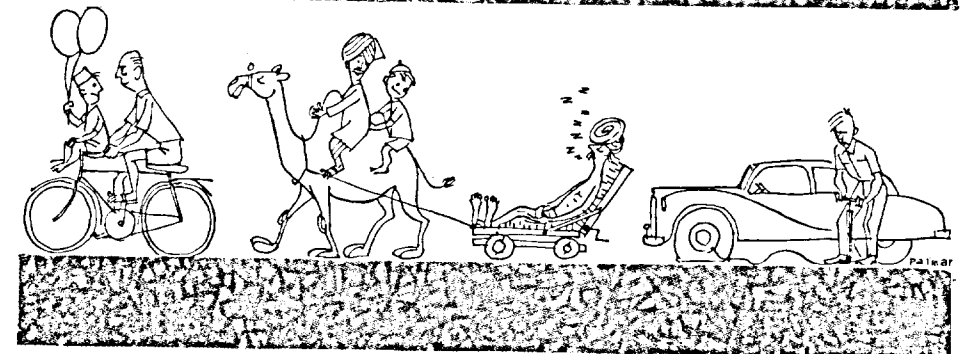
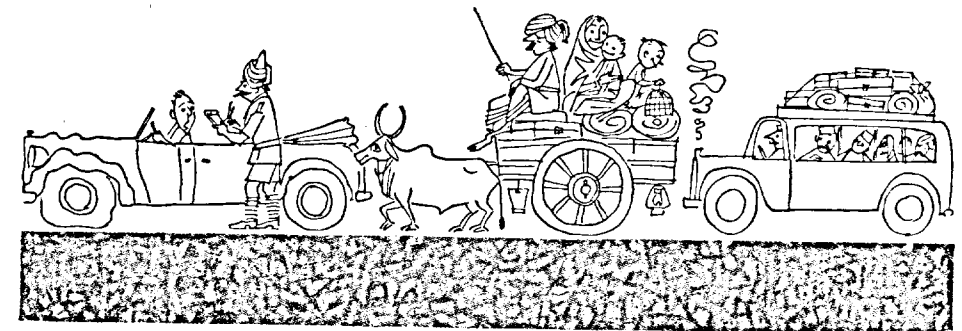
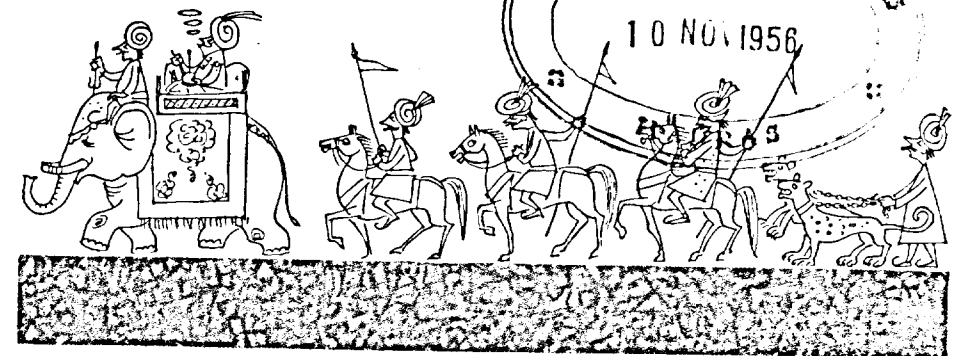




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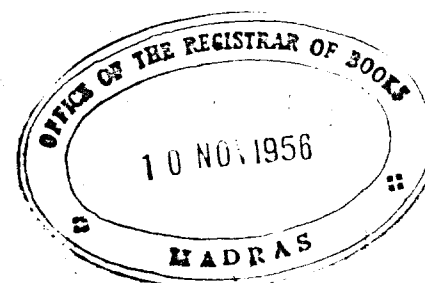
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MONTHLY REVIEW

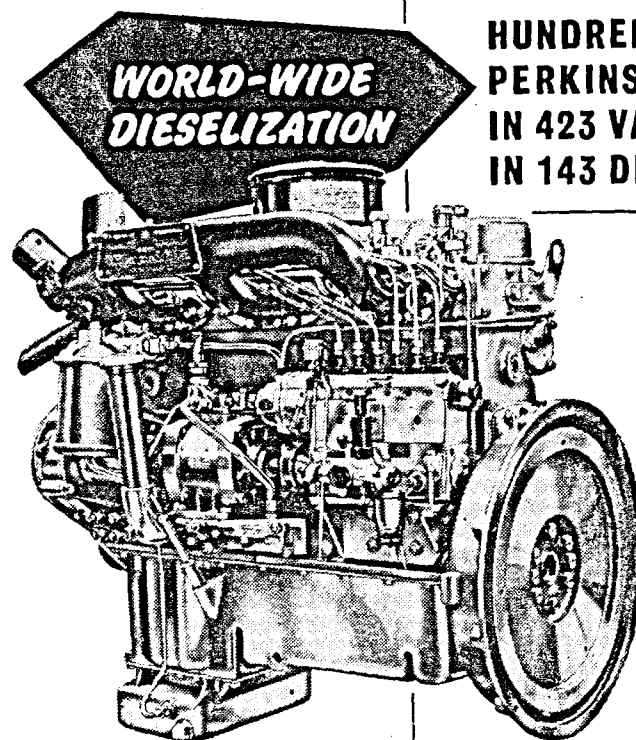
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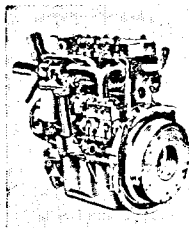
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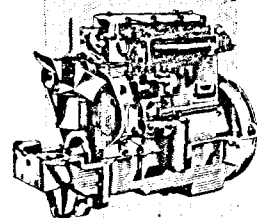
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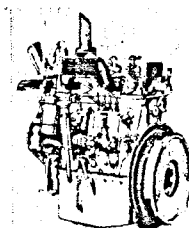
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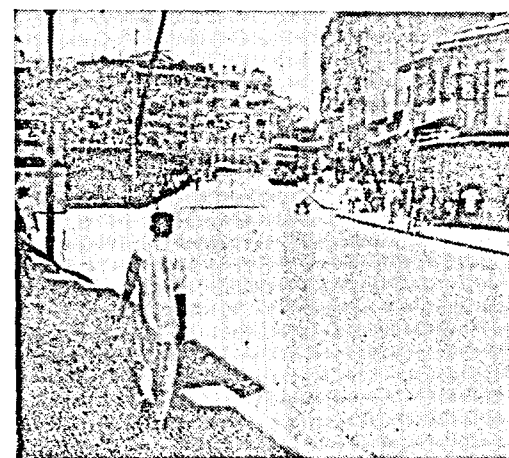
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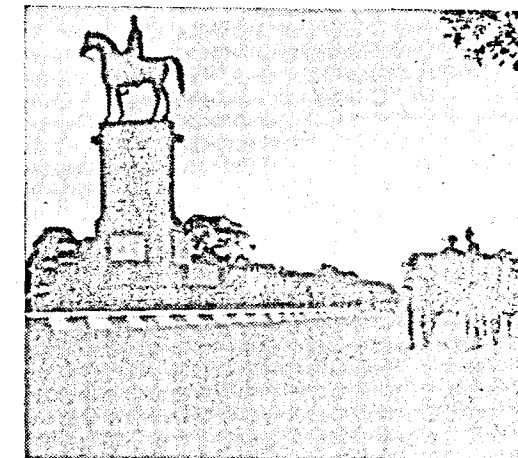
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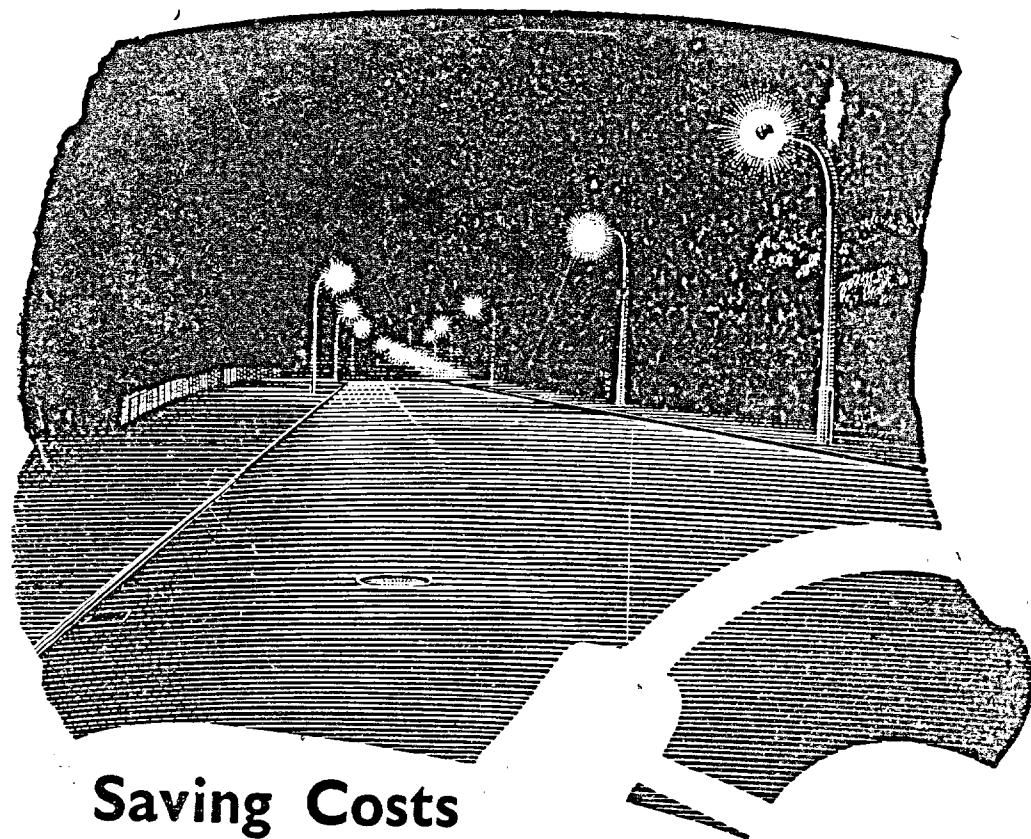
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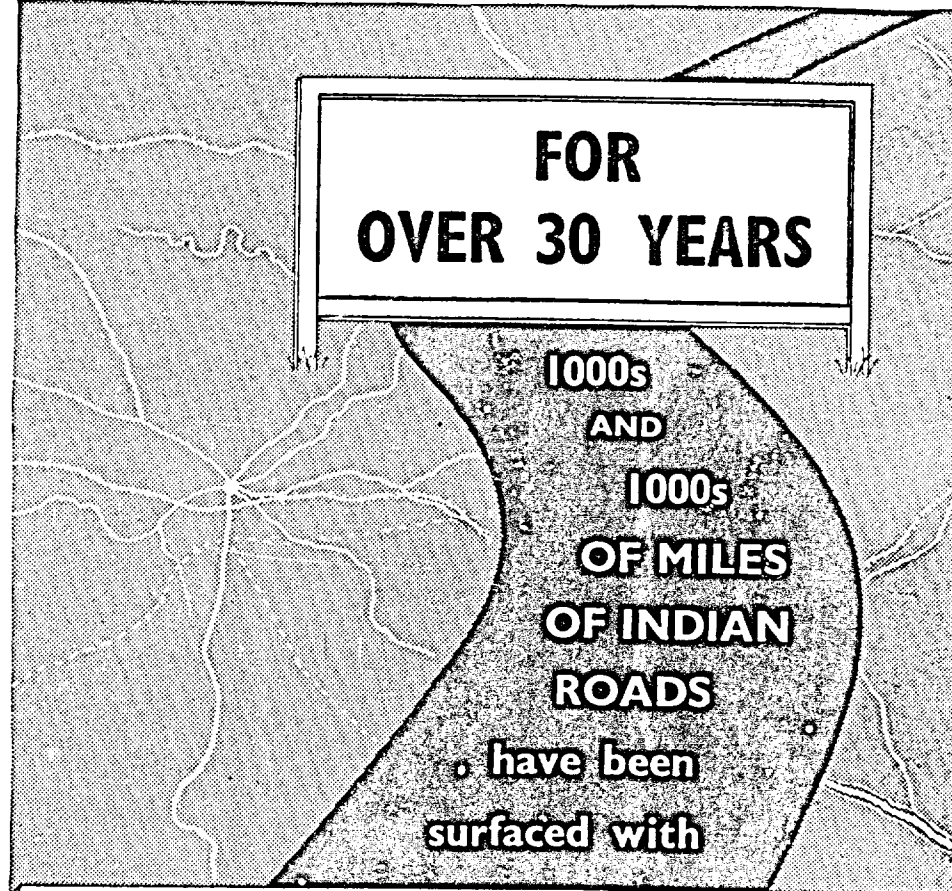
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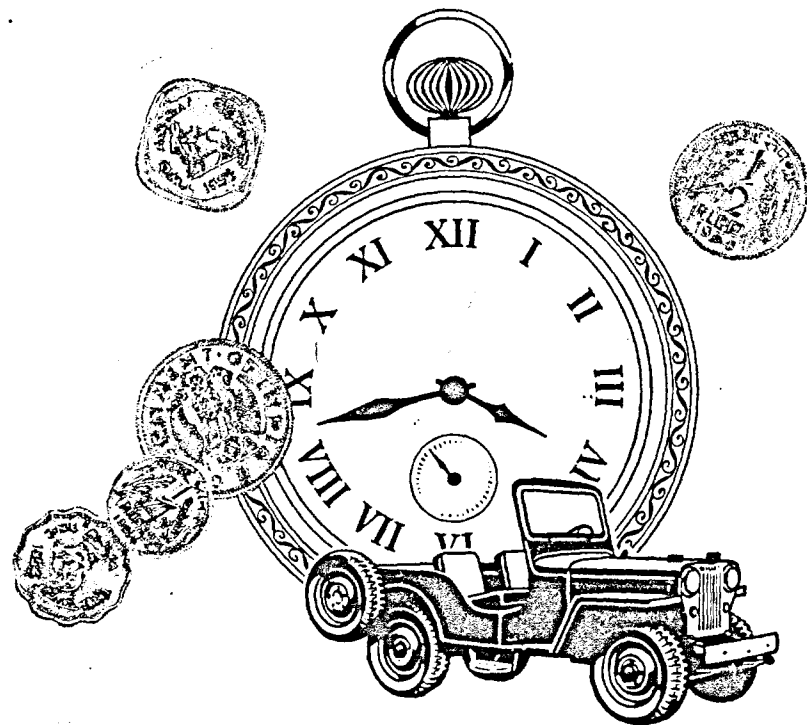


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vi

TRANSPORT- COMMUNICATIONS MONTHLY REVIEW OCTOBER 1956—No. 114

TABLE OF CONTENTS

	Page
GENERAL	
Bridging India's Rivers—Bridges across Amaskhal Nallah and Pochakhali Nallah	... 3
Highways of Uganda	... 7
The National Highways Bill in Lok Sabha	... 10
The National Highways Bill in Rajya Sabha	... 10
TECHNICAL	
Loading of Highway Bridges	... 12
Use of Principles of Soil Mechanics for Earthworks	... 16
HERE AND THERE	
1. Contract secured by Duress is not Valid but Voidable	... 18
2. Road Administrator for Federal-Aid Programmes (U. S. A.)	... 18
3. Roads help Rearing of Live Stock	... 18
4. Systematic Investigation of Accidents on Road	... 19
✓ 5. Traffic flow and Carriageway Width on Rural Roads	... 20
6. Provision of an additional Lane on Hills for Slow Moving Vehicles	... 21
7. A new Lightweight Cellular Concrete—Isocrete	... 21
8. Importance of Geometries for Farm Roads	... 21
CURRENT LITERATURE	
Abstracts	... 22
Selected Recent Literature in Engineering Journals	... 25
Publications added to the Roads Wing Library during June and July 1956	... 27
BUDGETS AND ADMINISTRATION REPORTS	
Govt. of Rajasthan, Civil Works Budget for 1956-57	... 29
List of Approved Works on National Highways	... 32
ALSO: Definitions of Highway Engineering Terms — New Language — Finishes for Automobiles.	

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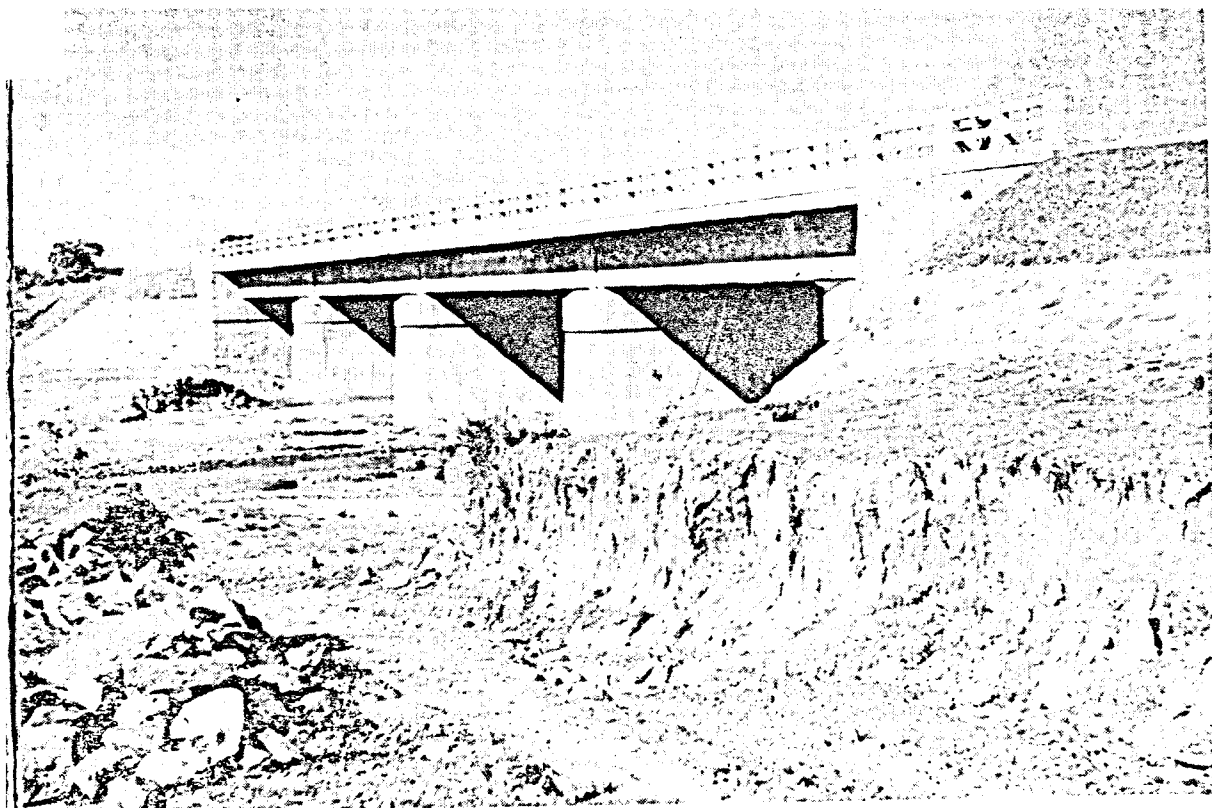
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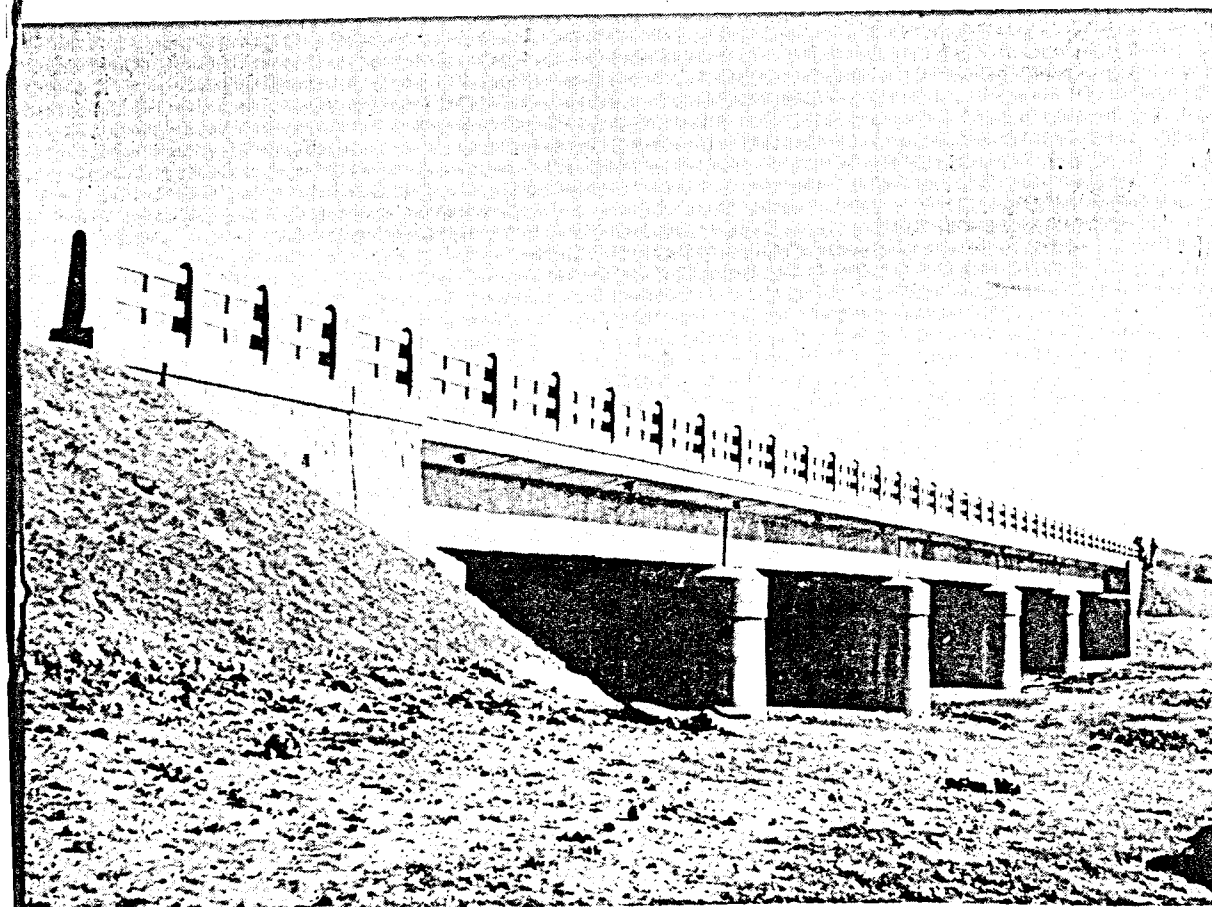
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BRIDGE ACROSS AMASKHAL NALLAH



TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

A REVIEW OF
ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

OCTOBER 1956

BRIDGING INDIA'S RIVERS

BRIDGES ACROSS AMASKHAL NALLAH AND POCHAKHALI NALLAH

NATIONAL Highway No. 6, the Bombay—Calcutta Road, crosses river Subernarekha at about $5\frac{1}{2}$ miles from its junction with National Highway No. 5, the Calcutta—Bombay Road. The Amaskhal Nallah which joins the Subernarekha is crossed by National Highway No. 6 at $3\frac{1}{2}$ miles south of the Subernarekha crossing. The Pochakhali Nallah is crossed at a distance of 6 miles 6 furlongs north of the Subernarekha crossing. This article gives a brief description of the bridges across these two nallahs.

Hydraulic Data

Amaskhal Nallah: At the site of the bridge the nallah has a catchment area of 12 square miles and the bridge is designed for a maximum flood discharge of 14,800 cusecs. The discharges by the different formulae in use, viz., Manning, Dickens, and the area cross-section method, have been worked out, and the maximum of these selected for the design purposes.

The normal scour depth worked out to 10 ft, assuming Lacey's silt factor of 1.5 for coarse sand. Thus the maximum scour depth for a round nosed pier is 20 ft and with an increase of one-third for grip purposes, the total depth of foundations required is 27 ft below the high flood level. With a depth of flow of 11 ft, the foundations are required to be taken to about 16 ft below the bed level.

Actually, the wells on which the piers are supported have been taken down to 20 ft below the bed level into yellow coarse sand mixed with gravel. The afflux worked out to 0.33 foot.

Pochakhali Nallah: The maximum discharge is 12,500 cusecs. Foundations have been taken to yellow sandy clay, well below the scour depth. The afflux works out to 0.24 foot.

Foundations

At both the sites, borings did not reveal the presence of rock at a reasonable depth below the bed. Therefore the well foundations have been taken well below the scour depth allowing for adequate grip, and at both the sites the nallahs have been bridged from bank to bank.

The piers are founded on two circular wells of 8 ft internal diameter with a steining 2 ft thick. The wells have an R. C. C. kerb 3 ft 3 in. in depth with angle iron cutting edge. The bottom 4 ft of the well is plugged with 1 : 2 : 4 cement concrete. The top plug consists of 1 : 3 : 6 cement concrete 2 ft thick. The wells have a reinforced capping slab 10 ft in width and 2 ft thick.

Piers

The piers are of cement concrete 1 : 3 : 6 lightly reinforced with 15 per cent plums and are 5 ft thick at top. They

have a side batter of 1 in 18. All the piers are capped by a capping slab 3 ft 6 in. thick.

Abutments

The abutments are 6 ft 6 in. in width below the capping slab. They have a front batter of 1 in 12, and the back is kept to suit requirements of stability. These are constructed in random rubble masonry in cement mortar (1 : 4).

Superstructure

The superstructure of both the bridges are similar. The Pochakhali nallah has 5 spans of 45 ft clear openings each, whereas the Amaskhal nallah has only 4 spans. The superstructure consists of reinforced concrete T-beams with 4 beams in the cross-section at 6 ft centre to centre. The deck slab is 8 in. in thickness and the stem of the T-beams is 4 ft 4 in. deep and 14 in. wide. Fillets 6 in. by 6 in. connect the stem of the T-beam with the deck slab. These 4 beams are connected

of the spans there are cross-beams 15 in. in width, connecting all the 4 beams. The longitudinal section of the Pochakhali nallah is shown in Fig. 1. Details of reinforcements for the inner and outer beams are given in Fig. 2.

Expansion Arrangements and Bearings

The superstructures of two adjacent spans are separated over the centre of the pier by means of an expansion gap of 1 in. The fixed end of the beam rests on lead sheet $\frac{3}{4}$ in. thick and is connected to the main T-beams through a mild steel plate 13 in. by 15 in. by 1 in. The expansion end of the beam rests on a reinforced concrete rocker 15 in. by 18 in. reinforced with $\frac{3}{4}$ in. diameter rods. Lead sheets 12 in. by 18 in. by $\frac{3}{4}$ in. are interposed between the rocker and the bed block at bottom and the beam at top.

The expansion gap of 1 in. is bridged by beams of mild steel plate 5 in. by $\frac{1}{4}$ in. thick. This plate is fixed at one end to an angle iron 3 in. by 2 in. by $\frac{1}{4}$ in. and slides on another angle iron 3 in. by 2 in. by $\frac{1}{4}$ in. Details of the rocker and the expansion arrangements are given in Fig. 3.

Construction

During the sinking of wells slight shifts and tilts in the wells had occurred, the maximum being 9 inches. But calculations showed that the wells were safe when the inclination of the wells did not exceed 1 in 100.

The bridges have been designed for I.R.C. Class AA loading. The roadway over the bridges is 24 ft wide between reinforced concrete kerbs which are 9 in. by 9 in. The railings extend to a height of 3 ft above the adjacent roadway surface.

Testing

The bridges were subjected to a test load of 77 tons spread over an area of 2 ft by 12 ft, and the deflections measured by means of a micrometer. The arrangements for measuring the deflections are given in Fig. 4. It was observed that the deflections were within limits and that there was full recuperation after the release of the load.

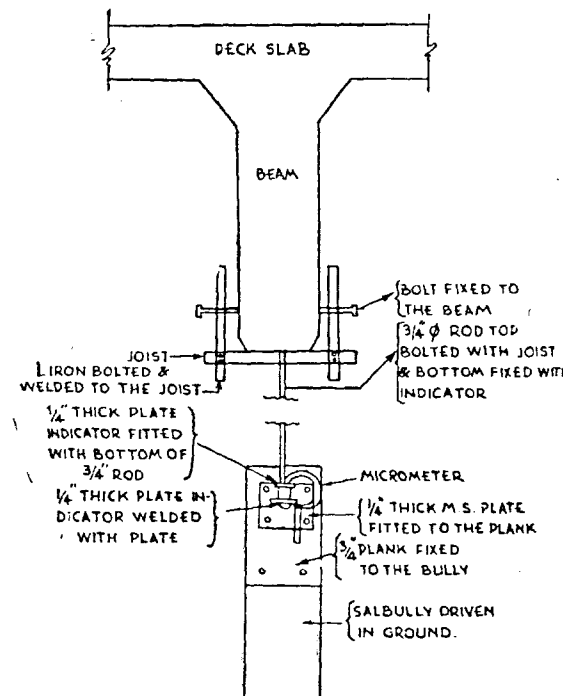
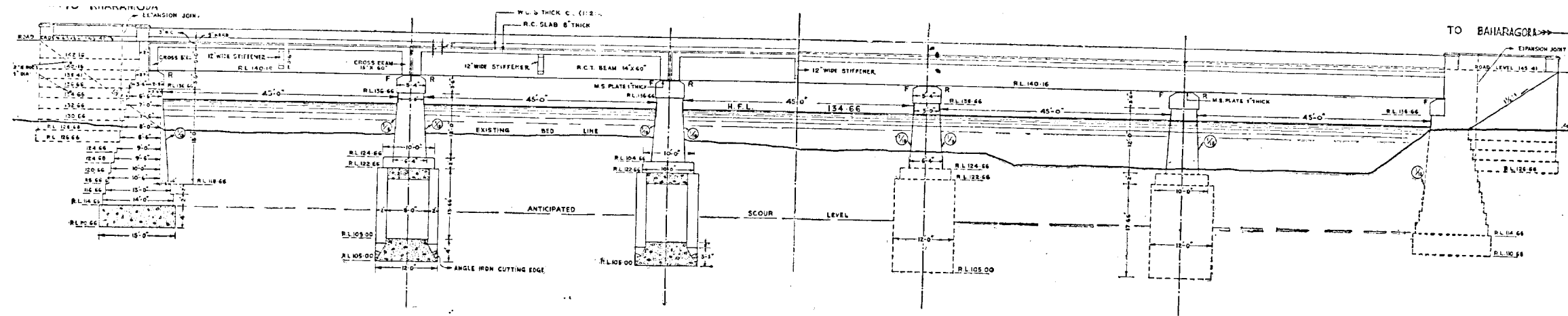


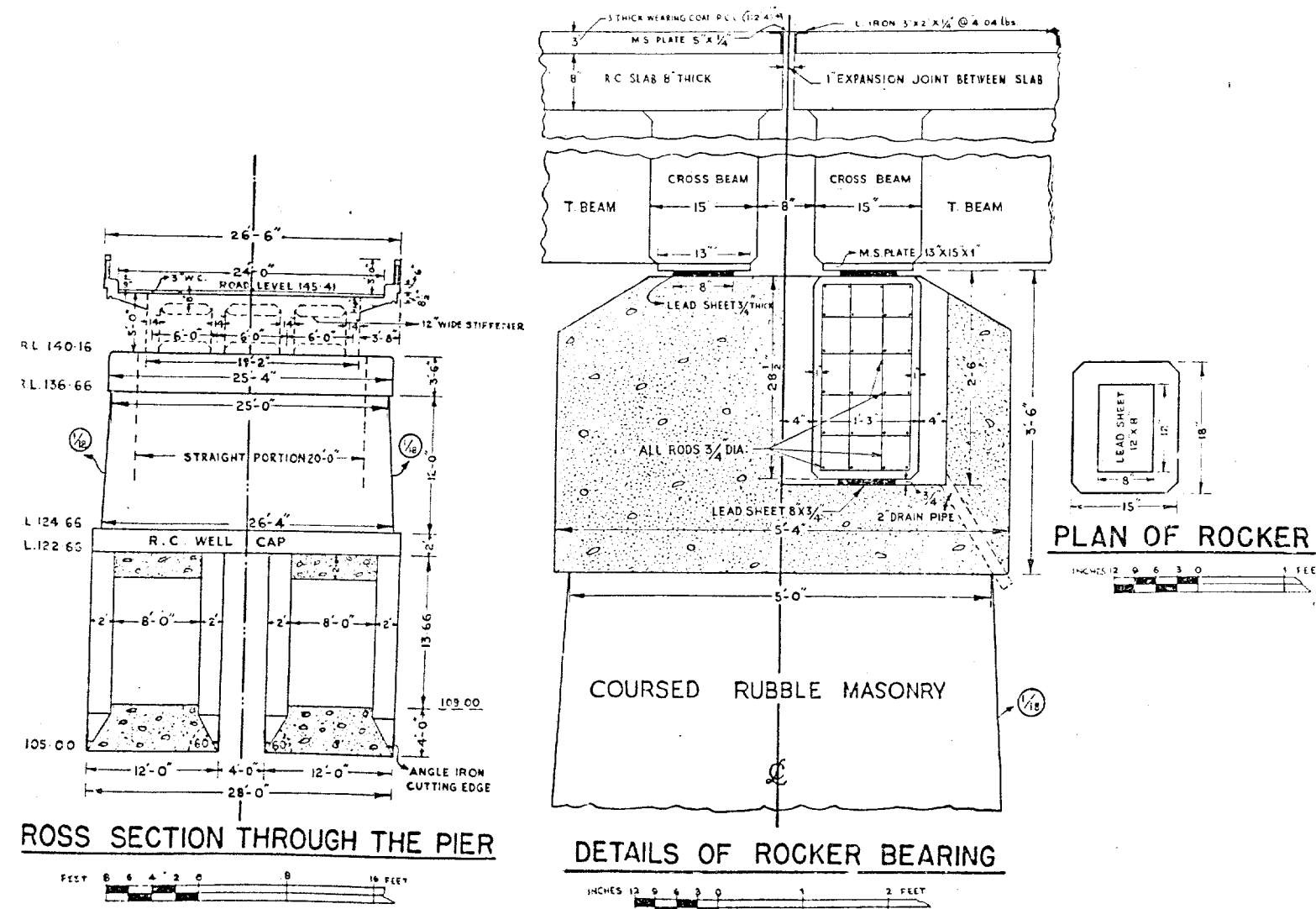
Fig. 4.

by means of 12 in. wide stiffeners at the centre of each of the span. At either end



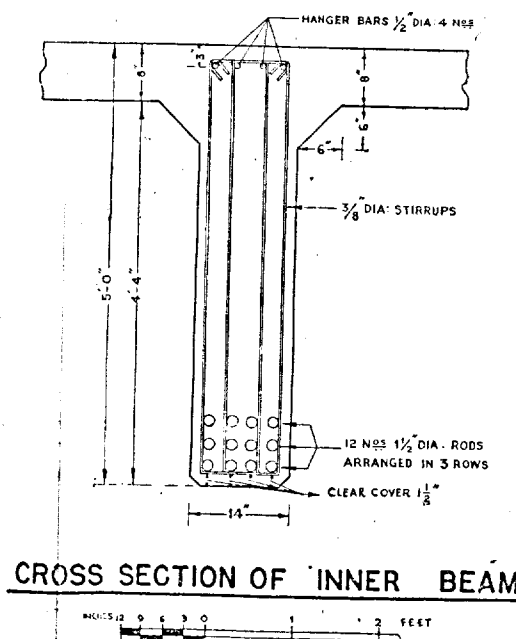
HALF LONGITUDINAL SECTION AND HALF ELEVATION

Fig. 1

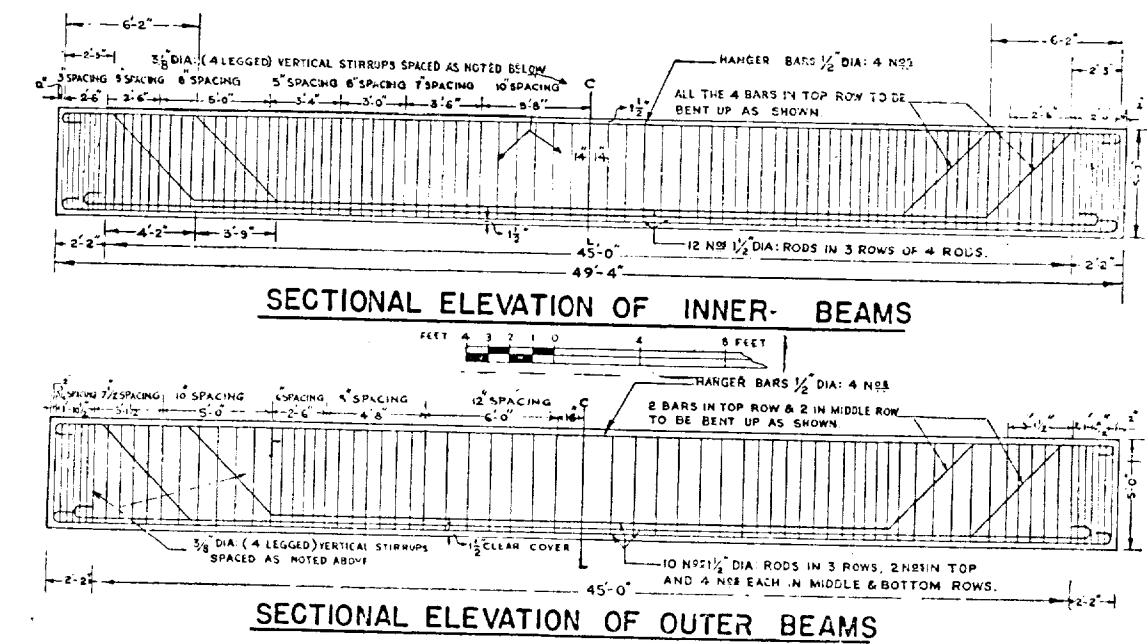


DETAILS OF ROCKER BEARING

Fig. 3



CROSS SECTION OF INNER BEAM



SECTIONAL ELEVATION OF OUTER BEAMS

HIGHWAYS OF UGANDA

The Country

UGANDA, a British Protectorate, has an area of 93,981 sq. miles, of which 13,689 are water, i.e., portions of Lake Victoria and Lake Albert in Central Africa. The population of the Protectorate is 5½ millions. The money crops of the country are cotton and coffee which are mainly exported and yield a revenue nearly Rs 27 crores by way of export duties. The transportation of coffee and cotton is mainly by means of roads.

Early History

Prior to the advent of British administration in 1900, tracks were in existence and the roads were gradually developed subsequent to that date, mainly for transporting the cotton crop to the ports on Lake Victoria. From there it was transported by steamers and barges to Port Kisumu in Kenya from where it was railed to Mombasa for export. In 1905-06, there were only 439 miles of roads in the country. Even by the end of 1907 there were no roads more than third class standard in the Protectorate. The chief means of transport before 1908, when the first motor lorry was put into use, was the bullock cart. During the period between 1920 and 1930 bullock carts were gradually replaced by motor vehicles and now only vehicles fitted with pneumatic tyres are permitted to travel on public roads. Since 1939, the number of motor vehicles has increased nearly four times and the following table is a record of the growth of motor vehicles.

Growth of Motor Vehicles

Year	Public service vehicles	Commercial vehicles	Cars	Motor Cycles	Total
1939...	150	1,929	2,520	779	5,378
1945...	137	1,390	1,990	840	4,357
1953...	345	5,593	8,180	3,090	17,208
1954...	338	7,706	9,336	3,726	21,106

When the motor vehicle came to use the roads, the earlier alignments were found inadequate and in 1908-09 the following standards were prescribed. It was also stipulated that no roads should be made until the alignments have been surveyed and laid out by a qualified surveyor.

	Class of Road				
	1st	2nd	3rd	4th	5th
Width (in ft)	25	20	20	20	16
Width at culvert and banks	20	16	—	—	—
Ruling gradient Per cent	3½	4-5	4-5	4-5	4
Ruling curve radius (in ft)	120	120	120	120	120

Vehicles Using the Roads

The common type of commercial vehicle is the 5-ton truck—pay load of 5 tons and gross laden weight of 8 tons—with a 5-ton load on the rear axle. There are some heavier vehicles and the Traffic Ordinance 1951 limits the permissible maximum weight on a single axle to 17,600 lb and a tandem axle group to 32,000 lb.

Construction

The chief material available in the country for construction of roads is laterite, known locally as moorum. The laterite is formed either by the action of water gradually leaching silica out of the soil so that the residual soil contains an excess of iron, or by ground water that is rich in iron oxides continually depositing these and cementing soil particles together to form small laterite nodules or concretions (pealaterite). In time these become cemented into larger lumps (6-12 in.) or solidly cemented fossilitic laterite (ron stone). The pea-laterite is found in layers, varying in thickness and quality under two or three feet of clayey soil and above residual laterite. The irregular shaped nodules when broken reveal a red, blue or black colour. This laterite is capable of reach-

ing a density of 125 lb per cu. ft. at a moisture content of 13 to 14 per cent.

When fast moving vehicles use this moorum surfaced road, the fine clayey binding material is lost and, therefore, the granular particles tend to corrugate during dry weather. If laterite containing excess of clay is used to counteract the tendency to corrugate in dry weather, during the wet season the surface becomes slippery. Therefore when the daily average traffic is of the order of 100 vehicles, the maintenance of laterite roads with good riding qualities is difficult and costly. Therefore the road has to be given a bituminous surface.

The edges of the carriageway are thickened with a flush kerb (6 in. deep and 4 in. wide) consisting of premix of bitumen and stone chippings.

In Uganda there are a number of swamps and some times a road has to pass a swampy area for nearly a mile in length. In such cases, the dead vegetation and mud overlying the clear sandy clay bottom is removed by mechanical excavation and good soil imported for forming the embankment. Special attention is given to provide adequate surface and subsoil drainage. Reinforced concrete box-type culverts are provided in the embankment for purposes of drainage.

Development Plans

In 1946, a development plan was drawn up for reconstruction of roads to modern geometric standards. The standards adopted were: carriageway width, 20-22 ft; shoulder width, minimum 5 ft; grade ruling, 5 per cent, maximum for short distances 8 per cent; stopping sight distances 600 ft, overtaking or passing 1,500 ft, with a minimum of 1,000 ft; curvature (radius in ft) 2,000 desirable, minimum of 1,000 and in hilly country 500.

Bridges have in the past been designed to 12 units of B. S. loading for highway bridges, but, in future, it is proposed to design for 15 units of that loading. Major bridges are designed for two lanes where traffic warrants it now or in the near future, otherwise for single lane (12 ft wide). Drainage culverts are made to the full width of the formation.

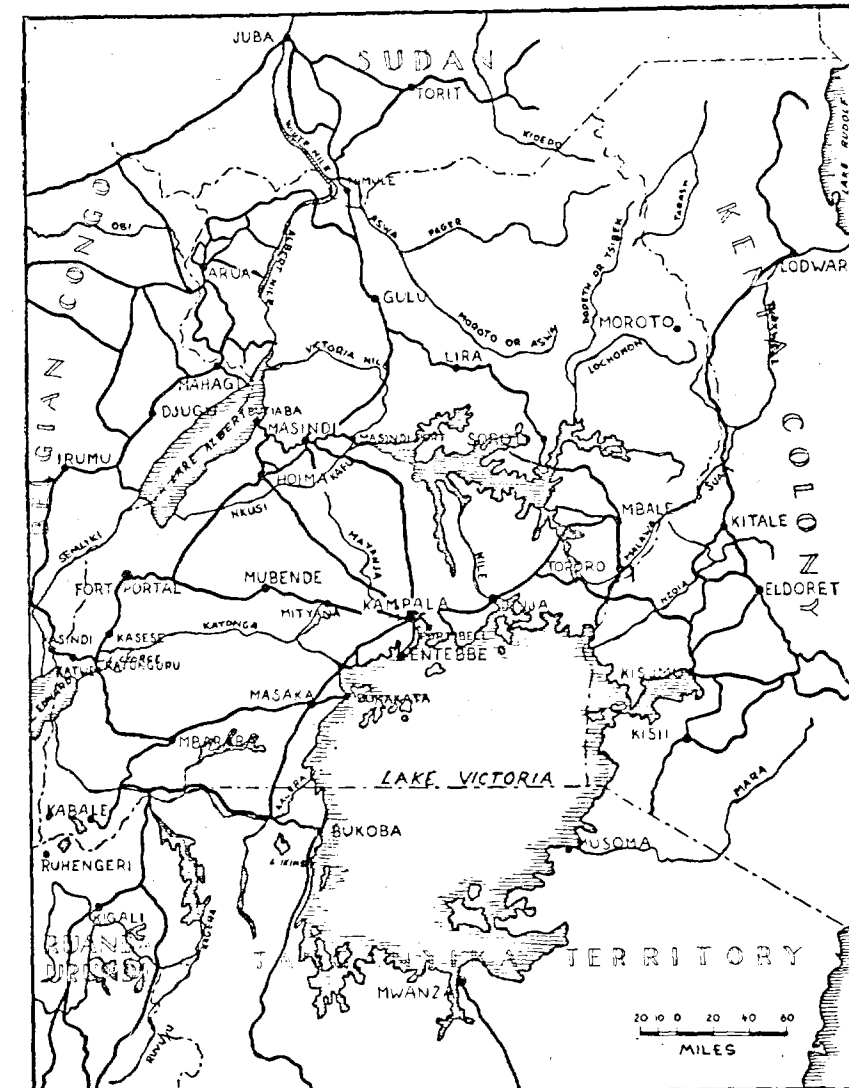
During the period 1946-55, approximately (Rs 5.4 crores were spent on the reconstruction of nearly 300 miles of highways and three major bridges.

In July 1955, a Five-Year Capital Development Plan, which envisages an



The road from Kampala to Jinja

In Uganda a bitumenised surface pavement is designed in accordance with the C.B.R. method. The base course consists of selected laterite with a low clay content, generally available within a distance of 3 miles. The compacted thickness of the base course varies from 4 to 6 in., depending on the sub-base soil. The bitumen surface consists of two-coat surface dressing. The prime coat is an application of a cut-back bitumen rapid curing at 1/5 gallon per sq. yard and blinded with ($\frac{1}{2}$ - $\frac{1}{4}$ in.) stone chippings. Road tar of suitable E. V. T. are used instead of the cut-back bitumen in prime coat if costs are favourable.



Highway system of Uganda

expenditure of Rs 6.75 crores), has been drawn up. Under this plan, priority will be given to complete reconstruction of the roads radiating from Kampala, the chief port on Lake Victoria.

Maintenance

The maintenance of moorum roads in the territory is done chiefly through gangs. One gang under a headman is employed for every 5 miles. These gangs attend to the day-to-day repairs such as filling of pot-holes, cleaning side drains, removing overgrowth of grass on the shoulders, and keeping the visibility open for about 100 ft width.

Units of machinery comprising excavators, tip trucks and motor graders are employed for the supply of gravel. There are 8 such units at work and these units are expected to be sufficient for renewing nearly 200 miles of roads with a gravel layer every alternate year.

Costs

The average cost of maintaining a gravel road was Rs 325 in 1930, Rs 13,600 in 1954. Re-sealing of the bitumen surface cost nearly Rs 13,500 per mile at present-day prices, and on average re-seals are required once in every 5 years.

—(From 'Road International,' No. 18, Autumn 1955.)

THE NATIONAL HIGHWAYS BILL IN LOK SABHA*

CONTINUING his replies to the debates on the National Highways Bill in Parliament, Shri O. V. Alagesan, Deputy Minister for Transport & Railways explained that the Union Government had been making grants for the construction of road to Badrinath, the road from Panvil to Mangalore and then to the Tranvancore-Cochin border. Also fund for the construction of the Aroor and Periyar bridges and the combined rail-road bridge over the Sariyur river have been sanctioned. Also construction of combined rail-road bridge across Sariyur

was under correspondence with the Railways.

Due to the limited funds it was not possible to have two parallel National Highways between Delhi and Kanpur to the north of the river Yamuna. The road connecting Kanpur to Delhi south of the Yamuna was preferred as it meant opening of a comparatively under-developed area. That was why the old Mughal Road from Kanpur to Delhi was not included in the National Highway system. After a clause by clause detailed discussion the Bill** was passed.

THE NATIONAL HIGHWAYS BILL IN RAJYA SABHA

THE Deputy Minister for Railways & Transport, Shri O. V. Alagesan, moving for consideration of the National Highways Bill as passed by the Lok Sabha said that the Bill seeks to obtain the approval of the Parliament for the existing provisional system of the National Highways and the assumption by the Government of India of statutory responsibility for their development and maintenance.

After the assumption of responsibility for the National Highways by the Central Government in 1947 upto the end of 1950-1951, i.e., before the commencement of the First Five-Year Plan about 110 miles of new roads and three large bridges were constructed. Also about 1000 miles of roads were improved. During the First Five Year Plan period, 636 miles of new roads and 30 major bridges besides a large number of minor bridges and culverts were constructed. About 4000 miles of the National Highways have been asphalted for one lane width. Under the Second Five Year Plan, a provision of Rs 55 crores had been made

for the development of National Highways. With this amount it was expected that the construction of 900 miles of new roads, 60 new bridges, widening of 1500 miles to 2-lane width and improvement and black-topping of 4700 miles would be achieved.

It was not possible to consider addition of new roads to the system since the provision for the development of National Highways in the Second Five Year Plan was not large.

Shri Rajinder Partap Sinha (Bihar) welcomed the Bill and said that when the Nagpur Plan was drawn up, the economic development that had been achieved during the First Five Year Plan period and that envisaged in the Second Five Year Plan was not anticipated. Since the development of roads should be in keeping with general economic development of the country, expenditure on roads should be related to the development expenditure in other sectors. Also roads should be

developed in order that they can supplement the capacity of the railways to move goods. If one looked at the targets envisaged in the Second Five Year Plan, it was apparent that opening up of new areas for agriculture, for development of mines, forests, etc. find an important place. Such development was retarded because of lack of transport. Railways alone could not meet the demand. On the other hand, roads are the only means by which new areas could be opened up and developed. Therefore, Shri Rajinder Partap Sinha urged the appointment of a high power Committee to examine road policy and programmes. In the light of the development programmes of the future the committee should draw up a new Plan for road development.

The West Coast Road was being developed with central assistance and as soon as it is completed, the road should be declared as a National Highway. It was an important route and there was no railway line running parallel to it.

Shri Rajinder Partap Sinha was of the opinion that the eastern and western frontiers were not adequately served by National Highways. These areas should have a well-developed network of

roads not only for its development but also from considerations of the defence needs. The road from Dhanbad to Jamshedpur via Purulia should also be taken into the National Highway system.

Shri Sinha also emphasised the need of self sufficiency in asphalt as import of asphalt was valued as much as Rs 5.3 crores in 1953 and Rs 2.3 crores in 1954.

A contribution of 2½ annas per gallon from the proceeds of the excise duty on petrol was being made to the Central Road Fund ever since 1931. The excise duty on motor spirit was -/6/- in 1928-29, it was annas -/15/- in 1956. It was clear that the contribution to the Central Road Development Fund was not in keeping with the rise in the excise duty. He urged that a higher rate should be put into the Central Road Fund.

The Nagpur Plan had suggested that an independent Road Board should deal with detailed policy and the day-to-day administration of road development works. Shri Rajinder Partap Sinha wished to know the policy of the Government in this regard.

(To be continued)

DEFINITIONS OF HIGHWAY ENGINEERING TERMS

ROUTE-MARKER : A sign indicating, by means of a number, a device, or a colour, the course of a particular route.

TRAFFIC SIGNAL : A device for the control, warning or guidance of traffic.

* Concluded from page 8 of September 1956 issue.

** Pages. 5-8 of August, 1956 issue.

LOADING OF HIGHWAY BRIDGES

AT the conclusion of the fifth Congress of the International Association for Bridge and Structural Engineering, a symposium on loading of highway bridges was organized. Papers on the following six subjects were discussed:

- (1) Studies of statistical methods of assessing the most severe combination of actual vehicles on given lengths and widths of bridges and tolerable risk factors.
- (2) Data regarding permissible heavy vehicles, their spacing and restrictions in the use of bridges and future developments.
- (3) Summary of current specifications for design loads and their justification.
- (4) Permissible stresses and limiting deflections used in the design of steel and concrete bridges.
- (5) Suggested modifications of loadings, permissible stresses and deflections.
- (6) Methods of estimating the load capacity of existing bridges.

The following is a summary of the discussions on the different topics:

Statistical Methods of Loading Assessment

In introducing this subject, Mr. Paez said that in modern engineering projects theory has advanced further than material execution. A margin of safety was made to allow for the risks involved when materials did not behave in accordance with design assumptions and the margin made the structure more expensive. Similarly with loading intensity, since it is not certain what loads will be applied to the structure in the future, a margin of safety must be allowed in the hope that this will not be exceeded. This further expense could be interpreted as a capital investment against possible risks.

The desire for security may have produced assumed design loadings in excess of those occurring in the life of the structure, and research into the actual loading intensities likely to arise had been made in many countries. Since human action was being investigated probability influences did not automatically apply and it was necessary to integrate experience and theory in order to extrapolate the results of the past into the future.

The possibility that the loading intensity might be accurately assessed theoretically was then discussed, firstly, considering the probability of an unfavourable sequence of moving vehicles and, secondly, that there was a statistical distribution of the heaviest vehicles within a traffic block. However, the maximum concentration was likely to occur when the distance between them was a minimum and the vehicles were stationary, and this had the added advantage of simplification in calculations. Mr. F. Borges of Portugal, reported that the uniform loading corresponding to a speed of 10 km per hour due to the spacing between the vehicles was equivalent to 74 per cent of the load for stationary vehicles and when the speed increased to 20 km per hour, the loading decreased to 54 per cent of the maximum loading when stationary. Moving vehicles might increase the loading intensity by impact effects but the increase due to impact was less than the reduction due to separation at speed.

Differences of approach were evident on the question of the statistical distribution of vehicles. Swedish and Japanese reports favoured this assumption, but Mr. W. Henderson, in the British contribution, had contended that it was only justified for large bridges and in such cases the effect was relatively small. The following reasons were given for the bunching of heavy vehicles:

- (1) The organised formation of con-

voys of vehicles operating from a factory, quarry or industry.

- (2) The difficulty which heavy lorries find in overtaking other vehicles.
- (3) The advantages for the drivers to travel in an unofficial convoy and benefit from mutual help. Military vehicles, even in peace time, frequently form convoys when movement was necessary. In Spain, geographical conditions were such that night trips by heavy vehicles were common to the capital and the chance ratio of heavy and light vehicles in traffic accumulation varied greatly from night to day. It was considered that these known variations between theoretical supposition and actual conditions provided a strong objection to the validity of statistical work based on chance distribution.

Loading and Dimensions of Bridge

Turning now to the question of the relationship between loading intensity and the length and width of the bridge the conditions under which a theoretical investigation should be based were first discussed. Assuming that a convoy of heavy trucks occupies one lane with a minimum separation, the distribution on the other lanes may be assumed as the most unfavourable chance distribution. The chance that a given loading would be surpassed could be assessed and suitable factors of safety estimated. The same type of investigation would make it possible to work out the reduction in equivalent loading when the deck was very wide or the span very long, and for the isolated point loads representing the heavily loaded axles of the ideal vehicle. These latter determine the size of the deck floor units for large structures and all the structural parts of small span bridges.

The alternative solution put forward by Mr. W. Henderson proposed an estimate based on reasonably likely probable events rather than one based on probability of occurrence. Loadings cannot attain impossible values due to physical considerations, and for the limiting values a lower factor of safety can be accepted. The loading proposed was free from

statistical calculation but not so the factor of safety. Logically the higher the accepted loading which was assumed to be physically unsurpassable, the lower the corresponding factor of safety, since the product of both was constant. The maximum loading capacity was this product.

For the short and medium span bridges a design loading can be adopted, such that its effects are reasonably equivalent to that of vehicle combinations which, though severe, are not uncommon. At the same time, consideration should be given to the most severe loading possible, and the design loading adjusted so that in the event of this most severe loading occurring, the factor of safety or load factor, when all other considerations both adverse and beneficial have been taken into account, would not be less than unity. For intermediate traffic conditions, intermediate values of load factor would be appropriate. It seemed doubtful whether sufficient statistical data was likely to be available to assess accurate probability factors, but a satisfactory adjustment could be made using intelligent judgment.

Dimensions and Weights of Heavy Vehicles

The design of the parts of a bridge is determined by different types of loading, individual wheel or axle loads determine secondary members while the total weight of the vehicles will be the criteria for the principal members. There are also two categories of vehicles, those which can be driven on the roads without special restrictions and those heavy vehicles which are subject to special licence. Vehicles in the first category may have their weights related to the design of the vehicle either in relation to axle loads or spacing of axles, those in the second category have the number of axles defined, the maximum axle load, the total weight, distance between front and last axle and load carrying capacity.

Data produced indicated that in all countries vehicles belonging to the heaviest class of normal commercial vehicles constitute a very small proportion of the number of commercial vehicles.

The general opinion in most countries seemed to be that the trend of development was towards a progressive increase in the weight of the load carrying capacity of vehicles.

Specified Design Loads

Full details of the loading specifications in each country had been summarised by Dr. Ostlund. In many countries several classifications of bridges were recognised and bridge loadings were varied accordingly. In others, one class only was used.

Loading regulations vary in each country, but three systems are adopted, lane loading, individual heavy vehicle loading or individual wheel or axle loading. The first is the most general and corresponds to the greatest load expected or caused by normal traffic. Traffic load can act in several lanes at the same time but a reduction is specified when a large number of traffic lanes are loaded simultaneously. In addition the load can be applied to that length (total span or part) which produces the most dangerous effect. Impact factors are also specified in a variety of forms.

Some countries stipulate that an individual heavy vehicle load shall be also used as a design load on certain main routes, but higher stresses are generally allowed in these conditions.

It was realised that considerable variations in specifications were unavoidable at the present time. Loading requirements were related to traffic conditions and varied considerably in intensity. The general form of the loading curves in relation to span length showed considerable similarity in all countries.

Permissible Stresses and Limiting Deflections

Summaries of the permissible stresses used for reinforced concrete and steel bridges were given and showed good agreement throughout. Few details were given in respect of prestressed concrete practice. Many countries had requirements for maximum permissible deflection due to live load varying from span/500 to span/600 for concrete bridges

and from span/500 to span/900 for steel bridges.

Slight modifications of loadings were proposed in some contributions to relate specified loadings more closely to actual conditions. An interesting suggestion was the modified form of loading which would enable the work of Leonhardt, Guyon and Massonet on grillage decks to be used with greater advantage. This was in the form of parallel lines of load having no width, each pair of lines spaced 6 ft apart, equivalent to the wheel spacing of heavy lorries. One pair of parallel lines would then be assumed to occupy any lateral position in one traffic lane but not closer than 3 ft to the adjacent pair of lanes, since adjacent wheels of two vehicles would not be closer than this distance. Each of these lines of load would vary with the loaded length.

Assessment of the Strength of Bridges

The necessity for bridge assessment lies in the inadequacy of the original loading in comparison with modern traffic demands or the deterioration of the structure due to age or other causes.

It is extremely fortunate in most countries that so many old bridges continue to prove useful, but many were heavily overdesigned originally. In addition modern knowledge of structural behaviour allows a more optimistic estimate of strength to be made by utilising the effects of composite action and the consolidation of fill, for example, where jack arches were used.

Strength assessments for bridges are necessary not only for the heavier normal types of vehicle but also for the abnormal vehicle carrying large indivisible loads. Reconstruction of old bridges may ultimately dispose of the need for assessments in the first group, but investigations for the abnormal loads may always be necessary in spite of the restrictions which are imposed on the type and use of the special trailer involved. Since however these abnormal loads will only be carried on approved routes, higher stresses can reasonably be allowed since their passage over the bridge can be subject to special conditions.

Orthodox calculations are made, in the first instance, based on appropriate standard specifications, to assess the strength of the structure. Stress adjustments are then often made on the grounds that it is economically worthwhile to shorten the life of a structure or to accept a greater probability of damage to the structure where it reduces the capacity of an otherwise satisfactory section of highway.

Where for reasons of age, complexity of construction, or other causes, it is difficult or impossible to arrive at a satisfactory estimate of strength, testing of bridges under actual loads is carried out. This technique has been applied most extensively in Sweden and Great Britain. It provides not only the answer to the immediate problem but also valuable information on the behaviour of structures. The interpretation of test results is a complicated and fascinating study. For each structure tested a careful integration must be made of its history, the method of its construction, its configuration and condition, and the test results, in order to arrive at a special theory for that particular bridge.

Differences in Test and Analysis

It is general experience that the stresses derived from measured strains and deformations are often considerably less than would be expected from orthodox analysis. To accept and use these results without further qualification could be dangerous, especially as it will frequently be necessary to extrapolate for greater loads. It should be a guiding principle in assessment by testing that a study is made of the differences between stresses arrived at by test and by analysis and a reasonable explanation of these differences reached before deciding on the capacity of a structure. It is necessary to decide whether or not various relieving factors will continue to operate dependably in different conditions or under greater loads.

Such relieving factors may be, for instance, friction in bearings, or at bolts or rivets, the composite action of ordinary filling or road surfacing material, and so on. The effects of dead and live load will also require separate consideration in most cases, care being necessary to decide which, if any, of the relieving factors for live load are also available for dead load.

A point which arises when considering the assessment of the strength of bridges by test is whether the permitted stresses should be greater or less than those acceptable in design. On the one hand it can be contended that allowance need not be made in the load factor for certain unknown quantities, while on the other hand, since all relieving factors have been taken into consideration, it could be suggested that adoption of lower stresses would be more consistent.

Masonry arch bridges continue to present major difficulties in assessment, judgment and experience being the most important factors in the estimation of their strength.

Mr. Henderson concluded his report with a brief description of the mobile testing machine used in Great Britain.

From whatever sources data are assembled relating to a bridge the final pronouncement as to its safe capacity will depend on experience and common sense in interpretation, and no method can safely disregard the work of carefully securing detailed information of the structure and its history combined with the need for an experienced bridge engineer to make the assessment.

It was decided that when the final report on the symposium was published, items of agreement and disagreement should be mentioned and indications of further investigation and research should be given.

(From 'The Surveyor', August 4, 1956.)

USE OF PRINCIPLES OF SOIL MECHANICS FOR EARTHWORKS

IN 1935, the Ohio Highway Department adopted a specification for earthwork which required moisture-density control for the compaction of embankments and subgrades. Experience had shown that the adoption of the specification yielded excellent results. Embankments constructed to this specification were free from slides or settlements and local failures seldom occurred. The subgrades densified to this specification were stable and adequate to support heavy traffic. Also, moisture control near the optimum resulted in rollers being used more efficiently and was found to be more economical for roller effort. The chief

points of the specification are given below.

- (a) Soils having a maximum dry weight of less than 90 lb per cu. ft. are unsuitable for and shall not be used in embankments 10 ft or less in height.
- (b) Soils having a maximum dry weight of less than 95 lbs. per cu. ft. are unsuitable and shall not be used in embankments 10 ft or more in height, or embankments of any height subject to long periods of flooding.
- (c) The following table shows the maximum laboratory dry weight and the minimum field compaction requirements:

Embankments 10 ft or less in height, and not subject to extensive floods		Embankments exceeding 10 ft in height, or of any height subject to long periods of flooding	
Maximum Laboratory Dry Weight lb per cu. ft.	Minimum Field Requirements per cent of Laboratory Maximum Dry Weight.	Maximum Laboratory Dry Weight lb per cu. ft.	Minimum Field Requirements per cent of Laboratory Maximum Dry Weight.
90.0-102.9 ...	100	95.0-102.9 ...	102
103.0-109.9 ...	98	103.0-109.9 ...	100
110.0-119.9 ...	96	110.0-119.9 ...	98
120.0 and more ...	95	120.0 and more ...	96

- (d) The moisture content for compaction of embankments or subgrades shall not be greater than 2 per cent over the optimum at the time of compaction.
- (e) The moisture content of subgrade soils which display pronounced elasticity or deformation under the construction equipment shall

not exceed the optimum. During the summer, soil to be excavated for which moisture content exceeds the optimum moisture for that soil by 8 per cent or more is considered unsuitable for use in embankments.

- (f) Subgrade is required to be compacted for a depth of 12 in. to

yield 98-102 per cent of the Standard compaction, depending on the maximum laboratory dry weight of the subgrade soil.

- (g) Soils with a maximum dry weight of less than 103 lbs per cu. ft. are considered unsuitable for use in a 12 in. compacted soil layer immediately below the surface of the subgrade. When the weight is less than 103 lbs per cu. ft., the soil has to be replaced by suitable granular material.
- (h) In the field, if the density is lower than specification requirements, additional rolling may be necessary or the moisture content will have to be adjusted. If these fail to produce the specified compaction, the weight of the roller may have to be increased, or the thickness of the layer reduced, or some other measure to attain satisfactory compaction adopted.

- (i) Where conditions are variable, density and moisture checks should be made more frequently. If consistently adequate densities are obtained, the number of passes of roller necessary to achieve the density may be obtained and the field control may then be merely the number of passes of the roller.

- (j) Because uniformity of subgrade compaction is necessary for a satisfactory performance of the highway pavement, use of heavy rubber-tyred rollers for pre-testing the stability of the subgrade has been found satisfactory.

- (k) For most fine-grained soils, moisture lower than A.A.S.H.O. Standard optimum is necessary for high stability and efficient compaction under heavy rubber-tyred rollers.

(From 'Highway Research Abstracts', July, 1956.)

NEW LANGUAGE

A certain local body wished to buy some length of "P.I.L.C.D.S.T.A.L.T." This turned out to be "paper insulated lead covered double steel tape armoured low tension" cable. Surely this must be a record?

FINISHES FOR AUTOMOBILES

There are two well-known finishes for automobiles: lacquer and liquor.

All curves should be adequately superelevated. It is useless and dangerous to do this piecemeal. If some are superelevated and some are not, the driver is taken unawares.

HERE AND THERE

1. CONTRACT SECURED BY DURESS IS NOT VALID BUT VOIDABLE

● IT is a fundamental and well-settled rule that a contract obtained by duress is not ordinarily void, but merely voidable, and it may be subsequently ratified and confirmed. It is elementary that the claim of duress must, to be availed of, be asserted promptly or within a reasonable time after the alleged duress has ceased to exist.

(From 'Engineering News-Record,' July, 19, 1956.)

2. ROAD ADMINISTRATOR FOR FEDERAL-AID PROGRAMMES (U.S.A)

● ROAD administrator to administer the huge 13-year highway programme is to be appointed by the President of the United States. He will work with the Secretary of Commerce to supplement the department's direction in the field of highways. This was the result of a resolution by a Senator for an independent 3-man agency to manage highway programmes.

The Bureau of Public Roads will, however, continue to be responsible for detailed administration of the highway programme. At present the Commissioner

of Public Roads has many responsibilities. He is "on a sub-Cabinet level, a policy maker and adviser to Congressional committees, the executive, and to many other State Governments. He also functions as an arbitrator in disputes between the Federal Government and the State Governments. In addition to this he is administrative head of the Bureau which employs nearly 6,300 employees and also the head of the engineering and research organizations."

(From Engineering News-Record, August 9, 1956)

3. ROADS HELP REARING OF LIVE STOCK

● AN Act titled The Agriculture (Improvement of Roads) Act of 1955 was passed by the British Parliament in December, 1955. This Act provides that certain highway authorities may submit proposals to the Minister of Agriculture, Fisheries and Food for effecting improvements to unclassified or unadopted roads in their areas, provided that

- (i) the road is situated in, or affords access to, a livestock rearing area, and
- (ii) the improvement which includes widening of the road, cutting of corners, and the provision of cattle-grids, would promote the

use of land in that area for purposes of agriculture or forestry.

For the purpose of the Act livestock rearing area means "an area consisting predominantly of mountains, hills or heath, being an area in which the principal industry or one of the principal industries is the breeding, rearing and maintenance of sheep or cattle."

Under this Act a total grant of £4 million (Rs 5.4 crores) may be granted within a period of seven years. The grant may be paid either on the completion, to the satisfaction of the Minister, of the work or by instalments.

A memorandum of guidance to local authorities explaining the provisions of

the Act is being drawn up in consultation with the County Councils' Association, and it is hoped that within the 7-year period the grant would have been spent and that the improvements to roads in

these areas would make a positive contribution to their rehabilitation.

(From 'The Surveyor', July 21, 1956.)

4. SYSTEMATIC INVESTIGATION OF ACCIDENTS ON ROAD

● The Engineers' Guild of England, the Association for Chartered, Civil, Mechanical and Electrical Engineers, made a plea for action by the Ministry of Transport on a scheme drawn up by them to help reduce road accidents. The Guild is of opinion that accidents are inherent in all forms of transportation and it is unlikely that they will be completely eliminated. Therefore with the objective of reducing the accident rate to the minimum, taking into consideration the conditions obtaining in the United Kingdom, the Association have worked out a proposal for a systematic investigation of accidents. The proposal in outline is given below.

At the County level, a qualified engineer whose sole work would be to examine, in consultation with the police, records of all fatal or other serious accidents on all classified roads including trunk roads, should be appointed. He will be designated Accident Investigating Engineer and will inspect the site of every serious accident in company with a police officer. He will work under the direction of the County Engineer. Under this scheme there will be a Divisional Accident Investigating Engineer under the Divisional Engineer in the Ministry of Transport. The Divisional Accident Investigating Engineer will be responsible for co-ordinating the work of the local Accident Investigating and the County Engineers and will prepare every month a list of accidents and send it to the Divisional Engineer.

The investigation of the accident should take into consideration and mention whether or not one or more of the following factors contributed to the cause of the accident:

1. Vertical or horizontal alignment of the road.
2. Insufficient width of carriageway.

3. Incorrect cross-fall of carriageway i.e., lack of superelevation or excessive camber.
4. Lack of or incorrect lane markings.
5. Ribbon development or uncontrolled access (e.g., waiting vehicles, vehicles emerging from private accesses).
6. Lack of parking or lay-by space.
7. Lack of definition of edge of carriageway.
8. Defective road junction layout.
9. Defective or insufficient warning, direction or mandatory signs or traffic control signals.
10. Insufficient or badly designed or sited street lighting.
11. Lit or unlit advertisements and signs confusing to drivers.
12. Insufficient or inadequate facilities for pedestrians crossing the carriageway.
13. Surface conditions of carriageway.
14. Mechanical defect in vehicle.
15. Defective lighting on vehicle.
16. Physical disability of driver.
17. Physical failure of driver.
18. Error of judgment by driver or pedestrian.
19. Other causes.

It was also expected that in case factors 1 to 13 be present, the approximate cost of remedying the defects be also given.

The Guild also made a plea for the setting up of a Road Accident Inspectorate under the Chief Engineer of the Ministry of Transport. This body would include engineers with experience in holding

public enquiries and of highway and traffic matters. They would be responsible for holding public enquiries and for the general direction of the Inspectorate. They would also make recommendations after analysis of individual accidents.

1. for mechanical improvements of vehicles and their equipment;
2. for improvement of road signs, signals equipment and standards, street lighting and the illumination of road signs;

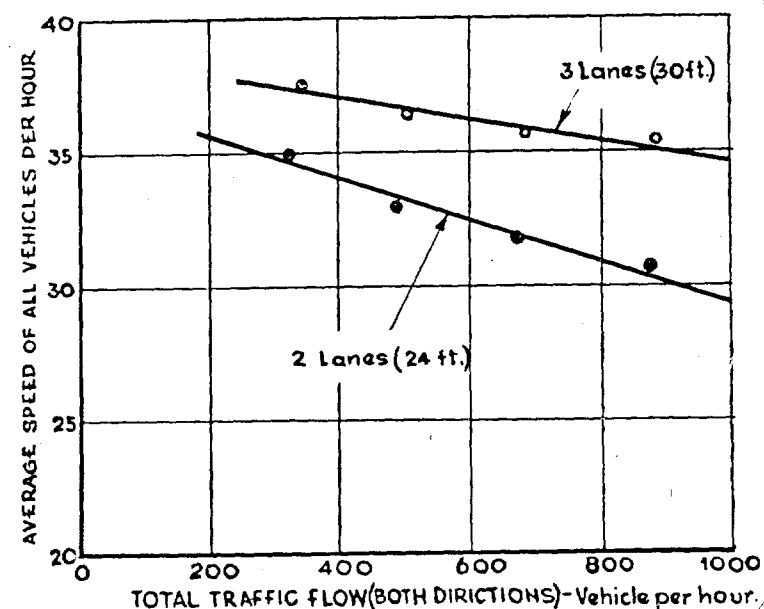
3. for a priority list of road improvements indicated by the results of accident investigation;
4. for additions or amendments to the Highway Code;
5. for matters calling for new legislation in the interests of safety;
6. any other matter which they consider would reduce the accident rate on highway.

(From 'Contractors Record & Municipal Engineering', August 15, 1956.)

5. TRAFFIC FLOW AND CARRIAGEWAY WIDTH ON RURAL ROADS

● INVESTIGATIONS have been made by the Road Research Laboratory, U.K. into the relation between the average speed of vehicles and the traffic flow on roads of different widths. The figure below compares the result obtained on a straight level two-lane section of a road with that on a three-lane section of the same road.

flows. These results can be used to investigate the economics of widening a 24-ft carriageway to 30 ft. For example, assuming that a vehicle-hour costs 10 s. and widening costs £1 per sq. ft. on a road carrying 600 vehicles per hour, on the average the reduction in journey time would represent an annual saving of at least 17 per cent per annum on the cost



The rate of reduction in speed with increasing flow is greater on the two-lane section than on the three-lane road, speeds being considerably higher on the three-lane road particularly at higher

of widening; for 800 vehicles per hour the saving would be 29 per cent per annum.

(From 'Road Research' 1955, Department of Scientific and Industrial Research, U. K.)

6. PROVISION OF AN ADDITIONAL LANE ON HILLS FOR SLOW MOVING VEHICLES

● THE power-weight ratio of heavy trucks is lower than that of most other vehicles, and as a consequence the speed of heavy trucks ascending hills is less than that of the bulk of the traffic. On long lengths of grade in excess of approximately 1 in 25, speed of heavy trucks usually reduces to about 7 miles per hour, or even less. Where such low speeds occur on a two-lane road carrying a large volume of traffic in both directions, concentrations of vehicles may occur on hills, moving slowly together behind trucks. If opposing traffic is relatively

light, some of the drivers held behind a truck may leave the queue to overtake, but limited sight distance may often render such manoeuvres hazardous.

In order to secure more convenient and safer flow of traffic in such circumstances, an additional lane on the climbing side of the road of several lengths of long steep grade, which allow slow vehicles to pull over to the left and give following faster vehicles the opportunity to overtake, are necessary.

(From 'Main Roads,' June 1956).

7. A NEW LIGHTWEIGHT CELLULAR CONCRETE—ISOCRETE

● A method of producing cellular concrete has been in use for the past fifteen years in Scandinavia. It is primarily intended for producing a topping on floors and roofs requiring insulation against heat and sound, and for the insulation of pipes and the manufacture of precast blocks and slabs.

The concrete is made by mixing sand and cement with an air-entraining emulsion in a special type of mixer. It is claimed that concrete with densities of from 19 lb to 75 lb per cubic foot can be obtained with crushing strengths varying from 70 lb to 750 lb per sq. inch and a

coefficient of thermal conductivity varying from 0.48 to 2.10. The air cells in the concrete are independent of each other and accordingly the concrete absorbs little water. For this reason it is claimed to have a high resistance to frost. The concrete is placed without vibration, which would tend to collapse the small air bubbles. It is very workable, however, and is screeded by drawing a board over the surface without tamping. This type of concrete is known as "Isocrete".

(From 'Concrete & Constructional Engineering', August 1956).

8. IMPORTANCE OF GEOMETRICS FOR FARM ROADS

● THE farm road has assumed a tremendous new importance in Wales, U. K. The track by which occasional journeys were made by the farmer for essential stores, and stock were taken to market on the hoof, now has to serve as an artery for motor traffic which is the medium of the social and commercial activity of the countryside. Instead of fetching a sack of flour every few weeks, delivery is obtained of town baked bread two or three times a week. If the farm road is too long or

steep to be improved for motor traffic it is a barrier to the modern world behind which the farm will decay. The improvement of the road has become a costly technical job and it no longer suffices for the farmer to resurface it by carrying occasional loads of gravel from a nearby stream or by filling in the wheel ruts with stones gathered from the arable fields as of old.

(From Bulletin of the British Road Federation, London, 1st August, 1956.)

CURRENT LITERATURE

ABSTRACTS

MANUAL OF RECOMMENDED PRACTICE FOR DETAILING REINFORCED CONCRETE HIGHWAY STRUCTURES, issued by the American Association of State Highway Officials, Washington 4, D. C.

THIS Manual lays down instructions for preparing drawings of reinforced concrete highway structures. The book is divided into three Chapters. In Chapter I recommendations on the standard sizes of drawings, symbols to be adopted, typical layouts, and methods of presenting reinforcement, etc., and recommended scales to be adopted are given. Chapter II deals with fabricating shop practice in respect of bending reinforcement to the various shapes. Chapter III contains typical drawings of reinforced concrete abutments, piers, pile trestles, slab bridges, arch bridges, retaining walls, box culverts etc.

INTERNATIONAL SYMPOSIUM ON NON-DESTRUCTIVE TESTING OF MATERIALS AND STRUCTURES, issued by the International Union of Testing and Research Laboratories for Materials and Structures. Headquarters, Geneva, Volumes I and II.

THE two volumes contain Papers on non-destructive testing presented at the International Symposium held recently.

The Papers are grouped under the following three heads:

- (1) Sonic Methods.
- (2) Hardness and Indentation Methods.
- (3) Methods based on Absorption or Scattering of X-rays and Neutrons.

The first volume contains 19 Papers dealing with sonic methods. Volume II

contains 9 Papers dealing with sonic methods, 9 dealing with indentation methods, and 4 dealing with absorption of scattering of X-rays.

General conclusions arrived at the symposium have been drafted by Dr. R. Jones of the Road Research Laboratory, England, and are given in Vol. I. Some of the main conclusions are:

1. Sonic methods of testing have potential use in quality control and for estimating the strength of placed concrete. The Papers presented show that completely satisfactory solutions have not yet been achieved although some works have attained limited success.
2. Rebound and indentation methods of testing concrete give wide dispersion in results. Therefore a large number of measurements are required. Even though the tests are relatively simple and the apparatus inexpensive, the methods are applicable only to the surface of the concrete and their use therefore is limited.
3. Suitable precautions to screen operators from the injurious effects of radiation are required when X-rays are adopted for testing

TRAFFIC ENGINEERING by Theodore M. Matson, Wilbur S. Smith and Frederick W. Hurd, McGraw-Hill Book Company, Inc., New York, 1955.

THIS comprehensive text book on traffic engineering written with a view to provide a text for traffic engineering training and reference for those engaged in highway traffic planning is divided into five sections, viz., Characteristics, Regulations, Control Devices and Aids,

Design, and Administration and Planning.

In the section Characteristics, the behaviour of road users, characteristics of vehicles, speed, volume of traffic, methods of collecting origin and destination data, etc., are dealt with. The section on Regulations deals with the various types of controls. In the section on Control Devices and Aids, traffic signs, road lighting, traffic signals, etc., are dealt with. The section on Administration and Planning deals with the organization for traffic engineering, off-street parking, etc.

From the road engineer's point of view the section on Design is very informative. In this section the various elements of geometric design such as cross sections, sight distances, vertical curves, horizontal alignment, intersection design in all its various aspects, are dealt with in a very lucid manner.

The book is illustrated with a number of figures and charts.

USE OF LEAN ROLLED CONCRETE IN ROAD CONSTRUCTION by Jack Mercer, *Contractors Record & Municipal Engineering*, June 27 & July 4, 1956.

IN England as early as 1949 lean concrete 14:1 had been used as a base for tarmacadam. At that time this kind of base was expensive when compared with brick soling. Since then nearly 26 miles of road, using lean concrete as a base and bituminous surfacing, have been constructed, and this article describes in detail the technique of construction such as water-cement ratio, mixing, laying, rolling and curing. The control of quality and testing methods used have also been described.

The conclusions reached are that the main advantage of lean concrete construction is economy in cement and extreme simplicity of technique. The type of construction described is said to yield a good riding surface. Experience had shown that the technique described was suitable both for the large and small job. This

type of construction has the advantage of rigid base combined with bituminous surface.

ALLOCATING MOTOR VEHICLE TAX RESPONSIBILITY BY THE INCREMENTAL METHOD. Bulletin 121 of the Highway Research Board, Washington, D. C.

THE incremental method of tax allocation is based on the principle that highway designs and costs are a function of the size, the weight of vehicles expected to use the road and their speeds. In this method of analysis, certain basic standards are assumed and the cost of the basic construction is distributed equally on all the types of vehicles using the road. When roads are to be constructed for vehicles of larger size or heavier weight than the assumed basic vehicle, the increase in cost is allocated to the group of vehicles requiring the increased standard. The cost of further successive increments is allotted to the group of vehicles requiring it.

This bulletin contains the following 5 Papers which have been discussed at the symposium on the subject during the meeting of the Highway Research Board in January 1955:

- (1) "Incremental Method of Allocating Highway Costs" by William D. Ross.
- (2) "Initial Problems Confronted in the Kentucky Incremental-Cost Study," by James W. Martin.
- (3) "Concepts of Cost Function and Incremental Solutions of Vehicle-Tax-Allocation Problem" by E. V. Kiley.
- (4) "Comments on Tax-Allocation by Incremental Method Based on Application of the Method in Minnesota, 1953-54," by David J. Bauer.
- (5) "On the Incremental Analysis of Highway-Cost Responsibility," by R. G. Hennes.

PENETRATION TESTS AND BEARING CAPACITY OF COHESIONLESS SOILS BY G. G. Meyerhof, *Journal Soil Mechanics and Foundations Division, Proceedings of the American Society of Civil Engineers*, January 1956.

THE relative density of cohesionless soils and the bearing capacity of foundations in such soils can frequently be determined most conveniently from the results of penetration tests made on the site. From a comparison between standard (dynamic) and static penetration resistances on a number of sites, a simple approximate correlation has been obtained between both types of tests to estimate the relative density and angle of internal friction.

The proposed relationships are applied to determine the ultimate bearing capacity of footings and the point resistance and skin friction of piles, and the results are compared with some field loading tests on plates and piles. The procedure outlined can also be used to estimate the allowable load on spread and piled foundations in cohesionless soils under various conditions in practice.

POLICY ON MAINTENANCE OF SHOULDERS, ROAD APPROACHES AND SIDEWALKS, The American Association of State Highway Officials, Washington, D. C.

THIS Policy which has been approved by a majority of States in the United States of America contains details of desirable practices on maintenance of turfed, soil aggregate and bituminous treated shoulders. Details of good practice for maintenance of footpaths in urban and rural sections, including methods of patch repairs, are given.

Under the head maintenance of roadside, control of vegetation including eradication of undesirable growth, control and prevention of erosion and maintenance of retaining walls are given. The methods of planting, trimming, removal, and pruning roadside trees and shrubs

are given in detail. Tables giving particulars of grasses and cover crops suitable for various types of soil and climatic conditions are included. Hints on maintaining roadside parks and roadside picnic and recreational spots are also given.

A RAPID FIELD METHOD FOR DESIGN OF CONCRETE MIXES by C. A. Baker. *The Journal of the Institution of Engineers, Australia*, April-May 1956.

THIS Paper outlines a new method of design of concrete mix for a given compressive strength. The object of a concrete mix design is to produce satisfactory concrete at minimum cost. Therefore, the most economic concrete mix is one which contains minimum cement content.

The method described is based on the investigations carried out at the Commonwealth Department of Works in Sydney. The steps in the preparation of the design are as under :

- (1) Preparation of a sand-cement mortar such that the cement slurry just fills the voids in the sand;
- (2) Reducing the sand content by such an amount as to provide enough excess slurry to coat the coarse aggregate which will be subsequently added to the mortar;
- (3) Addition of the coarse aggregate to the mortar until voids in the aggregate are just filled by the mortar.

The Paper deals in detail the development of the method, grading of the fine aggregate, and ratio of the coarse to the fine aggregate. The appendix gives a procedure for a field method of design for the concrete mix. It is claimed that by using this method of design it is possible for an inexperienced operator to determine the most economical proportions of

(Continued on page 28)

SELECTED RECENT LITERATURE IN ENGINEERING JOURNALS

X. BRIDGES AND OTHER STRUCTURES

1. The Ultimate Load Method of Design Safety and the Working Stress Fallacy; A. L. L. BAKER, *Concrete and Constructional Engineering*, Vol. LI, No. 3, March 1956, pp. 293-302.
2. Iteration Method of Solution of Inter Connected Frame Works with Large Deflections; JOSEF EISENMANN, *Der Bauingenieur*, Vol. 31, No. 2, February 1956, pp. 61-67 (in German).
3. Technical Panel Reject Forth Subway Scheme, Bridge to be Preferred on Grounds of Economy, Suitability and Greater Freedom from Wizard; *The Surveyor*, CXV, No. 3339, April 21, 1956, pp. 171 & 172.
4. Analysis of Frames with two Gables; V. A. MORGAN, *Concrete and Constructional Engineering*, Vol. LI, No. 2, February 1956, pp. 265-272.
5. Prestressed Platform Roofs; *Concrete and Constructional Engineering*, Vol. LI, No. 2, February 1956, pp. 273-274.
6. American Research on Decks of Road Bridges; *Concrete and Constructional Engineering*, Vol. LI, No. 2, February 1956, pp. 284-285.
7. Cracks in Reinforced Concrete; *Concrete and Constructional Engineering*, Vol. LI, No. 2, February 1956, p. 287.
8. Ultimate Strength Design; Leo H. COTNING, *Journal of the American Concrete Institute*, Vol. 27, No. 5, January 1956, pp. 505-524.
9. Precast Concrete Frames for American School Buildings; *Indian Concrete Journal*, Vol. 30, No. 4, April 1956, pp. 109-112.
10. Design of Twin Gabled Frames, B. S. S. RAO, *Indian Concrete Journal*, Vol. 30, No. 4, April 1956, pp. 113-119.
11. The Flexural Resistance of Prestressed Simply Supported Concrete Beams Within the Elastic Range; H. W. BRITTON, *The Journal of the Institution of Engineers, Australia*, Vol. 28, No. 1-2, January-February 1956, pp. 39-46.
12. Concrete Stress Distribution in Ultimate Strength Design; EIVIND HOGNESTAD, N. W. HANSON & DOUGLAS McHENRY, *Journal of the American Concrete Institute*, Vol. 27, No. 4, December 1955, pp. 455-479.
13. Design of Cylindrical Shells with Edge Beams; L. FISHER, *Journal of the American Concrete Institute*, Vol. 27, No. 4, December 1955, pp. 481-488.
14. Full Scale Tests of Concrete Bridge Rails; *Highways and Bridges and Engineering Works*, Vol. XXIII, No. 1134, April 11, 1956, p. 10.
15. The Dartford Purfleet Thames Tunnel, *Roads and Road Construction*, Vol. 31, No. 401, May 1956, pp. 150-152. See also, *The Surveyor*, Vol. CXV, No. 3340, April 28, 1956, pp. 193-194. See also, *The Highways Bridges and Engineering Works*, Vol. XXIII, No. 1136, 25 April 1956, p. 6. See also, *The Engineering New Record*, Vol. 156, No. 20, 17 May 1956, pp. 85-90.

16. **The Problem of Sway in Moment Distribution, General Treatment Using Concept of Virtual Work;** D. H. CLYDE, *Engineering, Vol. 181, No. 4709*, June 8, 1956, pp. 457-459.
17. **Buckling Under Complex Loading;** A. N. PROCTER, *The Engineer, Part I, Vol. 201, No. 5337*, June 8, 1956, pp. 629-632.
18. **Continuous Beams and Moment Distribution;** A. M. G. DEMPS, *The Journal of the Institution of Engineers, Australia, Vol. 28, No. 4-5*, April-May 1956, p. 108.
19. **Prestressing a Steel Girder Bridge, Renewal of a Corroded Railway Bridge;** *Engineering, Vol. 181, No. 4707*, 25th May 1956, pp. 408-409.
20. **An Alignment Chart for the Evaluation of the Dynamic Modulus of Elasticity and Poisson's Ratio for Concrete;** W. H. KING and I. D. G. LEE, *Magazine of Concrete Research, Vol. 7, No. 21*, November 1955, pp. 165-168.
21. **Stability of Beam Columns above Elastic Limit;** ROBERT L. KETTER, *Proceedings, American Society of Civil Engineers, Vol. 81 Separate No. 692*, May 1955.
22. **Rigid Culverts under High Overfills;** R. ROBINSON ROWE, *Proceedings, American Society of Civil Engineers, Vol. 81, Paper No. 823*, October 1955.
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24. **Reinforced Concrete Cantilever Road Bridge;** W. SCOTT WILSON, *Indian Concrete Journal, Vol. 30, No. 2*, February 1956, pp. 55-58.
25. **Beam Factors and Moment Coefficients for Members With Prismatic Launches;** ZORAH E. SHEFFNER, *Indian Concrete Journal, Vol. 30, No. 2*, February 1956, pp. 60-63.
26. **Pull on the Supports of Spherical Reservoirs;** DR. ENG. MARIA ESSLINGER, *Travaux, Vol. 40, No. 254*, December 1955, pp. 842-846, Part I (in French).
Travaux, Vol. 40, No. 255, January 1956, p. 43, Part II (in French).
27. **The Use of Tubular Scaffolding on the Seyssel Barrage Works;** MICHEL MARTINSON, *Travaux, Vol. 40, No. 255*, January 1956, pp. 35-42 (in French).
28. **The Use of Tubular Scaffolding on the Seyssel Barrage Works;** MICHEL MARTINSON, *Travaux, Vol. 40, No. 256*, February 1956, pp. 75-80, (in French).
29. **Prestressed Concrete Supports for Overhead Electric Lines;** P. LUMBARD, *Travaux, Vol. 40, No. 255*, January 1956, pp. 23-29 (in French).
30. **Wind Stability of High Buildings. Buildings with Transverse Internal Supporting Walls. Study of a Special Problem Concerning Cross Walls with Superposed Opening;** MARCEL TEOSIER, *La Technique Moderne Construction, Vol. XI, No. 1*, January 1956, pp. 19-22 (in French).
31. **Design and Construction of Thorpe Marsh Bridge;** *The Surveyor, Vol. CXV, No. 3335*, February 4, 1956, pp. 99-100.
32. **International Conference on Prestressing, Summary of Proceedings at Federation's Second Congress in Amsterdam;** *The Surveyor, Vol. CXIV, No. 3218*, October 8, 1955, pp. 994-995.
33. **World's Longest Span to cross the Humber, Consulting Engineer's Preliminary Report to Hull Corporation on Suspension Bridge Project;** *The Surveyor, Vol. CXIV, No. 3326*, December 3, 1955, pp. 1176-1178.

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1. **Earth Pressure Calculation** by F. B. Hansen (The Danish Technical Press, The Institution of Danish Civil Engineers, Copenhagen).
2. **The Progress of the First Five Year Plan on Indian Railway February 1956.** (Ministry of Railways), Railway Board.
3. **Report by the Railway Board on Indian Railways for 1954-55, Vol. I,** (Ministry of Railways), Railway Board.
4. **Report by the Railway Board on Indian Railways for 1954-55, Vol. II, Statistics.** (Ministry of Railways), Railway Board.
5. **Journal of the Royal Society of Arts, 28th May, 1954, No. 4926, Vol. CII.** (The Royal Society of Arts, G. Bell & Sons Limited, London.)
6. **Consideration Reg. the Calculation, Procedure of Guyon Masseu-net for Freely Supported Beam-frames and Extension of this procedure to any other systems** Translated from Der Bauingenieur, 1955, 30, No. 77-89 by the Insdoc
- National Physical Laboratory of India, Hillside Road, New Delhi.
7. **Concrete Roads Design and Construction, Road Research Laboratory, D. S. I. R.,** (Her Majesty's Stationery Office, London.)
8. **Law and the Engineer, The Law of Contract and Negligence as Affecting Engineers** (by Christopher R. Mayson), Chapman and Hall Ltd., 37, Essex Street, W. C. 2, London.
9. **The Supervision of Civil Engineering Construction** by A. C. Twiss, (Edward Arnold Ltd., London.)
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11. **Symposium on Permeability of Soils, ASTM Special Technical Publication No. 163** (American Society for Testing Materials, 1916, Race St., Philadelphia, 3, Pa.)
12. **International Symposium on Non-destructive Testing of Materials and Structures, Vols. I & II,** (Secretariat General Publication of Report, 12, Rue Brancion, Paris XVI.)

(Continued from page 24)

concrete for any available aggregates within two hours.

ANALYSIS OF STRUCTURES by M. Smolira, Concrete Publications Ltd., 14, Dartmouth Street, London, S. W. 1, (1955).

THE book gives in a handy form time-saving methods of analysing continuous frames with curved members and Vierendeel trusses.

Continuous beams with 2, 3 and 4 spans, settlement of supports, continuous beams on elastic foundations, inter-connected beams, etc., are dealt with in Chapter I. Chapter II on frames deals with portal frames, frames with inclined and curved members, thin elastic rings, etc. Chapter III deals with continuous frames with curved members, and Chapter IV about Vierendeel trusses. Numerous examples are worked out to illustrate the methods described.

USE OF THE KELLY BALL AS A DEVICE FOR MEASURING CONSISTENCY OF CONCRETE, Reported by William E. Grieb and Robert A. Marr, Public Roads Vol. 28, No. 12, February, 1956.

THE Kelly ball test is a simple field method for determining the consistency of plastic concrete. It is made by measuring the penetration of a 30-pound metal "ball" into the surface of the concrete. This test can be made on the concrete in place which results in a considerable savings in time and effort compared with the slump test. The data reported in this article show good correlation between the slump and Kelly ball penetration tests.

ACCELERATED CURING OF CONCRETE TEST CUBES—A Practical Site Procedure—by T. N. W. Akroyd

and R. G. Smith-Gander, 'Engineering', February 17, 1956.

PRODUCTION of uniform concrete requires control of materials, mixing, and placing. Generally under normal conditions of curing the strength of concrete laid cannot be obtained within 7 days after laying. Since it costs a great deal more to remove concrete 7 days old than concrete a few hours old, from the practical point of view it would be a great advantage to know the strength of concrete within a few hours of laying in position. The Authors have developed a new accelerated method of curing. In this process, test cubes are cast in the usual fashion and after 15 minutes they are put into water at a temperature of 50 deg. C. They are then cured in the minimum period of 7 hours by bringing water up to boiling point. After boiling for 7 hours the cubes are taken out of the moulds and tested for compression. A correlation between the strengths so obtained and the strength at 7 or 28 days cured by the conventional process has been worked out in the form of a graph. Thus the probable strength at 7 or 28 days could be ascertained within 7 hours of the casting of the concrete.

STABILIZATION BY PRESSURE GROUTING ON AMERICAN RAILROADS by R. Smith and R. B. Peck, Geotechnique, September 1955.

DURING the last 15 years, injection of cement-sand slurries into the subgrades of unstable railroad track has become a routine method of stabilization in the United States. This Paper describes the equipment developed for the work, the grouting mixtures used, and the results obtained. Savings in cost of maintenance are, on the average, sufficient to repay the cost of grouting in about 3 years, whereas the benefits generally have continued for many more years.

Fills that have become unstable because of accumulation of water in large voids have also been successfully treated by the method.

BUDGETS AND ADMINISTRATION REPORTS

GOVERNMENT OF RAJASTHAN, CIVIL WORKS BUDGET 1956-57

The following extracts relating to Civil Works have been taken from the Govt. of Rajasthan Budget for the year 1956-57.

Revenue (Civil Works)

Heads	(In lakhs of rupees)		
	Actuals 1954-55	Revised estimate 1955-56	Budget estimate 1956-57
Rents	10.84	15.00	20.00
Ferry receipts	.09	.09	.09
Tolls on roads	.22	.17	.22
Recoveries of Expenditure	.14	.03	.03
Transfer from Central Road Fund	37.97	11.36	23.36
Miscellaneous			
(i) Grant-in-aid from the Central Govt. for construction of State Roads of Economic or Inter-State Importance	36.86	25.00	62.50
(ii) Other Miscellaneous Receipts	17.96	8.00	6.00
Deduct—Refunds	- .11	-.30	-.10
Total	103.97	59.35	112.10

Expenditure (Civil Works)

Buildings

Original Works	4.47	5.11	—
Repairs	23.41	23.03	23.47

Communications

Original Works	—	25.00	62.50
Repairs	65.31	66.00	69.50

Miscellaneous

Original Works	—	—	—
Repairs	.87	5.00	2.00
Contribution to the Central Road Fund (Special Reserve)	20.00	—	—
Suspense	-19.31	4.74	3.55

Development Schemes

Five Year Plan Schemes

(i) Financed from State Revenues			
(a) Original Works—Buildings	.97	4.95	—
(b) Original Works—Communications	—	0.22	—
(ii) Financed from Central Assistance			
(a) Original works—Buildings	24.61	1.23	.69
(b) Original works—Communications	—	11.36	—

Heads	(In lakhs of rupees)		
	Actuals 1954-55	Revised estimate 1955-56	Budget estimate 1956-57
Other Schemes			
(i) Financed from Central Assistance			
Original Works—Communications	(—Included under		23.36
(ii) Financed partly from State Revenues and partly from Central Assistance	I above.		
Original works—Buildings	1.99	2.24	1.00
Add—New Items	—	—	.05
Establishment	7.45	6.69	8.23
Tools and Plant	4.66	2.62	2.88
Total	134.43	158.19	197.23

Capital Outlay on Civil Works financed from Revenue Account

Original works			
Buildings	28.82	48.02	87.00
Development Schemes			
Five Year Plan Schemes:			
(a) Financed from Central Assistance grants			
(i) communications	28.48	5.88	.22
(ii) Other Schemes	—	—	—
Establishment	2.65	2.51	3.94
Tools and Plant	1.74	0.98	1.42
Total	61.69	57.39	92.58

Capital account of Civil Works outside the Revenue Account

Original Works—Buildings	7.12	14.52	—
Original Works—Miscellaneous	—	—	1.00
Development Schemes			
Five Year Plan Schemes			
(i) Financed from State Revenue			
(a) Original Works—Buildings	8.37	8.54	101.19
(b) Original Works—Communications—		5.45	1.00
(c) Tools and Plant	—	—	4.00
(d) Grants and subsidy to local Bodies, etc.	—	—	16.00
(ii) Financed from Central Assistance			
(a) Original Works—Buildings	—	8.91	—
(b) Original Works—Communications	120.38	170.93	183.00

Heads	(In lakhs of rupees)		
	Actuals 1954-55	Revised estimate 1955-56	Budget estimate 1956-57
(iii) Financed partly from State Revenues and partly from Central Assistance:			
(a) Original Works—Buildings	—	13.74	36.00
(b) Original Works—Communications—		3.00	—
Deduct-Receipts and recoveries on Capital account	—	—	-25.00
Deduct-Amount Recoverable from Government of India	—	—	-21.00
Establishment	6.62	10.48	10.92
Tools and Plant	4.33	4.09	—
Total	146.82	239.66	307.11

Receipts under Motor Vehicles Act

(a) Receipts under the State Motor Vehicles Taxation Act	35.60	39.00	50.19
(b) Other Receipts	.16	.05	.10
Deduct-Refunds	-.02	-.05	-.29
Total	35.74	39.00	50.00

GOVERNMENT OF RAJASTHAN CIVIL WORKS BUDGET 1956-57**(A brief review)**

THE estimated revenue and expenditure figures for the year 1956-57 are Rs 2498.96 lakhs and Rs 2668.97 lakhs respectively. The anticipated surplus on the revenue account is therefore Rs 170.01 lakhs. The revised estimates for the year 1955-56 show a revenue of Rs 2173.52 lakhs, an expenditure of Rs 2420.85 lakhs and a revenue deficit of Rs 247.33 lakhs. In the year 1954-55 the actual revenue collections amounted to Rs 2254.46 lakhs only while the sum spent amounted to Rs 2066.00 lakhs only. The year 1954-55 thus ended with a revenue surplus of Rs 188.46 lakhs.

Revenue expenditure on Civil Works in 1956-57 is estimated at Rs 197.23 lakhs

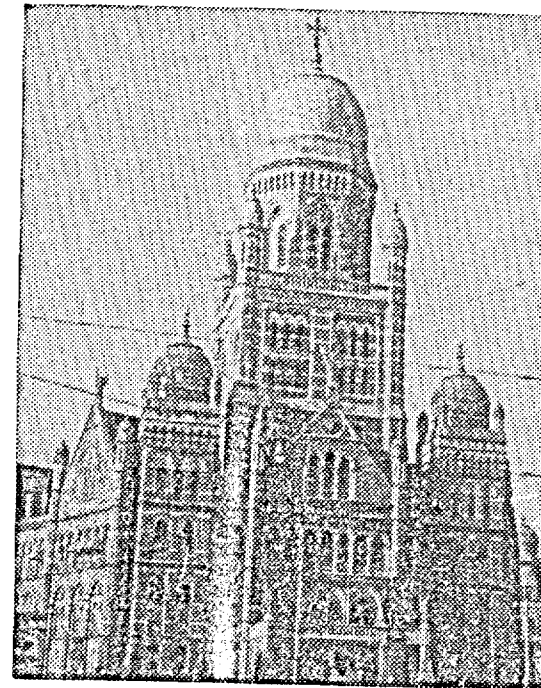
which forms 7.9 per cent of the total revenue for the year. The corresponding figures for the year 1955-56 (Revised estimate) and 1954-55 (Accounts) are 7.3 per cent and 6.0 per cent respectively.

The proportion of expenditure on communications (Original works and repairs) to total revenue for 1956-57 (Estimate) is 6.2 per cent. For 1955-56 (Revised estimates) the corresponding figure is 4.7 per cent.

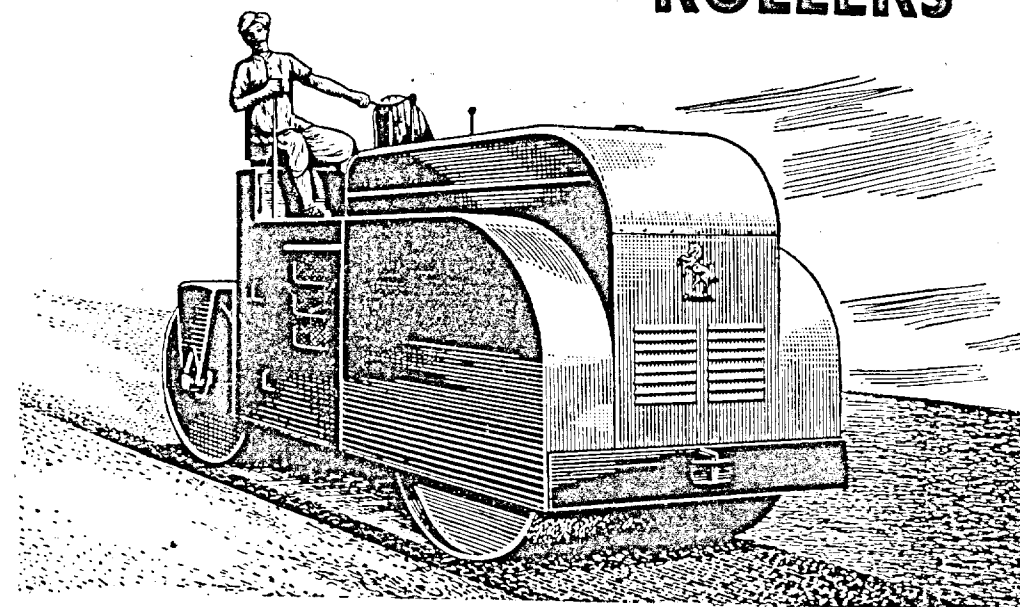
The total outlay in Civil Works outside the revenue account for the year 1956-57 is Rs 307.11 lakhs out of which Rs 184.00 lakhs are proposed to be spent on communications.

LIST OF APPROVED WORKS ON NATIONAL HIGHWAYS

S. No.	Job No.	Name of work	Amount (Rs in lakhs)
ANDHRA			
1.		Three works each costing less than 2 lakhs.	3.77
BIHAR			
2.	1652 BR 31	Survey for the construction of a high level bridge over Kosi at Kurusela on National Highway No. 31.	0.15
BOMBAY			
3.	TA 17 BM 8	Construction of a diversion of Bombay-Ahmedabad Road, National Highway No. 8 at Bulsar.	5.19
4.		Two works each costing less than 2 lakhs.	2.21
KUTCH			
5.	TA 20 KH 8A	Surface dressing in mile 9/2 to 18/5 of the Kandla-Chirai Section of the Kandla-Ahmedabad Road, National Highway No. 8 A.	3.27
MYSORE			
6.	1651 MY 4	Providing premixed chipping carpet $\frac{3}{4}$ in. thick to the central portion of 12 ft width in miles 44/1 to 72/3 of Madras Cannanore Road, National Highway No. 4.	4.97
PUNJAB			
7.	1648 PB 1	Laying $\frac{3}{4}$ in. thick premixed carpet in miles 214 and 222 of G. T. Road (National Highway No. 1) Jullunder Distt.	0.29
UTTAR PRADESH			
8.	1649 UP 29	Collection of hydraulic and design data for the construction of a bridge over the Tons River on Gorakhpur-Ghazipur Road, National Highway No. 29.	0.08
WEST BENGAL			
9.	1646 BG 6	Construction of the sub-section from M. 2/1 to M. 3/5 of Joypur Beel Alampur Section of the bypass from Willingdon bridge to Andul on National Highway No. 6.	2.80



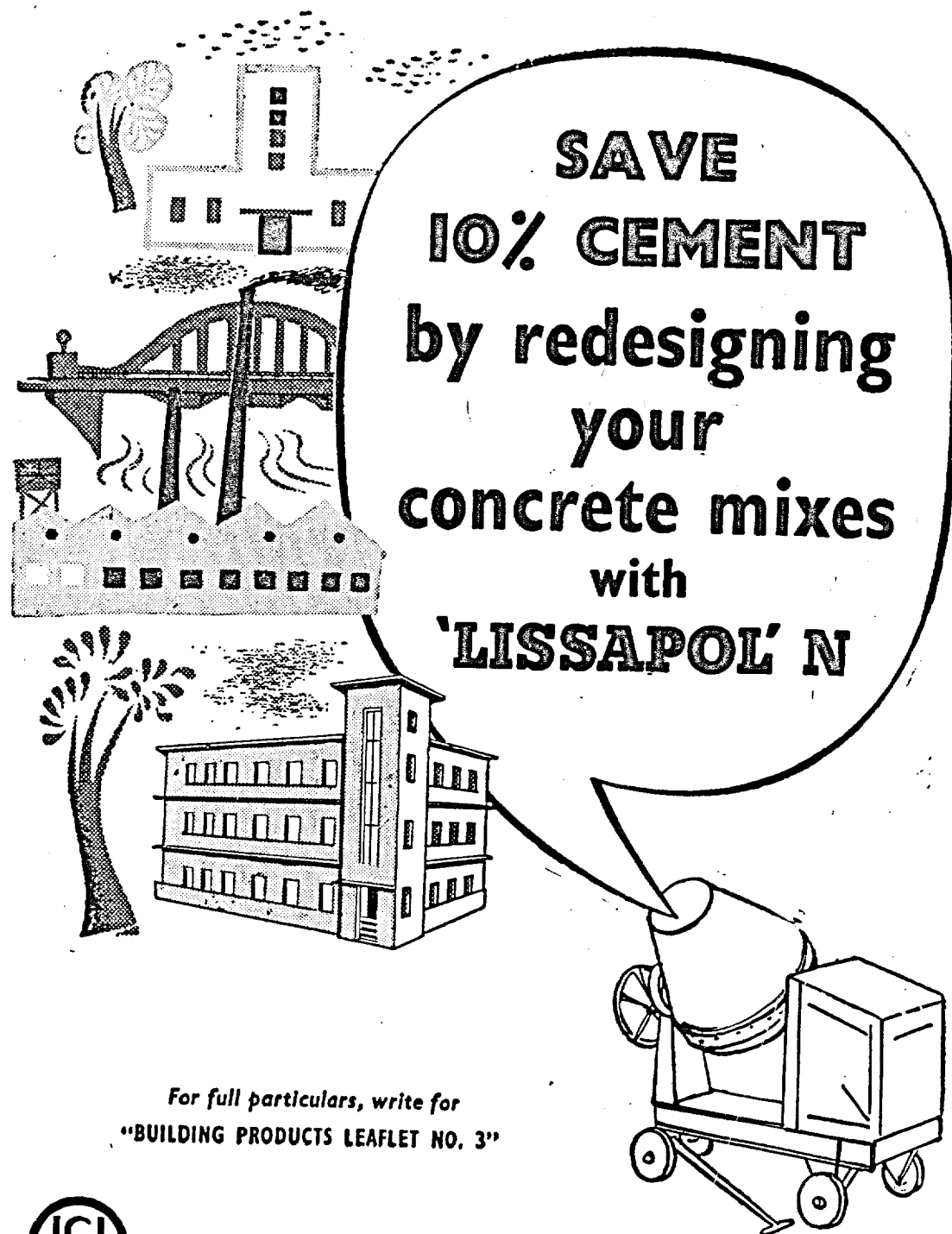
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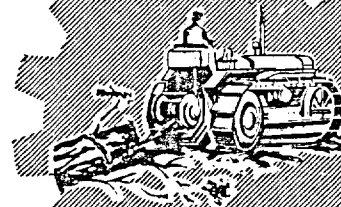
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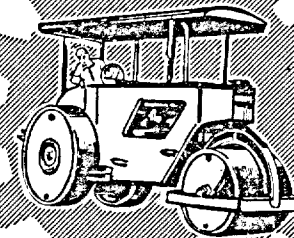
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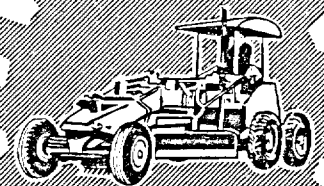
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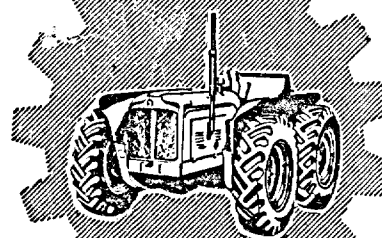
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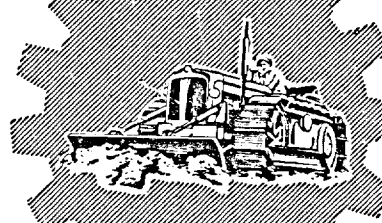
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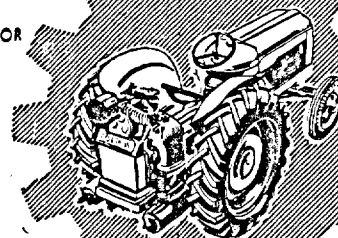


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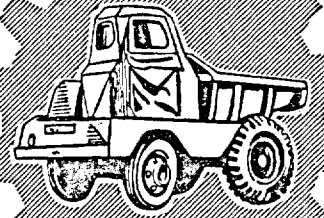


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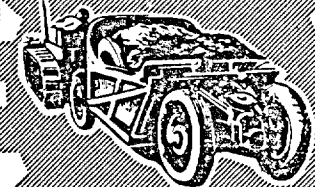
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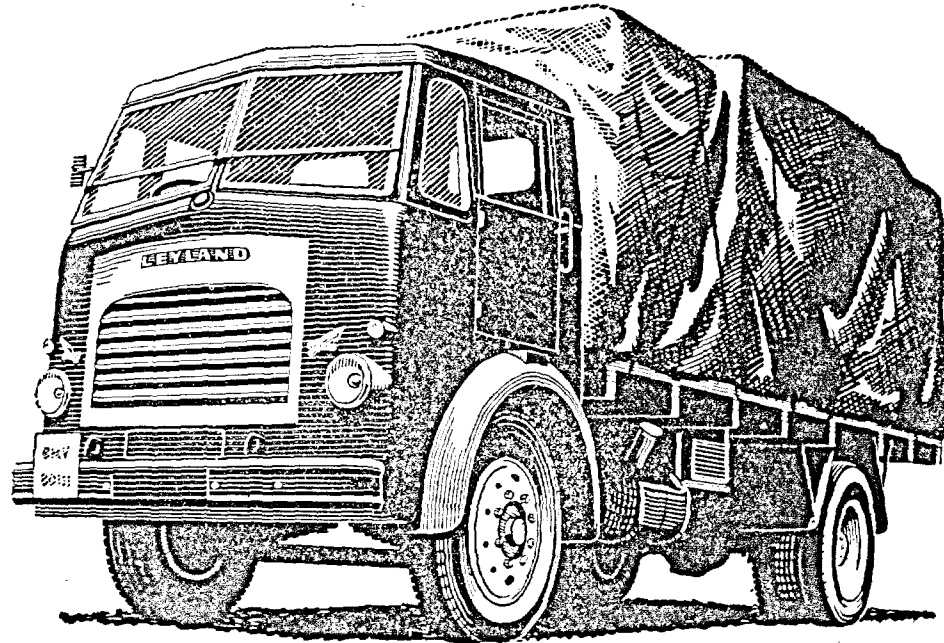
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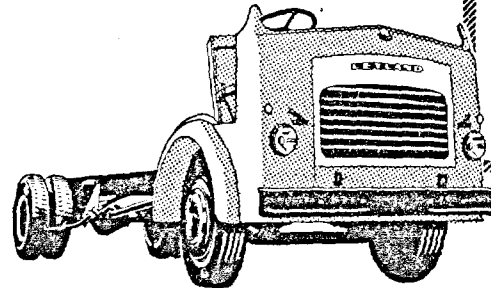
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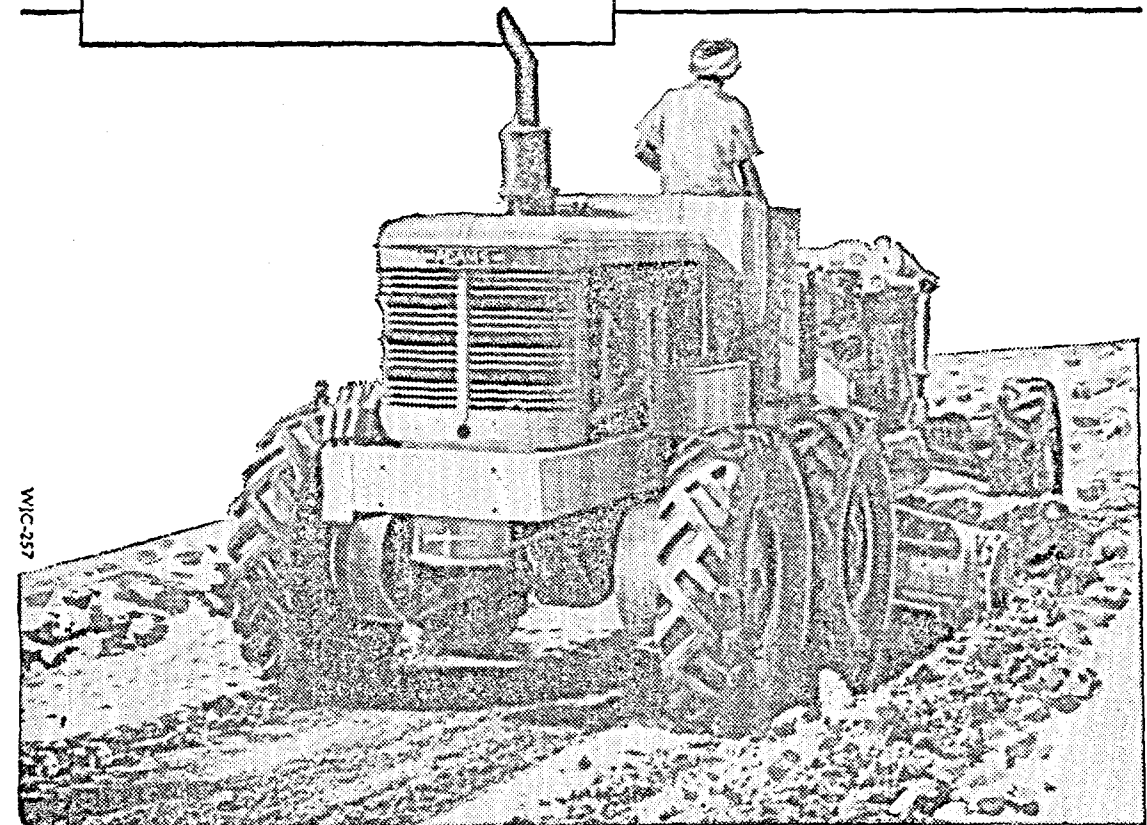
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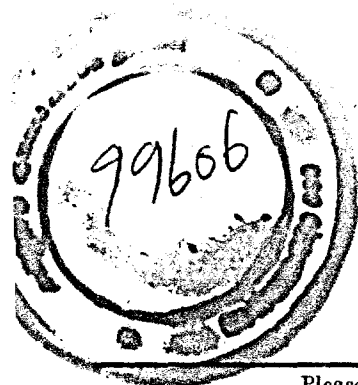
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