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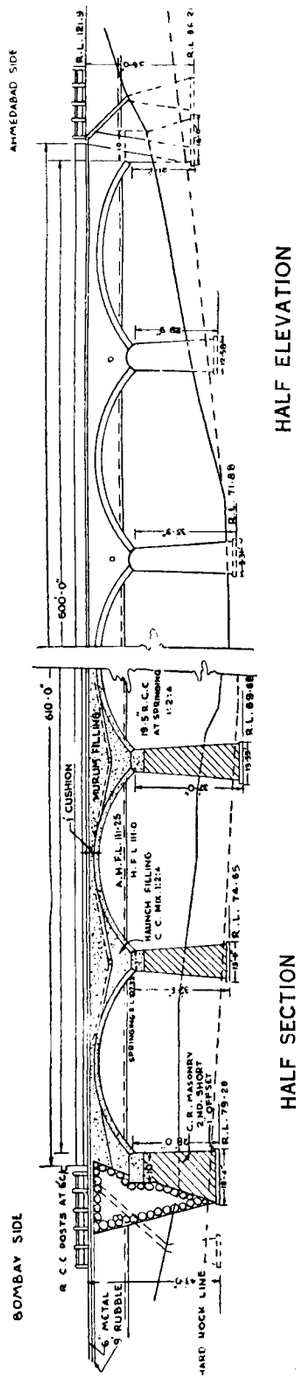

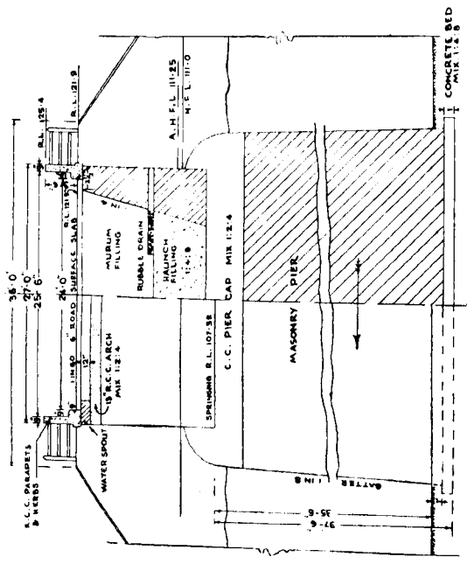

Fig. 1. SURYA BRIDGE

TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

A REVIEW OF
ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

NOVEMBER 1954

BRIDGING INDIA'S RIVERS

THE SURYA BRIDGE

THE Bombay-Ahmedabad-Rajputana-Delhi Road is being developed into a all weather route, at a cost of about Rs 6 crores by constructing the missing links and bridges thereon and by improving the existing kutcha sections of the road. One of the first new bridges to be constructed under this scheme is that across the Surya River at mile 1 of the new Tawah-Talasari Section in the Thana district.

History

The existing masonry submersible bridge 24 ft wide, with arched undervents having a lineal waterway of 224 ft had been serving the needs of the local traffic through the years. But the upgrading of the section to National Highway standard and the increasing traffic thereon necessitated the construction of a high level bridge.

Photo 1. A view of completed Bridge.

Location

The site of the bridge was fixed in a straight section of the river. The section at the site is well defined and has steep banks.

Hydraulic Particulars

Catchment area at site	140 sq. miles
Average annual rainfall in the area	87 in.
Design Discharge	1,01,300 cusecs
H. F. L.	R. L. 111.0
Natural velocity	5.15 ft/sec.
Waterway	9 spans of 60 ft each
Afflux worked out to	0.25 feet
Average Maximum velocity	6.0 ft/sec.*

Foundations:— Unyieldings, with good hard rock available almost at the surface of the bed.

Design and Salient Dimensions

The bridge consists of 9 spans of 60 ft clear each with R. C. C. spandrel filled elliptical arches Fig. 1. This type of structure fitted harmoniously into the hilly landscape around and involved the use of minimum steel and cement which were both in short supply at the time.

Rise to span ratio 1/5th

Width of roadway	24 ft clear between kerbs
Kerb 9 in. by 9 in.	section and parapet 9 in. thick of R. C. C
Steel in each arch	9 tons (approx.)
C. C. in each arch	2275 cu.ft.(approx.)

Loading

The bridge is designed for two lanes of I.R.C. Class A or one lane of I.R.C. Class AA loading whichever produced worse effect.

Photo 2. A Pier under construction.

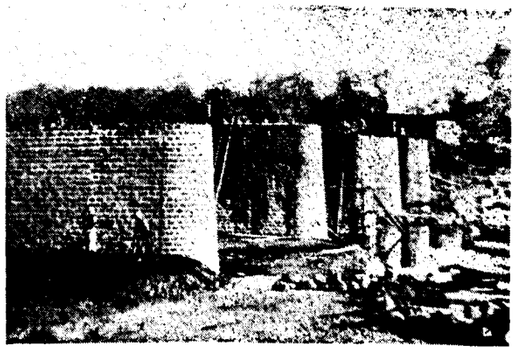

Photo 3. Masonry in Piers in progress.

Wearing Surface of Roadway

6 in. thick 1 : 2 : 4 cement concrete with a camber of 1 in 60.

Masonry

Coursed rubble in 1 : 6 cement mortar.

Haunch Filling

Plain cement concrete 1 : 4 : 8.

* Safe for the rocky bed.

Wing walls

30 ft splayed Top width of 1 ft 6 in. with front batter of 1 in 8 and back batter of 1 in 4.

Piers

Piers 7 ft 6 in. wide at top with side batter of 1 in 18. Maximum height of bridge from the lowest bed level to the top of the road surface is 52 ft.

Special Features

1. The arches were constructed by the "part method" described below.

The whole arch was divided into 9 parts. The anchorage of arch reinforcement was taken 3 ft deep into the piers which were surrounded by stone khandikies all around up to that depth. Firstly the cement concrete 1 : 2 : 4 was filled in the sections adjoining the skewback on either side alternately. After this the central bay at crown and the remaining 6 bays were concreted alternately. An immersion type vibrator with 2½ in. dia. needle was used.

2. The pier has been designed for the worst position of the load i.e., with full live load on one span and no live load on the adjoining one.

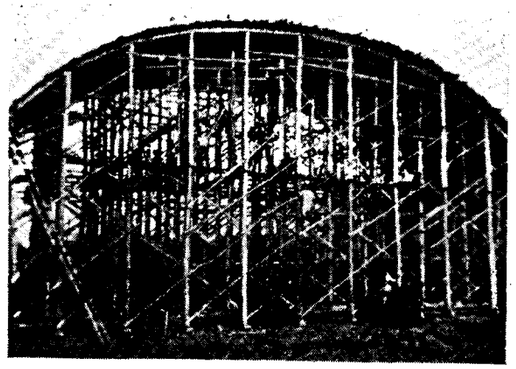

Photo 4. Centering for an arch.

Photo 5. Concreting of arch in progress.

Abutments

The width of abutments is 10 ft. Both their faces kept vertical for a depth of 8 ft below springing level, and a batter of 1 in 3 given below that depth on the bank side.

Cost

Cost of the bridge Rs 6.00 lakhs

Cost per running foot Rs 1,000

Photos 2 to 6 show the various stages of the work.

Photo 6. Placing of reinforcement in proportion.

ROAD DEVELOPMENT IN CANADA

Historical Review

IN 1890 there was not a single mile of Concrete or bituminous pavement on highways or city streets in Canada. At the turn of the century the highest type of pavement in general use consisted of water-bound macadam. It was confined to the main thoroughfares of the larger cities and towns, while side streets were more or less improved rights-of-way. Traffic itself was almost entirely of the horse and buggy type.

Up to this time, with the notable exception of military construction, roads were built to meet local requirements and were usually of a very low standard. Rural roads were developed at a leisurely pace and there was no reason to believe that the absolute supremacy of the railroad for all but entirely local transportation would ever be challenged. The division of jurisdiction over roads between the federal and provincial governments was predicated upon the continuation of the local nature and secondary importance of road systems. For this reason the British North America Act in 1867 specifically placed roads and road construction under the control of the provinces.

The development of the automobile, which appeared on the Canadian landscape in appreciable numbers early in the twentieth century, created a large and previously unexpected demand for new roads of much higher standard and for improvement of the old. Inevitably, the larger political unit, the province, was forced to undertake the responsibility for constructing and maintaining the main highways, because the need for staffs of highway engineers, for large, powerful, expensive units of road building machinery and for the tremendous sums of money required to carry on the large-scale activities were beyond the financial means of local units of government. During the period from 1907 to 1924 the provinces established the necessary provincial organizations to supervise construction and maintenance programmes on main highways and they also increased their financial support to municipalities for the building of local roads.

Federal Participation

That the growth of road transportation in Canada during the quarter century following 1904 was phenomenal, is indicated by the increase in motor vehicle registration in this period, during which time it multiplied about 2,200 times :

1904	535
1909	4,809
1914	74,246
1919	342,436
1924	645,263
1929	1,187,331

In 1919 the federal government acknowledged its concern and interest in the development of roads by passing the Canada Highway Act. This Act established a fund of 20 million dollars to be utilized by the provinces up to 40 per cent of the cost of construction and improvement of roads designated by the provinces and approved by the federal government. The total mileage of trunk and market roads authorized for this federal aid was 24,709. The amount allocated for this purpose by the federal government was not all spent until the fiscal year ending March 31, 1928.

Trans-Canada Highway

In 1932, the federal government passed the first of a series of legislative measures for the creation of works projects to combat the effects of economic depression. These unemployment relief projects included road building for which the senior authority provided sums of money to be matched dollar for dollar by the provinces. These agreements continued until 1941 when they expired. During that period the federal government spent a substantial amount on roads, much of it on the projected Trans-Canada Highway, particularly in Northern Ontario, where there was a large gap in the east-west artery.

Federal aid during these two periods, in addition to highway construction in national parks and assistance for certain special projects, represented the entire extent of the federal government's participation in road building until it embarked on the Trans-Canada Highway project in 1949. Neither the Canada Highway Act of 1919, nor the relief projects of the thirties were permitted to intrude upon provincial jurisdiction over highways. They had only the status of temporary measures intended either to encourage road building or to alleviate national economic distress.

Since 1920 the provincial highway systems in the nation have been developed along more systematic lines than formerly but the independent programming of the provinces, the desultory nature of federal assistance and the resistance of the provinces to any intrusion by the federal government into the highway field has deprived the nation of the well-developed and co-ordinated national system of high standard highways that might have now been in existence if an adequate programme of federal aid had been in effect during the past 30 years.

On December 10, 1949, the Trans-Canada Highway Act was passed providing for the greatest participation in highway construction that the federal government has undertaken so far. A fund of 150 million dollars was appropriated to be matched dollar by dollar by the provinces and to be spent on " the shortest practical east-west route " across Canada and each of the provinces. The route was to be designated by the provinces and was to be acceptable to the Trans-Canada Highway authority. Eight of the ten provinces have so far signed agreements which specify the federal government's right to establish design standards, to inspect routes and construction and to audit accounts.

It is expressly stated in the Trans-Canada Highway agreements with the provinces that the arrangement is temporary and will expire in 1956.

(Extracted from "The Report of the Pilot Committee on Roads for Canada" Nov. 6 1951)

DEFINITIONS OF HIGHWAY ENGINEERING TERMS

SIGHT DISTANCE: The distance along the road at which a driver has visibility of objects stationary or moving at a specified height, above a carriageway.

SUPERELEVATION: The inward tilt or transverse inclination given to the cross section of a carriageway on a horizontal curve to reduce the effects of centrifugal force on a moving vehicle. Superelevation is generally expressed as a slope.

DO YOU KNOW?

The first reinforced concrete structure was a boat? It was built in 1850 by the Frenchman, Lambot, who also made extensive use of concrete in the manufacture of flower pots.

CONCRETE ROADS AND MOTORWAYS OF BELGIUM

Concrete Roads

BELGIUM has some thirty million square yards of concrete-paved main and secondary roads (apart from the motorways); since 1948 an average of about three million square yards a year of concrete paving has been laid on provincial and municipal roads alone.

The majority of the motorways have been built since the war but many date from the early thirties.

A joint visit to Belgium was made by members of the Co-operative Research Committee of the Road Research Laboratory and the Cement and Concrete Association, and some fifty members of the Pavings Development Group (Concrete and Soil-Cement) - contractors, engineers and plant manufacturers. The following is a description of some of the roads inspection by the group.

The main road south from Brussels to Waterloo and Charleroi, its westward branch from Charleroi to Mons and Tournai, and the Tournai-Brussels road which completes the triangle, are typical of most post-war road construction work in Belgium, where State and Provincial roads are concerned.

The general design consists of a width of 29 ft 6 in. to 34 ft 6 in., divided into three traffic lanes and laid as three 8-in. thick concrete slabs. Longitudinal joints are treated as simple butt construction joints; transverse joints, which are spaced from 26 ft to 50 ft apart, are constructed without dowels. The cycle track on either side of the road is paved with concrete, separated from the carriageway by bankettes of stone sett paving.

The mechanized plant used in Belgium consisted of the complete train of three machines and curing tents. First was the spreader. This machine distributes the concrete over the surface of the road, levelling it to the required height. The mixed concrete is tipped into the bottomless trough of the machine which is provided with transverse bars that help to keep the concrete evenly distributed as it falls through, the operator on the platform of the machine can move the trough backwards and forwards transversely over the road, while the whole machine moves longitudinally on its rails, actuated by a motor. The spreader is followed by the S.G.M.E. vibrator-finisher which compacts the concrete to a generally smooth surface. A rotating bar with the paddle blades placed at the front of the machine gives the concrete a final levelling before compaction, to obtain the necessary surcharge, and a finishing beam at the rear is there to give it a final smoothing if desired. This, however, is usually considered excessive and the very slightly granular surface given by the ordinary vibrating beam is preferred. Lastly comes the joint-cutting machine now used on all State roads in Belgium. This machine is provided with a knife of the width of the road slab, which is sunk into the concrete about half-an-hour after placing, vibrated within the concrete and withdrawn, leaving a clean joint which is immediately filled with a performed filler. This generally consists of a strip of bitumen-coated cork, its sides faced with bitumen-impregnated felt. To the rear of the joint-cutting machine was hooked the train of curing tents-metal roofs which are left over the road for some twenty-four hours. As soon as the concrete is set sufficiently to bear a man's weight without marking, the tents are moved on and the road kept covered with damp sand for 10 to 15 days. The whole train runs on rails welded to the side forms; when concreting the second slab the wheels on one side run on the hardened concrete of the first. Each piece of plant was said to

require two men, making a gang of six employed on the actual concreting.

The road is constructed in two 10 ft strips. The subgrade here was clayey and the site had not previously been paved. The 8-in. thick concrete slab was being laid on a sub-base of ½ in. of sand, 4 in. of stone rejects and a 1½ in. topping of sand. The sand was being compacted by a vibratory roller.

The concrete was mixed at a central mixing plant nearly a mile away and brought to the site in a side tipping lorry; the contractors said they had no trouble with segregation. This, incidentally, appears to be standard practice in Belgium.

Near Leuze, on the road from Tournai to Brussels, a stretch of concrete carriageway some 640 yards in length has been constructed, for test purposes, without transverse joint. It was laid during the early summer of 1950, on a foundation formed partly by an existing lean concrete slab 6 in. thick, and partly by a widening strip of crushed stone placed on either side. The road is laid in two slabs each 15 ft wide and 7 in. thick throughout, separated by a longitudinal joint, each slab being reinforced with a different weight ef reinforcement. In one slab there was 7¾ lb per sq. yd. of reinforcement, and in the other 13 lb per sq. yd.; that in the first slab consisted of 10 mm. bars 5¾ in. apart in the longitudinal direction and 6 mm. bars 1 ft 8 in. apart in the transverse direction; in the second slab the transverse reinforcement was the same, but the longitudinal reinforcement consisted of 15 mm. bars 9 in. apart. Special steel with a breaking strength of 43 tons per sq. inch and an elastic limit of 30 tons per sq. inch was used in both.

Neither slab has cracked at all over a length of some 200 ft from the ends. After this the slab with 7¾ lb per sq. yd. reinforcement showed a considerable number of fine cracks, while that with the 13 lb per sq. yd. reinforcement had much fewer and much wider cracks.

Measurement of movement in the slab was effected by means of an apparatus passing a ray from one side to the other of the road, against which the movement of studs fixed in the road's surface could be measured. From the test so far it has been concluded that either a higher percentage of reinforcement or a much higher elastic limit in the steel, or a combination of both, would give better control of the formation of cracks in a slab constructed without joints.

Not very far from Brussels, to the south-west, is Geesbeek — a well-known beauty spot, the road has a total width of 20 ft, and was being constructed in two 10-ft wide slabs, 8 in. thick. Transverse joints occurred at intervals of from 35 ft to 42 ft and were staggered about a foot. This arrangement was said to avoid the disadvantage to the riding surface which could have ensured had the joints been opposite one another, while eliminating the sympathetic cracks that sometimes occur when the spacing is greater.

The joint cutting machine, known as the Vibrogir, was a lighter model than that seen at Tournai, and costs £1,000, as compared with the £2,000 S. G. M. E. machine in use at Tournai.

Here, also, the concrete was mixed about a mile from the site. The mixer was an elevated machine of about one cubic yard capacity, fed from four hoppers containing sand and three different sizes of coarse aggregate, and discharging into gauge boxes fitted to trolleys. The cement was measured by bag.

For a road, being similarly constructed between Deinz and Tielt, in the province of East Flanders, the foundation was provided by the old stone setts covered with a 3-in. layer of slab sand and compacted by a vibratory roller.

At St. Nicolas, near Antwerp, housing estate roads are constructed with interlocking concrete blocks, by a building society for small property owners.

Fixing of Tram And Railway Lines In Concrete Slabs

The setting of tram lines and level crossings in the concrete was a recurring theme. In Belgium this aspect of road construction is not merely an urban problem, but one which closely affects the construction of main roads between towns,

Belgian towns and cities still rely almost entirely on the tram service for their public transport, and although for replacement of trams by buses is continually under discussion, it is strongly, and so far successfully, being resisted by the powerful tramway companies. In the country, towns are linked by a network of *tramways vicinaux*, the long-distance trams—not quite trains—which run along the roadside, with occasional diversions over the fields. Moreover, in such a flat country railway level crossings are a common occurrence. Thus the installation of tram and railway lines in the road slab is a problem to which Belgian engineers must continue to give serious attention. They appear to have solved it extremely well and all such crossings have been achieved with a remarkably smooth and level surface.

In Brussels at the junction of the Avenue Churchill with the Chaussee de Waterloo and all along the Chaussee, which leads out of Brussels to the village and battlefield of Waterloo, the concrete carriageway lies on either side of a central band 14 ft wide, in which the double tram lines are set. The centre strip is constructed with a surface layer of asphalt, generally laid on a lean concrete base.

In the little town of Binche, near Charleroi, the double lines of track are set in the 720-yard long concrete-paved road, and a novel but practical method of construction had been used. The concrete is laid in two superimposed slabs, supports for the tramlines being embedded in the lower foundation slab. The supports consist of short lengths of old rail laid crosswise and upside down, with their 'top' flange slightly proud of the top surface of the lower slab. The tramlines are fixed by clips and bolts to these cast-in lengths of rail and the top slab is then cast.

On the Charleroi-Mons road, between the small towns of Peronues and Bray, the road passes over two level crossings, one straight and the other on the skew, which are similarly constructed. Both are practically imperceptible from the point of view of riding quality, and in both cases the concrete slab has behaved extremely well.

Approaching Charleroi, a length of road on either side of a level-crossing has been given a textured surface to act as a braking strip. Crushed stone was scattered on the fresh concrete and pressed in by one pass of the vibrator-finishing machine. The resulting surface has the appearance of being lightly and crisply pitted all over; it is said by the Divisional Engineer of the Province to be successful in frosty as well as wet weather.

Motorways

Belgium, although a small country, has unhesitatingly decided that motorways are essential to its full economic development. As in most countries, the volume of traffic in Belgium had vastly outgrown the capacity of the roads when, some years before the war, it was decided that the road system must be modernized. Since then the number of motor vehicles has continued to increase, while the proportion of lorries to private cars has grown even more noticeably; lorries now account for over thirty-six per cent of the total number of vehicles on the roads.

With this heavy volume of traffic on roads which were never designed for it, the accident rate was increasing at a disquieting rate, one of the main contributory causes being lack of continuity in a road's width, alignment and surface texture. Another serious lack in Belgium has been a good network of link roads, the absence of which frequently formed a serious obstacle to the economic development in one or another area; for the most part the Belgian road system suffers from being too radial in design. Thus the problem facing the Belgian administration in its road reconstruction programme was twofold: the construction of great trunk roads capable of carrying the very heavy volume of traffic between the important industrial centres, and the modernization of the whole network of roads covering the entire country.

Since work was put in hand the main trunk roads have been widened to 29 ft and again to 34 ft, but it is now becoming evident that in a great many cases these widths are already inadequate for the ever-growing needs of the traffic. To redesign existing main roads to the necessary widths and simultaneously to improve their alignment presents almost insuperable difficulties in built-up areas.

The only practical solution therefore appeared to be the construction of separate motorways across open country, not to replace the existing roads, which pass through the villages and towns of the countryside, but to duplicate them, running largely parallel, but reserved to motor traffic and incorporating the classic features of motorway design-restricted access, flyover and under bridges and dual carriageways.

It is exactly twenty years since the first plans for a motorway system were drawn up, but between 1934 and 1940 little had been done, and that little piecemeal and unco-ordinated. At the outbreak of war a stretch of the Ostend-Brussels motorway was in existence and a short section of the Antwerp-Brussels road. Progress on the work was then interrupted by the war, but since 1949 it has been resumed at a greatly accelerated rate and very great advances have been made in the construction of motorways: that to Antwerp is practically complete, but for the entrance into the capital; that to Ostend has been carried beyond Ghent on the Brussels side and to within a few miles of Ostend on the other.

Ostend-Brussels Motorway

The Ostend-Brussels motorway when completed will have a total length of some seventy miles. The completed portion, from Jabbeke at the west end to a point some six miles beyond Ghent at the east, is now in use, though, as a number of bridges are still not built, crossings and access points are in many places on the level where they will ultimately be by bridge and cloverleaf.

The original design of the motorway, as constructed before the war, provided for a total width of 98 ft 6 in., made up of two 23 ft concrete carriageways flanked by asphalt-surfaced bankettes 1 ft 4 in. wide on the inside and 3 ft wide on the outside, a planted centre strip 10 ft 6 in. wide, and 16 ft 6 in. wide verges on either side. In the new construction, the 98 ft 6 in. width is maintained, but the width of the carriageway is increased to 24 ft 6 in each, the bankettes are 1 ft 4 in. wide throughout and the width of the centre strip is increased to 11 ft.

In the section between Brussels and Alost (not yet constructed) the total width is to be 124 ft, to allow for carriageways 37 ft wide, each accommodating three lanes of traffic.

The motorway gives a general impression of easy efficiency, but it has nothing inhuman about it. It is a friendly road, not isolated from the country-side, but part of it, bordered by farmland, pine-woods and little green copses where small paths meander. The wide grass verges on either side enable a car to draw up where the driver, rather than the Government, decides. There are, furthermore, brick-paved lay-bys at 550-yard intervals. The centre strip is green, planted with privet and rhododendron, with young flowering mountain ash between. The gradients are kept low and steady (the maximum permitted is 4 per cent) so that there are points where the road is carried on embankment and bridges over canals, railways and roads in the valley below: at one such point the ancient spires and belfry of Bruges stand up among the trees some three or four miles to the north.

The riding surface is excellent, and the colour is designed for easy driving — the buff of the concrete carriageways contrasts with the black-topped bankettes and the access roads again are made plain by an asphalt carpet. At one point on the pre-war section of the road an interesting touch occurs—at the junction with the access road to Bruges the carriageway is coloured red; the colour is as fresh and clear today as when it was placed twenty years ago to warn motorists that they were approaching the junction.

The embankments are built up of earth compacted in layers not more than 1 ft 6 in. thick. They are formed either with soil from the cuttings, or when this is not available in sufficient quantities, from borrow pits near the road. These pits, later filled with water and bordered with grass and a natural growth of wild flowers, bushes and young trees, form attractive lakes at the roadside.

The treatment of the sub-base varies with the foundation conditions. On embankment, where the earth has been placed hydraulically, no sub-base is

provided. Where, on the other hand, the embankment is mechanically placed and compacted there is an 8 in. layer of crushed stone, graded from 0 to 20 mm. and from 40 to 63 mm. Section in cutting have a similar crushed stone subbase placed on a 1 ft layer of sand. The concrete slab is 9 in. thick and is laid to a cross fall of 1.5 per cent. It is made with two distinct types of mix, varied for experimental purposes: one continuously graded and batched by volume, consists, approximately, of 1 part of rapid hardening Portland cement to 1 part natural sand, 2 parts 25 to 40 mm. stone, and 2 parts 2 to 25 mm crushed stone. The alternative mix, made with gap graded aggregate and batched by weight, consists of 772 lb of rapid hardening Portland cement, 992 lb of dried natural sand, 1,047 lb of crushed stone graded from 5 to 10 mm. and 2,480 lb of material from 40 to 60 mm. Both mixes are required to give a minimum compressive strength of 8,500 lb per sq. inch at fifty-six days.

In the construction of the road, the bankettes were placed first, and used for fixing the rails on which the road-making plant was to run. Generally, no reinforcement is used on Belgian roads, but in certain places on the motorway, where the nature of the subgrade makes it necessary, mat reinforcement, with a weight of approximately 4½ lb. per square yard, is introduced in the bottom of the slab.

Construction of the concrete slab is entirely mechanized. The concrete is mixed at a central plant and transported by lorry to the point of placing. There it is tipped into the trough of the spreading machine which distributes it over the surface of the road.

Following the spreader, the concrete is compacted by the S.G.M.E. vibrator-finisher. Transverse joints are cut in the fresh concrete by means of the S.G.M.E. joint-cutter, and the joint immediately filled with performed filler.

Near Hekelgem, at the Brussels end of the motorway, a 270-yard-long section is being used for experimental purposes, to test the behaviour of the concrete slab and the sub-base in the presence of a number of variables. The soil has been given a thorough preliminary examination by borings and laboratory tests, and is now being tested after different treatments, prior to proceeding with the concreting.

The concrete slabs are to be of 6, 7, 8, 9, 10 and 12 inch thickness and are to be laid either directly on the soil or on foundation consisting either of 10 in. of compacted sand, 6 in. of broken stone or 6 in. of lean concrete. Each of these combinations will be laid on both compacted and uncompacted soil.

One lane of the experimental length in each carriageway will be used for accelerated traffic tests by vehicles to be provided by the army. The vehicles will be loaded to a 6 ton wheel load (13 tons is the maximum axle load permitted in Belgium). They will keep to the same line on each circuit and the trafficking will continue until failures occur. The remaining lane in each carriageway will be used for static loading tests.

During tests, strains (surface only), pressures and deflections will be measured.

An ultrasonic method of measuring the quality of concrete, developed by Professor Magnel of Ghent University, was demonstrated on the motorway. This method differs slightly from that developed in this country in that a mechanical hammer is used for applying the pulse and measurements are made on the horizontal surface of the road. It is said that by this means the crushing strength of the concrete can be measured to an accuracy of ± 300 lb. per sq. in. of the true value.

Antwerp-Brussels Motorway

The Antwerp-Brussels motorway has been constructed in two distinct stages—the first before the war, between September 1936 and January 1937, and the second, itself again in two stages, in 1950 and 1952. Near Brussels it runs into a single carriageway avenue laid in 1932, which leads to the royal suburb of Laeken.

This early road, like the remainder of the motorway, carries all the direct traffic, now amounting to some 8,000 vehicles a day, many of which are heavy lorries,

(*Continued on page 30*)

PRESENT TRENDS IN FRENCH ROAD-BUILDING TECHNIQUES

AFTER the stagnation of the war years, French techniques in road construction have been developed rapidly during the past few years, and fundamental changes are evident both in outlook and methods.

In general, one might say that road-building, has acquired the characteristics of an applied science and the simple rule of thumb methods of the pre-war period are being replaced more and more by precise regulations which are based on definite criteria and which permit engineers to follow more closely changes actually occuring.

Simultaneously, the possibilities of mechanisation have been considerably increased, opening up to the road builder fields hitherto unsuspected, and making road construction one of our more important industries.

France increased utilisation of local materials in the construction of highways; and developments in the use of coated materials.

Increasing utilisation of local materials

Advances in this field have been assisted, in France, by the occurrence of local raw materials which can be exploited without difficulty using mechanical methods, namely, gravels which are found in river beds, old watercourses and glacial regions, river sands, granitic sands, debris from landslides, soft limestone, industrial wastes, etc.

The use of these materials is extending rapidly and that is why cobbled base courses stone soling are being abandoned in favour of materials comprising bonded fines.

In the same way, the classical macadam, prepared from hard stone chippings, is in some cases being replaced by gravel consisting of partly crushed ballast.

There is also a growing tendency to adapt methods of construction to the material available rather than to search for materials suitable for a particular method. Therefore, considerable savings are realised since the cost of both manufacture and transport is reduced.

Our experience in the utilisation of local materials is, as yet, insufficient for precise standards of use to be laid down. Until this is possible in order to prevent disappointing results, contractors are advised against changing their methods and to issue several very limited general instructions.

The recommendations made for the choice of materials are:

1. The materials should be suitable for the preparation of well-compacted surfaces. This is usually possible with uniform granulometries of the type A. A. S. H. O.

2. The materials should have a minimum cohesive value due to the presence of a certain proportion of clayey mortar, which helps, among other things, in compacting.

This proportion should always be limited so that the stability of the finished base is not endangered. The plasticity index of the mortar (the proportion passing 0.5 mm.) should be less than 6 for upper layers which are to be surfaced.

This is the most decisive factor in this type of method, since any error, however slight, in estimating the quality of the

mortar may have disastrous effects on the final result.

4. If possible, the weight of fines (the fraction with particle size less than 0.08 mm.) should not exceed 60 per cent of that of the mortar, nor comprise above 10 per cent of the total weight for gravel soils and 20 per cent for sandy soils.

It is therefore obvious that the use of local materials cannot be contemplated without rigorous quality control to ensure that the conditions stated above are satisfied.

Eleven laboratories are to be established in the more important French towns and they will be equipped with all the apparatus necessary for studying soils and raw materials. They will have facilities for the determination of granulometrics, Atterberg limits, compactabilities, etc.

When relieved of the necessity for carrying out routine testing, the Laboratoire Central will be able to devote the major part of its resources to research.

In addition to this expansion of laboratory facilities in France, methods are being developed for the investigation and characterisation of local raw materials.

Experience has shown that mineral deposits are, in general, not well known, even by the local population, and they have been surveyed only very irregularly. It is therefore necessary to extend the field of investigations if sufficiently large and homogeneous deposits are to be exploited. The commercial potentialities of the methods in question depend on the fulfilment of this condition. Systematic studies of local materials have only recently begun in France, and the actual methods adopted are as follows:

—Geological examinations, and in particular a study of geological maps which define the areas for further investigation.

—A study of aerial photographs which can yield much valuable information concerning the terrain, drainage, and worked out or abandoned quarries, which would otherwise be difficult to obtain from the ground because of vegetation and relief.

—Enquiries and examinations on the spot, which, however, give few useful results since it has been found that the local population has only a very vague idea of the surrounding countryside and very quickly forgets the old workings which are visible on aerial photographs.

—Geophysical prospecting and, in particular, electrical sounding which gives information, not only on the nature of the subterranean strata, but also on the quality of the deposits. For instance, the resistance of a bed of gravel is related to the percentage of fines it contains and the method, therefore, makes it possible to distinguish between beds of gravel which are of good quality, and those which contain too much clay.

—Finally, rapid sampling which is usually carried out by boring.

Judicious application of these various procedures is, for the most part, a question of guess work and rule of thumb, but we hope eventually to make some progress in this connection and be able to specify a correct approach.

On the question of the use of binders, it is certain that the increasing use of materials containing an appreciable proportion of fine particles will result in wider use of impregnation processes rather than penetration methods which were specially adapted for the treatment of macadams.

Products based on tar are of particular interest to road builders for this purpose because of their adhesive qualities and ease of mixing with fine particles. They are consequently likely to have increasing importance.

Developments in coated materials

Surface coating has always been popular in France, and even to-day this type of surface is the most widely used and favoured by civil engineers.

During the past few years there has been, however, a distinct trend towards the use of pre-coated materials.

This is mainly due to the increase in traffic, the annual rate of increase of which is relatively high, reaching 7 per cent. This means that, roughly traffic is doubled every ten years.

The remarkable smoothness obtained on roads constructed from pre-coated materials, which contributes both to the comfort and economy of road users, has served to reinforce this trend. Certainly, the amount of pre-coated materials used in France is still far below that used in Great Britain, but it is probable that in time this gap will be gradually reduced.

The use of pre-coated materials is, to a large extent, a practice which grows spontaneously since an increase in the quantity used means more efficient application of the materials, a reduction in unit price and consequently greater tonnage for the same price.

The interests of road builders are concentrated on three methods:

Hot impregnation at a central plant with large output (50 to 100 tons per hour) of materials with uniform granulometry. The proportion of untreated material in the product is about 8 to 15 per cent.

Cold impregnation in travelling plants which are mobile and which treat on the site prepared gravels This method gives products with a quality inferior to those from the former, but it is more flexible and therefore better suited to undertakings of medium importance.

Impregnation at an established plant using tar and slag which gives the well-known product tarmacadam.

Tarmacadam is widely used in the regions of France where the metallurgical industry is well developed, that is, mainly in the North and the East.

Because of its versatility and storage possibilities tarmacadam is always very popular among road builders, who use it from choice in the construction of trunk highways. Various methods have been tried successfully for finishing tarmacadam surfaces and it is possible to obtain dense surfaces which are resistant to ageing. In this connection the composition "schlemm" is noteworthy. It is a mortar based on sand, asphalt and bitumen which has a liquid consistency which enables all the cracks in the tarmacadam surface to be filled easily.

(Extracted from "Road Tar" September, 1954.)

MANAGEMENT

"A fixed and rigid system of management," wrote Ford, "is not really a system of management at all—it is just a system; and anyone who attempts to manage according to rules will do well to inquire whether he is managing or being managed."

"No methods or formulas can be devised to substitute for human judgment and leadership. There can be no judgment without complete knowledge of that which is to be judged. There can be no leadership if the leader does not know what he is leading."

Experimental Surface Dressing Over Laterite Macadam on the Baripada-Balasore Section of Calcutta Madras Road

(Contributed)

THE surface of this road is being maintained at present with the laterite metal available by the roadside for an average rate of about Rs 9 per 100 cu. ft. The traffic is of the order of 275 tons a day of which only 1/3 is bullock cart traffic and the rest pneumatic tyred. For such light traffic the laterite available lasts well enough for a time ; but, being intrinsically a soft material, it wears out quickly by attrition and abrasion. Every passing vehicle raises clouds of dust in dry weather, while in the wet weather the surface develops pot holes.

The highway which connects the two District Headquarter towns of Baripada and Balasore and is the access road to the railway from the interior of Mayurbhanj District has to be maintained to a fair standard. So an estimate was prepared for upgrading the surface by providing surface dressing over granite stone metal 4 in. thick over laterite soling 6 in. thick. The cost worked out to Rs 8 lakhs for 28½ miles or to Rs 28,000 per mile. It was considered that this amount was exeessive for a surface which has to cater to a present traffic intensity of hardly 300 tons a day. The main element responsible for pushing up the cost is the granite metal which has to be transported over 21 miles and costs Rs 57 per 100 cu. ft.

Experience in Burma and Nigeria showed that laterite can be surface dressed and that the treatment improves the surface. So full scale experiments under actual field conditions were initiated on this road in 15/1 to 4 and 17/5 to 8 to see if a 6 in. thick laterite metal crust cannot take directly of a wearing coat of surface dressing and serve for a reasonable period.

Relevant data are given in the table below.

The specification adopted was to surface dress the laterite Water-Bound Macadam renewal coat 6 in. thick after applying a priming coat of Shalimar Tar No. 3-A. The primer was applied at the rate of 30 lb per 100 sq. ft. and flushed with 2.5 cu. ft. of sand.

	Experiments in the 16th mile	Experiments in the 17th mile
Dates of renewal of Laterite Water-Bound Macadam	28-3-52 to 3-4-52	6-4-52 to 1-5-52
Dates of Application of the Primer coat	11-4-52 to 17-4-52	8-5-52 to 15-5-52
Surface dressing—Dates of application	29-6-52 to 1-7-52 and 2-11-52 to 4-11-52	22-5-52 to 26-5-52
Quantities of Binder and chips used for 100 sq. ft.	37 lb of Shalimar Tar 3 applied with a brush and 5 cu. ft. of fine grained granite chips ¾ to ¼ in. having good wearing qualities.	30 lb of Shalimar Tar 3 A applied with a brush and 5 cu. ft. of white quarry pebbles.

Tests on the laterite used for the water-bound macadam showed the following :

(1) Wearing quality in the dry weather and raining season are poor.

(2) Compression strength fairly good.

(3) Apparent specific gravity 3.03.

(4) Absorption of water 0.73 per cent.

(5) Adhesion to Shalimar Tar 3-A good.

(6) Petrological characteristics–Compact, fine grained hornblendischiest.

The area has an annual rainfall of 52 inches and the maximum and minimum temperatures at Baripada town is 115°F in the summer and 47°F in the winter.

The road bed is well drained.

The traffic using the road is of the order of 300 tons a day. The details of a traffic count in the 17th mile from 26-2-54 to 4-3-54 are given in the table below.

	Mechanically prepelled vehicles						Animal Drawn vehicles		Cycles
	Trucks		Number of Buses		other light vehicles		Full	Empty	
	Full	Empty	Full	Empty	Full	Empty			
Total number in the week	106	40	102	—	74	7	376	123	1137
Weight in Tons	636	100	408	—	148	105	564	61	

The average tonnage per day is $\frac{2022}{7} = 289$.

SYMPOSIUM, THE TAIL—PIECE

The word "symposium" has now established itself firmly in our technical jargon and no conference is complete without a "symposium" figuring somewhere in the programme. The Oxford Dictionary gives its original meaning: "Ancient Greek after-dinner drinking party with music, dancers or conversation."

THE FIRST ROAD WAGON

In 1769 Captain Nicholus Cugnot, a French army officer contrived a crude steam driven "road wagon" which could run a few hundred yards.

DEVELOPMENTS IN PORTABLE ROADWAYS

IN order that the mobility of the armed forces be made as independent of terrain as possible, the Marine Corps has requested U. S. Navy Bureau of Yards and Docks to develop a portable roadway which can be easily placed over unstable terrain. The roadway, to be operationally acceptable, must be light in weight, easily transported, rapidly installed and support combat loads upto 60 tons. A prestressed timber roadway, currently under development, is one proposal to meet Marine Corps requirements.

A 148 feet length model of this roadway, designed to carry 10 ton loads, was recently tested in mud flats. A typical section of the roadway is 56 inches long, consists of 6 T members constructed of tongue and groove, 2 by 10 inch wood flanges and 2 by 6 inch web members. Deck sections are joined by six $\frac{5}{8}$ inch diameter steel rods which are prestressed mechanically by tightening nuts. Structural 3 by 12 inch wood members are placed along the side edges of the roadway to act as beams and to exclude water and mud. These members, fastened to the decking by tide down belts and steel straps, are joined longitudinally to each other by a stop and dowel joint.

In the first series of tests, the roadway, supported by mud with a bearing capacity of approximately 100 psf. (subgrade Modulus of 1.23 pcf)., was subjected to trials by vehicles varying in weight from 5,000 to 30,650 lb. under a static test load of 30,650 lb., applied by a 14 wheel vehicle, the maximum deflection noted was 0.13 foot. For all magnitudes of loading the effective length of the roadway, for which measurable deflections were observed, was approximately 67 feet.

Heavy Loading Tests

In order to determine the ultimate capacity of the roadway, a series of extremely heavy loadings were applied. To-date, vehicle loads of 72,800 lb have been applied with no evidence of structural failure.

Much work remains to be done in the development of this roadway. It was noted that magnitudes of deflections were approximately twice the theoretical values obtained by mathematical analysis. It is believed that this discrepancy is caused by inaccuracies in the determination of the subgrade moduli. This discrepancy is being resolved by instrumenting the subgrade with pressure cells to obtain more realistic values. Also, experiments have indicated that the bearing capacity of the soil could be increased by at least a third by installing vertical fins along the bottom boundary of the roadway to retain the soil-pressure bulbs. This feature probably will be incorporated in the final roadway. In addition investigations are continuing on methods of simplifying the assembly and installation of the roadway.

At the conclusion of these investigations plans are to scale up the roadway to carry the required 60 ton loads and then conduct the operational evaluation. —*Highway Research Abstracts, August, 1954.*

GOOD BUSINESS

Meeting the other fellow's needs is the surest method of satisfying our own.

HERE AND THERE

1. MADHYA BHARAT'S NEW ROADS

● THE ROAD journey between Guna and Bhilsa, district headquarters towns of Madhya Bharat, will be shortened by 62 miles on the completion of the Bajrangagarh-Aron and Aron-Sironj links, provided in the first Five-year Plan.

2. LEVEL CROSSINGS IN AUSTRALIA

● THE STATE Government of Victoria in Australia has appointed a committee to report on the abolition of railway level crossings. These crossings have for a long time been a problem in Victoria where there are 3,847 of them. Of these only 262 have gates and 85 are equipped with flashing lights or other warning devices.

(*From "Modern Transport", September 11, 1954*)

3. WORK ON TIBET-CHINA ROAD

● A PLEDGE by road workers to complete the highway from Sikiang to Lhasa by the end of this year is contained in a message sent to the first session of the National People's Congress in Peking, the New China News Agency reports.

"After more than three years' hard work," the message says "together with the members of the People's Liberation Army units in Tibet, we have completed a total length of 1,100 kilometres and have now pushed the road to the middle reaches of the Brahmaputra river. The road passes across ten or more high mountains, 4,500 metres above sea level and across the rapids of the Kinshi, the Lantsand and the Salween rivers."

(*From "The Hindu"-29-9-54.*)

4. RESEARCH

● IF IT were possible to show increased profits every time a fresh advance is made in research, if it were possible to point directly and unmistakably to great benefits of the research establishments financed or supported by the Government, then research would be conducted on a much wider scale than it is. But research is not like that; or at least only seldom is it like that. It advances as the sea on the shore-fitfully and unpredictably, a series of creeping movements, each deriving impetus from its predecessors.

(*From "Engineering," August 27, 1954.*)

5. FIFTH MEETING OF THE INTERNATIONAL ASSOCIATION FOR BRIDGE AND STRUCTURAL ENGINEERING, LISBON

● MEMBERS of the IABSE who desire to submit papers for the "Preliminary Publication" are requested to send to the General Secretariat of the Association at Zurich, Swiss Federal Institute of Technology, a short summary before 31st December 1954 and the full manuscript before 15th April 1955. Two typewritten copies of the manuscript are required; the drawings and sketches should be in India-ink and the respective text in pencil, if possible on a separate sheet. Each paper must be accompanied by a short summary, which will be published in the four official languages (English, French, German and Portuguese) valid during the time of the Congress.

The subjects for the 5th Congress, which will be held from 18th to 23rd June 1956 at Lisbon, are as follows:

A. GENERAL QUESTIONS

I. Loading and Strength of bridges and structures.

(a) Behaviour of materials and structures under statical long time loading.

(b) Behaviour of materials and structures under dynamical loading. (Vibrations, fatigue, impact.)

II. Slabs and various curved structures in reinforced concrete.

(a) General calculations (in elastic and plastic fields); experimental methods.

(b) Application of the methods of calculation to steel structures.

(c) Application of the methods of calculation to reinforced concrete structures.

B. STRUCTURES IN STEEL AND LIGHT METAL

III. Welded steel structures.

(a) Systematic investigation of constructional details (theory and experiment).

(b) Structural steels for welded structures.

(c) Various welding methods for the execution of welded steel construction.

IV. Structures in steel and light alloys.

(a) Light construction in steel.

(b) Construction in light alloy.

(c) Various structures (Power transmission poles a.s.o.).

(d) Maintenance of metal structures.

C. STRUCTURES IN REINFORCED AND PRESTRESSED CONCRETE

V. Special problems of reinforced and prestressed concrete.

(a) Crack formation (Use of high-tensile steels and steels with high bond strength, end anchorages, distribution of reinforcement, shear strength).

(b) Influence of atmospheric actions and of temperature changes on the behaviour of structures.

(c) Safety (calculation against cracking, rupture a.s.o.).

VI. Practice of reinforced and prestressed Concrete.

(a) Execution of the structures (formwork, shuttering, placing and control of concrete, transport of concrete, jointing of pre-fabricated elements, observation, control and maintenance of structures).

(b) New developments.

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6. THE MATERIALS ENGINEER IN HIGHWAY ENGINEERING

● "AS THE cost of materials and transport represent anything between 60 to 80 per cent of the cost of highway construction and maintenance, a competent and fully-trained and instructed material engineer may well have in his keeping a great potential source of economy," says Lt. Col. E. W. W. Richards, A.M.I.C.E., and Mr. F. N. Sparkes, M.I.C.E., in their Paper on the functions and place of a materials engineer in highway engineering, read at a meeting of the Institution of Highway Engineers in London.

The authors gave the main functions of the materials engineer as:

(1) to ensure the most effective and economical use of locally available and naturally occurring materials such as soils, road stones and aggregates;

(2) to ensure that synthetic materials (such as tar, bitumen, cement) and proprietory products (such as joint filling and sealing materials) satisfy specific requirements;

(3) to assist in the design of the road in regard to its layout and type, and the thickness and materials of construction;

(4) to exercise such controls over materials and processes during construction as will ensure a uniformity of product, smooth construction schedules and good workmanship;

(5) to organize course of instruction and demonstration to executive personnel so that by precept and example they may become aware of the importance of their particular part of the work and take a interest and pride in performing it.

To fulfil these functions the materials engineer must be thoroughly familiar with the many tests which may be made on various materials and must know how to relate the results to practical requirements. Briefly the tests are:

Soils.—Liquid and plastic limits, plasticity index, particle size distribution, moisture content by various methods, specific gravity of soil particles, dry density/moisture relation, dry density and plate bearing in the field, C.B.R., unconfined compression and tri-axial tests.

Concrete.—Setting time, soundness, fineness (and specific surface area) and chemical composition of cements; strength of standard mortars; grading, specific gravity, water absorption, organic and other impurities, crushing value and bulk density of aggregates; workability and analysis of fresh concrete; compressive and flexural strengths, shrinkage, modulus of elasticity, etc., of concrete.

Bituminous Materials.—Viscosity, distillation test and softening point of residual pitch; phenol and naphthalene content, test for insoluble matter and specific gravity of tars and, where appropriate, for cut-back bitumens; penetration, softening point and loss on heating of bitumens; viscosity, water content, etc., of emulsions; resistance of tars and bitumens to oxidation; grading, water absorption, adhesion, voids and bulk density of aggregates and fillers; analysis of freshly mixed materials.

Estimations of Thickness

A very important part of the work of the materials engineer would be the estimation of the required thickness of road on soils of different types. To make a safe but economical assessment of thickness he must be familiar with various methods of estimation based on soil characteristics. He must further know how to balance his estimates against his own experience so that the thickness finally selected can be the minimum consistent with durability. He will be much helped in this part of the work by making a survey of the condition of roads already existing in the area, and relating the design to the performance of different types of construction on various soils and under changing traffic conditions.

Standards are there, of course, for guidance, but a standard is not intended to be a unique recipe and unalterable; rather must it be regarded as an indication of the direction which should be followed having regard to local circumstances and conditions. If the basic requirements of satisfactory construction or manufacture are to be satisfied, the guidance of standards is general rather than specific, their prescriptions broad rather than restricted, and they are designed to cover

a variety of circumstances. The terms of specification are often qualitative rather than quantitative. It is in the interpretation and application that the element of materials engineering is called into play.

Laboratory facilities (central and mobile) must be provided if the work of the materials engineer is to be fully developed. But in smaller areas a less elaborate outfit can still produce useful results. Indeed, the use of a few sieves and other simple pieces of apparatus may well result in a marked improvement in the quality and uniformity of the materials being judged. The materials engineer must be often inspecting the pit or quarry from which his materials are taken.

Place in Highway Organization

The materials engineer is responsible for the selection, specification, control and use of all materials of construction. The highway organization of which the materials engineer forms part need not be always large or specialised. The research organizations which support them may not be initially of a size or for the resources or experience to undertake very sustained, elaborate and complex programmes of research. The materials engineer can be normally selected from the ranks of senior assistant engineers who have had reasonably long experience, specially on actual construction, and are familiar with its problems and requirements.

Education and Training

The study of materials is not generally considered by university authorities to be suitable for inclusion in their curricula. As a result, graduate engineers leave college unequipped to deal with problems with which they will certainly be confronted in the exercise of their profession. Hence the need for a specialised materials engineer to guide and instruct on materials in the light of his intense specialised knowledge and experience.

(Adapted from "The Surveyor" 3rd April, 1954)

7. CALCULATING WEIGHT OF ROUND BARS

● TO FIND the weight of a reinforcing bar, the following two steps are recommended:

(i) transform the fraction representing the diameter of the bar so that its denominator is 8.

(ii) now divide the square of the numerator by 24. The result gives the weight of the bar in lb. per linear foot.

Thus, to find the weight of a ½ in. diameter bar: the fraction ½ is written as 2/8. Weight per linear foot = $2^2/24 = 0.166$ lb. Again, to find the weight of a 5/16 in. diameter bar: the fraction 5/16 is written as 2.5/8. Weight per linear foot = $2.5^2/24 = 0.26$ lb.

(From "Indian Concrete Journal", September, 15, 1954.)

8. PRETENSIONING AND POSTTENSIONING

● MAJOR DIFFERENCE between the two methods is the manner in which prestress is transferred from the steel tendons to the concrete:

For Pretensioning, the tendons are stretched between heavy external anchorages at the ends of a casting bed, forms for one or more beams are placed around the steel, and concrete is placed in them. When the concrete attains sufficient strength, the tension on the tendons is relieved and the steel between beams cut. Thus, the prestress is transferred to the concrete through bond initially.

For Post-Tensioning, the beam is formed around unstressed tendons, bond between steel and concrete being prevented. The tendons are tensioned with jacks acting against the hardened concrete of the beam, and then the steel is anchored at the ends to it. The tendons may be grouted in later to establish bond, but initially the prestress is transferred to the concrete through the end anchorage.

(From "Engineering News-Record" August 19, 1954)

9. EXPANDED SHALE AGGREGATE REDUCES DEAD WEIGHT OF A BRIDGE

● EXPANDED-SHALE AGGREGATE was used in the construction of the deck of a bridge, nearly 3900 ft long and 31 ft 6 in. wide, over the Columbia river, U.S.A. It is estimated that the dead weight of the structure is about 1340 tons less than it would have been if normal aggregates had been used for the deck. The strength of concrete cylinders was more than 3,000 lb per square inch at 28 days and at 45 days the strength was in excess of 5,000 lb per square inch.

(From "Concrete and Constructional Engineering," August, 1954).

10. HIGHWAY FILL TO BE "FLOATED" OVER MUD FLATS

● A SECTION of a State highway is to be constructed over soft mud varying in depth from 20 to 75 ft. An adequate design, based on exhaustive tests of the underlying material, indicated that the fill should be constructed by pre-dredging to elevation minus 20, back-filling the trench with 5 ft of sand, building the remaining portion of the embankment to elevation plus 8 with clean rocky material, and completing the fill to elevation 17.5 with imported borrow. The estimated cost of constructing the fill in this was very high.

This high cost, and the difficulties of financing such a project, led to further studies in an effort to determine if a less costly method might be found, even if it should invite greater risks.

Experimental section

"Estimates indicated that, if a fill could be floated on the Bay mud, the work could be accomplished for much less cost. Although there was little engineering precedent to indicate such a method of construction would be successful, the possible savings warranted the attempt. An experimental project to construct approximately 2,100 ft of embankment. It was believed possible to float a fill, 400 ft wide at its base, at approximately elevation minus 10.5 ft below the top of the soft mud.

"While the floatation theory was not supported by construction, results of the first experiment were sufficiently promising to warrant further tests of the method on greater depths of mud. An additional section, approximately 1 mile in length, extending over the deeper mud strata was placed under construction. The results of the two experiments demonstrate that a satisfactory fill can be constructed without pre-dredging. The embankment is stable with a base width of 200 ft plus or minus and will carry eight lanes of traffic on a 132 ft roadbed. It is now estimated that the total cost of the fill will be 67 per cent of the cost of pre-dredged fill.

"Based on tests to date, ultimate settlement on the fill is expected to from 1½ to 5 ft, depending upon the depths of mud remaining beneath the constructed fill. Settlement is expected to continue over a long period."

(From "Western Construction", August, 1954)

11. SOIL CEMENT GETS SEVERE TEST IN ENGLAND

● "THE BREAKING of the training walls of the River Thames during the floods in February 1953, some of the roads constructed of 6 in. soil-cement with one surface dressing carried for some months traffic estimated to be in the region of 20,000 tons a day, of vehicles carrying materials for the repair and strengthening of the river walls. On these roads there was no sign of any failure of the road foundation. The main damage caused by this heavy traffic was the shearing off in places of the surface dressing with a thin layer of the soil-cement."

(From "Roads and Streets", August 1954).

CURRENT LITERATURE

ABSTRACTS

U.D.C. 625.7. "TESTS ON THE EFFECTS OF EXHAUST GASES OF JET ENGINES ON PAVEMENTS AND BITUMINOUS JOINT FILLING MATERIALS" 'Annales Des Ponts Et Chaussees, September-October 1954'.

Conventional bituminous pavements and joint-fillers in airport runways offer little resistance to the blast of burnt gas under jet operations.

To permit the study of their behaviour on samples and to secure anti-jet materials, the Laboratoire des Ponts et Chaussees made a testing apparatus, consisting mainly of a small blast pipe fed with illuminating gas and compressed air.

The choice of an adequate rate of combustion controlled by the feed of air and gas, allow to obtain in the jet of burnt gas at some distance away from the mouth of the blast-pipe, temperature and speed conditions approaching the real ones so that a very satisfactory concordance between the effects produced by the apparatus and those of the jet aircraft, may be observed.

Some considerations of a general order on the behaviour of pavements joint and joint-fillers, conclude the report in French.

U.D.C. 691.328 2.691.71. PRACTICAL ASPECTS OF PRESTRESSING BY CABLES. THE PROBLEM OF FRICTION. Annales De L'Institut Technique Du Batiment Et Des Travaux Publics, June 1954.

In structures prestressed by means of cables or bundles of hard steel bars stressed after the setting of the concrete, a large amount of friction opposes the transmission of stresses between the tensioning jacks and the portion of the cables which are in the most highly stressed zone of the structure.

The knowledge of these losses and of the degree of confidence which may be placed in the instruments are essential to the engineer, who must have a convenient method to appreciate their importance.

After a certain number of precise experiments aimed at determining the laws and co-efficients of stress transmission, a graphic design and control method was developed which avoids long and fastidious calculations of the exponential laws. This method makes it possible, using merely the pressure and elongation measurements effected at each tensioning operation and without in any way disturbing the progress of the work, to determine simply and rapidly the losses due to friction and accordingly to ascertain the law of stress distribution along the prestressing reinforcement.

U.D.C. No. 624. Elasticity in Engineering—by Ernest E. Schler—John Wiley and Sons, New York.

The book is divided into three parts. The first part deals with the Fundamental Equations and analysis of methods. In the seven chapters of this part are collected the basic equations in cortesion, cylindrical and spherical co-ordinates which are necessary for the solution of elastic problems.

The second part containing 5 chapters relates to Engineering problems in stable structures. The more commonly used beam, torsion and truss equations are reviewed and their limits of accuracy in terms of the more precise methods of elasticity are given. The third part deals with engineering problems in instability and one chapter each is devoted to columns, beam columns and instability of plates and shells.

SELECTED RECENT LITERATURE IN ENGINEERING JOURNALS

X. BRIDGES AND OTHER STRUCTURES

1. **The Prestressed Conveyor Bridge In Gas Coking Plant at Bertin**; Masiendrof — Robert Schwarz, *Beton Und Stahlbetonbau*, May 1954, pp. 106-115 (in German).

2. **Example of Design of a Simple Prestressed Concrete Bridge**; *Beton Und Stahlbetonbau*, May 1954, pp. 123-126 (in German).

   -Do- -Do- June 1954, pp. 135-138 (in German).

3. **The Lifting up of the Arched Bridge in Nymwegon**; Konrad Sattler, *Der Stahlbau*, May 1954, pp. 104-108 (in German).

4. **Suspension Bridges of Smaller and Intermediate Widths**; *Arne Selberg, Der Stahlbau*, May 1954, pp. 97-102 (in German).

5. **Static Wind Pressure on Suspension Bridges**; B. Topaloff, *Der Stahlbau*, May 1954, 109-113 (in German).

6. **Rapid and Economical Selection of Crane Rail Beams**; Erich Dembicky, *Der Stahlbau*, May 1954, pp. 115-116 (in German.)

7. **The Suspension Bridge Over the Loise at Ancemis**; *Der Stahlbau*, May, 1954, pp. 116-118 (in German).

8. **Proposal in Structural Steel for the Tufels Bridge of over the Schollon Ravine**; *Der Stahlbau*, May, 1954, pp. 118-120 (in German).

9. **The New Construction of the Brudermipl Bridge Over the Isar in Munich**; Hons and Anton Lohr, *Die Bautechnik*, May 1954, pp. 133-136 (in German).

10. **Tunnel and Bridge Structures Under Water, Planning and Execution**; Johannes Fiesinger, *Die Bautechnik*, May 1954, pp. 145-152 (in German).

11. **Design of Curved Frame Members by the Method of Balancing Moments**; Helmut Lindner, *Die Bautechnik*, May 1954, pp. 152-155 (in German).

12. **The Hartelire Bridge at Brest**; *Der Stahlbau*, April 1954, pp. 86-87 (in German).

13. **Prestressed Steel Structures—Economic and Safe Prestressed Structure**; *Der Sahlbau*—April 1954, pp. 91-94 (in German).

14. **Design of Frames by Relaxation of Yield Hinges**; J. Morley English, —Separate No. 322, *Proceedings of the American Society of Civil Engineers*, November, 1953.

15. **Principal Stresses by Photo-Elasticity**; K. D. Mahajan, *The Journal of the Institution of Military Engineers*, April 1954, pp. 115-122.

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(*Continued from page 12*)

between Antwerp and Brussels. During the war it carried the military traffic of three successive waves of armies, Belgian, German and British, rolling back and forth over it invasion and counter-invasion. Now it is a peaceful road shaded by deep-leaved, flowering chestnut trees; a busy road, with a steady flow of traffic, but busy in a quiet, rather suburban way.

The concrete slab is generally 7 in. thick, thickened to 9 in. at the edges and joints. There are transverse expansion joints and a central longitudinal joint crossed, at 3 ft 3 in. intervals, by hooked tie bars 31½ in. long and ⅝ in. in diameter, placed 4 in. below the surface.

This early concrete road, in spite of its age and heavy wear, is in remarkably good condition, with no sign of cracking, and the riding surface is excellent.

The 1936-37 section of the motorway proper is less satisfactory. It has suffered from a poor subgrade and inadequate drainage (in places the level of the water lable is higher than that of the road itself) and some of the slabs have subsided, while approximately one in five is cracked.

The northernmost end of the route, between Antwerp and Boom, is a new-looking and highly efficient dual-carriageway motorway which is to be still further widened by additional carriageways in the future. The two carriageways in this portion are each 23 ft wide, separated by an earth centre strip planted with occasional trees. Sett-paved laybys are provided at intervals, and there is a paved cycle path on either side. The concrete slab is 9 in. thick, laid on a sub-base of compacted sand 1¼ in. thick. There is a longitudinal joint down the centre and expansion joints at intervals of from 26 ft to 49 ft.

In the 1952 portion of this road the expansion joints are constructed without dowels, as is the general practice in Belgium, where all slabs are normally independent of one another. In the 1950 portion, on the other hand, dowels have been used, and it seems fairly evident that they are giving better results. Where they are used, adjoining slabs on this heavily trafficked road are absolutely level with one another, and there is no perceivable movement with the passing traffic. Where, on the other hand, there are no dowels, a slight step occurs in places between slabs, and distinct movement could be perceived. The Belgian authorities are, however, pursuing their trials for a further period before finally deciding on the general adoption of dowels —which would necessarily slow down the rate of construction.

The joints in the earlier portion of the road, where dowels are used, are formed in the ordinary way, a special timber filler being used, with a U-shaped metal cap which forms a channel to take th bituminous filling. Elsewhere the joints are cut in the fresh concrete with the S. G. M. E. vibrating joint-cutter—the method which is now standard practice in Belgium. The standard equipment of spreader and vibro-finisher was also used on this road, without the use of the finishing beam.

This road, which is the most heavily trafficked in Belgium, is of course to be carried up to the entrance to the capital, and it is planned eventually to increase its width to provide additional carriageway carrying in all twelve lanes of traffic.

(*Extracted from 'Concrete Quarterly No. 22'—April-June 54.*)

TREE PLANTING AT THE PROPER PLACE HELPS TRAFFIC

Plantings on the outside of curves and at bridge approaches help materially in defining roadway.

A traffic sign is hardly visible at sun set or sunrise when it is silhoutted against the sky. In such locations a background of trees helps.

BUDGETS AND ADMINISTRATION REPORTS

Government of Madhya Pradesh Budget for 1954-55

The following abstracts have been taken from the Civil Works Budget of Madhya Pradesh for 1954-55.

(All figures are in lakhs of rupees).

	Actuals 1952-53	Revised Estimate 1953-54	Budget Estimate 1954-55
Civil Works (Revenue)			
Rents of buildings	6.27	6.42	6.41
Ferry Receipts	4.12	4.32	4.25
Tolls on Roads	2.22	2.30	2.30
Recoveries of Expenditure	0.78	0.70	0.70
Miscellaneous	4.85	3.00	3.00
Transfer from Central Road Fund	3.56	10.15	14.35
Deduct-Refund	-0.72	-0.15	-0.10
Total	21.08	26.74	30.91
Civil Works (Expenditure)			
(To be executed by the Public Works Department and Local Bodies)			
Original Works			
Buildings	18.27	39.87	55.45
Communications	5.88	12.35	26.56
Miscellaneous	0.34	0.31	0.75
Repairs			
Buildings	22.29	21.88	22.11
Communications	92.95	91.91	94.17
Miscellaneous	0.21	0.93	1.10
Reserve with Government	...	...	2.00
Suspense	1.25	1.00	3.00
Grants-in-aid	3.04	0.86	1.50
Establishment*	37.97	33.35	47.21
Tools and Plant*	13.46	17.58	16.09
Total	195.66	220.04	269.94
Expenditure under Post-war Development Scheme.			
Original Works			
(a) Buildings	35.84	57.24	71.26
(b) Communications	59.14	52.76	55.76
(c) Miscellaneous	0.27	0.41	1.00
Grant-in-aid	0.31	0.73	0.78
Total	95.56	111.14	128.80
Total Expenditure on Civil Works met from revenue Account	291.22	331.18	398.74

* Includes expenditure under Post-War Development Scheme.

Capital Account of Civil Works outside Revenue Account.

	Accounts	Revised Estimate	Budget Estimate
Original Works			
Buildings	0.80	13.79	5.63
Deduct amount Financed from the Central Road Fund	-0.54	-0.55	-0.56
Deduct receipts & recoveries on capital Account	-0.37	—	-11.25
Establishment & Tools and Plant	nil	nil	nil
Total	-0.11	13.24	-6.18
Receipts from Roads			
Receipts under Motor Vehicle Acts	41.84	42.55	42.65
Sales Tax on motor Spirit and lubricants	40.37	42.00	42.00
Total	82.21	84.55	84.65

GOVERNMENT OF MADHYA PRADESH BUDGET FOR 1954-55.

(A brief review with reference to Civil Works)

THE estimate of revenue receipts for the year 1954-55 is Rs 2883 lakhs, including grants from the Government of India and transfer from the Development Fund. The expenditure on revenue account is estimated at Rs 3068 lakhs, resulting in a deficit of Rs 185 lakhs. But the deficit is only on revenue account, while the year is expected to close with a substantial overall balance. The revised estimate for 1953-54 indicated a revenue of Rs 2573 lakhs and expenditure on revenue account of Rs 2521 lakhs, with a consequent surplus of Rs 52 lakhs. In 1952-53 the actual revenue and expenditure amounted to Rs 2415 and Rs 1950 respectively, leaving a surplus of Rs 465 lakhs.

Expenditure on Civil Works during 1954-55 is estimated at Rs 399 lakhs, which forms 13.8 per cent of the total State revenue. The corresponding ratios for the two previous years were Rs 12.8 per cent for 53-54 (Revised Estimates) and 12.0 per cent for 1952-53 (Actuals). These figures do not take into account the Capital expenditure on Civil Works met from sources other than revenue. Out of the total revenue expenditure on Civil Works, Communications (Original Works and Repairs only) account for 6.5 per cent of the State revenue in 1952-53 (Actuals) and 6.1 per cent for both 1953-54 (Revised Estimates) and 1954-55 (Budget Estimates).

LIST OF APPROVED WORKS ON NATIONAL HIGHWAYS

S. No.	Job No.	Name of work	Amount (Rs in Lakhs)
		ASSAM	
1.	951 AS 40	Reconstruction of bridge No. 34/2 damaged during the rains of 1952 on G. S. Road-National Highway No. 40 in K & J Hills Divisions.	0.44
		HYDERABAD	
2.	952 HD 9	Upgrading Hyderabad-Masulipatam Road-N. H. No. 9 from mile 17 to 20.	0.49
3.	953 HD 9	Upgrading Hyderabad-Masulipatam Road-N. H. No. 9 from mile 20 to 92/4 and 107-115.	14.19
4.	957 HD 7	Constructing a bye pass road to Nirmal town on Hyderabad-Nagpur Road-N. H. No. 7 from mile 133/7 to mile 134/7.	0.81
		JAMMU & KASHMIR	
5.	954 JK	Construction of a high level bridge over Tarnah causeway along Pathankot-Jammu Road	8.32
6.	955 JK	Construction of the Pilot Heading of the Banihal Tunnel Project.	40.85
7.	956 JK	Replacement of the existing suspension bridge near Ramban over river Chenab in mile 96 of the Jammu-Srinagar Road by a single span steel trussed girder bridge.	3.88
		SAURASHTRA	
8.	958 SR 8B	Taking borings with core drill in the bed of river Minsar on National Highway No. 8 B.	0.09
9.	968 SR 8B	Providing 1½ in. premixed carpet etc. to Kuvadua-Bamanbore Section (miles 13/0 to 21/6) of Bamanbore Porbandar Road—N.H. No. 8 B	2.94
10.	971 SR 8B	Providing 1½ in. premixed carpet etc. to Porbandar-Kutiyana Section of Bamanbore-Rajkot-Porbandar Road—N. H. No. 8-B.	7.98
11.	974 SR 8B	Providing 1½ in. premixed carpet etc. to Jetpur-Upleta Section of Bamanbore-Porbandar Road—N. H. No. 8-B.	7.75
		BOMBAY	
12.	959 BM 8	Improvements to the Talasari-Damanganga section of Bombay Ahmedabad Road-N. H. No. 8.	5.36
13.	969 BM 8	Constructing diversions outside Palsana, Baleshwar and Chalthan villages on the Bombay-Ahmedabad Road—N. H. No. 8.	4.75

Continued

S. No.	Job No.	Name of work	Amount (Rs in Lakhs)
14.	972 BM 8	Improvements to Boriavi-Nadiad and Nadiad Karia Sections of N. H. No. 8	5.16
15.	976 BM 8	Widening the existing black-top surface of Bombay-Agra N. H. No. 3 in Nasik and West Khandesh Districts.	6.60
16.	977 BM 8A	Construction of Bagodra-Deopura Section of Ahmedabad-Kandla Road—N.H. No. 8-A	10.73
17.	978 BM 8	Providing cross drainage works in Karjan-Makarpura sub-section of Karjan-Baroda Section of Bombay Ahmedabad Road—N.H. No. 8.	1.44
		AJMER	
18.	960 AJM 8	Widening and reconsolidation of miles 15–18 of Beawar-Dewair Road	0.59
19.	961 AJM 8	Providing semigrout with seal coat including widening from 9 ft to 12 ft of miles 19–22 of Beawar-Dewair Road	0.74
20.	962 AJM 8	Widening metal width from 9 ft to 12 ft of miles 2–4 of Beawar-Dewair Road	0.22
21.	963 AJM 8	Widening of metal width from 9 ft to 12 ft 30/6 to 32/2 of Beawar-Dewair Road	0.19
		RAJASTHAN	
22.	964 RJ 8	Widening miles 17–30 of Jaipur-Ajmer Road National Highway No. 8.	1.31
23.	965 RJ 8	Construction of a bridge across the Som river at Kagdar on N. H. No. 8.	3.43
		ANDHRA	
24.	966 AH 5	Construction of Regulator-cum-Road bridge over the River Krishna at Vijayawada on N. H. No. 5.	39.08
		WEST BENGAL	
25.	A967 BG 34	Gazek-Raiganj Section of N. H. No. 34.	8.00
		ORISSA	
26.	970 RS 5	Black-topping N. H. No. 5 lying in Mayurbhanj district between Baripada and Balasore (length 24½ miles)	3.59
		SIKKIM	
27.	973 SK 31A	Construction of a diversion road at Majitor mile 22¼ of Rangpo-Gangtok Cart Road-N. H. No. 31-A.	0.80
		UTTAR PRADESH	
28.	975 UP 24	Widening cement concrete pavement on N. H. No. 24 between miles 7–28 (miles 1/3 to miles 21/6 of Ghaziabad-Hapur Road).	1.33

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