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TRANSPORT-COMMUNICATIONS

MONTHLY REVIEW

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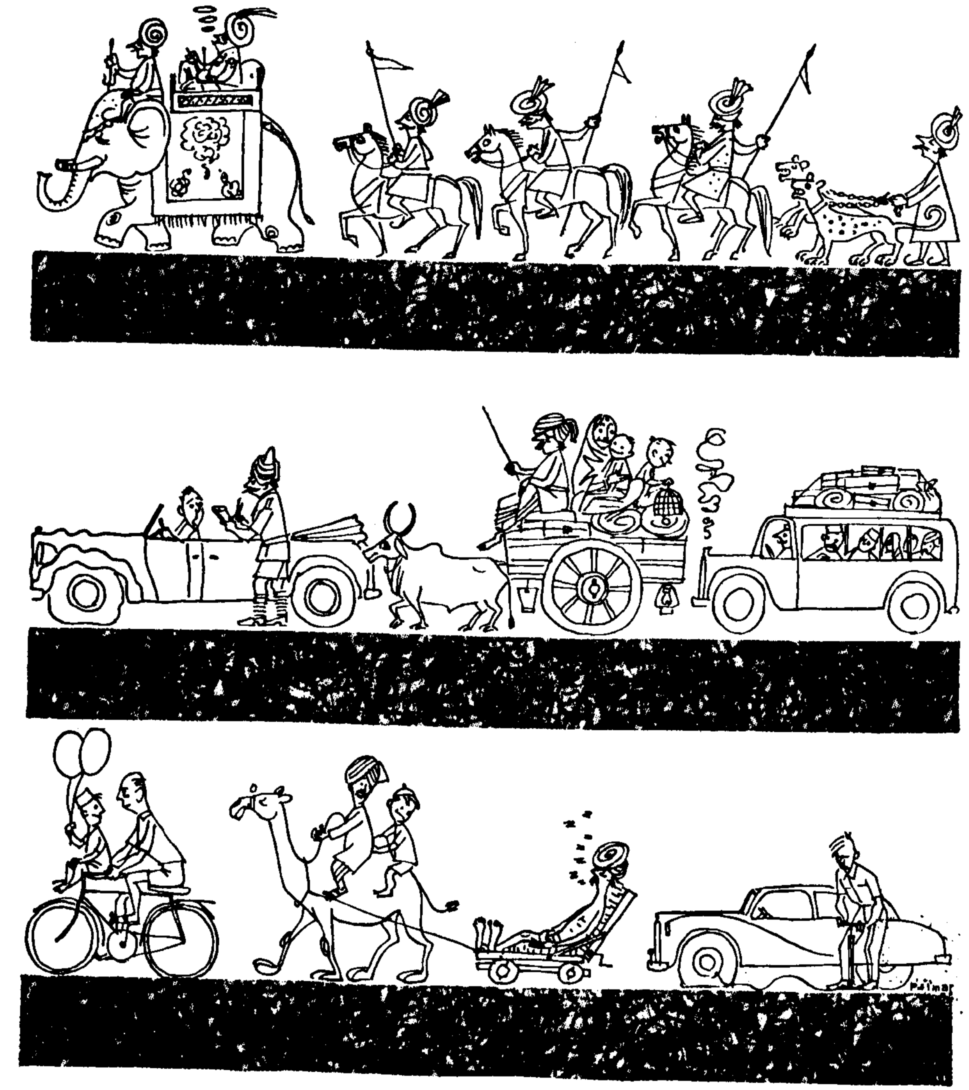

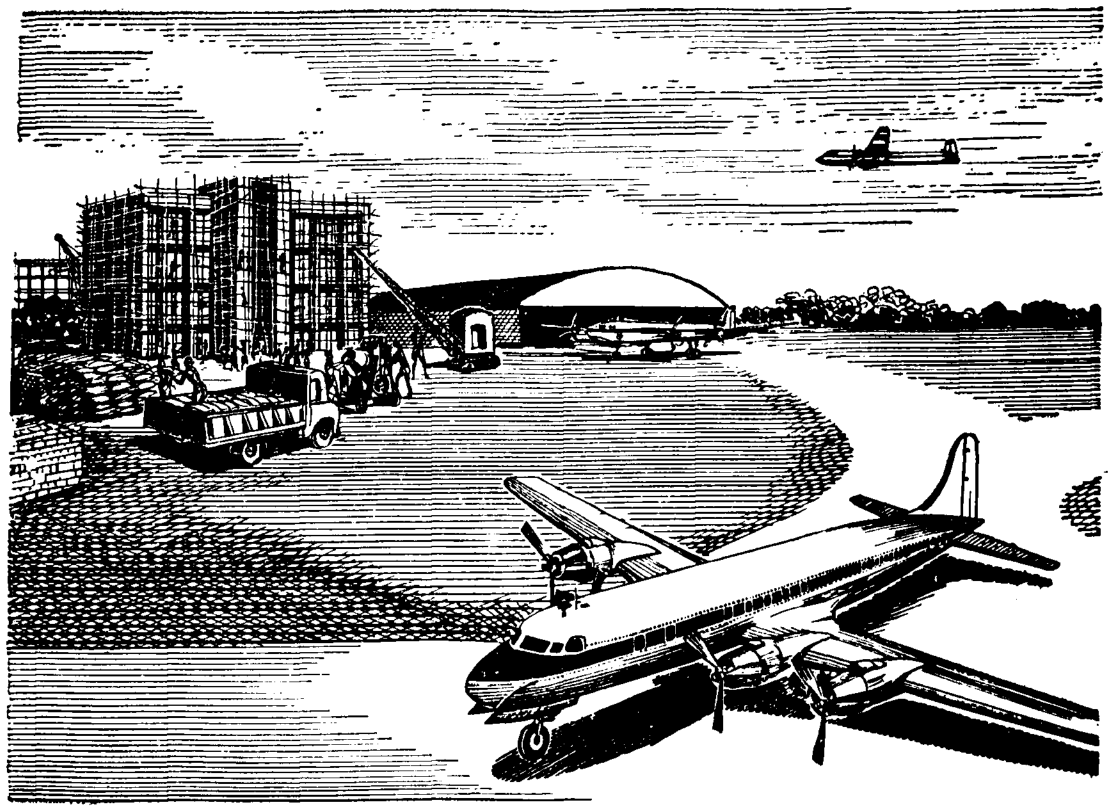

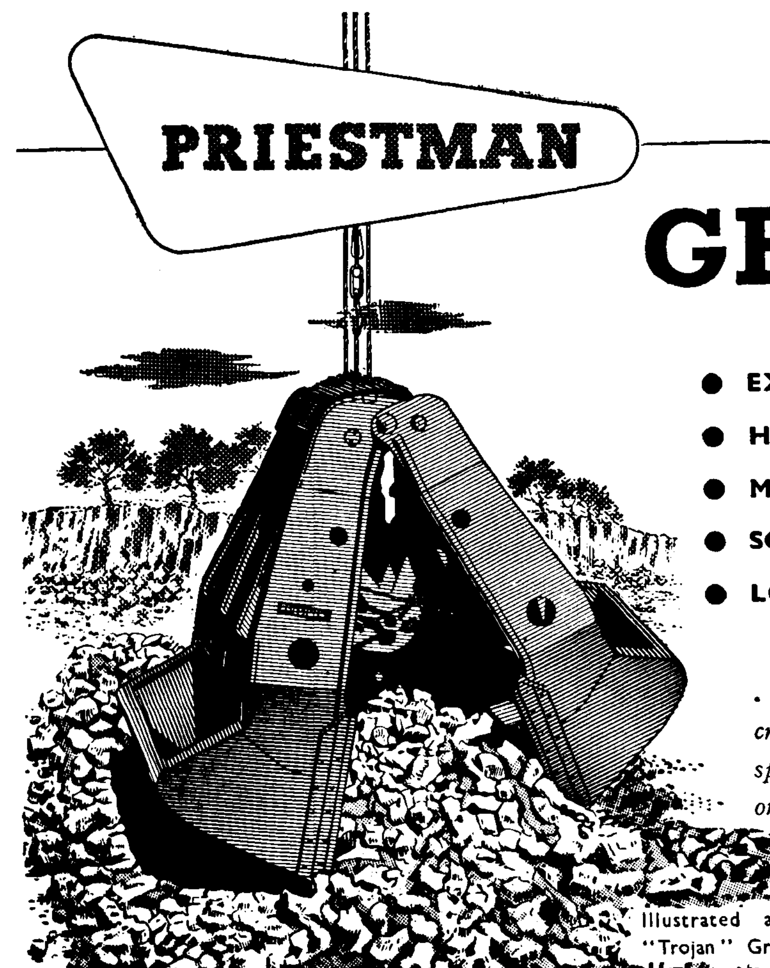

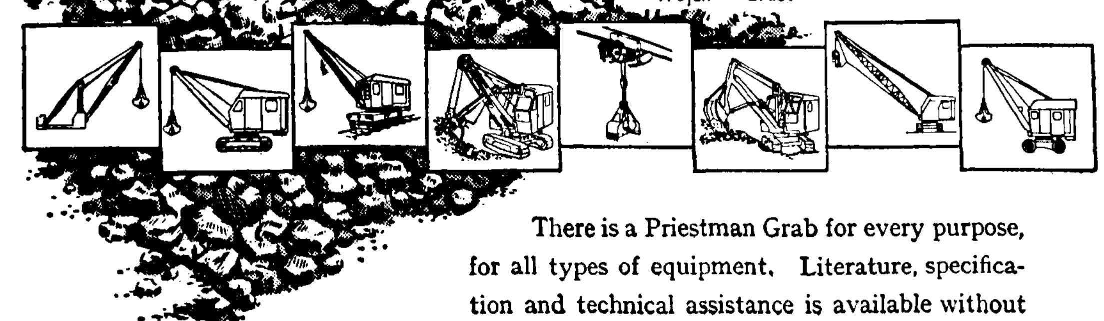

TRANSPORT-COMMUNICATIONS

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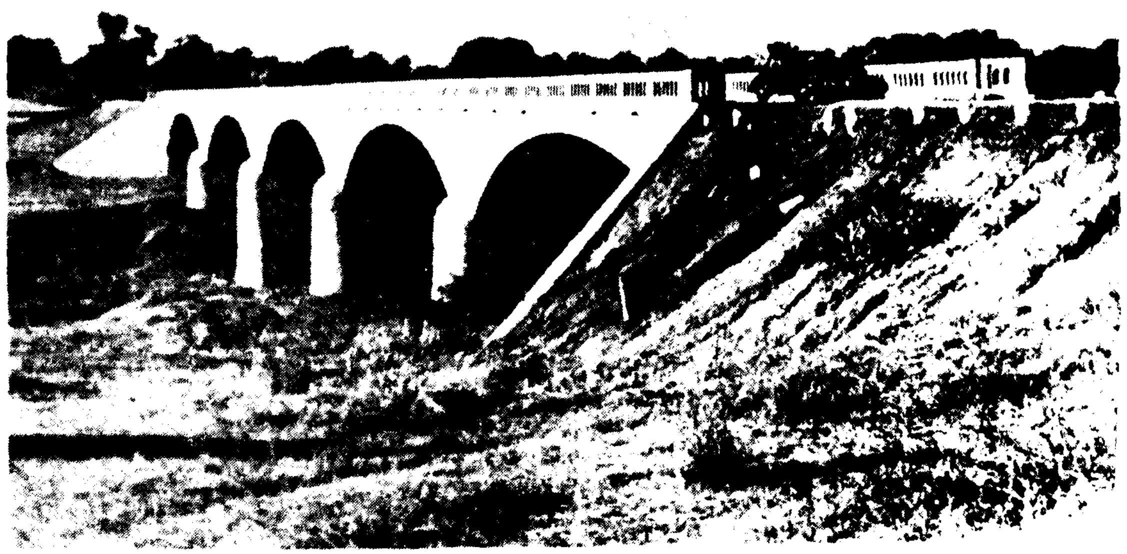

Photo 1. DHOLDHARA BRIDGE ON N. H. 8

TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

A REVIEW OF
ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

APRIL 1956

BRIDGING INDIA'S RIVERS

THE DHOLDHARA BRIDGE

THE Bombay-Nadiad-Rajputana-Delhi road, National Highway No. 8, crosses the Dholdhara river in mile 171/2. The absence of a bridge at this crossing was very inconvenient to traffic. During the rains the velocity in the river was high and the river therefore could not be easily crossed.

The Dholdhara river, which has a catchment area of 50 square miles at the site of the bridge, has its source to the west of Bansda and is a tributary to the river Ambica. Before the construction of the bridge there existed a causeway very near the confluence of two streams which form the Dholdhara river. The road had to make a detour to cross the river at this causeway. Therefore, a site 1,000 ft downstream of the causeway was selected as the best suited one from the point of view of availability of rock for the foundations, narrowness of the river, and alignment of the approaches. See Fig 1.

Hydraulic Particulars of the River

The discharge, based on Inglis' formula for the catchment area of 50 sq. miles, works out to 47,680 cusecs. This formula, $Q = \frac{7000\,A}{\sqrt{(A+4)}}$ where Q = the maximum flood discharge in cusecs and A = area of the catchment in square miles, has been found suitable for the Bombay State. The discharge based on the cross sections of the river and that worked out by the Inglis' formula were very nearly equal. Therefore, a discharge of 47,680 cusecs was adopted for the design. The average velocity of the natural stream at the site of the bridge is 6.3 ft per second.

Alternative Designs

Alternative designs for a submersible bridge with 12 spans of 25 ft each, consisting of four units of R. C. slab continuous over three spans; a high level bridge with 7 spans of 30 ft each; a high level bridge with 7 spans of 40 ft each; and a high level bridge with 5 spans of 60 each were worked out. Finally, a bridge with 5 spans of 60 ft giving a fluming ratio of 66.4 per cent was selected as the most suitable one.

Foundations

At the site of the bridge, rock is exposed in some places and is available at a depth of 20 ft near the banks. The foundations have been taken 2 ft into rock. The masonry in foundations, which is coursed rubble second sort in

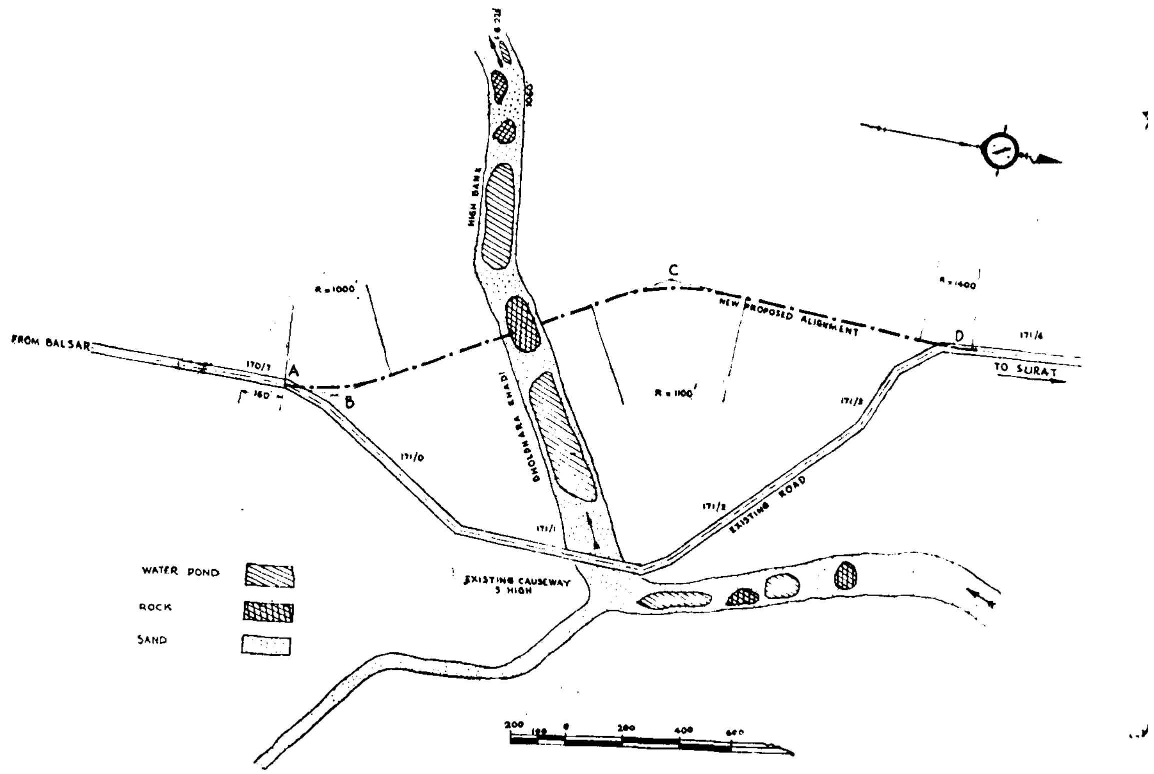

Fig. 1.

Photo 2. **Masonry in Progress**

Photo 3. **Centering for the Arches**

cement mortar 1 : 5, rests on a bedding of 1 : 3 : 6 cement concrete 1 ft thick. The piers are 7 ft 6 in. in width at top and have a batter of 1 in 18 with semi-circular cut and ease waters. Lightly reinforced cement concrete 1 : 2 : 4 pier caps, 3 ft thick, are provided. The abutments are 10 ft in width at top. They have a back batter of 1 in 3 and the front is vertical. The wing walls are

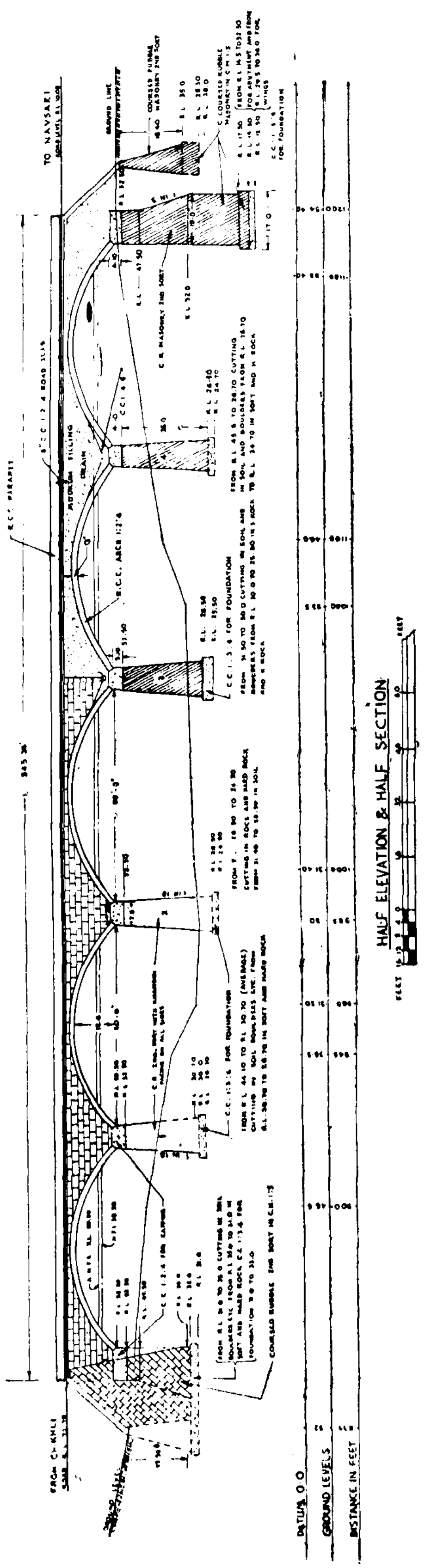

Fig. 2 (a)

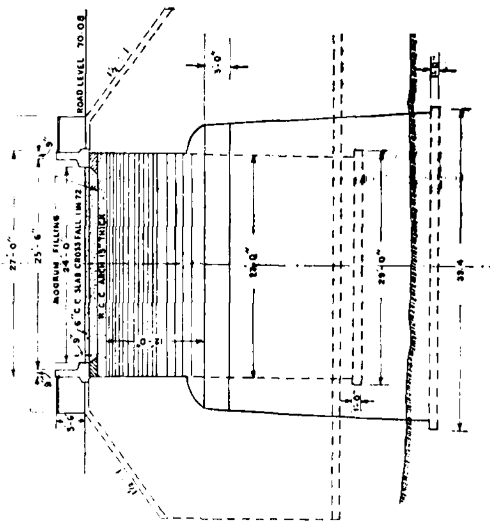

Fig. 2 (b)—Cross Section

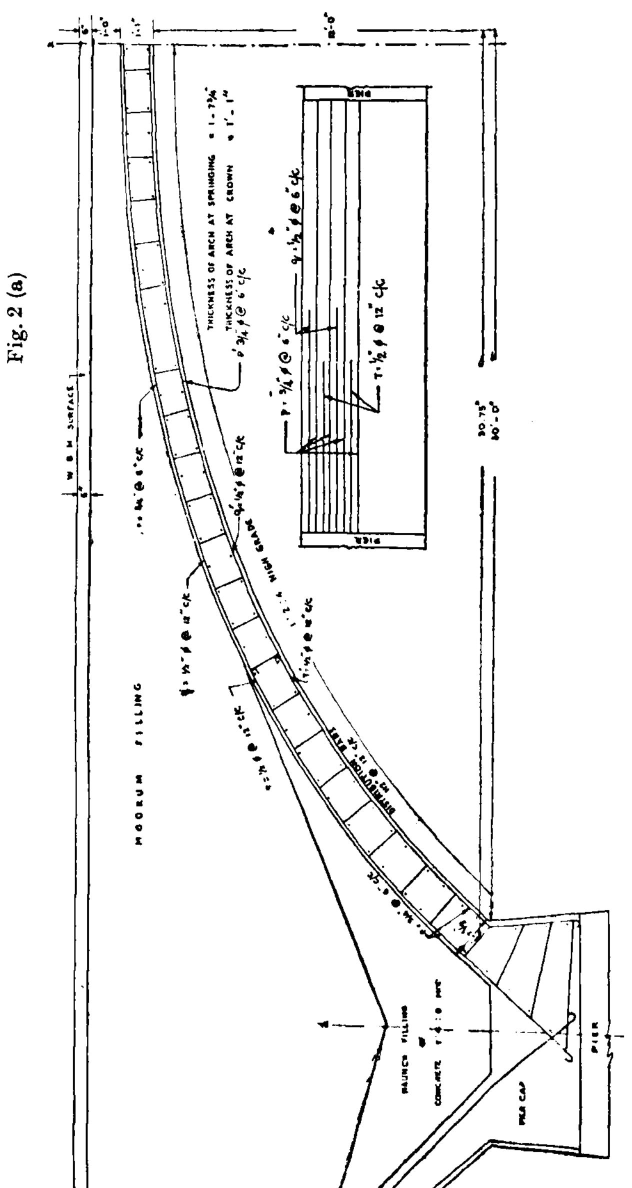

Fig. 3. Detail of R. C. Arch—60 ft Span

about 1 ft 9 in. thick at top with a front batter of about 1 in 7 and a back batter of about 1 in 4. These are splayed at 30 degrees. See Fig. 2 (a) & 2 (b).

Superstructure

The superstructure consists of reinforced cement concrete 1 : 2 : 4 spandrel filled sheet arches, 60 ft clear span, and a rise of 12 ft, giving a rise span ratio of 1/5. The thickness of the arch is 19.5 in. at the springing and 13 in. at the crown. The haunches are filled with plain cement concrete 1 : 4 : 8. A moorum cushion of 12 in. is provided at the crown of the arch. Details of reinforcement for the arch are given in Fig. 3. The Schedule of Reinforcement for the arch is given in the Table below.

The roadway is 24 ft clear between parapets and consists of a 6 in. thick cement concrete slab. The kerb and the parapet which are of reinforced cement concrete are fixed to the head walls with steel bars.

The bridge is designed for 2-lanes of I. R. C. Class A loading or one lane of Class AA loading whichever produced more severe stresses.

Cost

Total length of the bridge is 345 feet. The cost of the bridge is Rs 2,76,872. The cost per running foot works out to Rs 803/-.

SCHEDULE OF REINFORCEMENTS FOR ONE ARCH

Name of Bars.	Dia. of Bars in.	Length Ft-in.	No.	Wt Per Ft in Lb.	Total Wt in Lb
P	3/4	40–0	54	1.5	3240
P′	3/4	36–3	54	1.5	2936.25
Q	1/2	24–0	27	0.67	380
Q′	1/2	18–0	27	0.67	326
T	1/2	15–0	27	0.67	270
T′	1/2	13–0	27	0.67	235
Stirrups (a)	1/4	103–0	23	0.167	396
Stirrups (b)	1/4	202–0	3	0.167	101
Distribution	1/2	27–0	80	0.67	1447

PLANS FOR THE DEVELOPMENT OF INDIA'S NATIONAL HIGHWAYS

By

H. P. MATHRANI

PRIOR to the 1st April 1947, India had no National Highways. All the roads in the country were then looked after by various State Governments and local bodies with the result that there was no properly integrated road system in the country. There were only a few through arterial routes and even these did not have bridges across some of the large rivers.

The National Highway System

During the second World War, this lack of through-road communications in the country was keenly felt, and in December 1943 the Government of India convened a Conference of Chief Engineers of various States at Nagpur to examine the needs of the country in respect of road development and to submit suitable recommendations. This conference recommended that the roads in the country should be divided into four categories, viz., National Highways, State Highways, District roads, and Village roads, and that the Central Government should take over full financial liability for developing and maintaining the National Highways. This recommendation was accepted, and the Central Government took over this liability from the 1st April, 1947. The routes selected as suitable for inclusion in the National Highway system are called, at present, provisional National Highways since parliament has yet to pass a law declaring them as National Highways under the Constitution, and for these the Central Government have accepted full financial liability. These routes are roughly 14,000 miles in length.

On the 1st April, 1947 the selected National Highway routes had approximately 1,600 miles of missing road links and thousands of missing culverts and bridges, out of which as many as 120 were bridges on large rivers.

As a first step, a programme, which envisaged an expenditure of Rs. 235 millions, was drawn up for the development of the provisional National Highway system. In this limited programme, first priority was given to the construction of the missing road links and bridges on the more important routes. Improvement of existing roads was assigned lower priority except in cases where the traffic was comparatively heavy. Further, because of the time required for surveying and preparing designs and because of shortage of technical personnel and road building materials in the post-war period and other difficulties in the wake of partition, the progress made with the programme was initially slow. Thus, up to the end of 1950–51, i.e., before the commencement of the current Five Year Plan, only about 110 miles of new roads and three large bridges had been constructed and about 1,000 miles of roads improved in the existing National Highways system.

The First 5-Year Plan

The First Five-Year Plan, which came into force on the 1st April, 1951, included a provision of about Rs 200 millions for the development of National Highways. It was decided that in this plan too the order of priorities previously approved should be generally followed. As the funds provided were inadequate for constructing all the missing road links and bridges, only the more important arterial National Highways joining the main state capitals, major ports, and strategic points were selected for the purpose of closing the gaps and for providing at least one lane asphalted carriageway. National Highway routes parallel to these arterial highways and cross links were given comparatively low priority. The total cost of the programme to be taken up was limited to Rs 570 millions, i.e., roughly 200 per cent of the expenditure ceiling fixed in the plan. The unfinished projects at the end of the plan would be carried over to the next plan to ensure continuity of work and full utilisation of the executive organisations built up in the current plan period.

Achievements in the First 5-Year Plan

You would naturally like to know the physical targets actually achieved during the First plan which is coming to a close. So far roughly 600 miles of missing road links and hundreds of culverts and bridges, including 28 major bridges, have been constructed, nearly 4,000 miles of National Highways improved and provided with one-lane asphalted carriageway, and about 400 miles of these Highways made fit for two-lane traffic. Work is also in progress on the construction of nearly 650 miles of missing road links and hundreds of culverts and bridges, including 35 major bridges. Further, we have in hand the improvement and asphalting of nearly 3,000 miles and the provision of two-lane carriageway on about 300 miles of these Highways.

A road tunnel over 1½ miles long is under construction on the Jammu-Srinagar road across the Pirpanjal mountain range to make it an all weather road.

At present, a portion of this road gets snow-bound and becomes impassable for three to four months in a year. The work on this tunnel was commenced about a year back and a pilot heading has been driven in more than half the length.

Construction of bridges across rivers in the alluvial plains of India is a particularly difficult problem as these rivers are one to five miles wide, carry tremendous discharges of water during high floods and their bed material scours very deeply during these floods. These bridges have, therefore, to be provided with deep caisson foundations going down generally 60 to 100 ft below the bed of the rivers and in some cases even up to a depth of 150 ft or more. The design and sinking of these caissons present difficult problems and there is one instance on record where, while sinking these caissons, we met with artesian conditions and the impounded water from below began to rush through these caissons disturbing the entire bed material and making the caissons unstable. It required great engineering skill and ingenuity to overcome these difficulties and to stabilise the caissons so as to make them safe to withstand the weight of the bridge, which was approximatly 1200 tons per caisson.

The Second 5-Year Plan

Many of my listeners must be aware that our country's Second Five Year plan is almost ready. A sum of Rs 550 millions has been provided in this plan for the development of National Highways. According to our present tentative programme, it is expected that we will be able to take up under the Second plan the construction of almost all the missing links and some bye-passes round congested towns totalling about 600 miles, and almost all the missing river bridges numbering about 60. We also propose to provide at least one-lane aspahlted carriageway along the entire system and to take up the widening of roughly 4,000 miles of the Highways to provide two-lane carriageway. In short lengths having very heavy traffic, the provision of four-lane divided carriageway is also contemplated.

Before the present National Highways can be said to be reasonably developed for the immediate needs of our country, they have to be provided with a two-lane carriageway in their entire length and a very large number of the old bridges on these Highways have to be strengthened or reconstructed to withstand the loads of the modern heavy vehicles. Apart from this, it is essential to expand the National Highway system itself to meet the growing needs of the country's economic development which is proceeding at a rapid pace as a result of the First and Second Five-Year plans.

A talk broadcast on 22-3-'56.

—*(With permission from A. I. R)*

TRENDS IN MODERN BRIDGE DESIGN

By
V. VENKATARAMAYYA.

THE advance in bridge design and construction has been mostly gradual and evolutionary but in the last three decades certain distinct trends have been discernible and the progress has been rapid and spectacular.

The remarkable developments in structural engineering in the recent past have had their impact on bridge design and contributed in no small measure to this advancement.

The shortage of materials and rising costs consequent on the destruction wrought by the two world wars have compelled the bridge and structural designers to strike a new approach and to devise more economical and rational methods and shapes, although involving somewhat complicated analysis.

The earlier types of bridges were more massive, and the designs were based on rules of thumb evolved from past experience. They served their purpose admirably and some of them stand as perfect monuments in the boldness of their conception and execution. Judged from modern standards, however, they were extravagant in materials.

Except for arch bridges which are indeterminate structures, earlier efforts were concentrated in designing bridges as simple determinate structures, each part performing one and only one function as separate from the adjacent part, and the interaction of the one on the other was ignored.

MONOLITHIC STRUCTURE

One of the most notable trends in modern bridge design is to treat the bridge structure as a monolithic space-frame so that each part not only serves its function to carry the direct load on it but forms an integral part of the whole frame in transmitting the loads to the supports.

The progress and development in concrete technology and the advent of welding have helped the designer to evolve and construct slender monolithic structures which are elegant and which possess at the same time sufficient structural rigidity. A typical example of this type of construction is the rigid frame arch. By monolithic construction and continuity of vertical and horizontal portions, each part assists the other in resisting external loads and considerable economy is achieved.

Another example is the R. C. Tee-beam and slab construction, in which the slab transmits the wheel loads transversely and at the same time functions as the compression flange of the Tee-beam, since the slab is made monolithic with the beam. R. C. slab and Tee-beam spans have practically replaced steel girders for small span bridges.

A similar result is obtained in what is known as the "composite type of construction" in which the beam is of steel and the slab is of concrete. The slab is connected to the flange of the steel beam by means of shear connectors, to transmit the horizontal shear and to ensure monolithic action.

The composite type of construction has been adopted for the roadway deck of the Ganga Bridge at Mokameh. This type of construction provides a solid durable road deck and at the same time keeps the dead weight to the minimum, which is of considerable importance in the case of long span bridges.

By means of welding, the equivalent of Tee-beam and slab construction has also been achieved in steel, specially in Germany for spans as long as 660 feet. A thin steel plate suitably stiffened in both directions is rigidly attached to the top flanges of plate girders and when covered with one inch thick asphalt, serves as the road deck. The same plate serves also as the top flange of the plate girders.

WELDING SAVES STEEL

Apart from the advantage which welding provides for obtaining monolithic connection, welding is now more generally used for fabricating steel work including bridge girders on considerations of saving in weight of steel required. In Germany, riveting has practically disappeared from the steel fabrication shops and the steel work is almost entirely fabricated by welding. Special weldable high tensile steel has been developed and even long span highway and railway bridges are being fabricated by welding.

There is also a trend most noticeable in U. S. A. to substitute high strength bolts for rivets in site connections, as high strength bolted connections have a better clamping effect and improve the strength of the connected members, particularly under repeated loading. By adopting high strength bolts, expensive riveting equipment could be avoided for smaller jobs.

Welding for fabrication of bridge girders had been introduced in India as early as 1940 and a few plate girders have been fabricated by welding and installed on the Indian Railways. The individual members of 150 feet truss spans have also been fabricated by welding in the case of three important bridges.

For the Ganga Bridge at Mokameh, the entire steel work in roadway and railway floor systems is to be fabricated by welding. By the adoption of welding, appreciable saving in steel is achieved.

CONTINUOUS SPANS

Till recently, simple spans were generally adopted for bridges, as they are not affected by settlements of the supports. The present trend is to adopt continuous spans wherever possible and particularly where the foundations are on rock bed. Even when the foundations are in sand, the settlements after completion of the piers are negligible and may not materially affect the particular advantages of continuous spans. When the spans are continuous over a number of supports, the bending moments are not only less but change sign and the deflections are considerably reduced and also the erection by cantilevering is facilitated. On account of reduced deflection, smaller depth/span ratios could be permitted with advantage.

In Germany, a number of continuous welded plate girder spans with stiffened deck plate as detailed earlier, have been recently constructed for bridging the River Rhein near Cologne. For a span length of about 660 feet, the depth of the continuous welded plate girder which has a curved bottom flange, varies from about 20 feet at the pier to about 10 feet at the middle of the span. A number of continuous truss spans have also been erected in U. S. A. and other countries.

In case of damage or destruction of any part of a continuous span, restoration of through running may, however, take longer time.

ARCHES FOR SMALL BRIDGES

Arches, both rigid and two-hinged, mainly in concrete are being increasingly used for small and medium span bridges. There has, however, been a trend to use stiffened tied arches for medium long span bridges, in which the stiffening girder also serves as a tie. It is considered that the stiffened arch with a slender flexible arch rib has a better appearance and is economical at the same time, particularly when the dead load is of greater proportion as in the case of highway bridges.

A number of stiffened arch bridges have been built in Europe. By inclining the two arch ribs towards each other, a novel design has been got out and a stiffened arch bridge with inclined ribs has very recently been constructed in America. In this case a single arch member is only needed throughout the middle portion of the bridge span, thereby saving in lateral bracing between the arch ribs. The flexible arch ribs and the inclined stiffening girders were all fabricated by welding.

CANTILEVER DESIGN

Another trend has been for the adoption of balanced cantilever design for long spans, specially for highway bridges in reinforced concrete or steel, where the dead load is proportionately greater. A large number of balanced cantilever span bridges have been constructed in reinforced concrete on the Indian National Highways.

It may be mentioned here that for the Ganga Bridge at Mokameh, designs were prepared for balanced cantilever spans with centres of piers at 600 feet and a cantilever of 100 feet at either end. The

quotations received in response to global tenders had not, however, shown any saving for this design and a simply supported design, with a smaller length of span, was finally adopted.

For very long spans, suspension bridges with stiffening girders are preferred on considerations of economy and ease of erection. After the collapse of the Tacoma Narrows bridge under a gale of only 42 m.p.h. in 1940, extensive aerodynamic investigations on suspension bridges have been carried out and the importance of damping the vibrations and reducing the obstruction to the wind currents are now more clearly appreciated. On this account, wider widths of deck, and truss spans with open web for stiffening girders are now being adopted.

BOX SECTIONS

A box section is on the whole more rigid in all directions and requires less material than on open section. With welded fabrication, it is possible to completely seal off ingress of moisture into the box section, when the ends of the section are also closed. The inside of the box does not, therefore, require any maintenance. There is a distinct trend to adopt box sections for members of truss spans and also for plate girders by providing a continuous through flange plate top and bottom.

A few important bridges have been constructed in Germany and in Canada using built-up box sections. Where riveting has had to be adopted for fabricating the box section, the size of the box section is kept sufficiently large, to provide access for inspection and maintenance. The adoption of box sections wherever possible results in appreciable saving in steel.

Finally the trend for adoption of prestressing both for steel and concrete girders should be mentioned. In the case of steel truss spans, the usual prestressing is to eliminate, as far as possible, secondary bending (deformation) stresses in the members caused by the deflection of the span and rigidity of joints, by intentionally straining the members into the gusset connections, the gussets being initially laid out and drilled to suit the length of members in the loaded condition, whereas the members are fabricated to the cambered lengths (without load). Thus stresses opposite to the deformation stresses are set up in the members in the unloaded condition which will neutralise the actual deformation stresses when the span is loaded.

Besides the above type of prestressing, direct prestressing to induce direct stresses of the opposite sign to those under actual load in the members of the truss span, by means of stretching high tensile wire ropes and anchoring them to the tension boom has recently been adopted abroad in a few cases. By this means, steel with very high strength is used to the greatest advantage as the fluctuation in stress in the wire rope under these conditions is very small and the fatigue strength is not affected. Also, the question of buckling and the need to increase the minimum sections on that account does not arise, since the prestressing steel is always in tension.

ADVANTAGES OF PRESTRESSED CONCRETE

The trend for prestressing concrete and the resulting advantages are well known and need only be mentioned to bring out its importance. By prestressing concrete, the cracking of concrete which is weak in tension, is eliminated under design loads, and full use is made of the inherent high strength of concrete in compression. Full advantage of the high strength properties of the prestressing wires is availed of, without bringing in any disadvantages, such as cracking of the concrete.

A very large number of highway bridges and a few railway bridges have been constructed in India using prestressed concrete girders. By adopting prestressed concrete construction, appreciable savings in steel and concrete are achieved. For railway bridges, solid deck with ballasted floor is now generally adopted with prestressed concrete girder spans, in preference to open deck.

There is acute shortage of steel and cement in our country and it is imperative that every effort should be made to avail of all the latest trends in bridge design, so that the limited resources are used to the maximum extent and one slice of material made to serve the purpose where two are at present needed.

RESEARCH ON DECKS OF ROAD BRIDGES

RESEARCH on reinforced concrete slabs for road bridges carried out at the University of Illinois during the period 1936 to 1954 is reviewed in a recent Bulletin issued by the University.

The object of this research has been to determine the behaviour of reinforced concrete slabs subjected to vehicle wheel loads and to investigate the effects of the variables encountered in different types of bridge decks. The methods used have included a combination of mathematical analyses as well as extensive tests on scale-model bridges and on full-size elements of bridges.

The method may be summarised as follows. First, analyses were made to establish the variables and to aid in the planning of tests. Next, tests were made on laboratory specimens, usually scale models of highway bridges. And finally, recommendations for design were developed based on the results of the analytical and experimental studies. The design procedures proposed as a result of these investigations are usually made as simple as possible. In some cases they represent merely simplifications of the original analyses, justified by the correlations between theory and tests. In other cases, the procedures are based primarily on the experimental results but are stated in a form derived from or rationally related to the theoretical analyses.

Since ultimate strength was considered to be as important as behaviour at working loads, the problem of determining the maximum load carrying capacity of reinforced concrete slabs was encountered at almost all stages. In the belief that a clear understanding of the behaviour of beams must precede any attempt to explain the behaviour of slabs, an extensive fundamental study of the ultimate strength of reinforced concrete beams was undertaken.

The report discusses various types of bridges, and gives the following recommendations.

Slab Bridges with Edge beams

Square span Bridges :—Comparisons of the results of the tests with those predicted by the analyses indicated that the elastic analyses did not provide a suitable basis for design. For one thing, the movements carried by the beams were found to be appreciable, and any design procedure for the beams which neglected their interaction with the slab would lead to cross sections and reinforcement which would be unsatisfactory in service. Moreover, designs based on maximum localised moments in the slab produced structures having load-carrying capacities in terms of live load considerably in excess of those usually desired for highway bridges. The capacities of the test bridges seemed to be more closely related to the average moment across the width of the slab than to the maximum moment.

Skew Span Bridges :—Because of the large number of variables encountered in the skew bridges and the limited range of both the analyses and the tests, no generally applicable recommendations for design have been developed on the basis of these studies. It was concluded tentatively, however, that two-lane bridges having skews not greater than 45 deg. may be safely designed for moments in the slab and beams corresponding to those in a comparable square bridge, that is a bridge which has a span, width, thickness of slab, and beam details identical with those of the skew bridge, the span in both bridges being measured normal to the supports.

Slab and Girder Bridges

In highway bridges of the slab-and-girder type, the supporting beams may consist of steel I-beams acting independently, steel I-beams acting compositely with the slab, or concrete beams cast integrally and acting compositely with the slab.

Square spans: Recommendations for the design of single-span square I-beam

bridges were developed primarily on the basis of the theoretical analysis, since its general validity had been demonstrated by comparison with the test results and since a greater range of variables could be studied analytically than had been considered in the experimental programme. Expressions were developed for the controlling moments in the slab and beams. These expressions included originally all of the variables known to affect the behaviour and strength of I-beam bridges. However, the number and range of variables were reduced and the equations simplified by making designs for a large number of typical structures under various types of loading and determining the variables.

Continuous Bridges

The results of analyses and tests indicate that beams for continuous bridges can be designed for the same proportion of a wheel load as that proposed for single-span bridges and that the slab in the regions of positive moment may be similarly designed using the expressions for bending moments recommended for use with single-span bridges. In both cases the span of the single-span bridge used in these calculations should correspond to the portion of the continuous bridge between points of contraflexure. The distribution of moment on the beams may be considered to be the same in regions of positive and negative moment, but in composite bridges the variation in stiffness of the beams must be considered in apportioning the moment to the positive and negative-moment regions. It has been recommended further that the amount of transverse reinforcement in the top of the slab should be increased in regions over or adjacent to the piers.

Concrete Girder Bridges

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Bridges with concrete girders differ from those with steel I-beams principally in that the stiffness of the beams relative to the slab is much higher. No tests were made of this type of bridge in connection with the investigation of concrete bridge slabs. The analytical studies demonstrated that the behaviour of slab-and-girder bridges with transverse diaphragms is exceedingly complex. Consequently it has not been possible to formulate simple rules for the design of bridges with diaphragms or for the design of the diaphragms themselves. Generally, it can be stated that diaphragms to be most effective must be relatively stiff compared with the beams, and they will have their greatest effects in bridges for which the ratio of beam to slab stiffness is high, namely, in concrete girder bridges. It has been pointed out further that the use of stiff diaphragms may not always prove beneficial in so far as their effect on maximum beam-moments is concerned. For live loads placed on the bridge in such a manner that their centre of gravity is eccentric with respect to the longitudinal centre line of the bridge, the use of stiff diaphragms may increase appreciably the moment on the outside beam on the side of the bridge towards which the loads are shifted.

(From 'Concrete and Constructional Engineering' February, 1956, Vol. LI, No. 2, London.)

DEFINITIONS OF HIGHWAY ENGINEERING TERMS

MOORUM ROAD: A road with the carriageway composed of a consolidated layer or layers of moorum.

WATER-BOUND MACADAM: A type of surfacing in which stone fragments are first interlocked by rolling and then bound with smaller stone, gravel, etc. which is forced into the interstices by brooming, watering and rolling.

PREVENTION OF WET-WEATHER DAMAGE TO SURFACE DRESSINGS

Introduction

FAILURES of newly laid surface dressings may be caused by rain displacing the binder from the chippings, which are then whipped off by traffic.

Laboratory investigations and full-scale road experiments carried out by the Road Research Laboratory, Harmondsworth have shown that damage due to wet weather can be prevented by the adoption of any one of three simple processes which render the dressings immune to the action of water; this makes it possible to continue surface-dressing operations with confidence throughout periods of unsettled weather.

In two of these three processes, a solution of an adhesion agent in creosote is applied to the interface between the binder and the stone chippings. So far, the agents found to be effective for these two processes are certain quaternary ammonium compounds and certain long-chain amines and amides. The creosote solution of an agent may be applied to the dressing in one of two ways, either by precoating the chippings, or by sprinkling the solution on the binder before applying the chippings. During the experimental trials, pretreating the stone gave the more consistently good results, particularly in cold weather. The sprinkling technique, although cheaper than pretreating the stone, requires care on the site to ensure that the solution is always applied in the form of a fine mist. The specification for the creosote and the solution is given in Appendix I.

In the third process, an adhesion agent is dispersed directly in the binder, the treated binder being used in the normal manner. The quantity of agent required for this method is appreciably greater than in the other two processes and for this reason the cost is likely to be higher; more effective agents are required and only certain long chain amines have so far been found suitable. The method has the advantage of requiring no extra equipment and is more convenient.

Details of the three methods of using adhesion agents are given below.

Method 1

Pretreatment of the Stone Chippings

The chippings used for the surface dressing are treated before use with the solution of the agent in a suitable mixer. Probably the cheapest method of mixing is in the double-paddle mixer of a coated macadam or asphalt plant. Chippings less liable to produce dust may also be treated by mixing in a concrete mixer. The use of the largest available mixer is recommended as it is more economical in labour and time. The mixer should be cold, clean and free from dust, tar, bitumen or cement before use. There is no need to dry the aggregate.

The stone chippings are mixed with the solution of the agent at a rate depending on the type, size and cleanness of the stone. Large, smooth, clean stones will require less solution for adequate coating than small, rough, dusty chippings. Chippings can be coated wet or dry. Generally between 0.5 and 2.0 gal. of solution are required per ton of chipping, but exceptionally up to to 3 gallons of solution per ton of stone may be required. Mixing is continued for about two minutes until the chippings are coated with the solution When this occurs, it will be found that the chippings are waterproof. When water is poured on them it will collect in droplets instead of wetting the stone surface. This is a convenient and quick test for determining the mixing-time and quantity of solution required.

A simple and reliable test to show whether the stone is efficaciously coated

can be made by pressing the treated stone into a layer of binder about 1.5 mm. thick beneath the surface of water contained in a suitable vessel; after five minutes, the treated stone should adhere firmly to the binder. The method by which this test is carried out is given in Appendix II.

After coating, the chippings can be stocked in piles until required. Cases are known where chippings were still effectively coated after 4 months' storage by the roadside. In other cases the treatment has become less effective after a week's storage in the open. This point is still under investigation and until more is known it is recommended that chippings be used within one month of treatment.

The technique of pretreating the stone is most effective with aggregates that do not produce much dust, although success can be obtained with aggregates of all types. Dusty aggregates should receive the minimum amount of handling before mixing.

Pretreatment of the stone with the solution of the agent should cost not more than 1½ d. per sq. yd. (annas 15 per 100 sq ft.) of the finished road surface even when carried out in small batches in a concrete mixer. Ona large scale, the cost should be appreciably less.

Method 2

Sprinkling the Solution on the Binder Film

The solution of the agent in creosote is spread over the fresh binder film before the chippings are applied, by means of a sprinkling of spraying attachment fitted to the rear of the binder distributor. With equipment of this kind the treatment can be omitted when the weather conditions are favourable and applied at short notice when there is a risk of rain.

A simple apparatus in which the solution of the agent in creosote is applied at a rate such that one gallon covers between 140 and 180 sq. yd. has been developed at the Road Research Laboratory and used in the full-scale road trials. It consists of two rotary sprinklers driven by low-voltage electric motors, and maintained at a height of 2-3 in. above the binder film on a light trailing carriage. The solution is fed to the sprinklers by gravity from a tank mounted at the highest convenient point on the binder distributor.

This design of the trailing carriage has been used successfully in commercial practice. It is a prototype design and may be modified with advantage to suit the requirements of individual operators.

The apparatus should be calibrated at a depot before use, and at intervals during the season. Although the rate of application of the solution is not critical, the application of excess quantities will cause the creosote to soften the binder unduly.

Gritting is carried out in the normal way, immediately after the binder film has been sprinkled with the solution of the adhesion agent.

The sprinkling method of applying the solution should cost not more than two-thirds of a penny per square yard. (6.5 annas per 100 sq. ft)

The laboratory test described in Appendix II will indicate the effectiveness of an agent when used in this way.

Method 3

Treatment of the Binder

In this method the adhesion agent is incorporated in the binder before spraying. The method requires more effective agents than methods 1 and 2 and only a selected number are suitable. The Immersion Tray test described in Appendix II provides a ready means of determining the suitability of any agent for use by this method.

The quantity of agent required in this method of application varies markedly with the particular combination of agent binder and stone chosen for use. For example, it is known that less than 1.0 per cent of an agent in a binder is suitable to ensure good results with one stone, whereas the same agent must be used at a concentration of 2.5 per cent in the same binder to give good results with another stone. While, therefore, it would be possible to fix a concentration of agent which would be satisfactory with all stones, this concentration would be unduly high for some aggregates and if generally employed would lead to much wastage of relatively expensive agent. It is recommended therefore that the engineer should perform a simple test to determine the minimum quantity of agent needed to ensure success with the combination of stone and binder he intends to use. The appropriate test is described in Appendix II.

Lower concentrations than those indicated by the Immersion Tray test may sometimes be effective. It must be appreciated, however, that the use of such lower concentrations involves a degree of risk, and that under certain circumstances they will not provide complete protection to newly laid dressings from damage by heavy rain. It devolves upon the engineer to decide whether such a risk is justified on economic grounds bearing in mind the general climatic conditions in his area and the traffic conditions on the roads to be dressed.

The efficacy of the adhesion agents so far tested deteriorates markedly if they are kept hot in the binder and such loss of efficacy may be expected to be serious if the treated binder is maintained at a temperature exceeding 100° C (212° F) for longer than eight hours.

For this reason the agent should be incorporated in the binder immediately before spraying. With sprayers fitted with circulating pumps this is most conveniently done by adding the measured quantity of agent to the binder either during transit to the site or at the roadside, mixing the agent and the binder by circulating them through the pumping system. At least two thirds of the volume of binder in the tank should pass through the pump to ensure adequate dispersion of the agent.

This method of application of an agent is simpler and more convenient than the alternative methods described. Since relatively high concentrations of agent (up to 2.5 per cent by weight of the binder) are sometimes necessary, this method is likely to cost more than the alternative methods, the extra cost ranging from 1d. upwards, depending on the price and concentration of the agent used.

With high concentrations of agent (2.5 per cent and over) some emulsification of the binder in water may occur during the first few hours showing as a faint milkiness on the surface of the road. This situation is potentially dangerous since some of the binder may be washed away in the emulsion. So far such emulsification does not appear to have impaired the condition of surface dressings on which it has been noticed.

Concentrations of up to 1½ per cent of agent are not likely to produce changes in viscosity of practical significance in surface dressing and their effect on viscosity can be neglected. Where higher concentrations are used, it is recommended that tests be made and the viscosity of the original bitumen or tar be selected to give the required final viscosity. The agents are specific in their properties and no precise recommendation can be made to cover all agents with all the binders likely to be used.

APPENDIX I

Specification for the Solution of an Adhesion Agent in Light Creosote Oil for use in Surface Dressing

The solution shall consist of a mixture of the adhesion agent and light creosote oil. The concentration required is different for each agent.

The light creosote oil must conform to the following specification.

Specification for light creosote oil

The creosote oil shall be wholly derived from the distillation of gas-works vertical or horizontal-retort tars or of coke-oven tars and shall be free from volatile bases.

Distillation properties. The percentage of the oil which distils in the following temperature ranges shall be as indicated.

Temperature range	Percentage distilled
up to 200° C	0–10
up to 250° C	not less than 60
up to 270° C	not less than 80

Fluidity. It is most important that the creosote oil shall be fluid, that is, free from all suspended matter and from deposits of crystals at the lowest temperature likely to be experienced during use and storage.

APPENDIX II

The Road Research Laboratory Immersion Tray Test

(i) A 5¼-in. diameter tin lid is covered with 15–20 g. of cutback bitumen or road tar giving a film about 1·5 mm. thick. When this has cooled to room temperature it is immersed in water, also at room temperature to a depth of about 1 in. Half-inch chippings are then applied by hand and lightly pressed in. At least six pieces of the aggregate are used. The chippings are left for five minutes and are then removed from the binder film ; the percentage of binder retained on the chippings is assessed visually.

(ii) When testing a surface-active agent by the pretreated stone method the chippings are coated before use with a creosote solution of the agent. This is conveniently done by shaking 1 kg. (2 lb) of the stone in a clean tin with 5 c. c. of the solution for about one minute. Otherwise the procedure is as in (i) above.

(iii) When testing a surface-active agent for use by the sprinkling method, the binder film is sprinkled from a hand spray with 0·5 g of a creosote solution of the agent (i.e., a film approximately 0.04 mm thick), immediately before immersion in water. The creosote used must be to the specification given in Appendix I.

(iv) When testing a surface-active agent by the treated binder method, a quantity of agent is added to the binder and thoroughly stirred to ensure good dispersion. The procedure is then as in (i) above. The test is repeated with varying concentrations of agent in the binder until the minimum concentration required to give satisfactory results has been found. The concentration normally falls in the range 0.5 to 2.5 per cent by weight of agent.

(v) The agent may be considered satisfactory for use on the road if, in the test, when the chippings are lifted from the binder film, the faces which have been in contact with the film show no appreciable area uncoated with binder.

Note: Room temperature in the above test should not be lower than the expected road temperature when surface-dressing.

(From 'Road Research Road Note No. 14,' Deptt. of Scientific & Industrial Research, Road Research Laboratory, Harmondsworth.)

THE "GOOD ROADS" WAY TO PEACE

The prosperity of most nations is becoming more and more bound up with their international trade. The development of this trade is also without doubt an important factor in securing a lasting peace. Another factor which can have a big influence in fostering peace is the ever-increasing road tourist traffic. Good international roads and the simplest possible customs formalities could greatly assist international trade and tourism.

SETTING OUT ROAD CONSTRUCTION WORK

General

SETTING out is the marking on the ground of the position, boundaries and levels of work, so that the work may be readily constructed in conformity with the prepared designs, as shown on plans and described in specifications.

Setting out involves establishing reference or "recovery" pegs so as to be able to re-establish the positions of centre-line pegs; transferring levels from centre line pegs to recovery pegs; marking out the limits of clearing; marking out of the limits for cuts and fills, and marking the sites of culverts and retaining walls.

Checking Survey Pegs

The first task in setting out road work is to check that all pegs and bench marks shown on the plans are present, and are undisturbed since the original survey was carried out. Any lost pegs should be replaced, and pegs which may have been moved should be re-set. Pegs replaced or reset should be re-levelled, and the levels of the new pegs recorded on all working copies of the plans. This work should be carried out to the accuracy of the initial survey.

Methods of setting out vary with the country being traversed, and are described separately in relation to the following three classes of country :—

1. Open undulating rural country ;
2. Rough steep timbered country ;
3. Built-up urban areas.

Setting Out in Open Undulating Rural Country

It is assumed in this case that clearing is light and that cuts and fills are small.

Recovery Pegs :–Recovery pegs should be placed on either side of each centre-line peg, if not already established by the surveyor. The distance from centre line to recovery pegs should be such that all recovery pegs are in a position safe from interference by clearing, catch-drain, and earth-works operations.

The recovery peg offset distances should be even multiples of five feet, so that should records of them be unavailable to any particular person at any time, their distance from the centre line can be checked with a tape and the location of the centre-line pegs determined. Common distances for recovery pegs are 20 feet, 25 feet, and 30 feet from the centre-line pegs.

The line joining each recovery peg to its corresponding centre-line peg should be normal to the centre line of the road. On straights, this can be ensured with one sight of an optical square or, for greater accuracy, with a theodolite. A method which may be satisfactory after a little experience consists of standing over the centre-line peg, facing at right angles to the centre line, and opening the arms out along the line of the centre line ; the arms are then brought together and the line from the eyes over where the fingers touch is approximately normal to the centre line. Recovery pegs not placed normal to the centre line will result in clearing and batter pegs being placed too close to the centre line.

In setting recovery pegs, the tape must be held level unless a theodolite or other instrument for measuring vertical angles is used, and slope correction applied. Either a metal or a metallic tape may be used, but not a non-metallic tape. Metallic tapes should be checked periodically over a measured distance, and in particular, should be checked before re-use every time that they have been used in wet weather or under moist conditions.

Pegs used as recovery pegs should be dumpy pegs, either saw-cut or bush-cut, and should be driven so that they do not protrude more than about an inch above ground. The centre of the recovery peg at the top should be used as the reference

point, and should be set with an accuracy of plus or minus 1 inch.

It is usual to place indicator pegs, either sawn or bush-cut, at the backs of the recovery pegs, and facing the road centre line. The original centre-line indicator pegs can be used as the recovery indicator pegs on the high side of the cross-sections. The chainage of the centre line would then appear on the front of such indicator pegs, and the distance to the centre line should be marked on the back.

Recovery Pegs on Curves :–On curves the line of the recovery pegs is located along the half angle between equal adjacent chords and can be determined as shown in figure I. Lines normal to two chords of equal length from the centre-line peg are marked out, and the line

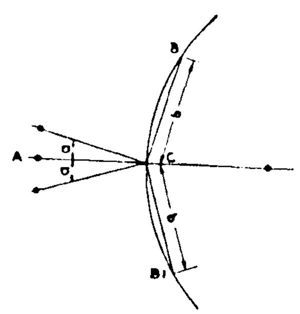

Fig. 1.
Locating Offset Pegs
on a curve

midway between these two is the line of the recovery pegs. An alternative, and slower method, is to calculate the angle ACB, or ACB_1, and set the line AC with a theodolite.

A further method of locating recovery pegs on curves is by use of a prismatic compass. Forward bearings are read at each station point in succession. A sight is then taken at each station on a bearing corresponding to the average of the adjacent forward bearing plus or minus ninety degrees. This method would not be correct where the distances between stations vary.

Without using optical instruments, a field method may be employed, using two tapes. Equal distances are measured and marked from the station along two equal chords. With the ends of a 100-foot (or other) metallic tape held on each of the marked points on the chords an indicator can be set at equal distance from the marked points. The recovery peg is then placed at the desired distance along the line from station to indicator.

The line as originally pegged consists of a series of straights and curves, shifts of the true centre line on account of transition and curve widening being disregarded in the original survey. The usual practice is to set the recovery pegs at a predetermined distance from the **nominal** centre line as originally pegged. The clearing pegs, and batter pegs would have to be set at the correct distances from the **true** centre line. Distances left or right from the nominal centre line to the true centre line, as well as the road widening on curves for New South Wales Main Roads, are given in Tables 3 to 6 inclusive of the Department of Main Road's publication, **Instructions for Design of Two-Lane Rural Highways** (M. R. Form No. 355).

Levelling Recovery Pegs :—When a sufficient length of road has been set out, and before construction commences, recovery pegs should be levelled by means of level and staff, and the levels tied in with the original survey levels of the road. Sometimes, in easy country, it is the practice to set the recovery pegs either at the pavement level or at finished subgrade level of the centre of the completed road. This has the advantage of making the pegman's task simpler when transferring the levels back.

Stakes to mark the Clearing :—Stakes should be placed at each cross-section to mark the limit of clearing required for the earthworks. Stakes are usually placed a uniform distance back from the limit of clearing to avoid displacement during the work, and are painted a distinctive colour.

In some instances, it may be desirable to leave sound trees ; even though they partly overhaul the road. The extent of clearing is often a matter of considering particular trees, rather than the complete clearing of a rigid determined width between stakes.

Usual practice is for the recovery pegs and clearing stakes to be set in position and the recovery pegs to be levelled and the clearing work carried out before the batter pegs are placed in position.

Batter Pegs :—Batter pegs are pegs placed to mark the edges of cut and fill at each cross-section. They are the guides for the plant when commencing the earth works. It is usual to stand batter pegs back two feet from the actual limit of cut or fill to ensure their safety, and to paint them a distinctive colour.

In open undulating country, it is usually sufficiently accurate to measure the locations of batter pegs by scaling off from the cross-sections. Subsequent levelling of the batter pegs would then check their accuracy. Wherever the slope of the ground is not as constant as is shown on the plans, the location of batter pegs must be determined by other means.

The simplest method is to carry out a re-survey of the cross-section to greater accuracy, and to measure the batter distance from a plot of this cross section (see Fig. 2).

Other methods as described later would not generally be required in open undulating country.

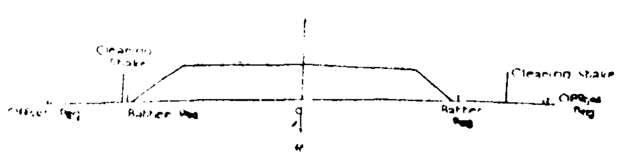

Fig. 2.
Layout of Pegs on Typical Cross-Section

Setting out Culverts.—For setting out purposes, culverts may be divided into two groups, namely pipe culverts and box culverts.

In the case of pipe culverts, the information required on the ground is the line of the culvert, the location of inlet and outlet of the culvert, and the grade line of the culvert invert.

The centre-line, chainage where the culvert crosses the road centre line, as read from the plan, should be noted. Regardless of the plan, the best location should be selected for the culvert, in such a way as to obtain the following :—

(i) Alignment and grading conforming as closely as possible with natural water course.

(ii) Minimum length of pipe to meet this condition.

(iii) Minimum excavation.

(iv) Adequate cover over the pipe.

(v) A suitable bedding or foundation for the pipe.

The line of the culvert is then set out with a theodolite, working from the road centre-line. Recovery pegs, with indicators, are set on the line of the culvert to either side of the road at a sufficient distance from the road to escape interference during construction (see Fig. 3). Recovery pegs are then levelled. Indicator pegs at the backs of recovery pegs should be marked with distinctive coloured paint to avoid confusion with ordinary road recovery pegs. On the indicator pegs should be shown the distance from recovery pegs to inlet or outlet, and the rise or fall from the recovery peg to invert level at the inlet or outlet.

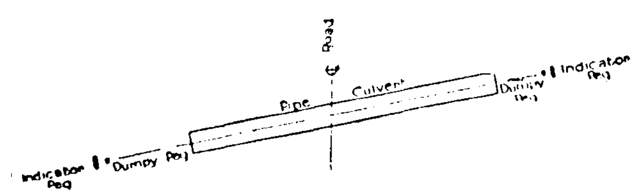

Fig. 3.
Layout of Pegs at Pipe Culvert

The setting out of reinforced concrete box culverts is a more complex procedure requiring particular consideration in each case.

The essential features are as follows :—

(i) Before excavation work starts, pegs should be provided to give the excavation depth, line and extent for the floor and the four wing wall foundations.

(ii) As the concreting work is formed continuous check should be maintained for line and level.

Where ground conditions are such that a bedding course of mass concrete is required under the culvert, it is often convenient to lay the bedding course with dimensions in plan slightly in excess of the culvert dimensions. This enables the plan of the foundations to be set out on the mass concrete, either by marking lines or by setting stub wooden pegs in the mass concrete outside the limit of the culvert foundations.

Setting Out Retaining Walls :—Essentially, the problem of setting out retaining walls is related to that of setting out batters, the principal extra requirement being a higher degree of accuracy.

Where retaining walls are associated with horizontal curves, change of grade, transitions, etc., these factors must be allowed for in determining the correct location of the toe of the wall.

Timber profiles will be required to guide in the building of the front and rear batters of stone retaining walls.

Recording Information :—All the information collected in setting out should be recorded and form the basis of instructions to foremen and pegmen.

A copy of tables of relevant information prepared should be placed in the engineer's office and copies handed to the foreman and to the particular ganger and pegman. A copy should also be held by the engineer.

Schedules of cuts and fills when compiled, should clearly indicate whether the information relates to subgrade level or finished pavement level and the depth of pavement required should be stated.

When all pegs have been placed as described above, and the table prepared and issued, there is little more required of the engineer in this matter, other than in checking the accuracy of any displaced pegs which have been renewed, and in providing the amended levels for them.

When the earthworks are nearing completion, the pegman replaces all centre pegs in the roadway at finished level as transferred from the recovery pegs. These pegs should then be accurately checked by the engineer for line, distance and level.

(To be continued)

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

DEFINITION OF A LECTURER

" A Lecturer is a person who talks in some one else's sleep."

HELPLESS

" Dad, why isn't a man allowed to have more than one wife ? "

" Son, when you're older you'll understand that the law protects those who cannot protect themselves."

HERE AND THERE

1. THE USE OF GUNITE AS A STRUCTURAL MATERIAL

● TWENTY-FIVE years ago gunite was a new material and was chiefly used for maintenance work on concrete structures and for protecting corroded steel-work. Today the most important use of gunite to the structural engineer lies in the systematic reconditioning of weathered reinforced concrete structures, by restoring them to a state equal to new and thus avoiding reconstruction.

Gunite is composed of cement and sharp sand mixed together in the dry state, and projected from a pneumatic machine known as a cement gun through a delivery pipe at the surface to be coated. Hydration takes place at the discharge nozzle. The term gunite does not include mortars which are wetted prior to discharge, whether or not a foaming agent is used, as the physical properties of gunite differ materially from all the mortars which are mixed wet before projection.

The most useful structural properties of gunite are its density and the physical bond which it obtains to a suitably prepared concrete surface. It also possesses high compressive and tensile strengths but these can seldom be used in a structural manner.

Materials other than cement and sand can be used when necessary. For example refractory materials are occasionally employed for special purposes but such uses are not structurally significant.

Lack of cover on the reinforcement is the commonest cause of deterioration. Decay is most evident on the external elevations. Structures in clear atmospheres have an average life of about 35 years before needing major refacing, and those in aggressive atmospheres 15-20 years. An adequate repair will have a much longer life than that of the original face-work.

In suitable cases, gunite can be used for strengthening weak structures built of such diverse materials as reinforced concrete, masonry, brickwork, steel and wrought iron, and examples are given. Often the only basis of design is that of providing a factor of safety against collapse. In the right conditions, this method can be used with confidence.

(*"The Structural Engineer, Februaty", 1956.*)

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2. THOUGHTS ON STREET LIGHTING

● FOR traffic safety, street illumination should provide pleasant and accurate night-seeing conditions. Other values, of course are as factors in discouraging crime and in promoting business. Generally speaking, the levels of illumination acceptable for crime prevention are lower than those adequate for traffic purposes, while those employed for business attraction are higher.

In visibility there are four primary factors:

1. time available to perceive and recognize an object;

2. size of object to be seen, from a brick to a tractor-trailer;

3. contrasts between object and background;

4. level and conditions of illumination, which derive from
   (a) the level and uniformity of pavement brightness
   (b) the brightness of the object to be seen, and
   (c) the amount of glare to the observer.

These in turn depend on the source of illumination (location, design, and lumen output of the lighting fixture) and on the reflection factors and characteristics of the pavement and objects thereon.

Discerning an Obstacle

Three means of discernment are: **silhouette, reverse silhouette,** and **surface detail**. When the obstacle to be seen has a lower brightness than its background, it is most easily recognized because of the silhouette it casts. Under most street-lighting conditions, seeing by silhouette predominates. When the obstacle is brighter than its background, but surface detail is lost, it is seen by reverse silhouette. When the brightness of the object makes the surface detail visible, it is seen by surface detail.

While uniformity of pavement brightness is a desired objective in street and highway lighting, the level of brightness for a given traffic condition is modified by the amount of glare. If little or no glare is present, lower levels of brightness will suffice. Glare not only causes discomfort but reduces visibility.

The glare from luminaires may be controlled by (1) higher mounting; (2) shielding the light source; and (3) reducing the brightness contrast of the light source with that of the general level of illumination. The relationship of blinding effect and mounting heights is shown in the table below:

Mounting Height (feet)	Relative Blinding Effect
30	1
25	1.4
22.5	1.7
20	2.1
17.5	2.7
15	3.8
12.5	6.5
10	13.1

When the average foot-candle intensity (lumens per square foot) desired on the pavement is determined, a lighting system can readily be designated by use of a utilization-efficiency chart for a given luminaire design and output.

The utilization chart derived from luminaire characteristics, illustrated in the following table, will vary for each luminaire design and is usually furnished by the manufacturer. Current Recommended Average Horizontal Foot-Candles (Lumens/Square Foot).

Pedestrian Traffic	Vehicular traffic classification			
	Very Light (under 150)	Light (150–500)	Medium (500–1,200)	Heavy to heaviest (1,200 up)
Heavy ...	*	0.8	1.0	1.2
Medium ...	*	0.6	0.8	1.0
Light or none † ...	0.2	0.4	0.6	0.8

Because of loss of lumen output due to dirt on glassware and reduction of lamp efficiency, the actual coefficient of utilization is reduced by a maintenance factor usually taken as 20 per cent.

(From 'The American City,' February, 1956).

* This condition is unusual, but if it should occur, the foot-candle figures appearing in the column to the right may be used.

† Lighted highways and expressways at grade should have illumination similar to that on urban streets with comparable traffic flow, either vehicular or pedestrian. An average of 0.6 ft-c is recommended for highways with full control of access as defined by the American Association of State Highway Officials, such as elevated or depressed expressways from which pedestrians are excluded. The values given for very light vehicular traffic pertain to roadways such as those in residential areas where vehicular speeds are low, of the order of 15 to 25 mph.

NOTE: The foot-candle values are based on a pavement having a reflectance of 10 per cent. When reflectance is poor (3 per cent), the average foot-candle level should be increased 50 per cent. When reflectance is unusually high (20 per cent or more), the recommended values may be decreased 25 per cent.

3. FAST-SETTING CEMENT

● ACCORDING to the article in STROITELNAJA GASTA (Construction Journal) by S. Gretshushnikov, director of the No. 1 Moscow Factory for construction of Prefabricated Concrete Parts, two methods are used by the Soviets for producing fine cements—specific surface between 5,000 and 6,000 sq. cm. per gram.

One method involves the collection of cement dust at filters in the cement factories. The report claims they are able to collect upto two tons per hour on each filter. The cement particles desired are less than 3 microns (1 micron = 1×10^{-6} meters).

The other method for the manufacture of the fine-grained cement is a milling process where the ground cement is passed through a second mill.

According to the report, these are the compressive strengths observed :

Time	Ordinary Cement (lb per sq in.)	Fast-Setting Cement (lb per sq in.)
24 hours	2,850	4,500
2 days	3,985	4,830
3 days	4,555	6,120
7 days	5,690	7,120

Thomas A. Edison experimented with very fine cements and found that there was a drawback; the fine cement particles were hydrated by moisture in the air, before the cement could be used.

(From 'Engineering News-Record' January 26, 1956.)

4. DENSE CARPETS

● IN Nottinghamshire in England the trend is to adopt denser carpets having better weatherproof qualities in preference to open textured ones. Although these are at present more expensive, this may be more than counter-balanced by the extended life which may be anticipated. With a view to putting this policy to the test, trial lengths of dense bituminous and dense tar carpet were put down during 1954-1955. Trial sections of bituminous gravel were also laid and they give every promise of success, although it is as yet too early to say what the life will be. There are extensive gravel deposits in the County and the use of this local material for bituminous carpeting may well result in considerable economies in future.

(From 'Highways and Bridges and Engineering Works,' February 22, 1956.)

5. USE OF BURNT RED SHALE FOR FOUNDATIONS OF CONCRETE ROADS

● Preliminary work of drainage, earthworks, and the laying of burnt red colliery shale to provide a suitable foundation for a concrete road, was undertaken at Oxton by-pass in England. The burnt red shale, when sealed by surface dressing at the appropriate time, gives a good uniform bearing capacity and ensures the maintenance of a satisfactory moisture content in the sub-soil. This is a very necessary pre-requisite to the construction of a concrete road.

(From 'Highways and Bridges and Engineering Works,' February 22, 1956.)

CURRENT LITERATURE

ABSTRACTS

AMERICAN STANDARD BUILDING CODE REQUIREMENTS FOR MASONRY, National Bureau of Standards, Miscellaneous Publication, 211, Superintendent of Documents, U. S. Govt. Printing Office, Washington 25, D. C. (July 1954).

THIS Standard is the revision of the earlier edition of 1954. The Code specifies the minimum requirements for materials, allowable stresses for all types of masonry. Five kinds of mortar for use in masonry are recognised and tabular statements giving the recommendations about the use of each kind in the different parts of a structure such as footings, walls, piers, etc., and allowable unit stresses for various descriptions of work such as solid masonry, masonry of hollow units, stone ashlar masonry, etc., are given.

A bibliography of 46 references is also listed

REDUCTION OF LATERAL EARTH PRESSURE ON QUAY WALLS BY USE OF STONE BACKFILL, Matsuhei Ichihara. Transactions of the Japan Society of Civil Engineers, December 1955.

A sand bin with a hinged, vertical wall and a force measuring apparatus having double mirror magnification were specially designed and built for this experiment. Active earth pressures on the wall, when it is slightly tilted, were measured for various backfill conditions. Varying amount of broken stone or coke was inserted between the sand and the wall.

The reduction of pressures due to such backfills is quite evidently found out numerically; the broken stone backfill reduces the pressures to 70 per cent of those without it; the coke backfill to 30 per cent.

The ordinary triangular shape of stone backfill with natural slope is confirmed to be most economical and effective. *(In Japanese)*

THICK RECTANGULAR PLATES ON AN ELASTIC FOUNDATION BY Daniel Frederick, Proceedings American Society of Civil Engineers, Paper No. 818, Volume 81, October, 1955.

THE governing equations and solutions for the bending of thick rectangular plates resting on an elastic foundation are presented using the theory of plates developed by E. Reissner. A discussion of various types of fixity of edges involving three boundary conditions is presented and it is shown that Levy and Navier type solutions can be used. Also, two simple examples are included. *(Author's Summary)*

INVESTIGATIONS ON FLY ASHES AS PUZZOLANIC ADMIXTURE by Yoshikoshi, Transactions of the Japan Society of Civil Engineers, No. 31, Japan.

This article is a report on a series of studies on the use of coal ashes of steam power plants. It is concluded that the various types of ashes are each useful as puzzolanic admixture. Details of the effect of adding fly ash on the properties of concrete are given and suggestions for methods of testing are offered. *(In Japanese)*

THE MEASUREMENT OF STRESS IN CONCRETE by J. B. C. Taylor and P. T. Evans, New Zealand Engineering, August 15, 1955.

PART I of this paper describes three types of gauges developed at the Dominion Physical Laboratory for measuring stress in concrete. The first, known as Mark I, used a variable-inductance system as transducer, while the second, known as Mark II, used bonded wire resistance strain gauges for this purpose. Both these types of gauges had a modulus of elasticity as close as possible to that of the concrete in which they were embedded. The third, known as Mark III, which used resistance strain gauges as for the Mark II type, was designed to measure stress in concrete independently of variations in the modulus of elasticity of the concrete.

Design, construction, tests and field applications of these three types of gauges are described, as well as experimental work in the use of bonded wire resistance strain gauges for measuring stress on concrete surfaces.

Part II of the Paper describes a comprehensive series of tests on gauges of the Mark III type which was carried out to establish a relationship between K (ratio of stress in concrete to stress in gauge) and the length-to-diameter ratio of the gauge.

THE BENDING MOMENT DUE TO THE SETTLEMENT OF SUPPORTS OF A THREE-SPAN CONTINUOUS BEAM, Toshiaki Fukaya. Journal of the Japan Society of Civil Engineers, December 1955.

IT is generally recognized that settling of supports of a three-span continuous beam bridge greatly affects the bending moment. However, inasmuch as the calculation to determine the influence of the settlement is comparatively complicated and not yet fully developed, designers generally work up a plan on the assumption that supports are not subject to settlement.

When the settlement occurs, the bending moments of bridge originally considered in designing should sometimes change. The Author has tried to deduce a general formula to figure out the bending moment due to settlement of the supports of a three-span continuous bridge. (*In Japanese*).

A SURVEY OF MODERN CONCRETE TECHNIQUE by E.E.H. Bate and D. A. Stewart. PROCEEDINGS OF THE INSTITUTION OF CIVIL ENGINEERS, PART III, DECEMBER 1955, VOLUME 4, NUMBER 3.

MODERN concreting techniques are shown against their historic background, and the effects of the introduction of mechanization upon the design and quality of the mix are indicated. The properties required of a concrete are discussed, and it is shown that there may be a cleavage between the most desirable properties from the client's and contractor's points of view.

Examination of the methods of designing mixes and of concreting techniques evolved by scientific investigation reveals how the client's and contractor's points of view may be made compatible. The theory of mix design and its application to concreting practice is discussed in detail, and the relationship of mix design to the design of the structure is examined with regard to size of section, distribution of reinforcement, and its cover, together with the development of heating and shrinkage in the concrete. The mechanization of mixing, transporting, and placing is discussed with reference to particular problems which arise with different plants and on different types of contract. The advantages to be gained from a careful design of mix, in its effect on site control and the use of mechanized placing, are examined in detail with reference to the complete structural design. Examples of the use of modern concrete technology are given, and mention is made of architectural effects which may be introduced at negligible cost. Finally, great emphasis is laid upon the desirability of training technicians and of introducing a craft of "Concretor." (*Author's Summary*).

A BIT MIXED

"I am very sorry I have not been paying my account, but I've just had another child. I promise you it won't occur again."

SELECTED RECENT LITERATURE IN ENGINEERING JOURNALS

XII. TRAFFIC MARKINGS, SIGNS AND SIGNALS

1. **Median Dividers on Urban Streets**; JOHN T. HANNA, *Traffic Quarterly*, October 53, pp. 468-478.

2. **Cycle Length and Signal Delay**; T. M. MATSON *and* W. R. MCGRATH, *Traffic Quarterly*, April 54, pp. 161-178.

3. **Traffic Indicators, Their Usefulness and Where They Should Be Placed;** W. W. E. VON HEMERT, *Road International*, No. 11, Winter 53-54, pp. 18, 19 & 62.

4. **The Automatic Traffic Signal Installation at Wooden Bridge Across Thur at Andelfingen**; S. SULGER BUEL, *Strasse und Verkehr*, November 53, pp. 437-438.

5. **Pedestrian Crossing Regulations**; *Roads and Road Construction*, May 54, p. 160.

6. **The Field of Modern Interconnected Traffic Control Signals**; HENRY A. HAUGH, *Traffic Engineering*, April 54, pp. 236-238, 245 & 248.

7. **Barrier Curb Design Compared**; *Engineering News Record*, March 25, 54, p. 64.

8. **Raised Concrete Strip to Divide Turnpike Lanes**; *Engineering News Record*, April 29, 54, p. 27.

9. **Lay it Down and Press it on—Result? A Traffic Lane and Fewer Confused Drivers**; *Engineering News Record*, May 13, 54, pp. 52, 54.

10. **Pedestrian Protection Signs**; GEORGE W. HOWIE, *Traffic Engineering*, March 54, pp. 214 & 223.

11. **New "Walk", "Don't Walk" Signals Installed**; *Traffic Engineering*, March 54, p. 221.

12. **The Field of Modern Interconnected Traffic Signals**; HENRY A. HAUGH, *Traffic Engineering*, April 54, pp. 236-238, 245 & 248.

13. **Traffic Sign Tests Find New Answers**; *Traffic Engineering*, April 54, p. 263.

14. **Field Sign Tried in Maine**; *Better Roads*, May 54, p. 40.

15. **Temporary Traffic Stripping**; *Better Roads*, May 54, p. 44.

16. **Temporary Traffic Strip Solves Highway Problem**; W. T. RHODES, *California Highways and Public Works*, March-April, 54, pp. 48-49.

17. **Warning and Other Signs—Specular Reflection Signs**; *Fortieth Annual Report of Victoria County Roads Board*, 1953-54, p. 79.

18. **Expressway Signs in the Chicago Metropolitan Area**; WILLIAM F. BANCH and JOHN T. NAGEL, *Highway Research Abstracts*, May 54, pp. 33-39.

19. **Barrier Curbs—Impact Test Program Proves Most Valuable**; J. L. BEATON, *California Highways and Public Works*, May-June 54, pp. 34-37.

20. **Use of Three-Phase Traffic-actuated Signals**; G. M. Webb, *California Highways and Public Works*, May-June 54, pp. 50-51.

21. **Traffic Line Marking on Main Roads**; *Main Roads*, June 54, pp. 117-119.

22. **Street Furniture**; A. G. Sheppard Fidler, *Roads and Road Construction*, July 54, pp. 209-210.

23. **Signalization Priority in Los Angeles County**; Harry Parker and Richard M. Bartle, *Traffic Engineering*, June 54, pp. 319-322.

24. **Plywood Signs Cut Replacement Costs**; *Traffic Engineering*, June 54, p. 346.

25. **Emulsified Asphalt for Pilot Lines**; *Highways and Bridges and Engineering Works*, August 4, 54, p. 8.

26. **Radar Detectors Umpire Traffic Intersections**; *The American City*, August 54, pp. 149 & 151.

27. **Cincinnati's Bicycle testing lane**; C. A. Harrell, *The American City*, August 1954, p. 13.

28. **Street furniture**; A. G. Sheppard Fidler, *Roads and Road Construction*, July 1954, pp. 209-210.

29. **Controlling Traffic Lights by Radio**; *Engineering News Record*, August 26, 1954, pp. 43-44.

30. **Reflectorised Traffic Signals**; Dr. Ludwig Merkle, *Strassen und Tiefbau*, August 1954, pp. 418-421, (in German.)

31. **Reversible Sign Technic**; John W. Limmeran, *Traffic Engineering*, August 1954, pp. 415-416.

32. **The Beaded Traffic Sign on Enamel Base**; *Strassen und Tiefbau*, October 1954, p. 337 (in German.)

33. **New Traffic Light Installations in London—Oxford Street Delays Reduced by Variable Time Vehicle Actuated Signals**; *The Surveyor*, December 4, 1954, pp. 1061-1062

See also Roads and Road construction Vol. 33 No. 385, January 55, pp. 17-20.

34. **Signalling Scheme at Swiss Cottage, Variable Maximum for Times of Peak traffic**; *The Surveyor*, December 4, 1954, pp. 1062-1064.

35. **Bright green pedestrian crossings, Michigan City Finds Them a success**; *Highways and Bridges*, November 24, 1954, p. 10.

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39. **Traffic Signals—Systems Evolved To Make Best Use of Existing Roads**; W. L. Fisher, *Road International, No. 14*, Autumn 54, pp. 20-22.

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41. **14-inch Reinforced Concrete Traffic Buttons for Wide Streets**; *American City, Vol. 70, No. 1*, January 55, p. 157.

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2. **Black Bolts Screws and Nuts B. S. 916 : 1953**—British Standards Institution, British Standards House, 2 Park St., London, W. 1.

3. **Recommendations on Methods of Protection against Corrosion for Light Gauge Steel used in Building P. D. 420 (September, 1953)** British Standards Institution, British Standards House, 2 Park St., London, W. 1.

4. **Accidents at Rural Three-Way Junctions** (Reprinted from Journal, Institution Highway Engineers, 1953, II (11), 56-67), J. C. Tanner, The Institution of Highway Engineers, 47, Victoria Street, Westminster, S. W. 1, London.

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8. **Methods for the Analysis of Iron & Steel, Part 29 : Sulphur in Basic Steel-making Slags B. S. 1121 :** 29 : 1953 (Gravimetric method), British Standards Institution, British Standards House, 2, Park St., London, W. 1.

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18. **Methods for the Analysis of Iron & Steel, Part 5 : Copper in permanent magnet alloys ", B. S. 1121 : Part 5 : 1953,** British Standards Institution, British Standards House, 2 Park St., London, W. 1.

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SOUND ADVICE

A negro and a white, have agreed to worship together at the same church. But the not-too-conscientious minister turned away the negro boy when he tried to worship at a "white" church. His advice to the boy was to pray that night to Jesus Christ and report the next morning if Jesus approved his desire. The boy returned next morning and the minister asked him if Jesus had given his approval. "No father", said the boy. "Jesus advised me not try to enter your church. For, He said, He Himself had tried for many years and failed."

BUDGETS AND ADMINISTRATION REPORTS

MADHYA BHARAT STATE BUDGET FOR 1955-56

The following extracts relating to Civil Works have been taken from the Madhya Bharat Budgets for the year 1955-56:

Revenue (Civil Works)

Items	(In lakhs of rupees)		
	Actuals 1953-54	Revised Estimates 1954-55	Budget Estimates 1955-56
1. Rents	2.95	3.00	5.20
2. Ferry Receipts	1.09	1.00	1.00
3. Receipts from Workshops	0.30	0.30	0.30
4. Recoveries of over payments	0.37	1.00	1.00
5. Miscellaneous	3.36	1.00	1.00
6. Transfer from Central Road Fund	4.17	8.00	13.00
7. Deduct-Refunds	-0.03	—	—
Total	12.21	14.30	21.50
Expenditure (Civil Works)			
Building			
Original Works	23.89	18.66	55.05
Repairs	12.68	15.51	18.30
Communication			
Original Works	20.05	10.58	22.35
Repairs	41.02	47.45	48.03
Miscellaneous			
Original Works	3.32	4.39	6.23
Repairs	0.06	0.06	0.06
Tools and Plant	2.66	—	—
Suspense	-7.99	4.00	4.00
Establishment	9.59	11.39	11.79
Add-Provision for Development Schemes under 6-Year Plan			
Buildings	57.58	39.92	50.75
Communications	—	50.19	123.53
Establishment	1.90	6.58	9.02
Deduct-Probable Savings	—	—	-40.00
Deduction & Economy cuts	—	—	-5.60
Deduct-Contribution from T. B. Fund, Indore	-0.21	-2.37	-1.00
Total	164.55	206.36	302.51

Items	(In lakhs of rupees)		
	Actuals 1953-55	Revised Estimates 1954-55	Budget Estimates 1955-56
Receipts from Roads			
Receipts under the Indian Motor Vehicles Act	9.87	0.95	0.70
Receipts under the State Motor Vehicles Taxation Act.	1.18	20.98	21.69
Other receipts	0.46	0.12	0.16
Deduct-Refunds	-0.08	-0.05	-0.05
Total	11.43	22.00	22.50

GOVERNMENT OF MADHYA BHARAT BUDGET 1955-56

A brief review with reference to Civil Works

THE total revenue for the year 1955-56 is estimated at Rs 1868.74 lakhs and the expenditure charged to revenue at Rs 1886.84 lakhs resulting in a budget deficit of Rs 18.10 lakhs. Revised Estimate for 1954-55 indicates a deficit of Rs 176.80 lakhs while in 1953-54 (Actuals) there was a surplus of Rs 163.73 lakhs.

Revenue expenditure on civil works for 1955-56 is estimated at Rs 302.51 lakhs which is about 16.19 per cent of the total State revenue. The correspondi for 1954-55 (Revised Estimate) a 54 (Actuals) are 14.52 per cent a per cent respectively.

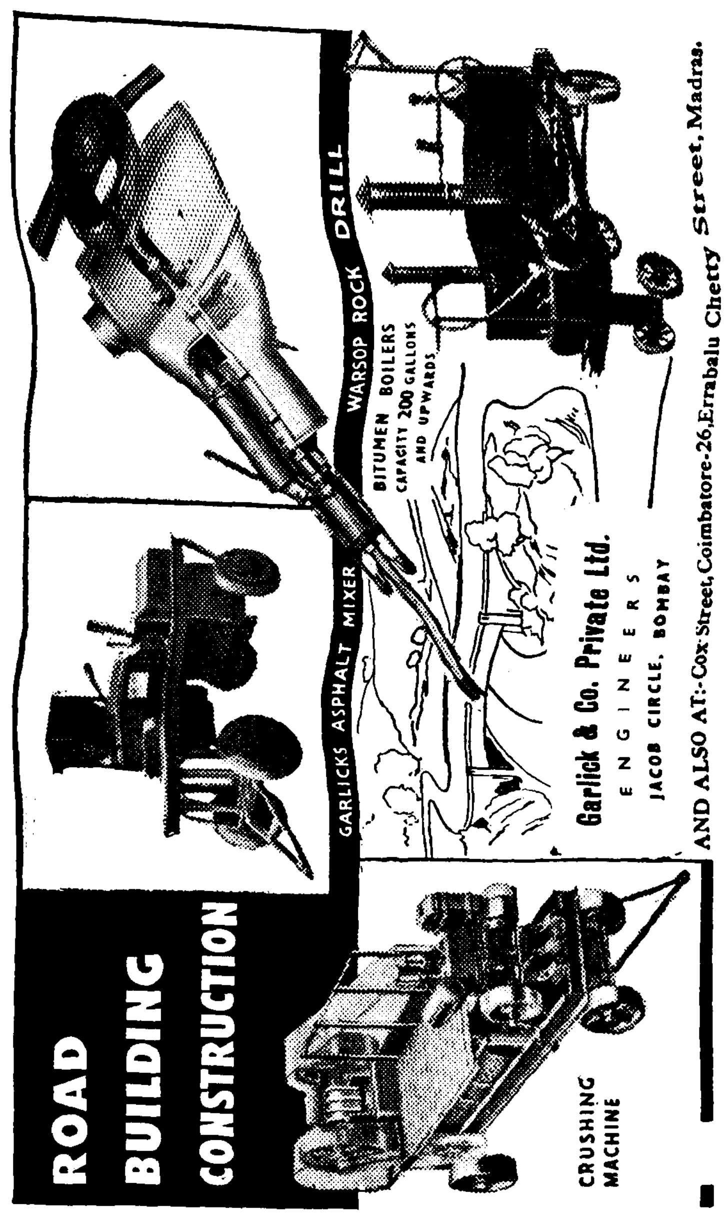
The budget expenditure on communication (Original) works and repairs only for 1955-56 is Rs. 192.91 lakhs which works out to 10.38 per cent of the total State revenue. The percentage for the previous years revised estimate works out to be 7.62 per cent.

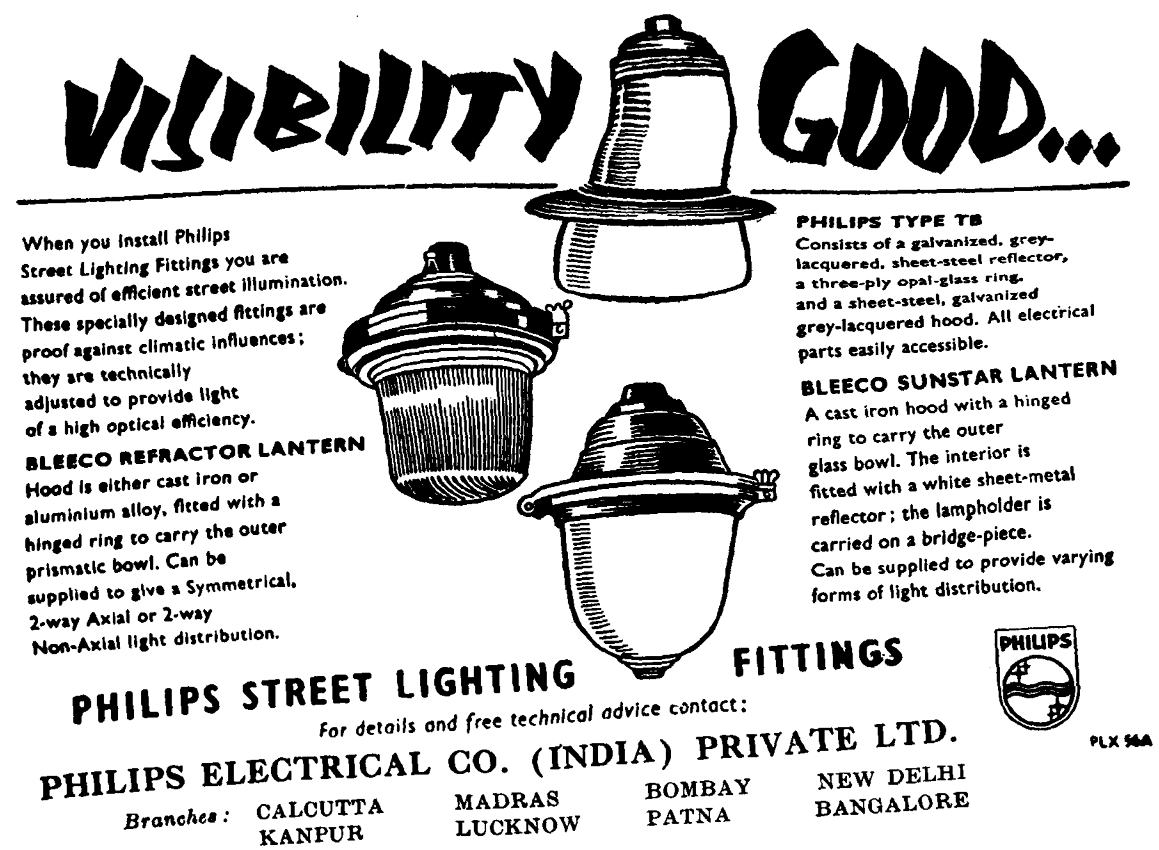
TRAFFIC OFFENCE DETECTION

In Sweden, local police are using helicopters on an experimental basis for detecting traffic offenders.

LIST OF APPROVED WORKS ON NATIONAL HIGHWAYS

S. No.	Job No.	Name of work	Amount (Rs in Lakhs)
		ANDHRA	
1.	1559 AH 7	Widening culverts between M. 91/0 to 157/7 of N. H. No. 7 from Anantapur to Mysore limits.	3.52
		ASSAM	
2.		Two works each costing less than 2 lakhs.	0.57
		BOMBAY	
3.	1566 BM 8	Construction of cross drainage works at Palanpur Khadi in chainage No. 61700 and a minor bridge at chainage No. 78350 in the Kadadra-Kathar Section of the Bombay-Ahmedabad Road N. H. No. 8.	0.65
		HIMACHAL PRADESH	
4.	1549 HP 22	Construction of Road Inspector quarter Ganghat and Godown at Jioori (below Sarahan) on H. T. Road, N. H. No. 22.	0.18
		MADHYA-BHARAT	
5.	1567 MB 3	Widening Sipa river bridge in mile 16 of Indore North Section of N. H. No. 3.	1.93
		MADRAS	
6.		Two works each costing less than 2 lakhs.	2.28
		MYSORE	
7.	1556 MY 4	Widening the bridge across the river Vdavathi at Hiriyur N. H. No. 4.	0.61
		PUNJAB	
8.		Two works each costing less than 2 lakhs.	0.20
		RAJASTHAN	
9.	1562 RJ 8	Construction of bridges on Kherwara-Bichiwara Section of N. H. No. 8.	3.25
10.		Three works each costing less than 2 lakhs.	3.39


ROAD
BUILDING
CONSTRUCTION
GARLICKS ASPHALT MIXER
WARSOP ROCK DRILL
BITUMEN BOILERS
CAPACITY 200 GALLONS AND UPWARDS
CRUSHING MACHINE
Garlick & Co. Private Ltd.
ENGINEERS
JACOB CIRCLE, BOMBAY
AND ALSO AT:- Cox Street, Coimbatore-26, Errabalu Chetty Street, Madras.


VISIBILITY GOOD...
When you install Philips Street Lighting Fittings you are assured of efficient street illumination. These specially designed fittings are proof against climatic influences; they are technically adjusted to provide light of a high optical efficiency.
BLEECO REFRACTOR LANTERN
Hood is either cast iron or aluminium alloy, fitted with a hinged ring to carry the outer prismatic bowl. Can be supplied to give a Symmetrical, 2-way Axial or 2-way Non-Axial light distribution.
PHILIPS TYPE TB
Consists of a galvanized, grey-lacquered, sheet-steel reflector, a three-ply opal-glass ring, and a sheet-steel, galvanized grey-lacquered hood. All electrical parts easily accessible.
BLEECO SUNSTAR LANTERN
A cast iron hood with a hinged ring to carry the outer glass bowl. The interior is fitted with a white sheet-metal reflector; the lampholder is carried on a bridge-piece. Can be supplied to provide varying forms of light distribution.
PHILIPS STREET LIGHTING FITTINGS
PHILIPS
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