materials.
38. **Punjab Public Works Department Building and Roads Branch Annual Report on the Working of Building and Roads Research Laboratory, Karnal for the year 1956-57** published by the Punjab Public Works Department Building and Roads Branch, Karnal.
39. **Guide to Concrete Road Construction Questions and Answers (2nd Ed.)** by Cement and Concrete Association, Great Britain.
40. **Statutory Instrument 1959—Road Traffic and Vehicles Traffic Signs. The Traffic (Amendments) Regulations, 1959** by Her Majesty's Stationery Office.
41. **Statutory Instrument 1958 No. 961 Wages Councils—The Wages Regulations** by Her Majesty's Stationery Office, London.
42. **Concrete Roads - 2 - Slab Design, Thickness & Joint** by Concrete & Concrete Association, London.
43. **Concrete Roads - 4 Construction Methods** by Concrete & Concrete Association, London.
44. **Broadway Series of Engineering Hand books XVII—Stability of Masonry & other structures of earth & water** by Sprague, Earnest H.
45. **Committee on Subordinate Legislator sixth and seventh reports (Second Lok Sabha) Presented on the 9th Sept. 1954** by Lok Sabha Secretariat, New Delhi.
46. **Proceedings Symposium on Prestressed Concrete** by Cement & Concrete Association, Australia.
47. **Report of the Commission Linguist on minority (First Report)** by Govt. of India Press, New Delhi.

48. **Methods Generales d' Essai Let de Controle en laboratorie Livdes Measures Geometrique Et Meconiques** by Hermila, Robert bu.
49. **Investigation of Performance of Pneumatic tyred Rollers in the Compaction of soil—Road Research Technical paper No. 45 (1959)** published by London Her Majesty's Stationery Office.
50. **Report 1959-60—Ministry of Health** issued by the Ministry of Health.
51. **Translation No. 3254—The Design and Installation of Carriageway markings of Federal Highways (Die Anordnung und ausflieung bon Fabrbahnmerkjerungen auf Bundesfernslussen)** by Haller, F. and published by INSDOC, National Physical Laboratory, Delhi.
52. **Report 1959-60 Ministry of Community Development & Co-operation.**
53. **Foundation of Structures (McGraw) Hill** by Dumbain, Clarene W. and published by McGraw Hill Book Company, Inc. New York, London.
54. **Structural Theory & Designs** by Young, J. McHardy and published by Grosby Lockwood and Sons, Ltd.
55. **Annual Report of the Registrar of Newspapers for India** by Indian Information and Broadcasting M/O.
56. **Proceedings of the first meeting of Transport Development Council held at New Delhi on the 24th & 25th June, 1959** by Manager Govt. of India.
57. **Road Transport Reorganisation Committee Report March 1957** by Manager Govt. of India.
58. **Pedestration Crossing (England & Wales) (Amendments Regulation 1959) & Statutory Instruments 1959. No. 2296) Road Traffic & Vehicles use of highways** by Her Majesty's Stationery Office, London.
59. **Translation No. 3337 Approaches to the Fredrikstad Bridge (FRE-DRIKSTADBROENS VIADUKT-FAG) Translated from Damsh by Frandsen, AG and published by INSDOC.**
60. **Translation No. 3259 Guide for the making of Nations Highways LEIRAAD VOOR DE BE BAKEN-ING VAH. RIJK SWEGEN (Translated from Dutch)** published by INSDOC.
61. **Souvenir of the Silver Jubilee of the Indian Roads Congress—1960.**

A group of tiny tots were overheard discussing their arrival in this big world. The versions differed somewhat. Billy claimed that his folks had bought him in a department store; Tony said the stork brought him; Diana said the doctor had brought her. Then a very tiny miss piped up, but rather modestly: "My folks were too poor to buy me; I was home made".

The wise man is one who constantly wonders afresh,

—Andre Gide.

BUDGETS AND ADMINISTRATION REPORTS

ANDHRA PRADESH BUDGET FOR 1959-60

The following extracts relating to civil works budget have been taken from the Andhra Pradesh Budget Publications for the year 1959-60.

Revenue

Heads	Actuals 1957-58	Revised Estimate 1958-59	Budget Estimate 1959-60
	(Rs in lakhs)		
Rents	13.67	11.54	12.50
Receipts from workshops	1.51	6.00	8.00
Recoveries of expenditure	39.42	24.00	24.00
Transfer from Central Road Fund	0.74	...	...
Ferry receipts of the Highways Deptt.	.01	2.52	2.53
Grant from Govt. of India for construction and development of State Roads of Economic or Inter-State importance.	...	25.68	15.38
Miscellaneous	20.50	17.44	17.76
Gross Total...	75.85	87.18	80.17
Deduct—refund	(-) 0.60	(-) 0.29	(-) 0.11
Net Total	75.25	86.89	80.06

Expenditure

ORIGINAL WORKS

Buildings	13.05	17.95	20.09
Communications	17.22	180.19	169.59

REPAIRS

Buildings	31.18	36.54	43.92
Communications	39.36	227.40	224.10
Miscellaneous	...	3.46	3.46
Establishment	122.20	121.25	140.79
Tools and Plant	2.84	23.55	20.42
Grants-in-aid	22.17	83.93	79.74
Suspense	(-) 19.02	22.71	7.77
Miscellaneous	179.19	...	...

Total... 408.19 716.98 709.88

Deduct—recoveries

(-) 87.92 (-) 215.89 (-) 203.38

Total—50-Civil works

320.27 501.09 505.90

Capital outlay on civil works

Heads	Actuals 1957-58	Revised Estimate 1958-59	Budget Estimate 1959-60
	(Rs in lakhs)		
ORIGINAL WORKS			
Buildings	165.84	222.68	249.30
Communications	6.80	88.99	136.46
Development works under Nizamsagar etc. projects	2.43	10.34	10.65
Works under the C.I.B.	0.84	2.00	4.28
Establishment	7.55	5.81	6.31
Tools and Plant	...	5.00	9.00
Outlay in connection with the formation of Andhra State	8.74	3.58	0.15
Micellaneous	30.50	...	...
Add—Amount transferred from 50-Civil works (State share of National Highways)	...	5.67	4.88
Establishment & Tools and Plant charges transferred from 50-Civil works on prorata basis	26.73	10.58	10.58
Suspense	(-) 0.28	...	...
Total...	249.15	354.65	431.61
Deduct—Central assistance for Schemes spon- sored by the Government of India	...	(-) 12.70	(-) 12.70
Total	249.15	341.95	418.91

Receipts from taxes on vehicles, etc.

Receipts under the Indian Motor Vehicles Act	40.78	25.91	25.91
Receipts under the Madras Motor Taxation Act	192.95	251.76	251.76
Other receipts	2.12	2.52	2.52
Motor spirit tax	69.40	87.39	85.93
Deduct—refunds	(-) 1.19	(-) 1.10	(-) 1.10
Total...	304.06	366.48	365.02

S. No.	Job No.	Name of work	Amounts (Rs in lakhs)
MADRAS			
10.	2196-MD-7	Upgrading Punnam Pugahur Road—National Highway No. 7—mile 5/2-5.	0.53
UTTAR PRADESH			
11.	2197-UP-2	Raising submerged portion of A.E.F. Road, N. H. No. 2 in Manipuri Distt. miles 36, 37, 38, 39, 41, 42, 46, & 47	7.05
12.	2214-UP-2	Widening to two lane traffic Kanpur-Allahabad section miles 566-593, National Highway No. 2.	15.33
WEST BENGAL			
13.	2195-BG-34	Construction of culverts below 20'-0" span from 0 to 3rd mile of Berhampore-Raghumathganj Sec. of N.H. No. 34 in the district of Murshidabad.	1.36
14.	2216-BG-2	Improvement to the G.T. Road—National Highway No. 2, (widening and resectioning) from mile 90 to 93.	5.43

(Continued from page 38)

ELLERT (S.).

Concrete roads from a technical & economic view-point.
Insdoc Trans. No. 1507.
Trans. from Danish from "Beton Teknik, Copenhagen 1950, 16 (4) 110-18".

5655

EITEL (W.).

Electron microscope & its application to ceramic problems.
Insdoc Trans. No. 854.
Trans. from German from "Berichte der Deutschen Keramischen Gesellschaft 1943, 24 (2), 37-53".

3577

ELKOUBY (J.).

Traffic in cities.
Insdoc Trans. No. 1735.
Trans. from French from "Urbanisme 1955, 24, 4-11".

5699

ENDELL (K.) HOFFMANN (U.) & MAEGDE-FRAU (E.).

On the nature of the argillaceous portion of raw materials in the German cement industry.
Insdoc Trans. No. 861.
Trans. from German from "Zement 1935, 24 (40), 625-33."

3687

ERICSSON (E.).

Damages to road surfaces
Insdoc Trans. No. 2045.
Trans. from "Svenska Vagforeningens. Tidskrift, Kungsgatan (Swedish) 1949, 36 (3), 112-115".

7466

EWALDSEN (H.).

Soil cement in Basements and Foundations.
Insdoc Trans. No. 1508.
Trans. from Danish from "Beton Teknik 1951, 17 (1), 15-21".

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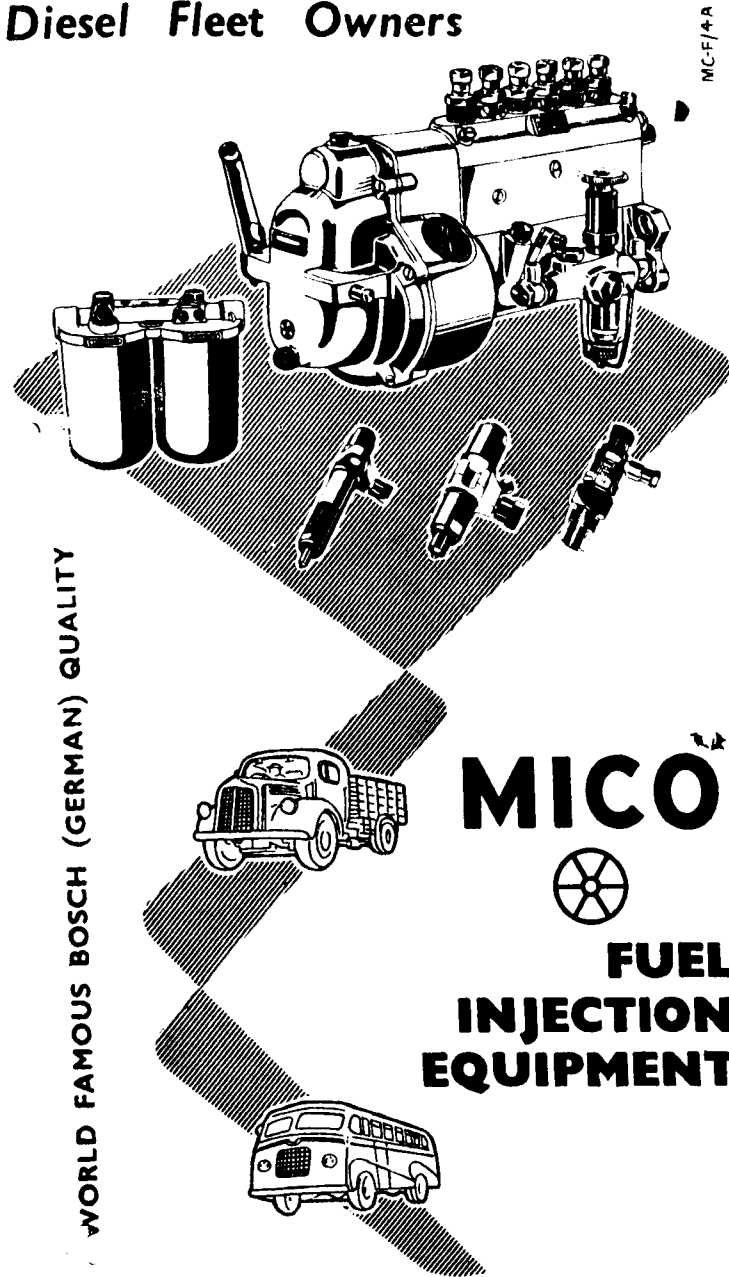
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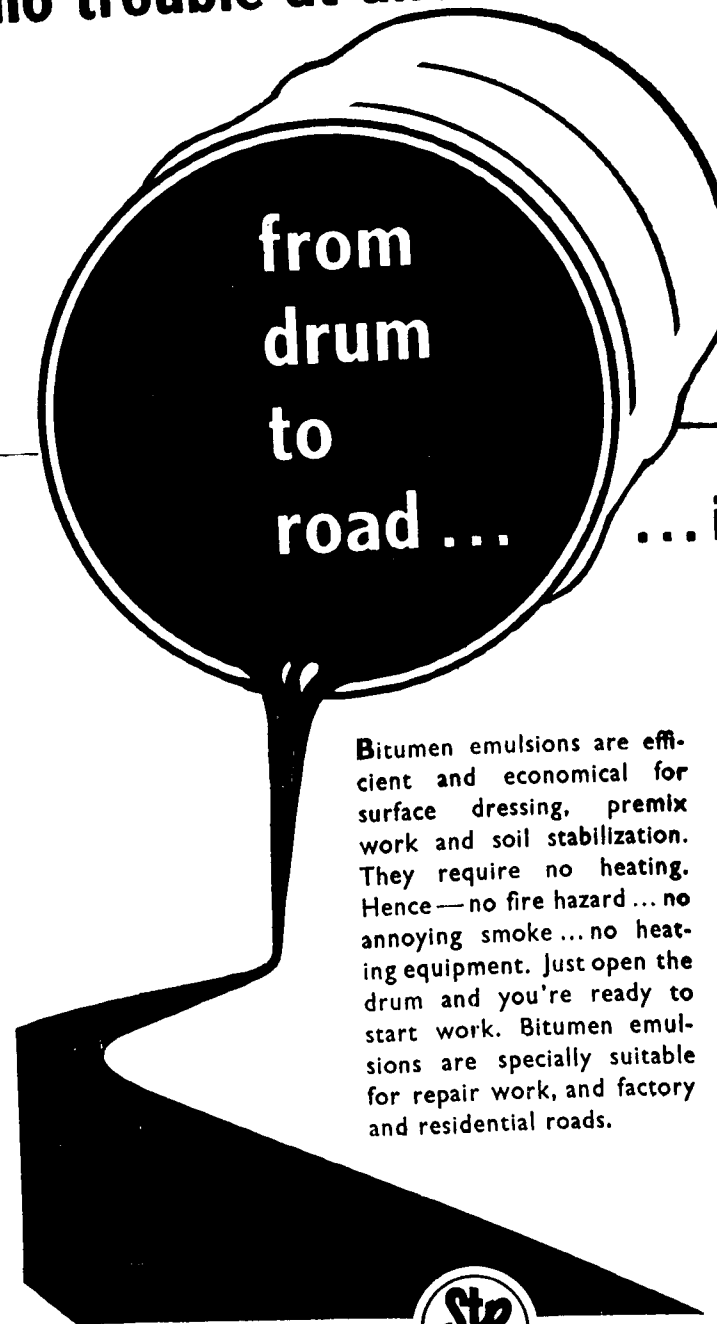
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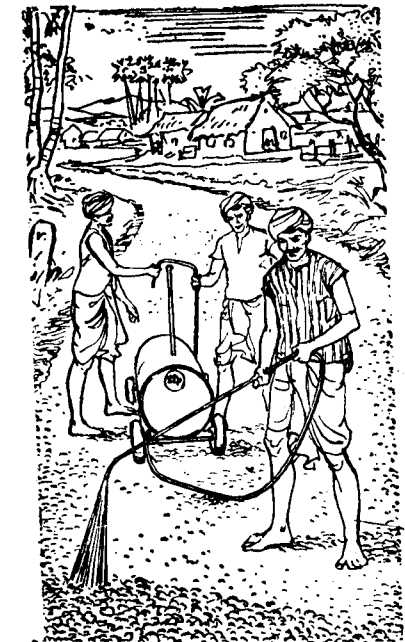
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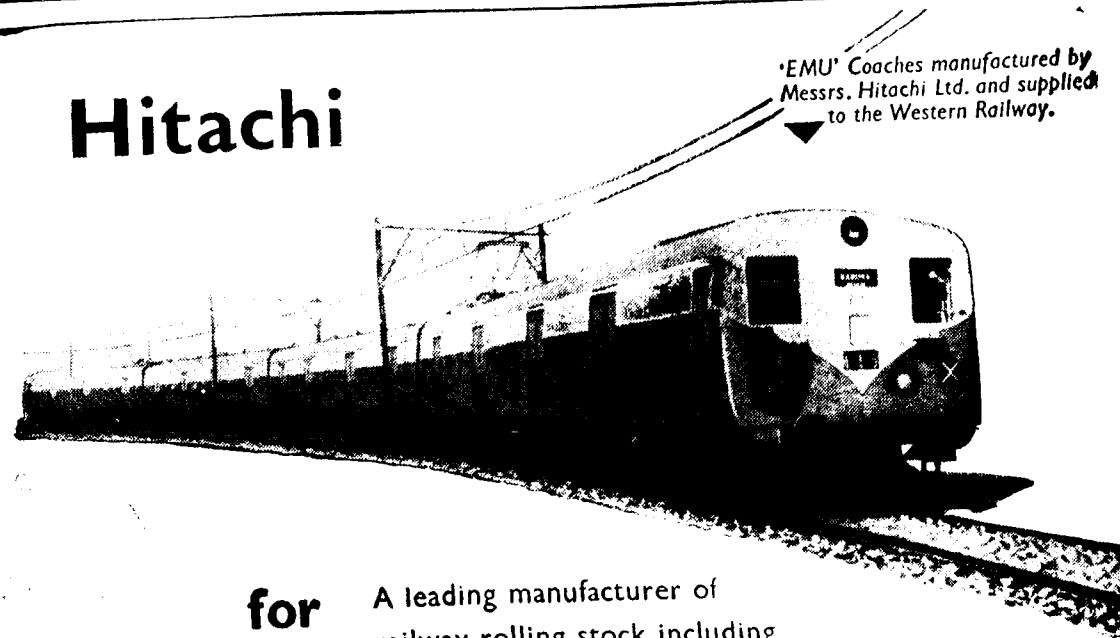
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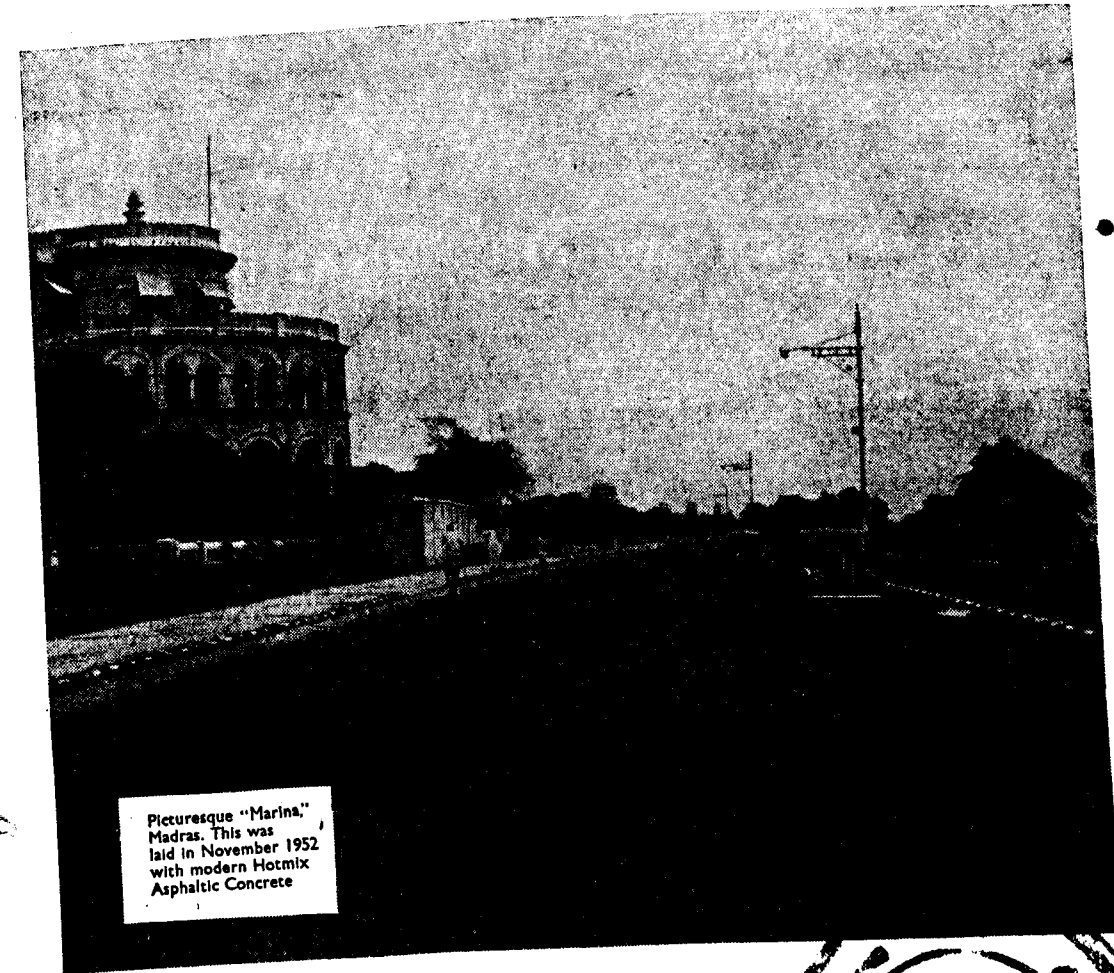
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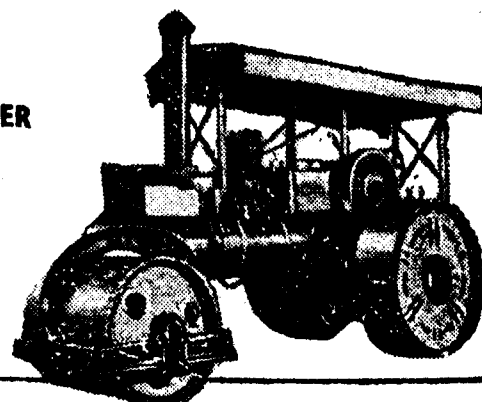
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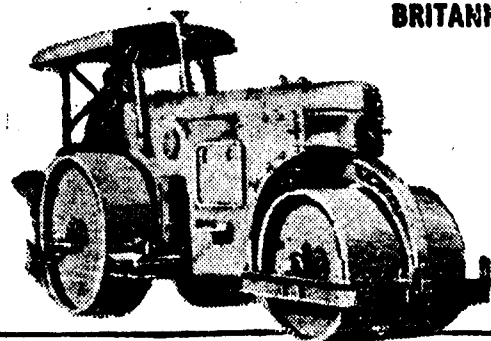
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