TRANSPORT-COMMUNICATIONS

MONTHLY REVIEW (TCMR)

NOVEMBER 1961—No. 175

INDIAN ROADS CONGRESS, NEW DELHI.


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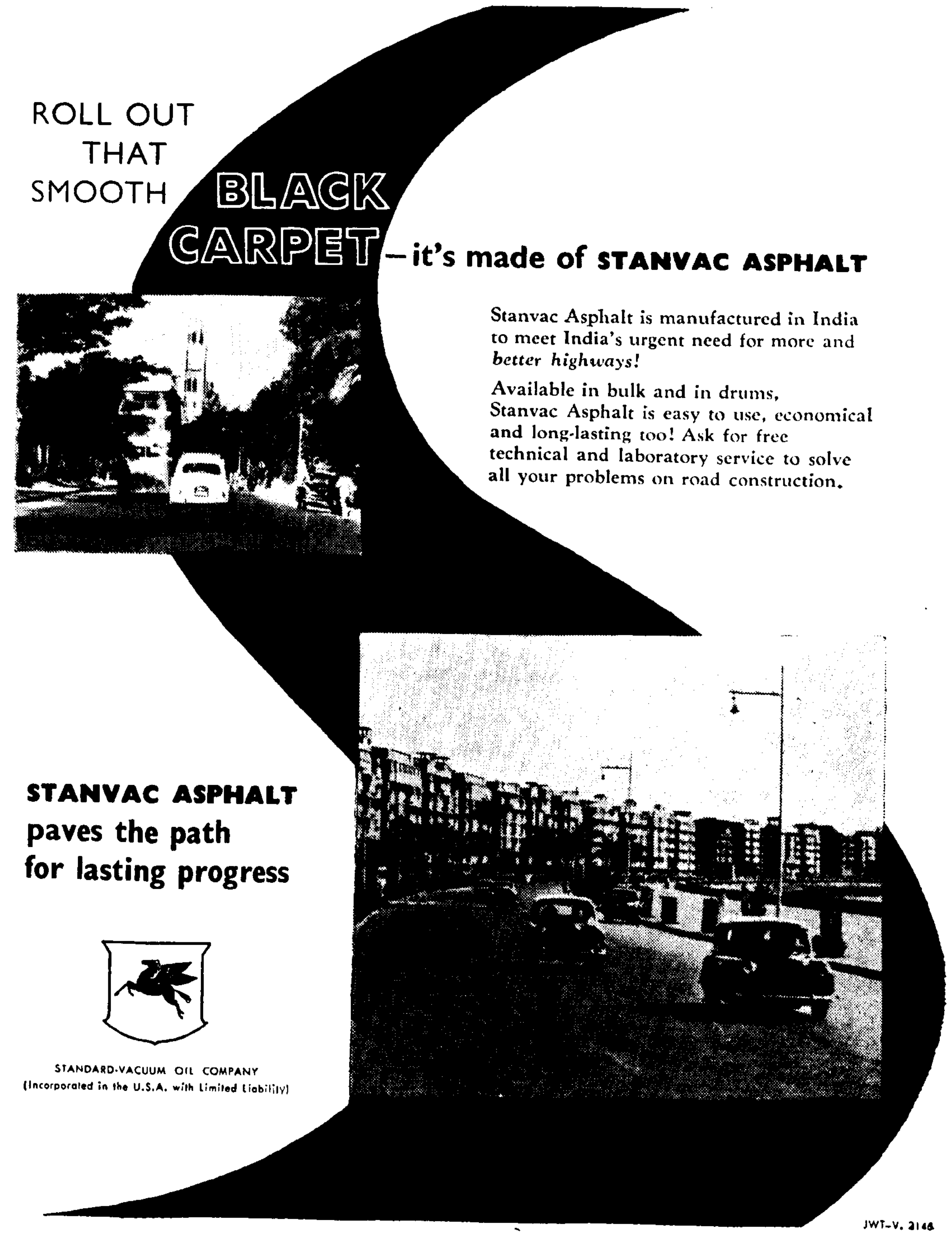
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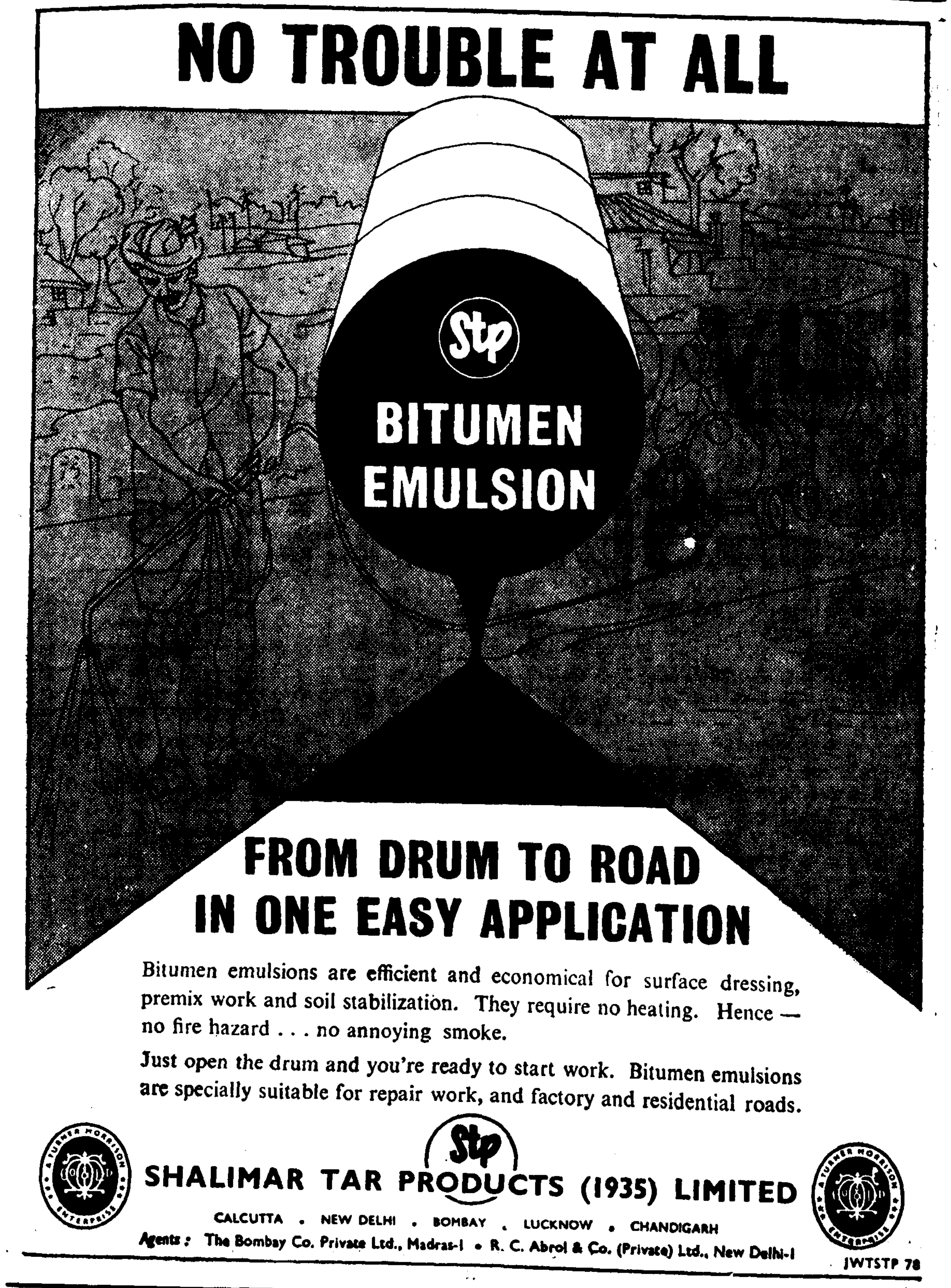

TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

NOVEMBER 1961—No. 175

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On the invitation of the Government of Bihar, the Indian Roads Congress is holding its 26th Session at Patna from the 13th to the 20th December 1961.

Details of the programme are given below :

Wednesday	13th	09.00—13.00	I.R.C. Committees
		14.30—17.00	59th I.R.C. Council meeting
Thursday	14th	09.00—11.00	* Formal Opening I.R.C. Session
		11.15	Photo
		14.00—15.00	Inauguration of the Session of the Indian National Society of Soil Mechanics and Foundation Engineering
		15.00—16.00	Business meeting of the Soil Mechanics Society
		16.00—17.30	Paper meetings of the Soil Mechanics Society
Friday	15th	09.00—11.00	I.R.C. Commitees Symposium of the Soil Mechanics Society
		11.00—13.00	Papers
		14.30—17.00	Papers
Saturday	16th	09.00—11.00	IABSE (ING) meetings
		11.00—13.00	Papers
		14.30—17.00	Discussion on General Report on Road Research
Sunday	17th	09.00—11.00	Business meeting
		11.00—13.00	Panel Discussion
		14.30—17.00	Chief Engineers' Meeting
Monday	18th	09.00—13.00	60th I.R.C. Council meeting
		14.30—17.00	Chief Engineers' meeting
Tuesday & Wednesday	19th & 20th	...	Inspections
Thursday	21st	...	Dispersal at Ranchi

* It is expected that the Governor of Bihar will inaugurate the session.

NOTE:

1. All meetings including Inauguration will be held in the premises of Government Officer's Flats, Patna.
2. Detailed programme of the meetings of the Committees will be intimated to members concerned and also displayed at the Session.
3. The order in which the Papers are to be read and discussed at the Session will be displayed on notice boards at the Session.

TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

A REVIEW OF
ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

NOVEMBER 1961

RECONSTRUCTION METHODS FOR A PRE-WAR AUTOBAHN SECTION

By

HAROLD J. McKEEVER

Editor of World Construction

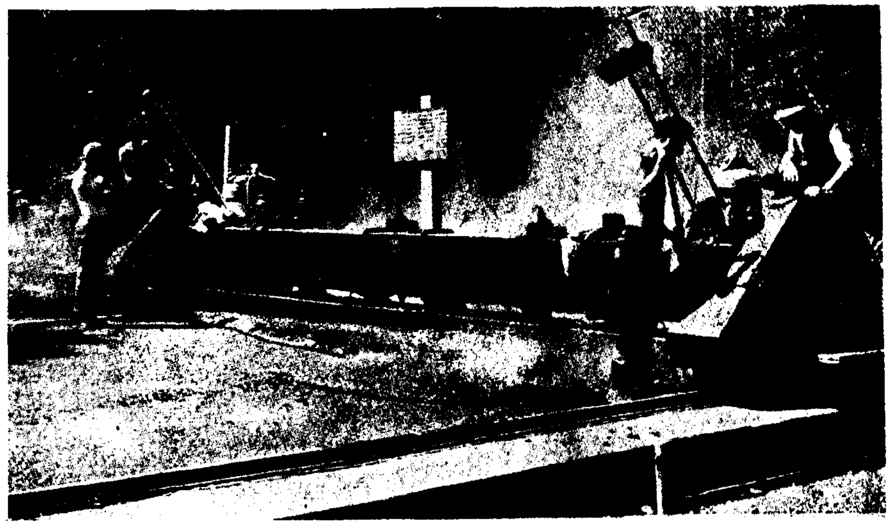
THE extensive program of autobahn construction in West Germany will link this country's principal cities and connect with peripheral countries. Because the spotlight has been played chiefly on the new construction, the interesting problems of reconstructing portions of the original pre-war autobahnen have not been given the attention they deserve, although this reconstruction is carried out at a rate of 80 million D-Marks per year.

These ribbons of portland cement concrete, dating from 1935 to 1939, represented extremely advanced geometric design. The concrete, however, usually was laid on the prevailing soil. Frost as well as soil instability has been a factor in the deterioration of these older segments, which, all in all, however, have stood up very well considering their age and the ever increasing traffic of the post-war years.

Following heavy maintenance, selected links of the super-roads began to be scheduled for complete reconstruction. About two-thirds of the mileage in this program involves bituminous reconstruction and one-third portland cement concrete. Asphalt has often been preferred because of avoidance of the 28-day curing period for concrete.

Pictured here are some of the construction steps in rebuilding a section completed within a three-month period by Hubert Zettelmeyer, contractor of Frankfurt/Main. This job encompassed 3.2 miles of dual highway just north of Frankfurt. Because of the heavy traffic using this highway (about 30,000 vehicles per day including perhaps 12,000 trucks and truck-trailers), the work was performed in two 1.6 mile sections, the first one to be completed before beginning the other to minimize the inconvenience for the traffic.

The old 1938 concrete pavement, 7.5 m wide and 22 cm thick, was heavily reinforced. In this instance the slab was founded on about 10 cm thickness of insulating material, the underlying soil being loess of a very troublesome character. Considering the fact that this soil had a Plasticity Index (ASTM) of 30 to 35, the engineers wondered how the pavement had been able to stand up as long as it did. Extensive cracking and faulting however had dictated complete replacement.



7.5 meter wide gussasphalt spreader with screed heated by bottled gas. Spreader runs on rails on top of concrete curbing, which is temporarily protected by burlap cloth

The first step was to break up the old slab with a drop ball suspended from a P & H truck crane. The rubble was piled using a Caterpillar Traxcavator, Model 977 and an Allis-Chalmers HD 11 tractor with dozer blade and the rubble and underlying base and soil removed down to 86 cm below top of pavement, using power shovels, Zettelmeyer 5 cu.m. dumpers and dump-trucks for disposal. The shovels were Wesserhuette units.

This operation while a simple one had to be controlled closely, so as to keep all equipment synchronized and lessen the time and distance involved in bypassing traffic.

During this stage old drainage lines, where found were completely removed. New drains were placed using porous concrete tile. Drains paralleled the new pavement under either shoulder, with frequent cross or connecting drains.

Following levelling and shaping to design grade, the subgrade was given a coating of tar emulsion, to protect the compacted soil from infiltration by rain water while exposed. Traffic was not allowed on the prepared grade. Cold tar emulsion was applied at the rate of 1 gal. per sq. meter.

Where the soil was 5 to 10 per cent over optimum moisture content, the top layer was given a stabilization, consisting of powdered quick lime worked in and intermixed. For this work a Seaman pulvimixer (now of American-Marietta manufacture, U.S.) was used. This treatment was carried usually to 17 cm depth, without need to add moisture, thanks to Germany's humid summer climate. Lime application was at the rate of 12 kg per sq. meter. This lime treatment considerably reduced both the moisture content and the plasticity of the loess subsoil, and thus enabled thorough compaction. Rolling was done immediately, along with shaping by motor graders, the tar seal treatment then following.

The building-up process on top of the undercut subgrade, thus prepared, consisted of placing 56 cm depth of well-graded pit-run gravel of clean quality, up to 5 cm maximum size. This frost-resistant material was placed and vibrated into two equal layers. A 2-ton shoe-type vibrating compactor, of Bohn & Kahler manufacture (German), was typical of the equipment found economical for this work.

The upper 16 cm of the second frost layer was stabilized with portland cement, again using the Seaman multi-pass mixer to thoroughly intermix cement and aggregate along with necessary moisture. A

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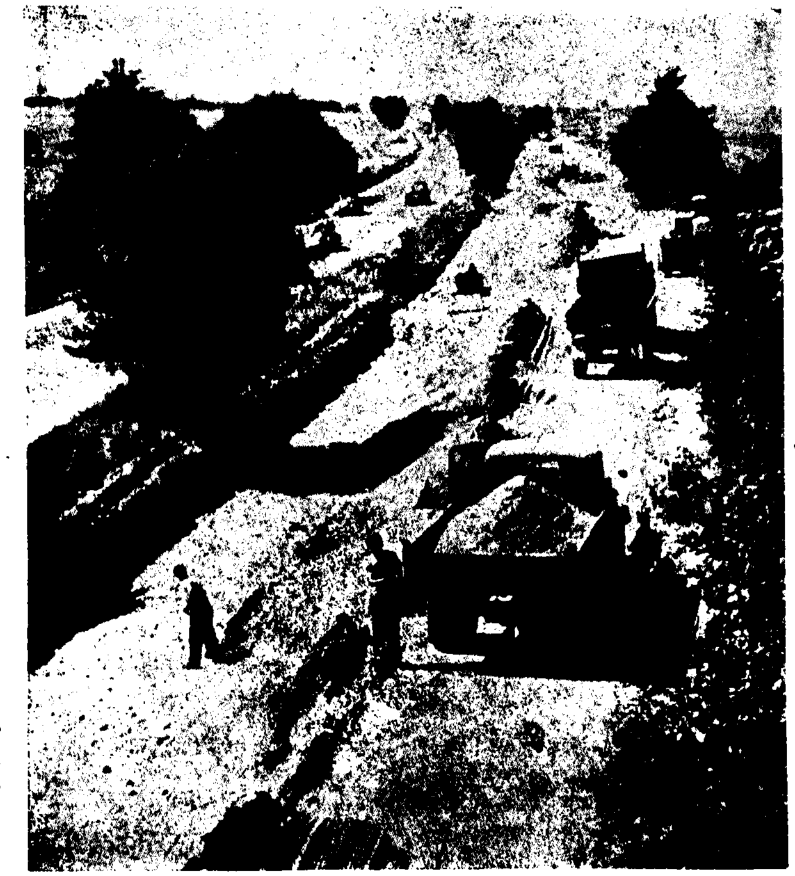
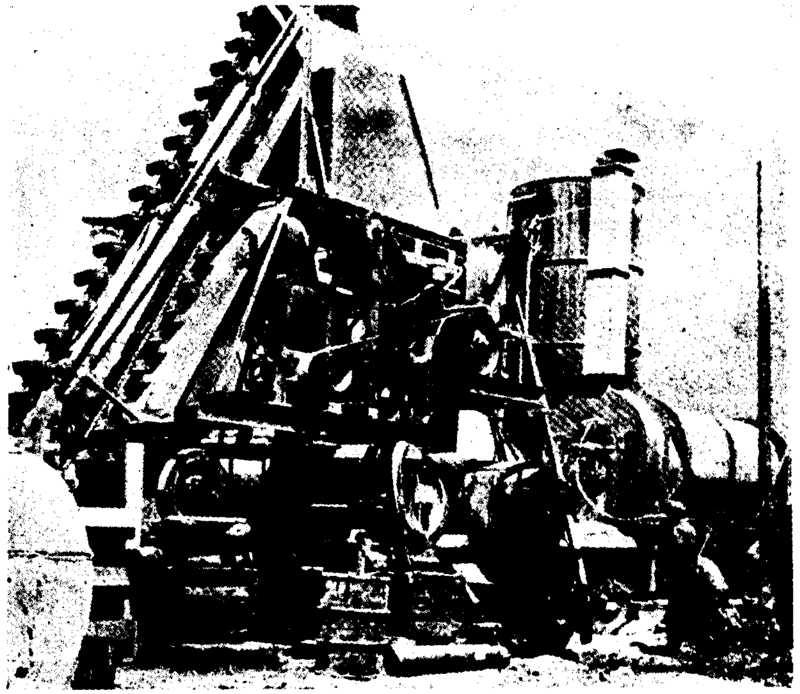


Sandy gravel for frost-resistant subbase is being supplied by dump trucks. Note porous concrete tiles in sub-drain trench at left. Traffic is using left lane of the autobahn

high-early strength cement was used at 25 kg per sq. meter application rate, to obtain the specified compressive strength of 80 kg per sq. cm. (about 1,100 psi) for test specimens at 28 days. The stabilization was made 40 cm wider than the 9-meter pavement width, using much care to secure uniformity of the material and evenness of surface. Each layer was dressed to evenness and compacted before applying and intermixing cement. Due to traffic control considerations the work was done in such short sections that it was uneconomical to utilize motor graders. Rolling was done with $1\frac{1}{2}$-ton tandem vibration rollers of Zettelmeyer manufacture.

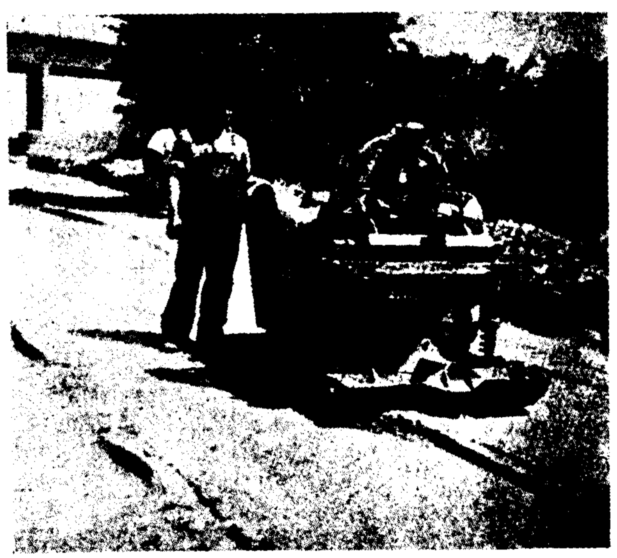
Next placed along both sides of pavement were the concrete curbs or sills which are a conspicuous feature of asphalt paved autobahn sections. The concrete curbing of high type, designed for early strength, was constructed 75 cm wide and 30 cm depth. The specification for compressive strength was 450 kg per sq. cm. (about 6,400 psi) at 28 days. For the upper 5 cm of this curbing a special white portland cement and white quartz aggregate were used to produce an effective color contrast against the asphalt pavement.

Following completion of the concrete curbs, three lifts of hot asphalt mix were placed to a depth totalling 18 cm. These base layers were produced from economically and locally available aggregates. The engineers employed the Natural Aggregate Bituminous Concrete approach to mixture design, which has been advocated recently also by some



A lower-capacity (older-type) hot-mix plant used for mixing gussasphalt on the project here described. A portable gussasphalt cooker of 4-ton capacity is seen in center underneath mixer. Dryer to the right is for drying and heating limestone filler; filler bulk storage is seen behind

Plate-type vibrator, manufactured by Bohn & Kahler, Germany, used for compaction of gravel subbase



authorities in the United States. The aggregate consisted of a 4-cm maximum pit-run gravel with the addition of 30 per cent by weight of crushed basalt of ½ to 1 in. size range. This addition served both to correct the gradation of the pit material, and to supply the crushed particles needed for good stability characteristics in the compacted mixture. The mixture tested to a (U.S.) Marshall stability of 500 kg minimum (1.100 lb). while meeting a Marshall Flow specification of not more than *40 tenths* mm (16 tenth in.). The mix design utilized 4 per cent by weight of 65 penetration asphalt cement.

The mixture for these base layers was produced in Zettelmeyer's high-production

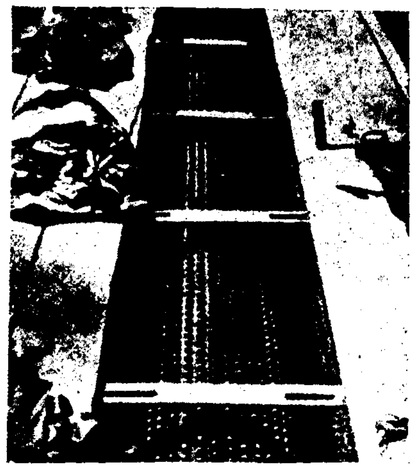
Breaking-up of demolished concrete by Caterpillar Traxcavator

Demolition of old concrete pavement by a 1½-ton steel drop ball, suspended from P & H truck crane

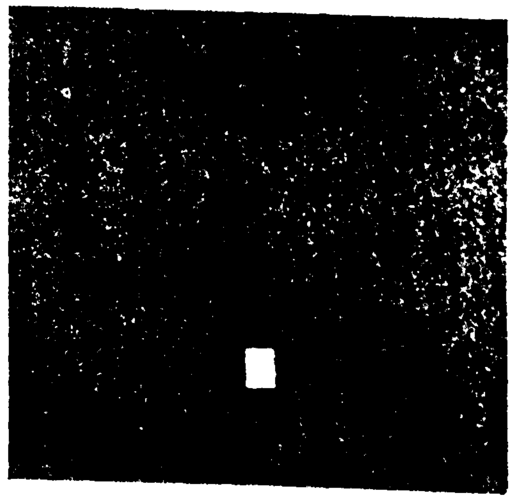
Barber-Greene (U.S.) asphalt plant (model 847 continuous type mixer, 837 dryer, elevators, gradation control unit and dust collector). Placement was with two Voegele bituminous pavers (German).

Then came two courses of asphalt binder of higher quality. The first was 4.5 cm thick utilizing 2.5 cm maximum aggregate, the second of 4.0 cm thickness using 1.8 cm maximum aggregate. Compaction was achieved by Zettelmeyer 3-wheel rollers of 8 to 14-ton weight.

Finally came the wearing surface, consisting of 3.5 thickness of the famed German " Gussasphalt ", a voidless mastic type mixture, to serve as a protection of the entire pavement system against moisture and traffic wear. The bituminous



Close-up of teeth-studded roller (7.5-meter wide), which is used to press precoated quartz chippings into hot surface of gussasphalt wearing course



Texture of finished gussasphalt wearing course, showing pattern left by teeth-studded roller

Storage of aggregate in partitioned boxes, using the embankment slope of road overpassing autobahn as the stockpile area

layers thus totalled 30 cm or 12 in. depth in all, as part of the pavement system 86 cm thick (34 in.).

The gussasphalt was produced in a plant here pictured, of a design widely used in German autobahn and street paving work. This plant, an older unit of 20 tons per hour capacity, has since been supplanted by new, more modern and productive equipment in the Zettelmeyer operations. The equipment included the mixing unit, and a fleet of towed 4-ton portable cookers or heating units with paddles designed to keep the heated viscous mixture of aggregate and bitumen from burning. The bitumen used was of 65 penetration grade, with Trinidad lake asphalt (containing some filler) added.

The gussasphalt here used is standard on most asphaltic autobahn work in Germany and rated as highly wear resistant. It was spread at a temperature of 200 degrees C. (392 F) to specified grade and thickness, by a special gussasphalt spreader with heated screed 7.5-meter wide, running on rails which were placed on the concrete curbing. Then asphalt-precoated crushed quartz chippings were sprinkled on at the rate of 5 kg per sq. meter while the surface was still hot. The final operation was the passage of an 8-in. diameter metal roller (again 7.5 meters wide on rails), studded with teeth to form the skid-resistant surface pattern and press the abrasion-resistant quartz particles into the surface. No rolling of this voidless mix is involved; when it cools, the road is ready to take traffic.

One of Zettelmeyer's mobile laboratories was available throughout the construction time to provide facilities for continuous testing soil, aggregates, concrete and asphalt mixes. This on-the-site service was required to conform to material and mix specifications, and to avoid financial losses for the contractor during the guaranteed 5-year free-maintenance period following completion of the work.

The site staff of Zettelmeyer on this project was headed by R. Lutz and consisted of two more civil engineers, a surveyor and a material-testing engineer. The contracting division of Hubert Zettelmeyer Company (founded in 1897) is one of the foremost German firms specialized in highway and airfield construction, working in all parts of West Germany and abroad. Well known all over the work is the manufacturing department of this company, makers of road-rollers, vibrating rollers, dumpers and loaders. This unique combination of manufacturing and contracting enables Zettelmeyer to seriously job-test their new developed equipment before starting mass production for sale.

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

TECHNICAL WRITERS & EDITORS—CLASSIFICATION, CRITERIA & FUNCTIONAL DESCRIPTIONS

DISSEMINATION of scientific information is currently engaging the attention of all advanced countries and efforts are being made to tackle the problem of speeding up communication of scientific and technical information. One of the basic requirements of any programme designed for this purpose is the availability of a class of workers specially trained in scientific and technical information work. This need has been recognized and in many countries a great deal of attention is paid to the training of such workers at various levels. But this situation in itself does not provide the necessary incentive for prospective candidates to take up scientific and information work as a career. This important activity should be recognized as a distinct profession and assigned a status; it should be considered as an essential and integral part of all scientific research and development activity. Though scientific and technical information workers are employed in various capacities in Government institutions, research and technical establishments, there has been no clear demarcation of their official positions and functions.

Like many other relatively new fields of work, the profession of the scientific and technical information worker is an evolving occupation, and in recent years a considerable degree of specialization has crept in the types of positions held by such people and in the types of jobs they do. Recognizing these growing specialization trends in this profession, the U.S. Civil Service Commission, in collaboration with other Government agencies and the Society of Technical Writers and Publishers, have issued a standard which lays down classification criteria and functional descriptions for technical writing and editing positions. The standard, the first of its kind on the subject, is the official guide for the classification of technical writing positions in U.S. Federal Service. The document, known as GS-1083-0, provides an objective means for assessing the requirements and types of scientific and technical writers of an organization and defines the nature of jobs to be done by them. The qualifications generally prescribed for workers in technical writing and editing positions are: substantial knowledge of subject-matter, field, and writing and editing skills, including the ability to determine the type of presentation best suited to the audience being addressed. The criteria employed in the evaluation of these positions are: difficulty and initiative required, and the degree of judgment involved. These positions are also evaluated on the basis of certain grade level guides, such as, whether the job to do requires simple expository writing or analytical presentation, or whether the subject-matter of the publication covers a simple or complex field, etc.

The publication of this standard re-emphasizes the need for organizing the profession of scientific and technical information workers on proper lines in all progressive countries. And to do this, facilities must be available for the training of workers for such jobs. In India, the training of scientific and technical information workers has not received the attention it deserves, particularly in view of the rapid scientific and techological developments in the country during the last two decades. There is urgent need for collecting factual information on the needs of Government institutions, research and technical establishments for scientific and technical information workers and measures have to be initiated to meet these needs. One of the important steps that should be taken in meeting the demand for trained personnel in this field is to organize courses in our universities and technical institutions for imparting basic training in the fundamentals of scientific and technical communication. Facilities should also be made available to science and engineering students at the graduate level to take up

(*Continued on page 13*)

ROUNDABOUTS PREFERRED TO SIGNAL-CONTROLLED JUNCTIONS

MIDDLESEX TRAFFIC ENGINEER ON RESULTS OF ACCIDENT INVESTIGATION

A COMPARISON of roundabout junctions with automatic traffic signal-controlled junctions has led to the conclusion that where there is room to construct a roundabout of adequate size then this form is to be preferred to traffic lights.

The idea is advanced by Mr. H. C. Smith, A.M.I.C.E., Assistant County Engineer in charge of the Traffic Engineering and Development Control Section of Middlesex County Highways Department.

In a report to the council Mr. Smith argues that the basic requirements of a road juction are to provide adequate safety for all users of the junction, and satisfactory traffic flow, having due regard to economy.

Comparison of Methods

His report is a comparison of two of the various methods adopted for junction and relates to 24 junctions within the County of Middlesex, 12 automatic signal-controlled and 12 roundabouts, the junctions being of similar four-way cross roads of relatively equivalent traffic flows and on sites including Trunk Roads, Class I, Class II and Class III junctions.

Tables accompanying the report show that over a ten-year period ending December 1960, fewer personal injury accidents occurred at roundabouts than at traffic light controlled junctions. Of the road users involved, 152 pedestrians were involved at the traffic light controlled junctions compared with a maximum of 51 at the roundabouts. These 51 included the pedestrian accidents at Hendon Central roundabout where 17 pedestrians were injured (over one-third of the total pedestrians injured on the other roundabout junctions).

The figures show that for the ten-year period approximately twice as many incidents occur at traffic light controlled junctions as at roundabouts for the same flow of vehicles in the same period of time.

The record of accidents at Brent Street junction with the North Circular Road for the three years prior to the removal of the roundabout was two in 1951, three in 1952, two in 1953, a total of seven. After the installation of traffic lights the accident record was seven in 1955, seven in 1956, and eight in 1957, a total of 22. In the year 1960, 12 personal injury accidents were recorded. Similarly, the accident rate at Neasden Road junction with North Circular Road increased since the traffic lights were substituted for the roundabout.

Signal Control

Dealing with signal control, Mr. Smith says an automatic traffic light signal is normally so arranged that while the green light gives freedom of passage in either direction along one road, the cross road traffic is stopped by the red light.

When there is a demand from the cross road traffic the signal lights change first to amber on all the roads into the junction and then to green on the cross road with the red light coming into operation on the other road, the delay in the change of the light signal being regulated by the traffic demands of each road and the time necessary for the various traffic streams to move out of the junction, the right turning traffic having to wait until the opposing stream has stopped, or there is a sufficient gap through which to cross.

To enable this turning traffic to clear the junction, the delay has sometimes to be increased by the red signal being displayed on all the roads. Similarly, it is sometimes necessary for all red signals to be displayed on all roads to provide for pedestrian cross movement at very busy junctions.

The demand is registered by the vehicle passing over a pad situated in the carriage-way, some 90 ft to 120 ft from the signal, and when there are frequent vehicles on both roads the lights can change in front of an approaching driver between the time he crosses the pad and before he reaches the stop line, in which case he may be unable to obey a signal.

There is always the possibility of two drivers, one on the main and one of the cross road approaching a signal just at the time of its change, both driving rather too fast and both 'jumping the lights' but only to a slight extent (each need only be fractionally wrong on a normally timed signal), and a collision in these conditions is generally serious.

Roundabouts 'More Acceptable'

In the case of a roundabout, Mr. Smith points out that because of the physical conditions traffic has to slow, also generally the roundabout permits traffic to pass through a junction satisfactorily and is more acceptable to drivers generally than traffic light controlled junctions. It is unusual for motorists to use side streets to avoid roundabouts, but there are many cases where drivers use a side street and other deviations to avoid a traffic light controlled junction in some cases even making a right turn across the opposing stream—a very serious source of danger, causing accidents away from the junction. Automatic traffic signal-controlled junctions create greater delay for traffic than roundabouts because of the need to obey the signals.

Turning to economics, Mr. Smith says: 'It is not sufficient to compare only the initial capital outlay of alternative schemes; such comparison should take into account the potential saving in the national expenditure, and the rate of return for the capital invested should be greater than would be the case if the money was invested elsewhere.

'The Road Research Laboratory estimate that the average cost of a personal injury accident at the 1947 values to be 540 pounds, the cost of delays varying from 5*s.* 2*d.* per vehicle hour, to 9*s.* 9*d.* per vehicle hour in congested areas, and the cost of vehicle operation as 4.2*d.* per vehicle mile.

'The initial cost of a roundabout is probably in the neighbourhood of 20,000 pounds as compared with 2,500 pounds for the installation and additional cost of maintenance of 110 pounds per annum for traffic lights.

'It will be noted from the accident figure that on average there are seven accidents per year at traffic light junctions as compared with four per year for roundabouts, *i.e.*, an additional three accidents per year, equivalent to a cost of 1,620 pounds per annum.

'The cost of delays per traffic light junction based on the average for the 12 sites considered is between 4,400 pounds and 8,300 pounds per annum, an average of 6,350 pounds.

'The additional distance travelled in using a roundabout is approximately 26 yd. and at the rate of 4.2*d.* per vehicle mile is 6.5 pound per day for the 12 roundabouts considered, or an average per roundabout per annum of 180 pounds.

The figures are presented as follows:

Annual cost—roundabouts.	*Pounds*
Interest on 20,000 at 5 per cent per annum ...	1,000
Cost of four accidents per year ...	2,160
Extra cost of travelling time ...	180
	3,340

Annual cost—automatic traffic signals ...	*Pounds*
Interest on 2,500 pounds at 5 per cent per annum ...	125
Cost of seven accidents per year ...	3,780
Extra cost of maintenance.	110
Cost of delays ...	6,350
	10,365

Mr. Smith argues, dealing with further considerations, that although gaps are created in the traffic streams leaving the traffic lights and these gaps are a help to pedestrians crossing traffic, etc., these benefits only last for a surprisingly short distance from the lights. Confusion and uncertainty can be created where lights cease to function through some breakdown.

He suggests, for the county highways committee's approval, that where there is room at a junction to construct a roundabout of a size adequate to deal with the expected traffic, then that form is to be preferred to traffic lights.

'Obviously', he states, 'when traffic reaches a certain volume no level crossing will be adequate for control and grade separation in some form of flyover ultimately becomes necessary.'

(From "The Surveyor and Municipal and County Engineer," August, 1961).

(Continued from page 10)

courses in the technical communication. The need for this cannot be overstated when it is realized how deficient many of our scientists and engineers are when it comes to communicating and presenting their own work.

At the professional level, on-the-job programmes should be set up for training new entrants. This practice is followed to great advantage in U.S.A. by all leading publishing houses, research institutions and industrial establishments like McGraw-Hill, Armour Research Foundation, American Chemical Society, Bell Telephone and General Electric. Only by initiating such training programmes can we hope to meet the country's need for scientific and technical writers.

(From "Journal of Scientific and Industrial Research" August, 1961.)

THE 5TH INTERNATIONAL CONFERENCE ON SOIL MECHANICS AND FOUNDATION ENGINEERING

THE 5th International Conference on Soil Mechanics and Foundation Engineering, held in Paris from July 17th to the 23rd, was attended by more than 1,000 engineers from some 50 countries.

In his opening address, the retiring president, Mr. A. W. Skempton, Professor of Civil Engineering, Imperial College, London, reviewed the past 25 years of progress and thought that there had been two notable achievements. First, it had been proved beyond all doubt that the behaviour of soils in practice could be analysed in a rational manner. This success could be attributed to the insistent and logical application of the principle of effective stress, Professor Karl Terzaghi's greatest discovery. Second, soil mechanics had been widely accepted by the civil engineering profession and by the universities. Soil mechanics was now reaching maturity and it was doubtful if any further spectacular growth was either likely or desirable.

Potential Dangers

Of the future, he thought that there were potential dangers in soil mechanics design work. One danger was that, unlike their predecessors, many present-day designers had little direct experience of understanding soils and rock behaviour through research work and, hence, the many factors which have to be assessed in reaching a correct solution to a given problem.

The best antidote to such "handbook" engineering was to help young engineers to develop an enquiring mind and to make full use of their site experience through observation and wherever possible, full scale tests. A second danger which could be foreseen was that engineers were beginning to regard their design criteria as conservative, largely due to the reduction in the number of soil failures since the advent of rational design procedures. However, the available field evidence had shown that the methods of analysis were often remarkably accurate and occasionally over-optimistic. The failure of an earth dam during or after construction had appalling economic consequences yet the present factors of safety used in design were much lower than in other branches of engineering. Therefore, the logical conclusion was that design procedures should continue to follow the rational methods which had been successfully developed over the past years, and any tendency towards intuitive design methods must be strongly resisted.

Tremendous Advances Likely

Dealing with the more favourable future prospects, Professor Skempton mentioned the tremendous advances which were likely to take place in design and construction. Buildings and earth dams were being built higher than ever before and the civil engineering profession was only just beginning to make full use of the potentialities brought about by improved geotechnical processes and the basic understanding of soil behaviour. He particularly stressed the future importance of rock mechanics as a complementry science to soil mechanics.

Technical Sessions

There were 270 papers published in the two volumes of Proceedings. Most of the papers gave information to supplement well-trodden paths of investigation, e.g., triaxial shear strength, correlation of soil properties with in-situ penetration tests, results of pile tests, etc. There was also a refreshing tendency to investigate rationally some complex problems. Two such subjects, which are of particular interest to Highway Engineers are the development of rational design methods for flexible pavements and the behaviour of partly saturated soils (i.e., the interaction of solid, liquid and gas). The effect of time (in addition to stress and strain) on various problems is provoking

(Continued on page 17)

RATE OF SPREAD OF CHIPPINGS AND BINDER FOR SURFACE TREATMENT

Rates of Spread of Chippings

If is necessary that the chippings completely cover the binder film but from only a single layer. After rolling, there should be a close mosaic, one stone thick.

It there is a shortage of chippings, there are too many voids between them so that they are not mutually locked together and the resistance of such a dressing to tangential forces of traffic is lower, the adhesive strength of the stone to the binder film being insufficient to prevent ravelling.

If there is a large excess of stone, the particles in excess over the single layer will partially interlock with the stone below and under traffic will act as levers and can cause dislodgment of the layers of stone adhering to the binder film.

It is necessary to calculate or measure exactly the rate of spread of chippings required. As this calculation is based on the mean diameter of the chippings, it is important that the material to be used on the road corresponds exactly to the required size specified.

Calculation of rate of spread of chippings

Let :

- Vf : volume of chippings held per m^2
- Vm : volume of chippings applied per m^2
- d : diameter defining the minimum size (mm.)
- D : diameter defining the maximum size (mm.)
- A : mean diameter of chippings (mm.)

Then:

$$A = \frac{d+D}{2}; \qquad Vf = A - \frac{A^2}{100};$$

$$Vm = Vf + \text{whip-off.}$$

The whip-off is arbitrarily taken as
1.50 litres/m^2 for $A = 20$.
1.25 litres/m^2 for $A = 10$.
1.00 litre/m^2 for $A = 5$.

Example of calculation : Material of size 16/22 mm.

$$d = 16;\ D = 22;\ A = \frac{16+22}{2} = 19$$

$$Vf = 19 - \frac{19^2}{100} = 15.39 \text{ litres/m}^2$$

$$Vm = 15.39 \text{ litres/m}^2 \text{ whip-off}$$
$$= 15.39 \text{ litres/m}^2 + 1.50 \text{ litre/m}^2$$
$$= 16.89 \text{ litres/m}^2 \ \ 17 \text{ litres/m}^2$$

It is advisible to use chippings of large size when the old road surface is rich and plastic. Surface dressing of an old asphaltic concrete surface which is dry and hard should preferably be done in two operations using small size chipping (4/8mm.) for the first layer. In the case of a road which is very hilly or winding the tangential forces under traffic are very important and the use of large size chippings (16/22mm) is particularly difficult and demands very careful technique.

Rate of Spread of Binder

The rate of spread of binder depends on serveral factors which are, in decreasing order of importance:

(a) the size of the stone, and secondly shape and type of stone;
(b) the condition of the road surface to be treated;
(c) traffic density;
(d) atmospheric conditions

The role of the binder in surface dressing is to fill the surface voids of the road (fissures and pores) and to fill two-thirds of the void space between the particles of the single stone layer of the dressing.

The rate of spread of binder is therefore a function of the thickness of the layer of

THE COMPACTION OF FLEXIBLE PAVEMENTS

A. A. MAXWELL*

SOME years ago the Corps of Engineers was faced with the necessity of designing flexible pavements to meet increasingly severe loading requirements. The need for stronger pavements was caused by an increase in aircraft weight, an increase in tire pressure, channelization of traffic, and an increase in amount of traffic. These changes occurred over a relatively short period of time, and the design criteria had to be changed accordingly. Test sections were constructed and subjected to accelerated traffic to obtain data on which to base design changes, and, in several instances, changes had to be based on judgment and the performance of existing airfields.

It appears that the highway designer is faced with somewhat the same problem today because of the ever-increasing amount of traffic and the increasing wheel loads and tire pressures. The problems encountered in designing a higher strength highway are similar to those met in improving airfield pavements, and the results of investigational work by the Corps of Engineers should thus be of some interest to this group. The various structural elements of a road and runway are similar, but the traffic on the two types of pavement differs greatly. A heavy-duty road is subjected to many millions of relatively light loads, while an airfield pavement is subjected to a much smaller number of very heavy loads. Wheel loadings on a road are approximately 5,000 or 10,000 lb on dual wheels at tire pressures somewhat less than 100 psi, while an Air Force heavy bomber has a wheel loading of 60,000 lb at a tire pressure of almost 300 psi.

Based primarily on judgment, it appears that a flexible pavement runway design for a load about equal to those encountered on highways would be satisfactory for highway use even though the traffic count would be very high. The base and sub-base courses used in airfield pavements are essentially non-plastic; therefore, if the pavement can support a reasonable number of load repetitions without distress, it should be able to support many more such repetitions as the strength is actually increased with any increase in density developed by the traffic. This would not be true, of course, in the case of a plastic base because moisture conditions could develop so that a loss of strength would occur with an increase in density. These remarks do not mean that flexible pavement designs for airfield use and for highway use will be identical, but they are intended to indicate that the two pavements will be near enough alike to warrant consideration of lessons learned in airfield pavement design in connection with highway pavement design.

The Corps of Engineers' investigations have included laboratory studies, full-scale accelerated traffic test sections, observation of airfield performance, and careful study of pavement failures to determine the cause of failure. Briefly, the findings from these studies have resulted in the requirement for better quality materials and the compaction of these materials to higher densities. The more important requirements of four Corps of Engineers' guide specifications will be discussed to illustrate the type of materials used and the degree of compaction required. These specifications are listed below:

Title of Specification	*Use*
Graded—Crushed—Aggregate Base Course	Base courses with design CBR of 100 or over.
Stabilized Aggregate Base Course ...	Base courses for roads and streets and airfield pavements designed for less than 100 psi tire pressure. Design CBR of 80.
Sub-base Course ...	Sub-base for airfields, roads and streets. Design CBR of 20-50. Base course for roads under certain conditions.
Select Material Sub-base Course ...	Lower levels of pavement structures Design CBR less than 20.

* Chief, Flexible Pavement Branch, Soils Division, Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi.

For any wheel loading, the intensity of stress decreases with increasing depth, which means that lower quality materials can be used at the greater depths below the surface. The materials listed in the preceding paragraph are shown in order of decreasing quality. Some of the requirements of these specifications are tabulated below:

Material	LA Wear	Sulphate	Fractured	Plasticity		Gradation
	+No. 4	Soundness	Faces	Maximum LL	Maximum PI	
Crushed stone agg. base	40	Yes	Yes	25	5	See table below
Stabilized agg.	50	No	Yes	25	5	See table below
Sub-base	50	No	No	25	5	Max. 15 per cent pass. 200
Select material Sub-base	No	No	No	35	12	Max. 25 per cent pass. 200

Sieve designation	*Base Course Gradations* Percentage by weight passing Square-Mesh Sieve*		
	No. 1	No. 2	No. 3
2 in.	100	—	—
1½ in.	70–100	100	—
¾ in.	45–80	60–100	100
½ in.	30–60	30–65	40–70
No. 4	20–50	20–50	20–50
No. 10	15–40	15–40	15–40
No. 40	5–25	5–25	5–25
No. 200	0–10	0–10	0–10

It is evident that the materials described are non-plastic or only slightly plastic. The poor performance of plastic base and sub-base courses has been one of the most conclusive and expensive findings of the Corps of Engineers' investigations. A base course with a plasticity index of, say, 10—12, handles easily and sets up firmly, permitting compaction without difficulty. However, with time, except in arid regions, the moisture content increases and traffic compaction causes a loss in strength and failure of the pavement. Entire aprons and taxiways have been removed and replaced because of the failure of plastic bases.

Before the compaction of the materials described above is discussed, it is desired to call attention to the compaction test utilized by the Corps of Engineers. The so-called

* Particles having diameters less than 0.02 mm. shall not be in excess of 3 per cent by weight of the total sample tested.

"modified" AASHO compaction test is used, which results in a considerably higher density than that obtained from the "standard" AASHO test. Very roughly, for cohesive materials, the density obtained from the standard procedure is about 90 per cent of that obtained from the modified procedure. The difference in density is smaller for non-plastic materials.

The CBR method of design utilized by the Corps of Engineers prescribes strength values intended to insure that the material has adequate shear strength. However, in addition to the strength requirement, there must also be a compaction requirement to insure that the layers do not densify an objectionable amount under traffic. Current compaction requirements have been determined from the results of full-scale accelerated test sections and performance data obtained from airfield pavements after a number of years of service. Compaction requirements are expressed as a percentage of the laboratory density obtained by the modified AASHO compaction test. The degree of compaction required varies first with the type of material. A higher degree of compaction is specified under all circumstances for cohesionless materials than for cohesive materials, simply because cohesionless materials are easier to compact and higher densities are readily obtained. The compaction requirements also vary with the expected wheel loadings and intensity of traffic and depth below the surface of the pavement.

The crushed stone base course is the highest quality base used in airfield pavement construction. It is usually necessary to blend several sizes of crushed stone to obtain a mixture meeting the gradation requirements. Materials for the crushed stone base course must be mixed in a stationary plant a travelling plant or by other means on a hard-surfaced area; they cannot be mixed in place. The blended material is placed on the sub-base by means of mechanical spreaders with a maximum compacted layer thickness of 6 in. and a minimum layer thickness of 2 in. It is especially important that the proper moisture content be obtained in this type material prior to compaction. Generally, the material compacts best when it is saturated. If adequate water is not present at the start of compaction, it is virtually impossible to increase the water content by surface sprinkling after compaction rolling has started. The reason for this is that these materials are densely graded; at high degrees of compaction, water applied to the surface will not penetrate through the layers in a reasonable length of time.

Crushed stone base courses are compacted by eight coverages of a rubber-tired roller capable of being loaded to 30,000 lb per tire and with tires inflated to 150 psi. Additional coverages are applied if necessary to obtain at least 100 per cent modified AASHO density. In certain traffic areas, an additional 30 coverages, termed "Proof-rolling," is required on each layer and on the surface on which the first layer of base is placed. Finish rolling may be accomplished with a 10-ton power roller rated at 300 lb per linear inch. The use of vibratory rollers for finishing is optional.

In the case of stabilized aggregate base courses, mixing in place is permitted when it is necessary to blend materials to obtain the proper gradation. Plant mixing is also permissible. The material is usually compacted to at least 100 per cent modified AASHO density with 10-ton power rollers and a heavy rubber-tired roller with a tire-inflation pressure of 90 psi and wheel load of 25,000 lb. An exception to this is made in cases where the material is used as the top layer of a pavement; in that case a wheel load of 30,000 lb and a tire pressure of 150 psi are prescribed. Proper water contents must be maintained during mixing and compaction.

The rollers and compaction requirements for sub-base courses are the same as those for the stabilized aggregate base course mentioned above. Select materials are those with a design CBR less than 20 (their physical characteristics have already been discussed). As these materials are generally slightly plastic, sheepsfoot rollers are permitted in the compaction of these materials. The roller is required to have a nominal foot pressure of 300 psi. Power rollers and small and large rubber-tired rollers are also permitted. The degree of compaction varies with wheel load and depth. The following tabulation illustrates the requirements for light-load pavements. For heavier loadings, of course, the depth figures would be much greater:

Light-Load Pavements

Single Wheel

Contact Area, 100 Sq. in.

Depth of Compaction for Select Materials and Subgrades

Depth of Compaction in Feet for

Percentages of Modified AASHO Compaction Shown

Wheel Load kips	100 per cent B*	100 per cent C†	95 per cent B	95 per cent C	90 per cent B	90 per cent C	85 per cent B	85 per cent C	80 per cent B	80 per cent C
				Cohesionless Materials						
10	1	1	1.5	1.5	2	2	3	2.5		
20	1.5	1	2	1.5	3	2.5	4	3.5		
25	1.5	1.5	2.5	2	3.5	3	4	4		
30	1.5	1.5	2.5	2.5	4	3.5	4.5	4		
				Cohesive Materials						
10	0.5	0.5	1	1	1	1	1.5	1.5	2	1.5
20	1	1	1.5	1	1.5	1.5	2	2	2.5	2.5
25	1	1	1.5	1.5	2	1.5	2.5	2	3	3
30	1	1	1.5	1.5	2	2	3	2.5	3.5	3

In addition to the specific requirements discussed above for particular base course materials, several general compaction requirements are in effect, cohesionless material for fills is never placed at densities lower than 95 per cent modified AASHO; for cohesive material in fills, 90 per cent modified AASHO is required. In the event that subgrades and cuts do not have the densities required considering the type material and depth below the pavement surface, the material is compacted from the surface to meet the required densities or removed and replaced with better materials.

A few words should be said about surface tolerances or smoothness. The finished surface of the flexible pavement cannot vary more than 1/8 in. when measured with a 10-ft straight edge, and must not depart over ½ in. from the design grade. It is virtually impossible to meet these requirements by adjustments in the top courses of the pavement. Careful attention must be paid to smoothness throughout the entire construction. The surface of each layer of the base and sub-base should not deviate more than 3/8 in. when tested with a 10-ft straight edge. If the completed surface is ½ in. or more below grade, the material must be excavated to a depth of 3 in. and replaced. In other words, it is not permissible to apply thin layers of material to the surface.

The Corps of Engineers has also found that heavy pneumatic-tired rollers are practically indispensable in the compaction of asphaltic concrete pavements which have a relatively low bitumen content. A pneumatic-tired roller with a wheel load of 4,500 lb and a tire inflation pressure of 90 psi is specified for compacting asphaltic concrete pavements. Generally, a three-wheel steel roller is used to "Knock Down" the mix

(*Continued on page 24*)

*B indicates runway ends

†C indicates runway interiors

BRIDGE DESIGN STUDY

45-TON TRAILER IN ACTION

'TESSIE', a new 45-ton single-axle trailer has been developed by the Ministry of Transport as an aid to the design of Britain's future bridges.

The trailer, consisting of an axle on which varying numbers of concrete weights can be balanced, is used to study the service behaviour of bridges. It has a lattice girder tow bar which can be extended so that the trailer axle is separated from the towing vehicle by as much as 53 ft. This make it possible to apply the known axle weight at a single point on an otherwise empty bridge. The resulting deflection in the bridge structure is measured by instruments capable of reading to 1/10,000 of an inch while even more delicate optical and acoustic gauges, capable of reading to a millionth of an inch, are used to measure strains.

Ministry engineers started ten years ago to build up data on the strength of masonry arch bridges by using 'Ossa' a bogie trailer mounting weights upto 90 tons.

Now the study is directed to the behaviour under load of the latest types of deck bridges, particularly those with prestressed concrete and composite steel and concrete decks. With these, it is possible to use comparatively light weights upto 45 tons.

'Tessie' has recently been used on several of the bridges on the Preston, Lancaster and Catterick By-passes. New Bridges on motorways and other roads under construction are chosen for study before they come into use. This avoids disruption of traffic, which could be considerable because measurements of "Tessie's effect on a bridge take at least a day".

There is no question of testing bridges to destruction or to see whether they will carry their design load. The object of the operations is to establish comprehensive data about bridge types, materials and components for a long-term analysis. This should, in time, establish the most economical forms of construction and economise by cutting down unnecessarily high safety margins.

The trailer has been developed by the Ministry of Transport, Bridges Branch and constructed at the Ministry's Hendon depot.

The Widnes approach spans are 83 ft between piers and of reinforced concrete.

(From "The Journal of the Institution of Municipal Engineers," July, 1961)

WORK BEGINS ON NORTH CHESHIRE SECTION OF BIRMINGHAM-PRESTON MOTORWAY

WORK began last week on the North Cheshire section of the Birmingham-Preston Motorway (m6). The inauguration ceremony was performed by the Chairman of the Cheshire County Council Sir J. Wesley Emberton, D.L.

The contract for this section—awarded to Tarmac Civil Engineering Ltd.—will provide over 15 miles of dual three-lane motorway at an approximate cost of 8,600,000 pounds.

The route lies through gently undulating countryside; maximum depth of cut will be 25 ft and filling to a depth of 30 ft will be required in several places.

There are 3 two-level interchanges (similar to the one at Pepperstock on the M1) providing elevated roundabouts over the motorway and the usual slip roads.

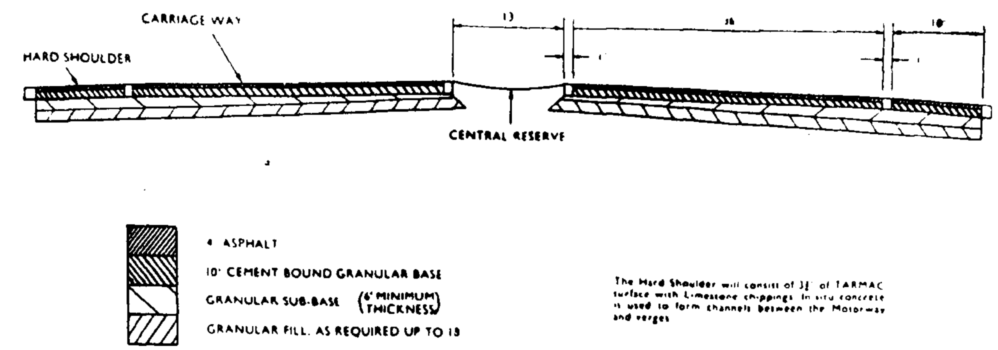
Granular sub-base (6 in. minimum thickness).

Also granular fill of upto 18 in. where this is required by ground conditions.

The hard shoulder will consist of 3¾ in. of Tarmac surface with limestone chippings. *In situ* concrete is used to form channels between the motorway and verges.

At approximately 1½ mile intervals emergency crossings will be provided from one carriageway to the other for use by police, ambulance and breakdown services only. These areas will be surfaced in a contrasting colour.

130 miles of drainage will be laid, ranging from 4 in. agricultural pipes to 54 in. concrete tubes.



Cross section of Motorway

Thirty-six Bridges

The contract provides for the building of 36 bridges, most of which will pass over the motorway.

Motorway Design

The motorway construction consists of two 36 ft carriageways with a 13 ft wide central reservation. There are two hard shoulders each 10 ft wide.

Design is as follows:

4 in. hot rolled asphalt.

10 in. cement bound granular base.

Details:

47,000 yards 4 in.—15 in. S.G. pipes; 6,000 yards 4 in.—9 in. agricultural pipes; 143,000 yards 4 in.—12 in. porous concrete pipes; 1,600 yards 12 in.—30 in. concrete pipes; 37,350 yards 15 in.—54 in. concrete pipes with "Cornelius" type joints; 3,600 gulley pots; 780 manholes.

Safety barriers will be placed on all embankments, and traffic lanes throughout the motorway will be marked by cats-eyes and white thermoplastic marginal strip.

(From "Highways & Bridges and Engineering Works," July 5, 1961)

TRAFFIC-SPEED TRENDS IN U.S.A.

Twenty-six States have reported the results of 761 speed studies conducted during 1960 on level tangent sections of main rural highways during periods of relatively low-traffic densities when most drivers can travel their desired speeds. The average speed of 52.6 m.p.h. for all vehicles was 0.6 m.p.h. above the 1959 revised average and was a record high. The average speeds for passenger cars, trucks and buses were 53.8, 48.4 and 55.4 m.p.h., respectively. This respresents an increase in speed for all types of vehicles.

Sixty-four per cent of the passenger cars, 37 per cent of the trucks and 71 per cent of the buses exceeded 50 m.p.h. Twenty per cent of the passenger cars, 4 per cent of the trucks and 27 per cent of buses exceeded 60 m.p.h.

(From "Better Roads", June, 1961)

(Continued from page 21)

immediately behind the spreader, and this is followed by rolling with the rubber-tired roller. Tandem rollers are then used to iron out the slight grooves that are sometimes present after compaction with pneumatic-tired rollers. At present, 98-100 per cent of laboratory Marshall density is specified. This density is easily obtained with the heavy rubber-tired roller described above.

In summary, it is evident that the experience of the Corps of Engineers in airfield construction in recent years has indicated (a) the requirement for better quality materials, (b) the requirement for higher degrees of compaction, and (c) the use of pneumatic-tired rollers to obtain the high density required.

Acknowledgments

This paper is based primarily on data collected by the U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, as a part of the studies on development of flexible pavement design criteria for Air Force and Army airfields under the direction of the Director, Col. Edmund H. Lang, Ce., and Technical Director, Mr. J. B. Tiffany. The work was conducted under the general supervision of Mr. W. J. Turnbull, Chief of the Soils Division, and Mr. C. R. Foster (formerly Assistant Chief of the Soils Division).

(From "Tennessee Highway Conference Bulletin No. 22", December, 1960.)

THE CORSO FRANCIA, ROME

(Contributed)

AMONG the grandiose works undertaken by the Italian Ministry of Public Works for the 1960 Olympic Games was the Corso Francia Viaduct in Rome.

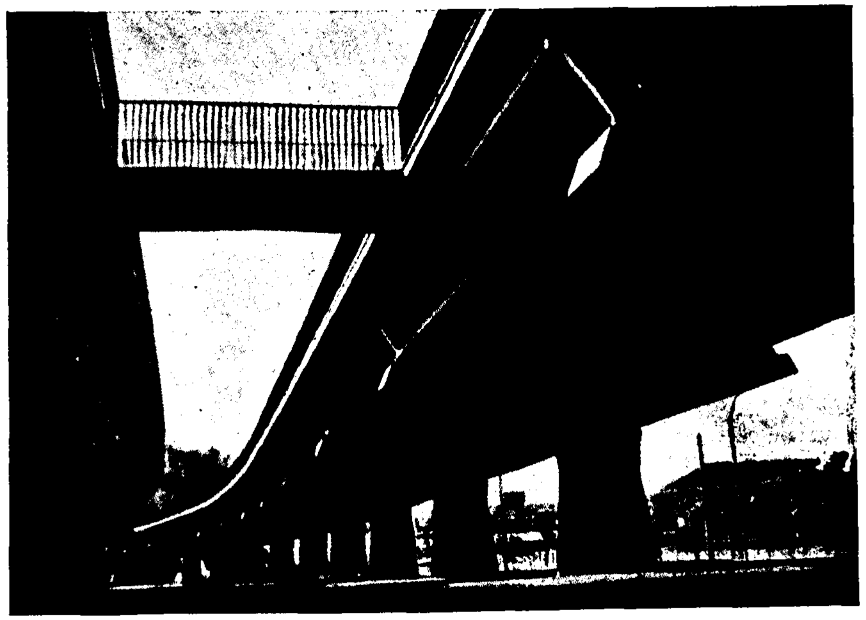
This elevated road runs from a bridge over the Tiber in the north-west (Flaminio) quarter of Rome, passes over the Olympic Village, and joins, at its townward end, the Viale Pilsudski which leads to the city centre and the fashionable Parioli District. It thus forms a direct road into Rome from the north; it also had the advantage of leading, by a simple system of multilevel intersections, to the huge official car park set up close to the Flaminio Stadium and the Palazzetto dello Sport in this important Games Centre. It is the first road to be designed and constructed by the great Engineer Pier Luigi Nervi; he was associated in it with five architects: Vittorio Cafiero, Adalberto Libera, Amedeo Luccichenti, Vincenzo Monaco and Luigi Moretti.

The viaduct is 3,000 ft long—approximately 2,000 ft of it straight, and remaining third curving and dividing to form the junction with the Viale Pilsudski. It consists of two separate carriageways, each carried on a central row of reinforced concrete columns with cantilevered cross-members; between these spans a series of precast prestressed V-section beams, five side by side forming the width of each carriageway and carrying the precast slabs which form the deck structure. The 16 ft gap between the two carriageways is spanned at intervals by light footbridges which carry lighting fittings.

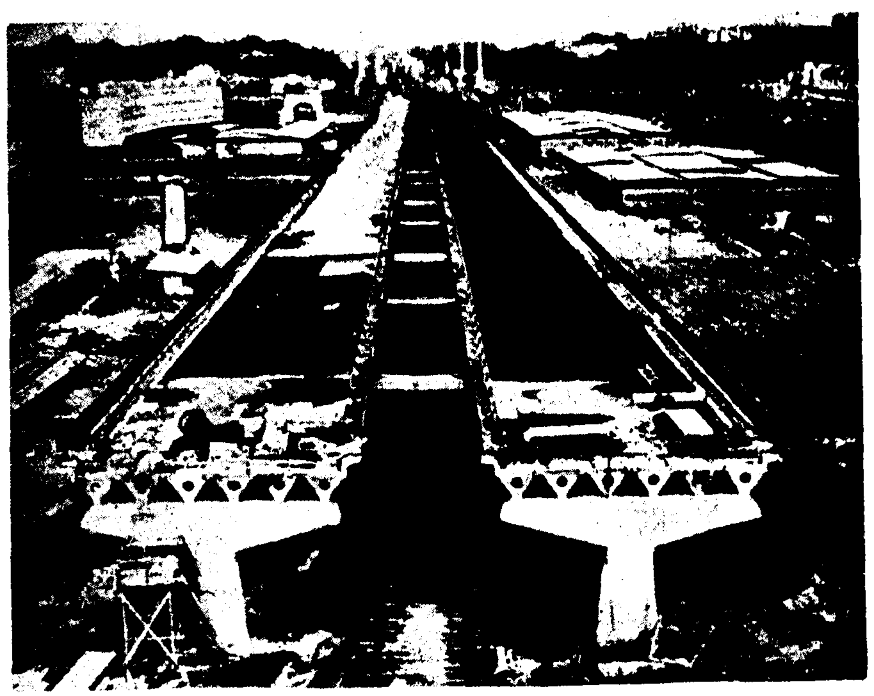
Each carriageway provides a three-lane road 34 ft 6 in. wide, and two 3 ft 3 in. footpaths. Where the road divides into four intersecting branches each is 24 ft 6 in., or two lanes wide.

The supporting columns are cruciform in section at the base, on a rectangular plan with a long axis of 11 ft and a short one of 7 ft twisting and tapering to the top where the section becomes 6 ft 6 in. by 4 ft rectangle. They vary in height from 11 ft 4 in. to about 26 ft according to the slope of the ground.

They were cast *in situ* against timber formwork made up of narrow fir boards backed by steel, carefully designed and made to leave narrow regular boardmarks on the fine quality concrete. Three sets of forms, made up in two halves and each reused on average 40 times, made the 120 columns. The differing heights were produced by



View showing one of the interconnecting pedestrian bridges



View during construction showing the six V-section longitudinal guides forming the superstructure

progressively shortening the forms from the bottom, thus only the taller columns have the true cruciform base ; in the shorter ones the arms of the cross become trapezoidal in shape.

The transverse cantilever members were also cast *in situ*, on top of the columns, in similarly-made forms with narrow boardmarks.

TheV-shaped longitudinal beams were cast in a casting yard near the site, in moulds lined with ferro-cement 0 (the fine quality mesh reinforced mortar material invented by Nervi) rubbed to a very smooth finish. Sixteen moulds were used to produce the 658 beams, approximately two-thirds of them straight and one-third curved, at the rate of four beams per day. The beams have an average length of 52 ft 6 in. a depth of about 3 ft 8 in. a width across the top of 6 ft 2 in. and at the bottom of 1 ft 3 in.; their wall thickness is $2\frac{3}{4}$ in. thickening at the ends to $6\frac{1}{2}$ in. Each beam is stiffened by three diaphragms and prestressed by cables along the bottom.

The tops of the trough-shaped beams are closed by 6 in. thick slabs precast in the same yard; they are formed into a monolithic deck slab by intermediate sections of *in situ* concrete, and the whole is topped by a layer of lean concrete and two layers of bituminous material.

Drainage is provided by the fall of the road to the outermost-beam, which forms a channel leading to down pipes within the columns. Electric lighting cables pass in the same way along the innermost beam and down the hollow columns.

The car park beneath the multiple end spans of the viaduct is extremely well laid out for rows of saw-tooth parking, with the parking areas and intermediate paths identified by different coloured paving. Young trees planted between the rows gave some much-needed shade last summer.

The total cost of the bridge, including traffic lights and tree-planting. amounted to approximately 690,000 pounds. The lighting which cost another 220,000 pounds is of special design. It forms a continuous strip along the side of each carriageway, at a height of approximately 3 ft which by careful angling eliminates dazzle and gives a uniform light over the whole of the road.

The whole construction was completed in thirteen months. It was carried out by the contracting firm of Nervi and Bartoli.

(From "Roads & Road Construction," February, 1961.)

HERE AND THERE

1. 'ENGINEER', 'TECHNOLOGIST' AND 'TECHNICIAN'

● A PROFESSIONAL ENGINEER is competent by virtue of his fundamental education and training to apply the scientific method and outlook to the analysis and solution of engineering problems. He is also able to assume personal responsibility for the development and application of engineering science, notably in research, designing, construction, manufacturing, superintending, managing, and in the education of the engineer. His work is predominantly intellectual and varied, and not of a routine mental or physical character. It requires the exercise of original thought and judgment.

His education will have been such as to make him capable of closely and continuously following progress in his branch of engineering science by consulting newly published works on a world-wide basis, assimilating such information and applying it independently. He is thus placed in a position to make contributions to the development of engineering science and its applications.

A TECHNOLOGIST is one who is engaged in the scientific study of industrial arts; he is therefore a kind of practical scientist. The definition that "a technologist is one who has studied the fundamental principles of his chosen technology and is able to use his knowledge and experience to initiate practical development" and "has the qualifications and experience required for membership of a professional institution", serves as a rough working rule for identifying a technologist.

A TECHNICIAN is a person "conversant with the technicalities of a particular subject qualified to work under the general direction of a technologist". The essential point seems to be that a technician is a practical man who can carry out assigned tasks in his technology, but is not necessarily fitted to extend its borders by the application of scientific reasoning. But there are marginal cases where it is difficult to distinguish a junior technologist from a senior technician, and the distinction is often a matter of habit or social prestige.

An engineering technician is one who can apply in a responsible manner proven techniques which are commonly understood by those who are experts in a branch of engineering or those techniques specially prescribed by professional engineers.

Under general professional engineering direction or following established engineering techniques, he is capable of carrying out duties which may be assigned to him.

In carrying out many of his duties, competent supervision of the work of *skilled craftsmen* will be necessary. The techniques employed demand experience and knowledge of a particular branch of engineering, combined with the ability to work out the details of a task in the light of well-established practice.

An engineering technician requires an education and training sufficient to enable him to understand the reasons for and the purposes of the operation for which he is responsible.

2. 12-YEAR ROAD PROGRAM FOR WEST GERMANY

● THE Minister of Transport of the German Federal Republic announced a 12-Year plan for road evelopment in Western Germany comprising an estimated expenditure of approximately (U.S.) 7 billion dollars. This amount will double the 1955 expressway network and modernize half of the length of federal roads. It is expected this work will meet the traffic demand of the next 20 years.

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

3. AN ECONOMIC INVESTIGATION

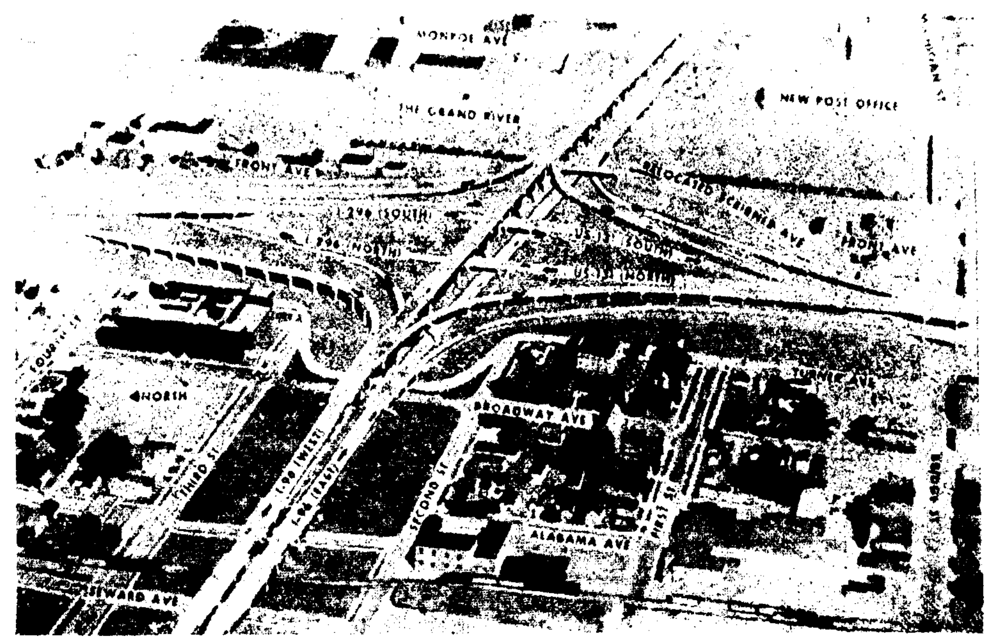
LANCASHIRE County Council Highways and Bridges Committee reports that an economic investigation has been made of the operation of the Lancaster By-pass in accordance with the methods recommended by the Ministry of Transport and the Road Research Laboratory. This investigation has shown that the savings in travel costs and accidents (with deductions for increased road maintenance) amount to 750,100 pounds a year. This represents a return of 17.3 per cent on the capital investment involved in the construction of the By-pass.

The main item in the savings arises from the reduced travel costs for vehicular traffic. Broadly it is made up from savings in the central area of Lancaster, where 23,000 vehicles moved at average speeds of 9.4 m.p.h., and on the approaches to Lancaster, where, for example, on the south section 20,800 vehicles moved at an average speed of 22 m.p.h. The diversion of the traffic on to the motorway has increased these speeds to 14.9 and 29.9 m.p.h., respectively, whilst traffic using the motorway amounts to 11,500 vehicles per day and travels at an average speed of 45.7 m.p.h. (cars).

As the amount of traffic on the roads increases so will the savings mount at a greater rate. Assuming the present rate of growth in traffic of 7 per cent per annum is maintained, then the road will have paid for itself in $4\frac{1}{2}$ years.

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

4. UNUSUAL DESIGN OF 11m. DOL. INTERCHANGE



● CONSTRUCTION will start soon on the first phase of this 11 million dollars interchange in Grand Rapids, says Michigan State Highway Department. The interchange, at the junction of the city's north-south and east-west freeways is unusual because of its "directional flow" design and the different elevation of the east-west freeway's roadways.

Traffic will flow in its desired direction rather than pass over or under the desired route and then doubling back. To allow "directional-flow", the eastbound east-west freeway is at ground level while the westbound lanes are 36 ft above the ground at their highest level.

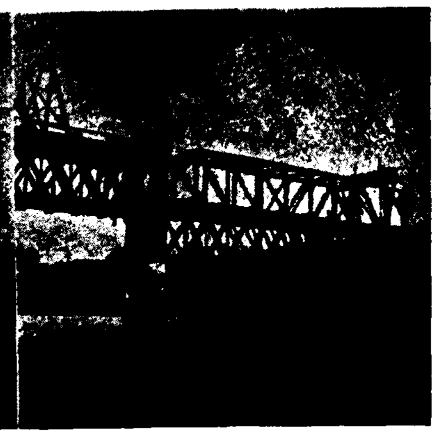
The difference in elevation kept right-of-way requirements to a minimum—the entire interchange covers only 20 acres.

(From "Highways Bridges and Engineering Works," July 5, 1961)

5. NOVEL METHOD OF BRIDGE SPAN RENEWAL

● A NOVEL method of bridge span renewal has been adopted by New Zealand railway engineers on the 600 ft railway bridge over the Wanganui River at Aramoho, Wanganui, whose five 120 ft wooden truss spans are being replaced by four 120 ft steel trusses and two 60 ft through plate girders.

The new span above the old one, ready for lowering



After lowering, the old span is suspended beneath the new one

To effect the replacement of the first four spans, four jacking posts are fitted on the outside of the bridge, one at each corner of the span being replaced. Each new steel span, fabricated in the Railways Department's Hutt workshops, is then assembled on top of the old one.

The track and carriers are removed from the old span, which is then fastened to the bottom of its steel successor and cut free at each end from the supporting cylinder piers. The new truss is then lowered by jack and secured in place, the track is relaid and reopened for traffic, and the old span hanging below is removed at leisure.

The renewal of the bridge structure is being done span by span. To reduce interference with rail traffic to a minimum, the actual truss replacement is done at weekends, when the bridge is closed for a period of 36 hours.

Removal of the track from the old truss before lowering is expedited by the use of steam cranes placed at each end of the span. Rails, sleepers, rail beams and bracing removed in this manner reduce the 130-ton weight of the timber truss by almost half.

The setting of bedplates for the new truss, on river pile or abutment, required almost eight hours for the concrete to set solidly before the new truss could be lowered into place.

Alterations to the eastern end of the bridge are also planned, to enable a roadway beneath the easternmost span to be widened.

(From "New Zealand Engineering," July 15, 1961)

6. MOTORWAY CONSTRUCTION IN BRITAIN

● THE CURRENT rate for bringing new motorways into operation in Britain is 6½ in. per minute, so reports the latest communication from the Roads Campaign Council. In the 1,001 days from December, 1958—when the Preston By-pass was opened—to 1st September this year, 148¾ miles of motorways have come into service. The construction costs are put at 54.4 million pounds.

Under construction at the moment is another 144 miles at an estimated 76½ million pounds. About 300 miles of motorway will have been opened by the end of 1963 and the cost will then have been 132 million pounds—but there can be little doubt that this sum will already have been saved by the first of the motorways. The Council estimate that, altogether, 928 miles of motorway are planned for the country by the Ministry of Transport.

Quoting the last Road Research Board annual report—that by 1980 there will be 25 million vehicles on Britain's roads (2½ times today's figure) and 34 million by 2000 A.D.–the Council point out that motorways should be designed and built with a view to enlargement. "It would be a national scandal if the taxpayers' money is wasted on roads outflanked by the meteoric rise in traffic," a Council spokesman commented. The plea that the Government should also give immediate priority to spending more (on roads) in urban districts was repeated.

From "Engineering," 22nd September, 1961)

LIST OF APPROVED WORKS ON NATIONAL HIGHWAYS

S. No.	Job No.	Name of the work	Amount Rs in lakhs
		UTTAR PRADESH	
1.	2685-UP-28	Minor additions and alterations to Inspection Bungalows and Rest Houses (i) Inspection Bungalow at Harriya in Basti, N.H. No. 28.	0.02
2.	2686-UP-2	Minor additions and alterations to Inspection Bungalow and Rest Houses (ii) Inspection Bungalow at Fatehpur, N.H. No. 2.	0.04
3.	2687-UP-2	Minor additions and alterations to Inspection Bungalows and Rest Houses (iii) Inspection Bungalow at Daulapur.	0.04
		DELHI	
4.	2688-DLH-1	Improvement to Upper Bela Road from its junction with Jamuna Bazaar to its junction with Alipur Road.	2.11
		M. P.	
5.	2689-GR-8A	Construction of approaches to Maha bridge near Dhuva on Wankaner Morvi Section of N.H. No. 8-A.	1.46

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(Continued from the previous issue)

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2. **Principles of Economic Planning.** Published by Eastern Economist Ltd., New Delhi.
3. **Lighting problems of towns in India.** Published by Local Self-Government Institute, Bombay.
4. **S.A.A. Int. 351 : Structural Steel in Building.** Published by Standard Association of Australia.
5. **Road Research Notes No. 3. The compaction of some Alluvial soils of India.** Published by C.R.R.I. of India, New Delhi.
6. **I.S: 1387—1959. General requirements for the supply of metals and metal products.** Published by I.S.I. New Delhi.
7. **Highway Research Board Proceedings Thirty-ninth Annual Meeting, Vol. 39, 1960.** Published by Highway Research Board, Washington.
8. **Annual Administration Report (1959-60)** Published by Tripura Administration.
9. **Annual General Administration Report Andaman & Nicobar Islands (1958-59).** Published by Chief Commissioner Andaman and Nicobar Islands.
10. **Report on the Administration for the year 1958-59.** Published by Laccaive Minicoy and Admini Islands.
11. **Administration Report of Himachal Pradesh: Administration for the year 1959-60** Published by Himachal Pradesh Administration.
12. **Manipur Administration Report.** Published by Manipur Administration.
13. **Delhi Administration Annual Report, 1959-60.** Published by Delhi Administration, Delhi.
14. **Annual Administration Report, 1958-59 Delhi Territory.** Published by Delhi Union Territory.
15. **Manipur Administration Report for the year ending 31st March, 1959.** Published by Manipur Administration.
16. **Report of the Union Public Service Commission for the period 1st April, 1959 to 31st March, 1960.**
17. **Madras Highway Manual, Vol. II, Construction Manual Chapter on Road side development.**
18. **I.S: 1343-1960: Code of Practice for Prestressed concrete.** Published by I.S.I. New Delhi.
19. **I.S: 1343-1960 : Specification for Black Hexagonal Blots 6-39 m. with nuts and Black Hexagon screws.** Published by I S.I. New Delhi.
20. **I.S: 1480-1960: Specification for metric scales for general purposes.**
21. **I.S: 1482-1960 : Specification for metric scales for use with drafting machines.** Published by I.S.I. New Delhi.
22. **I.S: 1521-1960: Method for Tensile testing of steel wire.** Published by I.S.I. New Delhi.
23. **I.S: 1556-1960 : Specification for hard drawn steel wire fabric for concrete reinforcement.** Published by I.S.I. New Delhi.
24. **I.S: 1599-1960 : Method for hand test for steel products other than sheet, strip wire and tube.** Published by I.S.I. New Delhi.
25. **I.S: 1635-1960 : Code of Pracitce for field slaking of lime and preparation of putty.**
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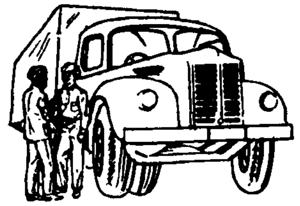

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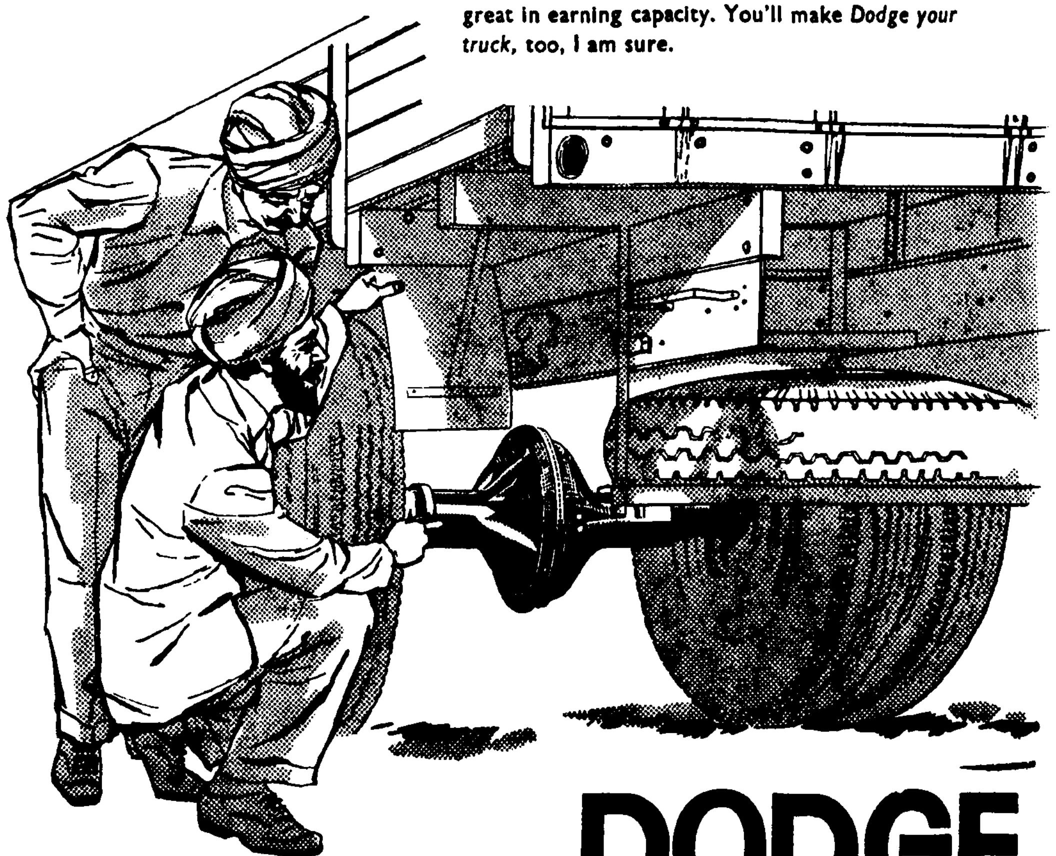

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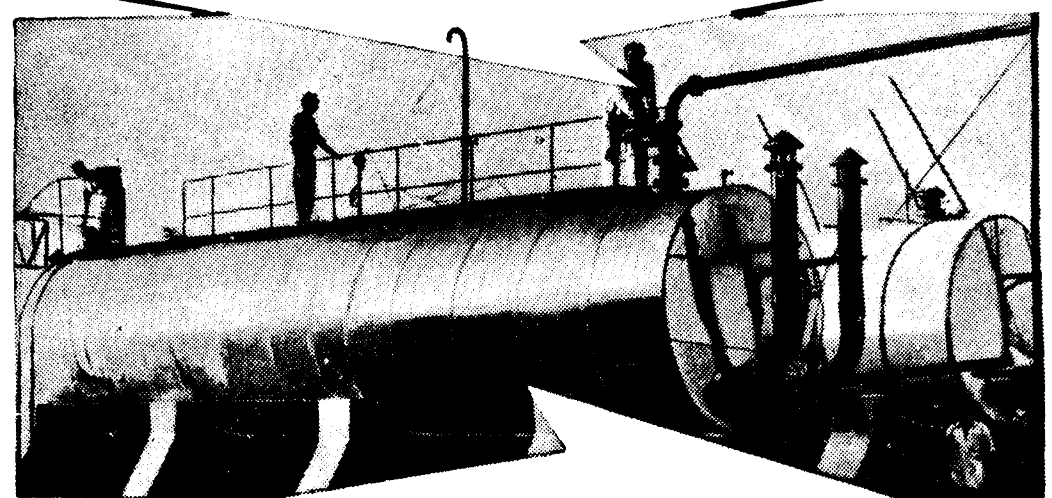

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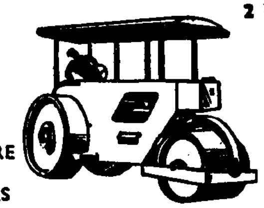

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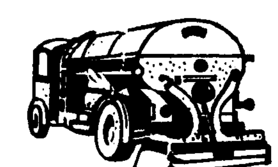

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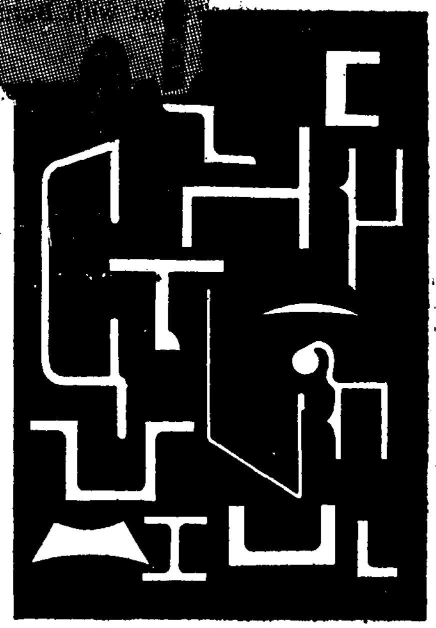

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