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TRANSPORT- COMMUNICATIONS

MONTHLY REVIEW (TCMR)

JUNE 1961—No. 170

31



INDIAN ROADS CONGRESS, NEW DELHI.

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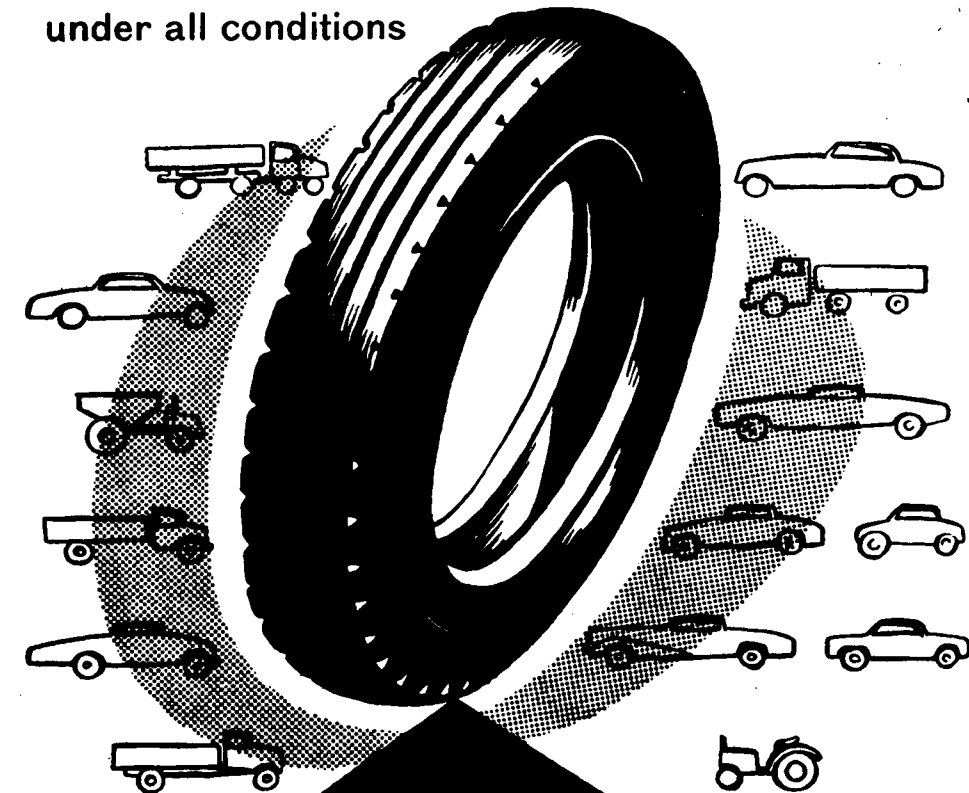
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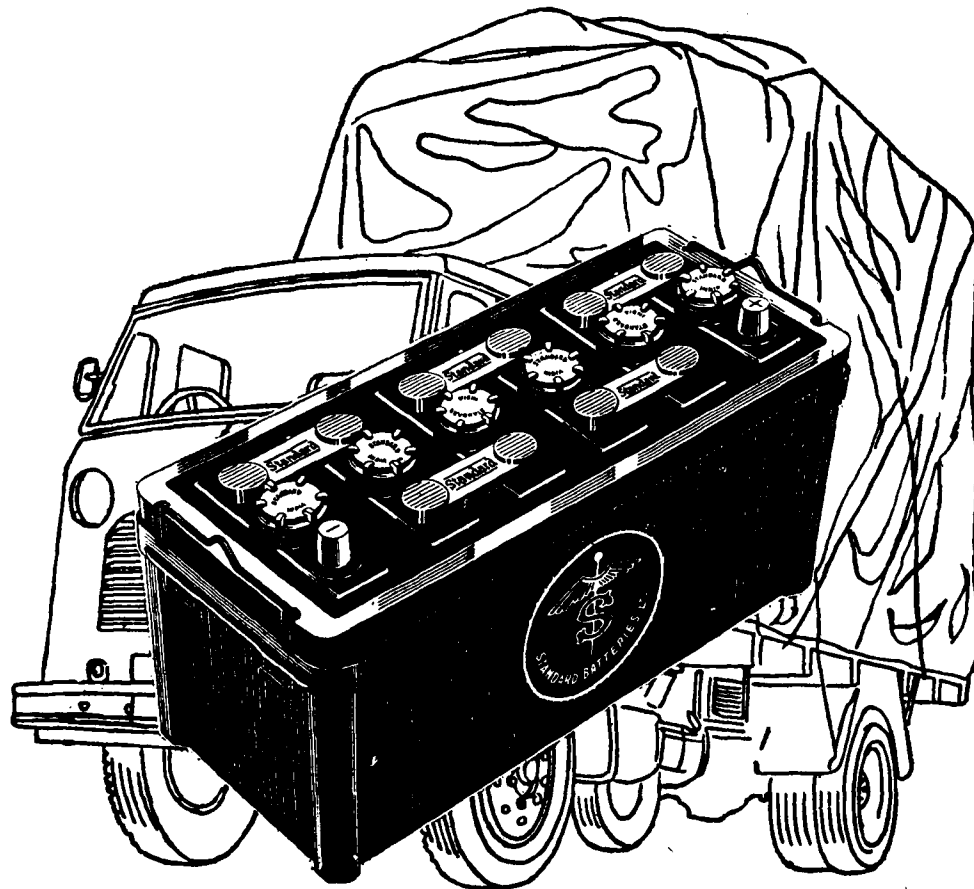
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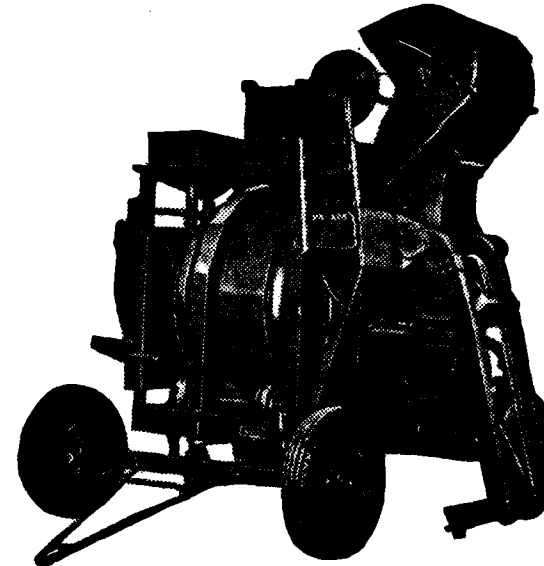
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JUNE 1961—No. 170

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Transport - Communications Monthly Review is published on the 25th of each month by the **Indian Roads Congress, New Delhi**.

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TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

A REVIEW OF
ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

JUNE 1961

FORMATION OF ROAD BOARD AN IMMEDIATE NECESSITY

FUTURE of roads and road transport is inseparably inter-connected. Road transport has a very dismal future unless we can provide a better road system. On the other hand, a better road system would be of little value unless future of road transport is assured.

Over a very long period, our people and goods have been transported by rail, road and by water, and, in recent years, also by air transportation. Due to rather rapid advances made in air transportation in recent years, some have hastily come to the conclusion that road and road transport will in future occupy comparatively minor position in matters relating to transportation.

If we try to see where our people live, where our agricultural produce grows, where are the manufacturing and industrial plants, and all those things which sustain our economic and general growth, we will find all these things on the ground and, consequently, road and surface transport will be with us for ever in one form or the other. It is obvious that the road and road transport will remain a favourite mode of transport for intermediate and short haul movements all over the country. The flexibility of road transport in collecting and delivering the goods and merchandise from door to door will continue to make this mode of transport a favourite one. With the increase in national wealth, our people will require in ever increasing number privately owned conveyance and the automobile is the answer to the individual needs of the private conveyance. Good roads will be in demand as never before.

Scientific changes and achievements in road transport will merely be improvements and modernisation of road transportation rather than a replacement. The road transport has very powerful influence, it touches the private and business life

of our people. It is truly vital to their health, happiness and prosperity. An overall highway plan looking 20 years ahead has been prepared. The plan envisages increase in mileage from 15,000 to 32,000 in the case of our National Highways, from 35,000 miles to 70,000 miles in the case of our State Highways, from 95,200 miles to 150,000 miles in the case of Major District Roads, from 78,700 miles to 180,000 miles in the case of Other District Roads, and, last but not the least, from 156,700 miles to 225,000 miles in the case of our Village Roads which help in the transportation of produce from villages to the market roads. This will, on completion, bring every village in developed and agricultural area within 4 miles of a metalled road and 1.5 miles of any road, and in under-developed and unculturable areas within 12 miles of a metalled road and 6 miles of any road. In addition, the plan envisages the increase in the manufacture of passenger cars from 25,500 and commercial vehicles from 28,000 in 1961 to 100,000 passenger cars and 230,000 commercial vehicles by 1981. The plan might be classified as slightly ambitious and recognising that it will be necessary from time to time to make many changes in such a plan, it certainly contains the basic features of a good road plan for our country and nation for the establishment of a certain definite road system to accomplish obvious objectives and likely future needs of our nation.

One might observe that all this planning or so-called dreaming is well and good, but where is the present day road builder and the road transport man going to get the money to build such facilities and get more, better and suitable vehicles to meet the increasing and changing demands. The reply is that the road users have always been in the past and are even now paying in various forms of taxation very much more than the funds provided for the development of roads and road transport.

Road and road transport might be termed a giant. But it is a sleeping giant and must be awakened to action for better service to the nation. The question is how can this unquestioned public demand and public support be roused into action to bring about that which the people desire and need. Our experience in other advanced countries teaches us that we must have a Road Board similar to our Railway Board to give continuous support to a good, sound road and road transport programme and policy. Such a Road Board should be an efficient non-political agency to formulate, administer and control the road transport policy and road programme and must be given independent administrative control of road funds made available from various sources. The Road Board should have definite authority and responsibility. By proper delegation, both of authority and responsibility, greatest advantages can be gained from the brains and brawn of those working in each branch of the Board. In addition, the Board must keep the construction programme in balance by avoiding preference for one or the other areas and show what can be done with the road funds available. The Board administrator must plan ahead and plan well.

The Council of the Indian Roads Congress has recommended to the Government of India immediate formation of the Road Board. The Board should be financed by a

fixed contribution from the country's exchequer in the same way and manner as that of the Railway's. It should have its own budget of road and road transport.

The functions of the Board should be as given below:—

1. Policy, direction and control of the construction and maintenance of National Highways, strategic roads and such other roads as may be found necessary for the development of the country as a whole.
2. Control of traffic on roads mentioned above and other roads carrying inter-State traffic, policy regarding priorities, allocation of funds, specifications and general licensing policy for vehicles pertaining to other road traffic.
3. Enunciation of the principles of taxation on road transport for financing the development and maintenance of roads.
4. Co-ordination of the plans for road development and production of vehicles and proposals for allocation of funds.
5. Assessment of the requirement of motor vehicles from time to time, formulation of specifications for them and assistance in their manufacture.
6. Promotion of road and road transport research and arrangements for the training of personnel for construction of roads and operation of road transport.

Any more delay in the formation of the proposed Road Board will definitely be against the integrated growth and interest of our nation.

Could our leaders and the Government of India give this matter urgent and immediate attention it deserves.

HIGHWAY ENGINEERING SHOWN GRAPHICALLY

By

N. K. VASWANI*, M.S. (Wis); B.E. (Bom.), M.A SCE., A.M.I.E.

Introduction

WITH the industrial development in India, increase in volume of traffic and heavier wheel loads have necessitated rational design of the road pavement and the rule of thumb or old practice cannot be depended upon. This graphical representation brings out some of the basic design principles. The diagrams are self explanatory ; explanation where necessary, is given.

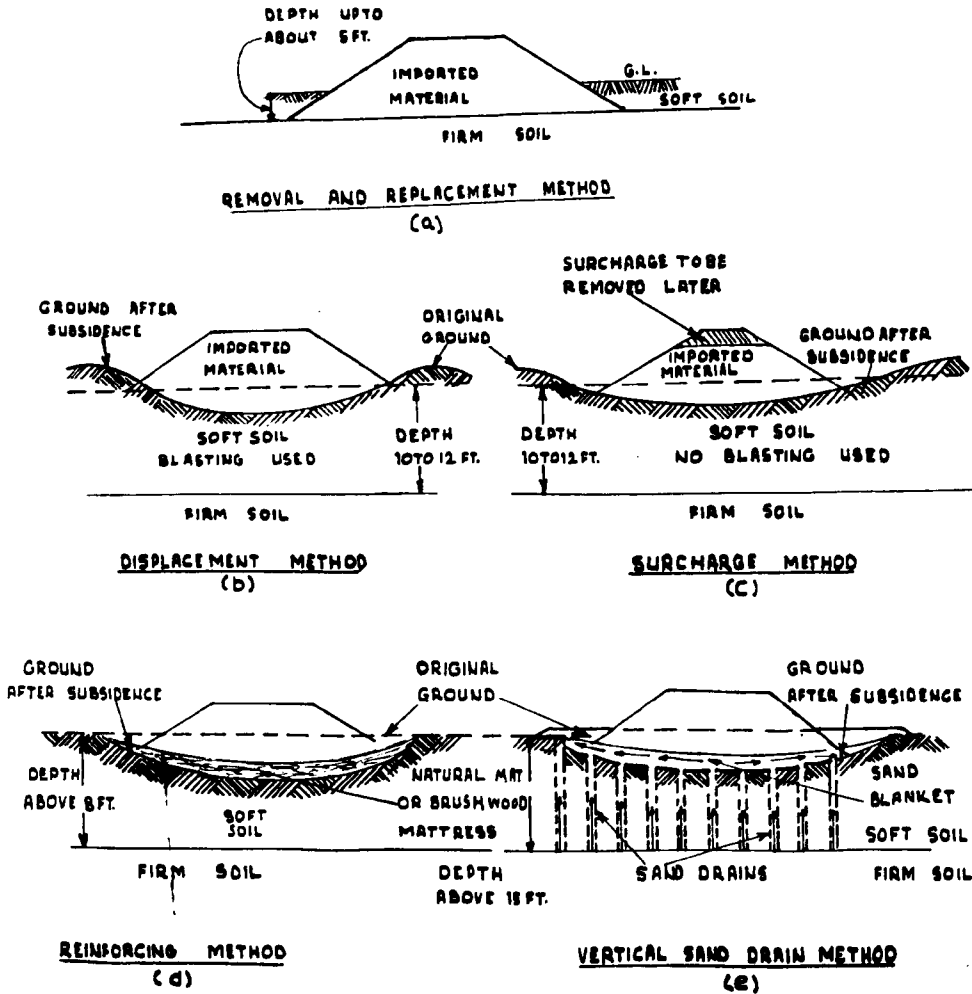


Fig. 1. Embankments on very soft soils

(a) If the depth of soft soil is small, it should be removed and embankment built, (b) Displacement may be caused by weight of fill alone. It may be supplemented.

* Reader in Civil Engg., University of Roorkee.

by explosives or jetting, or by 'relief method' in which relief trenches are provided, along the sides of the embankment. (c) Total likely displacement can be caused by providing a surcharge fill, which is removed after settlement is completed. (d) Lateral displacement may be prevented by reinforcement or by (e) providing free drainage through sand drains and sand blanket and loading slowly.

Bearing strength depends on total pressure minus pore water pressure.

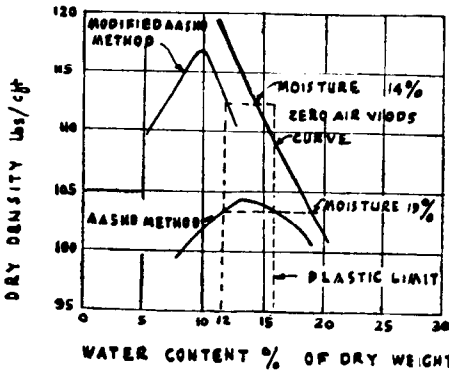


Fig. 2. Effect of increased compaction of subgrade

Increased compaction of subgrade results :

In increased density and hence increased strength.

Assume that the soil was compacted at 12 per cent moisture at two different densities shown above. As the soils get saturated (i.e., to zero air voids) in course of time, their moisture content would be 19 and 14 per cent respectively. Since the plastic limit of the soil is at 16 per cent moisture content, the soil with lower compacted density will exceed its plastic limit and loose its bearing power, while the soil with higher compacted density would remain stable.

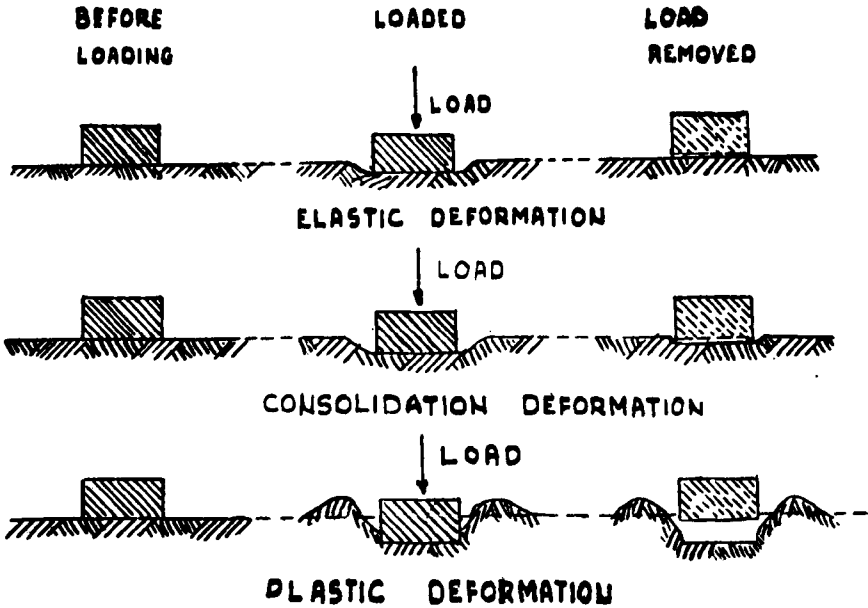


Fig. 3. Types of soil deformation

During elastic deformation air in the voids of the soil is compressed.

Consolidation deformation expels part of air and water from the voids of the soil.

In plastic deformation the fluid and air pressure combines with the forces produced by load and displaces the road material.

Deformation beyond a certain limit (usually taken as 0.5 in. for flexible pavements and 0.05 in. for rigid pavements) results in the breaking up of the pavement.

Elastic deformations do not result in the unevenness and breaking up of the road pavement.

Consolidation deformation, if gradual, results in unevenness of flexible pavements, but does not cause its failure. Plastic deformation causes failure.

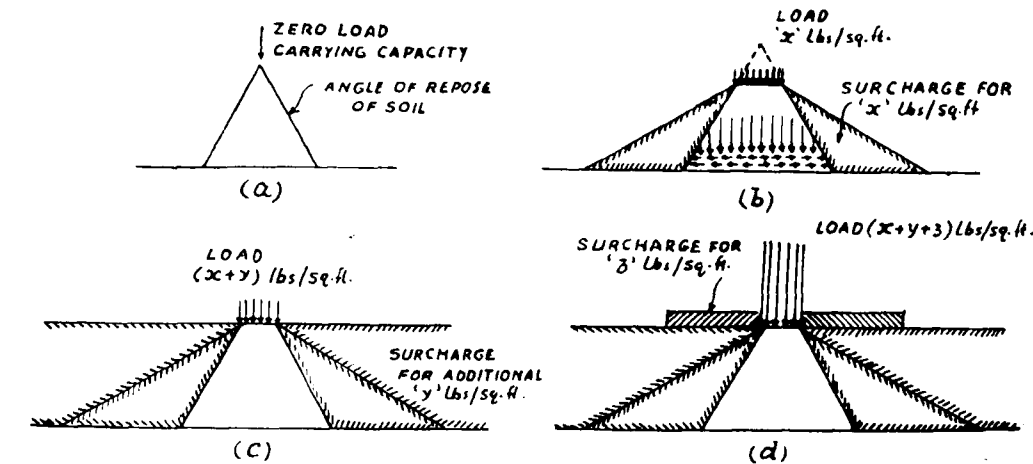


Fig. 4. Effect of surcharge

The surcharge is more effective in case of non-cohesive soils than in cohesive soils (Courtesy H.R.B.)

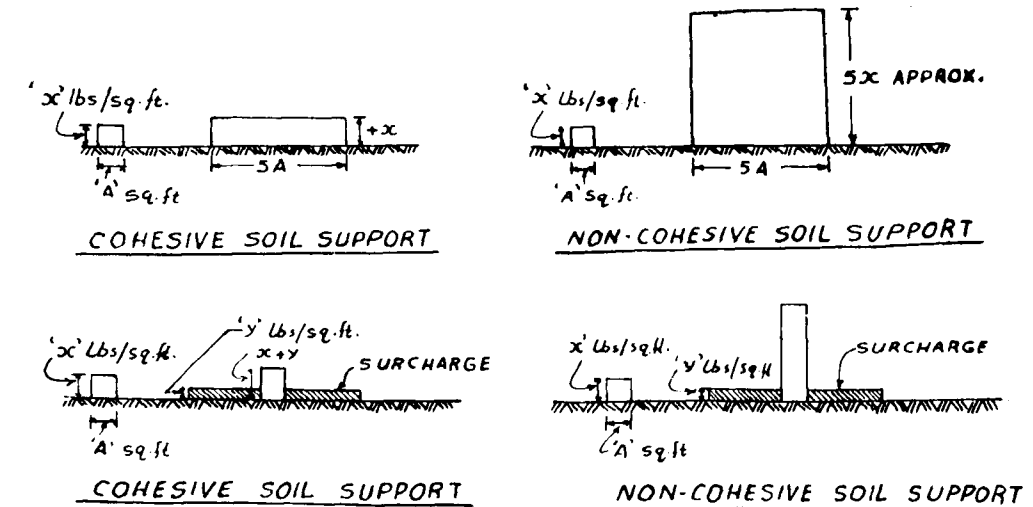


Fig. 5. Effect of load area and type of soil on the bearing power of soil

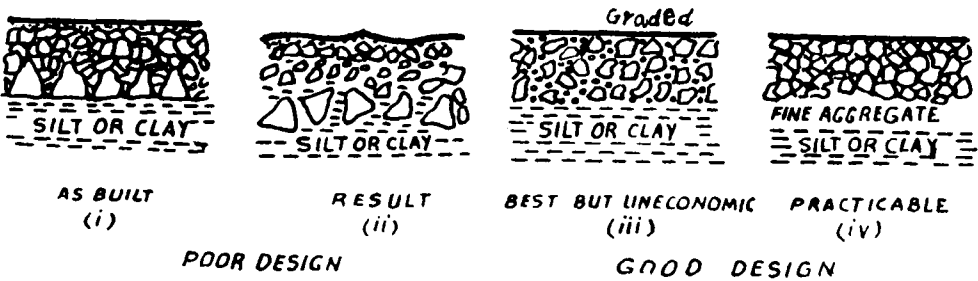


Fig. 6. Foundation design of waterbound macadam road

Boulder foundation or waterbound macadam foundation (open graded) should not be placed directly on fine soil. Due to capillary or even due to reduced evaporation under pavement, the fine soil becomes soft and enters the voids of the boulder foundation or open graded waterbound macadam base, caused by repetitive wheel loads. Graded aggregate or a layer of fine aggregate like sand will prevent this defect and maintain the structural strength of pavement.

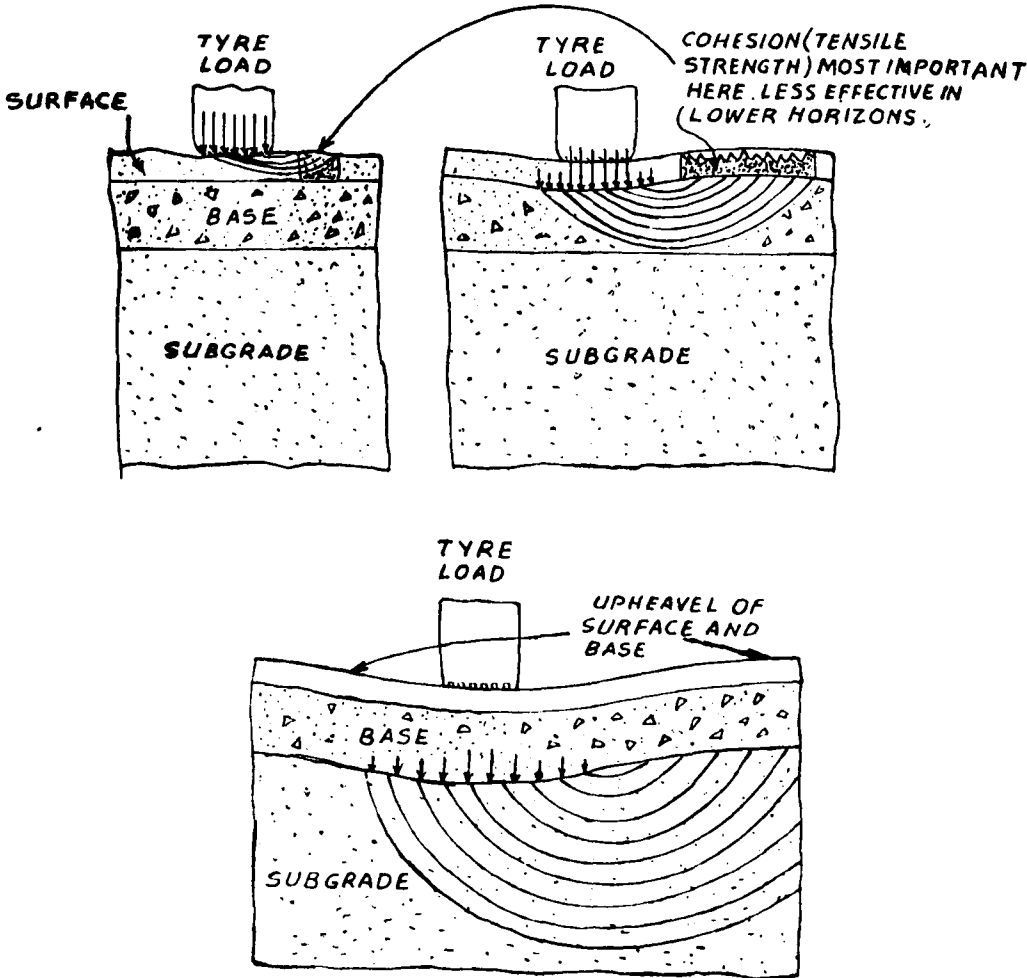


Fig. 7. Layer system in flexible pavement design

Plastic deformation in surface, base and subgrade courses in flexible pavements decreases as the distance below the surface increases. Decrease in plastic deformation results in decrease in shearing stress. Thus the materials provided in successive layers downwards may be progressively weaker.

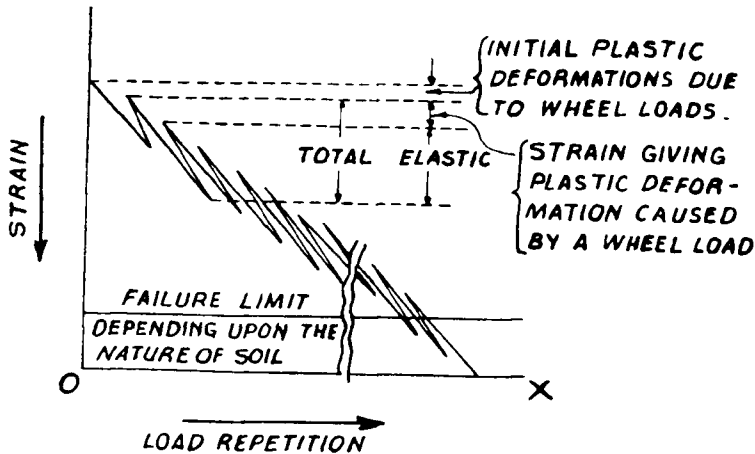


Fig. 8. Deformation characteristics of soil under wheel loads

Due to load repetitions, plastic deformation is introduced accompanied by elastic deformation. The soil gets fatigued and the pavement may fail due to plastic deformation.

The graph shows the strain on an enlarged scale.

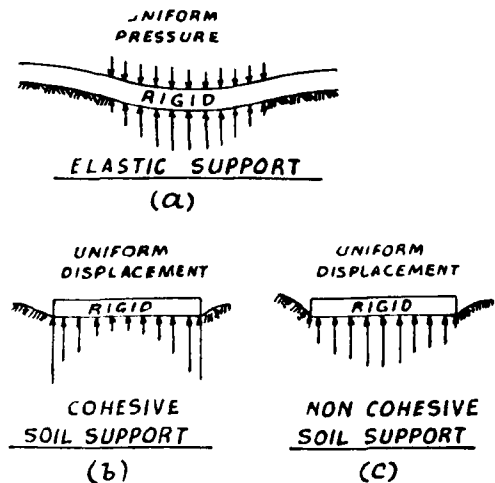


Fig. 9. Stresses v/s Displacement in Rigid slabs

(a) Uniform pressure in all elastic soils give non-uniform displacement; as in case of a concrete road slab, the reaction is non-uniform depending upon the deflection. A uniform displacement in all elastic soils give non-uniform pressure, as in case of building foundations.

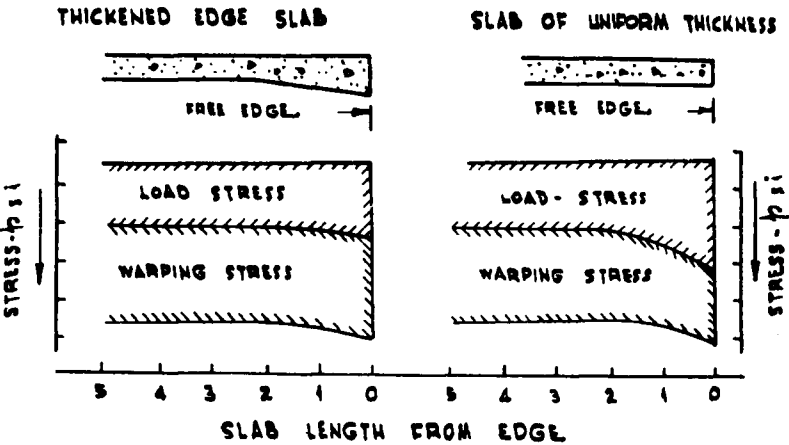


Fig. 10. Stresses in concrete pavements (Courtesy A. SCE, U.S.A.)

The sum of the stresses caused by load and warping are almost equal, in thickened edge concrete and slabs of uniform thickness.

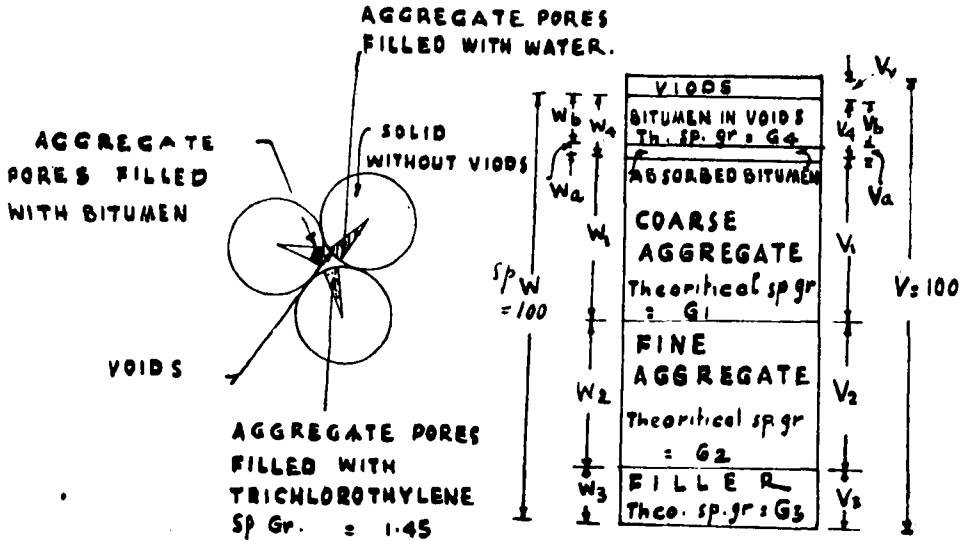


Fig. 11. Weight volume relationship in bituminous mixes

Let W_1, W_2 and W_3 be weights of oven dry aggregate in gms. and V_1, V_2, V_3 and V_4 be the bulk volumes, i.e., solids plus pores, in c. cms.

1. Maximum theoretical sp. gravity of a bituminous Mix

$$= \frac{W}{V_1 + V_2 + V_3 + V_4} = \frac{W}{\frac{W_1}{G_1} + \frac{W_2}{G_2} + \frac{W_3}{G_3} + \frac{W_4}{G_4}}$$

2. Bulk sp. gravity of bituminous mix (
- G_a
-)

$$= \frac{W_1 + W_2 + W_3}{V_1 + V_2 + V_3 + V_v}$$

3. Effective sp. gravity of aggregate

$$= \frac{W_1 + W_2 + W_3}{V_1 + V_2 + V_3 + V_v} = \frac{100 - W_4}{\text{Volume of mix} - \text{Volume of bitumen}}$$

$$= \frac{100 - W_4}{\frac{100}{\text{Bulk sp. gr. of mix}} - \frac{W_4}{\text{Sp. gr. of bitumen}}}$$

4. Bulk impregnated sp. gravity of aggregate

$$= G_{bi} = \frac{W - W_b}{V_1 + V_2 + V_3 + V_a}$$

If A = Wt. in gms. of oven dry sample B = Wt. in gms. of saturated surface dry sample C = Wt. in gms. of saturated sample in water

5. Bulk sp. gr. of aggregate (
- G_b
-) =
- $\frac{W_1 + W_2 + W_3}{V_1 + V_2 + V_3} = \frac{A}{B - C}$

6. Apparent sp. gr. of aggregate (
- G_a
-)

$$= \frac{W_1 + W_2 + W_3}{\text{Volume of solids only in the aggregate}} = \frac{A}{B - C}$$

Hence bulk sp. gr. is always less than apparent sp. gravity.

7. Per cent volume of bitumen in the mix

$$= \frac{V_4}{V} \times 100$$

$$= \frac{\text{P.C. of bitumen by weight} \times \text{B. sp. g. of mix}}{\text{Sp. gravity of bitumen}} \times 100$$

8. Volume in mineral aggregate = V.M.A.

$$= \frac{V_a + V_b}{V} \times 100$$

Assuming $V_a = 0$, we have

$$V.M.A. = \frac{V_v + V_4}{V} \times 100$$

$$= \frac{\text{Volume of aggregate voids}}{\text{Bulk volume}} \times 100$$

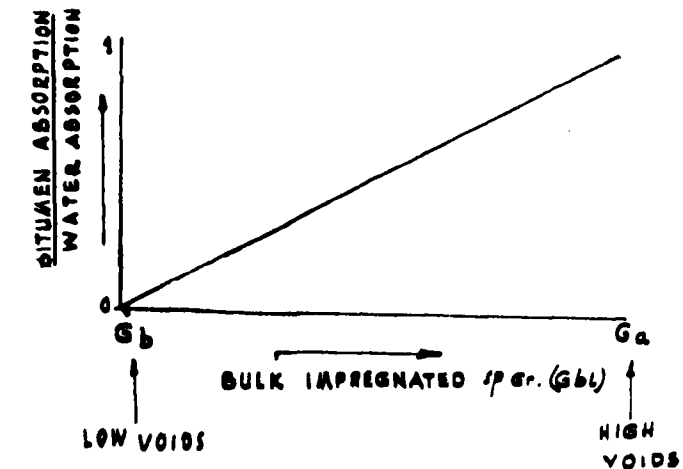
$$= \left(1 - \frac{\text{Volume of aggregate excluding voids}}{\text{Bulk volume}}\right) 100$$

$$= \left(1 - \frac{\text{Bulk sp. gravity}}{\text{Theoretical sp. gravity}}\right) 100$$

9. Percentage absorption =
- $\frac{B - A}{A} \times 100$

10. Percentage of voids in compacted mineral aggregate that were filled by bitumen = V.F.B.

$$= \frac{V_b}{V.M.A.} \times 100$$



$$\frac{\text{BITUMEN ABSORPTION}}{\text{WATER ABSORPTION}} = \frac{G_{bi} - G_b}{G_a - G_b}$$

Fig. 12. Effect of Bitumen Absorption on Design of Bituminous mixes

- (i) Use of bulk specific gravity (G_b) is accurate when aggregate absorbs no bitumen.
- (ii) In case of high absorptive aggregates, the calculated value of percentage of voids may be negative when bulk specific gravity (G_b) is employed.
- (iii) The use of apparent specific gravity (G_a) is accurate theoretically, when bitumen absorption equals water absorption.
- (iv) For aggregates which absorb less bitumen than water, if apparent specific gravity is employed for design, the calculated percentage of voids is greater than actual percentage.

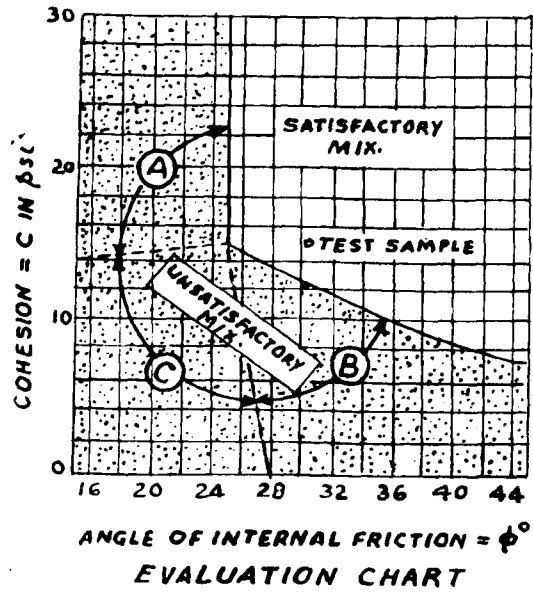
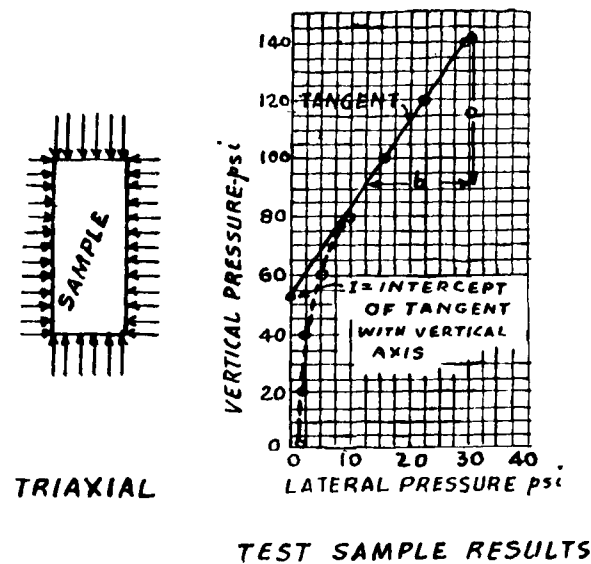


Fig. 13. Triaxial Testing of Bituminous mixes (Courtesy Asphalt Institute, U.S.A.)

Unlike soils, one sample is used for bituminous mixes. Vertical loads are applied and their corresponding lateral pressures determined. The test sample results are plotted on a graph of lateral pressure against vertical pressure. At upper portion of the curve where vertical loads are approximately proportional to the lateral pressures, a tangent to load pressure curve is drawn. The value of ' ϕ ' is determined from the equation— $Slope = \frac{a}{b} = Tan^2 \left(45 + \frac{\phi}{2} \right)$. The value of ' C ' is determined from the equation— I , intercept of tangent with vertical axis = $2 C Tan \left(45 + \frac{\phi}{2} \right)$. The values of ' ϕ ' and ' C ' of the test sample are plotted on the evaluation chart and the suitability of mix determined.

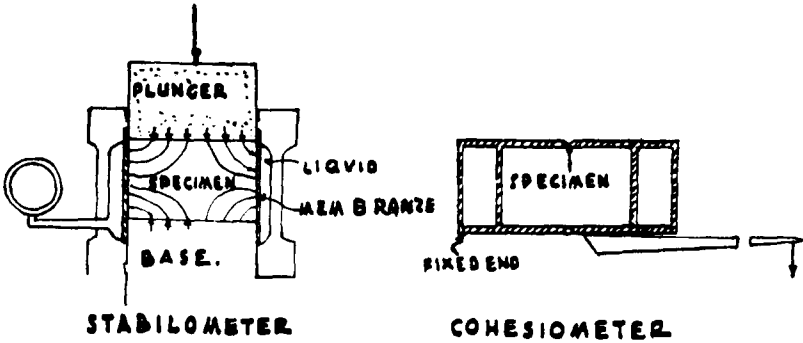


Fig. 14. Bituminous Mixture Testing by Hveem Stabilometer and Cohesimeter

Designed to determine in the laboratory the friction and cohesion value of bitumen mixes separately. Friction is evaluated from the stabilometer results. Cohesion which is a measure of tensile strength is evaluated by means of a cohesimeter.

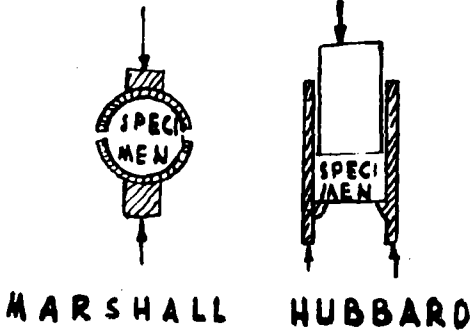


Fig. 15. Bituminous Mixture Testing by Marshall and Hubbard

Marshall test is carried out to determine the stability and flow value of bituminous mixes.

Hubbard-field test is an extrusion test and determines stability for sheet asphalt mixes.

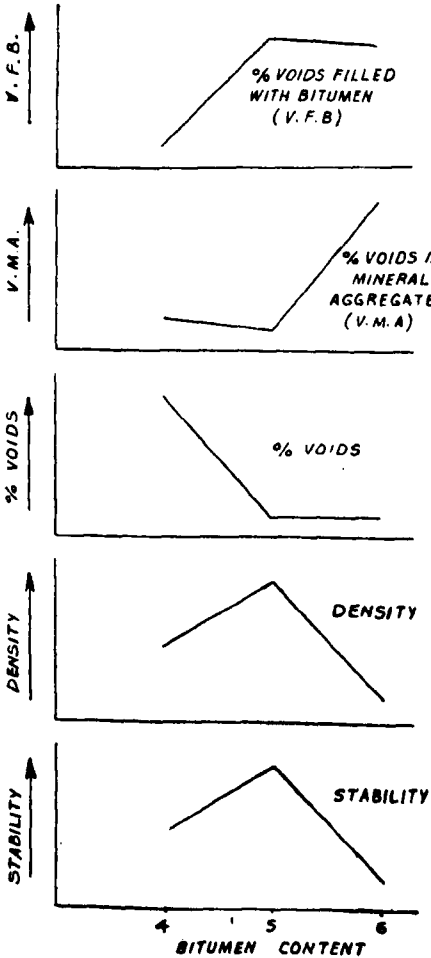


Fig. 16. Effect of bitumen contents

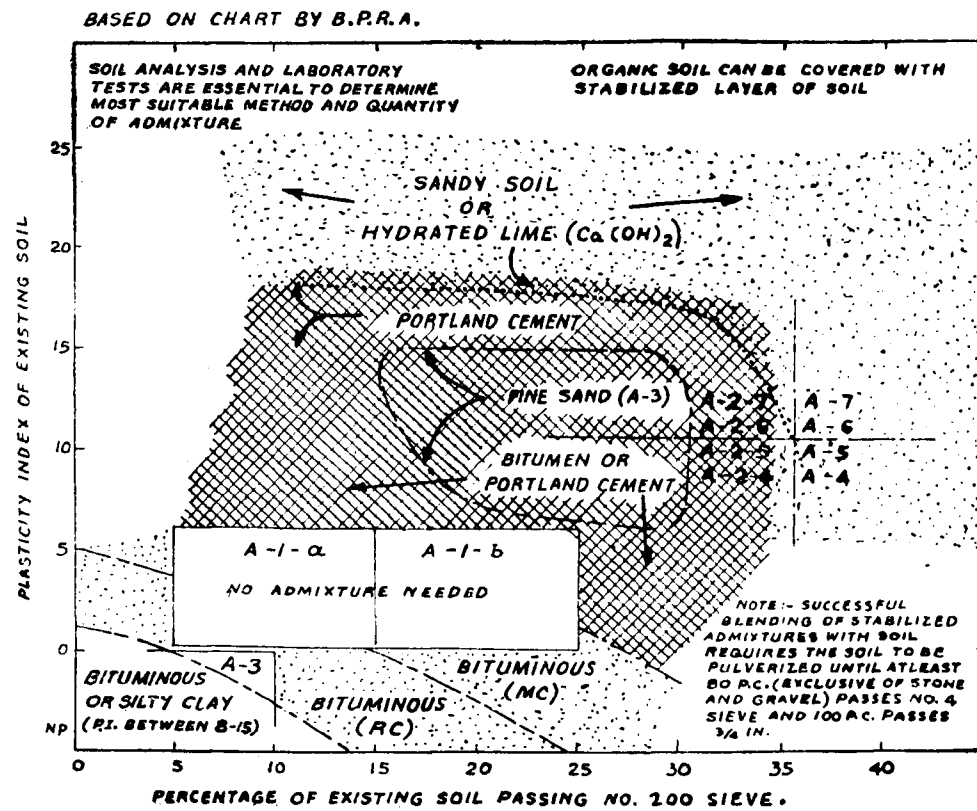


Fig. 17. Suggested stabilizing admixtures suitable for use with soils as indicated by plasticity index and amount passing No. 200 Sieve

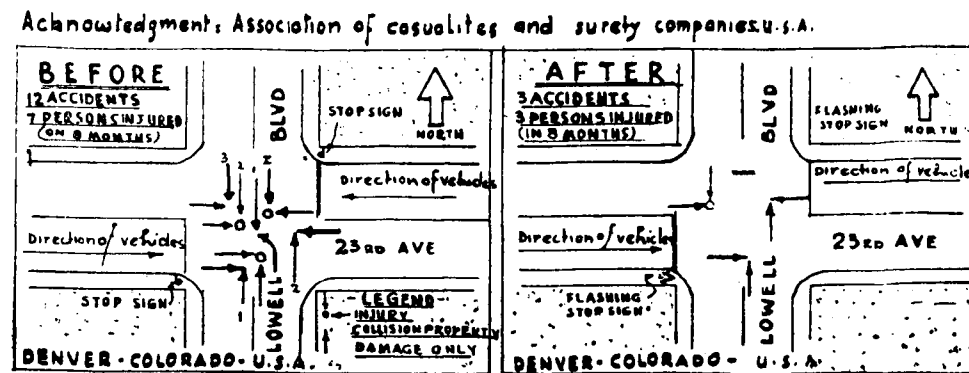


Fig. 18. Getting results through Traffic Engineering

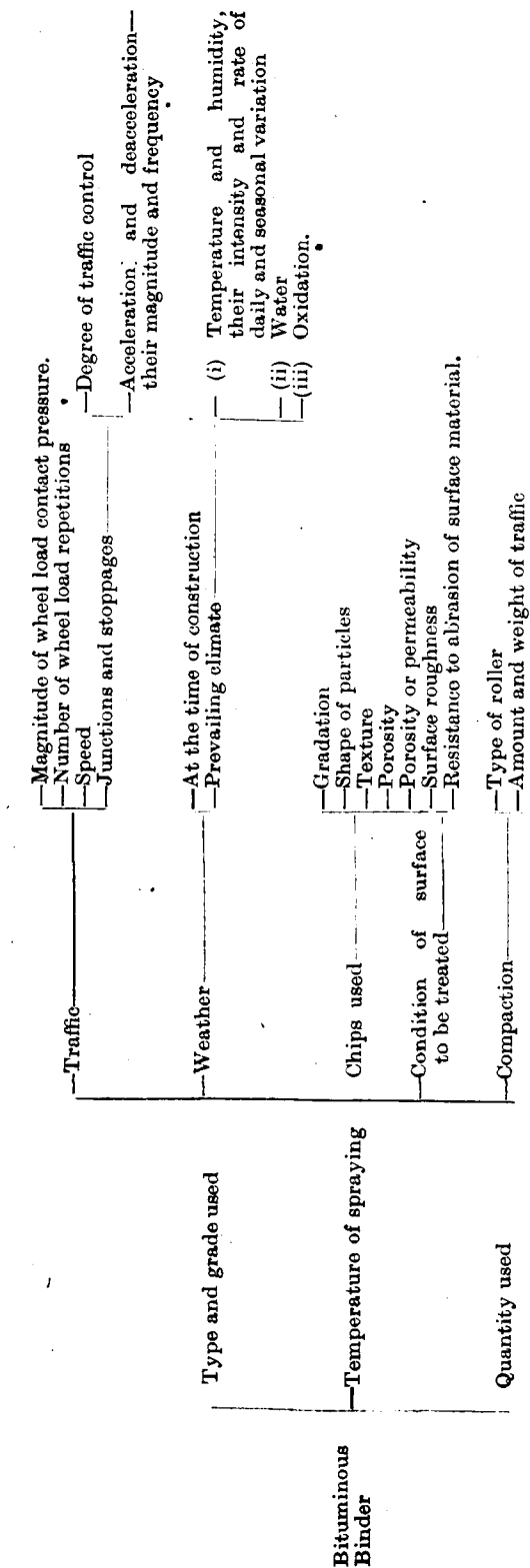


Chart 19. Factors affecting the choice and performance of bituminous binder for surface painting

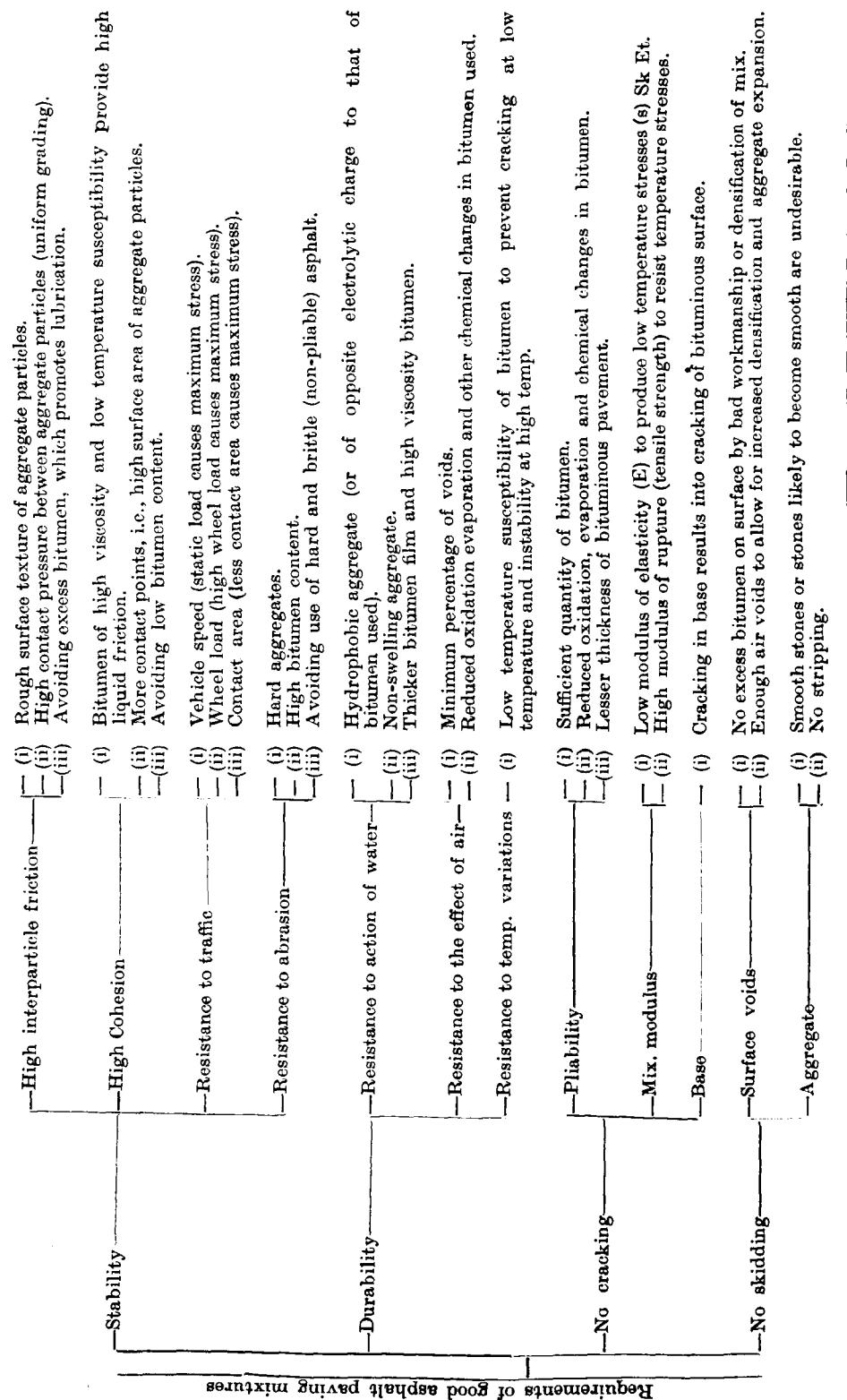


Chart 20. Requirements of good asphalt paving mixtures

BRITISH STANDARDS FOR DESIGN OF RURAL ROADS

INSTITUTION OF HIGHWAY ENGINEERS MEETING IN LONDON

IN a very informative paper presented at a meeting of the Institution of Highway Engineers, Mr. Ian A. Cram, A.M.I.C.E., M. I. MUN. E., M. INST. H. E., showed very clearly that rural road design must be based on traffic studies and the principles of dynamics and that theory must be supplemented by practical experience.

The paper deals first with traffic capacity and it is pointed out that the capacities of various widths of road are often greatly exceeded. It is suggested that more suitable maxima would be 6,000 p.c.u.'s* per 16-hour day for single 24 ft carriageways; 6,000 to 15,000 for single 33 ft; 15,000 to 35,000 for dual 24 ft; and over 35,000 for dual 36 ft.

In discussing the forecasting of future traffic the author refers to the admitted inadequacy of the Ministry's original recommendation that 75 per cent should be added to the 1954 Census figures and suggests that an addition of 200 per cent would be a more realistic method which should safely cover traffic needs for a further ten or fifteen years.

Mr. Cram expresses the opinion, with which many people will agree, that "parking problems and costs could bring about a reduced use of personal transport, especially in conjunction with improved diesel and electric train services" adding that "the number of vehicles, especially cars, will undoubtedly increase, but the use of each unit may diminish".

Speed and Curvature

The paper next deals with design speeds and the following values are suggested for various types of roads:

Type of road	Design speed m.p.h.
All roads subject to 30 m.p.h. limit	...
Class III roads	...

Class II roads	...	40
Class I roads	...	50
Trunk roads	...	60
Motor roads	...	70

These speeds should satisfy the vast majority of drivers, but one is uneasy when motor manufacturers are producing stock models capable of 150 m.p.h., and out of 41 cars tested by a motoring journal during 1960, 17 were stated to have exceeded 100 m.p.h.

Horizontal curve design and transitions are discussed at some length, the Ministry's super-elevation allowances are quoted and the minimum curve radii for comfortable driving at various speeds are given thus:

Design speed m.p.h.	Minimum radius in feet
30	...
40	...
50	...
60	...
70	...

These figures imply that the combined resistance to skidding provided by super-elevation and road friction would be .34, .31, .22 and .18, respectively, which are quite acceptable values.

There will be general agreement with Mr. Cram's statement that "the length of transition has virtually no bearing on the speed characteristics of any curve and there is a definite speed-radius relationship".

It is suggested in the paper that all curves, even of very large radius, should have transitions and reference is made to the curves of 10,000 ft radius on the Meriden by-pass which, in the author's opinion, would have been given a better appearance if transitions had been provided. It is stated, however, that transitions used for

* Passenger-Car-Units.

this purpose need be no longer than 200 ft, or thereabouts.

Transition Danger

Mr. Cram advocates the adoption of circular arcs of as great a length as possible and advises that nothing approaching a wholly transitional curve should be used. It is emphasised very rightly, that such curves constitute a definite trap, particularly if the transition is long and the minimum radius sharp. To quote the author's words: "In such conditions the driver can find himself on the sharp radius at too high a speed and 'runs out of road'."

The paper includes a very useful set of tables giving the following curve data: radius in feet, super-elevation, height of outer channel above inner channel and transition length for carriageways of various widths.

Visibility on horizontal curves is next considered and the fallacy of acquiring large areas of ground on the inside of curves with the idea of improving visibility is clearly shown by diagrams. Although this procedure is effective for drivers taking the curve in a right-hand direction, it is not for those travelling in the reverse direction.

In dealing with vertical curves the author advocates a method of design based on a factor "m" defined as the rate of gradient expressed as a percentage per 100 ft along the curve and states that "experimental work suggests that a vertical acceleration of 1.5 ft per second is comfortable and on this assumption the following relationship can be established giving suitable values of "m" for various speeds:

Speed, m.p.h.	"m" per cent		
30	...	...	7.8
40	...	...	4.4
50	...	...	2.8
60	...	...	2.0
70	...	...	1.4

The factor "m" also has a bearing on the vertical sight line distance and the relevant figures are as follows:

Sight line distance feet	"m" per cent		
150	...	...	13.3
250	...	...	4.8

350	...	...	2.4
450	...	...	1.47
500	...	...	1.20
650	...	...	0.71
900	...	...	0.37
1,000	...	...	0.30
1,200	...	...	0.20

Junction Design

The importance of junction design is shown by the fact, quoted by Mr. Cram that 27 per cent of accidents on rural roads occur at these points. Grade separations are recommended on all new construction and it is pointed out that simple designs are often possible without providing connections to minor roads.

The advisability of providing acceleration and deceleration lanes of adequate length is mentioned and comment is made of the inefficiency of the 200 ft by 8 ft splays recommended in Memo. 575.

At junctions of minor roads with 24 ft carriageway main roads the author recommends exit and entrance curves of 40 ft radius combined with transitions having a 3 ft shift and omitting the splays.

Minor roads forming junctions with major roads, however, require different treatment and Mr. Cram is not in favour of 'squaring up' a left-hand Y junction as this has been found to increase accidents rather than reduce them.

In the case of minor junctions on single three-lane carriageways the excellent recommendation is made that the main road should be converted to 24 ft dual carriageways for a sufficient distance to cover the junction. The central reserve should be wide enough to contain a deceleration lane for right-hand-out traffic and a minimum width of 36 ft is suggested.

More elaborate channelisation schemes are applicable where the minor road is quite important and forms a Y junction so that there are virtually only left-hand-on the right-hand-off movements in relation to the main road.

It will be generally agreed that as Mr. Cram states "minor road junctions on two-lane dual carriageway main roads functioning as such and carrying traffic up to the

maximum suggested of 35,000 p.c.u.'s per 16-hour day, should certainly not exist if the main road is new construction". He adds that on old construction the proper treatment is elimination and concentration.

Roundabouts

The differences between traffic conditions at rural and urban roundabouts causes Mr. Cram to doubt the validity of the roundabout capacity charts given in the Ministry of Transport "Blue Book" which apparently are meant to apply to built-up areas and he holds the view that weaving angle and carriageway width have little bearing on maximum capacity at rural roundabouts where speeds of 20 to 25 m.p.h. occur.

A calculated capacity of a weaving length based on observed headways is given as 1,300 vehicles per hour, which, with 30 per cent of commercial vehicles is equivalent to 2,100 p.c.u.'s per hour. This agrees with a count taken at the Stone-bridge roundabout, the busiest in Warwickshire, which in 1959

was carrying 2,100 p.c.u.'s per hour through a weaving area.

It is suggested that a minimum diameter of 120 ft should be used for the island, combined with a width of 30 ft for the weaving areas and the author considers that large designs would be uneconomic. These remarks are supplemented by a very useful table giving the maximum weaving area flows for a variety of road widths and traffic movements and from this it can be deduced that a normal sized roundabout is permissible at the junction of any combination of single 24 and single 33 ft carriage-ways, but where one or both is dual a roundabout will be ineffective and a grade separation should be adopted.

Mr. Cram is to be congratulated on producing such a valuable paper in which theory and practice are so skilfully blended and design principles based on a happy combination of both.

(From 'Highways and Bridges and Engineering Works', April 12, 1961.)

DEFINITIONS OF HIGHWAY ENGINEERING TERMS

HYDRAULIC GRADIENT: The slope of the hydraulic gradient line.

- HYDRAULIC GRADIENT LINE:
1. The line joining the levels to which water rises in pressure pipes (manometer tubes) erected at points along a flowing conduit.
 2. The waterline along an open channel.
 3. The line of saturation in the earth section of an embankment, dam, tank bund or other earth structures for retaining water.

USES OF BLAST FURNACE SLAG IN ROAD WORKS AND BUILDINGS

SOUTH WALES MUNICIPAL ENGINEERS' MEETING AT PORT TALBOT

PROPERTIES of different types of blast furnace slag and their uses in road construction and building were discussed by Mr. G. E. Broadhead, B.Sc. (Eng.), A.M.I.C.E., in a paper given at the meeting of the Institution of Municipal Engineers, South Wales District, which followed the opening of the new automatic slag processing installation at Morfa Bank, Port Talbot... (see the Surveyor, 18 February).

Mr. Broadhead said there were three main types of slag-air-cooled, the most common form; granulated slag, produced by discharging the molten slag into pools of water; and foamed slag, formed by directing a jet of water on to the molten stream as it was discharged.

Air-cooled slag in roads

Discussing the use of air-cooled slag as a road-making aggregate, Mr. Broadhead continued:

The types of construction used in road-making fall into two categories which, although not expressing accurately the functions of the construction have become acceptable terms in the nomenclature of highway engineering. These are flexible and rigid. A high strength concrete slab is considered to represent the rigid type while the flexible type is composed of crushed and graded aggregate mixed with water, bitumen or tar in such proportions that the optimum density, stability and durability are obtained for the given grading and material with the recognised compaction equipment. Providing the design thickness of a flexible pavement is sufficient to ensure the subgrade is not overstressed then repetitive loading by traffic will continue to compact the pavement to a higher density and its resistance to deformation will thereby be increased.

The construction layers of a flexible pavement which rest on the subgrade are the sub-base, base, base course and wearing course,

Sub-base

Reference to Road Note No. 29 indicates that the necessity for a *sub-base* will depend on:

- The loading and frequency of traffic;
- The C.B.R. of the subgrade (below about 12 per cent a sub-base should be used on all new roads which are more than lightly trafficked, i.e., on those with more than 150 commercial vehicles per day).
- the necessity or not to provide a construction thickness of 18 in. which is considered to be the minimum cover needed to protect a frost susceptible subgrade.

To perform its function satisfactorily, the sub-base itself should have a C.B.R. of at least 20 per cent for the heaviest traffic conditions and 15 per cent for the remainder; also, of course, down to a depth of 18 in. it should be frost resistant. Many granular materials will satisfy these conditions and crusher run blast furnace slag will provide a first-class sub-base.

Base material

The requirements for the base material are more stringent than for the sub-base in view of the fact that the stresses it has to resist are greater. However, as for sub-bases, the conditions of loading influence the choice and over the years such variations as hand-pitching, single-sized material with vibrated fines, coated macadams, wet



Air-cooled slag for the new automatic processing plant at Port Talbot being loaded for transport to the loading chute leading to the primary crusher

mix, rolled dry lean concrete, cement bound granular bases and dense bitumen macadam have been and are being used. By full-scale road experiments the R.R.L. are establishing the virtue of densely graded mixtures and this, coupled with machine laying, the frequent necessity for frost resistance, and a desire for a higher standard of impermeability at the base level of the construction are all indicating the advantages of cement and bituminous bound bases.

Very stable lean-mix bases can be produced with slag using clause 806 of the M.O.T. Specification for Road and Bridge Works which requires about 60 per cent $\pm$ 5 per cent of $1\frac{1}{2}$ in. nominal size coarse aggregate with a cement content of between 2.5 and 5.0 per cent. On the other hand, although a wet mix, which is in effect a waterbound macadam, may not be so resistant to frost as the cement and bituminous bound bases, when made with slag the trace of natural cementitious properties in the fine aggregate will bind the material more firmly together. Hence, within limits, and provided that it is not attacked by severe frost in its early life, the road base properties of a slag wet mix are

likely to improve with age, and provide a more stable and denser base than many other aggregates.

The use of a bituminous binder in road bases is expanding rapidly on the continent and although in this country we are tending to wait for more of our own results of trial areas before using these materials on a wide scale, there are definite signs that well designed dense bituminous bound road bases have distinct advantages which cannot be ignored; some of these advantages are:

Good load spreading properties High degree of impermeability.

Flexibility, in that they tend to deform under excess load without fracturing, hence reducing the risk of cracking in the surface courses.

Can be trafficked almost immediately after laying, provided the road is not overstressed.

High degree of frost resistance.

Can be laid by machine to within close tolerances of levels.

A dense bituminous base specification could either be taken from B.S. 594: 1958, or Table 3 of Appendix 4 of Road Note No. 29, or a specification issued by the British Slag Federation for road bases. At present, Appendix 4 of the Road Note refers only to base courses, and not bases but the grading quoted for the $1\frac{1}{2}$ in. nominal size material is practically identical to that specified by the British Slag Federation for road bases, although the binder in the latter case is approximately 1.2 per cent lower. Bases made with slag are inherently mechanically stable and the property of a normal slag mixture to permit fairly wide tolerances on binder content without becoming unstable is a distinct advantage. This is particularly important because, after it is laid, it is relatively easy to observe if a wearing course mixture is beginning to fail and remedial action can be taken, but bases are not visible and there is frequently no warning of failure until it happens. Hence, the safety factor of binder content tolerance introduces a safety factor in the mix design, which is not available to all other aggregates.

Base course and wearing course

Many of the advantages which are claimed for bituminous bases are also available to bituminous base courses and wearing courses depending on the type of material specified. Such courses contribute strength to the road structure and are no longer considered as simply a riding surface. Because of this and the high traffic stresses which they must withstand, close control should be exercised over their production and the various B.S. Specification should be consulted so as to use the correct mixture and thickness for the expected traffic. Blast furnace slag for wearing and base courses is included in the British Standards as follows:

B.S. 1621 and 802 for Bitumen and Tar macadam

B.S. 1690 for Fine Cold Asphalt

B.S. 594 for Rolled Asphalt

In all cases, the slag course aggregate is at present required to satisfy the following conditions as assessed in accordance with tests in B.S. 1047:

- (1) Stability, i.e., freedom from lime and iron unsoundness.

- (2) Sulphur content not to exceed 2.75 per cent.
- (3) Bulk density to be at least 78 lb/cu. ft.
- (4) Water absorption not to exceed 4 per cent.

If the slag complies with these values then it will provide an excellent road-making aggregate for use in wearing and base courses. Evidence is available to show that slag in bituminous mixtures can withstand very heavy trafficking and for Dense Bitumen Macadam wearing courses in B.S. 1621: 1960 slag is the only aggregate for which sufficient evidence at present exists for use on the heavier trafficked roads, i.e., those over about 20,000 tons per day. It is also one of the most successful aggregates for incorporation in Fine Cold Asphalt.

Polished stone value

Over the last two years attention has been focussed on the Polished-stone value and this test is now included in B.S. 812: 1960. Distribution of the P.S.Vs. obtained by R.R.L. on slag aggregate as quoted in their Technical Paper No. 43 gives a range of about 0.35 to 0.6, only nine values being quoted. This range does not compare unfavourably with some of the other rock groups and higher values than 0.6 have been obtained on some slags, e.g., the value for the Margam slag is 0.7.

Surface dressing

The surface characteristics, particle shape and cleanness of slag make it a suitable aggregate for surface dressing and, being less sensitive to slight variations in binder distribution and having an alkaline reaction with water, it is resistant to variations in the technique of application, fattening up in hot weather, and stripping in wet weather.

Other uses

Air cooled slag as a concrete aggregate

It is important that the stability of the slag should be established before use in concrete and particularly in structural concrete, i.e., that either of the two equations in B.S. 1047: 1952 which control the lime contents are satisfied:

$$\begin{aligned} \text{(a) } \text{CaO} + 0.8 \text{ Mgo} &\leq 1.2 \text{ SiO}_2 + 0.4 \text{ Al}_2\text{O}_3 + 1.75 \text{ S} \\ \text{CaO} &\leq 0.9 \text{ SiO}_2 + 0.1 \text{ Al}_2\text{O}_3 + 1.75 \text{ S} \end{aligned}$$

or failing this that the microscopic test is satisfactory. This is to establish that crystalline dicalcium silicate (larnite) is not present. In addition, that iron unsoundness is not present and that the acid soluble sulphate is not greater than 0.7 per cent and the total sulphur is not greater than, 2 per cent.

Depending on the cooling technique slag is generally capable of complying with the maximum absorption value of 10 per cent and the bulk density minimum of 78 lb/cu. ft. although the latter may be a problem with high lime content slag which is inclined to give off gases during cooling and which may have to be cooled rapidly to ensure that lime unsoundness will not occur. It is desirable that the slag shall be crystalline and not glassy and to ensure this with high silica slags slow cooling is preferable.

Such slag will provide a useful concrete aggregate and it is widely used for the manufacture of precast concrete products, e.g., kerbs, flags, pipes, etc., and also in reinforced concrete in which it has been established that there is no danger of the reinforcement being corroded provided that the slag satisfies B.S. 1047 and the concrete is of normal density.

Air-cooled slag as a medium for percolating filters

B.S. 1438: 1948 defines the function of a filter medium in a percolating filter as that of providing "an extended surface to serve as a support for the organisms, including bacteria and fungi, which bring about the purification of polluted liquids supplied to the filter. The changes brought about by these organisms occur most readily under aerobic conditions".

Slag is used very successfully as a filter medium. Its rough and pitted surface texture together with its frequent vesicular nature provide a very large surface area over which the effluent can percolate and on which the bacteria and fungi can operate. Due to the fact that it is an aggregate which can be crushed to a cubical shape and is consequently almost completely free from flaky particles it can provide the maximum quantity of controlled voids with no bedding down, and can thus ensure a free flow for the effluent through the medium.

Other requirements for a filter medium are that it should be:

Clean and free from any fine matter which would wash down and clog it.

Durable so as to resist the variations in temperature (both diurnal and seasonal) and the disintegrating action of the effluent and organisms.

Strong so as to withstand handling and the weight of the superimposed layers without fracture.

To assess whether a slag will be suitable the quantitative and qualitative tests in B.S. 1438 require that it shall comply with the stability requirements of B.S. 1047 and that all aggregates, including slag, shall comply with:

- (1) Sodium sulphate soundness test of 20×24 hour cycles of 19 hours immersion in sodium sulphate solution followed by five hours drying and cooling, during which the loss in weight shall not exceed 3 per cent, nor the number of failed stones be equal to 10 per cent.
- (2) Flakiness not to exceed 20 per cent and elongation not to exceed 40 per cent on 1 in. aggregate with slight adjustment for other sizes.
- (3) Fines passing No. 7 sieve not to exceed 5 per cent.

Granulated slag as a Portland Cement clinker

By adding lime to slag of the following composition a cement clinker similar to that of a typical Portland cement can be made:

35-50 per cent Lime

30-40 per cent Silica

10-18 per cent Alumina

To 100 per cent Magnesium, Manganese and Iron oxides

The cement is made by finely grinding and mixing the lime and the slag in the appropriate proportions, and burning the mixture in a rotary kiln. The dry process of manufacture is normally used in the manufacture of the clinker.

D411-2, N48
N61-120

Portland blast furnace cement

P.B.F. cement is covered by B.S. 146: 1958 in which the maximum quantity of added blast furnace slag in the cement is fixed at 65 per cent. P.B.F. cement is normally manufactured from cement clinker (frequently made by burning slag and limestone), granulated slag and a proportion of gypsum to control the set. The components are fed to a mill and finely ground as for normal Portland cement. The cement clinker must comply with the composition limits laid down in B.S. 12 for normal Portland cement. In addition, the physical properties, e.g., fineness, setting time, etc., and composition of the finished cement are specified in B.S. 146. The granulated slag used in the manufacture of P.B.F. cement frequently has a high lime content, but, from the point of view of the finished cement, this is not essential because a lower lime content in the slag can be compensated for by increasing the quantity of cement clinker in the finished cement.

P.B.F. cement is not so widely manufactured in Great Britain as it is on the Continent, and its production has been centred in the Glasgow area for many years. Some of the properties of P.B.F. cement are:

- (i) It achieves the same final strengths as Ordinary Portland Cement (O.P.C.), but its early strengths, e.g., at seven days and 28 days, are lower.
- (ii) It has a lower heat evolution than O.P.C. This is an advantage in large mass concrete structures, but not in cold weather.
- (iii) Slightly greater resistance to sulphate attack than O.P.C.

Super sulphate cement

Composition: The following constituents are ground very finely together:

- 80–85 per cent granulated slag with a minimum alumina content of 12 per cent.
 - 10–15 per cent well-burnt gypsum.
 - 5 per cent Portland cement.
- Some of the properties of the cement are:

- (1) Very high sulphate resistance, hence it is useful for work in sea

water, sulphate-bearing soils, chemical works, etc.

- (2) Low heat evolution.
- (3) Necessary to be kept moist during early curing to prevent surface dusting.
- (4) Decrease in rate of gain in strength under cold and hot (above 40 deg. C.) conditions.

Foamed slag

F.S. is a lightweight building aggregate which is marketed in the following gradings:

Coarse ½ in.-1/8 in. loose	
mean density	... 33 lb./cu.ft.
Fine 1/8 in. down loose	
mean density	... 45 "
All-in. ½ in. down loose	
mean density	... 42 "

It is used:

- (1) As an aggregate for lightweight concrete and refractory purposes.
- (2) As filling material to reduce heat and sound transmission (K value = 0.8).
- (3) In mortar for anti-condensation and acoustic purposes.

Foamed slag concrete

Foamed slag concrete varies in density from 60–95 lb./cu.ft. depending on the uses; the denser the concrete the stronger it is, but the lower densities give better acoustic and thermal properties.

Some properties of foamed slag concrete are:

Crushing strength

About 250 to 2,000 lb./sq. in. at 28 days, depending on density and cement content.

Thermal conductivity (K)

About 1.3 to 2.7, depending on density (average for flint gravel concrete = 10.3) (average for common brick = 8.6).

Heat insulation (U)

About 0.23 for 9 in. thick cast in situ wall, and about 0.15 for 10 in. of two-load bearing blocks (11 in. cavity brick wall has a value of about 0.3)

Sound Insulation

4 in. thick reduces airborne sound by about 45 decibels.

Fire resistance

Non-combustibility and low heat transmission give blocks high fire resistance.

Weather resistance

Water will penetrate up to about 1½ in., but as there is very little capillarity, it does not penetrate further but falls by gravity to an impermeable layer where it should be able to run out.

Rendering and plastering

Waterproof renderings are not suitable. Open textured renderings are satisfactory.

Fixing

Blocks can be easily cut, and cut nails can be readily driven in.

Uses

Roof and floor screeds, precast units for walls, casing steelwork.

(Note: Most information on foamed slag obtained from Foamed Slag Producers' Association.)

Quantities of slag used

The following figures, which have been supplied by the British Slag Federation, represent the weight of air-cooled blast furnace slag sold for various purposes during the inclusive dates 1955–1959 expressed in units of 1,000 tons:

Year	Road stone	Rail track ballast	Concrete aggregate	Dry slag other than road-stone	Total
1955	4,554	474	100	353	5,481
1956	5,033	646	109	254	6,042
1957	5,352	780	101	250	6,483
1958	5,019	804	67	237	6,127
1959	5,206	1,009	61	213	6,489

In the next month issue, an article on Automatic Slag Processing Plant will be given.

(From 'The Surveyor and Municipal and County Engineer, 4th March, 1961'.)

After dining and wining rather too well a gentleman was meandering home very late when he spotted a strange and disconcerting luminous something in a small pond beside the road. A policeman was standing nearby, so the reveler called to him: Tell me, officer, what is that peculiar light in the pond?

The policeman looked. "Why, that's the moon," he said.

"The moon?" cried the man. "What am I doing up here?"

FIRE-FIGHTING PROBLEMS IN MULTI-STOREY BUILDINGS ESSENTIAL FEATURE OF DESIGN

THE problem of fire-fighting in multi-storey buildings was among the points discussed by Mr. F.W. Delve, C.B.E., Chief officer of the London Fire Brigade, in the course of a paper on *Fire Precautions in Buildings* which he presented to the Royal Institution of Chartered Surveyors.

Before the war, said Mr. Delve, building in London had been generally confined in height to below 100 ft. except for occasional architectural features. The present trend was to build higher and higher buildings and in the past few years many buildings of greater height than 100 ft had been erected. The highest building under construction at the present moment was on Millbank and would have a height of about 387 ft.

In general, a multi-storey building presented a more difficult problem of fire-fighting than a single-storey building, and the greater the height the more complex this problem became. Up to the 80 to 100 ft height certain fire-fighting operations could be conducted from fire brigade ladders, but when a building rose above these heights all-fire-fighting, and indeed rescue work, must be done from within the building and to achieve this certain features became essential and these could be summarised as follows:

- (i) Satisfactory access for brigade appliances up to entries to a building.
- (ii) A means whereby upper floors can be reached quickly.
- (iii) A suitable area within the building in which firemen can assemble and prepare their equipment for fire-fighting.
- (iv) The means for fighting a fire.
- (v) A safe exit should the need to withdraw from a building be necessary.

As to (i), one of the primary needs for effective fire-fighting was good access to the building involved. Town-planning in the past had seldom given adequate consideration to the needs of firemen in fighting fires. Anyone who was familiar with industrial towns and cities, especially London, knew of the narrow, tortuous roadways in densely built-up areas of high fire-risk where it was impossible to manoeuvre modern fire-fighting appliances and where access was limited to personnel and the equipment they could carry.

Nowadays there was a wider appreciation of fire-fighting requirements among town-planners; in London, plans of all housing estates and buildings controlled under section 20 of the London Building Acts received by the superintending architect were forwarded to the Brigade to ensure, amongst other things, that suitable access was provided.

The Brigade issued a printed form showing the minimum access requirements. It was available to architects and surveyors on request.

Item (ii) could be catered for by the provision of a lift which firemen could take control of by means of a 'fire switch' at building entrance level. Such a lift should be of a size and loading that it could carry a crew of firemen with their equipment (not less than 1,200 lb); be of a speed relative to the height of the building, that was, its time of travel from the ground to top-most storey should be about 1 min. Above all, the lift must be suitably sited in a ventilated lobby between the floor area and a staircase.

A suitable area [item (iii)] was a ventilated lobby (or lobbies where the floor area was in excess of 10,000 sq. ft.). Means of fighting a fire [item (iv)] was provided for by the installation of dry rising mains up to the 200 ft height, wet rising mains, adequately boosted, above that height and

by hose reels and such other fire equipment necessary to tackle the fire risk at large.

A satisfactory means of exit [item (v)] could only be provided by the installation of enclosed fire-resisting staircases, adequately ventilated and suitably sited, one or more of which could be entered only by way of a ventilated lobby.

Air-conditioning

Other items of concern to firemen in high buildings were the materials used for ceiling and wall linings, construction of partitions, etc., which above the height of 80 ft should be incombustible. One other matter that was adding complexity to fire-fighting problems in high buildings was the increasing practice of fully air-conditioning buildings. When this equipment was installed it should be insured that the controlled air movement was such that, in the event of a fire, smoke would not be drawn into corridors, staircases or other escape routes.

Earlier, Mr. Delve stated that the fire loss in 1959 in the United Kingdom and Eire was estimated at 44,179,000 pounds

compared with losses ranging between approximately 24 million pounds and 28 million pounds in the previous five years. Moreover, the loss in the first six months of 1960 had been nearly 27 million pounds, which suggested that the figure for the whole year might be even higher than in 1959.

He gave the following statistics of fires and occurrences attended by the London Fire Brigade in the London County Council area—1959:

Fires (other than grass or chimney) . . .	11,390
Fires, grass . . .	3,298
Fires, chimney . . .	3,617
False alarms—given with good intent . . .	3,703
False alarms—malicious . . .	2,925
Special services . . .	3,318

Total number calls attended . . . 28,251

(From 'The Surveyor and Municipal and County Engineer', 7th January, 1961)

The patient telephoned her dentist for an emergency appointment. "I'm in agony," she said. "I've got to get relief or go crazy."

Said the obliging dentist, "If you are having such pain, we could work you in this afternoon."

"Make it tomorrow," said the lady. "I'm going to a bridge game this afternoon."

A bad character was brought before the judge very often.

Once he did not engage an advocate to defend.

He was questioned by the Judge, 'you have no lawyer to defend you.'

He replied, 'No, my Lord, 'I have decided to speak the truth'.

SOME DETAILS OF SINGAPORE'S MERDEKA BRIDGE

A HIGHWAY bridge completed in Singapore in the period 1955 to utilized large precast piles and had other noteworthy features of design and construction. The photographs here reproduced, together with the data, were supplied to WORLD CONSTRUCTION by Mr. Placido O. Urbanes, Jr., the Editor of *Philippine Architecture, Engineering & Construction Record*, of Manila.

Foundations were designed from soil penetration tests to determine pile depth required for each of the 26 piers for this multi-lane bridge. Three standard B.S.P. pile frames 93 ft high were used.

Pile lengths of 60 ft and upto 80 ft were required. Safe handling of the long, slender piles was a problem met by rolling each pile from the casting bed onto long rail-trolleys

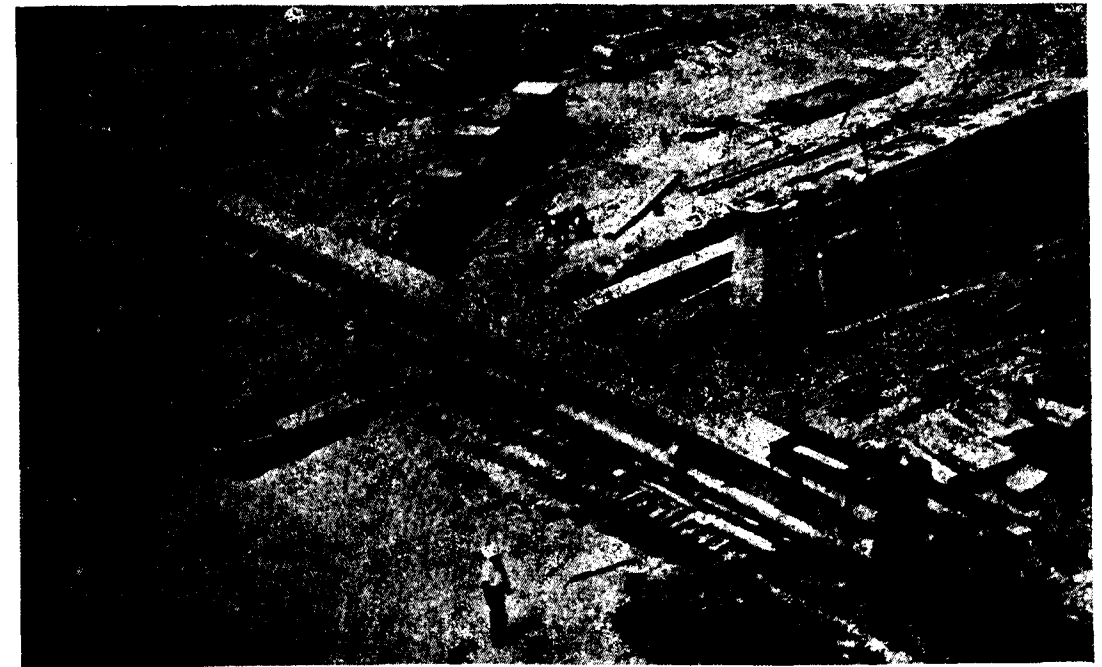
having a strongly reinforced frame. Each pile thus supported at 3 ft intervals throughout its length was carefully travelled to the pile frame. There it was lifted by means of a 5-point suspension using special slings and snatch blocks, plus a direct-lift cable attached to the lower end.

Full-scale loading tests were carried out for selected piles that had reached apparently satisfactory sets, to verify their safety and the reliability of pile-bearing computations.

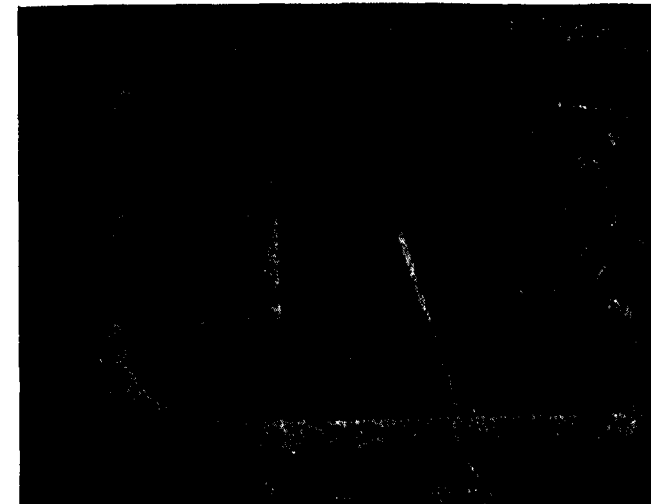
Eleven piers in the river section involved caissons. Each river pier caisson surrounded four pile bents. Caisson sinking under progressive concrete lifts was partially controlled by chain blocks, timber piles and guides. Some use of lateral jack pressure was necessary to keep the caissons true. A



Modern precasting methods marked the erection of this structure which today handles a high volume of motor traffic in the Singapore area



Rail transport of a precast beam is in progress here along the approach portion of the bridge



Caisson for a river pier has been sunk to final position and footing columns constructed for supporting the pier frames

50-ton surcharge load consisting of concrete blocks and water-filled tanks aided final settlement into the channel mud. The bottom was then cleaned, bottom precast plugs grouted in position, the foundation piles immediately driven and concrete up monolithically with the corners of the caisson.

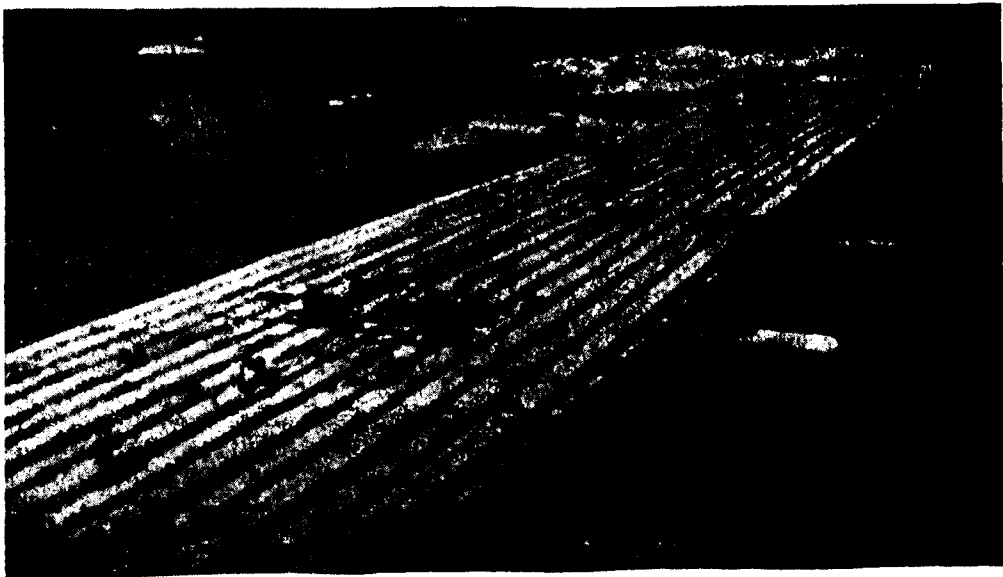
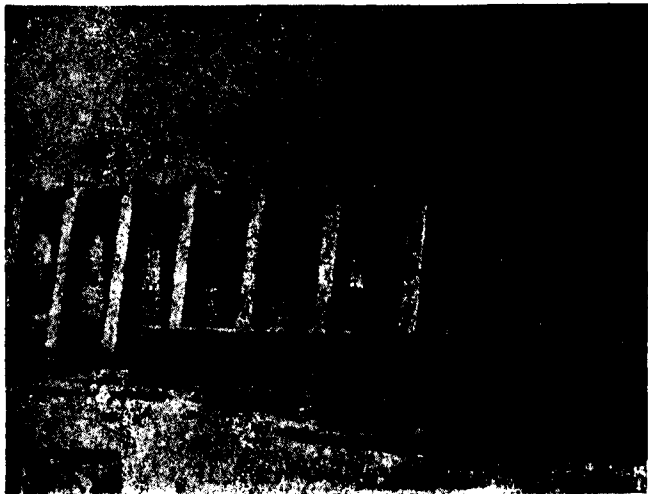
Piers included standardized precast concrete "A frame" units. These were cast well in advance of erection to permit thorough curing. Using mobile cranes the frames were set, levelled, aligned and grouted in, after which reinforced concrete sheathing walls and cap beams were cast in place.

The main deck beams of prestressed concrete, numbering 367 in all, were constructed on ten casting beds—seven located off one end and three off the other end of the bridge. Prestressing involved 1-1/8-in. dia. high tensile steel tendons in unitube sheathing.

Particular care was taken in the preparation, placing and sampling and curing of the concrete, so that all test results should be truly representative of the concrete actu-

ally in place in the beams. The concrete was placed at the two ends and in the centre and worked towards the quarter-points. Pneumatic vibrators were fixed on both sides of the shuttering at the level of the junction fillet of the bottom flange, and four sets of special long strip-vibrators were used by labourers working the concrete as it was deposited into the web and top flange. At least nine samples of test cubes per beam were taken from the mix at the beam-placing positions, three samples from each

The reinforced concrete A-frames, precast and set in position as part of standardized pier construction



The beams are all in position for the river spans and work in progress to grout between beams

end block and three from the centre of the beam.

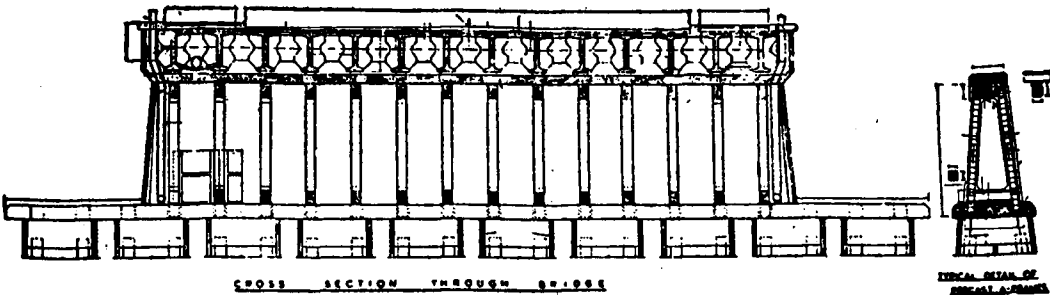
These three samples from each zone of the beam were taken at different levels: that is, bottom flange, middle of the web, and top flange. There were 17 cu. yd. of concrete in each beam, and placing and vibrating normally took 1 1/2 hours to 2 hours to complete, after which the top flange was covered with hessian and well-watered. Formwork was stripped after 18 hours and the fresh concrete protected from the sun and well-watered.

Post-tensioning involving gradual increments of loads on the stressing jacks up to 42 tons was done under full technical control. Neat cement grout was forced under pressure of 25-50 psi by hand apparatus to fill the unitubes and effect mechanical bond with tensioned tendons.

The 30-ton beams were moved from the casting yard on rail bogies along a temporary track, and set on the approach bank alongside towers placed at the bridge ends. Each beam was picked up with two 16-ton chain hoists and placed



Showing how beams were lifted into position



Cross-section of deck and detail of pier A-frames

(Continued on page 35)

ROADS IN REGIONS WITH ARTIFICIAL IRRIGATION

THE principal feature of regions with irrigated cultivation (Uzbek S.S.R., Turkmen S.S.R., Tadjik S.S.R., southern regions of the Kazakh S.S.R.) from the point of view of the operation of road structures is the unfavourable regime caused by the general rise of groundwater level due to irrigation and flushing of fields, the local increase of groundwater level when the roads pass near irrigation canals, and the flooding of ditches and borrow pits by flushing and irrigation waters.

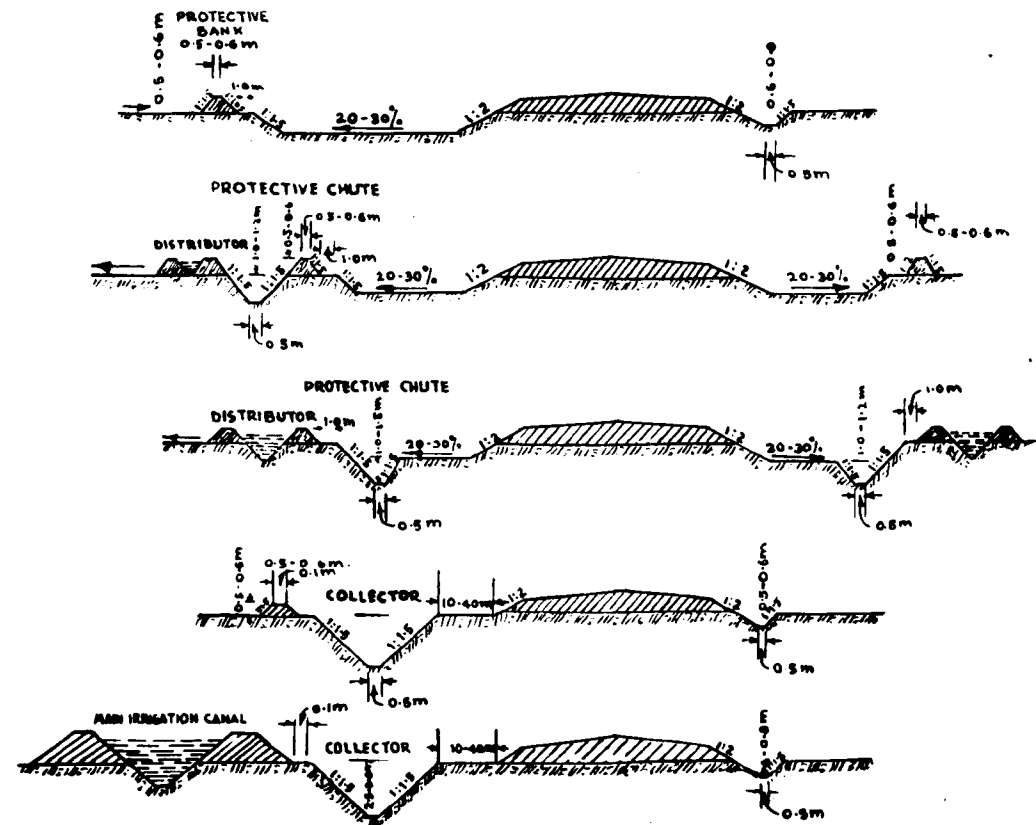
The main principles of designing and building roads in these conditions are :

- (a) protection of fill against possible sources of moistening by an additional raising above groundwater level ; widening of the borrow pits

and their protection against inflow- ing water from the fields ;

- (b) when the water from the fields may flow into the borrow pit—to collect the water at the outer edge of the borrow pit and divert it by ensuring the necessary cross fall at the bottom of the borrow pit and by the construction of protec- tive longitudinal gutters or chan- nels ;
- (c) for high groundwater level—lower- ing and preventing the rise of level by the installation of drains and collectors.

On the basis of these principles, recom- mended types of cross-sections have been



worked out for road beds in regions with artificial irrigation (Fig. on page 34) :

- (a) Cross-section with one-side borrow pit (at upper side) when the width of the right-of-way is limited ;
- (b), (c) cross-section with protective chutes (gutters) and soil banks when the road passes over irri- gated areas ;
- (d) Collector cross-section used for high ground water level and combi- nation of road and irrigation work ; the fill in this case is built with the help of an excavator, the borrow pit being combined with the drain (collector) ;
- (e) Cross-section used when road passes near main canal ; the collec- tor serves for drainage of infiltrat- ing waters.

The requirements for elevation of the edge of the road bed are usually the same as for saline soils. At low places with

possible flooding of the borrow-pits by atmospheric and irrigation waters, and also on rice fields, the fill height above ground level must be at least 1.2 m. For seasonal fluctuations of groundwater level, the high- est possible level is taken for calculations when designing the road bed independent of the season of its appearance and duration. In this case it should be borne in mind that impermeable black pavements built in regions with artificial irrigation where the traffic intensity is high in the agricultural seasons, limits the evaporation. The moist- ening therefore of the upper layers of the road bed with capillary moisture is danger- ous for the road even in the hot summer months, when the fields are being irrigated.

(Extracts from the report of the U.S.S.R. in Question IV—Low Cost Roads—of Section 1—Design, Construction and Maintenance of Roads and Runways—of the XI Congress of the Permanent International Association of Road Congresses held at Rio De Janeiro in year 1959.)

(Continued from page 33)

on a timber bridge piece spanning between tower and pier top. The beam was then moved transversely into position and lowered onto its seats. The beams seated on a rocker and a fixed bearing.

The yard at one end was used at the last to fabricate 74 beams which were taken across the completed deck for spans at the other end. This procedure utilizing rails was made necessary by unexpected founda- tion settlement under the casting beds.

Transverse post-tensioning was done for

each span using unitubes and grouting, and the cast-in-place portion of the deck then constructed. Tensioning was done simul- taneously from either parapet, working progressively from the end to the centre of the span, and omitting alternate tendons for later tensioning.

Edge beams, curbs, electrical duct, con- crete deck, and lighting completed the structure.

(From 'World Construction,' September, 1960)

HERE AND THERE

1. HOW TO MAKE TIRES LAST LONGER

● MODERN earth movers are equipped with large tires that have boosted haul road speeds and cut the costs of off-the-road operations. The economy and productivity possible with these tires, can be lost however unless common sense rules are followed to prolong tire life. So observes International Harvester Company's Construction Equipment Division Service Department, which notes that the key to proper tire care is a daily tire inspection. Emphasis should be on the following points:—

1. Inflation should be inspected with a low-pressure gauge, marked in one-pound gradations, in the mornings when the tires are cool. Should a tire be found considerably under-inflated, the vehicle is not to be operated until the cause of the air loss is located and repaired.

Under-inflation causes rapid wear on the outer edges of the tread. Also the excessive flexing results in building up of internal heat. Blow-outs frequently result.

Continued under-inflation leads to radial cracks, while over-inflation causes rapid wear at the centre of the tread and often brings side wall breaks, the result of impact loads.

Should pressure build up during the day, it is advisable not to bleed tires, as the added pressure automatically compensates for the additional heat by preventing side wall flexing, which would generate more internal heat.

2. Inspection should be made for cuts which penetrate to the cord body. If cuts



These radial cracks were caused by under-inflation



Small cuts in the cord body spread rapidly



Small cuts in the cord body spread rapidly

are not repaired immediately, they will spread quickly. Shallow cuts should be skived with a knife or bullnosed rasp to prevent small stones from becoming imbedded and working through the cords.

3. Rims and flanges should be checked for damage. If tires are dismounted for repair, it is recommended the rims be cleaned and painted to make mounting easier and to prevent rust damage. All oil or grease found on rim assemblies should be removed, as this material causes rubber to deteriorate fast. Therefore, it makes good sense not to park a vehicle overnight on a greasy or oily spot.

4. *Dual Tires.*—Caked mud and rocks should be removed from tires, and especially from between rear mounted duals. If uneven tire wear is detected, the cause should be located and corrected as soon as possible.

Mismatched tires on dual assemblies result in unequal load distribution, with the new, larger tire wearing rapidly and the smaller tire usually scuffing severely.

This situation can be avoided by mounting tires on the same diameter on dual



Blow-out was caused by continued over-inflation

assemblies. If it is necessary to use a slightly smaller tire, it should be placed on the inside position.

5. Tire life and job costs are affected greatly by conditions of haul roads. Roads that are well designed and sufficiently maintained may double or even triple haul speeds, thereby drastically lowering dirt moving costs.

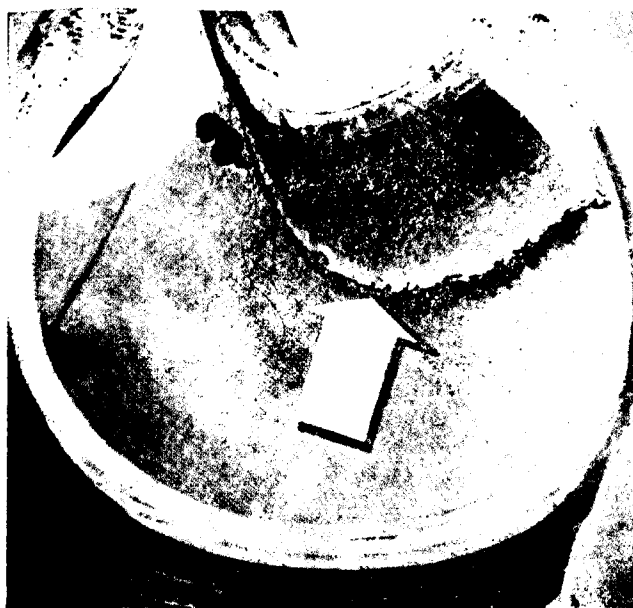
Steep grades and sharp turns mean slippage, which shortens tire life. Loose or embedded rocks increase the possibility of damaging cuts and jolts. Shocks and impacts resulting in down time or minor problems on smooth haul roads.

6. Proper storage of tires is all important. Tires and tubes stored under the wrong conditions can age more quickly than those in daily service. Light, heat, oil, dust, dirt and moving air all are responsible for deterioration.

The following four steps are important:—

Store in a cool, dry, dark area, one protected from the wind. Cover tires with tarpaulin, if such an area is not available.

Do not store tires in the same area with gasoline or lubricants. Even lubricant



Typical flex break caused by overloading the tire



Skive out area to prevent stone from penetrating cords



Deterioration caused by oil or grease



Obstructions should be removed from between rear-mounted dual tires

vapours can be absorbed by the rubber, with rapid deterioration resulting.

Pile tires on a wood foundation to keep them off dirty, oily floors. Keep the same sizes together, and never place a large tire on a smaller one.

Tires stored outside always should be protected with a waterproof covering. It is essential to keep water and oil from the inside of the tire casing. A certain method of preventing this is to mount the tires on a wheel, with air pressure reduced 50 per cent. The entire assembly then should be covered with tarpaulin.

These steps are recommended for long storage periods, and for those of comparative briefness.

7. There also is a best time to buy tires—in the fall or early Winter—for longer tire life. The cooler the tire runs, the longer it will last.

Tires that have run all Winter have thinner treads than new tires and, therefore, run cooler. New tires with heavier treads run hotter, wearing down about 30 per cent faster.

8. A careful watch on overloading is a must. A 20 per cent overload, for example, drops expected tire life by 30 per cent. The ratio continues, until 100 per cent overload only 25 per cent of normal tire life can be expected.

(From 'World Construction', April, 1961.)

2. 5-YEAR ROAD PROGRAM FOR PAKISTAN

● PAKISTAN plans to spend (U.S.) 114 million dollars for highway development in its Second Five-Year Plan (1960—65). The Government has programmed 52.5 million dollars each in East and West Pakistan and 9.4 million dollars in Karachi and other special areas.

In West Pakistan, according to the International Road Federation, about 850 miles of new roads and improvement work on 250 miles of existing roads will be completed at a cost of 19.3 million dollars. The

bridge over the Indus River near Thatta and certain other smaller bridges will also be finished.

The plan for West Pakistan includes construction of 450 miles of road along the Makran coast to be completed after 1965. Also planned is the building of 110 miles of the Kalat-Khuzdar section of the Karachi-Kalat-Quetta road.

(From 'World Construction', April, 1961.)

3. WHY WE NEED BETTER ROADS

● THIS is the title of a booklet issued by the recently formed Better Highways Information Foundation, Washington. Here are some of the reasons why:

Better roads affect you personally—vitally—and in many ways now.

You have a personal stake in better highways if you own a car, drive to work, drive to another town, or try to get clear of a crowded city on a Saturday afternoon to drive the family to the country.

You have a personal stake in better highways if you have children old enough to drive a car.

You and your family have a personal stake in the higher standards of living which better highways promote.

You have a personal stake if your firm or your farm ships or receives goods by highway.

You have a stake as a taxpayer for you are paying for new roads—and you are paying the higher cost of using inadequate roads.

Better highways are a sound investment now. They will save lives, time and money. They will save your time and money—Perhaps your life.

(From 'Better Roads' Journal of the New Zealand Road Federation, March, 1961.)

4. ROADING PROBLEM A COMMON DENOMINATOR

● IT is not without significance that Governments and organisations throughout the world talk a great deal about present and future problems concerning roads and traffic.

Throughout all of these proceedings are to be found ideas, suggestions and, indeed, strong convictions about what should be done to improve conditions. Strange as it may seem, these expressions strike a common chord in almost every country so that by substituting place names, mileages, cost and traffic figures, the story of each nation's roading situation is a repetitive process.

This all adds up to the fact that we can derive much information and help from the common experiences of other people when it comes to the all-important issue of what should be done in our own circumstances.

Here are some of the statements made and views expressed in the British Parliament last year during a debate on road traffic views that were based on conditions in the United Kingdom—not New Zealand.

It was estimated that accidents put 200 million pounds on administration and insurance costs.

The Government would make an attempt to tackle some of the problems associated with the five major trunk roads, but would leave, virtually unsolved, the biggest problem of all—that of urban congestion.

There must be continuity of planning.

The problem was not merely one of getting from city to city. It was what to do when you got to the congested urban areas.

The local authority associations and individual highway authorities have asked

to be given as much advance information as possible about road projects. I think they ought to be given as much information as we can give them. Before the end of this year we hope to send these highway authorities lists of schemes for the next three years.

It is utter folly to expect a local authority to plan annually.

He was astonished to see how much interest was being generated in off-street parking.

Heavy trucks did not cause congestion. They may cause momentary congestion, but most of it is caused by private cars and we have to face the fact that if people want private cars, we must provide as many roads for them as we can afford.

I ask the Ministry to clean up these very stupid notices on the roads and make them more effective (referring to notices no longer applicable).

It would be quite wrong artificially to introduce some kind of diversion to persuade or to direct people to use the railways rather than the roads. After all, this was a free country. What they wanted to see was a highly modernised road system and a highly modernised railway system. Let a person take his choice of the two in transporting his goods.

It may be, of course, that any similarity to what is being said in New Zealand on some of the points is purely coincidental.

(From 'Better Roads, Journal of the New Zealand Road Federation', March, 1961.)

5. ACCURATE ATOMIC CLOCK

● AN atomic clock so accurate that its maximum error would not exceed one second in 1,271 years has been developed for the American Air Force. The 62.5-pound (28 Kilogram) device, expected to become operational next year, gets its power and precision from small amounts of radiation. It can be used in laboratories—replacing

present-day 600-pound (270 kilogram) equipment—as well as in air and space craft for communications, navigation and other complex operations. The clock is known officially as an Airborne Atomic Frequency Standard.

(From 'Engineering News of India', May, 1961.)

6. A SCAMMELL CONSTRUCTOR ON FLYOVER PROJECT

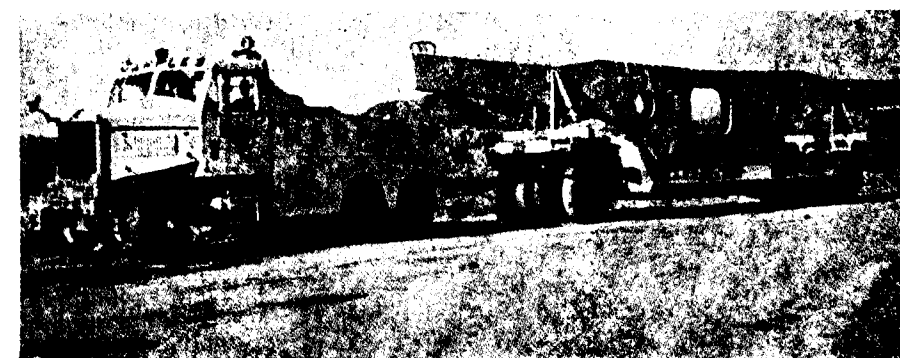
● A NEW Scammell Constructor 6 × 4 tractor has been helping in the construction of London County Council's Hammersmith Flyover. Purchased by Marples, Ridgeway and Partners Ltd., it is operated in turn with two-crane low loading trailers, delivering the first of the 420 precast concrete beams which will form the 1,000 yards of elevated road.

The beams weigh upto 60 tons each and are 26 to 59 ft in length and 6 ft 6 in. to 9 ft in depth. They are cast at Heston and transported 8 miles to the site.

when restarting against a gradient. A separate hand-operated reaction valve in the cab controls air to the trailer brakes only.

Accommodation is provided for 2 crew in addition to the driver in the coach-built cab. The driver's seat is of the bucket type with independent vertical and horizontal adjustment. Steering is air pressure power assisted, providing very light operation and ease of control when manoeuvring for loading and unloading.

The trailers are of two different types—one



Powered by an 11.1 litre Leyland 161 b.h.p. 6-cylinder diesel engine, the constructor is fitted with a Scammell 6-speed gearbox and 2-speed transposing box, giving 12 forward speeds. Each of the Scammell double-reduction epicyclic axles forming the rear bogie is individually driven by a separate propeller shaft.

Air pressure power braking operates on all wheels, including those on the trailer, from the foot pedal and a lever on the steering column, the latter being most useful

mounted on 16.00-20 in. tyres having a payload capacity upto 60 tons, and the other, a 30-ton model, on 14.00-20 in. tyres. The deck length in both cases is 22 ft and each is fitted with a bolster at front and rear carrying adjustable struts for retaining the cantilever beams in position. Two trailers are employed so that one can be loaded whilst the other is delivering to the site.

(From 'Highways and Bridges and Engineering Works', February 1st, 1961.)

LIST OF APPROVED WORKS ON NATIONAL HIGHWAYS

S. No.	Job No.	Name of the work	Amount (Rs in lakhs)
ANDHRA PRADESH			
1.	2538-AH-7	Construction of a high bridge in place of an existing causeway across Palmakola river in mile 18/4 of Hyderabad-Kurnool Road, N.H. No. 7.	2.15
2.	2542-AH-7	Widening the B.T. surface to 22 ft in miles 32/6 to 57/0 of Kurnool-Gooty section of N.H. No. 7.	3.91
3.		Nine works each costing less than 2 lakhs ...	1.10
ASSAM			
4.	2558-AS-37	Remetalling and surfacing certain miles in between 136 and 145 of Assam Trunk Road East, N.H. No. 37 in Devagaon sub-division.	3.46
		Two works each costing less than 2 lakhs ...	1.89
MADHYA PRADESH			
6.	2537-MP-3	Improvement to existing culverts in miles 122/8 to 153/8 of N.H. No. 43 in Dandakaranya area.	1.56
7.	2548-MP-26	Widening and blacktopping metalled width to 12 ft and formation to 38 ft, miles 66/0 to 88/0 of Narsinghpur section of N.H. No. 26.	6.95
MADRAS			
8.	2540-MD-4	Reconstructing and strengthening the existing culverts in miles 5/0 to 54/0 of N.H. No. 4.	2.24
9.	2563-MD-46	Reconstruction of a bridge across Agaram river at mile 10/5 of Ranipet-Krishnagiri Road, N.H. No. 46.	8.60
10.		Four works each costing less than 2 lakhs ...	2.65
MAHARASHTRA			
11.		Three works each costing less than 2 lakhs ...	4.11

S. No.	Job No.	Name of the work	Amount (Rs. in lakhs)
MYSORE			
12.	2562-MY-4	Improvements to Tavadighat in miles 172/0 to 173/5 of Poona-Bangalore Road, N.H. No. 4 near Nipani in Mysore State.	2.20
13.	2565-MY-4	Improvements to Hairpin curve in mile 224 of Poona-Bangalore Road, N.H. No. 4 in Belgaum Distt.	2.12
14.		Two works each costing less than 2 lakhs	1.73
ORISSA			
15.		Seven works each costing less than 2 lakhs	6.82
RAJASTHAN			
16.	2547-RJ-8	Improving miles 8 and 9 (Ghat section) and providing retaining walls in high banks Udaipur-Nathdwara Road, N.H. No. 8.	2.32
UTTAR PRADESH			
17.	2543-UP-24	Widening the road to two-lane in Garhmukteshwar-Muradabad section of N.H. No. 24 (miles 59/0 to 66/6).	5.75
WEST BENGAL			
18.	2564-BG-34	Construction of minor bridges (about 20 ft span) in Berhampur-Raghunathganj section of N.H. No. 34.	3.91

A visitor in the back areas of New England stopped at an antique shop and was amazed at the collection of snuffboxes. "I've never seen so many snuffboxes," he said.

"Yes," the proprietor replied, "they were handed down to me from my grandmother."

"Oh, your grandmother took snuff?" the visitor asked,

"No, just snuffboxes."

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who
know

buy Springs
with
confidence

In actual service Canara Springs have always given a good account of themselves. Made from the best material and tested carefully before despatch, the springs inspire confidence in users. The consistent quality is a guarantee of permanent satisfaction. Canara Springs create and maintain confidence as the best

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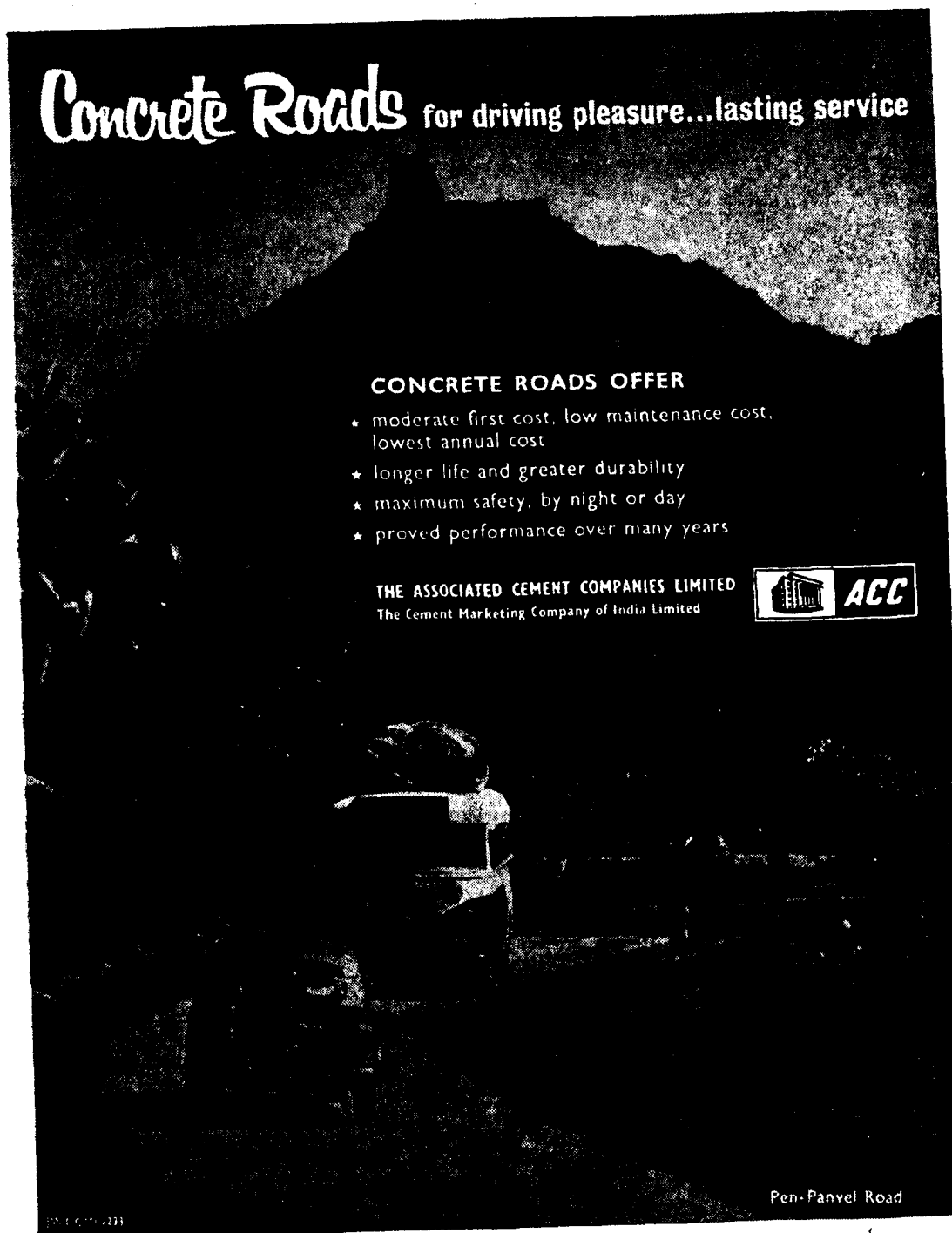
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The power-packed Ashok Leyland Comet tractor combines with the "Gama" Semi-Trailer manufactured by Mahindra Owen Private Limited to offer you these unique advantages:

1. Carries 11 tons, at no extra fuel or running cost per pound.
2. Negotiates easily sharp bends and steep gradients because its turning circle is about half that of the normal two-axled vehicle.
3. If you have two trailers for each tractor, one can be on the move while the other is being loaded. You save the time wasted between the loading operations.

As its weight is distributed over three axles, the Ashok Leyland Comet tractor-trailer unit is easy on the roads.

Ask for further particulars from our dealers

ASHOK LEYLAND COMET

-precision built to give lasting service

ASHOK LEYLAND LIMITED

Ennore, Madras



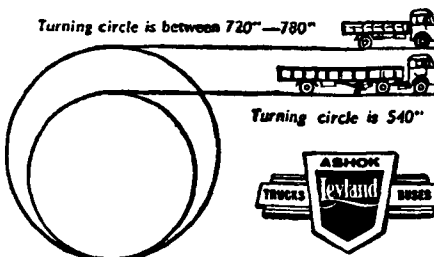
Carries 7 1/2-ton payload

Carries 11-ton payload



A trailer carries the goods

Meanwhile the other is loaded



Turning circle is between 720"—780"

Turning circle is 540"



JWT/AL-1234a

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vii



In 1660, it took Shahjehan
five days to travel
from Delhi to Agra...

Today, by road, it takes 4 hours! Because today's modern asphalt highways are engineered for safer, more comfortable and quicker transport. These asphalt roads last longer, ride safer and provide more miles of wider roads for less money. It is not surprising therefore that Caltex Asphalts are increasingly used to build modern highways stretching like giant ribbons across the country. Also used for roofing, battery boxes and many other items. Write for Caltex Technical Service and Advice.

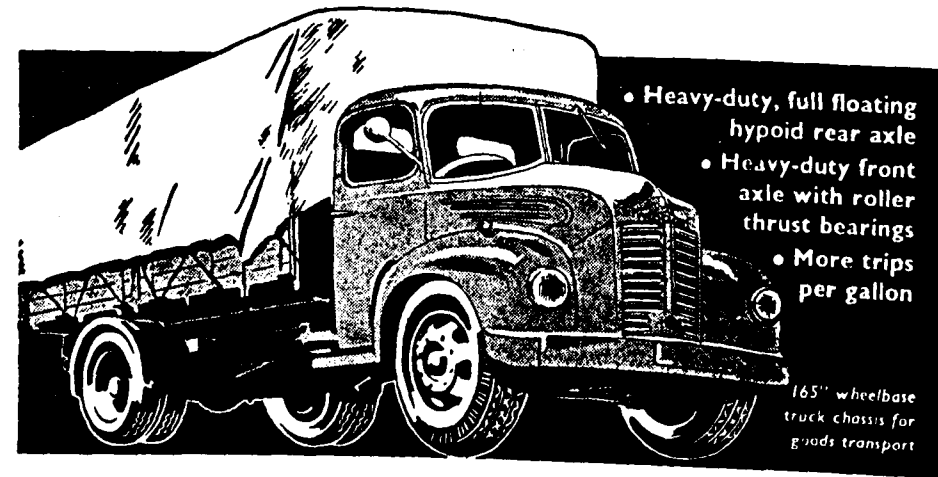


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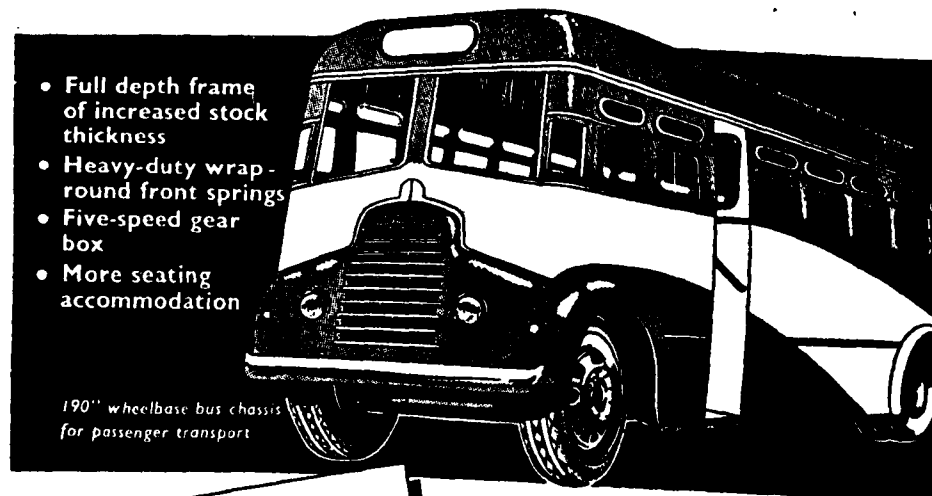
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viii



DODGE

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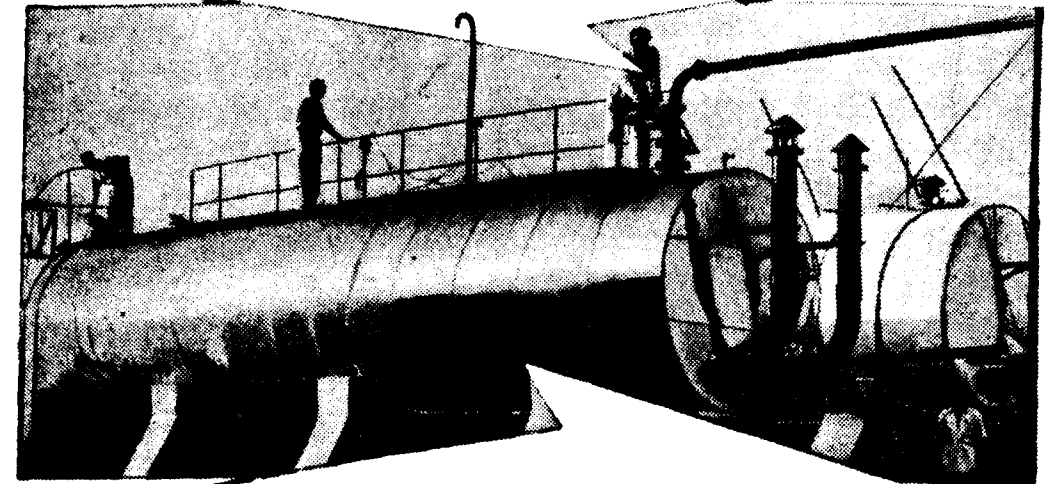


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AGRIND FABRICATIONS LTD

for Burmah Shell, the first marketing organisation to make easier distribution of Bitumen, which, until the other day, came to market in drums. Agrind Truck Mounted Tar/Bitumen Distribution Tankers, by their time-saving mechanical handling, help wider, quicker and economical supply of Bulk Bitumen.



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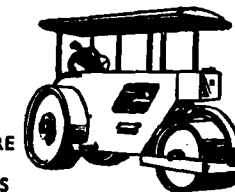
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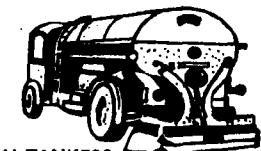
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AGRIND-MOORE
DIESEL
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BITUMEN
DISTRIBUTION TANKERS
Capacity—750 gallons to 1500 gallons.



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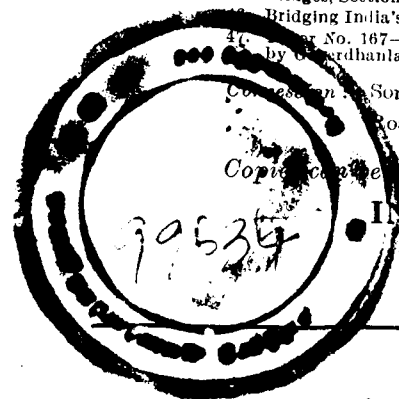
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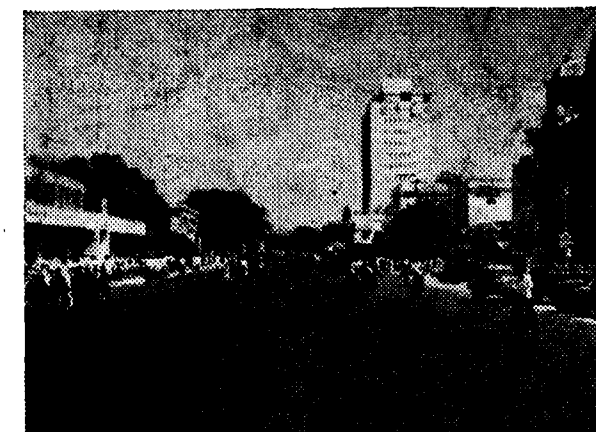
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